



Evaluating Carbon Policy Risk

**Resource Planner's Forum
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System Modeling Framework

- PacifiCorp uses its integrated resource planning models to analyze carbon risk
 - Capacity expansion optimization model, *System Optimizer*
 - Determines least-cost mix of future resources based on minimizing the portfolio's Present Value of Revenue Requirements (sum of real levelized fixed costs and variable costs)
 - Resources include thermal, renewables, demand-side management, transmission expansions, existing plant retirements and betterments
 - Multiple portfolios developed based on input scenarios
 - Stochastic production cost model, *Planning and Risk*
 - Run Monte Carlo simulation of each portfolio under alternate CO₂ cost adder trajectories; investigating use of a stochastic CO₂ cost variable
 - For risk assessment, determine average cost and upper-tail risk metrics for portfolio comparison

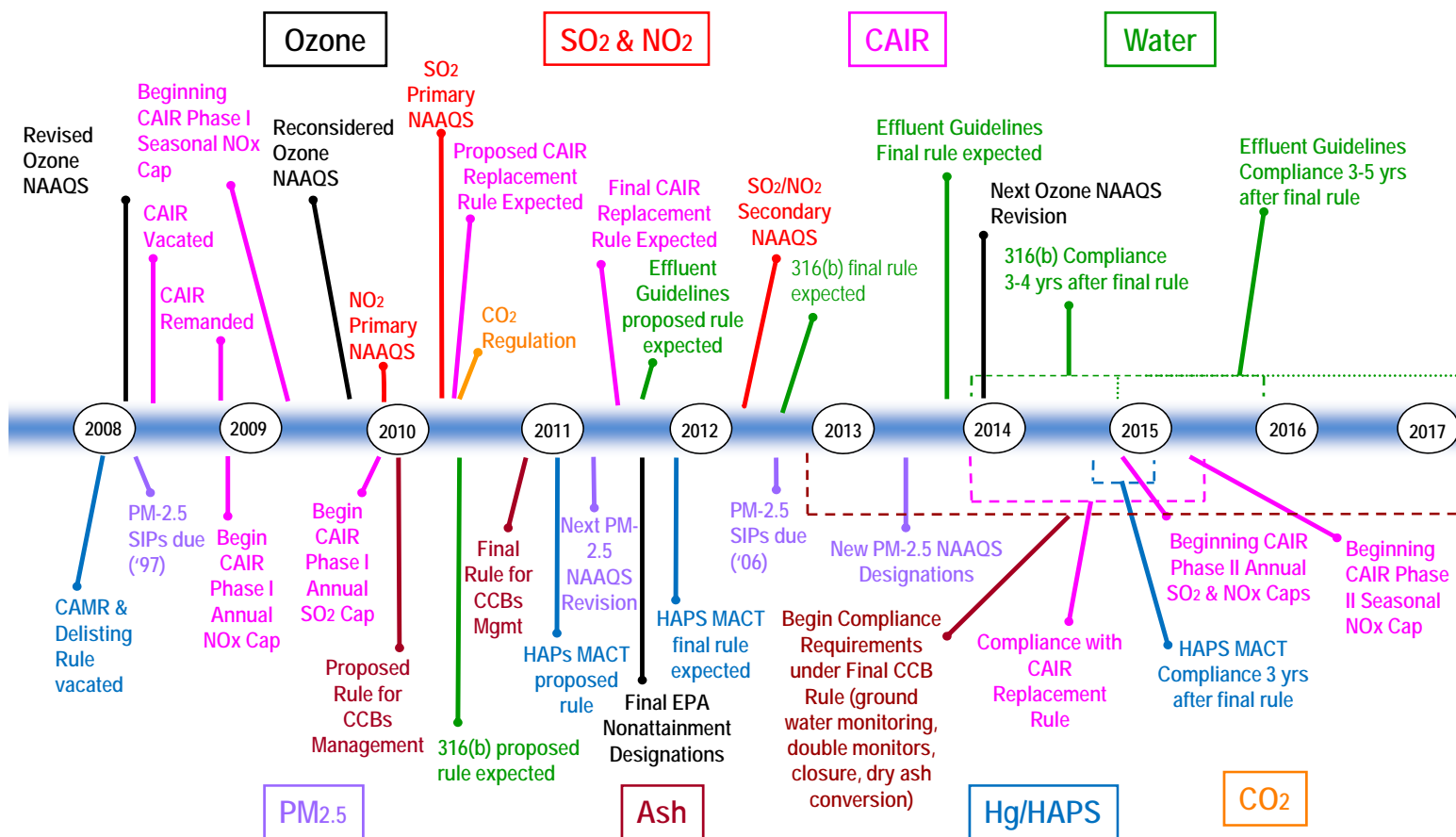
System Modeling Framework

- The impact of CO₂ regulations on fuel, electricity, and other emission prices is captured outside of the capacity expansion model
 - PacifiCorp uses ICF International's Integrated Planning Model (IPM®) model to forecast CO₂ policy market price impacts
 - These price impacts are incorporated into the Company's forward price curve forecasting process
 - Resulting forward price curves loaded into *System Optimizer*

System Modeling Framework

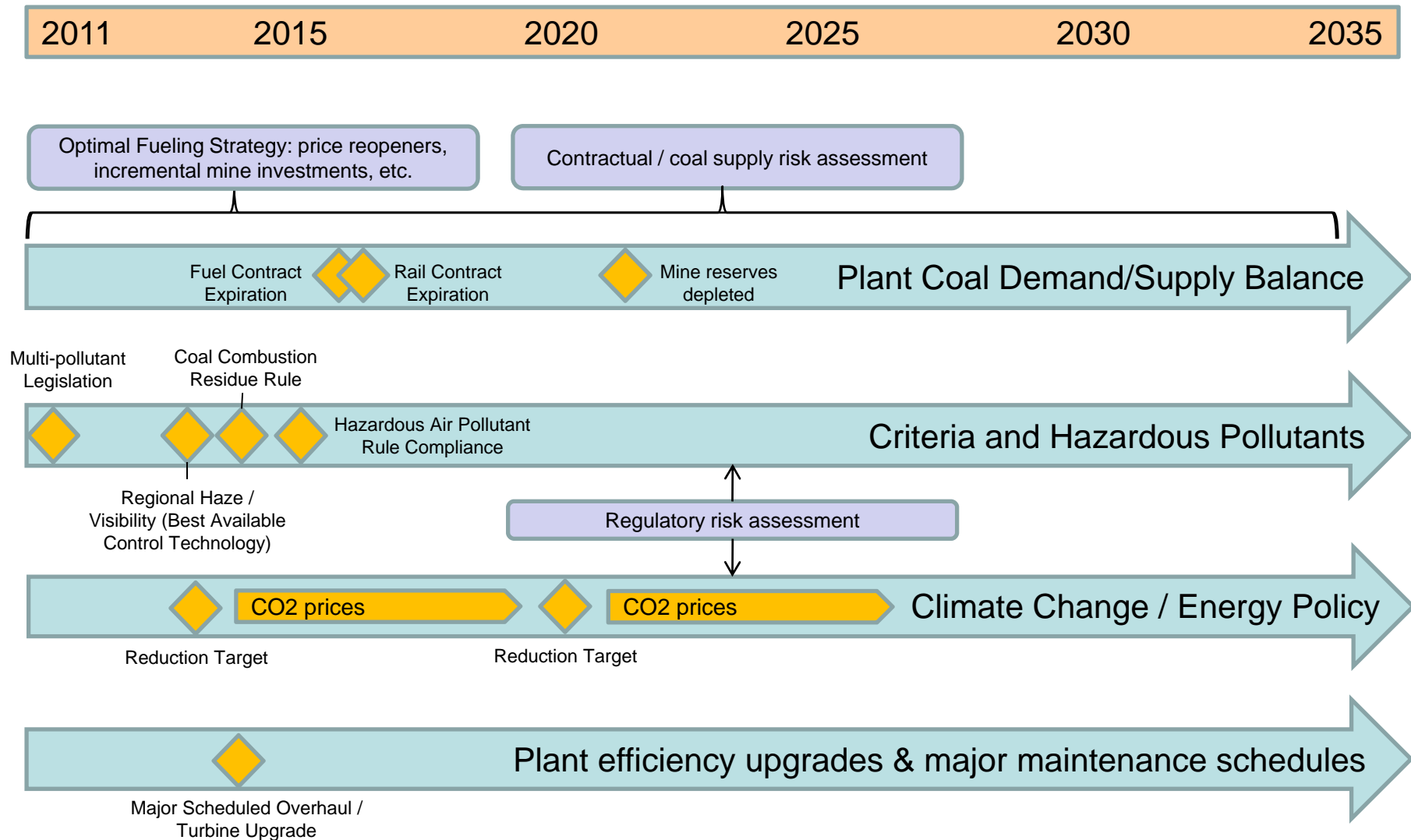
- CO₂ cost adder selection
 - Primary rely on CO₂ tax, although cap & trade and hard cap compliance scenarios examined
 - Tax values (\$/ton), chosen based on levels needed to significantly change resource mix
 - No CO₂ tax – determines baseline for cost impact evaluation
 - \$45 – level needed to flatten emissions growth in the long term
 - \$70 – level needed to significantly reduce emissions growth
 - \$100 – high-end value associated with an aggressive federal emission reduction policy
 - Public stakeholder input solicited on reasonableness of these cost adders
 - Base scenario has cost adders escalated annually at forecasted inflation rate; alternate scenario with additional real escalation

Federal Environmental Regulatory Timeline



-- adapted from Wegman (EPA 2003)

Key Decision Points Associated With an Early Retirement Option



Modeling Coal Plant Retirement Options

- *System Optimizer* optimizes the timing of coal plant retirements
- Model assesses the net present value cost trade-off of running each plant versus early retirement
 - Continued plant operations accounts for required incremental pollution control and coal mine investments/capital depreciation schedules, fuel costs, operation & maintenance costs, and CO₂ dispatch cost adder
 - The model calculates capital additions on an escalated real-levelized basis to handle investment end effects

Modeling Coal Plant Retirement Options

- Early retirement accounts for the cost of replacement generating capacity, and decommissioning costs
- For replacement baseload capacity, the model has the following available options:
 - Coal plant retrofits
 - Repower with a gas-fired combined cycle combustion turbine
 - If feasible, boiler fuel conversion to natural gas
 - Gas-fired resources at other sites
 - Firm market purchases
 - Beginning in 2030, nuclear, carbon capture and sequestration retrofits, and integrated gasification combined cycle (IGCC)

Modeling Coal Plant Retirement Options

- Recently implemented model customizations account for:
 - Load-area based CO₂ emission performance standards in California, Oregon, and Washington
 - Renewable/clean energy standards at both federal and state levels
- Capacity expansion modeling is a deterministic screening tool
 - Scenario analysis determines robustness of resource portfolio under alternate input assumptions
 - Does not address regulatory/legal risks or political concerns
 - Does not address transmission power flow impacts