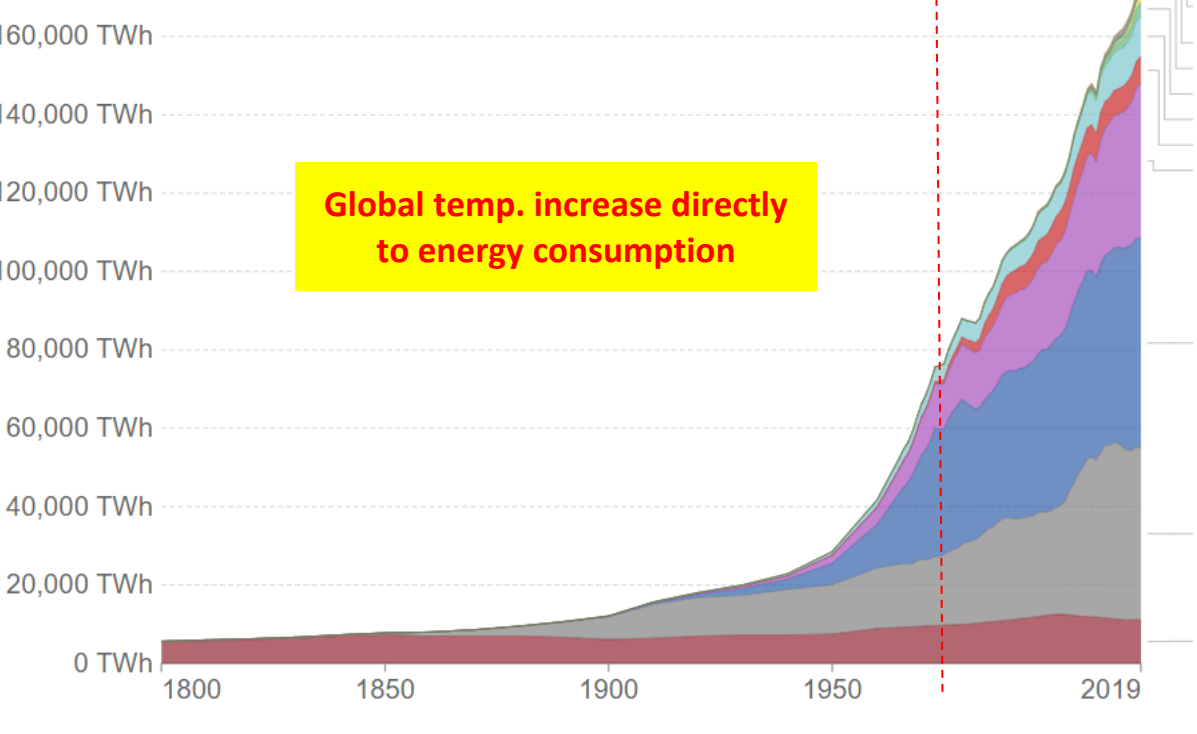
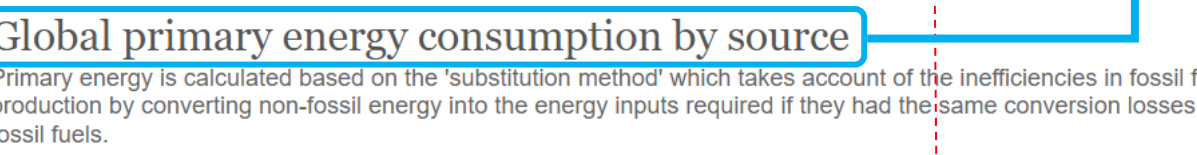
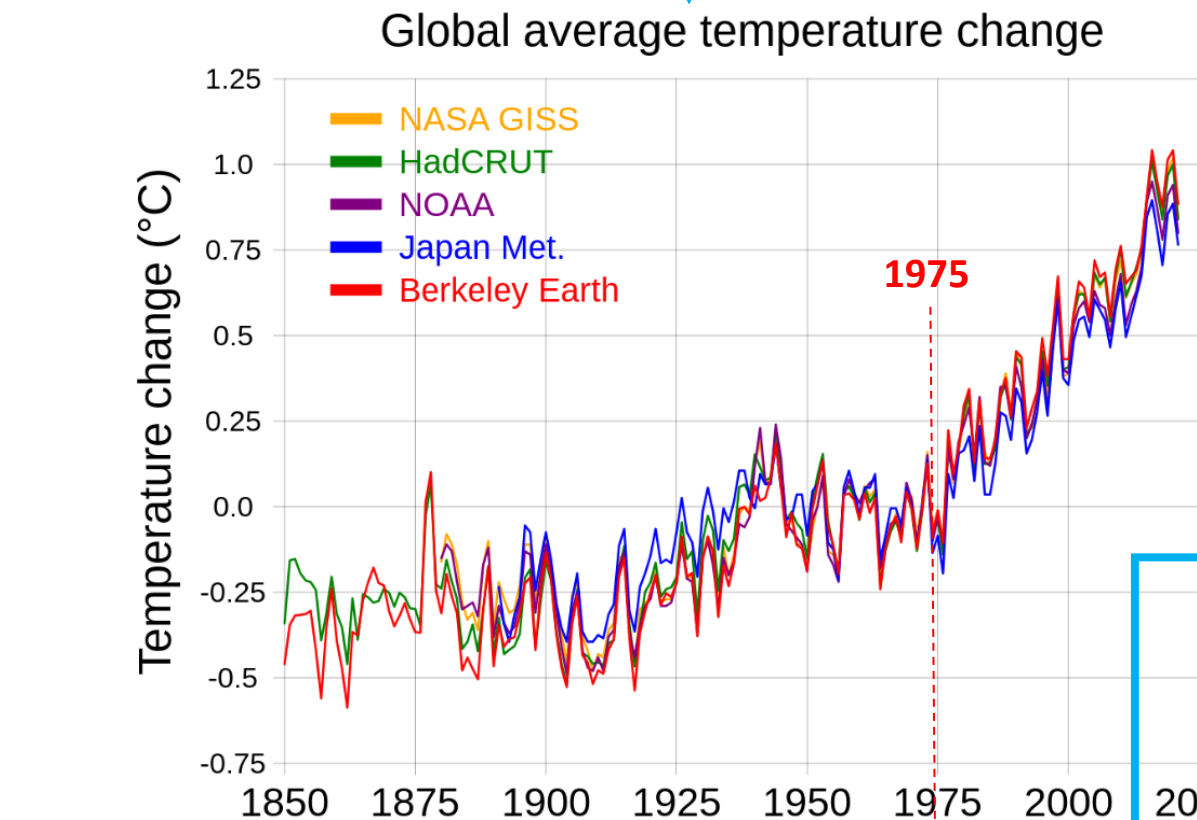
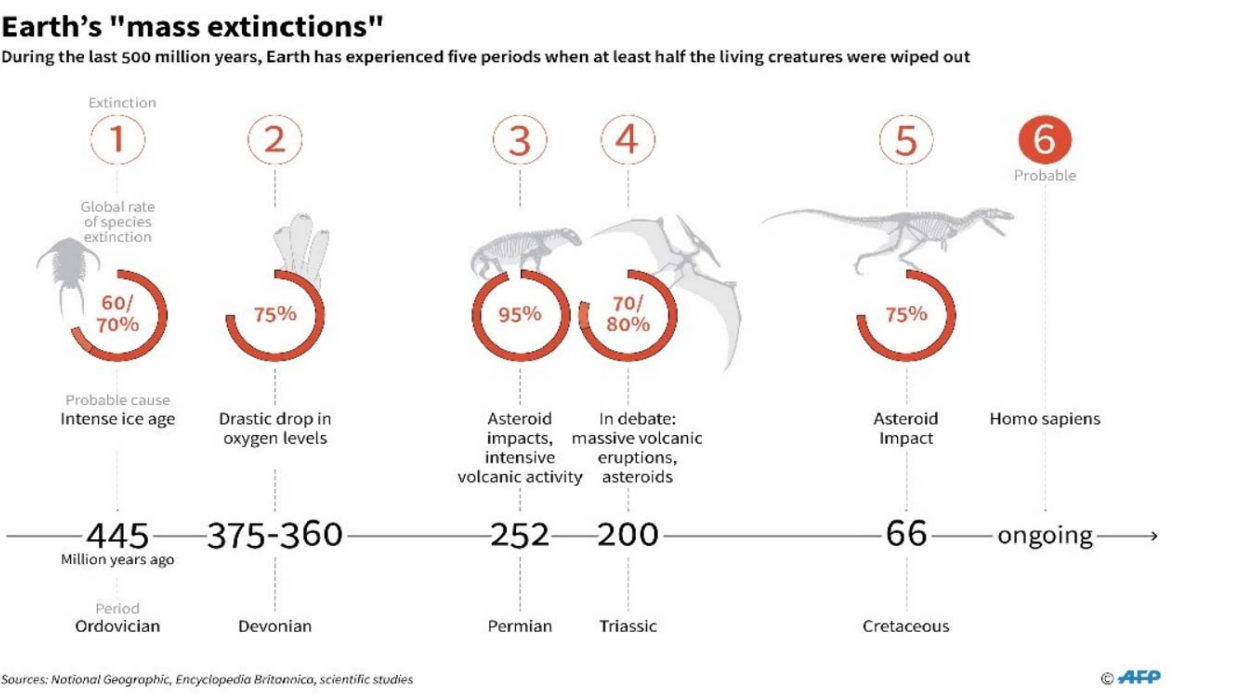
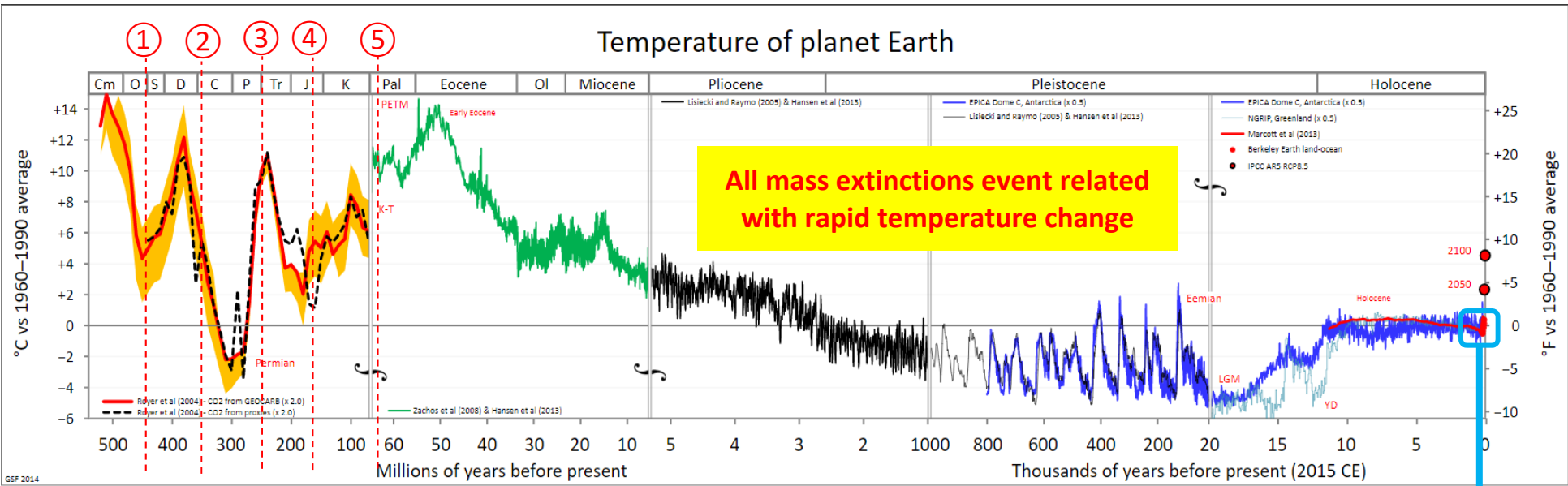


Global temperature change vs energy consumption & renewable energy

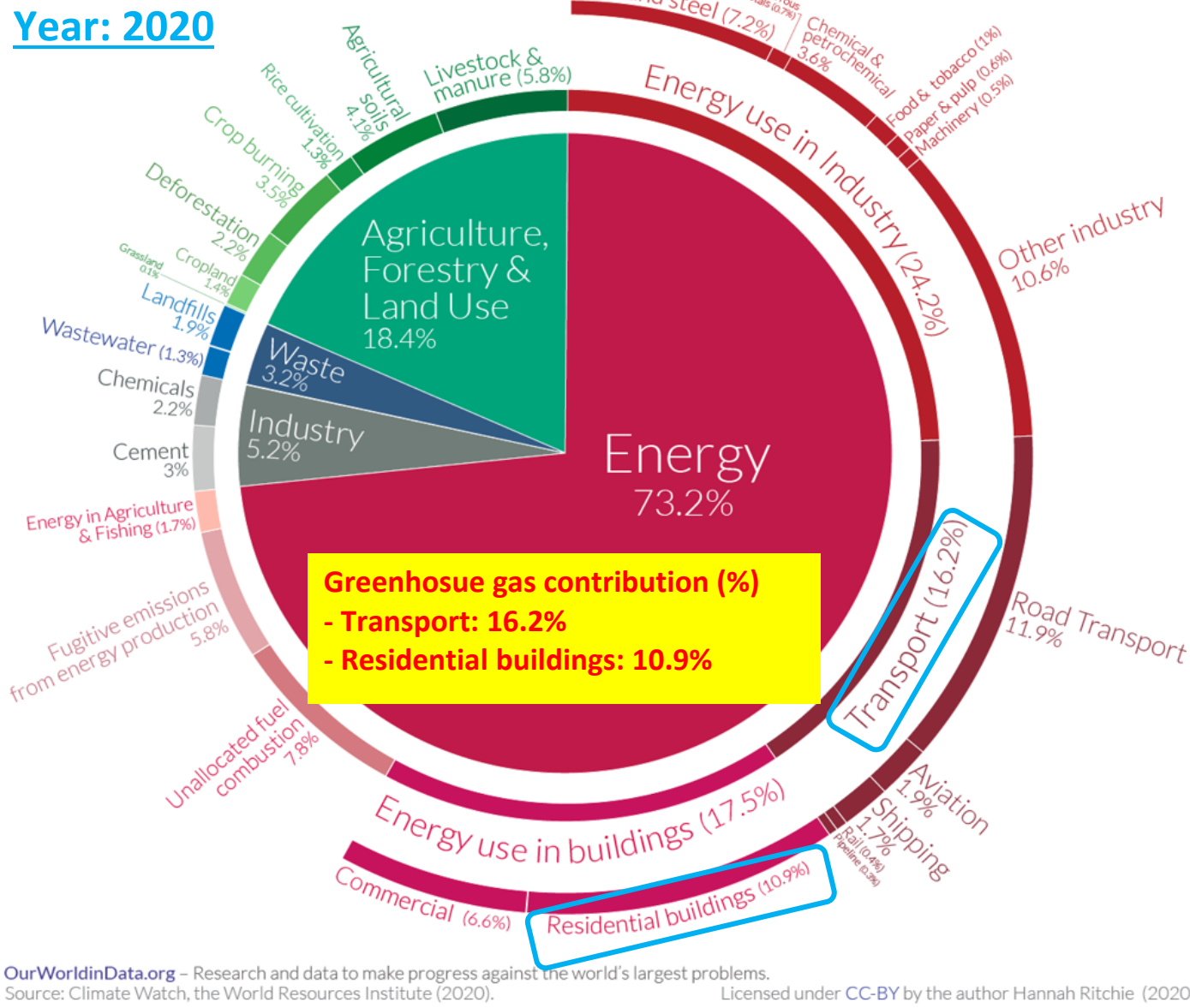
Summary by Nattawat Rattanalangkarn (September 2022)

- Key points
- Global temperature history + event (REF)
  - Energy consumption vs temperature change
  - Green house gas emission by sector
  - CO2 emission by fuel type / region
  - what would be our future by 2100?

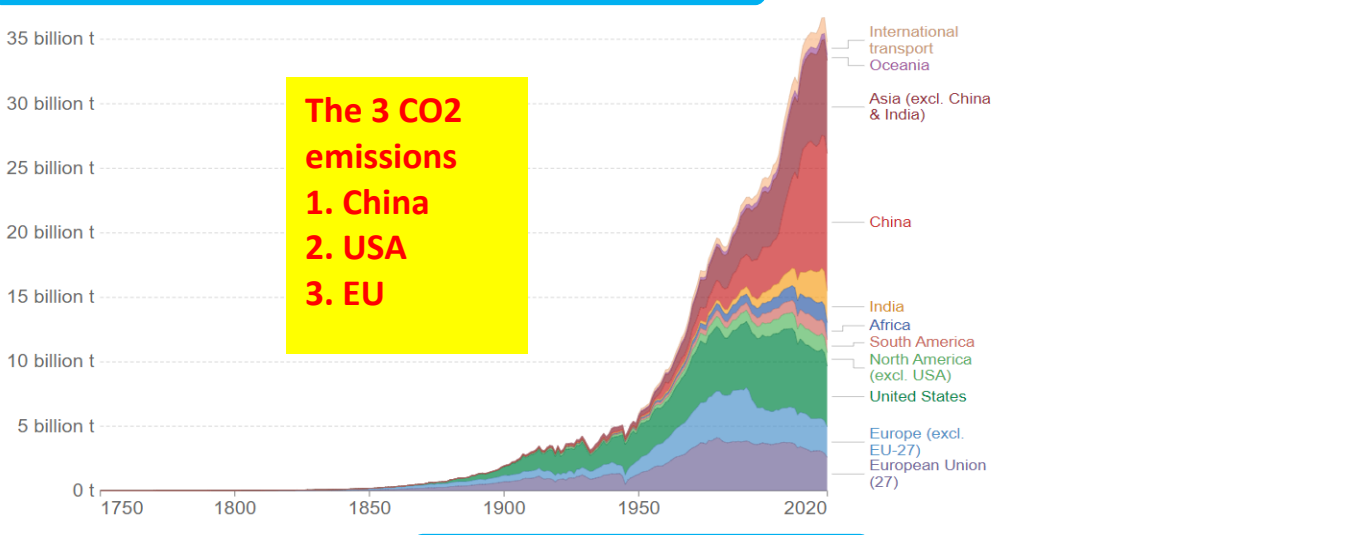


Global greenhouse gas emissions by sector

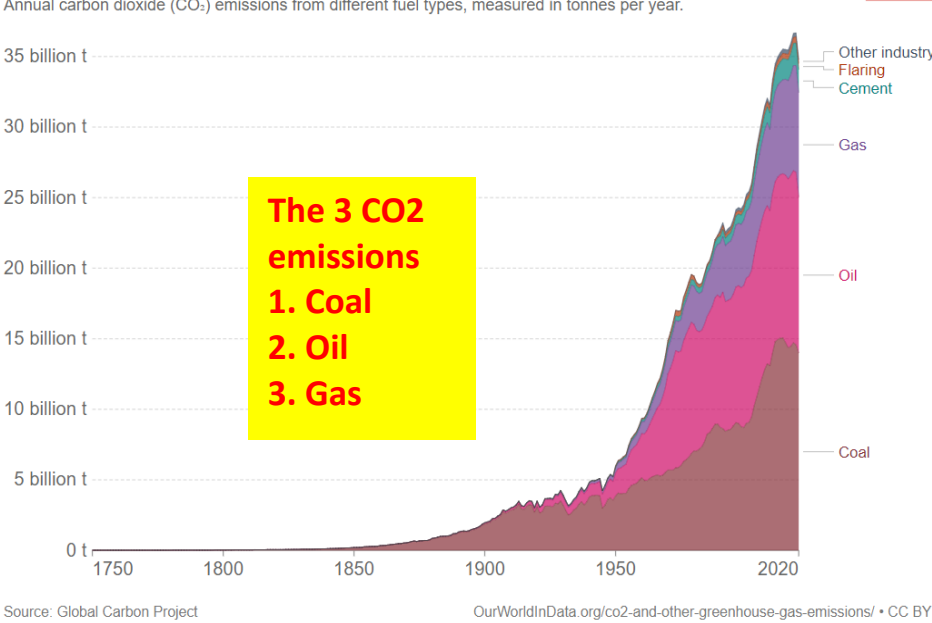
This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO<sub>2</sub>eq.



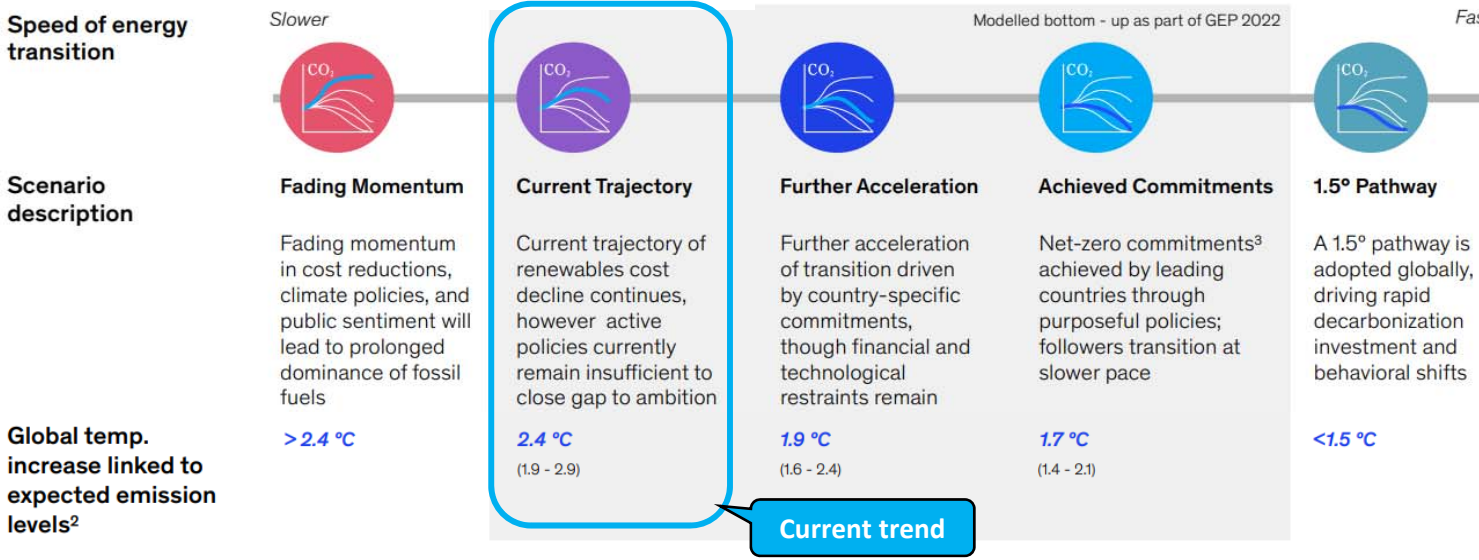
Annual CO2 emissions from fossil fuels, by world region



CO2 emissions by fuel type, World



What would be our future by 2100?



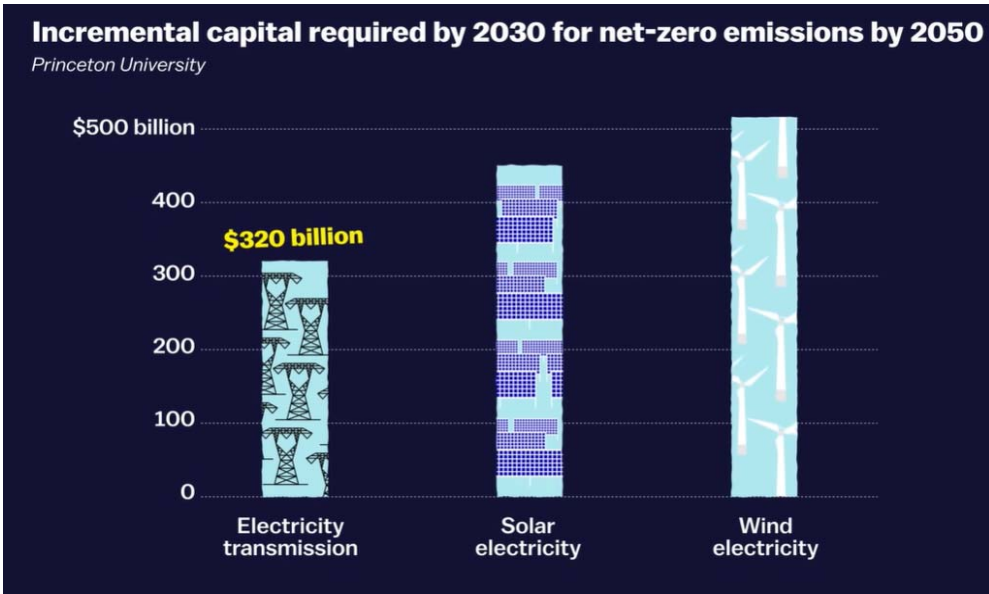
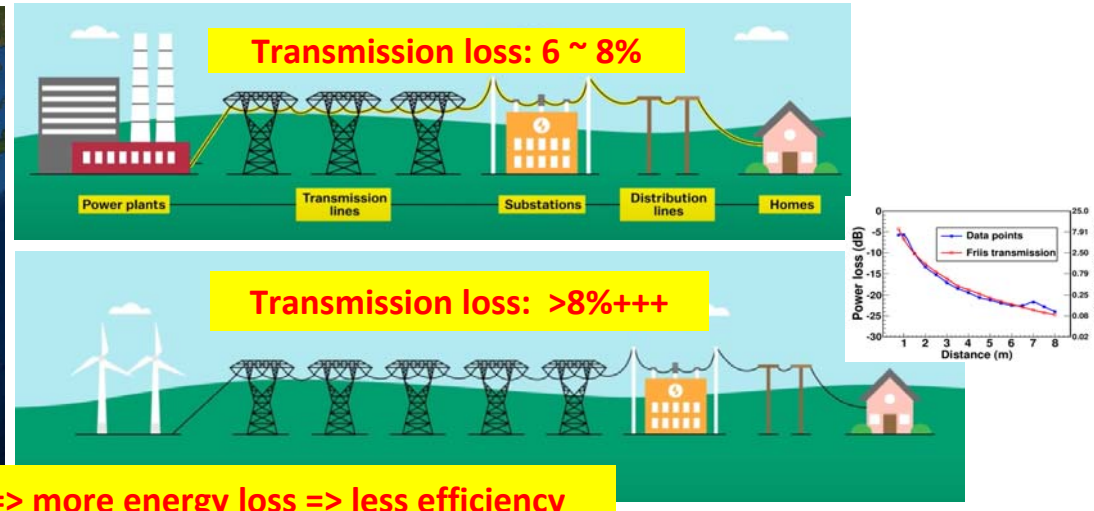
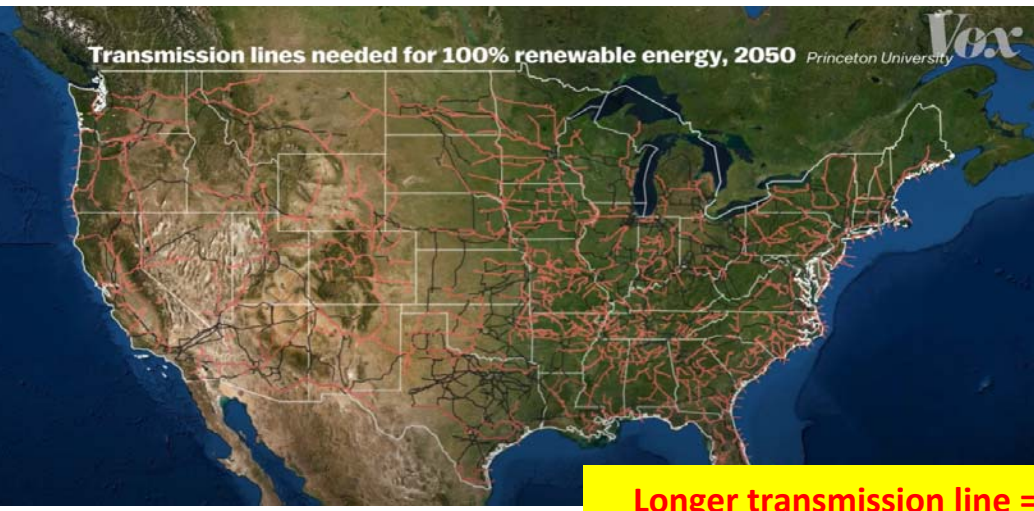
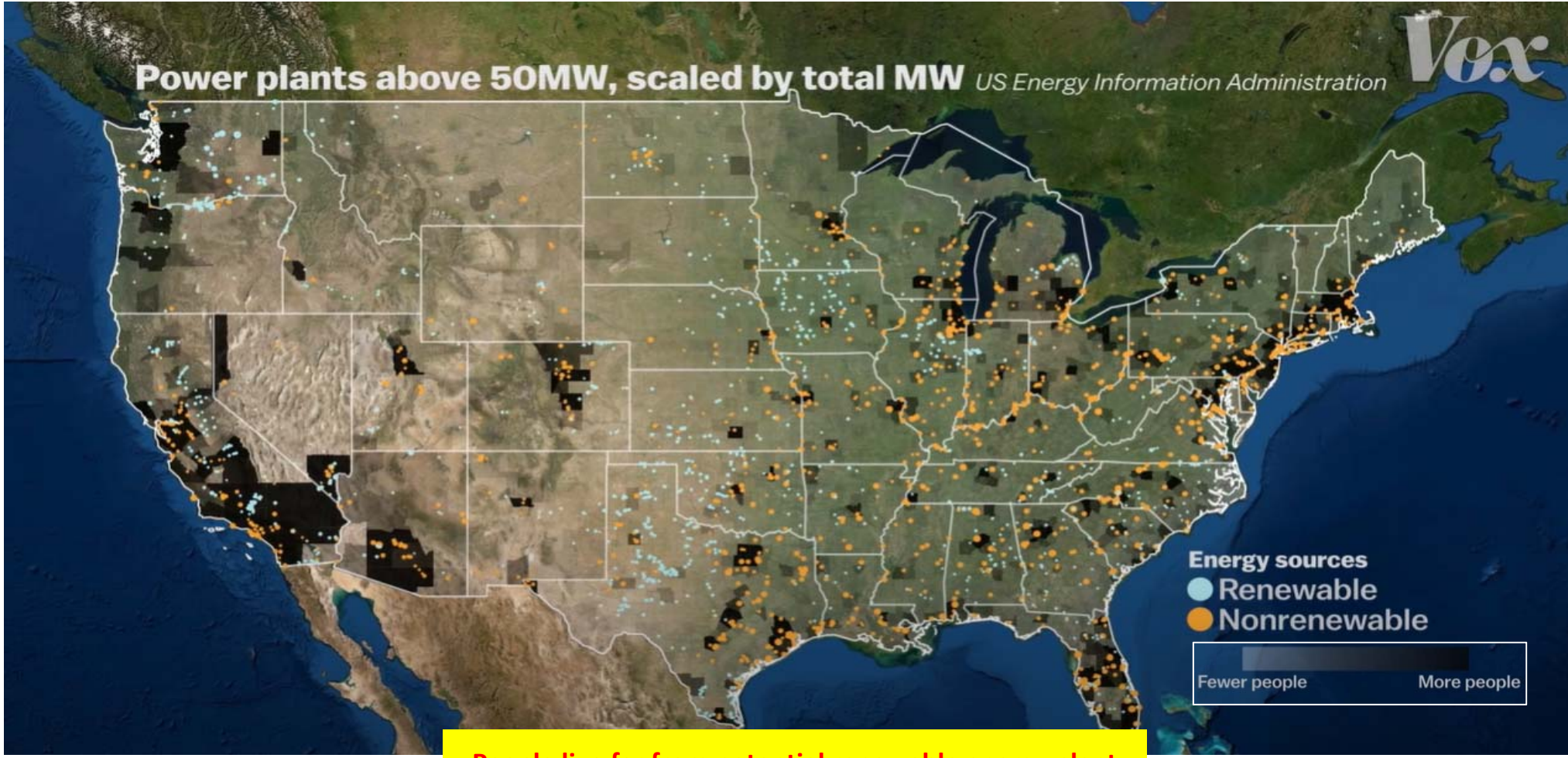
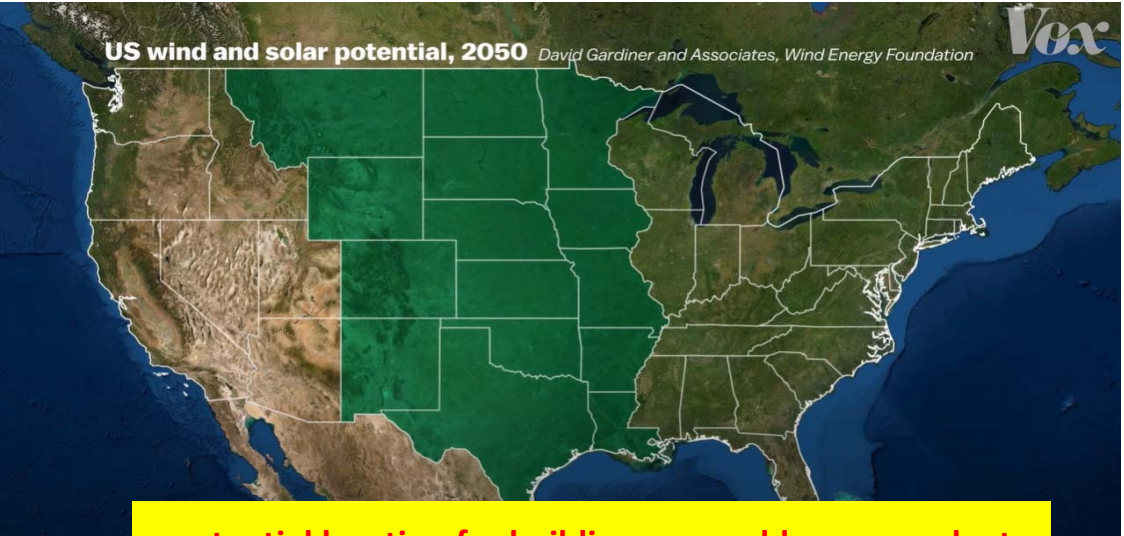
What are current restriction of renewable / alternative energy? (interm of science & engineerings)

Summary by Nattawat Rattanalangkarn (September 2022)

Renewable energy

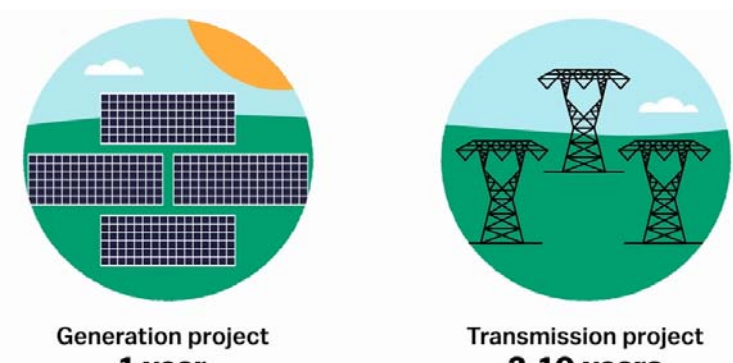
Restriction of renewable energy (Wind farm & solar farm)

1. Current power line capacity (not design for additional power source)
2. Renewable enery plant location (cannot use current facility)
3. Required new grid system / new transmission line



\*REMARK: more transmission => need to consider expropriate

Estimate construction lead time



Summary

- Need high investment
- Need time for building infrastructure
- Less transmission efficiency (higher energy cost)

Alternative energy (Transport)

Restriction of alternative energy

1. Efficiency (energy source weight / outpur)
2. Cost
3. Supply station

Output energy / weight efficiency comparison

- 1 Kg of diesel fuel is roughly => 45.5 MJ/kg
- 1 Kg of batteries produce => 2.5 MJ/kg
- \*output/kg less than diesel 18 times\*

- A SUV with full tank: ~68 Kg of diesel (Capacity: 80L) if want to travel to same distance by batteries: 918 Kg (\*Estimate fuel conversion loss ~25%)

Due to energy / weight efficiency problem => Aviation and shipping still cannot implement batteries

So how many energy options for road transportation?

	Advantage	Disadvantage
1. Mild Hybrid Electric Vehicle (MHEV)	1. Lower CO2 emissions (compare to ICE) 2. Better fuel economy (fuel cost down - compare to ICE) 3. Smoother ride (Compare to ICE) 4. Vehicle cheaper than HEV	1. More mechanical parts (compare to ICE) 2. More expensive repair cost (compare to ICE)
2. Hybrid Electric Vehicle (HEV)	1. Lower CO2 emissions (compare to MHEV) 2. Better fuel economy (fuel cost down - compare to MHEV) 3. Smoother and silent in EV (Compare to MHEV) 4. Lower taxes than MHEV	1. More mechanical parts (compare to MHEV) 2. More expensive repair cost (compare to MHEV) 3. Vehicle price more expensive (compare to MHEV)
3. Plug-in Hybrid Electric Vehicle (PHEV)	1. Lower CO2 emissions (compare to HEV) 2. Better fuel economy (fuel cost down - compare to HEV) 3. Smoother and silent in EV (Compare to HEV) 4. Lower taxes than HEV 5. Charge with cable	1. More mechanical parts (compare to HEV) 2. More expensive repair cost (compare to HEV) 3. Vehicle price more expensive (compare to HEV) 4. Consume more fuel with 0 battery
4. Battery Electric Vehicle (BEV)	1. Zero CO2 emissions 2. Completely Smoother and silent 3. Lower taxes 4. Higher torque	1. Higher maintenance cost 2. Changing infrastructure not enough 3. Fully charge ~1 Hr 4. Short driving range 5. Heavier vehicle weight - Tesla model 3 (Standard range) => Weight: 1,611kg / travel range: 438km - Toyota altis 2022 (1.6 Standard) => Weight: 1,315kg / travel range: 780km
5. Fuel Cell Electric Vehicle (FCEV)	1. Zero CO2 emissions 2. Completely Smoother and silent 3. Lower taxes 4. Higher torque 5. Fast refueling 6. Longer travel range	1. High maintenance cost 2. Need high infrastructure investment 3. Highly flammable 4. High fuel cost

this picture shown compulsory equipment only  
\*in actual vehicle may come with battery\*

Key points

Renewable energy power grid need to develop along relatively with EVs growth, otherwiss we will end up convert CO2 emission from Oil => Coal only



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How electricity is produced

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Renewable energy restrictions in US

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[https://www.youtube.com/watch?v=a4pXAmljdUA&list=PLZhp889UPLIoN2piMka4TjClZkq0u1b\\_1&index=3&ab\\_channel=Let%27sGrowUp](https://www.youtube.com/watch?v=a4pXAmljdUA&list=PLZhp889UPLIoN2piMka4TjClZkq0u1b_1&index=3&ab_channel=Let%27sGrowUp)