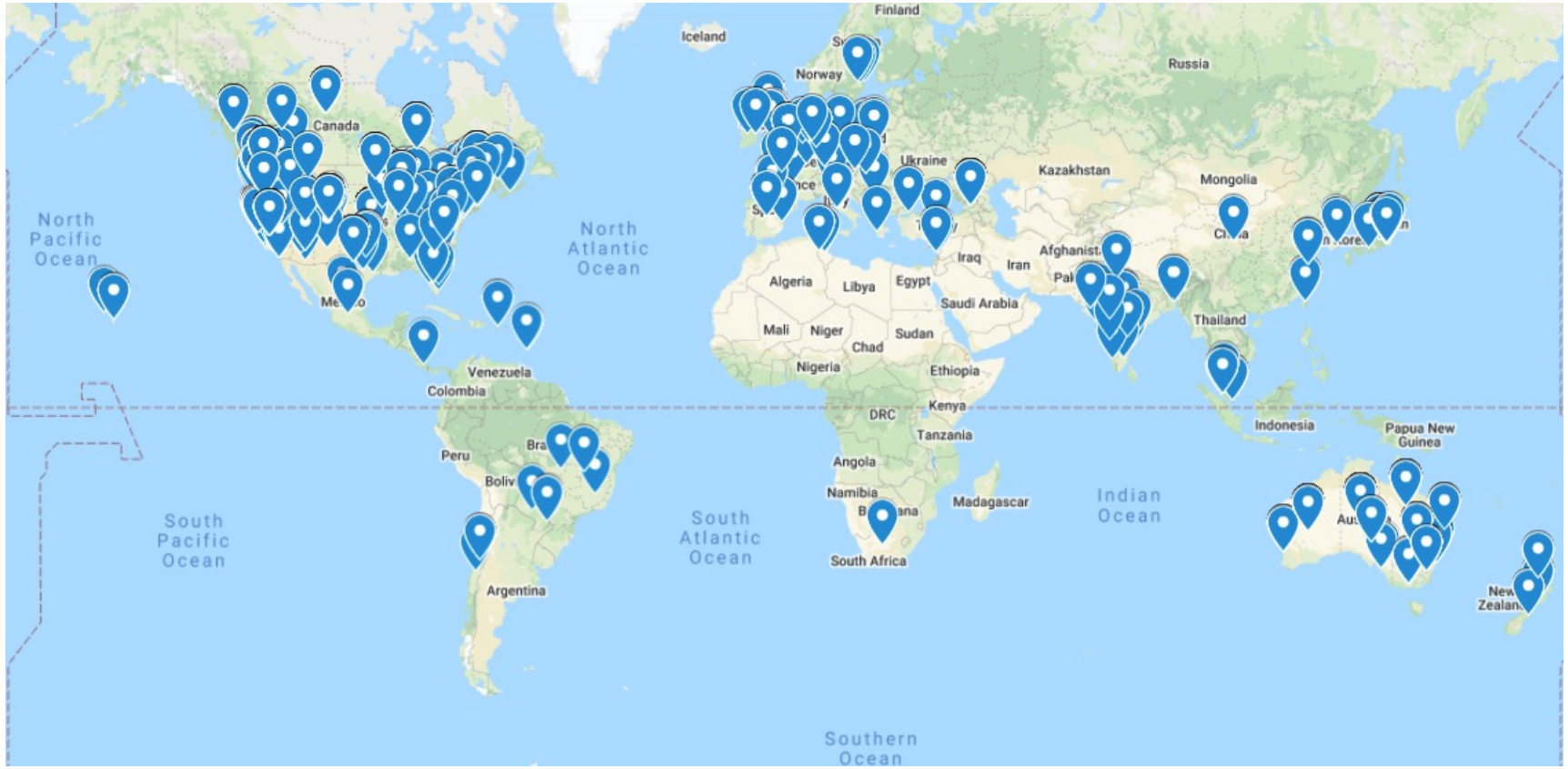
GridEdge Intelligence

Welcome to a GridEdge Intelligence Mini Forum:

Is IEEE 2030.5 *THE* DER Protocol?

May 25, 2021

Global Interest in IEEE 2030.5 – 404



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Bangladesh = 1
Belgium = 1
Brazil = 1
Canada = 24
Chile = 1
China = 2
Costa Rica = 1
France = 2
Germany = 3
India = 8
Ireland = 1
Italy = 3
Japan = 11
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Malaysia = 2
Mexico = 1
Netherlands = 3
New Zealand = 4
Paraguay = 1
Poland = 2
Puerto Rico = 3
Serbia = 1
Singapore = 5
South Africa = 1
South Korea = 1
Spain = 5
Sweden = 1
Taiwan = 3
Tunisia = 1
Turkey = 1
United Kingdom = 2
Untied States = 249

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Mini-Forum Agenda

- Acknowledgements
  - GridEdge Intelligence
- Special Guest: Tom Tansy
  - IEEE 2030.5 ECS Chair, GEI Advisor, SunSpec Chair
- Webinar – Stuart, David, Eamonn and Andrew
- Q&A – 30 min
- Closing

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Our Partners in this Mini-Forum

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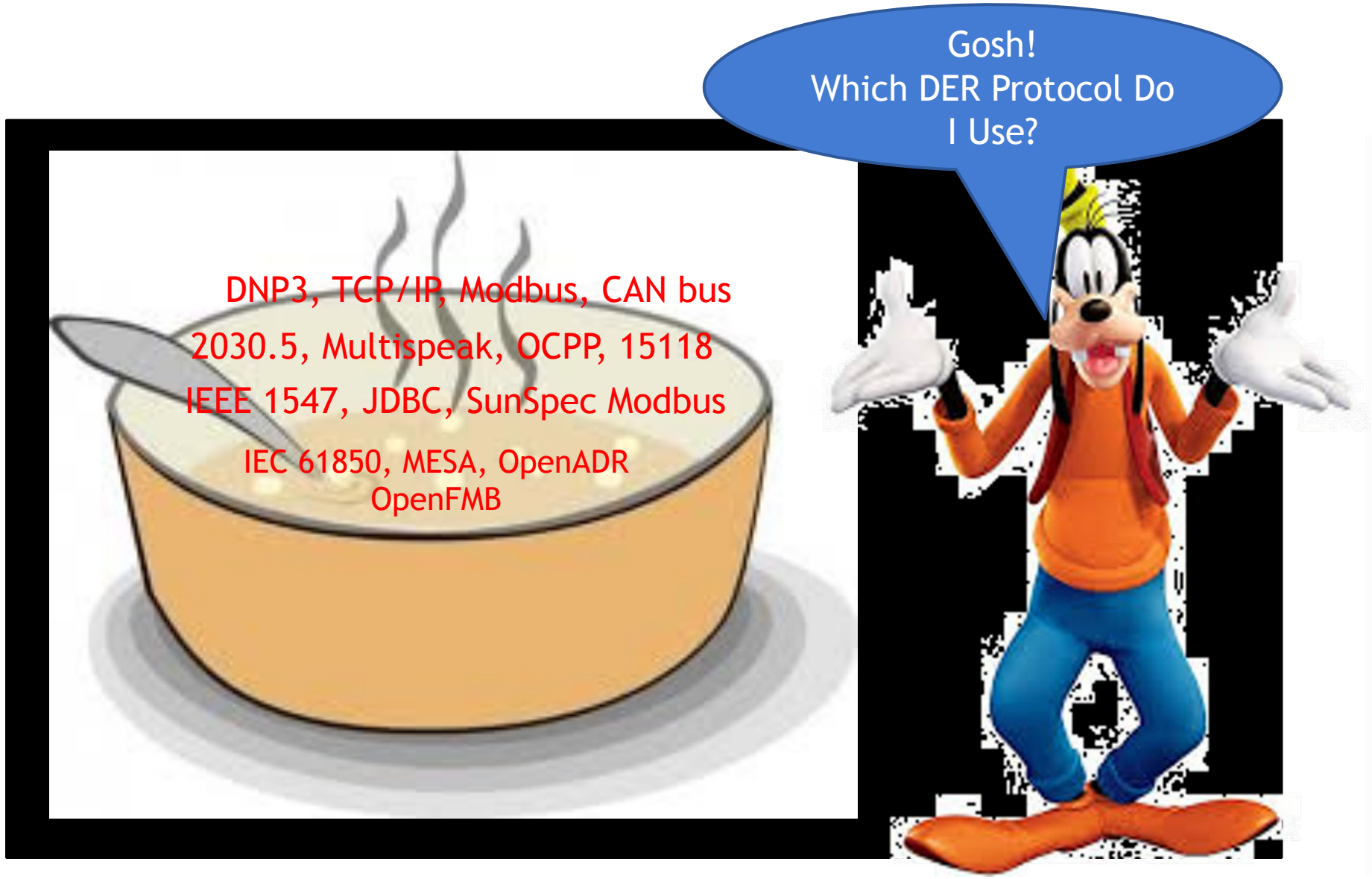
GridEdge Intelligence is A Service



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GridEdge Intelligence: GOALS

Accelerate selection, adoption and implementation of standard communications protocols for grid edge resource integration into grid operations.

- ***Selection***: understand which protocol is best for your application
- ***Adoption***: who and why
- ***Implementation***: resources to ensure success for utilities and vendors
- ***Standards***: open industry standards
- ***Grid Edge Resources***: at the edge of the grid – manageable load (DR) and generation (DER)
- ***Integration***: making grid edge resources part of grid management success

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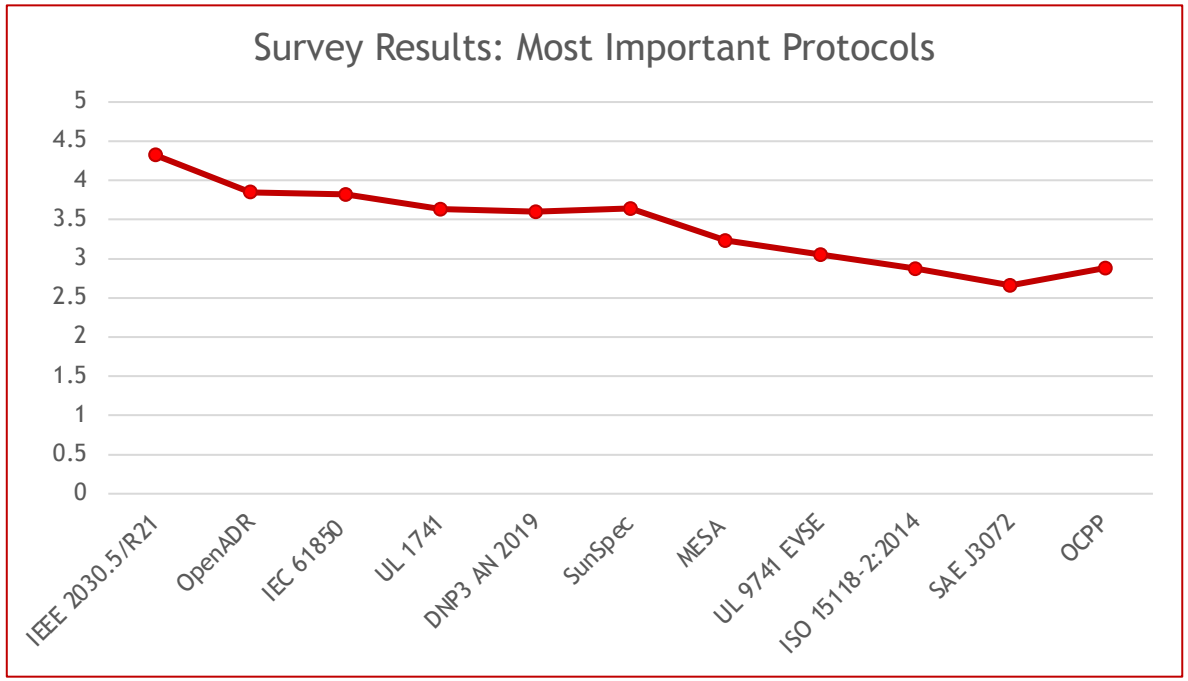
Covered and Planned Protocols

- **IEEE 2030.5*** – ***first standard mandated anywhere for DER management***
- **OpenADR** – ***first standard developed and used for DR applications. Now an IEC standard***
- **IEEE 1547-2018/UL 1741-SB** – ***first time interoperability is required in a functional DER standard***
- **DNP3 – IEEE Std 1815™*** – ***preferred by US utilities for SCADA and DER – incumbent DER protocol***
- **SunSpec Modbus and TCP/IP*** – ***first standard to standardize inverter control***
- **IEC 61850** – ***most influential standard(s) in EU and rest of the world***



**** Named in IEEE 1547-2018***

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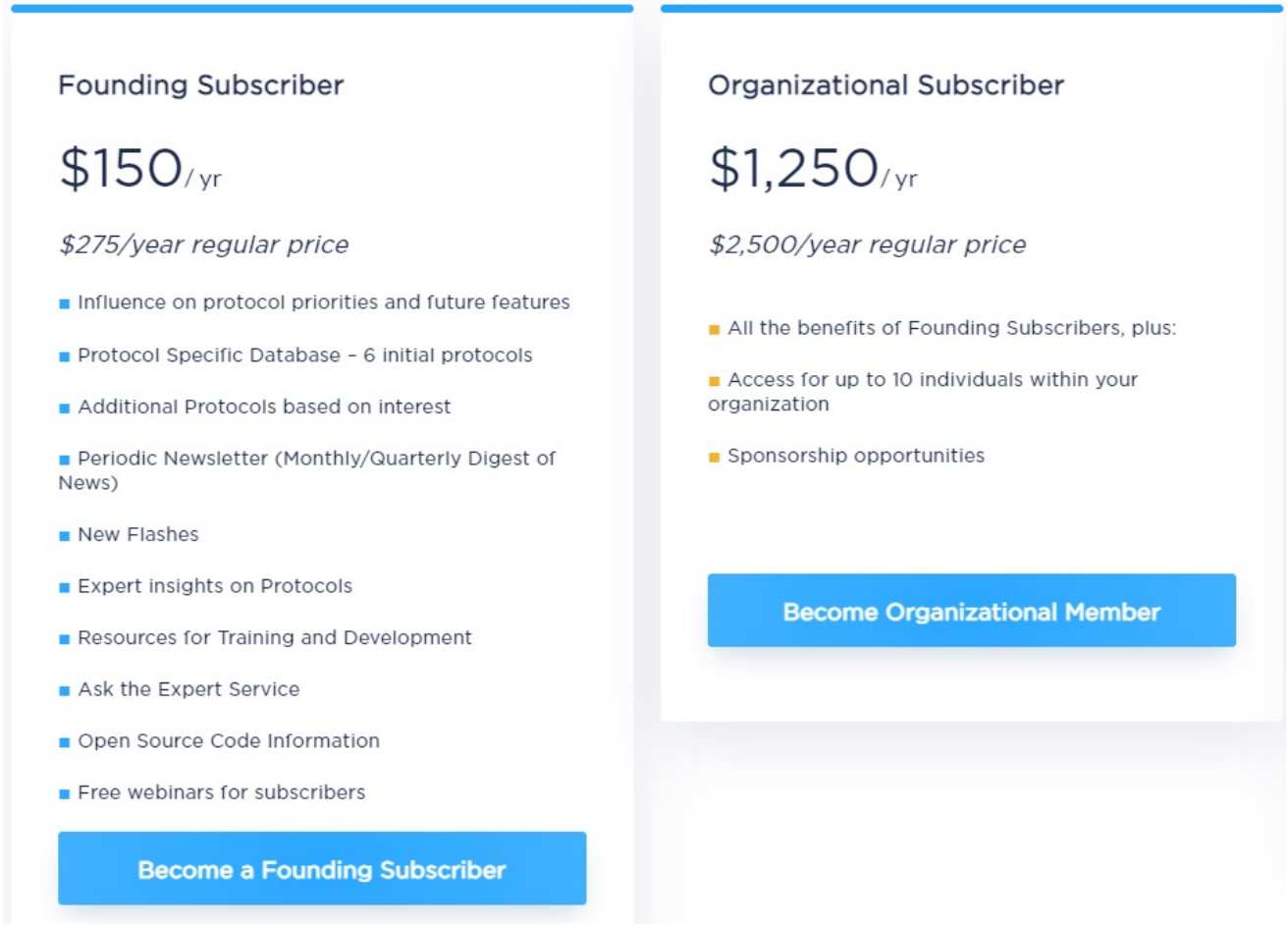
An Invitation to Participate!!

- Take a 5 min survey and get a $5 gift card
- Become a Founding Subscriber
- Become a Contributor
  - Something to add? Product or training listing? Use case? Protocol article? Other? Send to contributions@gridedgeintelligence.com
- Questions? Contact info@gridedgeintelligence.com



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QualityLogic Announcements

- **IEEE 1547.1 webinar June 3, 8AM PDT, see June 2021 Webinar – IEEE 1547-2018 Interoperability Requirements – QualityLogic**
- **Watch for a 3-day QualityLogic public, virtual workshop on IEEE 2030.5, June 22-24. To be announced after today's webinar**
  - **Special discount for GEI Subscribers**

GridEdge Intelligence

Special Guest: Tom Tansy

- Chair of the IEEE 2030.5 Ecosystem Steering Committee
- GridEdge Intelligence Advisor
- Chair, SunSpec Alliance

GridEdge Intelligence

Now to the Webinar…

- Practical Interoperability of DER with Utility and Market Systems
  - Real Life Interoperability Solutions for Distributed Energy Resources
- Stuart McCafferty, GridIntellect Founder
- Andrew Mears, SwitchDin CEO
- Joined by David Forfia, Eamonn McCormick and Tom Tansy for Q&A

GridEdge Intelligence

Presenters Today

- **Stuart McCafferty**
  - GridEdge Intelligence Advisor
  - Co-inventor of EnergyIoT Reference Architecture
  - Prior to founding GridIntellect, Stuart worked for Black & Veatch supporting the utility, technology, and vendor communities in strategy
  - Air Force Academy graduate, US military veteran, Energy Fellowship recipient
  - Energy “Expert” for Energy Central,
  - Vice Chair of the Open Field Message Bus (OpenFMB) user group.

- **Andrew Mears**
  - Founder and CEO of SwitchDin, Newcastle, Australia
  - Director and Co-founder of Eighteen04, a curated co-working space for clean tech and smart city related startups.
  - He was chief technical advisor to the UN and World Bank on low emissions development and rural electrification.
  - BE and ME degrees in Electrical Engineering from University of Newcastle, and doctorate from University of Technology Sydney.

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Presenters Today

- **David Forfia**
  - Grid Architecture Lead at Utilicast
  - Chair of the GridWise Architecture Council
  - Co-inventor of EnergyIoT Reference Architecture
  - Former Director of Enterprise Architecture and IT Transformation at the Electric Reliability Council of Texas (ERCOT)
  - Director and Board Chair at SGIP.
  - BBA from the University of Texas at Austin and an MBA from St. Edward's University.
- **Eamonn McCormick**
  - Technology and Business Architecture Services Lead at Utilicast
  - Co-inventor of EnergyIoT Reference Architecture
  - Strategic Advisor to CEDIS, Quotient Labs, NXT-comm and Energy Block Chain consortium
  - Former Chief Business and IT Integration Architect at ERCOT
  - Degrees in Engineering and Management Science from University College Dublin.

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Practical Interoperability of DER with Utility and Market Systems

Real Life Interoperability Solutions for Distributed Energy Resources

- Stuart McCafferty, GridIntellect Founder

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GridIntellect Intelligent Grid Solutions

Utilicast

switchDin

Agenda

1. EnergyIoT Reference Architecture
2. IEEE 2030.5 Architecture and Benefits
3. Practical Application for Developing Solution Architectures for DER

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EnergyIoT Reference Architecture

3 Architectural Layers for IoT interoperability, scalability, abstraction, and bottoms-up hierarchical designs

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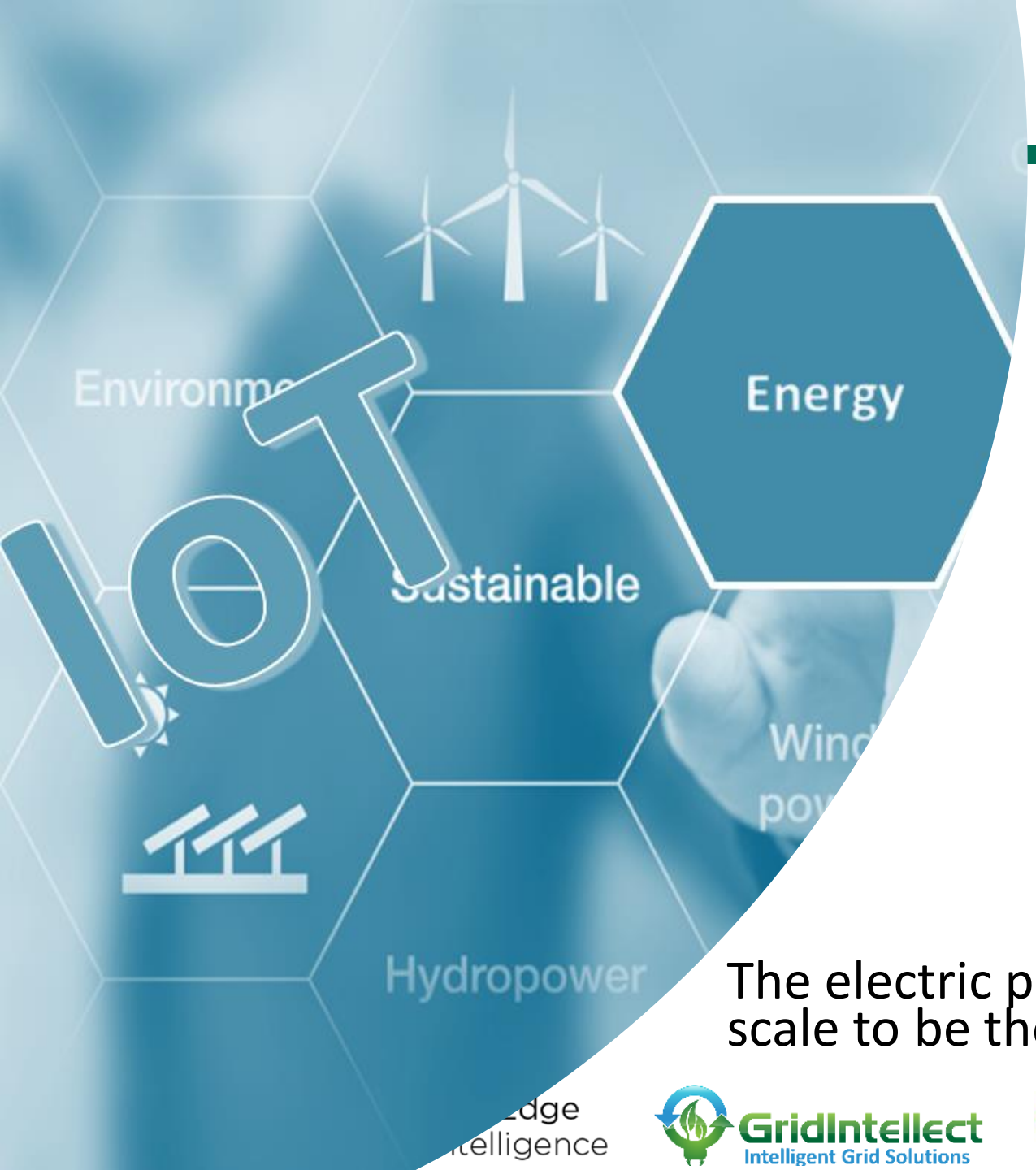

Energy – the "Poster Child" for the Internet of Things

- Electric Power Grid – "the biggest machine in the world!"
- Distributed assets
- Machine-to-machine communications and autonomous operations
- Big Data
- IP Addressable
- Virtualization, Containerization, Orchestration
- Analytics and Artificial Intelligence

The electric power grid has all the IoT building blocks and scale to be the ultimate example of IoT

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Modern Architecture Principles

- Is Event-driven
- Is Data-centric
- Is Secure
- Is Service-oriented
- Is elastic and scalable
- Enables edge computing as well as more traditional centralized computing
- Uses Internet Protocol (IP) addressing scheme
- Uses rich semantics for communication (not points or register-based)
- Is extensible/designed to be future-proofed
- Is redundant/fail safe
- Makes use of the cloud
- Employs distributed hierarchical control/coordination
- Is designed with expected communication loss

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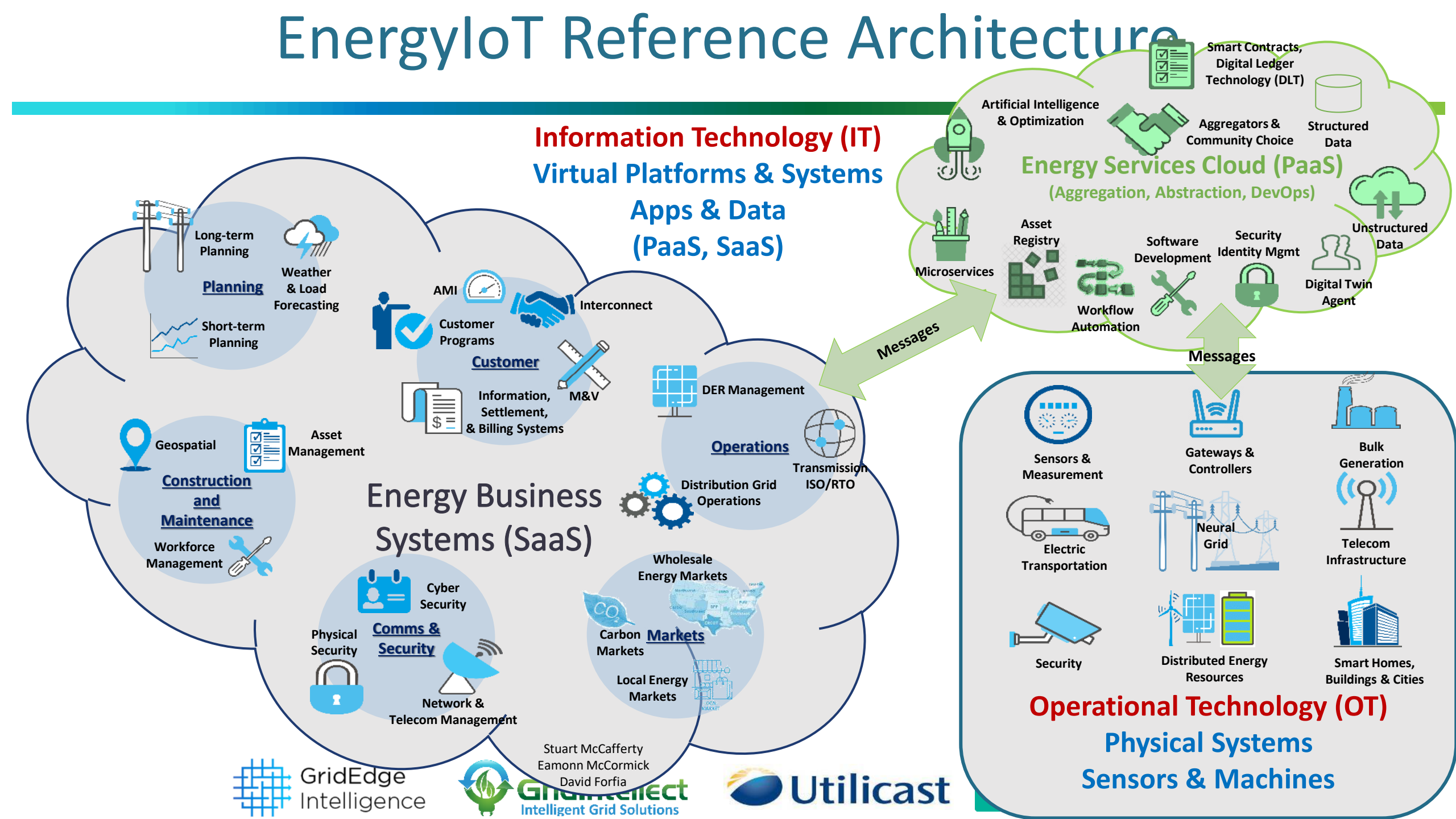
EnergyIoT Reference Architecture



Stuart McCafferty
Eamonn McCormick
David Forfia

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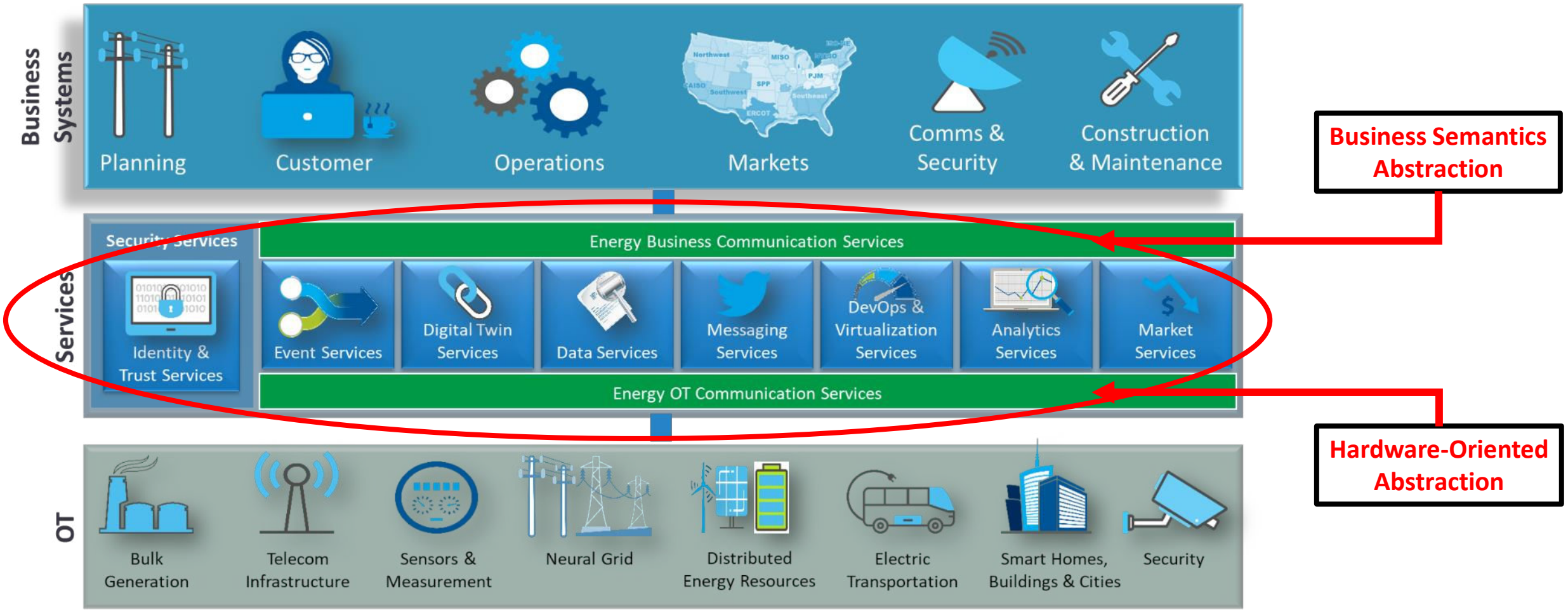
EnergyIoT Stacked Architectural View



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More EnergyIoT-Related (Free) Information

7 articles on the EnergyIoT Reference Architecture:

- Energy Central - https://energycentral.com/topics/tags/call-action-series

Additional related articles:

- Individual and aggregated DER interoperability
- Grid architecture
- Robots
- DSO
- Climate change
- Decarbonization
- Flexibility markets
- EV fleet management
- Biofuels
- Interoperability communication protocols
- And more!

- Energy Central - https://energycentral.com/o/GridIntellect

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IEEE 2030.5 Protocol

The feature-rich Internet of Things electric power protocol for DER interoperability.

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Why IEEE 2030.5?

- History
  - Originally called Smart Energy Profile (SEP) developed by Zigbee Alliance in 2009
  - Developed to leverage electricity smart meters to communicate with BTM assets
  - Based on CIM and IEC 61850-4-720 DER Information Model. Specified in the Communications Recommendations adopted by the CPUC.
  - Identified by NIST Smart Grid Interoperability Panel (SGIP) as critical interoperability protocol
  - Included in SEPA's Catalog of Standards
  - Adopted and ratified by IEEE and now on Version 2
  - One of 3 inverter communication protocols allowed by California Rule 21
    - IEEE 2030.5 is the "default" communications protocol
- Features
  - Information model profile based on CIM
  - Supports wide variety of grid service messages
  - Supports all forms of DER (controllable loads, distributed generation, energy storage, electric vehicle charging)
  - Utilizes pub/sub (MQTT) and REST (HTTPS) communication protocols
- Useful IEEE 2030.5 Links
  - IEEE Standard for purchase ($280)
  - QualityLogic suite of test tools
  - SunSpec Alliance 2030.5 certification information
  - DER interoperability GridEdge Intelligence service

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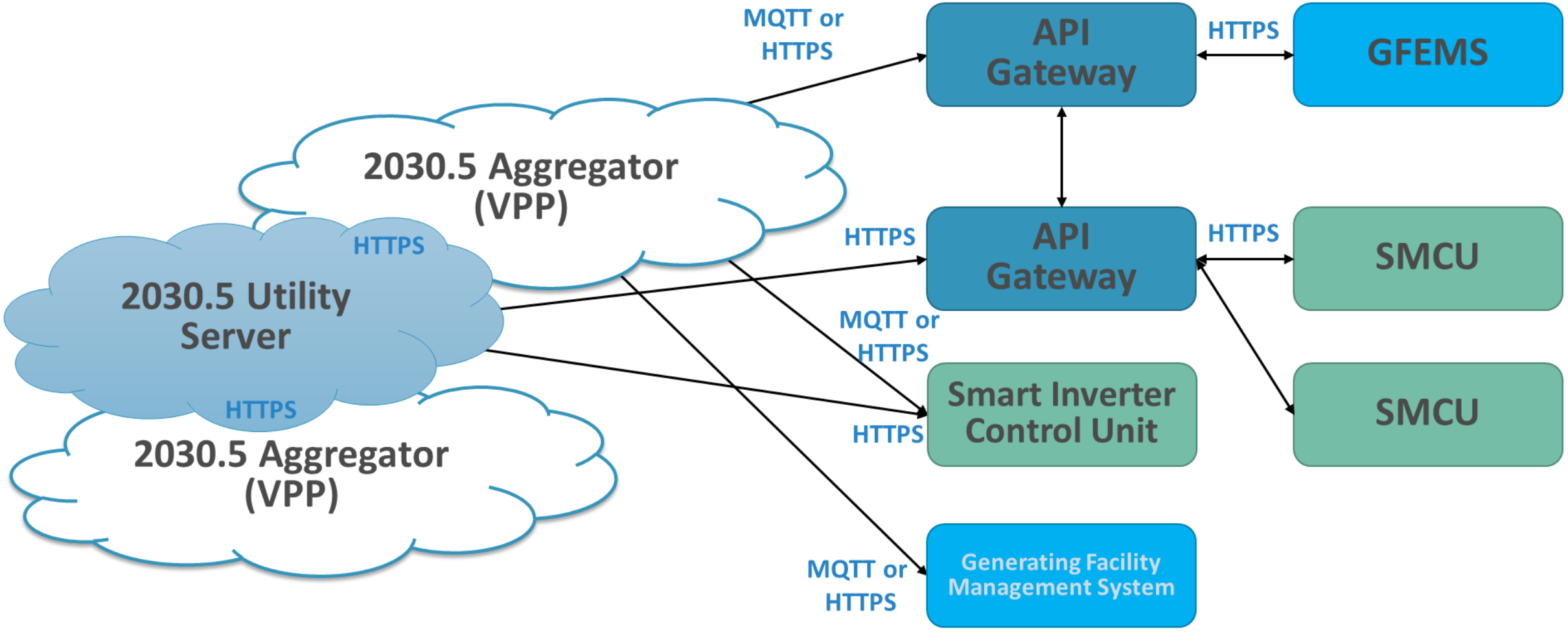
IEEE 2030.5 Architecture



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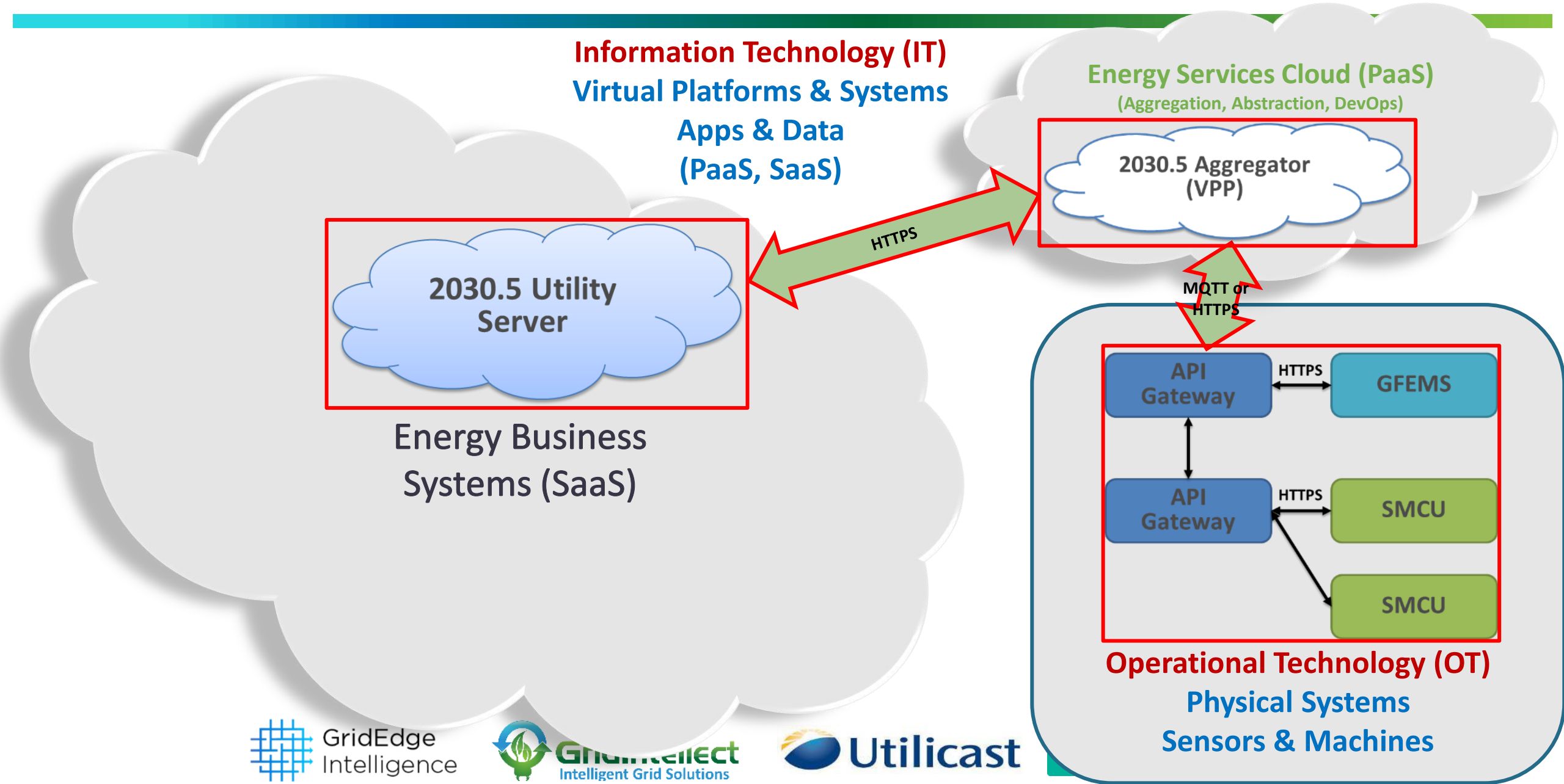
Mapping IEEE 2030.5 to the EnergyIoT Reference Architecture



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DER Solution Architecture Methodology Example

Practical use of mapping IEEE 2030.5 to the EnergyIoT Reference Architecture to rapidly develop high level DER solution architectures.

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Developing Rapid DER Solution Architectures

What?

- Use case driven design
- Simple visual architectural representation
- Layered architecture
- The “beginning” of in-depth architecture work

Example Use Case

Residential behind-the-meter DER interoperability with utility operations systems and automated interconnect process

Why?

- It’s quick! ~30 minutes
- Easy to collaborate or build on your own
- Easy to communicate to all skill levels
- No need for specialized tools
- High level visualization for:
  - Where architectural elements reside
    - On prem, in the cloud, in a cloud platform, at the edge
  - Interfaces and dependencies
  - Communication methods

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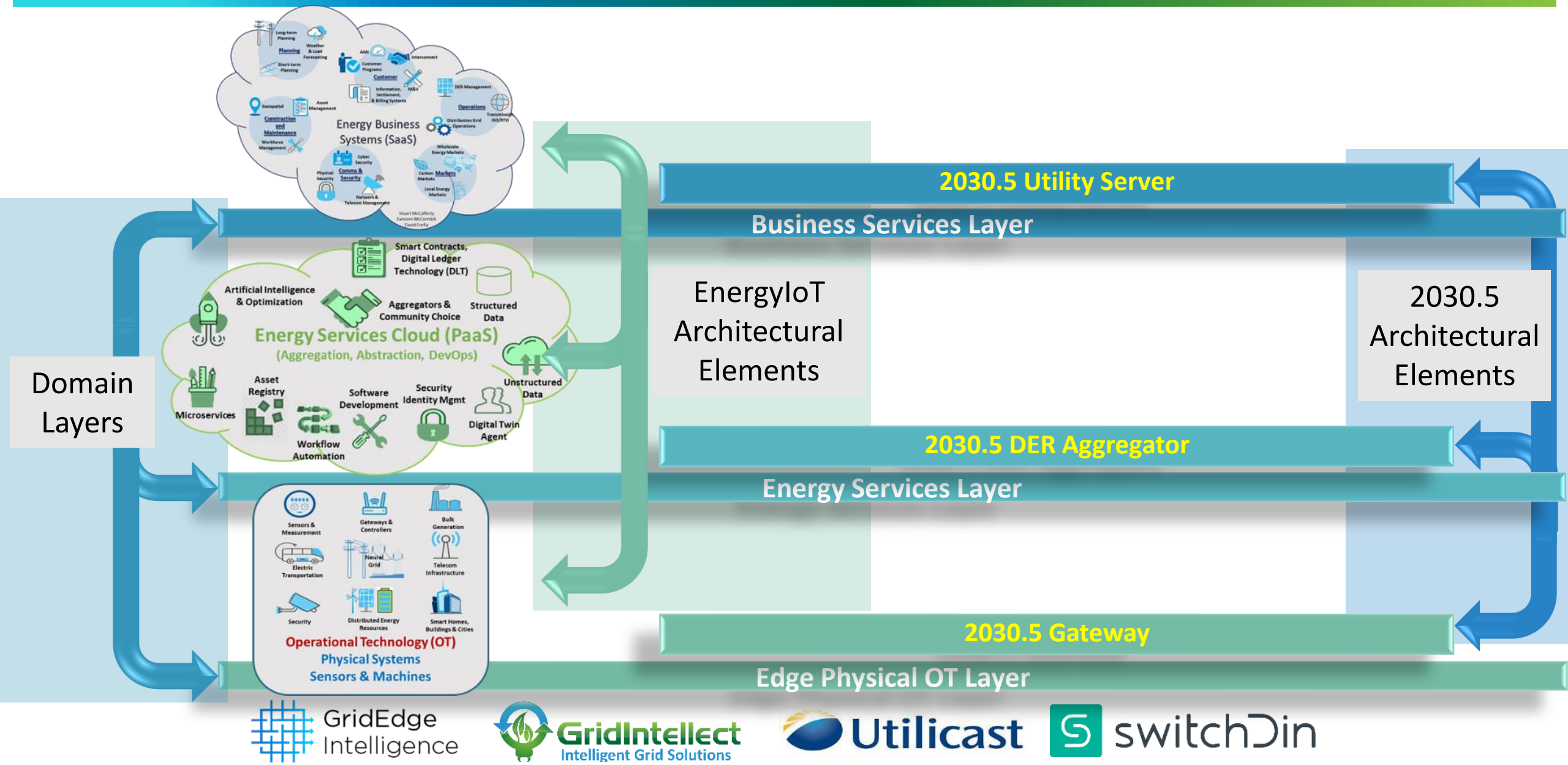
Step 1: Create a Layered Template



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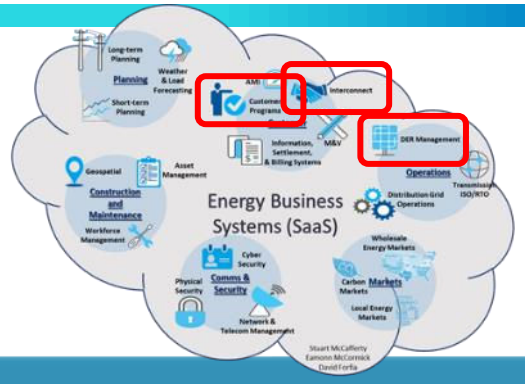
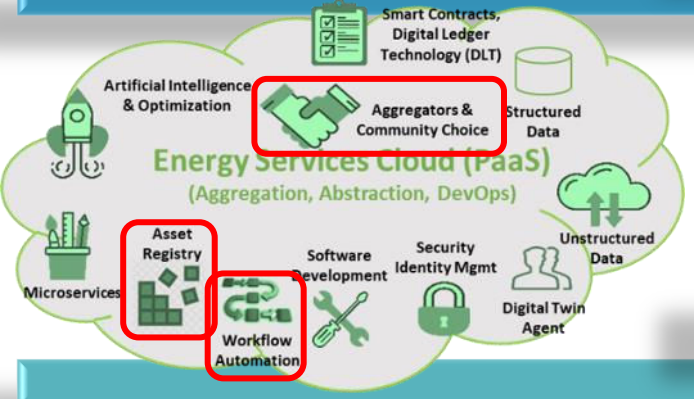
Step 2: Identify Associated EnergyIoT Subdomains and Elements



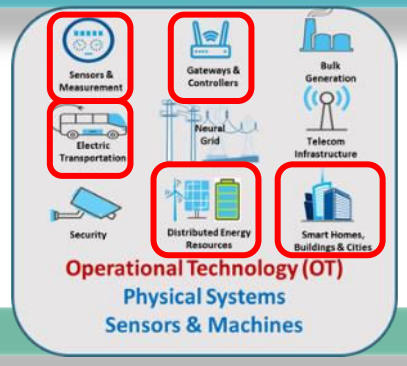
2030.5 Utility Server

Business Services Layer



2030.5 DER Aggregator

Energy Services Layer



2030.5 Gateway

Edge Physical OT Layer

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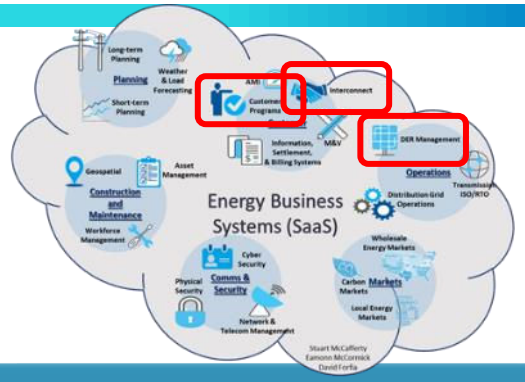
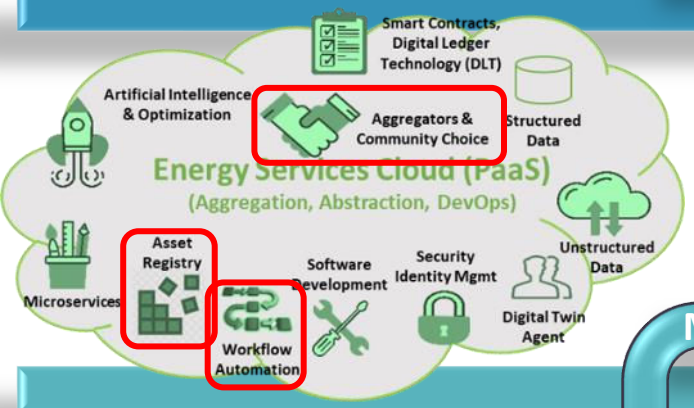
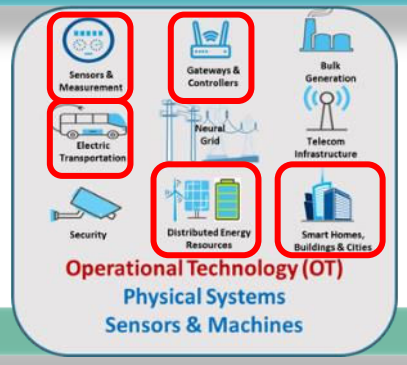
Step 3: Fill-in Additional Architectural and Functional Details







DER Visibility & Situational Awareness

DER Services Event Management

Power Flow Modeling & Simulation

Interconnect Data

Customer Program Participants

Operational & Financial Optimization

Asset Registry

2030.5 Utility Server

Business Services Layer

Customer Program Participants

DER Registry & Availability

Interconnect Automated Workflow

Customer Participation Opt-Out Data

Event Performance Data

DER Groupings (VPP)

Dispatch Scheduling

DER Discovery

Residential Customer Portal

Customer Participation Prediction

Event Performance Prediction

DER Gateway Locations & Demographics

MQTT

2030.5 DER Aggregator

HTTPS

Energy Services Layer

Gateway Installation Application

Gateway Device

Home Energy Management System (EMS)

Distributed Generation

Controllable Loads

HTTPS

Electric Vehicles

Metering

2030.5 Gateway

Edge Physical OT Layer

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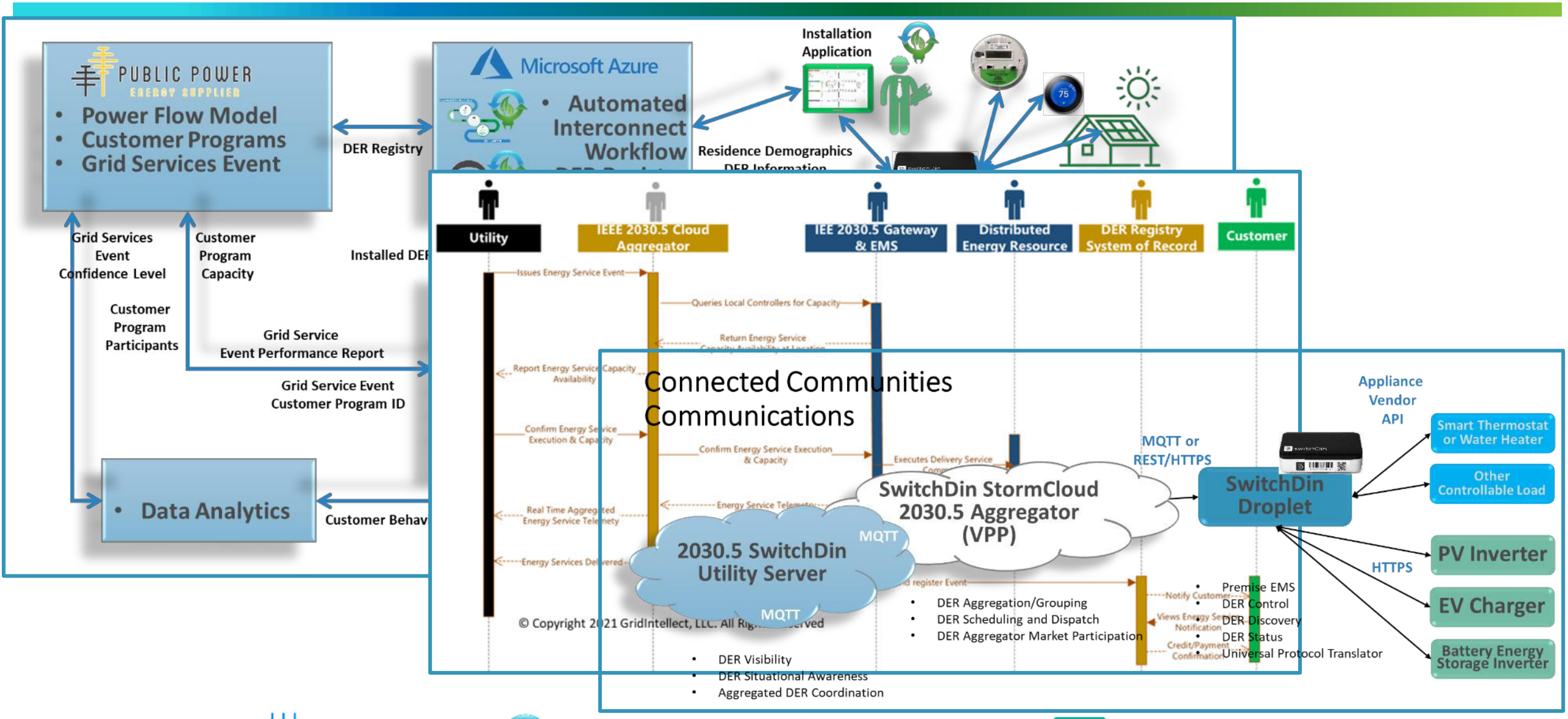
Step 4 and Beyond: Create Supporting Architectural Drawings



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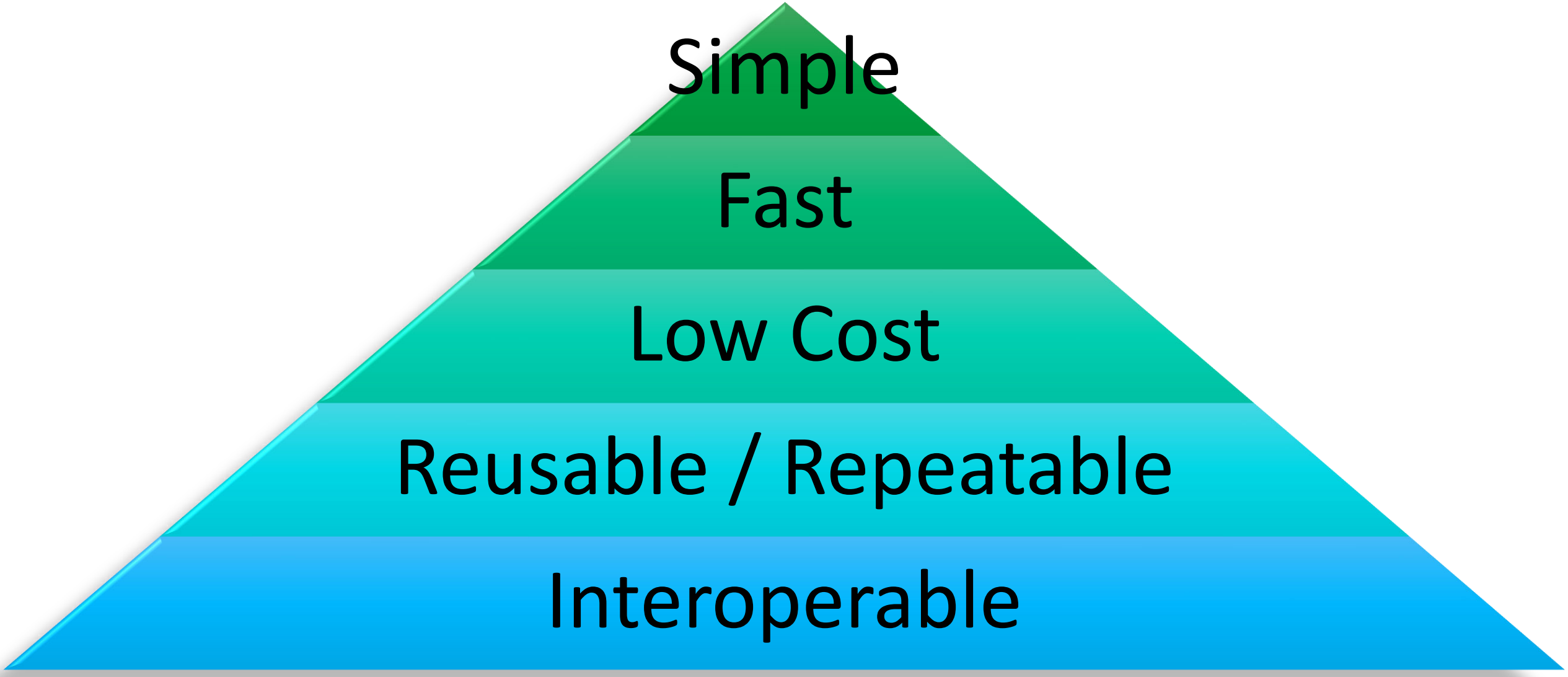
Value of DER Solution Architecture Methodology



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- YouTube: https://www.youtube.com/channel/UCFw2j4ocTBceZ7gm5QWRQ3w
- DER Solution Architecture Template: https://energycentral.com/o/GridIntellect/der-solution-architecture-methodology-example-and-template

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IEEE 2030.5 - Australia

Dr Andrew Mears, CEO

25 May 2021

www.switchdin.com

switchDin

About SwitchDin

Energy software company **founded in 2014**

37 staff, including 5 PhDs, based in Newcastle, Australia

greater than 4,500 sites orchestrated
8 utility partners
30+ manufacturing partners
Innovative projects around Australia

Seats on AS 4777 standards committee, CEC Inverter Listing Working Group, AEMO DER taskforce

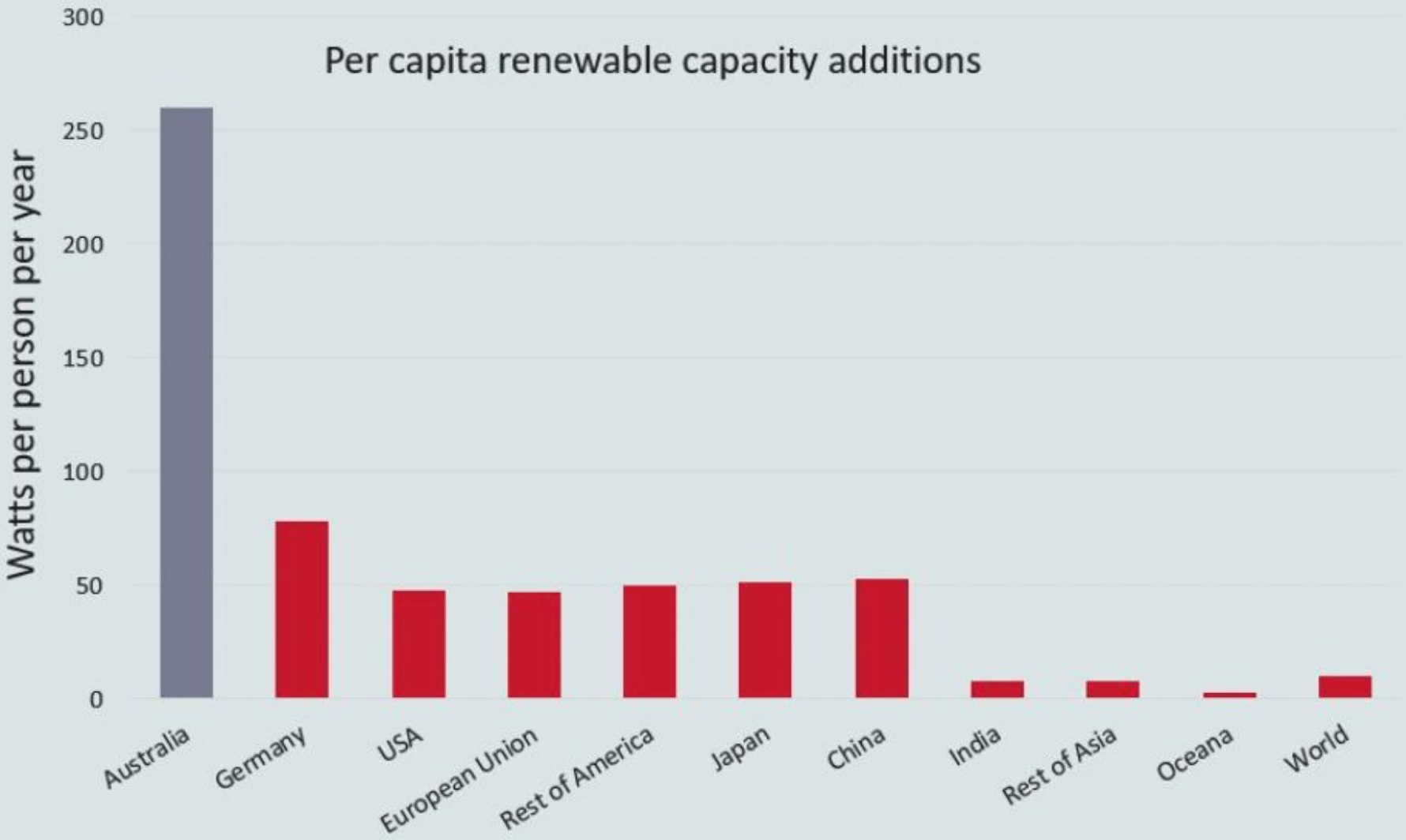
Energy utility & retailer partners include

Ausgrid, SA Power Networks, Horizon Power, Simply Energy by ENGIE, AGL, Energy Queensland, Origin, AusNet Services

Device integrations with over 30 brands, including

Fronius, SMA, Sungrow, Solis, GoodWe, Growatt, Q CELLS, sonnen, FIMER, Selectronic, victron energy, SENEC

Australia is undergoing the fastest DER transition in the world: AEMO



Last 3 years:

Solar

1,000% increase in large-scale solar farms **from 6 to 52**

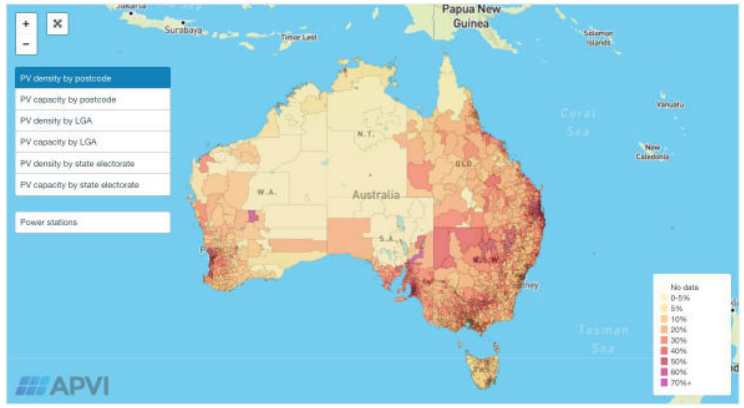
Wind

Almost doubled **from 36 to 58** wind farms

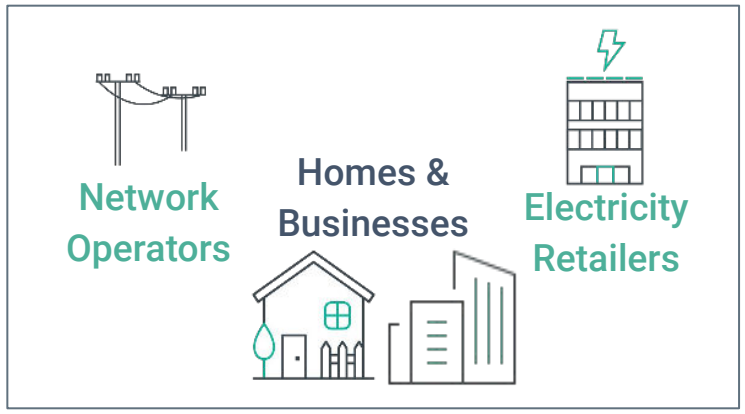
Source: BLAKERS et al. PATHWAY TO 100% RENEWABLE ELECTRICITY, IEEE JOURNAL OF PHOTOVOLTAICS, VOL. 9, NO. 6, NOVEMBER 2019

The Australian DER context

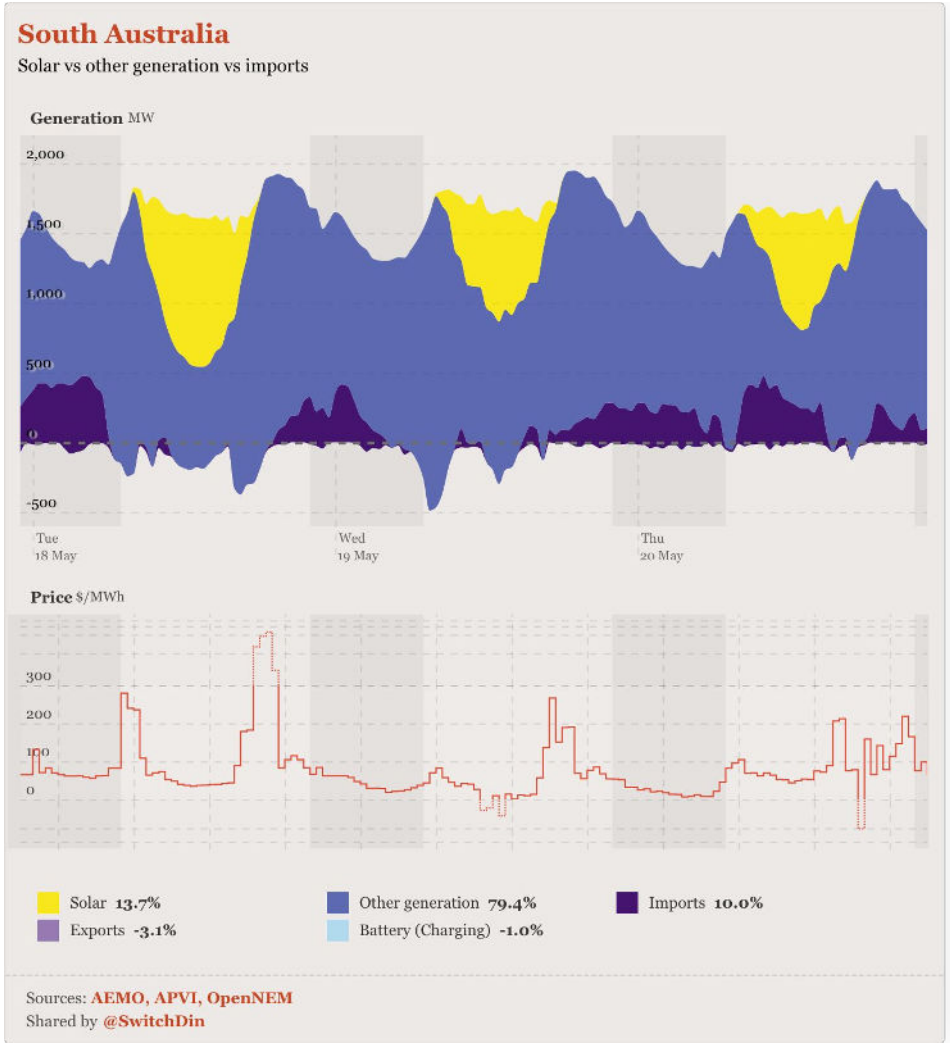
World-leading uptake of rooftop solar, with up to 40% of Aus consumers to have assets on site by 2027 (ENA)



Disaggregated electricity market for most of Aus population - retailers vs LV networks (DNSPs)

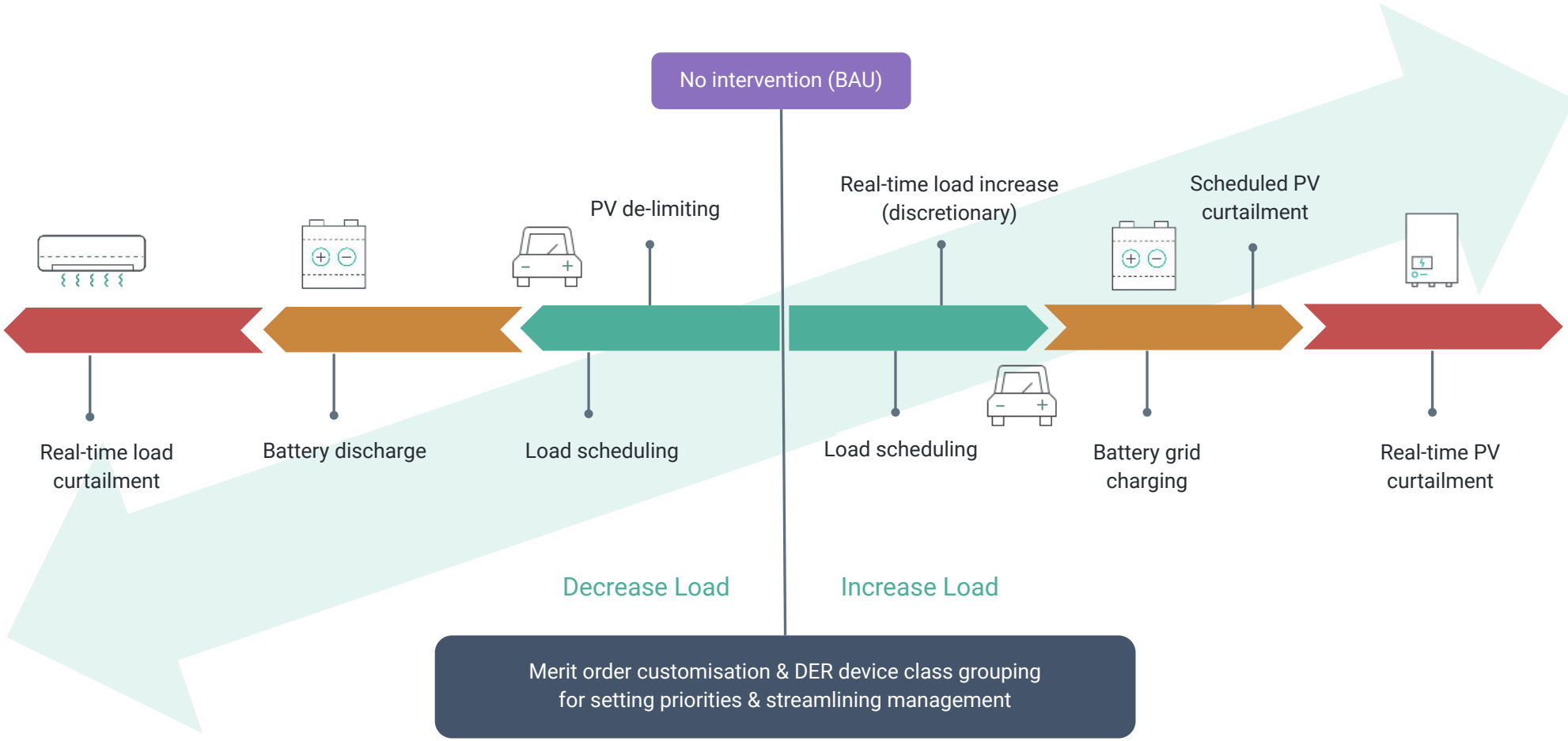


Increasing spot market price volatility, e.g. South Australia, where rooftop solar is huge and negative spot market prices are increasingly common



Unlocking the Fully Flexible load Spectrum

A toolkit for energy companies



SwitchDin Unlocks Value by Bridging the Gaps

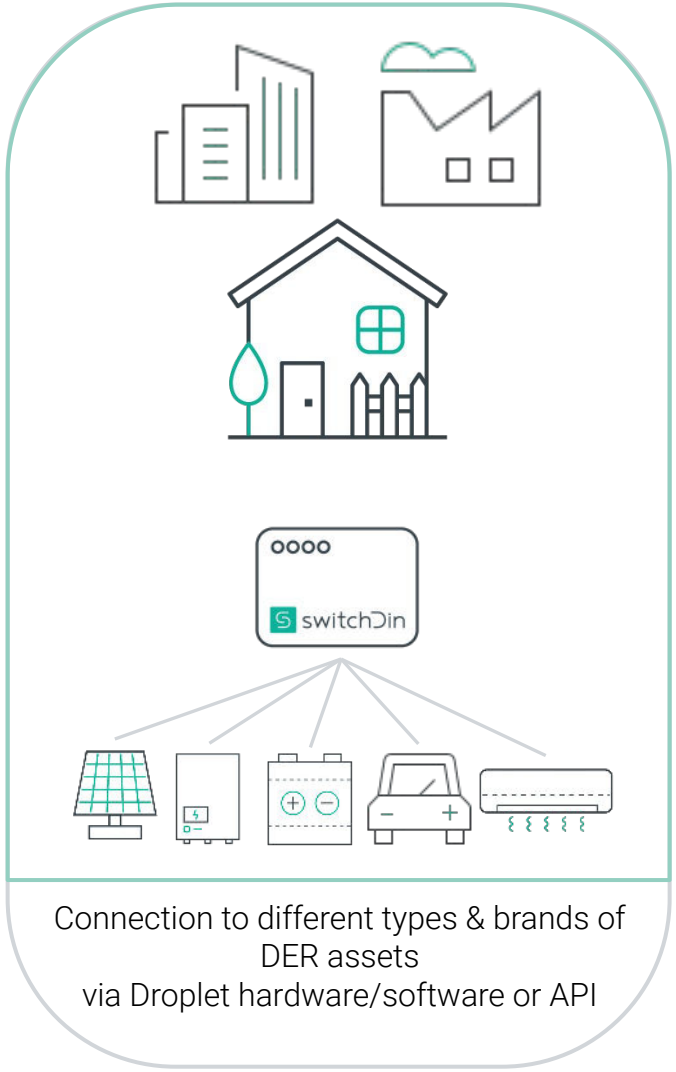
behind the meter integration + utility readiness

Front-of-meter benefits:

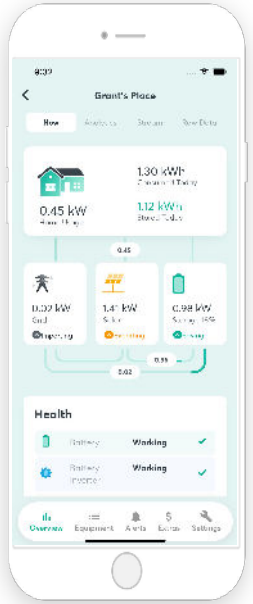
New opportunities between DER asset owners and energy companies

Network Operators

Electricity Retailers



Connection to different types & brands of DER assets
via Droplet hardware/software or API



Behind-the-meter benefits:

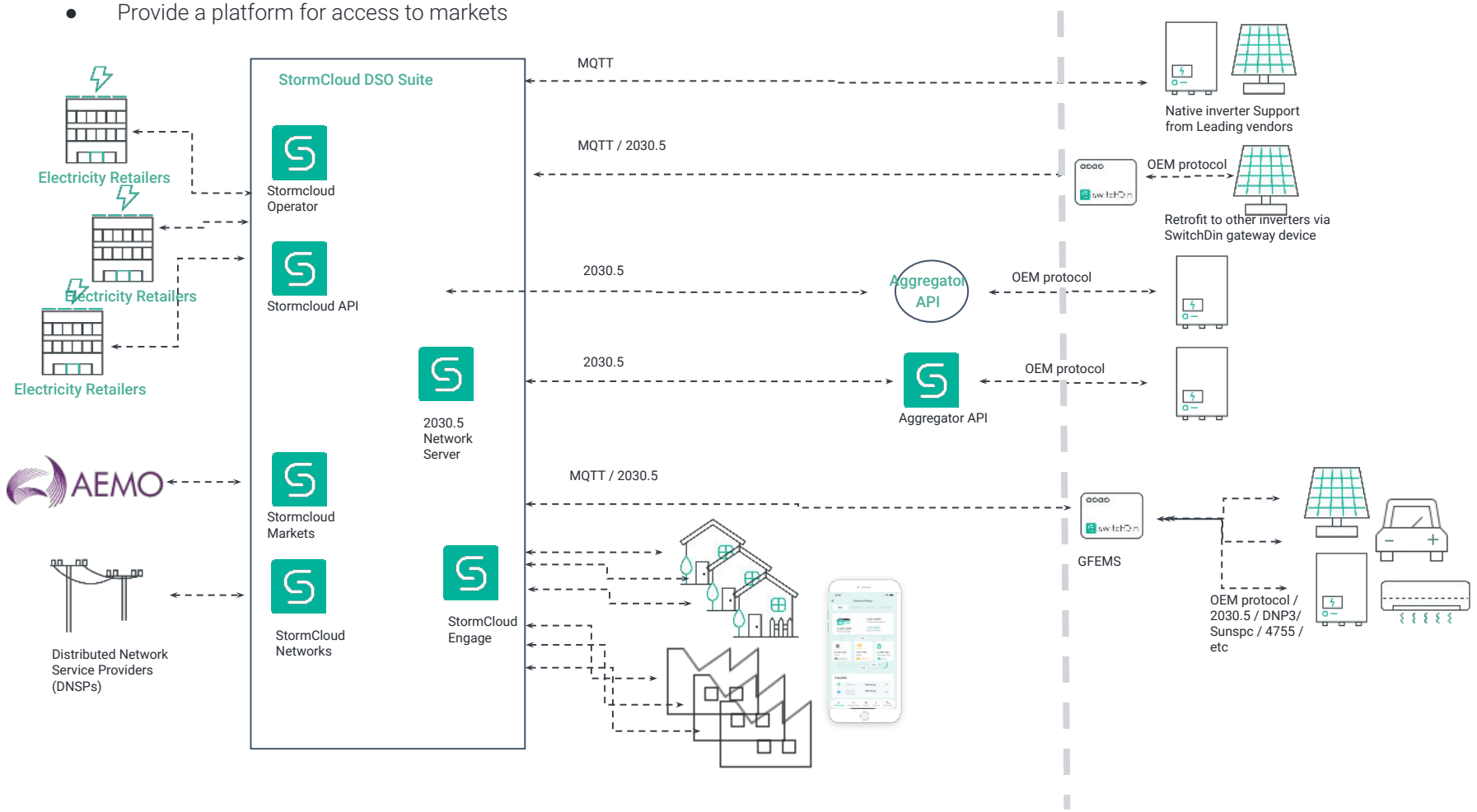
-Energy monitoring & management
-Asset & tariff optimisation
-Alerts & other integrations
-Expansion-ready

Energy Customers with DER Assets

SwitchDin Flexible Energy IoT Architecture

Transform the network business model to enable them to be an operating platform for DER and markets.

- Focus on flexibility of DER assets and maximise value for asset owners
- Ensure safe and efficient operation within physical limits
- Provide a platform for access to markets

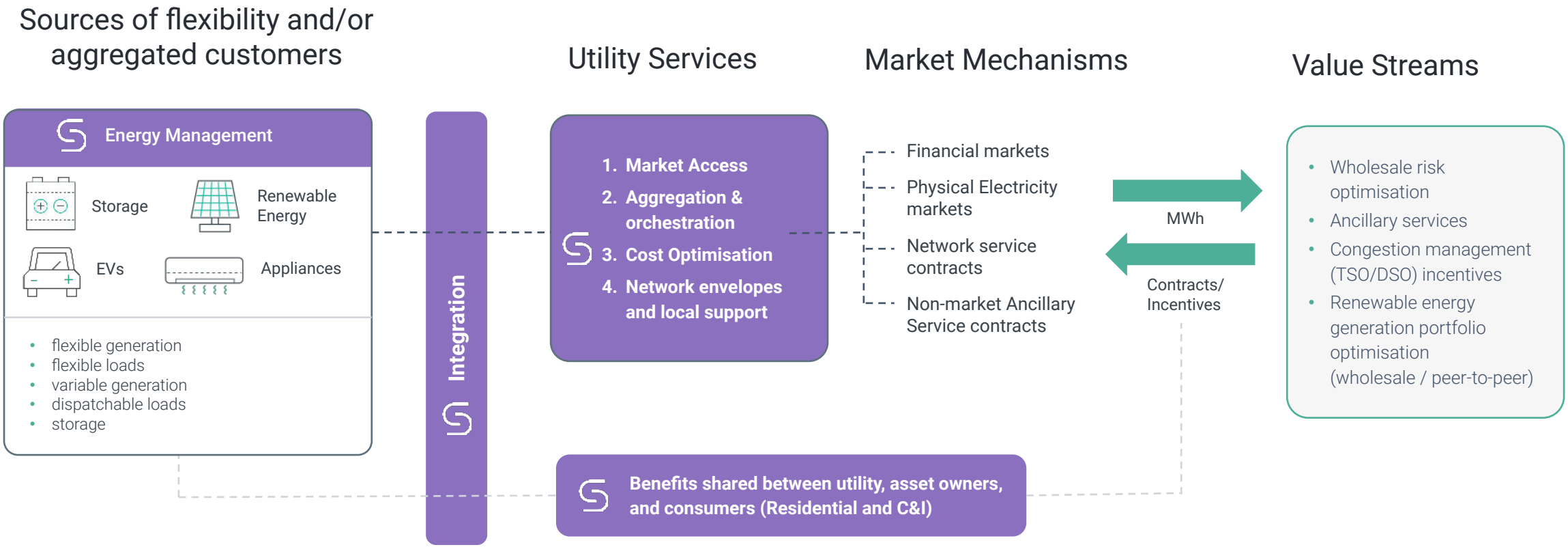


Business Processes

- Device, customer and Retailer registration
- Contracting of services
- Deployment support and the role of intermediaries
- Network and market tools
- Bidding and Settlement

The SwitchDin end-to-end Business Solution

Core flexibility & aggregation services (in a box)



IEEE 2030.5 case studies from Australia

How IEEE 2030.5 fits into Australia

There is no nation-wide standard for DER orchestration, but distribution networks are trialling different options case-by-case

IEEE 2030.5 is a possible standard to use given its adoption in larger markets such as California

SwitchDin is the first company to be implementing both server and client solutions in Australia and has supported all the main pilots.

SwitchDin involved in development of CSIP-Aus based on CSIP Implementation Guide (was/is/why); API working group (ANU) now applying this

This process is 'shoehorning' the standard into Aus context - especially for visibility of individual assets and loads behind point of common coupling

Pioneering IEEE 2030.5 projects:

→ Horizon Power Onslow DER Project (Western Australia)

→ Flexible Exports project with SA Power Networks and Ausnet Services (SA & VIC)

→ ANU/ Zepben Evolve project

But it's not the only game in town… there are other non-IEEE 2030.5 DER orchestration projects by SwitchDin's and others

→ Horizon Power Smart Sun Pilot

→ Bruny Island CONSORT / Network-Aware Coordination (NAC) Project in Tasmania

→ Network model approach & Dynamic Operating Envelopes by SA Power Networks

Non network-projects (market focus):

→ Energy Locals / Tesla VPP (SA)

→ Simply Energy VPPx (SA)

→ Origin Energy VPP (VIC)

→ AGL VPP (VIC)

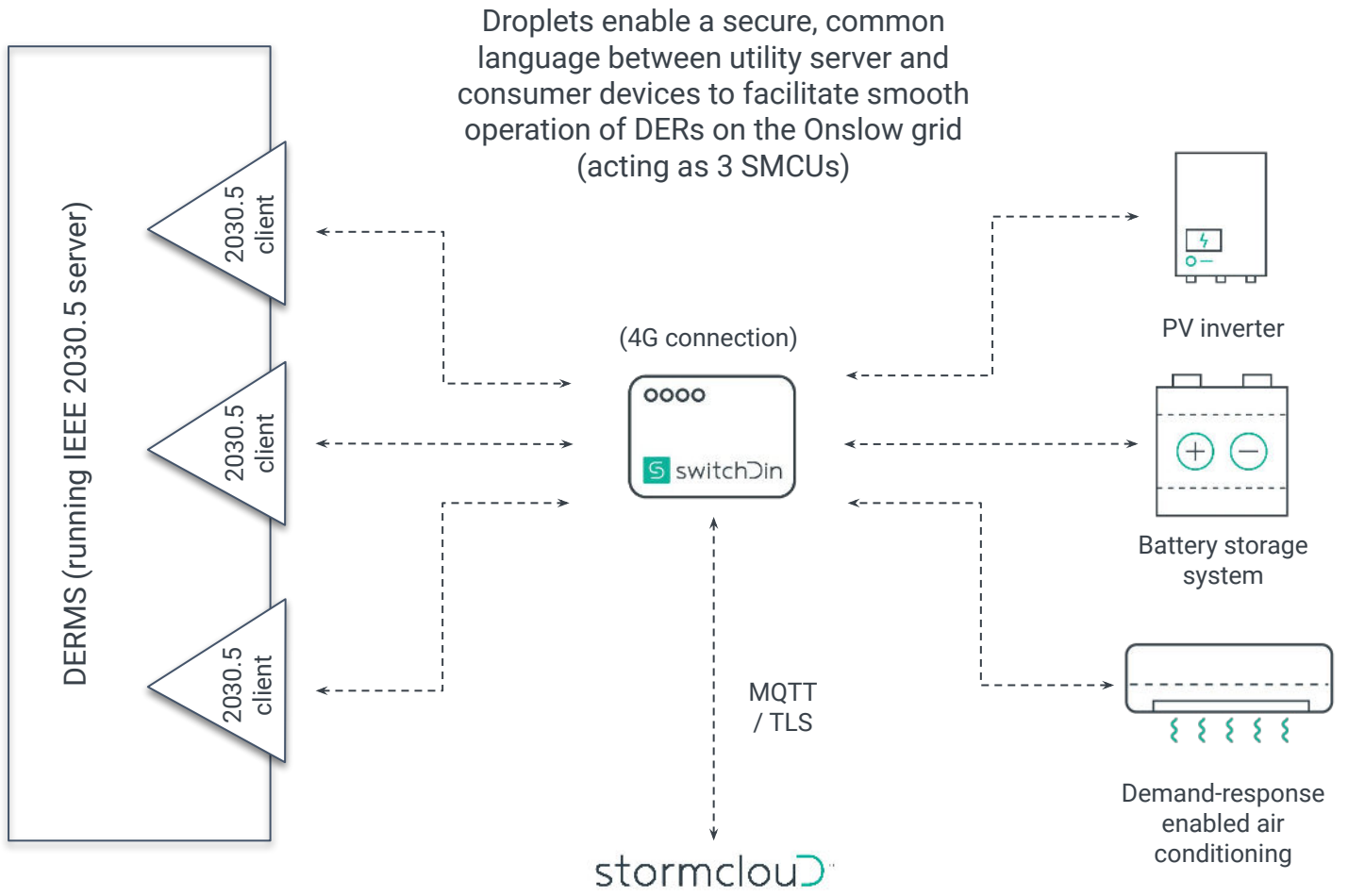
Onslow DER Project (Horizon Power, Western Australia)

Background:

- Horizon Power services rural/regional WA
- Integrated utility operating 38 separate power systems across the state's vast area
- In line with the state's DER Roadmap, rolling out new and innovative ways to provide its customers with more sustainable and affordable energy
- Onslow has a local population of about 900, with constraints on connection DER like solar PV & battery storage to maintain grid stability
- Unmanaged hosting capacity of 850kW of solar, which Horizon Power estimated it could nearly triple by increasing asset visibility and introducing feed-in management
- First 'business as usual' approach to DER asset management in Aus
- Among the first Aus projects to deploy IEEE 2030.5 for registration and management of assets

Onslow DER Project (Horizon Power, Western Australia)

High level block diagram: How the SwithDIn Droplet interfaces with the distributed Energy Resource Management System (DERMS) and customer Distributed Energy Resources (DERs) in Horizon Power's Onslow DER Project



SwitchDin Droplets with IEEE 2030.5 client act as secure gateway devices (SGDs)

Onslow DER Project
(Horizon Power, Western Australia)

Highlights & outcomes:

- SwitchDin's Utility Droplets deployed as 'secure gateway devices' running IEEE 2030.5 client, acting as smart control units (SMCUs)
- SwitchDin worked closely to develop implementation of server with Horizon Power and DERMS provider (PXiSE) and implementation of IEEE 2030.5 client
- DER assets included PV inverters, battery storage, and air conditioners (DREDs)
- No group management functions (as per utility specifications)
- Approx half of Onslow households now have Droplets installed with their systems
- 2.4MW PV capacity / 1.9MW inverter capacity now installed throughout Onslow (up from 850kW)

IEEE 2030.5 adaptations included:

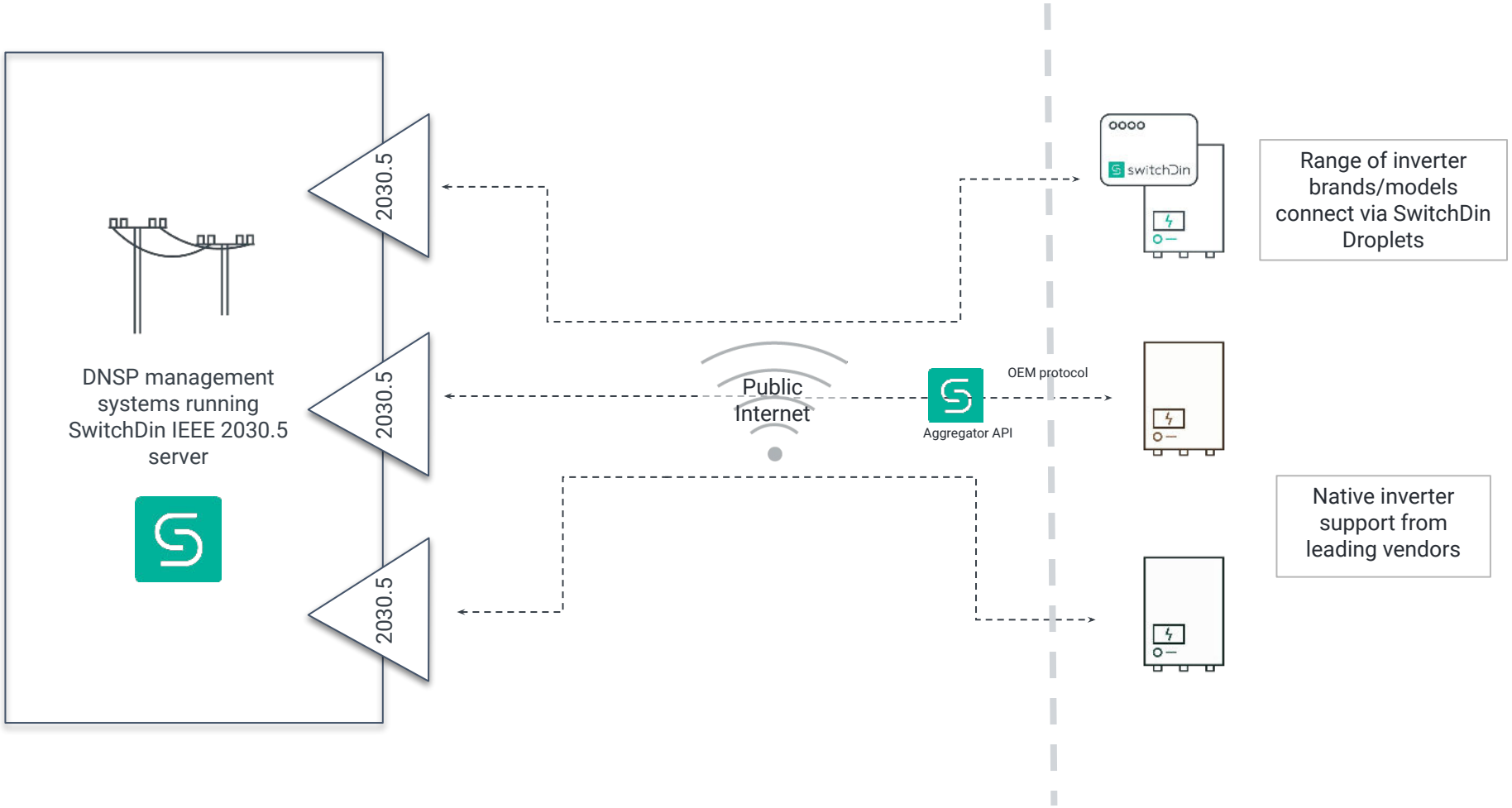
- Control of individual assets 'behind the meter' as opposed to site's Point of Common Coupling (PCC - for site-level control) as in Californian implementation (not GFEMS)
- If devices not registered (i.e. lost connection) with SEP server, default production reduced to 0W
- Horizon Power is the certificate authority (SERCA)
- To try to minimise data costs, types of payloads:
  - XML (plain text) - uncompressed
  - GZIP'ed XML payloads (compressed) - not in accordance with the standard

ARENA Flexible Exports (SA Power Networks & Ausnet Services)

Background:

- SA Power Networks and Ausnet Services are two DNSPs grappling with high uptake of rooftop solar
- Traditional DNSP strategy has been to implement static export limits or system sizes on newly connected PV systems to maintain system stability
- Flexible Export connection type is proposed as a solution that will maximise benefits for both DER owners & DNSPs
- Soon to be deployed for select areas of Adelaide (where network congestion is an issue), and regional Victoria (where static export limits are implemented)
- 600 sites to be enrolled as part of the trial beginning mid-2021

ARENA Flexible Exports
(SA Power Networks & Ausnet Services)



SwitchDin Residential Droplets connect a range of other inverter assets

ARENA Flexible Exports
(SA Power Networks & Ausnet Services)

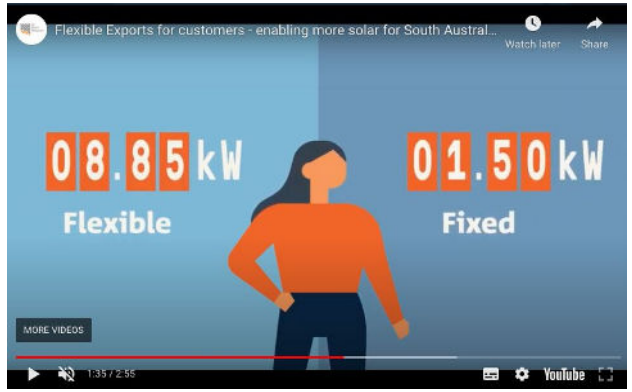
Highlights & outcomes so far

- SwitchDin provides the ‘technology backbone’ to the project, developing the IEEE 2030.5 server as a ‘plug in’ for the utilities, removing complexity
- Fronius (SNAP), Growatt & FIMER inverters via Droplets adapting to IEEE 2030.5 clients
- No group management functions

- SA Power Networks launched Flexible Exports as ‘a new solar connection option’ that will allow solar customers to export up to 10kW/ph when feasible
- Supporting state regulator’s Smarter Homes ‘Dynamic Export’ requirement, which becomes mandatory from Oct 2021

IEEE 2030.5 adaptations include:

- new control to differentiate behind the meter control and Point of Common Coupling (PCC) control
- SwitchDin operates as the certificate authority (SERCA)
- DefaultDERControl is being used as the failsafe mechanism to revert the PV to zero export on loss of comms to the utility server



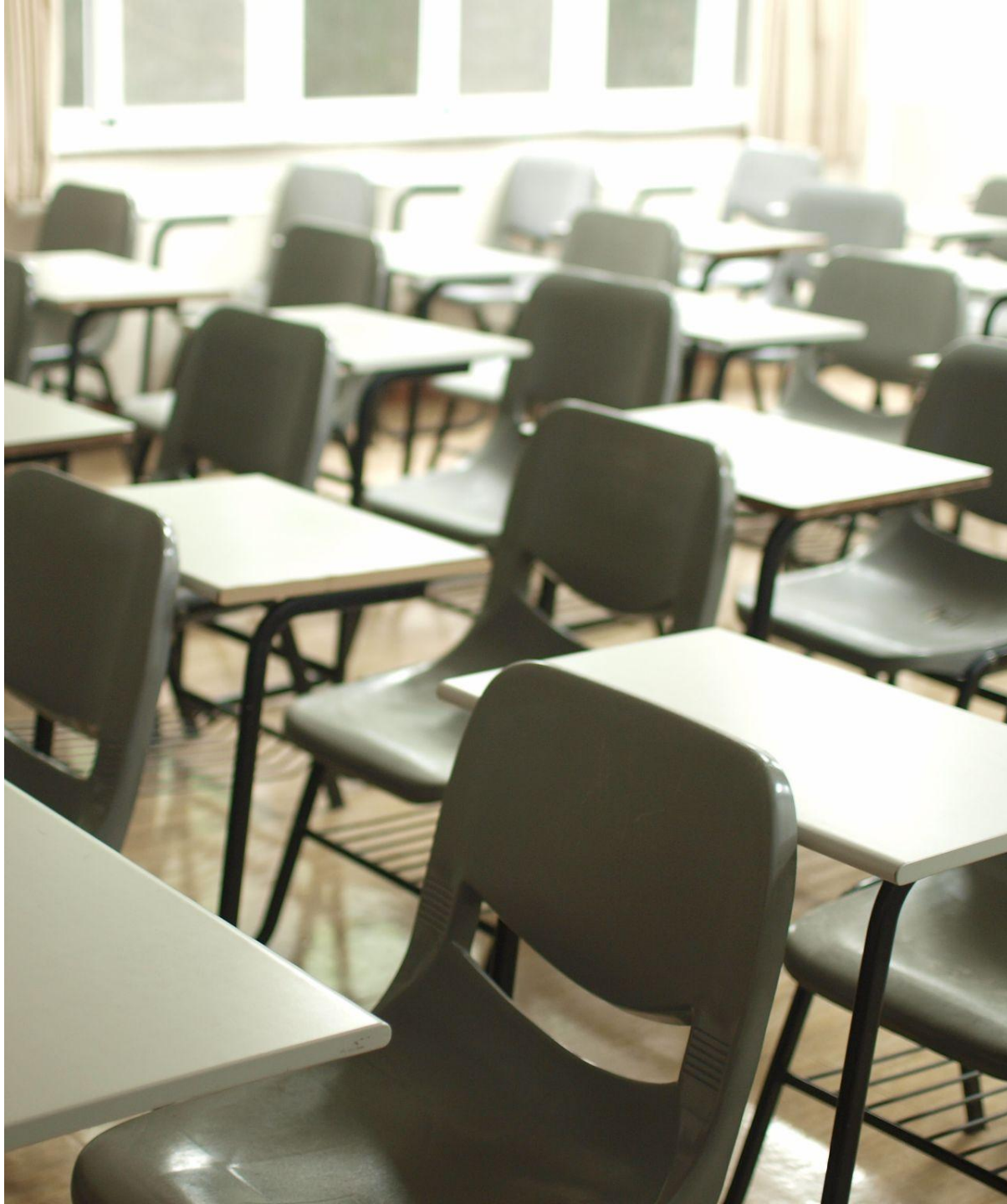
More info:
www.sapowernetworks.com.au/future-energy/solar/

Industry Lessons Learned

- Organisation structure and asset ownership models can’t be overlooked
- OEM adoption is key
- One architecture fits all is not the objective
- Semantics of standard and interpreted has consequences for interoperability.

  > “Implementers SHALL refer to each utility’s Interconnection Handbook for requirements related to the creation, use or management of this identifier [GUID]” [CSIP implementation guide]

- Needs to be developed as rollout progressed. Linking with deployment workflows (e.g. default settings or modes of autonomous functions at deployment)



IEEE 2030.5 implementation: Key challenges

- **Heavy on data** → uses XML, restful API. delivers heavy data usage driving comms costs
- **Uses bounded variables (so not floating)** → not generic, requiring larger payloads
- **Doesn't differentiate between assets at PCC (e.g. EMS) or direct control of BTM assets** → specified an export limit (opModExpLimW - New) and also generation limit (opModMaxLimW)
- **Certificate management AU not part of Sunspec certificate chain** → sovereign risk requires own certificate management process in AU
- **Registration process needs AU specific data** (NMI, address) in CSIP AUS → add new payloads to standard

The future of IEEE 2030.5 in Australia

- **Likely that IEEE 2030.5 will continue to be adopted, but challenge to reach standardisation,** continuing to vary by state, project and/or DSNP with modifications to suit the application
- Data costs will continue to be a challenge to the business model unless hybrid IoT deployed.
- Expect increasing trials of alternative options (e.g. IEC61850, OpenADR and IIoT)
- DER API Working group - 2030.5 implementation guide & CSIP-AU
    - Horizon Power, DRED control (AS4755) into CSIP-AU
    - Flexible Export, Export Limit Control into CSIP-AU
    - Demand Limit Control
    - Dynamic Operating Envelopes

Thank You

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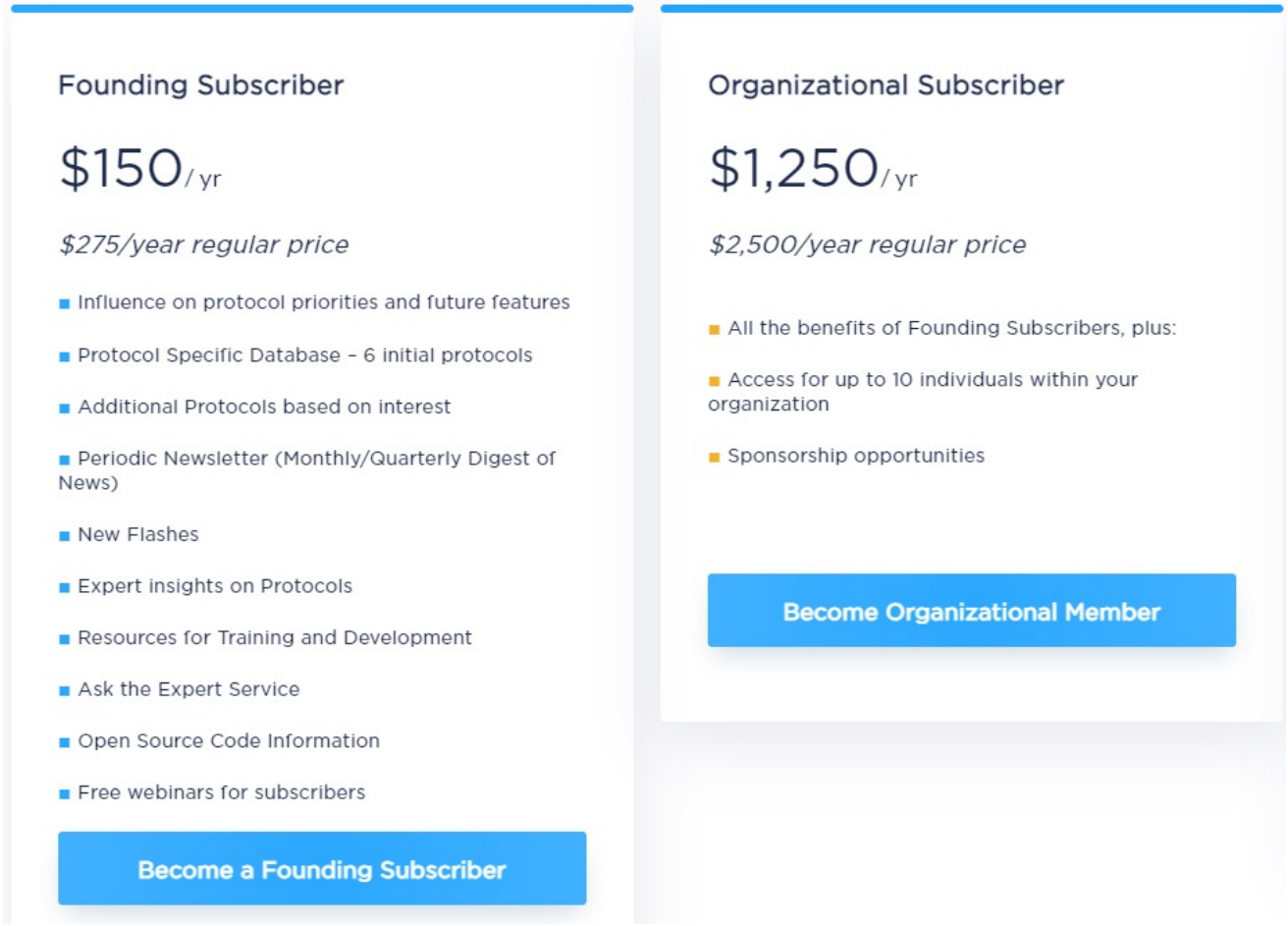

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In Conclusion

- Many thanks to Stuart, Andrew, David, Eamonn and Tom
- Watch for an email
  - Feedback survey
  - Links to the slides and recording (available to everyone for one week after posting)
- Future GEI Mini-Forums? Let us know if you'd like to see more – and what topic

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