

Managing tails begins with planning

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- ... operations depend on planning
- ... planning depends on simulations of future outcomes



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This impacts all planning processes

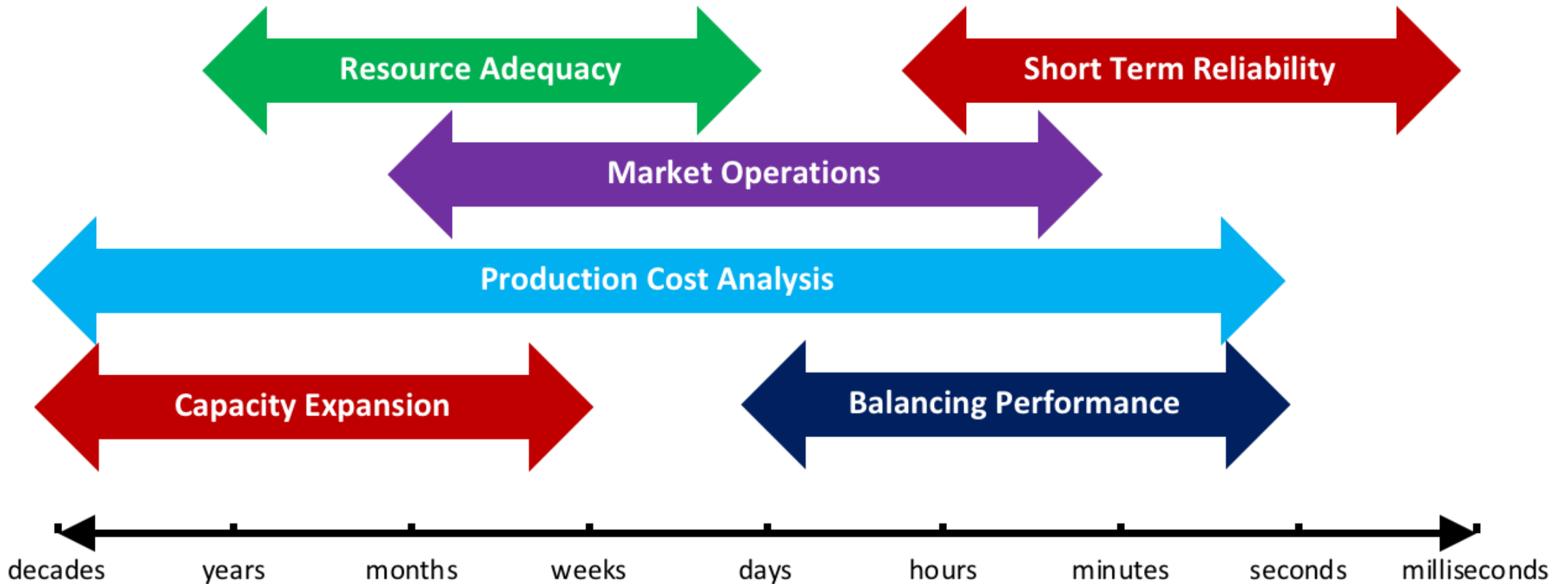
- **Transmission expansion**
- **Generation expansion**
- **Asset valuation**
- **Resource adequacy**
- **Maintenance scheduling**
- **Production-cost modeling**
- **Market Design**
- **“Week-ahead” scheduling**
- **Day-ahead scheduling**
- **Reliability scheduling**
- **Real-time scheduling**

... so why did we develop PSO ?

- Challenges of renewable integration
 - Missing reliability and economic impacts in planning studies
 - Difficult to evaluate new resources and sources of flexibility
 - Difficult to evaluate impact of changing policies (e.g., reliability, incentives)
 - Need to quantify value of flexibility, better forecasts, new policies
- Goals for PSO development
 - Simulation of future markets and utility operations
 - Support effective use of distribution resources
 - Flexible modeling: we don't know what future capabilities look like
 - Flexible deployment: we don't know how problems will be solved

Renewable integration impacts all processes

- Coordination and evaluation of resources across all time frames



Question 1: What are exciting new feature of PSO?

- Growth of PSO capabilities has grown in parallel with ESIG
- Ability to broadly optimize and co-optimize new and existing resources across all time frames (CX, RA, PCM, AGC)
 - Transmission (nodal and zonal)
 - Energy storage (including impacts of efficiency and endurance)
 - Fuel networks and storage
 - Emissions
 - Power-to-fuel (e.g., electrolyzers)
 - Fuel-to-fuel (e.g., hydrogen to ammonia)
 - Nationwide down to distribution level, configurable to user needs

Question 2: Exciting case studies

- Capacity expansion with co-optimized transmission and generation
- Capacity expansion of battery storage and impacts of efficiency and endurance
- Capacity expansion of hydrogen economy for seasonal energy storage
- Operational resource adequacy
- Multi-interconnection models: EI and WECC
- Stochastic modeling