Multistage stochastic programming formulation

- Handles both strategic (e.g., fuel price uncertainty) and operational (e.g., different profiles of representative days) uncertainties.
- Number of scenarios grows exponentially with the number of stages.

Algorithmic Capabilities

**Forward Pass**
- Scenario Sampling
- Solve subproblems for a subset of the scenarios.
- Get the Statistical Upper Bound (for a certain confidence level)

**Backward Pass**
- Solve for all children nodes of the nodes in the sampled scenarios.
- Relaxed subproblems.
- Benders cut takes the weighted average of the coefficients for the cut based on the conditional probability
- Solution of node 1 is the Lower Bound

SDDiP has potential for parallelization
- Synchronization

Hypothetical case study: ERCOT

Test algorithmic capabilities and performance
- Number of scenarios ranging from thousands to billions.
- Problem size ranging from quadrillions to variables and constraints.
- All solved in less than 24 hours.

These results show how powerful SDDiP can be for practical large-scale multistage stochastic programming problems.

Here-and-now decisions vary according to the scenario tree

Value of stochastic programming

By considering carbon tax as an uncertain parameter, the value of stochastic programming is $2.18 billion, which is the savings one can achieve in the long term.

Remarks and Future work

- IDAES is developing cutting-edge scalable analysis approaches that enable quantification of the adoption and impact of proposed generator designs.
- Current activities focusing on increasing model fidelity:
  - Improving the transmission representation in the model and including the option for transmission expansion.
  - Developing strategies to efficiency solve nonlinear transmission models.
  - Adding construction lead time to the multistage formulation.
  - Extending parallel SDDiP to address risk-averse problems and stage-wise dependent problems.

Contact: John Sirola, jsiirola@sandia.gov