Grid Modernization Stakeholder Workshop

May 10, 2017

Smart Electric Power Alliance

Relevant Standards

Electrical Integration

- **IEEE 1547** Suite: DER Devices (e.g. Smart Inverters), Full Revision Underway
  - SGIP Working Group PAP 7 worked on use case descriptions for 1547.8. The group extended ES-DER object models in IEC 61850-7-420 as needed.
  - Expanded Voltage Ride-Through, Expanded Frequency Ride-Through, Frequency-Watt "Droop" (like Germany!), New Secondary Network Language, Expanded Power Quality Details, Improved Anti-Islanding, Active Voltage Support
- **UL 1741**--Scope: Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources
- **UL 9540** -- Standard for Safety for Energy Storage Systems and Equipment

Substation DER and Control Integration (SCADA)

- **IEC 61850** Suite w/DER model: Substation

Field DER Integration

- **IEEE 2030 Suite**: Device Model (e.g. Inverters, Meters, EV's)
- OpenADR + ASHRAE 201: H/B/I + DER Service Model (e.g. DR, DP)-- Current investigation into expanding OpenADR Services Model for 1547 Smart Inverters
- **OpenFMB™**

Data Integration

- **OrangeButton** (Industry driven defacto standard)

http://www.gridstandardsmap.com

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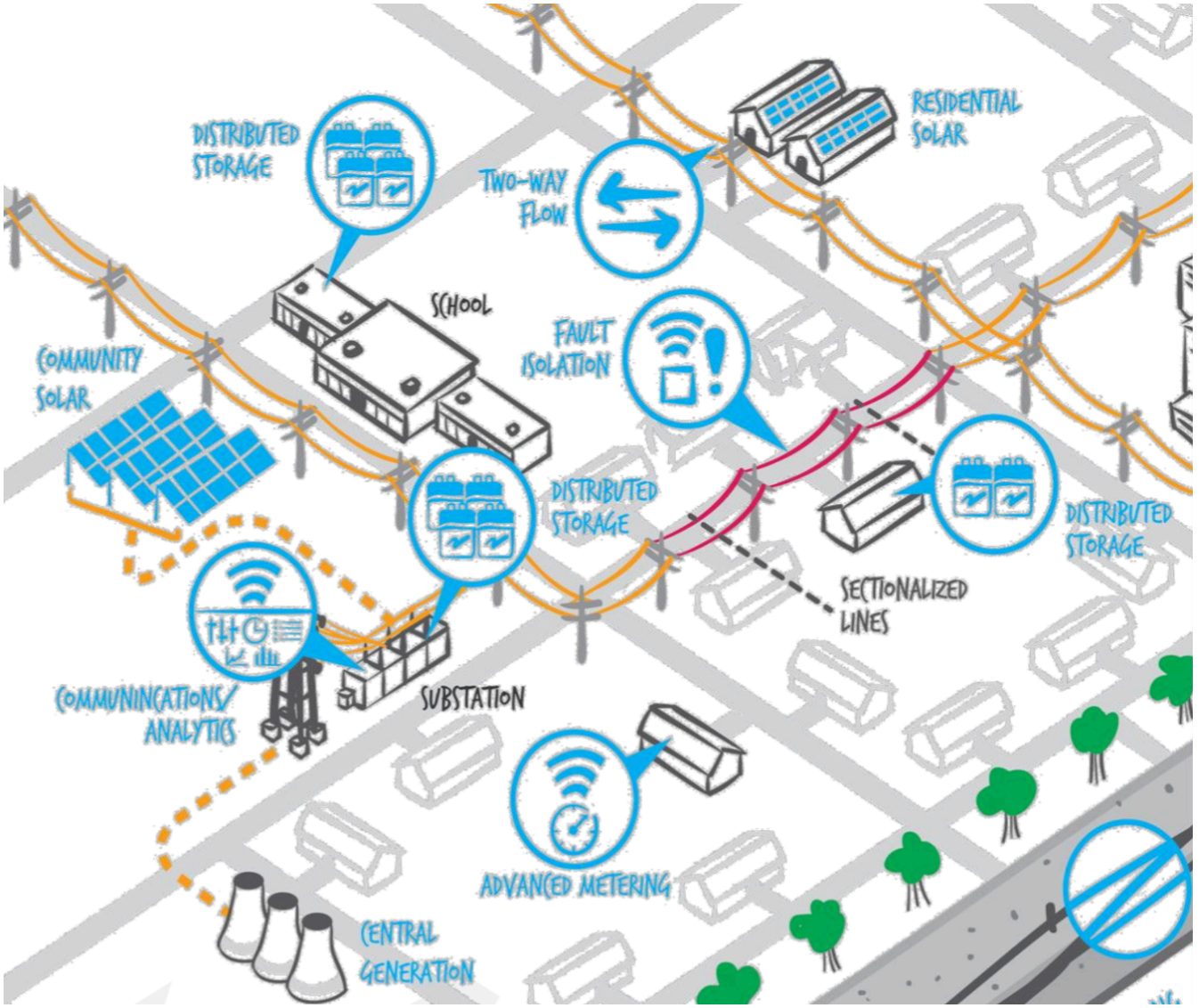
Relevant OpenFMB™ SGIP Use Cases

- DER Circuit Segment Management
  - Primary Scenario: Voltage, Frequency, Power Factor Support
    - DER Point of Interconnection (POI) Coordination
  - Secondary Extensions
    - Solar Smoothing: Reduce Circuit Segment Volatility
    - Volt-VAr Management: Power Factor Optimization
    - Peak Demand: Shaving/Shifting
  - Tertiary Extensions
    - Distribution Transfer-Trip
    - Anti-Islanding: Inadvertent Island Detection



Picture: courtesy of Duke

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Key lessons learned from Grid Modernization Efforts

- Grid Modernization also includes retooling processes and making sure skills exist for the change… it is not just technology.
- Leverage AMI beyond customer operation benefits for the operations side regarding voltage control and outage restoration(ETRs), asset near-future failures (transformers).
- Customers want “Flexibility at a more local level” and don’t want to hear ‘No’ but rather how to work together
- Customer and Local Community Engagement & Education is important
- Process/system mechanism to distinguish telecomm issues from device issues (many processes, systems, groups working together)
- A setup of Executive Dashboards can go a long way to simplify what is happening in the field
- Time accuracy and synchronization are key for microgrid

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Considerations

- Understanding if controls will be completely centralized, distributed, or a mixture of both
- Planning communications as a multi-use network where possible while assuring QoS
- Thinking through what dashboards & analytics you will need
  - Manage deployments (ex, AMI) or understand what is occurring in operation (ex, FLISR)
  - Different views/information may be
  - required by different groups (field, ops, engineering)
  - Consider a new job code “Data Scientist”

Ex: OpenFMB dashboard at Duke

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Smart Electric Power Alliance

Sharon S. Allan
Chief Innovation Officer

1220 19th Street
Suite 800
Washington DC 20036-2405

SEPA
www.sepapower.org

Mobile: +1-919-414-2173
sallan@sepapower.org
www.linkedin.com/in/sharonallan
https://twitter.com/sharonsallan

Smart Electric Power Alliance

- BACKUP
  - Extra Information for leave behind

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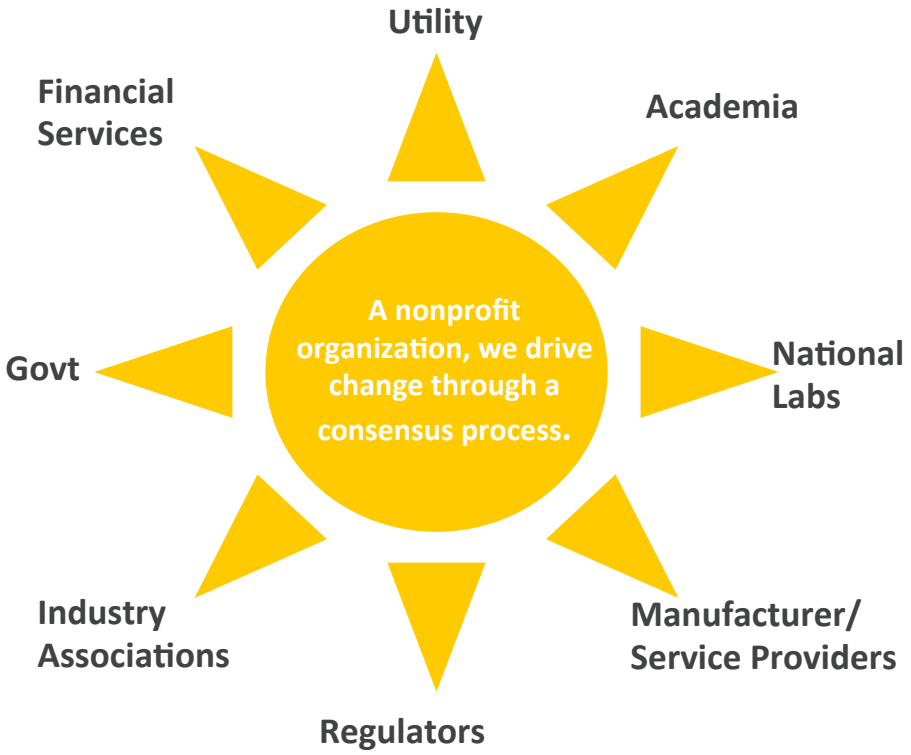
About SEPA

Mission: To facilitate the power industry's smart transition to a clean energy future through standards & interoperability, education, research, and collaboration.

SGIP merged with SEPA on 4/1/2017. We are still in the process of integrating the two organizations so both websites are still operational until such time that we get all the SGIP content migrated to the SEPA website



www.sgip.org
www.sepapower.org

~1200 Member Companies
(over 570 utility companies)

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Strategic Focus

- Driving development and adoption of standards for interoperability at the grid edge where integration and coordination of Distributed Energy Resources (DER) are becoming part of the overall grid
- Serving as the voice for Internet of Things (IoT) for the energy sector
- Convening stakeholders to address distributed energy resource activities
- Growing Cybersecurity knowledge sharing
- Executing Orange Button by a developing a standardized solar data taxonomy to reduce the cost of solar
- Driving education of interoperability through the work outputs of our committees
- Providing Market Research and Program Advisory Services for Solar

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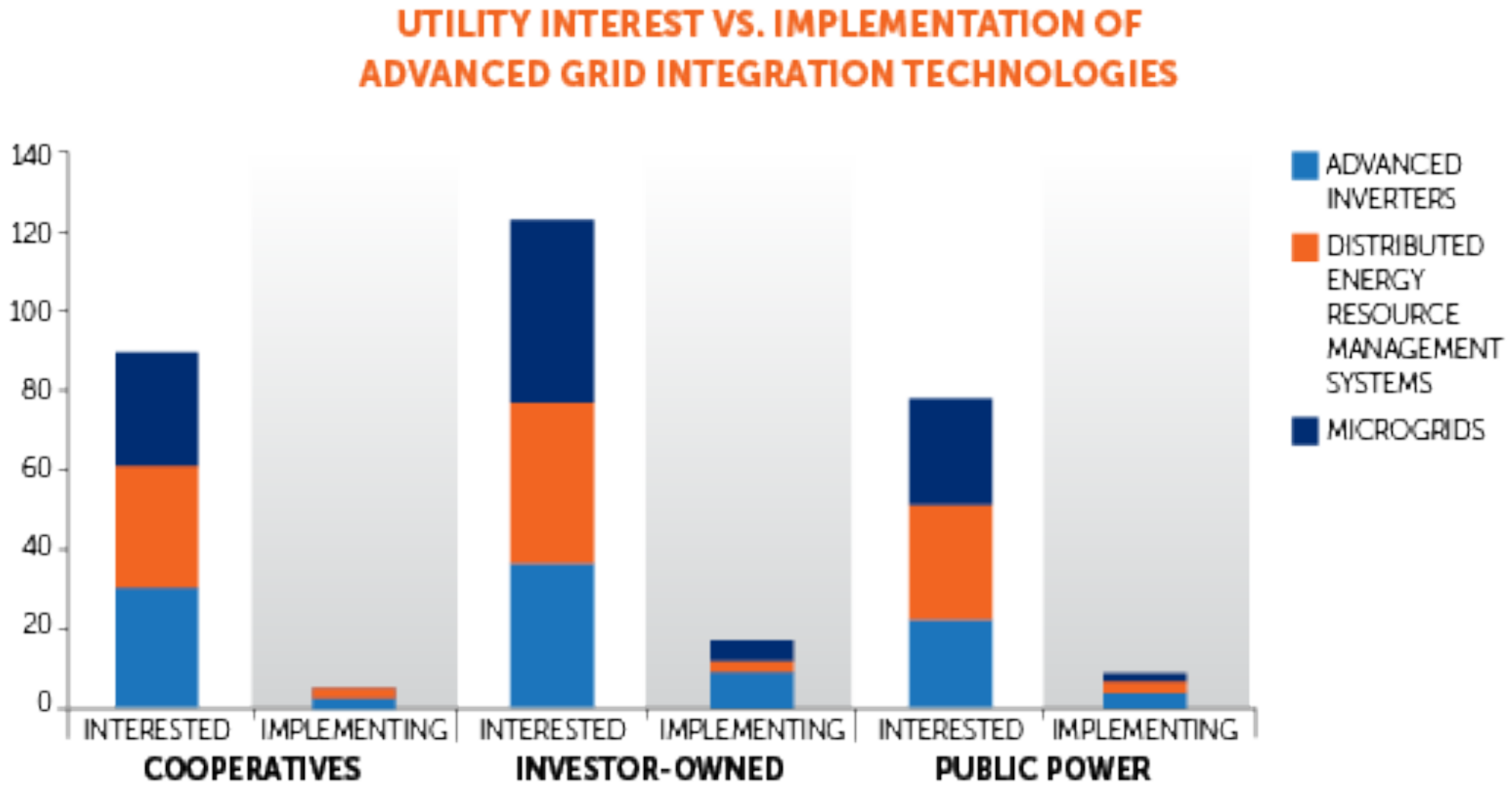
Management Systems for DERs are in the early days



Source: Smart Electric Power Alliance, 2016

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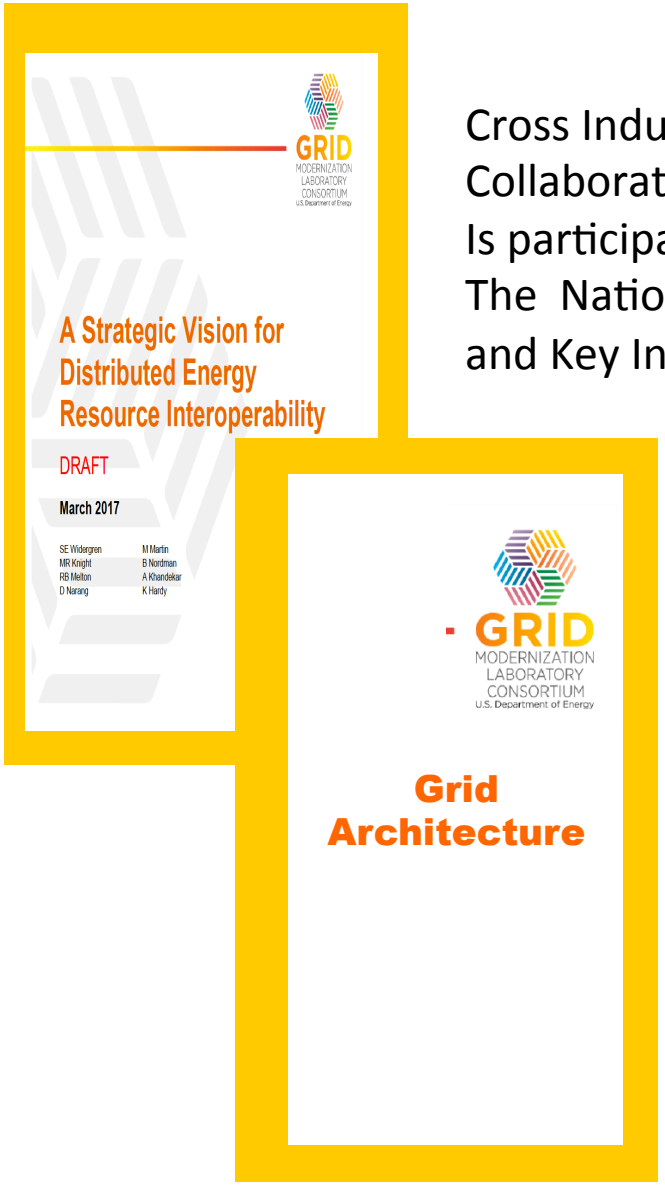
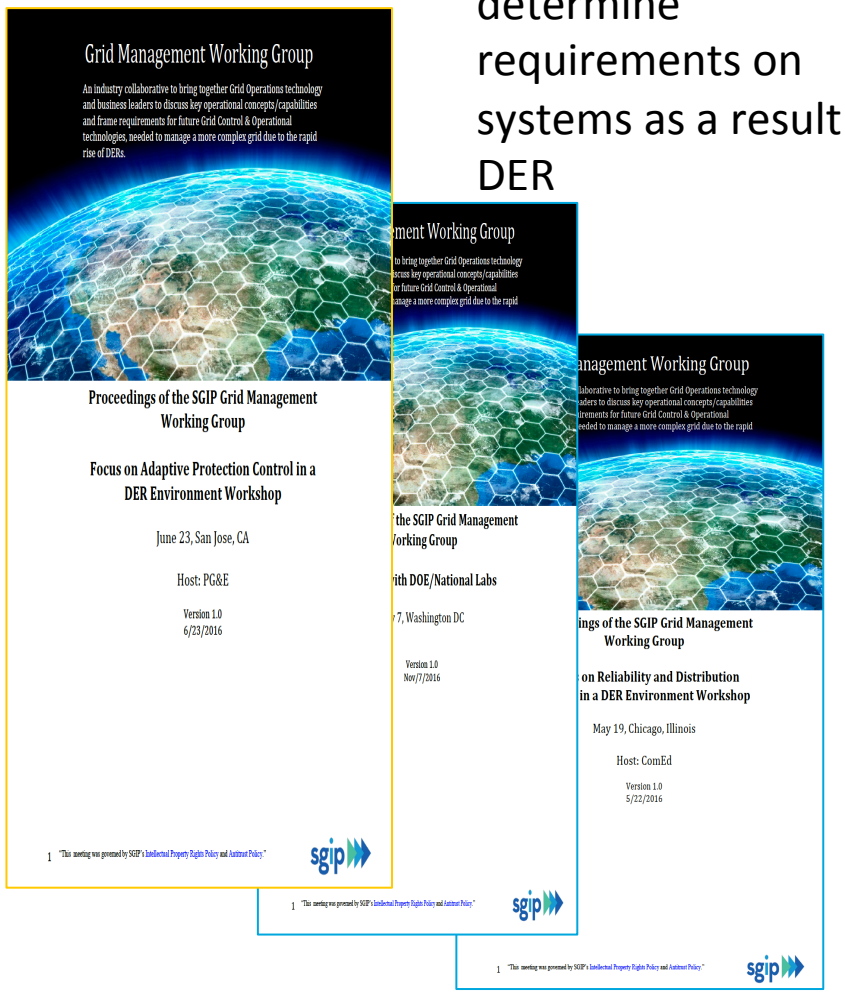
Examples of Good Things Happening to Help DER implementations

- GMLC Projects



Cross Industry Collaborations that SGIP Is participating in with The National Labs, and Key Industry leaders

- Grid Mgmt. Group
- OpenFMB



Collaboration that SGIP is leading to determine requirements on systems as a result of DER

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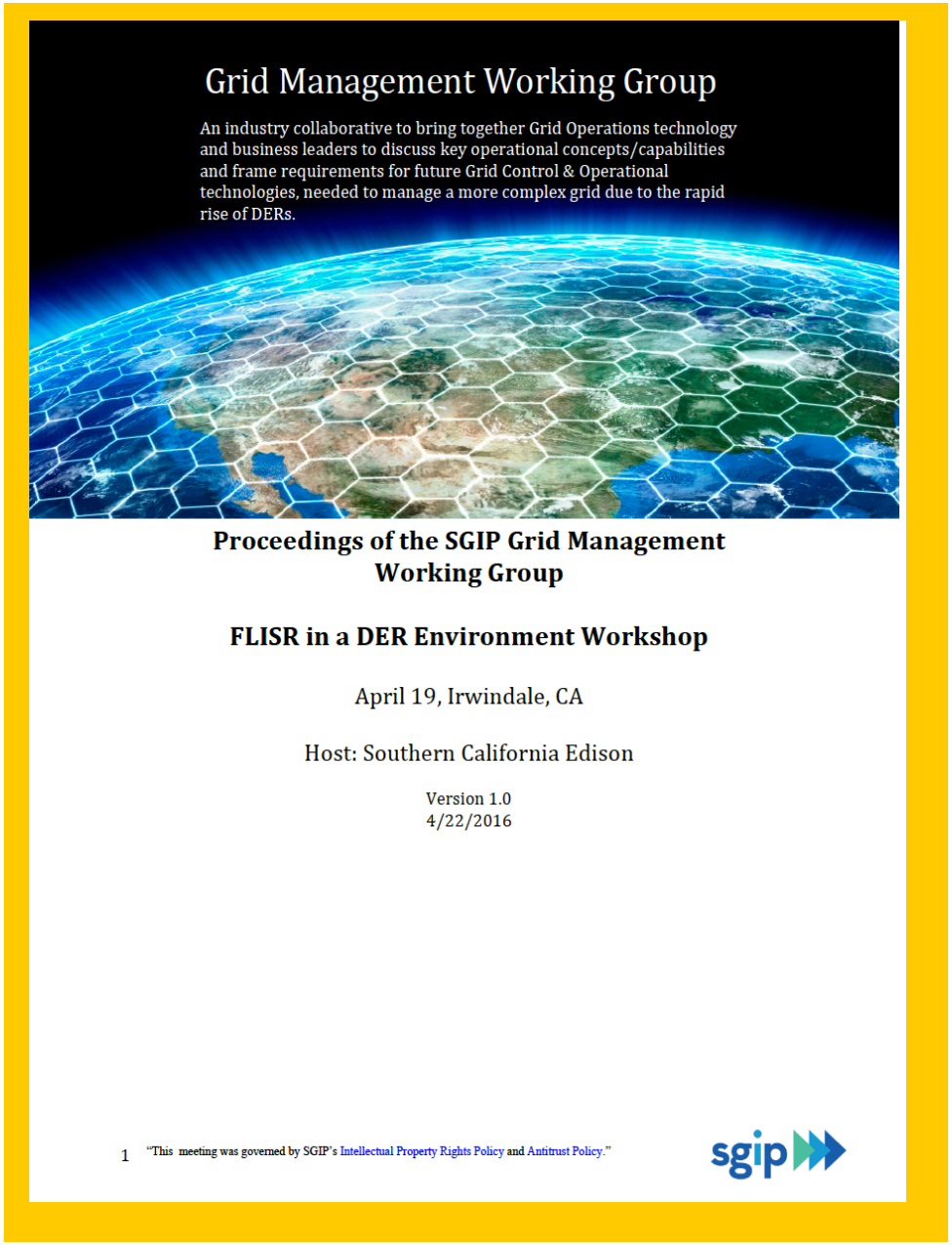
DERs have an Affect on Existing Processes



Example Requirements

ID	Requirement
FR 13	System must continuously evaluate situation over time, determine optimal solution, and initiate automatic or machine assisted (manumatic) actions
FR 14	Need status of volt/VAR management devices
FR 15	FLISR optimizer can form and manage isolated grids (microgrids) in its optimization
FR 16	Isolated grids need to identify regulating device (see microgrid use case)
FR 17	Need frequency and phase angle sensing for docking and undocking (see microgrid use case)

SGIP has been running a working committee to tease out requirements on distribution system processes as a result of higher penetration DER

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- OPENFMB Introduction

SGIP kicked off this activity in 2015 with a few utilities, vendors, and other industry participants such as EPRI, NIST, etc.

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OpenFMB™: The Catalyst for Interoperability

- Open Field Message Bus (OpenFMB™) is a reference architecture and framework for distributed intelligence and grid-edge interoperability
- Leverages existing standards to federate data between field devices and harmonize them with centralized systems
  - Utility industry standardized semantic models
    - **IEC's Common Information Model (CIM) used in first reference implementation**
    - **Other standards/platforms being considered (e.g. IEC 61850, OpenADR, Volttron, etc.)**
  - Internet of Things (IoT) publish/subscribe protocols
    - **DDS: Data Distribution Service**
    - **MQTT: Message Queue Telemetry Transport**
    - **AMQP: Advanced Message Queue Protocol**
- Scales operations independently, without a system-wide rollout
  - Flexible integration of renewables and storage with the existing grid
  - Accelerates ability to stack operational benefits
- OpenFMB™ RMQ.26 standard was ratified in March 2016 by the North American Energy Standards Board (NAESB)

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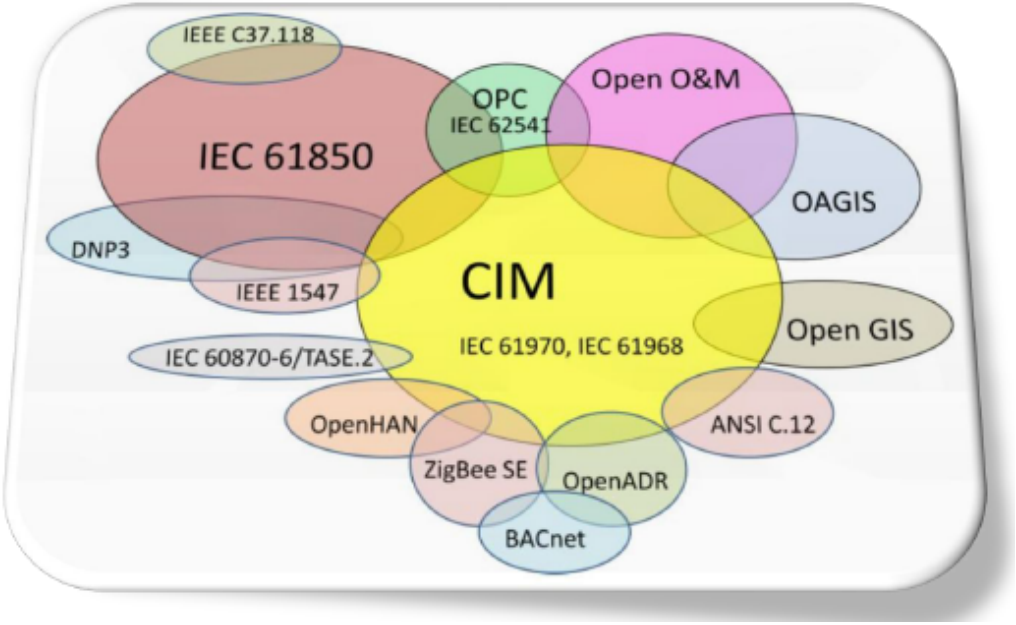
OpenFMB™: Guiding Principles

- Agile and Evolving Architecture
  - No “one-size-fits-all” technology for DERs with existing T&D
  - Any Common Data Model with Any IoT Pub/Sub Protocol
- No reinventing wheel / No duplicating of standards effort



- Focus on business value by solving real problems
- Flexibility, scalability, & backward-compatibility are critical
- Security & configuration built-in at the start

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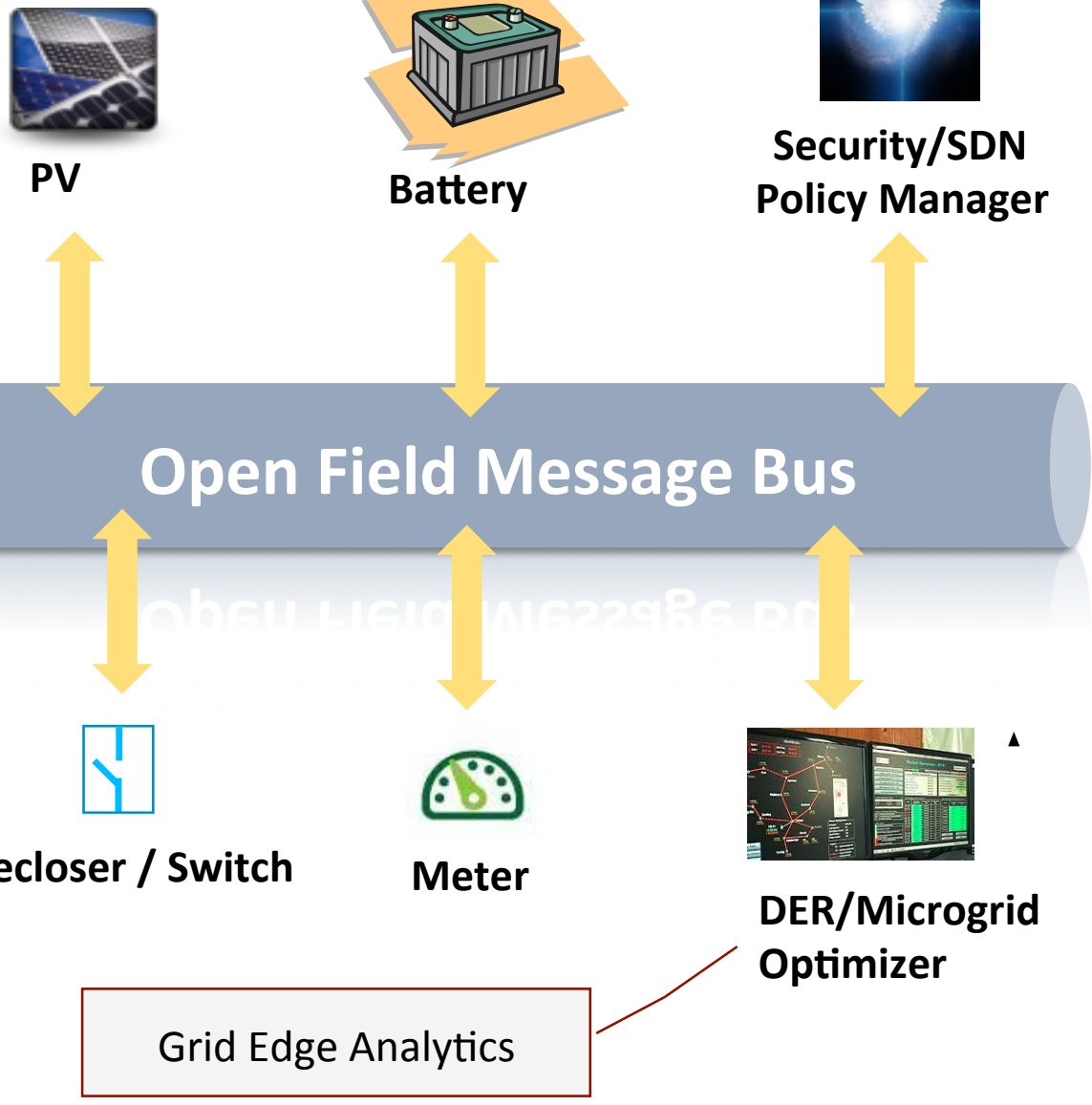
OpenFMB™ : Federated Deterministic Exchanges

- Periodic Readings - Pub every few secs or near-real-time
- Data-Driven Events – on status change in near-real-time



Readings
KW A/B/C
KVAR A/B/C
V A/B/C
I A/B/C
Phase Angle A/B/C
KWh
Timestamp
State of Charge

Status, Events, Alarms, & Control
Trip / Open
Timestamp

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Learn More & Participate

SGIP OpenFMB™ Information:

www.sgip.org/openfmb

What you can do now:

- **Download OpenFMB Code**

www.openfmb.io

- openfmb-simulators - https://github.com/openfmb/openfmb-simulators
- openfmb-hmi - https://github.com/openfmb/openfmb-hmi
- openfmb-adapters https://github.com/openfmb/openfmb-adapters
- openfmb-common-mqtt https://github.com/openfmb/openfmb-common-mqtt
- openfmb-loadpublisher https://github.com/openfmb/openfmb-loadpublisher
- DNP3 - https://github.com/gec/dnp3
- Modbus - https://github.com/gec/modbus

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Information About OrangeButton

SGIP (now SEPA) was awarded by DOE the OrangeButton Program to lead cross stakeholder meetings, generate requirements, and educate the industry on OrangeButton, we are working with Sunspec, NREL and KwhAnalytics.

Smart Electric Power Alliance

SUNSPEC ALLIANCE

kWh analytics

NREL NATIONAL RENEWABLE ENERGY LABORATORY

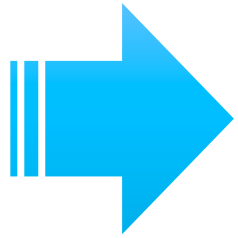
Powered by SunShot U.S. Department of Energy

About OrangeButton

- DOE initiated program to reduce the soft costs of Solar

  - **Increase Bankability of Solar Projects**
  - Reduce cost of capital
  - Improve accuracy of risk calculations

  - **Reduce Transaction Costs**
  - Eliminate friction at handoff points
  - Improve data access



- Finance
- Solar O&M
- Deployment
- Real Estate
- Grid Integration

Target = 60% industry adoption

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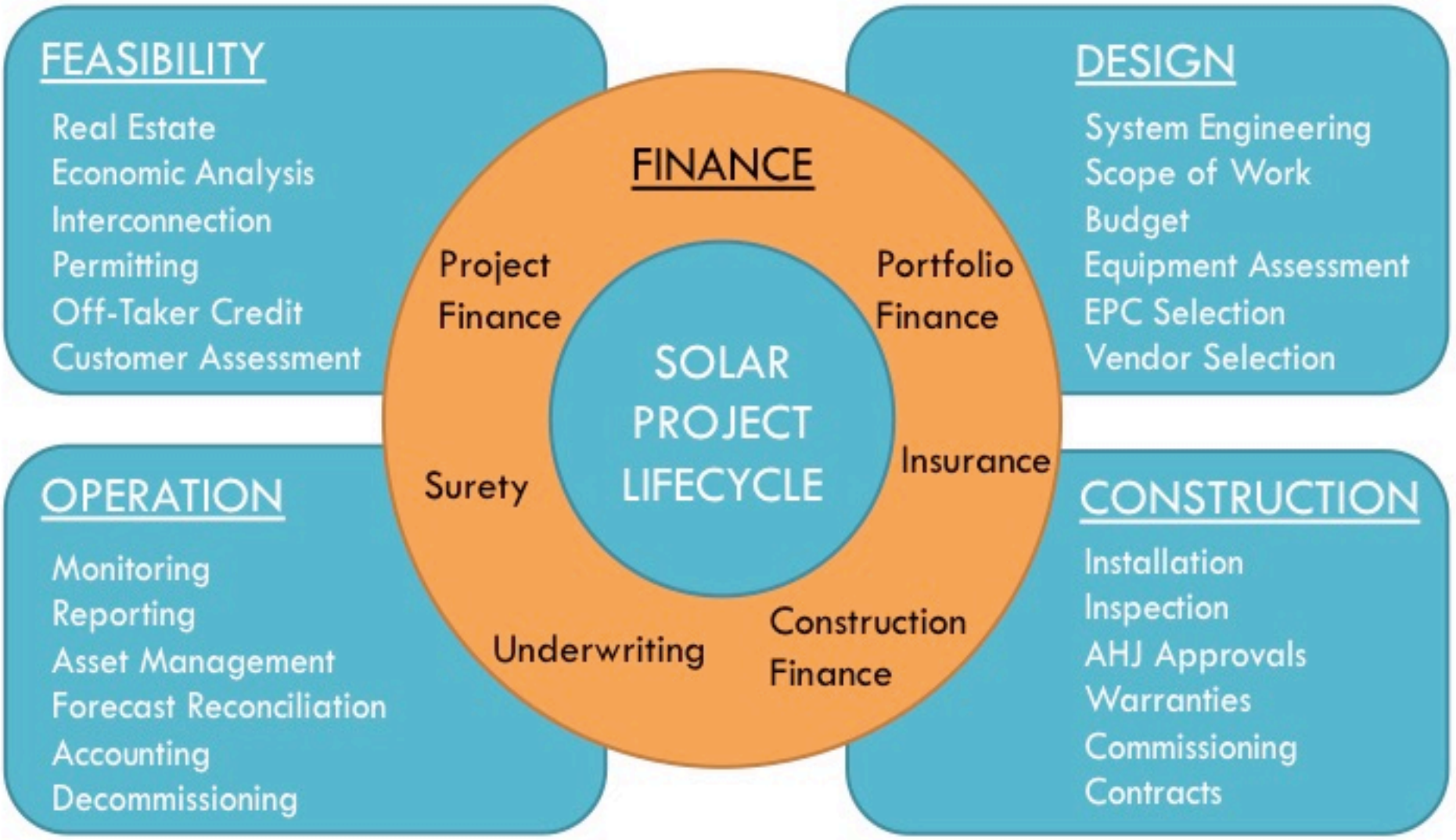
Orange Button Standard will cover the data exchanges across the lifecycle of solar



DATA TAXONOMY
INFORMATION MODELS
APPLICATION PROGRAMMING INTERFACES (APIs)
COMPLIANCE TEST SUITE

Orange Button Taxonomy Basics (finance example)

SolarCity

	As of December 31,				
	2015	2014	2013	2012	2011
	(in thousands)				
Consolidated balance sheet data:					
Cash and cash equivalents	$ 382,544	$ 504,383	$ 577,080	$ 160,080	$ 50,471
Total current assets	$ 902,138	$ 997,616	$ 785,924	$ 313,938	$ 241,522
Solar energy systems, leased and to be leased - net	$ 4,375,555	$ 2,796,796	$ 1,682,521	$ 984,121	$ 535,609
Total assets	$ 7,287,118	$ 4,551,219	$ 2,792,120	$ 1,335,592	$ 812,703
Total current liabilities	$ 1,193,362	$ 566,513	$ 338,029	$ 213,939	$ 246,886
Long-term debt, net of current portion	$ 1,006,595	$ 282,789	$ 231,504	$ 76,864	$ 14,111
Convertible senior notes, net of current portion	$ 894,560	$ 777,726	$ 222,827	$ —	$ —
Solar asset-backed notes, net of current portion	$ 395,667	$ 293,215	$ 46,824	$ —	$ —
Deferred revenue, net of current portion	$ 1,010,491	$ 557,408	$ 410,161	$ 204,396	$ 101,359
Financing obligation, net of current portion	$ 68,940	$ 73,379	$ 78,505	$ 140,639	$ 61,685
Other liabilities and deferred credits	$ 279,006	$ 218,024	$ 193,439	$ 114,006	$ 36,314
Redeemable noncontrolling interests in subsidiaries	$ 320,935	$ 186,788	$ 44,709	$ 12,827	$ 22,308
Convertible redeemable preferred stock	$ —	$ —	$ —	$ —	$ 125,722
Total stockholders' equity (deficit)	$ (316,680)	$ 745,642	$ 617,598	$ 183,601	$ (37,662)
Noncontrolling interests in subsidiaries	$ 535,062	$ 409,942	$ 186,817	$ 96,793	$ 100,338

Orange Button Taxonomy Basics

Entity
Solar City Corporation

Units
USD

Data Field & Agreed Upon Definitions
Current Assets

SolarCity

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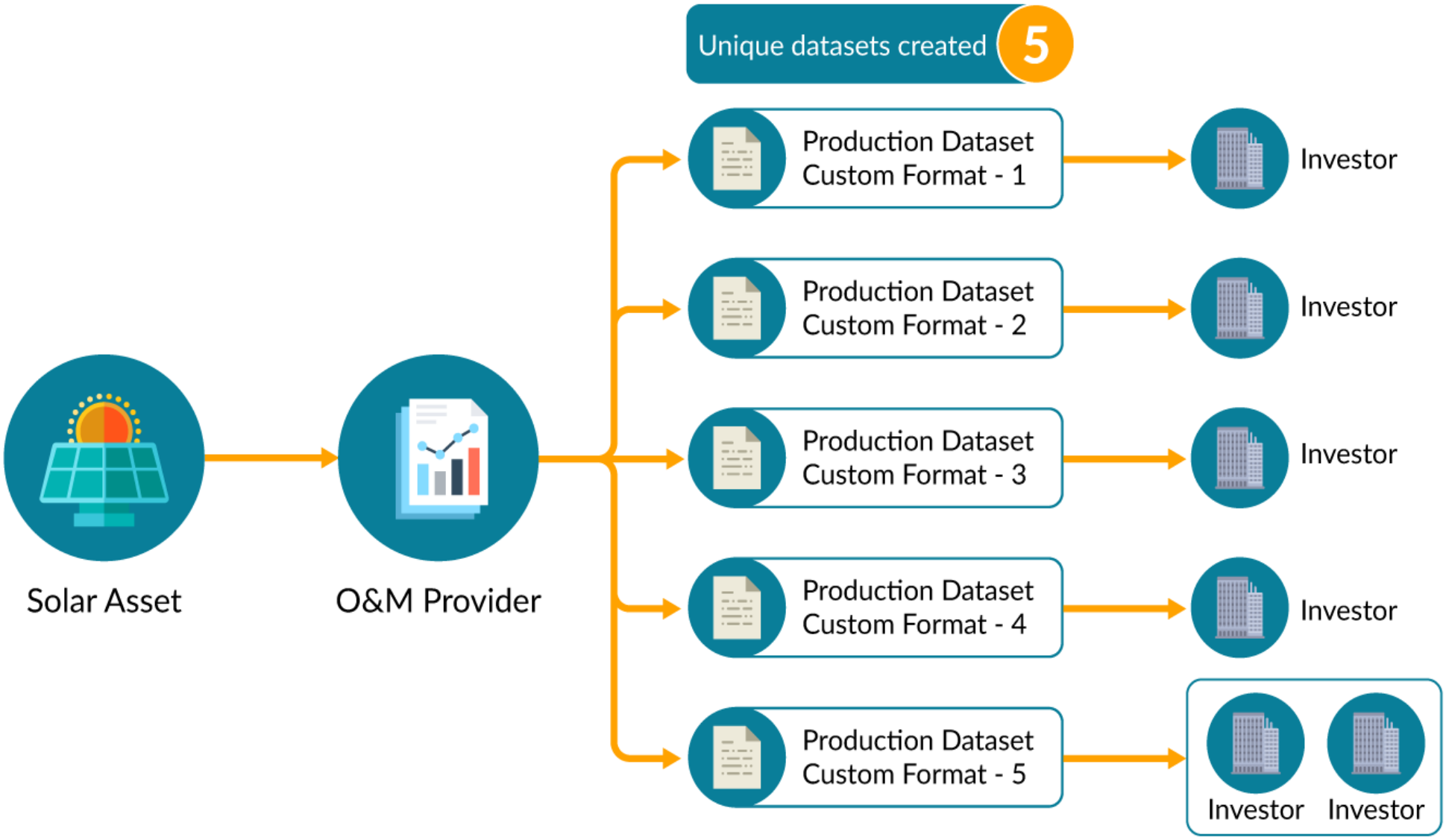
Decimals
Thousands

Period
2015

Orange Button Aims to Drive Down Soft Costs



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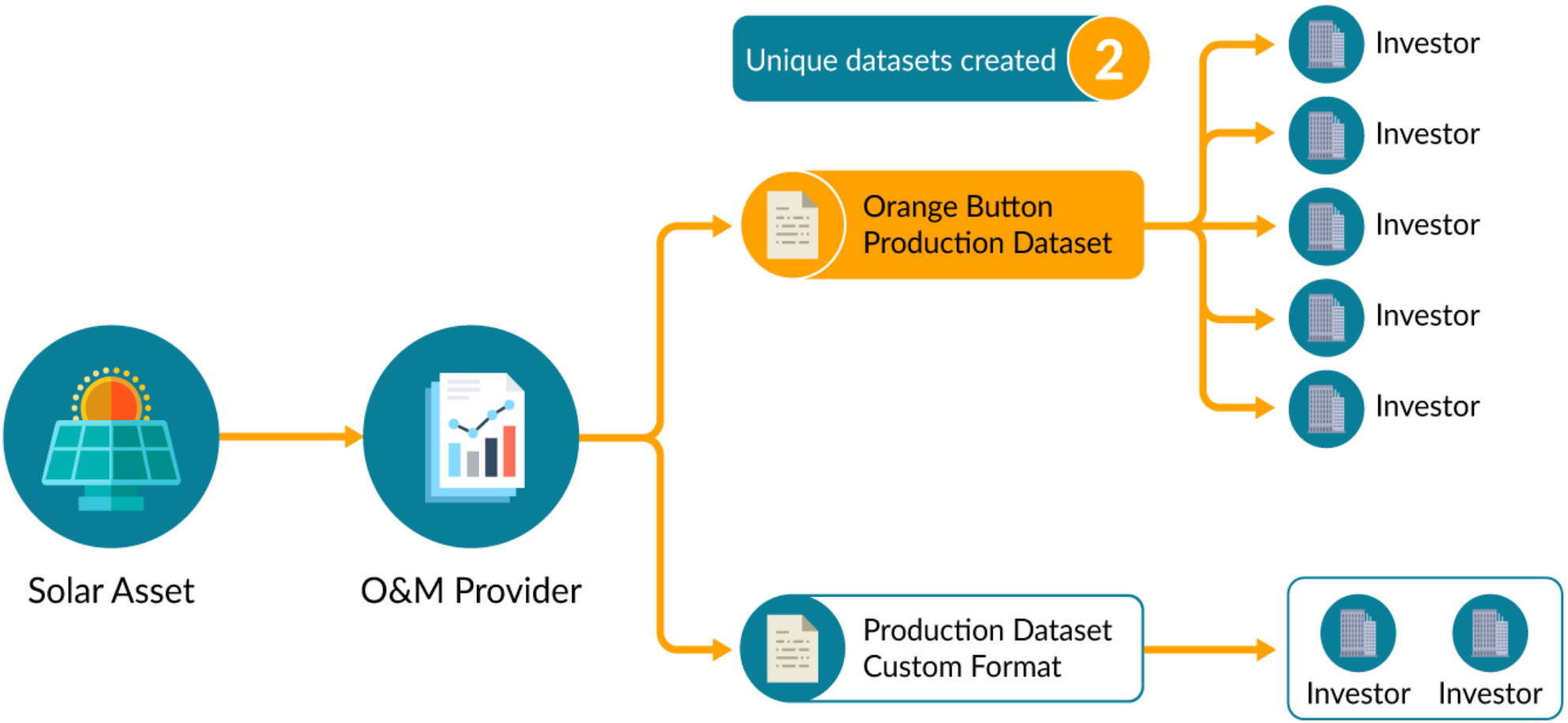
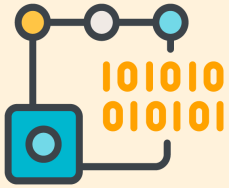


Orange Button Development Roadmap

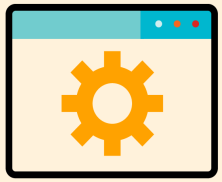
REQUIREMENTS AND USE CASES

- Finance
- Design
- Deploy
- Integrate
- Operate and Maintain



TAXONOMY AND DATA STANDARD

- Develop and Publish
  - Taxonomy
  - Information Model
- Data Standards
- APIs
- Test Framework



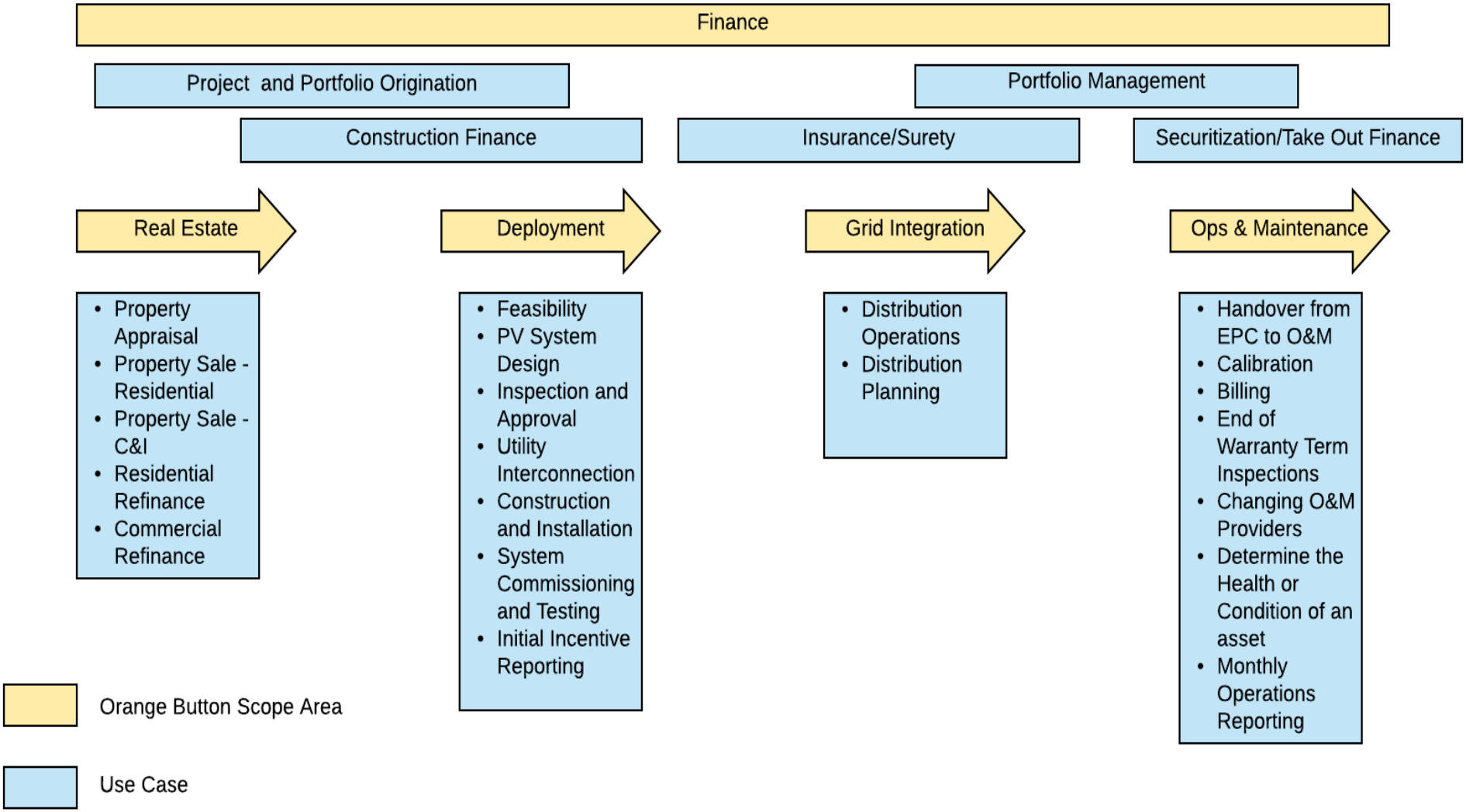
ADOPTION AND TOOLS

- Solar Data Translation Platform
- Solar Data Catalog (www.orangebuttondata.org)

Orange Button 2017 Deliverables

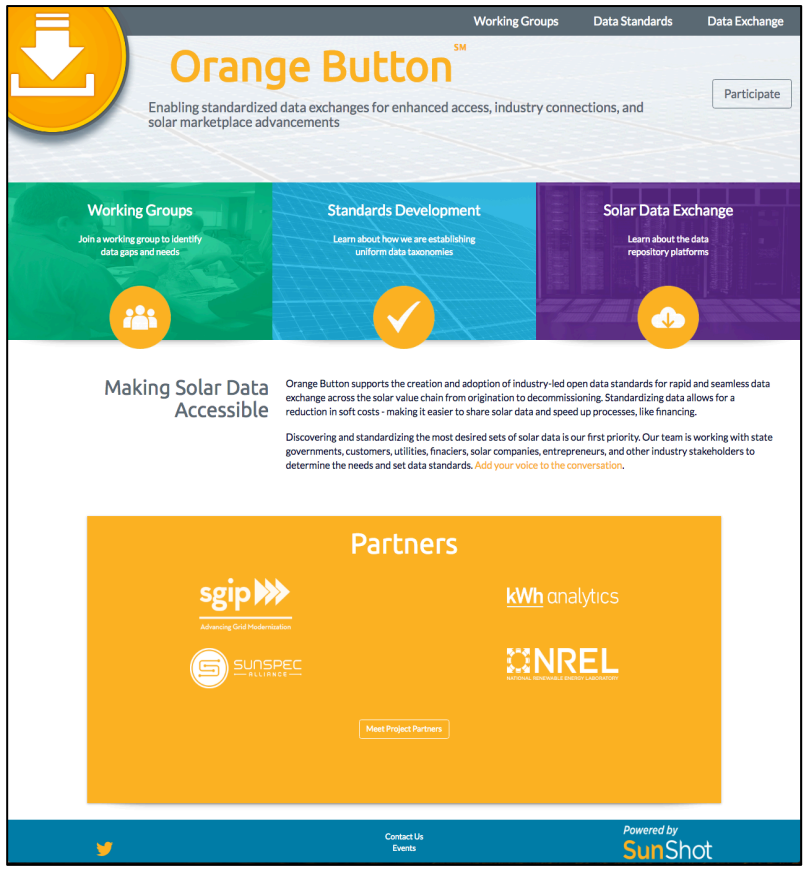
- **Orange Button Data Taxonomy Releases**
  - July 2017
- **Orange Button Web Services API Releases**
  - July 2017
- **Orange Button Conformance Test Framework**
  - May 2017 – Release 1
  - July 2017 & January 2018 - Updates
- **Demo Day & Hackathon**
  - Q4 2017

Solar Project Lifecycle + Use Cases



ORANGE BUTTON

Enabling a Solar Data Marketplace



Solar Industry

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Orange Button Opportunities

- **Participate in working groups**
- **Talk to business partners about using it**
- **Learn how to implement it**
- **Build it into your applications**

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THANK YOU