SunSpec Alliance Orange Button Update

Developing a Standardized Solar Data Taxonomy and Software Tools

Increased Solar Bankability

Increased Transaction Efficiency
• About the SunSpec Alliance
• Solar finance landscape
• Project role / goals
• Seven critical achievements
• Challenges
• Insights / surprises
• Recommendations
SunSpec Alliance

- The information standards and certification organization for the Distributed Energy Resource (DER) industry
- Publisher of SunSpec Modbus and Orange Button de facto standards
- Test and certification authority for major DER communication standards (IEEE 1547, IEEE 2030.5, and IEEE 1815)
- Core team of eight professionals leveraging contributions from 1,000+ supporting organizations
- Board representation from
Diverse Data Needs Of Solar Finance
Traditional Data Exchange

Data contained in a range of file formats is collected by project sponsors and sent to the bank in the form of Monthly Operating Reports. Data is manually entered into system of record.
Data with documents as needed would flow from business system to business system with people reviewing, instead of transcribing data.
SunSpec Project Role and Goals

- Determine data requirements from use cases developed by SEPA/SGIP
- Publish Orange Button taxonomy and Application Program Interfaces (APIs)
- Deliver an open compliance test suite
- Drive adoption with industry leaders
- Convened 330+ companies to validate Orange Button functional requirements
  - 1,000’s of industry expert-hours invested
  - 100’s of meetings and development sessions
330+ Orange Button Implementers

365-Pronto
3megawatt
Bminutenergy Renewables
A1 Sun
ABB
Acadia Micro
Accuenergy
Active Development
Acutly Power Group
Advanced Grid Consulting
After the Sawdust
Alectris
Alconen
Alfidi Capital
Alien Energy
Allan Jones Consulting
Allied Resources Collective
Alpha Energy
Alta Energy
Americal Solar
Ampron
Amzur Technologies
Applied Solar Energy
ARR Solar
Aris Solar
Array Energy
Aurora Solar
BayWa r.e.
Berkeley National Lab
Black & Veatch
Blue Banyan Solutions
Boston University
BPS Asset Management
Brightenergies
Brooks Engineering
Building Physics
Burning Daylight Solar
Byckskan Power
CA Energy Commission
Casaapal
Canadian Solar
CamnetENERGY
Cap Vert Energie
CapstreamX
Case Western Reserve University
Cate Street Capital
CEI
Center For Sustainable Energy
Certain Solar
Certent
Chengdu Uni-Link Energy
Chint Power Systems
Cisco Systems
Clean Energy Associates
Clean Energy Storage
Clean Power Research
CleanTech Energy
CleanTechPube
Common Energy
ConEd
Connecticut Green Bank
Consulting
Cophec Solar
Corefiling
Cyient
DATAJAVA
DC Systems
Decent Energy
Demand Energy
DER Lab
DEG Energy Capital
Distributed Sun
Dividend Finance
DNV GL
Donnelley Financial Solutions
Droosan GridTech
Dragony Solar
Draker Energy
Drift Marketplace
Dura-Foam
E/NW CAPITAL NY
E7 Ventures
Eco-NRG
Ecogy Solar
Ecomly
EDF
Ego
ElectriQ Power
Energous
Energy Toolbox
Enerparc
Enervest Florida
Enphase Energy
EnterSolar
EOS Energy Storage
EPC power
EPRI
ERI/TIT/TVCA
EV Goback
EXERGY
EY
FASB
First Solar Electric
FIT/UMIT GROUP
Fourth Partner Energy
Fraunhofer CSE
Fromius
Galland Consulting
Garnet 3 Consulting
Ginlon Solis
Gold Medial Power
Green Button Alliance
Han Solar
Hawaiian Electric Company
Heliolytics
Hi-Power Solar
High Performance PV
Horizon Power
Huawei Technologies USA
IBTS
Ideal Power
IDEMA Global Partners
Igen-tech
Imperial Irrigation District
Independent Software Contractor for Solar
Infowith
InformaTrac
Ingeteam
Innomy New Ventures
Innovisionary Consulting
Innovate Clean Energy
Intelligent Design Solar
Island Pacific Energy
items international
Johnson Controls
KACO New Energy
Kisemson
Kitu Systems
KriSolar
Korea Smart Grid Association
KWH Analytics
Kwibit
Kyocera Corporation
Lapl - Light and Power for All
Lawrence Berkeley National Laboratory
Lease Direct
LEEDS
Leynald
LGE
Lincoln International
LION Energy
Lucron Energy
Longhorn Solar
LongTailPipe
Lotek
Luxol
Macquarie Energy
MacTr US
MAPI Energy Solutions Company
MAQL TECHNOLOGIES (M) SDN BHD
Marlin May
Massachusetts Clean Energy Center
MaxISI
Maxim Integrated
Mayoreos del Norte
Melink Corporation
MEPLI
Merrill Corporation
MESA Standards Alliance
Microgrid Energy
Murata Manufacturing
Mustang Prairie
Namaste Solar
Native Sun Group
Natural Resources Canada
Navigant
NEC Energy Solutions
Netfix
Neovado Engineering
New Energy
New Generation Power
New Sun Road
Nixon Peabody
Northern Power Systems
NRCA
NREL
OATI
Obelux
Olive
Omnidian
Omron
OpenADR Alliance
OpenGrid
OpenEnergy
OpenGrid.Solutions
Oracle
P3 Data Systems
Pace Worx
Pacific Communication Group
Paco Consulting
Pansonic Corporation
Paxson Systems
PvVue
PGM
Phoenix Contact
Pika Energy
Platte River Power Authority
PNGL
Power Analytics Corporation
Power Factors
PowerDash
PowerHub
Promise Energy
Purregen Power
PV Hardware
PVComplete
QCS Energy
QualityLogic
Quick Mount PV
R&R Solar Solutions
Ra Power Management
RC Cabled, Inc.
REC Solar
Redback Technologies
Renewable Energy Coalition
Renewable NRG Systems
RES Americas
RETIC
Rio Grande Solar
Rottman-Associates
Salesforce
Sand Hill Angels
Sandia National Laboratories
Sargent & Lundy
SCE
School loop
Seeder
SEET
Semenole Financial Services
Sighten
Silfab Solar
Siva Power
Skyline Solar
Skyview Ventures
SMA
Smart Energy Power Alliance
Smart Meter Network
Smarter Grid Solutions
SoftBank Energy
Sol Systems
Sol-UP USA
Solar Data Systems
Solar Energy Industries Association
SOLAR USA POWER
SolarEdge Group
SolarEdge
SolarGaps
SolarNation
Solar Network Foundation
SolarNexus
SolarReta
Solectria
Soligist
Sologistics
Soltage
SOLV
Sonnedix
SPower
SRC
SRECTrade
ST International
STT Construction
Stalwart Power
State of Hawaii
Stern
Stoneacre Energy Solutions
Strategen Consulting
SunElement Energy
Sungroup/Cornell
SunLink Corporation
Sunlytics
Sunnova Energy Corporation
Sunny Energy
SunPower
Sunrun
Sunset Technology
Sunshine Analytics
SunSniffer GmbH
SunSystem Technology
Surety Resources
Sustainable
Taubuchi
Taitem Engineering
Tesla
Texas Instruments
The Cadmus Group
The Leighty Foundation
Toronto Region and Conservation Authority
Trekker Control Works
TrinaSolar
Trillium3
Trustwave
TUV Rheinland
U.S. DOE
U.S. PV Manufacturing Consortium
U.S. Treasury
Ubilogix
Underwriter’s Laboratories
University of California San Diego
University of Southern California
USI
Utah Applied Solar Energy
UtilityAPI
Vaisala
Valentin Software
VDE
Vector Engineering
VERT Solar Finance
Vestas
Vivint Solar
Wells Fargo
Wiz Nuclear
Wisdom Systems
WMP
Xanthus Consulting International
XBRL US
Xcel Energy
Xylem
Yaskawa Solecctria Solar
Ygrene Energy Fund
Youngery
Developed Orange Button Taxonomy

- Developed 4,500 taxonomy entries by dissecting 25+ priority use cases
What Is A Taxonomy?

- “The branch of science concerned with classification and systematics”
- A dictionary of terms (names) and corresponding data elements (values) associated with a business domain (e.g. solar finance)
- Can be used to facilitate information exchange between software applications

**Orange Button Taxonomy Example**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual All-inYield</td>
<td>Total (all-in) yield. (Asset mgmt and transaction/trade)</td>
<td>Percentage</td>
</tr>
<tr>
<td>Predicted All-inYield</td>
<td>Total (all-in) yield. (Asset mgmt and transaction/trade)</td>
<td>Percentage</td>
</tr>
<tr>
<td>Predicted All-inYield</td>
<td>Total (all-in) yield. (Asset transaction/trade only)</td>
<td>Percentage</td>
</tr>
<tr>
<td>Actual CostsAndExpenses</td>
<td>Total costs of sales and operating expenses for the period. (Asset mgmt and transaction/trade, 2015 US GAAP Financial Reporting XBRL Tag)</td>
<td>currency/W</td>
</tr>
<tr>
<td>Predicted CostsAndExpenses</td>
<td>Total costs of sales and operating expenses for the period. (Asset mgmt and transaction/trade, 2015 US GAAP Financial Reporting XBRL Tag)</td>
<td>currency/W</td>
</tr>
<tr>
<td>Actual TotalOfAllProjectAccountBalances</td>
<td>Total of all project account balances at the end of the reporting period. (Asset mgmt and transaction/trade)</td>
<td>currency/W</td>
</tr>
<tr>
<td>Predicted TotalOfAllProjectAccountBalances</td>
<td>Total of all project account balances at the end of the reporting period. (Asset mgmt and transaction/trade)</td>
<td>currency/W</td>
</tr>
<tr>
<td>Actual UnleveredInternalRateOfReturn</td>
<td>Unlevered internal rate of return. (Asset mgmt and transaction/trade)</td>
<td>Percentage</td>
</tr>
<tr>
<td>Predicted UnleveredInternalRateOfReturn</td>
<td>Unlevered internal rate of return. (Asset mgmt and transaction/trade)</td>
<td>Percentage</td>
</tr>
<tr>
<td>Actual PropertyPlantAndEquipmentUsefulLife</td>
<td>Useful life of long lived, physical assets used in the normal conduct of business and not intended for resale, in 'PnYnMnDTnHnMnS' format, for example, 'P1Y5M13D' represents the reported fact of one year, five months, and thirteen days. Examples include, but not limited to, land, buildings, machinery and equipment, office equipment, furniture and fixtures, and computer equipment. (Asset mgmt and transaction/trade, 2015 US GAAP Financial Reporting XBRL Tag)</td>
<td>yyyy.mm.dd.hl</td>
</tr>
</tbody>
</table>
### What Is A Use Case?

<table>
<thead>
<tr>
<th>Use Case ID:</th>
<th>Working Group:</th>
<th>Use Case Description:</th>
<th>Description/Business Use:</th>
<th>Success End Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR-FIN.001</td>
<td>Finance</td>
<td>Origination</td>
<td>Projects are originated by a developer and financed by an investor. Project developer</td>
<td>Data is collected in order to make a real investment decision. Example investment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>compiles project information for investor due diligence analysis process</td>
<td>decision document underwriting / approval document</td>
</tr>
<tr>
<td>MR-FIN.002</td>
<td>Finance</td>
<td>Portfolio Management</td>
<td>Investor develops periodic reports to track project and fund performance based on</td>
<td>Periodic (quarterly/annual) data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>information provided by asset manager, O&amp;M provider, etc.</td>
<td>Periodic report is complete</td>
</tr>
<tr>
<td>MR-FIN.003</td>
<td>Finance</td>
<td>Insurance/Surety</td>
<td>Insurance and Surety products are developed to insure against specific risk factors</td>
<td>Ability for portfolio management</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(casualty, property damage) and to ensure payment to various entities</td>
<td>Insurance / surety provider has reports successfully reviewed:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Solar Installation Agreement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Master Purchases Agreement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Solar Construction Loan Agreement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Construction Progress Report</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Commissioning Report</td>
</tr>
<tr>
<td>MR-FIN.004</td>
<td>Finance</td>
<td>Construction Finance</td>
<td>Project is constructed through short-term financial mechanisms. Construction finance</td>
<td>Securitization / Take-out Capital</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>is removed upon project completion and operation, replaced by the term financial</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>structure</td>
<td></td>
</tr>
<tr>
<td>MR-FIN.005</td>
<td>Finance</td>
<td>Securitization/Take-out</td>
<td>Securitization/take-out finance replenishes capital to allow further project</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>deployment. Sold to long-term bond investors, others as stream of cash flows</td>
<td></td>
</tr>
<tr>
<td>MR-OM.001</td>
<td>Solar O&amp;M</td>
<td>Handover from EPC to O&amp;M</td>
<td>EPC provides solar asset data to an O&amp;M provider prior to placing the asset into</td>
<td>Required data is received by the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>production. The O&amp;M provider accepts the data and makes preparations to include the</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>asset in its operational portfolio. The use case accounts for the project developer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>being involved during the entire process and of an EPC acting as the operator</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(affiliated service provider).</td>
<td></td>
</tr>
<tr>
<td>MR-OM.005</td>
<td>Solar O&amp;M</td>
<td>Calibration</td>
<td>See notes</td>
<td>Required data is received by the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This use case provides a recommended standardized set of O&amp;M billing data types</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>frequently utilized by Solar O&amp;M operators to transact with another party.</td>
<td></td>
</tr>
<tr>
<td>MR-OM.007</td>
<td>Solar O&amp;M</td>
<td>Billing</td>
<td>Expiration of the warranty term of solar equipment that requires an inspection (prior</td>
<td>Required data is received</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>to expiration).</td>
<td></td>
</tr>
<tr>
<td>MR-OM.009</td>
<td>Solar O&amp;M</td>
<td>End of warranty term inspections</td>
<td>This use case describes the process and data required when the responsibility of</td>
<td>Required data is received</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>operations are changed from O&amp;M service providers or another.</td>
<td></td>
</tr>
<tr>
<td>MR-OM.010</td>
<td>Solar O&amp;M</td>
<td>Change of O&amp;M Provider</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

25 use cases yielded 4,500 distinct Orange Button solar finance terms
Delivered Orange Button 1.0

• Delivered Orange Button 1.0
  o Supported from SunSpec.org
  o Available royalty-free on GitHub
Orange Button 1.0 Resources

Orange ButtonSM is an open data interchange standard for the Distributed Energy (solar PV plus storage) industry. Comprised of information models, a standard taxonomy, a standard Application Program Interface (API), and supporting compliance test suites, Orange Button enables the free flow of data between information systems used in the solar asset lifecycle. Orange Button 1.0 has been released to the public.

Orange Button 1.0 Components

- Orange Button 1.0 solar finance taxonomy (browsable – account required) or ZIP file.
- Orange Button 1.0 Taxonomy Guide
- Orange Button API Specification and Orange Button XBRL API description

Orange Button 1.0 was based on these market and product requirements:

- Orange Button Finance Market Requirements (produced by SEPA)
- Orange Button Operations & Maintenance (produced by SEPA)
- Orange Button "Deployment" Market Requirements (produced by SEPA)
- Orange Button Initiative Product Requirements v1.1 (produced by SunSpec)
The 2018 Solar Taxonomy developed by XBRL US and SunSpec Alliance for the Orange Button Initiative. [https://xbrl.us/solar](https://xbrl.us/solar)
Delivered Orange Button API’s

- Delivered Orange Button API(s) and compliance test suite
Orange Button APIs

• XBRL with XML and JSON encoding
  o Best support for financial reporting use cases

• OpenAPI with JSON encoding
  o Best support for operational use cases
Orange Button Test Suite

Objectives:
• To test an Orange Button compatible RESTful interface
• To test standard conformance

Key Features:
• Provides extended functionality to SVP users
• Dual platform compatibility
Driving adoption in highly influential companies
Orange Button Adopters

- BayWa r.e. renewable energy
- Fronius
- salesforce
- blue banyan
- LG Life’s Good
- Sustainable Power Group
- Clean Power Research
- Mercatus
- SUNPOWER
- DNV GL
- ORACLE
- WELLS FARGO
• Established Orange Button open source software developer community and reference architecture
Orange Button Developer Community

Orange Button GitHub
https://github.com/SunSpecOrangeButton

Orange Button Slack Channel
https://orange-button.slack.com
Orange Button Reference Architecture

Orange Button Open Source Code
Design Proposal

Core Shared Open Source Code
(Python 2.7.x and 3.x compatible / Framework Agnostic)
https://github.com/SunspecOrangeButton/core

- Converter
- Validation (Basic)
- Identifier Generation
- JSON/XML XBRL
- Future Component
- Future Component

Model

Solar Taxonomy (XSD)
https://github.com/SunspecOrangeButton/solar-taxonomy

Reference Edition REST Server
Python 2.7.x / Django
https://github.com/SunspecOrangeButton/reference

Database (MySQL)

Leverages

Legend
- Orange Button Core Open Source Community Maintained
- Orange Button Reference Edition Sunspec Maintained
- XBRL Open Source
- XBRL Community Maintained

Documentation
https://github.com/SunspecOrangeButton/documentation

Alternative Implementations
Non python based core or reference implementations to be added by community participants as needed.

ob-python-xbrl-generator
Python 2.7.9
https://github.com/SunspecOrangeButton/ob-python-xbrl-generator

Leverages

Arele
Python 3.5 / Bottle
https://github.com/Arelle/Arelle

Arele Plugins
Python 3.5
https://github.com/Arelle/Arelle

Xule Validation (Advanced)
Python 2.7.9

SEC Database
(PostgreSQL)
• Leveraged $2M in DOE funding to harvest another $2M industry investment ($4M+)
Challenges

• Bridging distinct needs of software development communities
  o Financial: external reporting orientation, less focus on programming efficiency
  o Operational: internal process orientation, high focus on efficiency

• Executing huge project in short time frame
• Orange Button taxonomy is an essential asset
• XBRL is verbose but mandated by U.S. GAAP and the SEC
• OpenAPI and JSON are the clear preferences of contemporary developers
• Engagement with software developers is key
Recommendations

• Adopt Orange Button within federal agencies
• Make Orange Button a national standard
• Invest in Orange Button’s ongoing development