TESCO METERING

Metering Operations

Upcoming Impacts to Utilities: DERs to EVs to Grid Modernization

GLEMS
Great Lakes Electric Meter School

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Track 4 - Advanced Metering

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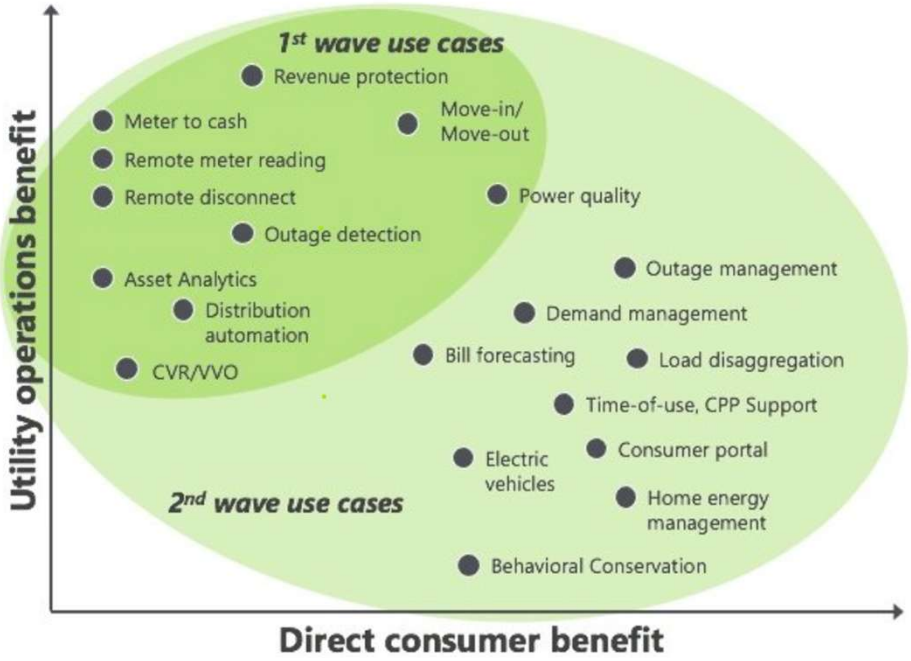
TESCO Metering

Topics to Cover as We Look to the Future

- How Metering Has Changed from the 1870's to the 2010's
- Metering Today and the status of our Advanced Metering Infrastructure, Smart Meters and a Smartgrid
- Meter Services role in the utility of the future
  - Big Data and Rolling Trucks
- Meters – the shape of the future?

Presentation Goals

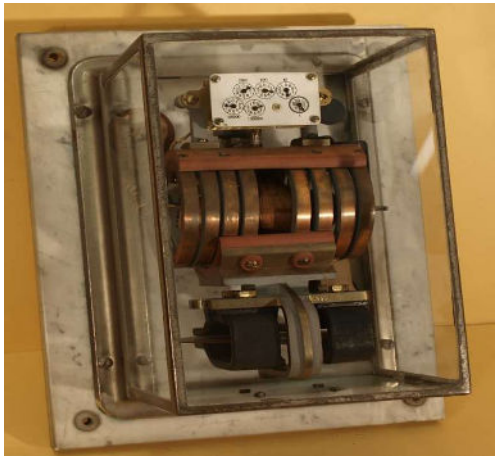
1. Provide a high-level overview of technology innovations and related market influences for meter operations departments in electric utilities
2. Offer an industry review of AMI technologies past and present with insight into next generation technology and impacts
3. Look ahead at ongoing and expanding DER penetration, preparation for VPPs, and Electrification Initiatives

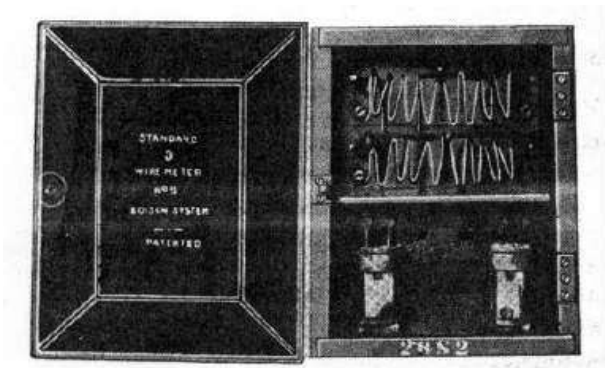


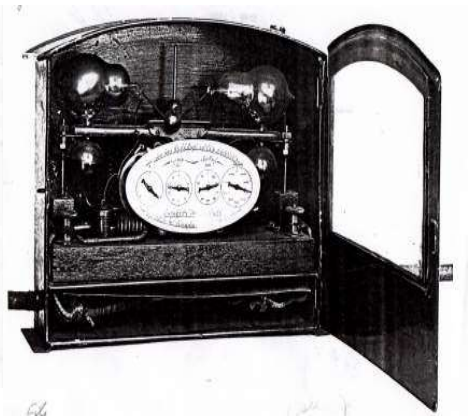
*https://www.greentechmedia.com/squared/dispatches-from-the-grid-edge/how-to-ensure-the-next-generation-of-smart-meters-are-smart-enough-for-the-grid-edge

1870's to 1900

- Electric Metering is Invented
- After a few interesting "false starts" several inventors and firms developed and began producing induction meters that are still recognizable to us today
- Four of the five present meter manufacturers were producing meters:
  - Sangamo (Itron)
  - GE (Aclara)
  - Westinghouse (Honeywell)
  - Duncan (L+G)





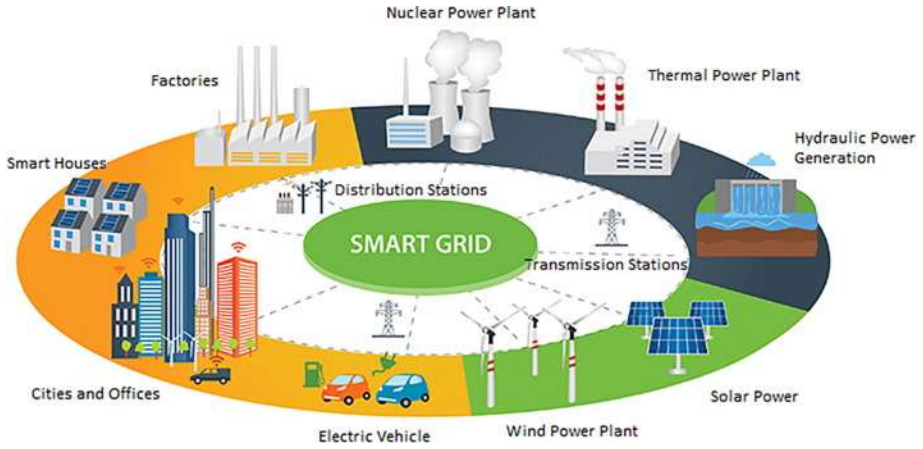


1900 to 2000

- Not much changed – we use an induction meter for most of the century and only toward the very end of the century start using electronic meters.
  - Meters are standardized in the first half of the century
  - NC Meter School begins 1923 – they had a bell
  - Socket base meters take over for A-base meters
  - Electronic meters are introduced
  - Communications begins to be integrated into higher end metering
  - Same big four meter manufacturers

2000 to Present

- The last electromechanical meters are produced. All new meters produced in North America are electronic
- The concept of a Smart Grid is introduced as like our metering infrastructure the grid had not changed much in design since the inception of the grid more than a century ago
- The “brains” of a Smart Grid is an Advanced Metering Infrastructure (AMI)
- The heart of this Infrastructure is a “Smart” meter as the meter becomes a two way communication device with more features built in than just metrology



2000 to Present

- A host of new communication vendors enter the market and work with meter manufacturers to put their technology under the cover of the meter
- Meter Manufacturer's also develop their own communication technology to put under the cover
- Additional features such as Disconnect switches and power quality monitoring become standard accessories to be included under the cover of a new meter
- Meters are no longer looked at as simply energy measurement devices

Evolution of Meter Operations Workload

- History focused on billing accuracy, measurement, and consumption
- Evolution from mechanical meters to solid state to AMR to AMI
- Expansions of AMI use cases and reduced truck rolls
- Advent of advanced analytics, customer access to data, and interval billing
- Evolution to automated systems that are now a hub for everything from DER integrations to electrification planning
- Expertise with data management and large data sets
- Expertise with regulatory driven initiatives
- Evaluations of competing new technologies
- Physical Post Installation Inspections to Over the Air inspections via power quality reads
- Meter exchanges for rate changes to Over the Air Reprogramming
- Meters now see an Expected Useful Life (EUL) of 10-15 years instead of 20 years
- Less than 3% of the 125M+ Smart Meters installed across the US fulfill the initial 2009 promise of customer savings*

*https://www.utilitydive.com/news/97-of-smart-meters-fail-to-provide-promised-customer-benefits-can-3b-in/632662/

Evolution of AMI Technologies

- Power Line Communication – leverages existing infrastructure
  - Cost effective, less bandwidth, interference
- Radio Frequency – unlicensed and licensed spectrums, mesh or point-to-point
  - Licensed vs Unlicensed
  - Base stations vs Collectors and Repeaters
  - Fixed pathway vs self-forming and self-healing
- Cellular Endpoints
  - Faster deployments, network reliability, cost, obsolescence concerns
- Hybrid Communications
  - Multiple communication methods on a single radio – Wi-Fi, Zigbee, PLC, Mesh, Cellular
- "Future – Proof" Meters with software updates and "apps"
  - Reduced restrictions from memory capacity and firmware prohibited upgrades

Evolution of AMI Analytics & Use Cases

AMI with Alarms, Flags, Events, & Intervals

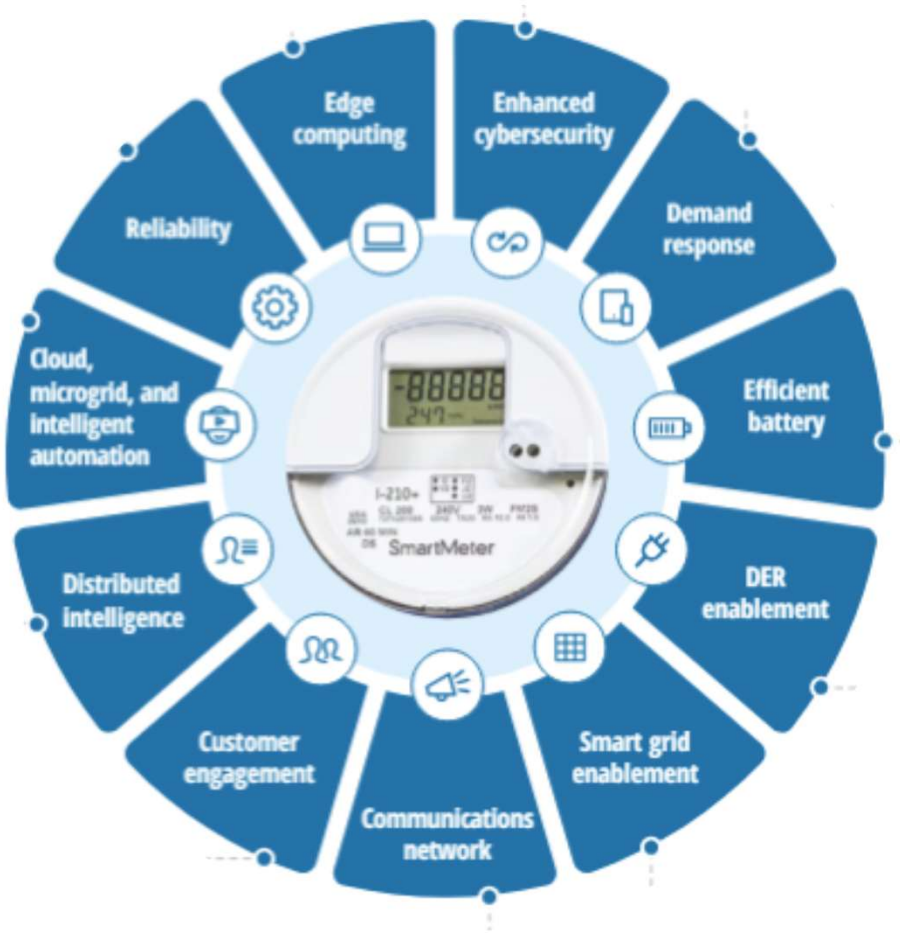
- Outage Reporting
- Theft and Tamper Events
- Interval Data Analysis
- Voltage Monitoring
- Temperature Monitoring
- Load Disaggregation
- RCDC for Credit, Move – In / Move – Out, PrePay
- Analytics Platforms

AMI 2.0 with Distributed Intelligence & Edge Computing

- Location Awareness
- Bypass Detection & Magnetic Tamper
- 8+ Channels of Interval Data
- Impedance Detection
- Temperature Trending
- EV and Solar Detection
- Smart Prepay
- App Platforms

AMI 2.0

- AMI 1.0 operational benefits have been captured
- A second round of capital replacement is under way
- Costs are harder to justify as labor resources and reduced truck rolls have been already offset
- Consumers want benefits that are automated and easy to acquire
- Meters can now be paired to Apps via Wi-Fi



*https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/next-gen-advanced-metering-infrastructure.html?nc=42

*"Any electric utility that deployed AMI prior to 2010 or which has not yet deployed AMI should be in the planning phases to replace their aging AMI assets today"

AMI 2.0

Can we use our existing infrastructure?

Do we have to rip out and replace with a new infrastructure?

What about LTL back haul or a Private Network?

What about Power Line Carrier? Is there life there for my most remote service areas?

AMI 2.0 Infrastructure

- Second Generation AMI and potentially new communication paradigms as LTL data becomes less and less expensive and reaches larger and larger areas – without new infrastructure

- Research in Power Line Carrier Technology may provide expanded bandwidth to allow for greater data transfer more frequently without as much new infrastructure

- Mesh networks continue to improve and AMI 2.0 is anticipating leveraging the infrastructure installed in AMI 1.0

Strategic Partnerships

Many hardware-based providers are finding value leveraging relationships by shifting to software and loading into existing hardware with market fit (smart meters)

- Landis+Gyr and Sense (from CTs and modules to meters)
  - In-home high resolution energy monitoring and machine learning via app
- Landis+Gyr and SPAN (from smart panels to utility connection via meters)
  - Sub-metering at circuit level, prep for VPPs, and DER control
- Aclara and Utilidata (from adapters to meters)
  - Distributed AI with NVIDIA module and KARMAN platform
- Itron and Schneider and MS Azure
  - ADMS, IOT Solutions, VPP prep

Distributed Energy Resources (DERs)

Small-scale units of local generation connected to the grid at the distribution level. These resources can include renewable energy systems, energy storage, demand response technologies, and electric vehicles.

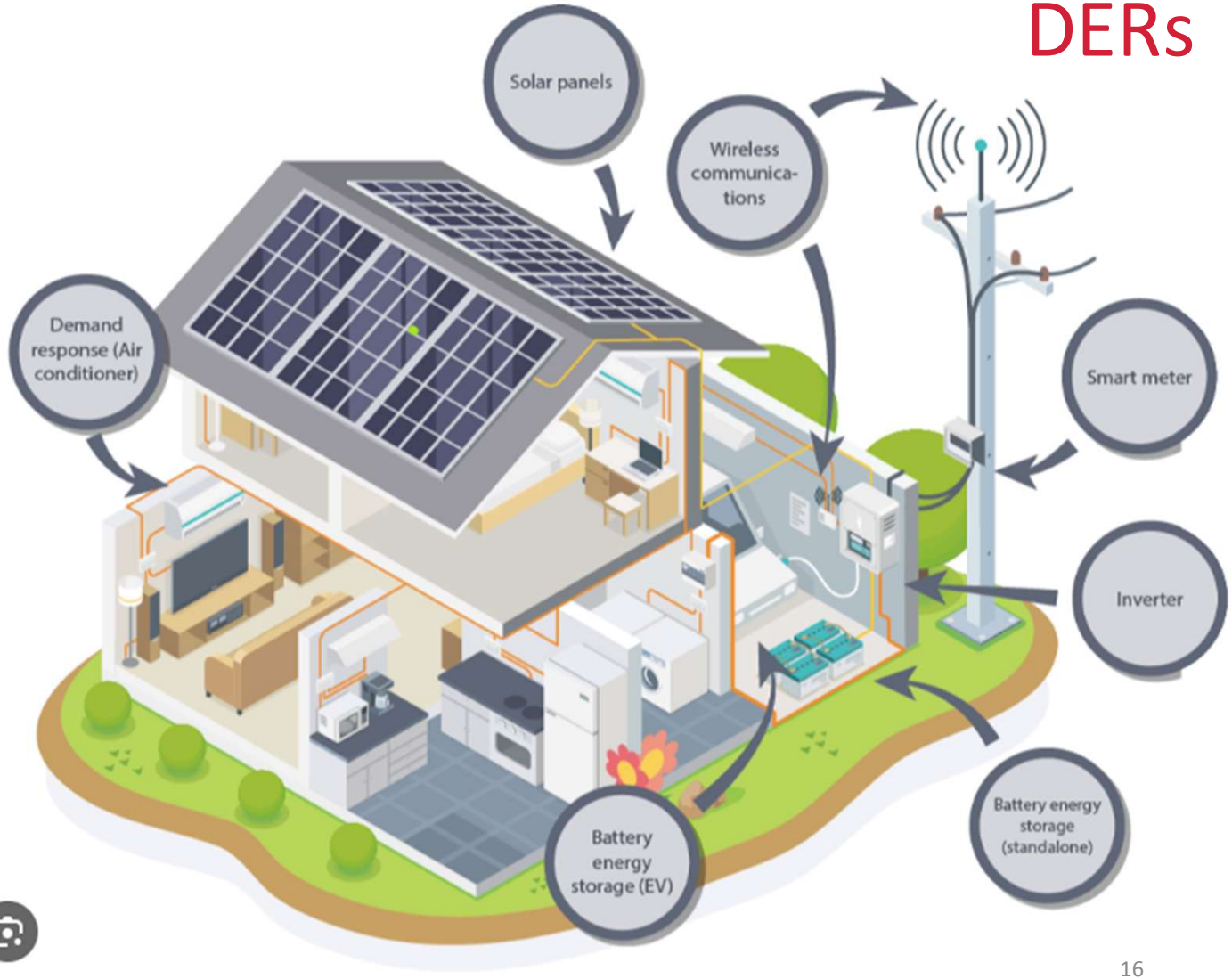
Benefits

- Grid Reliability and Resilience
- Environmental
- Economic Efficiency
- Energy Independence
- Customer Empowerment
- LMI & REC Programs

Challenges

- Grid Integration
- Regulatory and Policy
- Economic Barriers
- Technical Challenges
- Customer Satisfaction
- Dated Infrastructure & Installation Cost

DERs



*https://www.cummins.com/news/2021/11/04/what-are-distributed-energy-resources-and-how-do-they-work

Virtual Power Plants (VPPs)

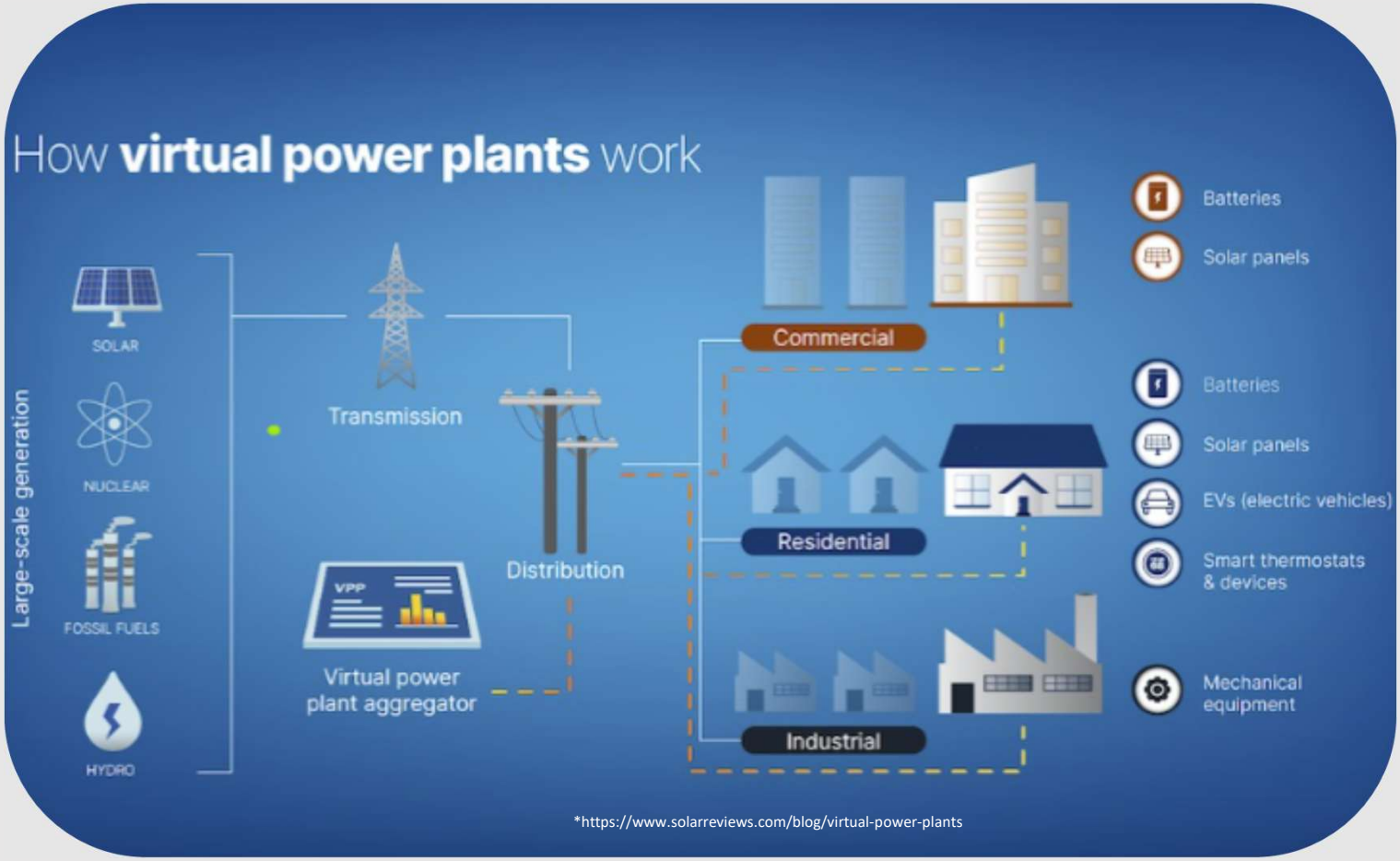
A system that integrates various Distributed Energy Resources (DERs) such as solar panels, wind turbines, energy storage systems, electric vehicles, and demand response units, using advanced software to manage and optimize their collective output as if they were a single power plant.

Functions and Capabilities

- Combine multiple DERs into a single manageable entity
- Real time monitoring and control
- Demand response via load shifting and peak shaving
- Energy trading – participate in energy markets to sell excess or provide services like frequency regulations

Regulatory involvement, AI and software integration, and cyber security pose risks but also offer opportunities

VPPs

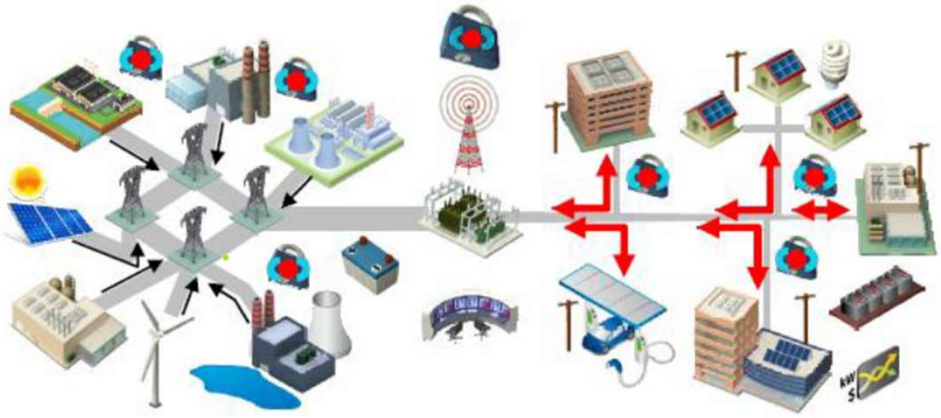


*https://www.solarreviews.com/blog/virtual-power-plants

Grid Modernization

- AMI
  - DI, Edge Computing, Monitoring, 2-Way Comms
- Grid Automation and Control
  - SCADA, ADMS
- Integration of DERs
  - Microgrids, Control
- Enhanced Communications
  - High speed, reliability
- Advanced Data Analytics
  - AI and Machine Learning
- Cybersecurity
  - Encryption, Firewalls, Intrusion Detection

This is the process of updating and enhancing the traditional electric grid to improve its reliability, efficiency, resilience, and ability to integrate with new technologies. It involves implementation of advanced technologies and practices to meet the changing needs and challenges of the energy landscape.



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This is replacing fossil fuel-based technologies with those that are powered by electricity. This shift aligns to sustainability goals, reduces greenhouse gas emissions, and enhances energy efficiency.

- Electric Vehicles
- Appliances
- Electric Hot Water
- Air Source Heat Pumps

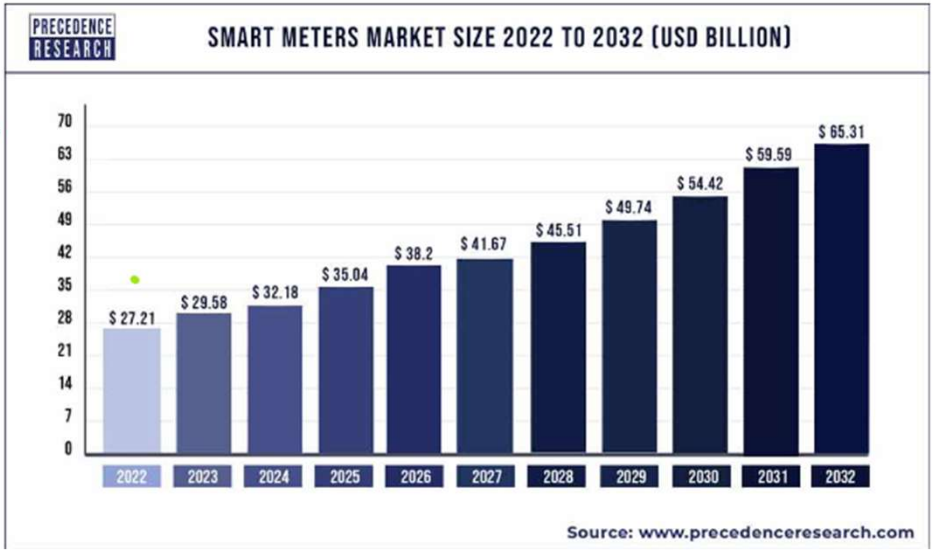
Regulatory Frameworks, subsidies, rebates, and pricing initiatives all drive increases.

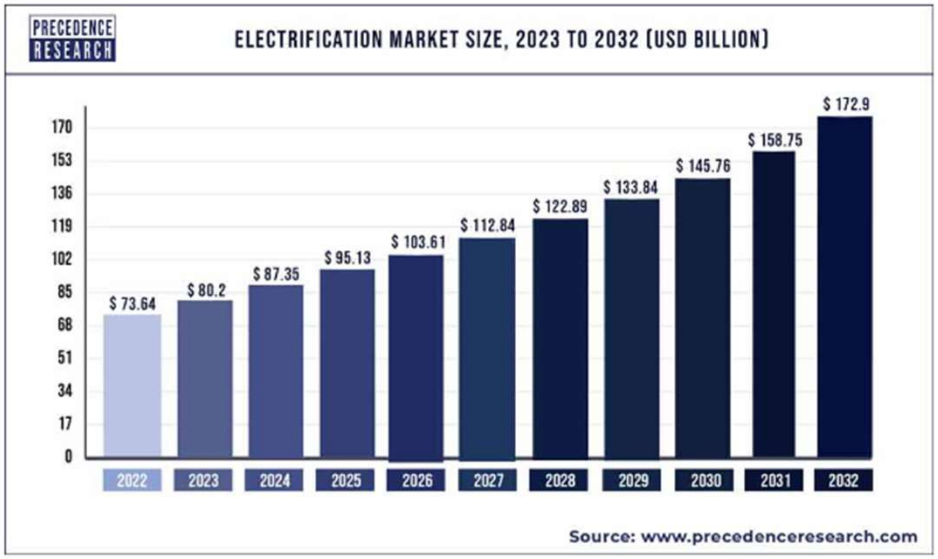
Many of these changes require added home wiring, service panel upgrades, and challenges with location of assets and availability of circuits.

3X Market Size of Smart Grid

>$100B in next 2 years

tescometering.com





Solutions for Electrification & DER Integration

Many competing systems and technology solutions exist to solve the crux of the electrification problem – growing demand, aging infrastructure, cost avoidance and load / source limitations for both the utility and consumer.

Consumers can adopt some solutions independently via a DER application while others require varying levels of utility interaction and/or approval.

- Meter Socket Adapters (MSAs)
- New DER ready ANSI form 42S / 43S meter / sockets
- Smart Panels
- Load And Energy Management Systems
- Power Control Systems (PCS)

Why a Meter Socket Adapter (MSA) ?

Electrification and isolation for home backup can be costly.

For residential buildings and the end consumer, electrification may involve:

- ASHP – Air Source Heat Pump in place of gas / oil heat
- Electric hot water – on demand, tank, via heat pump
- EVSE – Electric Vehicle Supply Equipment – EV Chargers
- BESS - Battery Energy Storage Systems
- PV Solar – residential PV solar systems

- Many of these technologies have added cost for home wiring, require main / service panel upgrades (MPUs), and involve challenges with physical location of assets.
  - The global market in the US exceeds $100 billion!

- MSAs can enable significant cost savings as we move to electrification by reducing labor costs and standardizing installations.

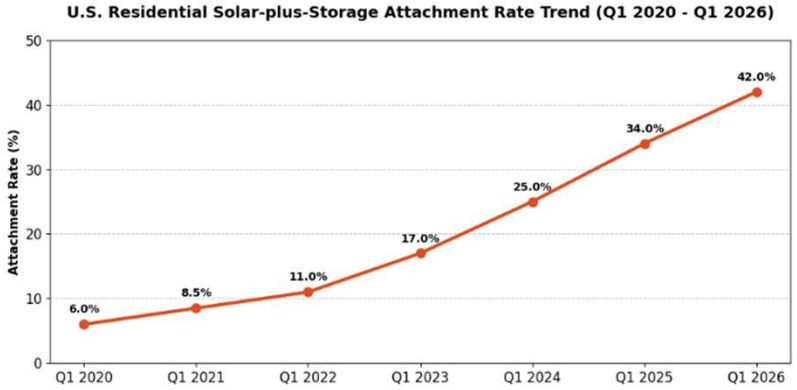
- In territories with a meter main combination panel, costs to add isolation can require a completely new panel, circuit relocation, and further equipment. Adding an MSA can negate all of this.

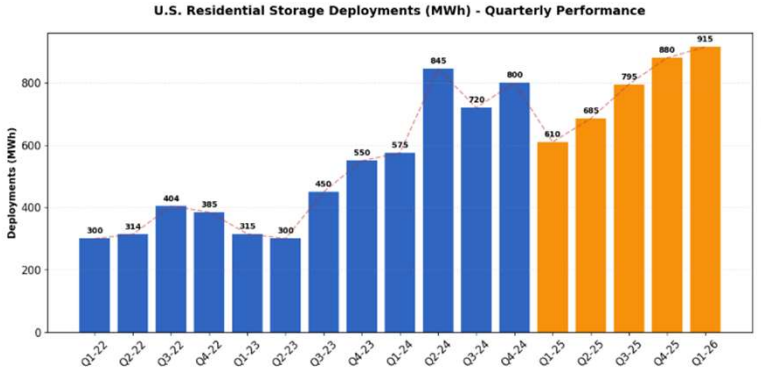
Reference: Pecan Street & Juniper Research

Why a Meter Socket Adapter (MSA) ?

Battery Attachment Rates are Rapidly Growing

- National residential solar plus storage attachment rates reached 42% in Q1 2026 up from 34% in Q1 2025. Most of this is attributed to the “net billing” transition in major markets and the emergence of more sophisticated Virtual Power Plant (VPP) incentives.
- Sunrun (one of the largest national DER installers) reported a record 71% attachment rate in their Q4 2025 earnings.
  - Hawaii is at 100% attachment, California at 92%, and the rest of the country is above 20% - doubling in the past year with more storage friendly rates in the Northeast and Midwest ISOs.





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https://investors.sunrun.com/news-events/press-releases/detail/364/sunrun-reports-fourth-quarter-and-full-year-2025-financial
https://pv-magazine-usa.com/2026/02/25/solar-and-storage-to-lead-record-breaking-86-gw-of-new-u-s-capacity-in-2026/

MSAs in the Market

Commercial MSAs for Backup via BESS (Customer Owned MSAs)

- Tesla Backup Switch
  - https://www.tesla.com/support/energy/powerwall/learn/tesla-backup-switch
- Enphase IQ Collar
  - https://enphase.com/store/storage/gen4/iq-meter-collar
- ConnectDER IslandDER
  - https://connectder.com/products/islandder
- Sigen Backup Switch
  - https://www.sigenergy.com/us/products/backup-switch

- Value Proposition
  - https://www.youtube.com/watch?v=_KyvxEip0Tg

MSAs in the Market

Commercial MSAs for Backup via BESS (Customer Owned MSAs)

- Value Proposition https://www.youtube.com/watch?v=_KyvxEip0Tg

MSAs in the Market

MSAs for Backup via Portable Generator (Mix of Customer and Utility Owned)

- TESCO BPTM
  - https://www.tescometering.com/wp-content/uploads/2025/07/BPTM-Brochure.pdf?srsltid=AfmBOoqxiNjwkxoojtC2qWq9010mjDROn5VMwu69qRdaeB-NukS9tk2a

- Generlink
  - https://shopgenerlink.com/

- Marwell Quick-Set Generator Adapter
  - https://marwellcorp.com/wp-content/files/catalog/PAGE-53.pdf

MSAs in the Market

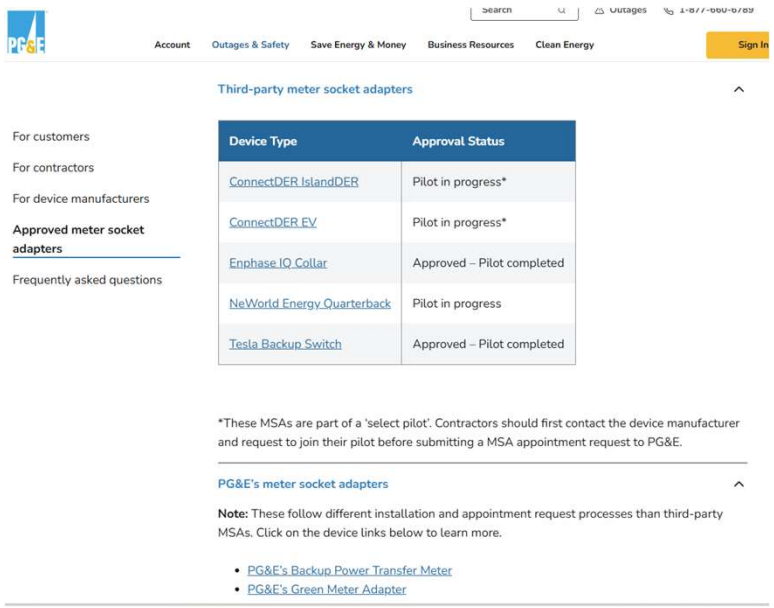
Commercial MSAs for DER Interconnection (Mix of Customer & Utility Owned)

- ConnectDER Solar MSA
  - https://connectder.com/products/solar-meter-adapter/
- ConnectDER EV MSA
  - https://connectder.com/products/ev-meter-socket-adapter/
- SPAN Edge (Coming soon)
  - https://www.span.io/products/edge
- **Devices that support an AC branch circuit connection generally require a separate Neutral attachment which can complicate the installation and require further training and equipment.**

Utility Approval

A Utility must "approve" an MSA before it may be installed in the meter socket containing the billing meter.

- There are two models for "approval here" – utility direct engagement and / or approval as a result of regulatory framework.
  - Some utilities may understand the value of the technology for MSAs and directly approve.
    - IE ComEd, Green Mountain Power, Hawaii Electric, AEP West Virgina
  - Others may wait for regulatory guidance or will act only after regulatory framework is in place.
    - IE Eversource, Delmarva Power, Southern California Edison
- Once approved, the MSA Manufacturer and model # is added to an Approved List / Utility Handbook.



Utility Approval Process

Test & Evaluate

- Test sample units
- Review NRTL / Standards Listing Reports
- Review Manufacturer Documentation
- Intracompany review
- Regulatory response (if applicable)

Approve

- Add to utility handbook / approved list with model numbers
- Update training documentation for meter install / exchange / removal
- Add an option for MSA selection within DER interconnection applications
- Inform field crews of new customer owned device
- Initiate pilot (if applicable)

Market is Opened

- Complete pilot (if applicable) and work with OEM
- Manufacturer begins sales in the approved service territory
- Interconnection applications are processed with an MSA
- Customer Installs begin
- Products are promoted to support clean energy goals, electrification, and LMI programs / initiatives

Utility Installation Models

Utility Model

- Utility personnel and authorized utility representatives (contractors) are the only parties allowed to remove the utility meter and install the MSA then re-install the utility meter.
- Some have a customer portal to request installation and have a varying SLA timeframe.
- The customer may be charged for the cost of the truck roll.
  - More common with CA IOUs

Joint Meet

- Utility personnel and authorized utility representatives (contractors) are the only parties allowed to remove the utility meter and re-install the utility meter.
- The installers must meet the utility and install the MSA.
- Utility personnel then re-install the meter and seal the socket.
- Some have a customer portal to request installation and have a varying SLA timeframe.
- The customer may be charged for the cost of the truck roll.

Installer Model

- Qualified personal (installers) are allowed to remove the utility meter, install the Meter Socket Adapter, and re-install the utility meter.
- Some utilities may audit none, some, or all installs after the installer completes work.
- No added costs to the consumer.
- No delays or schedule challenges.
- Preferred by the consumer and installer.
- Active discussion ongoing for installer certification and training programs for this model.

What Does it all Mean for Meter Operations?

- Education and Training
- Resource Allocation
- Funding for AMI 2.0
  - How to EOL current hardware & software
  - Trending equipment failure rates
  - Replacement schedule
  - New vs existing networks
- Standardization and Interoperability
- Customer Driven Programs

Ultimately, this will result in the evolution of the Meter Operations practice!

The Shape of Metering to Come 2026 and Beyond

Meters that do not look like meters as we know them, will become a part of our world.

- Streetlights
- Smart Poles
- Electric vehicle chargers
- Sub meters – which may now become our meters

Questions and Discussion

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