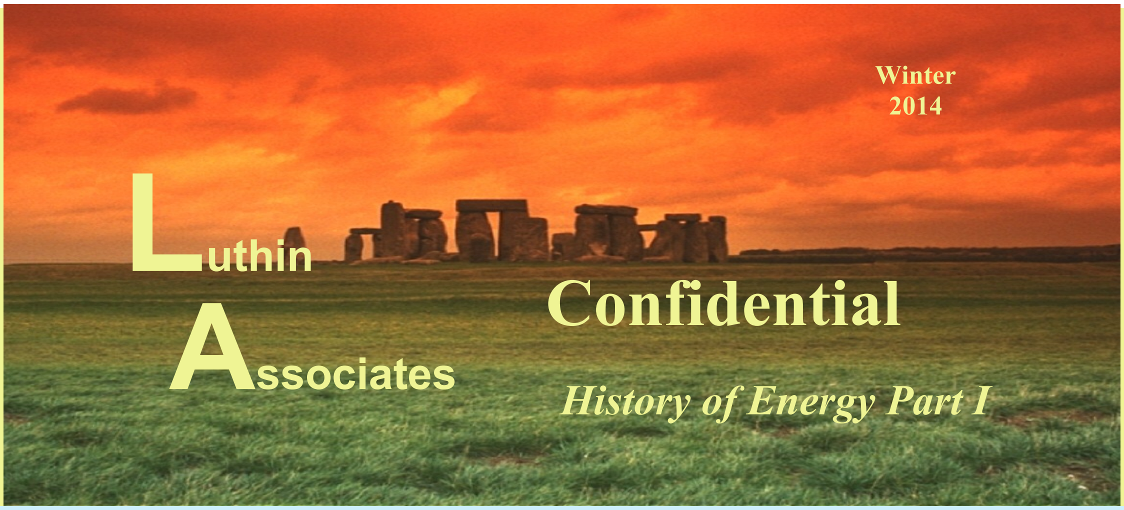

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History of Lighting - Part 1

Mel Brooks' 2000-year old man used torches in his cave, but today's lighting is a tad more sophisticated, having gone through half a dozen stages, each producing more light out of less energy i.e., efficacy, than its predecessor.

Torches made of moss and animal fat, and crude oil lamps were the mainstay for indoor lighting until the processing of animal fat into wax gave us the candle in roughly 3000 BCE (efficacy: about 0.1 lumens/watt). That option worked for much of early recorded European history, but during the Islamic Golden Age (roughly 900—1000 AD), a Persian doctor refined kerosene from crude oil and used it in the first manufactured oil lamp and the first street lights in Andalusian Cordoba, now Spain.

It wasn't until the late 1700's that European oil lamps (at ~0.3 lumens/watt) became widely available and accepted due to improvements in design and the whaling industry's ability to produce sperm oil. That refined product burned cleanly, didn't smell too bad, and was relatively cheap compared to commercially-made candles.

The Industrial Revolution in 19th Century Europe gave us dynamo-based electricity and the first carbon arc lamps (at ~2-4 lumen/watt). They were used mostly in open areas such as parks, street lighting, and large industrial spaces and rail yards. Arc lights didn't get much traction in the US until much later, due to the lack of an electric distribution system. During that century, gas lighting and kerosene lamps dominated.

In the early 1800s, gas light (initially at less than 1 lumen/watt), used coal gas or natural gas from mines or wells, and was relatively common in urban England. Its use expanded rapidly after the development of the incandescent gas mantle around 1890. That device more than doubled the efficacy (to 2 lumens/watt) of gas lighting, using a filament containing thorium and cerium, which converted more of the gas flame's heat into white light. Gas lighting then cost about a quarter of candles and less than kerosene. It created a great demand that eventually led to the creation of the first utilities. Gas light dominated for several decades (through World War I, for those having access to it), until electricity became available, gradually supplanting both gas and kerosene lighting.

As the 20th century approached, Edison created his electric incandescent lamp (1.4 lumens/watt), and the power industry adopted it as a standard. During this period, Nikola Tesla, and others, demonstrated forms of fluorescent lighting where gases in a tube glowed when charged by electricity. Efficacy began to exceed 20 lumens/watt. It wasn't until 1926, however, that the first fluorescent lamp received a patent and not until after World War II when commercial fluorescents (~60-70 lumens/watt) began to supplant incandescent.

With the rapid development of technologies in the postwar era, other forms of lighting were developed, producing the first diodes emitting visible red light, the Light Emitting Diode (LED) in 1962. Mercury vapor and *(continued on pg 2)*.

History of Lighting Part I….Continued.

metal halides came to market in the late '60s (at 50-100 lumens/watt), and sodium vapor lamps in the '70s, with efficacies up to 180. Although more efficient, several of these light sources, especially sodium, provided light that distorted colors and was far from white.

Compact fluorescents with built-in ballasts came to market in 1981 (50 lumens/watt), the first white high-pressure sodium lamp (the Philips white SON) in 1985, and the first commercially available electronic ballast appeared in 1987. The early '90s saw an explosion of new and ever more efficient light sources: electrode-less fluorescent aka induction lighting in 1991; the first ceramic metal halide (CMH) in 1992; and, in 1994, the first T5 fluorescents and sulfur-based lamps. Efficacies for white sources were now routinely exceeding 70 and approaching 100.

But the lighting revolution was just getting started. After almost 30 years in development, the first phosphor-based blue (and later white) LEDs were seen in 1995. As cost dropped, and efficacy rapidly improved, they began to supplant sources that had ruled some types of fixtures for decades. In only a few years, tritium lighting which used a slightly radioactive glowing gas, common in exit signs, essentially bit the dust even though it used no power for illumination.

In the 21st century, competition among sources continues. Fluorescent lamps, powered by electronic ballasts operating in computer-designed fixtures, are producing greater efficiency and longevity, giving LEDs a run for their money. High-output fluorescents are pushing metal halide aside, just as induction lighting competes with LED for street lighting. Efficacies near 100 are now considered the norm with LED having a theoretical potential exceeding 200.

The biggest loser in all this competition is the incandescent lamp, which ruled downlights and table lamps for almost a century. Screw-in LED units, while still relatively expensive, are quickly supplanting Edison's venerable invention. Through international competition, government regulation, and various financial incentives, incandescence is fast becoming the "whale oil" of our time. During its heyday however, many billions of Edison's bulbs were produced and used by billions of people, making it the king of indoor lighting for decades.

To paraphrase King Louis XVI in the *History of the World – Part 1*, "It was good to be the King".

How to Become A Producer

In Mel Brooks' *The Producers*, shady Broadway impresario Max Bialystock learns that, with some creative accounting, he could make more money with a flop than a hit. In a similar reversal of apparent logic, some power customers in the lower Hudson Valley may soon find they could "make more money with a float than a fixed", i.e., taking a power deal wherein the capacity charge is allowed to float rather than being fixed into the overall price.

When one buys a fixed power price, the cost of each component (energy, capacity, ancillaries, etc.) is held constant, regardless of what happens in the wholesale market (good or bad). This enables the customer to reduce their risks at the supplier's expense. Of course, that expense gets passed along to the customer. While energy i.e., the kWh, is the biggest piece of the pie, each customer in the NYISO is also "tagged" with a demand charge, a kW capacity level, based on their prior summer's peak demand. That number is then multiplied each month by a $/kW price that may vary by locale and the methods used by the supplier to secure its capacity costs.

The NYISO has generally charged capacity based on three zones: New York City (zone J), Long Island (zone K) and the Rest of State (ROS). Since the creation of the ISO, capacity pricing in ROS has typically been only a fraction of that seen in NYC, for reasons best covered in a separate article. The ISO zones in the lower Hudson Valley (G, H, and I), however, have, according to some in this debate, had their capacity charges artificially suppressed by that differentiation. To address this situation, a New Capacity Zone (NCZ) is being created that covers zones G, H, I and J .

Con Edison's territory includes most of zone H (upper Westchester), zone I (Westchester County near or below US Route 287) and zone J. Zone G covers counties served by Central Hudson Gas and Electric (parts of Orange, Putnam, Sullivan, Ulster, Greene and Albany Counties and all of Dutchess),Orange & Rockland Utilities (serving part of Orange and all of Rockland) and NYSEG (parts of Putnam and upper Westchester).

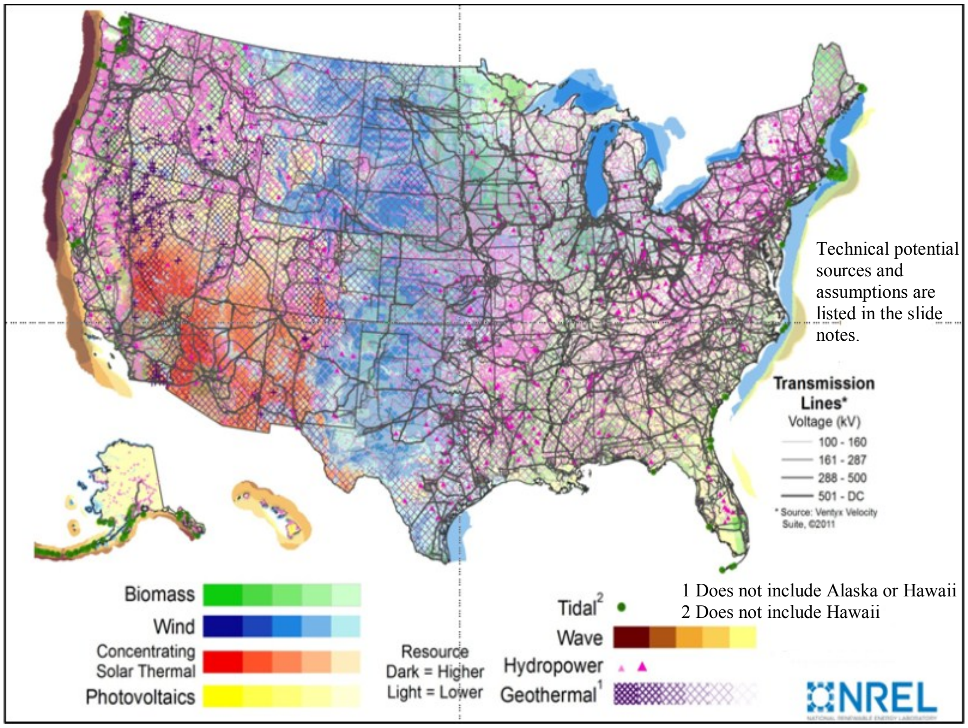
In August 13, 2013, the Federal Energy Regulatory Commission approved the NYISO's proposal to create the NCZ, which would significantly increase the capacity costs, $/kW, for accounts in Zones G, H, and I and, to a lesser degree, Zone J. For zones G, H and I, a fixed price contract may increase by about $.015/kWh i.e., 15 mills. In Zone J, the average increase will be less because NYC load already has to buy most of their capacity from more expensive in-City resources but will likely

(continued on page 4).

Factoid: High (Voltage) Anxiety

We all love the idea of powering America on renewable energy, but a lot of that energy will be coming from sites lacking the high-voltage transmission needed to move it to where it's needed. DOE's National Renewable Energy Lab (NREL) map web site features an overlay (see chart to the right) of the existing transmission grid versus the locations of major wind and solar resources. The main takeaway: unless a lot of new transmission gets built, the dream of a renewable energy future may remain just a dream. Especially stark is the blue midsection with a huge wind potential but lacking transmission facilities.

Source: www.nrel.gov/gis/maps.html



Can Spaceballs be Shot Out of Earth Tubes?

Alas, no. But those tubes might cut your HVAC bill by using the earth to pre-heat and pre-cool fresh air entering your building.

Depending on locale, ground temperatures 10 to 15 feet below the surface remain relatively constant (around 50° F). Some new buildings are installing concrete piping at that level to act as a conduit for ventilation air entering the building's HVAC system. When outside air is cold, passing it through underground piping allows the earth to preheat it by about 15° F, thus cutting energy needed by preheat coils.

In the summer, warm moist air pulled through the earth tubes may be pre-cooled by 10-15° F and slightly dried in the process, thus cutting load and energy use by the building's cooling system.

Because the earth is a nearly infinite heat sink/source (compared to air flowing into a building), it acts as a continuous passive free provider of energy, with no mechanical parts. The technical term for this process is "ground-coupled heat exchange." Because the heat transfer rate is based on temperature difference, most energy is saved when outside air temperatures are rather high or low, and in locations where such extremes e.g., northern and southern US are more common.

In the 2012 constructed Earth Rangers Centre in Canada, earth tubes are integrated with heat recovery and demand-controlled ventilation to significantly cut the cost of conditioning ventilation air. Find more details on its earth tubes at:www.ercshowcase.com/hvac/earth-tubes/ .

For its earth tubes, that facility used 27" diameter concrete sewer pipes about 66 feet long, but other materials and configurations e.g., a 5" PVC piping array, have been used elsewhere. Length, pitch angle, drainage, and other characteristics are determined by local conditions, such as the amount of condensation that may occur when moist summer air is cooled. To avoid mold and ensure that air quality is maintained, a non-toxic bactericide may be embedded in earth tube materials or surfaces. UV filtration is used at the Centre to kill any undesired microbes before they enter the building's HVAC system (as is done at many existing facilities lacking earth tubes).

To learn more about the technical details of the earth tube process (which is often used in Europe) go to: www.esru.strath.ac.uk/EandE/Web_sites/09-10/Hybrid_systems/earthtoair.htm .

How to Become A Producer Continued...

range between 3 and 5 mills/kWh (a mill is a tenth of a cent) depending on a customer's load profile. Critics of the plan say that could cost ratepayers in the lower Hudson Valley an extra $350 million a year, though proponents claim the hit would be somewhat less.

Scheduled to take effect May 1, 2014, the NCZ issue is already affecting fixed price contracts that start earlier in 2014 as power suppliers "bake in" the expected extra cost of capacity.
But now the debate has taken an interesting turn. US Senator Chuck Schumer (D-NY) and others have asked the NYISO to phase in the higher capacity cost over a 3-year span rather than having it hit all at once in May. The ISO also sensitive of price impacts and filed a request on November 27, 2013 with FERC requesting a phase in, though many power generators are not happy with the request. As of early 2014, it's unclear what exactly will happen until FERC acts on the NYISO request.

So here's where you get to play Max Bialystock: if you're planning to take a fixed price power contract in 2014, you may want to consider letting the capacity part of the price float, and fix just the energy and other parts. Otherwise, you could be "baking in" the full increase in capacity pricing even if it is instead phased in over 3 years. In NYC, that phase-in could cut that 3-5 mill hike down to 1-2 mills in the first year. For accounts in Zones G, H, and I, the savings in the first year could be a full penny per kWh (i.e., 15% or more of the total supply price). There's essentially no downside to floating the capacity: if the full NCZ charge does hit on May 1, you'd get the same fixed price as is being quoted right now. But if it's instead phased in, you should be charged only the rate as it rises over the next three years.

These are questions you may want to discuss with your energy consultant.

Yup – you could make more money with a float than a fixed!

On A Personal Note...

In 2014, my firm will be 20 years old. I can honestly tell you that although I have enjoyed my role as an entrepreneur, there have been a few "high anxiety" moments.

The challenge I struggle with constantly is how to continue to bring value to my clients. This newsletter is one way to do that. Hopefully, it is entertaining you at least as well as Max Bialystock has.

One of the most significant energy saving opportunities I have seen in my career will occur beginning in 2014. Energy conservation incentive levels in the Con Edison territory for energy efficiency, energy storage, demand response, and fuel switching that results in peak demand reductions will soon be double to triple what NYSERDA and Con Edison are presently paying. This increase is a result of a recent Public Service Commission order which reviewed the reliability requirements commensurate with a possible retirement of Indian Point.

The program will consist of 100MW of Energy Efficiency and Load Shaping which will result in peak demand reduction. Details of the program which will be jointly administered by NYSERDA and Con Edison, will be finalized in the near future.

In addition to the EE/DR programs mentioned above, NYSERDA will be responsible for an additional 25 MW of combined heat and power projects. Details of the incentive levels and program details still need to be finalized.

One caveat, projects have to be in the ground prior to the summer of 2016. So now is the time to think about how to take advantage of this opportunity. Just like Leopold Bloom who knew how to make money by doing less, you can save money on energy costs while using less, energy that is.

We will continue to keep you updated once both programs are finalized.

Happy New Year!

Catherine Luthin

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