Episode 2 - "A Master Plan to Achieve Clean Energy Transition"

Previously, on Energy Transition Crisis: We explained why climate change isn't the only reason we urgently need to break our addition to fossil fuels, any why Peak Cheap Oil may be an even more compelling reason. We then explored why cheap and abundant energy is so essential to our standard of living, examined where we get our energy today, distinguished baseload from intermittent energy supply, and explained why wind and solar are best suited to intermittent supply. Now, to lay out a Master Plan to replace fossil fuels with clean energy, here's Erik Townsend.

Now it's time to dive into what it's really going to take to phase out fossil fuels and transition to clean energy, including the parts the politicians always leave out, because they don't have any good solutions to offer.

In today's world, most baseload electricity is produced by coal-burning powerplants. The electricity they generate is carried by transmission lines to supply homes and businesses.

To meet intermittent electric demand, natural gas-fired powerplants supplement the baseload supplied by coal-burning powerplants. Wind and Solar also supply intermittent electric demand.

In areas where hydropower has been developed, hydro supplements coal-fired powerplants to deliver baseload supply, and in a few places like New Zealand, hydro may nearly eliminate the need for coal-fired plants.

The vast majority of vehicles on the road are fueled by internal combustion engines which burn gasoline or diesel fuel, both of which are refined from crude oil, which supplies 32% of our energy needs today. The crude oil is sent to the refinery on ships or through pipelines, and refined into gasoline, diesel fuel, jet airplane fuel, and a special variant of diesel fuel used by ships at sea.

Gasoline and Diesel are delivered by truck to filling stations, where they're sold to vehicle operators.

Farming equipment, heavy construction equipment, and several other kinds of industrial machinery are also powered by diesel fuel, which is usually delivered by truck.

To phase out fossil fuels, the solution begins with replacing most internal combustion engines with electric motors.

For passenger cars and many other vehicles, rechargeable batteries replace the fuel tank of conventional vehicles, and the electric vehicle is recharged by connecting it to a charging station supplied by the electric mains.

A common misconception is that electricity is a greener alternative to fossil fuels for powering vehicles. That's not the right way to think about it. Electricity is a clean and efficient way to transmit energy from where it's produced to where it's needed. In this example, the gasoline-fueled internal combustion engine of an old-school vehicle is being replaced by an electric vehicle with a rechargeable electric battery that can be recharged from the electric mains.

But the energy to recharge that battery still has to be produced from some other energy source, in this case, a combination of coal and natural gas. Some of the energy needed to recharge the vehicle battery might come from solar, provided the vehicle is being recharged during daylight hours on a sunny day.

It's important to understand that replacing internal combustion engines with electric vehicles doesn't stop carbon emissions. Rather, this moves the pollution from the vehicle itself to the coal or gas-fired electric powerplant that burns fossil fuels to produce the electricity needed to recharge the electric vehicle.

The only exceptions to this are in rare locations such as New Zealand where almost all electricity is generated from hydropower, or other sources that don't burn fossil fuels to produce electricity.

So, replacing all the internal combustion engines with electric motors powered by rechargeable batteries is only the first step toward eliminating greenhouse gas emissions. To finish the job, we need to replace all the fossil fuel-burning electric power stations with clean energy alternatives that don't produce greenhouse gas emissions.

Politicians would have you believe that wind and solar alone will solve this problem. They don't have any realistic solutions to propose, so they appeal to your emotions by talking up a wind and solar utopia, where all our energy needs are satisfied by clean renewable wind and solar energy and we all live happily ever after.

They neglect to mention that every solar array and wind turbine ever built to date combined supplies less than 2% of energy demand, or that we would need to build at least 50 times more new wind and solar in the next 25 years than we managed to build in the last 25 years to even begin to solve the problem. Nor do they explain where all the land would come from to build all those wind farms and solar arrays.

Remember, wind and solar are intermittent energy sources. It's possible to store the energy they produce in batteries, and then use those batteries to supply the electric grid when the energy is needed. But batteries introduce inefficiencies, meaning not all the energy used to charge the batteries comes back out of the batteries. So using this approach would require building even more than 50 times as much new wind and solar in the next 25 years as we were able to build in the last 25 years. It would also require a staggering supply of battery metals we

don't have a source for, since all the battery metals we can possibly hope to mine will be needed for electric vehicle batteries.

And to be clear, even if we replaced every single coal- and gas-fired powerplant on the face of the Earth with clean renewable alternatives, we'd still be less than halfway to solving the problem. Remember, in today's world, 32% of our energy is supplied by crude oil and the fuels refined from it. But now we're talking about getting rid of all the internal combustion engines that rely on oil and replacing them with electric motors! That means we don't just need to replace every single fossil fuel burning electric power station on earth with a clean alternative. That's just what's needed to replace the electricity we already have. To phase-out crude oil by replacing internal combustion engines with electric motors will almost double electric demand, and after accounting for expected growth between now and 2050, it will more than double.

The bottom line is we're going to need 160k TWh of thermal energy to produce about 80k TWh of electricity by 2050. I'm going to continue to reference thermal energy figures because even some renewables such as Geothermal involve the same inefficiencies as fossil fuels when converting heat energy into electricity. Just keep in mind that 1 TWh of wind or solar electricity is just as good as 2 TWh of thermal energy from other sources, but that's only true when the wind or solar energy is being consumed as it's being produced, rather than being stored in batteries.

Building 80k TWh of clean electric power generation capacity by 2050 means building more than twice as many electric power plants in the next 25 years as have ever been built ever before. That would be a daunting challenge if we were just building new fossil fuel burning powerplants using well-developed technology. To do it all with clean energy is going to be a monumental challenge, and to count on wind and solar alone meeting all our needs for both baseload and intermittent electricity is just plain ludicrous! Remember, even with government subsidies helping the cause, we only managed to build <3k TWh of wind and solar combined in the last 25 years. The cost of solar in particular has come way down, so we can build a lot more than 3k TWh in the next 25 years, but not that much more!

To be clear, I'm not against wind and solar. Every bit of wind and solar we can realistically build in the next 25 years will be a welcome source of intermittent supply that could provide as much as 35% of the 80k TWh of total electric generation capacity required to phase-out fossil fuels. My point is simply that it's long past time to get serious about figuring out where the other 65% is going to come from, and it's going to have to be baseload power, to complement the intermittent wind and solar that's already being built.

All the politicians' talk of electric vehicles, wind turbines, and solar arrays always leaves out any credible analysis of scale. As soon as you take a serious look at this problem and analyze what's really needed to phase-out fossil fuels, it becomes resoundingly clear that we don't even have a

plan for how we're going to build new clean-energy electric powerplants at anything remotely close to the scale needed to phase-out fossil fuels by 2050.

For most energy needs that don't physically move around, direct supply of electricity is the best way to get energy from where it's produced to where it's consumed. For passenger cars and most other vehicles, rechargeable batteries that can be charged when the vehicle stops and connects to the electric mains are the way to go.

But some machines such as ships at sea and certain types of heavy construction equipment use so much energy that rechargeable batteries can't hold enough juice to meet the need. That's where hydrogen and ammonia liquid fuel come in.

There's been a lot of confusion about hydrogen in green energy circles. Similar to electricity, a lot of people mistakenly think hydrogen is an energy source that could be an alternative to fossil fuels. That's just plain wrong. Although hydrogen is an element occurring in nature, there are no natural sources for pure hydrogen needed to make hydrogen fuel cells. Rather, hydrogen must be produced by consuming energy from some other source, such as wind or solar. So the right way to think about hydrogen is not as an alternative to fossil fuels, but rather, as an alternative to batteries. Just as a battery provides a way to store energy so it can be used when the vehicle is not connected to the electric mains, hydrogen achieves the same thing, but it can store more energy per unit of weight than current generation batteries. It's another way of getting energy from where it's produced to where it's needed. This makes hydrogen an excellent option for powering heavy equipment that requires more energy density than batteries can supply.

Ammonia Liquid Fuel is similar to Hydrogen in the purpose it serves, but it's less well known. Its big advantage is that it can fuel existing diesel engines without any carbon emissions. Ammonia is a dangerous gas so handling it presents some challenges, but it may be the best option for fueling ships at sea which consume far more energy crossing an ocean than could possibly be supplied by electric batteries between recharges. Just like Hydrogen and Electricity, making Ammonia Liquid Fuel consumes energy that must be produced from some other energy source, such as Wind, Solar or Hydropower.

To summarize, the energy transition begins with replacing internal combustion engines with electric motors, but that's only the beginning. Then we need to replace every single fossil fuel-burning electric power plant on earth with a clean energy version. Those new powerplants need to meet both intermittent and baseload power generation requirements. But that's just to replace the electricity we already have. To phase-out oil and account for anticipated demand growth through 2050, we need to more than double our current electric generation capacity.

But wait, we're not done yet. Once we get rid of all the internal combustion engines so that all vehicles are electric or hydrogen-powered, and then we build out enough clean energy electric powerplants to supply more than twice as much electricity as we have today in order to charge all those vehicles and meet other electric demands, how are we going to get all that new electricity from where it's produced to where it's needed?

The electric grids of almost every country on earth are already running at or over their design capacity. That's why, for decades now, we've had rolling blackouts in California during summertime when air conditioning demands are highest. To electrify the rest of the vehicle fleet, we're going to need to deliver more than twice as much electricity from power stations to consumers than ever before.

That's not a matter of just replacing a circuit breaker with a bigger one. It's going to require completely rebuilding the existing electric power distribution grids of most countries, and that by itself is a monumental public works undertaking that will take decades to complete and which will cost hundreds of billions of dollars globally. This is a really, REALLY big deal, and the financial and environmental impacts due to all the mining required will be monumental.

Have you noticed how politicians never bring this need up when talking about green energy? They're more than happy to decree that they will outlaw the manufacture of vehicles with internal combustion engines, because they know that story resonates well with voters. But they have no credible plan for where the electricity to recharge a fully electric vehicle fleet would come from, or how it would be delivered to consumers.

They don't want to be honest with you about the challenges we face unless they already have a good solution they can personally take credit for. And they know they don't have any good answers for where the hundreds of billions of dollars needed to rebuild our electric grids will come from or how much environmental damage will be done by all the mining that will be required.

The need to rebuild our electric grids is just one of many challenges the politicians never seem willing to discuss, so while we're on that topic, let's cover some others.

Less than 5% of the vehicles on the road today are electric. The other 95% need to be replaced with electric models, and that's going to cost more than anyone wants to admit. So far, electric vehicles have been a status symbol that only affluent people can afford. But the worst pollution comes from the oldest, lowest-value vehicles that tend to be owned by low-income people. Telling a guy who's already struggling just to feed his family on his meager salary that, in the name of the environment, he has to trade his 20-year old pickup truck in for a new $80,000 Tesla just isn't going to work unless someone else foots most of the bill.

Electric vehicles require an enormous amount of copper for their electric motors, and the Lithium-Ion and Lithium-polymer batteries they run on require large amounts of nickel, cobalt, lithium, and manganese. Electric vehicle demand has already caused price dislocations in these metals, and so far, we've only electrified less than 5% of the fleet. Building enough electric vehicles to replace the 95% of vehicles still running on internal combustion engines would require more copper and battery metals than our mining industry even knows where to mine.

So, mining the battery metals needed to make electric vehicles is going to be a nearly impossible challenge, and it will take a huge toll on the environment. To try and simultaneously make enough batteries to allow wind and solar to become baseload power sources is crazy. It will already be an immense financial and environmental challenge just to mine enough battery metals to electrify the vehicle fleet.

Disposal of worn-out Lithium-Ion and Lithium-Polymer batteries will create an environmental risk of epic proportions when the entire global vehicle fleet is running on them.

Now to be clear, these problems can all be overcome. For example, we can reserve all the battery metals for the vehicle fleet, and we can institutionalize Lithium battery recycling internationally, to keep the environmental impact in check. We can also impose clean mining standards to reduce the environmental impact of mining both copper and battery metals.

My point is simply that while these problems are solvable, they haven't been solved yet. It's long past time for us to move the public debate beyond fairy tale fantasies of wind and solar solving everything, and take a serious look at what this energy transition is really going to take. We've only just barely gotten started, and we have a long way to go.

A challenge the politicians will never admit is Greenflation, referring to economic inflation caused by climate and environmental policy. Look, nothing is free in life, and upgrading anything to something better always costs money. There's no getting around that. We absolutely MUST make this energy transition; our future depends on it. But it won't come for free.

The most obvious cost is upgrading the vehicle fleet, which will be very expensive. So expensive that it will likely be necessary to provide government subsidies or loan guarantees for lower income vehicle owners to upgrade.

But upgrading the vehicle fleet is just the start! Upgrading the electric grid and building out twice as many new electric power stations in the next 25 years than we ever built in all of history before that is an utterly massive infrastructure investment, and so far, nobody is even discussing where the money is going to come from. No matter how the financing is worked out, the result will be a cost burden that all of society will have to bear. That means the price of

everything will go up, as monetary inflation is caused by all the government subsidies needed to build all those new powerplants and electric grids.

I predict that when the inflation I've described hits the economy, the debate over clean energy transition will become even more politicized and heated than it already is today. Some people will cite the inflation being caused by climate policy as reason to abandon clean energy objectives and just go back to polluting the environment. The more that Greenflation puts economic pressure on the broad population, the more that point of view will gain popularity, despite that it's a recipe for certain disaster.

The best way to offset Greenflation is to strive to make our future energy supply so much more abundant and inexpensive than it is today, that the burden of Greenflation during the transition will be paid off many times over by the dividend of cheap and abundant clean energy for generations to come. But the fact remains that we're going to pay more for everything during the transition period, before we begin to reap those benefits, and that inflation is going to fuel political tension. There's no getting around this.

And the burden won't just be financial. Re-building all the electric grids around the world will require even more copper that we don't have and don't have a credible plan to find and mine in the time it's needed. The unavoidable result of mining all that copper will be a massive environmental impact. We can reduce the impact by imposing new environmental restrictions on mining operations, but doing so will increase the cost of mining that copper, and even further exacerbate Greenflation!

I'm using Copper to illustrate my point, but the same holds true for nickel, cobalt, lithium and manganese, all of which are absolutely essential to electrifying the vehicle fleet.

Now I want you to open your mind and imagine what the world would be like if we seize the opportunity not just to replace fossil fuels with an equal amount of clean energy, but to instead figure out a way to bring online a much larger amount of clean, environmentally friendly energy, while at the same time, making it cheaper than fossil fuel-derived energy is now. And even cheaper than it was when I was a kid, when gasoline cost just 30 cents per gallon.

What if we could figure out a way to replace fossil fuels with new sources of clean, environmentally responsible energy which cost the equivalent of gasoline prices well below one dollar per gallon in today's inflation-adjusted dollars, or about 26 cents per liter if you prefer metric units?

If energy from fossil fuels made it possible to abolish slavery, made higher education available to the masses, got most of us off the hook for having to work on farms, and created a society with hundreds of occupations to choose from, can you imagine what would be possible if we

went through another similar magnitude increase in the amount of cheap and abundant energy available to advance our standard of living?

If you favor universal basic income and free university education for everyone who wants it, cheap abundant energy is what would make those policy goals attainable. And it would mean the standard of living now enjoyed only by affluent people in “first world” countries could be shared with the entire human race.

I’m convinced that vision for the future is attainable, if we can just get serious about this energy transition and stop wasting time on politicians’ fairy tales and broken promises. The purpose of this docuseries is to lay out a solid plan for doing exactly that. Building out 80k TWh of clean electric generation capacity by 2050 so that fossil fuels can be phased out completely IS a realistic goal, and later episodes of this docuseries will explain exactly how we can achieve that goal.

But unfortunately, we’ve already waited far too long to get serious about solving these problems. Climate-inspired public policy has become all the rage in recent years, but despite good intentions, much of that policy has been ill-conceived. And I’m convinced it’s about to backfire in the form of a global energy crisis that can no longer be avoided.

The next episode of this docuseries will fully explain why mistakes that have already been made will cause a global energy crisis in the mid-2020s, and why it’s too late to avoid that crisis now. Then the remaining episodes will explore what it’s really going to take beyond just wind and solar to build out all the clean energy needed to replace the 160k TWh of thermal energy we’d otherwise need to get from fossil fuels.