

## **The Power Grid - Quest paper 2/2/18 Charlie Belch**

Thanks to Connie for discussing with me the impossibility of including both the Power Grid and the Cyber Grid. Two different subjects. So, this paper will be on the Power Grid. The Cyber Grid is really another subject for another Quest paper.

First, I would like to thank the people who have helped me to prepare this paper. Several long conversations with former Mayor Graham Richard, who was involved with the co-generation of electricity since before he was Mayor and continues in this field today from his base in San Francisco.

Second, Tracy Warner the PIO for Indiana and Michigan Electric for volumes of articles and one long cup of coffee,

Third, my old friend from seminary for five years in the 50's, John Mullin, who it turns out served as Senior Attorney for the Nuclear Power Generation Division of The Babcock & Wilcox Company of Lynchburg, Virginia, serving in Singapore and Washington DC and holding other high-sounding titles in the utility industry.

And as always to Dana Wichern for her guidance, and to Michelle Devinney for her drafting and editing skills. To Howard Traxmore for his input.

I relied heavily on the 2016 book *The Grid* by Gretchen Bakke, a cultural anthropologist professor at the University of Chicago. (Hold up book)

Let me say first what I am not going to talk about today

1. The difference between AC and DC. This discussion goes back to Tesla and Edison, and continues today

2. Watts, voltage, surge, and other esoteric attributes of electricity. Nor will I address electricity in quantum physics. No theories based on quarks or gluons.
3. The nature of electricity – except to say it is a commodity which, at least until recently, you could not inventory and sell like soybeans or even bananas.
4. The early struggles between Edison in New York and great developers like Samuel Insull in Chicago, who helped through trial and error and determination evolve into The Grid we have today.
5. Any attempt to explain or describe all the various arrangements springing up today between utilities and the vast myriad of the producers of electricity.
6. I will not discuss the effect of any electromagnetic bombs which could be used to destroy The Grid. There is a plethora of articles by utilities and governments describing why that should not happen.
7. I will not discuss the transmission of electricity over the internet, as envisioned by Nikola Tesla, except to say that you will just have to imagine what that would do for us.

I hope the talk will be brief enough to engender a long discussion afterward, because I think that is where the true strength and joy of Quest shines, and I look forward to such a discussion with the felicitous expectation that I will learn even more about the subject.

To begin please join me in my mind, so that my observations will make sense. In The Grid you have one, multiple producers of power, two, a distribution network to deliver that power to, three, consumers of the power.

To repeat I&M with a coal fired plant at Rockport delivering power through its grid, to us through wires and outlets. And now, there is a significant and dynamic fourth part to the grid beyond the production of power, the distribution of power and the consumption of power, and that is the storage of power, with the use of batteries. Battery power especially in other parts of the world, like China and India, is seeing exponential growth in its ability to store power and use it as needed.

Electricity is not a commodity like soybeans or bananas, but battery storage is moving it in that direction. The storage time is growing and that is the dynamic that is changing The Grid. The Grid no longer just produces, distributes, and uses. Now, it stores electricity.

We are at a junction, at a time when things are literally about to explode. A time when utility companies are about to pay us to use electricity. Although forces are in place to forestall that eventuality – thanks to people like Scott Pruitt on the federal level and many electric utilities throughout the country -- the inevitability of this fact is indisputable and is already a reality in many places in the world. To understand how to get there, that is how we get to the point where utilities are paying us to use electricity, we first must understand how we got here.

The Grid has been the heart of our utility system for almost a century, and between 1930 and 1960 it provided a solid foundation. It met an ever-increasing demand for utilities at a time when homes and workplaces required more and more energy to function. Always a safe investment during this time were utility stocks and bonds. Profit was assured. More of our population's necessities and luxuries were powered by The Grid.

The Grid was, in its time, a rather sophisticated means to power the country. It's comprised of the wires that we see on the streets, a transformer and of course the utility poles which became, for better or worse, a ubiquitous part of the landscape by the middle of the 20<sup>th</sup> century. From there, the wires run to a substation, to additional larger transformers and thanks to a series of relays, switches, fuses and the like, make their connection to the power plant. The Grid's interconnection with other utilities has long been a vital part of our daily life.

In fact, The Grid is a dinosaur. Oh, it is being modernized and new lines built, but the inherent inflexibility of its relationships with networks and suppliers makes it a dinosaur. It has already been demonstrated to be unnecessary to the production of energy, and despite recent political efforts to revive the coal industry and to maintain our country's dependence on fossil fuels, the tide of change is already upon us.

A metaphor for the future is already in our hands every day – our own personal grid.  
(PULL OUT YOUR PHONE!)

Could you even imagine such a thing as a smart phone twenty years ago? Yet, there it is in your hand, not just a phone, but a library, an atlas, a text communication device, personal servant... right in our hand. For gosh sakes, it talks to you and is powered by a battery, and the life of that battery gets longer every time we acquire a new smart phone. I remember sitting on the floor in airports to charge my flip phone. Now there are kiosks along all the terminals for charging and it takes less time. This is not going to stop, it is just going to get better. Your phone is a battery powered grid that does specific things. I will come back to the smart phone later, but for now, even though it is a mini special communication grid, it is a metaphor for the future of the power grid. Technology moves so fast these days, that advances seem limited only by our imaginations.

This is what I'm saying: Given current market forces in the power industry, especially when you include the unlimited growth of battery power, utilities will be paying us to use electricity. And in fact, most utilities will become distribution networks, not power generating networks. The utilities will become the collectors of power and will distribute it back to those who need it. Again, they will collect power from solar and wind generators and distribute power back to those who need it. The #1 most salient point is that most of the country is not set up for innovation. Who would have thought just 20 years ago how far we have come in telecommunications?

So, let's better understand how The Grid has functioned over the years. Although referred to as "The Grid," our country is actually fueled by three interconnecting grids of dozens of utilities: one Grid powers the East, one Grid powers the West, and, because they're special, one powers Texas. That's right. Texas has their own grid, which will make secession that much easier for them. Quebec is also separate in Canada. There is a parallel. For decades this elaborate

system worked like a charm, but thanks to the muck and mire of bureaucracy, the grid has fallen behind, making it weaker and less efficient. As Gretchen Bakke describes it: “Looking at its sleek lines and high towers, one might mistake The Grid for an electrical transportation superhighway. But to those intimately acquainted with it, another image springs to mind—that of an old, beat-up, pothole-riddled, one-lane dirt road. The Grid is worn down, it’s patched up, and every hoped-for improvement is expensive and bureaucratically bemired.”

That state of disrepair has caused problems well beyond the inconveniences and discomfort of summer blackouts and massive outages and pose a threat to our national security. More than 70 percent of the grid’s transmission lines are 25 years old, and the result has been an ever-increasing number of significant blackouts. In 2001 there were just 15, but by 2007 that number rose to 78. By 2011, there were 307 major power outages. That represents a 2000% increase in just 10 years. Obviously, outages of any significant length of time can wreak havoc with the economy, but even short-term power outages can dramatically affect our productivity. To quantify the economic threat with dollar signs, the 2003 East Coast blackout, which lasted for two days, left eight states and 50 million people without electricity. The cost of that blackout was six-billion dollars in lost revenue, enough to impact our country’s GDP that year.

The cost of these outages is not only measured in money but also in the threat to our national security. The White House, has experienced four power outages in the 21<sup>st</sup> century. Although the long-term effects of The Grid’s increasingly fragile state have become more apparent in recent years, engineers and environmentalists have long warned of this inevitability. In 1979 two of them – Amory and Hunter Lovins – presented a report to the Pentagon in which they made clear that the disrepair to The Grid posed a significant threat to our national security. At a time when gas prices were soaring and dependence on foreign oil was a major concern, the Lovinses firmly stated that our nation was more threatened by the brittleness of its grid than it was by possible disruptions in the flow of oil from overseas. They referred not just to its physical weakening but more importantly its inflexibility. When this report was published the following year, only two men, President Jimmy Carter and Senator Richard Lugar took this warning to heart. President Reagan had the resulting solar panels removed from the White House.

In recent years, there has been increased attention paid to our long-time dependence on fossil fuels like coal and gas and a move toward cleaner options like wind and solar energy. The

United States is already lagging our friends overseas. Germany is an excellent example. Germany has taken a completely opposite approach to utilities than we have in the United States. While here rates are raised disproportionately for poor and transient populations, Germany instead raises its rates on businesses and manufacturers. In the process, that money has been used to move toward renewable sources of energy, and Germany is weaning themselves from grid-provided electricity completely.

Efforts to move in this direction back home have been slow but steady. To quote Bakke, “Maneuvering to capture market share is a big part of what is driving the energy transition, and it is in a constant state of vacillation. One step forward, two steps back, we lurch rather than cruise into the future. The changes to our grid will not happen overnight, but they are already far enough along to be rightly considered irreversible.” Not surprisingly, Hawaii has increased its use of solar power and often produce more power than they need – and more than the grid can handle. As of 2015, Hawaii was no longer allowing solar home owners connection to the grid because that excess power would cause the grid to shutdown to prevent damage. But while naysayers would be quick to point out that Hawaii’s climate is uniquely conducive to solar power, Vermont – a state with significantly less sunshine – has had success with solar power and has also had to limit new solar connections to the grid. In 2015 Texas, which has been moving toward wind power for some time, (I must pause for all of you to provide your own joke for such a delicious straight line)....Texas had a particularly blustery day in 2015 in which the price per megawatt of power in Texas dropped to -64 cents. Clearly something is in the wind.

Even the United States Army has finally caught on, which is saying something since, as a former Air Force First Sergeant, I steadfastly believe that Army Intelligence is an oxymoron. But when the Army in Afghanistan discovered they were using 70 percent of their fuel to deliver fuel to their bases, they tapped into nature, using solar and wind power. Now there are bases in Afghanistan that are home to a couple hundred soldiers, and they are self-contained – net zero energy consumed. Their backup to solar and wind are diesel engines that run on kitchen and human waste. What I am saying is that the logic of what the Army is doing, and other states are doing, is the future. Regardless of the power of Utilities over legislatures, the model developed by the Army and others, cannot be stopped, because it is lower in cost and it protects our national security.

Google what Elon Musk has been doing with battery Powerwalls combined with solar panels in Puerto Rico. Tesla has a kit for a home where all the flat surfaces and panels are solar. Add a windmill and a battery and each home is a grid, ready to generate what it needs and supply the excess to other users. China and India are ahead of us in battery production and the demand for stand-alone grids is skyrocketing.

Although there was a move at the federal level to explore clean and renewable sources of energy, as a means of addressing both soaring energy costs and escalating climate change, the current administration in Washington have different concerns. There is clearly a movement underway to deny the science of renewables and climate change. There is also a distinct lack of knowledge of the workings of the grid. As if to prove Bakke's contention that our country's transition is "one step forward, two steps back," last April Secretary of Energy Rick Perry proposed a study to ascertain grid reliability. The memo which commissioned the study stated that "baseload power is necessary to a well-functioning electric grid." In fact, "baseload power" amounts to centralizing the production of power and making it more vulnerable.

There's an inherent problem with the assertion that "baseload power" is essential to a well-functioning grid: it simply isn't true. In their article "The Grid Needs a Symphony, not a Shouting Match," Mark Dyson and Amory Lovins dispute this assertion saying "This notion has been thoroughly disproven by a diverse community of utilities, system operators, economists, and other experts that moved on from this topic years ago. To these practitioners, this premise seems as backward as if President Eisenhower, instead of launching the interstate highway system, had called for restudy of the virtues of horse-drawn carriages."

It's worth noting that the committee unanimously voted down Perry's proposal. In fact, even among the Trump nominees, it is too obvious that the addition of battery, wind, and solar is more efficient as we look to power our future. Fluence, a company owned by Siemens and AES, is already making the move toward battery and other alternate forms of power. It's just a matter of time before other utility companies accept the inevitability of these alternatives. The unwillingness to accept this is at the heart of the anti-science, anti-truth campaign currently being waged among our government leaders. In a recent op-ed, Indiana University President Michael McRobbie said "Today we routinely witness rampant attacks on established knowledge, a fundamental rejection in some quarters of basic science, and political upheaval around the globe

driven by wild claims and spurious statistics...In short, teaching truth and training our students for the jobs of tomorrow are not – and must never be viewed as – inseparable.”

Think again about your phone, about how that small device in your pocket reimagines the original purpose of the not just the internet communications grid but the future of The Power Grid. Your phone is the Kendallville electrical grid, your’s Decatur, your’s Huntington, etc., etc., etc. Some grids also produce power and share it with other grids. If the Army can do it, so can Decatur. Habitat for Humanity is building homes now in Michigan that are stand-alone – net zero homes. There are complete subdivisions in California being built and sold that are stand-alone independent grids. There are isolated cities and hospitals on our northern plains, not to mention cities and towns in the interior of continent of Africa. All stand-alone power grids.

Battery power does things that at one time we could have only imagined. As the price of batteries continues to fall, and the length of their charges continue to grow, they are an excellent way for us to not just save money but also protect our national security. Batteries will eventually provide each of us our own silo of electricity. The possibilities are astounding, and while we are currently behind many other countries (and even a few of our own states), our future will move away from our current dependence on the dilapidated grid and toward innovative approaches to energy. All that stands in our way is the tension that exists between those who wish to move forward and those who remain fiercely determined to maintain the status quo. As Bakke points out at the end of The Grid: “It’s not hard to have a less polluting, less irritating, and more reliable electrical system than the one we have. What is hard is figuring out how to bring big dreams, smart inventions, and popular will together with the entrenched interests of the powers that currently govern, own, and make a profit from the grid.”

It is therefore incumbent upon each of us to make our voices heard and move beyond a technology which began failing us nearly 50 years ago. We must find a more sustainable method of powering our world.

Let me end with a metaphor for where we are. Most people in this room have sat and listened to a symphony orchestra as they warm up. Each instrument is playing different parts or maybe a scale, and the sound is, to say the least, cacophonous. That is what the current situation sounds like. How we strike the baton and become a symphony is our challenge.