Overview of “Assessment of the Extra Capacity of Alternative Energy Electrical Power Systems to Completely Replace Fossil Fuels”

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by
Bernie McCune

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Opening Comments

- This is a huge document and I will only be hitting some of the main points

- If you are really interested, use the address on the previous page to download the 80+Meg document and take a look for yourself

- The Abstract and the first 200+ pages will give you an interesting but incomplete overview of the issues

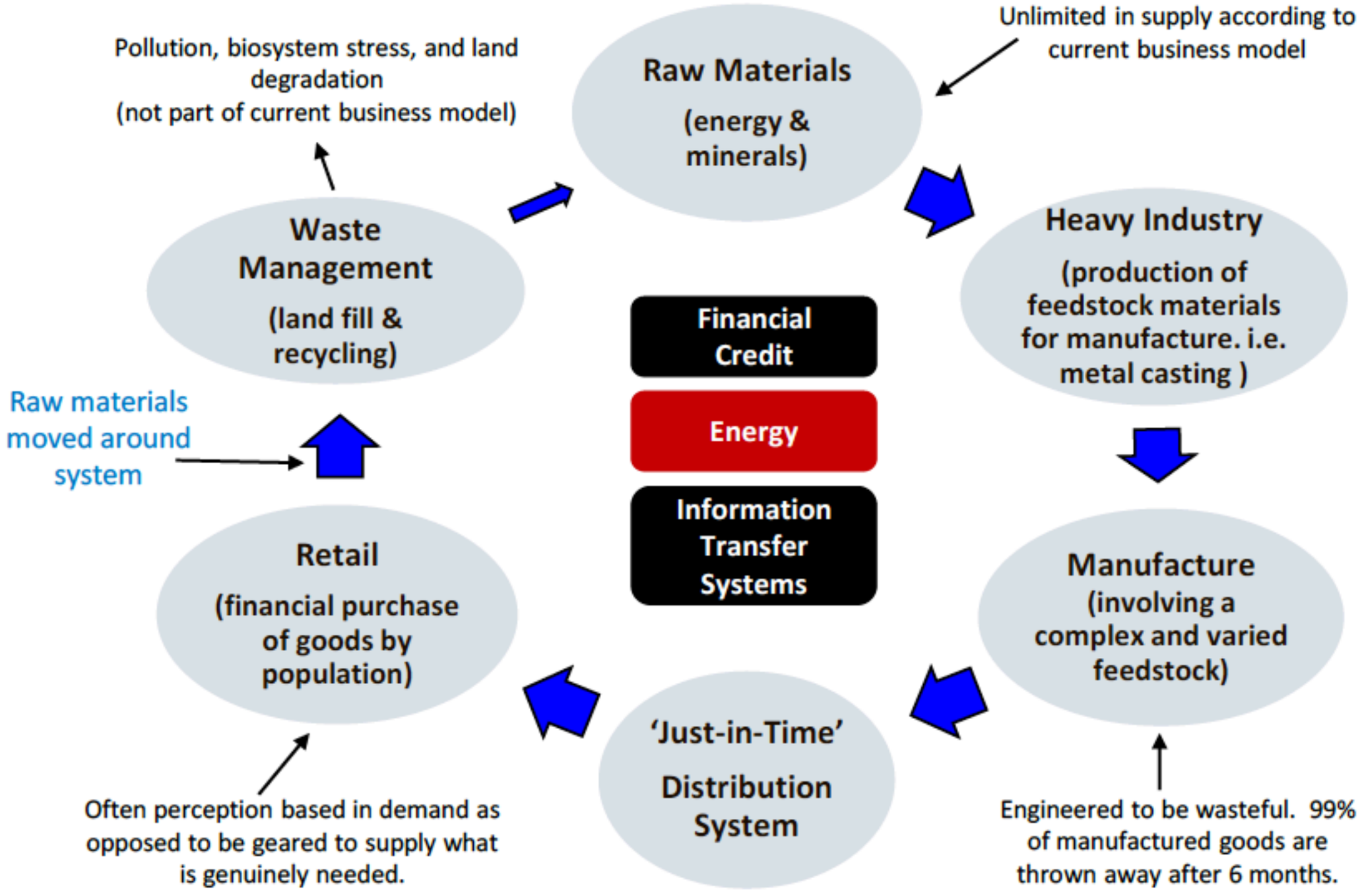
- Contrary to what the Net Zero folks might think, the issues and the process of getting rid of fossil fuels are very complicated and will take much time and money to resolve the transfer to alternatives

A Very Deep Dive into Energy

Energy is the master resource

Energy is the master resource. It allows and facilitates all physical work done, the development of technology and allows human population to live in such high density settlements like modern cities. Energy consumption correlates directly with the real economy (Bradley and Fulmer 2008). The real economy, which is the part of the economy that is concerned with actually producing goods and services, as opposed to the part of the economy that is concerned with buying and selling on the financial markets. Future projections of global energy demand are usually developed on past behavior, with no understanding of finite limits or depleting resources. Generally, reserves have been projected on by past production and demand has been defined by population growth and economic GDP.

A Simple Model of the current global industrial system



Objective of this Report - To focus on the requirement of minerals

- This requirement has been completely ignored and is of fundamental importance in the attempt to make changes in our energy needs

- In just 18 years (2000 to 2018) the production increase of industrial minerals has been 144%

- In order to “ramp up” the numbers of alternative energy requirements, real numbers of eVs, solar and wind systems and battery requirements must be known so that realistic mineral requirements can be learned

- Lead time for obtaining actual sources of ores can be long when developing 1000 sources of minerals can find only 2 real (producing) ones

This author believes Human caused Global Warming is a real issue

- At least it is a factor in all his calculations and projections
- As most studies do, his effort is to have some sort of resolution by 2100 (or at least hope for that)
- My thought, let’s not put any less than a 200 year limit on resolving our future energy issues
- This will allow for unforeseen solutions to pop up in the next 100 years and give us a chance to develop and transition to them in plenty of time

Most Studies have seriously underestimated the size and scope of the task at hand

- The number of vehicles in the global transport fleet
- The number of lithium batteries to be manufactured
- Extra power production capacity that will be required in the future
- The capability for renewable power generations system to replace fossil fuel power generation systems
- The time required to develop, construct and commission a non-fossil fuel industrial ecosystem
- The current industrial and economic dependency on fossil fuels (oil, gas, and coal)
- Long term and medium term reliability of the fossil fuel industry

And the Big Questions

- Are Solar and Wind Systems with Li-Battery backup the only Alternates “Out There”?
- Should we be looking a bit out of the box?

The first half of this report will attempt to answer the following questions:

- How much of each of the fossil fuels is consumed at a global scale, EU scale, US scale and Chinese scale?
  - How is the existing industrial ecosystem dependent on them?

- What applications are those fossil fuels used for?
  - Quantify each application in context of its replacement.

- How many cars, trucks, ships, trains & aircraft are there, and what do they do?
- How many batteries will be needed?
- How many hydrogen cells will be needed?
- How much extra electrical power capacity is required to phase out fossil fuels completely?

Continued

- What are alternatives to fossil fuel power generation?
  - What quantity of those alternatives is required to arrange a successful complete replacement of fossil fuels?

- How many new power stations will be needed and of what kind?
- Could biofuels contribute?
- How many solar panels will be needed?
- How many wind generator turbines will be needed?
- What quantity of minerals will be needed to do this?

Six scenarios and the pertinent calculations will be presented (using a 2018 scope of operations):

- Scenario A – phase out ICE and substitute with EV (Section 18)
- Scenario B – phase out fossil fuels completely are replaced with non-fossil fuel power and EV's (Section 23)
- Scenario C – phase out ICE and substitute with hydrogen cells (Section 20)
- Scenario D – phase out petroleum as a fuel and substitute with biofuel (Section 22)
- Scenario E - phase out fossil fuel power generation and substitute with nuclear power (Section 25)
- Scenario F – A hybrid solution based on the learnings of A-E (Section 26)

There are huge amounts of real data in this report and lots of clever ideas about solving our energy problems

- It is well worth digging very deep into this report

- The graphics are “in your face” especially when it comes to the influence of China and India on our energy requirements (over the past few decades and into the future)

- By slowing the energy crisis down some, we should be able to continue to expand the global economy as well as bring the poorer global population into the middle class

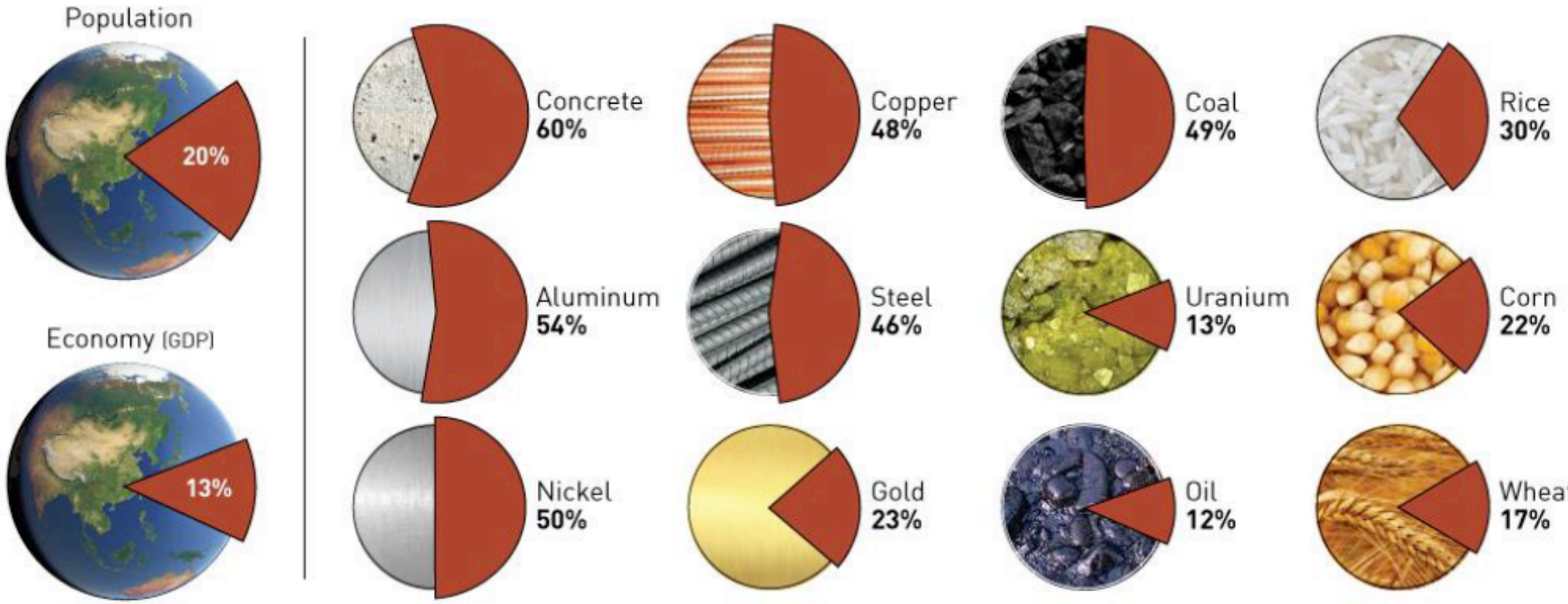


Figure 3.16. Chinese consumption of natural resources in 2015 as a fraction of global consumption
(Source: visualcapitalist.com) (Copyright: https://www.visualcapitalist.com/frequently-asked-questions/)

Figure 3.16 shows the market share of global consumption of raw material resources. As can be seen China consumes enough raw materials and dominates enough heavy industry (steel and cement production are proxies for this) that Chinese industrial output could be considered as a proxy for the global industrial market.

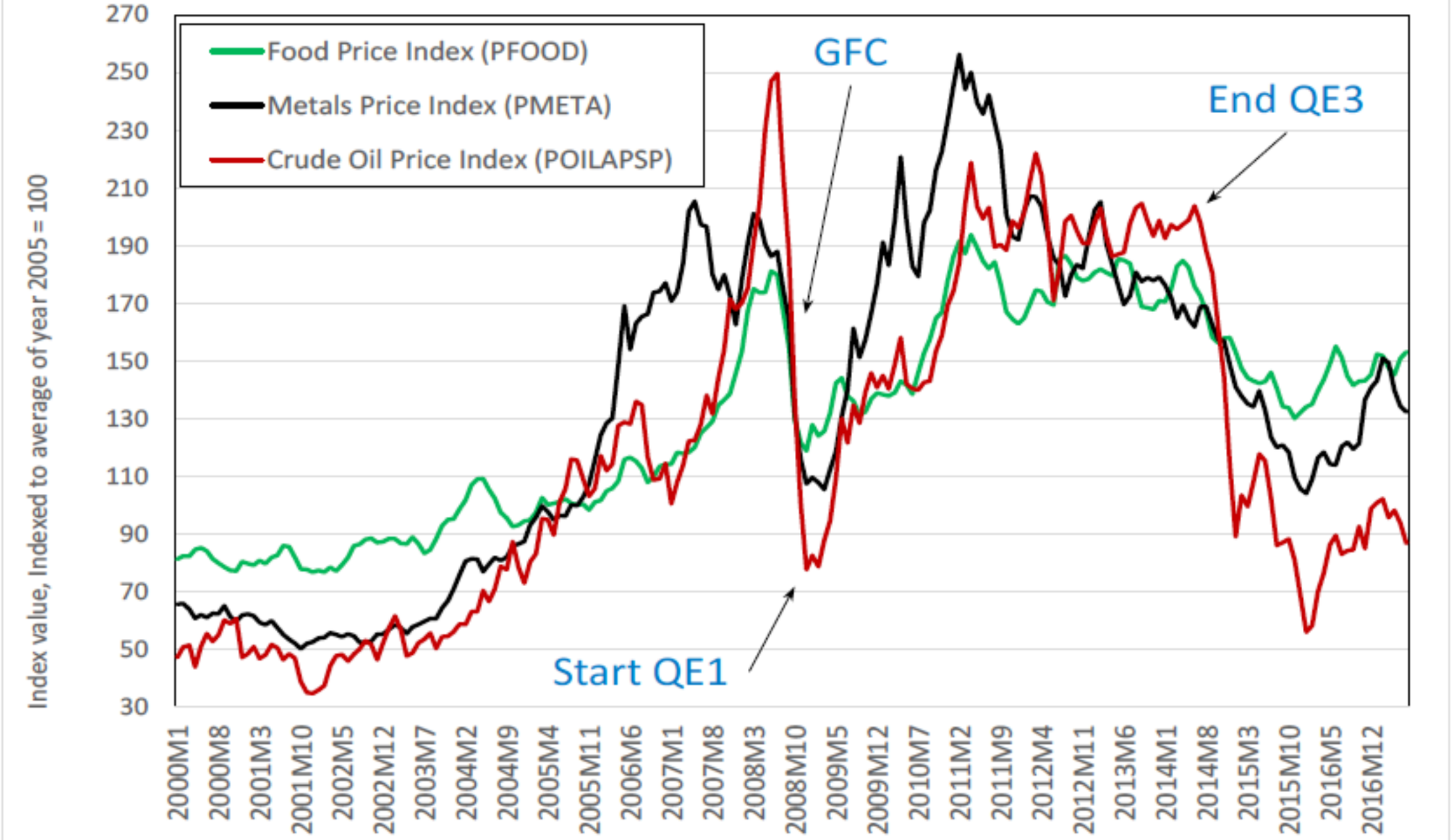


Figure 3.12. Correlation between global food price, metal price and crude oil
(Source: IMF Primary Commodity Price System, http://www.imf.org/external/np/res/commod/External_Data.xls)

GFC: Global Financial Crisis of 2008

QE1: Quantitative Easing Stage 1, the creation of $USD by the U.S. federal Reserve to mitigate the GFC

QE3: Quantitative Easing Stage 3

About 100 pages “in”

- Section 5 Energy Flows in Major Economies
- Section 6 Energy Returned on Energy Invested (ERoEI Ratio) of Energy Resources
- It gets to the point where you can just play around looking at the data
- Section 7 Predicted Future Demand for Energy is fairly speculative and probably just fun to do but we probably need to put a better “rope” around our guess at 200 years to have the alternates in place

About 200 pages “in”

- Section 10 Fossil Fuel Dependency to Manufacture Plastics is another fun subject. Bill Gutman may give us a presentation on the potential harm that micro plastics are to the environment. There is a little of that in this report.

- Section 11 Fossil Fuel Dependency of Industrial Agriculture. Both these subjects make a case for turning from FF energy production to a chemicals base for Sec 10 & 11.

- Environmental and Population Issues cannot be forgotten but if we can mostly resolve the Energy issues perhaps we can look at these very real human effects without any climate baggage

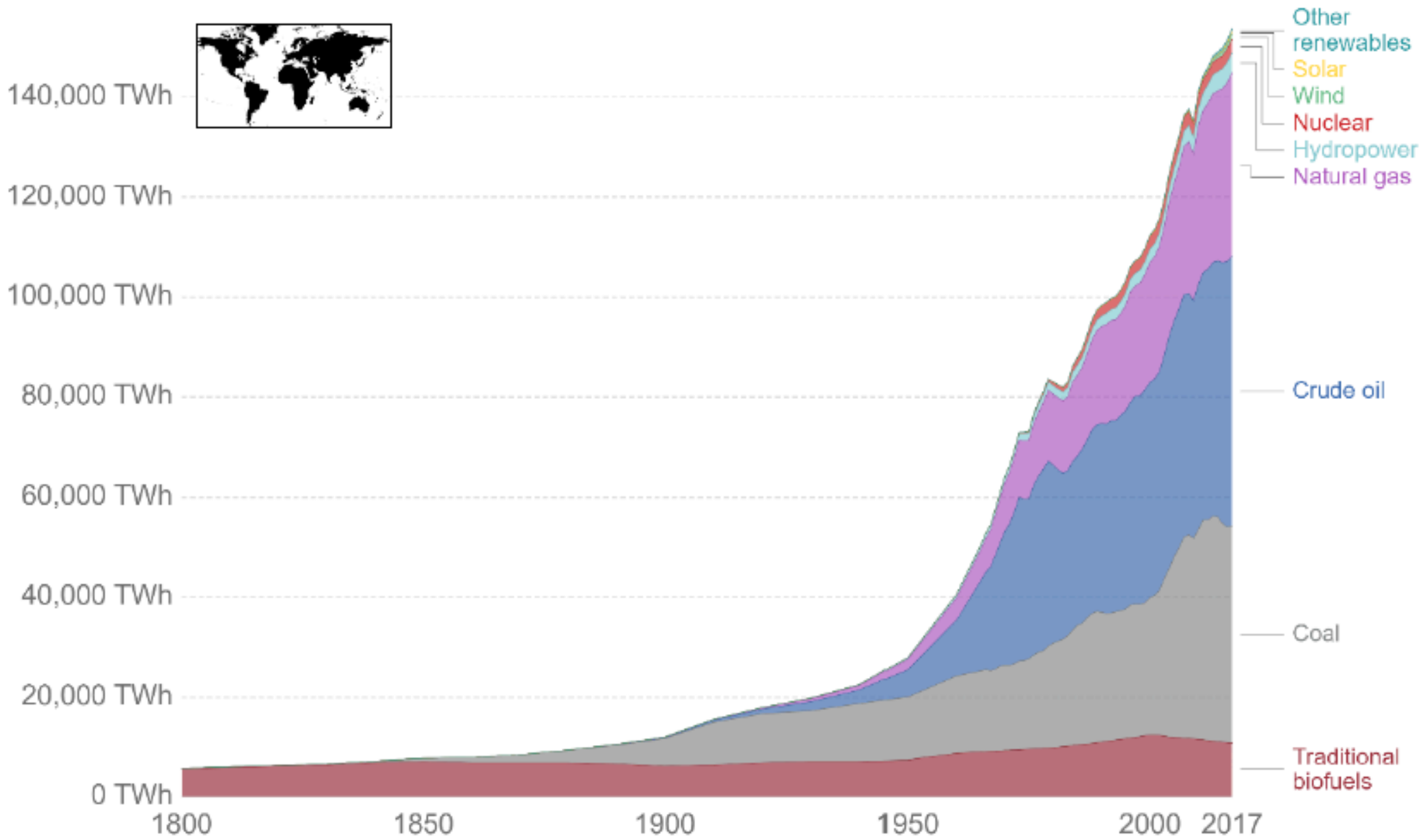


Figure 9.1. Global Primary energy consumption. Units measured in terawatt-hours (TWh) per year. Classification 'other renewables' are renewable technologies not including solar, wind, hydropower and traditional biofuels.
(Source: Our World in Data, BP Statistical review of World Energy 2018)
(World Map Image by Clker-Free-Vector-Images from Pixabay)

More than 1/2 way through

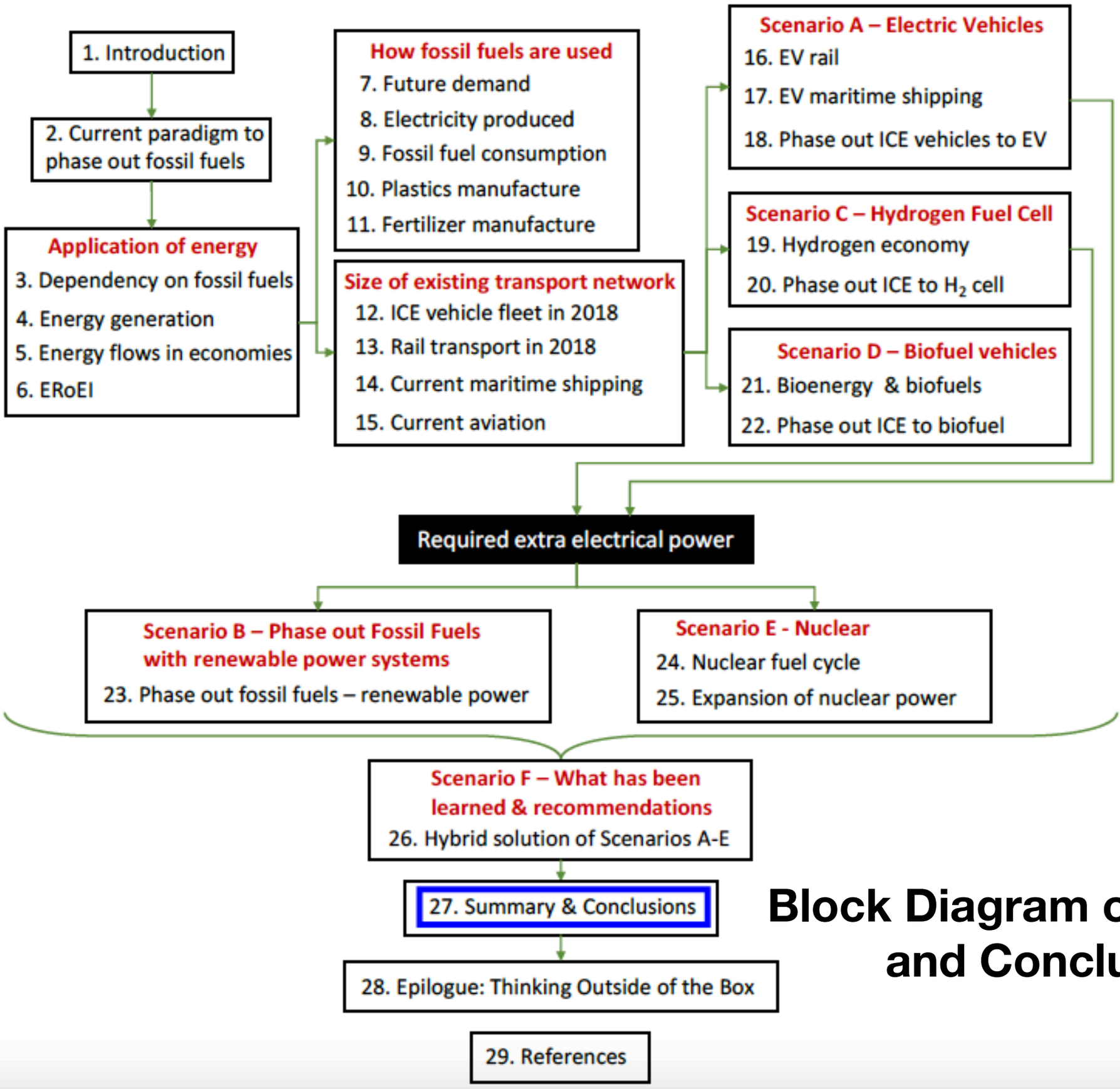
- Hydrogen and Nuclear Energy elements are explored. These may turn into some solid alternates (or not).

- Re-look at Coal and Wood Pellets as viable alternates

- And then Hybrids

- And Finally Summary and Conclusions

- And Epiloge



Block Diagram of Summary and Conclusions

This report emphasizes that every developed economy around the World is highly dependent on fossil fuels, which in turn is linked to industrial activity, economic GDP, food production. A case has been made that the price of oil, in particular, correlates with global economic downturns, as well as other geopolitical events. The Food Index, Metals Index and Crude Oil Index (as measured by the IMF and World Bank) all correlate strongly and are therefore interdependent. Furthermore, since 1980, changes in Chinese industrial output also correlates with changes in the oil price.

It is also clear that the growth in consumption of fossil fuels (energy) correlates strongly with global human population growth, and with increasing sophistication in technology, the amount of energy needed per capita has increased along with it. Thus, it is clear that each individual in the human population has been consuming more and more energy with each passing year.

Some Conclusions

- **The task to phase out fossil fuels is much larger than the current paradigm allows for**

- **Current planning for the phasing out of fossil fuels has significantly underestimated the size of the task**

- **Biofuel and Biomass are needed but cannot be scaled-up (Scenario D)**

- **Nuclear will be needed but cannot replace fossil fuel power generation (Scenario E)**

- **Non-fossil fuel systems may not be effective enough to replace fossil fuel systems**

Some Challenges

Challenge 1: Not enough time to meet construction targets

Challenge 2: Sourcing enough minerals to supply manufacture of renewable technology

Challenge 3: Developing enough power storage to manage intermittent power supply

Challenge 4: Finding enough new sites for hydroelectric power plants

Challenge 5: Phasing out petrochemical fertilizers, herbicides, and pesticides

Challenge 6: Human population growth

Epilogue - Thinking Outside the Box

This report has shown that the phasing out of fossil fuels will probably not go to plan or be sufficient for our needs to build a new industrial ecosystem to match the existing system.

The current industrial ecosystem dependence on fossil fuels, oil in particular, could soon become unreliable due to the challenges facing the oil and gas industry (Michaux 2019). Conventional thinking will be insufficient, and the human propensity to innovate in the face of adversity is now needed. Necessity is the mother of invention. The ideas presented in this section (Section 28) have historically been the subject of intense debate and often not accepted. Now is the time to consider unorthodox ideas once again for industrial problem-solving.

The strategic tasks before us now

-all in a short time-

- Rebuild the fossil fuel energy system and supporting infrastructure in a few decades
- Mitigate climate change
- Rehabilitate arable land that has been degraded with improper application of industrial agriculture, by reestablishing the soil food web in whole geographical regions.
- Remove plastic pollution from the ocean
- Reverse ocean acidification
- Revegetate large regions of the planet, to reestablish the natural biodiversity of flora and fauna.

Let’s Really think outside the box

- The previous Epilogue was about the author’s ideas - still somewhat inside the box
- Let’s really look at the real issues - not human caused climate change or trying to decrease atmospheric CO2
- Start looking for better and more refined alternatives and begin to develop them
- . . .and not get in a big hurry
- Still this report has some very good ideas, is a cautionary tale and has tons of data (versus speculative models)