GRID MODERNIZATION INITIATIVE PEER REVIEW

GMLC Project 1.2.3: Testing Network and Open Library

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1.2.3 Testing Network and Open Library
High Level Summary

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Project Description

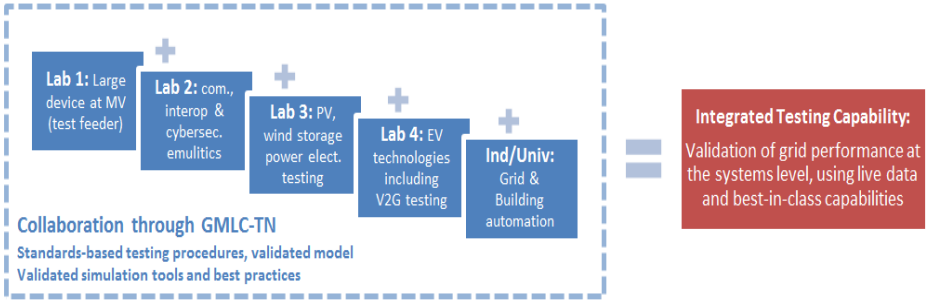
Accelerate grid modernization by **improving access to National Lab testing infrastructure for grid devices and systems, and related models and tools**. Enable national labs to drive innovation more effectively and synergistically.

Value Proposition

- ✓ Access to testing resources and validated models is vital to grid modernization
- ✓ Make optimal use of vast and growing set of grid-related testing and simulation resources at National Labs and beyond.
- ✓ Major opportunities to make an impact by improving information, accessibility, and collaboration

Project Objectives

- ✓ Establish a Testing Network (GMLC-TN) as a federated, lab-based resource for testing and performance validation of grid devices and systems
- ✓ Establish an Open Library (GMLC-OL) as a public repository for validated models, simulation tools and testing resources



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Project Team

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Project Participants and Roles	
SNL	Project lead, responsible for TN task
INL	Responsible for OL task
LLNL, ANL, PNNL, NREL, ORNL, LBNL, SRNL, BNL	Support TN and OL tasks, including partnerships & outreach; supply models, simulation tools and testing resources
Utilities, Natl. Labs, Academia, Manufacturers	Stakeholders

PROJECT FUNDING

Lab	FY16 $K	FY17 $K	FY18 $K
SNL	350	300	250
INL	150	200	250
NREL	75	75	75
PNNL	75	75	75
ORNL	75	75	75
ANL	75	75	75
LBNL	75	75	75
SRNL	75	75	75
BNL	25	25	25
LLNL	25	25	25

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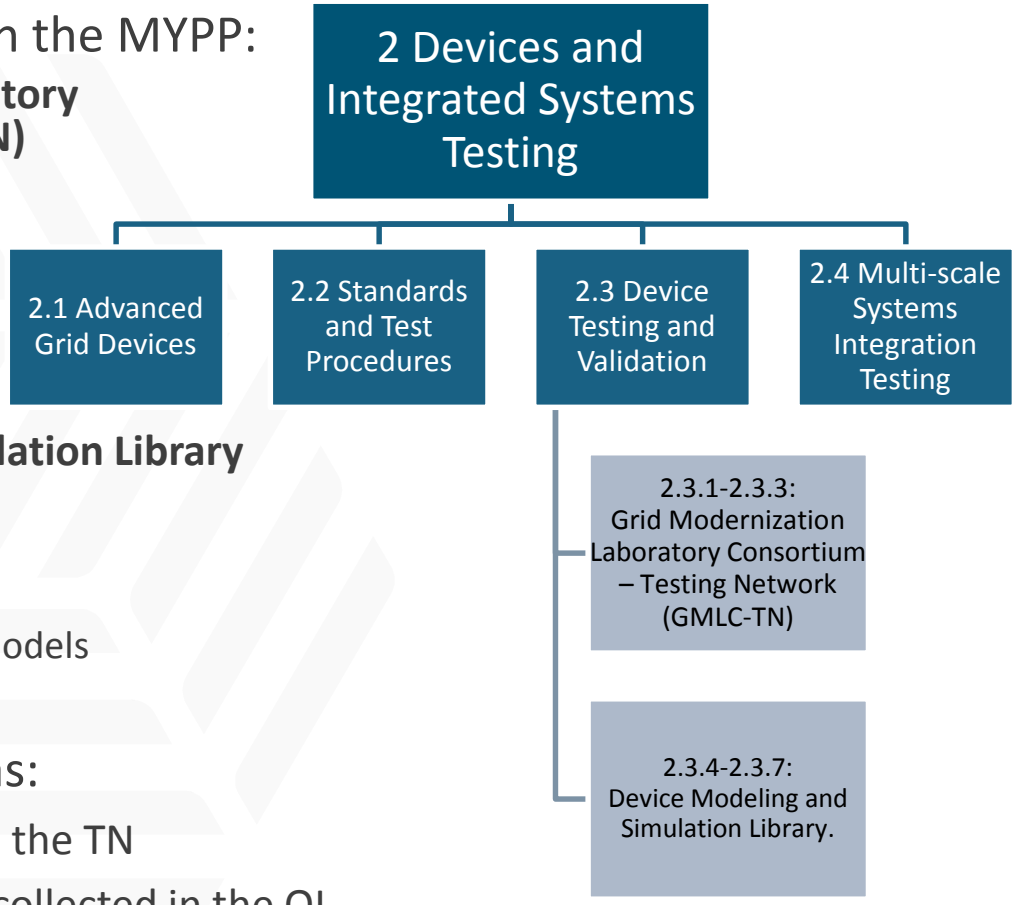
Relationship to Grid Modernization MYPP

This project is specifically mentioned in the MYPP:

- **2.3.1 – 2.3.3: Grid Modernization Laboratory Consortium – Testing Network (GMLC-TN)**
  - Index of National Lab, university, industry resources.
  - Gaps between existing and desired capabilities.
  - Expand GMLC-TN to achieve desired capabilities.
- **2.3.4 – 2.3.7: Device Modeling and Simulation Library**
  - Unified model description
  - Open model library (OL)
  - Populate library
  - Simulation framework w/interoperable models



Also aligns with activities in other areas:

- Devices developed in 2.1 can be tested in the TN
- Test procedures developed in 2.2 can be collected in the OL
- Multi-scale testing in 2.4 can utilize the TN

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Approach

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Stakeholder outreach and coordination

	PY SMART Milestone
PY1 – Establish Foundations (Start: APR 2016) 1. Develop TN governance structure 2. Design common framework for testing capability and OL 3. Catalog and publish testing capabilities at DOE Natl. Labs 4. Engage existing consortia, conduct pilot to inform TN/OL	GMLC-TN framework draft documents will be completed provided to DOE, GMLC and EAB; GMLC-OL specifications will be published; catalog of Natl. Labs testing capabilities at will be published.
PY2 – Deploy GMLC TN/OL 1. Launch TN via Membership Agreement & website 2. Populate the OL with open-source resources and models 3. Catalog and publish testing capability information available beyond DOE Natl. Labs	GMLC-TN will be formally established through adoption of the GMLC framework by Full Members; a first version of GMLC-OL implementation will be accessible publicly.
PY3 – Ensure Future Sustainability 1. Expand OL and testing capabilities information databases 2. Enhance value proposition and business model	GMLC-TN procedures will be documented; a sustainable funding mechanism for baseline activities will be established and approved by DOE, GMLC and EAB; enhanced GNLC-OL will make models and testing resources publicly available.

>PY3 – Transition

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Key Project Milestones

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Milestone	Status	Due Date
PY1		
GMLC-TN stakeholder workshop hosted and documented	Completed	9/31/16
Testing capabilities catalog for DOE National Labs	Completed	2/15/17
Common framework for device models	Completed	9/31/16
PY2		
First GMLC-TN General Assembly	Preparing	7/1/17
Assessment of testing capabilities beyond National Labs	Beginning	10/1/17
GMLC-OL published and populated	In progress	1/1/18
GMLC-OL model requirements published	In progress	3/31/18
PY3		
Operations and funding plan	Upcoming	1/1/19
Revised testing capability catalog	Upcoming	1/1/19
Test resources library (test procedures, scripts, equipment specs)	In progress	3/3/19

Stakeholder Workshop

Sept 14, 2016 at NREL

- 35 attendees, ~1/2 from industry and academia
- Three parallel breakout sessions to solicit feedback, focused on industry stakeholders

GMLC-TN Main Messages:

- Branding and raising awareness
- Industry participation
- Break down barriers to working with labs

GMLC-OL Main Messages:

- Scope breadth extremely challenging
- Keeping model information up-to-date
- Commonality between TN and OL valuable

Full report delivered to DOE, public release in progress

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Catalog of National Laboratory Test Facilities and Capabilities

- To facilitate better understanding of laboratory capabilities
- 10 National Labs, 39 distinct facilities
- 168 capability/application technology pairs
  - e.g., hardware in the loop testing of dist. sys. components
- Matrices; but also paragraphs describing facilities and capabilities
- Catalog delivered to DOE, public release forthcoming
- Searchable online version soon; periodic updates

Test Facility

- Energy Systems Integration Facility (NREL)
- Distributed Energy Technologies Laboratory (Sandia)
- …

Test Capability

- Communications Interoperability
- Cybersecurity
- Hardware in the Loop
- Grid Compatibility and Interconnection
- Reliability / Safety / Failure Analysis
- Systems Integration and Control

Application Technology

- Building Technologies
- Dist. Sys. Components
- Electric Vehicles
- Energy Storage
- Fuel Cells
- ICT and AMI
- Integrated Energy Systems
- Microturbines and Gensets
- PV
- Trans. Sys. Components
- Wind

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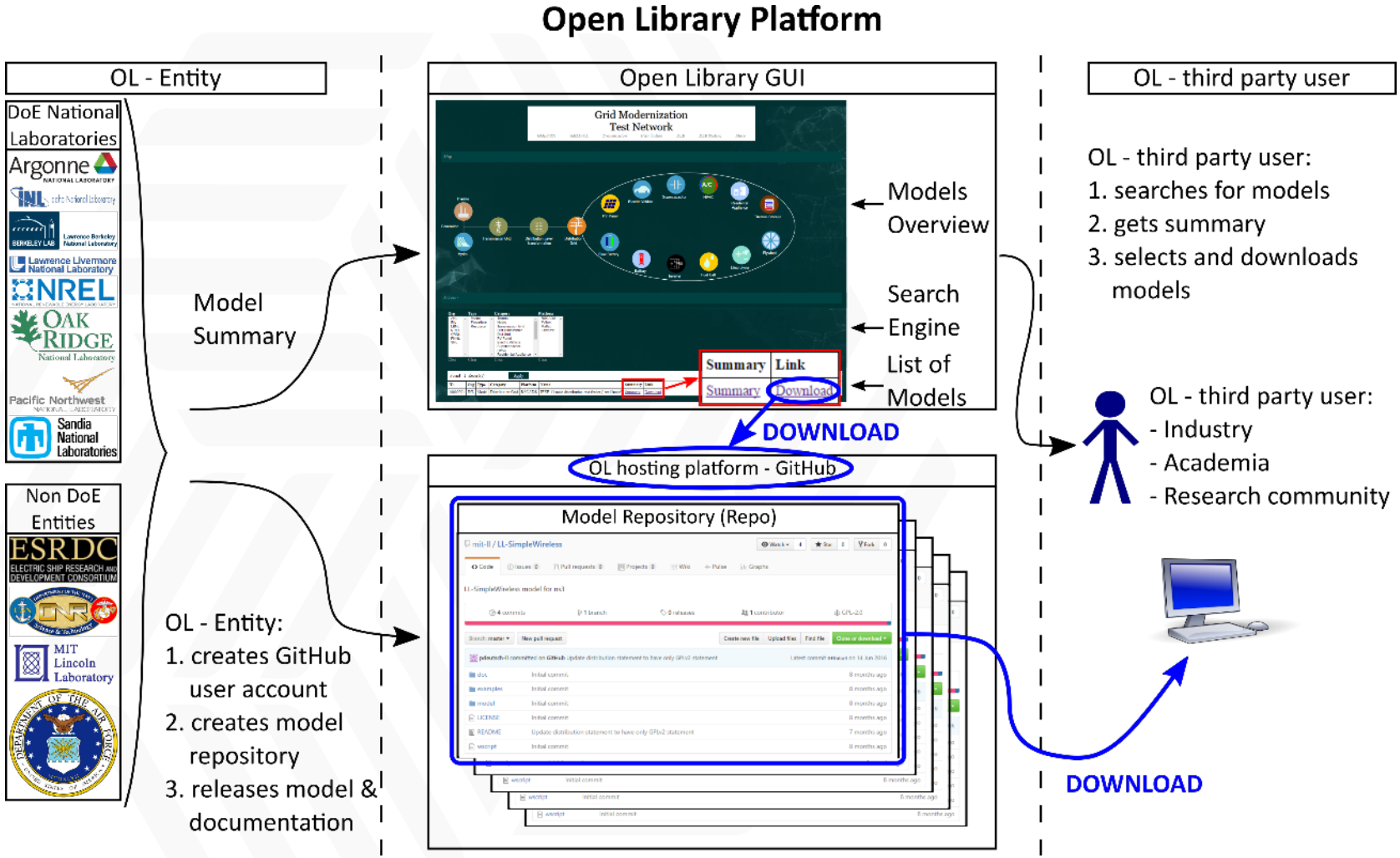
Accomplishments to Date



1.2.3 Testing Network and Open Library
Response to December 2016 Program Review

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Recommendation	Response
How will the labs work with industry using this new model? It's not clear to date. Please be ready to discuss at the Annual Peer Review.	• Industry core users of TN and OL • Publicizing to and soliciting feedback from industry • TN can help make it easier to partner with Natl. Labs • Industry test facilities can join TN
Please also be ready to discuss more explicitly what kind of models will be stored in the Open Library and determine the governance model for using the library.	• Challenge is too many models – only including devices and controllers connected to grid • Have a taxonomy for OL • Initial goal is models from other GMLC projects • Later, expansion to models beyond Natl Labs • Using lessons learned from other model collections

Please coordinate with the awardees of ARPA-E's GRID DATA to ensure we don't develop multiple libraries with the same or similar information.	• ARPA-E's GRID DATA:
	  • NREL (distribution)
	  • PNNL (transmission)
	• We have had discussions about using the OL as a way to make GRID DATA models public

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Response to December 2016 Program Review

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Recommendation	Response

Please look at how this complements the survey done of smart grid test beds.	• Looked in detail at survey efforts by SGIP and DERLab
	  • Cover a broad set of labs in "overview" detail
	  • Our capabilities self-assessment catalog covers only National Laboratories, but in a high detail
	• Also referenced previous DOE surveys
	• We are partnering with SGIP as we expand our catalog to facilities beyond the National Laboratories in PY2

Please be ready to discuss how this aligns with the work at MIT Lincoln Laboratory.	• Partnering with MIT/LL to understand how to best setup partnerships involving non-lab users with proprietary information, share models, etc. • We are reviewing other libraries and testing networks, including MIT/LL, to incorporate best practices and content into the OL and TN
Please send the report from the workshop.	• Provided to DOE technical monitors • Public release in progress

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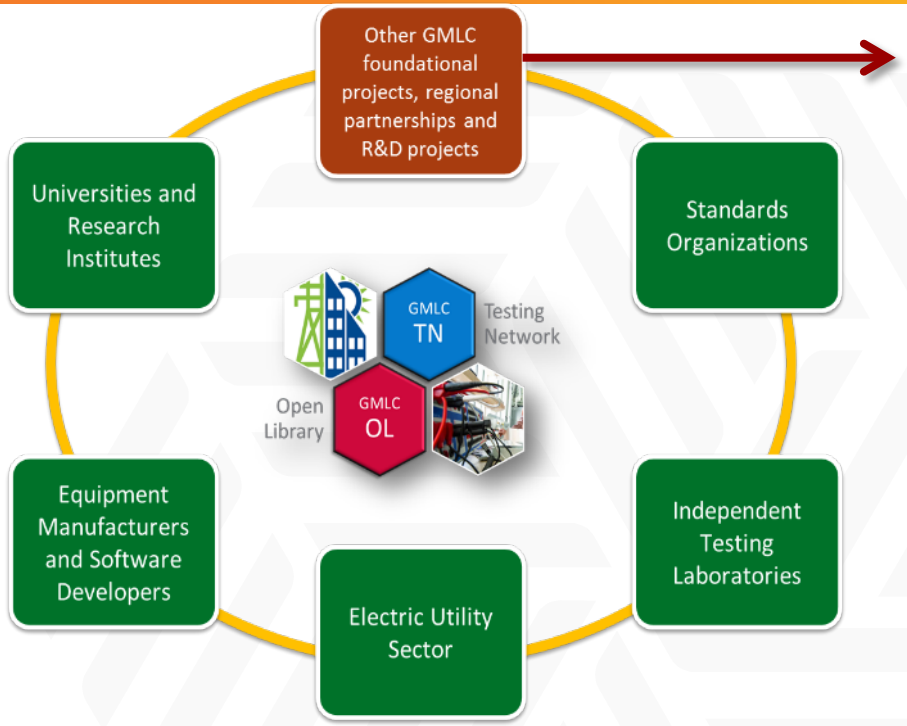
Project Integration and Collaboration



GMLC Project Stakeholders	
GMLC Foundational	1.2.2 – Interoperability
	1.4.1 – Standards and Test Procedures
	1.4.2 – Grid Device Testing for Grid Services
GMLC Regional Demos	1.3.1 – Southeast Regional Consortium
	1.3.4 – Industrial Microgrid for Security & Resiliency
	1.3.5 – California DER Siting and Optimization Tool
	1.3.9 – Idaho Falls Distrib. Network Reconfiguration
	1.3.11 – NOLA Grid Analysis and Design for Resiliency
	1.3.21 – Alaska Microgrid Partnership
	1.3.22 – Technical Support to NY State REV Initiative
	1.3.29 – Hawaii Grid Frequency Support from Inverters
	1.3.33 – Midwest Interconnection Seams Study
Program Specific	TRAC, ES, ADMS, TR, VTO, SETO, AGM, FCTO

This work has been presented at:

- GMLC 1.2.3 Stakeholder Workshop
  - concurrent w/1.4.2 and 1.4.1 Workshops
- Coordination Teleconference with DERLab
- HICSS paper on testbeds (Jan. 2017)
- Coordination meetings with SGIP
- US-UK Grid Modernization Workshop (Feb. 2017)
- Session at IEEE ISGT (Apr. 2017)
- Factsheets/PowerPoint slides distributed to team to facilitate outreach

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Next Steps and Future Plans

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GMLC Project 1.2.3 is creating an Testing Network and Open Library

- Enduring resource that supports grid modernization by enhancing collaboration among relevant stakeholders

Short Term Plans:

- GMLC Testing Network and Open Library website
  - Searchable version of facilities/capabilities catalog
  - Open Library with descriptions of models
- Collect additional models and testing procedures for Open Library
- Outreach to coordinate with other GMLC projects
- Governance Structure for Testing Network
  - Agreement-based entity
  - MOU to facilitate cooperation amongst the National Laboratories and streamline partnership
  - General Assembly meeting in summer 2017

Long Term/Ongoing:

- Additional stakeholder outreach
- Expand facilities/capabilities catalog beyond National Labs
  - Coordination with SGIP
- Expand Open Library
- Develop sustainable model for Testing Network and Open Library
- Efforts to federate testing facilities
- Actively participating as a team in efforts such as RT-Superlab to learn about gaps

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Next Steps and Future Plans

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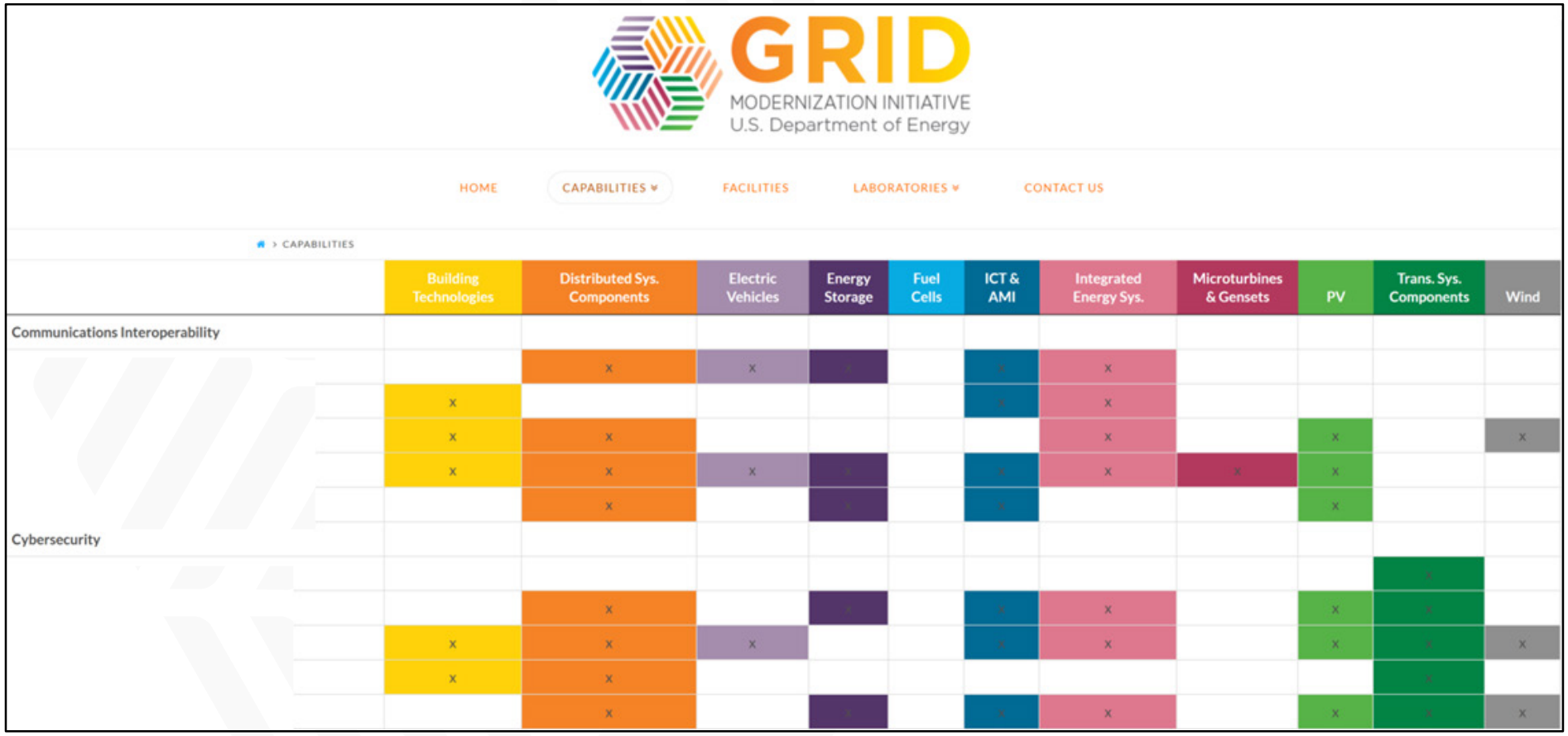
After 1 year…

- Overall PY1 goal to establish foundations for TN and OL accomplished
- Validated the opportunity space
  - Industry looking to National Labs for leadership
  - Difficult to find information on National Laboratory Capabilities
  - Models and tools from GMLC, National Lab, and beyond not well organized
- PY1 product: self-assessment catalog
  - Something new and valuable
  - Requires periodic updates
- OL taxonomy established
  - Challenge will be to deal with the large scope of grid devices and systems models

BACKUP SLIDES

Website with Testing Facilities and Capabilities



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Pre-survey of Lab-based Facilities and Capabilities

- Established baseline for publically-available information
  - Data is scattered, inconsistent, outdated, absent
- Identified relevant information domain
  - Testing facilities
  - Capability categories
  - Technology application areas

GMLC Testing Network Capabilities Pre-Survey

Grid Modernization LABORATORY CONSORTIUM

Objective:
This is a preliminary request for information on testing capabilities across the various National Labs. It is not meant to be extremely detailed or entirely comprehensive. This effort is intended to inform the development of a more focused and effective survey that will be sent out in September-October of 2016.

Due Date: July 22, 2016

Steps	Description
1	Add information in each of the columns for **testing capabilities** at your National Lab. Be sure to map testing capabilities to the associated testing facilities.
2	Add information in each of the columns for **testing facilities** at your National Lab.
3	Once completed, send information to Dan Grubbs (dlgrubb@sandia.gov) at Sandia National Labs.

1. Testing Capabilities

Lab Name	Testing Capability	Associated Facility	Description (~150 words)	Category[1]	Capability POC
SNL	Inverter Interoperability	Distributed Energy Technology Lab (DETL)	Sandia conducts interoperability characterization of PV inverters and other power electronics-based DER. Specialized test beds involving grid simulators and flexible communications platforms are used to automatically configure units and systems under test (USUT) to modify their behaviors (for example, by setting parameters to advanced grid functions) and then verifying performance by characterizing both the electrical behavior and adherence to emerging communication interoperability specifications. An automated System Validation Platform that controls the USUT, test equipment (such as grid simulators), and data acquisition systems allows for rapid and repeatable testing of a large set of scenarios	PV Systems	Jay Johnson 505.284.9586 jjohns@sandia.gov

2. Testing Facilities

Lab Name	Testing Facility	Description (~150 words)	Category[2]	Facility POC
		The DETL provides a highly configurable distributed systems evaluation platform	• PV Systems	

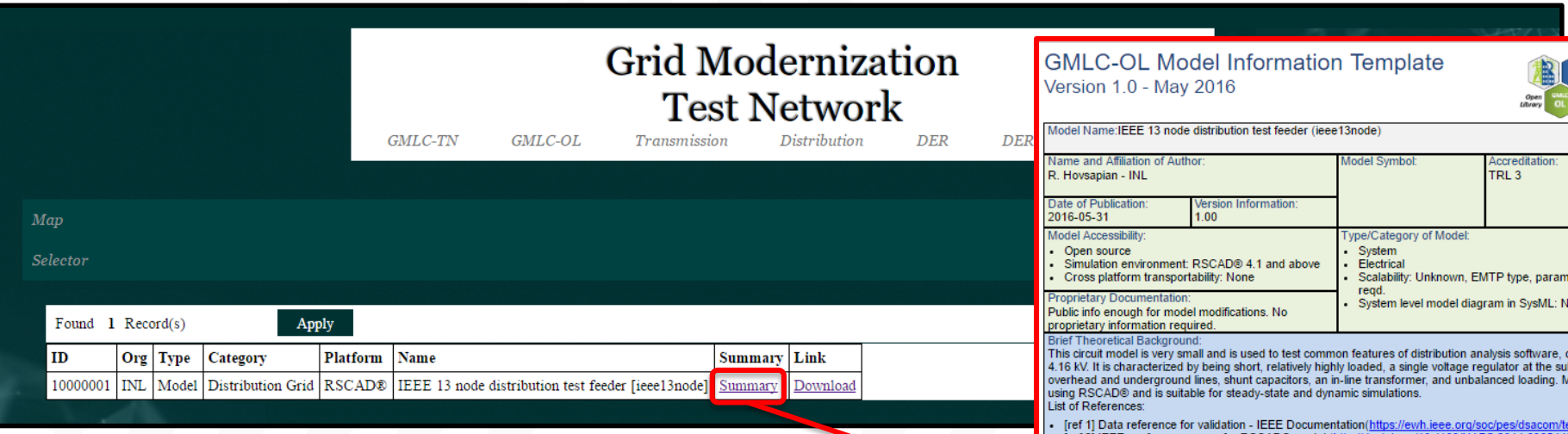
ARGONNE-NATIONAL-LABORATORY
Lemont, IL
- → Advanced Photon Source User Facility—Allows better understanding of premature failures by using an advanced photon source light beam to look deep inside the material of failed turbine components to locate microscopic cracks inside the steel bearings.
- → Atmospheric Radiation Measurement Climate Research Facilities—Provides access to meteorological instrumentation for wind forecasting and plant optimization.

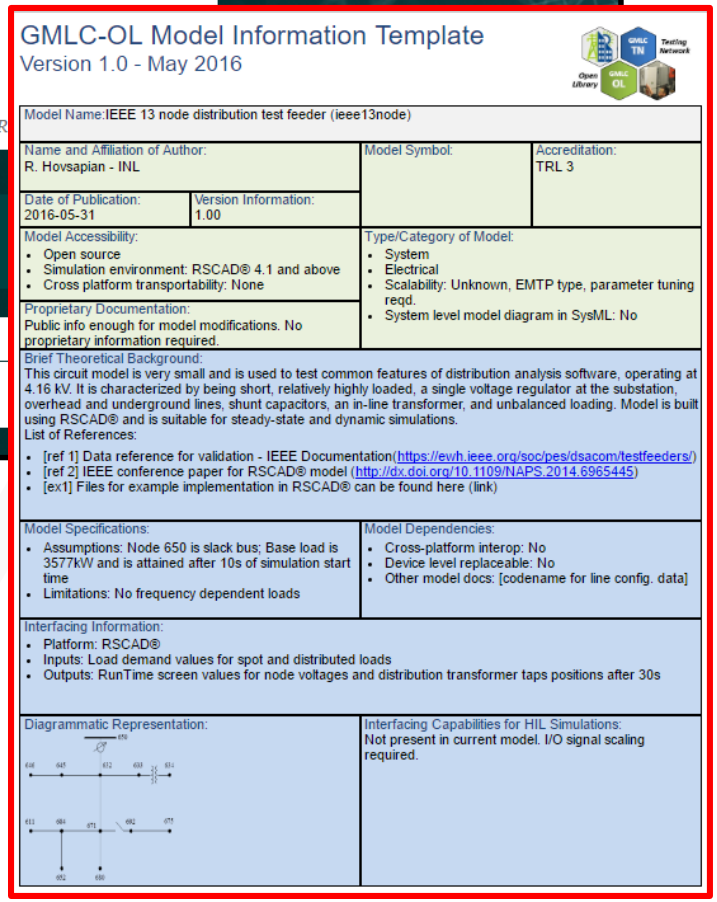
IDAHO-NATIONAL-LABORATORY
Idaho Falls, ID
- → The Critical Infrastructure Test Range Complex—Offers a complex fiber optic communication network and scientific grade instrumentation and data acquisition systems to support complex power grid testing.
- → Wireless National User Facility—Enables researchers to address national challenges in infrastructure security, communications interoperability, spectrum utilization, and the reliability of wireless technologies.

LAWRENCE-BERKELEY-NATIONAL-LABORATORY
Berkeley, CA
- → Electricity Markets and Policy Research—Delivers research and analysis expertise, including renewable energy policies, market potential of renewable electricity sources, electric grid operations and infrastructure impacts, and public acceptance and deployment barriers.
- → Cyclotron Road—Offers a home for top entrepreneurial researchers to advance technologies until they can succeed beyond the research lab by supporting critical technology development and helping identify the most suitable business models, partners, and financing mechanisms for long term impact.

LAWRENCE-LIVERMORE-NATIONAL-LABORATORY
Livermore, CA
- → Model and Site Validation—Supplies a 7,000 acre rural facility used as a key site for model and observation site validation.
- → Mobile Observational Instruments—Gives access to mobile observational instruments, including LIDAR, surface flux measurements, and sonic anemometry.

Open Library GUI - Summary





GMLC-OL Model Information Template
Version 1.0 - May 2016

Model Name:IEEE 13 node distribution test feeder (ieee13node)

Name and Affiliation of Author:
R. Hovsapian - INL

Model Symbol:

Accreditation:
TRL 3

Date of Publication:
2016-05-31

Version Information:
1.00

Model Accessibility:
- Open source
- Simulation environment: RSCAD® 4.1 and above
- Cross platform transportability: None

Type/Category of Model:
- System
- Electrical
- Scalability: Unknown, EMTP type, parameter tuning reqd.
- System level model diagram in SysML: No

Proprietary Documentation:
Public info enough for model modifications. No proprietary information required.

Brief Theoretical Background:
This circuit model is very small and is used to test common features of distribution analysis software, operating at 4.16 kV. It is characterized by being short, relatively highly loaded, a single voltage regulator at the substation, overhead and underground lines, shunt capacitors, an in-line transformer, and unbalanced loading. Model is built using RSCAD® and is suitable for steady-state and dynamic simulations.
List of References:
- [ref 1] Data reference for validation - IEEE Documentation(https://ewh.ieee.org/soc/pes/dsacom/testfeeders/)
- [ref 2] IEEE conference paper for RSCAD® model (http://dx.doi.org/10.1109/NAPS.2014.6965445)
- [ex1] Files for example implementation in RSCAD® can be found here (link)

Model Specifications:
- Assumptions: Node 650 is slack bus; Base load is 3577kW and is attained after 10s of simulation start time
- Limitations: No frequency dependent loads

Model Dependencies:
- Cross-platform interop: No
- Device level replaceable: No
- Other model docs: [codename for line config. data]

Interfacing Information:
- Platform: RSCAD®
- Inputs: Load demand values for spot and distributed loads
- Outputs: RunTime screen values for node voltages and distribution transformer taps positions after 30s

Diagrammatic Representation:

Interfacing Capabilities for HIL Simulations:
Not present in current model. I/O signal scaling required.

Common Framework describes a model and is located on the Open Library webpage assigned to that model.

Open Library Organization