Data-Driven Distributed (3D) Solar Visibility Prize

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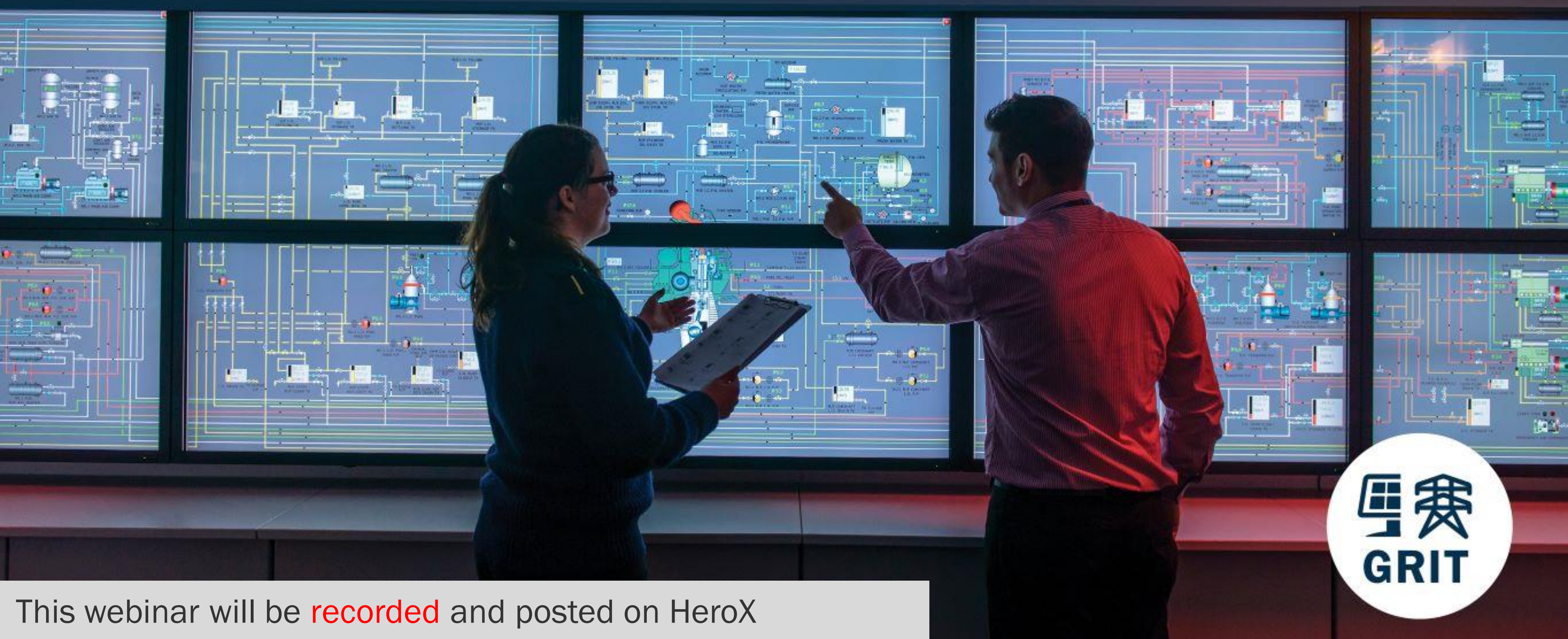

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Topics

AMERICAN MADE
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The American-Made program is your **fast track to the clean energy revolution**. Funded by the U.S. Department of Energy, we incentivize innovation through prizes, training, teaming, and mentoring, connecting the nation's entrepreneurs and innovators to America's national labs and the private sector.

The American Made Program is growing:

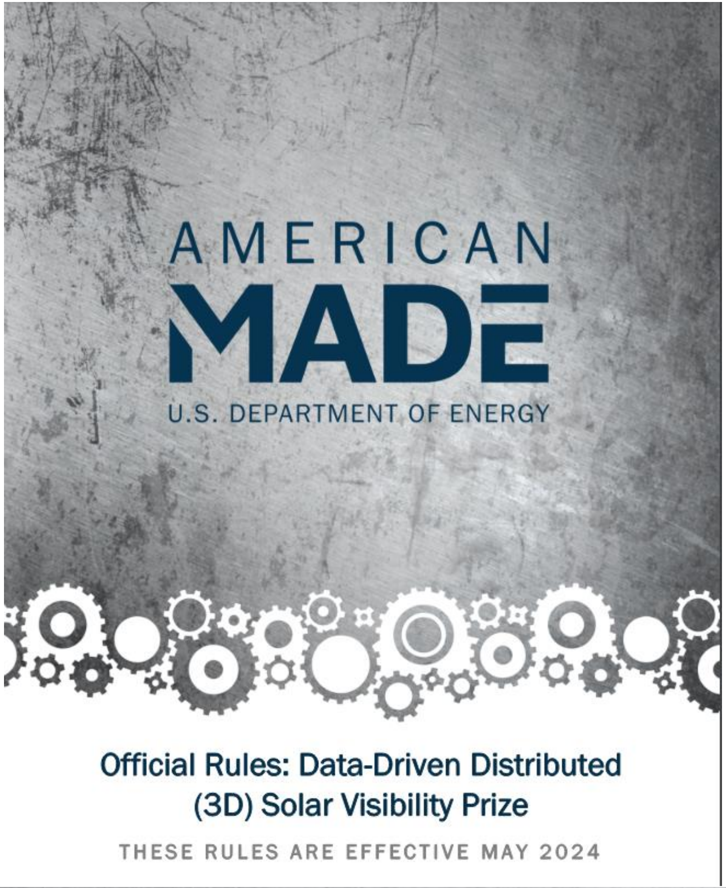
$100M in cash prizes and support

40+ prizes

300+ Network members

AmericanMadeChallenges.org

Read the Rules



Official rules of the

3D Solar Visibility Prize

are available online

https://americanmadechallenges.org/challenges/3D-solar-visibility/docs/3D-Solar-Visibility-Prize-Official-Rules.pdf

Or

3D Solar Visibility Prize HeroX Page --> Resources Tab

3D Solar Visibility Prize Overview

Prize Goals

- Increase stakeholder awareness of the state of the art in data-driven models and algorithms that provide accurate understanding of the electricity voltage, load, and power generation amounts (known as state estimation) including the contribution from distributed solar energy resources.

- Demonstrate the feasibility of fair, transparent, and uniform evaluations of computation models and algorithms using the publicly available, open-source data and software platform, Open Energy Data Initiative Solar Integration (OEDI SI). OEDI SI, a collaboration among multiple national labs with support from SETO, will serve as the benchmarking platform.

- Promote the adoption and use of these models and algorithms by researchers and industry practitioners to evaluate distribution network modeling and analysis algorithms using transparent and uniform metrics and specifications.

Prizes to Win

	Number of Prizes Awarded	Prizes
Winners	Up to two (2) anticipated cash prizes	$50,000 each
Runners-Up	Up to three (3) anticipated cash prizes	$25,000 each

Up to $175,000 in cash prizes

3D Solar Visibility Prize Process

Important Dates

Already Completed

Competitors Sign Up on HeroX

Submit an Intent to Compete Package by **July 10**

Access to Historical Data no later than **July 15, 4:00 pm ET**

Started

In Progress

Technical Webinar for Registered Competitors

July 17, 12:30 pm ET

Model Training & Pseudo-measurement Analysis

July 15 through August 11

Upload your executables

4 weeks

Distribution State Estimation Practice Week (via OEDI SI platform)

August 5 through August 9

1 week

Distribution State Estimation Competition Period (via OEDI SI platform)

August 12 through August 25

2 weeks

Winners and Awards Announced

March 2025

(DistribuTech)

Scoring

Scoring Mechanism

- For each 15 minutes snapshot, score is calculated as follows:
  - $State\ Estimation\ Skill_i = M_1 + M_2 + M_3$
    - M_1: Mean absolute error for the state variables
    - M_2 :Bonus for number of bad data correctly detected and identified (if any).
    - M_3 :Bonus for number of topology changes correctly detected and identified (if any).
- The daily state estimation skill will be a simple average of the 15-minute state estimation skills for the 12-hour time-series for that day.
- The final average state estimation skill for the competition period (14 days) is computed as:
  - $Final\ State\ Estimation\ Skill = {}^{1}/_{14} * \sum_{1}^{14} Daily\ State\ Estimation\ Skilli$
- **Winners will be selected based on the final state estimation skill score.**

Prize Metrics (M_1)

- Mean absolute error for the state variables (X_{MAE}) is calculated as:
  - $X_{MAE} = \frac{1}{N}\sum_{i=1}^{N} |x_i - x_i^e|$
  - Where x_i^e are the estimated state variables for x_i, defined by voltage magnitudes (*in per unit*) and phase angles (*in radians*) at distribution network nodes. $N = 2n - 1$, where *n* is the number of nodes (buses).

  - M_1 is calculated as the following for *voltage magnitudes (in per units):*
    - $M_1 = 1.00$ if $X_{MAE} \leq 0.001$
    - $M_1 = -1.00$ if $0.02 \leq X_{MAE}$
    - $M_1 = f(x)$ where f(x) is calculated as a linear function for 0.001 < X_{MAE} <0.02.

  - M_1 is calculated as the following for *voltage angles (in radians):*
    - $M_1 = 1.00$ if $X_{MAE} \leq 0.017$
    - $M_1 = -1.00$ if $0.09 \leq X_{MAE}$
    - $M_1 = f(x)$ where f(x) is calculated as a linear function for $0.017 < X_{MAE} < 0.09$.

Prize Metrics (M_2)

- M_2 is a bonus point for the number of bad data correctly detected and identified that is calculated as:
  - $M_2 = 0.2$ if 100% correctly detected and identified,
  - $M_2 = 0.15$ if 75% correctly detected and identified.
  - $M_2 = 0.1$ if 50% correctly detected and identified.
  - $M_2 = 0.05$ if 25% correctly detected and identified.

- This metric will be calculated by the prize administrator, because the actual number of bad data and their locations will not be known by the competitors. The competitors will also need to provide the measurement identity and location for the bad data measurement(s) they identified.

The bad data detection and identification will need to be general and scalable. The competitors will have to define how they detect and identify bad data. Manual or arbitrary detection of measurements with gross errors (bad data) will not be acceptable.

Prize Metrics (M_3)

- M_3 is a bonus point for the number of topology changes correctly detected and identified that is calculated as:
  - $M_3 = 0.2$ if 100% correctly detected and identified,
  - $M_3 = 0.15$ if 75% correctly detected and identified.
  - $M_3 = 0.1$ if 50% correctly detected and identified.
  - $M_3 = 0.05$ if 25% correctly detected and identified.

- This metric will be calculated by the prize administrator, because the actual number of topology changes and their locations will not be known by the competitors. Topology changes will include only on/off status changes at the switches provided in the network topology file.

The topology change detection and identification algorithm will need to be general and scalable. The competitors will have to define how they detect topology changes. Manual or arbitrary detection of topology changes will not be acceptable.

Additional Information

- There will not be bad data and topology changes *simultaneously* in the measurement set. In other words, there may be only bad data *OR* only topology change(s) in any of the measurement set. A particular measurement set will not flag any of these prior to the submission of results. The competitors are responsible for detecting and identifying them. They will be penalized for falsely reporting bad data or topology changes as explained below.

- The competitors will have to upload their algorithms either as open-source code or as executable docker containers prior to the start of the competition. The U.S. Department of Energy and National Renewable Energy Laboratory prize and technical teams reserve the right to *audit* submitted results set.

Important Notes from the Rules Documents

1. Please make sure to download the latest Rules Document and read "Appendix 1: Details on the Input Data and Process for the Prize" before you start working on your algorithm(s).
2. Please also make sure you read Q&A at Data-Driven Distributed (3D) Solar Visibility Prize | HeroX
   a) Several questions came up since the announcement of this Prize, and you may find it helpful to review those.
3. This Prize is open to those who are eligible under the conditions stated earlier in this presentation and in the Rules document.
   a) As such, we need to make sure that it is a transparent and fair process.
   b) We also need to make sure that your results are auditable and reproducible.

More Details on Rules

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Important Notes from the Rules Documents (contd.)

1. Network Model Formats

   a) OpenDSS

   System model without load and PV profiles

   - Buscoords.dss
   - Intermediates.txt
   - LineCodes.dss
   - Lines.dss
   - LoadShapes.dss
   - Loads.dss
   - Master.dss
   - PVSystems.dss
   - Transformers.dss

   b) Topology JSON containing:

   - admittance
     - admittance_matrix: [real, imaginary]
     - ids: node name
     - units: siemens (S)
   - incidences
     - from_equipment
     - to_equipment
     - ids: connection name
   - base_voltage_magnitudes
     - values
     - ids: node name
     - units: V (volts)
   - base_voltage_angles
     - values
     - ids: node name
     - units: radians
   - slack_bus
   - switches
     - true: closed
     - false: open
   - bus_coords

Important Notes from the Rules Documents (contd.)

2. Measurement Data
   a) Active power (kW)
   b) Reactive power (kVar)
   c) Voltage magnitudes (volts)
   d) Reference for voltage angles at substation/slack bus (radians)

- measured_active_power.csv
- measured_reactive_power.csv
- measured_voltage_magnitudes.csv
- reference_voltage_angles.csv

- Inside each measurement csv:
  a) Format
     - Row: timestep (from 7:00 to 18:45 each day)
     - Column: location of the measurement (node name)
  b) Topologies
     - Topology 1: 4/1 7:00 to 6/14 18:45
     - Topology 2: 6/15 7:00 to 6/29 18:45
- Measurement types: SCADA, micro-PMU, and AMI
- Other "measurements": P & Q at zero-injection nodes, which are zero

Timestep	P1UDT942	P1UDT942	P1UDT942	P1UDT882	P1UDT882	P1UDM38	P1UDM38
4/1/2018 7:00	-113.169	-125.82	-107.306	0	0	0	0
4/1/2018 7:15	-120.312	-129.134	-111.684	0	0	0	0
4/1/2018 7:30	-121.234	-131.573	-112.368	0	0	0	0
4/1/2018 7:45	-124.185	-130.061	-112.477	0	0	0	0
4/1/2018 8:00	-124.111	-129.197	-110.815	0	0	0	0
4/1/2018 8:15	-128.994	-133.429	-114.103	0	0	0	0
4/1/2018 8:30	-128.215	-129.7	-113.563	0	0	0	0
4/1/2018 8:45	-122.495	-125.21	-108.659	0	0	0	0
4/1/2018 9:00	-123.95	-125.405	-108.701	0	0	0	0
4/1/2018 9:15	-128.011	-128.667	-108.572	0	0	0	0

Important Notes from the Rules Documents (contd.)

3. Actual Voltages
   a) Voltage magnitudes (volts)
   b) Voltage angles (radians)

actual_voltage_angles.csv

actual_voltage_magnitudes.csv

- Inside voltage magnitudes/angles csv: Format
  - Row: timestep (from 7:00 to 18:45 each day)
  - Column: node name

Timestep	P1UDT942	P1UDT942	P1UDT942	P1UDT882	P1UDT882	P1ULV410
4/1/2018 7:00	7415.544	7415.544	7415.544	122.6125	122.6382	121.6871
4/1/2018 7:15	7415.544	7415.544	7415.544	122.6631	122.6884	121.8091
4/1/2018 7:30	7415.544	7415.544	7415.544	122.6613	122.6866	121.8077
4/1/2018 7:45	7415.544	7415.544	7415.544	122.6646	122.6899	121.8118
4/1/2018 8:00	7415.544	7415.544	7415.544	122.6685	122.6938	121.8162
4/1/2018 8:15	7415.544	7415.544	7415.544	122.6728	122.6981	121.8209
4/1/2018 8:30	7415.544	7415.544	7415.544	122.6775	122.7028	121.8262
4/1/2018 8:45	7415.544	7415.544	7415.544	122.6765	122.7019	121.8256
4/1/2018 9:00	7415.544	7415.544	7415.544	122.6785	122.7038	121.8277
4/1/2018 9:15	7415.544	7415.544	7415.544	122.6823	122.7076	121.8314
4/1/2018 9:30	7415.544	7415.544	7415.544	122.6876	122.713	121.8369

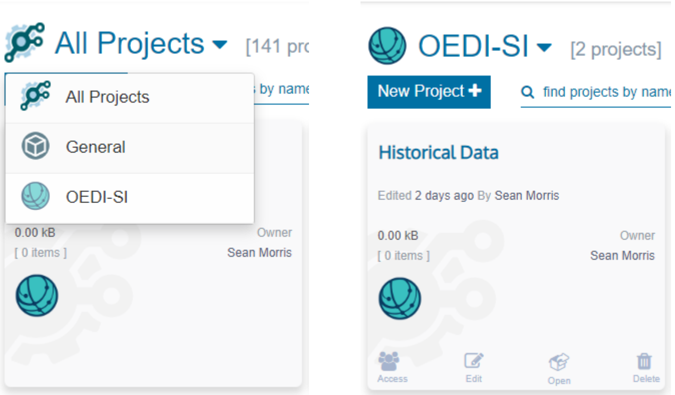
How to Use Open Energy Data Initiative Solar Integration (OEDI-SI)

How to Download the Historical & Network Model Data

1. Set up an account on Data Foundry
   a) Receive an email invitation
   b) Follow the registration link to create a new account

2. Access historical data
   a) Once logged in, select "OEDI-SI"
   b) Folder "Historical Data" contains the historical data

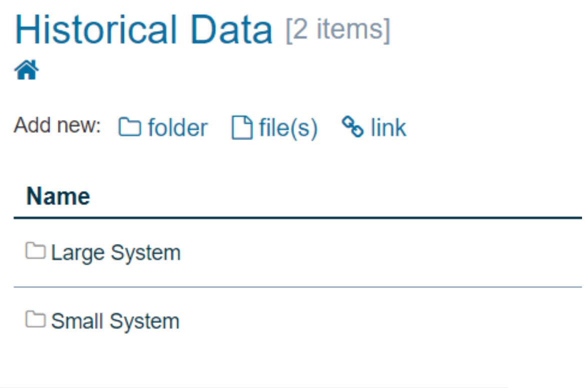
   Note: Only team captains have the access to the "Historical Data"

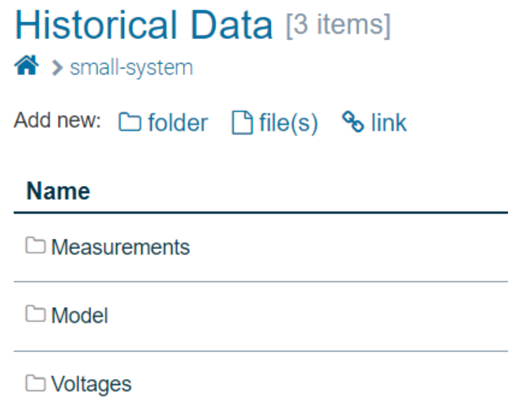


How to Download the Historical & Network Model Data

- Test systems
  a) Small system
  b) Large system

- Inside each system folder
  a) Model: OpenDSS model and topology.json
  b) Measurements
  c) Voltages: actual voltages





Submission

1. Algorithm submission
    a) Upload by August 10, 2024, 5 pm ET
    b) Format: open-source code or executable

2. Result submission
    a) Competition period: August 12, 2024 to August 25, 2024
    b) For each day,
        - measurement data for 7:00 to 18:45 (48 timesteps at 15-minute resolution) will be made available at set time
        - competitors must submit their distribution state estimator's results by 9 pm ET

Submission

3. Results should include:
   a) Estimated voltage magnitudes and voltage angles
   b) (Optional) Measurement quality indicator used to calculate the number of bad data correctly detected (if any)
      - If not submitted, $M_2 = 0$
   c) (Optional) Switch status, used to calculate the number of topology changes correctly identified (if any)
      - If not submitted, $M_3 = 0$

4. Naming convention and sample result files (with the format to follow) will be shared

How to Upload Your Results

3. Results should include:
   a) Estimated voltage magnitudes and voltage angles
   b) (Optional) Measurement quality indicator used to calculate the number of bad data correctly detected (if any)
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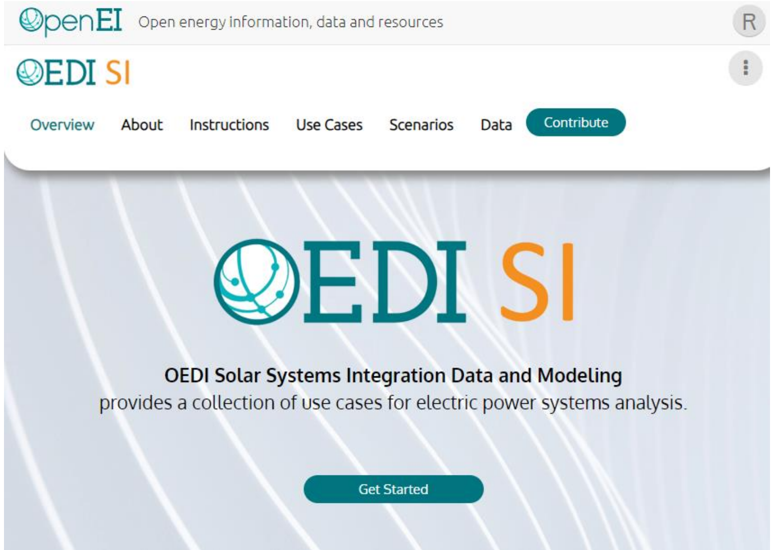
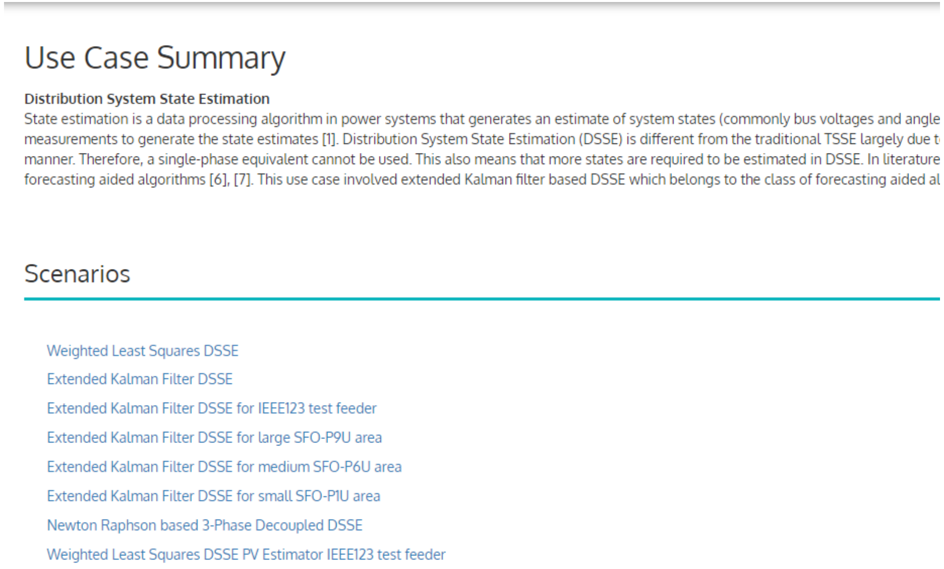
Check out OEDI-SI Website

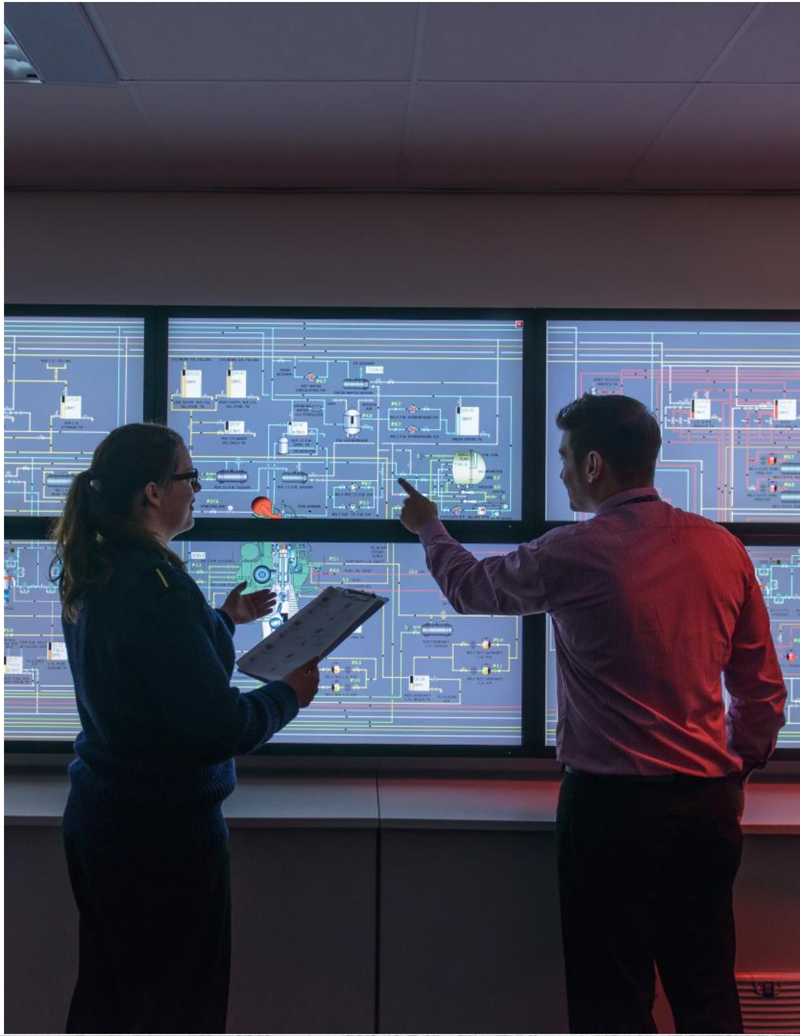
https://openei.org/wiki/OEDI-SI/Overview



Distribution System State Estimation



Questions?



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