

Will the Green New Deal Shut Down Our Refineries and Power Plants? or Where Will I Get My Power?

In the beginning, power companies were absolute monopolies. The wires coming into our houses only came from one company. They made the electricity, and they set the prices. They paid thousands of engineers to design and build magnificent, multi-billion dollar nuclear and coal plants. All that has changed. Power companies have far less control.

After Three Mile Island, no one believed the promises that a nuclear disaster couldn't happen here. At about the same time, smog from coal plants upwind crept into Monument Valley and into the Grand Canyon. Power companies became the enemy. There were petitions, demonstrations, and lawsuits. It's different overseas. In the managed economies of China, Russia, and in the Arab States, big fossil fuel and nuclear plants still dominate. But the last successful contract for a domestic nuclear plant was signed in 1973, and it's doubtful that another large coal plant will ever again be built in this country.

Some wonder if the proposals of the Green New Deal are the solution. If we make all our buildings, cars, and planes more efficient, maybe we don't need big utilities or oil refineries. After all, state regulators have broken the monopoly. Power companies no longer get to build what they want, when they want it. They have to compete with outsiders to provide the lowest-cost plants. And the regulators have opened utilities' transmission lines to their competitors, too. In some states, most of the generating plants have been sold to outsiders. As their giant coal and nuclear plants reach their end of life, they are not being replaced by new coal or nuclear, but by smaller jet engine plants or by renewable energy from the wind and the sun.

The new power companies are increasingly you and I. It's not just solar panels on our roofs. Factories and power-hungry data centers now build their own, smaller power plants "behind the meter" and only use the traditional grid for back up.

Still, skeptics ask, "Is the Green New Deal even possible?" Others wonder, "Is it perhaps inevitable?" One thing is certain. Where you get your electricity in the future will not be where you got it from in the past.

Biographical Sketch

William R. Gould, Jr.

Mr. Gould received bachelor's and master's degrees in Mechanical Engineering from BYU in 1972. He is a registered Mechanical and/or Nuclear engineer in several states.

His career was spent in managing the design, construction, and operation of some of the largest and most complex power plants in the world. These power plants were fueled by coal, fuel oil, natural gas, nuclear, or most recently, by wind and by solar power. They include plants built overseas in Asia and Africa, as well as in several U.S. states.

He has been a frequent speaker at technical conferences and a consultant for the US Department of Energy and other industry groups. His most recent position was the Executive Vice President and Chief Technology Officer of the SolarReserve company, which built high temperature solar thermal power plants like the 110-megawatt Crescent Dunes station in Nevada, which has enough energy storage so that it can continue delivering electricity at full power all through the night.

But he counts as his greatest joy his marriage to the former Carol Howell of Provo, Utah, with whom he has been married for over 50 years, their seven children, 28 grandchildren and two great-grandchildren.



Will the Green New Deal Doom Our Refineries and Power Companies? or Where Will I Get My Power?

**WILLIAM R. AND ERLYN J. GOULD DISTINGUISHED LECTURE
ON TECHNOLOGY AND THE QUALITY OF LIFE
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Introduction

It's a pleasure to be with you today. This lecture series was initiated by my parents twenty-seven years ago. If Dad were here today, he would tell you that theirs was a team effort. His name appeared on in the headlines, but Mother was a full partner. She took him beyond thermodynamics and energy flows to an appreciation for the humanities, a love of diverse peoples and their arts and letters. My brothers, Gil and Wayne, and I spent our careers in the power industry. Gil was on the financial and risk management side, I worked in design and construction, and Wayne operated the large power plants, and utility systems. Today, I share their insights as much as my own.

Background

Today's topic needs a little background. In October of 1980, Dad rose to national prominence by declaring that the company he led, the Southern California Edison Company, would never again build the coal and nuclear power plants which were the standard all over the world. His was one of the largest power companies in the country and was very influential. In that early day, renewable energy was untested, unreliable, and much more expensive. But contrary to the industry consensus, that is exactly what he would build. Now, 40 years later, renewables seem pretty conventional. But it wasn't so in 1980. The story unfolded like this.

In the 1950s, power companies wanted to increase sales. You may remember slogans like "Live Better Electrically," and you may have bought an "All Electric Medallion Home." Then new electrical devices became popular. We bought electric can openers, carving knives, toothbrushes, and even lawnmowers. Our record players grew into huge entertainment systems. In the '60s, electrical demand got out of hand. In fact, economists taught that electricity was price inelastic, meaning that no matter what the price was, customers would continue buying the same amount or more. The annual growth in power was 7.2 percent nationally, and in California, it reached a staggering 9.4 percent. That meant that utilities had to double all their plants and transmission lines every eight years or so! They had to build big and build fast. Engineers built giant coal-fired and huge nuclear power plants. I was one of them

A decent coal boiler would yield six to nine hundred megawatts (MW) and nuclear plants could be 1200 (MW). Power companies grouped several boilers or reactors together in one place. If you've driven near Delta, Utah, for example, you've seen three

coal boilers whose total output is 1900 megawatts. The plants at Delta are far from the largest. China, Japan, Europe, and Saudi Arabia have built stations much, much larger. My thermodynamics professors taught me that improving the efficiency of the steam cycle could only be increased by raising the temperatures and pressures, and this only happened at large scale. Why now turn to tiny, inefficient renewable plants? Had the laws of thermodynamics changed? No. Those thermodynamic truths still govern. Today in centrally planned economies like China, Russia, and in the Arab kingdoms, large nuclear and fossil-fueled plants still reign.

Dad turned his back on all that. Everyone knew that electricity would cost more, the grid would be less reliable, and these renewable technologies might not even work. Overnight, Dad was hailed as a visionary and an environmental pioneer. The company stock soared. Environmentalists loved him, but his peers in the “C” suites of big utilities were less sanguine. Everyone knew the only way to meet demand was with coal and nuclear. One of his peers called him the day after the news hit the papers and sarcastically asked “Well Bill, what did the good tooth fairy bring to you last night?”



Dad wasn't against technology. If he could have had his way, he would have built nuclear plants all throughout California. But on March 28th of 1979, reactor number 2 at Three Mile Island melted. Jane Fonda starred in a movie called “The China Syndrome,” which depicted a reactor meltdown that might have sent a reactor core

melting through the earth all the way to China. Chernobyl's number four reactor would explode seven years later. After Three Mile Island, no one believed the confident, - some said arrogant - engineers who claimed that a nuclear accident just couldn't happen here.

Large coal came under fire, too. There were reports of fly ash and smog drifting into Monument Valley and into the Grand Canyon from coal plants upwind. Public sentiment turned against the power companies. There were protests, demonstrations and lawsuits. The people wanted to stop big power.

Bankers Select Technology

Blocking new construction didn't turn out to be very hard. Protesters didn't need a formal cancellation. All they had to do was delay construction. Utilities had to borrow billions of dollars from banks to build such beasts, and a single day's interest could easily cost a million dollars. If a plant were tied up in court for weeks or months, well, that is all it took. The big banks on Wall Street would no longer take the financial risk of a legal delay. Few said this openly at the time, but it became clear that the bankers selected the technologies by what they would and would not finance.

Dad was not a wide-eyed visionary predicting flying cars and vacations on Mars. But he could see what was coming. He quietly confided in Wayne, "Son, I had no choice. I was not the first CEO to think about renewables. I was just the first to accept the inevitable." He used to tell us "if you have no options, you have no dilemma." The inevitable is now obvious. But even bigger changes than these renewable technologies were to follow.

Jet Engines

I was a junior engineer in the late '60s at power plant near Los Angeles. These plants were designed before the '73 oil crisis and could burn either oil or natural gas. Today, only nations that have too much of the stuff burn oil to make electricity. I remember taking an 11x17 inch sketch pad up to the burner fronts on the boilers. I sketched the routing for the small piping that carried either oil or gas to each burner. Pipe fitters would come along later and weld the piping in place to my sketch. But on the same site was a concrete block building about 40 feet long. It held a jet engine like those on a 707 airplane. This was an experiment to see if the jet engine could drive an electrical generator. The operators didn't think much of the jets. They were small and were horribly inefficient

The fossil-fueled plants next door were much, much bigger. Their turbines alone would not fit in this auditorium. And as big as they were, they were built to precise tolerances. To start one, operators had to slowly heat them from room temperature to over 1000 degrees and then gradually increase the pressure. These plants take a day or two to start and to shut down.

Nuclear plants had additional constraints and large coal plants could be just as complex. We no longer throw scoops of coal into a furnace. Chunks of coal are loaded onto conveyer belts which lead to crushers and mills to pulverize the coal until the particles of dust are as fine as face powder. This coal dust is then blown into the boiler with compressed air. At the backend, filters, precipitators, and chemical sprays capture fly ash and scrub the smog producing oxides of nitrogen and sulfur out of the smoke. The pace of the exhaust system matches the pace at the front end, or pollutants are released, and fines are paid. Like a 747, all these systems operate beautifully at full power, but takeoffs and landings are more complicated.

But with these little jet engines, you just pushed a button and ten minutes later, you're at full power. The jets had another feature that would change everything. You could buy one right off the assembly line. Power companies no longer needed thousands of engineers to design and build the big plants.

Then engineers did what engineers do. They tweaked and fiddled and improved things. The jet-generators are now called "combined cycle" plants and are more efficient than traditional boilers. You've seen one. As you drive toward Provo, if you look off to your right to where Geneva Steel once was, you'll see two such plants. They don't fit in a 40-foot room anymore. That's the "Lake Side Power Station." It has four jet engines whose exhaust also feeds two steam turbines. Together they generate over 1200 megawatts. That's as much as a nuclear plant without all the safety concerns. And it's cheaper, too.



Politicians Take Over

Power companies are a type of monopoly. The wires coming into our houses only come from one company. They make the electricity, and originally, they set the prices. But early on, politicians got involved. The politicians didn't trust utility prices. So, they formed state energy commissions and created what's called the Division of Rate Payer Advocates. Their job is to make sure that this monopoly charges the lowest cost.

Since entrepreneurs could now buy a combined cycle power plant almost "off the assembly line," the regulators encouraged businessmen to compete with traditional power companies. Pretty soon investors started building their own plants all over the place and selling the power to the power company. Some utilities still own most of their generating plants. Others like buying power to redistribute and not having to worry about breakdowns and repaying the bank loans. You and I make similar decisions. Why own the cow when you can go to WalMart day or night and buy a quart of milk or even a pint of Double Fudge ice cream?

Next the regulators demanded that competitors could sell their power over the utility's own transmission and distribution network and not be charged a profit. They called these transmission mandates "Common Carrier."

The distribution network carries power the last mile to the customer. Traditional power companies still manage the distribution network. But that has gotten much harder. When customers install their own rooftop solar panels, they want some place to sell their excess power. We're not only talking about homeowners with a few panels on their roofs. Many businesses now build their own small power plants next to their factories and data centers. They're called "behind the meter" generators. Now the local distribution network has to pass electricity both ways - first, from the grid to the people and second, from the customer back to the grid. The original lines to get power to our homes were often smaller than what's needed to sell power back to the grid.

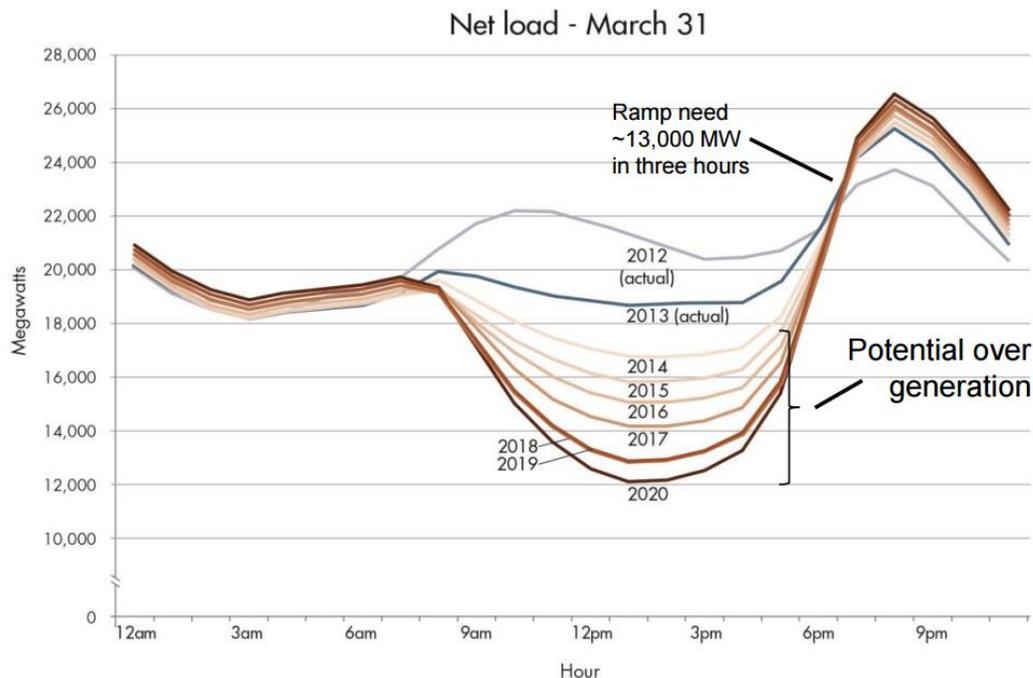
Where will I get my power in the future? Who are the new power companies? Increasingly, it is you and I! As homeowners and as businesses, we're increasingly finding it cheaper to generate our own electricity and just use the grid for back-up.

Storage

My dad would scarcely recognize today's power company. But one challenge he would know very well. Standing in the middle of the control room one day, Dad pointed to the power output meter and said to Wayne, "Now, watch this." The plant's output suddenly jumped up a few percent. It stayed there for about four minutes and then dropped back to its previous level. In the evenings, it happens four or five times an hour. Why? It's TV commercials. When a commercial comes on, someone jumps up from the couch, turns on the light in the hall and then in the kitchen, he opens the refrigerator door for a cold drink, and then goes back to the couch.

And this illustrates a basic fact about electricity. Except in small quantities like in flashlights and cell phones, electricity cannot be economically stored. The customers' demand for energy feeds back to the generators and controls their output. The natural gas and water companies don't experience this. You can think of the customers' demand and the generators as two large rotating steel disks connected by a rubber axel - if one speeds up, the other will try to catch up. When the demand goes up, the generator tries to catch up, but for an instant, the normal frequency slows down a tiny bit, and then the voltage also drops. Yesterday's lightbulb didn't much care about frequency and voltage fluctuations, but today's computers care a lot. We want the grid to give us as much power as we want, whenever we want it, and we want the power cycle to be very, very stable.

Now we add the wind and solar to the mix. Sometimes the wind gusts and sometimes the sun goes behind a cloud. Voltages fluctuate. And on a bright, sunny day our combined solar panels produce too much power. The power grid has to accept the customers' excess power. When that happens, the utilities have to turn down their boilers and reactors. Each year more and more solar and wind are being installed and this trend shows no signs of slowing.



This what the

California regulators call this the “Duck Curve” because some folks thought it looks a little bit like a duck with the beak on the right.

It shows the net power that the utilities have to come up with after accepting all their customers’ excess wind and solar power. Each year power companies have to cut back more and more to accommodate customers’ excess power. That makes grid management really tough. They have to receive customers’ excess power, and then when the sun sets and the solar kilowatts go away, they have to quickly fire up their boilers to meet the steep load increase. It was a lot simpler to manage before renewables came along. But there is another dramatic change that may help.

Electrification of Transportation

We are in the opening scenes of a revolution in electric transportation. This goes far beyond prestige cars for the wealthy like the Tesla Roadster. All major car makers are bringing electric cars to the market. There are already electric busses, electric ferries in ports, and fleets of battery-powered delivery vans and service vehicles.

This summer the pharmaceutical company, AstroZeneca, for example, announced that they would be transitioning its fleet of 16,000 vehicles to battery power. In addition, the California Air Resources Board (CARB), just required all busses and shuttles at airports to be zero emission vehicles (ZEVs) by 2035. That’s over 1000 busses and shuttles. There are announcements every week of additional fleets of delivery and service vehicles being converted.

They are not doing this to get from zero to sixty in three seconds. And the conversion is more than just a concern for the environment. These busses and vehicle fleets are

politically helpful, to be sure, but economics is driving the conversion. The cost for a municipal bus powered by diesel fuel, for example, is in the range of 70 cents per mile. That same bus fueled by electricity costs about 20 cents. There is a valid business case for the conversion.

Amid all this change, some think that the Green New Deal will solve our problems.

Senator [Edward Markey](#) and Representative [Alexandria Ocasio-Cortez](#) call for a “10-year national mobilization,” whose primary goals would be:

- "Guaranteeing a job with a family-sustaining wage, adequate family and medical leave, paid vacations, and retirement security to all people of the United States."
- "Providing all people of the United States with – (i) high-quality health care; (ii) affordable, safe, and adequate housing; (iii) economic security; and (iv) access to clean water, clean air, healthy and affordable food, and nature."
- "Providing resources, training, and high-quality education, including higher education, to all people of the United States."
- "Meeting 100 percent of the power demand in the United States through clean, renewable, and zero-emission energy sources."
- "Repairing and upgrading the infrastructure in the United States, including . . . by eliminating pollution and greenhouse gas emissions as much as technologically feasible."
- "Building or upgrading to energy-efficient, distributed, and ‘smart’ power grids, and working to ensure affordable access to electricity."
- "Upgrading all existing buildings in the United States and building new buildings to achieve maximal energy efficiency, water efficiency, safety, affordability, comfort, and durability, including through electrification."
- "Overhauling transportation systems in the United States to eliminate pollution and greenhouse gas emissions from the transportation sector as much as is technologically feasible, including through investment in – (i) zero-emission vehicle infrastructure and manufacturing; (ii) clean, affordable, and accessible public transportation; and (iii) high-speed rail."
- "Spurring massive growth in clean manufacturing in the United States and removing pollution and greenhouse gas emissions from manufacturing and industry as much as is technologically feasible."
- "Working collaboratively with farmers and ranchers in the United States to eliminate pollution and greenhouse gas emissions from the agricultural sector as much as is technologically feasible." ([The Washington Post](#) (February 11, 2019))

No one can argue with the utopian dream. We all want to save the planet. I am not qualified to speak about the aspects of the Green New Deal dealing with what is called social justice, or guaranteeing all citizens be given food, water, and money, or bringing an end to all oppression. But I can offer a couple of insights related to energy. The biggest question is “Do we have the tools to motivate such dramatic change?” Here are some tools that have been tried in the past.

Compulsion

Governments, including dictatorships, have a poor record of compelling individual behavior. Many gave their lives breaching the wall in Berlin or by paddling inner-tube rafts from Cuba to Florida. We're not very successful at compelling behavior in this country either. Think of the controversy over Obamacare's individual insurance mandate, or New York's attempt to ban large sugary sodas, or California trying to ban plastic straws and plastic shopping bags. Certainly, in spite of strict laws, a multi-billion-dollar market in cocaine and opioids thrives. However wise and well-intentioned these laws may be, customers don't like to be compelled.

Persuasion

We're not much better at persuasion, either. Many of you will remember watching the president of the United States appearing on nationwide television in during the 1973 OPEC oil crisis. President Carter was concerned about the spiking price for home heating oil. He put on a warm sweater and encouraged all of us to turn our thermostats down and get used to less comfort. If his "sweater diplomacy" had any effect, such effect has not endured. And while we all complained about OPEC while waiting in long gas lines, few of us gave up our cars. In the end, we act in our own perceived self-interest.

But I can tell you some strategies that have worked in the past and may lead to implementing parts of the Green New Deal.

Remove the Decision

An invisible compulsion takes place when the government simply takes the decision out of the hands of the customer. For example, the recipe for the gasoline we put in our cars contains a mix of chemicals mandated by the government. Lead compounds were taken out many years ago. At certain times of the year, refiners add oxygen-rich chemicals to reduce smog. You and I don't get to choose whether we like these additives. If we want gasoline, we buy what's for sale. In like fashion, we generally don't get to choose whether our drinking water is fluoridated, chlorinated, or not. And the airplanes we fly on have required safety features we're not even aware of.

Fuel standards imposed on auto makers is an example with mixed results. When I was a boy, my father drove a big, beige Dodge station wagon. The third row was a bench seat facing the rear. It was long and heavy and drank a lot of gas. Station wagons disappeared off the American roads in the '80s. The cause of their death shows how governments can take the decision away from customer.

"Stringent fuel economy regulations imposed on cars in the 1970s had made it practically impossible for automakers to keep selling big station wagons. Yet many Americans still wanted roomy vehicles.

The answer ... Lee Iacocca [of Chrysler] realized, was to make family vehicles that were regulated as light trucks, a category of vehicles that includes pickups.

The government had placed far more lenient fuel economy rules on light trucks, as well as more lenient safety and air pollution standards.

Cargo vans, a tiny niche marketed to carpenters, plumbers and other workers, were regulated as light trucks. When Chrysler introduced the minivan in 1983, fewer than three percent of them were configured as cargo vehicles, with just a couple of seats in the front and a long, flat bed in the back. But that was enough for Mr. Iacocca to persuade federal regulators to label all minivans as light trucks.

It's ironic, because there might have been less fuel consumed had the government just left station wagons alone rather than instead effectively pushing consumers into even bigger minivans. The unintended consequences of regulations can be hard to predict, but it's not hard to predict that there will be some, because there almost invariably are." (Keith Bradsher, *New York Times*, July 3, 2019, *Lee Iacocca Was a C.E.O for the Television Age*)

Could the government do something similar to compel environmental change? Of course. If we want to build a new home, our contractors must comply with local building codes which impose fire safety, seismic, and other standards that a government agent has decided are for our good. Could the codes require solar panels, thick insulation, and LED lighting? They could. In July of this year, the city council in Berkeley, California, for example, passed a resolution banning natural gas connections in all new-home construction.

Imposing requirements on new construction is one thing, but imposing change on existing cars, plants and buildings is a much, much bigger political challenge. Existing buildings and structures have always been "grandfathered" in under new laws.

Incentives

In the 1980s, Congress wanted customers to buy cleaner energy. They changed the tax code to give tax deductions and, more significantly, tax credits for windmills and solar panels. You'll remember the explosive growth of wind farms near Palm Springs, in the Tehachapi mountains north of Los Angeles, and in the Altamont Pass east of San Francisco. These could never be financed without tax credits.

Regulators also hoped that homeowners would put solar panels on their roofs. This was slower in coming until some state regulators required power companies to buy all excess power from homeowners, and in some jurisdictions required them to pay the customer - not wholesale, - but full retail rates for that excess power. It's called "Net Metering." The combination of these government incentives, coupled with falling costs from cheap, imported Chinese panels sparked explosive growth in solar.

"A similar green explosion is underway in Norway where "From the affordable Nissan Leaf to the luxurious Tesla, more than half of new cars sold in the country in March were run on batteries rather than fuel. "We will probably pass 50 percent" for the full year as well, says Christina Bu, secretary general of the

Norwegian EV (electric vehicle) Association. While the Nordic country is the biggest oil producer in Western Europe, it is officially aiming for all new cars sold to be zero emission by 2025.” (Pierre-Henry Deshayes, *From Princes to Undertakers, Norway’s Motorists Go Electric*, AFP July 9, 2019)

How do they do it? In Norway, electric cars are almost entirely exempt from the heavy taxes imposed on gasoline and diesel cars, which makes them competitively priced. They are also exempt from toll roads and are permitted to drive in bus lanes. Could that happen here? It could.

Recognize that incentives can work in both positive and negative directions. You’ve heard of politicians proposing a carbon tax. Such a tax would discourage customers from burning both natural gas in their homes and gasoline in their cars. Where is your pain threshold? What if a carbon tax increased the price of gasoline by 30, 50 or 90 cents a gallon? At what point would you switch to a battery-powered car?

The Controversy over Tax Credits and Incentives.

Some progressive politicians, however, see a downside to such incentives. Their logic runs like this. Only the wealthy pay taxes and only the wealthy can afford solar panels and electric cars. The poor are left out. If we pay the wealthy to install solar panels and to buy electric cars, the net effect is that the poor have to pay higher costs. This “regressive” policy widens the gap between the “haves” and the “have-nots.” Similarly, a carbon tax on natural gas and on gasoline disproportionately hurts the poor who can’t afford to buy new appliances or a Tesla Roadster.

Popular Demand

We, the people, can effect change, too. In 2001, the citizens of San Francisco approved a ballot initiative for the city to issue 100 million dollars’ worth of bonds to finance solar panels on the city buildings downtown. The Moscone Convention Center, for example, received a portion of those funds and soon installed 645 kilowatts of solar panels. It was the largest roof-mounted installation of solar panels in the country at the time. Some cynics watched the coastal fog creep over the hills in Daly City and through the Golden Gate. They quip that “Fog City” may not be the best place for solar power. It was, however, the best place for an enthusiastic electorate to voice their popular demand.

Remember that big coal plant near Delta? It’s scheduled for retirement in six years. It’s not worn out, and we certainly haven’t run out of coal. But it sells its power to municipal utilities in Southern California. These city councils voted that they would not renew their contracts with the politically incorrect coal plant when the contracts expire in 2025. Is this likely to happen again? Yes, it will. In New Mexico, PNM announced that they will decommission all their coal plants in six years.

Can the Green New Deal be Accomplished?

Well, no. It can't - at least not within 10 years.

Proponents say that if we had an urgent, national mobilization like the life-or-death mobilization in World War II, then we could do the same today with energy. But even the heroic mobilization of the 1940s is orders of magnitude smaller than the effort to rebuild every home, factory and skyscraper in America, and to scrap all internal combustion and aircraft engines.

For example, the most complex ship we built in the '40s was the aircraft carrier. The USS Lake Champlain was the last one built in that period, being commissioned in June of 1945. It had eight small fuel oil boilers driving four Westinghouse geared turbine drives. But even a World War II aircraft carrier is less costly and less complex than a nuclear plant or an oil refinery or an assembly line in Detroit. We had 36 aircraft carriers during the war, but we have thousands of complex plants and factories today. What's more, rebuilding literally hundreds of millions of homes and skyscrapers just make the prospect more remote. Even if we had a unified political will and limitless money, there isn't enough skilled labor or building materials in the country to rebuild every home, building and factory within ten years.

But is the Green New Deal going in the right direction? Sure. Will some of the proposals be accomplished more gradually? Yes. They will happen over a much longer time span. Some make economic sense right now. Others will be driven by a combination of the mechanisms we've discussed today, including government compulsion, persuasion, removing the decision, incentives, and popular demand. The one thing you can always count on is that customers will act in their own perceived self-interest. And the government has some tools to shape that perceived self-interest.

Lest We Forget

Let me conclude by telling you that when I was 10 or 12 years old, I idly thumbed through my father's textbooks from classes he took here at the "U." The titles included *Thermodynamics of Steam* and *Kinematics of Machines*. I took a book down from the shelf and leafed through the pages, understanding nothing. On the inside cover there was a fragment of verse written in my father's left-slanted handwriting. It said: "Lest We Forget."

You may recognize this phrase from Rudyard Kipling's "Recessional". Part of which reads:

"The tumult and the shouting dies,
The captains and the kings depart,
Still stands thine ancient sacrifice,
An humble and a contrite heart,
Lord God of Hosts be with us yet,
Lest we forget, lest we forget"

Then I noticed that every textbook of his, *Machine Design, Heat Transfer, Strength of Material* - all of them - contained the same phrase, "Lest we forget." Intrigued, I took the book to him in his study and asked what it meant. He got quiet and very serious, and then said.

"I am the first member of my family to graduate from college." Years later, this institution would award him an honorary doctorate degree, but that night he said, "I can never forget that my own father, Gilbert, had to leave school after the third grade to support his mother by selling newspapers for pennies on a street corner in Salt Lake City. His father, Richard, was too poor to go to school, but learned on his own how to read and write. His father, John, knew how to sign his own name, but his father, Richard, spent all his days in the coal mines in Wales and could only 'make his mark' with an 'X.'"

"My son," he said, "remember... education is a rare privilege. Almost none of your ancestors could even read." They lived out their simple lives in terrible ignorance in coal mines and on peasant farms. They were subject to the caprice of the weather and to illnesses they could never comprehend.

As Dad received national acclaim as a visionary for embracing renewables and predicting the future of the power industry, he would deflect that praise and say that he was simply the first to embrace the inevitable, and he only did what engineers always do. He was given a problem and he solved it.

And he did so with deep gratitude for the education he received here at the "U."