SMART-DS: Synthetic Models for Advanced, Realistic Testing: Distribution Systems and Scenarios

Bri-Mathias Hodge and Bryan Palmintier, NREL

March 30, 2016
GRID DATA Kickoff
Denver, CO

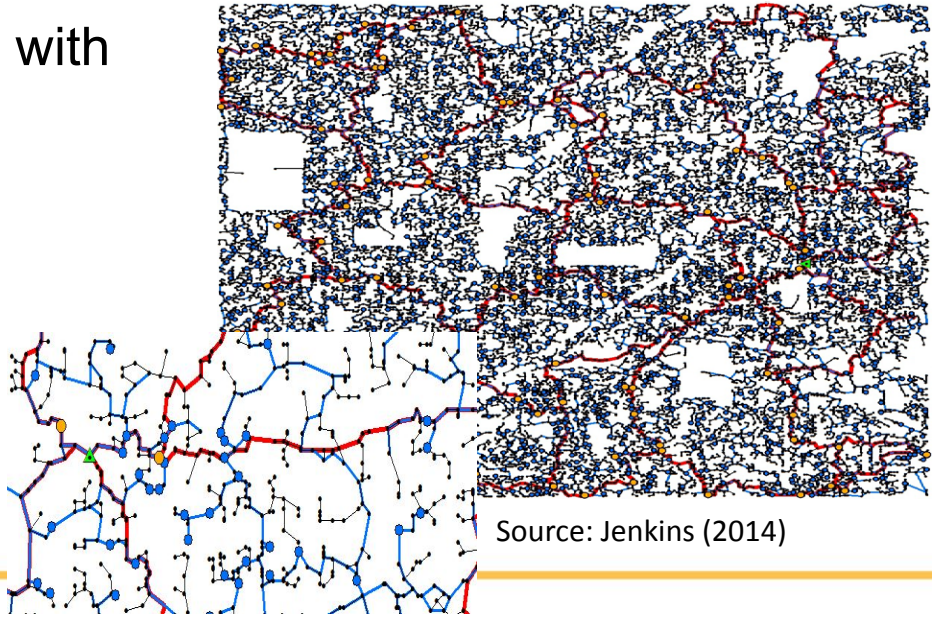
NREL/PR-5D00-66325

Team

- **Core Project Team:**
  - National Renewable Energy Laboratory (NREL)
    - Lead, Distribution, Scenario Tools (T&D), Validation
  - MIT
    - Distribution: Data, Tools, Models , Validation, and Scenarios
  - Comillas-IIT
    - Core development for synthetic distribution tool
  - GE Grid Services
    - Validation of Distribution models
- **Technical Review Committee and Data Partners:**
  - Sacramento Municipal Utility District (SMUD)
  - Duke Energy
  - Southern California Edison (SCE)
  - Perdenales Electric Cooperative (PEC)
  - Midcontinent Independent System Operator (MISO)
  - Independent System Operator – New England (ISO-NE)
  - City of Loveland

Smart–DS: Distribution Systems

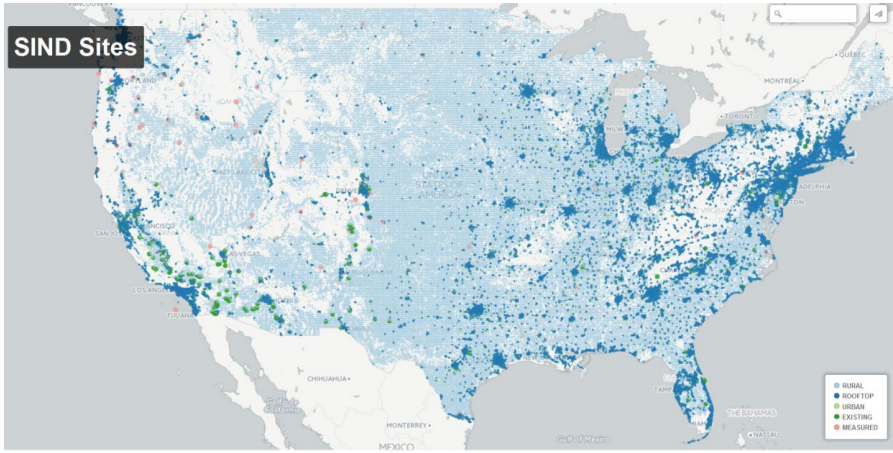
- Full-scale, high quality synthetic distribution system dataset(s) for testing distribution automation algorithms, distributed control approaches, ADMS capabilities, and other emerging distribution technologies.
- Adapt MIT/Comillas-IIT Reference Network Model for U.S. (to create RNM-US)
- Detailed statistical summary of the U.S. distribution system characteristics and costs.
- Smart-DS Cases:
  - Multiple neighboring substations with attached feeders and switches
  - Target: 100+ substations, 500+ feeders, 1M+ customers
  - Arbitrary DER combinations
  - Also: Smaller test case(s)
  - Maybe: T+D connections



Source: Jenkins (2014)

Smart–DS: Scenarios

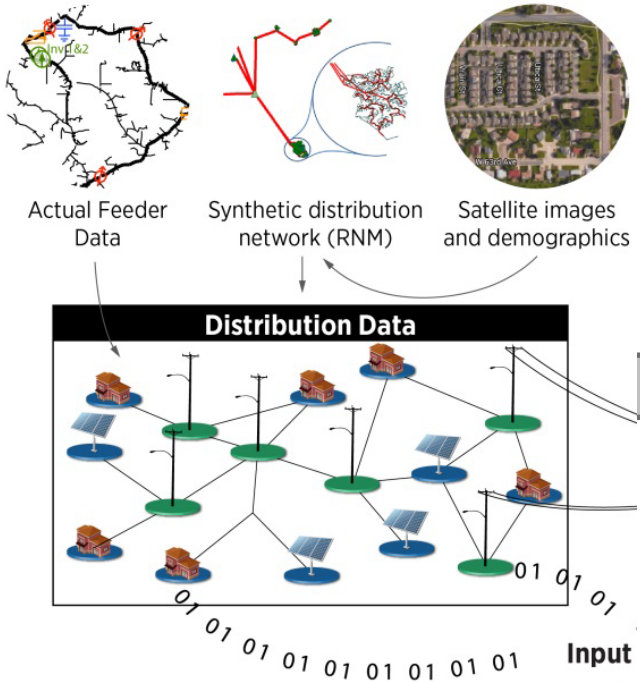
- Advanced, automated scenario generation tools for matching resource/weather data; standardized DER and generation scenarios; and more.
  - Time series data for algorithm performance evaluation over a full range of operating conditions
  - World-class high spatial/ temporal resolution solar and wind resource data with forecasts.



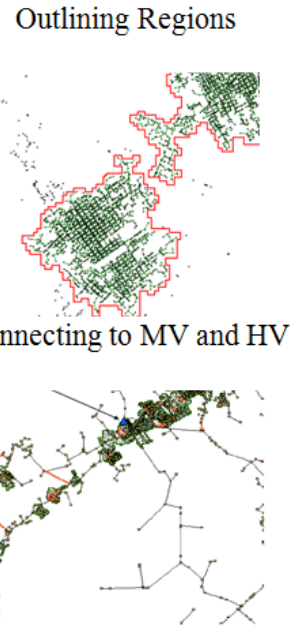
- Transmission: API for time-synchronized resource data (wind, solar, weather) with forecasts at high temporal and spatial resolution plus generator scenarios
- Distribution: ability to add DER devices and functionality, such as: solar PV, smart inverters, electric vehicles, batteries, and demand response

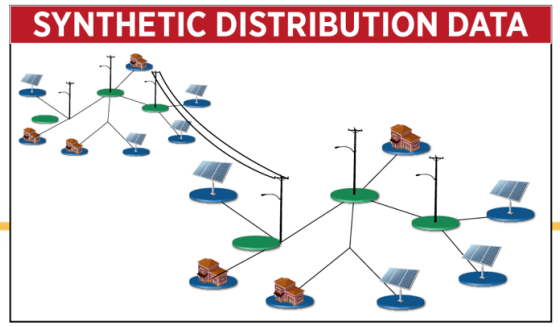
Distribution Models

RNM US-Model



Data Partners





RNM existing: European country-scale regulation
New for RNM-US:

- *3ph unbalanced*
- *Voltage regulation*
- *Small MV/LV transformers*
- *Support tools*

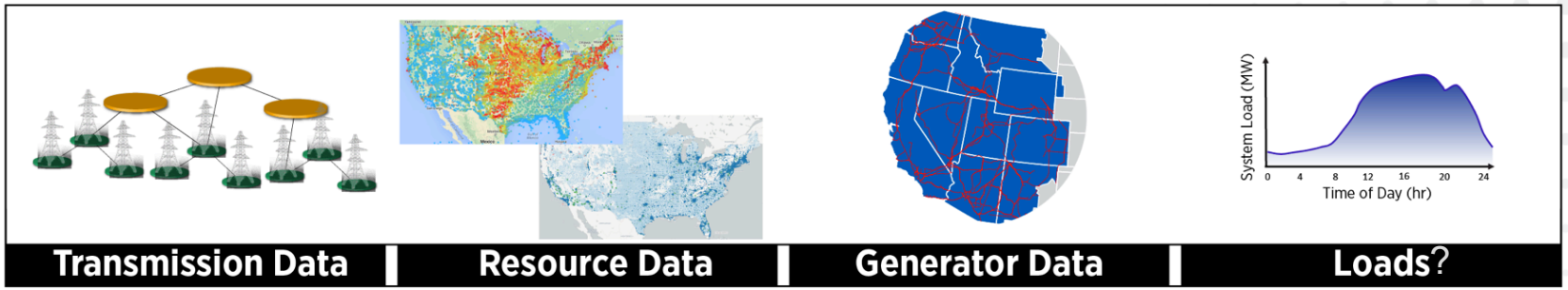
Validation

Three Pronged Approach:

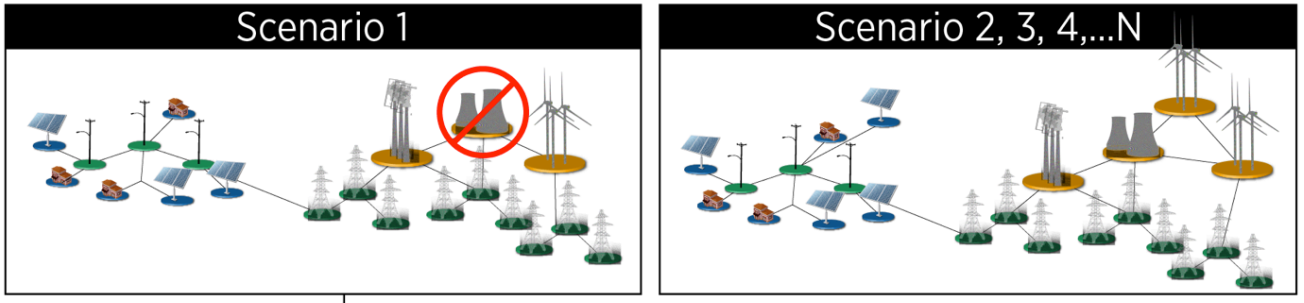
- Statistical Validation
  - Customers per transformer, load distribution, number of reclosers/fuses, regulators, switches & their ratings, …
- Operational Validation
  - *Alstom's e-terra* suite of tools will be used (a common data exchange format will be chosen)
  - Power flow convergence, distribution of flows, voltage distribution, transformer loading
- Expert comments
  - Technical Review Committee

Validation with e-terra

Scenarios



Scenario Generation



Validation
- Statistical
- Operational
- Expert Review

On-the-fly scenario generation tools:
- *High-resolution resource time series*
- *Randomized generation/DER*

Standard "sets" IDed for comparisons

Smart–DS: Distribution Systems

- Characterize US Distribution System
  - Initial: public, existing data (for RNM-US development)
  - Comprehensive US distribution system characterization:
    - Summary data (# of (miles, customers, regulators, etc.) per feeder
    - Feeder details
    - Cost table
- Develop RNM-US model and supporting tools
  - Initial: Secondary transformers, input processing
  - 1-Yr: 3-phase unbalanced, regulators
- Generate Prototype Datasets (first real data Y2Q1)
- Validation Tool Development
  - Extend GE Tool
  - Statistical Processing

Smart–DS: Scenarios

- Design API for accessing renewable resource data
  - On demand customized access to the Wind Integration National Dataset (WIND) Toolkit and Solar Integration National Dataset (SIND) Toolkit
- Develop automated tools for distribution feeder scenario generation
  - Automatically placing DER technologies (PV, storage, EVs, DR) on feeders to specified penetration levels
- Develop automated tools for transmission scenarios and assess opportunities for transmission-distribution system scenario generation
  - NREL Standard Scenarios for generation fleet mix and penetration levels
  - Wind and solar time series data (forecasts and actuals)

Smart-DS: **Outreach & Coordination**

- Establishing Connections
  - Assemble TRC (semi-annual meetings)
  - Collect data from data partners (5+ distribution utilities)
  - Coordinate with repository teams:
    - data formatting
    - Scenario API integration (or not)
- Engage Future Users
  - Stakeholder Analysis & Discussions
  - Increase Awareness through Newsletters, Web, Conferences, Publications, Workshops, etc.

Technology-to-Market

- Building the best possible distribution datasets
  - Key Data Partners (input and TRC):
    - Sacramento Municipal Utility District (SMUD)
    - Duke Energy
    - Perdenales Electric Cooperative (PEC)
    - Southern California Edison (SCE)
- Disseminating the Results
  - Conferences (ISGT, PES GM, PSCC, others)
  - WANTED: Repository Teams, let's coordinate formats, etc.
- Products
  - Open Source: Scenario Generation Tools (T&D)
  - Licensed: RNM-US

Opportunities for GRID DATA Collaborations

- Distribution Related:
  - WANTED: additional data partners to share distribution system information (NDA and/or Confidential identity OK)
  - WANTED: additional partners/users to aid in identifying and testing use cases unmet by current datasets
  - Technical Review Committee participation
  - Beta testing
- Scenario Related:
  - Test/Inform transmission level scenarios using ReEDS Standard Scenarios – with wind and solar resource data, thermal generator build out and parameters
  - Combined transmission and distribution modeling?
  - Possible on-the-fly scenario generation capabilities (with Repository teams)

Conclusions

- SMART-DS: Synthetic Models for Advanced, Realistic Testing
- Distribution Systems: Large-scale, synthetic distribution systems (and characterization) built by RNM-US
- Scenarios: Automated scenario generation tools for matching resource/weather data; DERs, generation, etc.
- Working Together:
  - Distribution data
  - Repository data formats
  - API Integration?
  - Let's discuss T+scenario and T+D interactions
  - Partners (& connections) for distribution applications unmet by current datasets
    - Grid edge devices
    - Automatic reconfiguration (e.g. DA, FLISR, etc.)
    - Large d-OPF