Environmental Justice considerations for Carbon Capture and Sequestration

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Primary goal must always be to stop global warming.

It is a number one goal of environmental justice advocates to stop human caused global warming no matter what it does to huge industry, the stock markets, and their living costs.

Ending this threat must be done with real reductions. Policies must be aimed at ending, not prolonging, fossil fuel as an energy source. Programs that enhance ecosystems and rely on natural systems to increase carbon storage should be promoted strongly. In California, and also around the world, it is low-income and people of color who have the most to lose as Greenhouse gases heat the planet.

- When increased heat and drought take away the ability of rural societies to grow food, we see wars for scarce resources expand and desperate migrations to other lands.
- As the ocean becomes acidified and sea levels rise people who have traditionally lived by the sea lose everything as both the sea life is disrupted and their homes are submerged.
- With a warmer climate air pollution worsens and low income residents who are more exposed suffer the worst. We currently see drought taking away both jobs and water from residents right here in California.
- Adaptation to changing climatic conditions is hardest for those without access to resources. The rich can do whatever they need for food and housing on a warmer planet but they will have to build walls to keep out those who cannot afford to adapt.

For the above reasons, California and the world, must do what is necessary to combat a warming planet. We must, at a minimum, reach the 2050 goal of GHG emissions 80% below current levels (or the comparable 1990 levels) and we must plan for a zero carbon economy with natural carbon negative enhancements from 2050 onwards.

It is imperative to look seven generations into the future in regards to how current actions affect the future. It is also imperative to look at the big picture and see clearly the result of current actions in all their ramifications. Environmental justice advocates demand this.

In regards to CCS, no matter what form it takes, we must do a thorough life cycle analysis of all projects which claim to reduce GHG emissions or atmospheric concentrations.

We must go beyond the currently limited life cycle analysis procedures used in the low carbon fuel standard. We must consider more thoroughly economic factors, environmental factors not directly related to GHG emissions, and the social factors such as displacement, cultural change, air pollution, and health.

It is obvious we must greatly speed up the rate of reductions over the next few years. Also, we must move directly towards the for 2030 goals with plans that carry us to 2050 and no pause in a continuing downward spiral to zero carbon.

For the 2050 goal of reducing total GHG emissions 80%, it is obvious that electrical generation emissions must be reduced more than 80%. *California, in fact, must double its electrical output and decrease the related carbon emissions to nearly zero by 2050.* It is imperative that we must reduce emissions from electrical generation at least 95% below that sector's total current emissions while increasing generation dramatically.

Other sectors are not going to make the 80% reductions by 2050 so electricity can and must make up the difference.

- Agriculture, some heavy manufacturing like cement and glass factories, and heavy duty long distance transportation, including air travel, will continue to use some fossil fuel and not be likely to reduce emissions by 80%.
- Most other transportation, such as private vehicles and short run buses and trucks, must be electrified. Our heating of buildings must transition quickly away from natural gas to electricity.
- The population will also expand demanding more electricity for all energy needs.

CCS and electrical production using fossil fuel

Even though there is no viable project to do this in California, there is a lot of misguided talk about how much CO2 is sequestered when CCS is used with fossil fuel electrical generation. Importantly, the only figure that should mean anything is not how much CO2 is sequestered but how much is released per net MWh of production to the grid. An 1100 MW fossil fuel project with CCS is not taking 3 million cars off the road, as it may advertise, but it is instead releasing CO2 equivalent to placing an extra 300,000 cars on the road.

A big question that should be answered today is how many pounds of CO2 per MWh of electricity to the grid can be allowed in 2050 with or without CCS? It does little good to reach 2030 goals with CCS technology built into new power plants if that technology is useless in terms of 2050 goals when most of these new power plants will still be in operation.

In 2050, the 300,000 GWh of electricity used today in California will double to 600,000 GWh. But, the emissions of today (or in 1990) need to be reduced by 80%. In other words, the GHG emissions from electrical production should drop from around 90 million CO2e MT today to 18 million MT in 2050.

Today we have reached an average GHG efficiency level for total electrical production of approximately 600 lb CO2e/MWh. In 2050 we will need an average efficiency level of 60 lb CO2e/MWh. This is about 10% of the current average and that is the bottom line for emissions in 2050.

- A lifecycle look at wind and solar CO2e emissions per MWh gives figures around 20 to 60 lb of CO2e per MWh with optimal manufacturing efficiencies in place. There might be room for a few fossil fuel power plants with CCS technology if the average rate of emissions is less than 200 lb CO2e/MWh.
- But, there is no CCS with fossil fuel technology conceivable today which can do this, especially with a true life-cycle emissions analysis.

HECA, poster child for CCS, was touted as a clean coal power plant and/or low carbon fertilizer manufacturer.

It would capture and sequester 90% or 3 million tons of CO2 per year and produce 350 MW to the grid when operating. But, when the CEC analyzed the immediate, on-site power balance, taking into account the gasifier, air separation unit, and all the energy needed to compress and inject the CO2, they came up with a net 60 MW to the grid under the best circumstances.

- HECA would release 300,000 tons of CO2 per year. Operating 90% of the time, that is over 1200 lbs of CO2 per MWh. Well above California's current SB 1368 emission performance standard of 1100 lbs per MWh.
- To be of any use whatsoever, HECA would have to capture and sequester 99% of its CO2, not 90%. But the cost of that would be prohibitive. The cost was already prohibitive at around $4 billion for this 60 MW of net production.
- Since the cost is so high, why bother? It certainly is not useful to low-income residents to have to pay subsidies for this high cost, relatively high carbon electricity source, that fossil fuel producers think may keep them in business a few more years. The DOE and the PUC were jumping at the chance to subsidize this project, even going to illegal means at one point if PUC emails are to be believed. The subsidy money could have been better used for truly clean solar and wind subsidies in low income communities instead of this polluting and expensive project.
- HECA, of course, was using imported coal as the fuel. Going to natural gas with the same technology may cut the CO2 emission rate by as much as 50%. But, even 600 lb CO2 per MWh would be useless in 2050 if the average needs to be 60. It may be low carbon today and helpful for 2030 goals but we have to look to 2050 to justify these expensive projects.

HECA had other problems.

- HECA needed massive amounts of usable irrigation water for cooling; it took hundreds of acres of prime farmland out of production; it put hundreds of tons of criteria air pollutants into the air, it put the equivalent of 900 new truck trips daily onto country roads, it had a huge waste stream, and it would have forced a low-income farm labor camp of 200 families to live adjacent to a coal depot where two coal trains a week would be unloaded for the next 25 years. These

are classic environmental justice issues that were seemingly ok for Kern County residents to live with but not Long Beach where the project was first proposed.

- HECA did not come close to producing a form of hydrogen that would be useful in fuel cells. That would have been far more expensive and produced an even bigger waste stream. In fact, HECA did a disservice to any notion of producing a clean fuel like Hydrogen here in California.

Finally, before leaving this discussion of CCS and fossil fuel there is the matter of the production of the fossil fuel for use in these projects. We know coal mining is a disruptive ecological disaster and releases methane in the process. Fracking and waste water disposal are giving us environmental nightmares as well. New oil train depots and pipelines, plus the exporting of coal and pet coke, are all steps backwards in terms of ending global warming. Life-cycle emissions including production and oil industry exports must be counted when government decides it is ok to keep using fossil fuel as long as we capture the CO2 and sequester it. Environmental Justice demands a life-cycle assessment of the entire fossil fuel industry if we are to put a bandaide on part of it through the use of CCS.

Biomass for electricity with CCS has a lot of the same issues as fossil fuel but also many unique issues.

Biomass energy is very inefficient, very dirty and not a sustainable resource for energy production.

- Collecting, grinding, and transporting biomass is energy intensive, especially in the forest where access is limited.
- Burning biomass is less efficient than coal. The fuel has less energy per ton and a lot more moisture which combine to make less electricity per ton and higher amounts of CO2/MWh.
- Biomass incinerators endanger the lives of nearby residents because of the constant stream of particulate matter especially when they have historically failed often to keep emission control units operating properly with this dirty and complicated fuel source.

Is Biomass a truly renewable fuel or is it partially renewable or is it just as dirty as fossil fuel in terms of CO2 emissions? A life cycle assessment is needed to analyze this process. It gets more complicated with CCS introduced. Is it truly carbon negative? Is it viable or sustainable? Is the process worsening criteria air pollutants in places failing to meet National Ambient Air Quality Standards?

These questions must be answered before promotion of CCS and carbon negative generation of electricity from biomass. It is generally difficult to achieve carbon negative emissions using CCS if you can't start with authentic carbon neutrality in the fuel source.

- In order to define the burning of biomass as carbon neutral, it has to be accepted that over a 30-100 year period (depending on location), new tree or plant growth, will absorb the amount of carbon released by the burning. But, that assumption may kill us because CO2 in the atmosphere is increased instantaneously as the biomass burns thereby heating the planet even further. There is a huge bubble of new CO2 just at the time when decreases would have the most beneficial effect on moderating global warming and when increases can be fatal in terms of tipping points. Before going too far down this road of carbon neutral biomass incineration somebody needs to decide how large this bubble is going to be and if we can afford it in terms of current global warming and tipping points.
- Some will continue to insist the biomass from the forest is renewable and it doesn't matter how long it takes because eventually the accounting balance will be carbon neutral. But, consider that the biomass facility will not operate long enough to reach the point of carbon neutrality. After 30 years of operation the plant is obsolete but the bubble of CO2 will continue for perhaps another 50 years until full absorption by new plant growth. Perhaps the carbon accounting should be based on what happens during the life of the facility and not be extended to some unknown future long after the facility is shut down?
- Even without the extended time period for recouping the CO2 in order to declare carbon neutrality, there is also a question of alternatives and what use of biomass is the best in terms of limiting or preferably decreasing CO2 in the atmosphere? In terms of GHG emissions is there a better use for agricultural waste, or for dead trees in a forest, other than chipping, shredding, hauling, and incineration? Note: the term incineration is meant to be generic for all forms of burning with or without higher pressures and/or oxygen.
- That fact that almost all biomass can be incorporated into the soil either with help or through natural processes should always be part of the alternatives thoroughly analyzed. Biomass builds the carbon content of the soil up to a maximum stabilization point where additional biomass is needed to simply maintain the level of carbon sequestration in the soil. CO2 is continually released from organic processes in the soil but there is a huge capacity for building up the level of sequestration that has potential for reducing significantly levels of CO2 in the atmosphere. That alternative should always be part of the accounting calculations.

Two parts of the carbon cycle are not always analyzed properly with biomass.

- Increased biomass in the soil leads to faster plant growth and increased sequestration of carbon in the soil.
- Decreased biomass in the soil slows down plant growth and decreases sequestered soil carbon. In other words, there is nothing carbon neutral about burning biomass. It puts CO2 into the air that would otherwise be sequestered in

the soil. This fact needs to be part of the life cycle analysis of CO2 emissions from burning biomass.

- To be redundant for emphasis, in the forest there are trees which, in the ideal situation, are in carbon balance with the forest soil. As trees die, new growth makes use of the carbon and nutrients resulting from the breakdown of woody biomass. This woody biomass contains moisture and nutrients. It is 1% nitrogen for example. Trees that die and are harvested are often 75 to 150 years old and it takes that long, under ideal conditions for new growth to replace the carbon stored in these trees.
- Removing trees from a forest is the same as removing carbon from the soil. That is the part of the carbon life cycle no one wants to look at. Soil is the biggest reservoir of carbon on earth. There is three times as much carbon in soil as there is in the atmosphere.
- When the soil loses some of its carbon its capacity to grow plants which absorb carbon from the air is naturally decreased.

Therefore, to claim that burning trees for energy is carbon neutral is really nonsense. First, a huge amount of carbon is released to the atmosphere and is not reabsorbed for many years. Second, the rate of new growth may be significantly slower than the original growth. So, we are increasing atmospheric carbon at a time when it is most critical to stop because right now the world is facing the dynamics of escalating irreversible climate change. Second, even if the change were to be gradual, the regrowth of the carbon which has been incinerated will be slower because the soil has been weakened.

Forest biomass and agricultural biomass are not sustainable energy sources.

- Forest biomass is greatly limited due to the total area available and inaccessibility of many areas. Also, there is really no such thing as surplus or waste biomass in a forest in terms of the carbon cycle.
- The nutrients and carbon produced in agricultural biomass must be provided and supplemented with high energy manufactured inputs which offset any gains of annual replacement rates of carbon. There is no waste biomass in agriculture, only inconvenience.

In summary, when looking at the whole picture, burning biomass for energy is probably just as harmful for global warming as burning fossil fuel. It may actually be worse because it releases twice as much CO2 than a natural gas power plant per MWh. If and when CCS is applied to the process of incinerating biomass, it would very likely not be carbon negative because the CO2 not captured and still released would be large compared to the net energy output.

The ancillary energy needs, especially for this inefficient fuel would greatly decrease net energy output. The carbon negative calculation depends on a very lengthy regrowth period in a forest. It is doubtful that biomass with CCS can contribute to our needs in 2050 for total CO2 emission

rates well under 100 lbs of CO2 per MWh. We also know the amount of biomass available, even using aggressive, soil depleting rates of removal for energy production, will never be more than a tiny fraction of our total energy needs in 2050.

It should be emphasized that the dirtiness of the whole process makes it unacceptable to environmental justice communities. Where are these facilities to be located and which low-income communities will receive all the trucking through their area? Why should they have to subsidize this basically cave man invented method of procuring energy with higher energy rates because of inefficiency and perhaps and expensive CCS technology that probably does nothing to end global warming?

Sequestration of CO2

There are a lot of environmental justice issues surrounding the sequestration part of CCS. Two methods are proposed; Enhanced Oil Recovery and direct injection in a Class VI well likely underneath a low income community or under someone's farmland. This applies to CCS using CO2 from fossil fuel, biomass or other processes such as fermentation.

Neither of these two methods, EOR or direct injection, are acceptable in terms of environmental justice.

First, consider EOR.

- EOR increases supply, and perpetuates the myth that fossil fuel will always be available. We cannot possibly burn all the known oil reserves and keep global warming under 2 degrees centigrade.
- The produced oil from CO2 injection or EOR has no other viable means of production and will increase global warming.
- Environmental Justice says the world cannot afford this type of dangerous and energy intensive oil production which both increases the fossil fuel supply and also increases the rate of GHG emissions from its production. Someone else has already taken the credit for the capture of the CO2 so this new oil likely has a much higher carbon intensity than more traditionally produced oil. It doesn't make sense to increase oil production through a method designed to decrease CO2 emissions from power plants. This reasoning is similar to why it does not make sense to build extensive new oil pipelines.
- With EOR through injection of CO2 there are threats to nearby groundwater. This threat is unacceptable with or without global warming causing drought and massive water shortages in California.
- There is a lot of doubt about how much CO2 is permanently sequestered in an old oil field and who is ultimately responsible for keeping it there over the next thousand years.

Environmental justice asks for a complete lifecycle analysis for EOR with CO2 projects. Fossil fuel use must be phased out rapidly so any project claiming to continue use of fossil fuel with CCS in order to make it viable, must play by very strict rules. Methane leaks from coal mines, natural gas leaks from pipelines and storage projects, all must be considered in calculating CO2 rates of electrical production using CCS.

It must be a requirement that negative environmental impacts from CCS projects be fully and directly mitigated in the community where the project takes place. In an ideal world, a cleaner environment would result in impacted communities if current power production and oil production using fossil fuel were phased out as the goals of AB32 are met. CCS with EOR continues many operations that are currently massive pollution sources. These new operations can potentially polluting worsen current negative environmental situations.

Deep well injection into a saline formation is also problematic.

- No community in the San Joaquin Valley that I am aware of would welcome this activity beneath their communities even though political leaders may welcome it because of tax dollars. That is always this disconnect between leaders elected with money from big polluters and the majority residents of low income communities.
- Farmers in Kern County have already announced their displeasure at the recent proposal by HECA to inject CO2 under their property. If land owners have the rights to the pore space under their land it will never happen and money is not an issue.
- Real reasons of concern are threats to ground water and potential leaks. We always have large, high atmospheric pressure, episodes of almost zero air movement during our winters causing ground fog in the first 1,000 feet of the atmosphere to linger for weeks at a time trapping pollution. These same conditions can trap CO2 and keep it from dispersing. Everyone should know that a concentrated cloud of leaking CO2 can mean instant death and it has happened. Lake Nyos in 1986 is the classic example. Restaurant workers have also died from high CO2 poisoning and it has happened many times to miners. Any leak under the right weather conditions can kill nearby farm workers or residents even if the injection and subsequent leak is several miles from a town or city.

What about earthquakes and CCS?

- There are unknown faults in a lot of the San Joaquin Valley where the CCS projects would be proposed. Perhaps the safest place for injection would be in the Tulare Lake Bed region or around Visalia on this map.
- Just in 2016 an unknown fault was discovered a couple miles from the Westcarb Kimberlina simulation of CO2 injection. 16 measurable earthquakes resulted. The

site was very near to high pressure injection of waste water in the North Shafter Oil Field.

Environmental Justice and CCS from ethanol plants is being considered but has economic and social issues.

- Unfortunately, the Life Cycle Analysis of corn ethanol has not considered the world-wide economic and social aspects of growing food for fuel. It has not considered that one result of expanding corn or grain alcohol may be a real need to build a huge wall to keep out a huge portion of the world's population who may be starving. Until those considerations are built into the analysis there is no need to talk about adding CCS to the debacle.

Natural systems are carbon negative if we allow them to be.

- Ultimately, the cheapest and safest method of CCS is the natural process of plants taking in CO2 through photosynthesis and the CO2 building up in the soil as a result of dying biomass from the plants being incorporated into the soil. This is not really the topic of these workshops but its beauty, cheapness, simplicity, and the level of co-benefits through synergistic events and the massive scale makes these workshop discussions about other methods of CCS seem irrelevant.

Finally, in all these projects we need to have an open and fair decision making process.

- It is clear to those following the current investigation of the alleged corruption at the PUC the past couple years that certain people feel their ideas are so good for society that they do not have to follow proper procedures to push through their projects. Millions of dollars of taxpayer money has been wasted on HECA, the ill-conceived CCS project, because of behind the scenes manipulations.