Oil Crisis and the Energy Transition

Executive Summary

- **The oil supply crisis is on track**
- **The current energy transition plan will make the crisis worse**
- **A better energy transition plan will be harder to implement after the crisis hits**

Oil Crisis

Recap

What is different since the last talk (less than 4 years ago):

- **US oil production stopped growing**
- **Over 120B barrels consumed, over 7% of all oil ever produced**
- **Decrease in cap-ex spending**

However,

- **Peak Demand / Energy Transition narrative into overdrive**
- **Governments suppressed the oil price**
- **Demand still not recovered from COVID**

Tightening Market

(mmbd)	2019	2022	Change
Average Oil Price	$64	$99	54%
Global GDP	$87 T	$100 T	15%
Global Demand	100.9	99.4	Flattish
Non-OPEC Production	65.7	65.7	Flat
OPEC Production	34.6	34.2	Flattish
Saudi	9.8	10.4	UP
Nigeria + Angola	3.1	2.3	DOWN
OECD Inventories	2,876	2,766	-110
Government Inventories	1,535	1,217	-318
Adj OECD Inventories	2,876	2,448	-15%

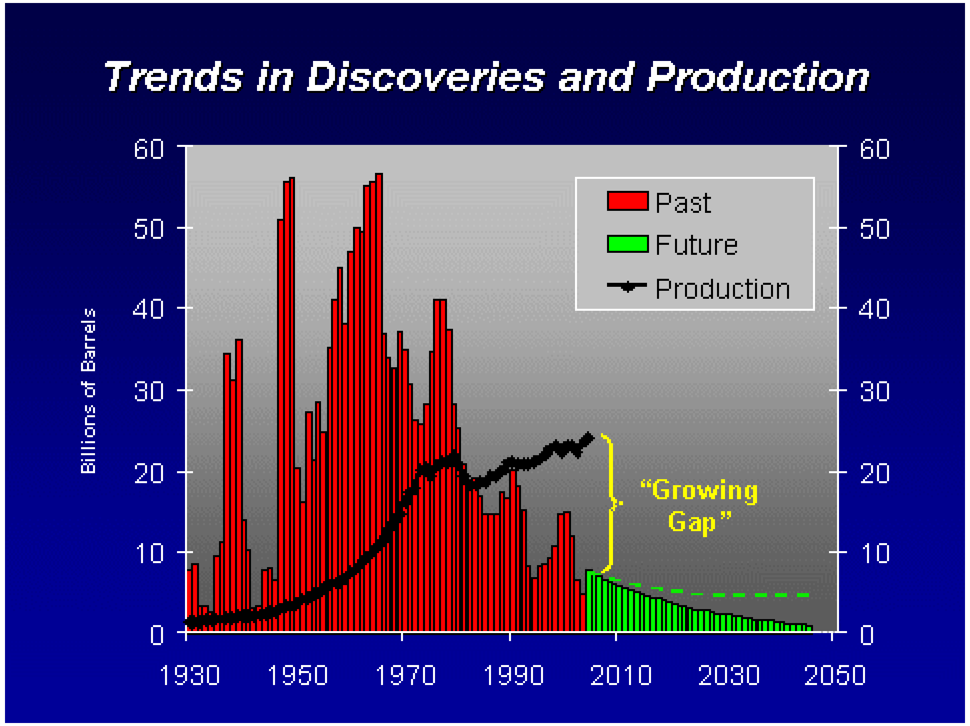
- **Adjusted OECD commercial inventories are at the lowest level in 20 years.**
- Non-OPEC production has not grown despite a higher oil price.
- OPEC productive capacity appears to have declined.
- Demand has not grown despite large growth in global GDP.

No US Production Growth

- US production peaked at 13.1mmb/d or 0.9mmb/d higher than here.
- US production has been flat for 10 months.

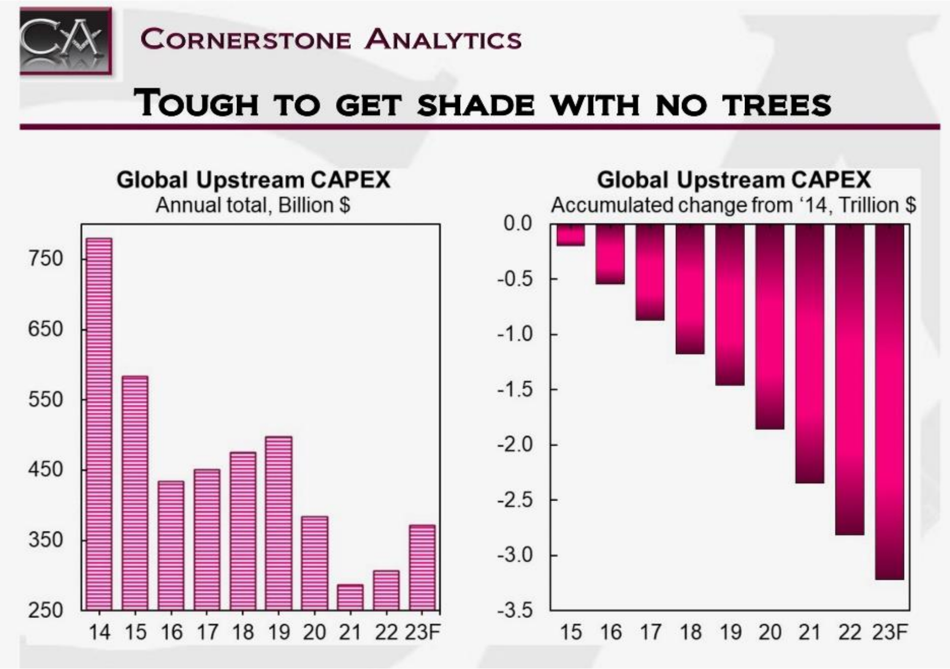
- **Without US tight oil growth, we would have had an oil crisis a decade ago.**

Oil is Finite



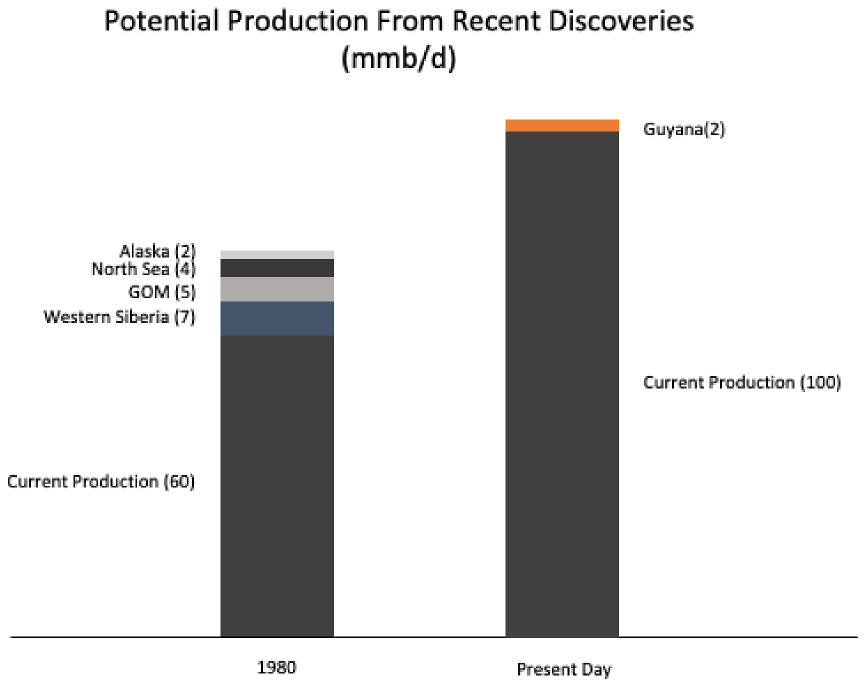
- James Schlesinger's chart, presented to the Committee on Foreign Relations in 2005, shows discoveries peaking in 1962 and production outpacing discoveries starting in 1981.
- Since late 2019, we have consumed over 120B barrels or over 7% of all oil ever produced.
- If we assume a EUR (Estimated Ultimate Recovery) of 2.6T barrels, we are 64% depleted.

Capital Discipline



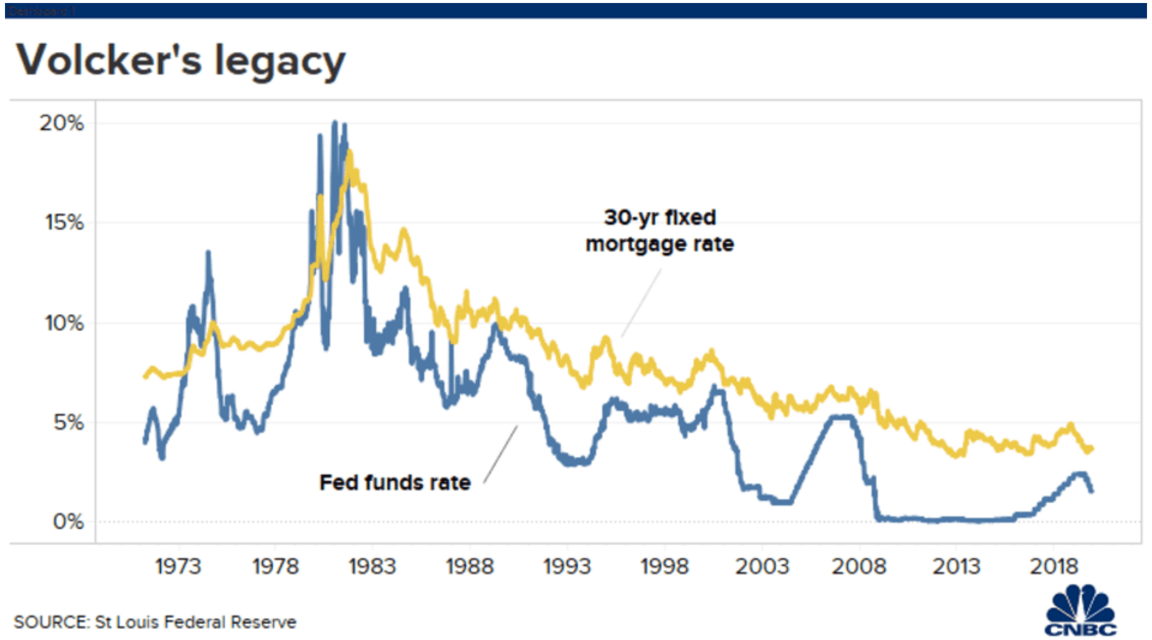
- The oil industry is not investing for growth. The cap-ex level is so low that it is doubtful that production will hold flat.
- The capital deficit from 2014 to present is over $3T.
- There is little reason to spend if the reserves don't exist or if peak demand is a concern.

Few Discoveries



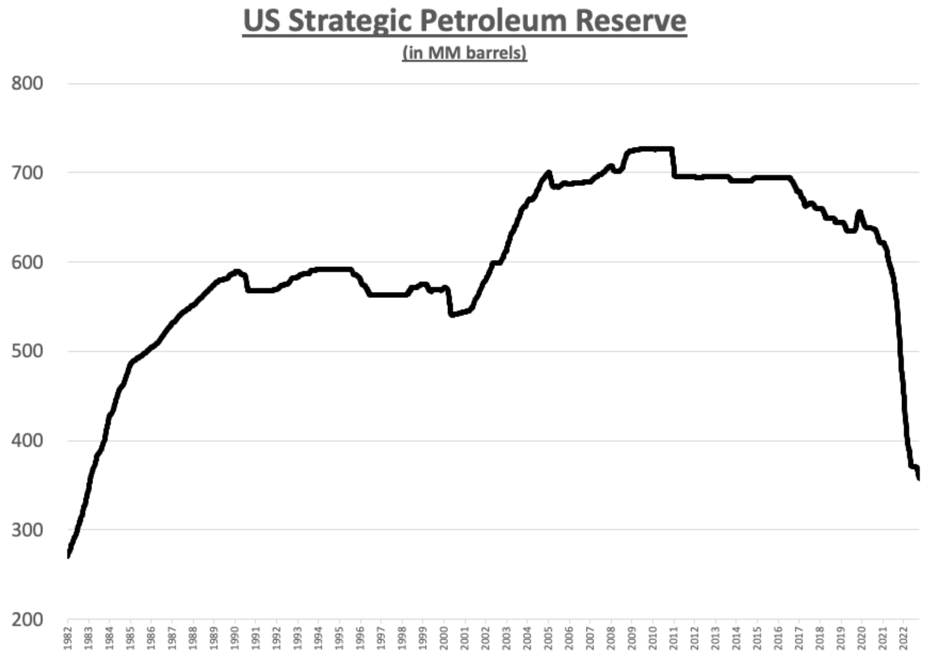
- In 1980, recent discoveries could add 30% to base production; whereas, today that number is 2%.

Fed Policy



- Volcker caused back-to-back recessions in 1981 and 1982 in order to tame inflation. In the 1980s, oil prices would have fallen under their own weight without the Fed tightening, given the huge discoveries in the 1970s.
- Today, the Fed needs to allow oil prices to rise and all relative prices to adjust, given the lack of recent discoveries.
- Without a deep appreciation of the oil situation, a policy error is a high probability.

SPR



- The SPR has been cut in half from peak with over 350mm barrels sold. The sales prevented OECD commercial inventories from dropping to unprecedented lows.
- The Ukraine / Russia war provides a strategic rational for selling government inventories. The SPR today is less critical with high US oil production.
- Nevertheless, suppressing the oil price is a policy error.
- SPR sales are about to end which will support the oil price.

Demand

(mmbd)	2019-2022 Change
Global GDP Growth	15%
Global Demand Growth	Flattish
Missing Demand	~5.0
Air Travel	1.0
China	1.0
Working from Home	0.5
Catch Up Demand	~2.5
Working from Home	1.5
Electrification	0.6
Re-shoring Supply Chains	0.4
Lost Demand	~2.5

- There is about 2.5mmb/d of demand still to come back from COVID.
- This ‘catch up’ demand could offset the impact of a potential recession.
- Without a recession, the world will be short oil.

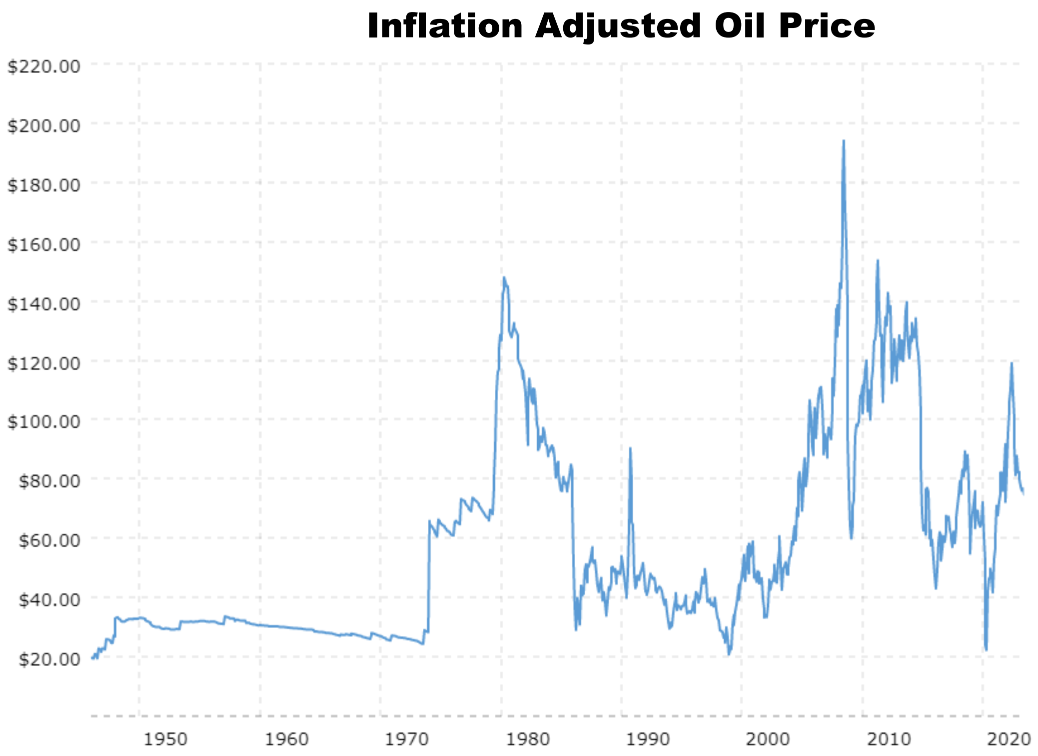
OPEC

“The IEA should be very careful about further undermining oil industry investments.”

Haitham Al Ghais, OPEC Secretary General

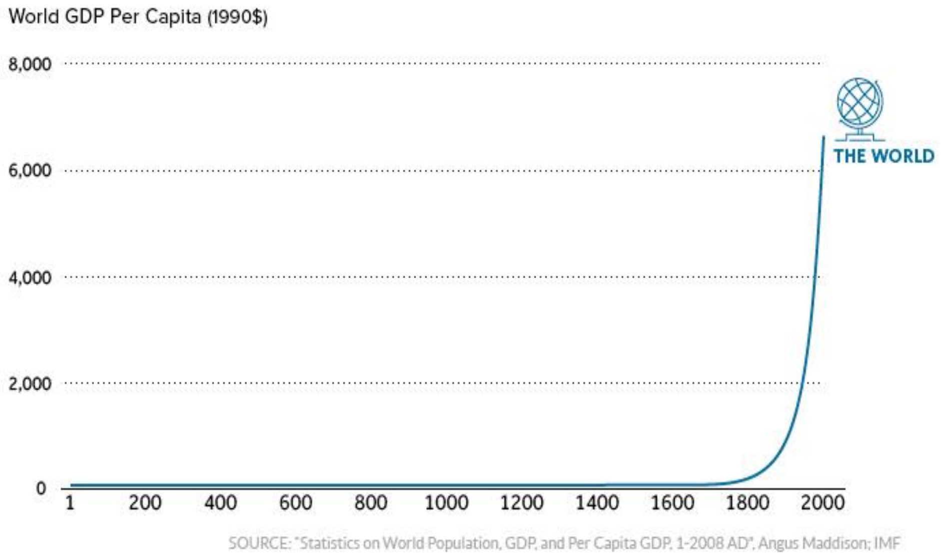
- With US oil production no longer growing, OPEC controls the oil market.
- OPEC is pre-emptively cutting production in anticipation of a recession.
- OPEC apparently wants to change the narrative from ‘abundance’ to ‘scarcity’.
- Fighting OPEC is a losing strategy.

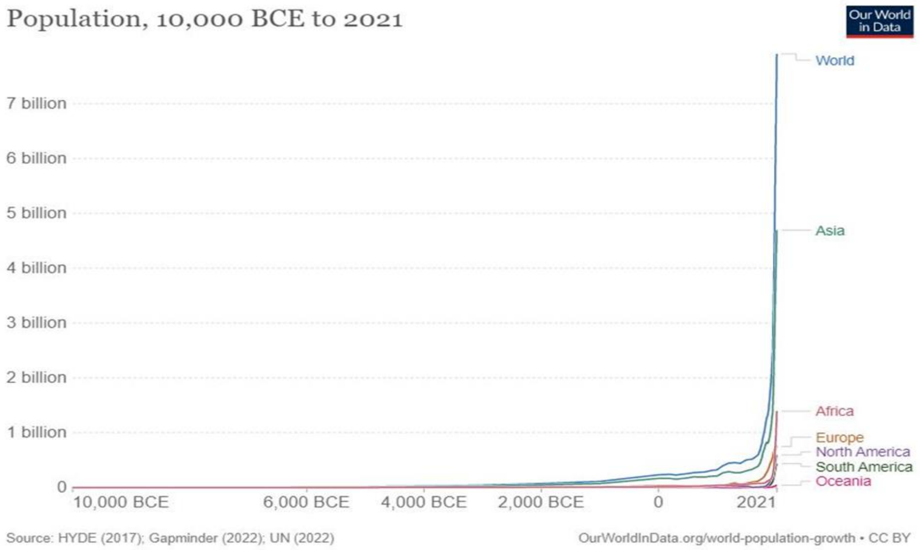
Crude Volatility



- A very small move in demand, supply, or inventories can have a very big impact on the oil price.
- In the 1970s, OPEC took up the oil price 14x in nominal dollars. Today, they can do what they like.
- The inflation adjusted high was $195. We are likely to see prices above that.

Prosperity





- Thomas Malthus published ***An Essay on the Principle of Population*** in 1798. At the time, his theory was an accurate explanation of the past.
- Economic historians have difficulty understanding the remarkable inflection in the global economy, but prosperity was driven by hydrocarbons: coal, oil and gas.
- Steam ships and rail opened up global trade and the Ricardian benefits of comparative advantage.
- Wars were won based on access to hydrocarbons.

Energy Intensity

Average American	2.5 gallons/d oil
	35 kWh/d electricity
Total	~450 MJ/d
Average Adult Caloric Intake	~10 MJ/d

- Hydrocarbons give the ‘average’ American the daily equivalent energy of 45 humans.

Insecure Energy Future

- A coherent plan for The Energy Transition is essential for prosperity and human flourishing

- Moving oil consumption to a grid solely powered by renewables makes for a very insecure energy future

    - How many days will society survive in a blackout?

The Energy Transition

Master Plan Part 3

Recently, Elon Musk unveiled his 'Master Plan Part 3' for the Energy Transition. His plan could become the consensus path forward. This misguided plan leads to an insecure energy future

Main points of contention:

- **All Renewables Transition Path vs Multiple Transition Paths**
- **Battery Electric improves efficiency vs No substantive efficiency improvement**
- **'Fool Cells' vs Hydrogen Economy**
- **No Limits to Resources vs Limited Resources**
- **CO2 Avoidance Paramount vs Energy Security and Human Flourishing Paramount**

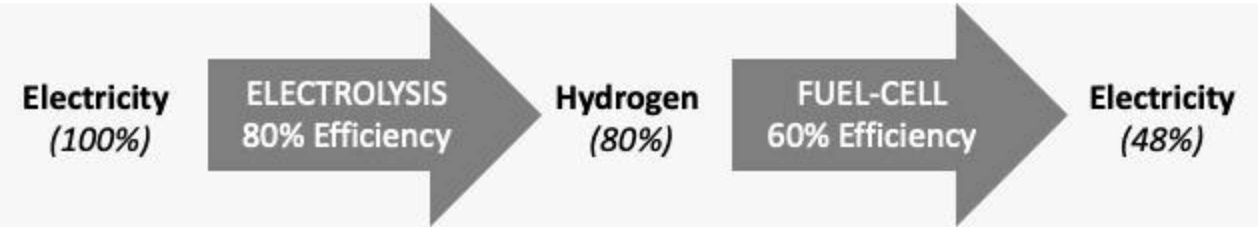
Supporting Arguments

Efficiency Ratio

Vehicle Class	ICE Vehicle Avg[5]	Electric Vehicles	Efficiency Ratio
Passenger Car	24.2 MPG	115 MPGe (292 Wh.mi)[e]	4.8X
Light Truck/Van	17.5 MPG	75 MPGe (450 Wh.mi)[f]	4.3X
Class 8 Truck	5.3 MPG (diesel)	22 MPGe (1.7 kWh.mi)[f]	4.2X

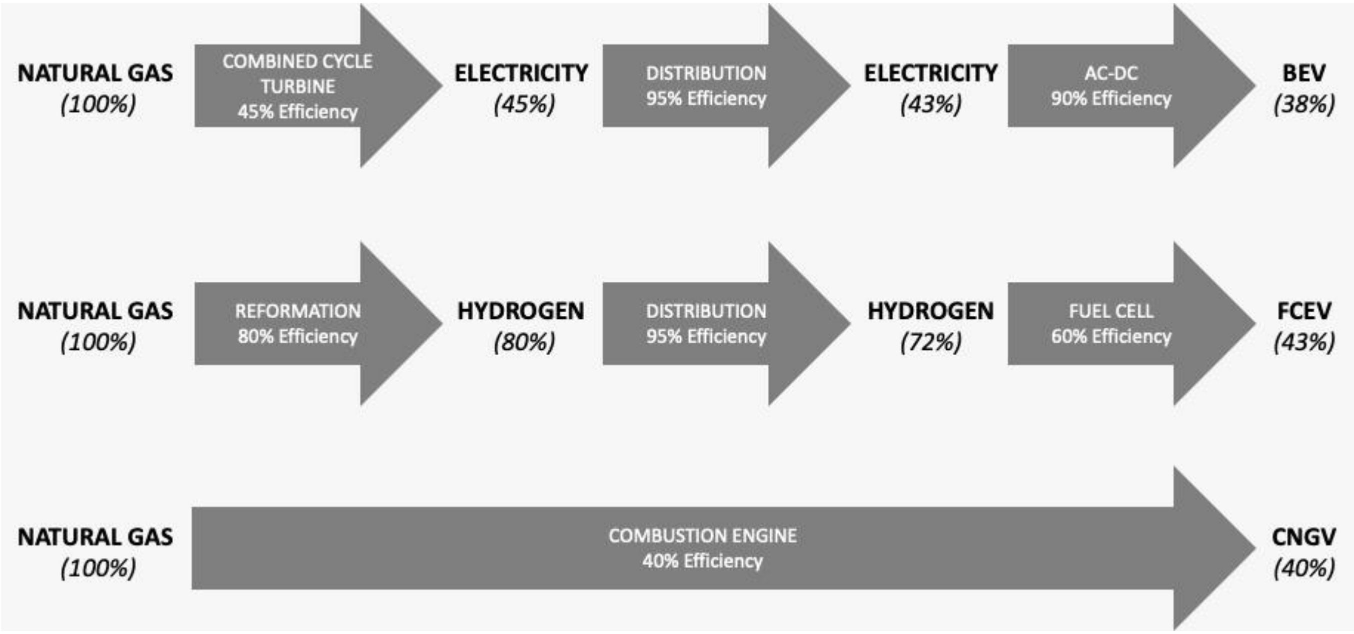
Table 1: Electric vs Internal Combustion Vehicle Efficiency

Fool Cells



Transition Path: Natural Gas

Natural Gas Efficiency



- Vehicles running on electricity or hydrogen produced by natural gas have similar efficiency to vehicles running on natural gas directly.
- Reformation of natural gas is relatively efficient because heat is used to separate H2 from C while heat is wasted when natural gas is used in a turbine.
- Deployment of CNG infrastructure makes little sense because a CNG engine has low torque and because the infrastructure will need to be replaced once we ultimately move off natural gas.

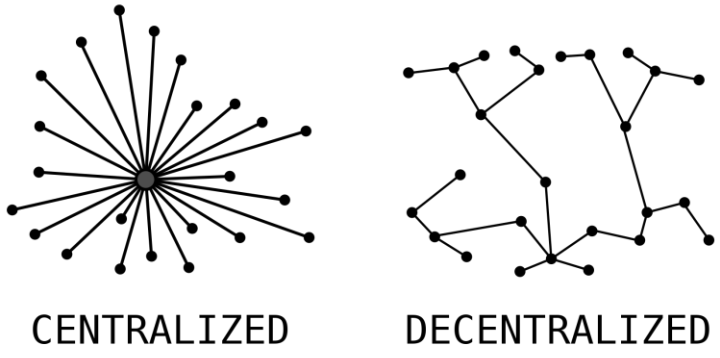
Natural Gas MPGe

Vehicle	Type	MPGe
Tesla Model 3	BEV	125
Toyota Mirai	FCEV	76
Honda Civic	CNGV	28

- Natural Gas powered vehicles have roughly the same efficiency regardless of the different MPGe. The ‘efficiency ratio’ is meaningless.
- On an energy equivalency basis, electricity is most expensive, then hydrogen, then natural gas.
- The FCEV and the BEV have a small efficiency advantage in cities because of regenerative braking.

- **The main reason a BEV is cheaper to run than an ICEV is not because it is more efficient, but because the BEV runs on nat gas/coal, while the ICEV runs on oil.**
- **BEVs and FCEVs are cheaper to power because they run on lower cost fuel.**

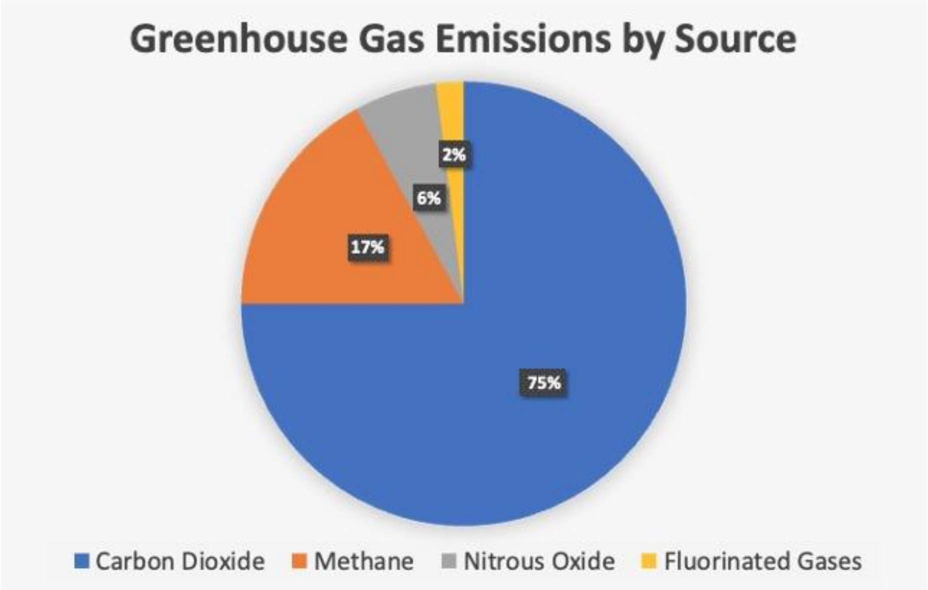
Rapid Deployment of Hydrogen



- The fastest path to an Energy Transition in North America would be hydrogen produced from natural gas in a decentralized modular manner. The local, decentralized production of hydrogen saves on distribution costs.
- **The grid could never be expanded as quickly as decentralized hydrogen from natural gas.**

- Steam CO2 reforming is more efficient and produces less CO2 than steam methane reforming. The process uses heat from electricity (as opposed to natural gas) so it has no combustion.
- **Hydrogen from steam CO2 reforming will clean our air when compared to either diesel/gasoline vehicles or to hydrogen from steam methane reforming.**

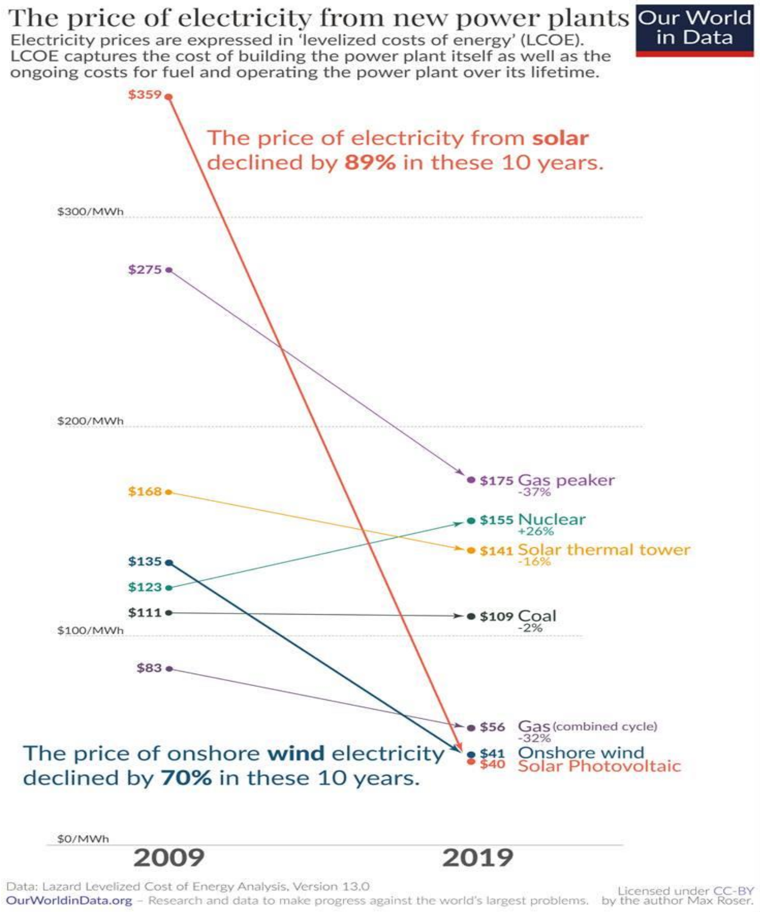
Flaring / RNG



- The majority of methane emissions come from flaring and the input gases to RNG (landfill gas, wastewater gas, manure gas, etc.)
- Steam CO2 reforming uses an extremely high temperature and has a long residence time so it can process flared or contaminated gas
    - The current system of subsidies for RNG makes little sense as the contaminated gas could be economically run through a steam CO2 reformer.

Transition Path: Renewables

Levelized Costs of Energy



- **Levelized Costs of Energy (LCOE) provides the economic justification for a rapid adoption of renewables.**

True Cost of Renewables

[40*.7+(40+250)*.3] / .68 = $169 /MWh

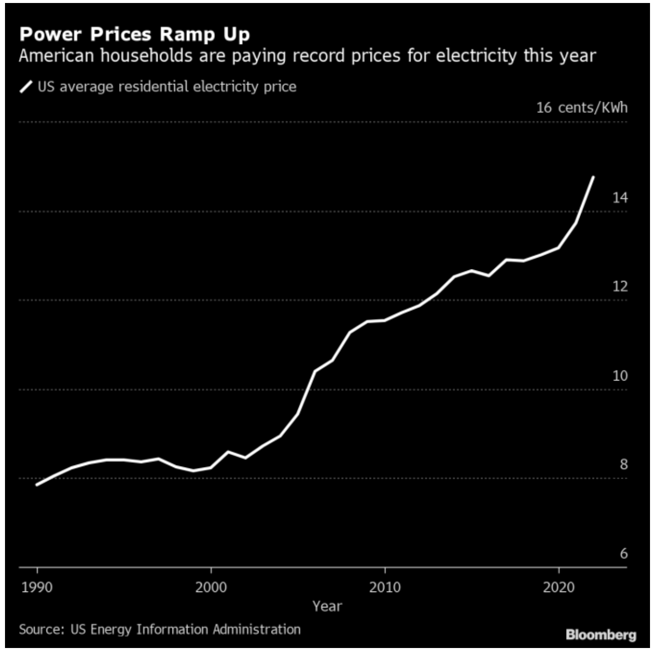
[LCOE * Utilization + (LCOE+LCOS) * Utilization] / (1 – Curtailment)

- **When storage and curtailment are accounted, renewables move from the lowest cost source of electricity to the highest.**

- At small scale, intermittency can be ignored but, at large scale, intermittency is problematic.
- More renewables will lead to blackouts if the electricity they generate underpins the grid.

- **The irony of pushing renewables is that it undermines the economics of BEV.**

Increasing Electricity Prices



- Power prices have steadily increased despite the huge shift of generation to natural gas and renewables, supposedly low cost sources of electricity.

- **More renewables forces the curtailment of natural gas generation which drives up the cost of electricity generated from natural gas. Renewables diminish the returns on traditional forms of electricity generation.**
- **Curtailment cannot be avoided when renewables are added to the grid.**

Master Plan Fails

"…the optimal generation and storage portfolio resulted in 32% curtailment."

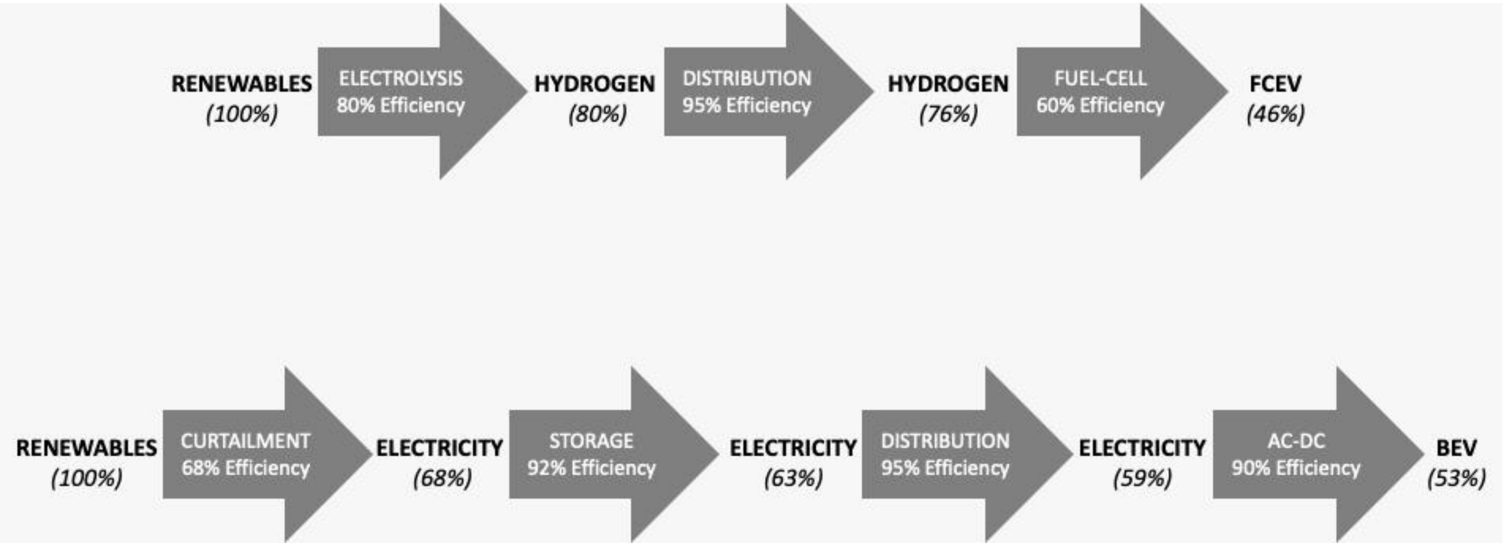
Storage/Other Technologies	Installed Capacity (GW)	Installed Capacity (TWh)
8h Lithium-ion Storage	815	6.5
Industrial Thermal Storage	453	6.9
Electrolyzer	418	Na
Hydrogen Storage*	Na	107
Total	1,686	120

Table 6: Model Results for US only

- **To balance the grid, the 'Master Plan Part 3' assumes 32% curtailment and, ironically, a massive amount of hydrogen storage.**

- The huge amount of curtailment indicates that storage is extremely expensive. Otherwise, the plan would increase storage and lower curtailment.
- Hydrogen is used in the plan to shift power from the shoulder periods to the winter or summer by using enormous salt caverns for storage.

Renewables Efficiency



- Running renewables through the grid is only slightly more efficient than making hydrogen directly.
  - Grid storage is 80% efficient (per EIA) and hydrogen storage is 48% efficient (and 30% of the electricity runs through storage.)

- **The slight efficiency gain does not warrant putting the security of the grid at risk.**

Hydrogen saves Renewables

- Efficiency does not take into account the capital costs to create the energy. A system can have high thermal efficiency, but cost a lot to build.

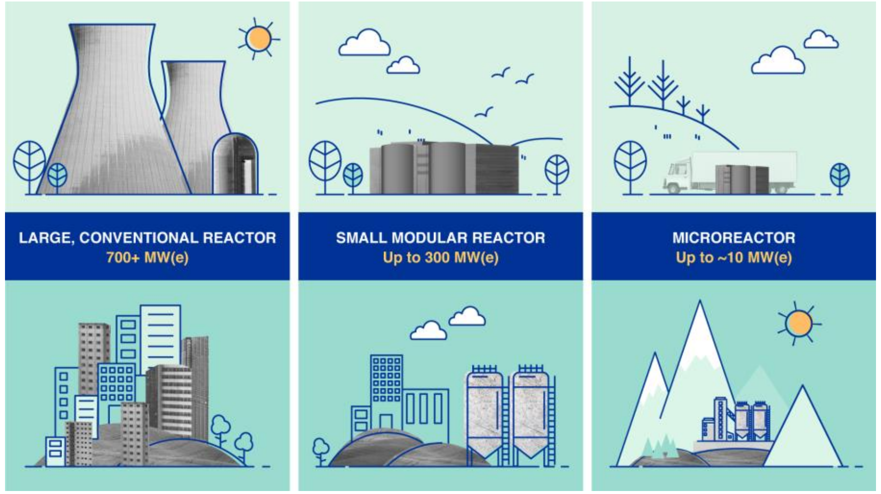
    - Transmission and distribution is 95% efficient but approximately doubles the cost of electricity. Copper, aluminum, securing rights of way, all add to the cost of transmission.
    - The Levelized Costs of Storage (LCOS) for hydrogen and battery are expected to be about equal despite the hydrogen system being ‘only’ 48% efficient. The huge cost of the batteries offset the higher battery efficiency.

- Capital costs for electrolyzers, storage, and fuel cells will drop rapidly as manufacturing scales. The Levelized Costs of Hydrogen (LCOH) from renewables will ultimately be much cheaper than the LCOE + LCOS of electricity from renewables.
- Despite cost improvements, hydrogen from renewables, like electricity from renewables, will be a higher cost source of fuel. Nevertheless, as the oil crisis unfolds, hydrogen from renewables could prove to be much more economic than diesel or gasoline.

- **Producing hydrogen from renewables avoids destabilizing the grid. Furthermore, if renewables are used to produce hydrogen, there will be NO curtailment.**

Transition Path: Nuclear

Small Modular Reactors



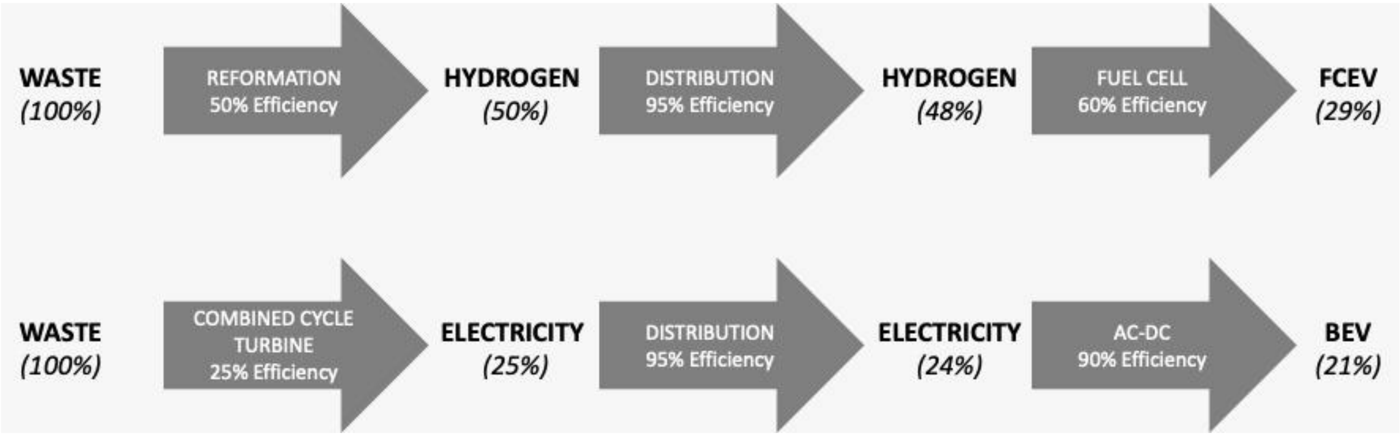
- **There is no sustainable future without a widespread nuclear renaissance.**

- Small Modular Reactors (SMR) are about a third the size of traditional plants. The smaller size allows systems and components to be factory assembly for large scale, low cost, rapid roll-out. The smaller size also makes permitting easier and more proximal to urban areas for lower distribution costs.
- SMRs are under construction or under licensing in China, Russia, India, South Korea, Argentina, Canada and the United States.

- **Traditional nuclear power is only 35% efficient with 65% of the energy escaping through heat. The heat can be used to make hydrogen through high-temperature electrolysis or through thermal chemical production. Nuclear could be a low cost source of hydrogen and hydrogen can make nuclear more efficient.**

Transition Path: Waste

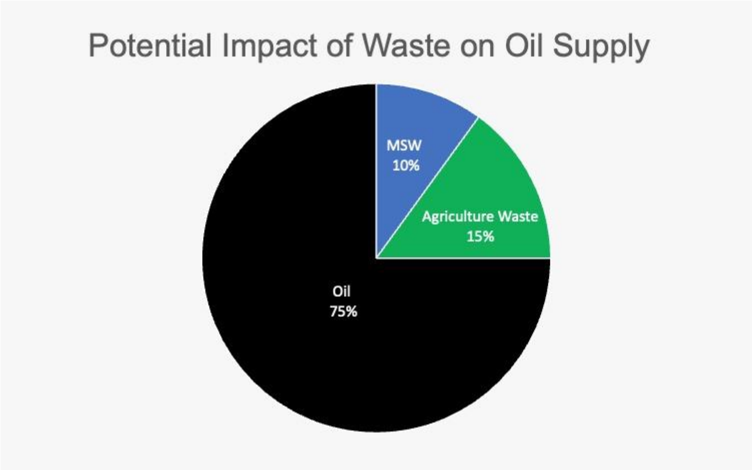
Waste Efficiency



- The thermal chemical reformation of waste is substantially more efficient than the combustion of waste. **Unlike other paths to an energy transition, the input is free.**
- With a non-combustion reformation process, the waste is disposed without any pollutants or contaminants released to the atmosphere. The process can handle plastics, medical waste, and other highly toxic materials. **The carbon intensity score is negative because the process prevents the release of landfill gas.**

- **The thermal chemical reformation of waste using a non-combustion process is the most green path to the energy transition.**

Material Impact



- Annually over 2B tonnes of municipal solid waste (MSW) is generated per year. Of that, over 250mm tonnes of plastic waste is generated. According to The World Bank, "***extremely conservatively***" over one third of the waste is not managed in an environmentally safe manner.
- Looking forward, The World Bank expects 3.5B tonnes of MSW by 2050.
- If all the MSW were reformed using a thermal chemical process, it could produce 10mmb/d BOE of hydrogen or Sustainable Aviation Fuel. If agricultural waste were also reformed, an incremental 15mmd/d BOE could be produced. Combined, waste could theoretically offset 25% of oil supply.

- **Waste is a local resource and available in all regions.**

Sustainable Aviation Fuel (SAF)

- There are three main ways of producing SAF:
    - Musk's theoretical plan: H_2 generated from electrolysis of water, CO generated from electrolysis or CO_2, syngas (H_2 + CO) then run through the Fisher-Tropsch process
    - Hydrotreated Esters and Fatty Acids (HEFA) process: refines vegetable oils and agricultural products
    - Thermal chemical reformation of waste: turns waste into syngas which then runs through the Fisher-Tropsch process
- The Musk process, while creative, is extremely expensive and will make air travel available only to the rich.
- Agricultural processes will put pressure on food prices.
- The thermal chemical reformation of waste will generate SAF from an input which is free while solving the waste problem. **This process will truly clean the planet**.

Energy Efficiency

Electricity is Expensive

	$ per kWh	$ per BOE
Europe	~0.40	$680
US	0.18	$306
China	0.08	$136

- The average price of diesel in the US today is ~$4.00 per gallon or $168 per barrel. Backing out taxes, this would be $147 per barrel or roughly equivalent to the price of electricity in China.
- Given the high cost of electricity, the 'efficiency ratio' or MPGe for BEVs needs to be high.
- Nevertheless, the ratio of MPGe versus MPG is a meaningless number because it does not take into account the cost of the fuel.

- **BEVs and FCEVs are cheaper to fuel because they run on nat gas/coal and not because they are more 'efficient'. Increasing renewables will increase the cost of fueling BEVs and FCEVs.**

The Efficient Hydrogen Economy

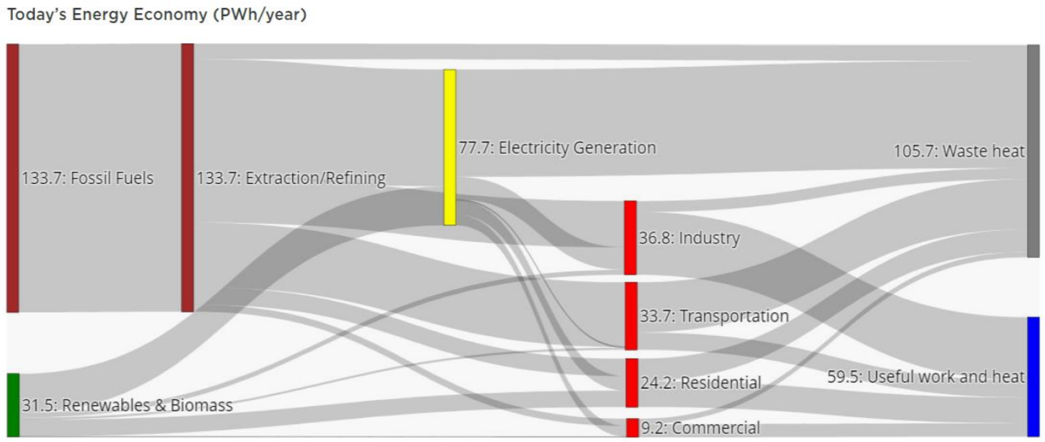


Figure 3: Global Energy Flow by Sector, IEA & Tesla analysis

Waste heat

Useful work and heat

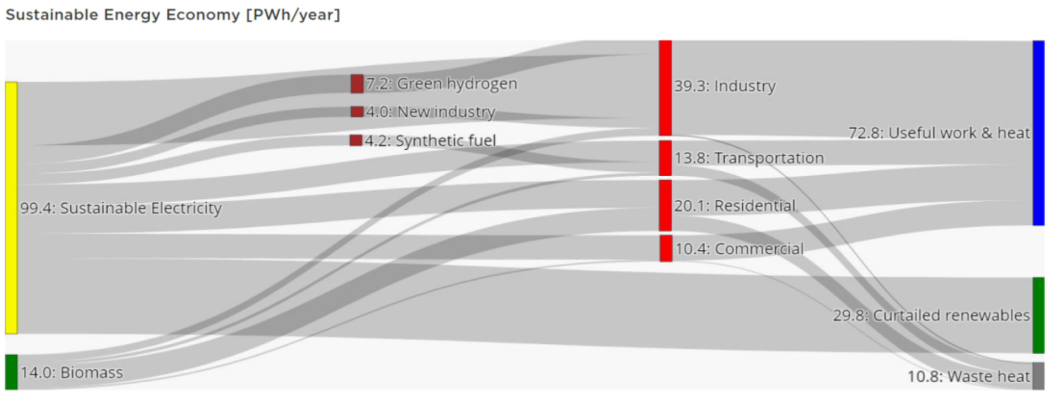


Figure 15: Sustainable Energy Economy, Global Energy Flow by Sector, IEA & Tesla analysis

Useful work and heat

Curtailment

- **The Hydrogen Economy will use 'waste heat' in the reformation of hydrogen and will not curtail renewables.**

Hydrogen Economy

Hydrogen Infrastructure Advantage

- Prudence dictates that we keep two energy systems (transportation / electricity). In a blackout, we still want to be able to drive.

- Hydrogen's largest advantage is that it is not dependent on the grid

    - The grid needs an overhaul
    - Over 70% of the US electricity grid is more than 25 years old
    - The Internet is increasing strain on the grid
    - Crypto is increasing strain on the grid
    - BEVs are increasing strain on the grid
    - Renewables are increasing strain on the grid
    - ➢ **Blackouts are increasing**

- A FCEV fueling network would replicate the current fueling network using a similar amount of real estate. A BEV fueling network would be over 8x larger than the current network because vehicles need to sit while they charge.

    - Over 8x more real estate is needed for a BEV charging network

- **Once the hydrogen fueling infrastructure is built there will be a network effect that will drive down costs.**

Hydrogen Charging Advantage

- A FCEV can refuel in about the same time as a diesel / gasoline vehicle. Range anxiety is minimal because FCEVs have long range and can always fill up quickly.
- A BEV can charge overnight when plugged-in, but could be 'stranded' at a charging station if used too much during the day. This disadvantage makes BEVs unpractical for commercial vehicles which have high utilization.

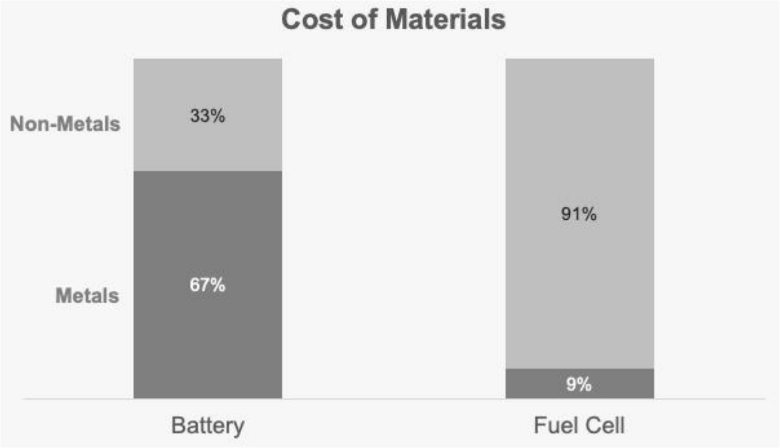
- **Super-Charging a Class 8 truck could be very problematic:**

  800 kW battery charged in 45 minutes needs over 1 MWh of power

  1 MWh equals what 825 US homes use on average

Blackout

FCEV Cost Advantage



- Once the network effect takes hold, economies of scale will drive down costs for the Hydrogen Economy. Battery production has already scaled so the majority of costs are in the metals.

  - **Metal cost inflation will devastate BEVs**

- The Hydrogen Economy relies on far fewer limited resources than the Master Plan.

- The Hydrogen Economy will require a much smaller infrastructure spend.

FCEV and BEV advantages

- Amazing acceleration – **FCEVs could have more torque because of lower weight than BEVs**
- Regenerative Breaking
- No emissions
- Silence

- Both vehicles are electric so much of the progress made on BEVs can apply to FCEVs
    - Electric power train

FCEV Only Advantages:

- Higher residual value
- Lower weight
- Better performance in extreme temperatures

Distribution Disadvantage

DOE / EIA 2030 costs	$ per kg	$ per kWh	$ per BOE
Compressed Hydrogen	0.9 - 1.9		43 - 90
Piped Hydrogen	0.2 - 0.5		9 - 24
Transmission & Distribution		0.054	92

- Hydrogen and electricity are very expensive to distribute compared to diesel and gasoline.
- Piped hydrogen has a large cost advantage over electricity transmission and distribution. Building a low cost infrastructure will greatly improve the efficiency of the Hydrogen Economy.
- Modular hydrogen production is more likely to use piped hydrogen distribution.

Limits to Resources

Land

Land Area Required

Solar land area requirement is estimated based on a US Lawrence Berkeley National Laboratory (LBNL) empirical assessment of actual US projects, which found that the median power density for fixed-tilt systems installed from 2011-2019 was 2.8 acres/MWdc[57]. Converting MWdc to MWac using a 1.4 conversion ratio yields roughly 3.9 acres/MWac. Therefore, the global solar panel fleet of 18.3TW will require roughly 71.4 million acres, or 0.19% of the total 36.8 billion acres global land area.

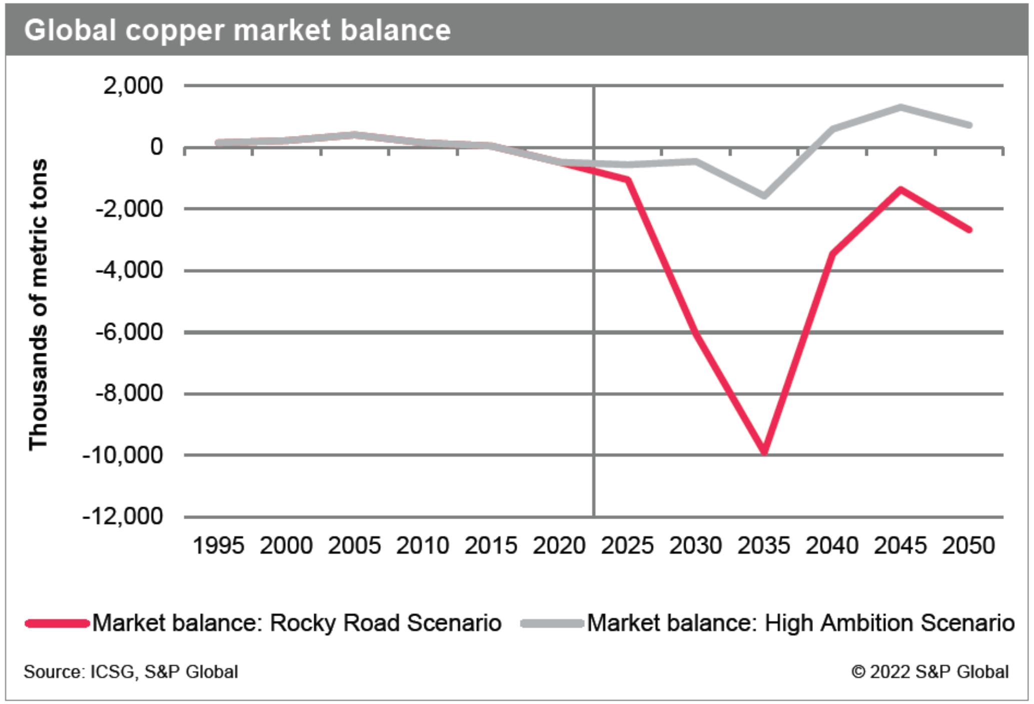
Wind land area requirement is estimated based on a US National Renewable Energy Laboratory (NREL) study which found that the direct land usage is 0.75 acres per MW[58]. Therefore, the global wind turbine fleet of 12.2TW will require an estimated 9.2 million acres, or 0.02% of total land area.

Table 14: Solar and Wind Direct Land Area by Continent

- In the ‘Master Plan Part 3’ scenario, Solar Direct Land Area and Wind Direct Land Area of total global land are only 0.19% and 0.02% respectively. (The dots are very hard to see because they are so small.)

- **The ‘Master Plan’ chart is greatly misleading. Global urban land area as a percentage of total global land was only 0.69% in 2020.**
- **The larger the distance from urban areas, the greater the transmission and distribution costs. Transmission and distribution costs are already equal to generation costs.**

Copper



- According to a recent study, ***The Future of Copper: Will the looming supply gap short-circuit the energy transition?***, Chaired by Daniel Yergin, it is likely that the world will be short copper.
- Most other copper market studies reach the same conclusion.

- **Given the stakes involved in the energy transition, a Hydrogen Economy that does not depend on the grid is the more prudent path forward.**

Nickel, Cobalt

Vehicle Type	Tesla Equivalent	Cathode	Pack Size (kWh)	Vehicle Sales	Global Fleet	Global Fleet (TWh)
Compact	[TBD]	LFP	53	42M	686M	36
Midsized	Model 3/Y	LFP	75	24M	380M	28
Commercial/ Passenger Vans	[TBD]	High Nickel	100	10M	163M	16
Large Sedans, SUVs & Trucks	Model S/X, Cybertruck	High Nickel	100	9M	149M	15
Bus	[TBD]	LFP	300	1M	5M	2
Short Range Heavy Truck	Semi Light	LFP	500	1M	6.7M	3
Long Range Heavy Truck	Semi Heavy	High Nickel	800	2M	13.3M	11
Total	-	-	-	**89M**	**1,403M**	**112**

Table 7: Vehicle Fleet Breakdown

- Musk implicitly acknowledges the limitations to nickel and cobalt production by moving his vehicles to LFP chemistry. LFP batteries are heavier and have poor charging performance so not an optimum choice.
- 42% of the battery power in the 'Master Plan Part 3' model is 'High Nickel'. These vehicles could be moved to FCEVs to avoid limits to resources and straining the grid.
- The remaining LFP vehicles could be a mix of FCEVs and BEVs.

Maximizing Resources

- Batteries are critical to the Hydrogen Economy. Every FCEV has a huge battery which is powered by hydrogen instead of the grid. The batteries provide extra power when the vehicle needs more torque (accelerating or carrying a heavy load.) When the fuel cell has excess capacity, it powers the battery. Furthermore, batteries allow for regenerative breaking.

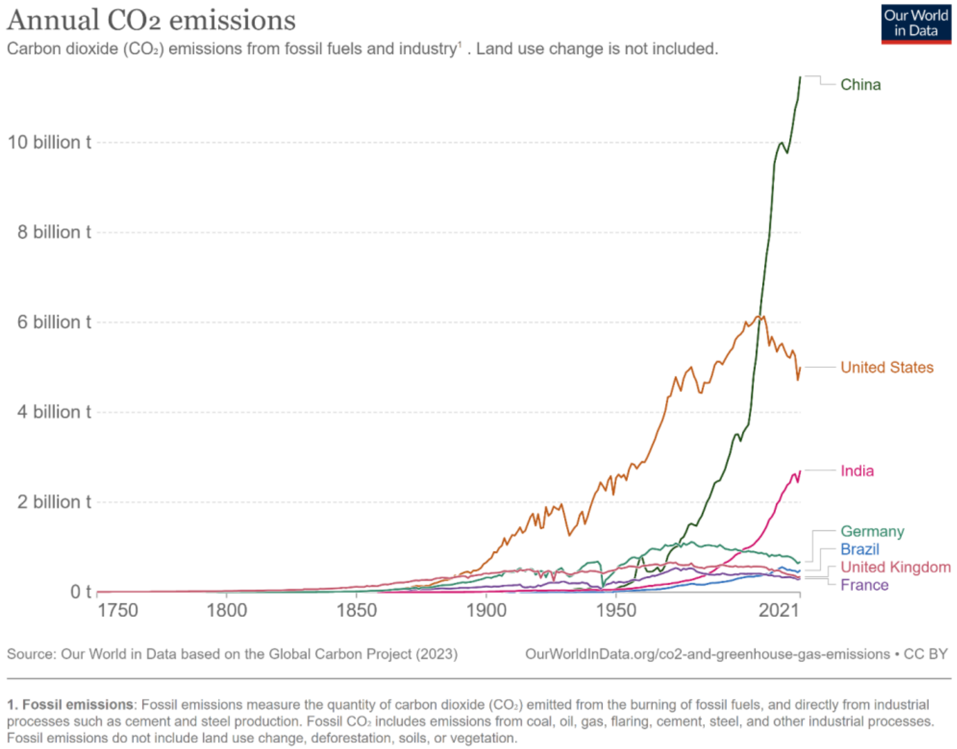
- Batteries for a FCEV are about a fifth the size of batteries for a comparable BEV. Given limited resources, 5x more FCEVs can be produced than BEVs.

- Atomic Layer Deposition ('ALD') is one of the most critical technologies for the energy transition. ALD provides a protective layer at the nano level to allow for 'thrifting' or cutting the size of the resource used. Materials used in the following products can be cut by up to 30% and still provide the same or greater output.

    - Batteries (cuts all battery metals)
    - Electrolyzers (cuts platinum and iridium)
    - Hydrogen Storage (cuts graphite)
    - Fuels Cells (cuts platinum)
    - Motors (cuts rare earth metals)

Energy Security and Human Flourishing

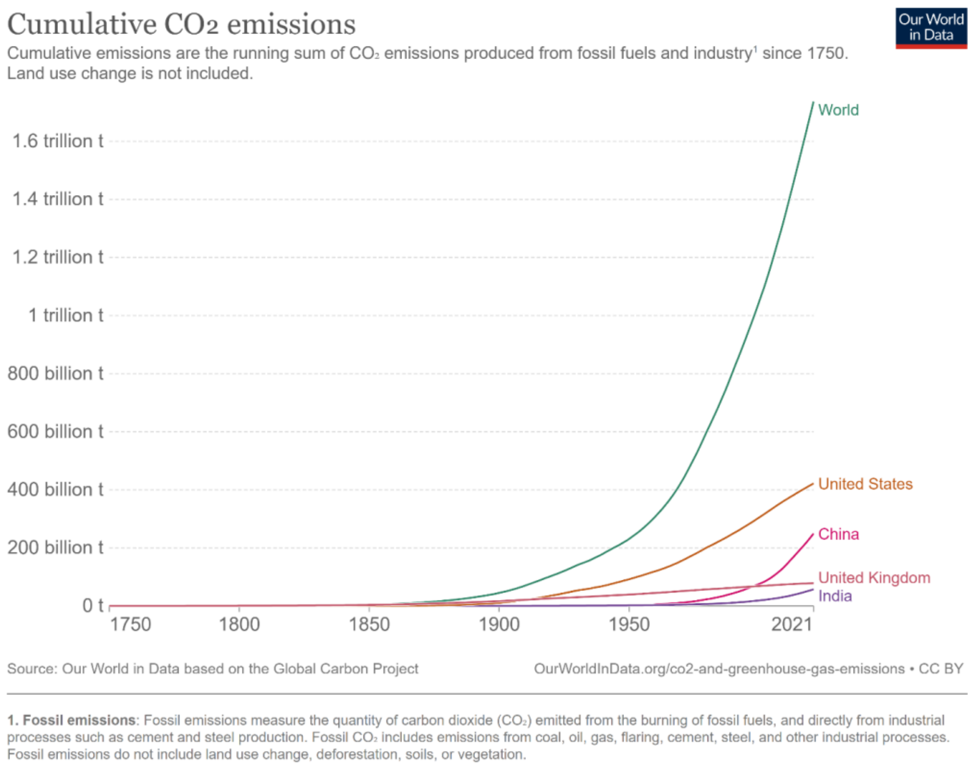
Policy Focus



- China is not dropping emissions, nor should it. The developing world deserves a higher standard of living.
- The BEV transition in China is driven by security of supply issues.
  - In China, BEVs produce significantly more CO2 than ICE vehicles because of the coal mix in the grid.
  - Chinese electricity prices are very cheap creating a further economic incentive to buy BEVs.

- The West's primary policy focus should also be energy security and human flourishing.

CO2 Saturation



- CO2 emissions are cumulative. Even if the OECD drops emissions, they will still add to cumulative CO2. The developing countries will not drop CO2 emissions, nor should they.
- The warming effect of each additional CO2 molecule decreases logarithmically as its concentration increases. There is a CO2 saturation point where incremental CO2 has minimal impact on heat trapping. CO2 saturation is not debated although there is some debate as to whether we have already hit saturation.

- **Peak oil supply could cause a much bigger crisis than global warming. Fortunately, climate concerns have started us down the transition path.**

Master Plan Redux

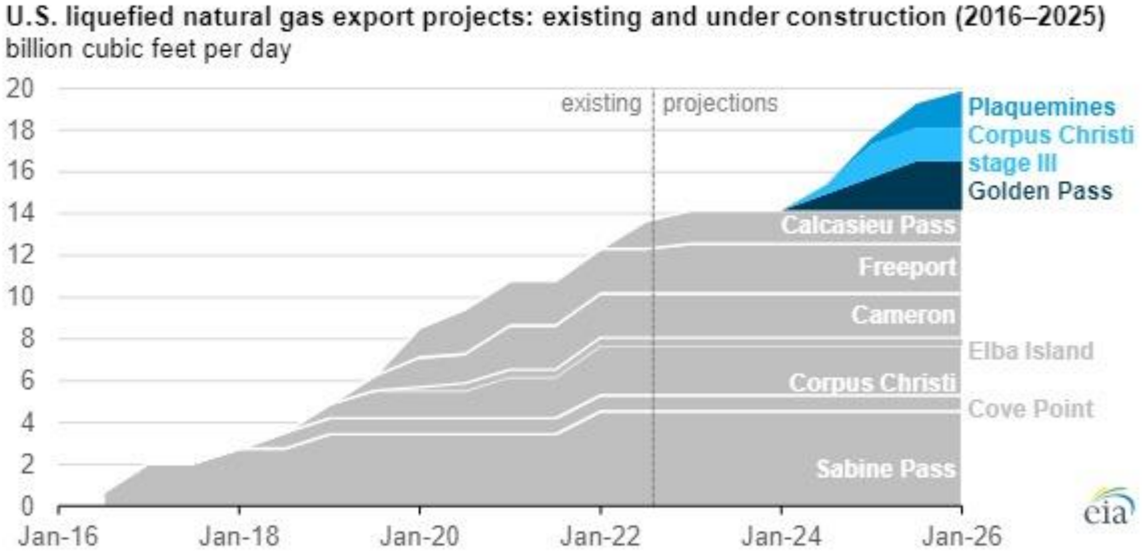
- Pivot hard to hydrogen produced from natural gas in North America to free up oil for the rest of the world. While this is a temporary solution, it could substantially mitigate an oil crisis.

- Push as hard as possible on the thermal chemical reformation of waste to produce hydrogen and SAF. The thermal chemical reformation of waste has the important benefit of meaningfully cleaning the environment.

- Accompany renewables with electrolysis in order to keep the grid balanced. A broken grid could lead to societal collapse, a risk that should not be taken.

- Accelerate Nuclear SMR and use the ‘waste heat’ to produce hydrogen. Ultimately, nuclear is critical to sustain human existence and we cannot delay this path any longer.

Reaction Time



- Impressive feats are possible with the right plan:
  - The US went from minimal LNG exports to being the world's largest LNG exporter in 6 years.
  - The US added the equivalent of 2 Saudi Arabias worth of oil production in the last 15 years (oil + gas.)
- **Transitioning to a Hydrogen Economy in short order is possible.**
- **Fuel Cell technology is finally at a point to enable the transition to a better world.**

National Security

- China controls the BEV transition. America can control the hydrogen transition.

- American was the largest producer of coal, then oil, and then natural gas.

    - America should become the largest producer of hydrogen. We have the resources and the ingenuity to make this happen.

Human Flourishing

- **A Hydrogen Economy ultimately powered by waste, renewables, and nuclear could be a better world than the world we live in now.**
    - **The hydrogen economy will be powered by lower cost resources than oil.**
    - **Every region can be energy secure and clean.**
- **In the interim, by producing hydrogen from natural gas and exporting North American oil, the world economy will be protected from the coming oil crisis.**

Mark Gordon, CFA

Mark Gordon is Managing Partner and CIO of Ascent Funds. He is a former CFO and Director of the Board for NASDAQ-listed Hyzon Motors.

Prior to this, Mark was a senior portfolio manager at Janus Henderson, where he managed the Alphagen Energy Funds. Before that, Mark was a Senior Analyst at Paulson & Co responsible for the energy sector. Prior to Paulson, Mark was a Portfolio Manager at Soros Fund Management where he ran an energy and natural resources fund for three years. Mark spent eight years at Goldman Sachs Asset Management ending as a Portfolio Manager and a Managing Director.

Mark has an MBA (honors) from the University of Chicago with concentrations in Analytic Finance and Economics. Mark has an MA from Stanford University and a BA from Brown University (honors). Mark is a CFA charterholder. Mark was awarded a second degree black belt in Tae Kwon Do and he completed the Ironman Triathlon World Championship in Kona, Hawaii. Mark is based in Miami.