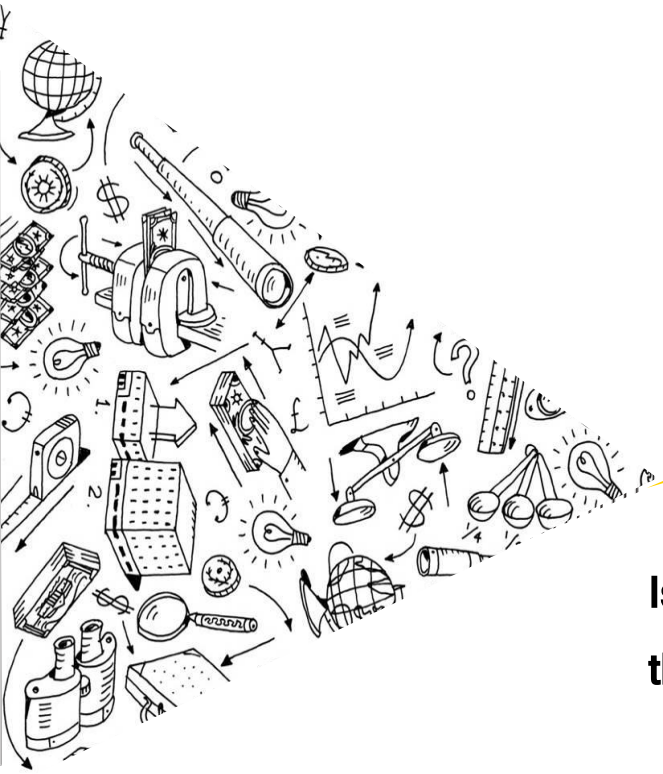


Is converting coal to gas the right move?

How to make a complex critical asset decision in the face of uncertainty

ERNST & YOUNG
Quality In Everything We Do

What's the issue?

Impacts of market and regulatory drivers on plant economics

- As the cost of operating a coal-fired plant continues to rise, many major utilities are presently in the process of evaluating treatment of their aging (and increasingly uneconomic) coal fleet
  - A multitude of Environmental Protection Agency (EPA) regulations will require utilities to meet new emissions standards
  - The all-in cost of mining and transporting coal is also rising
- Natural gas is becoming more attractive as a replacement energy source for an increasing number of utilities
  - New drilling techniques have opened up previously untouchable shale gas, thereby increasing the domestic supply of natural gas
  - With natural gas prices continuing to hover around an all-time low, the fuel economics of running a gas plant are becoming more attractive than running a coal plant
- Within the context of a growing number of coal plant retirements, several high-profile utilities have announced an intent to convert existing coal plants to burn natural gas

Why now?

Regulatory uncertainty drives decision-making urgency

- A significant number of regulations for coal plants will be coming into force within the next several years
  - At the *federal* level …
    - The EPA has spent the last several years working on new rules to limit carbon emissions on power plants
    - The re-election of President Obama is expected to accelerate their implementation
  - And at the *state* and *regional* levels …
    - Energy regulators (e.g., RGGI, CARB) are implementing their own regulations to limit carbon dioxide and other emissions from coal plants
- A "wait and see" approach may not be the prudent path forward, despite significant uncertainty as to the exact timing and stringency of regulations
  - The power and utilities industry has shown in the past that as an environmental mandate nears, competition among utilities for scarce resources (i.e., EPC firms) tends to drive up the all-in costs of compliance
- Unless they act now, coal-centric utilities and merchant coal plant owners may not be able to provide the best value to ratepayers or shareholders

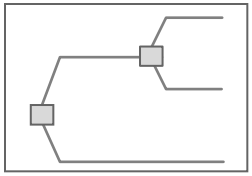
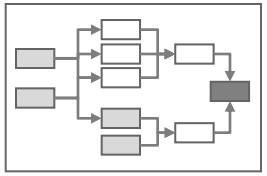
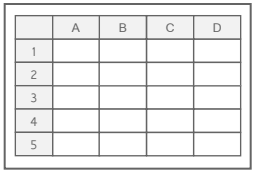
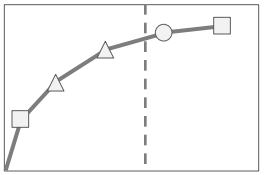
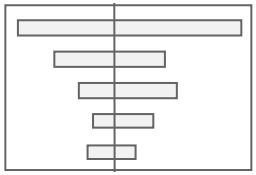
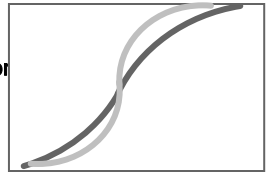
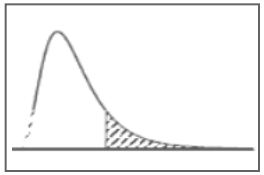
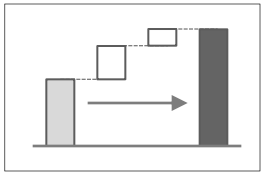
What's the fix?

Perspectives on a leading practice, driver-based decision approach

Work steps	Key questions
1. Understand the options	• Which coal units are in scope? • Based on key technical considerations, what are the viable conversion options for each unit in scope? • What are the key decision drivers (i.e., controllable versus uncontrollable)?
2. Evaluate each option	• Based on a driver-based model, what is the most economically valuable option for each coal unit? • At the asset portfolio level, what set of strategic investment decisions optimizes total generation asset value across the fleet?
3. Conduct scenario-based planning	• What does sensitivity testing tell us about the robustness of each option? • How does the probabilistic treatment of key risk drivers via simulation and/or scenario analysis inform our preferred path forward?
4. Consider creative alternatives	• Are there embedded options/learning events that strengthen the analysis? • What innovative approaches (e.g., partnerships with joint developers, manufacturers and/or pipeline owners) could increase the value of a given option?

What's the fix?

Perspectives on a leading practice, driver-based decision approach

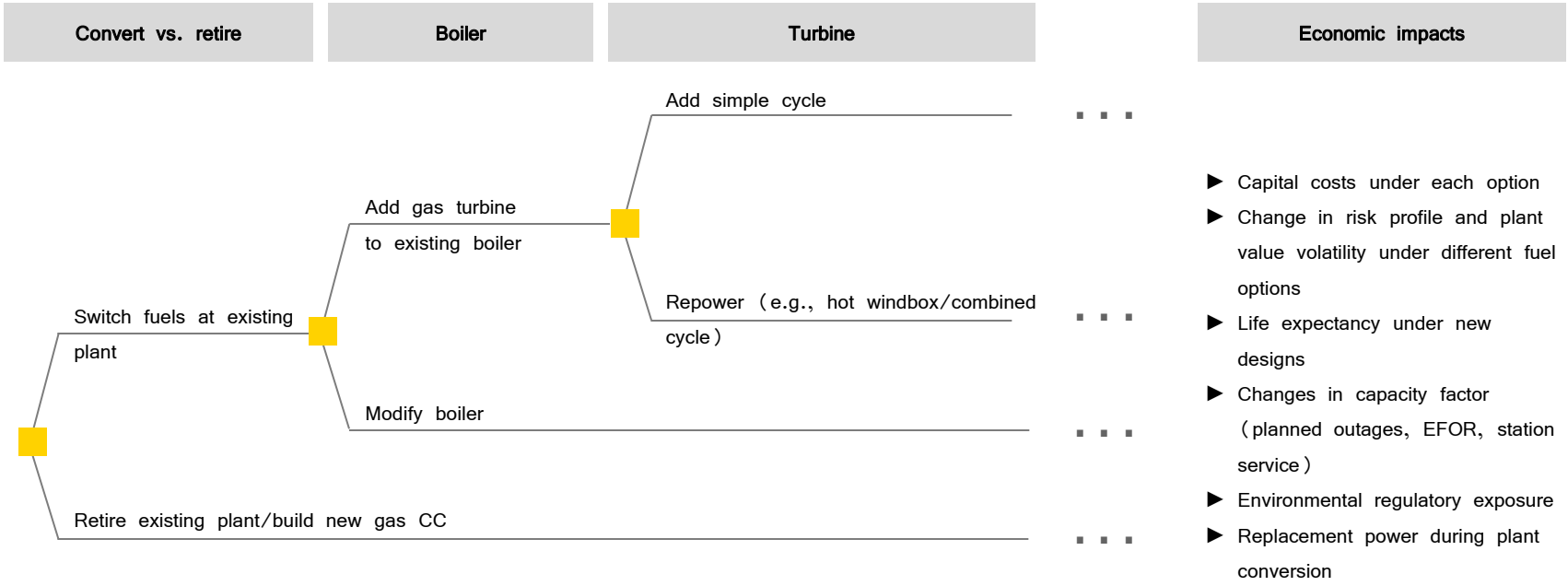
Work steps	Analytical tools			
1. Understand the options	Decision tree		Driver diagram	
2. Evaluate each option	Driver model		Funding curve	
3. Conduct scenario-based planning	Sensitivity analysis		Probability distribution	
4. Consider creative alternatives	Real options		Value creation	

1. Understand the options

Selecting a range of options based on technical considerations

The potential options for each coal unit under consideration for conversion should be evaluated carefully for technical feasibility, which in turn impacts project costs.

Illustrative decision structure for coal-gas capacity replacement

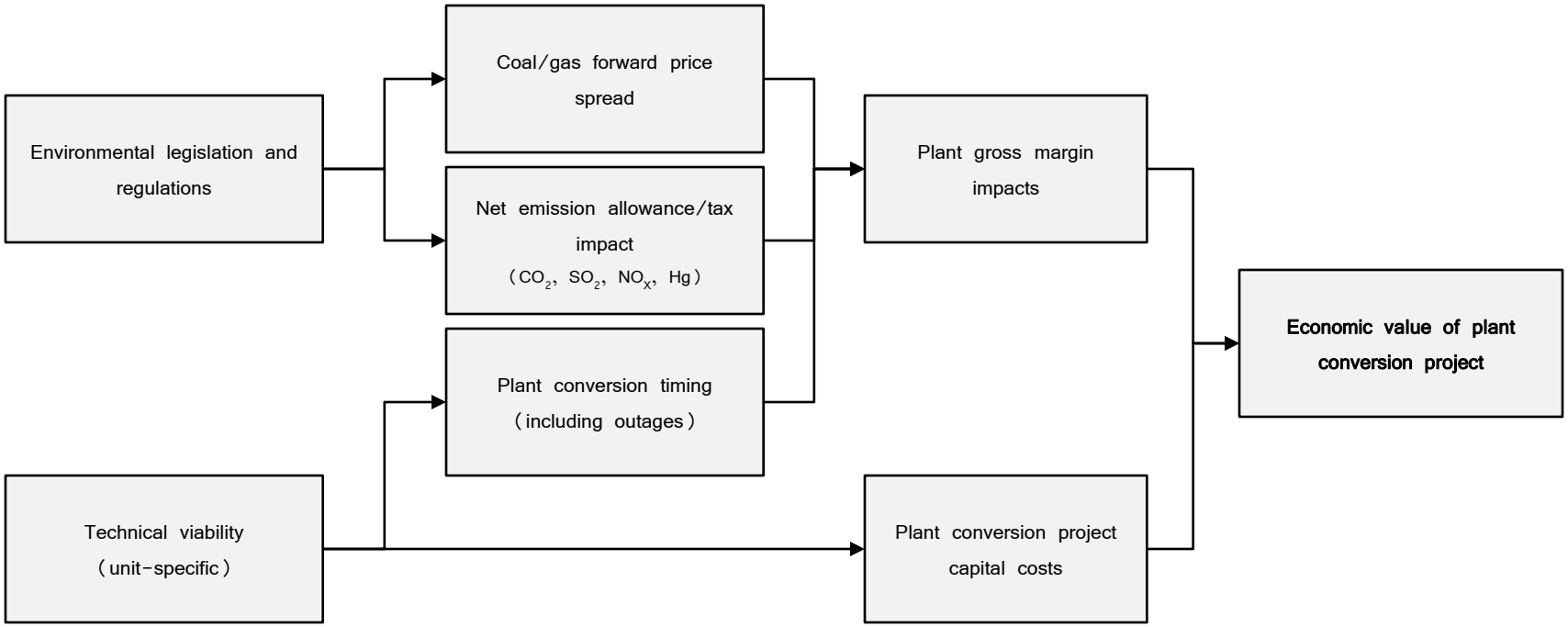


1. Understand the options

Identifying key decision drivers

The high-level driver diagram below maps the relationship among key drivers toward an economic evaluation (with a more detailed structure mapped out prior to the modeling exercise).

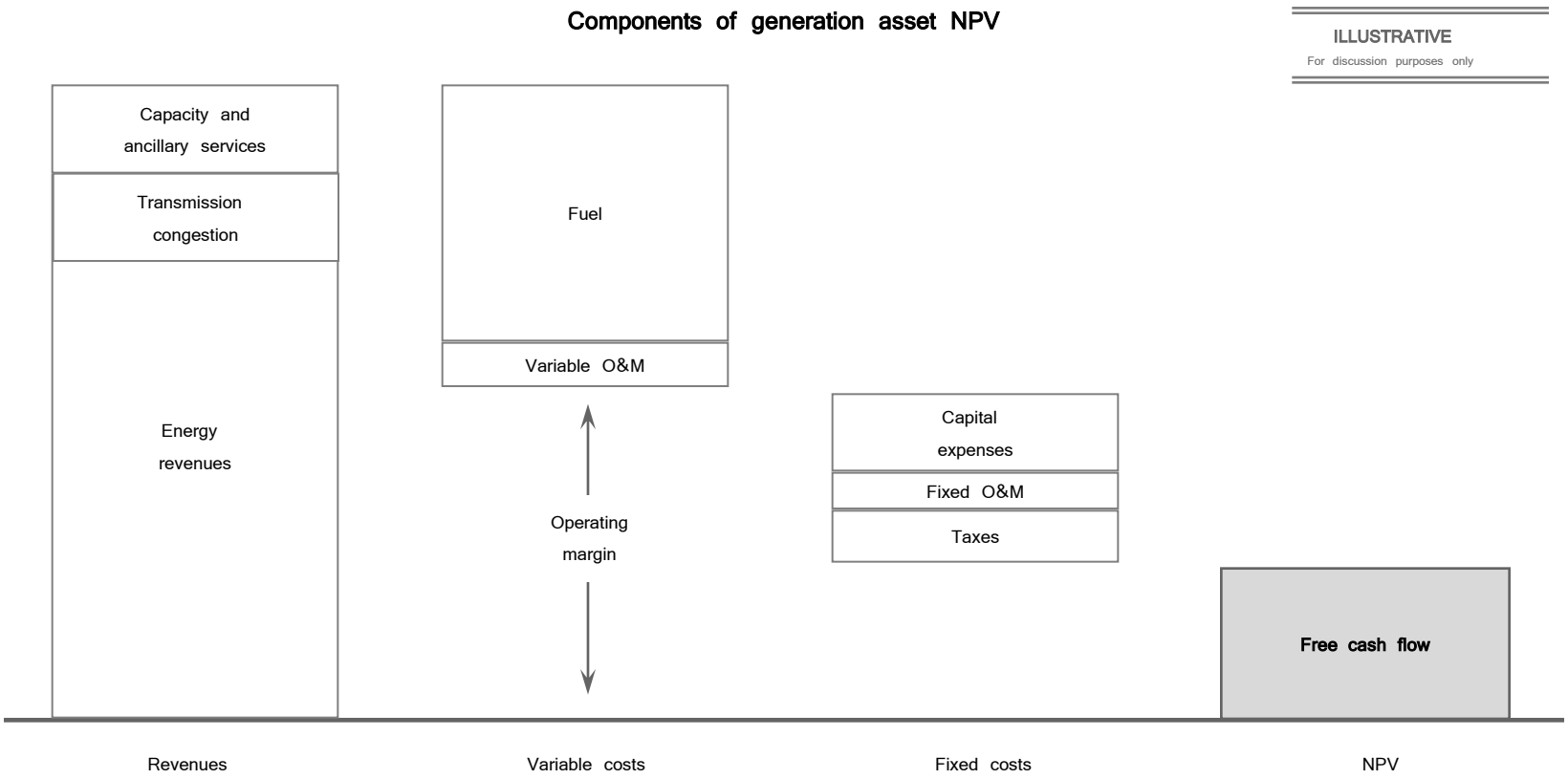
Illustrative driver diagram for coal-to-gas conversion decision



2. Evaluate each option

Developing a driver model for a coal generation asset

A detailed driver-based spreadsheet model will yield a plant gross margin, from which we calculate the net present value of free cash flow of a plant as the estimate of generation asset value.

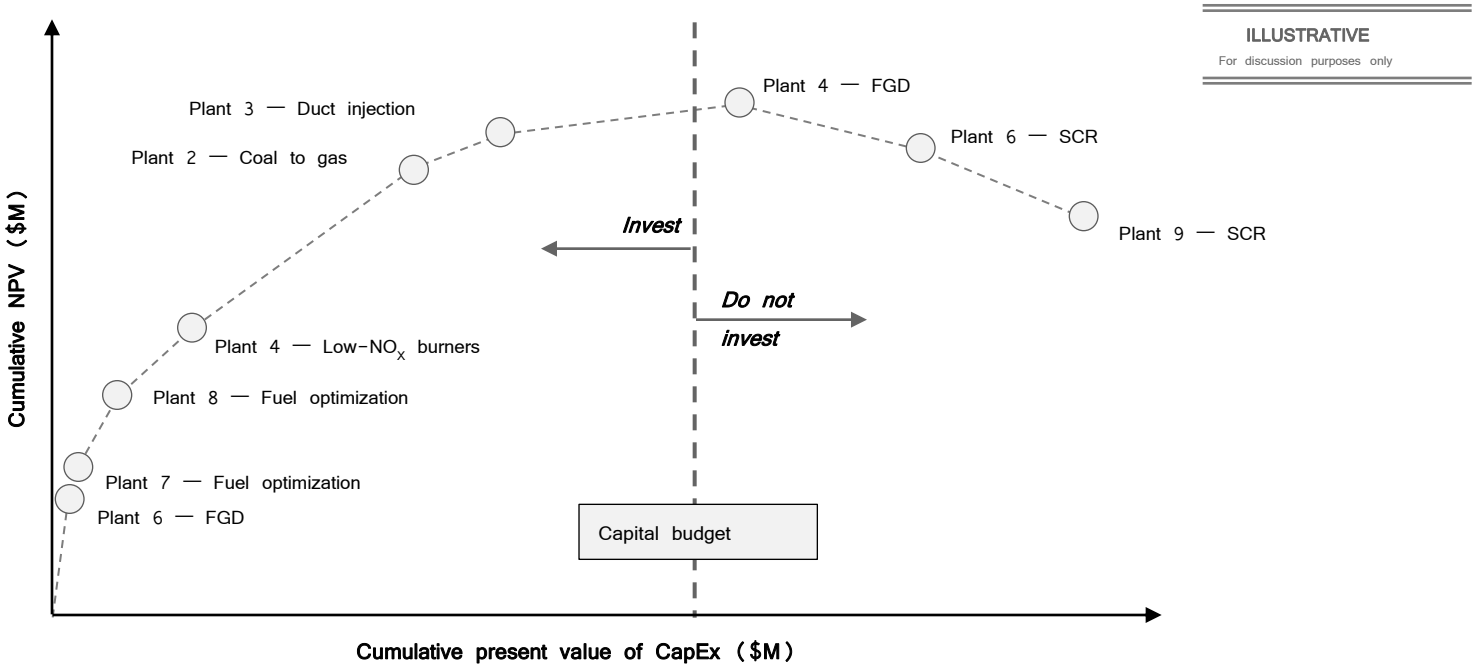


2. Evaluate each option

Optimizing generation portfolio value

A potential coal-to-gas conversion investment should be contemplated within the context of the fleet-wide portfolio of asset investments. An investment productivity curve ("funding curve") provides a "bang-for-the-buck" prioritization that identifies the highest value-creating portfolio of investments of generation assets. Projects are ranked according to the increase in economic value that results from the project divided by the project investment.

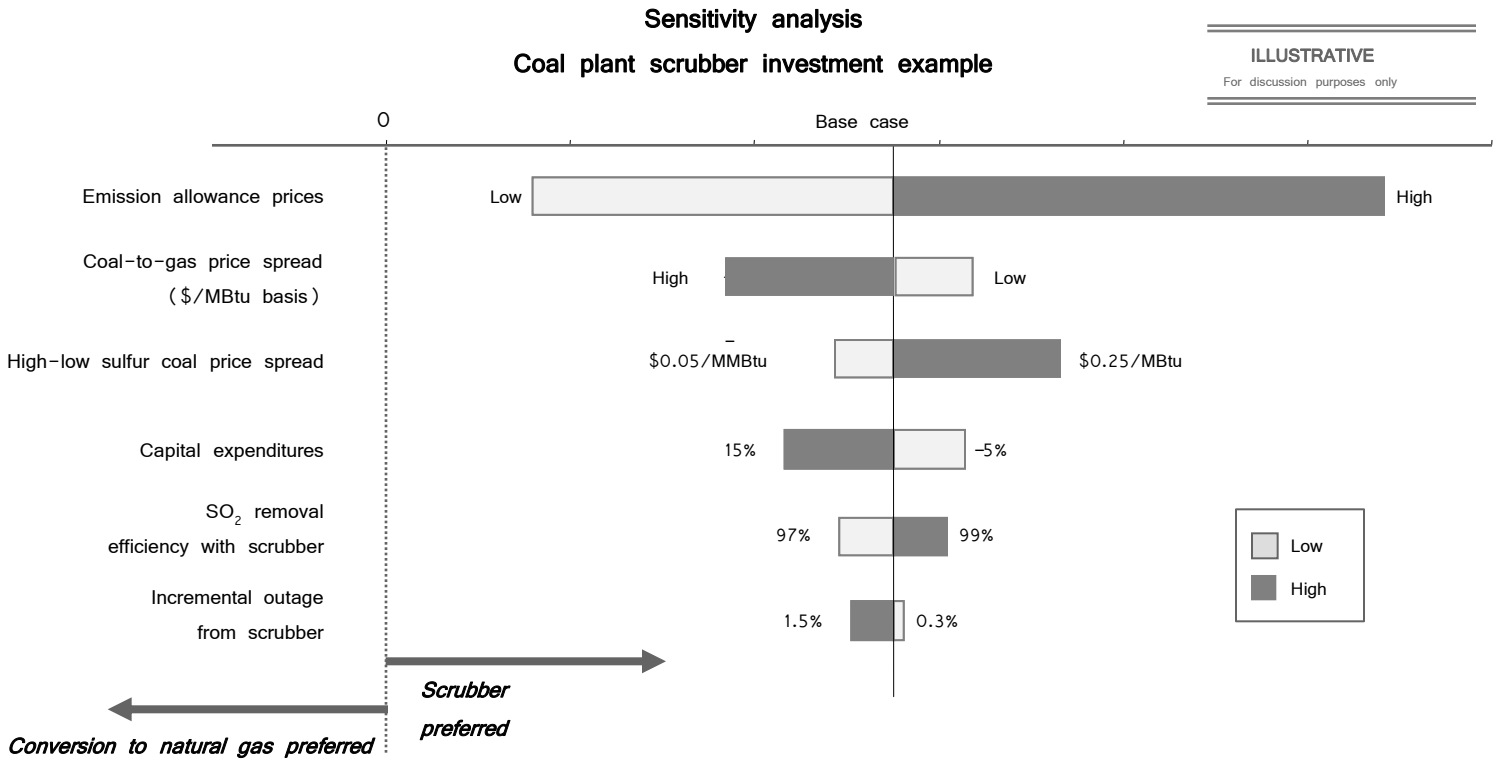
Funding curve for fleet-wide environmental investments



3. Conduct scenario-based planning

Leveraging sensitivity analysis to assess the key drivers of uncertainty

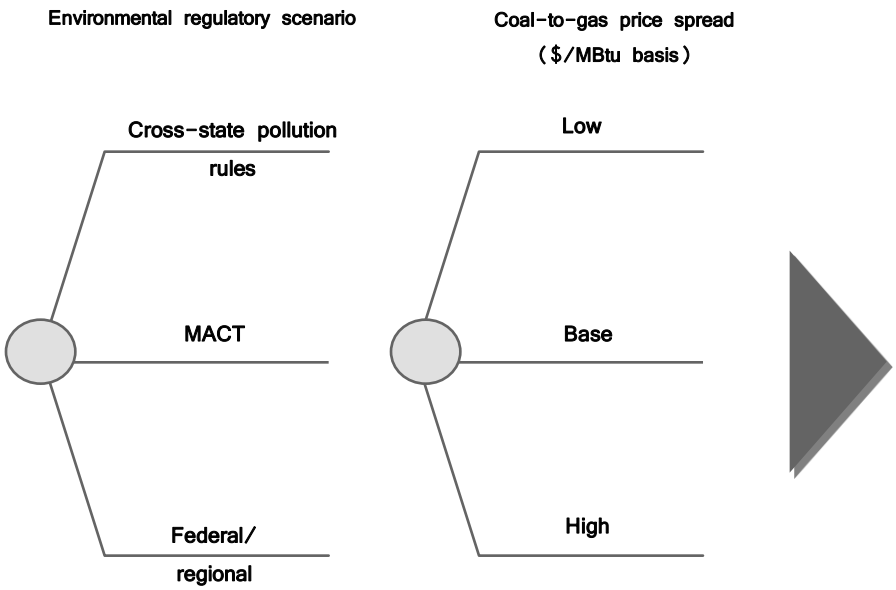
Deterministic sensitivity analysis using the driver model reveals which drivers contribute the most significant source of uncertainty for an investment, as illustrated by the "tornado diagram" for the scrubber investment example below:



3. Conduct scenario-based planning

Moving beyond deterministic forecasts to probability distributions

A probability distribution of plant value under coal/gas conversion versus harvest or early retirement can be obtained by computing the plant gross margin under various input uncertainties.



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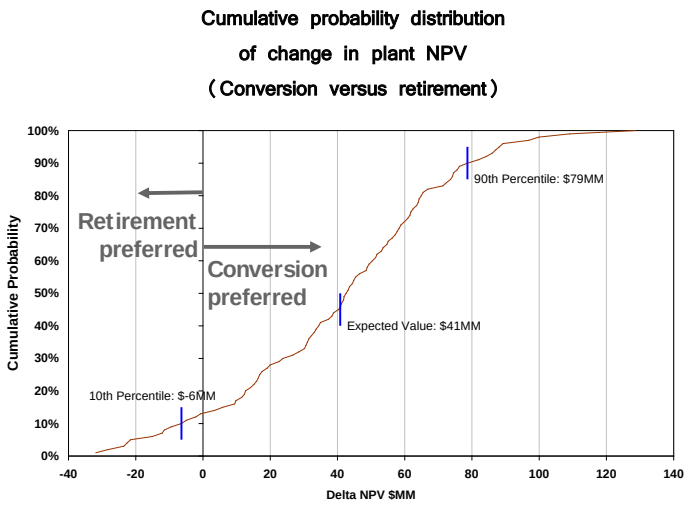
For discussion purposes only

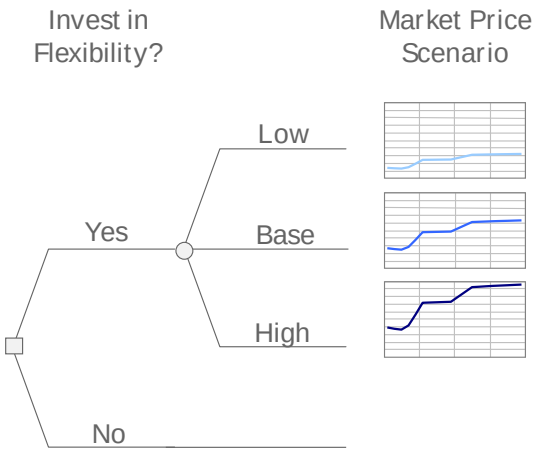


4. Consider creative alternatives

Maximizing investment value using real options

The robustness of the coal-to-gas investment decision can be further improved by incorporating any embedded options that, if exercised, could increase plant economic value.

Real option method 1: Scenario-based



Many companies have low, base and high curves for their most relevant market prices.

However, this type of approach doesn't accurately reflect the impact of monthly or daily price movements (i.e., volatility) on economic value.

Real option method 2: Simulation-based

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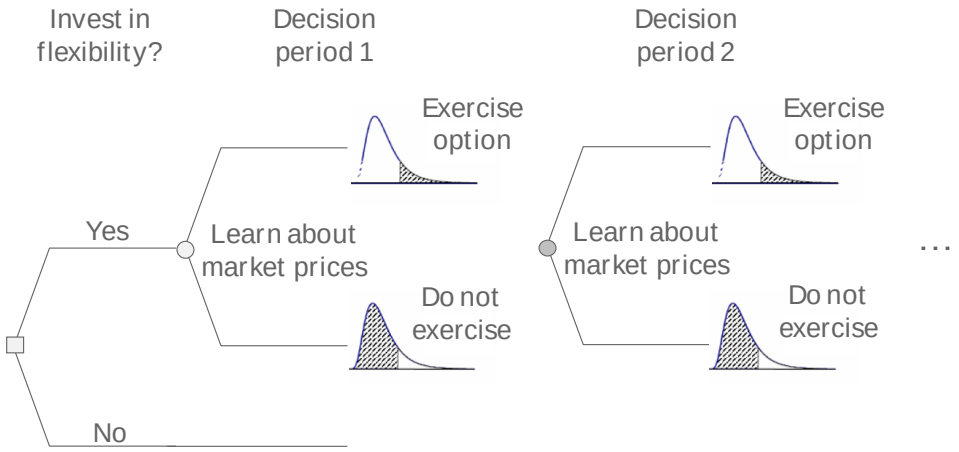
For discussion purposes only



A more sophisticated mathematical approach sometimes captures more of the value impacts of price fluctuations.

For this method, we use market observations of volatility, forward curves, etc., to enable the modeling of a stochastic price process to represent the key input. In the above example, the key input is a market price over time.

What's the bottom line?

- While the interaction between regulations and fuel price dynamics plays out, it is vital to embrace a long-term view on the mix of fuels (e.g., coal, gas, nuclear, renewables) present in the generation asset portfolio
- As coal costs continue to rise and the perfect storm of federal, state and regional regulations seek to limit carbon emissions from coal-fired plants, there is no better time to consider converting aging coal-fired plants to gas
  - Natural gas prices have stabilized, and are now consistently lower than coal prices
  - Gas-fired plants are far cheaper to build than coal-fired plants; coal-to-gas conversions can be even cheaper
  - Gas-fired plants are more environmentally friendly to operate
- If utilities set to retire coal-fired plants are seeking to maximize value for ratepayers, shareholders and their own organization, they should leverage a robust, well-structured, risk-informed decision process to determine whether coal-to-gas conversion is a viable alternative

Key contacts

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Additional thought leadership on this topic:

EY 5 Series: Is converting coal to gas the right move?

Related article by Andy Patterson and Eric Chung published in Jan/Feb 2013 issue of *Electric Light & Power*:

Utilities weigh conversations to natural gas

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