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Microbiology Laboratories

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Grid-Building Interaction,Microgrids and Passive Building

This week we welcomedLisa White, Associate Director at Phius (Passive House Institute US). She discussedpassive buildings and how they are durable, healthy, resilient, comfortable, and sustainable.And how they are critical for facilitating a future electric grid powered by renewable energy.

Lisa White is the Associate Director and a technical lead for Phius andhas been with Phius since 2012. She led the building certification review team for seven years and is an instructor for Certified Passive House Consultant (CPHC®) training and WUFI® Passive energy modeling software training. She holds a degree in Environmental Sustainability with a minor in Architecture from the University of Illinois at Urbana-Champaign, and a Master's in Energy Engineering from the University of Illinois at Chicago.

Nuggets mined from today's episode:

Hello Lisa please tell our audience a little about Phius and your work with them?
Phius is a 501(c)3 organization. Phius is focused on making every building support the health of both people and the planet.

Phius trains and certifies professionals, maintains the Phius climate-specific passive building standard, certifies and quality assures passive buildings, certifies high-performance building products and conducts research to advance high-performance building. They also have an Alliance membership group, which assembles in local chapters across North America.

The technical staff of Phius set performance metrics on standards and reviews all elements of a building throughout design and construction for certification.

Unlike point-based LEED Certification which more people are familiar with, Phius Certification is pass/fail and is focused on reducing energy use, improving occupant health and resilience alongside the goal of thoughtful net zero design. Phius has ~1200 projects completed or in progress which comprise over 18 million square feet. Phius is growing exponentially in the US and Canada.

Phius promotes and facilitates policies that provide a deep level of energy efficiency which is a big contributor to the recentgrowth.

Your presentation at Summer Camp got my attention. It was called Grid-Building Interaction, Micro-grids, and Passive Building. Let's go through highlights of the presentation for our audience.

First how do you define passive? Passive building is a design methodology that utilizes a set of principles to achieve a rigorous level of energy efficiency while also creating comfortable, healthy indoor living spaces. These principles can be applied to all buildings, including single-family homes, multifamily apartment buildings, schools, skyscrapers and more.

What is the grid? The grid can be defined as the biggest machine on earth. In the US there are 3 Grid Interconnections: East, West and Texas which are not connected. Smaller regions within each interconnect are operated by Independent Service Operators (ISOs) or operators in de-regulated markets. For the most part, power flows in one direction from generation of supply through high voltage transmission lines, stepped down to lower voltage distribution to meet the customer load. Current grid infrastructure facilitates one-way communications, but the demand needs to start responding to the supply availability and stress on the grid.

Share of renewable energy is growing. What are the categories of "renewable" energy? Currently, the share of US electric generation resources consists of 35% natural gas, 22% coal, 20% nuclear, 14% renewable (non hydro), 7% hydro. The EIA forecasts renewables to be the fastest growing source of electricity generation.

Renewable energy in this context is primary solar (rooftop, utility scale and concentrated solar power) as well as wind energy (onshore and offshore).

Meeting the daily load? To this day, the grid load that the regional operators must plan for has been fairly predictable. Daily variability is based on building occupancy and seasonal variability is based on space conditioning loads. The typical load is broken into three categories – baseload, load following, and peaking and each of these are constrained to various generation resource types. Baseload power supply is mostly constrained to constant output. Load following supply can change output quickly and respond to change in load. Peak plants rarely operate but must be maintained. The US has 2.5-3 times more generation capacity than is being used annually because the capacity is sized to meet the system peak so that reliability can be ensured.

*Hourly marginal carbon emissions concept.*Because the load on the grid changes, the generation resource mix delivering the load also changes. This means that the carbon dioxide emissions associated with meeting the "next" kWh is variable. Similarly, delivering power constantly varies in cost for the provider but generally is sold at a flat rate to consumers (though real-time or time-of-use pricing is available through many utilities).

Typical Simplified Source Energy Accounting. CO2 emissions for power generation vary due to time of day and the mix of suppliers. Some sources are greener than others, but, typical programs that account for operational building emissions use a flat rate for grid electricity use.

The Grid is Changing. Factors driving change: Electrification (of buildings and cars), Decarbonization (shifting to intermittent renewable sources), Decentralization (smaller scale utility renewables and customers as generators), Digitalization (communication and signals)

Transmission Congestion. Most of the existing transmission infrastructure on the US grid doesn't have sufficient wire capacity to deliver power during peak renewable energy output, so renewable energy resources that are available may be curtailed in areas of high renewable penetration.

Decarbonization Movement: Factors driving significant change to the grid:

- Net zero buildings
- Electrification Movement (electrifying building heating, hot water, etc)
- Dispatchable fossil fuels switching to variable renewable resources.

Net Zero Buildings: The commonly accepted definition of 'Net Zero' focuses on a net calculation of energy consumed and produced over the course of the year. Annually, the production must be equal to or greater than energy consumed.

Net Zero does not equal Zero Impact, Zero Grid Resilience, or Zero Operating Emissions.

Not all kWh used and produced are equal. In a typical net zero building with rooftop solar, energy use is happening during all hours but the production is only happening during daylight hours – so the emissions associated with the energy used may be greater than the emissions offset during the day when solar energy is produced.

Net Zero focuses on how much instead of when. As more intermittent renewable resources are added to the grid, and overall electricity demand is increasing, there must be a shift to not only focus on how much energy is being used but also consider when it's being used. For example, laundry, electrical vehicle charging, preheating/precooling building can be scheduled when electricity is less costly/more renewable energy supply is available.

GEB (Grid-Interactive Efficient Building) Integration of optimal communication and control. Based on the stress on the grid (peak times) there may be a signal to tell the customer to reduce energy use. Or alternatively in times of high renewable supply, the building may shift loads to use energy at that time. This concept is about enabling building loads to be smart and responsive to supply signals.

*Load shifting and shedding.*GEBs can shift load to different times of the day when emissions on the grid are lower, or shed load altogether during times of high stress on the grid. Passive building enclosures + addition of thermal storage enhance the viability of this toolkit.

The peak is shifting. Electrifying heating system in buildings shifts the grid peak from summer to winter. As a reminder, the grid capacity right now is sized to meet

the summer peak, so a shift to winter will mean more capacity required while also trying to transition to replace existing resources with renewable resources.

What are micro-grids and how will they help? In contrast to the central grid, micro-grids are smaller clusters of buildings where multidirectional power flow can occur in more of a mesh network rather than unidirectional energy flow. These are usually connected to a centralized grid but able to function independently.

Minimum Components that make up a Micro-grid

- Central micro-grid energy controller/manager/optimization system.
- Energy demand/load from buildings with grid enabled loads (GEBs).
- Energy generation.
- Energy storage.

Benefits:

- Generation is closer to the load.
- Less reliance on vulnerable transmission and distribution lines.
- Resilience when central grid is down.
- Reduces stress on central grid.
- Energy independence.
- May lower costs for occupants

The ripple effects of conservation. Conserving energy in buildings ripples beyond reductions in utility bill costs. When you examine beyond the building boundary, 40% energy reduction of passive building ripples through. Conservation= less generation, less storage, and less transmission needed for the renewable energy transition

Why not more nuclear? There are a lot of mixed opinions out there for nuclear, as it's not fossil-fuel based and doesn't directly emit carbon emissions but also has toxic waste. Nuclear plants have 40-year life expectancy. Many plants are nearing their end of life expectancy. Nuclear plants produce a steady stream of electricity and cannot respond to spikes, so while they can continue to serve the baseload, their current technology isn't suited to pairing with renewable resources like wind and solar

Lisa's Final Comment:

Tactics to offset Winter Peak capacity: reduce the load, make the load smart and manage the load between buildings. This will be incredibly critical to building electrification, decarbonization, and facilitating a grid-wide renewable energy transition quickest and at the least total system cost.

Z-Man signing off

Trivia Question:

Name the voluntary standard used in Switzerland for reducing a property's eco footprint?

Answer: MINERGIE-P

Answered by: Don Weekes