## Episode 1 - "The Need for Energy Transition"

The single greatest challenge humanity faces in the 21st century is breaking our addiction to fossil fuels and replacing them with clean energy alternatives.

For several decades we've known that fossil fuels are a finite resource that can't possibly last forever, and that burning them pollutes our atmosphere.

The risk of permanent and irreversible climate change has been widely discussed for over 20 years, yet to this day, we still rely on fossil fuels for more than 85% of our energy supply.

If we get this energy transition right, we can usher in a whole new era of human prosperity, and give future generations the gift of sustainable, affordable clean energy that will never run out.

Politicians want you to believe they already have a viable plan to achieve net zero carbon emissions by 2050, and that we've already made enough progress in this energy transition to begin phasing out fossil fuels.

They're lying!

They talk up their policies of subsidizing wind and solar energy development to appeal to your emotions, hoping you'll conclude that great strides of progress are already being made.

They never mention that every single wind turbine ever built combined with every single solar farm ever built supplies less than 2% of our energy needs. The politicians never admit that achieving their stated goals by 2050 with wind and solar alone would require building 50 times as much new wind and solar in the next 25 years as we were able to build in the last 25 years.

They never tell you that the Electric Vehicle revolution will require unprecedented increases in environmentally destructive mining operations needed to supply all the copper, lithium, nickel, cobalt, and manganese required to build all those electric vehicles.

They never acknowledge how much economic inflation will be caused by the policies they falsely claim will achieve this energy transition by 2050.

If the politicians have this under control, why has almost no real progress been made after two full decades of broken promises?

Our politicians are paying lip service to energy transition to get your votes and stay in power. But in reality, almost no actual progress has been made toward reducing our dependence on fossil fuels.

And that's not even the worst of it. I predict that well-intended but badly ill-conceived climate policy will directly cause a global energy crisis in the mid-2020s that could easily have been avoided with sound energy policy.

I'm Erik Townsend. I was a software entrepreneur in the '90s, and later went on to manage a hedge fund. I'm fully retired now, but I remain passionately committed to helping solve the greatest problem humanity faces: the Global Energy Crisis that's certain to occur as we struggle to transition from fossil fuels to cleaner, greener sources of energy to power the global economy, while simultaneously decarbonizing our atmosphere.

If you aren't yet sold on the urgent need to break our addiction to fossil fuels, I hope to persuade you. And climate change isn't the only reason.

If you, like me, are already passionate about this cause, I'll show you how badly you've been misled about how big a challenge this transition will be, how long it will take, and what it will cost.

Politicians aren't genuinely engaged in solving this problem! They're engaged in talking about solving this problem to win your votes. But so far, their policies aren't realistic and won't achieve the stated goals in the stated timeframes. I'll show you why later in this episode.

The purpose of this docuseries is to explain why this transition is needed and what it's really going to take, including the parts we don't yet have good solutions for. I'll show you the many challenges the politicians never mention, such as how much the Energy Transition will cost and the environmental impact of the transition itself.

But put your seatbelt on, because I'm not running for office and I'm not selling anything, so I'm not going to sugar-coat the challenges that lie ahead of us. And if you've been evangelized by the propaganda that wind and solar alone can solve this problem by 2050, I'm going to challenge some of your beliefs with hard data that tell another story.

You see, this will be a tale of failed government policies, corporate greed, bureaucracy, and corruption causing missed opportunities to cure our fossil fuels addiction decades ago. Our elected leaders have made a real mess of energy policy, so unfortunately, we're going to be in for a bumpy ride.

But if we can correct our course and get this energy transition right, we have the opportunity to usher in a whole new era of human prosperity.

We currently rely on fossil fuels for more than 85% of our energy needs. Nuclear power supplies less than 2%, and wood and other biofuels supply almost 8%.

The remaining 5% comprises all renewable energy sources combined, with Wind and solar contributing less than 2% of current energy demand. That's right, after all the politicians hyped up talk, Wind and Solar combined only supplies a measly 2% of our total energy needs.

There are two reasons we urgently need to break our addiction to fossil fuels. The first is the risk of climate change reaching a tipping point where it becomes irreversible. This argument is extremely well-known, so in the interest of time, I'm not going to bother repeating what you already know.

In my opinion, the second reason is even more compelling, but it's far less widely understood. I call it peak cheap oil. The executive summary is that we've already found and developed all the oilfields where it's cheap and easy to produce crude oil. There's still plenty of oil left in the Earth's crust, but from here on out, producing that oil is going to get much more expensive over time. So expensive that it will eventually cripple the economy.

The number of years it will take to transition the global economy off fossil fuels, even if we make it our top priority, will be greater than the number of years we have left before peak cheap oil drives energy prices to economy-crippling levels.

We're not "running out of oil." We've already run out of new oilfields where oil is cheap and easy to produce. From here on out, more and more complex technology will be needed to produce more oil. That means prices will continue to rise until energy from oil becomes completely unaffordable, causing an energy crisis that could throw the global economy into depression and plunge the entire world into to resource wars.

None of these things are set to happen next month or even next year. But they will happen in far fewer years than it will take to transition the global economy off fossil fuels. And that means we've already waited too long to avert a crisis.

The importance of energy to our standard of living cannot be overstated! Societal Complexity is a function of the amount of Cheap & Abundant Energy available to the economy. This is a key lesson of this docuseries, so let me explain why it's so important.

200 250 years ago, almost everyone in society worked on farms, because there was no alternative. We needed almost everyone's help just to grow the food we needed to survive. Not to turn a profit—just to survive. University education was extremely rare, and few professions even existed. Firewood provided the sole source of energy for heating and cooking. Plumbing hadn't even been invented yet, and in some countries, including the United States, human slavery was rationalized as necessary, because there was no alternative source for the physical labor needed to run the farms and plantations of the day.

What changed that allowed us to advance so much faster in the last 200 250 years, so that we now live in air-conditioned Highrise buildings with heat and electric lighting? University education is widely available, and we can choose from literally hundreds of occupations that didn't even exist 200 250 years ago, and then spend our leisure time reading social media on our smartphones, or even traveling anywhere in the world in just a few hours travel time.

Most people answer by saying Technology is what changed, but technology is a 2nd-order effect, not the driving force. The reason humanity has made so much more progress in the last 250 years than it did in the 500 years before that, is a marked increase in the availability of cheap and abundant energy. Technology is just how energy is harnessed and put to work to advance society.

It all began with the commercialization of the steam engine in the 1760s and '70s. Since then, cheap and abundant energy derived first from coal and then later from oil has enabled a profound increase in the pace of human advancement.

With Gasoline prices reaching record highs recently, it might not feel like energy is "cheap" right now. But when you consider that one gallon of gasoline produces the same amount of useful work as up to 482 hours of human labor, it's still much cheaper than hiring someone to do the same work manually.

If you're skeptical, try this experiment: Put just $5 worth of gasoline in your car. That won't even buy you two gallons in the United States, and even less in Europe—maybe only 2 or 3 liters. Then put your two strongest friends in the car and drive away from your house until the tank runs dry. Then get out and PUSH the car home. You'll very quickly develop a whole new appreciation for how much human labor is replaced by just $5 worth of energy from gasoline… even at today's elevated prices.

In case you're not inclined to actually push a car around just to prove this point, another statistic that drives this idea home is that even a professional athlete can't do as much physical labor in a single day as the electricity you could buy for less than half a dollar in most countries.

We abolished human slavery, eliminated the need for almost everyone in society to work on farms, and made university education available to the masses because of the cheap and plentiful energy we get from fossil fuels. That's how important cheap and abundant energy is to our way of life.

In the beginning, we didn't understand how badly we were polluting our atmosphere by burning all those fossil fuels. But now it's been decades since we figured that out, and yet we still haven't changed our ways. And we've always known that we're slowly depleting a finite resource that can't possibly last forever, yet we never seem to take seriously the risk that it might run out someday.

Less than one billion human beings lived on planet Earth when the Steam Engine was commercialized in the 1770's. Today that figure is over 8 billion. That population growth was directly enabled by modern farming. We literally cannot feed the current population of our planet without modern farming equipment, which requires energy that's presently supplied by oil. That's how much our way of life and our very ability to sustain the lives of everyone on our planet depends on having the energy we now derive primarily from fossil fuels.

The pace of societal advancement has slowed noticeably just in my own lifetime, and the primary reason is that Gasoline doesn't cost 30 cents a gallon like it did when I was a kid. Adjusted for inflation that's $2 per gallon in today's dollars, but actual prices at the pump are closer to double that amount. When gasoline prices move over $6 in the United States as I predict they will by 2025, we'll be paying three times as much for energy as when I was a kid, even after adjusting for inflation.

If you're old enough to remember the boom times of the 1980s and '90s, and wonder why it's harder for most people to get by in today's economy, the reason is the higher cost of energy slowing the pace of advancement.

How many years are left before peak cheap oil makes energy prices completely unaffordable is a matter of debate. But at this point, it's an academic debate because we're going to reach that point in less time than it will take to transition the economy off fossil fuels.

Modern society is addicted to fossil fuels because we're quite literally dependent on the energy they provide for our survival. That means nothing is more important than ensuring that we find enough clean energy to continue to allow society to thrive, because without the energy we currently rely on fossil fuels for, we'd be forced back into the dark ages. But if we continue to rely on fossil fuels for this energy, we'll destroy ourselves.

This chart shows global energy consumption broken down by source. 85% of our energy supply comes from the three primary fossil fuels of Coal in Grey, Oil in Blue, and Natural Gas in Purple.

We get energy from fossil fuels is by burning them to release heat, and the chart shows the total thermal energy we derive from each source.

We use the heat energy released by burning fossil fuels most efficiently when that heat is used directly to heat something else. For example, when natural gas is used to heat a building, up to 96% of the heat energy released by burning the natural gas is put to good use, and very little goes to waste.

But when we use fossil fuels to make electricity, the process is far less efficient. The typical natural gas fired electric powerplant is 55% efficient, while the very best state of the art high-efficiency gas fired powerplants are up to 64% efficient.

Coal is even less efficient than natural gas. Aging coal-fired powerplants are typically only 35 – 38% efficient, and the very best state of the art coal-fired electric powerstations are only 46% efficient. That means that more than half the heat energy released by burning coal is wasted when it's used to make electricity. The rest goes up the smokestack along with all the greenhouse gasses produced by burning all that coal.

Internal combustion engines are even worse! Most gasoline engines operate at around 20% thermal efficiency. That means when you spend $100 filling your car's tank with gasoline, $80 of your hard-earned money will go to producing heat and greenhouse gases that all come out the tailpipe and do nothing to propel your vehicle.

The latest high-efficiency diesel engines can operate at up to 40% thermal efficiency, but even then, more than half your money is being spent polluting the atmosphere and nothing else. Less than half the energy released by burning fossil fuels in any internal combustion engine is used to propel the vehicle. Thankfully, electric motors are much more efficient.

Advocates of Wind and Solar renewables are quick to point out that while the Wind energy shown in green and the solar energy shown in orange appear tiny by comparison, they don't suffer the thermal inefficiencies that cause up to 2/3 of all the energy released by burning fossil fuels to be wasted.

That's partly true, and when wind and solar energy are consumed immediately as they're being produced, it's reasonable to double the electric energy values shown on the chart to get the equivalent amount of thermal energy that would be needed from fossil fuels in order to deliver the same amount of electricity.

But this isn't an apples-to-apples comparison. To understand why, we first need to explain Baseload vs. Intermittent power generation, so let's cover that next.

Electrical demand is neither constant nor predictable. This chart shows typical electric demand over the course of a 24-hr period. Demand is lowest in the overnight period when people are sleeping and relatively little energy is demanded. Of course, electricity is always being consumed. Refrigeration is just one example of something that demands electricity on a 24/7 basis, regardless of whether anyone is awake or what they're doing. The electricity demand which exists 24/7 is known as baseload demand. But then there are peak demand periods, such as mealtimes, when energy is demanded for cooking. The energy needed to make up the gap between baseload and peak demand is known as intermittent demand.

Some energy sources are best suited to supplying baseload power, and others are only suited to supplying intermittent power, while still others are good for both applications. Coal burning power plants can't just be switched on or off at the press of a button, so they're best suited only to supplying baseload electricity. The same is true of Nuclear. Conversely, natural gas fired

electric generators are much easier to turn on or off, so they're much better suited to meeting intermittent demand, but they can also supply baseload power if necessary.

Wind and solar renewables are inherently intermittent sources of energy. They work great when the wind is blowing and the sun is shining, but solar doesn't produce any electricity at night and wind turbines don't produce any electricity when the wind is calm. So when it comes to meeting that mid-afternoon intermittent electric demand to run air conditioning equipment, wind and solar are well suited to the task.

Energy storage technology allows the electricity produced by wind and solar to be stored in batteries until it's needed. But energy storage introduces its own inefficiencies, just as burning fossil fuels to make electricity introduces inefficiencies. And as I'll explain in the next episode, we're going to need all the battery metals we can realistically expect to mine in the next 20 years just to make electric vehicle batteries, so it really doesn't make sense to count on wind and solar for baseload power needs.

This is today's version of the daily cyclical demand chart, but the energy transition is going to change the picture. Currently, less than 5% of vehicles on the road are electric, so recharging them doesn't contribute much to overnight electric demand. At least not yet. But when we fully electrify the vehicle fleet, most vehicles will be charged overnight, and the wee hours before dawn will become a high demand period for vehicle charging as opposed to the lowest demand period now.

Not all renewables are inherently intermittent energy sources. Hydropower and geothermal renewables are much better suited to meeting baseload supply needs. In the case of geothermal, it's already a good source of baseload electricity. And if we can achieve a few technological advances, geothermal has the potential to go from a good source of baseload power to a terrific source. So terrific that I've dedicated an entire episode of this docuseries to Geothermal renewable energy.

Hydropower is a terrific renewable electricity source, but as Peter Zeihan wrote in his recent book, all the best geographically promising opportunities for hydropower around the globe have, for the most part, already been developed, so unfortunately, we can't expect much growth from hydro in coming years.

Now that we're armed with an understanding of baseload vs. intermittent electricity, let's return to the energy demand chart. It's true that wind and solar don't suffer the inefficiencies of fossil fuels when they're used to produce electricity, but it's equally true that wind and solar are not suitable as baseload power sources.

That's not to say we shouldn't continue building more wind and solar. We need more wind and solar and they'll serve us well as daytime intermittent energy sources.

But by my calculations, even if we build as much new wind and solar as we possibly can, it still won't supply more than 35% of total energy demand by 2050 vs. less than 2% today. It's long past time to get serious about figuring out where the other 65% will come from, and it'll need to be baseload power to complement the intermittent supply we'll get from wind and solar.

The goal of this first episode has been to explain the foundational concepts you need to understand so that we can lay out a master plan to replace all the energy we get from fossil fuels in the next episode. The key points to remember from this episode are that very little progress has been made to date on Energy Transition, which is the single most important challenge we face in the 21st century, and Peak Cheap Oil is just as important a reason as climate change. Most people don't realize how critically important cheap and abundant energy is to our standard of living. It's essential to understand the difference between intermittent and baseload electricity. And where all the baseload electricity will come from, to supply 65% of our energy needs by 2050, is the big question that not enough people are talking about.

So in the next episode of Energy Transition Crisis, I'll lay out a Master Plan showing the steps needed to break our fossil fuels addiction and achieve a Clean Energy Transition, including exactly how much clean energy will be required, and what needs to be done to change our systems and public infrastructure in order to replace fossil fuels with clean energy.