CLIMATE CHANGE

Overview of Problems and Solutions

Abstract

The paper is written in Q&A format and includes some top-line bullet points. The paper is designed for non-technical readers. If you are interested in more information about the types of solutions and the technology to address climate change, please send an email. The list of solutions will change over time as technologies are refined and/or new technologies are introduced.

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Top-Line Observations about Climate Change

- Climate change is real and getting worse. Lots of hard data to support.
- Earth warming much faster than normal warming/cooling cycle, which occurs over thousands of years
- Effects of climate change will get worse the longer we wait to act – more droughts, excessive rain, extreme hot/cold, more tornados and more intense hurricanes
- What about coastlines? Coastlines will be altered no matter what action taken. For example, in North Carolina, the barrier islands to disappear by 2100, if not sooner.
- Scope of problem – worldwide and all countries need to reduce emissions
- Who will be affected? Everyone in every country. More disruption on coasts.
- Solutions – technology available today to make huge progress. More tech on the horizon. Think Apollo program – at beginning US understood how to build rockets but needed to improve tech for trip to the moon.
- How should US approach solving climate change? Think approach US took during WWII. Massive effort and everyone involved. Effort needs to be fair and equitable.
- Cost to solve? Expensive but no alternative. Think WWII.
- Solutions will involve some sacrifices, lifestyle changes. Think WWII with some rationing required and some shortages.
- What if we do nothing? Unknown but likely very bad. Last time CO_2 concentration this high for sustained period was 3-5,000,000 years ago, before modern man.
- Doing nothing is Russian Roulette with very bad odds. Doing nothing is like playing Russian Roulette with 5 rounds in the chamber and 1 empty. Taking action is like playing Russian Roulette with 1 round in the chamber, 5 empty. No guarantees but good odds.

General Q&A

Q Is climate change real or is the weather the past few years just unusual?

A Climate change real. Climate change is about weather patterns over time, not week to week or year to year. The pattern of "unusual" weather – increased frequency and/or intensity of extreme hot, extreme cold, forest fires, drought, hurricanes, etc. -- will grow worse over time. Some change in weather patterns will occur even if we start today taking action to reduce contributors to climate change. Without taking action, problems with weather will be even worse.

Q What is the cause of climate change?

A A major cause is increased CO_2 (carbon dioxide) from burning coal, natural gas, gasoline and diesel fuel. CO_2 captures some of the heat that normally would go back into space. A simple example. On a sunny day put your hand close to a dark rock or asphalt surface. The heat is caused by infrared rays from the sun. Unlike oxygen and nitrogen that aren't affected by infrared rays, CO_2 captures some of these infrared rays. The more CO_2 in the atmosphere, the more heat is captured in the earth's atmosphere. The earth needs some CO_2 to make it livable and grow food. Too much CO_2 makes earth unlivable, at least for humans.

Q How much CO_2 is too much?

A Current level of CO_2 is over 400 ppm (parts per million), roughly 2x what is was before the beginning of the Industrial Revolution. The last time CO_2 was 400+ ppm over an extended period – several centuries or more – was 3-5 million years ago, before the evolution of modern man. 3-5 million years ago oceans were significantly higher than today – 30' or more. Without a dramatic reduction in emission of CO_2, by end of 21st Century, concentration could exceed 500 ppm with some forecasts projecting 1,000 ppm.

Q What does this rise in CO_2 mean for North Carolina?

A Unfortunately, no matter what action we take, by the year 2100 North Carolinians could see the barrier islands disappear and many of today's coastal communities partially under water.

Q What's the solution to climate change or are we doomed no matter what we do?

A We are not doomed if we start taking action now. The longer we wait, the more difficult the solution becomes. Think of the solution as a 3-legged stool. The legs are:

1) Using existing and likely future technology to reduce CO_2 and other GHG (greenhouse gas) – methane, e.g.
2) Providing adequate funds to pay for implementing technology
3) Creating new jobs to replace those lost and ideally creating even more jobs

Q How do we implement these solutions?

A Think of another 3-legged stool. Most of the necessary technology is available today. Thus the implementation plan is one that is more dependent on a willingness to solve the problem. To address climate change both society and legislators need to commit to:

1) Implementing science-based solutions, not political solutions
2) Using not just public funds but insisting on private funds as well
3) Ensuring fair-and equitable implementation across all socio-economic groups. Like Covid-19, all socio-economic groups will be affected by climate change.

Q What about an example, say how do we eliminate emissions from transportation?

A Simple answer is all cars, trucks, buses, trains, ships and even airplanes need to become electric. Let's look at what needs to happen to reach a target of zero carbon emissions from transportation by 2050 – less than 30 years from now.

a) 2035 (or sooner) – all new cars, SUV's and pick-ups need to be electric
b) 2040 – all new buses, semi-trucks, garbage trucks, etc. need to be electric
c) 2050 – all cars and trucks on the road need to be electric or use a zero-carbon fuel, like hydrogen
d) Trains are fairly easy to convert and many trains are already electric. Marine craft, especially ferries are relatively easy to convert. Airplanes are more difficult but zero-carbon fuels being developed that would eliminate most emissions.
e) An interim solution for trucks, trains, ships and planes is to use existing low-carbon fuel, such as biodiesel. Doing so can reduce emissions from say a garbage truck by about 75%.

Q How do we get rid of all cars and trucks using gas and diesel? Some last 20 years or more.

A The approach to getting rid of gas/diesel-burning cars is a good example of why fairness and equity are important.

a) First consider the cost of new car/trucks as a percent of income. While the price of electric vehicles (EV) has declined over time, the price of an EV is still higher than a gas model. The problem – how can someone on a limited budget afford to buy a new EV, or even afford to buy a used EV?

b) Next to get old cars/trucks off the road by 2050, there needs to be a "buy-back" program." The problem – what amount should the owner be paid for say a 15-year-old car with 175,000 miles? As a used car, even in today's terms, a high-mileage 15-year-old car is not worth much. But to the owner the car is worth a lot. If the car is taken off the road, then the owner has to buy an EV in order to be able to get around. Same problem for small-business owner who can only afford used vehicles. So the fairness problem is making sure the "buy-back" price for the old car is high enough that the owner can buy a reliable EV.

Q What about recharging all these EV's? How's that going to work?

A Refilling a car/truck's fuel tank with gas or diesel is simple and quick. In and out of the ubiquitous gas station in 10 minutes or less and off for 300-400 miles, or more. Recharging an EV is more complicated. Here's the 3-legged stool.

1) Longer time required. Even for what's called "fast charging," time involved is 30+ minutes and that's only for a partial recharge. Some recharge "pumps" might be tied up for several hours, even all day. If the owner is not nearby, how do you free up the "pump"

2) Recharging at home is solution for most daily travel. But what about people in who live in apartments, especially in urban areas with limited access parking or maybe only street parking? Where do they recharge?

3) Price to recharge may vary during the day. While gasoline prices do vary sometimes one day to the next, the price is posted for all to read. There are no regulations yet on owners of recharging stations using "time-of-day" pricing. For someone with limited income and an immediate need to recharge, the cost could be 3-4x what it would be to recharge later in the day. Another fairness issue that needs to be addressed.

Q Converting homes and commercial buildings to all electric to eliminate CO_2 seems as complicated as transportation. And who's going to pay for it?

A Take a typical house. What equipment uses natural gas and therefore contributes to climate change? A heating and air-conditioning system, water heater, cooking stove, clothes dryer, gas fireplace, gas grille and for a few, a heated swimming pool. Like for transportation, the goal is to replace natural-gas powered equipment with electric-powered versions no later than 2050. Same fairness-and-equity problem – who's going to pay for all the equipment? We'll not worry about paying for the swimming-pool heater.

Q Will electric service in houses and commercial buildings have to be upgraded when all the new electric appliances are installed? And does the utility have enough generating capacity?

A Yes and maybe. Upgrading electrical service will be required in many private homes and commercial buildings. The amount of upgrade is fairly easy to calculate. Same old question, who's going to pay for the upgrade?

As far as the utility's capacity to generate electricity, that's more complicated. Utilities are being pushed to generate as much electricity as possible from solar and wind. But the sun is not out all the time and the wind doesn't blow all the time. So how do utilities make sure there's enough electricity available when customers want it? The technology exists to allow utilities to store electricity being generated but not being used. The open issue is how to generate electricity more evenly and make sure enough is available when there are several days or even weeks of little sun or wind.

Q What about job losses in the coal and oil-and-gas industries? Putting those folks out of work doesn't seem fair.

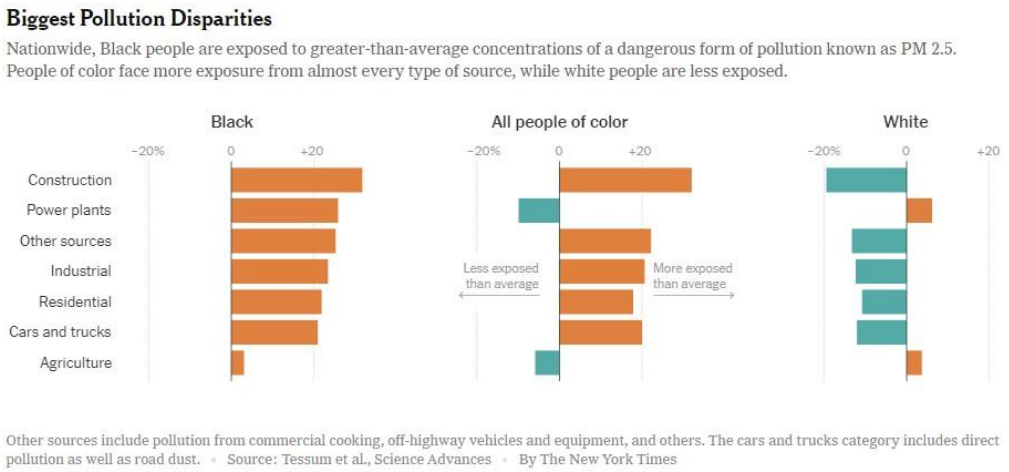
A Fairness in training for a new job is an important issue. There is no solution to climate change without eliminating most oil-and-gas production and all coal production. A program for job transition is another 3-legged stool.

1) Identifying and then creating proper training for jobs with sustained employment opportunities
2) Commitment by those whose jobs are lost to make every effort to learn new skills. The old job is not going to come back so for any kind of higher-paying job a new skill is required.
3) Appropriate financial support during training and the transition to the new job

Some, or even many of the new jobs, might require relocation. Mining operations – coal and oil-and-gas – often are in remote areas. The mining area may be too remote or too sparsely populated to support the type of jobs with sustained employment opportunities.

Q Fairness is a big issue. According to a recent article in the New York Times, in the US people of color are exposed to more pollution than whites. Is that going to continue, or even get worse?

A The situation should improve. For people of color, much of the additional exposure is associated with urban living and being exposed to emissions from transportation and commercial sources. As transportation and the commercial sector transition to electric, emissions in urban areas should decline. Power plants in the future will be more solar and wind, which don't have emissions.



Q What about all the pollution in China? All those coal plants. Are the Chinese going to commit to reducing pollution?

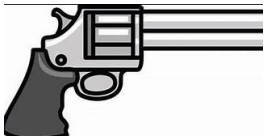
A I can't speak for China. But what I know is this. China sells far more electric cars and trucks than the US. China is building a sophisticated high-speed electric rail network. If like most other situations, the Chinese will respond to economic pressure to change. In order to exert that pressure the US needs to change and take a leadership role.

Q Solving the climate change problem seems so complicated. Can it really work?

A Labeling solutions to climate change as "complicated" is an understatement. Rest assured there are highly skilled people working on practical, affordable solutions. No matter the technical solution, everyone is going to be affected somehow. As a result, we, that is societal we, need to make sure the solutions are implemented. And the solutions are implemented fairly and equitably. And, yes, you'll still be able to eat red meat. Although cows are a source of methane, there's no proposal to make eating hamburgers illegal.

Q Still not convinced climate change is a major problem?

A OK, then let's play Russian Roulette. Imagine climate change as a game of Russian Roulette. If you want to ignore climate change and do nothing, then load the chamber not with one bullet but with five bullets. Now, spin the chamber and pull the trigger. Chances are the outcome will not be a good one.



If you want to take serious action to address climate change, then you put only one round in the chamber. A positive outcome is not guaranteed but the chances are very good. So ask yourself, do I want to play Russian Roulette with five rounds in the chamber or just one round?