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SunSpec Orange Button Initiative
Product Requirements

Abstract

SunSpec is establishing an open, commercially viable solar data exchange system having a uniform taxonomy, information models, APIs, and compliance test software, to enable free data flow among commercial software products addressing the solar asset lifecycle. This document describes the highest priority Orange Button Initiative use cases, including sufficient coverage information to meet marketing requirements.

License Agreement and Copyright Notice

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Revision History

Version	Date	Comments
1.0	2-5-2018	Initial release
1.1	3-15-18	Changed name of SEPA

About the SunSpec Alliance

The SunSpec Alliance is a trade alliance of developers, manufacturers, operators, and service providers together pursuing open information standards for the distributed energy industry. SunSpec standards address most operational aspects of PV, storage, and other distributed energy power plants on the smart grid, including residential, commercial, and utility-scale systems, thus reducing cost, promoting innovation, and accelerating industry growth.

Over 100 organizations are members of the SunSpec Alliance, including global leaders from Asia, Europe, and North America. Membership is open to corporations, non-profits, and individuals. For more information about the SunSpec Alliance, or to download SunSpec specifications at no charge, visit sunspec.org.

About the SunSpec Specification Process

SunSpec Alliance specifications are initiated by SunSpec members to establish an industry standard for mutual benefit. Any SunSpec member can propose a technical work item. Given sufficient interest and the time and resources to participate, and barring significant objections, a workgroup is formed and its charter is approved by the board of directors. The workgroup meets regularly to advance the agenda of the team.

The output of the workgroup is generally in the form of a SunSpec Interoperability Specification. These documents are considered to be normative, meaning that there is a matter of conformance required to support interoperability. The revision and associated process of managing these documents is tightly controlled. Other documents are informative, or make some recommendation with regard to best practices, but are not a matter of conformance. Informative documents can be revised more freely and more frequently to improve the quality and quantity of information provided.

SunSpec Interoperability Specifications follow a lifecycle pattern of: DRAFT, TEST, APPROVED, and SUPERSEDED.

For more information or to download a SunSpec Alliance specification, go to https://sunspec.org/about-sunspec-specifications/.

Acknowledgement

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1 Introduction

The SunSpec Orange Button Initiative is an industry-driven effort to establish a uniform data taxonomy for interchange of interoperable datasets used during the lifecycle of a solar project.

The SunSpec team seeks to establish an open, commercially viable solar data exchange system, having a uniform taxonomy, information models, APIs, and a compliance test software suite, to enable free data flow between commercial software products that address the solar asset lifecycle:

- Provide ready-to-use standards for wide industry adoption.
- Accelerate development of interoperable solutions at low cost by providing reference software and a compliance test suite.
- Drive industry adoption of the open data interchange standards.
- Reduce project soft costs to facilitate solar market growth and expansion.

1.1 Purpose

The Product Requirements Document (PRD) establishes the Orange Button data exchange requirements, derived from the Marketing Requirements Documents (MRDs), for the following deliverables:

- Develop and publish open data taxonomy and interchange standards.
- Develop and deploy an open compliance test suite.

1.2 Scope and Applicability

The PRD covers the use cases selected by the technical working groups. They are selected from use cases considered to have highest initial priority and that include sufficient information for coverage according to the MRDs.

1.3 Assumptions

Assumptions made in this PRD are based on research results described in the MRDs.

1.4 Stakeholder Identification

Stakeholders include solar project developers, investors, financial institutions, solar integrators and EPCs, financial institutions, consumers, distribution utilities, solar industry equipment suppliers, asset owners, solar O&M providers, and other solar lifecycle participants.

1.5 Market Assessment

Inconsistent nomenclature and data element definition throughout the solar industry increases the costs of analyzing and transferring data, which increases costs and slows capital formation for solar deployment. Historically, data has been transferred from project developers and various due diligence service providers to banks and investors. This often required manual data re-entry due to inconsistent data platforms and taxonomies.

The Orange Button initiative envisions a world where such costly data re-entry is not necessary, thus speeding up the transaction process and removing unnecessary cost incurrence.

Creating a consistent data dictionary across the various communities that interact with the data, such as developers, financiers, asset managers, and insurance and surety providers,

accelerates processes, increases transaction volume, and improves business propositions. Creating industry-led, open data standards for data exchange across the solar value chain ultimately reduces market inefficiencies and lowers consumer costs.

1.6 Target Demographics

Beneficiaries of the taxonomy include solar project developers, investors, financial institutions, solar integrators and EPCs, consumers, insurance providers, distribution utilities, solar industry equipment suppliers, asset owners, solar O&M providers, and other solar lifecycle participants.

2 Acronyms and Abbreviations

Acronym/Abbreviation	Meaning
AHJ	Authority Having Jurisdiction
API	Application Programming Interface
CSIP	Common Smart Inverter Profile
CSV	comma-separated values
EPC	Engineering, Procurement and Construction
IEC	International Electrotechnical Commission
IECRE	International Electrotechnical Commission Renewable Energy
IOU	Investor Owned Utility
JSON	JavaScript Object Notation
LLCA	Limited Liability Company Act
MR	Marketing Requirement
MRD	Marketing Requirements Document
NREL	National Renewable Energy Laboratory
O&M	Operations and Maintenance
PII	personal identifiable information
PPA	Power Purchase Agreement
PR	Product Requirement
REST	Representational State Transfer
SPE	special purpose entity
TCP	Transmission Control Protocol
TWG	Technical Working Group
XBRL	eXtensible Business Reporting Language
XBRL US	XBRL US, Inc., the US jurisdiction of the XBRL International organization
XML	eXtensible Markup Language

3 Product Schedule

3.1 Critical Milestones

Date	Milestone
March 1-September 1, 2016	MRD Development
March 1, 2017	MRD Handover to TWG
March 1-September 1, 2017	TWG review MRD, create PRD and taxonomy
September 1-October 13, 2017	Release draft for public review
October 14, 2017-January 5, 2018	Updates, modifications, additions
January 8-19, 2018	Release of draft, version 2, for public review
January 19 – February 2, 2018	Updates, modifications, additions
February 5-16, 2018	Release of draft, version 3, for public review
February 19-28, 2018	Updates, modifications, additions
March 15, 2018	Release of Taxonomy version 1.0

3.2 Alpha and Beta Stage Testing Plan

Date	Testing Plan
September 1, 2017	Release of draft version 1
January 8, 2018	Release of draft version 2
February 5, 2018	Release of draft version 3
March 15, 2018	Release of Taxonomy 1.0

4 Requirements

The solar data exchange system consists of a uniform taxonomy, information models, APIs, and a compliance test software suite. This section defines the requirements for conforming implementations.

4.1 Functional Requirements

Functional requirements derive from the use cases described in the MRDs.

Use Case Marketing Requirement Title/ID	Priority	Working Group	Directive	Constraints
Origination MR-FIN.001	1	Finance and Feasibility	Data fields included in the taxonomy cover onboarding information about the developer, asset manager, operators, plus checklists that cover permits, certifications, regulatory requirements, titles, site-related issues, e.g., environmental, natural and cultural issues. Fields also cover system design, equipment and production estimates. Also includes content used in numerous contracts needed to set up a solar installation including letters of credit, Master Limited Partnership, Site Lease, LLCA, Master Services Agreement, etc. Includes documents needed to arrange types of financing including leases, sales leaseback and partnership flip.	The coverage in this area is significant but it may not reflect all possible data fields. Coverage of individual reports may focus on bank needs for the report, which may be limited to a subset of the full report, for example, availability of the report, execution date, counterparties and other highlights.
Portfolio Management MR-FIN.002	1	Finance and Feasibility	Data fields included in the taxonomy are designed to reflect the monitoring aspects of portfolio management, examples of which may include monthly operating reports, energy forecasting and budgeting, plant certifications, credit reports, issues and performance tracking.	The coverage in this area is significant but it may not reflect all possible data fields and/or methods by which different investors track production, budgeting and issues performance.

Use Case Marketing Requirement Title/ID	Priority	Working Group	Directive	Constraints
Insurance/Surety MR-FIN.003	1	Finance and Feasibility	Data fields included cover basic information on certifications and policies related to property, casualty, universal, workers compensation, business interruption, surety, commercial general and energy production.	Does not include all surety bond form types. May not include all insurance forms.
Construction Finance MR-FIN.004	1	Finance and Feasibility	Data fields cover financial data collected during the evaluation and build of the solar plant, including data reported in agreements such as the Master Purchase Agreement, as well as commissioning data and construction progress reports.	May not reflect all form types used.
Securitization and Takeout MR-FIN.005	1	Finance and Feasibility	Data fields cover financial data collected during the securitization process, including off-taker credit, system performance, O&M performance indicators, and other risk data.	May not reflect all form types used.
Distribution Operations MR-GI.001	2	Operations and Feasibility		Has not been covered sufficiently in phase one because of lower priority determination. Will focus on this in phase two.
Distribution Planning MR-GI.002	2	Operations and Feasibility	This product shall allow distribution grid planners access to solar PV capacity and performance data originating from systems deployed on their grids as input data into their distribution grid modeling efforts (e.g. power-flow and integrated capacity analysis).	Interconnection agreements should include system capacity information. Behind-the-meter asset owners must make their performance data available to utilities directly or through third-party monitoring companies.
Interconnect Agreement MR-GI.003	3	Operations and Feasibility	The product should allow users to access data and documents concerning the interconnection agreement with the interconnect utility. The interconnection	Documentation storage is necessary. Similar to permitting, the key constraint for this use case is the variability in what is

Use Case Marketing Requirement Title/ID	Priority	Working Group	Directive	Constraints
			process is served by a product that allows the seller or buyer of the PV asset to submit interconnection information to the customer (buyer) load serving entity (LSE, or often referred to as the electric utility).	required by each LSE for interconnection. Often this does include PII, so there is an element of data security. Additionally, there could be documents that need to be exchanged, which would be similar to the PV design use case.
Handover from EPC to O&M MR-OM.001	1	Operations	This product shall provide a complete set of reports and data necessary for an O&M provider to maintain equipment to meet existing warranty requirements and clauses within performance or availability guarantees. Products should be able to store all information generated during the design phase and the construction phase for a project, to enable the O&M provider to understand how a project was designed, what equipment was selected, how it was constructed, and commissioning, QC and performance test results. The product should store information allowing the O&M provider to understand why a project was designed and installed as it was, including revisions made during the construction or commissioning phases. The product should provide exact equipment specifications, model numbers, revisions, and serial numbers for equipment used on a project. The product should allow the O&M provider to establish benchmarks for system operation and	Constraints include transferability of warranties and existing contract provisions.

Use Case Marketing Requirement Title/ID	Priority	Working Group	Directive	Constraints
			performance. The product should provide information to the O&M provider on equipment suppliers, manufacturers and service providers, including warranties, third party warranties and service plans acquired for the equipment.	
Calibration MR-OM.005	2	Operations		Has not been covered sufficiently in phase one because of lower priority determination.
Billing MR-OM.007	1	Operations	This product shall provide a complete set of report and data elements necessary to send and receive invoices related to O&M activities.	The coverage in this area has not been covered sufficiently in phase one and may not reflect all possible data fields and/or methods where invoices are sent and received, related to specific operations or maintenance activities.
End of Warranty Term Inspections MR-OM.009	1	Operations	This product shall provide a complete set of reports and data elements that outline the equipment's condition state and adherence to recommended warranty maintenance prior to warranty expiration.	The coverage in this area has not been covered sufficiently in phase one as this is not yet an activity that many maintenance service providers have encountered. Constraints may include a necessary procedure that is component specific, with data fields that are not present, or part of O&M use cases that have not yet been developed.
Change of O&M Provider MR-OM.010	1	Operations	This product shall provide a complete set of reports and data elements both used and generated by the existing O&M provider to ensure continuity in operations.	The coverage in this area is significant but it may not reflect all possible data fields and/or methods by which different O&M providers monitor and measure system performance and health. Reporting and

Use Case Marketing Requirement Title/ID	Priority	Working Group	Directive	Constraints
				archiving of monthly metrics is provided, but collection, analysis and archiving of data to support computation of metrics are not provided.
Determine the health or condition of an asset MR-OM.012	2	Operations		Has not been covered sufficiently in phase one because of lower priority determination.
Monthly Operations Reporting MR-OM.013	1	Operations	This product shall provide a complete set of data elements to report the asset energy and financial performance to an interested party, such as the asset owner, asset manager or asset financier.	Constraints include the system and data collection working properly, so the necessary data can be obtained and analyzed to arrive at the reported monthly metrics. Reporting and archiving of monthly metrics is provided, but collection, analysis and archiving of data to support computation of metrics are not provided.
Sales Agreement, including Customer Acquisition and Feasibility MR-DEP.001	1	Feasibility, Design and Construction	The product must allow authorized users access to data contained in proposals, energy production and savings modeling and estimates, customer energy usage prior to installing solar, preliminary designs, promotional material, written agreements, prices. The product must provide data on contractor(s) involved, workmanship warranties, performance guarantees and financing arranged.	Documentation storage is required. For this specific use case, the possible constraints on the data include access to personal identifiable information (PII) and the associated data accuracy. For PII, certain security requirements would be necessary to ensure that aspects of individual or company's credit worthiness are not passed without proper security. For the data accuracy need associated with the site assessment, it will be important to qualify the data by some form of uncertainty measure. Resulting from the host

Use Case Marketing Requirement Title/ID	Priority	Working Group	Directive	Constraints
				of different approaches in the market, the standard should not incorrectly equate different source data as it will increase financial risk of the asset class.
PV System Design, including Electrical & Structural Design MR-DEP.002	1	Feasibility, Design and Construction	This product provides data needed for all pre-deployment PV system design processes, beginning with an executed sales agreement and concluding with design documents ready for submittal to a local permitting Authority Having Jurisdiction (AHJ) and local utility for interconnection. The PV system design and electrical wiring configuration is served by a product that will allow the user to transfer documents between process stakeholders. This need is driven by existing approaches of PV system design and wiring diagram tools that typically output document files.	Product does not have abstraction to represent AHJ specific requirements in consistent format. The main constraint for this use case is the need to include documents (likely PDF in format) via transfer.
AHJ (Authority Having Jurisdiction) Plan Review, Permitting, Inspection, Approval MR-DEP.003	1	Feasibility, Design and Construction	Product should provide data on the AHJ involved, the project permit, and inspection results. The AHJ permitting process is served by a product that allows the seller of the PV asset, on behalf of the off-taker, to submit permitting information to the AHJ or authority having jurisdiction.	Documentation storage is required. A key constraint for this use case is the variability in information that is required by the large number of AHJs in the U.S. For this use case to be properly integrated into the standard, sparse or flexible data fields will need to be considered.
Utility Interconnection (Plan Approval; Permission to Operate) MR-DEP.004	3	Feasibility, Design and Construction	The product should allow users to access data and documents concerning utility plan review and approvals, utility exceptions to plan sets,	Documentation storage is necessary. The information showing that an interconnection agreement has been established with a utility company, the utility

Use Case Marketing Requirement Title/ID	Priority	Working Group	Directive	Constraints
			and utility permission to operate.	inspection results and permission to operate from the utility is not that extensive.
Construction/Installation MR-DEP.005	3	Feasibility, Design and Construction	Product should provide data on the AHJ involved, the project permit, and inspection results. The AHJ permitting process is served by a product that allows the seller of the PV asset, on behalf of the off-taker, to submit permitting information to the AHJ or authority having jurisdiction.	Documentation storage is necessary. The information showing milestone dates of completion, along with documented changes that occurred during construction, is not that extensive.
System Commissioning and Testing MR-DEP.006	3	Feasibility, Design and Construction	The product should allow users to access data concerning the commissioning and testing of a system. This should include commissioning checklists, QC checklists, defined term test results, applicable industry standard/spec for defined terms, and system rework.	Has not been covered sufficiently in phase one
Initial Incentive Reporting MR-DEP.007	3	Feasibility, Design and Construction		Has not been covered sufficiently in phase one.
Property Appraisal MR-RE.001	1	Feasibility, Design and Construction	The real estate – appraisal use case requires a product that allows the exchange of information that impacts a property assessment as a result of adding a PV system and the associated process for asset sizing, both residential and commercial.	Constraints include the need for document attachment formats (like PDF) to support standard home appraisal output.
Property Sale - Residential MR-RE.002	1	Feasibility, Design and Construction		Has not been covered sufficiently in phase one.
Property Sale - C&I and MF MR-RE.003	1	Feasibility, Design and Construction		Has not been covered sufficiently in phase one.

Use Case Marketing Requirement Title/ID	Priority	Working Group	Directive	Constraints
Residential Refinance MR-RE.004	1	Feasibility, Design and Construction		Has not been covered sufficiently in phase one.
Commercial Refinance MR-RE.005	1	Feasibility, Design and Construction		Has not been covered sufficiently in phase one.

4.2 Usability Requirements

The data standard realized usability requirements by:

- platform-independence, which is also nonproprietary and open
- incorporating standards developed and maintained by voluntary consensus standards bodies
- consistency with and implementation of applicable accounting and reporting principles
- computer-readable and fully searchable information rendering
- rendering human and machine readable reports
- continual upgradability, as needed
- consistent and comparable data generation
- standardization of reporting period, reporting entity, unit of measure, and other associated financial data attributes
- reliance on internationally recognized and used standards, where possible
- extensibility for accommodating new reporting requirements within solar or similar reporting requirements in other industries, such as other renewable energy and energy efficiency.

4.3 Technical Requirements

The solar data exchange system has the following technical requirements.

4.3.1 Security

Security is out of scope for this project.

4.3.2 Network

The network shall use the TCP protocol.

4.3.3 Platform

The Orange Button Taxonomy is built on an XBRL platform.

XBRL is the international standard for the electronic representation of business reports. The XBRL 2.1 Specification, which defines the metadata associated with financial and business information, can be used with multiple formats, including XML, JSON and CSV.

XBRL permits the definition, preparation, and exchange of reporting information across organizational boundaries, and enables validation at various steps in the process. The XBRL specification provides for metadata creation and testing, which includes taxonomies, concepts and dimensions (tables), and for the creation and testing of data components known as

instances and facts. XBRL defines the basic building blocks of facts, instance documents, concepts (data fields) and taxonomies, which are common to all implementations of XBRL.

4.3.4   Integration

The Orange Button Taxonomy is a stand-alone taxonomy. It leverages concepts drawn from the US GAAP Financial Reporting Taxonomy, which is used by all US public companies to report financial data to the Securities and Exchange Commission (SEC).

In addition to the US GAAP concepts, Orange Button defines concepts specific to solar financing not defined in the US GAAP Taxonomy. Solar-specific concepts were developed by integrating existing solar standards, including IECRE and SunSpec, and solar-finance terms generally used in the industry for project finance, portfolio management, construction finance, and insurance.

Figure 1 Solar Standards and Finance Integration

The Orange Button Taxonomy design works with the open source Orange Button XBRL APIs.

Orange Button has multiple Entry Points, which are methods for accessing all or some part of the Taxonomy. These entry points permit preparers to view sections of the taxonomy relevant to a specific report, contract, topic, or data collection. This eliminates the need for data producers and consumers to scan the entire taxonomy, and improves search capability. Accessing smaller entry points also enables faster taxonomy download, which improves the user experience for software applications. For example, the cutsheet entry point does not load the US GAAP taxonomy because does not require US GAAP terms.

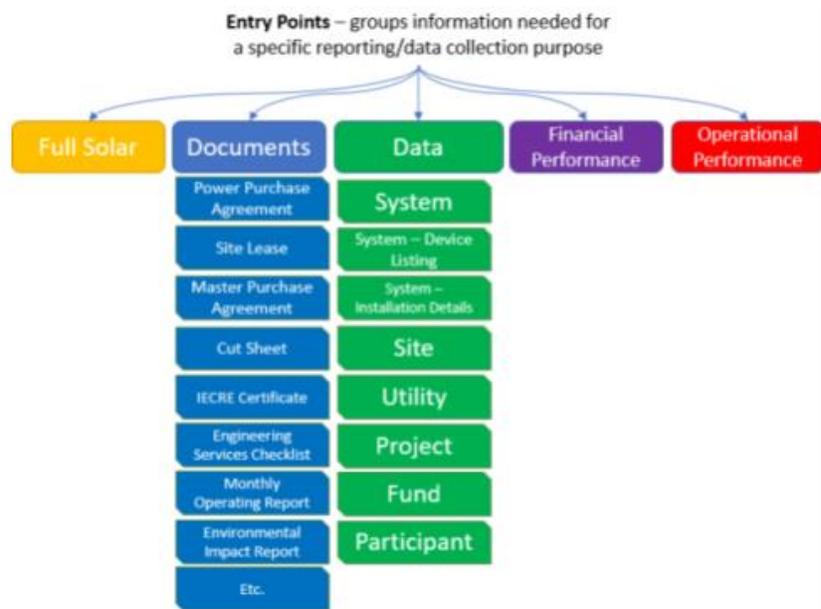Figure 2 shows the Orange Button entry points.

Figure 2 Entry Points

The **Full Solar** entry point contains all approximately 3,700 Taxonomy elements. This entry point takes more time to load than the other entry points that have fewer concepts.

There is a separate **Document** entry point for each type of document. For example, Power Purchase Agreement and Site Lease documents are separate entry points. With hundreds of documents, contracts, and reports produced during the evaluation, build, and operations of a solar project, hundreds of document-type entry points exist.

The **Data** entry points represent collections of data fields that related to a system or site.

The **Financial Performance** entry point represents data related to project or fund financial performance.

The **Operational Performance** entry points represent PV System data related to operational performance, such as operational issue reports or repairs needed reports.

With subsequent Orange Button releases, new entry points can be created as new uses for the Taxonomy are defined. Users can also create custom entry points, which can be used to arrange files in a structure that meets specific purposes. Taxonomy files are partitioned in a way that permits maximum flexibility in adding and removing custom entry point components.

4.3.5   REST Interface

See the REST API specification at sunspec.org.

4.3.6   License

XBRL is an open source, financial data standard with no associated licensing fees. As such, the Orange Button Taxonomy is an open standard with no associated licensing fees.

The Orange Button Taxonomy is jointly owned by SunSpec Alliance and XBRL US. The XBRL specification is managed and maintained by XBRL International, a global nonprofit standards organization.

4.4 Support Requirements

Support requirements for the Orange Button Taxonomy include:

- Information models
- APIs
- Compliance test suite

Appendix A: Supporting Research

Finance

The Finance Working Group developed the use cases to focus its efforts on key inefficiencies and to facilitate the various areas of offering, reporting, and pooling of capital investment.

Solar finance is comprised generally of three groups of associated actors and two basic finance components in which they interact. The three groups of actors include (1) the end-consumer, or offtaker; (2) the developer and/or asset manager; (3) and the various sources of capital and investment products. The two finance components include Financial Offtake products and Investment Structures. Where customers directly own solar systems, the offtake and capital product can be one and the same (e.g., a direct loan to a consumer to purchase a solar system). However, the majority of solar systems in the U.S. are third-party owned systems that involve a more complex arrangement.
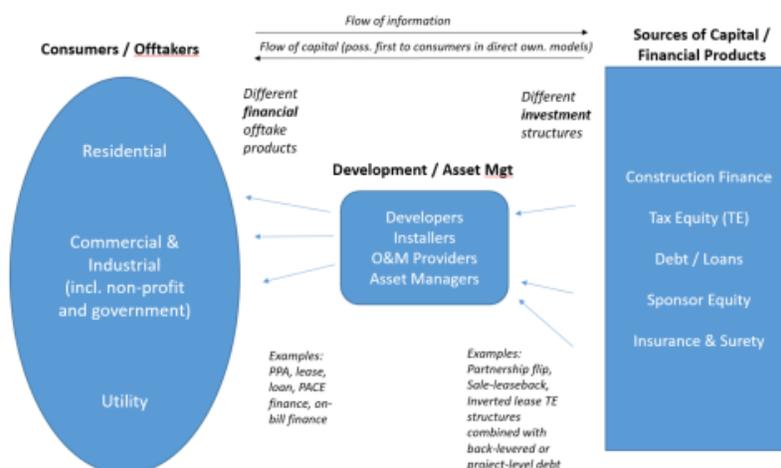
Solar Finance Landscape

Among those interrelated parts are an innumerable combination of offtake financial products, development and asset management business models, and types of financial structures and credit enhancement products and services. New varieties are being invented on a seemingly daily basis. Accordingly, it would be impossible to attempt to list all forms of capital formation, offtake finance or development business models. Instead, we broke down our need for information into five basic use cases. The most relevant of the use cases is Project Origination, which incorporates much of the figure, above, including all associated offtake-related information as well as the medium-term sources of capital: tax equity, debt (including both project and back-levered debt) and sponsor equity. Although this represents a wide array of potential projects, the working group believes there is considerable overlap in the type of information required across these products. The other four use cases include:

- Portfolio Management (representing ongoing need for operations, maintenance, cash flow and other overarching asset management data requirements)
- Construction Finance
- Insurance and Surety
- Securitization / Take-out Finance

Across all five use cases, 25 specific actors were recognized, each of which may have different permutations or roles depending on a specific business model related to project investment, offtaker finance, asset management, or other stages of development.

Solar finance use cases range over an extraordinary number of business models that offer one or more consumer finance options, investment opportunities, or both. Commonly, in the U.S., a third-party ownership structure is used to monetize the tax credits and facilitate a lease or PPA that allows the power offtaker to pay a low-cost amount consistent with their reduction in utility bills. The finance working group found a significant overlap in the data required among those business models covered under the origination use case. Accordingly, this business model is incorporated in the origination use case, which also includes loans and other forms of capital formation and consumer finance options. Similarly, the working group found solar projects were frequently financed via a special purpose entity (SPE) which legally separated the developer and the development projects. In the future, there may be a need to further differentiate this use case, but the working group determined it is best included in the broader origination use case for now.

Importantly, there should be an opportunity to leverage existing taxonomies including the IECRE working group of the International Electrotechnical Commission (IEC) database (also referred to as IEC 61724, photovoltaic system performance monitoring – guidelines for measurement, data exchange and analysis). Additional taxonomies are also relevant such as the

SunSpec taxonomy for solar securitization (initially developed for NREL's Solar Access to Public Capital working group's mock securitization process). Further leveraging of existing taxonomies may also be valuable to the process of creating a single taxonomy across the solar finance landscape. The Finance Working Group identified hundreds of reports and thousands of individual data fields in the project finance process including data fields first developed in the IECRE database (IEC 61724) and additional fields offered by members of the Finance Working Group as relevant to the origination process.

Grid Integration

The Grid Integration use cases and data requirements for the Orange Button data taxonomy defined in the market requirements document relate to the data needs of utilities, ISOs, and solar developers with regard to new utility-scale and behind the meter connections. The objective was to identify datasets to be included in the Orange Button data taxonomy that would enable asset owners and utilities to use the data taxonomy and obtain and exchange the information needed to accelerate the development, grid integration, and ongoing operations of solar assets.

A significant part of our effort was invested in surveying the landscape of existing practices and previously defined datasets to determine what gaps or inconsistencies existed that could be incorporated in the Orange Button data taxonomy to increase bankability and lower transaction costs. The scope of the data taxonomy requirements defined by the Grid Integration Working Group address behind-the-meter solar installations and utility scale solar plants. However, note that utility scale interconnection agreements undergo a higher degree of rigor, regulation, and guidance and have an interconnection planning process that is separate from the behind-the-meter process at utilities. The data taxonomy requirements presented here may not address the scope and needs of all utility scale interconnection and planning processes not covered by the California Rule 21 interconnection regulation.

Also evaluated for inclusion in the Orange Button data taxonomy was the programmatic exchange of an agreed upon set of information that must be submitted with an interconnect request. We found that notable effort had been undertaken and success achieved by, among others, the California Smart Inverter Implementation Working Group, and the Interstate Renewable Energy Council, that have produced defined datasets to be used in support of Grid Integration related aspects of the solar project lifecycle. The California Smart Inverter Working Group has developed an implementation guide to the Common Smart Inverter Profile (CSIP) defined in the California Rule 21 Smart Inverter process (see Appendix – IEEE 2030.5 Common California IOU Rule 21 Implementation Guide for Smart Inverters). Our evaluation determined that the scope, architecture, requirements, and the standards used as the basis of the CSIP document and fully defined in IEEE 2030.5 (Smart Energy Profile 2.0) adequately defined the datasets required for the data communications Grid Integration aspect of the Orange Button data taxonomy to achieve its goals. Additionally, the acceptance of the guidelines outside of the State of California and the agreed upon likelihood of continued adoption of CA Rule 21, CSIP guidelines, and IEEE 1547-2018 by additional jurisdictions led the working group to adopt these guidelines as the base set of requirements for defining Grid Integration data communications requirements for the Orange Button data taxonomy.

The Grid Integration Working Group also considered datasets that enabled Distribution Operations and Distribution Planning as in scope for the data taxonomy. Use cases have been developed for both topics that define the required datasets. No existing defined standards were found to have scope specific enough to Distribution Planning and Distribution Operations to merit recommending inclusion of the entire standard's dataset to the Orange Button data taxonomy, instead, individual required data types were identified and included in the relevant use cases.

Data and information required to facilitate an Interconnect Agreement was also identified as in scope for the Orange Button data taxonomy. An Interconnect Agreement use case has been identified as low priority and has not been developed, and the group recommends the development of the Interconnect Agreement use case, and inclusion in the data taxonomy, as in scope for a follow on phase at a later date after the initial launch of the taxonomy. If Orange Button program timelines allow, the results of an evaluation of existing programmatic means of exchanging information required for interconnection may be included as a requirement for the Orange Button data taxonomy.

Deployment

Solar deployment includes construction, testing, and interconnection with the grid. The construction data requirements include land entitlement requirements, permitting, real estate construction regulations, construction project management, and feedback from actual construction processes. Testing of the solar asset involves identifying the data needed to assure safety and reliability requirements are met, as well as the performance and regulatory requirements. During interconnection, the solar asset needs to coordinate closely with the utility and exchange the data needed by both parties for the grid integration process as defined by the Grid Interconnection standards and specifications.

Significant useful data is generated during the Deployment phase of the solar project lifecycle. The Deployment working group focused on ways to standardize the needed data in both the input to, and output from, the Deployment phase. Inputs to the Deployment phase include information regarding site characteristics, locally adopted regulations, environmental and climatic data, and relevant customer information including anticipated electricity usage and

potential system production. Outputs from the Deployment phase are used in every downstream phase of the solar asset lifecycle. The PV system is designed in the Deployment phase, including specific components and subsystems, and the system and design information is used in all subsequent phases.

O&M

The Solar O&M Working Group derived the Solar O&M data requirements for the Orange Button data taxonomy from a set of use cases representative of the solar project lifecycle beginning with the handoff from EPC to an O&M provider, and ending with the ongoing reporting of asset performance data. In between these beginning and ending use cases each aspect of the responsibilities of a Solar O&M provider are represented.

The participants in the Solar O&M working group consistently identified a set of data requirements that were common across most of the use cases in the collection. Missing numbers in the sequence of use case identifiers are due to removal or consolidation of use cases that, when developed, had nearly identical or significantly similar required data types.

Solar O&M providers are focused on operating the solar asset to achieve the revenue requirements of the asset owners, while still meeting grid and regulatory requirements. The data requirements thus include a wide range of information including, for example, utility contractual prices, market prices, utility regulations, and constraints that might affect revenues, facility maintenance requirements, and system functional and security updates. Data maintained by Solar O&M providers is used for a multitude purposes ranging from operational expense modeling to distribution utility planning and many others.

Real Estate

The objective of the Orange Button Real Estate Working Group is to identify key real estate events and use cases and their data requirements. For both residential and non-residential properties, we identified property appraisals, property sales, and property refinances as the key events. Key actors include property owners and buyers, appraisers, real estate agents, title companies, and financiers. We listed forty-seven identified data fields and rated their importance to each use-cases' sub-use cases.

Commercial and Residential solar real estate includes six main groups of actors: 1) property buyers; 2) property sellers; 3) real estate agents; 4) appraisal professionals; 5) title search companies; and 6) banks and other financial institutions. Key transactions fall into three categories: 1) Property Sale; 2) Property Appraisal; and 3) Property refinancing. Each transaction has its own sometimes non-mutually exclusive set of steps. How a transaction proceeds depends on factors such as the system location, system characteristics, system ownership and financing, electricity rates, and more. The steps and issues detailed regarding commercial real estate transactions and refinancing are very similar to residential real estate transactions and therefore will not be separately outlined in this document.

In a residential property sale, a realtor lists the property, an appraiser values the property, a title company searches local property records, and parties draft purchase and sale documents. The nature of the solar system and system location affects each action taken by the actors. Real estate agents need to know the technology installed (i.e., photovoltaic vs. solar thermal), system size, system ownership, and more to not only properly list the property but also pass on accurate information to the other actors. Complete information is not always easily accessible

by real estate agents. A property appraisal could be done independently or as part of a sale. In a property appraisal, an appraiser first determines whether the system should be included in the home appraisal. Systems owned by another party (i.e., solar leases and Power Purchase Agreements) can be noted in a home appraisal but not be included in the estimate of value. Parties may verify a system's ownership status by collecting information from the seller and/or through a title search which consists of searching for UCC-1 filings with the State Corporation Commission (or similar office) and precautionary fixture filings made with the home's local property records offices. The intent of the filings is to publicize the third-party owner's or financier's interest in the system and declare that the system is personal property. Moreover, there may be inconsistency in the timing and frequency and thoroughness of filing therefore parties should also obtain documentation from the seller where possible.

An appraiser will reconcile the estimates from the income, cost, and sales comparison approaches, weighting them depending on the market for solar and their competency with a particular approach. To make an accurate comparison, the appraiser will need to know the technology installed and the date of installation at the very least. Other factors might include hardware warranties, operation and maintenance costs, roof tilt and azimuth and whether storage is included with the system. If market penetration is low or no similar homes have recently been sold with solar, other approaches will be given higher weights or be relied upon completely. The cost approach is derived from the replacement cost of a similarly sized system at the time the assessment is occurring, while taking into account the system's age and federal, state, and local incentives. Under the income approach, the appraiser will use actual or estimated system production, electricity rates, expected hardware replacement and maintenance costs, and a prevailing discount rate to estimate the present value of the system's net-operating-income (i.e., energy cost savings) over time.

To learn whether the system was installed according to state and local code, parties will pull up system permits. Finally, the parties will prepare the Purchase and Sale documents, which will transfer ownership of the home along with the system to the homebuyer. The documents will list the existence of the system and whether the system is owned by the home seller or by a third-party. System ownership is important to address because a third-party owned system agreement (i.e., leases and Power Purchase Agreements) place restrictions on the system transfers, but not home sales. Flagging this will ensure that the home buyer and seller make the necessary arrangements to transfer the system. Home refinancing involves many of the same steps as a home sale, except that there are no sale and purchase documents.

The working group developed the taxonomy for five separate use cases, and, under them a total of twenty-one sub-use cases, covering the sale, appraisal and refinance of residential and nonresidential (including multi-family, commercial and industrial) properties. The sub-use cases include the listing and appraising of the property as well as conducting a title search, pulling permits and preparing documents for closing. There is a great deal of overlap between those various use and sub-use cases. For example, the appraising of a property, because of its distinct needs is both listed separately as a use-case and also as a sub-use case under Residential Property Sale. Similarly, the refinancing of a residential property was considered to be nearly identical in terms of the solar data needs as the refinancing of a non-residential property. Therefore, to simply this Market Requirements Document, and the following section, only a Residential Sale (MR-RE.002) and the Appraising of a Property (MR-RE.001) Use Cases are described in detail. The remaining use cases and sub-use cases are simply noted below those, but without the full description. All of the detailed information, though, is contained in the attached appendices.