THE VALUE OF FRONT-OF-THE-METER ENERGY STORAGE

By Matt Stedl

ICC Energy Storage Policy Session

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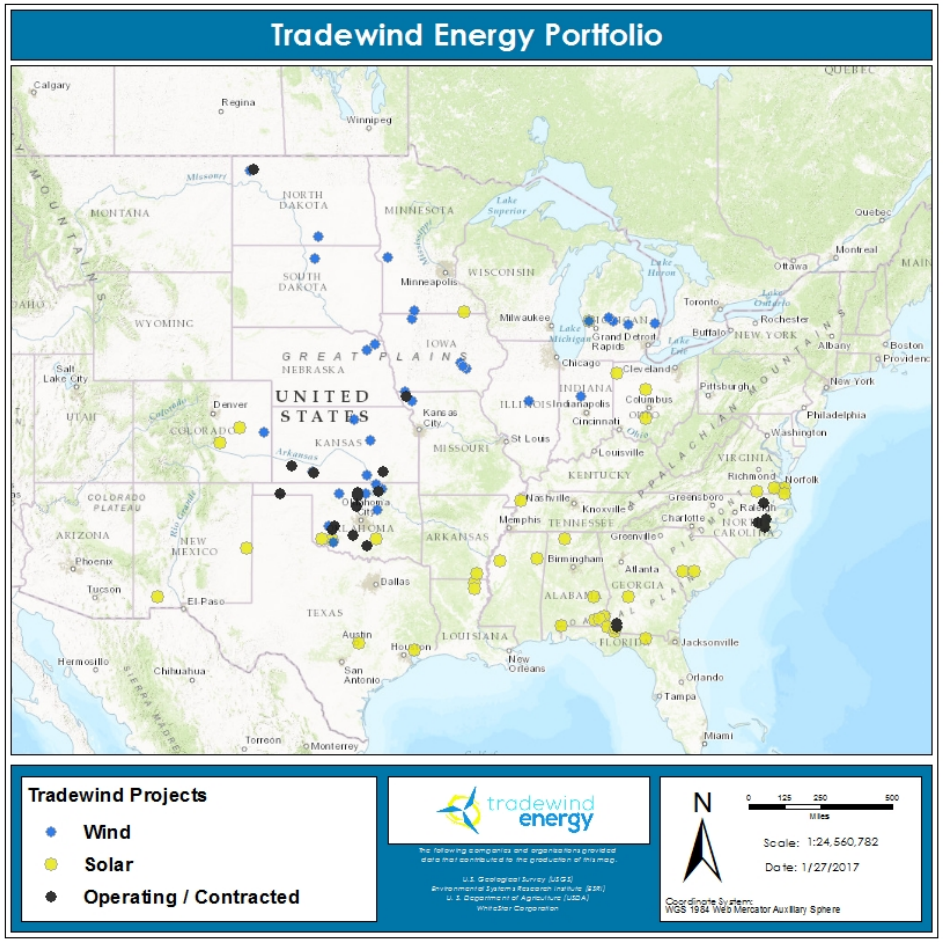
Chicago, IL

Tradewind Energy

Among the Largest & Most Successful Wind & Solar Development Companies in the U.S.

- **Company Info**
  - Founded in 2002
  - Headquarters in Lenexa, KS
  - 140+ full time employees
- **Current Development Portfolio**
  - Present in more than 25 states
  - #1 US Wind Developer in 2017
  - **More than 8 GW of wind assets**
  - **More than 3 GW of solar assets**
- **Tradewind Success**
  - **3 GW+ contracted & operating projects**
  - Successes total more than $5 Billion capital investments
  - Equivalent to powering 1 million US homes



Customers


Google
DUKE ENERGY
KCP&L
energizing life
T··Mobile·
Arkansas Electric Cooperative Corporation
We Are Arkansas
GRDA
Grand River Dam Authority
ALABAMA POWER
A SOUTHERN COMPANY
Midwest Energy, Inc.
BASIN ELECTRIC POWER COOPERATIVE
A Touchstone Energy® Cooperative
SUNFLOWER ELECTRIC POWER CORPORATION
TVA
KANSAS CITY BPU
THE POWER OF COMMUNITY
wfec
western farmers electric cooperative
A Touchstone Energy® Cooperative
PEC
GEORGIA POWER
A SOUTHERN COMPANY
AEP
PUBLIC SERVICE COMPANY OF OKLAHOMA
A unit of American Electric Power
Associated Electric Cooperative Inc.
A Touchstone Energy® Cooperative
CITY UTILITIES
Bringing Power Home.℠
IPL
Independence Power & Light
Your Community Energy Partner

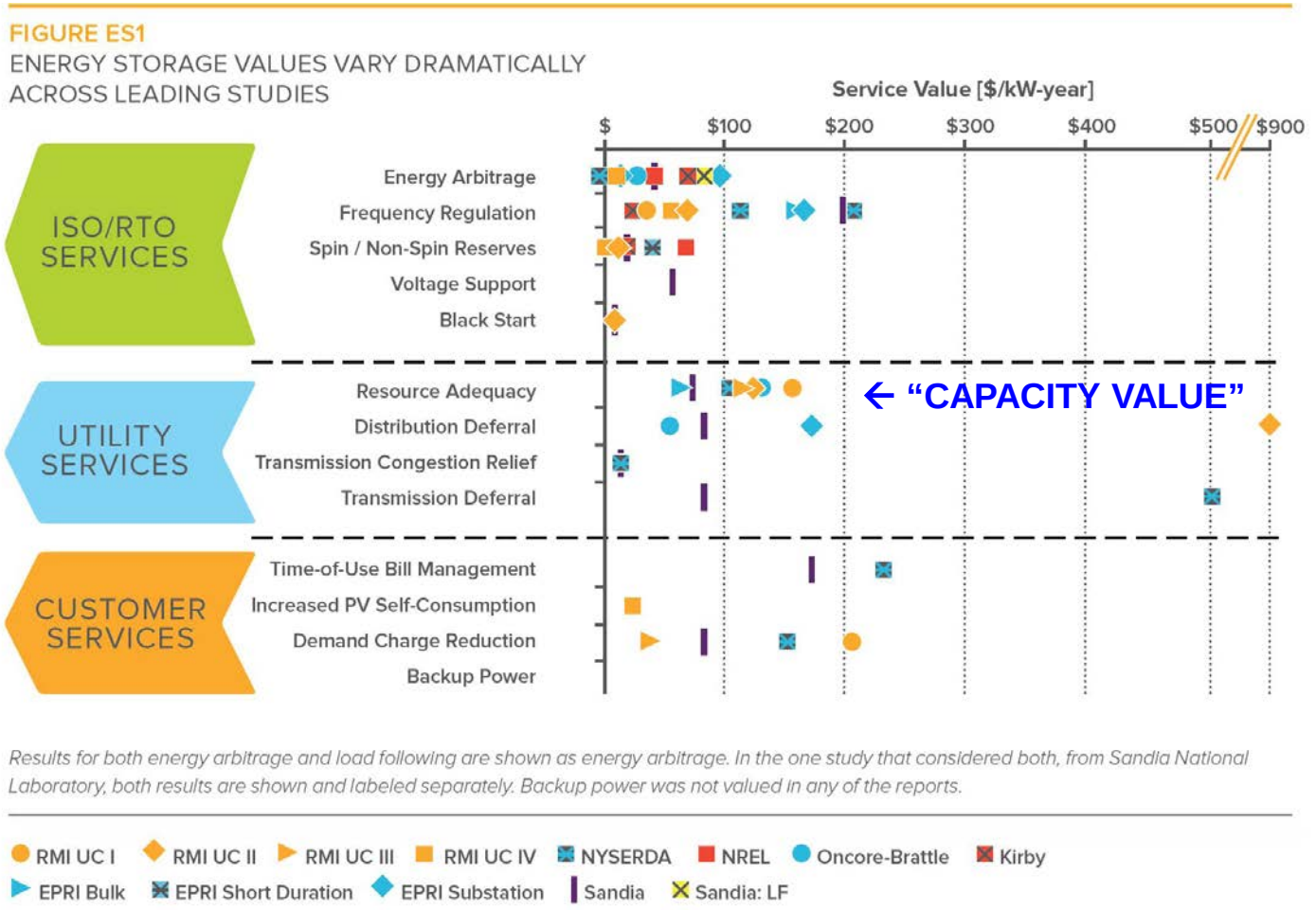
AGENDA

1. Front-of-the-Meter (FTM) Energy Storage Applications
2. FTM Energy Storage Configurations
3. Solar + Storage
4. Current FTM Challenges

FTM ENERGY STORAGE KEY APPLICATIONS

1. Provide Firm Capacity to non-firm solar and wind projects
2. Act as a shock absorber to the system
   - Frequency Regulation (fast response)
3. Energy Time Shift: Load during times of excess/inexpensive generation, Generator at peak load times
4. Transmission and Distribution deferral

FTM ENERGY STORAGE APPLICATIONS



FTM ENERGY STORAGE – APPLICATION VALUES

IN DECREASING ORDER OF MARKET VALUE*

1. **Frequency Regulation (Ancillary Services)**
2. **Capacity Value (or "Resource Adequacy")**
3. **Transmission Deferral**
4. **Distribution Deferral**
5. **Energy Arbitrage (buy low, sell high)**
6. **Spinning Reserve/ Voltage Support / Blackstart**

*Market Values are highly location-dependent, this is a representative list of market values based on higher-end of spectrum.

FTM ENERGY STORAGE CONFIGURATIONS

- **Stand-Alone Wholesale "Generator" & "Load":**
  - Energy Arbitrage (Load-Following) – Charge Off-Peak, Discharge On-Peak
  - Capacity Value / FR / Spinning Reserve / Voltage Support
  - Future Ramping Products?
  - Interconnection through ISO/State generator interconnection process
- **Stand-Alone Transmission and/or Distribution Asset**
  - Transmission planning process or NWA (non-wires alternative)
  - Typically rated-based asset
  - Other compensation structures?

FTM ENERGY STORAGE APPLICATIONS (cont.)

- **Co-located with Wind (Wind + Storage)**
  - Energy Arbitrage / Curtailment abatement (charge solar during curtailment)
  - Capacity Value
  - Bulk Storage options
  - Ramp Rate Control (no rapid cut-out)
  - FR/Ancillary services in off-hours
  - NOT ITC eligibility (typically)

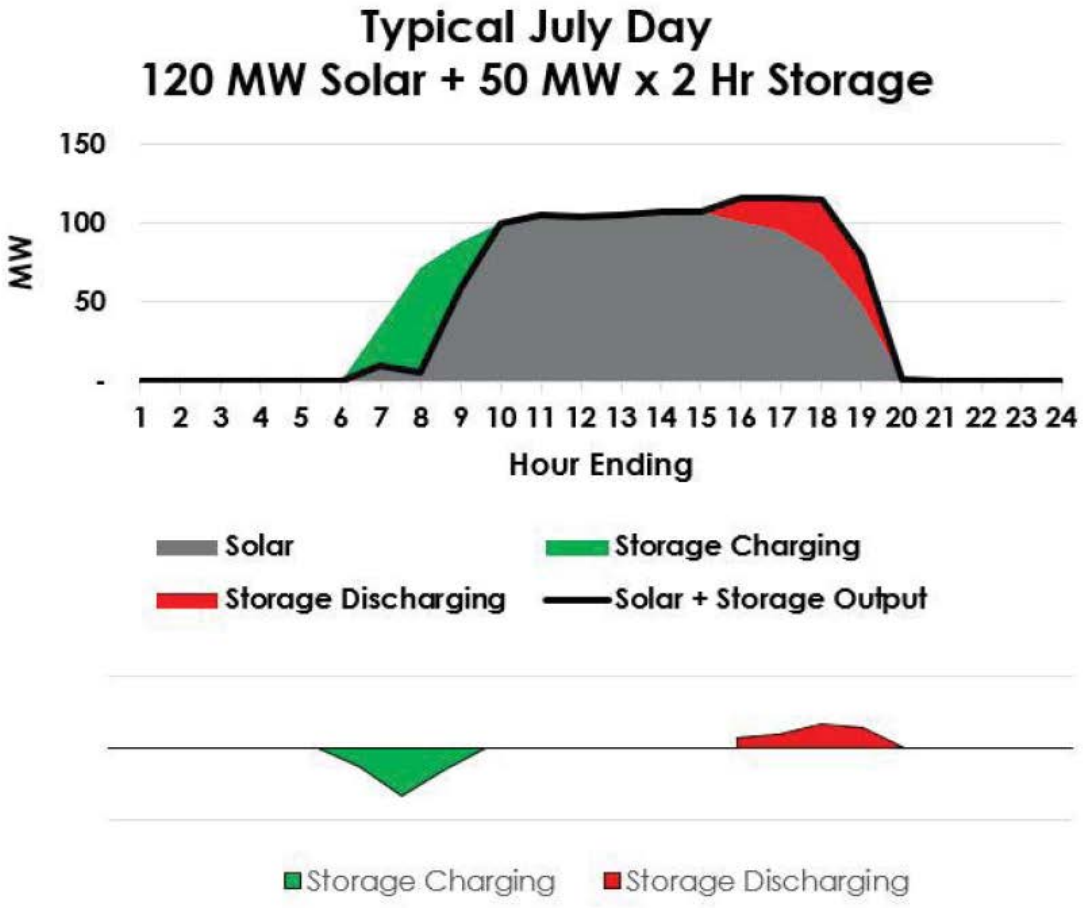
- **Co-located w/Solar (Solar + Storage)**

BENEFITS OF SOLAR + STORAGE:

Benefits of Solar and Storage

- Firm capacity and energy from a renewable resource when coupled with solar
- Storage qualifies for the ITC when charged from solar (first five years)
- Option to charge from the grid post-ITC period
- Other revenue possibilities
  - Energy arbitrage
  - Spinning reserves
  - Frequency regulation
  - Voltage support
- Added system flexibility/black start and ramp rate control capability
- Pricing structure options
  - Fixed & variable
  - Blended $/MWh (solar+storage)
- FERC Order 845
  - Will allow net zero addition of storage capacity without material modification to Interconnection – subject to the current ISO rule-making process

SOLAR + STORAGE DISPATCH PROFILE:



CURRENT FTM ENRGY STORAGE CHALLENGES:

1. **Market Participation (FERC Order 841 to address)**
2. **Interconnection Process (FERC Order 845 to address)**
3. **Proper compensation for value provided to system (FERC Order 841 to address)**
4. **Lack of predictable cash flow (State mandates/procurements helping a lot)**

Contact

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