Line 3, Oil and Climate

Tuesday Group, Ely MN Sept 14th 2021 Barbara Jones

This is the first of two talks on Line 3. The second will be given by Frank Bibeau, lawyer and activist who will talk about legal issues, social justice and treaty rights. Here we will investigate why Line 3 exists, what it carries, what it does to the environment and climate, how we use oil, how dependent we are on it, how we can address the problems. We will also consider how Keystone XL, Line 3 and Dakota Access have given us such powerful ways to protest against the increasing use of this very damaging resource. The first image is from Enbridge showing the pipeline being assembled before it is put underground. The second image shows the resistance movement led by indigenous people and people across the state and beyond. The protesters were cuffed and arrested shortly after this image was taken. This was one of many ongoing protests along the route of the pipeline.

What do the protesters want? The obvious answer is that they want to protect the land and water from oil spills. Many are indigenous people, the land is covered by treaty rights and is held sacred by many. But they want more than that, they want "**SYSTEM CHANGE**". We are held hostage by oil. In our present society without oil there would not be enough food. Planting seed, fertilizing, pest control, harvesting and transport are all dependent of oil. Almost all of our everyday goods also depend on fossil fuels for their production and distribution. We have an oil addiction. As a result we are pumping greenhouse gases into the atmosphere and changing the environment and climate we rely on for our continued civilization. We need energy but it must be clean energy. The protesters are making a statement to make us reflect on our situation and take action to convince our legislators to take climate change seriously.

Excerpt from "The Pipeline and the Paradigm" by Samuel Avery

The Keystone XL pipeline is the fuse of the Alberta carbon bomb. It connects billion of tons of tar sand carbon to the atmosphere. In scope it is local, regional, national, and global. The pipeline is a real physical presence in itself and symbolic of a reality larger than itself. It will devastate the lives of indigenous people who live in and downstream from the tar sands region, endanger those who live along its route, and put at permanent risk those who live in the world it will forever alter. A handful of forward thinking people will not stop it physically, but if they try to stop it, there is an excellent chance they will bring revolutionary new awareness to the society that witnesses them in action. The pipeline will become a symbol of environmental degradation as a whole.

This text comes from the protesters themselves. It is part of a full page ad in the StarTribune submitted by "***We Protect the Waters.org", "Giniw Collective", "RISE Coalition", "Red Lake Treaty Camp", and "Honor The Earth"***

"Dear President Biden,

Your presidency is a watershed in human history, the last chance to turn the tide before climate disruption spirals out of control. We are encouraged and grateful that you clearly signaled your resolve by rejecting the Keystone XL pipeline on day 1. The "climate test" for the KXL decision was clear and compelling. We ask you to apply it now to the Enbridge Line 3 pipeline.

The imperative to end fossil fuel infrastructure expansion is common sense, backed by multiple lines of scientific and economic research.

As significant as the climate policy implications, Line 3 violates the rights and lifeways of the Anishinaabe people by endangering the headwaters of the Mississippi River, including critical areas for hunting, fishing, harvesting wild rice, and cultural resources -- rights that the US is bound by treaty and integrity to uphold.

Please end the era of fossil fuel expansion decisively, so we can begin the era of clean energy and climate solutions with all the hope and commitment it requires. Science, justice, and the boundless American capacity to tackle big challenges are on our side. Time is not."

This is what is mined in Alberta Canada. It is called oil sands if you are in the oil biz, or tar sands if you are an environmentalist. It is a very heavy oil and sand mix that is almost solid. The sand is removed with a process that uses water and a frothing agent. The products are bitumen, dirty sand and water with an oily froth on top. The bitumen has a consistency between molasses and peanut butter and has to be processed into synthetic crude or mixed with more fluid hydrocarbons to make it flow through a pipe.

Open pits mines are so large they can be seen from space. Here are two maps at the same scale. One larger map shows the open pit complex north of Ft. McMurray in Alberta. The area shown is about 50 miles from end to end. For comparison the smaller map is at the same scale and shows the Rust Hull Mahoning iron open pit mine near Hibbing MN.

Here are some images of the open pit mines. The general view shows the tailings ponds, a yellow sulfur storage area and a refining plant.

To access the tar sand layer the trees of the boreal forest and muskeg (overburden) must be removed.

Giant scoops remove the tar sand and trucks which are the largest in the world take it to be processed. After the sand is removed the bitumen is either refined it into “syncrude” (synthetic crude oil) or mixed with liquid hydrocarbon gas to form “dilbit” diluted bitumen.

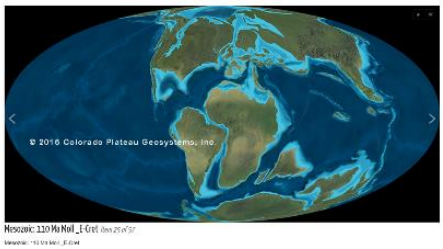
The process uses a lot of water, up to 4:1 water to oil. The waste water, a nasty, oily, waste-slime yuck, is pumped into giant tailing ponds. Picture a pond fourteen miles in circumference with icky water floating on a forty-meter-thick layer of oil/sand/dirt slurry. It is so toxic birds die if they land. The orange scarecrow you see here is part of a system to keep birds away.

The Cretaceous 150 – 66 million years ago

Oil formation happened during the Cretaceous Period around 110 million years ago. The earth was warmer than now, due to volcanic activity. There was no ice at either pole and sea levels were high. Dinosaurs roamed the land.

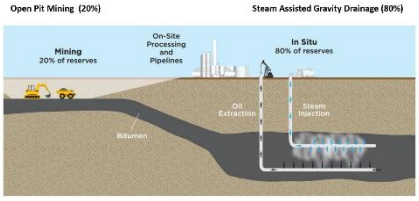
The continents were moving away from Pangeia but the major landmasses including North America are recognizable. There was an inland sea covering the central part of N America at that time. Phytoplankton, algae zooplankton lived in the water. Like plants they convert sunlight carbon dioxide and water to make hydrocarbons. The organisms die, sink and over the millennia form a layer mixed with sand on the bottom.

110 million years ago Cretaceous

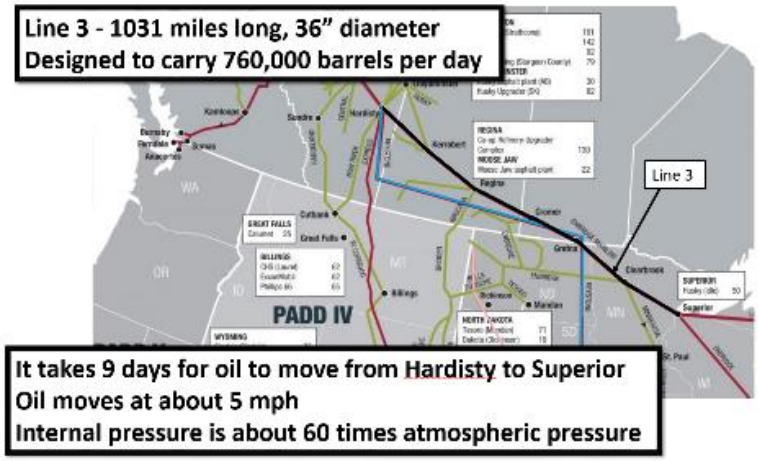


Eventually plate tectonic movement caused the Pacific Plate to hit the North American plate. This forced the Rocky Mountains to rise and the mid-continent ocean vanishes. The accumulated hydrocarbons get buried and baked. Temperature is important when you are baking. In this case the oil ended up a bit overdone making bitumen not sweet crude oil.

Some of the bitumen occurs near the surface and is dug in open pits. Most (80%) is too deep and is reached by wells. To extract the deeper material 2 wells are dug vertically down into the tar sand layer, then horizontally through the layer. Steam from superhot water is squirted through the upper pipe into the upper part of the oil layer to melt the ooze, the lower pipe collects the melted oil which is then pumped out for processing. This is called "In Situ" or SAGD Steam Assisted Gravity Drainage. SAGD needs a lot more energy and water to extract the oil than open pit mining.



This is what SAGD looks like. It seems less destructive than open pit mining, but the forest is chopped up with access roads, pipes, power lines, waste water lakes and processing plants. Open pit extraction was used first, but with 80% of the resource too deep for open pits the SAGD process is now extensively used. More than half of the oil extracted now comes from SAGD.



Ideally oil is found near the industries that use it. Three major things determine the price of oil.
1. Light vs heavy,
2. Sweet vs sour (sulfur content is undesirable)
3. Access to users.
The Alberta Oil Patch is not near the industrial center of Canada, or near the ocean for tanker transport. The oil is also heavy and sour.

Many large pipelines fan out from Alberta. PADD stands for Petroleum Administration for Defense District established during gasoline rationing in WW2.

Blue shows Keystone. This is the "original" Keystone owned by TC Energy (Trans Canada) which is operational at 590,000 barrels per day. Keystone XL (XL for export line) was planned to carry 830,000 barrels per day from both Alberta and N Dakota. It was delayed by Obama, permitted again by Trump and finally cancelled by Biden on day 1 of his presidency. Biden revoked the border crossing permit. The original Keystone is still in operation.

Pink shows the Dakota Access Pipeline. This carries crude from North Dakota Bakken formation to Illinois. It became operational in 2017. The Sioux Tribal Nations and others (15,000 people) protested for months at Standing Rock. It moves about 600,000 barrels of oil per day. A judge ordered a shut down in 2020 for new environmental review. This did not happen. Its legal status is unclear at best but it is still operating. Its many owners include Energy Transfer, Phillips 66, Marathon and Enbridge.

Black shows Line 3. This line was built in 1968 and is currently operational with reduced flow due to age related safety issues. The new line 3 is larger and mostly runs along the same route. The Canadian part is completed and a large part of the Minnesota part is finished. It runs to the Husky plant in Superior WI which is presently closed for a rebuild after the fire in April 2018. Beyond Superior some of the oil goes to Michigan and some to the Pine Bend refinery south of MSP, the largest refinery outside of an oil producing state. Note that 30% of the entire US oil imports enter through Minnesota.

Line 3 is just over 1000 miles long, 36" in diameter and is planned to carry 760,000 barrels of oil per day. These numbers are typical of the main pipelines. There are pumping stations every 20 to 50 miles depending on terrain. It takes a drop of oil 9 days to travel from Hardisty Alberta to Superior Wisconsin. That is about 5 mph. The pressure in the pipe is over 60 atmospheres.

Here are published statistics from Enbridge. From 2011 – 2020 Enbridge pipes carried 29.5 billion barrels of oil with 99.99989% safety. The amount that was NOT carried safely was 100% - 99.99989% = 0.00011%, of that 29.5 billion barrels. That is 30,044 barrels (2 Olympic swimming pools).

Here are statistics for 2 bad pipe breaks:

Kalamazoo MI July 2010 – spill of 24,000 barrels (1 million gallons), cleanup 1.2 B$

Oil is a proprietary and secret mix of volatile and viscous components including carcinogenic benzene, toluene, ethyl benzene and Xylene (BTEX). After a spill the volatile stuff floats on water and evaporates or is mopped up in the usual not very efficient way. The heavy crude SINKS and is very hard to find or clean.

Another bad spill happened in Grand Rapids MN March 1991 – 40,000 barrels (1.7 million gallons) "It just covered these aspen trees, because it went up 30, 40 feet," an observer recalled. "It was quite a geyser."

Here are some more statistics:

From 2002 to present, Enbridge and its joint ventures and subsidiaries reported 307 hazardous liquids incidents releasing a total of 66,059 barrels of hazardous liquids.

Thirty of these incidents were reported to contaminate water resources, including 17 which contaminated groundwater. This does not include recent spills of drilling mud on the construction of Line 3.

Comparing pipelines to rail cars statistics show that rail cars are not safe either. One recent disaster happened at a Canadian town called Lac-Mégantic in July 2013. In this event 73 rails cars of N Dakota crude oil rolled away unattended. The train had a single engineer who parked it for the night and went to a hotel. There was a fire in one of the engines which was extinguished and the engine was stopped for safety with the fire fighters not understanding that their action also released power to the brakes. The train rolled down a long 1.2% grade reaching 65mph on a curve in town. It derailed and the oil exploded with 47 deaths and burning oil in the town's sewer system.

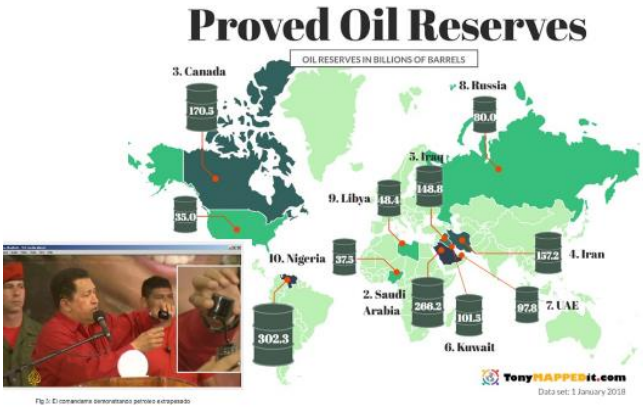
	OIL Reserves million BBL	OIL Prodn million BBL/day	Years left	Oil Consmptn million BBL/day	Oil Consumptn BBL/(yr.person)
Venezuela (1)	300,000	0.5	1650	0.4	5
Saudi Arabia (2)	266,000	11	66	3.1	33
Canada (3)	168,000	5.3	86	2.5	25
Russia (8)	80,000	9.9	22	3.9	9
USA (10)	47,000	18.6	7	20.5	22

Data from US Energy Information Administration

This is a list of some oil reserves worldwide by country. Looking at the left column Venezuela has the largest reserves, followed by the Saudis and Canada. Russia is #8 and the USA #10. The next column shows oil production in barrels per day. Venezuela is barely pumping at all, but the rest are pumping substantial amounts.

The third column "Years Left" is how long the oil will last at the pumping rate shown. Note the small number for the USA. Actually this number has been fairly constant since the 1940's. As we have used more oil we have found more oil and developed new techniques to recover that oil. Given that, we should take the quoted oil reserves with some suspicion.

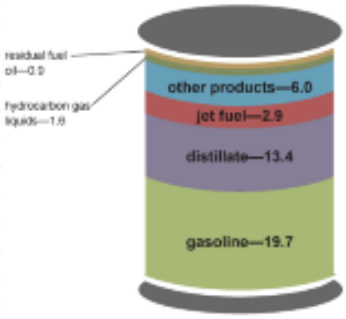
Next is oil consumption, USA consumes more than it pumps making it an importer. The others listed are exporters. Right column is oil consumption per person. Note that this scales with economic conditions and many countries are close to zero consumption. Worldwide average is 5 barrels per person per year. The Saudis have so much oil they can build ski slopes in the desert.



This is a world map of oil reserves. Note that Venezuela's oil is tar sand oil too. Hugo Chavez showing viscous crude. Many countries in the mid-east apart from the Saudis in have huge reserves of conventional crude. Almost all of this is transported by sea.

Petroleum products produced from one 42-gallon barrel of oil input at U.S. refineries, 2019

Product	Gallons
Finished motor gasoline	19.40
Distillate fuel oil	12.47
Kerosene-type jet fuel	4.41
Petroleum coke	2.06
Still gas	1.64
Hydrocarbon gas liquids	1.47
Residual fuel oil	0.88
Asphalt and road oil	0.60
Naphtha for feedstocks	0.46
Lubricants	0.42
Other oils for feedstocks	0.26
Miscellaneous products	0.21
Special naphtha	0.08
Finished aviation gasoline	0.04
Kerosene	0.04
Waxes	< 0.01
Total	44.65
Processing gain	2.65



Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*, February 2021, preliminary data

Oil is refined into many products, some form the basis of the chemical industry. About 5% goes to manufacture of various plastics and 95% gasoline, diesel, jet fuel, bunker fuel for transportation. We need to solve both transportation and plastics issues to become oil free.

We use petroleum products everyday in addition to gasoline and diesel

Propane, ethane, butane, jet fuel, heating oil, lubricants

Perfume, hair dye, cosmetics (lipstick, makeup, foundation, eyeshadow, mascara, eyeliner), hand lotion, soap, shaving cream, deodorant, panty hose, combs, shampoo, eyeglasses and contact lenses.

Clothing fabrics: acrylic, rayon, vegan leather, polyester, nylon and spandex.

Non-stick petroleum-based coatings for cookware, non-scratching spatula

Plastics: bags and bottles, handles and control knobs, and insulation on electrical cords and sockets.

Single use plastics are a nasty problem

Floor tiles, rugs, vinyl siding, roof shingles
Cars: tires, upholstery, body parts, lap belts, asphalt on the road

Medical equipment: IV bags, antihistamines, asprin, artificial limbs, dentures, hearing aids, heart valves, ppe, N95 masks

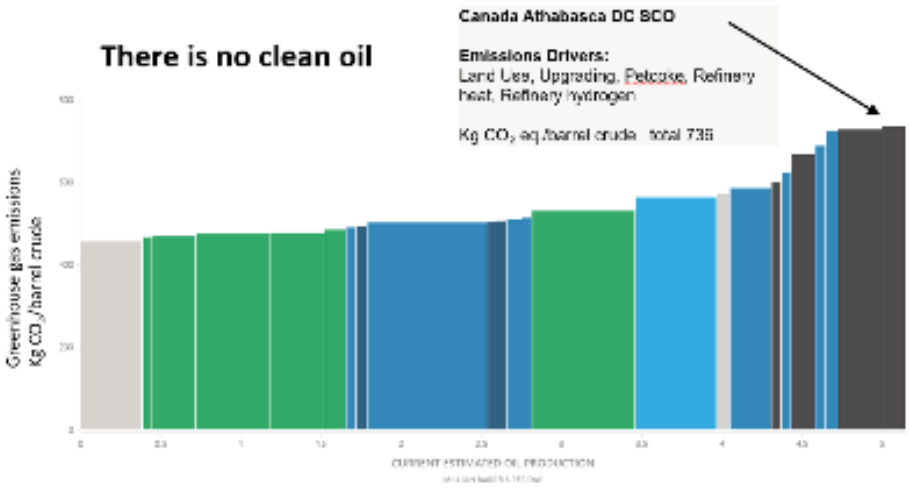
5% of oil used for plastics

95% of oil used for transportation

This is what you get for the 5% not used for transportation. Natural gas is also used in plastics. As an alternative some items could be made from vegetable based oils. Plastic waste is another problem we need to address. 40% of plastics are single use. Garbage from single use plastics is found everywhere, even on remote beaches and in mid-ocean gyres.

Micro-plastics are found in every environment and creature.

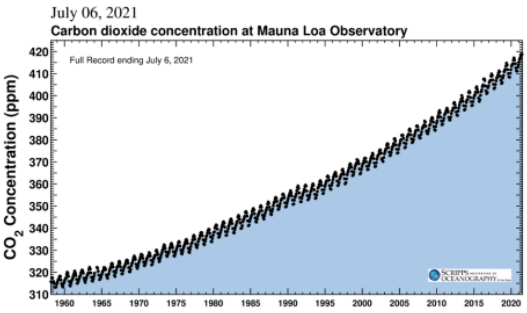
There is no clean crude oil, but some are dirtier than others. This plot shows the total CO2 generated by extracting and refining the oil and burning the final product. For the tar sands extra energy is needed to remove overburden, dig it up, or heat it enough to pump, separate from sand, refine or dilute it. These processes are not all needed for the classic oil well. Some of the environmental literature compares only the CO2 released by the extraction of the oil, and does not count the CO2 made as the oil is burned. This comparison makes tar sand oil a factor of 10 or so dirtier than conventional oil. But the amount of CO2 released to the atmosphere must allow for burning the oil too. That is what is shown here. The tar sand oil generates about 60% more greenhouse gases that conventional oil.



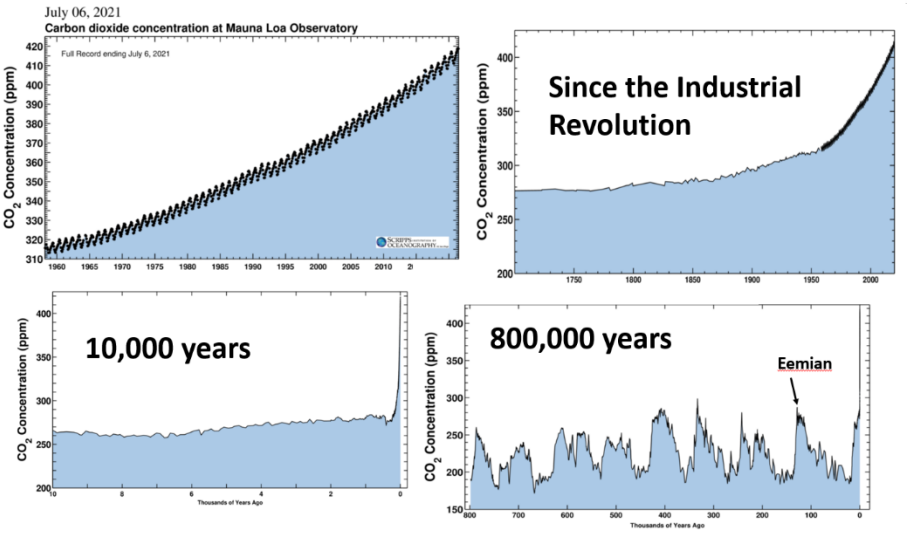
Energy Return on Investment, EROI. This is a way to compare the extra energy needed to produce the oil from Alberta vs Saudi Arabia. Saudi Aramco needs to drill a well, pump the oil, transport it, refine it, all this takes energy. They use the energy of 1 barrel of oil to produce about 33 barrels of oil. That is an EROI of 33. Higher EROI numbers are better. Open pit tar sand oil has EROI of 5 to 8, In situ extraction has a lower value mainly because of the extra energy needed to produce the steam needed to melt the bitumen. The best oil is exploited first so EROI numbers tend to get lower over time. Both take a lot more energy than needed in the mid-east.

Even for a hydropower facility you have to build and maintain a dam and the turbines and power lines, so the energy is not free. But EROI for hydro is a healthy 100. Its downside is the loss of wild rivers. The situation for corn ethanol is complex with some claiming that the EROI is less than one. Use of corn ethanol is maintained by mandates and subsidies with debatable benefits to the climate.

The Keeling Curve shows the increase of CO2 in the atmosphere as measured every day for 63 years from Mauna Loa Hawaii. It is consistent with estimates of the amount of coal/oil/gas used each year. The little bumps are annual cycles of summer plant growth. This would even out if it were the same in both N and S hemispheres, but there is more land area in the north. Note there was no observed improvement for the pandemic year of 2020 and the curve is getting steeper not flatter.



This graphic shows CO2 levels over longer time scales. The top left graph is the Keeling curve that we already discussed. Looking back to 1700 we see that the CO2 increase coincides with the start of the industrial revolution. Data from before 1958 come from ice cores that preserve bubbles of ancient atmosphere. The atmosphere and climate have been remarkably stable for the past 10,000 years. The last plot shows the ice ages with warm periods coinciding with high CO2 levels and cold periods having low CO2 levels. The last warm period (interglacial) lasted 15,000 years about 125,000 years ago and was called the Eemian.

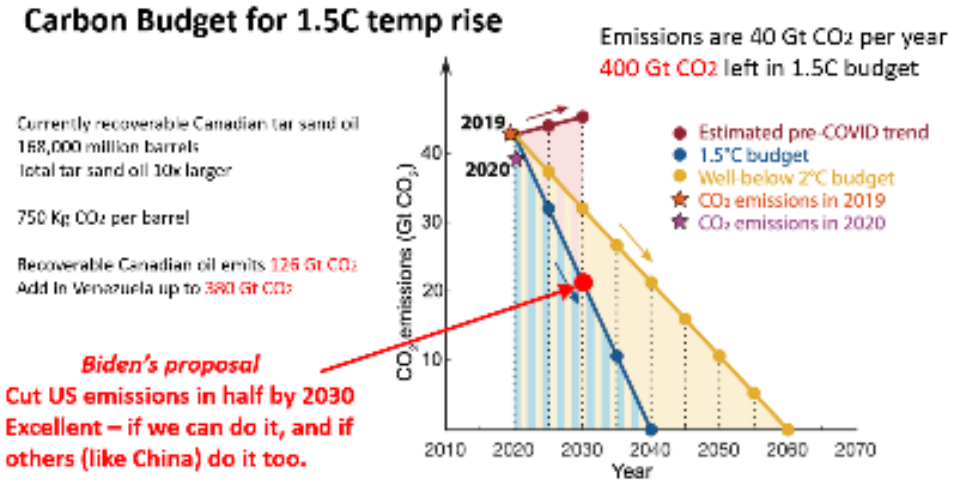


Past climate states CO2 levels in the Eemian (125,000 years ago) were about 300 ppm but the earth was much warmer and sea levels were 10 – 20 feet higher than now. This is what will happen in our long term future if we do not bring down our CO2 levels. It takes a long time for the effects to be fully realized.

To find a CO2 level as high as we currently have (>400 ppm) we have to go back about 4 million years when temperatures were even more extreme and sea levels were up to 100 feet higher than now.

STEVE SACK STAR TRIBUNE

Biden is proposing a 3.5 trillion dollar bill which would start to address climate issues. Congress objects to the funding needed. Steve Sack (in the StarTribune) catches the need to sieze the moment.



The temperature rise we expect depends on the amount of CO2 we put into the atmosphere. At the moment the whole world is putting about 40 Gtons CO2 per year. (That is 40 billion tons or 40 x 10^9 tons) The temperature has risen about 1.1C already above pre-industrial levels.

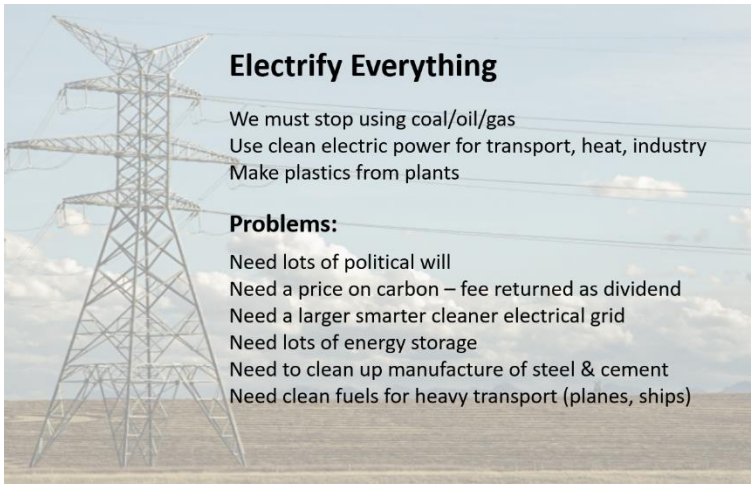
To limit the temperature rise to 1.5C we can put only about another 400 Gtons into the atmosphere. So we can do business as usual (BAU) for another 10 years, but then NO MORE. Or we can ramp down between now and some future date. A straight line ramp between 2020 and 2040 is consistent with the 400 Gton budget. Note that 2020 was lower than 2019 by about the amount needed although the drop was a result of the pandemic, not a deliberate reduction motivated by climate. We need 2021 to be lower than 2020, and so on till we reach zero. If we can achieve this the temps will plateau at 1.5C higher than the preindustrial levels around 2050. If we choose a slower ramp, like the yellow line that reaches zero at 2060, we will emit more CO2 and the temp rise will be higher. In either case, sea level rise and ocean acidification will continue for much longer, these are "baked in" already. The danger of tipping points (methane

from perma frost, arctic ice melt, slowing the Gulf stream etc) remains almost impossible to calculate.

Burning all the currently recoverable Alberta tar sand oil uses 1/3 of the budget. If we add the recoverable Venezuelan oil we reach our budget limit. That excludes all other coal/oil/gas emissions so is quite unrealistic. If new techniques are developed to recover more of this resource we go way over budget.

Total world reserves of fossil fuels would yield abut 10x more than the 1.5C budget. Researchers have concluded that we must leave most of our fossil fuel reserves in the ground.

Biden proposes to cut USA emissions by half by 2030. That is ambitious but not impossible. If the rest of the world does the same we will be on track to get to the 1.5C target and avoid the worst climate problems. HOW DO WE GET THERE?



If we have no coal, no oil, no gas we must get our energy from solar, wind, nuclear, hydro etc. and electrify everything.

Coal is already on the way out in USA displaced by gas which is cheaper. The use of coal for electrical power in developing countries is still a problem.

Providing a stable electrical grid powered by wind and solar which are variable sources needs a lot of energy storage. Nuclear power generates minimal CO2 and can provide baseload capability. The electric grid needs to be larger and smarter to deliver the extra power for transport, heating and industry.

Thinking about transportation, we already have battery electric vehicles from all the major manufacturers. We need infrastructure – charging stations and a jobs program for displaced auto mechanics. Biden's goal is 50% of new cars to be electric by 2030. For larger vehicles hydrogen fuel cells may be better. Planes are a problem that could be solved by bio generated jet fuel. Ships use bunker fuel the dirtiest and cheapest oil. Hydrogen or ammonia fuel cells are possible solutions.

Carbon Fee and Dividend as advocated by Citizens' Climate Lobby is now under consideration by congress. Fossil fuel extractors would pay a fee to the government scaled to the amount of CO2 their coal/oil/gas would release to the atmosphere. The govt would then disperse the collected fees as a dividend to each household. Both fees and dividend would increase over

time. Products made with dirty energy would become more expensive than products made with carbon free energy, but the increase in costs would be more than offset by the dividend payments for all but the biggest consumers. The net result would be a push to greener products and a big savings in CO2 emissions.

Corporate Average Fuel Economy (CAFE) Standards

In 2011 Obama and 13 large car makers increased efficiency standards 5% per year to reach 54 mpg by 2026

2021 average is 25 mpg

Biden administration:
New car sales 50% EV by 2030

MN Clean Cars 2021:

MN to join 14 other states and DC in following CA higher standards in 2024

BEVs use energy 3x more efficiently than ICE
Need clean electricity otherwise little gain

The government established the Corporate Average Fuel Economy (CAFÉ) standards after the 1973 oil embargo to raise the average mpg of vehicles. Manufacturers pay penalties for lack of compliance. Obama's standards were ambitious to reach 54mpg in 2026. Trump rolled them back. Biden plans to roll back the roll backs and rumors report he will upped the efficiency even more. In 2021 the CAFÉ standard for new cars is 39 mpg, but the average car on the road is a few years old and gets an average of 25 mpg. Electric vehicles use energy more efficiently, about 60% of the energy in the battery goes to moving the car, vs less than 20% for gasoline. Almost all the rest goes to heat. But if you charge your EV battery from a coal fired power plant there is little gain.

There are plenty of models of EV cars. Ford is coming out with an electric F150 truck next year. Their advert stresses that you can run power tools on a job site from the truck, or the whole house for 3 days in a power outage. There are a couple of semi trailer trucks starting to appear, but as weight increases and the demand for long distance uninterrupted driving increases batteries become less suitable. Hydrogen fuel cells are better. Overhead wires for electric trucks exist on Germany's autobahn. China has half a million electric passenger buses.

Canadian oil is financially viable as long as the oil price is above about $50 per barrel. This makes it a riskier investment than oil that is easier to extract. There is also social pressure from stockholders to divest from assets that are seen to be excessively polluting. If the oil is left in the ground because of financial or political pressures it is referred to as a "stranded asset". Many large funds are pulling out of Canadian oil. In addition many of the large oil companies are also withdrawing, although most of these companies are not totally divesting of oil, just of tar sands oil. Recently Harvard announced it is eliminating all fossil fuels from its endowment. The Pope is pushing to get the Catholic Church to do the same. Norway's sovereign wealth fund is divesting from fossil fuels too, although there is some irony here as Norway's recent wealth came from North Sea Oil.

Returning to the statement from the protesters which we saw at the start, this is their final paragraph:

"Please end the era of fossil fuel expansion decisively, so we can begin the era of clean energy and climate solutions with all the hope and commitment it requires. Science, justice, and the boundless American capacity to tackle big challenges are on our side. Time is not."

We Protect the Waters.org [Giniw Collective](#) [RISE Coalition](#) [Red Lake Treaty Camp](#) [Honor The Earth](#)