Aggregating Metrics

Prepared for
Smart Grid Workshop, Brookhaven National Laboratory
8 Oct 2015

Julia Phillips
Deputy Director, Methodology
Risk and Infrastructure Science Center

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- Supports the critical national and homeland security priorities of a variety of Federal sponsors

Overview

- Metrics
- Grid Modernization
- Decision Analytics
- Example

Developing Metrics

- Why?
  - Establish a baseline and measure progress from that baseline
- Identify goals and objectives (for all decision makers)
- Characteristics of good metrics
  - Comprehensive
  - Operational
  - Divisible
  - Independent
  - Minimal

- The above create defensible, transparent and repeatable metrics
- Metrics for different purposes and levels
  - Performance based vs. strategic
  - Driven by needs and goals of decision makers
  - Tactical and operational level goals should support strategic goals

Grid Modernization

- Department of Energy Grid Modernization Mutli-Year Program Plan
  - Revision based on findings from the first phase of the Quadrennial Energy Review and the Quadrennial Technology Review
  - Essential to the security and economic health of our nation
- Grid Modernization Vision

  The future grid provides a critical platform for U.S. prosperity, competitiveness, and innovation in a global clean energy economy. It must deliver ***reliable, affordable,*** *and* ***clean electricity*** *to consumers where they want it, when they want it, how they want it.**
- Goals of Grid Modernization
  - Achieve public policy objectives
  - Sustain economic growth and innovation
  - Mitigate risks and secure the nation

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* Webinar, 20 May 15, Kevin Lynn, DOE/EERE Grid Modernization Initiative

Key Attributes of a Modernized Grid

- **Reliable:** The lights remain on and the grid is protected against threat
- **Affordable:** Costs remain reasonable for the consumers
- **Clean:** Reduce environmental impact
- **Flexible:** Ability to absorb rapid changes in supply, demand, delivery or demand changes
- **Innovation:** Encourage new technologies, products, services, and business models

These can be the categories of metrics upon which to establish the baseline and measure progress towards grid modernization

The Grid Modernization Initiative

- Establishment of an aggressive 5-year grid modernization strategy
  - Development of a laboratory consortium to assist in meeting the goals
  - This new crosscutting effort help the nation achieve at least three key outcomes within the next ten years:
    - **> 10% reduction in the societal costs of power outages**
    - **> 33% decrease in cost of reserve margins while maintaining reliability**
    - **> 50% cut in the costs of wind and solar and other DG integration**

How does a decision maker choose options for modernizing the grid given the five key attributes and three key outcomes?

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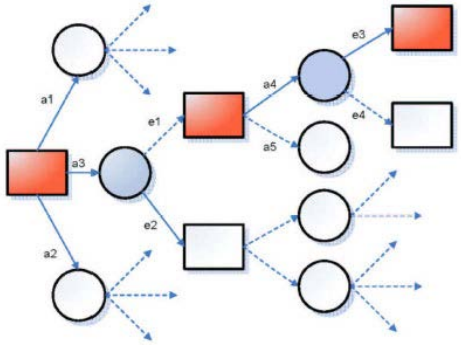
Decision Analysis – Underlying Theory

- Decision analysis is an approach that has found wide applicability in real world problems
- Decision analysis methods reduce bias and promote transparency
- Decision analysis provides a structured approach to complex problems that is defensible, ensures consistency, and reproducibility of results
- Decision analysis methods can be useful – and are being used – for aggregating disparate groups of metrics to inform decision makers



Informing the Decision Maker

- Decision makers for grid modernization are faced with multiple, sometimes conflicting objectives
  - Strategic goals are simplified into sub-goals with measureable objectives
- Decision analysis can provide a methodology to combine these metrics into portfolios (alternatives)
  - Draws on theories of both single attribute and multi-attributes utility theory under uncertainty
  - Takes decision maker preferences and priorities into account by considering tradeoffs between conflicting objectives
- Portfolio optimization techniques can be used to prioritize alternatives and inform decisions subject to constraints

Combined methodology provides a method to compare conflicting objectives while satisfying strategic level goals and initiatives

An Example for Grid Modernization

- Strategic goals of the Grid Modernization Initiative
  - Achieve public policy objectives
  - Sustain economic growth and innovation
  - Mitigate risks and secure the nation
- Three outcomes within the next ten years:
  - Greater than 10% reduction in the societal costs of power outages
  - Greater than 33% decrease in cost of reserve margins while maintaining reliability
  - Greater than 50% cut in the costs of wind and solar and other DG integration
- The key attributes can be used to measure effectiveness to modernize the grid to achieve these goals

The Key Attributes

- Five key attributes suggested for a modernized grid
  - Reliable
  - Affordable
  - Clean
  - Flexible
  - Innovation
- Each attribute might consist of multiple metrics that capture the attribute
- Steps towards identifying those metrics
  - Agreed upon definitions of the five attributes
  - Determine the metric(s) that will enable you to capture the different aspects of the attribute as identified by the definition
  - Determine scales that will accompany each of those metrics (e.g., natural, constructed, or hybrid scales)
  - Alternatives would be evaluated with respect to the different metrics and those scales

The Key Attributes (cont.)

- Some Underlying Properties of Utility Functions
  - Preference Consistency
  - In situations involving uncertainty, E[U] is an appropriate index to evaluate alternatives
  - Multi-attribute utility theory incorporates two concepts of value independence
    - Preferential Independence
    - Utility Independence
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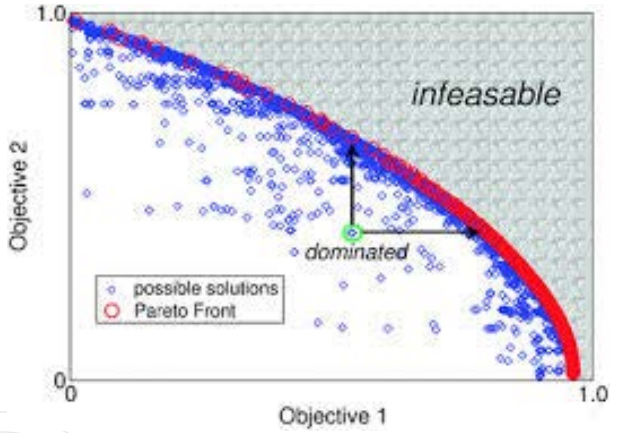
Complexities and Alternatives

- Complexities
  - A number of separate metrics may contribute to each of the key attributes
  - Ensure the metrics under each attribute satisfy the assumptions: complete, independent, minimal, etc.
  - These types of properties must hold when considering decision maker preferences across attributes
  - Different decision makers could have significantly different preferences and risk attitudes

- Determining the alternatives to pursue
  - Optimization of a portfolio of alternatives
  - Constraints based on time, money, and risk attitudes of decision makers



Conclusion

- Aggregating metrics can help inform consistent and transparent decision making
- The process is complex; methods to deal with complexity
  - Decision Analytics
  - Portfolio Optimization
- Provides a method to incorporate decision maker preferences while still satisfying strategic level goals
- Example is in progress with the lab consortium on metrics that gauge grid modernization efforts

For more information, please contact:

Julia Phillips
Deputy Director
Risk and Infrastructure Science Center (RISC)
Global Security Sciences Division (GSS)
Argonne National Laboratory
630-252-2505
phillipsj@anl.gov