



Uncertainty in IRP: Common Pitfalls and Best Practices

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Agenda

- ✓ **Introduction**
- **Challenges**
 - Inputs: Data Sources
 - Outputs: Risk Metrics
 - Analysis: Optimization Models
- **Recommendations**
- **Next Steps**

What is (an) IRP?

- An integrated resource **plan** (IRP) is “a utility plan for meeting forecasted annual peak and energy demand, plus some established reserve margin, through a combination of supply-side and demand-side resources over a specified future period.”
 - Synapse Energy Economics, Best Practices in Electric Utility Integrated Resource Planning, June 2013.
- Integrated resource **planning** (IRP) is “a process of planning to meet users needs for electricity services in a way that satisfies multiple objectives...”
 - The Tellus Institute, Best Practices Guide: Integrated Resource Planning for Electricity, June 2010.

What is a top-quality IRP?

- Better Plan
 - Better Decisions
 - The “What” in IRP
- Better Planning
 - Better Processes
 - The “How” in IRP

The goal of this presentation is to help you deal more effectively with uncertainty both in the plan and in the planning.

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Data Sources - Demonstration



Data Sources - Demonstration

- The probability depends on what you know (or think you know). There is no objectively-correct probability.

Data Sources - Insights

- Uncertainty is a state of information not a state of nature
- Probability is simply a formal (explicit and precise) way of conveying your state of information
- Historical data, financial markets and forecasting models (“hard data”) are important but judgment cannot be avoided; in some cases, it is all that is available
- A common pitfall in IRP is to limit rigorous analysis to uncertainties where there is hard data; this misses some of the biggest factors
 - Technology change, market disruption, federal/state politics, environmental regulation
- A best practice is to recognize the subjective nature of uncertainty, and adopt rigorous methods for dealing with judgment
- Experts (both internal and external) have a critical role in providing these judgments; stakeholders (including utility executives and regulators) have a critical role in identifying these experts and in evaluating their judgment

Data Sources - Example

CAA Section 111(d) Sensitivity Analysis

██████████ developed multiple sensitivities for the EPA's proposed regulation for regulating CO₂ emissions from existing generating sources under CAA Section 111(d). The multiple sensitivities are a reflection of the considerable uncertainty related to the stipulations of the finalized regulation scheduled to be issued in summer 2015. Each sensitivity, with the exception of a null sensitivity in which no restrictions are assumed, is based on a set of assumptions on compliance stipulations for the final regulation. Analyzing multiple sensitivities allows the estimation of a range of possible cost impacts from CAA Section 111(d). The cost sensitivity analysis could provide information to state-level agencies tasked with the development of state plans for CAA Section 111(d) implementation.

Stochastic Risk Analysis

The stochastic analysis assesses the effect on portfolio costs when select variables take on values different from their planning-case levels. Stochastic variables are selected based on the degree to which there is uncertainty regarding their forecasts and to the degree they can affect the analysis results (i.e., portfolio costs).

██████████ identified the following three variables for the stochastic analysis:

1. *Natural gas price*—Natural gas prices follow a log-normal distribution centered on the planning case forecast. Natural gas prices are serial correlated, and the serial correlation is based on the historic year-to-year correlation from 1990 through 2014. The serial correlation factor is 0.65.
2. *Customer load*—Customer load follows a normal distribution and is correlated with ██████████ regional load ██████████ worked with ██████████ ██████████ as part of research conducted for the 2013 IRP to estimate the correlation between ██████████ customer load and regional customer load. The correlation factor is 0.50.
3. *Hydroelectric variability*—Hydroelectric variability follows a normal distribution. ██████████ owned hydroelectric generation is correlated with the ██████████ regional hydroelectric generation, and the correlation factor is 0.70. This correlation was derived using historical streamflow data from 1928 through 2009.

Data Sources - Example

- Identify and create a stochastic model for each key source of portfolio risk which in this analysis were identified:
 - Natural gas prices;
 - Natural gas basis;
 - Coal prices;
 - Load (electricity demand);
 - CO₂ emission prices; and
 - New generation capital cost.

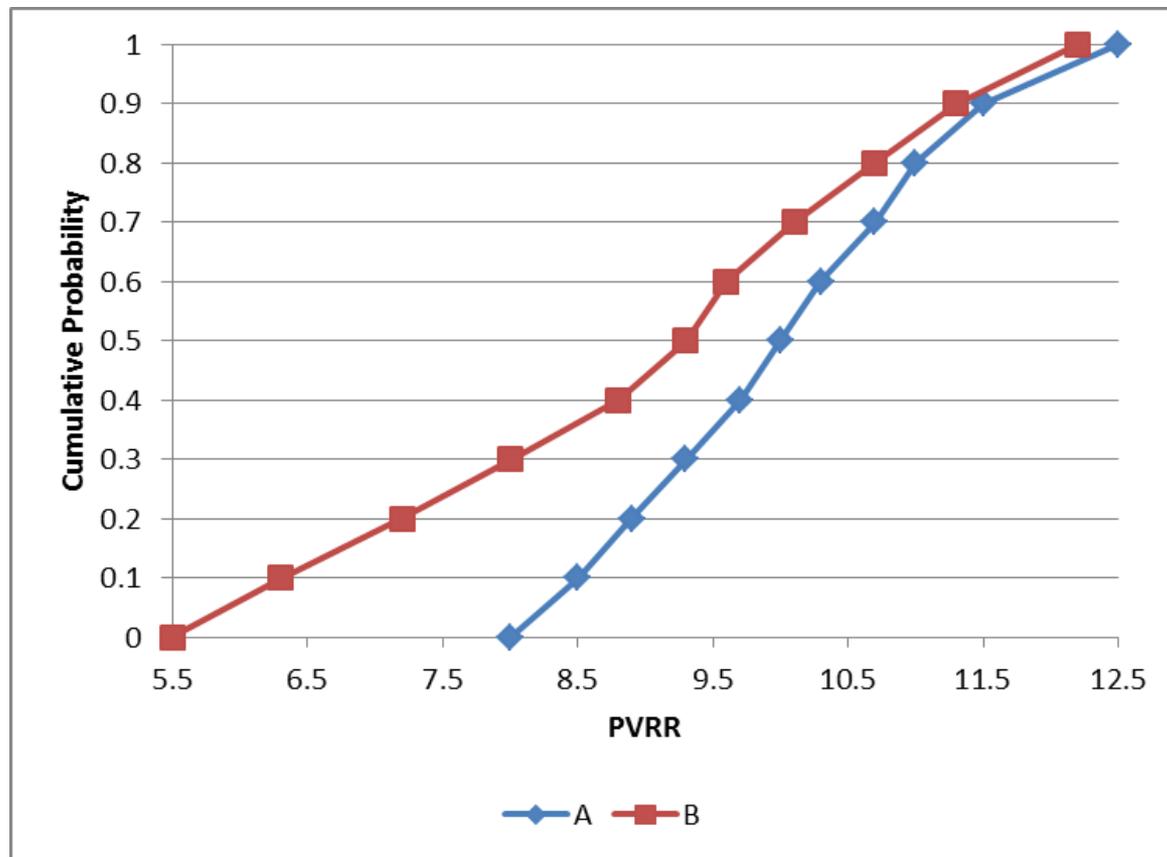
Risk Metrics - Demonstration

- Consider the following two resource plans (assuming all impacts are identical other than PVRR)

| Resource Plan | PVRR Mean | PVRR 10-90 range |
|---------------|--------------|------------------|
| A | \$10 billion | \$ 3 billion |
| B | \$9 billion | \$ 5 billion |

Risk Metrics - Demonstration

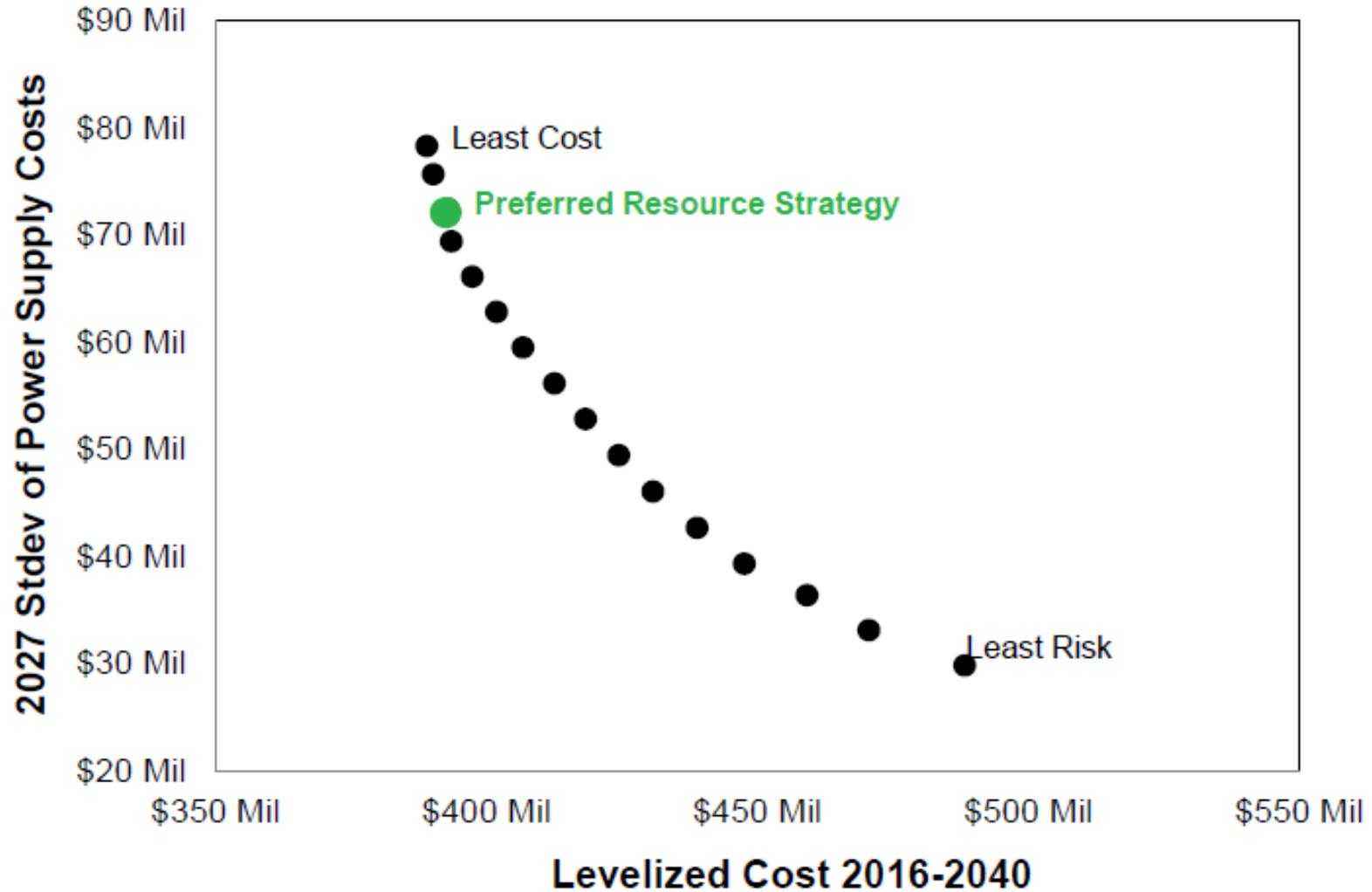
- Plan B dominates Plan A; it has a lower cost in all possible futures. There is no mean/risk tradeoff.



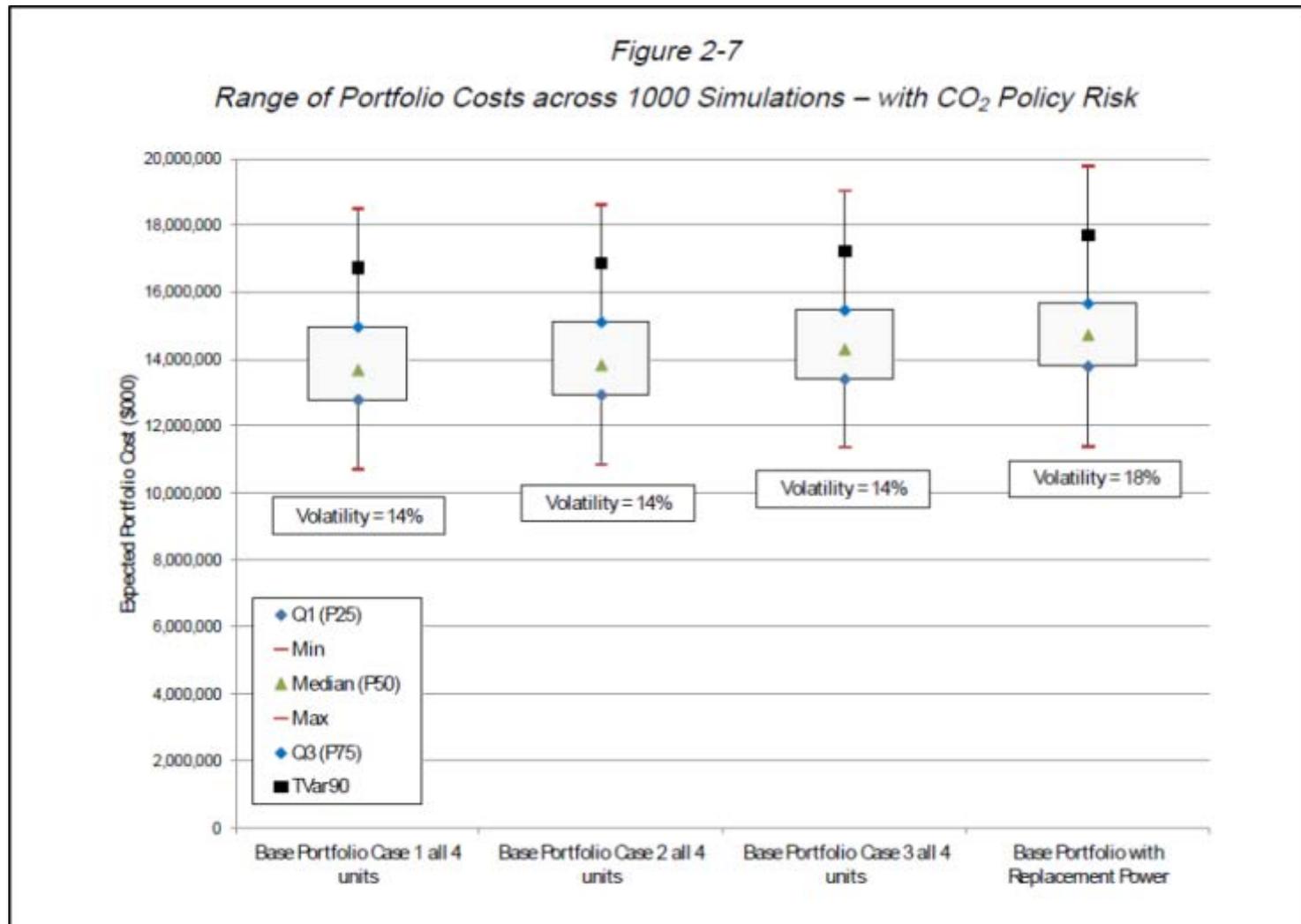
Risk Metrics - Insights

- Risk metrics are critically important in uncertainty analysis but must be selected and used carefully
- Some metrics are better than others; seemingly-reasonable and well-accepted metrics can provide misleading results
- A common pitfall is using standard financial or heuristic measures that may not be suitable for IRP
 - Standard deviation, 10-90 range, 90-mean range, scenario-by-scenario difference (regret)
- A best practice is to use metrics from management science that capture real impacts on stakeholders (ratepayers, shareholders)
 - 90th percentile (tail) value, expected tail value

Risk Metrics - Example



Risk Metrics - Example



Optimization Models - Demonstration



- Consider a personal financial investment. Your choices include:
 - Real estate (performed best in 25% of past 20 years)
 - Commodities (20%)
 - Small cap growth (20%)
 - Small cap value (10%)
 - Large cap value (10%)
 - Large cap growth (10%)
 - Bonds (5%)

Optimization Models - Demonstration



- The best choice (S&P) over all years was not best in any given year.

Optimization Models - Insights

- The best decision under uncertainty (across a range of futures) need not look much like the best decision in any given future
- For optimal decision-making under uncertainty, the role of deterministic optimization models should be very limited
 - In an uncertain world, knowing what is best in any given future is of modest value
- A common pitfall is to use detailed deterministic (or operationally stochastic) optimization models to identify the candidate resource plans
 - Aurora, Plexos, Strategist, System Optimizer
- A best practice is to use a wide range of approaches to identify candidate portfolios, and use a decision analysis or real options approach to evaluate them
- Detailed system (production simulation) models are still needed to evaluate impacts of particular portfolios in particular futures

Optimization Models - Example

An optimal, integrated portfolio for each scenario and sensitivity was created using the portfolio optimization model [REDACTED] to combine supply-side resources with the demand-side bundles. The optimization model used the inputs provided to identify the lowest cost portfolio that:

- Meets capacity need
- Meets renewable resources/RECS need
- Includes as much conservation as is cost effective

Once the optimal portfolio for each of the deterministic scenarios was identified, [REDACTED] conducted risk analysis on select portfolios. The [REDACTED] process used to calculate risk measures for each portfolio is briefly discussed below.

Optimization Models - Example

Traditional utility-based resource plans develop deterministic scenarios to minimize the NPV of revenue requirements....

[The model] represents a substantial improvement over traditional planning models by simulating 20 years of physical and market dynamics over 750 futures...

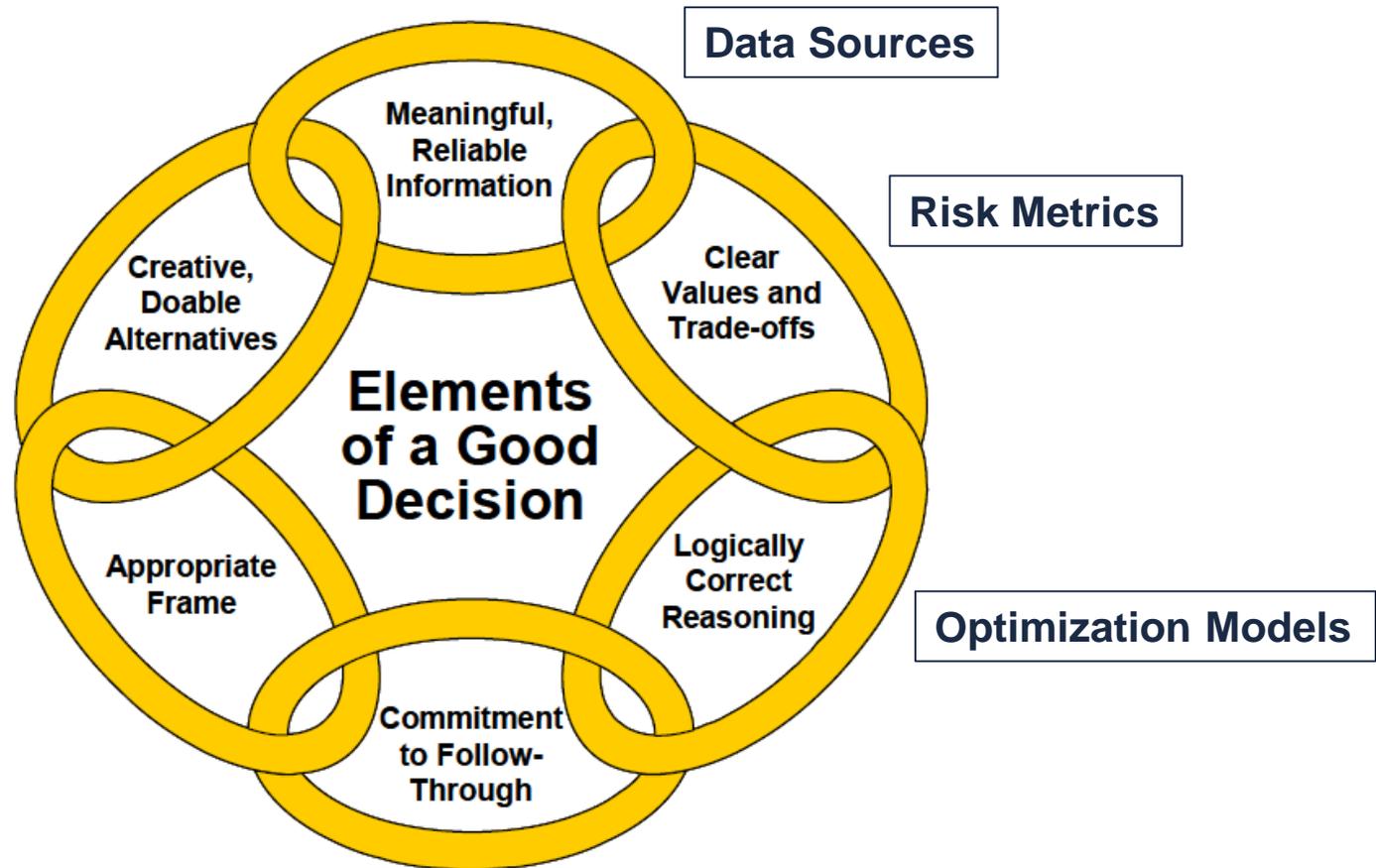
[The model]...distinguishes itself from other software solutions by integrating meaningful uncertainty into...decision-making ...[in] a two-stage process...

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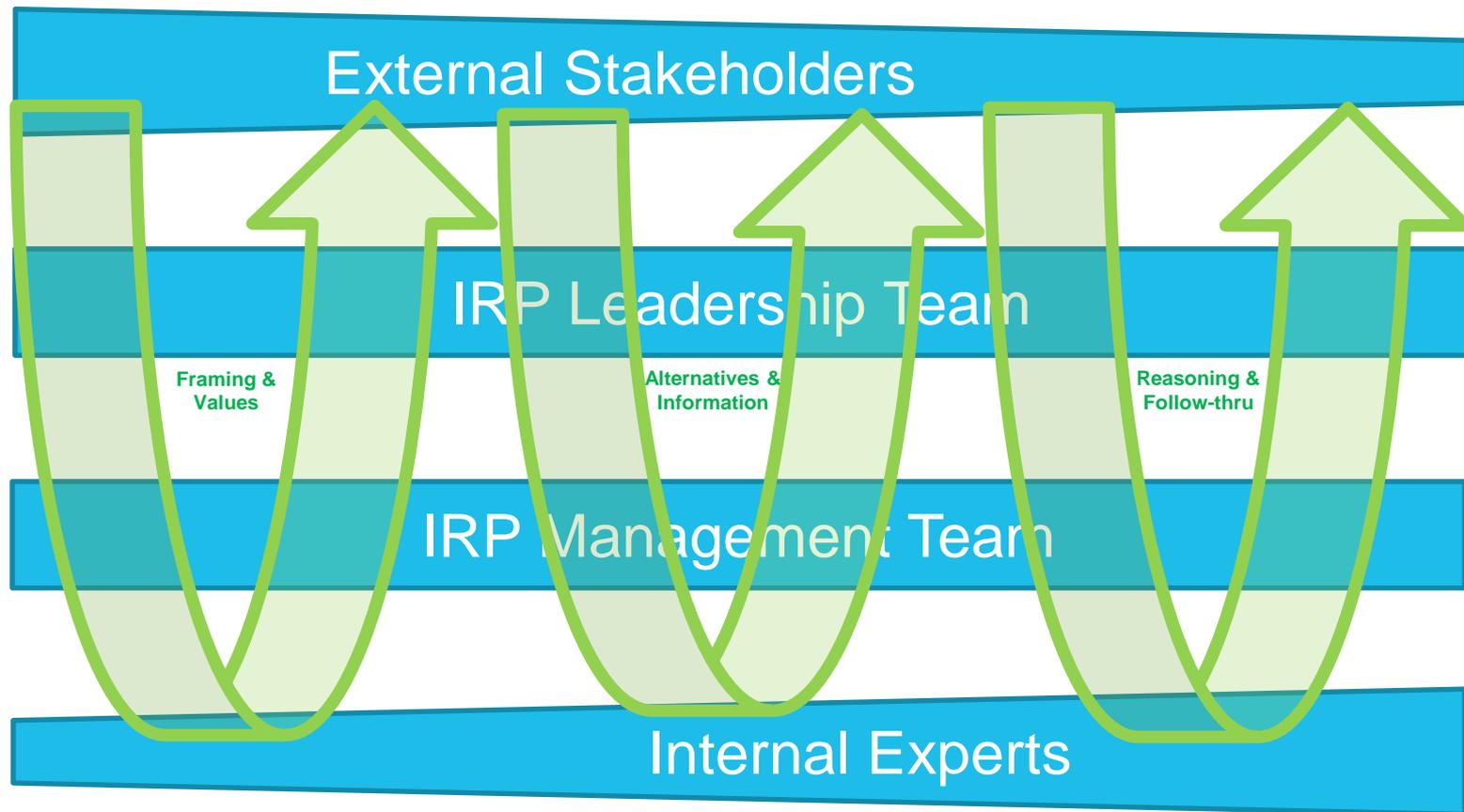
Better plan = better decisions

- “Decision Quality” can provide a best practice checklist for an Integrated Resource Plan.



Better planning = more efficient and effective process

- The “Dialog Decision Process” can provide a best practice roadmap for Integrated Resource Planning (with appropriate refinements).



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For more information:

- Read
 - Adam Borison, *Electric Power Resource Planning Under Uncertainty, Critical Review and Best Practices*, November 2014
 - Adam Borison, *IRP Best Practices*, May 2015
 - Carl Spetzler et. al., Decision Quality: Value Creation from Better Business Decisions, March 2016
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