Grid Services and Technologies Valuation Framework

The Long-Term Vision for Development and Implementation

June 2018

Grid Modernization Laboratory Consortium

ORNL/SPR-2018/875

ORNL/SPR-2018/875

Grid Services and Technologies Valuation Framework

The Long-Term Vision for Development and Implementation

Grid Modernization Laboratory Consortium Members:

R. Boero[7]
J. Brinch[8]
S. W. Hadley[1,9]
R. F. Jeffers[6]
M. Kintner-Meyer[2]
V. Koritarov[3]
A. D. Mills[5]
P. W. O'Connor[1]
G. Porro[4]
M. Ruth[4]
A. Somani[2]
K. Worthington[8]
V. N. Vargas[6]

[1] Oak Ridge National Laboratory
[2] Pacific Northwest National Laboratory
[3] Argonne National Laboratory
[4] National Renewable Energy Laboratory
[5] Lawrence Berkeley National Laboratory
[6] Sandia National Laboratories
[7] Los Alamos National Laboratory
[8] National Association of Regulatory Commissioners
[9] SRA International, Inc., a General Dynamics Information Technology company

June 2018

Acronyms and Abbreviations

DOE	Department of Energy
FEA	Federal Enterprise Architecture
GMLC	Grid Modernization Laboratory Consortium
GAAP	Generally Accepted Accounting Principles
ISO	International Standards Organization
PUC	public utilities commission
TOGAF	The Open Group Architectural Framework

Contents

Figures

Table

1.0 Introduction

The US electric grid is a vast complex of equipment, processes, and controls to deliver clean, reliable, and economical electricity to consumers. Every grid service and technology bring a variety of values and costs to the system. The values are often expressed as reliability, flexibility, resilience, affordability, sustainability, and/or security. The values are often difficult to measure, not directly comparable, and subject to various stakeholders' different perspectives. The level of accuracy, precision, and depth of value analysis can vary greatly between studies but is not readily visible.

Nonetheless, it is difficult to overstate the importance of producing credible, analytically sound information about the comparative value of the products and services available through existing and emerging grid-related technologies. The fundamental function of valuation processes is to provide vital information to decision-makers for thousands of daily business decisions. Without quality information, the decision process bogs down; decision-makers may simply procrastinate—or if near-term decisions must be made quickly, the risk of making poor choices rises sharply. Thus, a general theory and grid-specific framework is needed to provide a common basis for understanding, explaining, and improving valuation methods—and their results.

A general theory of valuation would attempt to explain the reality that any process or project has costs and benefits for multiple attributes—not just economics but also aesthetics, reliability, security, environmental sustainability, etc. Some costs and benefits may be internalized, whereas others only affect stakeholders beyond the decision-makers and are considered externalities. The economics discipline has studied values extensively; the theory called for here is one aspect of this, valuation, or how values in different attributes and different parties are measured and balanced between each other.

A valuation framework is a more specific application or instantiation of the theory for grid activities and will guide future valuation studies to enable electricity-sector stakeholders to conduct, interpret, and most importantly, compare valuation studies with high levels of consistency, transparency, repeatability, and extensibility. Since any technology's costs and benefits depend on the system it is in, the framework must be able to include the system-level impacts on and of the technology, including both the physical and financial impacts on electric services. It must also incorporate the institutional and market context (e.g., regulations, market structure, competing alternatives) to help ensure that new and existing technologies will be able to compete, cooperate, and be compensated fairly. It should be expandable to incorporate interdependent infrastructures such as gas, water, or transportation.

The framework will provide a systematic approach to defining and documenting the scale, scope, and assumptions that are the basis of any valuation or modeling activity. The framework would not be a methodology in itself for calculating values. Rather, as stakeholders determine their needs and resources, they will use the framework to determine the best methodologies and tools to use. Methodologies are used to calculate values, using appropriate metrics. Tools may be used to instantiate the methodologies. They may be complicated, such as a full-system-capacity expansion model to determine future system impacts, or as simple as a spreadsheet calculation of benefits and costs, depending on the metrics used and precision required. Different methodologies may be applied to calculate different metrics in a single valuation study. If multiple metrics are used to arrive at a composite value, the user will need to supply assumptions about how to weight or compare these metrics. In a competitive market, different providers are likely to offer their own versions of methodologies and tools to serve a given purpose.

This vision is intended to enable two broad outcomes: a generic decision process to aid stakeholders in determining the valuation methodologies and tools most appropriate for their needs, and a common language to enhance transparency and comparability between valuation studies while giving room for stakeholder perspectives to affect the assumptions, methods, and conclusions.

Decision processes developed to satisfy valuation requirements have typically been custom-built to serve the need at hand, with little regard for the development of or adherence to generic principles or concepts. A framework must go beyond only the specification of metrics and the calculation of values—some easily quantified, others not easily quantified—and the creation of a means to join disparate values into a larger decision process. Stakeholders will have different perspectives as to what values need to be studied and to what depth. The framework must take into account, and reconcile if possible, such differences. Project developers may be most interested in the compensable values their project would bring, whereas utilities may be concerned with a broader set of values corresponding to impacts across their entire system. Regulators may be most concerned with provision of services fairly, safely, and cost-effectively for rate-setting, whereas other policymakers may be concerned with additional social policy aspects. Technical analysts (e.g., utility and public utilities commission [PUC] staff, researchers) will desire a more detailed understanding of the systems and values than more senior decision-makers and executives will expect. The general theory and framework must provide a vocabulary to enable communication among these disparate parties and must suggest basic principles for the reconciliation of conflicting assumptions, opinions, or preferences.

The vision assumes that because of a broad, strong need for widely accepted valuation processes (and the information they produce), with some effort we can eventually develop a body of standard principles and practices for valuation, similar to today's generally accepted accounting principles for finance. This will require development, application, and refinement of a successful and useful general theory and framework, acceptance by key sectors on the minimum amount of transparency and detail, and the establishment of an independent standards body. These tasks are beyond the scope of the current project, which will take initial steps in the direction outlined above.

To summarize, a valuation framework will

- aid users to select the best methodologies to evaluate the technology or service in question,
- aid the development of mechanisms for consolidating multiple values so derived into a comparable figure of merit, and
- provide a common minimum set of information requirements that will enable others to validate the results.

Further, the framework will not

- be a single methodology or tool that defines the value of all technologies,
- suggest an approved form of valuation that must be used by all,
- require all tools to be open access with no proprietary value added, or
- define all assumptions and value weights.

To address this challenge, the Department of Energy (DOE) has funded a 3-year project to begin development of a framework to guide the valuation of the services and impacts of grid-related technologies. Seven national laboratories with assistance from a stakeholder group will design and test the framework against real-world valuation challenges. Whereas the vision described here is for a fully developed and accepted framework, the current project will have a more limited scope to

- develop a decision process to identify recommended methodologies,

- develop a process for users to consolidate different metric values for an overall value,
- create an initial list of assumptions and results needed for basic validation, and
- utilize a stakeholder advisory group to assist in developing a relevant and useful tool.

The current project will not involve

- refinement of the theory and framework to increase their depth and breadth, and
- broader stakeholder application and expansion to additional sectors.

The next section articulates goals for the current Grid Modernization Laboratory Consortium (GMLC) valuation project to work toward, as follows:

1. Development of a working-level version of the framework
2. Trial applications of the framework at impactful stakeholders' levels

2.0 Framework Development

The term "framework" was first applied to the development of information systems or enterprise architecture in 1987 with an article in *IBM Systems Journal* by J. A. Zachman.[1] It was later expanded to The Open Group Architectural Framework (TOGAF)[2] and the Federal Enterprise Architecture (FEA).[3] Roger Sessions describes[4] Zachman's framework as a *taxonomy*, TOGAF as a *process*, and FEA as a *prescriptive methodology*. Each approach has strengths and weaknesses. He recommends that any group not necessarily choose only one but rather blend them to what fits best with the situation.

A framework for the valuation of grid services and technologies would be more limited than a full enterprise architecture because it addresses only the valuation of the results of certain activities, rather than the complete planning, implementation, and control of the system in which the activities take place. At the same time, it must be broad because it encompasses the entire electricity system rather than just an individual business enterprise within it, with a greater set of stakeholders and competing goals. However, the nomenclature and partitioning—specifically the taxonomy/process/prescriptive methodology delineation introduced above for information systems—is useful in specifying the blend of required attributes from which to construct the proposed valuation framework. The long-term vision for this project is to accomplish the three following interrelated goals in the construction of a unified framework:

1. **Development of a Grid Services and Technology Taxonomy** and an associated glossary that documents and classifies services and technologies, the different types of products that these bring to the power system, and metrics relevant and applicable to each. It will include a listing of the scale and scope of various quantification methodologies available, including their necessary inputs, outputs, and resources required based on their classification into the taxonomy. Reliance on the common language created through the taxonomy will be essential to ensuring transparency and comparability between studies.

2. **Formal Deconstruction of Valuation as a *Process,*** documenting the linkages among the methods, metrics, and perspectives outlined in the taxonomy.

3. **Development of Standard, Stakeholder-Vetted Guidelines** on the implementation and documentation of a valuation process. This *prescriptive methodology* will outline the minimum acceptable and ideal implementations of the process. The guidelines would aid those conducting a valuation study in their selection of values, metrics, and methods—including the appropriate scope and capabilities of tools and data—to produce the quantified information necessary to support decision-making in the specific context of those evaluating an investment decision, and attributes of the technology or service investment being assessed. Importantly, a key aspect of the guidelines is consistent, appropriate documentation and transparency of the methods,

---

[1] John A. Zachman. "A Framework for Information Systems Architecture." In *IBM Systems Journal*, vol. 26, no. 3 (1987). IBM Publication G321-5298. Available from http://www.research.ibm.com/journal/50th/applications/zachman.html. Accessed April 29, 2016.

[2] The Open Group, "TOGAF®, an Open Group Standard," The Open Group, 1995–2016. Available from http://www.opengroup.org/subjectareas/enterprise/togaf. Accessed April 28, 2016.

[3] Office of Management and Budget, "Federal Enterprise Architecture (FEA)," Office of Management and Budget, 2005–2016. Available from https://www.whitehouse.gov/omb/e-gov/fea/. Accessed April 28, 2016.

[4] Session, Roger, "A Comparison of the Top Four Enterprise-Architecture Methodologies," ObjectWatch, Inc., May 2007. Available from https://msdn.microsoft.com/en-us/library/bb466232.aspx. Accessed April 28, 2016.

assumptions, and data used in the valuation process. This allows valuation outcomes to be transparently discussed, assumptions to be evaluated, and results to be reproduced by other interested parties.

In this conceptualization of the theory, grid-related technologies can provide a variety of needed services—and the value of these services is quantified (ideally, monetized) in terms of a series of predefined metrics according to industry-accepted methods. The physical and market characteristics of the technology or service being evaluated, and the perspective of the evaluator, are then used to determine the appropriate scopes, metrics, and methods to be included in the valuation process.

Application of the Valuation Framework: The prescriptive decision process of the framework should allow for an assessment of alternative valuation methodologies, based on a user's needs and resources available. Following the application of the methodology (or methodologies) selected by the user, the framework should allow for a multicriteria assessment that integrates the different values derived into a composite figure of merit.

Figure 2.1 gives an example of how a framework-based decision process may provide a systematic means to collect and compare the results from the selected valuation methods. Users would first establish their information needs and the resources available for answering their questions. Based on these, they would determine the mix of products to be examined and the metrics to be applied. They would examine the possible methodologies available for quantification of these products and select those most appropriate. They would then need to establish the baseline and the assumed new state, apply the methodologies to determine resultant values of the different metrics, and finally weight the comparative value of each metric based on their perspective or perspectives.

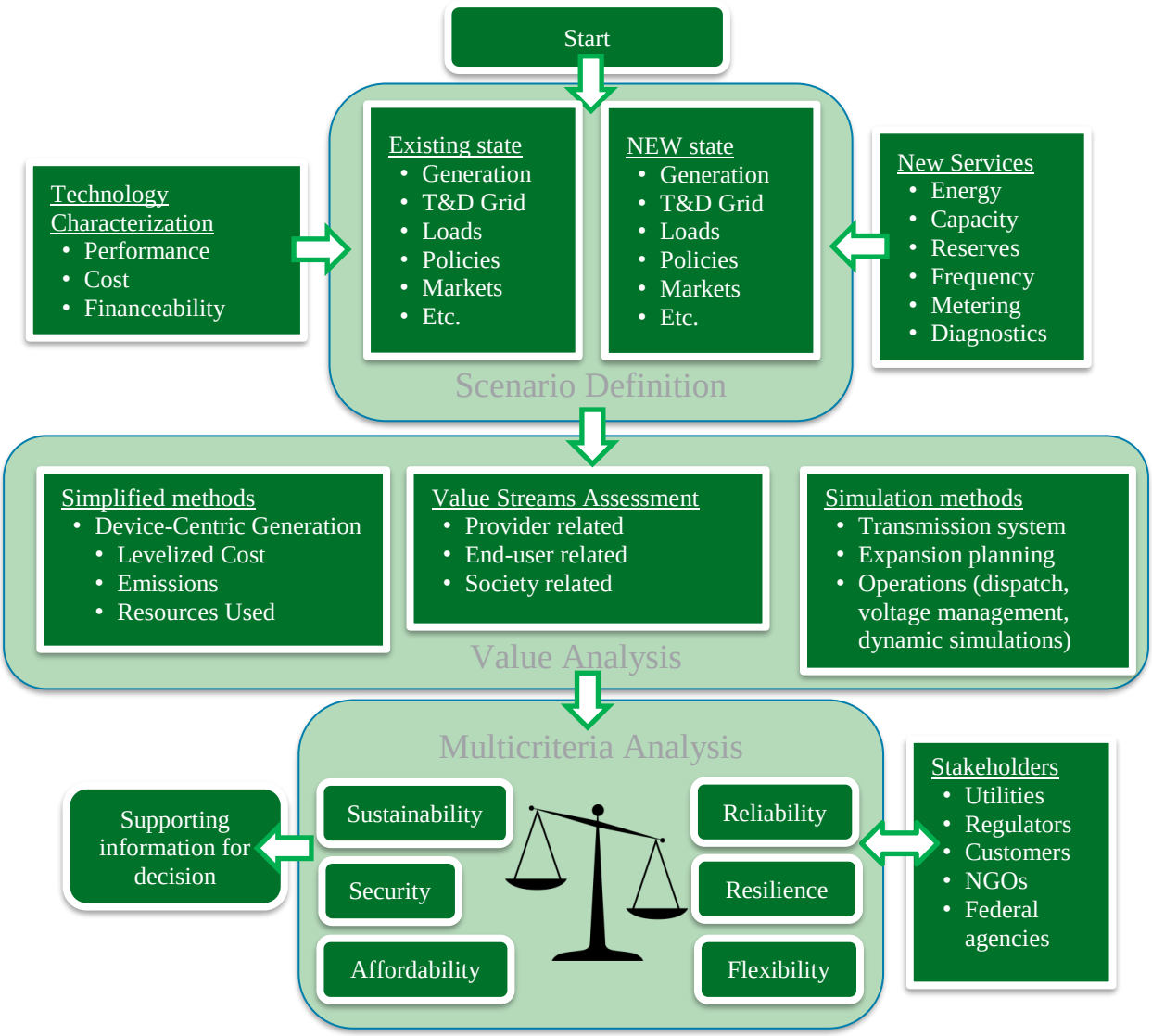


Figure 2.1. A framework-based decision process.
(Notes: T&D = transmission & distribution; NGO = nongovernmental organization.)

Users will not have to conduct a detailed, complex analysis of the entire electric system if they have more limited needs and/or resources. For example, those doing a screening analysis of possible technologies may use simplified methods concerned largely with just the new technology. An individual project developer may have a detailed analysis of a new project but a simpler understanding of the grid as a whole. By contrast, utilities preparing integrated resource plans or transmission plans must have a broader understanding of the systemwide interactions between technologies and services.

Departures from Today's Valuation Processes: Today's valuation processes often lack transparency and completeness. A fully transparent valuation process would not only reveal assumptions and modeling approaches but also show intermediate results, provide full exposure of all end results, and give full clarity in all of the input data sets used for driving simulation or other modeling efforts. This is a clear departure from today's common practice where, in document form, key input assumptions are qualitatively described and, due to data size and confidentiality, not all input data are released. In the long-term vision, the prescriptive valuation guidelines would detail the data that should be made available

electronically. With an appropriate data analytics tool, a data set can be interrogated for specific questions. For instance, if a PUC's staff members are interested not only in the capital cost of future distributed photovoltaics but also in the intrinsic assumption about the cost decline mechanism used in the modeling, and how the cost decline may change from technology to technology, that information could be revealed.

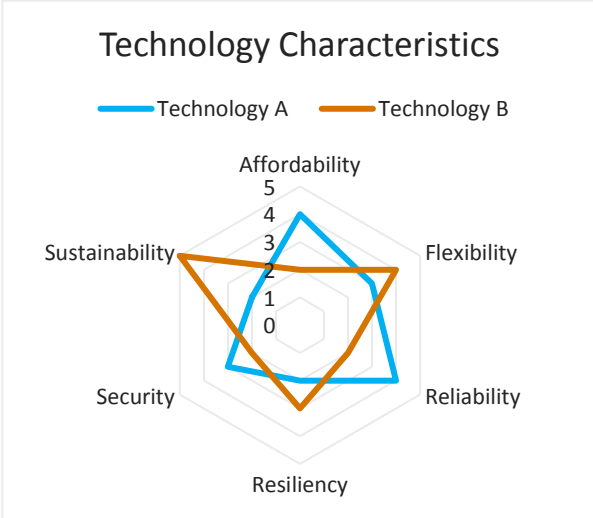
Regarding the completeness of a given valuation methodology (or an application of it), there is a broadening awareness of the need to recognize the spatial and time-varying value of technologies and grid services. Some of the recent distributed resource planning proceedings have addressed the spatial aspect of value creation and cost causation of distributed technologies. The California PUC required the investor-owned utilities to perform a distribution resource plan to determine the optimal locations for distributed resources and then to design market structures to incentivize the deployment at those locations. A transactive energy system is predicated on the notion that participating entities or devices in an electricity market have some means of establishing the time-dependent value of their products or services at their particular location. An industry-vetted framework would allow for the consistent and transparent assessment of these increasingly complex sources of value.

Broadening the Scope of Valuation: The valuation of grid services and technologies in the future will need to consider a broad set of values that currently are either addressed in isolation from others or not addressed at all. For instance, information about the cobenefits of certain technologies, such as reduced land use or water consumption, is generally not considered in the selection of future generation technologies. The environmental impacts are often considered in the permitting process when the decision of a particular technology has already been largely settled. In the future, the environmental impacts or the long-term sustainability characteristics of a technology will ideally be taken into consideration early on in the transmission planning or resource adequacy planning processes. Similarly, the implications of technologies for the operational and structural flexibility of the broader electricity system should be considered, as should their implications for the system's resilience to extreme events. Societal impacts such as jobs or economic development may also be considered.

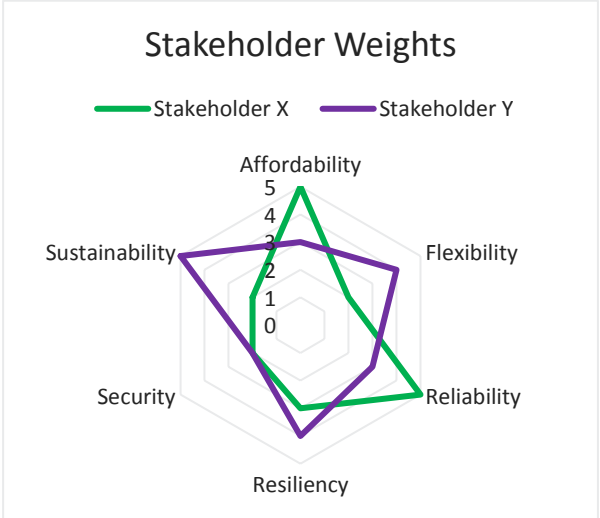
The future vision of the valuation methodologies will enable analysts to explore in more depth the implication of a policy, a new technology, or operational procedures on a broad scale of impacts that include the overall system's reliability, resilience, flexibility, sustainability, affordability, and security. This will require new modeling and simulation methodologies, some of which have not been developed. It also requires a much more integrated approach, with data sets much richer than those in current use.

Role of Standards and Common Valuation Processes: The vision of a future theory of valuation will require methodological improvements and data exploration capabilities to enable a full declarative and self-descriptive form of all data inputs. To enable data exploration techniques across many domains and disciplines, rigorous data definitions and standards must be developed to define data clearly and unambiguously. If successful, data describing the electric infrastructure can then be ingested into different analysis programs to explore values of certain technologies for different questions in different domains. For instance, if one explores rooftop photovoltaic systems and their impacts on the distribution system of a particular service territory, one would need to have (1) a physical representation of the housing stock to be able to determine the available roof area and the orientation; and (2) a power flow model to estimate impacts on reliability, cost implications with potential protection upgrades, and the economic viability of this technology. Standards to represent common electrical infrastructure components are necessary. Furthermore, grid assets need to be geo-coded to estimate impacts on the physical landscape and how they may affect land, water, and air resources. At the same time, some of this data may be proprietary or have security implications if made widely available. This openness versus privacy issue must be addressed for a successful valuation framework.

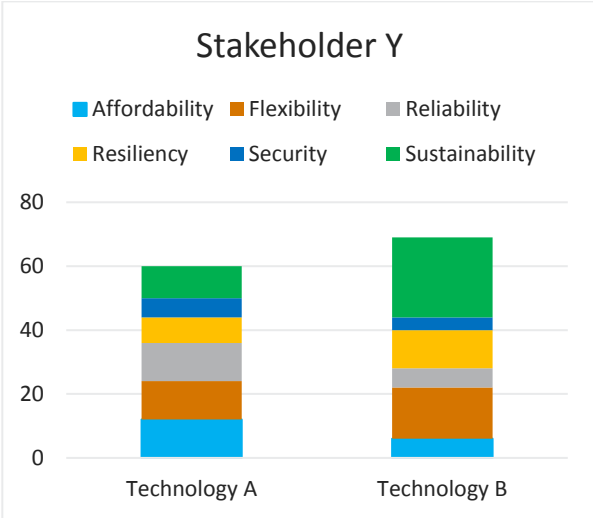
Multicriteria Decision Support Tools Become Necessary to Consider Broad Scope of Valuation: In this future vision, the broad valuation process will comprehensively estimate value streams, including impacts to electric system properties, expressed in terms of six essential basic attributes (reliability, flexibility, resilience, affordability, sustainability, and security). Decision-makers may choose one of the six as being of particular interest, or they may choose to focus on a subset of the six groups. One way to harmonize the disparate metrics and properties is to monetize all metrics to one common unit. Economics has led many analysts in designing methods to monetize values that are currently not expressed in a monetary unit. However, some metrics may not lend themselves to monetizing; a value for a unit of, for example, resilience may not exist; or the uncertainties or ranges of possible monetization may be overwhelming. In such cases, the decision-maker is left to deal with a multicriteria decision-making problem in which alternative decisions exhibit multiple values (see Figure 2.2). Currently, no tools exist for grid infrastructure investments that enable multicriteria decision-making. New methodologies and tools need to be developed to assist this process.



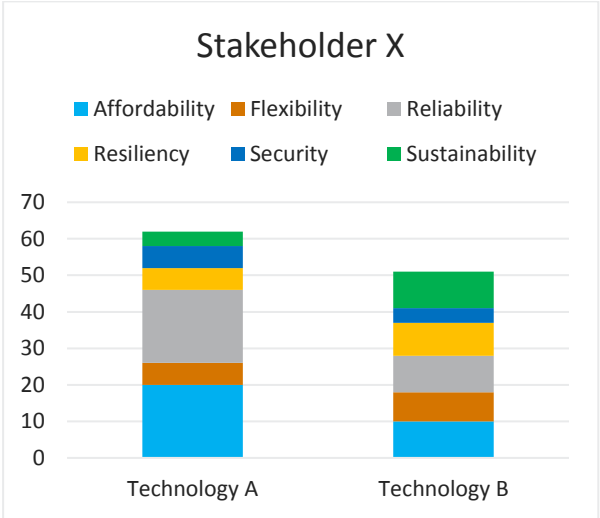
Technologies differ across key metrics.



Stakeholders differ on how they value key metrics.



Stakeholder X sees technology A as superior.



Stakeholder Y sees technology B as superior.

Figure 2.2. Value from the perspective of different stakeholders.

Although such methods may still lead to different results from different stakeholders, the reasons for the differences can be made more transparent and are subject to negotiation. Different technologies will have strengths or weaknesses in different metrics, and different stakeholders will place different weights on the different metrics. In Figure 2.2, technology B is more favorable than technology A from sustainability, resilience, and flexibility metrics but less favorable in affordability, reliability, and security metrics. For stakeholder Y, sustainability, resiliency, and flexibility are most important, so technology B will be favored, whereas stakeholder X ranks affordability, reliability, and security highest, therefore likely ranking technology A as most favored.

3.0 Implementing the Vision: A Roadmap to Generally Accepted Valuation Principles

Achieving the goals of wide acceptance and industry standard usage of the Valuation Framework requires a development and implementation process operating in three phases. These phases work through the conceptualization of the framework, its critical review by the user communities, and a long-term approach to standardization and adoption. The intent is to interactively develop an increasingly sophisticated framework that will ultimately serve as the blueprint for a more formal process of standardization akin to that used in the development of the accounting profession's Generally Accepted Accounting Principles (GAAP) or international standards development.

Although the prioritization and focus of each phase differ, the activities in each are intended to address key issues in the establishment and improvement of the *content* of the framework as well as its a*doption and institutionalization* in valuation studies across the United States.

Phase 1: Baseline Framework Development (2016–2018)

Content
The initial efforts to determine scope of, define, and populate the valuation framework will occur under the GMLC 1.2.4: Grid Services and Technologies Valuation Framework Development Project. At the end of the initial 3 years, the project will have produced a set of guidelines for valuation vetted through interactions with the project's stakeholder advisory group and external reviewers. The guidelines will consist of a step-by-step process from determining the study scope to assembling information to supporting decision-making with associated deliverables, checklists, and other aids. These guidelines will be complemented by a centralized resource—the catalog of methods and tools—which provides a reference for the methods, tools, and metrics (in conjunction with GMLC 1.1) used in conducting and interpreting valuation studies.

The guidelines (*process*) and catalog (*taxonomy*) are the core elements of the framework as described in Section 2 and are expected to make substantial progress toward the goals of transparency and repeatability described in this vision document through the systematic treatment of valuation. At the end of the first phase of development, the framework should allow a user to execute a valuation study—and document it—in such a way that key assumptions are made transparent and the steps taken from question formulation through modeling and, ultimately, decision-making are documented and repeatable. However, further efforts will be necessary to ensure that valuation studies become *comparable* (beyond being transparent), and the framework approach must broaden to achieve the goal of extensibility beyond immediate electric power sector concerns, such as increasingly complex interactions with interdependent systems (e.g., commerce, communications, water, transportation).

Adoption and Institutionalization
At the close of the first 3-year phase of developing the framework, it will not yet be in wide use in the broader valuation community. However, the systematic approach to valuation described in the framework will likely begin to appear in whole or partial application in studies directly influenced by the project's broad laboratory expert team and stakeholder advisory group. Additional outreach efforts during the first phase of framework development (external review, conference and workshop presentations, etc.) will begin an expanded socialization of the framework within the broader valuation stakeholder community.

Phase 2: Industry Engagement, Adoption, and Revision (2019–2020)

Phase 2 builds on the foundation created in Phase 1 to push the framework toward the long-term visions of comparability and extensibility and to begin the demonstration and outreach processes necessary to facilitate widespread adoption.

Content
The valuation framework must consistently support comparability across different valuations. This need is reflected by encountering contradicting outcomes of analysis that are attempting to address similar or the same questions, typified by often contentious debates about the value of distributed energy resources Achieving comparability will require defining modeling templates and mapping inputs and outputs of model and analysis results into common formats. The valuation framework is not intended to standardize *how* modeling occurs in support of grid-related decision-making, but it is ultimately necessary to standardize and structure methods for developing and reporting assumptions, outputs, results, and synthesis approaches so that clear conclusions can be made relative to the differences between study approaches, outcomes, and recommendations. In addition, to promote comparability, this structure should enable basic "auditing" of valuation studies in accordance with the framework guidelines.

The second core improvement to valuation framework content, which must occur in Phase 2, is to expand the compendium of modeling approaches—and information requirements and flows— both to improve the framework users' abilities to identify the best tool for each situation and to provide information on additional systems interdependent with the power system. These include (but are not limited to) fuel, water, communications, and transportation infrastructure. Other systems that address the vision for extensibility will also be considered.

Adoption and Institutionalization
Although the framework will be used selectively following successful completion of Phase 1, broader, higher-profile adoption will be necessary to signal its utility to the valuation stakeholder community. This can be achieved through two primary focuses: (1) high-visibility demonstration of applicability and utility to real-world use cases, and (2) direct engagement of relevant professional associations and valuation practitioners and consumers including nongovernmental organizations, regulatory organizations, consultants, and researchers/research institutions.

The first focus on institutionalization begins with immediate stakeholders in DOE. If DOE regards the framework of value, it becomes imperative for DOE to promote its use internally through implementation for technology valuation and similar studies conducted by DOE offices and contractors. In addition, as appropriate DOE solicitations could request the proposers to use the framework for estimating impacts and then document all inputs/assumptions according to the framework guidelines.

To enable DOE to implement the framework internally and request proposers to estimate impacts using the framework, the valuation team will, in conjunction with project teams, develop checklists and tools to determine the key question addressed by the DOE project, identify alternatives, identify stakeholders, and catalog metrics early in Phase 2. The valuation team will work with several project teams to improve the process for prioritizing impacts, selecting a synthesis approach, and selecting tools to quantify and compare impacts of the alternatives. The valuation team will also work with DOE and the GMLC metrics team to identify key metrics and develop simple tools that proposers to DOE solicitations can use to quantify impacts consistently, such as levelized cost of energy calculations that have been required and used in the past.

The second focus would include directly engaging a broader swath of stakeholders, specifically organizations for whom the standardized approaches envisioned for the valuation framework align with

their core missions. The initial focus of that engagement is intended to identify one or more "champion organizations" that can implement and audit valuation processes in the future and work with that organization to identify initial valuation strategy implementation, acceptable costs, and auditing strategies. The goal is to develop a foundation and strategy for institutionalization in Phase 3.

Such organizations would include prospective users/consumers of the framework, such as members of the National Association of Regulatory Utility Commissioners, the Power and Energy Society of the Institute of Electrical and Electronics Engineers, the US Association of Energy Economics, and the Society for Benefit-Cost Analysis.

Equally important will be outreach to organizations external to the power sector which can bring experience with formalized analytical and business practices into the energy-related valuation. Potential partner organizations in this space include the Financial Accounting Standards Board—which maintains the US generally accepted accounting principles—or the National Association of Certified Valuators and Analysts.

Initial outreach to these types of organizations should begin during Phase 1 to involve them in review of the draft valuation framework. This initial contact and subsequent engagement through Phase 2 should lead to the identification of one or more "champion organizations."

Expansion of modeling approaches
Under the framework's initial phase, the project team started a catalog of methods and tools. The catalog will be further developed to better link priority metrics identified in earlier elements of the methodology to tools that can address each element. It will also address tradeoffs between cost to develop data sets and tools vs. confidence in the results so that users of the framework can select the best suite of tools to address their key metrics and priority impacts under their funding and resource limitations. It will also consider synergistic outputs (e.g., where a single tool calculates estimates for multiple metrics, thus offering more value than that of a lower-cost tool that provides fewer estimates).

Phase 3: Formal Standards Development (2021–2025)

Content and Institutionalization

Once critical mass on agreement adhering to the guidelines exists amongst the broader valuation community, the concepts, guidance, and prescriptions contained in the framework guidelines can be formalized into standards to formally constrain what can and cannot be considered a "valuation" study. These formalized standards can then allow a champion organization identified during Phase 2 to certify professionals in the field.

The International Standards Organization (ISO) notes that development of a standard typically takes 3 years. Although international in scope, ISO standards still provide a useful reference point for consideration. Analytical standards similar in spirit (if not form) to the proposed valuation framework have typically taken a similar amount of time to reach final publication. The environmental life cycle assessment, ISO 14040:1997, took approximately 3.5 years from initiation to publication. Given that electricity sector "valuation" is a broader space, additional time is allocated to move from the blueprint provided by the valuation framework guidelines to fully formed standards and principles for evaluating and auditing studies.

The roadmap timeline for the years 2016 to 2025 is shown in Table 3.1.

Table 3.1. Roadmap milestones.

Roadmap Milestones	Date
Phase 1	
Complete iterative framework drafts and test cases	2016–2018
Complete test case on bulk power	2017
Complete draft 2 following bulk power test case and stakeholder review	2018
Complete draft 3 following distribution case study and stakeholder review	2018
Phase 2	
Identify and engage appropriate professional organizations; establish valuation user communities	2019
Publish reports and articles in trade publications that include or refer to improved checklists and tools to be used to implement the framework	2019–2020
Identify and begin working with "champion organization(s)"	2020
Apply framework in high profile Department of Energy use case(s)	2020
Issue updated valuation framework guidelines that includes an expanded catalog of methods and tools	2020
Phase 3	
Establish technical committees in conjunction with champion organization(s) to oversee development of valuation standards and principles	2021
Issue valuation committee's draft valuation standards and principles	2023
Issue valuation committee's valuation standards and principles	2025

http://gridmodernization.labworks.org/