



Progressing Toward a Clean Energy Future

Louisville Metro Council

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PPL companies

This presentation tries to focus on “what is” and not “what ought to be”

“Everyone is entitled to his own opinion, but not to his own facts.”
— **Daniel Patrick Moynihan**

“Facts are stubborn things; and whatever may be our wishes, our inclinations, or the dictates of our passion, they cannot alter the state of facts and evidence.”
— **John Adams**

LG&E and KU support a “clean energy future” and Metro Council’s interest in how this might be achieved

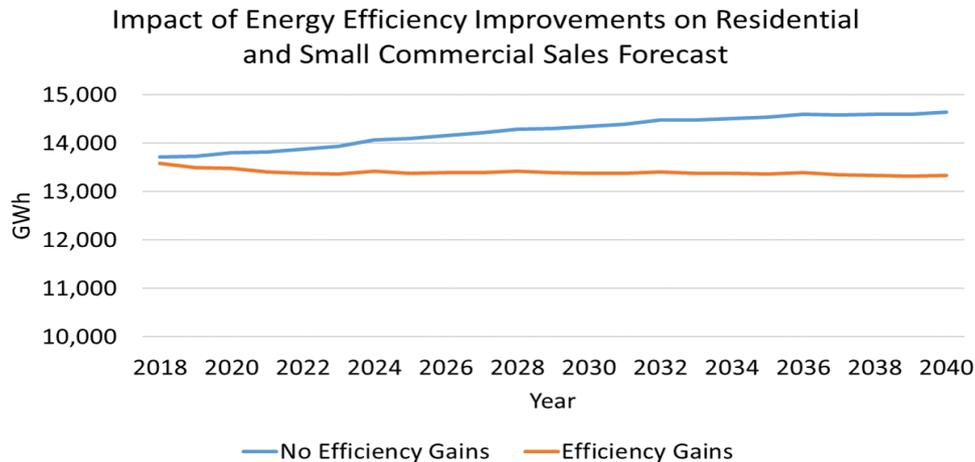
- Long history of renewable generation and energy efficiency activities
- State regulation via the Kentucky Public Service Commission (“KPSC”) is not a barrier to a clean energy future
- Highlands study is illustrative of technology and economic challenges that the current resolution will need to address to be fully implemented
- The Metro Council and the community need to have “eyes wide open” as they contemplate the language and implications of the proposed resolution, i.e., “What does it really mean to utilize “clean” energy for 100% of the community’s needs?”

The Companies have a long history of supporting renewable generation and have been leaders in KY in solar generation

- Ohio Falls and Dix Dam hydro generation date from the 1920s and \$171 million was spent on upgrades and refurbishments over the last 15 years
- Brown solar site was the first utility scale solar plant in the state (2016) and is still the largest
- Issued an RFP in February for up to 200 MW of renewable generation
 - Large number of responses but all were solar and wind (no geothermal, tidal, bio-matter or hydro as specified in Draft Resolution)
 - The Companies are not proposing any “self-build” option
 - Results will be filed with the KPSC by the end of the year
- Business solar – Archdiocese of Louisville and Makers Mark
- Community solar – Solar Share project went live this summer with first array and continuing to market shares
- Approximately 7 MW of distributed solar consisting of ~600 residential customers and ~100 commercial customers

Striving for greater energy efficiency never stops - it's a joint effort with our customers

- Cumulative Demand Side Management (DSM) programs resulted in reducing load by 460 MW and 1.2 million MWh in 2018
 - Since 2008, the Companies have collected over \$300 million to fund DSM programs
- Current load forecast is flat in large part due to customers installing more efficient appliances and lighting on their own



- We provide customers relevant ways to manage costs throughout the year. For example, see <https://lge-ku.com/energy-efficiency-tips> for energy savings videos and other information

The KPSC regulatory structure is not a barrier to renewables or energy efficiency

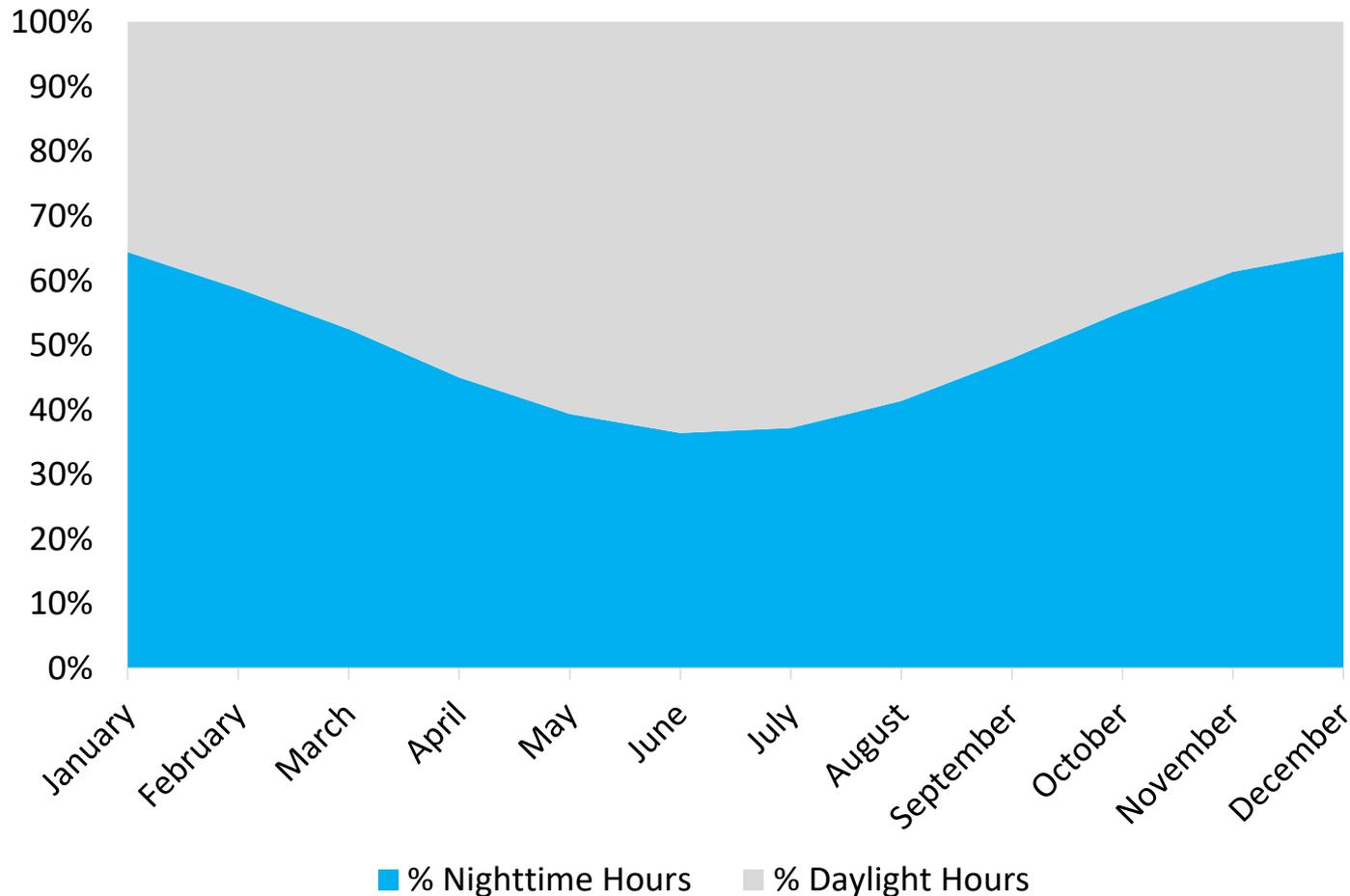
- It is untrue as a speaker suggested at the last meeting that the KPSC does not care about the overall bill - only the unit cost (cents/kWh)
 - Every generation-related case that I've been involved in has been focused on the least-cost "revenue requirements"
 - Revenue requirements are essentially the "total bill" for all customers
 - A rate case is primarily focused on "revenue requirements"
- It is untrue that customers only care about the size of their total bill – they also care about the individual rate components because that can impact decision making
- It is untrue that the Companies and the KPSC do not consider "cost of pollution" (including potential future CO₂ regulations) in evaluating future generation resources
- Companies always go to the market as part of any new resource option – required by KPSC in order to determine "least-cost" resource
- It is untrue that "LG&E is always going to be against you if you're working towards 100% clean and renewable energy..."

The Highlands study was not “...a bad answer to a bad question...” and it provides important insights to the challenges of being 100% renewable

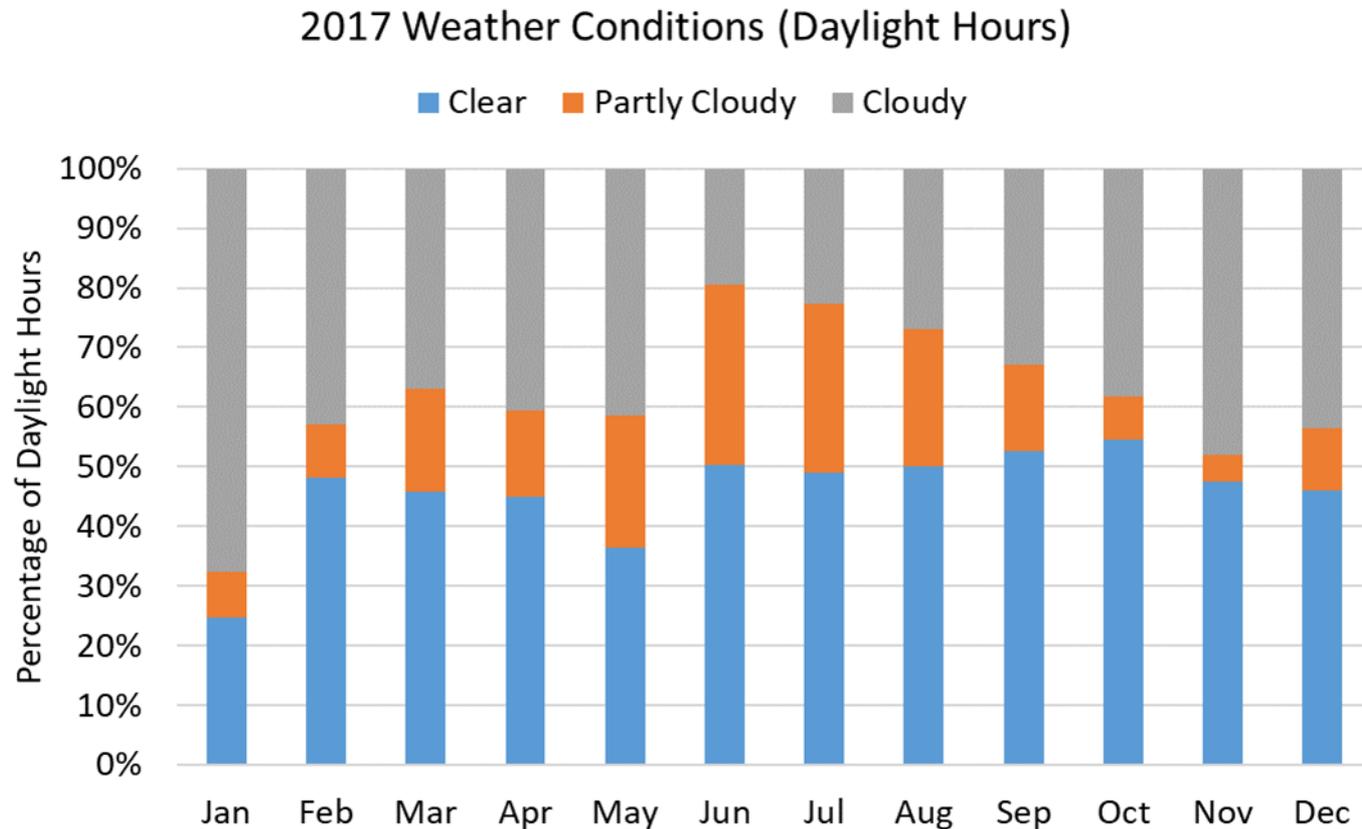
- The study asked and answered exactly the question that our customers ask us every moment of the day, “How are you going to provide me with reliable, cost effective energy every second of the day in all weather conditions?”
 - Equating annual energy usage with annual solar panel production is not 100% renewable
- A speaker at the last meeting made a number of misstatements about the study:
 - The study did evaluate putting panels on homes/businesses (Table 1 & Table 2)
 - We were not suggesting actually putting the panels and batteries in Cherokee Park - that was used to illustrate the land area required (top of page 10), especially in light of interest in small, local generation sources
 - While the physical life of solar panels may be 30-50 years, the typical manufacturer warranty is 20-25 years and the output degrades by 0.5% to 1.0% annually. Furthermore, inverter life is around 10 years.
 - The study assumed 100% of the panels, inverters, and batteries performed perfectly for 30 years (page 12).

Solar will always be challenged because a large percent of electricity demand is at night

LG&E and KU Electricity Consumption by Time of Day



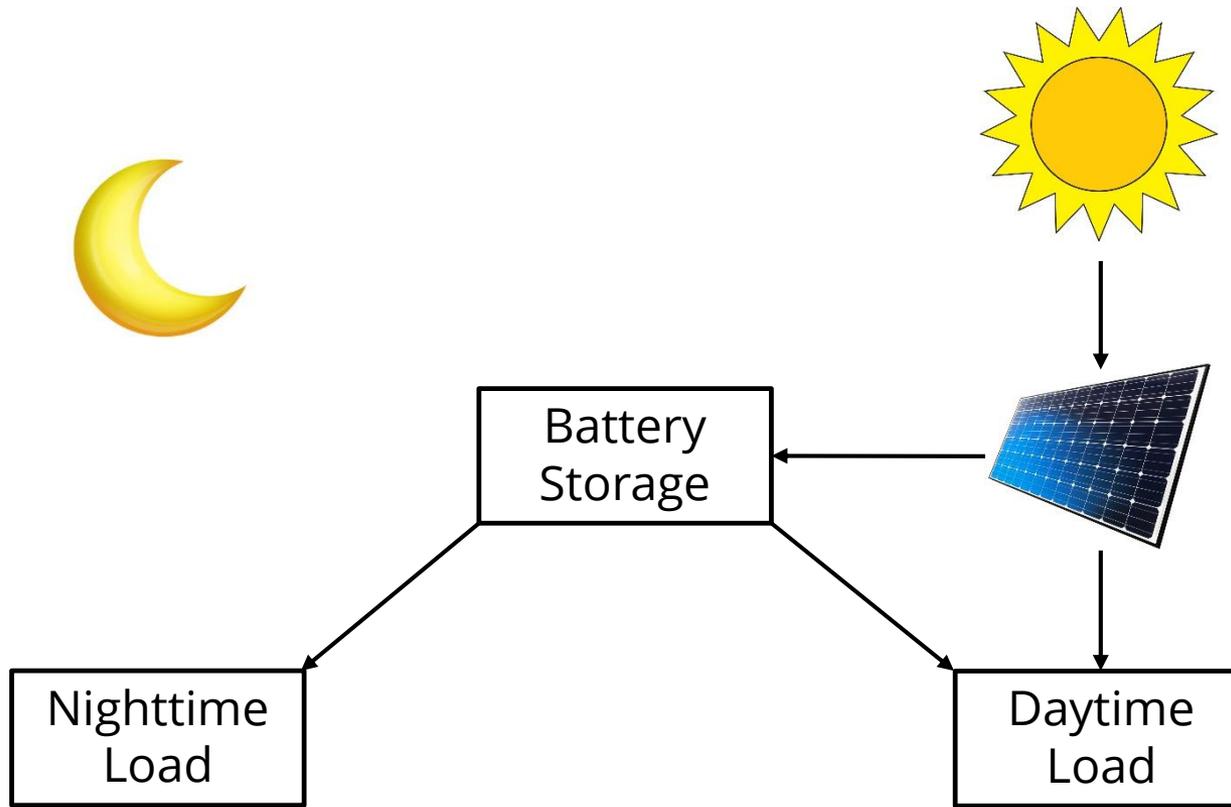
Winter is much cloudier than summer which challenges solar generation in Kentucky



Source: Weather Underground

Highlands technology study asked the question...

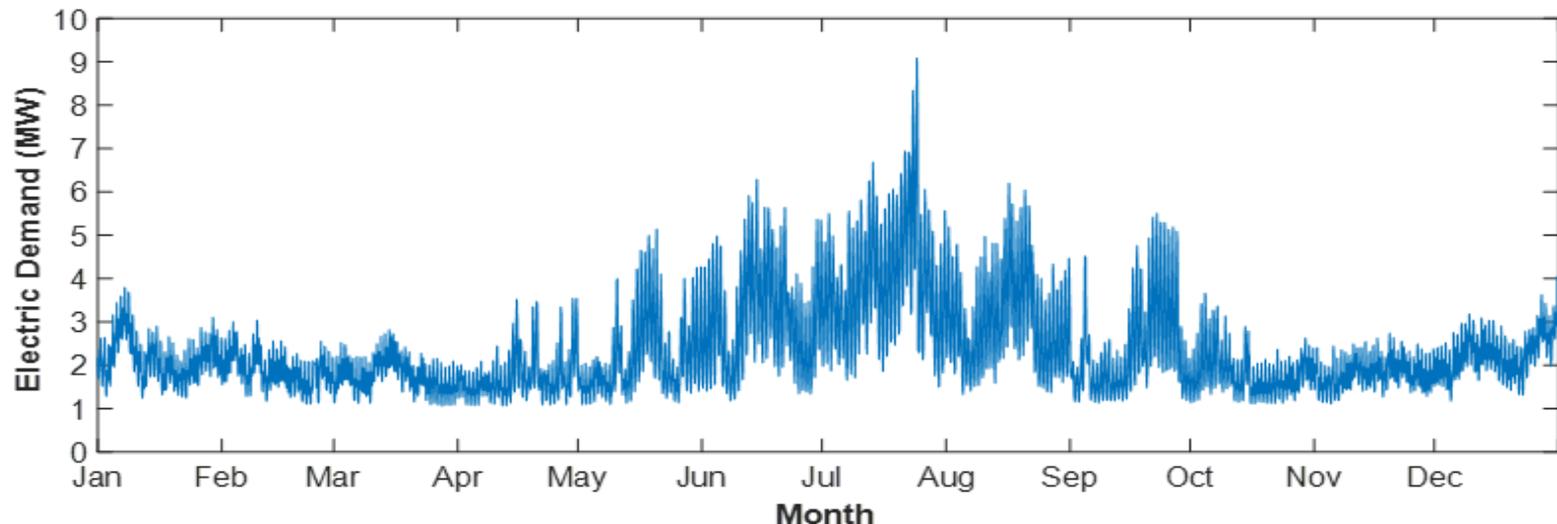
“What is required to meet 100% of the energy requirements of a typical distribution circuit with solar generation and battery storage?”



Highland 1103 is a typical residential/small commercial circuit on LG&E system

- ~1,600 residential customers
- ~240 small commercial customers
- Customers use natural gas in homes and businesses
- Peak Demand: ~9 MW
- Annual consumption: ~20,500 MWh
- Less than 0.4% of Jefferson County's total electricity consumption

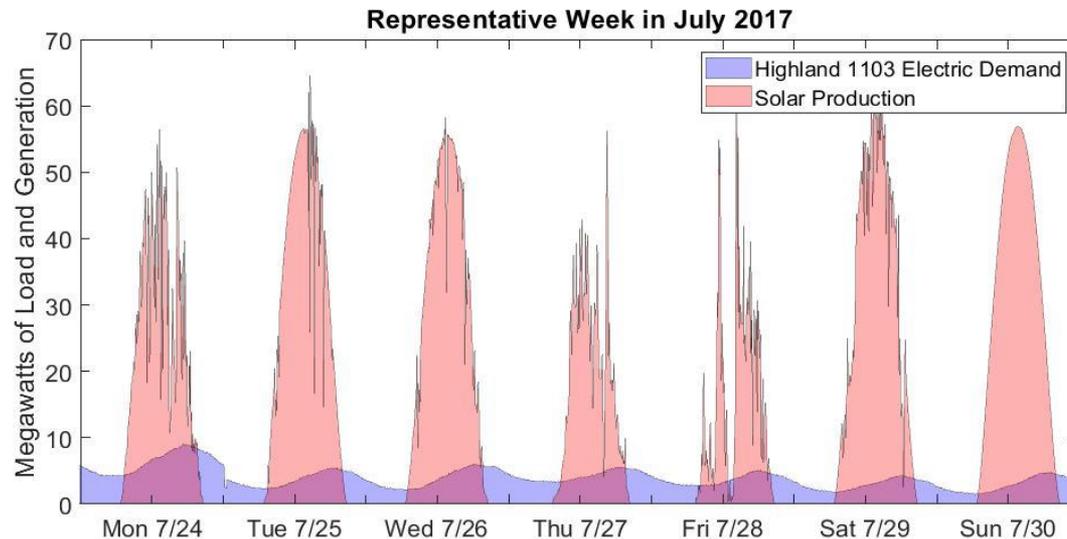
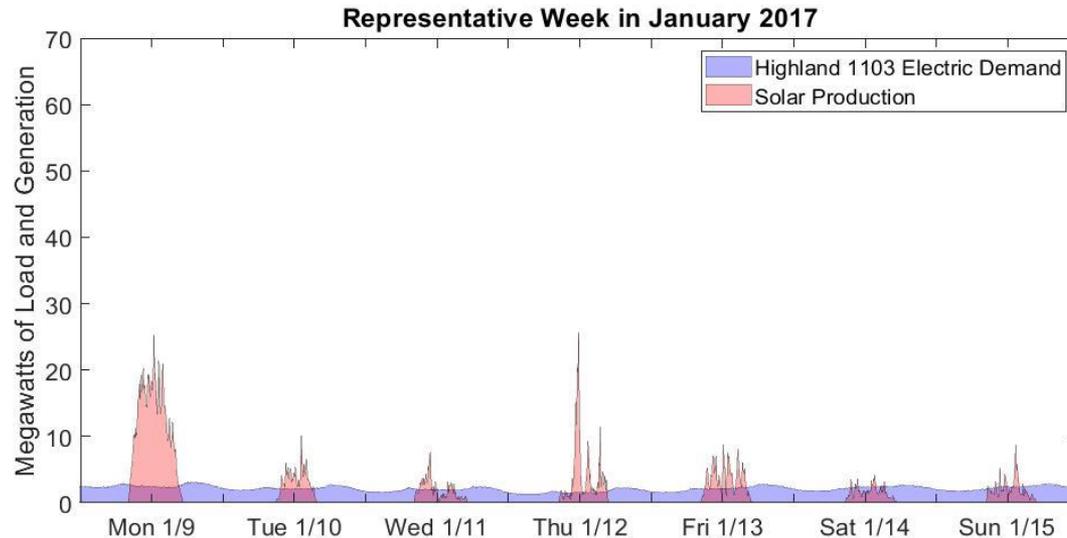
Highland 1103 5-Minute Demand Data for 2017



To meet 100% of the circuit's actual 5-minute load required...

- 75 MW of solar
- 300 MWh of battery storage
- 250 to 300 acres
- Scale of system driven by winter:
 - Load shape
 - Shorter days
 - Clouds
- Solar panel and storage investment of around \$200 million
 - If only served 20,500 MWh annually then investment is around \$10 million
- Scaling this result to the entire LG&E and KU system would cost over \$100 billion with a “b”
 - Compare cost to the \$6 billion existing net book value of the Companies' entire coal fleet
 - Results are consistent with national studies (e.g., “Deep decarbonization requires deep pockets – trillions required to make transition”, Wood Mackenzie, June 2019)

Key focus for ensuring reliability shifts from meeting peak hour demand to meeting energy needs in darker winter



Key Findings from Highlands Study

- Key focus for ensuring reliability shifts from meeting peak hour demand to meeting energy needs in cloudy, darker winter
 - Shift from natural gas heating exacerbates this problem
- Given the extent of winter cloudiness, solar is not an ideal resource for charging batteries in Kentucky
- To serve load with 100% renewables, other renewable technologies will likely need to play a role but options are limited
- Currently studying a circuit in Lexington to evaluate:
 - Impact of residential electric heating load and EV penetration
 - Multiple years
 - Additional renewable resource technologies

Report is publicly available at: <https://lge-ku.com/environment/solar>

The Companies do not oppose the resolution but strongly urge clarity to facilitate planning and execution

For example, the definition of “clean renewable electricity” may exclude all forms of generation

“...can be extracted, generated, and consumed with neutral carbon emissions or no emissions at all, *and with no current or future threat to life and the natural environment;*” (emphasis added)

This is what people think of when you say “clean energy”



This is what it takes to make “clean energy” -- steel, petrochemicals, concrete, aluminum, lithium, cobalt, coal, and much, much more



Building and operating a solar farm may impact “life and the natural environment”

- All forms of farming require clearing the land
 - Utility scale solar typically requires around 5 acres per MW
 - For the LG&E/KU system to be 100% renewable annually would require ~14,500 MW of solar generation requiring over 110 square miles of solar panels
- Materials required to construct a solar farm include concrete, steel, & copper cable
 - Solar panels are primarily made from glass, plastic, and aluminum
- End of life recycling and disposal is in its infancy
 - International Renewable Energy Agency estimates that 2050 solar goals consistent with Paris Accords will result in disposal of more than double the tonnage of all today's global plastic waste
- Solar projects are facing permit challenges
 - Maryland projects were denied because, “...these two proposed projects would harm the nearby high-quality stream in Charles County and threaten our continued restoration progress in the Chesapeake Bay watershed.”
 - Neighbors are fighting proposed largest solar farm east of the Rockies near Spotsylvania, Virginia – 1.8 million panels on 10 square miles

Building and operating a wind farm may impact “life and the natural environment”

- All forms of farming require clearing the land
 - Utility scale wind farms typically require around 60 acres per MW
 - For the LG&E/KU system to be 100% renewable annually would require ~10,500 MW of wind generation requiring over 1,000 square miles of wind mills
- According to a report from the National Renewable Energy Laboratory, wind turbines are predominantly made of steel (71-79% of total turbine mass), fiberglass, resin, or plastic (11-16%), iron or cast iron (5- 17%), copper (1%), and aluminum (0-2%).
- Wind turbines kill birds and bats
 - Audubon Society strongly supports wind power and recognizes that it will not be without some impact; while wind energy helps birds on a global scale by curbing climate change, wind power facilities can harm birds through direct collisions with turbines and other structures, including power lines. Wind power facilities can also degrade or destroy habitat, cause disturbance and displacement, and disrupt important ecological links.
 - Wind turbines kill 600,000 to 900,000 bats every year in the US
- Wind turbines have “end-of-life” disposal challenges

Used wind turbine blades end up in a Montana landfill

- Fiberglass turbine blades are not recyclable
- This site will contain more than 1,000 blades and motor housing units
 - Each blade needs between 30 and 45 cubic yards of landfill space



Our citizens, small business, and major employers rely on natural gas – would that still be possible in 2040?

- Will existing gas customers need to retrofit to all-electric?
 - 250,000 residential customers
 - 20,000 commercial customers
 - 900 industrial customers
- Gas is important to many industries
 - Restaurants & hotels
 - Distilleries
 - Autos, appliances, healthcare
 - Education
 - Tourism: airport, convention center, fairgrounds, YUM Center
- Many back-up power systems in homes, business, and hospitals are fueled by gas

Resolution should provide clarity on what is meant by its “100%” goals

- The Highlands study was 100% renewable energy, 100% of the time
 - (Annual renewable energy generated) = (Annual energy consumed) is not the same as 100% renewable energy, 100% of the time
 - The difference really matters!
- Sierra Club uses an annual definition
 - “A community is powered with 100% renewable energy when the amount of energy generated from renewable energy sources...equals or exceeds 100% of the annual energy consumed within the community.”
- Six cities cited by prior speaker are only 100% renewable using Sierra Club’s definition
 - All rely to some degree on fossil fuel resources from the regional grid or host utility to meet their real-time electricity needs
- The existing resolution may exclude the generation technologies that allow these cities to meet Sierra Club’s definition

Wind and solar made up 8.8% of annual U.S. electricity generation in 2018 – up from about 8.3% in 2017

| Energy Source | Share of total electricity generated |
|-------------------|--------------------------------------|
| Fossil Fuels | 63.0% |
| Natural Gas | 34.9% |
| Coal | 27.2% |
| Other | 0.9% |
| Nuclear | 19.2% |
| Renewables | 17.7% |
| Hydro | 6.9% |
| Wind | 6.5% |
| Utility Solar | 1.6% |
| Distributed Solar | 0.7% |
| Biomass | 1.5% |
| Geothermal | 0.4% |
| Other | 0.2% |
| Total | 100% |

Source: U.S. Energy Information Administration

We support efforts to transition to a “clean energy” future – key uncertainties are percentage, pace and cost

- Parent company PPL Corp. has a goal of reducing CO₂ emissions by 70% from 2010 levels by 2050
- LG&E and KU have retired 1,000 MW of coal since 2013 including Brown Units 1 & 2 (270 MW) in February of this year
- Construction of new state-of-the-art natural gas combined cycle plant at Cane Run site in 2015 reduced our CO₂ emissions by 60 percent per MWh compared to the coal units that were retired and recently demolished – cited by the City in its Climate Disclosure Project (CDP) reporting
- Recycle coal combustion by-products like fly ash and synthetic gypsum (which is produced by removing SO₂ from our air emissions) into products like dry wall, concrete and cement (helped build the new downtown bridge)
 - Reduces need for future landfill and this year will return \$9 million to customers
- Likely will seek to add cost effective renewable energy to our fleet as a result of renewable RFP. If successful, we will seek additional renewable generation.
- Offer energy efficiency programs & information and solar programs for customers of all sizes