



Welcome!!

T.C. Williams High School - A Peek Into the Trade Show & Renewable Energy Industry

April 25, 2019

Today's Agenda

9:30 [Get Settled & Introductions](#)

9:45 Sustainability, Our Partners & Education

10:00 Energy Storage & the tradeshow market

10:10 Break

10:15 A deep dive into the changing market and technology
of the Renewable Energy Industry

11:00 Lunch

TRIVIA

1 HOUR OF SOLAR ENERGY HITTING THE EARTH COULD POWER ALL OF HUMANITY'S NEEDS FOR...

- A. 1 HOUR
- B. 1 YEAR
- C. 10 YEARS
- D. FOREVER

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- **B. 1 YEAR**
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SOLAR PANEL COSTS HAVE _____ SINCE 1977

- A. RISEN
- B. FALLEN

SOLAR PANEL COSTS HAVE _____ SINCE 1977

- A. RISEN
- B. FALLEN BY 99%

WHICH COUNTRY IS THE LARGEST PRODUCER OF SOLAR POWER?

- A. CHINA
- B. CANADA
- C. USA
- D. GERMANY

WHICH COUNTRY IS THE LARGEST PRODUCER OF SOLAR POWER?

- A. CHINA (174 GW INSTALLED)
- B. CANADA
- C. USA (64 GW INSTALLED)
- D. GERMANY

WHICH STATE IN THE USA HAS THE MOST SOLAR?

- A. TEXAS
- B. NEW YORK
- C. CALIFORNIA
- D. NORTH CAROLINA

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- **C. CALIFORNIA**
- D. NORTH CAROLINA

WHICH INDUSTRY EMPLOYS THE MOST WORKERS?

- A. COAL
- B. OIL
- C. NATURAL GAS
- D. SOLAR

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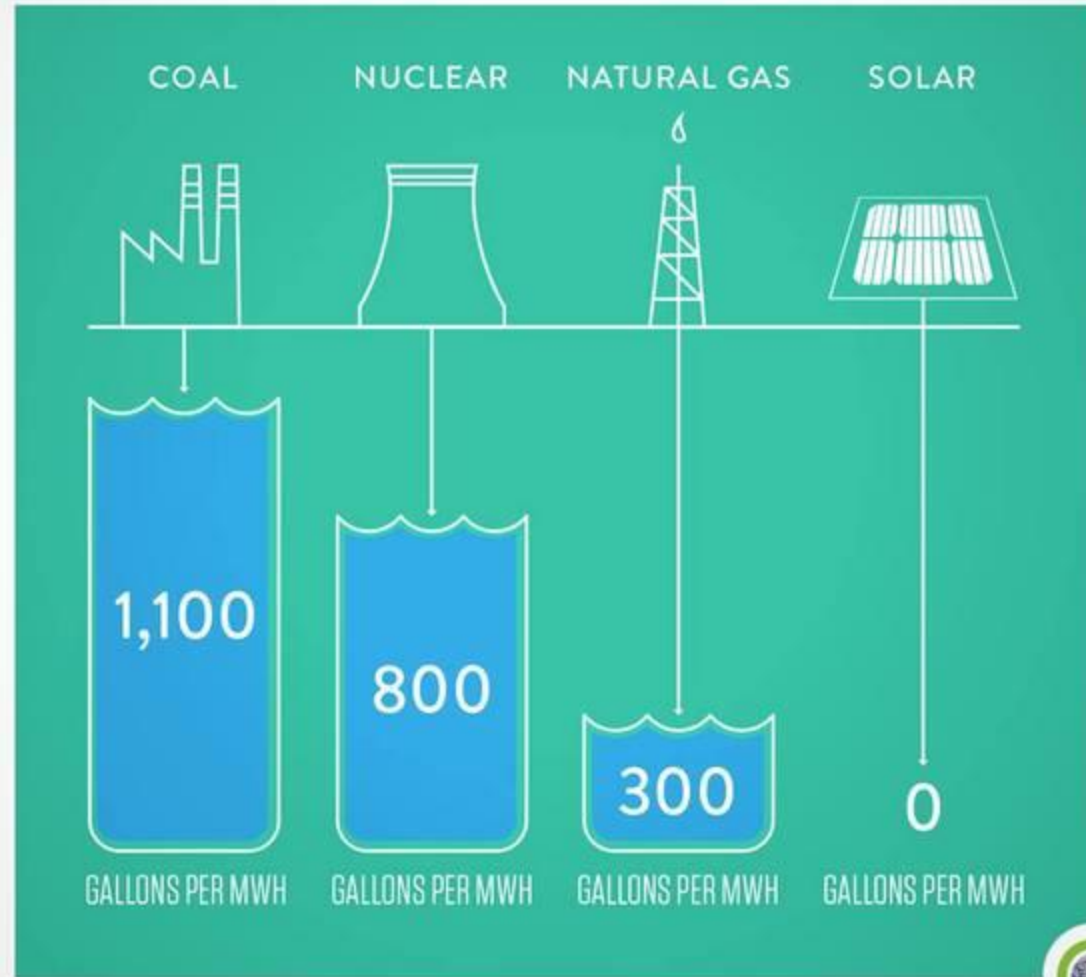
WHICH OF THE FOLLOWING POWER SOURCES USES THE MOST WATER?

- A. COAL
- B. NUCLEAR
- C. NATURAL GAS
- D. SOLAR PANELS

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- A. COAL
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- C. NATURAL GAS
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WATER USED BY POWER PLANTS



OUR PARTNERS



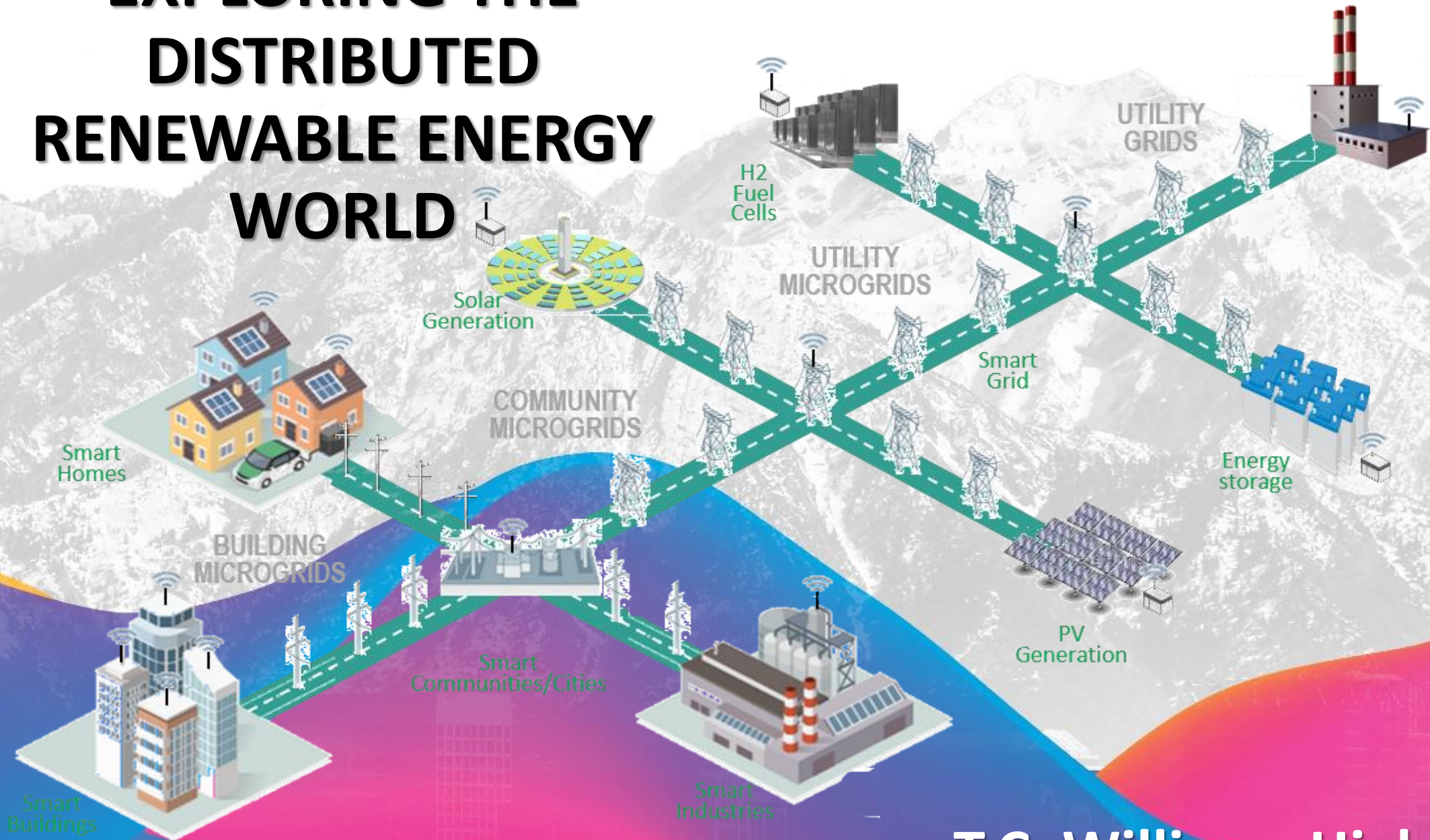


- ADVOCACY
- EDUCATION
- REPRESENTS THE US SOLAR ENERGY INDUSTRY (OVER 242,000 EMPLOYEES)
- WORKS TO CREATE JOBS AND DIVERSITY, REMOVE MARKET BARRIERS, AND EDUCATION THE PUBLIC AND POLICYMAKERS ON THE BENEFITS OF SOLAR ENERGY



- FACILITATE THE ELECTRIC POWER INDUSTRY'S SMART TRANSITION TO A CLEAN AND MODERN ENERGY FUTURE
- EDUCATION, RESEARCH, CODES AND STANDARDS, AND COLLABORATION
- ENVISIONS A CARBON-FREE WORLD BY 2050
- WORK WITH OVER 1000 MEMBERS INCLUDING 700+ UTILITIES

EXPLORING THE DISTRIBUTED RENEWABLE ENERGY WORLD



T.C. Williams High School



BACK TO THE FUTURE

WITH DISTRIBUTED RENEWABLE ENERGY



What do you want from me...

Why are you here?



Can you share your
dream with us?



What you hold in
your consciousness
tends to manifest...



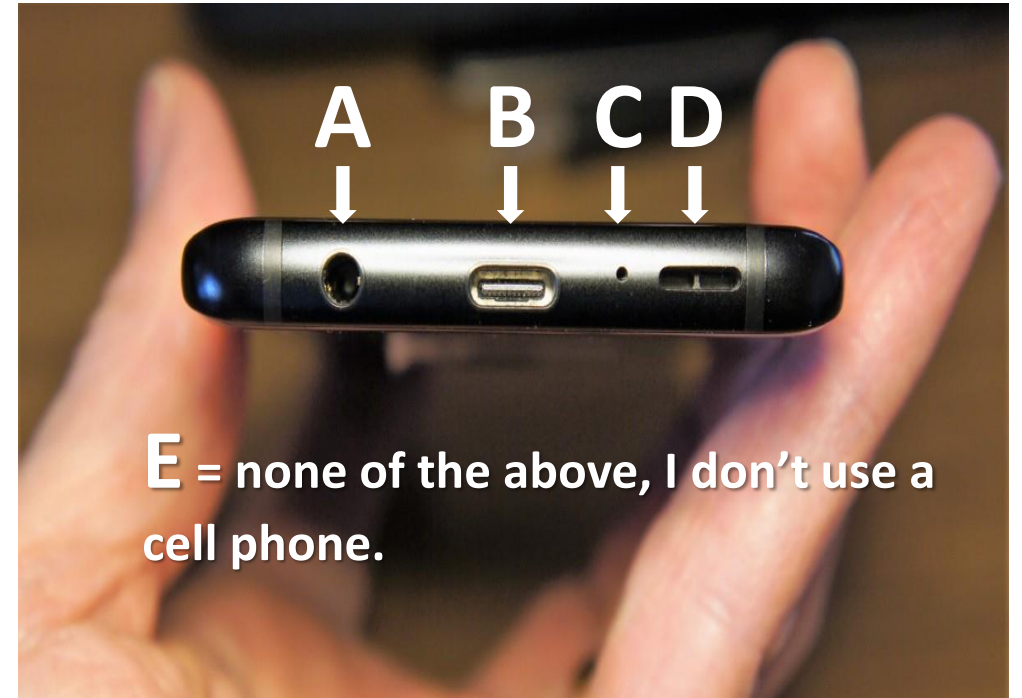
Calibrating the group:

What's Your Electricity I.Q.?

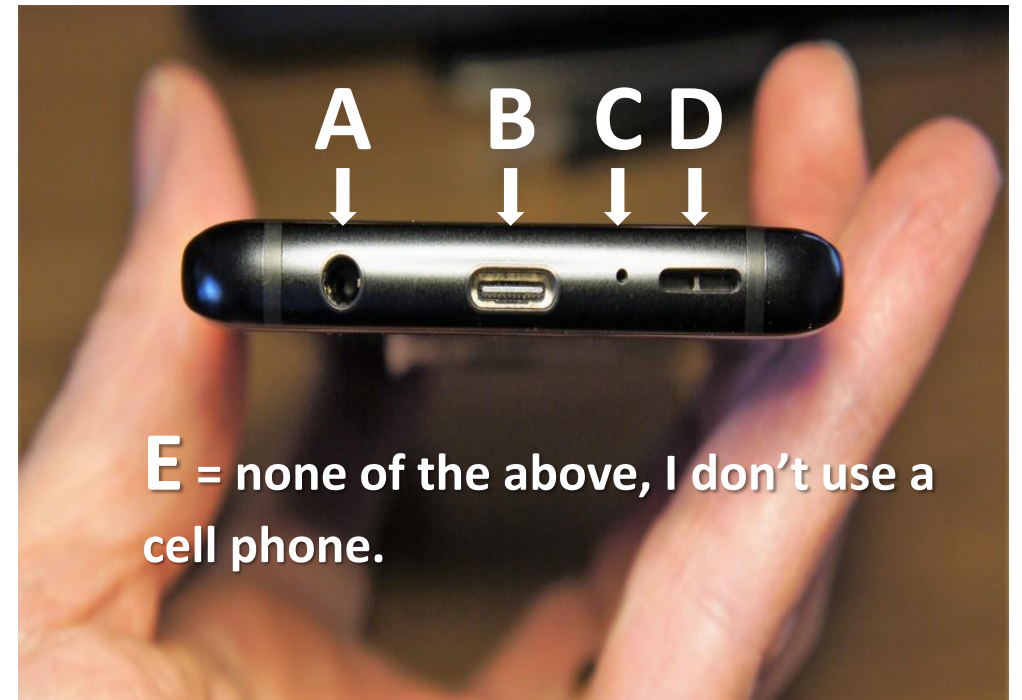
Determine the general level of familiarity with the subject

On a scale of 1 to 10...

1 = I can find the
power charger port on
my cell phone (most of
the time).



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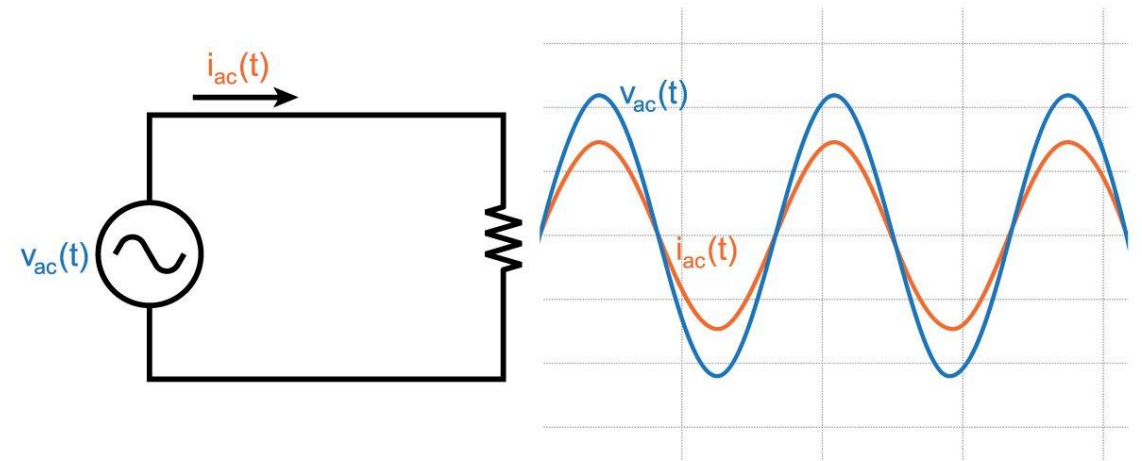


BONUS: Add **one** point for each correctly
identified port on your phone!

PENALTY: Deduct **one** point if you answered "E"

10 = I can
mathematically determine
the total harmonic
distortion in an electric
circuit using Fourier's law
of conduction.

$$THD_I = \frac{\sqrt{\sum_{n=2}^{\infty} I_n^2}}{I_1} \quad THD_V = \frac{\sqrt{\sum_{n=2}^{\infty} V_n^2}}{V_1}$$



BONUS: No bonus available. Hey genius, you crushed this and don't need any bonus points.

PENALTY: Deduct **five** points if you thought harmonic distortion was the name of a 90's rock band... **three** points if you have used a cell phone app to determine THD.

1 = You understand why they put those safety thingies in outlets and that electricity can be dangerous.



BONUS: Add **one** point if you listened to your mom! Add a second point if you still use safety covers on your home sockets.

PENALTY: Deduct **one** point if you still like to play with electrical things.

10 = Using Ohms Law and assuming a body resistance of approx. 2000 Ohms, you mathematically determined that electricity up to 50 volts ac or 120 volts dc can be safe to touch and is called SELV= Safe Extra Low Voltage.

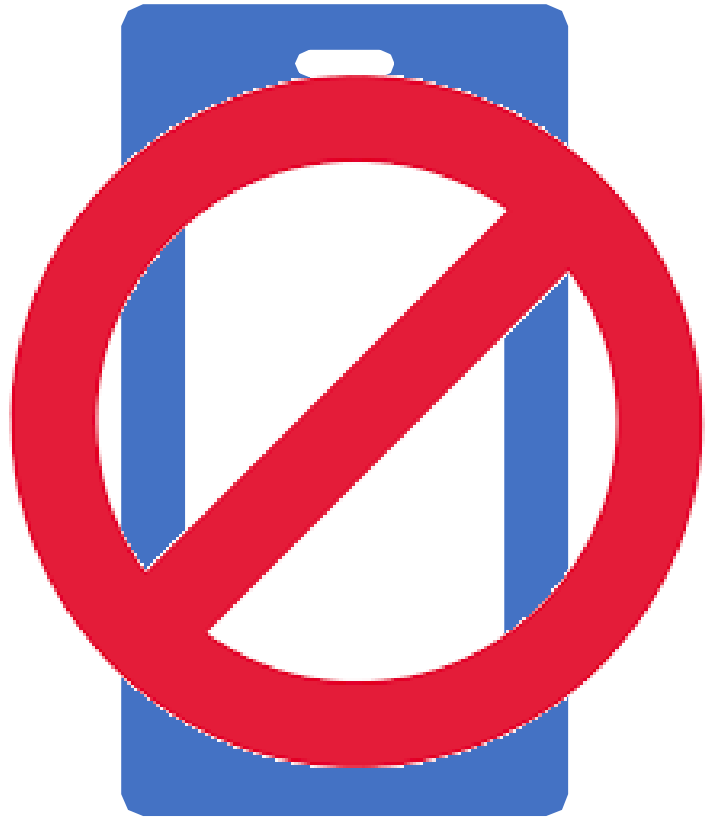
Ohm's
Law

$$I = \frac{V}{R}$$

Electric current = Voltage / Resistance

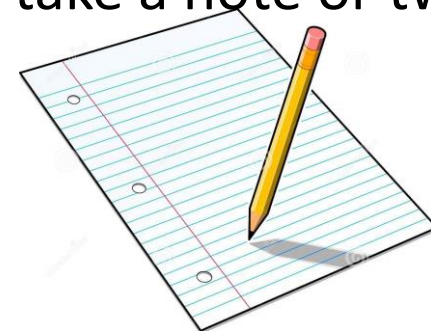
BONUS: No bonus available. Hey genius, you crushed this and don't need any bonus points.

PENALTY: Deduct **five** points if you thought OHM stands for "Oh How Marvelous" in crypto-speak.



Please put your cell phones and scientific calculators away, we won't need either of them.

You can, however, hold onto your note books, pencils and pens – you may want to take a note or two...



Distributed Renewable Energy

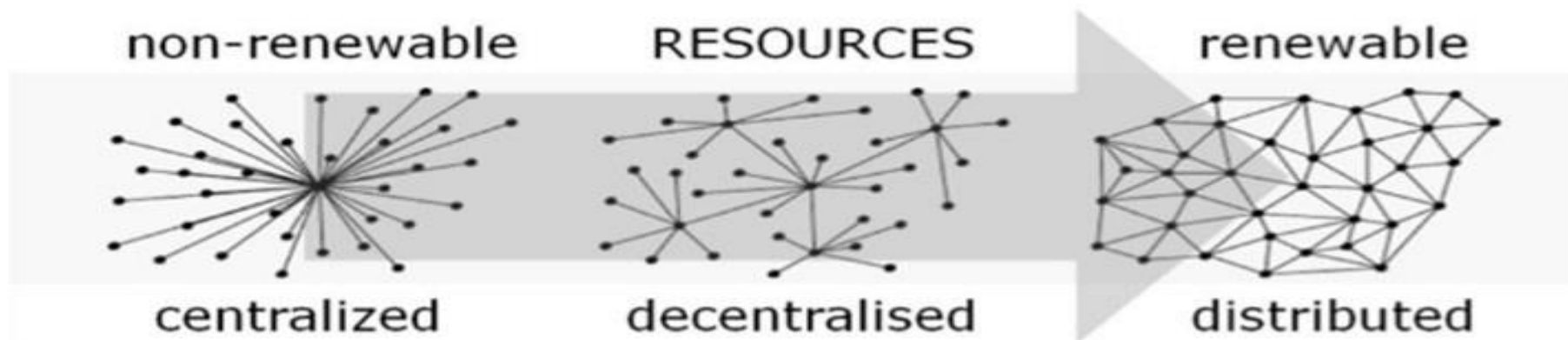
“Technology poised to transform electricity.”

The goal: Be able to answer these four key questions:

- ☐ **What is Distributed Renewable Energy (DER)?**
- ☐ **What are Microgrids and what do they have to do with DER?**
- ☐ **What are some of the value propositions for DER Microgrids?**
- ☐ **What are the key business models for DER Microgrids?**

What is Distributed Renewable Energy?

- Hydro Generators (Dams)
- Wind Turbine
- Solar (Photovoltaic)
- Hydrogen (Fuel Cell)
- Bio Fuel ICE Generators
- Thermoelectric Generators
- Combined Heat and Power Generators
- Piezo-Electric Generators
- Wave/Tide Generators



What is a Microgrid

“The technology that is poised to transform electricity.”

The local integration of...

✓ Smart Energy **Supply**

✓ Smart Energy **Loads**

✓ Smart Energy **Storage**

✓ Smart Energy **System Management**



The Distributed Renewable Energy Value Proposition

“The technology that is poised to transform electricity.”

☐ Resiliency

☐ Environmental benefits

☐ Energy Independence

☐ Reliability

☐ Cost savings

☐ Service to Remote locations

☐ Energy Access in Developing World

☐ Military Bases

☐ Grid Independent Campuses/Communities

☐ Peak Shaving or Demand Charge Reduction

☐ 3rd Party Power Services

☐ Utility System Support

☐ EMP Protection

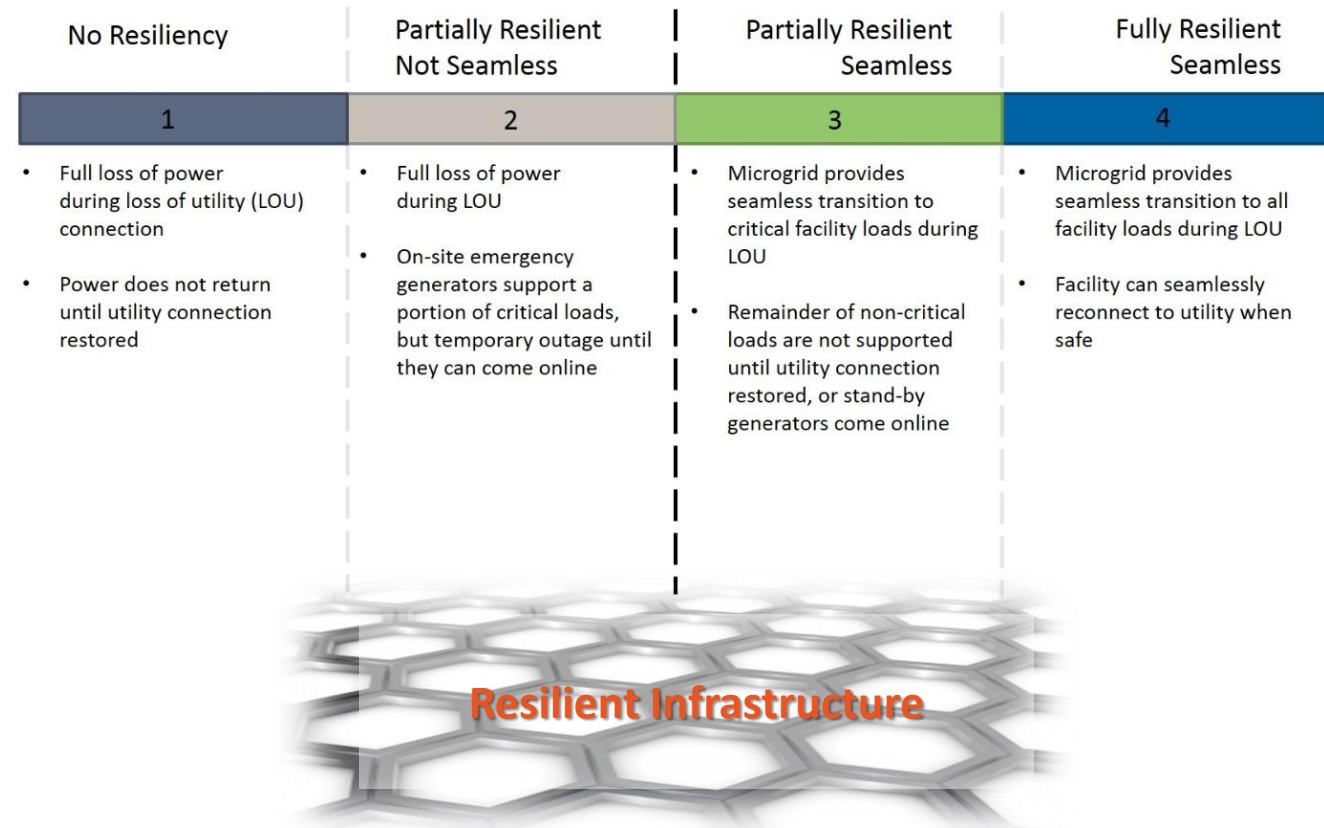
☐ Energy Efficiency

The Resiliency Value Proposition

“The technology that is poised to transform electricity.”

- Severe weather-related electricity outages cost the US economy over \$336 billion dollars between 2003 and 2012.
- Medium to large scale commercial and industrial customers incur an average cost of \$21,312 from a one-hour interruption and \$98,278 per hour from outages lasting eight hours.
- Microgrids reduce outages by locating electricity generation close to where it is consumed.
- While microgrids can remain connected to the macrogrid they have the ability to disconnect from the macrogrid when necessary to assure continuous operations.

THE SPECTRUM OF GRID RESILIENCY



The Reliability Value Proposition

“The technology that is poised to transform electricity.”

- Complex power electronics are involved to integrate distributed energy resources into a local power system, and can reduce overall system service reliability.
- However, done using inherently simple system architectures, they can alternatively and dramatically improve overall system reliability.
- DC Coupled microgrids reduce electronics and fault vulnerability, by avoiding the system complexity of multi-source frequency and phase synchronization as well as line balancing, thus providing an inherently higher level of service equipment reliability.

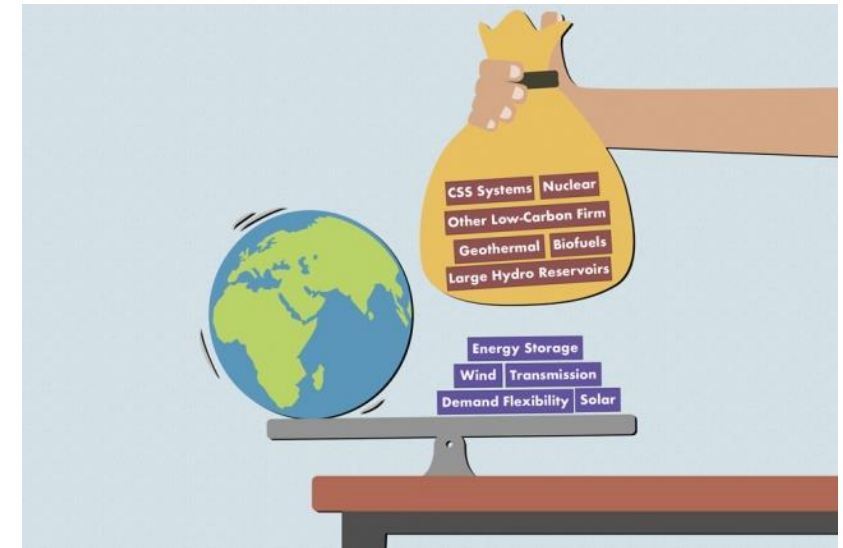


The Cost Savings Value Proposition

“The technology that is poised to transform electricity.”

The potential cost benefits of developing and operating a microgrid include the following:

- \$ Choice of sources
- \$ Energy Arbitrage
- \$ Reliability benefits (during outages not caused by events outside the microgrid's service domain)
- \$ Benefits of avoiding major power outages (i.e., outages caused by major storms or other events beyond the microgrid's service domain).
- \$ Power quality benefits.
- \$ Environmental benefits.



The Environmental Value Proposition

“The technology that is poised to transform electricity.”

- Many businesses and communities establish clean energy goals to reduce the environmental impact of their power generation.
- Microgrids can integrate a wide range of green power production technologies including solar, wind, fuel cells, combined heat and power (CHP) plants, and energy storage technologies. Even natural gas generators, used in many CHP plants, fall on the cleaner side of fossil fuels.
- Advanced microgrids can be programmed to achieve specific sustainability goals, such as use of lowest carbon resources to the maximum extent possible.



The Remote Location Value Proposition

“The technology that is poised to transform electricity.”

- Remote power service can be very expensive compared to the same service in a populated service area.
- Remote feeder in remote and/or rugged areas are expensive to install and maintain and often incur “long-duration outage events.”
- Lack of right-of-way options can also be expensive and difficult barriers to using the more conventional solution of adding a redundant feeder line.
- The off-grid versus microgrids can also be grid-connected for redundancy and alternatively be used to capture some of the bulk-system benefits, as well as the local microgrid distribution value, such as grid-hardening.”



The Energy Access Value Proposition

“The technology that is poised to transform electricity.”

- Over 1.2billion people currently live without electricity in their homes and on their farms.
- The advantage of a microgrid solution is it does not require costly grid extension. Scalable microgrid systems can provide small-scale electricity access in remote areas relatively inexpensively and often more quickly than utilities or governments can extend centralized grids.
- These microgrids can be powered with clean, alternative energy sources and it is possible to integrate microgrid infrastructure with the national grid if and when it arrives to an area.



The Military Value Proposition

“The technology that is poised to transform electricity.”

- US military operations represent the largest consumer of all forms of energy globally.
- Microgrid technology is helping to stem its heavy reliance upon fossil fuels by incorporating more renewables and could save \$8-20 billion over 20 years.
- Microgrids also provide increased physical security, high mobility and additional cybersecurity and EMP protection/isolation.
- Military microgrids have been deployed by the US DOD in three key segments: stationary bases, forward operating bases (FOBs), and tactical mobile systems.



The Campus/Community Value Proposition

“The technology that is poised to transform electricity.”

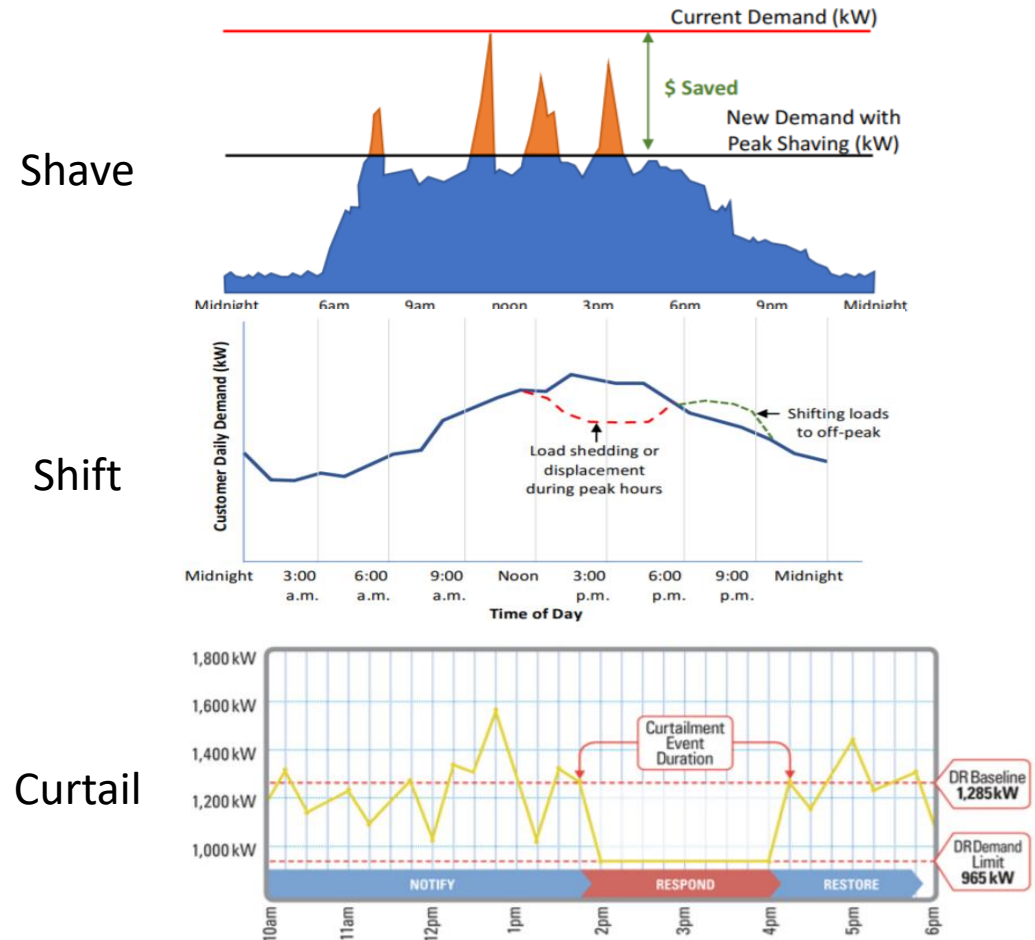
- While microgrids can be viewed as the best way to integrate distributed energy resources, they can also multi-task multiple resources within their boundaries, such as solar, energy storage, wind power, fossil fuel generators, load and even other microgrids.
- Microgrid clusters are expected to take this type of management to a new level, with one microgrid reaching into another to share resources in a kind of “grid of grids” architecture and functionality.
- On a campus or community basis, this provides an inherently robust level of service surety for all the electricity needs within the interconnected system, regardless of the availability of individual resources.



The Peak Demand Value Proposition

“The technology that is poised to transform electricity.”

- Microgrids can play a critical and valuable role in managing peak loads in electricity demand both internal or external to the microgrid boundaries.
- On a local level, they can load shave or provide peaking capability by controlling local sources, loads and storage based on local priorities and conditions.
- On an external basis, they can provide overall load curtailment or grid load support based on local priorities, economic incentives and other conditions.



The Renewable Energy Value Proposition

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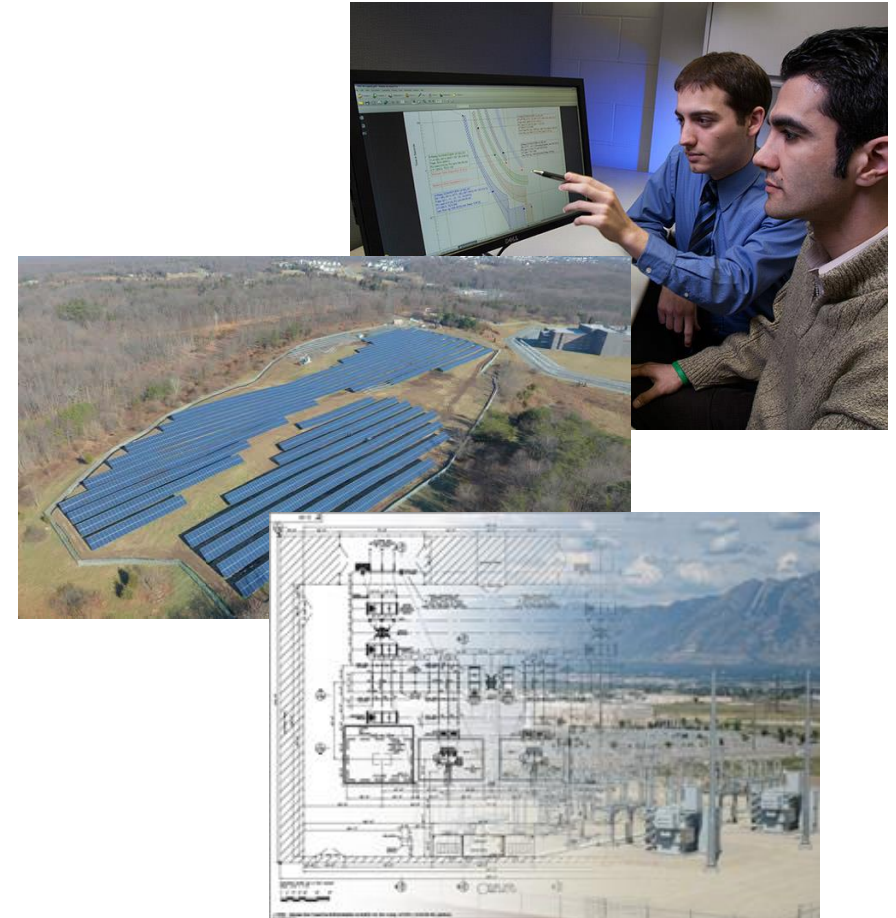
- Microgrids can help manage the variability created by high penetrations of solar and wind power and other non-dispatchable renewable electricity sources.
- By improving power management, these microgrids can enable the addition of greater amounts of distributed renewable energy to the overall power mix while adding stability and other resources to the overall electricity system mix.
- Because microgrids can store intermittent over-production of renewable energy sources, they can be ‘clipped’ and saved for future use in load shaving or riding through main grid outages.



The 3rd Party Services Value Proposition

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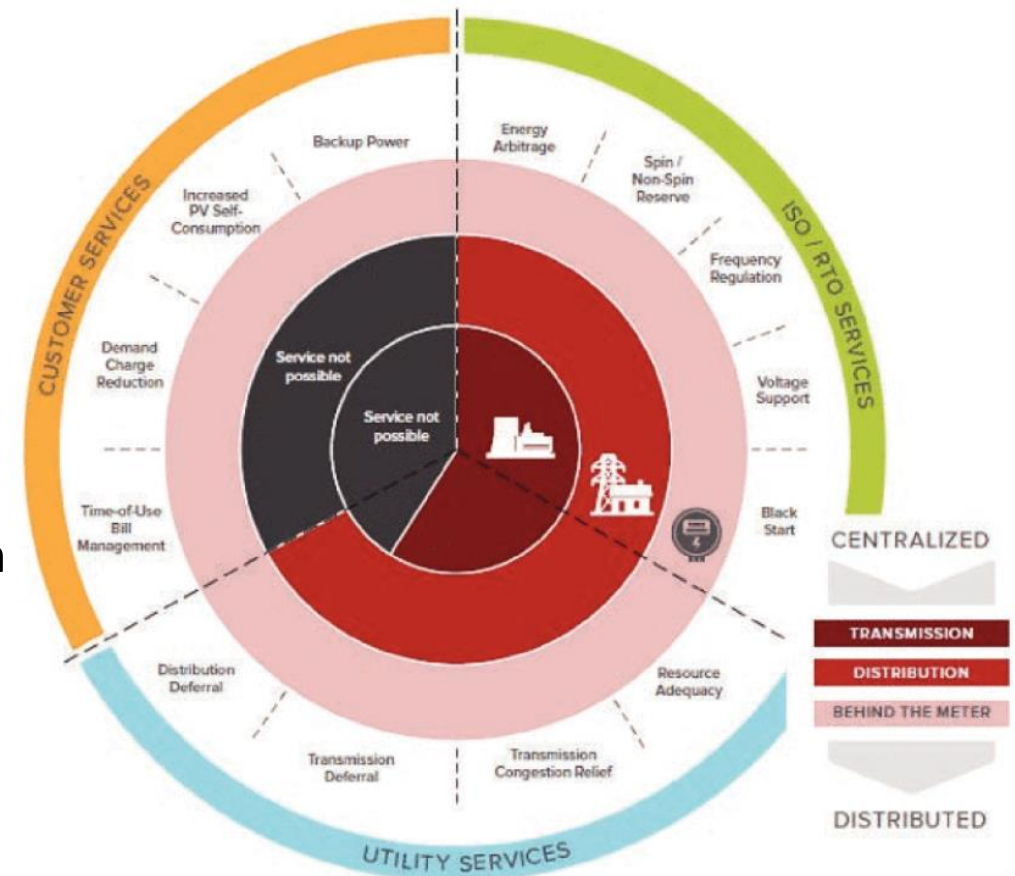
- Almost 25 percent of microgrids today use the Energy-as-a-Service Model, (EaaS) and can be applied to a microgrid that is large or small, simple or complex.
- As microgrids can provide a variety of capabilities that either compliment traditional grid services, EaaS contracts are typically customized to include the host's unique needs and concerns for reliability, demand response, load management, power quality and other issues.
- EaaS services often take the place of enterprise owners having to engineer or finance needed upgrades or improvements to their existing renewable energy systems.



The Utility Support Value Proposition

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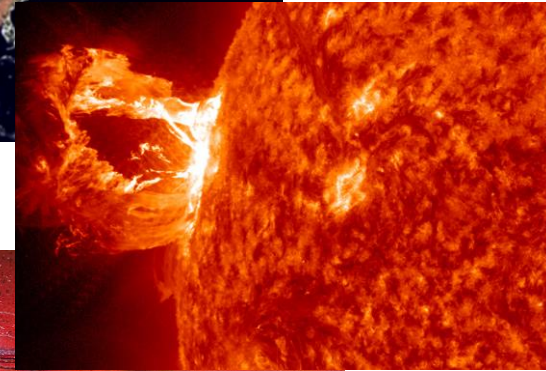
- Microgrids can provide valuable means to lower costs or generate new revenues for a IOUs or electric Co-ops:
 - Integrate distributed renewable energy sources & storage for resource adequacy and lower environmental protection costs
 - Reduced Grid de-stabilization mitigation costs.
 - Grid performance/cost (freq. regulation, , VaRs, voltage, spinning & non-spinning reserve, black start, transmission congestion, transmission and distribution deferral
 - Increased wholesale arbitrage
 - Electricity as a Service (EaaS) revenues
 - Reduced remote area service costs



The EMP Protection Value Proposition

“The technology that is poised to transform electricity.”

- A one-megaton nuclear bomb detonated 250 miles over the continental U.S. would create an electromagnetic pulse (EMP) that could take out the power grid for months or years.
- A solar storm similar to the one 1859, would have a similar effect & wreak havoc around the world.
- Renewable energy-powered, EMP-protected microgrids can provide electricity for critical infrastructure facilities in the event of such disasters
- Microgrids can create islands of power that can interrupt the cascading effects of wide-scale failures of the traditional grid.



The Energy Efficiency Value Proposition

“The technology that is poised to transform electricity.”

- In the traditional system relying on central station generation, six percent of power is lost in transmission lines.
- Microgrids designed to use the direct current (DC) power directly from the generation source have the potential for an additional seven to thirty percent energy savings by improving conversion efficiencies.
- Microgrids can efficiency managing local loads and properly “match” them to local distributed generation resources.
- Microgrids can enable local owners/operators to set priorities and policies about energy use that encourage lower cost and higher efficiencies.



Microgrid Business Models

“The technology that is poised to transform electricity.”

- ☐ **Customer Owned Microgrid Systems**
- ☐ **Microgrid as a Service**
- ☐ **Pay-As-You-Go Microgrids**

Click on one to learn more...

Customer Owned System Business Model

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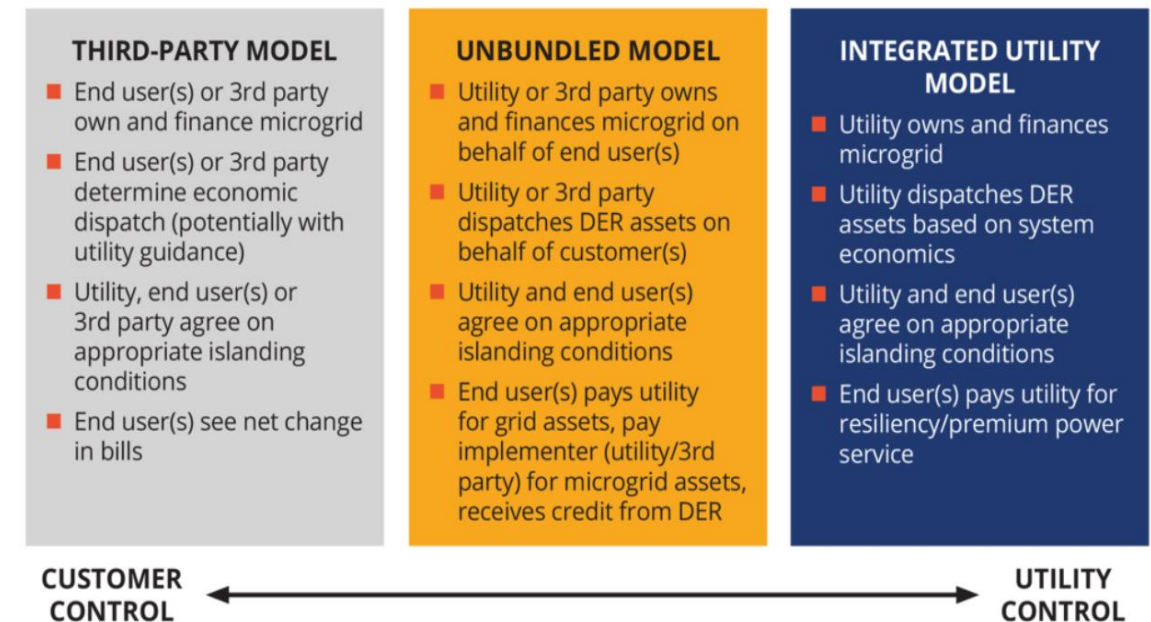
- In a customer-owned business model, the financial risk associated with the capital cost of a microgrid falls directly onto the customers/owner.
- The result is that all savings (or losses) are available to the owner unlike where as in the “microgrid as a service (MaaS) model the customer essentially pays a premium to avoid and possible risk associated with the initial or operating cost of the microgrid.



Microgrid as a Service Business Model

“The technology that is poised to transform electricity.”

- Microgrid as a Service (MaaS), opens the microgrid market to individual businesses and entities that are unable to provide the upfront capital outlays typically required for a microgrid project.
- The Microgrids-as-a-Service model removes the financial risk and complexity, enabling more microgrids to become a reality. In addition to providing the hardware and software, MaaS providers arrange the financing and the operation & maintenance agreements to make microgrid deployment an affordable turnkey solution.



Pay-As-You-Go Business Model

“The technology that is poised to transform electricity.”

- Microgrids are key for emerging economies. In Bangladesh, Pakistan, Indonesia, Africa and more, people are taking advantage of cheap renewables.
- Pay-as-you-go plans allow the user to budget and pay for what they can afford while helping the supplier minimize financial risk due to unsecured debt and credit/collection problems.
- Pay-as-you go in North America is largely used as a pre-pay service to help secure the debt associated with new microgrid investments both within and outside the traditional utility domain.



Typical Pay-As-You-Go customer Service Box

Frequently Asked Microgrid Questions

“The technology that is poised to transform electricity.”

- ☐ What is the typical size of a microgrid?
- ☐ Do microgrids use AC or DC electricity?
- ☐ How long can a microgrid operate if the main grid goes down?
- ☐ What is the difference between a microgrid, a nano-grid, a peco-grid, and a mini-grid?
- ☐ What is your question about microgrids: (we'll add them here...)



Unfortunately, we've run out of time for today.



We hope you had
fun!

Back to the **Future II**

of Electricity

THE END