



Energy: The interconnection of energy limits and the economy and what this means for the future



Gail Tverberg, [OurFiniteWorld.com](http://OurFiniteWorld.com), October 17, 2022

## Why listen to Gail Tverberg?

---

- ▶ Many researchers specialize in one area
  - ▶ Economists, geologists, historians, physicists, limit-to-growth modelers, inventors
  - ▶ Can't put together the full picture
- ▶ Gail Tverberg is an actuary
  - ▶ Masters' Degree in Math; Fellow of the Casualty Actuarial Society
  - ▶ Worked until 2007 in the insurance industry
  - ▶ Since 2007, she has tried to put together the “real story” of energy and the economy
    - ▶ Started OurFiniteWorld.com blog in 2007
    - ▶ Also became editor at TheOilDrum.com
    - ▶ OFW continues today; completely not-for-profit
    - ▶ Readers contribute research ideas
  - ▶ There is a big market for research that provides happily-ever-after endings
    - ▶ Much less interest in research that only wants to determine the real story

## Is it *always* possible to fix economic problems by adjustments to the financial system?

---

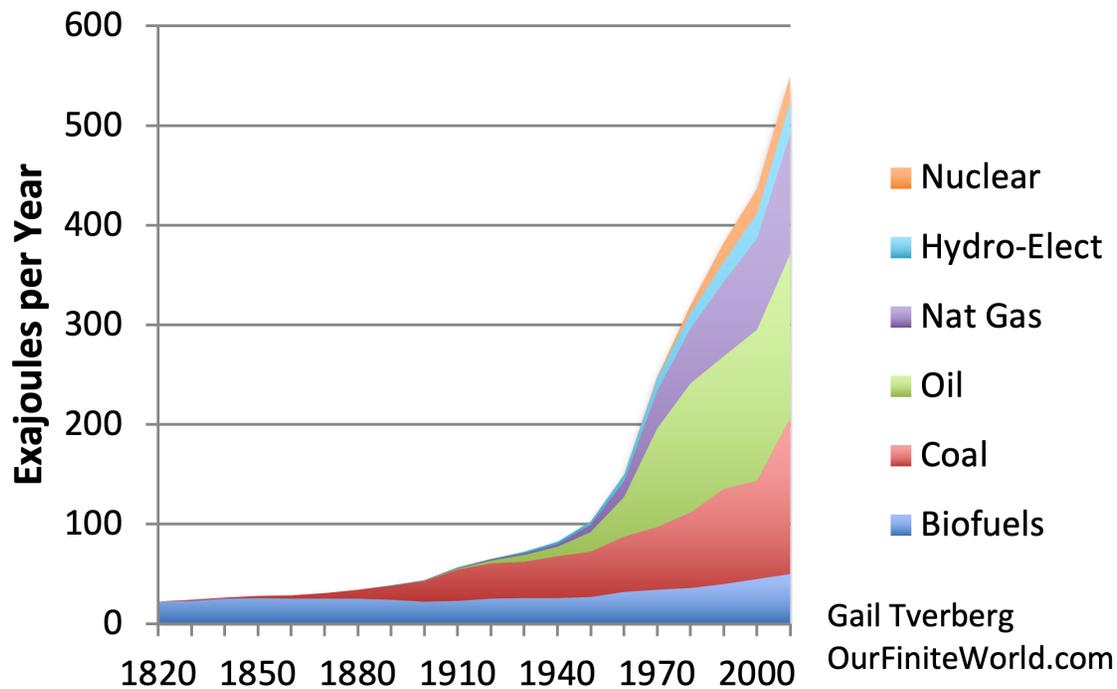
- ▶ My answer is no:
  - ▶ It is easy for central banks to print money and raise and lower interest rates
  - ▶ But **we can't eat money**
- ▶ System must be more complex
  - ▶ Actual physical goods and services are needed
  - ▶ Takes energy and other resources
  - ▶ Problems with energy supply need to be considered as well

# The physics perspective

**Physics view** of the economy says that the growing supply of affordable energy is the foundation of economic growth

---

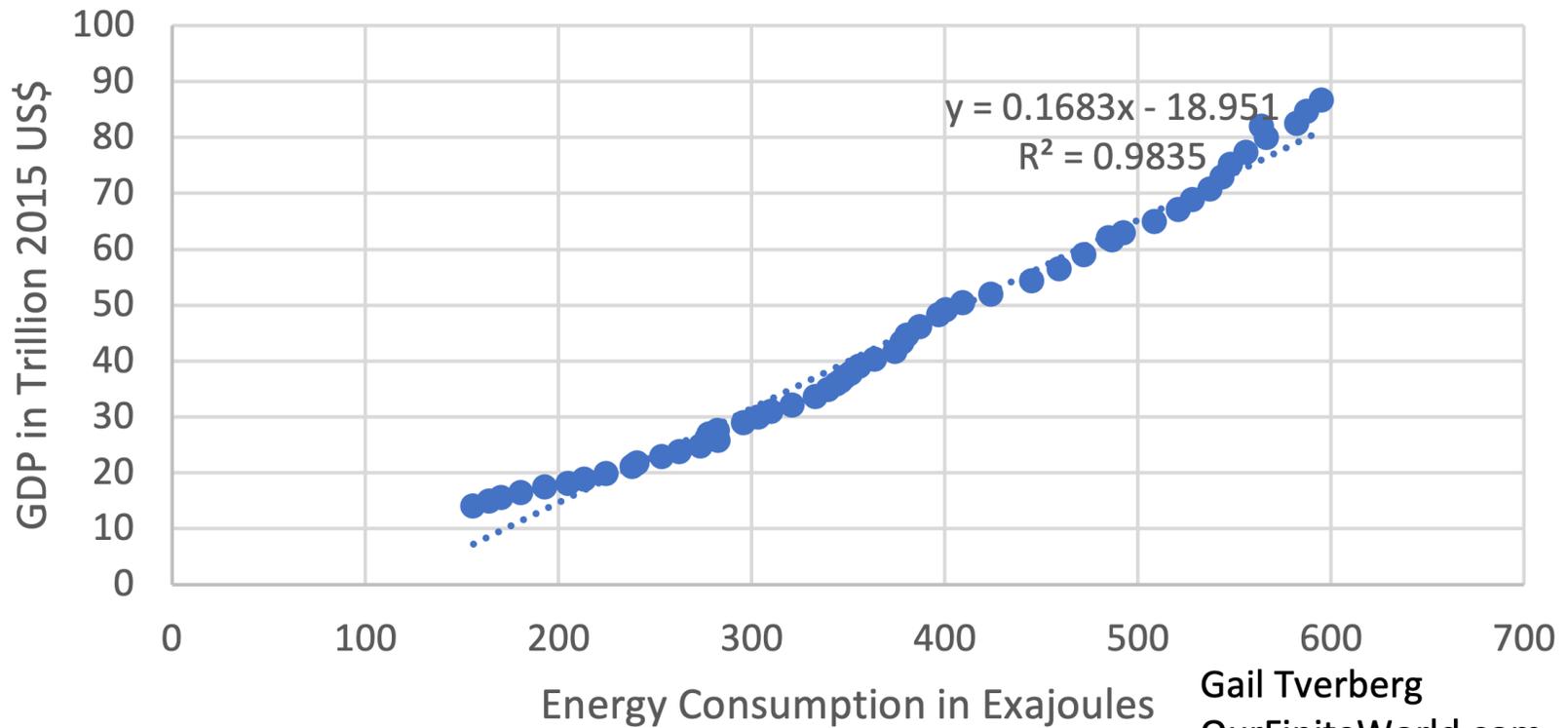
**World Energy Consumption 1820-2010**



Data Sources: Vaclav Smil, *Energy Transitions: History, Requirements and Prospects* and *BP Statistical Review of World Energy*

---

## Relationship between GDP and Energy Consumption 1965 to 2021



Source: Energy from BP; GDP from World Bank

Gail Tverberg  
OurFiniteWorld.com

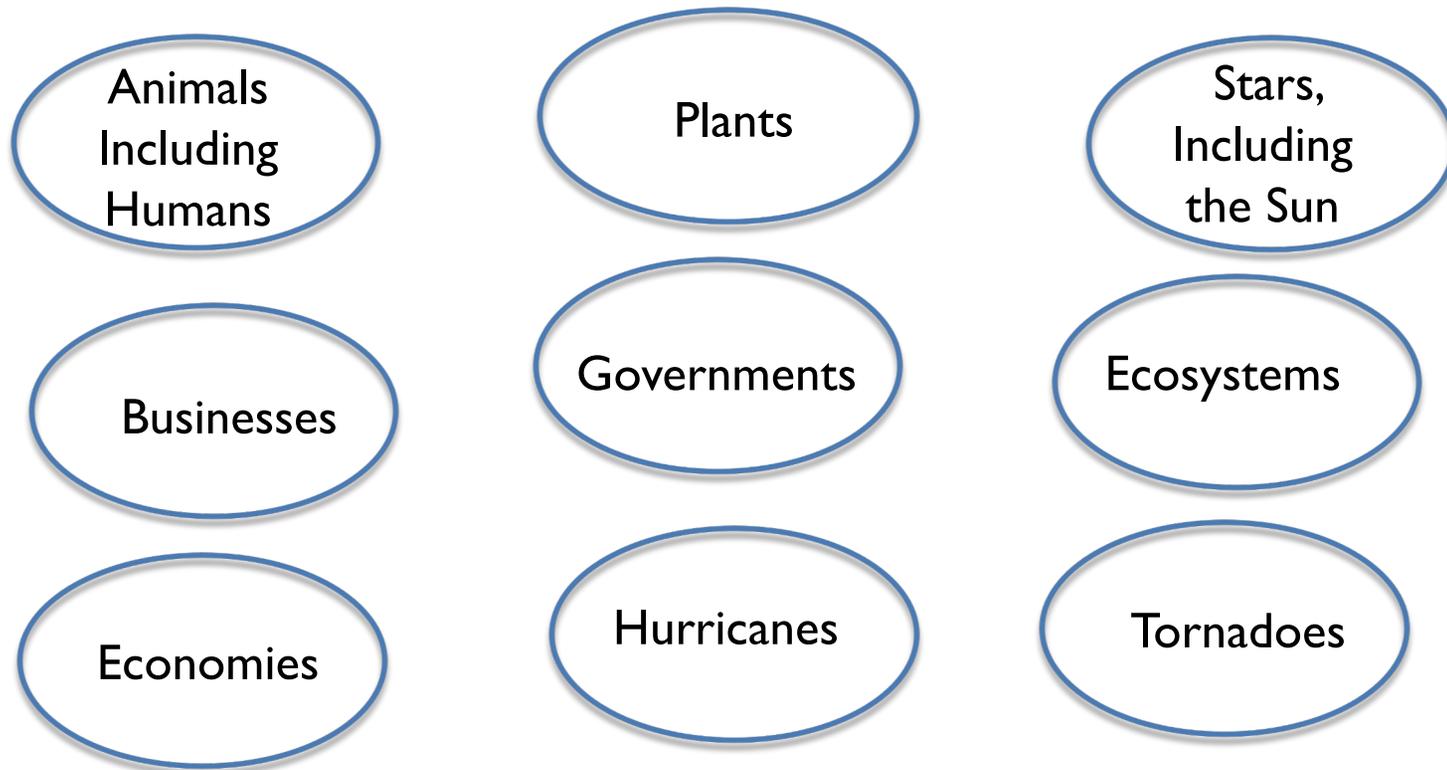
## Energy is “dissipated” in all aspects of the economy

---

- ▶ Humans eat food
  - ▶ Food provides energy, measured in calories
- ▶ Cooking food requires energy
- ▶ Heating homes requires energy
- ▶ Making solar panels requires energy
- ▶ Transportation requires energy

Anything that seems to grow by itself is a *dissipative structure*. These structures eventually come to an end.

---



Physics-based economy: The economy is built up in layers, like a child's building toy. The center is hollow.

The economy is a self-organizing physics-based system  
(Y. Shiozawa, 1996; Chaisson, 2001; Roddier, 2017)

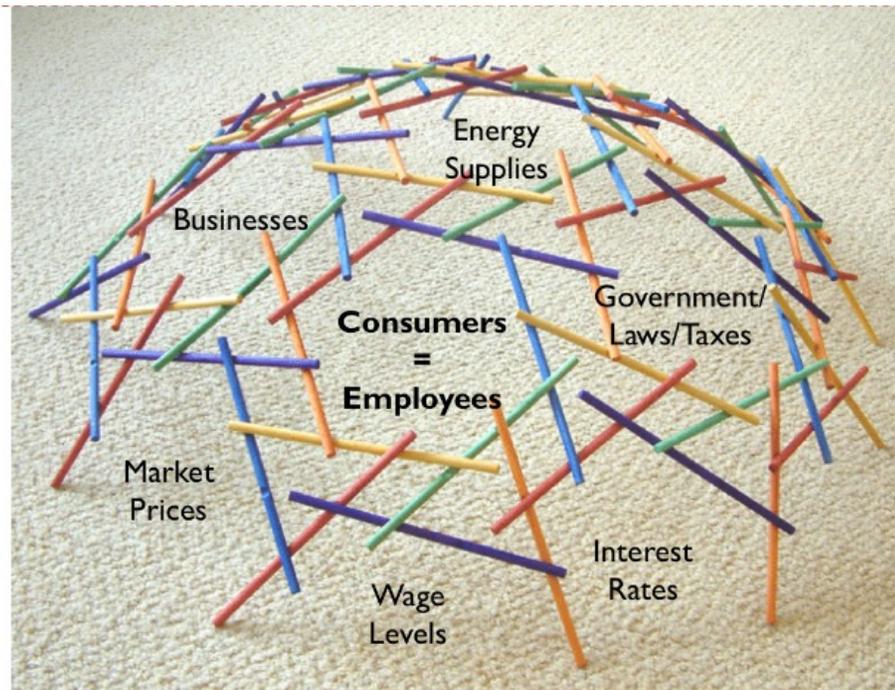


Chart by Gail Tverberg  
OurFiniteWorld.com

Energy supply needs to be both *inexpensive-to-produce* and *growing-in-quantity* to maintain a growing economy

---

- ▶ Example: Food supply for a growing population
  - ▶ Energy used in food production needs to be inexpensive
  - ▶ Quantity of energy used needs grow with population
  - ▶ Quantity of energy used may need to grow **faster** than population
    - ▶ More people per unit of arable land leads to more intensive agriculture
    - ▶ Or citizens demand more meat
- ▶ At same time, food needs to be affordable
  - ▶ High energy prices lead to high food prices
  - ▶ Poor people starve if food prices are too high

## Major problem: Cost of energy production eventually rises

---

- ▶ First fossil fuel removed is easiest to extract and ship
  - ▶ Later extraction is more expensive
    - ▶ Diminishing returns
  - ▶ Improved technology helps keep prices down for a while
    - ▶ But eventually fails
- ▶ High energy prices spill over to everything else
  - ▶ Food
  - ▶ Automobiles
  - ▶ Homes
- ▶ If regulators hold oil prices down, producers stop drilling
  - ▶ We get a problem of low supply and recession

Finances provide a two-way lever

## As an economy grows, growing debt is helpful

---

- ▶ On the way up, growing debt allows investments of all kinds
  - ▶ Plant a field
  - ▶ Build a factory
  - ▶ Train a worker
- ▶ If the cost of energy products starts to rise, increasing debt at lower interest rates can help hide the problem
  - ▶ Lower interest rates keep monthly payments on cars, homes lower, even if asset prices rise
  - ▶ Principle central banks have been using since 1981

Chart below shows huge decrease in interest rates since 1981. Lower rates have allowed a growing debt bubble.

- ▶ Some interest rates near 0% since 2008
- ▶ Now central banks are raising interest rates again



US Treasury 10-year and 3-month yield rates, in chart by Federal Reserve of St. Louis

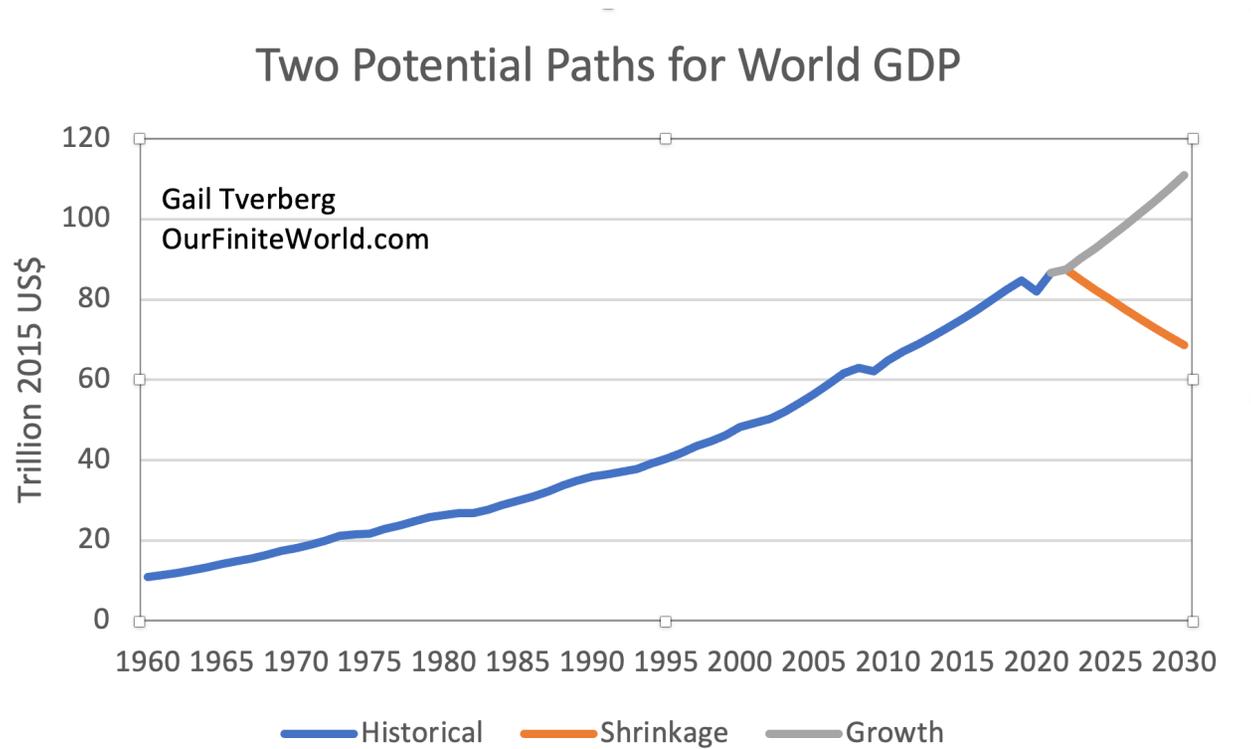
Obstacles are hit when cheap-to-produce energy stops growing sufficiently rapidly. Shift occurred in 2019.

---

- ▶ Governments find it easy to increase money supply, but they can't increase energy supplies in the same way
- ▶ **Inflation becomes a problem**, if added funds get back to the consumer
- ▶ Central banks raise interest rates
  - ▶ Higher monthly payments
  - ▶ Fewer buyers can afford homes, cars
- ▶ Economy slows
  - ▶ Debt bubble may collapse
  - ▶ Asset prices likely to fall

Economy could start to shrink

World GDP has grown at close to 3% per year. Will this continue, or will growth turn to shrinkage?



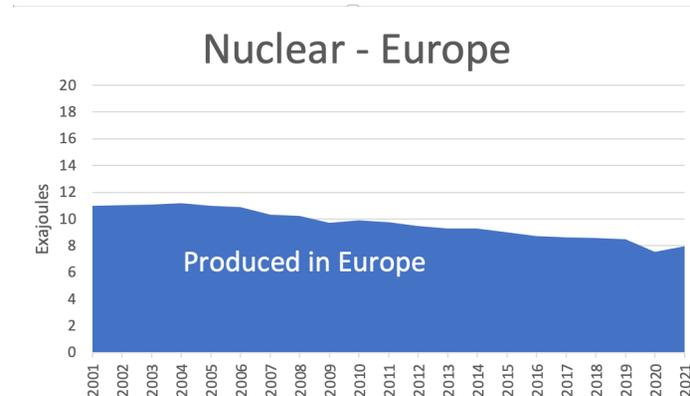
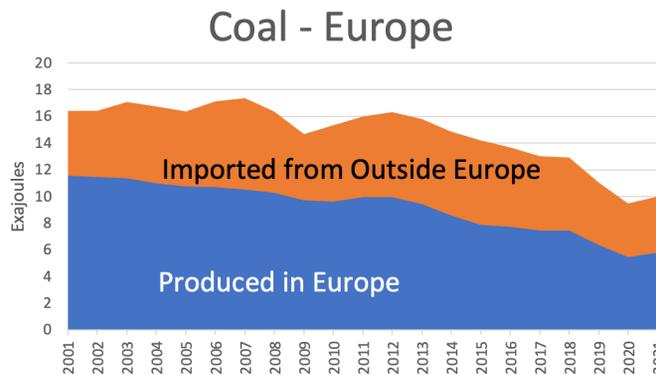
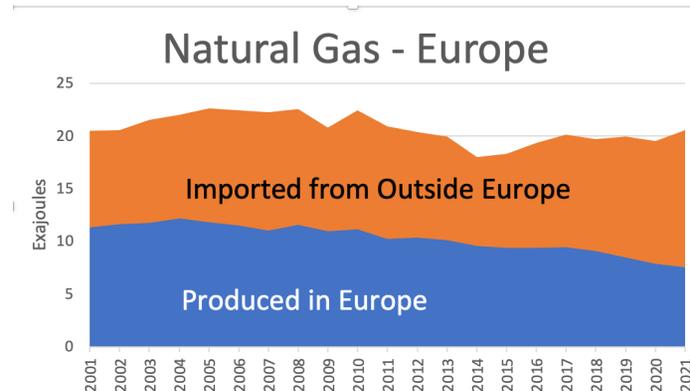
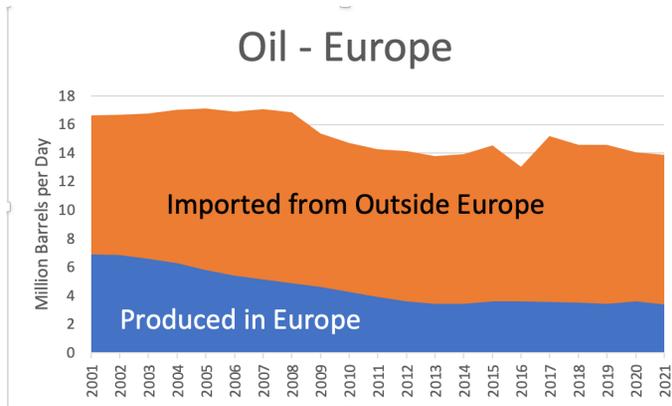
Historical GDP based on World Bank; shrinkage assumes -3% per year; growth assumes 3% per year

Shrinkage likely not to be shared equally; stronger countries will try to push aside weaker countries

---

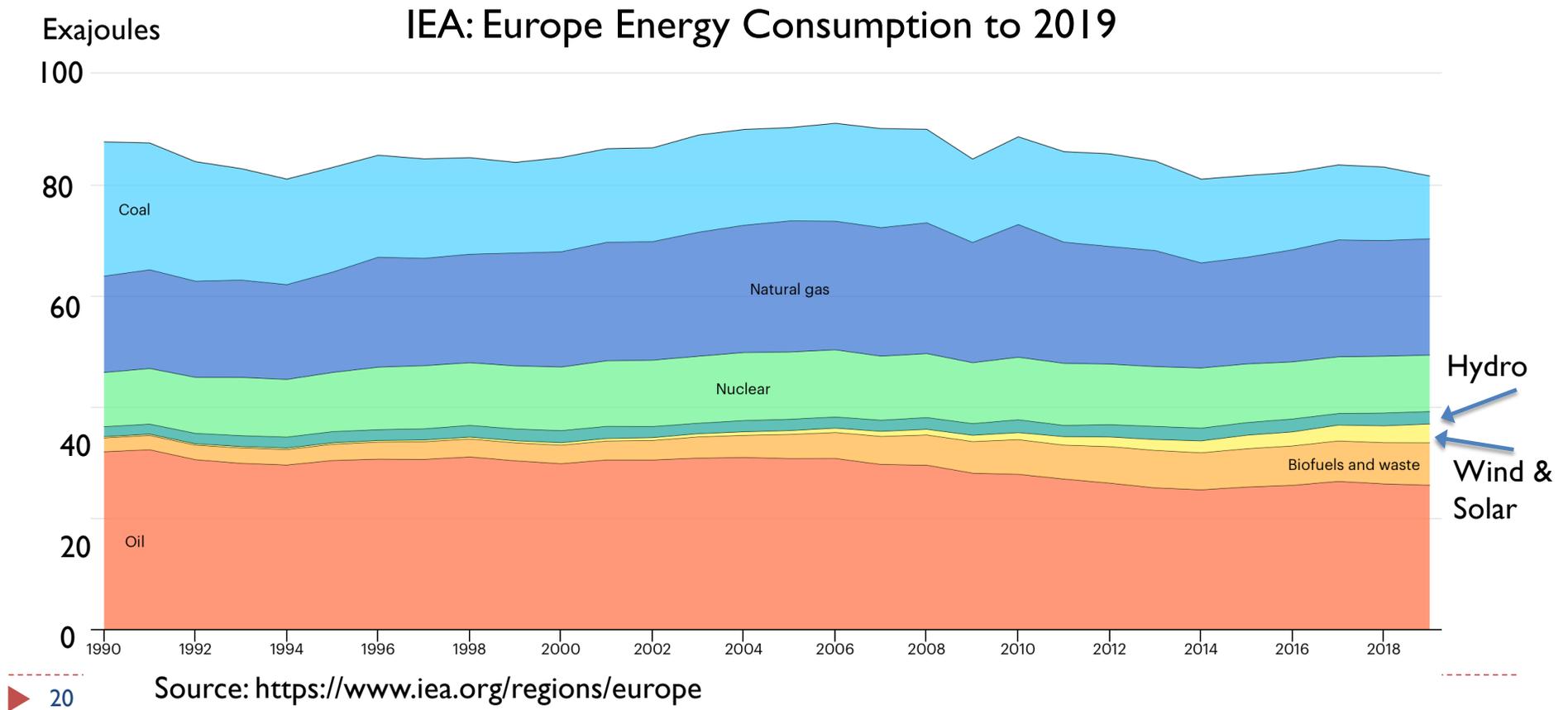


Europe began using its local fuel supplies many years ago; now it is heavily dependent on imports.



Data source: *BP 2022 Statistical Review of World Energy*

Now Europe's energy consumption is falling, even with imports. Wind and solar play a minor role.



What can Europe do now?

# 1. The energy problem is likely to be persistent. Need to simplify.

---

- ▶ Encourage multiple generations to move in together
  - ▶ Or friends share an apartment
- ▶ Cut back on non-essential purchases
  - ▶ Prioritize food, warm clothing
- ▶ Encourage home schooling
  - ▶ Also, encourage families to care for own small children at home
- ▶ Prioritize health care for young people over the elderly
  - ▶ Fewer years of active life lost if elderly cannot get adequate care

## 2. Understand the dynamics

---

- ▶ Europe is terribly dependent on fossil fuel imports
  - ▶ Needs to be on good terms with exporters
    - ▶ Even Russia
  - ▶ Holding down prices is counter-productive
    - ▶ Exporters will produce less
- ▶ Wind and solar are not living up to expectations
  - ▶ Don't provide much heat in winter
    - ▶ Summer to winter storage is impossible
  - ▶ Don't help food supply
- ▶ Wars are part of the dynamics of not enough resources to go around