GRID MODERNIZATION INITIATIVE PEER REVIEW

PATRICK O'CONNOR, ORNL

September 4–7

Sheraton Pentagon City Hotel – Arlington, VA

Grid Services & Technologies
Valuation Framework – GLMC 1.2.4

Grid Services and Technologies Valuation Framework – GMLC 1.2.4

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Project Description

Develop a valuation framework that will allow electricity-sector stakeholders to **conduct, interpret, and compare valuation studies** of existing and emerging grid services and technologies with high levels of **consistency, transparency, repeatability, and extensibility**.

Value Proposition

- **Valuation is crucial factor in investment and policy decisions…**
- **But lack of underlying framework**
  - Prevents comparison or consolidation
  - Leads to conflict over correct method
  - Slows approval of investment
- **Decision makers** need information they can reliably interpret and compare

Project Objectives

Produce a framework: a systematic approach to conducting and interpreting valuation, resulting in:

- Increased transparency in methods and assumptions used to evaluate grid technologies and services.
- The ability of stakeholders to identify value beyond monetary savings and costs.
- Useful and used guidance for the broad range of valuation applications.
- The foundation of reaching a long-term vision of improved, broadly consistent valuation practices.

Contribution to GMI MYPP Goals

Incorporate new technologies, including DER, into modern grid planning, operations, & optimization

GMMYPP Goals:

Grid Services & Technologies Valuation Framework
Project Team

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Project Participants and Roles

Laboratories

ORNL – Project manager; framework development
PNNL – Review state of valuation
ANL – Taxonomy and glossary
NREL – Test cases
LBNL – Review and taxonomy support
SNL – Framework development support
LANL – Framework development support

Industry

NARUC – partner supporting Stakeholder Advisory Group engagement

PROJECT FUNDING			
Lab	FY16 $	FY17$	FY18 $
ORNL	375k	325k	415k
PNNL	200k	175k	205k
NREL	95k	200k	170k
ANL	155k	100k	60k
LBNL	105k	100k	60k
SNL	40k	50k	60k
LANL	30k	55k	30k
TOTAL	**$1M**	**$1M**	**$1M**

Grid Services & Technologies Valuation Framework
Roadmap to the Vision

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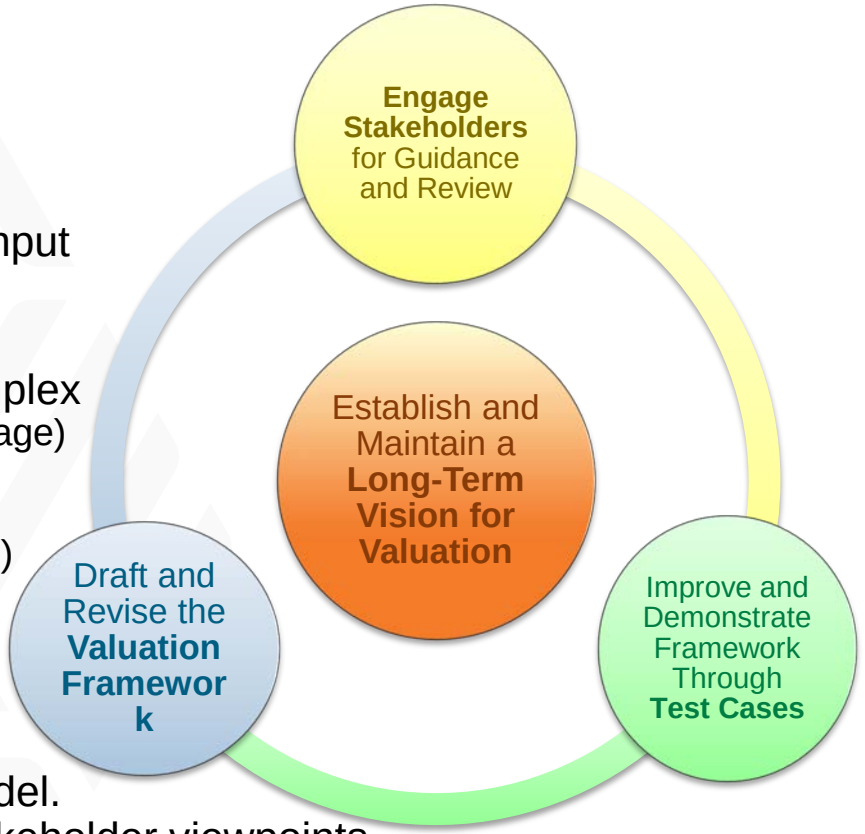
Phase I: Baseline Framework Development	*Phase II: Revision, Expansion, Industry Adoption*	*Phase III: Standards Development*
Goal: **Transparency** and **repeatability** with **credibility to industry** • Focus on the *process* of valuation. • Industry-reviewed draft framework. • Test cases to apply the framework.	Goal: **Comparability** and **extensibility** with **usage by industry** • More formal structure. • Expand coverage to include other infrastructures. • Application of framework by DOE and contractors. • Industry use of framework for selected valuation studies.	Goal: **Industry hand-off** for development of **"Generally Accepted Valuation Principles (GAVP)"** • "Champion Organization" for long-term ownership. • Stakeholder-driven process to transform guidelines into GAVP. • Ability for professional certification, third-party audit. • Likely to take 5+ years, even with Valuation Framework as the foundation.

2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026

Grid Services & Technologies Valuation Framework
Approach

Approach:

1. Engage Stakeholder Advisory Group (SAG)
2. Review Past Valuation Studies
3. Identify Best Practices and Guidance
4. Formulate Framework
5. Apply to Test Cases & Incorporate Advisor Input
6. Iterate and Refine



Key Issues:

- Valuation-based decisions are now more complex
  - New technologies (e.g., renewable energy, storage)
  - New grid structures (e.g., microgrid)
  - Complex value metrics (e.g., resilience)
  - Multi-criteria values (some not easily monetized)
- Implicit assumptions and choices of evaluation methods are not transparent
- Uneven quality, inconsistent studies

Distinctive Characteristics:

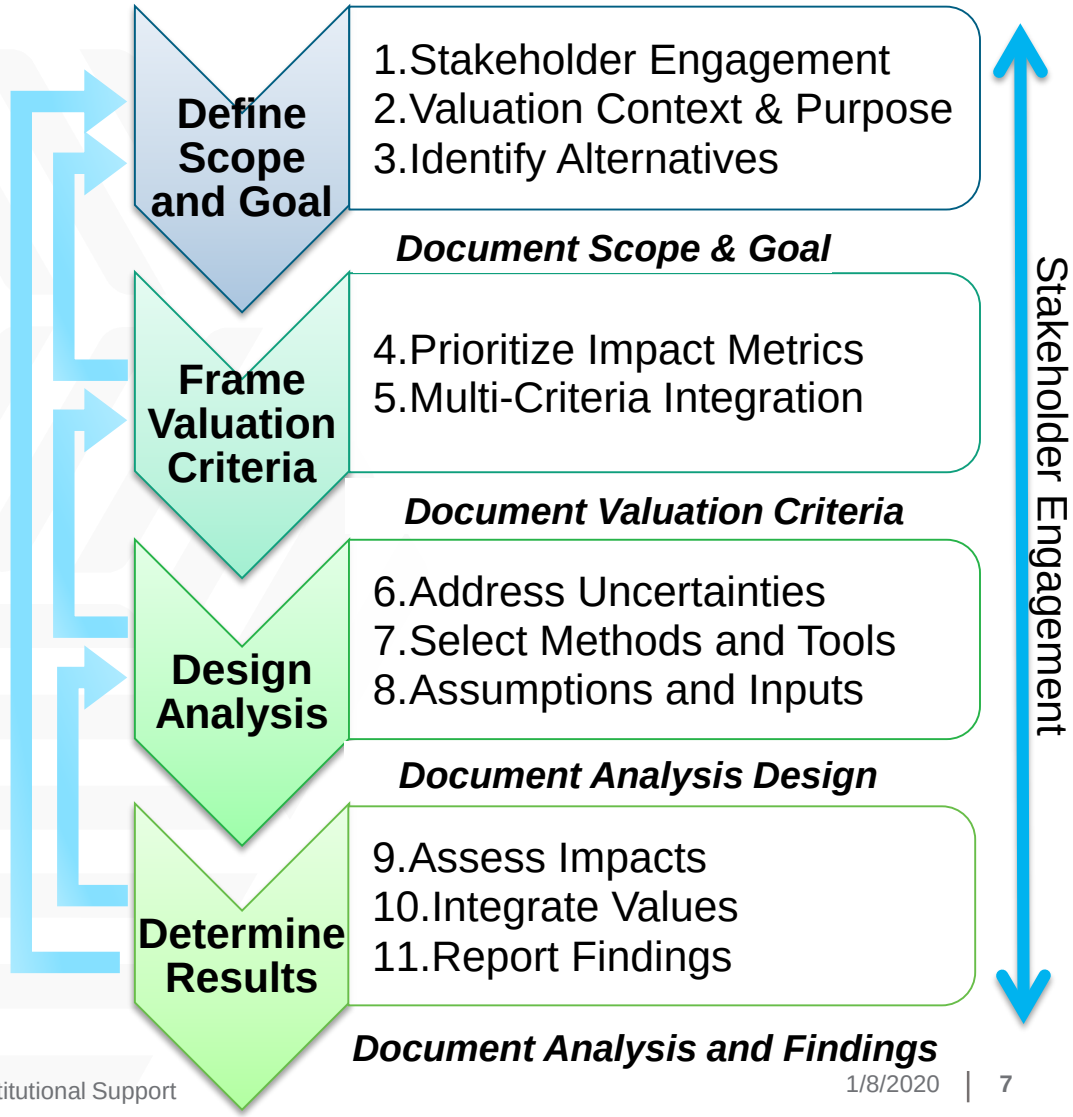
- The Framework is a process, not another model.
- Deliberate identification of decision basis, stakeholder viewpoints, metrics needed, multi-criteria approach, uncertainties, choice of methods & tools.
- Ensures early alignment of valuation methods with study goals and scope.

Accomplishments

- Established Stakeholder Advisory Group (SAG)
  - Crucial industry & regulator involvement
- Developed Initial Valuation Framework
  - Long-term Vision of a Standard for Valuation – set goals and scope
  - Assessed current practices and state-of-the-art – need & gap analysis
  - Initial Structure & Guidance (Version 1.0)
  - Review by SAG
- Test Cases
  - #1: Tabletop exercise – review past studies through the valuation “lens”
  - #2: SAG participation in pilot application
- Revised Guidance – Version 2.0
- External Review (invited ~50 industry experts + SAG)

Grid Services & Technologies Valuation Framework
Activities of Past Year: Refined Framework

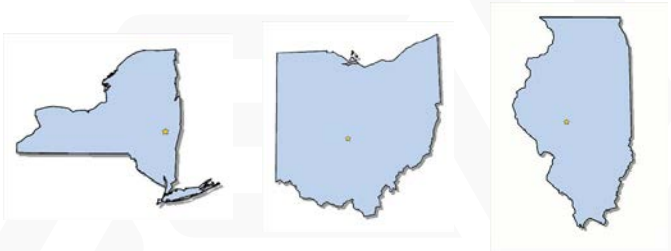
- Expanded step descriptions.
- Enhanced guidance for stakeholder engagement.
- Specified information flows among phases and steps.
- Added documentation requirements for each phase.



Activities of Past Year: Test Cases

Test Case 1: Use of framework to ***compare similar* studies**

States with nuclear valuation studies:



Key Framework improvements:

- Ensure Valuation objective is followed and metrics directly address the decision basis.
- Ensure the valuation analysis team is multi-disciplinary.
- Made explicit the information flows between steps.
- Adjusted order and potential for iterations between process steps.

Test Case 2: Use of framework to ***construct* a complex study**

Subset of SAG as stakeholders

Alternatives for fictional Anytown, FL:

- Upgrade of substation (BAU)
- Various microgrid configurations

Key Framework improvements:

- Guidelines to better identify alternatives, metrics, and methods.
- Directions on use of iteration.
- Added non grid-related metrics.
- Focused on analysis methods, beyond engineering models.
- Created documentation of decisions as they were made during study.
- Added final step to track results.

Grid Services & Technologies Valuation Framework
Activities of Past Year: Stakeholder Advisory Group

SAG includes policymakers, regulators, utilities, grid operators, generation developers, and advocacy groups.

SAG: Workshops / Reviewed Outputs / Participated in Test Case #2

Key Feedback from SAG

- Valuation Framework is a valuable tool
- This valuation process is especially useful for decisions with significant public accountability.
- Process metrics and methods must go beyond engineering-centric models to include economics, environment, stakeholder acceptance.
- Provided guidance for dealing with uncertainties and risk.
- Stakeholder engagement is crucial for acceptance of decisions.
- The SAG was supportive of this project's accomplishments.
  - *Structured process and inherent transparency* improves usefulness and objectivity.
  - Especially useful with *complex metrics*, *advanced technologies* and *new grid architectures.*

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Sectors

- ✓ Regulators/Legislators
- ✓ Utilities
- ✓ Customer/Environmental Groups
- ✓ Technical Experts
- ✓ Regional Coordinators
- ✓ Suppliers

Name	Organization
Denis Bergeron	Maine Public Utilities Commission
Ed Finley; Alt. Kim Jones	North Carolina Utilities Commission
Matthew Shuerger	Minnesota Public Utility Commission
Nick Wagner	Iowa Public Utility Commission
Ray Palmer	Federal Energy Regulatory Commission
Jeff Morris	Washington State Legislature
Tom Sloan	Kansas State Legislature
Gary Brinkworth	Tennessee Valley Authority
Lilian Bruce	Electric Power Board, Chattanooga
Sekou Sidime	Commonwealth Edison
Enrique Mejorada	Pacific Gas & Electric
David Kolata	Citizens Utility Board
Ron Lehr	Western Clean Energy Advocates

Name	Organization
Michael Bailey	Western Electricity Coordinating Council
David Whiteley	Eastern Interconnection Planning Collaborative
J. T. Smith	Midcontinent ISO
Betsy Beck	American Wind Energy Association
Rohan Ma	Solar City
Elia Gilfenbaum	Tesla
Jonathan Lesser	Continental Economics
Bernard Neenan	Independent Consultant
Ben Hobbs	Johns Hopkins University
Michael Moore	Cornell University
Erin Erben	EPRI

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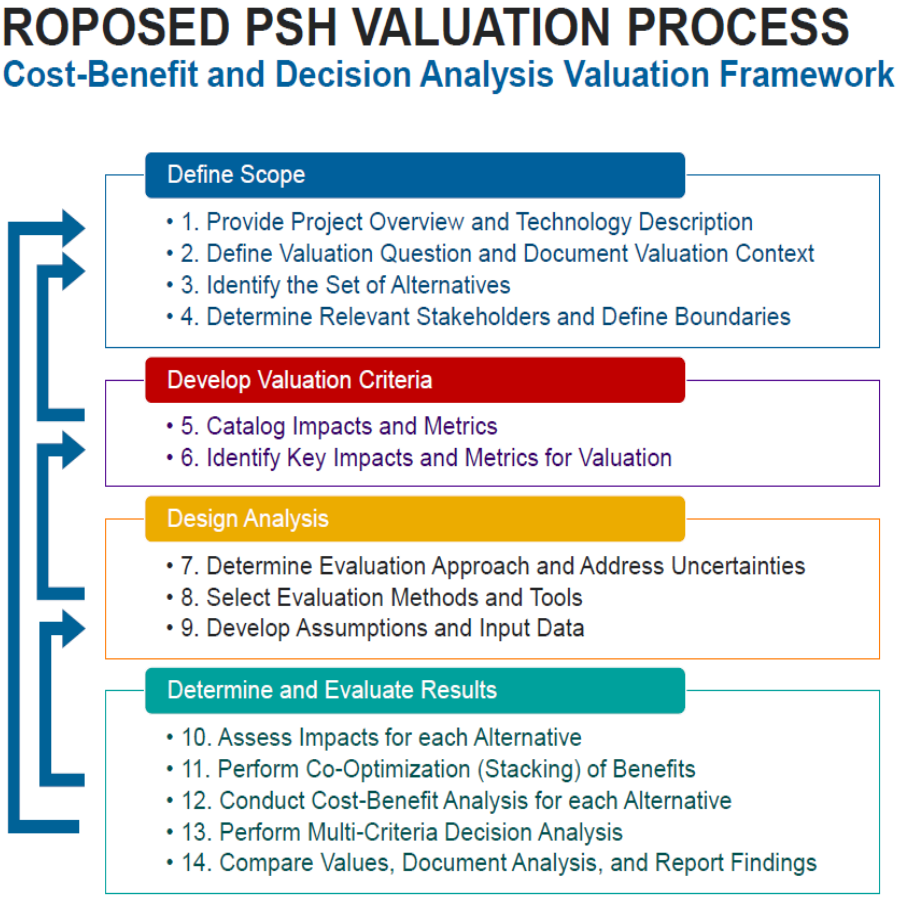
Valuation Framework Applied in Other DOE Projects

- EERE/WPTO: Assessing the Value of Pumped-Storage Hydropower
- Across DOE offices: Beyond LCOE
- GMLC/LVAT: Value 5 distribution system demonstrations

Other Projects Used as Resources for Valuation Framework

- GMLC Metrics Analysis (GMLC 1.1)



Basis for Future Valuation Standard/GAVP

- Valuations become more complicated as grid technologies and grid configurations become more complex.
- Reliance on “traditional” methods and models have not kept pace
  - Flawed by implicit assumptions (metrics, models) used in earlier, simpler grid studies.
  - Tradeoffs not addressed adequately.
- Other disciplines have met similar challenges by standardizing the required elements in a process:
  - ISO 9000
  - Building Commissioning
  - Medical Procedure Checklists
  - Aviation Checklists
- Guidance Document describes a framework of steps to make sure that requirements are specified and choices are made deliberately.
  - Generally assumed this is already done, but very often it is not.
  - The Framework’s *structured process and inherent transparency* will improve objectivity of valuation studies and usefulness of results to decision makers.

Grid Services & Technologies Valuation Framework

Next Steps

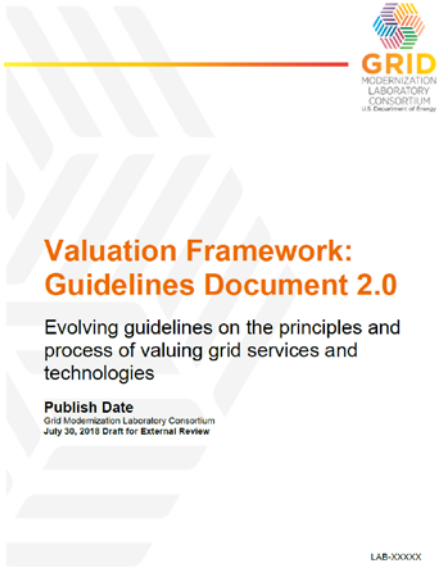
- *Incorporate external reviewers' comments*.
- *Practical applications – work with ongoing valuation efforts to apply the Framework*.

  SAG participants recommended having the project team provide assistance and facilitation to appropriate policy-making or valuation studies:
- *Disseminate the Valuation Guidance*

  Effectively communicate the "process" methodology
- *Continue outreach and "cross-pollination" with other DOE projects.*

  *A*pplication of the framework, and continued improvement through feedback from users
- *Standardize principles developed in the Valuation Framework.*

  The Framework will identify essential activities that must be included in a valuation study to ensure transparency, accuracy, unbiased results, and results responsive to the needs of decision makers.



Roadmap to the Vision

Phase II: Revision, Expansion, Industry Adoption

Goal: **Comparability** and **extensibility** with **usage by industry**

BACKUP SLIDES

Valuation Framework Development

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Objectives

- Develop a Grid Services and Technology Taxonomy
- Describe Valuation formally, as an explicit *Process,*
- Develop Standard, Stakeholder-Vetted Guidelines for the process.

Phases

A. Define the scope of the valuation including purpose, alternatives, and stakeholder engagement
B. Frame the valuation criteria through identification of key metrics and integration
C. Design the analysis including methodology selection, input data, and treatment of uncertainty
D. Determine and document the results

Phases	Steps
Decide to do a Valuation	Identify need; Define Basic Purpose and Objective
	➢ Result: Decision Documentation
A: Define Scope & Goal	1. Plan and Initiate Stakeholder Engagement
	2. Document the Valuation Context and Purpose
	3. Identify the Range of Alternatives
	➢ Result: Scope & Goal Documentation
B: Frame Valuation Criteria	4. Identify Key Impact Metrics for Valuation
	5. Determine Multi-Criteria Integration Approach
	➢ Result: Valuation Criteria Documentation
C: Design Analysis	6. Determine Approach to Address Uncertainties
	7. Select Assessment Methods and Tools
	8. Develop Assumptions and Input Data
	➢ Result: Analysis Design Documentation
D: Determine & Present Results	9. Impacts for Each Alternative
	10. Calculate Integrated Values for Each Alternative
	11. Compare Values, Document Analysis & Report Findings
	➢ Result: Results Documentation

A. Define Scope and Goal

1. Expanded stakeholder engagement guidance
   - Accounting for stakeholder perspectives and priorities
   - Soliciting inputs and feedback from stakeholders to ensure buy-in
   - Identifying primary basis for making decision/choosing alternative – formulate in terms of metrics/impacts to be considered
   - Guidance for factoring stakeholder input into other activities
2. Additional guidance on framing purpose, scope and context of the valuation
   - Formulate the specific decision
   - Define scope – energy sub-sector, technologies, policies, etc.
   - Identify resource and schedule constraints
3. Define alternatives
   - Must be specific about choices
   - Include “business as usual” case

B. Frame Valuation Criteria

4. Identify relevant impacts and metrics
   - What is basis for decision (from #1)?
   - Prioritize metrics – essential/important/desirable
   - Characterize complex/compound metrics in terms of basic metrics; Specify methods to obtain complex metrics from the basic ones
   - **Expand metrics beyond power system attributes** – e.g., economics
5. Formulate approach to integrate multiple criteria
   - How to visualize/process complex valuations with disparate, sometimes competing metrics and their tradeoffs
   - Expanded guidance on options – monetize, other common units, list separately, suggested graphic presentations
   - Tradeoffs and prioritization among metrics/impacts
   - Will help frame and inform constructive debate among stakeholders about choice

C. Design the Analysis

6. How to address uncertainty – categorize and manage it
   - Uncertainty in data, model accuracy, events/condition of power grid
   - Uncertainty can drive various types of Risk
   - Different strategies for different metrics: Sensitivity analysis; Scenario analysis; Probabilistic analysis
   - Illustrative scenarios and sensitivity studies may be efficient to address complex, multi-variate valuation decisions (e.g., resilience)
7. Select Methods and Tools
   - Characterize tools' capabilities in same terms as the information requirements of the valuation question (steps #1, 2, 3, 4, 5)
   - Use methodologies for deriving and calculating metrics (steps #4, 5, 6)
   - SAG members cautioned against analysts' over-reliance on models with which they are comfortable ("when you're a hammer…")
   - **Reduce emphasis on engineering models** – choice is not likely to be between models, but rather between methods and between levels of calculation detail/resolution

C. Design the Analysis (continued)

8. Assumptions & Input Data
   - The choice of assumptions about the state of the region and the power system and its customers will have substantial impacts on the quantitative results of the modeled alternatives.
   - Are data available? Confidence in data accuracy?
   - **Consistency required among input data from different sources**
   - Often **implicit assumptions** are made that can bias results: the framework offers a **deliberate process** to help identify such assumptions and document them

D. Determine and Present Results

9. Assess impacts for each alternative
   - Informed by steps #4, 6, 7, 8
10. Calculate integrated values for each alternative
    - Informed by Steps #1,5
11. Compare values, document analysis and findings

    This step documents the findings, including the opportunity to publish a “matrix” of metrics, if appropriate, rather than trying to combine all metrics into a single valuation number/index/metric. Step 1 (Stakeholder Engagement) and Step 5 (Multi-Criteria Integration Approach) inform the format and content of the presentation of valuation findings. Steps 8 (Assumptions & Input Data), 9 (Calculate Impacts); and 10 (Calculate Integrated Values) determine the numeric values.

Grid Services & Technologies Valuation Framework

Test Case #1 (Tabletop)

Focus: State Support for Existing At-Risk Nuclear Generators

- Explore recent studies on the implications of premature retirement of existing at-risk nuclear plants or the impacts of specific support programs (e.g., zero emissions credits [ZEC])
- From a specific state perspective (PUC or legislature)
- NY, IL, OH

New York

- PSC approved creation of ZECs to provide additional revenue stream to at-risk (upstate) nuclear plants as part of Clean Energy Standard (CES) Order
- CES cost study conducted by PSC/NYSERDA staff based on State Benefit-Cost Analysis requirements includes impact of ZEC program

Illinois

- Legislation passed as part of a broader Jobs Bill related to electricity generation that creates Zero Emissions Credits (ZECs) to provide additional to qualifying nuclear plants
- Comprehensive analysis conducted by state agencies to estimate impacts of pre-mature nuclear plant retirement

Ohio

- Senate Bill 128 introduced to Zero Emission Nuclear Resource Program (ZEN) to provide additional revenue stream to at-risk nuclear plants Followed PUC filing and decision on Energy Security Plan (ESP) to promote electricity rate stability via a virtual PPA that was later prevented by FERC
- Fiscal analysis conducted by Ohio Legislative Service Commission (LCS) and stakeholder-specific analysis (e.g., Ohio Consumer's Counsel)

Brattle published separate but similar analyses for IL, NY, and OH estimating the contribution of at-risk nuclear plants to each state's economy, including the potential impact of plant closures on power prices and cost to consumers

First Test Case – Tabletop Exercise

(August – December 2017)

*Purpose: Test the Framework's usefulness for interpreting, **comparing**, and contrasting studies; and identify opportunities for improvement*

*Approach: Compare Framework Guidelines to approaches used in existing assessments of potential state **support for existing nuclear generators that are economically at-risk***

Best practices identified during the review

- A must-follow, clear question and directive to perform the analysis
- Identification of boundaries for analysis – geographic, time scales
- Well-documented Cost-Benefit Analysis methodology with intent to apply consistently across investment/policy decisions
- Robust documentation of methods and results for each process step
- Recognition that future is uncertain: implications on method selection and confidence in results

Key improvement opportunities that were identified

- This exploration of prior work was helpful in informing the structure of the valuation approach
- Need to connect how the valuation study will explicitly inform a specific decision
- Consider establishing an integrated method from which all impacts can be derived consistently
- Often the final benefits or costs may be highly uncertain. It is important to identify and document what factors and assumptions drive this uncertainty.
- Allocation of costs, benefits, and risks can be an important consideration, including the resulting synthesis of these allocation outcomes
- Robust documentation that includes the decision context and key analyses can inform future valuations for similar questions considered in other jurisdictions

Grid Services & Technologies Valuation Framework
Test Case #2 (Interactive Exercise)
Focus: Project Opportunity – Microgrid

Source: https://www.delta-ee.com/research-consulting/micro-grids.html

Question:

Identify the value of a microgrid that postpones the need for a substation upgrade and / or provides additional resilience and compare to a baseline option (substation upgrade).

Alternatives:

- Build microgrid
- Upgrade substation and distribution feeders
- Add generators to defer substation upgrading
- Add distributed storage / gen without coordination

Stakeholders Represented:

- Utility
- Directly impacted customers
- Other customers
- Local government
- Community representatives

Potential Metrics:

- Cost to owner
- Cost to utility
- Value streams on bulk power system
- Economic value to Anytown, FL
- Value streams to owner (under tariff options)
- Reliability (short outages)
- Resilience for bulk power system
- Impact on emissions
- Equity / cost distribution
- Cost minimization
- Innovation impacts

Grid Services & Technologies Valuation Framework
Second Test Case – Interactive Exercise with Volunteers from SAG *(April – October 2018)*

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Purpose: Test drive the framework to systematically and transparently ***consider a more complex valuation of a grid technology*** *or service –* ***microgrid vs. conventional system*** *expansion; consider* ***value of improved resilience*** *in addition to power production economics*

Approach: Used a sub-set of the SAG; performed a detailed consideration of each step in the framework through roleplay, discussions of experience, and review and recommendations

Key improvement opportunities identified:

- Develop guidance to help identify alternatives, and include tools that help remind stakeholders of the basis for consideration
- Improve the method for identifying key metrics by increasing stakeholder input and considering non-power system metrics (e.g., regional economics)
- Provide option for methods to calculate metrics, together with estimated costs/effort and expected accuracy of each method
- Guidance document, as presented, was too focused on engineering models and technical calculations – basis of decision is often economics or “soft” metrics
- Provide visualization options for multiple metrics
- Include the framework’s activities explicitly tracking impacts resulting from each alternative on key metrics
- Improve directions regarding iterations back to previous steps (when, how, etc.)
- Develop methods for reminding stakeholders of decisions made during previous steps

Grid Services & Technologies Valuation Framework
Some Takeaways from Test Cases, SAG Coordination

- Expand list of metrics – don't limit to electrical system
- Over-reliance on engineering models. Choice of financial calculation methods also important.
- *Methods* more important than *models.*
- Decision makers may need analysis methods for broad/regional impacts (not just grid engineering-focused) to make their choice.
- Consultants very often are pre-disposed to use their own or familiar models and methods. *Much concern about making sure methodology used for valuation actually addresses the information needs of decision makers and important stakeholders.*
- *SAG participants very positive about the value of Valuation Framework.*
  - Making sure valuation analysis results (type, scope, format) match decision makers' needs
  - Being deliberate in choosing – **and documenting** – methods, assumptions, input data, valuation criteria. Required for both quality and transparency of valuation
  - Applying the framework *process* more valuable than developing large catalogs of tools and resources

External Review of Guidance

- Project team and SAG Identified approximately 50 potential external reviewers across the energy sector
- Version 2.0 of the Valuation Framework Guidelines Document has incorporated additional work by project team, extensive internal review, and some feedback from Test Cases
- External Reviewers invited to comment
  - Is the document sufficiently specific to identify the audience(s) for which it written? If not, who (do you think) is the audience?
  - Does the document help advance the overarching goals of improving the transparency, consistency, and repeatability of the valuation process? If not, how can it be improved?
  - The document describes in general terms an overarching process. As a next step, where in the document or process do you think more concrete guidance is needed, and would advance the discipline of valuation?
  - Any other comments regarding usefulness, strengths & weaknesses, next steps?