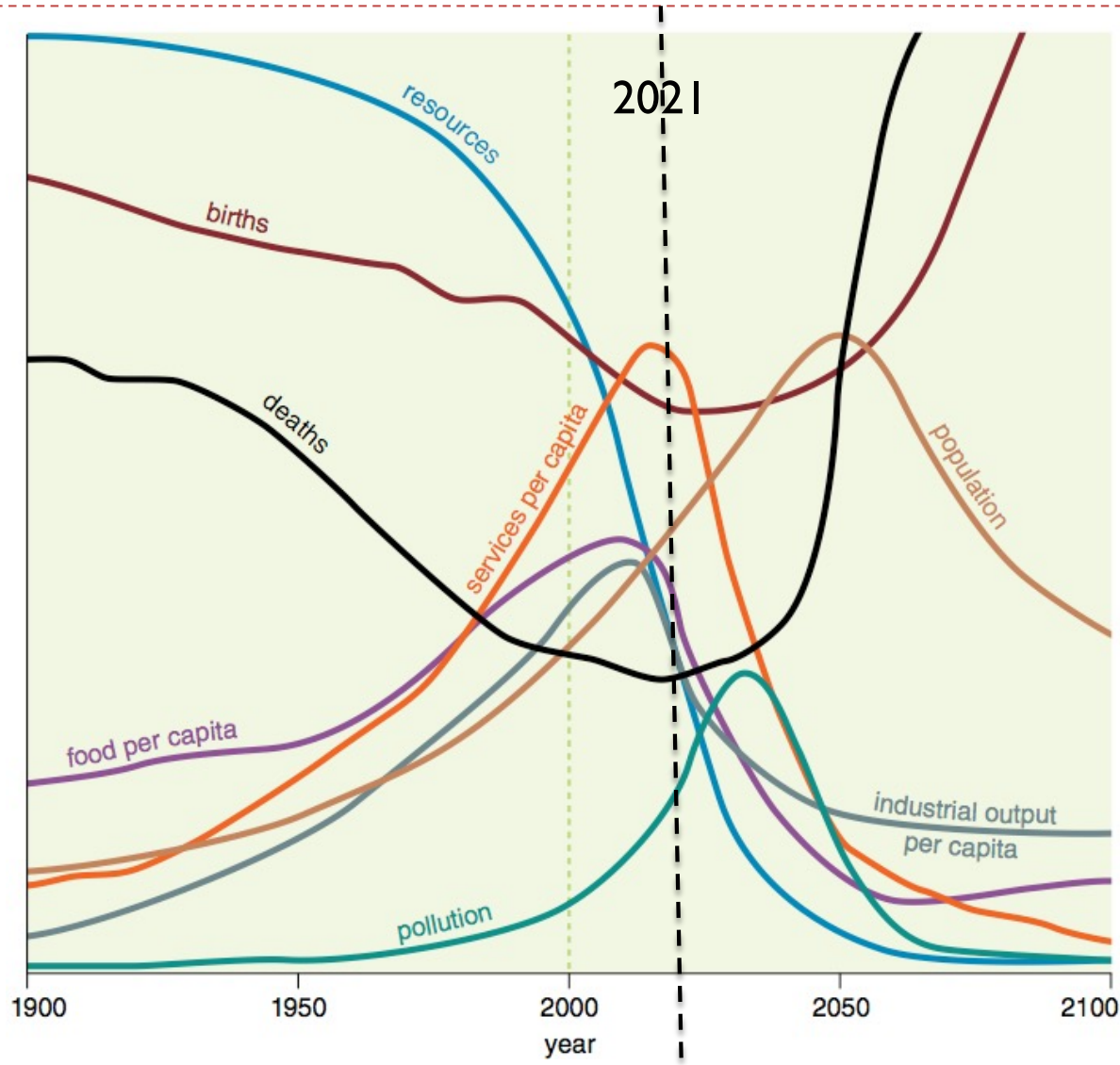


To Be Sustainable, Green Energy Must
Generate Adequate Taxable Revenue

Gail Tverberg – OurFiniteWorld.com – Sept. 7, 2021

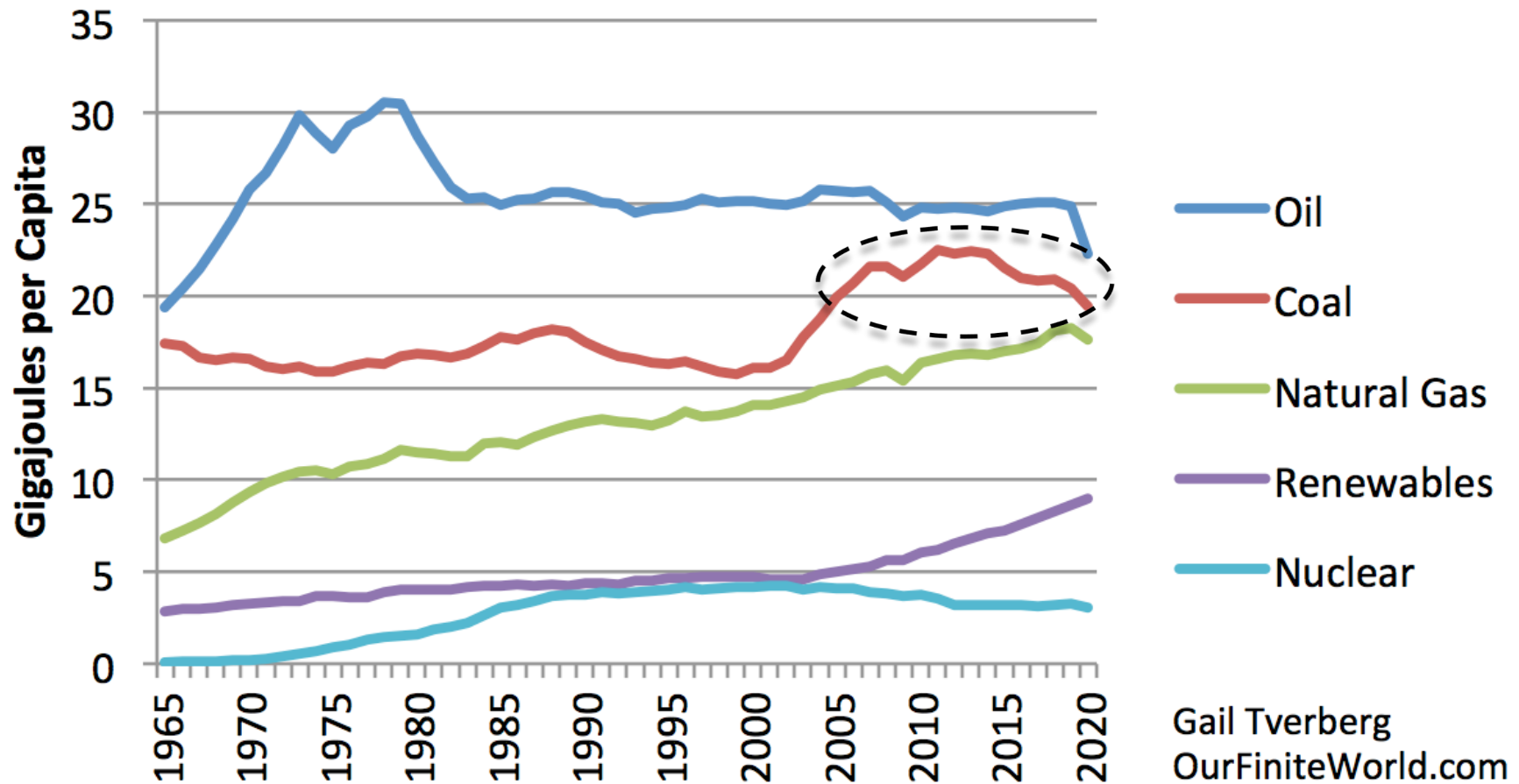
Green energy's role is changing

We seem to have hit “Limits to Growth”



Energy consumption per capita growth varies by fuel

World Energy per Capita by Fuel



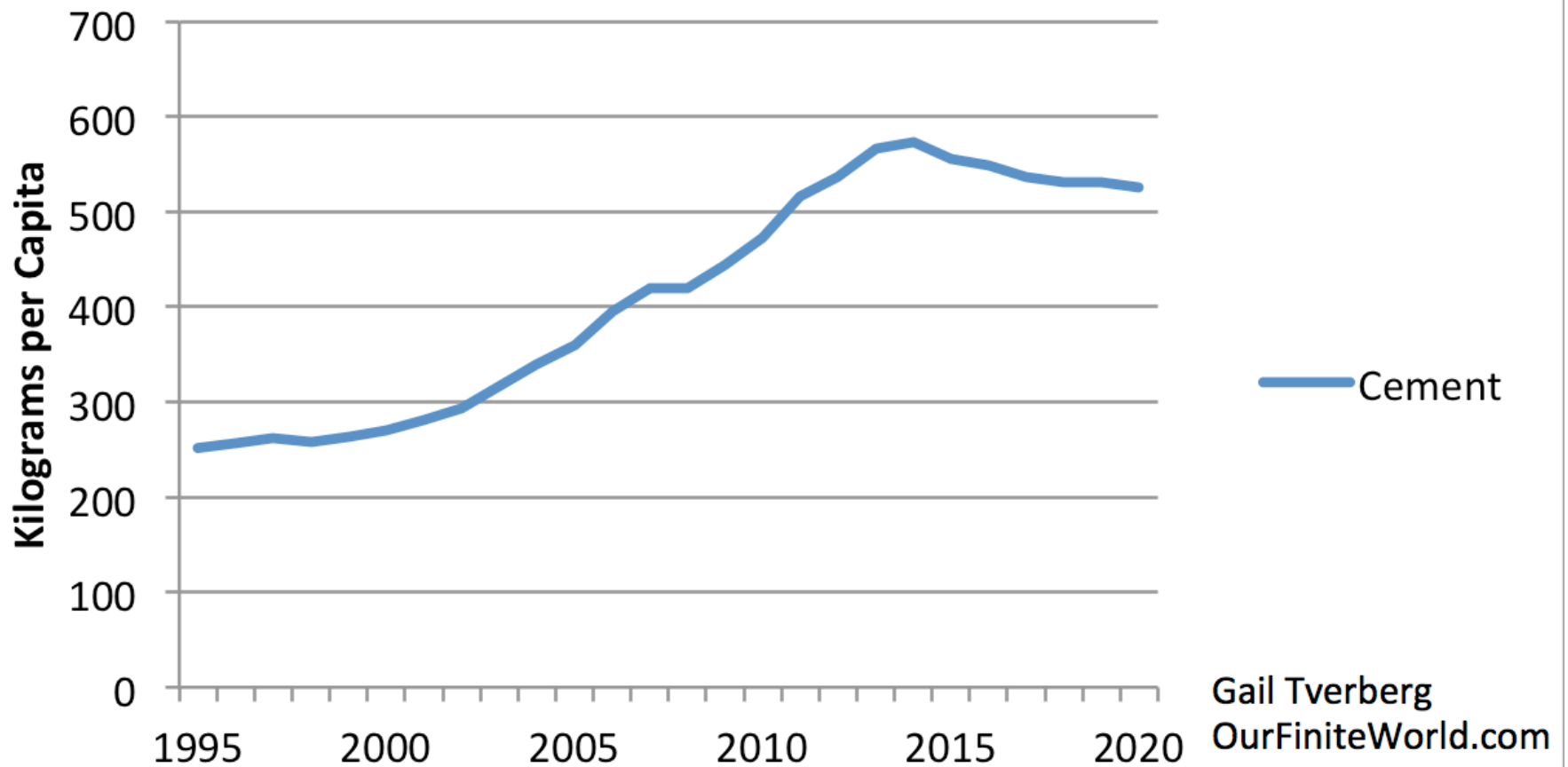
Source: Based on BP 2021 Statistical Review of World Energy data.

To keep economy operating, some fuels need to be profitable and growing in quantity

- ▶ Renewables are growing
 - ▶ But their growth is enabled by mandates and subsidies
 - ▶ Not necessarily profitable
- ▶ Natural gas is growing, but was down in 2009 and 2020
 - ▶ Recession affects natural gas production
- ▶ Coal's maximum per capita supply was in 2013
 - ▶ Tends to be the world's highest EROEI fuel
 - ▶ China is having problems with its production
- ▶ Oil and nuclear are both down per capita
- ▶ Conclusion: Renewables and natural gas will need to play a larger role in the future

Industrial production per capita is headed down. Example: Cement

World Per Capita Cement Production

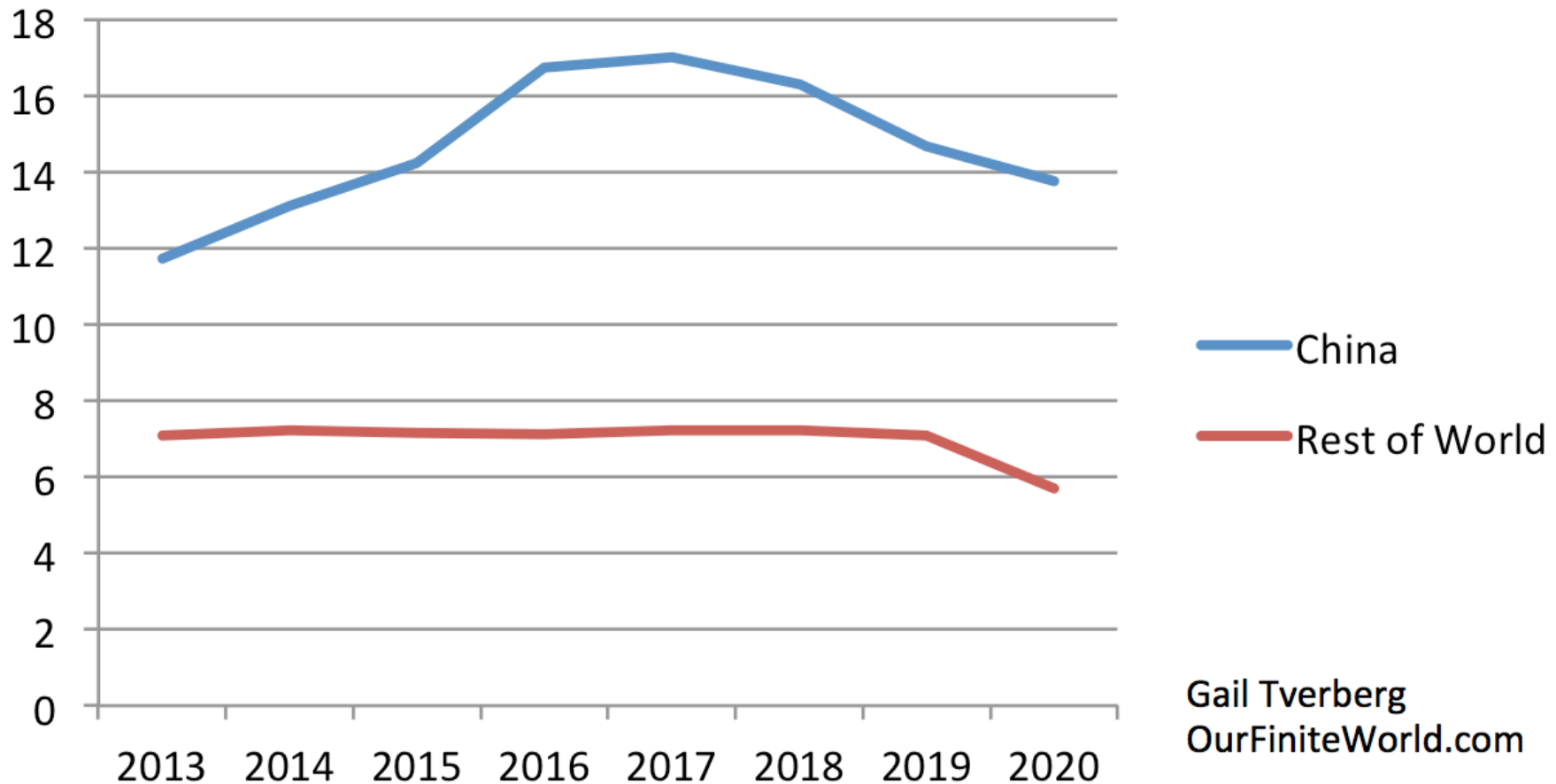


Source: United States Geological Service

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New automobiles per capita are headed down, especially in China

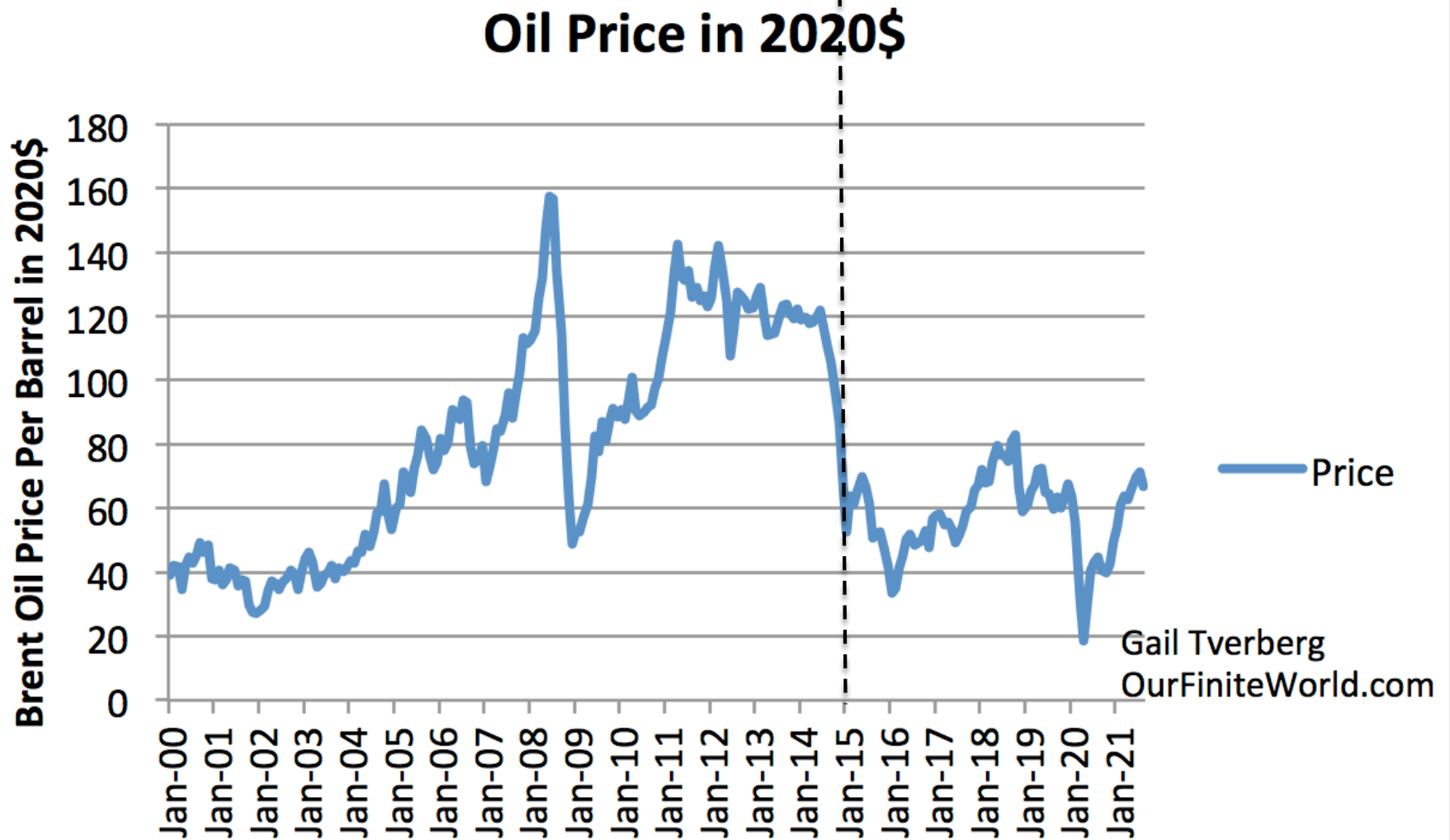
Car Sales per 1000 People



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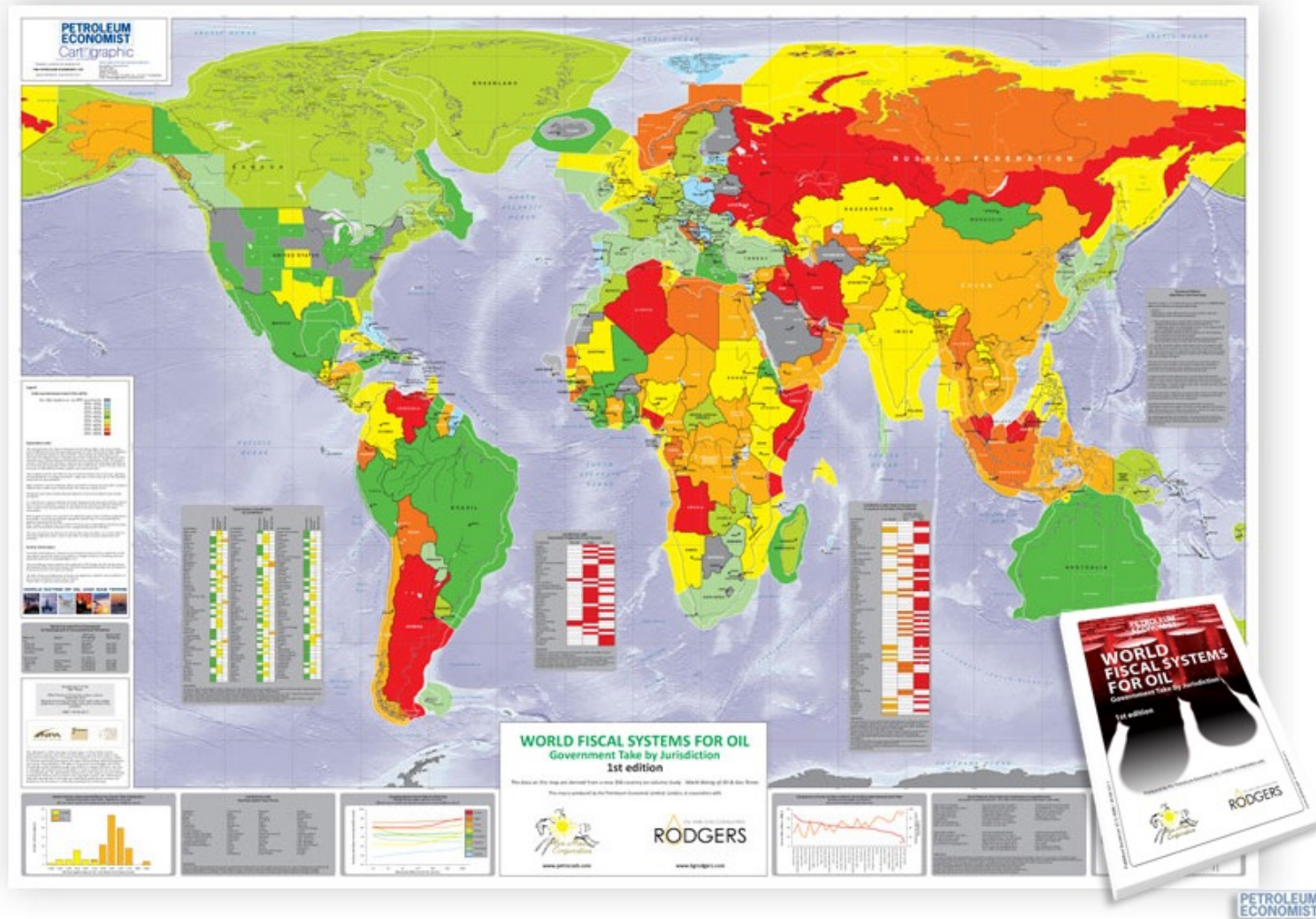
Source: <https://www.best-selling-cars.com/international/2020-full-year-international-worldwide-car-sales/>

World oil prices fell in late 2014. Low prices make producers unprofitable; cut taxes paid



Based on EIA Brent spot oil prices, adjusted by CPI All Items, Urban.

Oil taxes have been very high; benefit of low EROEI captured by governments as taxes



To Summarize: “Limits to Growth” already seems to be a problem

- ▶ Oil, coal and nuclear are all falling on a per capita basis
- ▶ Basic problem is inadequate prices; low profitability
- ▶ Renewables and natural gas need to play a bigger role
 - ▶ Cannot expect high prices!
 - ▶ Need to be profitable
 - ▶ Need to pay taxes
 - ▶ Provide roads, education, law enforcement
 - ▶ Cannot expect continued subsidies

The importance of storage and easy transportability

How do cities and governments grow?

- ▶ James C. Scott in *Against the Grain* gives a clue
- ▶ Points out the importance of *grain*
 - ▶ Easy to see as it grows
 - ▶ Easy tax
 - ▶ Easy to store
 - ▶ Easy to transport
- ▶ Farmers growing root crops could be just as productive
 - ▶ Equal return on human labor, in some sense
 - ▶ But benefits stay very local
 - ▶ Hard to store
 - ▶ Hard to transport

My conclusions from this example

- ▶ High EROEI in itself is not enough
- ▶ Energy must be available *when* it is needed
 - ▶ Right time of year – winter
 - ▶ Right time of day - night
- ▶ Energy must be available *where* it is needed
- ▶ Cost of transport and storage important
 - ▶ Really need to be included in any EROEI calculation
 - ▶ Misleading to compare “well-head” EROEIs
 - ▶ Roads built for oil and coal were dual purpose
 - ▶ Gave “lift” to rest of the economy
 - ▶ Almost a negative cost of transport!

EROEI Calculations For Green Energy Needs to Include All Costs

The only pricing system/EROEI system that can work is “Utility Pricing”

- ▶ Needs to consider total costs of a “package” that gives year-around, 24-hour per day, electricity.
- ▶ Includes:
 - ▶ Devices themselves
 - ▶ Including backup devices, storage and necessary overbuilding
 - ▶ Electricity transmission and maintenance
 - ▶ Includes fire suppression or prevention
 - ▶ “Winterizing” the system
 - ▶ Costs associated with replacing devices, as they wear out
 - ▶ Repairs after hurricanes; windstorms; fires
 - ▶ In areas with dry seasons, an approach besides hydro
- ▶ The package needs to include a layer for taxes
- ▶ Package cost should consider loan repayment and interest
 - ▶ Also dividend payments to shareholders

Green energy systems need to be self-supporting, going forward

- ▶ The overall economy will be less able to support Green Energy
 - ▶ Example: Effective Aug 1, 2021, China will end subsidies for new solar and onshore wind
- ▶ “Auction approach” for wind and solar only covers a small portion of the overall cost of the system
 - ▶ Assumes the only cost is the devices themselves
 - ▶ Gives misleading idea of total costs
- ▶ The big issue will be “Lack of Affordability”
 - ▶ Evaluated with all costs included
 - ▶ Tied to Green Energy not having a high enough EROEI

Some EROEI-Related Observations

1. It is the *overall EROEI* of the energy system that is important, not the pieces

▶ World EROEI

- ▶ Includes coal, oil, natural gas

 - ▶ Plus nuclear, renewables

- ▶ Delivered to end users (not wellhead)

▶ World overall EROEI seems to have fallen too low in 2014

- ▶ Per capita coal reached peak in 2013

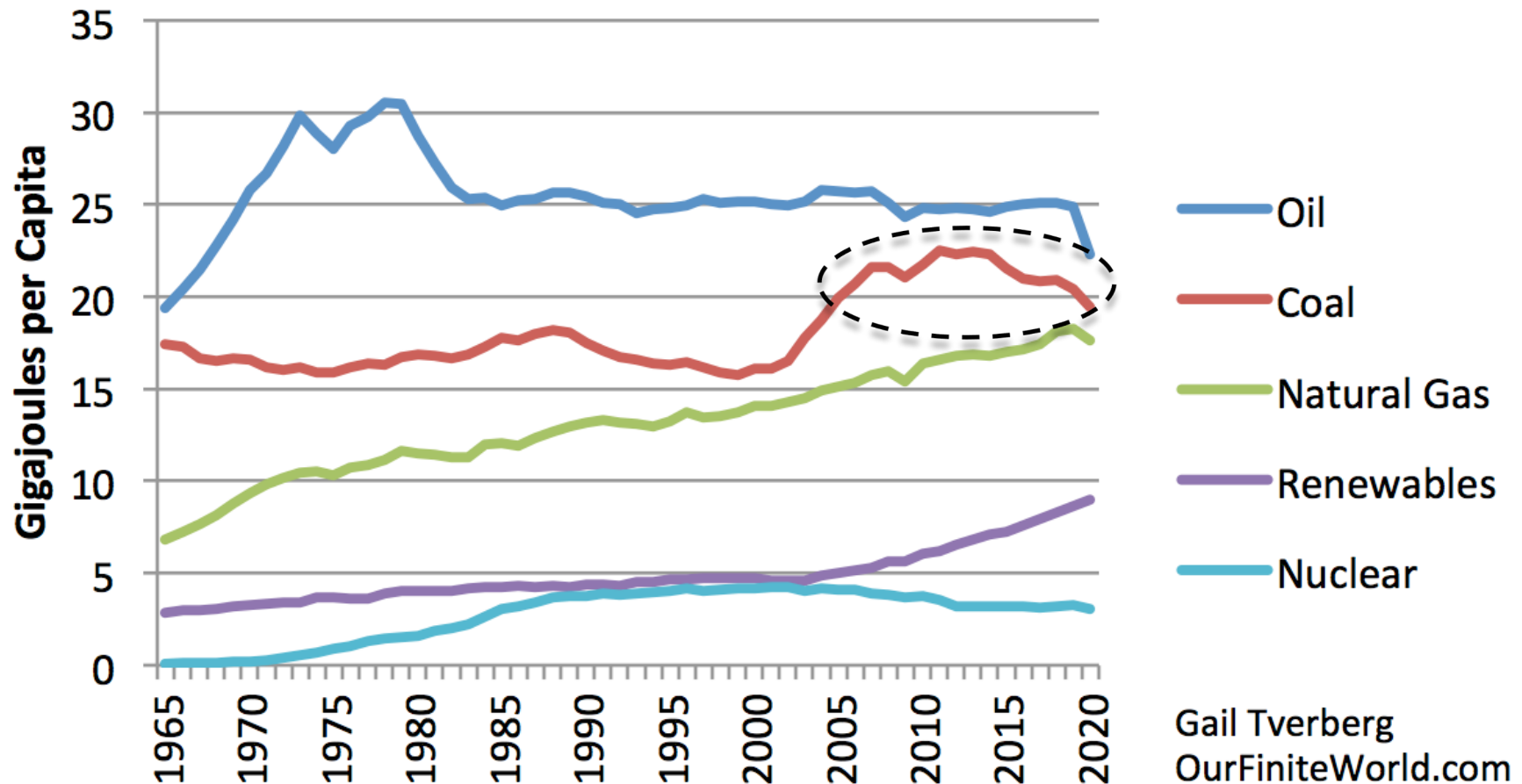
 - ▶ World EROEI probably fell lower in 2014

- ▶ Oil prices fell too low then

- ▶ They haven't been able to recover to \$120 barrel level

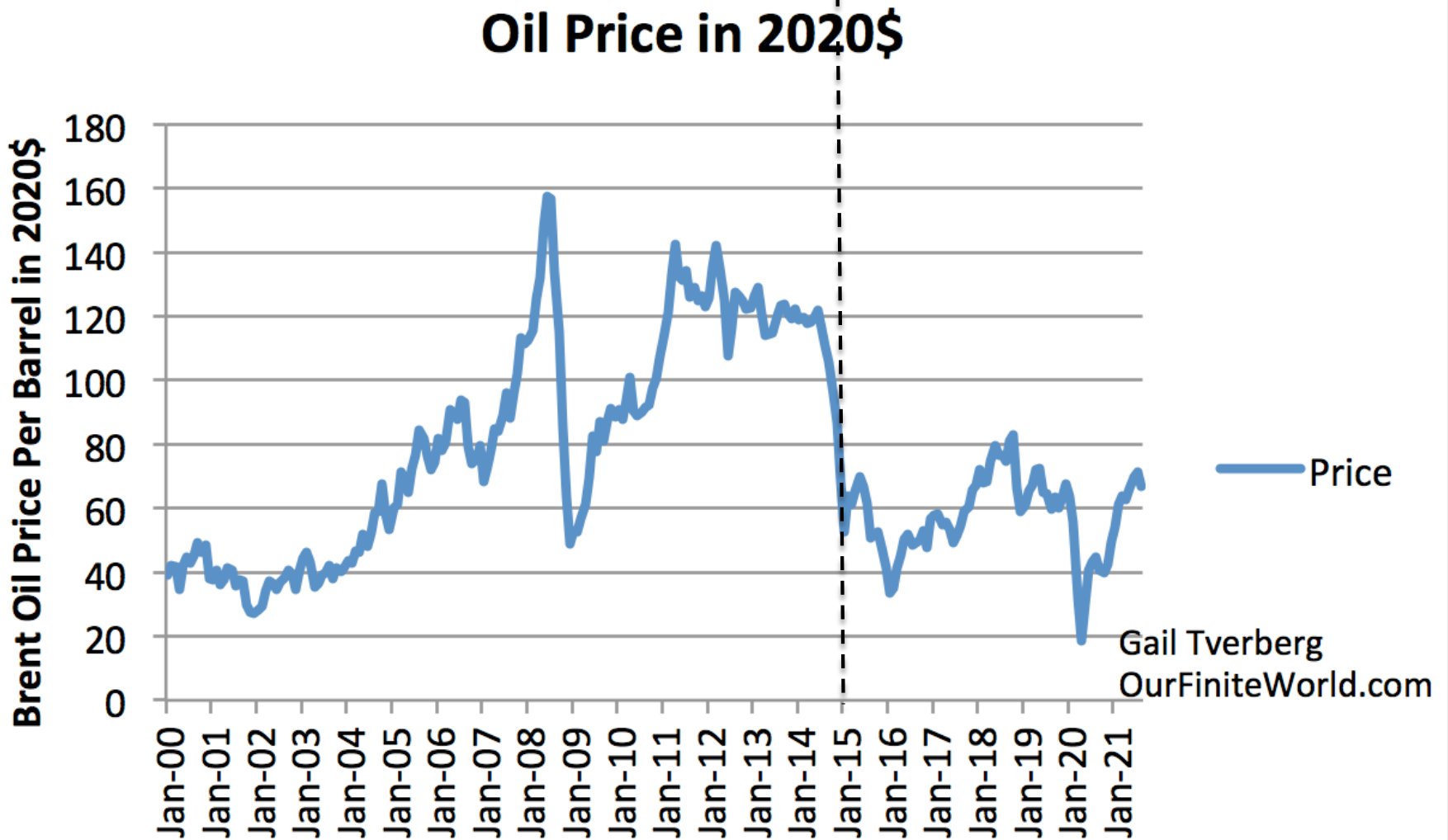
Weighted average of EROEI of fuels is now too low – less coal, more renewables

World Energy per Capita by Fuel



Source: Based on BP 2021 Statistical Review of World Energy data.

World oil prices fell in late 2014. This was first year per capita coal supply was lower.



Based on EIA Brent spot oil prices, adjusted by CPI All Items, Urban.

2. Belief that energy prices will rise with scarcity is not valid

- ▶ This is a belief picked up from Neoclassical Economics
- ▶ Energy availability affects both
 - ▶ *Supply* of finished goods
 - ▶ *Wages* available to buy finished goods
- ▶ Diminishing returns leads to higher costs of production
 - ▶ Consumers can't necessarily afford these higher costs
- ▶ Reason production of coal and oil are cut back is *prices too low for the producer*
- ▶ Real markers of scarcity
 - ▶ Broken supply lines
 - ▶ Empty shelves in stores
 - ▶ Conflict among nations

3. It is return on *Energy Return on Human Labor* that is important

- ▶ The economy is really two sided:
 - ▶ Supply side
 - ▶ Affordability side – What can workers afford?
- ▶ Energy Return on Human Labor is analogous to return on labor of fish
 - ▶ In humans, it looks like wages
 - ▶ High return on human labor corresponds to “little wage disparity”
 - ▶ Even the poor can afford food, housing and transportation
- ▶ High return on human labor goes along with high overall system EROEI
 - ▶ Workers can afford the output of the system
 - ▶ Oil prices don't fall too low