Wind Integration in Smarter Grids

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WINDPOWER 2012

Challenges and Opportunities

"How many things are judged impossible before they actually happen."

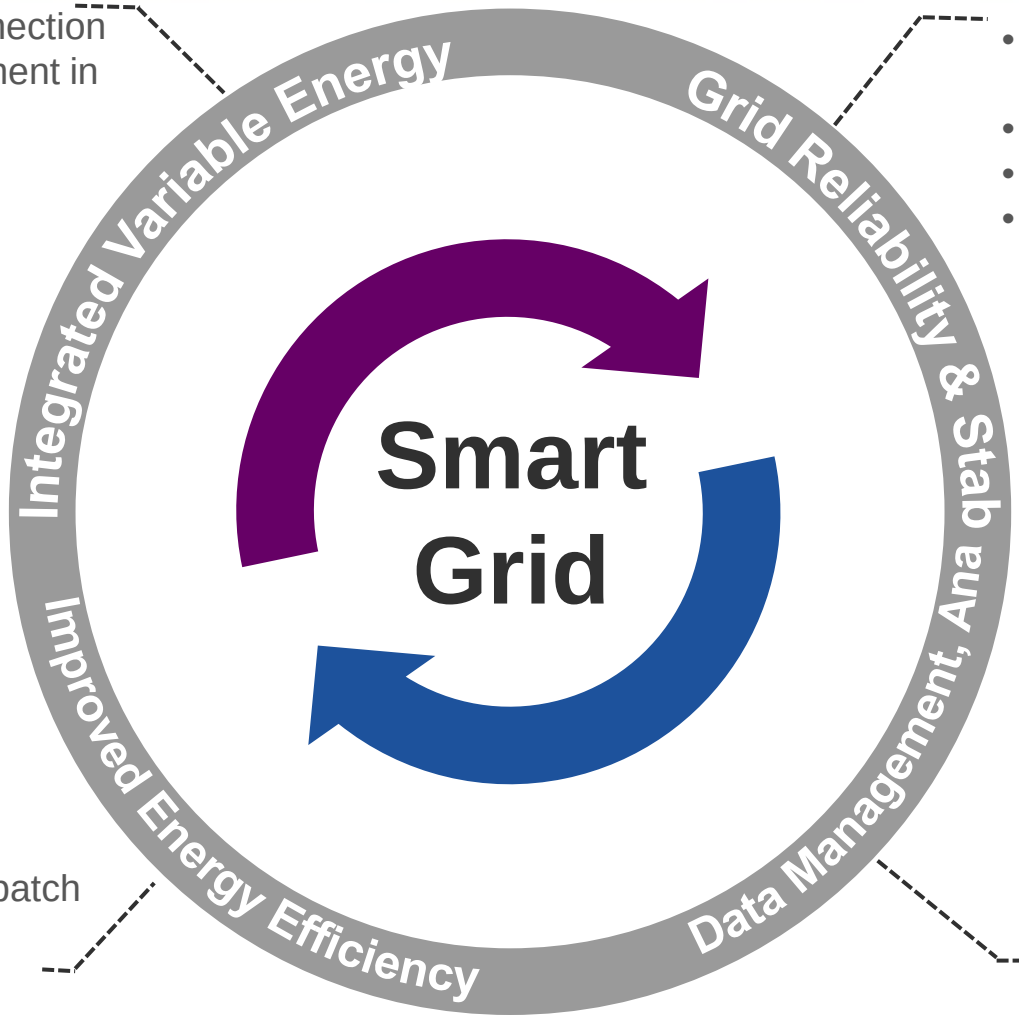
Pliny the Elder, Naturalis Historia, VII

"Insisting that a thing is impossible because we cannot accomplish it."

Cicero's Six Mistakes of Man

Strategic Challenges for Smartening Electricity Grids

- Renewable grid connection
- Wind/solar management in grid control rooms
- Meshed DC grids



- On-line stability software in control rooms
- Digital substations
- PMU's
- Wide Area Automation and Defense Plan

- Improve market dispatch efficiency
- On-line substation asset management
- Demand side management

- Data integration with control room system
- User friendly visualization of the data tsunami
- Turn data into useable, real-time knowledge

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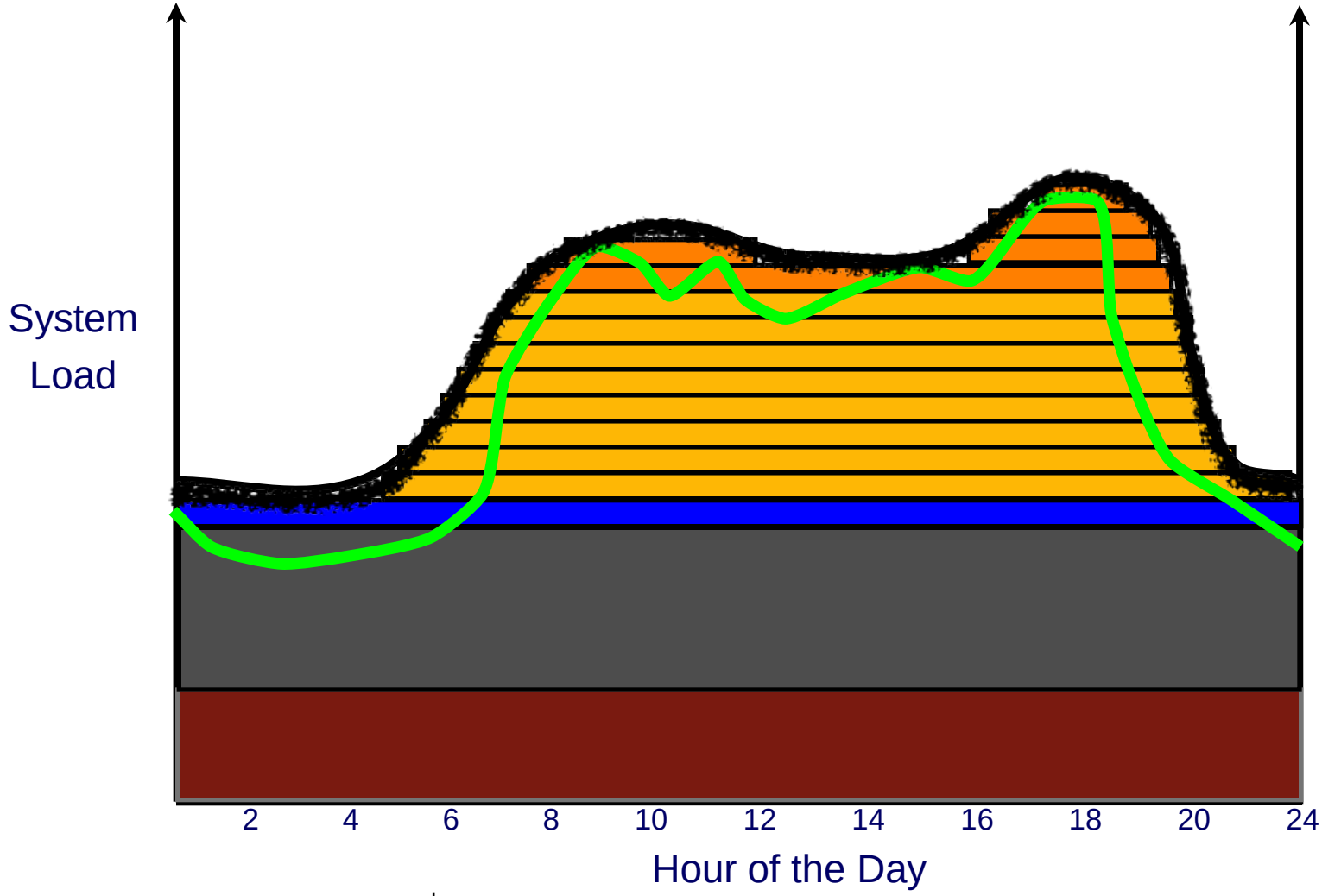
Growth of renewables & smart grid will “change the game”

Dispatch of Traditional Resources



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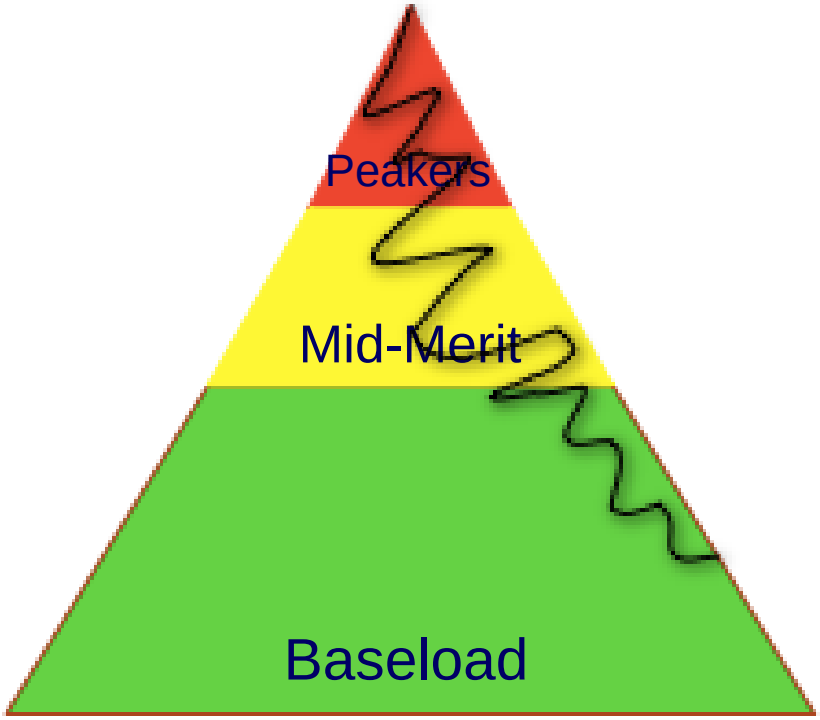
Current operating metrics and tools are insufficient to optimize the potential of our new resources and capabilities

Challenges to the Status Quo



Credit to Keith Parks of Xcel Energy

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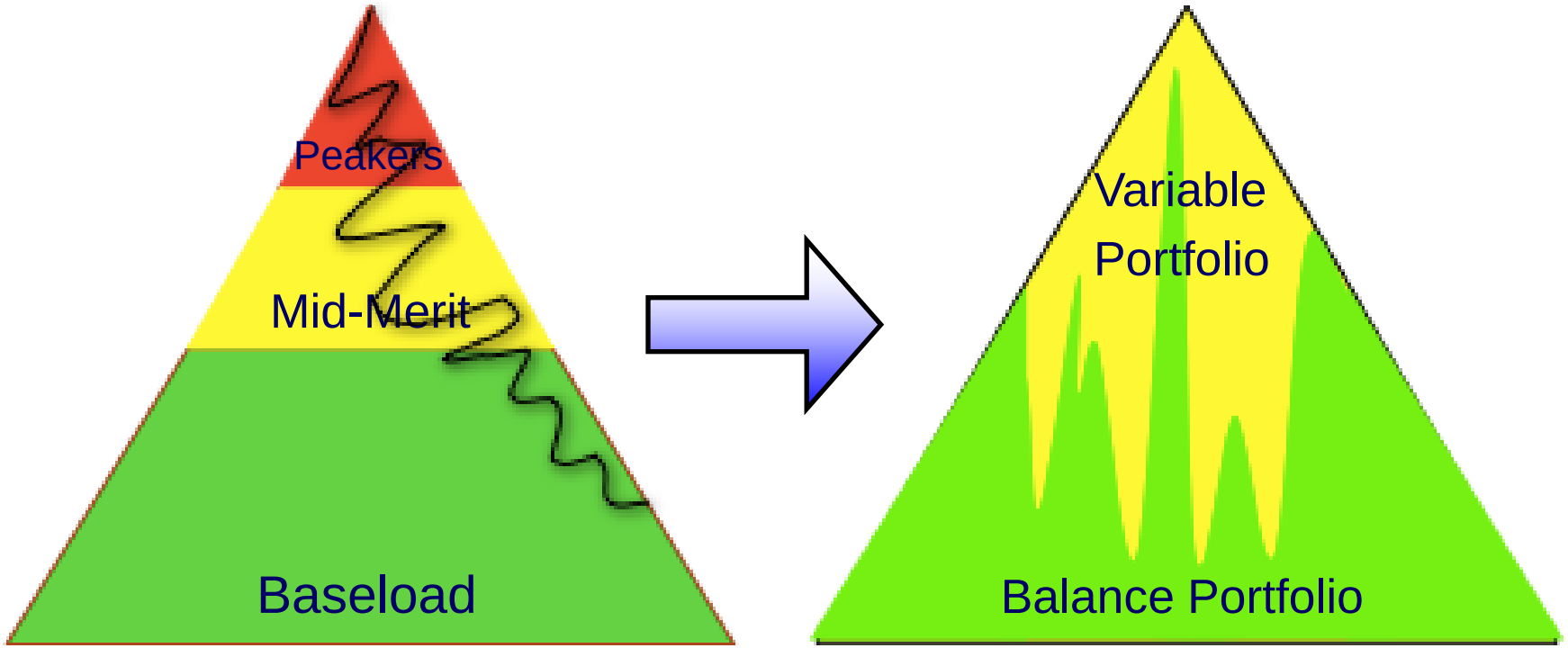
What perspective do we need, and what products and metrics do we need to develop, to better address this change?

Major Transition - Catalyst for Change



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Triad of Successful Integration

- **Physical**
  - How are plants connected to the grid?
  - What level of control do I have to use their flexibility?
- **Operational**
  - What are my operating rules and assumptions?
  - What are my motivations and rewards?
- **Informational**
  - What forecasts and information are available?
  - Can I turn the information into actionable intelligence?

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Many Sources of Flexibility

- **Transmission**
  - High voltage direct current transmission, flexible AC transmission systems, dynamic line rating
- **Generation**
  - Faster gas turbines, making flexibility accessible and rewarded
- **Load**
  - Demand response, price-sensitive loads, electric vehicles
- **Energy Storage**
  - Virtual power plants (demand response, etc.) versus storage
- **Operational Flexibility**
  - Faster electricity markets, larger balancing areas
  - Control center decision support tools, look-ahead simulation, forecasts integrated in tools

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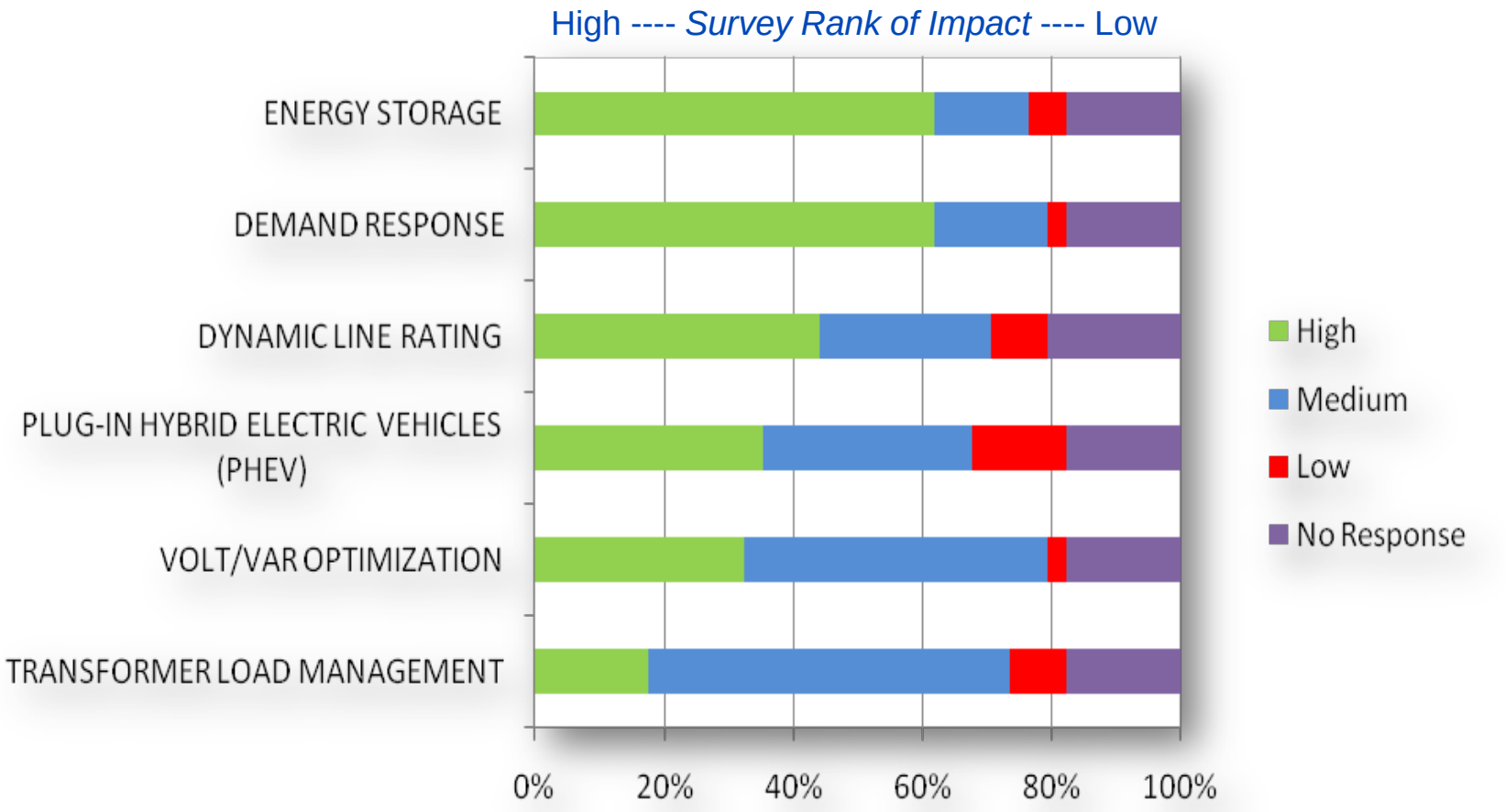
Smart technologies must be efficient and cost competitive for mass-scale deployment to create significant value to the grid

Smarter Technologies - Great Potential



Source: L. Jones, Strategies and Decision Support Systems for Integrating Variable Energy Resources in Control Centers for Reliable Grid Operations, December 2011.

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Driven by both policy and technology, the nature of the system will evolve, and so must our definition of the "problem"

Changing Metrics

- **Higher level frameworks**
  - Do different goals change what is important?
- **Planning versus operational metrics**
  - How do we encourage and compensate flexibility?
- **Implicit characteristics of the problem space**
  - You get what you measure
  - Problem definitions impact the perceived problem solutions
- **Timing is everything?**

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Because timing influences forecasting and uncertainty, rules and operating practices directly influence accuracy and cost

Timing Windows Do Matter

- **Wind forecasting example:**
  - Lower forecast error within 15 minutes of real time
  - Good (but higher) forecast error from weather models for 4-48 hours ahead
  - Forecast error for 1-2 hours ahead almost as high as for the 4-48 hour-ahead period

- **The goal is to align timing to exploit best forecasts and best system flexibility**

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When comparing various approaches, why do some seem implicitly more satisfying?

Attributes of Quality Transactions

- Bidirectional exchange of real and meaningful value
- Belief that the parties will act rationally based on the information provided to them
- Clear guidance on what you should do
- Clarity around how you could improve and how that would benefit you
- Provides an enduring, sustainable framework

Quality

(in the "Zen and the Art of Motorcycle Maintenance" sense?)

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The Good, The Controversial, The Difficult?

- **Stochastic models**
  - Planning, flexibility & reserves
- **Use of smart grid data**
  - Distribution & end user
- **Wind as a full market participant**
  - Timing, dispatch and curtailment
- **System-level optimization**
  - Growing emphasis on acquiring flexibility and cost allocation, but how and why?

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Discussion

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