WHEN TRUST MATTERS

DNV

Making Renewable Energy Reliable

Why DERs are the power plant of the future

Wesley Whited – Principal Consultant IoT Technology

Intro & Agenda

Today's Presenter

Wesley Whited

Principal Consultant for IoT Technology

- Program Designer
- Emerging Technology Research
- Building System Integration

DNV

International Energy Managment Consultancy

- Program Design & Implementation for Iowa C&I Midstream program
  - Lighting
  - HVAC
  - Food Service

Agenda

1.0 What is the grid & how is it changing?

2.0 What is/isn’t a VPP?

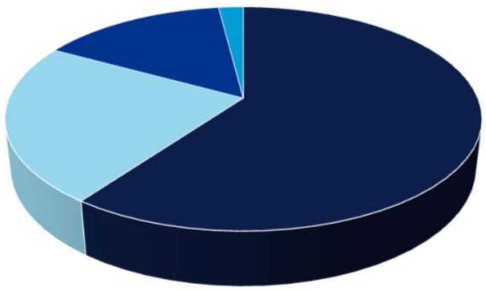
3.0 What powers a VPP?

4.0 What challenges lie ahead?

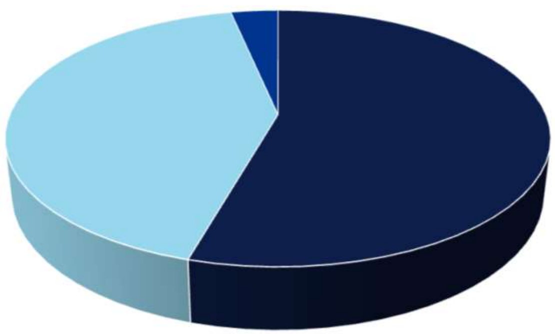
5.0 What future opportunities do VPPs enable from Trade Allies?

What is the grid & how is it changing

Iowa's grid capacity 21.8 GW / 71.3 TWh



90 utilities



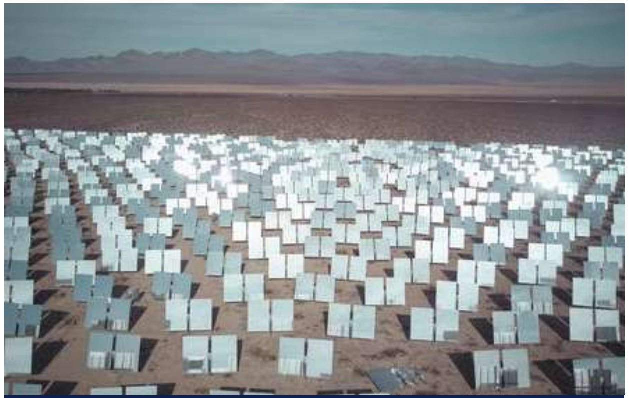
What is the grid?

The world's largest machine

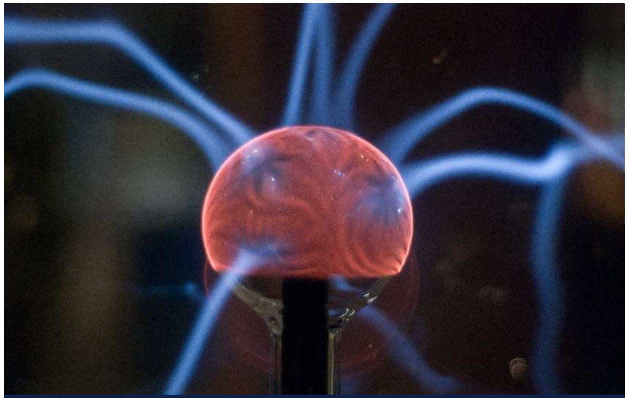
- 141 years old (& showing its age)
  - The average transformer is 35 years old
- Iowa is 2nd in installed wind capacity
- Wind accounts for $22B in capital spending at employs ~4,000 Iowans

The grid constantly balances supply & demand

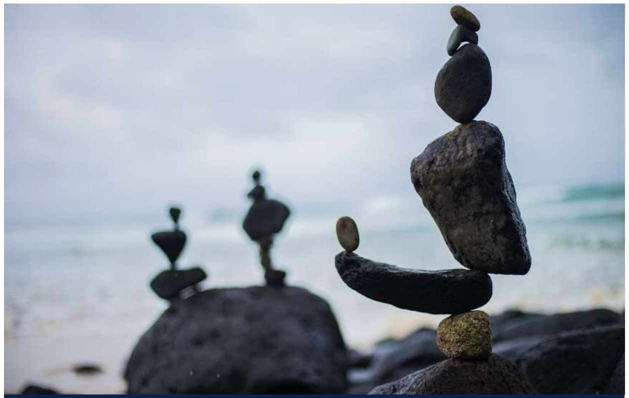
Challenges for tomorrow



Integrate a massive amount of renewable energy



Electrify (nearly) everything!



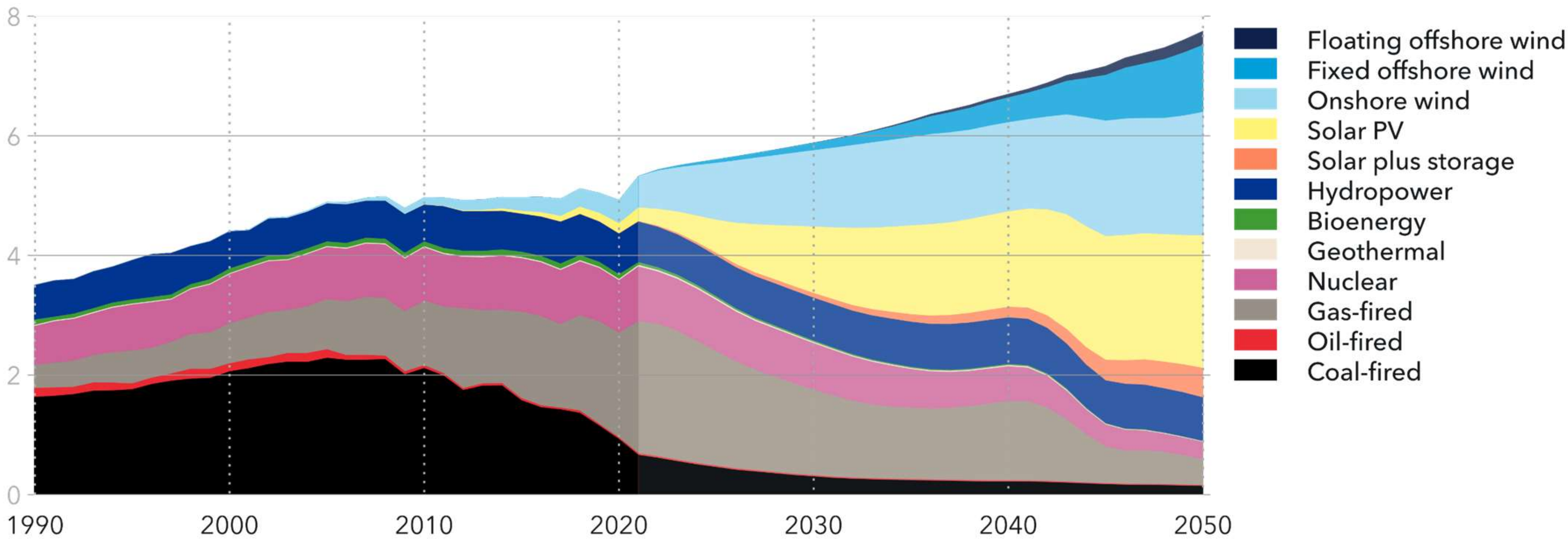
Find new ways to balance supply & demand

Renewables will be 90% of supply by 2050

North America

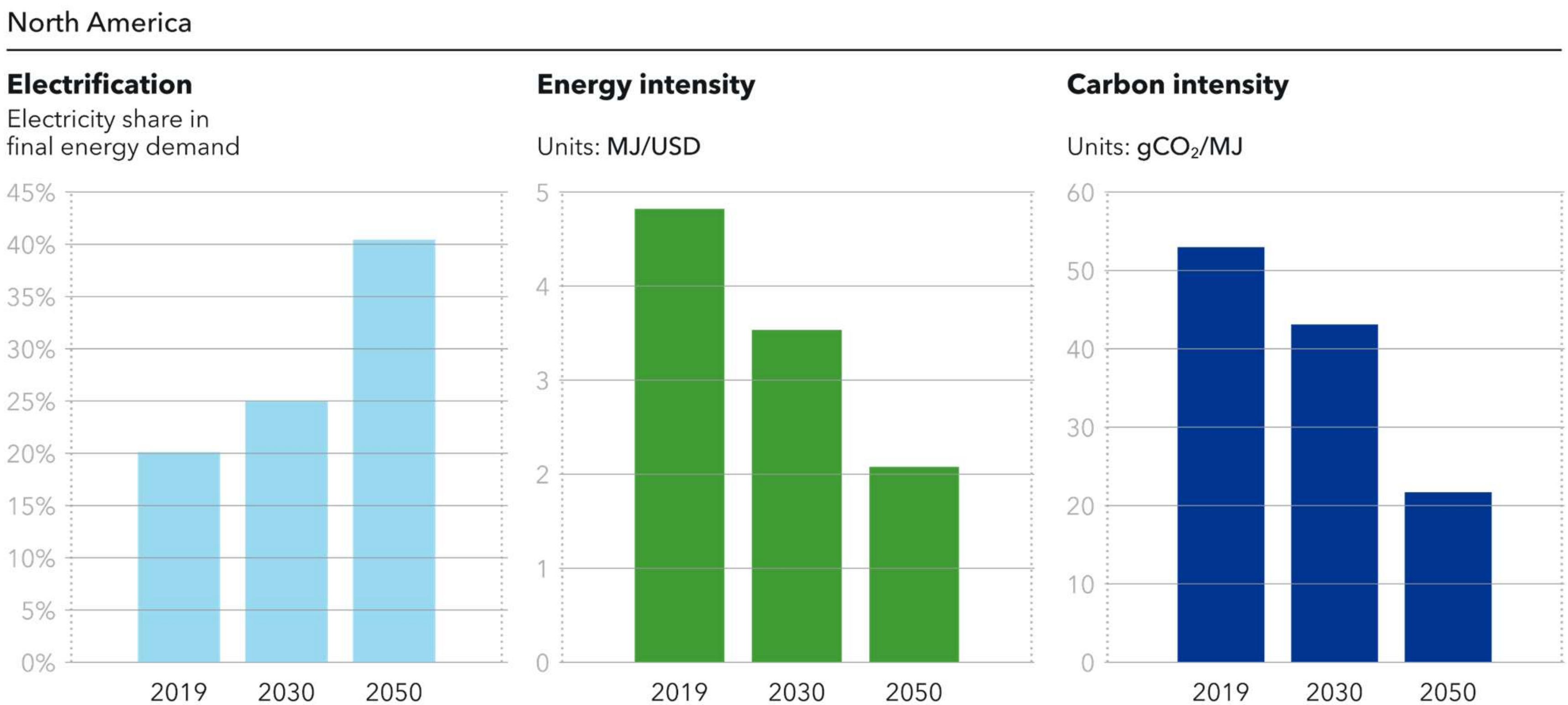
Grid-connected electricity generation by power station type

Units: PWh/yr

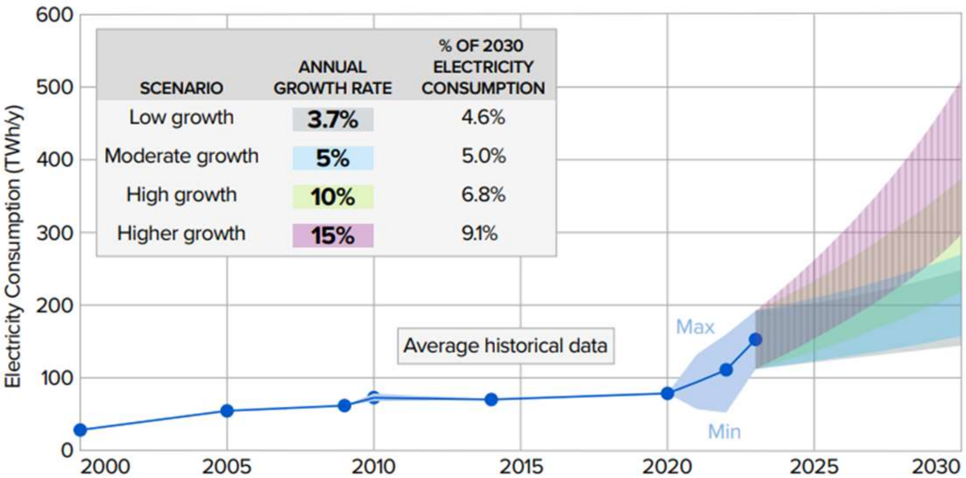


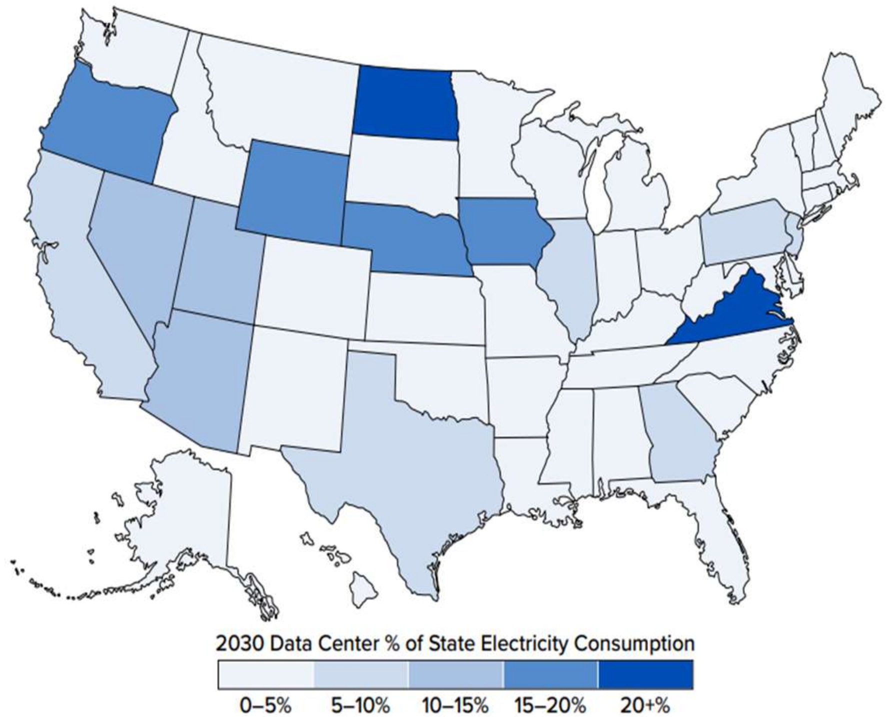
Historical data source: IEA WEB (2020), GlobalData (2021)

Building & Transportation Electronification will double electric use!



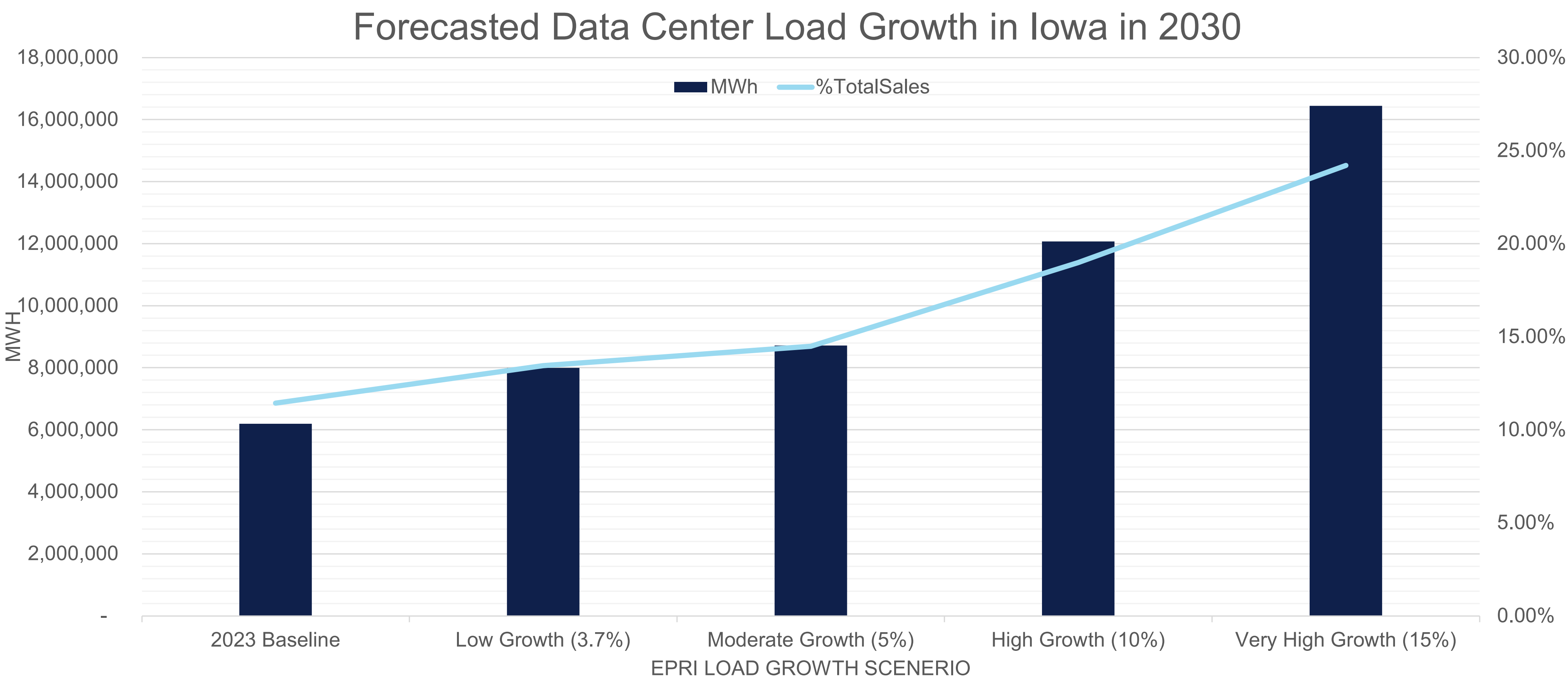
Data center load will dramatically grow





Source: EPRI AI & Data Center Energy Consumption 2024

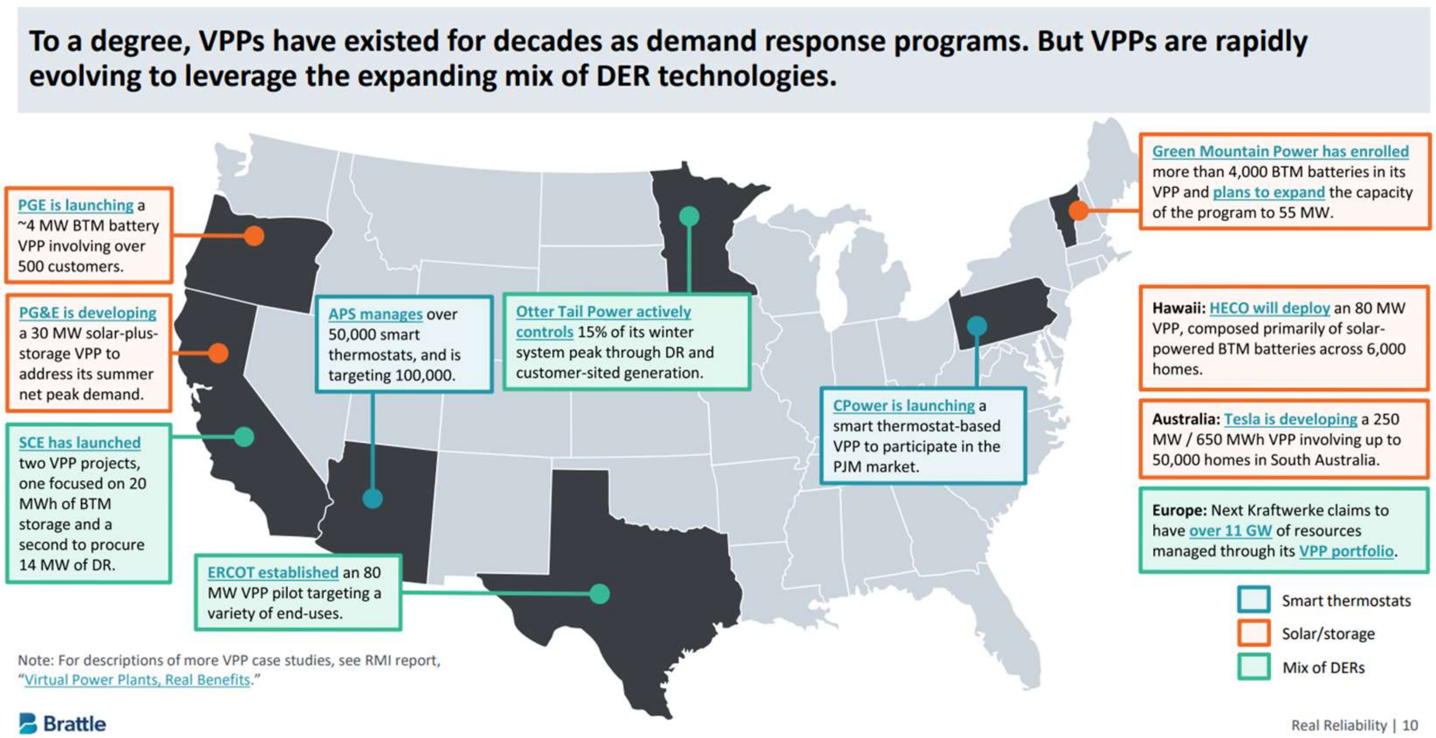
Data centers will add 1.78 – 10.25 TWh of new load



Policy Principals of a VPP

CT0

Early state's establishing VPP pilots



CT0 [@Whited, Wesley] if these are important to be able to see we should put them on separate slides. If not then put together is fine

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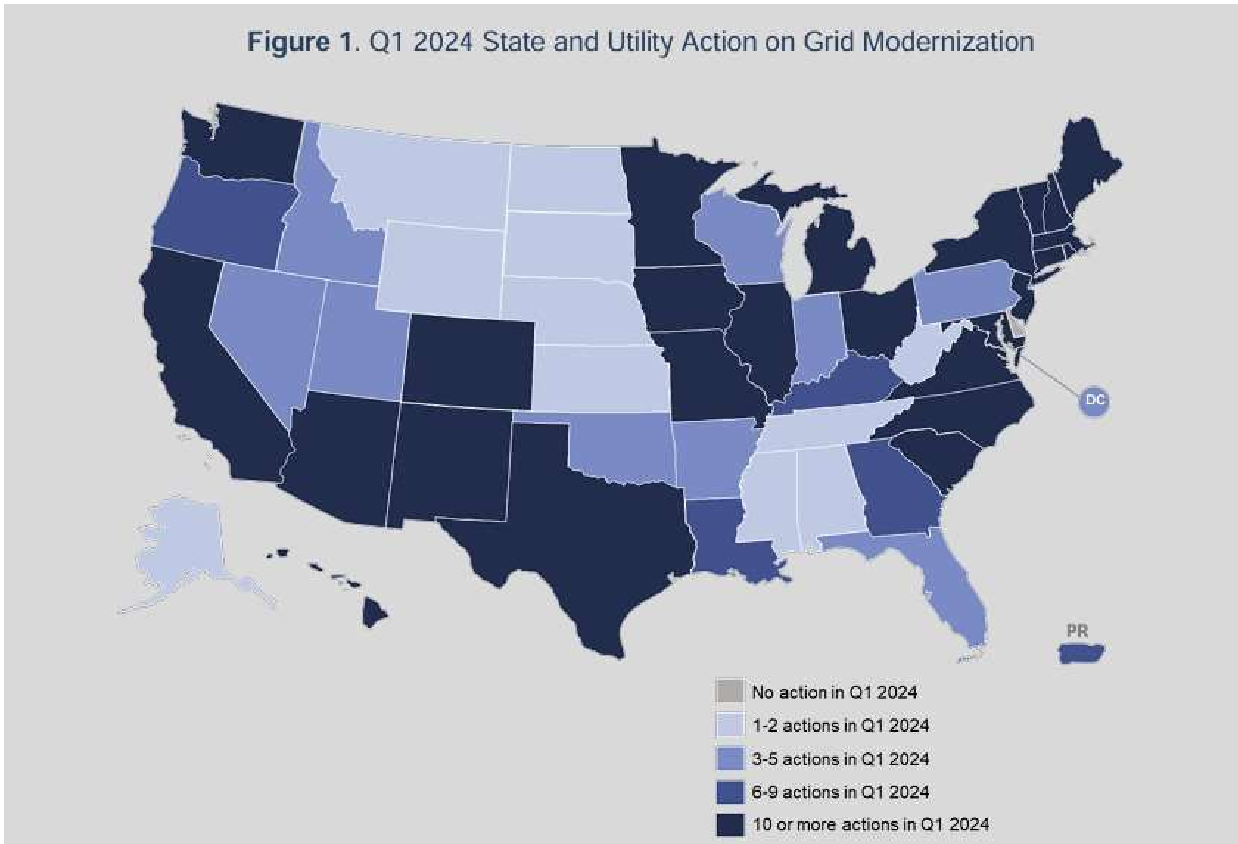
Early state's establishing VPP pilots



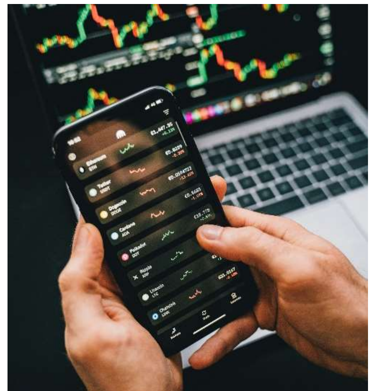
VP3's policy principals that advance VPPs

DER Asset Base

- Advance policies that expand DER adoption by diverse end-users
- Technology-agnostic approach

VPP Design

- Require open protocols & standards
- Follow lessons of early programs
- Support utility planning & investment

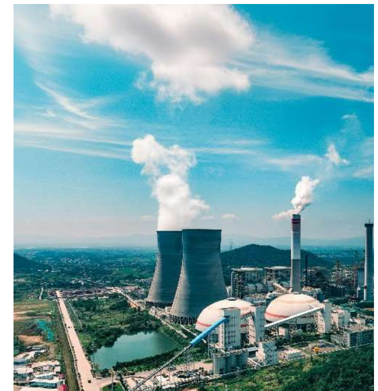


Compensation

- Fair compensation for services delivered
- Enable value stacking
- Support policies that value VPP contribution to reliability

Customer Exp

- Maintain customer choice
- Customer data ownership
- Educate customers & make enrollment easy



Operators Role

- Enable wholesale & retail market participation
- Encourage 3rd party providers
- Open-source EM&V

AMI saturation by state

73% Residential

70% Commercial

70% Industrial

73% Across USA

State	Res. AMI sat.%	Comm. AMI sat.%	Ind. AMI sat.%	Total AMI sat.%
AK	76%	66%	67%	75%
AL	90%	85%	97%	89%
AR	81%	75%	91%	81%
AZ	90%	92%	77%	90%
CA	85%	88%	72%	86%
CO	63%	38%	92%	60%
CT	18%	17%	16%	18%
DC	100%	98%	0%	99%
DE	94%	94%	95%	94%
FL	93%	92%	79%	93%
GA	92%	89%	84%	92%
HI	49%	22%	13%	46%
IA	46%	49%	65%	47%
ID	81%	81%	93%	81%
IL	93%	93%	94%	93%
IN	74%	67%	72%	73%
KS	95%	93%	94%	95%
KY	50%	40%	25%	49%
LA	79%	65%	81%	77%
MA	8%	6%	23%	8%
MD	87%	86%	4%	86%
ME	94%	91%	82%	94%
MI	97%	94%	72%	97%
MN	48%	39%	31%	47%
MO	74%	66%	67%	73%
MS	81%	75%	81%	80%
MT	28%	20%	48%	27%
NC	90%	89%	64%	90%
ND	32%	22%	71%	31%
NE	31%	42%	92%	36%
NH	21%	21%	3%	21%
NJ	16%	18%	28%	16%
NM	15%	15%	72%	15%
NV	96%	96%	75%	96%
NY	18%	22%	10%	18%
OH	52%	49%	55%	52%
OK	91%	90%	98%	91%
OR	91%	93%	90%	91%
PA	98%	98%	96%	98%
RI	1%	1%	4%	1%
SC	80%	77%	65%	79%
SD	61%	63%	67%	61%
TN	95%	92%	76%	94%
TX	91%	86%	65%	90%
UT	26%	28%	22%	26%
VA	74%	72%	74%	74%
VT	85%	90%	87%	86%
WA	60%	57%	51%	60%
WI	82%	80%	71%	82%
WV	31%	31%	13%	31%
WY	40%	38%	64%	40%

What exactly is/isn’t a VPP?

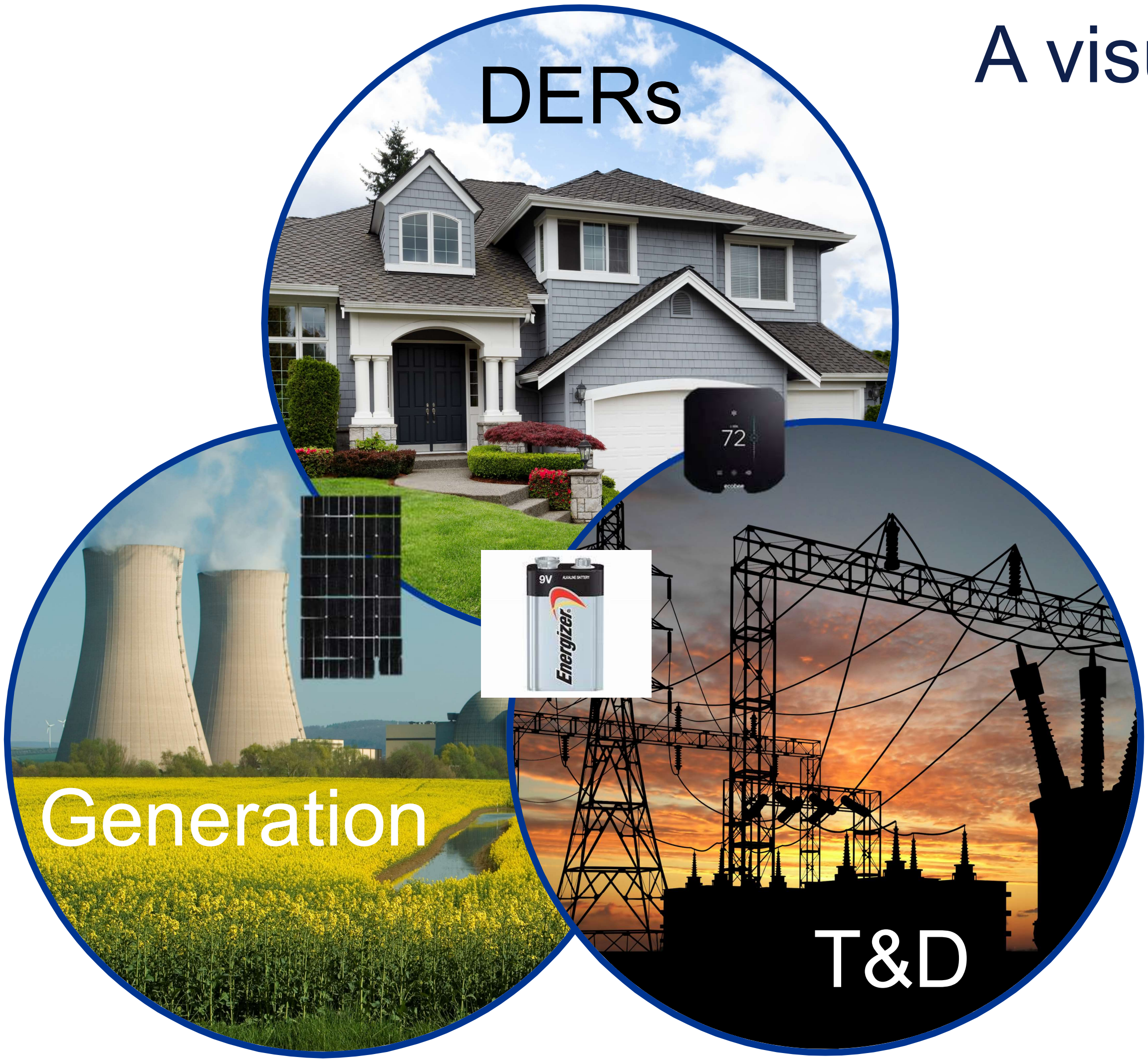
DOE definition

VPPs are aggregations of distributed energy resources (DERs) such as rooftop solar with behind-the-meter (BTM) batteries, electric vehicles (EVs) and chargers, electric water heaters, smart buildings and their controls, and flexible commercial and industrial (C&I) loads that can balance electricity demand and supply and provide utility-scale and utility-grade grid services like a traditional power plant. VPPs enroll DER owners – including residential, commercial, and industrial electricity consumers – in a variety of participation models that offer rewards for contributing to efficient grid operations.

Layman's definition

VPP's aggregate customer technology into a single resource to get more out of the grid we've already paid for

A visual definition of a VPP



A Distributed Energy Resource (DER) is

- Small-scale resource sited BTM
- Provides a grid-service by
  - Injecting power back to the grid
  - Reducing demand from a device
    - Active Control
    - Scheduling Load
  - Providing an alternative resource for balancing

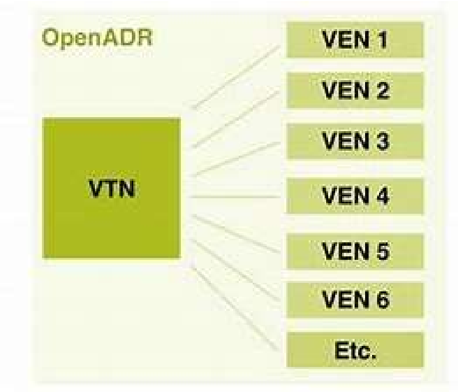
Four universal basics of all VPPs

Capacity lives behind the meter

- Ownership and control models over the DER can vary, but the capacity comes from BTM

Monetized by Arbitrage

- VPPs create value by using/storing energy when its cheap and deferring/exporting capacity when its expensive



Require Aggregation

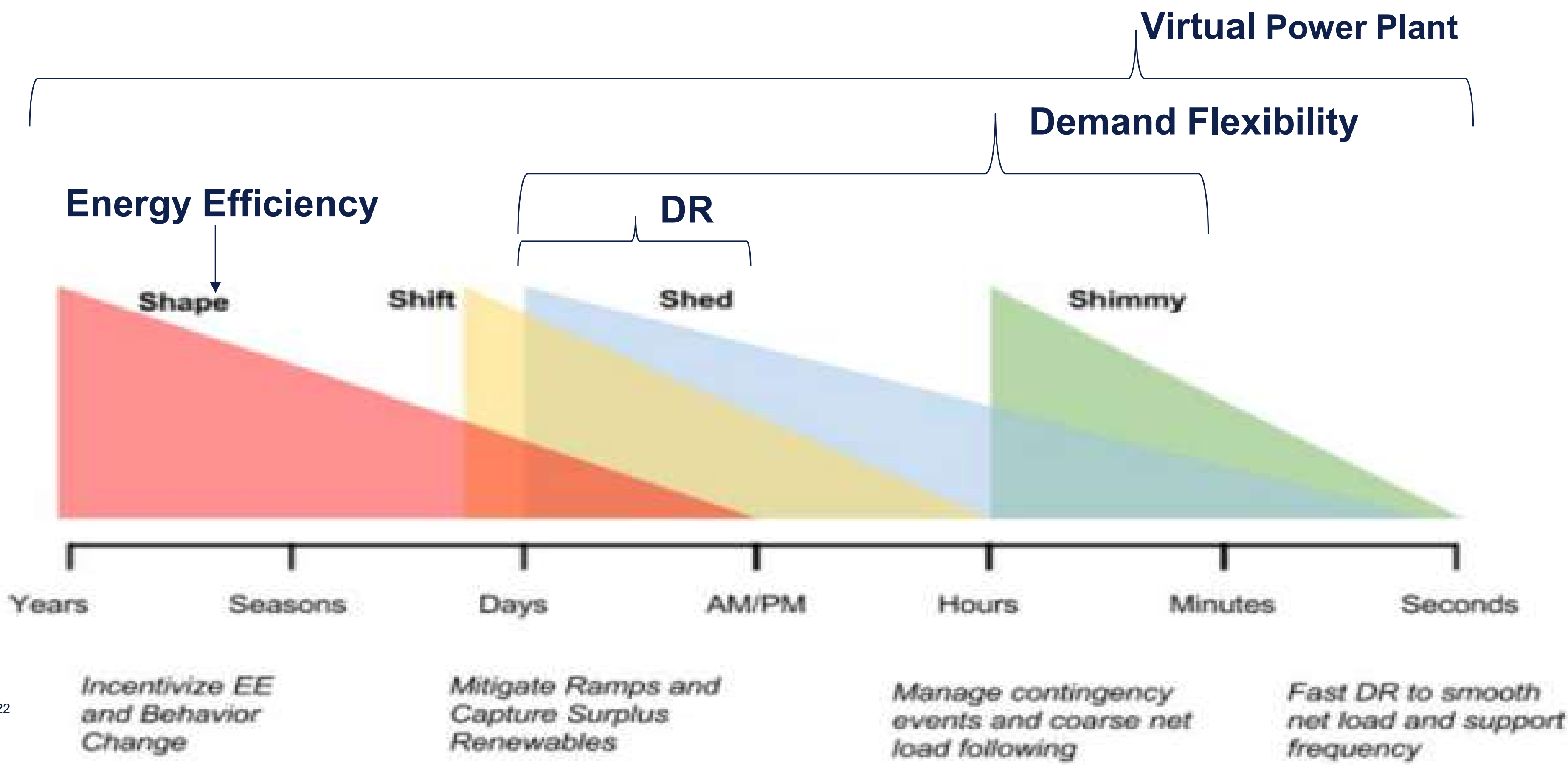
- The key to VPPs is to aggregate and orchestrate many DERs VPPs are evolving from one-way (paging) systems

Avoid or Defer other Grid Costs

- VPPs avoid or defer utility investments into generation, T&D, and Ancillary Services

What powers a VPP?

Grid view of customer services



Where does VPP capacity come from?

Residential Customer

- Shape: Insulation
- Shift: Smart T-Stat
- Shed: Pool Pump
- Shimmy: GIWH
- Inject: Net-metering

Commercial Customer

Shape: LED retrofit

Shift: Adv Rooftop Controls

Shed: Lighting Controls

Shimmy: Stationary Battery

Inject: Bi-directional EV Fleet EVSE

Industrial Customer

Shape: Custom Project

Shift: Industrial Operations

Shed: Interruptible Load

Shimmy: Lith-Ion Forklift

Inject: CHP

What core technologies power VPPs

Smart T-Stat

- Residential & SMB
- Easy to schedule
- Requires a tight envelope to maintain occupant comfort

GIWH

- Residential & SMB
- Easy to schedule
- ~50% of water heaters will require a fuel switch

EV/EVSE

- Light Duty → Fleet
- Difficult to schedule
- Limited to no applications today

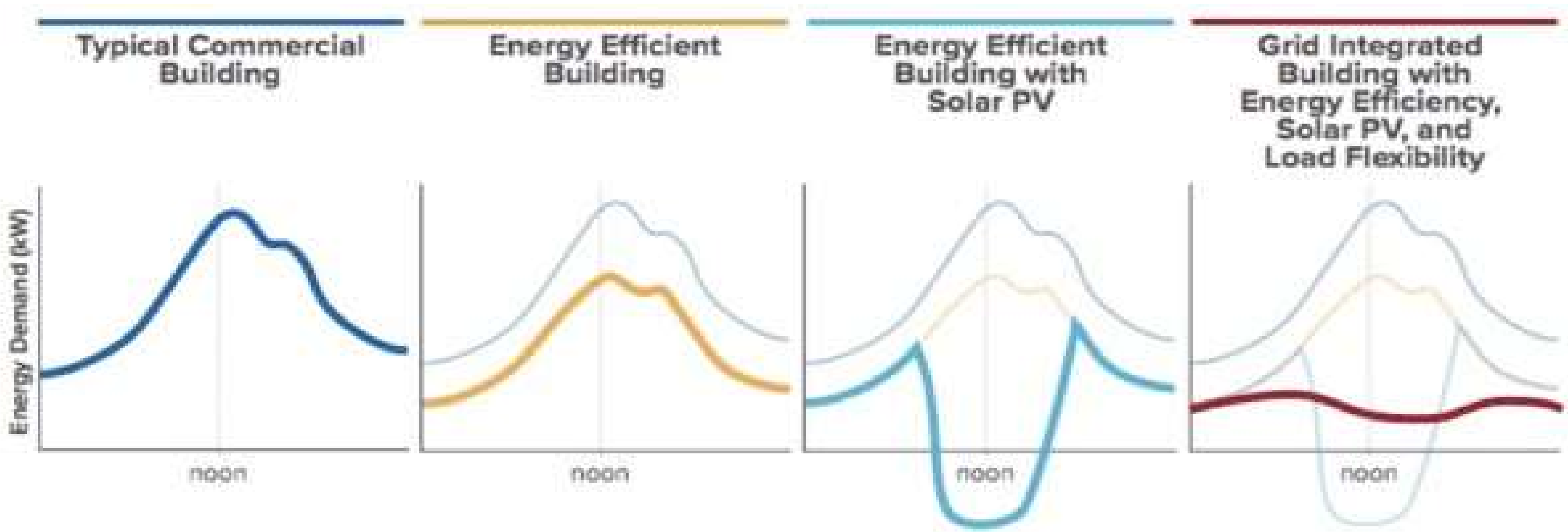
Rooftop Solar

- Most customer types
- Depended on season
- Expensive & net metering is changing

Battery Storage

- Most customer types
- Easy to schedule
- Expensive, but can perform most grid-services and easy to pair with solar

How IoT makes buildings more flexible



When all building loads are integrated into a common platform, you get flexibility in:

- Ability to optimize for cost, carbon or reliability based on a price or emissions trigger
- Ability to forecast flexible load potential
- Ability to automate curtailment while balancing occupant comfort

Source: US Department of Energy

Future Challenges?

Customer & societal challenges

Cost-Related Barriers: High initial investment and the need for additional upgrades.

Socioeconomic Barriers: Challenges in underserved communities, including lack of capital and affordable home ownership.

Market Access Challenges: Limited ability to participate in a wholesale market

Integration & interoperability challenges

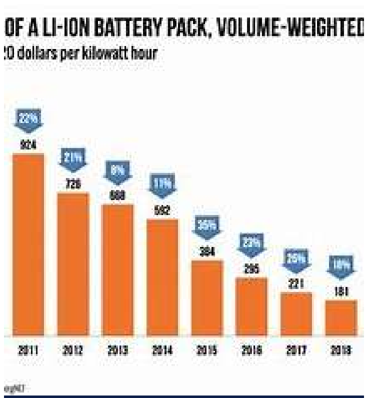
Compatibility with Existing Grid Infrastructure: Ensuring that DERs and VPP systems can integrate smoothly with current grid systems.

Standardization of Communication Protocols: Lack of recognized communication standards to streamline VPP operations and response to grid conditions.

Operational Challenges: Need for improved control technologies, streamlined communications, and customer-engaging compensation models.

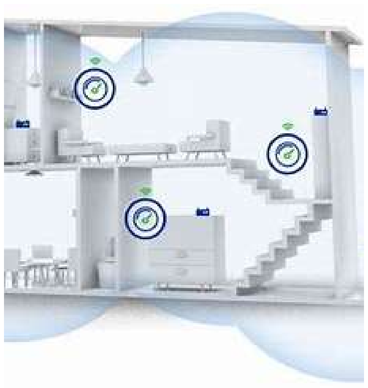
Future Opportunities

Five forces moving VPPs to an inflection point



Declining DER Costs

- Especially true for BESS
- Eventually for EVs



IoT Trends

- Traditional devices are going ‘Smart’ giving everything an IP address & sensor

Enhanced Dispatchability

- The algorithms used to orchestrate DERs are improving

Policy Goals

- FERC 222 will open wholesale markets to VPPs
- The IRA invests in electrification & EE

Rates Continue to Rise

- Electric rates are outpacing inflation. PUCs will seek to avoid future costs

The business impacts of demand flexibility

Service based business models

IoT expertise & device Cx

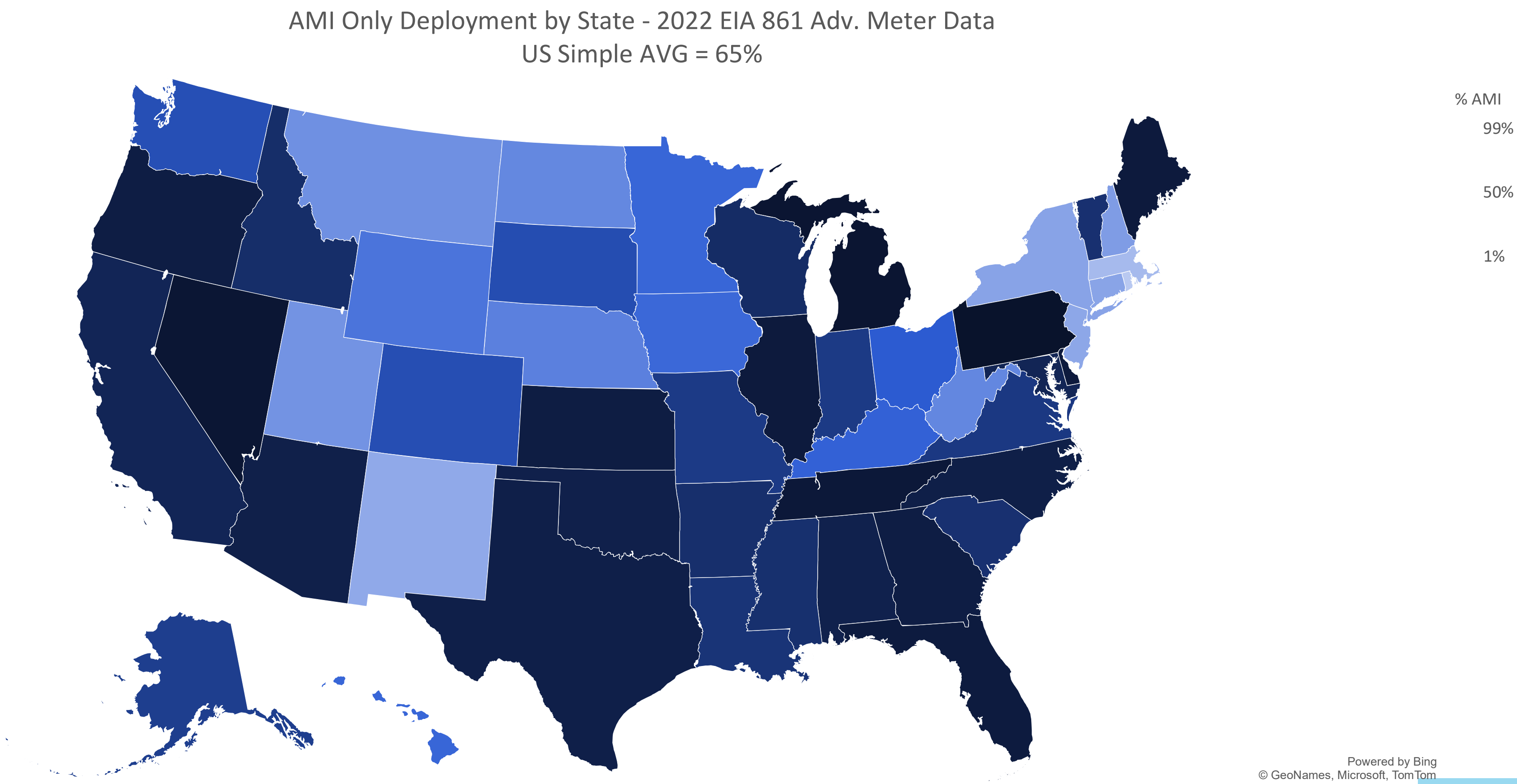
Performance based incentives

Uncommon partnership

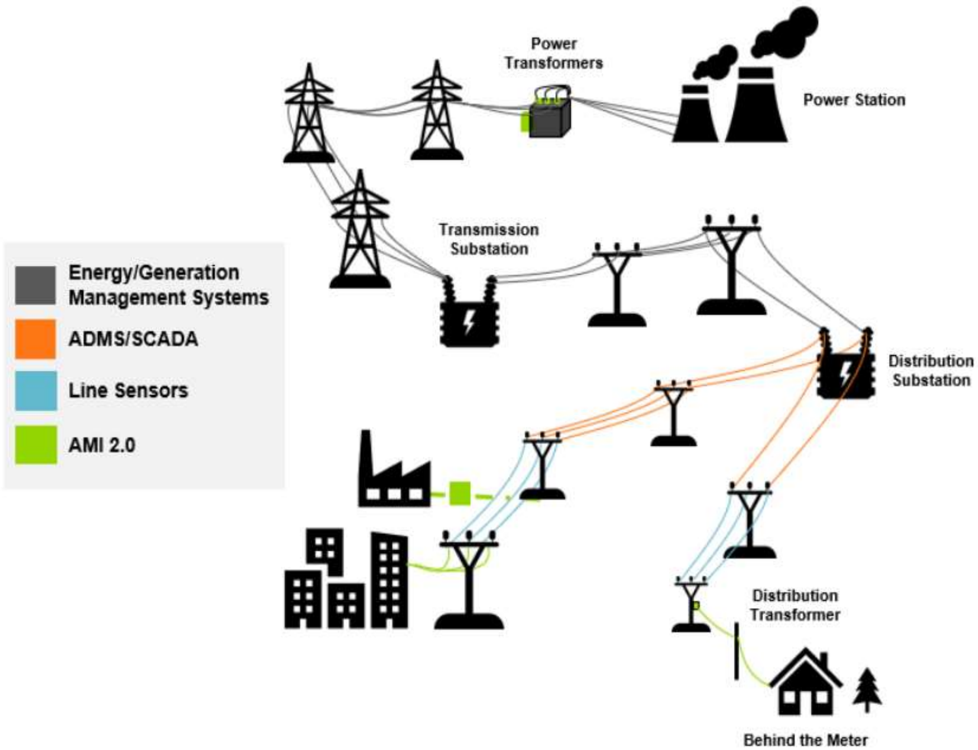
"In the evolving energy landscape, no single company or sector can thrive in isolation. It’s the uncommon partnerships—between contractors, utilities, tech providers, and aggregators—that will unlock the full potential of demand flexibility and transform traditional business models into future-proof, value-driven services."

Hidden content to be reviewed and moved

State of Utility Advanced Metering – AMI Only



Technical Operability for the Grid



(Source: Guidehouse Insights)

- Real-time visibility into the distribution system
- Coordination between different utility-grid control systems (ADMS < - > DERMs)

Policy makers need to enable markets for DERs

Utility Markets

- Demand Response Programs
- Capacity Payment
- Non-Wires-Alternative

Wholesale Markets

- Frequency Regulation
- Voltage Support
- Energy Arbitrage

Abstract

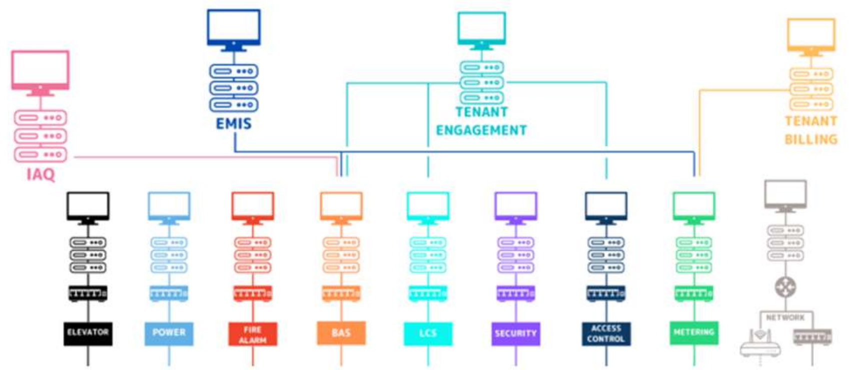
- Abstract Description: *

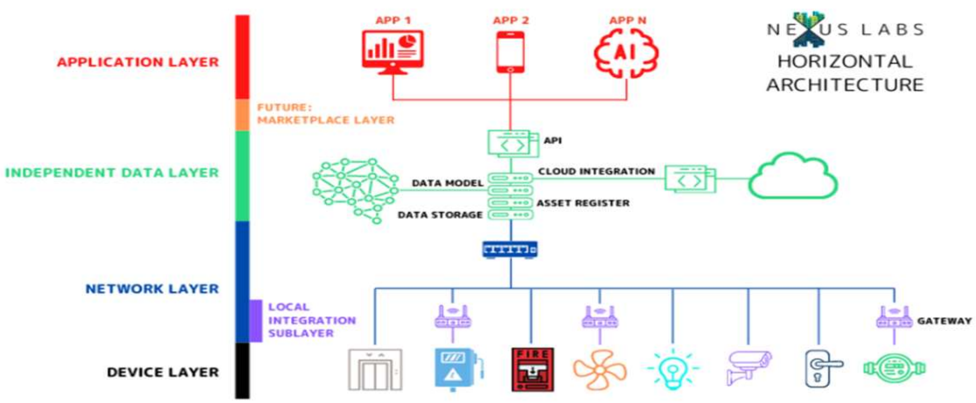
- Join Wes Whited, a nationally recognized IoT expert, for a deep dive into Virtual Power Plants (VPPs)! The session will explore how these innovative systems aggregate distributed energy resources (DERs) like rooftop solar and battery storage to create a powerful, flexible grid resource. We will delve into the DERs that contribute capacity to the VPP and how market structures like demand response programs unlock stackable revenue streams. We will estimate the exciting market potential for VPPs in Iowa by leveraging real-world data from energy sales and projecting organic growth through market-based electrification opportunities

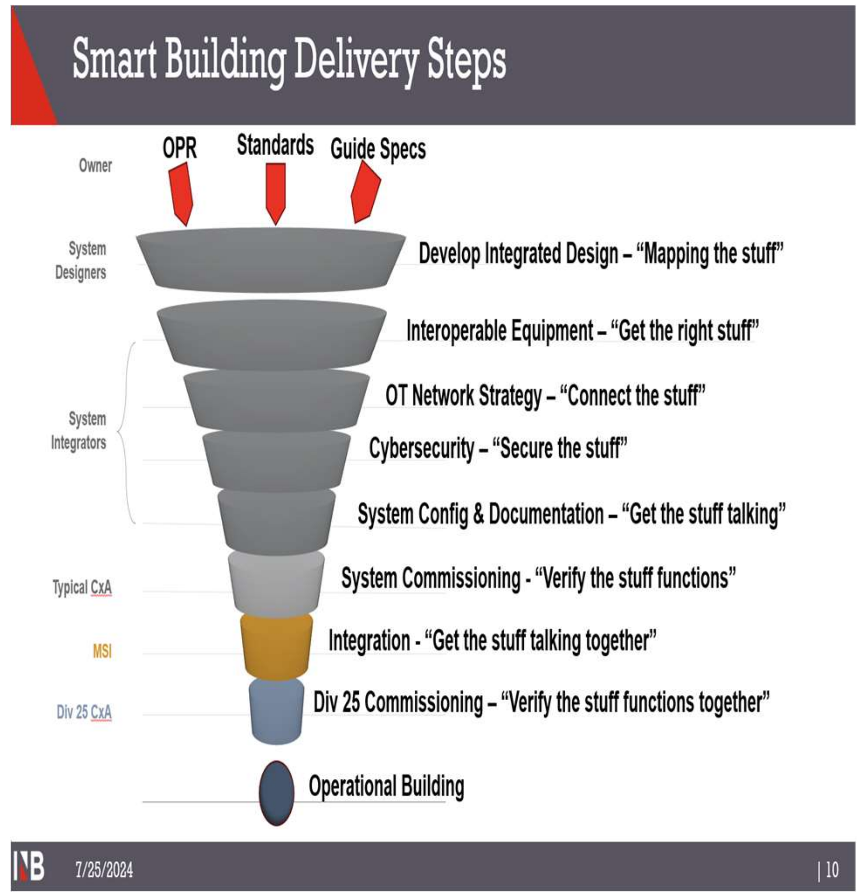
Learning Objectives

- The audience will understand the core concept of Virtual Power Plants and their role in creating flexibility for the modern grid.
- The audience will be able to identify the various distributed energy resources (DERs) contributing to a VPP and the critical customer segments likely to adopt these DERs.
- The audience will learn about market structures, such as demand response programs that monetize VPP capacity, and leave with real-world examples of successful early programs
- *
- The audience will gain insights into the market potential for VPPs based on Iowa's electric sales data and electrification growth trends.

Interoperability at the building level







What's the best place to start?

- Customer education
- Smart Thermostats
- Water heater controllers