

Technology Innovation

Key Megatrends Driving R&D

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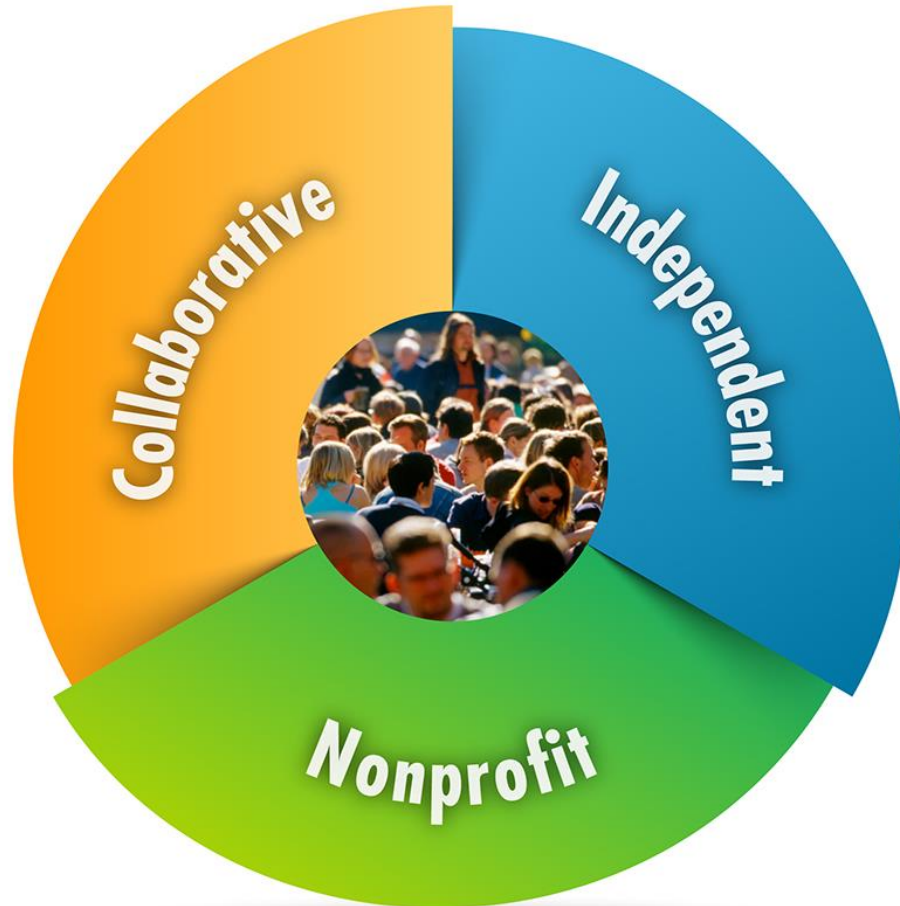
NASEO Midwestern Regional Meeting

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Minneapolis, MN



Three Key Aspects of EPRI



Independent

Objective, scientifically based results address reliability, efficiency, affordability, health, safety, and the environment

Nonprofit

Chartered to serve the public benefit

Collaborative

Bring together scientists, engineers, academic researchers, and industry experts

EPRI SECTOR R&D PORTFOLIO

TECHNOLOGY INNOVATION

EPRI SECTORS



GLOBAL
RESEARCH &
INDUSTRY
INPUT


INNOVATION
SCOUTING


EMERGING
TECHNOLOGY
R&D

 ENERGY &
ENVIRONMENT

 GENERATION

 NUCLEAR

 POWER
DISTRIBUTION
& UTILIZATION

 POWER
TRANSMISSION


ELECTRIC
SECTOR

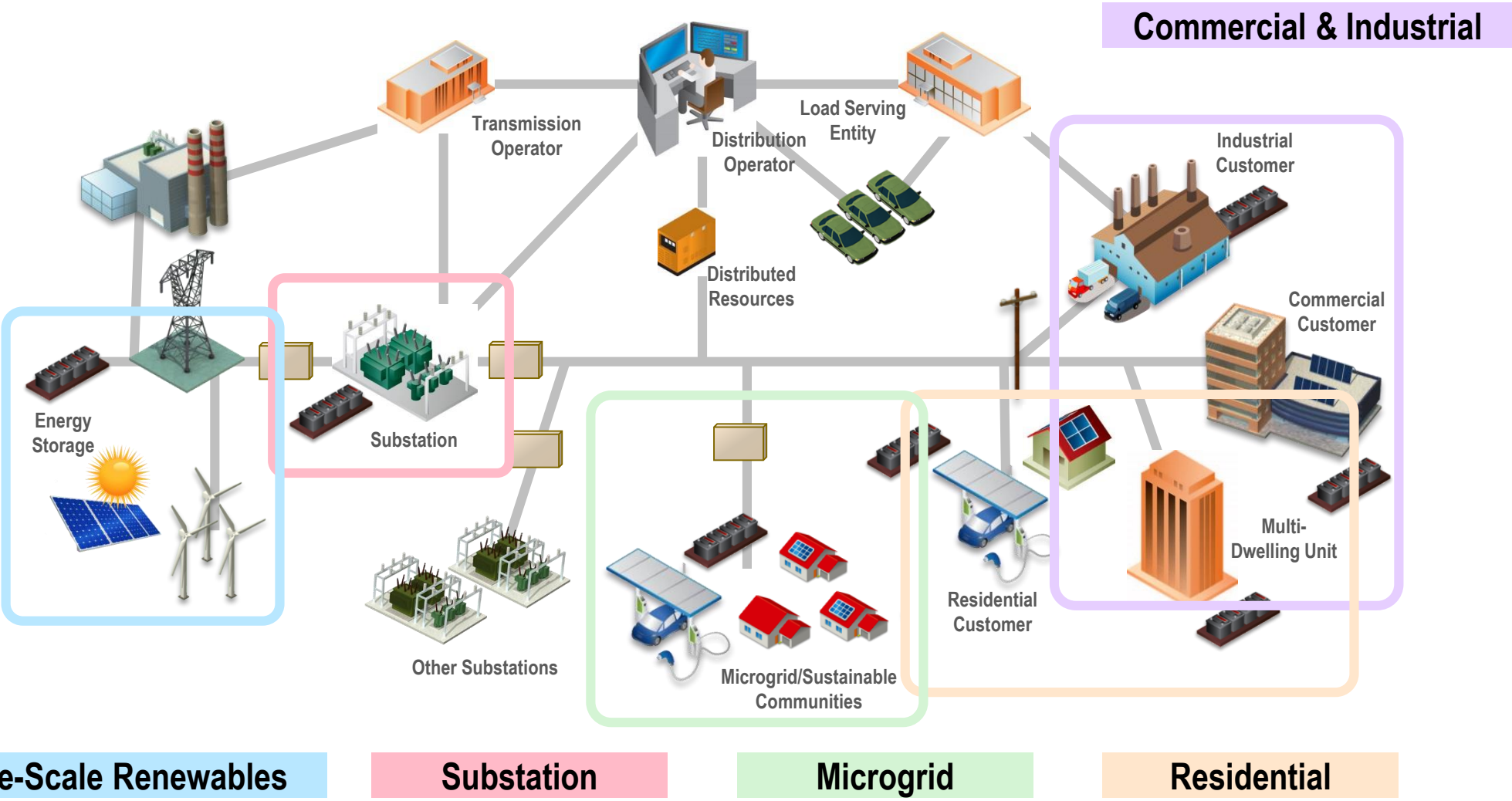

THOUGHT LEADERSHIP

Key Megatrends Impacting the Electricity Sector

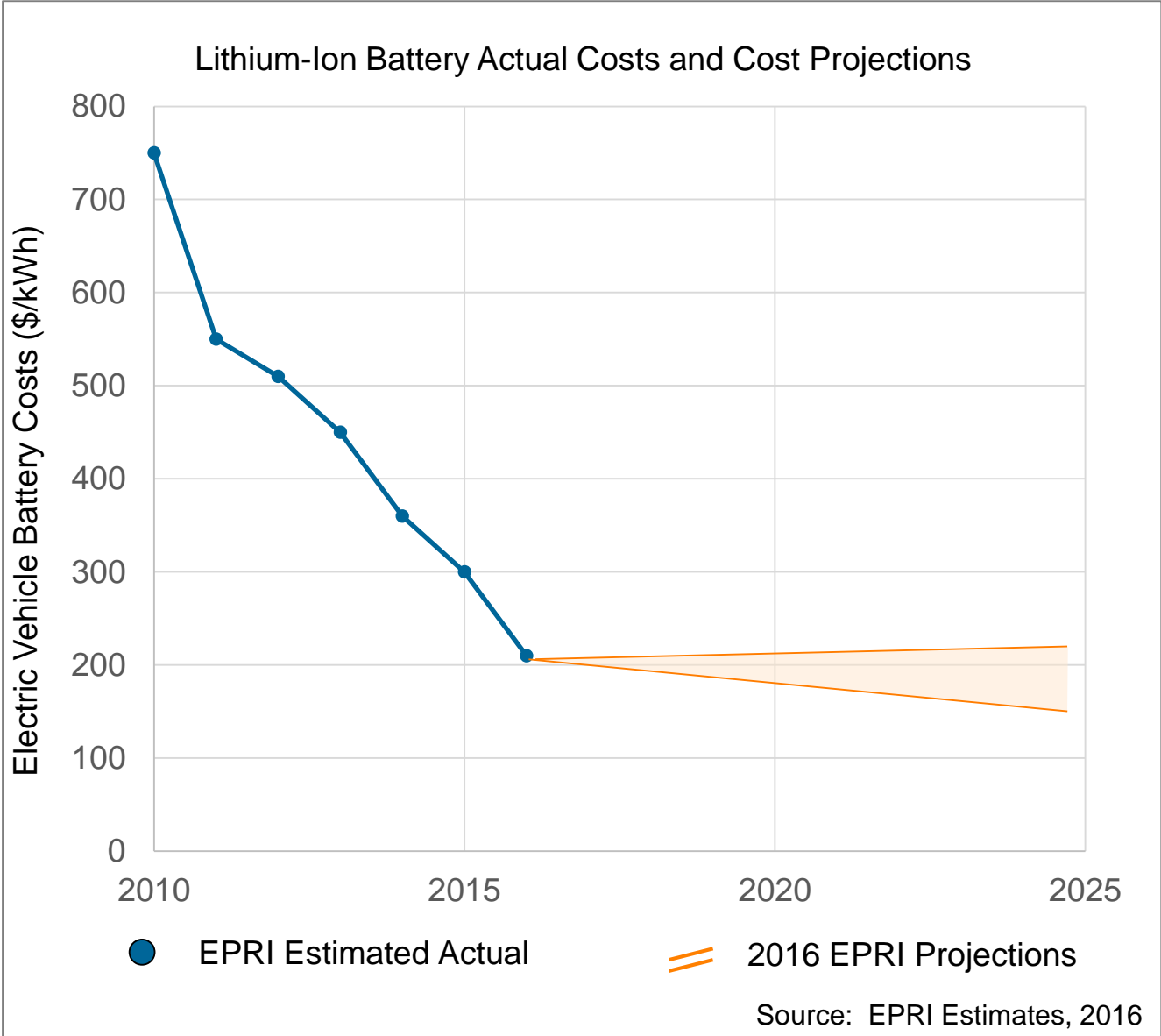
- Decentralization
- Digitization
- Efficient Electrification



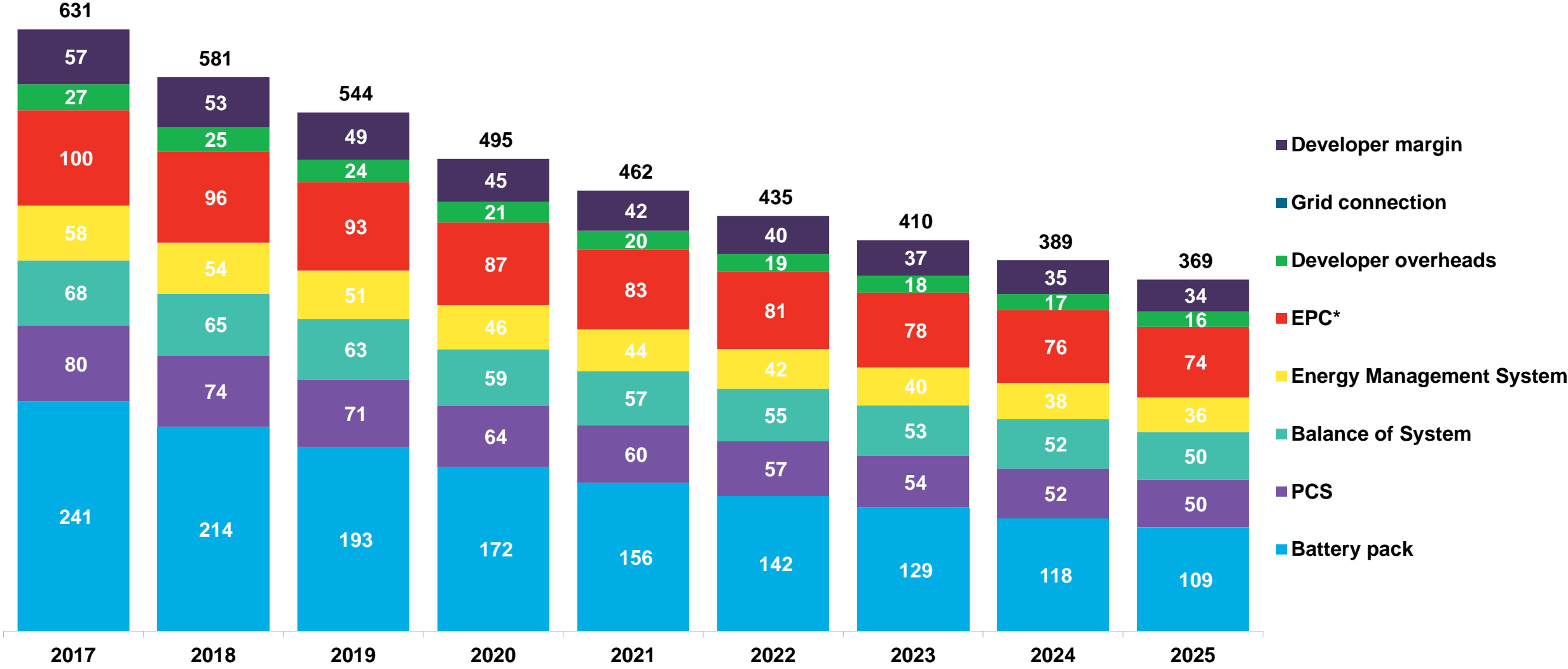
Decentralization - Energy Storage



Future Costs Trends and Insights For Lithium Ion Systems

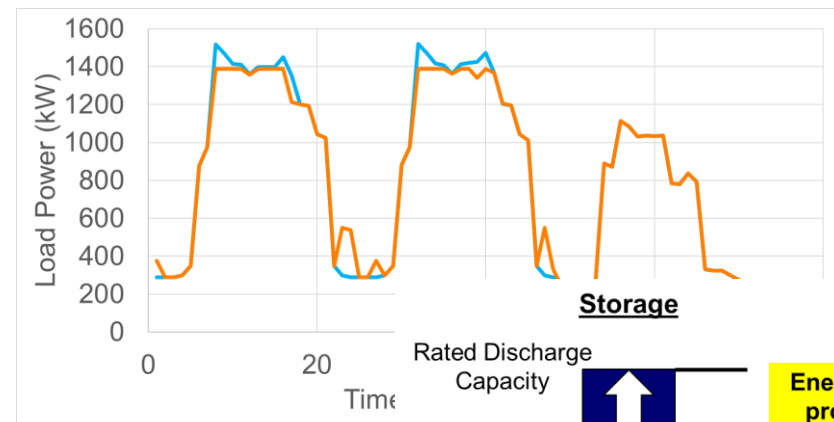


Forecasted Battery Energy Storage System Price Trends

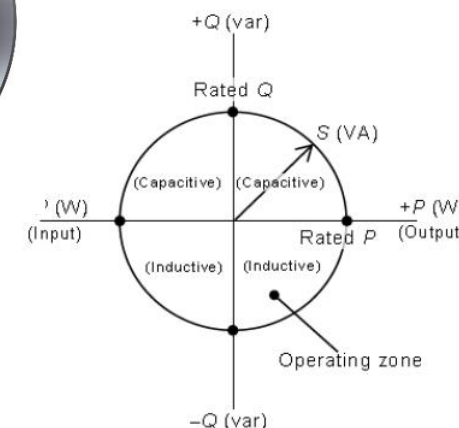
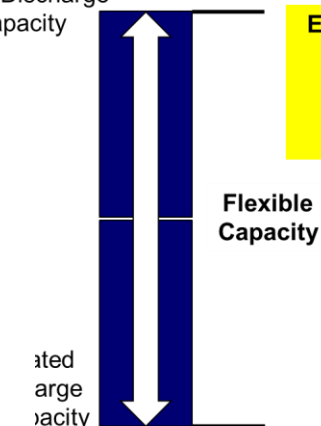


Key Considerations

- **Capacity Resource:** Peaker replacement or non-wires alternative
- **Flexibility Resource:** System ramping, renewable variability and uncertainty
- **Reliability / Resiliency Resource:** Backup power, microgrid, black start
- **Voltage / Power Quality Resource:** Dynamic, 4-quadrant inverter capabilities



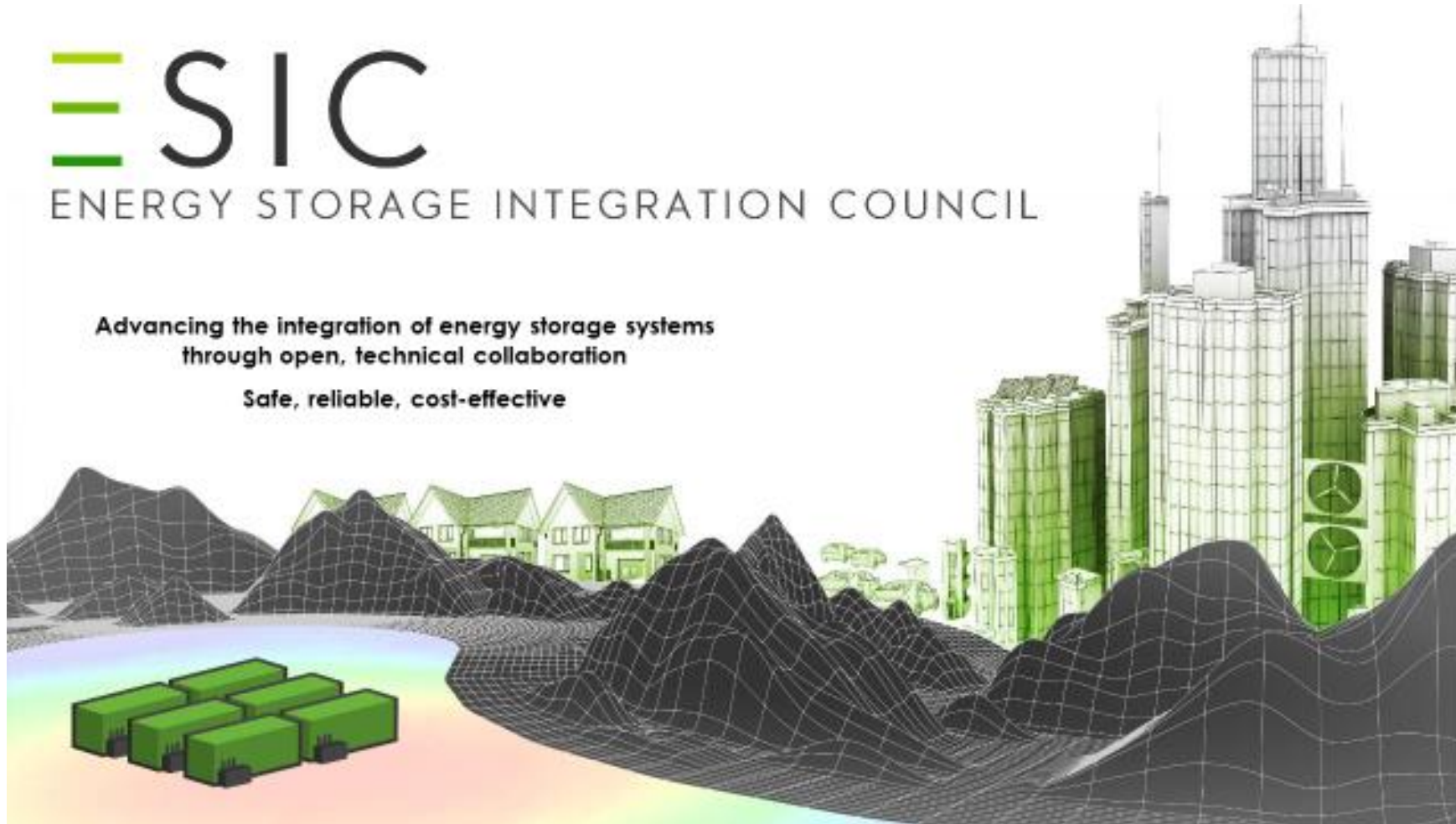
Energy storage may provide 2-4 times flexible range of conventional generation




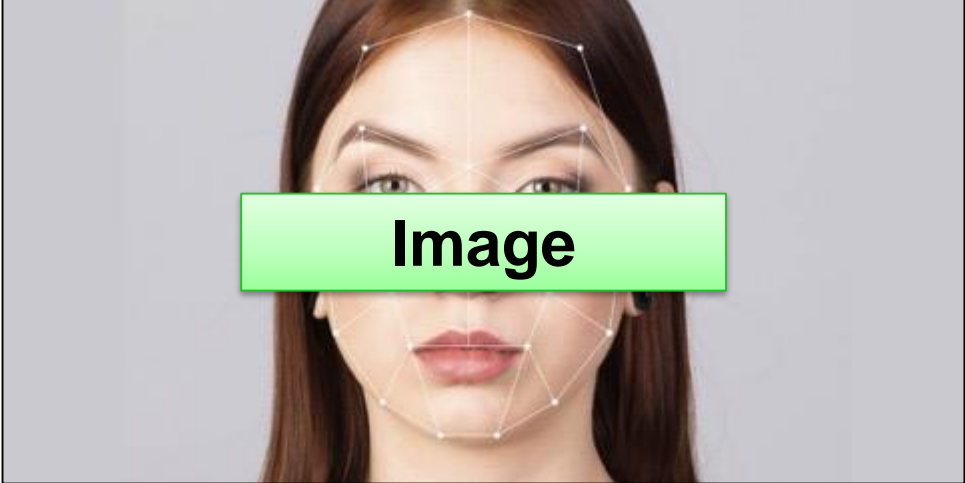
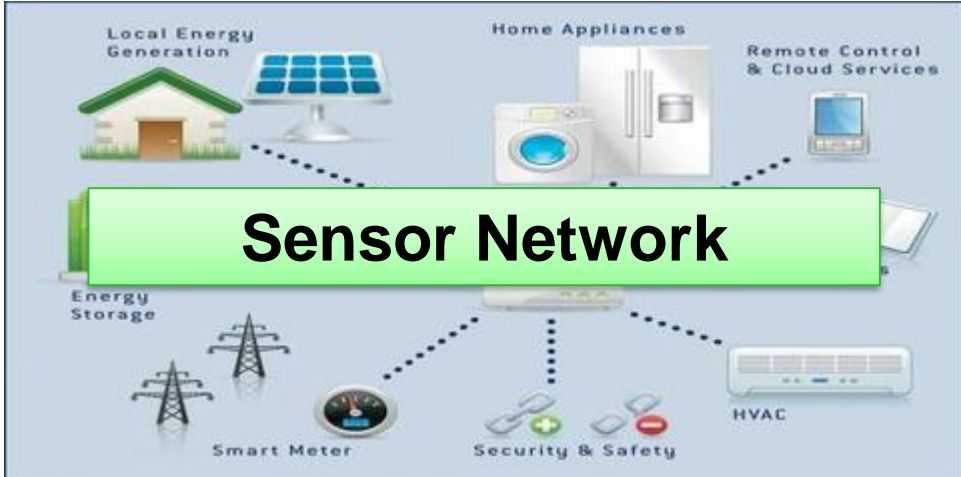
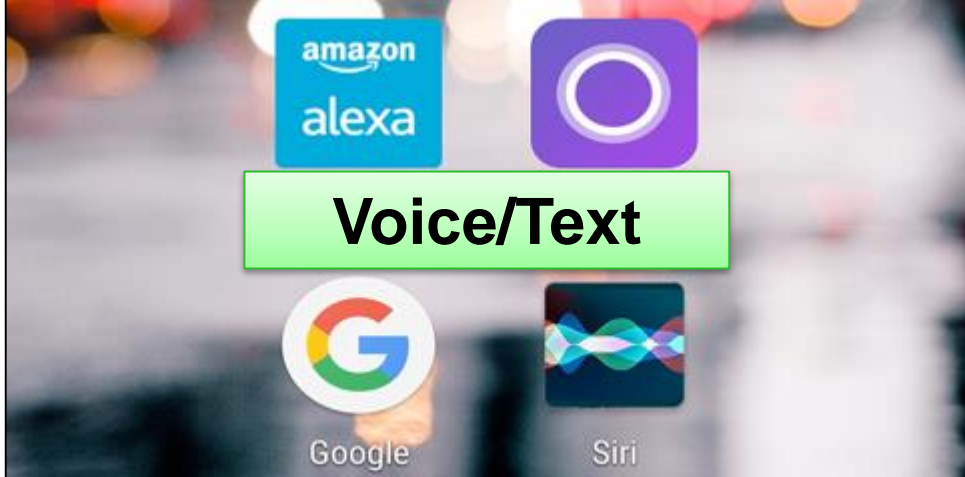
Work at EPRI

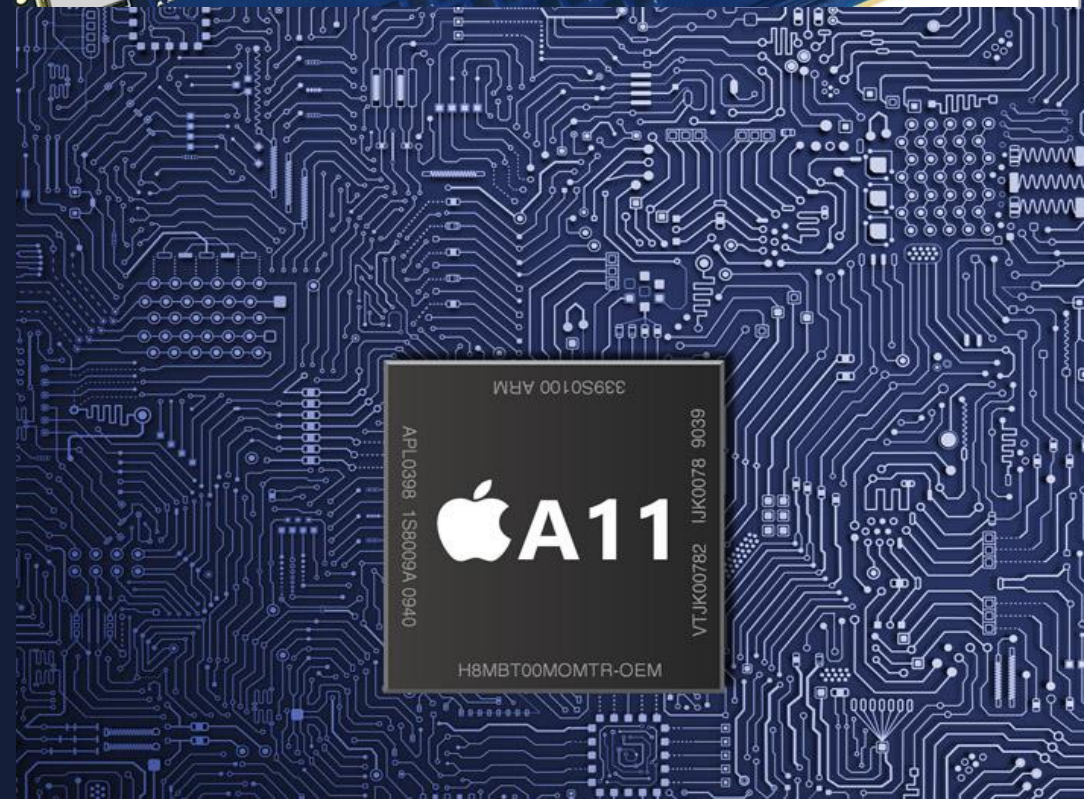
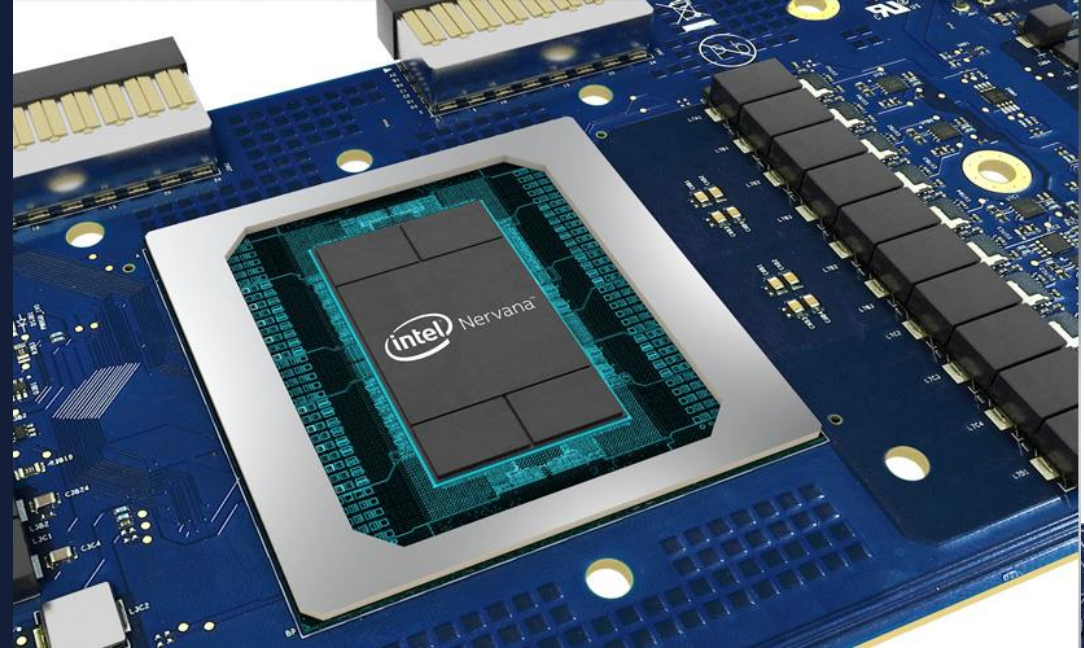
ESIC ENERGY STORAGE INTEGRATION COUNCIL

**Advancing the integration of energy storage systems
through open, technical collaboration
Safe, reliable, cost-effective**

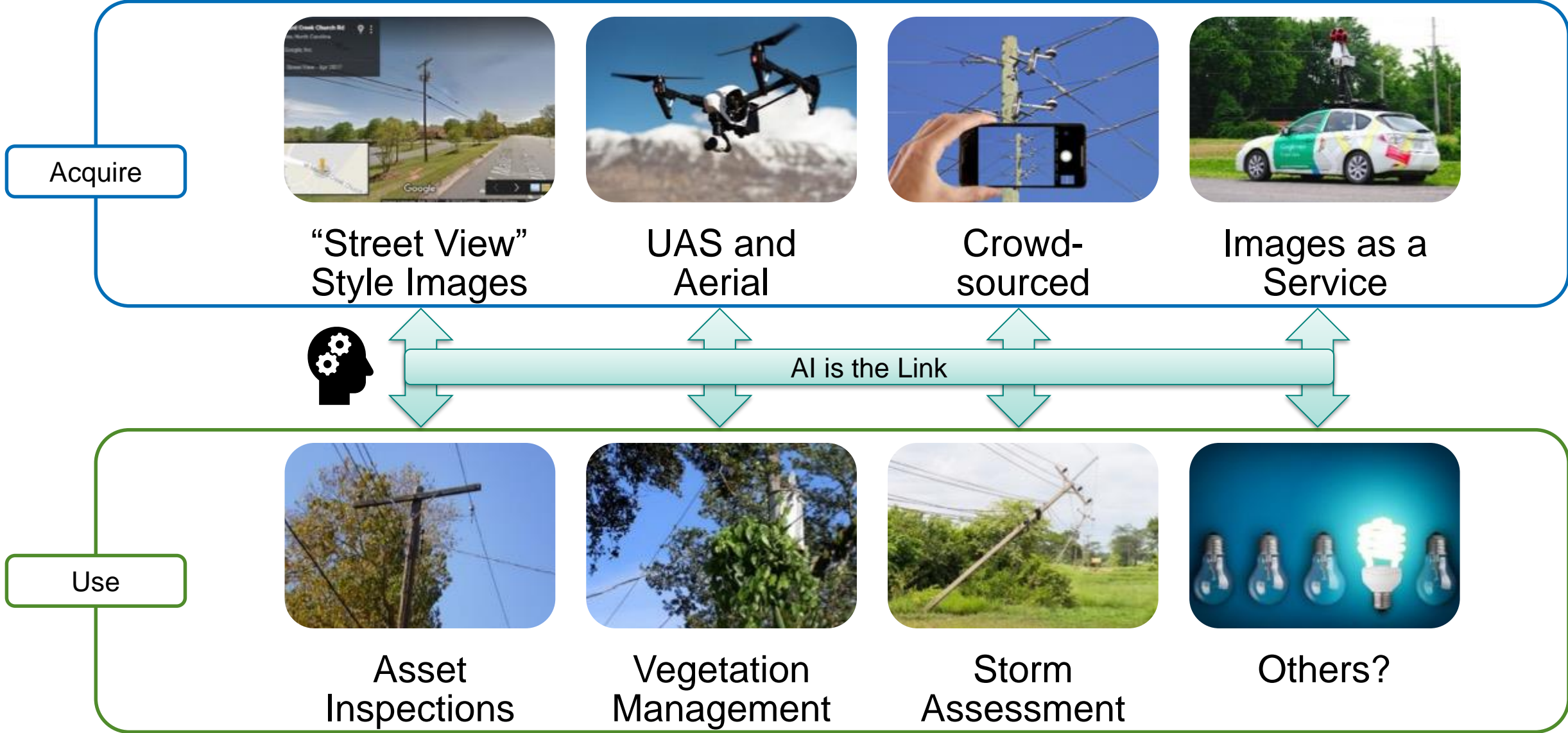


Digitalization – Artificial Intelligence

| | | STRUCTURED | UNSTRUCTURED |
|----------------|-------|---|---|
| TYPE OF CLIENT | APP | <p>Task List</p>  <p>Workflow/Process/Web</p> <p>For planned maintenance. (preventive maintenance and inspection) For routine Maintenance (prepared repair)</p> |  <p>Image</p> |
| | THING |  <p>Sensor Network</p> |  <p>Voice/Text</p> |



Key Considerations



Efficient Electrification – Indoor Food Production



Farm to table in hours rather than days



Leafy greens travel an average of



before reaching a store

“We’re giving people food that tastes better and is better for them.”

– **Matt Barnard**

“Grocers would love to get another four to five days of shelf life for leafy greens.”

– **Mikey Vu**

“Because we work with physics, not against it, we save a lot of money.”

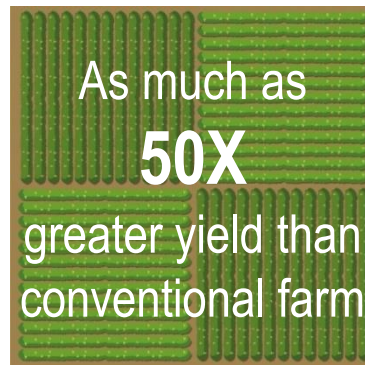
– **Matt Barnard**

Global supply of fruits & vegetables are



22%

short of nutritional needs





Custom Warehouse



Pods – Shipping containers



Controlled Greenhouse



Variants

Drivers for Indoor Food Production

- Today 80% of the world's arable land is in use.
 - “If every city on earth were to grow 10% of its produce indoors, it would allow us to take 340,000 square miles of farmland back to forest” – Prof Dickson D. Despommier, Columbia University
- *By 2050:*
 - World population ~9.6 billion (currently ~7.5 billion)
 - 80% of world population living in urban areas
- Water conservation is a growing concern
- Reduced “food miles”

Key Considerations

- Potential Demand Response (DR)
- Not supported in current codes/standards
- Each installation potentially represents a large grid load
 - Augmented greenhouses and vertical farms are often in the tens of MWs range
- The impact of these operations on the grid must be fully understood
- The operational characteristics of these installations are seasonal
- Winter and summer have different load shapes



Photo from Philips Lighting / GreenSense Farms



Photo from National Geographic

Demonstrating Indoor Food Production at EPRI's Lab





Together...Shaping the Future of Electricity