

DR POWER

Data Repository for Power system Open models With Evolving Resources

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PNNL

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Team

▶ PNNL

- Mark Rice (Principal Investigator)
- Steve Elbert (Co-principal Investigator)
- Jenn Hodas (Tech-to-Market Lead)
- Olga A. Kuchar (e-grids.org Web Portal Lead)
- Laurentiu Marinovici (Data Curation Lead)

▶ NRECA

- David Pinney (Open Modeling Framework Lead)
- Justin Yang (Software Developer)

Steering Committee

Team

Type of Organization	Member	Institution
Academic	Daniel Kirschen	U. Washington
Academic	Warren Powell	Princeton University
Academic	Andy Sun	Georgia Tech
Government	Richard O'Neill	FERC
Industry	Yonghong Chen	MISO
Industry	Mani Vadari	Modern Grid Solution
Non-PNNL FFRDC	Jean-Paul Watson	Sandia National Laboratory

Curation Working Group

Team

Institution	Member	Expertise
NREL	Bryan Palmintier	GRID DATA Project
U. Michigan	Pascal Van Hentenryck	GRID DATA Project
UIUC	Gabriel Weaver	Model evolution
Furman University	Christopher Blackwell	Multi-versioned data sets with attributes
PNNL	Ruisheng Diao	GRID DATA Project
PNNL	Justin Day	Research Librarian

- ▶ Mission: design, develop and host a data repository and web portal to:
 - Provide open-access power grid datasets and the capability to review, annotate, verify, and search submitted datasets
 - Ensure sustainable model and dataset dissemination and evolution through user-defined dataset creation and validation
 - Integrate and extend NRECA's success with OMF to include transmission modeling
- ▶ Challenges
 - Evolving and proprietary models
 - No standard approach to models
 - Planning engineers use bus-branch models
 - Real-time operators use node-breaker models
 - Cutting-edge technology is not always defined in the models
 - DR POWER targeting support for:
 - OMF/GridLAB-D (high-resolution distribution models)
 - PTI and MATPOWER (planning models)

- ▶ Deliver the ability to collaboratively build, refine, review, and evolve high-fidelity power system models and accelerate grid optimization algorithm development
- ▶ Integrate community developed tools, esp. GRID DATA tools

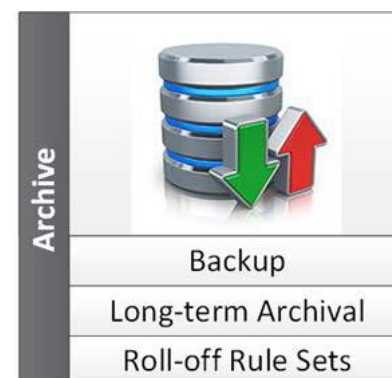
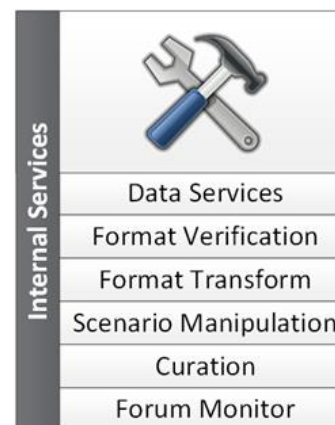
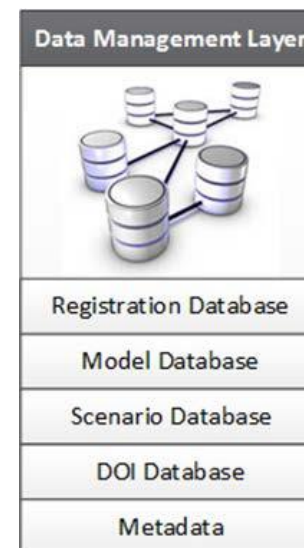
Metric	State of the Art	Project Targets
Open Access	3 stale websites 10's of models Limited scenario sets	1 web portal 1,000s of models/data sets 1,000,000s of scenarios
Flexibility	Models are in limited formats No way to add new model details	Perform data transformations on-the-fly Ability to add new fields as needed and evolve the models, maintaining model history
Scalability	Total models are less than 1 Gigabyte	High-throughput scalable portal technology with petabyte storage
Sustainability	Static websites	PNNL is committed to building a dynamic community resource

- ▶ Open-access web client for using data repository capabilities
- ▶ Execute tools for dataset generation, modification, citation, etc.
- ▶ Save results from such tools to repository and display the results to user
- ▶ Display various reports such as dataset version details, curation details, etc.
- ▶ Track upload, download, and access statistics

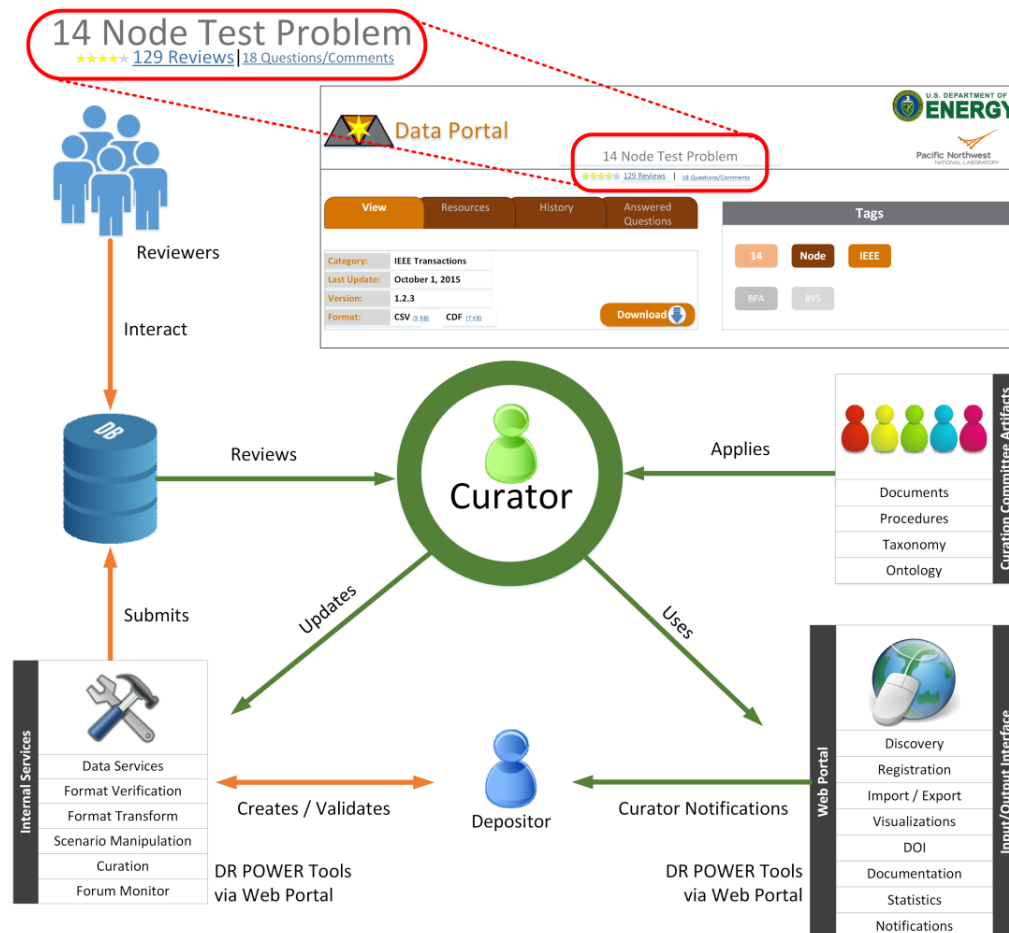


Data Repository (Back-End)

- ▶ Download requested model and scenario data in any available format
- ▶ Upload and store datasets for different power grid models; assign DOI
- ▶ Import models of various formats, including currently available open models
- ▶ Save review of dataset and annotations performed by users
- ▶ Maintain dataset versioning after modification
- ▶ Save additional scenario information for time-series data generated



Active Curation



- ▶ Based on Digital Curation Center Lifecycle Model
- ▶ Curators will review uploaded models
- ▶ Curators will help guide model creation
- ▶ Community participation in reviews, questions, comments, etc.

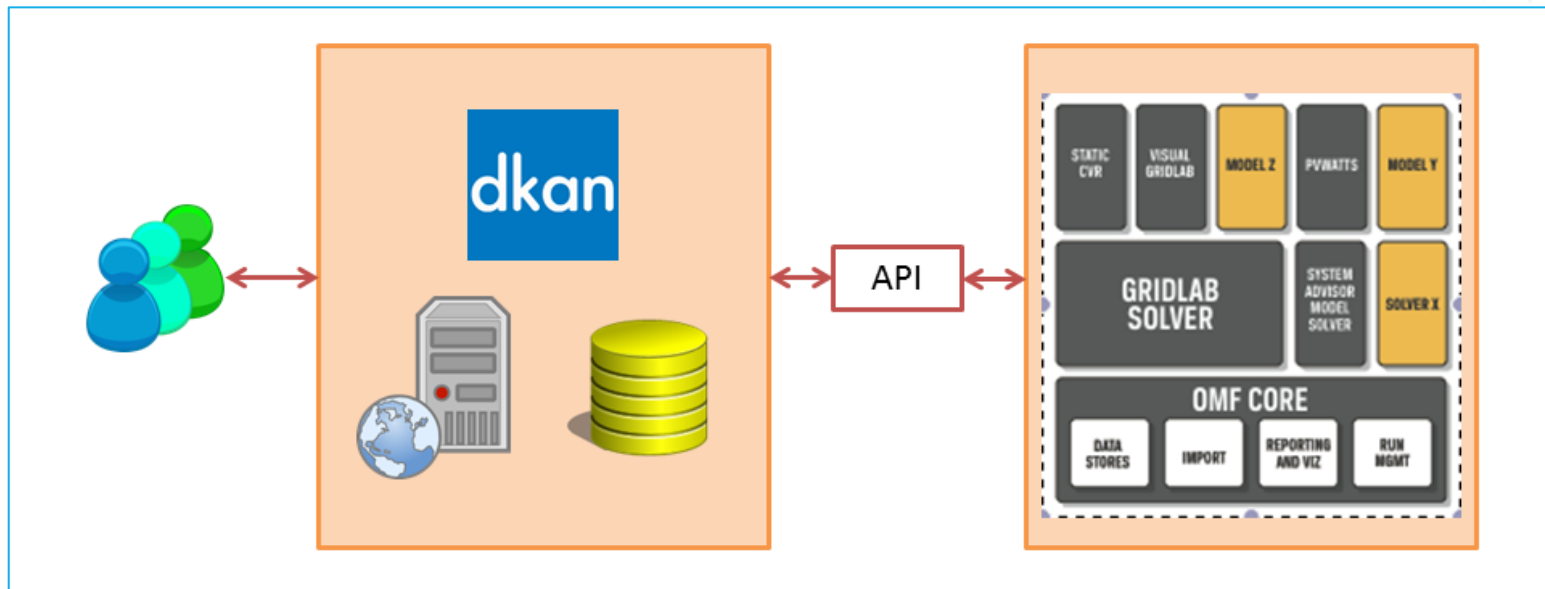
Short-term Goals

- ▶ Web Portal Version 1 deployed with following capabilities:
 - Register users
 - Upload/download models
 - Basic search
 - Populate with existing models
- ▶ DOI citations
- ▶ Tagging dictionary
 - Community engagement in curation process
- ▶ Format conversion and verification
 - PTI-MATPOWER
- ▶ Steering Committee engagement
- ▶ OMF
 - Updated Transmission User Interface
 - Integration into Web Portal

Long-term Goals

- ▶ Sustainability
 - PNNL/EIOC hosting
- ▶ Community Engagement/Adoption
 - Work with GRID DATA teams to make sure the repository meets their needs
 - Data repository for journals (e.g. IEEE)
- ▶ Functionality and maintainability
 - Ease-of-use
 - Citations

Overview and Docker Release




- ▶ Drupal distribution to develop data portals
- ▶ Free, open-source open data platform with a full suite of cataloging, publishing, and visualization features that allows organizations to easily share data with the public
- ▶ Used to power many data portals, including:
 - Whitehouse (<http://www.whitehouse.gov>)
 - USDA (<http://www.usda.gov>)
 - California Data (<http://data.ca.gov>)
 - HHS (<http://www.healthdata.gov>)
- ▶ Meets open standards (e.g. Open Data, DCAT)
- ▶ Distributed by NüCivic, a subsidiary of GovDelivery

Open Modeling Framework


- ▶ Free, open source software development effort led by NRECA's Cooperative Research Network (<http://omf.coop>)
- ▶ Provide model editing and verification capabilities for both transmission and distribution networks
- ▶ As of December 2015: 115 users from 40 utilities

Data Portal Wireframe Main Page

Technical Approach



Power System Datasets



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NATIONAL LABORATORY

[Home](#) [About](#) [Help](#)

1,127 Datasets and counting

[Search](#)

[DOI Search](#) [Advanced Search](#)

[Sign In](#)

[Model Discovery](#)

[Model Tools](#)

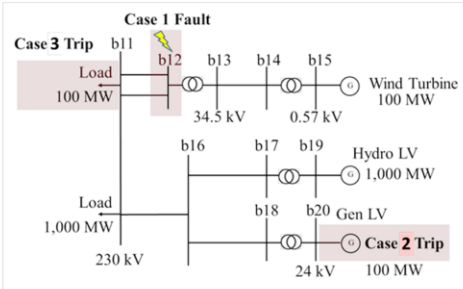
[Submit](#)

[Download](#)

[Best Practices](#)

[Contact Us](#)

[Help](#)



Case 1 Fault

Case 3 Trip

Load 100 MW

b11 b12 b13 b14 b15

34.5 kV 0.57 kV

Wind Turbine 100 MW

b16 b17 b19

Hydro LV 1,000 MW

b18 b20




Gen LV

Case 2 Trip

100 MW

230 kV 24 kV

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Data Portal Wireframe

Data Discovery

Technical Approach



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Data Discovery

Test Cases

☐ Power Flow

- [14 Bus](#)
- [30 Bus](#)
- [57 Bus](#)
- [118 Bus](#)
- [300 Bus](#)

☐ Dynamic

- [17 Generator](#)
- [50 Generator](#)

Search Results



1-5 of 5 Test Cases



14 Bus Test Case



Validated

(23 Reviewers, 8 questions answered)

Options:

[CDF](#)

[CSV](#)

[JPG](#)

30 Bus Test Case



Incomplete

(2 Reviewers, 0 questions answered)

Options:

[CDF](#)

[CSV](#)

[JPG](#)

57 Bus Test Case



Validated

(8 Reviewers, 1 questions answered)

Options:

[CDF](#)


[CSV](#)



[JPG](#)

Data Portal Wireframe

OMF Example

Technical Approach

 **Data Portal**



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GridlabMulti 14 Bus Test Case

★★★★★ [129 Reviews](#) | [18 Questions/Comments](#)

View

Resources

History

Answered Questions

Category: IEEE Transactions

Last Update: October 1, 2015

Version: 1.2.3

Format: [CSV \(5 KB\)](#) [CDF \(7 KB\)](#)




[Open](#) [Download](#)

Tags

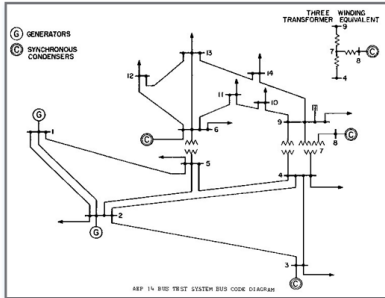
[14](#) [Node](#) [IEEE](#)

[BPA](#) [BVS](#)

Tell the world about the dataset!

Preview



IEEE 14 BUS TEST SYSTEM BUS CODE DIAGRAM

Developer Tools

Dataset URI: [.gov/pnwsgd/0E12F...](#) [Copy URI](#)

REST API: [.gov/pnwsgd/0G318...](#) [Copy URI](#)

Do more with the data!

[Suggest an idea](#) [Request data](#)

Data Portal Wireframe

OMF Example (2)

Open Modeling Framework » Model "Demo gridlabMulti 13 Node Feeder"

Model Input

Model Type Help?	Model Name	User
gridlabMulti	Demo gridlabMulti 13 Node Feeder	public
Created	Run Time	
2014-07-30 11:21:37.074000	0:01:03	

Feeder 1 [+](#)

[Open Editor](#) 13 Node Ref Feeder Flat

Feeder 2 [-](#)

[Open Editor](#) 13 Node Ref Feeder Laid Out ZERO CVR

Zip Code	Simulation Length	Length Units
64735	100	Hours

Simulation Start Date (YYYY-MM-DD)
2014-07-30

☐ Enable Email Update [Duplicate](#)

Power Consumption From Transmission System [Hide / Show](#)

Substation Powerflow Technical Losses DG Power

Data Portal Wireframe

OMF Example (3)

Open Modeling Framework » Model "OlgaPVWatts"

Model Input

Model Type Help?	Model Name	User
pvWatts	OlgaPVWatts	Olga.Kuchar@pnnl.gov
Created	Run Time	
2016-09-30 20:06:54.460019	0:00:00	

System Specifications

Zip Code	System Size (kWp-DC)	Inverter Size (kW-AC)
64735	5	0
Inverter Efficiency (%)	Non-Inverter Efficiency (%)	
92	77	

Advanced Options

Max Power Temperature Coefficient (%/°C)	Tracker Rotation Limit (degrees)	Tracking Mode
0.45	45.0	Fixed
Tilt (degrees)	Azimuth (degrees)	Wind stow speed (m/s)
-	180	0
Simulation Start Date (YYYY-MM-DD)	Simulation Length	Length Units
2012-01-01	8760	Hours

[Delete](#) [Publish](#) [Duplicate](#) [Run Model](#)

PVWatts © was developed by the [National Renewable Energy Lab](#)

Digital Object Identifier (DOI)



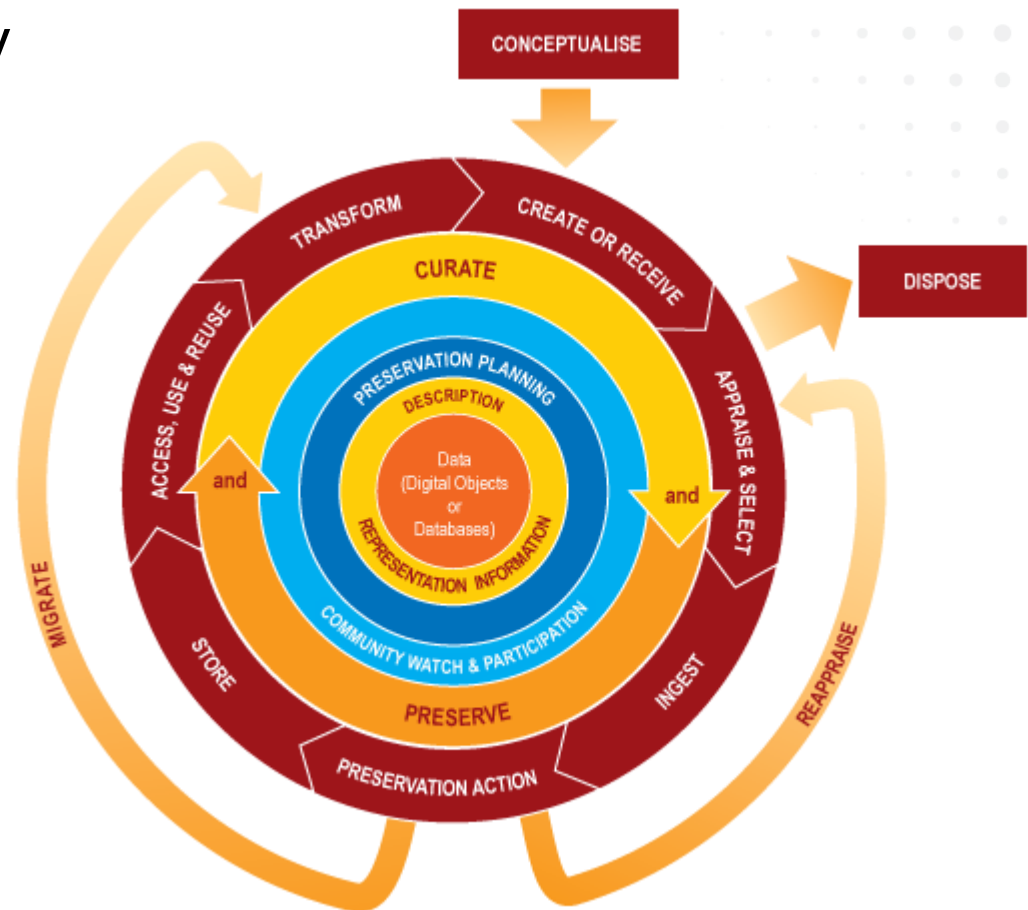
- ▶ Uniquely identifies a digital data object (<http://doi.org>)
- ▶ Using DataCite's API to mint and update DOIs
- ▶ Name preferably includes an ORCiD ID (<http://orcid.org>)

- ▶ Provide programmatic/automated access
- ▶ Read-only/download access (no writes or uploads via the API)
 - Upload is via user interface for CEII security
- ▶ Follows Open Data Schema

- ▶ FISMA compliant
- ▶ Content web proxy firewall
- ▶ Scanned, usually daily, for vulnerabilities
- ▶ Data in transit is protected via Open SSH and Open SSL
- ▶ Daily, weekly, and monthly backups
- ▶ Registration for data uploads and forum participation
- ▶ Terms and Conditions acceptance upon registration
- ▶ Additional Drupal's built-in security features
- ▶ RBAC user roles

Curation Working Group

- ▶ Appraising methodology based on inputs from experts in the group
- ▶ Engaging a community of users to bring in a larger set of models
- ▶ Transformation through advanced tagging and metadata addition to facilitate searching and classification



DCC Curation Lifecycle model

<http://www.dcc.ac.uk/resources/curation-lifecycle-model>

- ▶ A data provider will certify that the uploaded file does not contain any CEII or Proprietary Information
- ▶ Human curators will review the uploaded file(s) in the context of possible CEII and other data quality issues
- ▶ Data found to be CEII or Proprietary will be immediately removed from public access and any backups
- ▶ DOI will remain with a status update

Web Portal Version 1

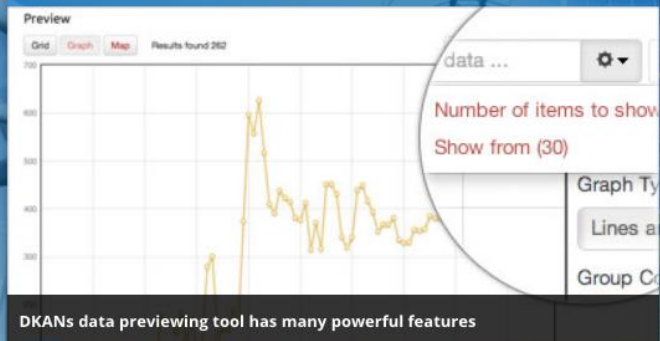
Accomplishments

[Catalog](#) [Groups](#) [Stories](#) [Topics ▾](#) [Resources](#) [About](#)

[Log in](#) [Register](#)

Search for datasets directly from the homepage or by navigating to the Datasets search page where you can facet by tags, groups and format.



You can add a Dataset to get a sense of publisher workflow. This form can be customised to require many additional fields. In this demo only the most basic fields are required.

Base MVA Lines testcase

Transmission



Distribution

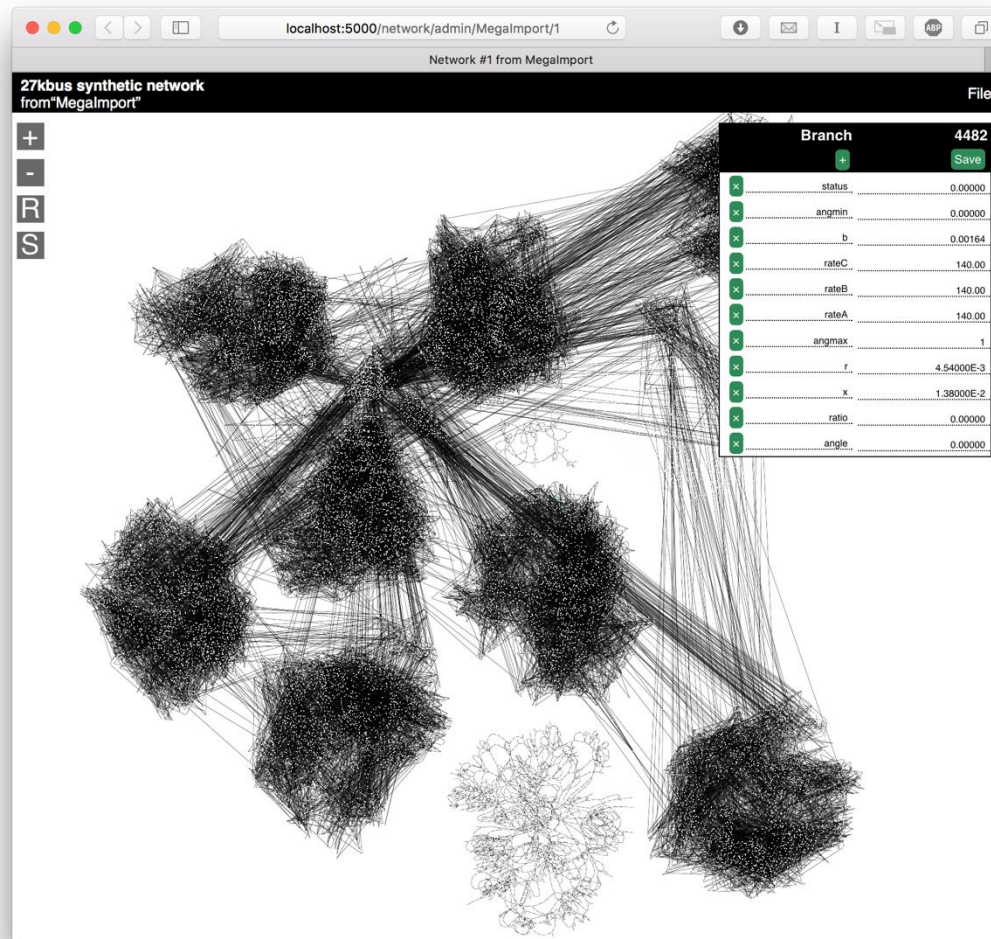
- ▶ Register users
- ▶ Upload/download models
- ▶ Basic search
- ▶ Populated with Richard Christie's models
- ▶ Tagging dictionary
- ▶ CEII certification

☐ This file contains no Critical Electric Infrastructure Information (CEII) *

By checking this box, I hereby acknowledge that the data in this file contains no Critical Electric Infrastructure Information (CEII) as defined in 18 C.F.R. § 388.113(c)(1); as well as "Critical Electric Infrastructure Information" and "Defense Critical Electric Infrastructure" as defined in Sec. 215A(a)(3) of the Federal Power Act (16 U.S.C 824 et seq.) as amended by Division F, Section 61003 of the Fixing America's Surface Transportation Act or the "FAST Act", 2015, Pub. L., No. 114-94 and as further defined, designated or identified in any regulations or orders promulgated thereunder.

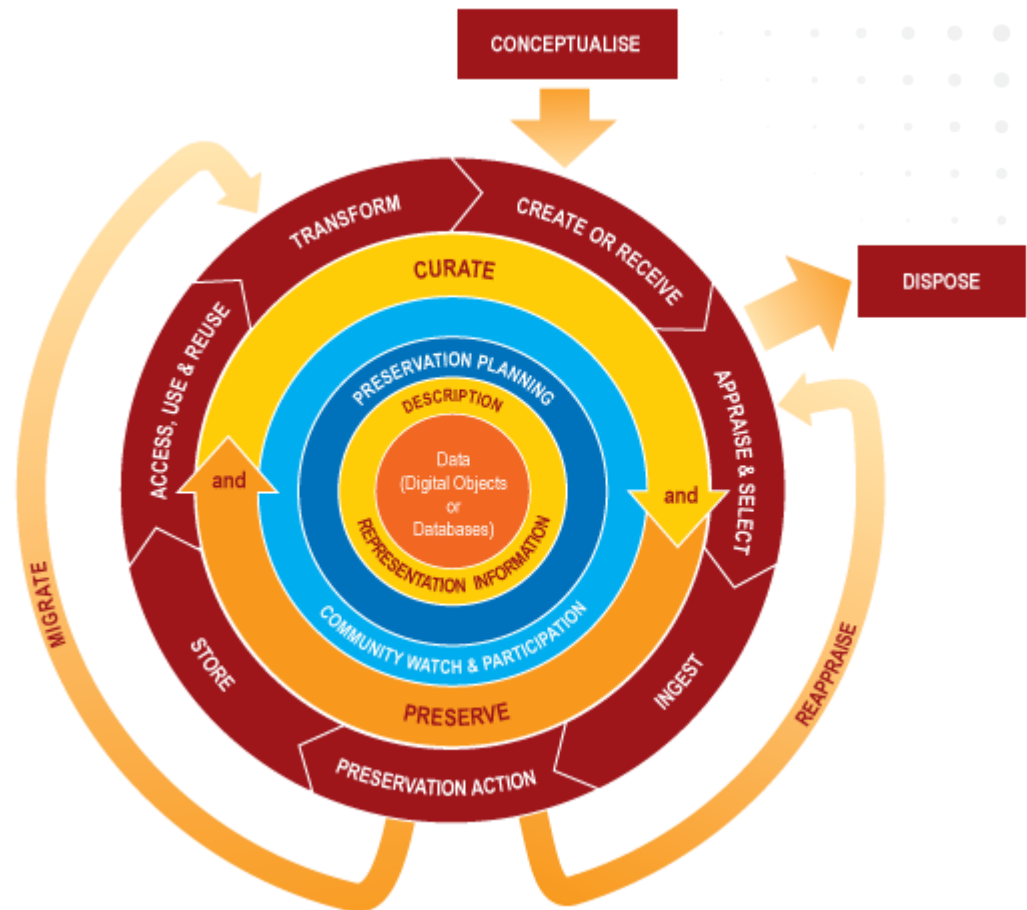
OMF Improvements

Accomplishments



<https://drive.google.com/open?id=0B0hLAR4WQ4X4RIFfcFNISnA4UUk>

- ▶ Conceptualize
 - Power System data dictionary
 - Taxonomy and tagging
- ▶ Create or receive
 - Selection of different models in particular formats



DCC Curation Lifecycle model

<http://www.dcc.ac.uk/resources/curation-lifecycle-model>

Changes in Approach

- ▶ IEC Technical Committee 57: Common Information Model
 - Not used by GRID DATA teams
 - Expensive to maintain
 - Commonly used to represent node-breaker models
 - Bus-branch models preferred for steady-state (e.g. power flow, OPF)
- ▶ OMF uses MATPOWER as base transmission class

Challenges Ahead

Accomplishments

- ▶ Community engagement
- ▶ Taxonomy expansion
- ▶ Curation Guidance
- ▶ Format conversions and verification

Focus for the Year Ahead

2017 Goals

- ▶ Live Web Portal (awaiting approvals)
- ▶ Community engagement
- ▶ Evolution of curation process
- ▶ Updated Transmission User Interface (OMF)
- ▶ Improvements to the portal:
 - PTI-MATPOWER conversions
 - OMF access
 - GRID DATA tools

- ▶ Institutional funding
- ▶ Continual community development
- ▶ Synergistic opportunities:
 - End-use load energy consumption (building data)
 - DARPA RADICS program
 - Hosting solar and wind data (e.g. NREL)

Thank you!