MDT

Microgrid Design Toolkit

What is a Microgrid?

Microgrids are organized collections of distributed energy resources (DER) and controls that can operate autonomously (independent of a bulk power grid) when necessary (or always) to provide electrical power. They support resiliency, security, efficiency, local control, and increased access to renewable resources. They can provide reliable power during times when the bulk utility power is unavailable and be leveraged for economic value during grid-tied operations.

Highlights

What does MDT Enable?

The MDT is an application that aids in the design of microgrid systems. Haphazard microgrid design can create many problems around maintenance, safety, power quality/stability, and central dispatch control to name a few. The MDT can be used to provide efficient trade-space analysis in the preliminary design of a microgrid system and an understanding of design choices on such problems.

Why is MDT important?

The MDT can not only be used to illuminate the trade space of design alternatives when planning a microgrid, it can also provide a variety of performance, reliability, and cost-related insights for candidate microgrid designs. Without this type of information, designers rely on engineering judgement and a quantitative analysis of relatively few candidate designs. As a result, a full understanding of the trade-offs inherent in the problem is often not achieved.

Example Applications

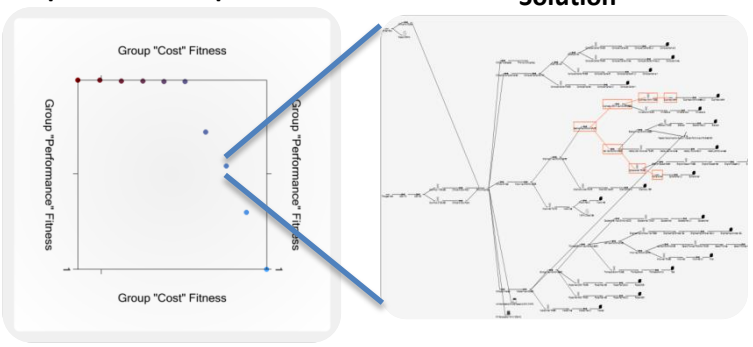
The MDT and its underlying technologies have been used on several programs and by several agencies to help design and assess microgrids. Some examples include:

- The *Smart Power Infrastructure Demonstration for Energy Reliability and Security* (SPIDERS) program
- The City of Hoboken, NJ backup power system
- The US Marine Corps for Expeditionary Units & Brigades

MDT Overview

The MDT is a decision support software tool for microgrid designers in the early stages of the design process. The software employs powerful search algorithms to identify and characterize the trade space of alternative microgrid design decisions in terms of user defined objectives. Common examples of such objectives are cost, performance, and reliability.

Optimal Trade Space | **Details of Candidate Solution**



Pareto Solutions for a Microgrid Design Problem

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA ·

MICROGRID DESIGN TOOLKIT

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Key Features

The MDT performs a multi-objective search to produce a Pareto frontier of efficient microgrid solutions. That frontier is the expression of the efficient trade-offs that can be made amongst the user-defined dimensions (commonly cost, performance, reliability, etc.). The MDT provides a wide range of interactive displays and charts to help a designer understand the results of the search and the implications of different decisions on the resulting quality of the microgrid.

Optimization Features

- Topology and asset selection optimization
- Multi-objective optimization for trade space exploration
- Energy and asset reliability calculations
- Rich set of performance statistics generated for each design

Input Features

- An extensive set of input validation checks with detailed error descriptions and navigation support
- A separate asset specification database which can be reused from analysis to analysis
- User selectable metrics to optimize over and to group them into trade-off dimensions
- Fixed and variable topology input allowing one to ask questions such as:
  - "Should an existing generator be replaced? If so, what type should the new one be and how big should it be?"
  - "Should we build a new building to house additional generation assets and if so, what generation assets should be used and where should the building be connected to the grid?"
  - "Should we install a new redundant backup feeder on our microgrid?"
  - "Should we add a PV installation and if so how big? If we add one, should we also add a battery to support it and if so, how big should it be?"

Output Features

The MDT provides many views and features to help explore the trade space to extract information such as:

- "What are the characteristics of solutions that perform well along a particular trade off dimension?"
- "What are the technology decisions that have been ruled out as undesirable?"
- "Given a baseline solution, how much money will be required to realize a 10% improvement in performance?"

Key Benefits

Using the MDT, a designer can:

- Effectively search through very large design spaces for efficient alternatives
- Investigate the simultaneous impacts of several design decisions
- Have defensible, quantitative evidence for decisions
- Gain a quantitative understanding of the tradeoff relationships between design objectives (cost and performance for example)
- Gain a quantitative understanding of the trade-offs associated with alternate design (technological) decisions
- Identify "no brainer" choices to reduce the number of design considerations
- Perform what-if analysis by altering the input without loss of information to include or not include certain features in a run of the solver
- Perform hypothesis testing by manually generating solutions and comparing to the solutions found by the MDT

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