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** Updated content from previous version is marked in **blue text**, for convenience*

** Work-in-progress content that may get updated at later stage, based on pending input from stakeholders, is marked in **brown text**, for convenience*

VGI Valuation Method

Below is an updated version of the six-step VGI Valuation Method, originally proposed by PG&E.[1] Upon achieving consensus within this Working Group, we shall refer to this updated Proposal as the ***California VGI Use-Case Assessment Method***, and it shall be used primarily to answer the three main questions of this Vehicle Grid Integration Working Group (VGI WG):

a. What VGI use cases can provide value now, and how can that value be captured?
b. How does the value of VGI use cases compare to other storage or Distributed Energy Resources?
c. What policies need to be changed or adopted to allow additional use cases to be deployed in the future?

The method is presented sequentially in this section. The steps are:

Step 1: Define A VGI Framework
Step 2: Identify Hypothetical VGI Use-Cases
Step 3: Screen Out Impractical VGI Use-Cases
Step 4: Score VGI Use-Cases' Potential Benefits, Costs, and Implementability
Step 5: Rank VGI Use-Cases based on Benefits, Costs, and Implementability
Step 6: Make Recommendations on Policy, Market, or Technology

Step 1: Define A VGI Framework

This first step identifies six key <u>*Dimensions*</u> along which VGI use-cases can be designed, and their value subsequently assessed. The Dimensions are illustrated in Figure 1 and summarized below, and a detailed description is included in Appendix B.[2]

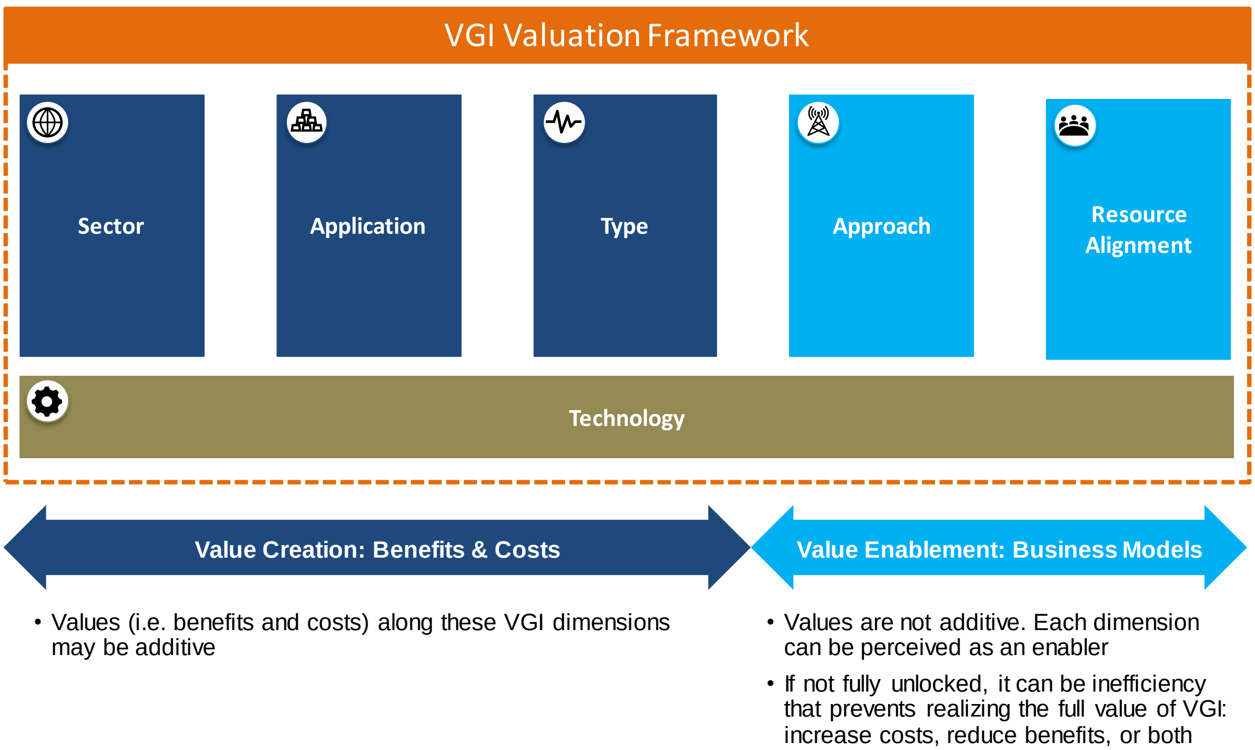
- **Sector**:
  - Pinpoints where the vehicle is used and charged/discharged
  - Could be broadly grouped into *residential* and *commercial* categories, or subsets thereof (e.g. commercial school bus, or commercial public destination)
  - Determines the loadshapes – both in "reference" and "optimized" forms – that are to be associated with the VGI use-case
  - Determines the plug-in schedule that is to be associated with the VGI use-case

[1] Karim Farhat. PG&E VGI Valuation Method. Gridworks VGI Framing Doc. August 2019.
[2] Karim Farhat. PG&E's VGI Valuation Framework, as originally published in "*A Comprehensive Guide to Electric Vehicle Managed Charging*" SEPA, May 2019.

- **Application:**
    - Refers to the service(s) VGI aims to provide
    - Could be broadly grouped into *customer-centric* and *system-centric* services
    - The prospect of "stacking" these services, and their values, is important and relevant not only to VGI but also to other DERs such as battery energy storage

- **Type**:
    - Determines the power flow to and/or from the vehicle
    - Could be uni-directional (*V1G*) or bi-directional (*V2G*)

Figure 1



- **Approach:**
    - Refers to the control mechanism through which the vehicle's charge and/or discharge is managed
    - Could be either *indirect (i.e. passive) or direct (i.e. active).*
    - Fundamentally, *indirect (passive)* control involves adjusting the EV charge/discharge by responding to a "signal" only, without prescribing what the charge/discharge adjustment entails. The receiver of the signal chooses how exactly to respond to that signal, including possibly not responding at all. The response is measurable (e.g. in terms of kW or kWh).
    - On the other hand, *direct (active)* control involves adjusting the EV charge/discharge by responding to both a "signal" as well as "dispatching instructions" that prescribes what the charge/discharge adjustment entails. In this case, the receiver of the signal is provided clear instructions on the requirements to respond to that signal, and both the "dispatching instructions" as well as the response are measurable (e.g. in terms of kW or

kWh). The "dispatching instructions" can be passed downstream all the way to the EV/EVSE from a variety of actors (e.g. system operator, grid operator, load serving entity, service provider, aggregator, etc.). If the EV/EVSE receives "dispatching instructions" from at least one entity, the approach shall be considered *direct*, regardless which entity originated the "dispatching instructions".

- For both *direct* and *indirect* control, the signal can be economic (e.g. time-of-use price), environmental (e.g. GHG intensity), or reliability-based (e.g. distribution-grid congestion). Utility time-of-use rates are a good example of *passive control* mechanism, whereas Demand Response programs (based on CAISO market clearing prices) are a good example of *active control* mechanism.
- Embedded in this dimension is also the role of aggregation

- **Resource Alignment:**
  - The framework distinguishes between two important actors: "EV actor" is the party that controls and/or operates the electric vehicle, and "EVSE actor" is the party that controls and/or operates the electric vehicle charger under the utility meter.
  - Based on that, the framework views the EV-EVSE combination as the Resource.
  - If the EV and EVSE are controlled and/or operated by the same actor, the EV-EVSE Resource is *unified*. Alternatively, if the EV and EVSE are controlled and/or operated by different actors, the EV-EVSE Resource is *fragmented*.
  - Furthermore, if the EV actor and EVSE actor are aligned in their intentions and actions, the EV-EVSE Resource is *aligned*. Alternatively, if the EV actor and EVSE actor are not aligned in their intentions and actions, the EV-EVSE Resource is *misaligned*.
  - By default, if the EV-EVSE Resource is *unified*, it must also be *aligned*, since the EV and EVSE are controlled and/or operated by the same actor. However, in the case the EV-EVSE Resource is *fragmented*, it may be either *aligned* or *misaligned.* Among other factors, incentive design may be an important consideration to achieve alignment between the EV actor and EVSE actor, and to guarantee the delivery of the VGI service.
  - Ultimately, the Resource Alignment dimension yields three potential prospects: (1) *EV-EVSE Unified, Aligned*; (2) *EV-EVSE Fragmented, Aligned*; (3) *EV-EVSE Fragmented, Misaligned*.

- **Technology:**
  - Identifies the hardware and software needed to realize the VGI opportunity
  - Technology considerations include, but are not limited to:
    - electric vehicle type (e.g. battery electric vehicle, plugin-hybrid electric vehicle)
    - charging rate (e.g. L1, L2, fast-charge)
    - charging type (e.g. AC with mobile inverter, DC with stationary inverter)
    - communication requirements and pathways to EV and/or EVSE
  - Technology solution sets are diverse and span across the other five VGI Dimensions

The VGI framework treats *Sector*, *Application*, and *Type* as "value creation" Dimensions, since they determine how VGI value (both benefits and costs) is created and where it comes from. Value along these Dimensions may be additive. For example, residential charging can be added to commercial charging; wholesale ancillary services can be added to capacity services, and managed charging can be added to managed discharging, resulting in additional benefits and/or costs.

The VGI framework also treats *Approach* and *Resource Alignment* as "value enablement" Dimensions, since they determine how VGI value (both benefits and costs) can be unlocked and effectively captured. Value-enablement Dimensions compliment value-creation Dimensions to accurately characterize benefits and costs. For example, no matter how significant the potential net-benefits may be from leveraging managed charging of EV fleets for distribution-grid upgrade deferral, that value may never be realized in real life if the approach is inappropriate, or the EV and EVSE actors are fragmented and misaligned.

As Technology spans across the other five Dimensions, it has the potential to impact benefits and costs, in terms of both "value creation" as well as "value enablement." In this Working Group, to maintain a delicate balance between simplicity and accuracy, reasonable assumptions on Technology will be made along the other five Dimensions, whenever needed, to valuate and score VGI benefits and/or costs.

Step 2: Identify Hypothetical VGI Use-Cases

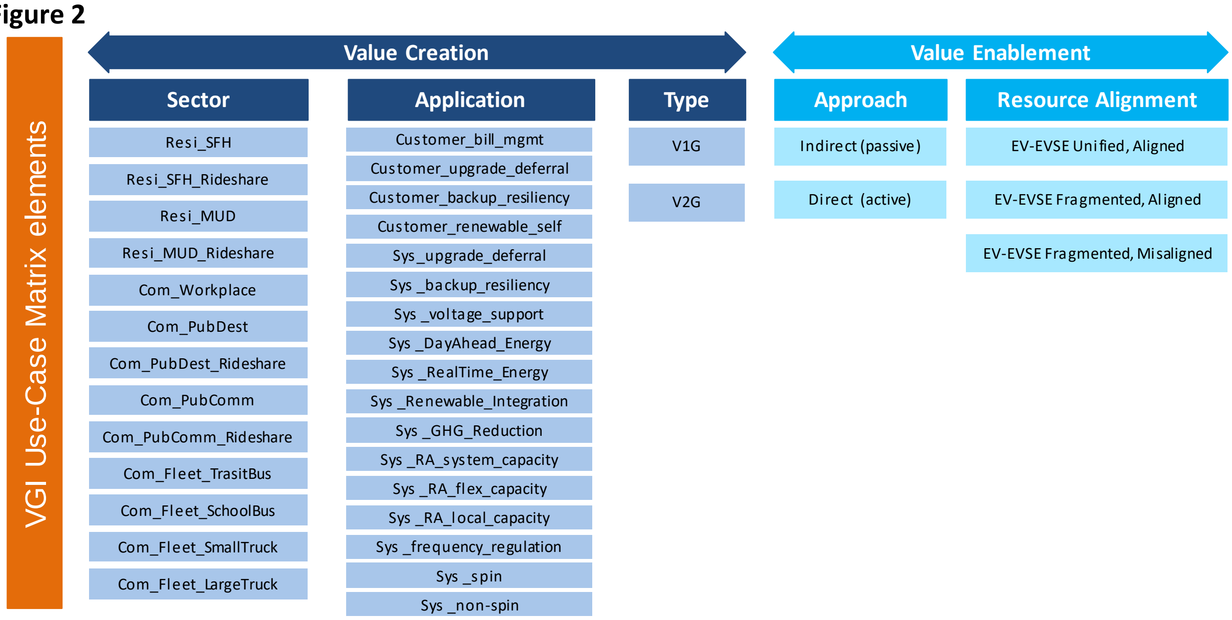
Together, the aforementioned six *Dimensions* constitute the main pillars of a VGI framework by which use-cases are scoped and defined. Under each Dimension, several options can be identified; we refer to those options as *Elements*. For example, as shown in Figure 2, *Customer - Bill Management* and *System - Day-Ahead Energy* are Elements of the Dimension *Application*. Some of the key Dimensions, such as *Sector* or *Application*, could have many potential Elements. Table 1 and Figure 2 document the Elements for each of the value-relevant Dimensions: *Sector, Application, Type, Approach,* and *Resource Alignment*.

Table 1.

Dimension	Element
Sector	Residential - Single Family Home
	Residential - Single Family Home - Rideshare
	Residential - Multi-Unit Dwelling
	Residential - Multi-Unit Dwelling - Rideshare
	Commercial - Workplace
	Commercial - Public, Destination
	Commercial - Public, Destination - Rideshare
	Commercial - Public, Commute
	Commercial - Public, Commute - Rideshare
	Commercial - Fleet, Transit Bus
	Commercial - Fleet, School Bus
	Commercial - Fleet, Small Truck (class 2-5)
	Commercial - Fleet, Large Truck (class 6-8)
Application	Customer - Bill Management
	Customer - Upgrade Deferral
	Customer - Backup, Resiliency
	Customer - Renewable Self-Consumption
	System - Grid Upgrade Deferral
	System - Backup, Resiliency

	System - Voltage Support
	System - Day-Ahead Energy
	System - Real-Time Energy
	System - Renewable Integration
	System - GHG Reduction
	System - RA, System Capacity
	System - RA, Flex Capacity
	System - RA, Local Capacity
	System - Frequency Regulation Up/Down
	System - Spinning Reserve
	System - Non-Spinning Reserve
Type	V1G
	V2G
Approach	Indirect (passive)
	Direct (active)
Resource Alignment	EV-EVSE Unified, Aligned
	EV-EVSE Fragmented, Aligned
	EV-EVSE Fragmented, Misaligned

Figure 2



Example use-cases: ChargeForward Pilot collaboration between PG&E and BMW

Resi_SF	WS_DayAhead_Energy	V1G	Direct	EV-EVSE Unified, Aligned	L2, AC, BEV & PHEV, Telematics
Resi_SF	WS_Renewable_Integration	V1G	Direct	EV-EVSE Unified, Aligned	L2, AC, BEV & PHEV, Telematics
Com_Workplace	WS_Renewable_Integration	V1G	Direct	EV-EVSE Fragmented, Misaligned	L2, AC, BEV & PHEV, Telematics

One particular aspect to note in the Elements under the *Sector* Dimension is the simplified representation of medium-duty and heavy-duty (MDHD) electric vehicles. The MDHD space covers a wide range of vehicle classes and vocations. While each MDHD vehicle class and/or vocation may contribute a unique set of VGI use-cases, the electrification in the MDHD space is still in its early stages. Therefore, to maintain simplicity while still honoring inclusivity, the proposed Method carves out four distinct MDHD Elements in *Sector*: *Transit Bus*, *School Bus*, *Small Truck (Class 2-5)*, and *Large Truck (Class 6-8)*. *School Bus* and *Transit Bus* are highlighted due to their distinct charging behavior as well as to special emphasis in California and around the country on accelerating their electrification. Overall, understanding and articulating the VGI use-cases associated with these four simplified MDHD Elements will provide sufficient clarity into their associated VGI value, without adding too much complexity.

This method defines a use-case as a unique combination of Elements under the six Dimensions identified in the framework. To illustrate, below we present an example VGI use-case by choosing a *Sector*, an *Application*, and a *Type*, then selecting an *Approach* and identifying the nature and degree of the *Resource Alignment*; we also highlight the relevant Technology components:

Example: Amazon Delivery Fleet
Sector: Commercial – Fleet, Small Truck (Class 2-5)
Application: Customer – Bill Management
Type: V1G
Approach: Indirect
Resource Alignment: EV-EVSE Unified, Aligned
Technology: Electric Vans; OpenADR Communication Standard; DCFC

VGI use-cases can be simple or advanced. A simple use-case consists of only one choice for each dimensional Element, as in the example provided above. An advanced use-case may consist of multiple choices for each dimensional Element, as would be the case if the commercial fleet in the above example provided both energy and capacity services in the wholesale market.

In theory, hundreds of combinations of Elements in the framework could be made, resulting in hundreds of hypothetical VGI use-cases with distinct values.

Step 3: Screen Out Impractical VGI Use-Cases

Fundamentally, all VGI use-cases are intended to be voluntary in nature, aiming to complement and not jeopardize the primary objective of electric vehicles, which is meeting the customer's mobility needs. Given that overarching principle, the next important step is to identify *Screens* that can be applied to the full range of hypothetical use-cases in order to filter out "impractical" use-cases. Applying those screens yields a focused set of use-cases that can be further characterized and scored. Screens may emerge from technological feasibility, market rules, customer preferences, or data availability, among other considerations.

Screens should also be articulated and applied within a clearly defined and agreed upon timeframe for evaluation (hereby referred to as the "Timeframe"). For this Valuation Method, the Timeframe is defined as follows:

- For VGI "now" value: the Timeframe extends from 2019 up to and including 2022.
- For VGI "future" value: the Timeframe extends from 2023 up to and including 2030.

Given the Timeframe specifications above, the following list of Screens can be applied for refining VGI use-cases:

- **Technological feasibility**:
    - Screen 1 (apply to "now" Timeframe only): Filter out use-cases that require hardware and/or software technologies or solutions that, within the Timeframe: (1) have not been operated or demonstrated to operate in California, (2) are not compatible to California, and (3) are not easily adaptable to California. For clarification: technologies that are being piloted in California today are considered feasible and should not be filtered out within the "now" timeframe.

- **Market rules**: from a market perspective, VGI use-cases can be broadly divided into three categories: (A) use-cases that can be implemented under existing market participation rules; (B) use-cases that are not possible to implement under existing market participation rules, but are possible to implement under updated rules in the specified Timeframe (e.g. within the "now" Timeframe, this includes market rules under consideration in active regulatory proceedings such as IDER and DDOR); (C) use-cases that are not possible to implement under existing market participation rules, and also not possible to implement under updated rules in the specified Timeframe (i.e. require substantial rule changes that will take longer than the duration of the specified Timeframe).
    - Screen 2a (apply to "now" and "future" Timeframes): Filter out use-cases (C) involving applications and services that cannot be offered through existing or reformed/updated wholesale (e.g. CAISO) market participation rules within the Timeframe.
    - Screen 2b (apply to "now" and "future" Timeframes): Filter out use-cases (C) involving applications or services that cannot be offered through existing or reformed/updated retail market participation rules (including utility rates and programs) within the Timeframe.

- **Customer preferences:**
    - Screen 3a (apply to "now" and "future" Timeframes): Filter out use-cases that significantly conflicts with or compromises customer mobility needs or lifestyle preferences, within the Timeframe.
    - Screen 3b (apply to "now" and "future" Timeframes): Filter out use-cases that are likely to have significantly low customer adoption rate and/or participation rate, within the Timeframe.

- **Data availability:**
  - Screen 4a (apply to "now" and "future" Timeframes): Filter out use-cases where data needed to score VGI value does not exist, and cannot be reasonably and reliably inferred or simulated, within the Timeframe. Necessary data is listed in detail in Step 4a and 4b; this could include, but is not limited to, the following:
    - Reference unmanaged charging profiles, including total mobility energy need as well as charging behavior
    - Plug-in schedule that shows when the EV is connected and available to interact with the grid
    - Operational specifications of the offered service
    - Economic/monetary value of the offered service
  - Screen 4b (apply to "now" and "future" Timeframes): Filter out use-cases that can only be characterized and/or valuated using private data not publicly available within the Timeframe

The outcome from this Step is a short-list of use-cases that pass all the Screens.

Step 4: Score VGI Use-Cases' Potential Benefits, Costs, and Implementability

Having identified potential use-cases and screened them for impracticalities, this method turns next to scoring the potential benefits and costs of use-cases.

To simplify this complex task, this Step shall be composed of three sub-steps:

- Step 4a: scoring of Benefits
- Step 4b: scoring of Costs
- Step 4c: scoring of Implementability

The proposed scoring mechanism reflects the consensus among the Working Group participants to not proceed with an actual monetary quantification of benefits and costs for VGI use-cases in this Working Group. The Working Group reached a consensus on not being capable of, and therefore not proceeding with, quantifying the monetary ($$) costs and benefits of VGI use-cases, due to both the limited amount of time available for execution as well as the complexity of the quantification task. One implication of this outcome is that, due to the nature of scoring, cost scores may not be directly compared / contrasted to benefit scores.

Step 4a: Scoring of Benefits

Definition and Scope:

- This sub-step shall focus only on the three "value creation" Dimensions of the VGI Valuation Framework: Sector, Application, and Type. Effectively, this means that this sub-step shall aim to score Benefits for each unique combination of VGI sectors, applications, and types, but it will not address how, and the extent to which, that benefit is captured via different forms and degrees of control mechanisms (Approach), or EV-EVSE resource fragmentation & alignment (Resource Alignment).

- To be clear, all VGI Dimensions remain important for valuating VGI benefits. After this Step 4a addresses the total value of benefits, Step 6 shall make recommendations on the best means to capture as much of that value as possible. This is explained in more detail in Step 6.

- For a specific combination of Sector, Application, and Type, Benefits refer to the "**total addressable market**", which accounts for two elements:
    - Benefits per EV in the use-case
    - Total available population of EVs in the use-case

Process:

The process in this sub-step goes as follows:

- The short-list of screened VGI use-cases from Step 3 are grouped together into *3D use-cases* that account for the Sector, Application, and Type elements only, but drop and disregard the Approach and Resource Alignment elements.

- Each 3D use-case is assigned a Total Benefit Score between 1 and 25
    - Total Benefit Score = {Benefit Score A} x {Benefit Score B}
    - Benefit Score A: a 1-to-5 score that accounts for the benefits per EV
        - Higher score refers to larger benefits per EV
    - Benefit Score B: a 1-to-5 score that accounts for the available population of EVs
        - Higher score refers to larger available population of EVs

  Refer to Table 2 for specific examples.

- When assigning Benefit Score A: stakeholders should score the incremental benefits of VGI relative to a "reference" EV charging profile. This reference profile should focus on average market conditions related to unmanaged EV charging.

- When assigning both Benefit Score A and Benefit Score B: stakeholders are encouraged to leverage publicly available resources to inform their efforts. Also, stakeholders are encouraged to think about the various factors that may influence these scores; a non-comprehensive list of those factors is included below, for additional guidance:
    - Sector-related factors that may influence benefits:
        - energy demand for mobility needs
        - Schedule of when the EV is plugged-in and available to interact with the grid
    - Application-related factors that may influence benefits:
        - The magnitude of the economic signal (e.g. price of wholesale energy) to maximize or minimize charge/discharge over time
    - Type-related factors that may influence benefits:
        - V1G versus V2G
        - battery characteristics or constraints (e.g. battery capacity in kWh)
        - EV-EVSE characteristics or constraints (e.g. level of charging in kW)

- The relevant Sub-group shall decide on the procedure for how to gather and document the benefit scoring information from the various participating stakeholders.

- To ensure consistent interpretation by stakeholders, the relevant Sub-group shall also strive to provide additional guidance and clarity on the significance of each numerical value for Benefit Scores A and B. To the extent possible, the numerical scores should be tied to real values or value ranges. For example, Benefit Score A = 1 refers to [$0-$100] range, and Benefit Score B = 1 refers to [1-1,000] EV population range.

Sub-Step 4b: Scoring of Costs

Definition and Scope:

- To account for the full range of VGI costs, evaluating costs considers all five dimensions: Sector, Application, Type, Approach, and Resource Alignment.

- For a specific combination of Sector, Application, Type, Approach, and Resource Alignment: Costs refer to "**expenses incurred by the buyer**", which in this Methodology shall be either the participating Customer (for Customer-Application use-cases) or California overall (for System-Application use-cases). The cost to the buyer is the same as the price charged by the seller. This methodology requires a high-level, aggregate, scaled characterization of prices or charges typically set by the seller, which are the expenses incurred by the buyer. This would also be within a specific Timeframe (i.e. 2019-2022 for evaluation within the "now" timeframe).
    - For additional clarity: This methodology does not require identifying private or internal costs borne by service or equipment providers for providing services or producing components. Instead, this Methodology requires identifying prices typically charged by those service or equipment providers to offer the same or similar service or equipment.

- Costs should account for the following elements:
    - Hardware
    - Software/IT
    - Operation and management services
    - Administrative expenses

Process:

The process in this sub-step goes as follows:

- Every use-case in the short-list of screened VGI use-cases from Step 3 shall be assigned a unique Total Cost Score between 1 and 10.
    - Total Cost Score is a weighted average of four cost scores:
        - Cost Score A: a 1-to-5 score that accounts for hardware expenses
        - Cost Score B: a 1-to-5 score that accounts for software/IT expenses
        - Cost Score C: a 1-to-5 score that accounts for operation and management services
        - Cost Score D: a 1-to-5 score that accounts for administrative expenses
    - For all Cost Scores A-D: Higher score refers to higher expenses
    - For all Cost Scores A-D: costs should be assessed as annualized expenses
    - The weights assigned to each Cost Score are:
        - Cost Score A: 20%
        - Cost Score B: 20%

- Cost Score C: 35%
- Cost Score D: 25%
- The Total Cost Score is then computed as:
  Total Cost Score = 0.2x(A) + 0.2x(B) + 0.35x(C) + 0.25x(D)

Refer to Table 2 for specific examples

- When assigning Cost Scores A-D, stakeholders are encouraged to leverage publicly available resources. Some cost data is already publicly available, in the form of prices for products and services by their providers/sellers (example 1, example 2). Among other forms, this data is sometimes published directly by the vendors, in regulatory filings, or in public reports.

- The relevant Sub-group shall decide on the procedure for how to gather and document the cost scoring information from the various participating stakeholders. Any potential concerns related to anti-trust should be properly addressed, without hindering progress.

- To ensure consistent interpretation by stakeholders, the relevant Sub-group shall also strive to provide additional guidance and clarity on the significance of each numerical value for Cost Scores A-D. To the extent possible, the numerical scores should be tied to real values or value ranges. For example, Cost Score A = 1 refers to [$0-$30] range, and Cost Score B = 1 refers to [$0-$10] range.

Sub-Step 4c: Scoring of Implementability

Definition and Scope:

- Implementability is defined as "**difficulty and risk associated with implementing and scaling up**" a use-case.

- Effectively, Implementability accounts for four interrelated elements, which may be interpreted subjectively by different stakeholders:
    - Difficulty of implementation
    - Difficulty of scaling up
    - Risk of implementation
    - Risk of scaling up

Process:

The process in this sub-step goes as follows:

- Every use-case in the short-list of screened VGI use-cases from Step 3 shall be assigned a unique Implementability Score between 1 and 5
    - Stakeholders should weigh in all four elements in their overall Implementability Score, but the four elements of Implementability will not be assigned distinct scores
    - Higher score refers to lower difficulty and risk of implementing and scaling up

- In addition to the Implementability Score, stakeholders can provide stylized comments to qualitatively document the most prominent considerations that influenced their Score. A wide range of considerations might influence the Implementability Score. Still, stakeholders are highly encouraged to clearly explain their most influential considerations and associate those with the four aforementioned elements, to the extent possible.

- The relevant Sub-group shall decide on the procedure for how to gather and document the implementability scoring information from the various participating stakeholders.

Table 2.

Step 3: Screened Use-Cases (illustrative examples)				
Sector	**Application**	**Type**	**Approach**	**Resource Alignment**
Commercial - Workplace	System - Grid Upgrade Deferral	V1G	Direct	EV-EVSE Fragmented, Aligned
Commercial - Workplace	System - Grid Upgrade Deferral	V1G	Direct	EV-EVSE Fragmented, Misaligned
Commercial - Workplace	System - Grid Upgrade Deferral	V1G	Indirect	EV-EVSE Fragmented, Aligned

Step 4a: 3D Use-Cases to score benefits (illustrative examples)					
Sector	**Application**	**Type**	**Benefit Score A**	**Benefit Score B**	**Total Benefit Score**
Commercial - Workplace	System - Grid Upgrade Deferral	V1G	4	2	8

Step 4b: Use-Cases to score costs (illustrative examples)									
Sector	**Application**	**Type**	**Approach**	**Resource Alignment**	**Cost Score A**	**Cost Score B**	**Cost Score C**	**Cost Score D**	**Total Cost Score**
Commercial - Workplace	System - Grid Upgrade Deferral	V1G	Direct	EV-EVSE Fragmented, Aligned	2	3	3	2	2.6
Commercial - Workplace	System - Grid Upgrade Deferral	V1G	Direct	EV-EVSE Fragmented, Misaligned	2	3	4	3	3.2
Commercial - Workplace	System - Grid Upgrade Deferral	V1G	Indirect	EV-EVSE Fragmented, Aligned	2	1	3	3	2.4

Step 4c: Use-Cases to score implementability (illustrative examples)						
Sector	**Application**	**Type**	**Approach**	**Resource Alignment**	**Implementa-bility Score**	**Comment**
Commercial - Workplace	System - Grid Upgrade Deferral	V1G	Direct	EV-EVSE Fragmented, Aligned	2	Difficult to implement: convince customers to participate

Commercial - Workplace	System - Grid Upgrade Deferral	V1G	Direct	EV-EVSE Fragmented, Misaligned	1	Very difficult to implement: convince customers, and align incentives, to participate
Commercial - Workplace	System - Grid Upgrade Deferral	V1G	Indirect	EV-EVSE Fragmented, Aligned	2	Difficult to implement: convince customers to participate; complex rates

Additional guidance for scoring VGI benefits and costs:

1. Distinction between use-cases with "Customer" Application and use-case with "System" Application: The procedures outlined in Steps 4a and 4b can be applied to all screened use-cases from Step 3. However, the resulting values (benefits, costs) for uses-cases with "Customer" Application shall not be compared to the resulting values (benefits, costs) for use-cases with "System" Application. Fundamentally, this is because these two sets of use-cases assess value from different perspectives, consistent with guidelines provided in the PUC's Standard Practice Manual[3], and in alignment with the recent Decision Adopting Cost-Effectiveness Analysis Framework Policies For All Distributed Energy Resource (Rulemaking 14-10-003)[4].

- Customer-Application use-cases: The benefits and costs associated with these use-cases are computed from the participant(s) perspective. The benefits are to the participating Customer. The costs are also to the participating Customer. These use-cases may use "retail" and other economic signals (e.g. utility rates or incremental LCFS credits) to compute the benefits.
- System-Application use-cases: The benefits and costs associated with these use-cases are computed from a California-wide perspective. The benefits are to California overall. The costs are also to California overall.

Subsequent steps of this Methodology shall not compare Customer-Application use-cases to System-Application uses-cases based on value.

2. The application of "cost-effectiveness (CE) tests" and "least-cost, best-fit (LCBF) principles" for VGI valuation: It is very important to clarify that the proposed simplified procedure in Step 4a and Step 4b to score VGI benefits and costs shall only be used to help address the three PUC questions in this Working Group. Accordingly, the proposed procedure is not intended as a replacement or substitute to existing CE tests or LCBF principles for evaluating VGI as a Distributed Energy Resource (DER). Both the CE tests (e.g. Total Resource Cost test) and the LCBF principles (e.g. Portfolio Adjusted Value metric) shall continue to be used, as relevant and per guidance in existing DER regulatory proceedings, to evaluate current or future specific VGI initiatives. The CE tests shall continue to be applied to evaluate potential VGI initiatives within a Demand Response construct or program, and the LCBF principles shall continue to be applied to evaluate offers for potential VGI procurement initiatives.

3. Leveraging publicly available information and data: To ensure transparency, to the extent possible, publicly available data sources and information should be used to score the benefit and cost items. A

[3] https://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf

[4] http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M293/K833/293833387.PDF

good example is leveraging the PUC's Avoided Cost Calculator[5] to score some of the System benefits such as the avoided cost of supplying electricity.

4. Timeframe:

- Data used to score benefits, costs, and implementability should refer to the same Timeframe.
- To score VGI benefits, costs, and implementability "now" within the timeframe extending from 2019 to 2022: to the extent possible, use data and resources for year 2019.
- To score VGI benefits, costs, and implementability "in the future" within the timeframe extending from 2023 to 2030: to the extent possible, use data and resources for year 2025.

The outcome from this Step 4 is a clear scoring of benefits, costs, and implementability for each VGI use-case that passes the Screens in Step 3.

Step 5: Rank VGI Use-Cases based on Benefits, Costs, and Implementability

Step 5 shall be implemented separately for:

- *Customer-Application use-cases*
- *System-Application use-cases*

The results of Step 4 feed into Step 5, which aims to rank the VGI use-cases.

- Stakeholders shall collaborate to carve out four distinct sets of use-cases:
    - Set "HL": high benefits, low costs
    - Set "HH": high benefits, high costs
    - Set "LL": low benefits, low costs
    - Set "LH": low benefits, high costs
    - Because the Total Benefit Score and Total Cost Score were derived based on different criteria, the categorization of a use-case into any of the aforementioned four sets shall not be misinterpreted as being reflective of that use-case's net-benefit.

- Subsequently, within each of the four Sets, stakeholders shall collaborate to further categorize use-cases into two sub-sets:
    - Sub-set "h": high implementability
    - Sub-set "l": low implementability

- The detailed procedure for carving out these distinct sets and sub-sets is left to the relevant Sub-group.

Step 6: Make Recommendations on Policy, Market, or Technology

Step 6 shall be implemented separately for:

- *Customer-Application use-cases*
- *System-Application use-cases*

[5] The CPUC's Avoided Cost Calculator: https://www.cpuc.ca.gov/general.aspx?id=5267

This final step draws on all previous steps to infer recommendations on how to capture and/or improve the value of VGI use-cases. Recommendations made in this step may be related to policy, market, or technology needs.

Leveraging the ranking in Step 5, unique recommendations can be carved out for four distinct sets of well-articulated, screened, and scored VGI use-cases:

- **For VGI use-cases in Set HL, with *high* Benefits and *low* Costs:**
    - Focus on best ways to capture value:
        - Recommendations for more granular and realistic analysis and quantification of benefits, costs, and net-benefits in monetary ($$) terms?
        - Recommendations on considering specific rates, programs, and/or projects?
        - Recommendations on role of customer? Value attribution to various parties?
    - For sub-set "l" of low implementability use-cases:
        - Recommendations to overcome barriers to implementation and scaling-up?

- **For VGI use-cases in Sets LL or HH, either with *high* Benefits and *high* Costs or with *low* Benefits and *low* Costs:**
    - Focus on best ways to clarify and improve value:
        - Recommendations for more granular and realistic analysis and quantification of benefits, costs, and net-benefits in monetary ($$) terms?
        - Recommendations for increasing benefits, reducing costs, or both?
        - Recommendations for progressive improvement of value over time?
    - For sub-set "l" of low implementability use-cases:
        - Recommendations to overcome barriers to implementation and scaling-up?

- **For VGI use-cases in Set LH, with *low* Benefits and *high* Costs:**
    - Focus on best ways to improve value:
        - Recommendations for increasing benefits, reducing costs, or both?
        - Recommendations for progressive improvement of value over time?
        - Recommendations for additional R&D?

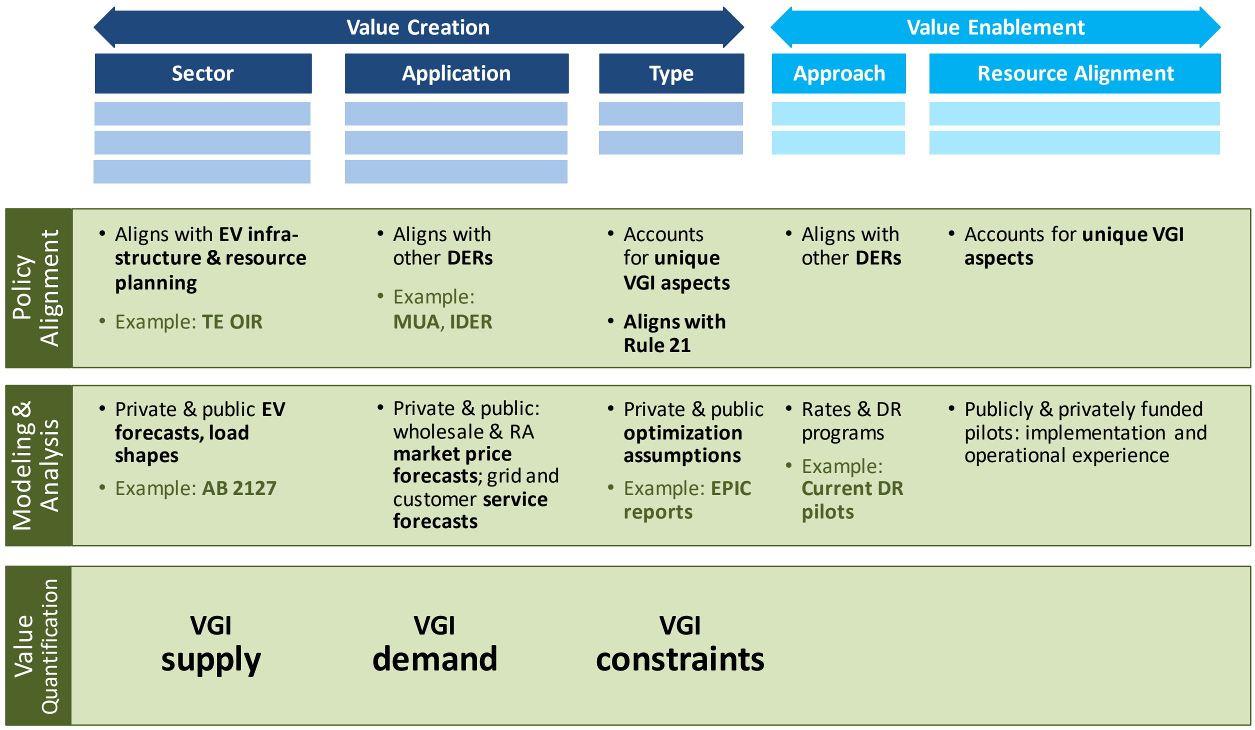
As with Steps 3-5, recommendations in this Step should be tailored to the relevant Timeframe.

The results of this Step are recommendations to policy makers, market participants, or technology and solution providers that can enable further clarifying, capturing, and improving VGI value.

Conclusion

Combined, these six steps break the inquiry on VGI value into manageable pieces, addressed in a sequence that allows for transparent, efficient, and inclusive consideration of use-cases. More broadly, as highlighted in Figure 3, the proposed *California VGI Use-Case Assessment Method* helps achieve three key objectives: (1) aligning VGI policy and regulations with those impacting the broader transportation electrification goal and other DERs; (2) identifying a short-list of attractive VGI use-cases in the short-term; (3) developing a transparent and collaborative process for industry stakeholders to assess a wide range of factors impacting VGI benefits, costs, and implementability.

Figure 3


Value Creation
Value Enablement
Sector
Application
Type
Approach
Resource Alignment
Policy Alignment
Aligns with EV infra-structure & resource planning
Example: TE OIR
Aligns with other DERs
Example: MUA, IDER
Accounts for unique VGI aspects
Aligns with Rule 21
Aligns with other DERs
Accounts for unique VGI aspects
Modeling & Analysis
Private & public EV forecasts, load shapes
Example: AB 2127
Private & public: wholesale & RA market price forecasts; grid and customer service forecasts
Private & public optimization assumptions
Example: EPIC reports
Rates & DR programs
Example: Current DR pilots
Publicly & privately funded pilots: implementation and operational experience
Value Quantification
VGI supply
VGI demand
VGI constraints

Appendix A

PG&E, SCE, and SDG&E submit the following list of comments to summarize and clarify the updates made in this Proposal.

- **[Page 2]** Step 1, Approach: Proposed updates take into account stakeholder feedback during 09/26 WG Workshop # 2, regarding the need for further detail and clarity.

- **[Page 4-6]** Step 2, Fleet and MDHD: Content will be re-evaluated based on pending feedback from CALSTART and Union of Concerned Scientists (UCS). Through direct conversations, IOUs, CALSTART, and UCS agreed that CALSTART/UCS will make specific recommendations on how to update the categorization of medium- and heavy-duty vehicle Elements in the Sector Dimension. To date, the IOUs have not received these recommendations.

- **[Page 7]** Step 3, Screen 1: Proposed updates take into account PUC feedback during 09/26 WG Workshop #2 on the ability to consider VGI solutions that can be "imported" to California.

- **[Page 7]** Step 3, Screen 2a and Screen 2b: Proposed updates take into account stakeholder feedback during 09/26 WG Workshop #2 on including retail price signals and utility rates within the scope of participation rules.

- **[Page 8-12]** Step 4: Proposed updates take into account the consensus among stakeholders on 03/10 WG Call to not proceed with an actual monetary quantification of benefits and costs for VGI use-cases. The Working Group reached a consensus on not being capable of, and therefore not proceeding with, quantifying the monetary ($$) costs and benefits of VGI use-cases, due to both the limited amount of time available for execution as well as the complexity of the quantification task.

- **[Page 8-12]** Step 4: Proposed updates are consistent with, and build on, the IOUs perspective on several topics related to assessing the benefits and costs of VGI use-cases, which the IOUs shared in a separate document[6].

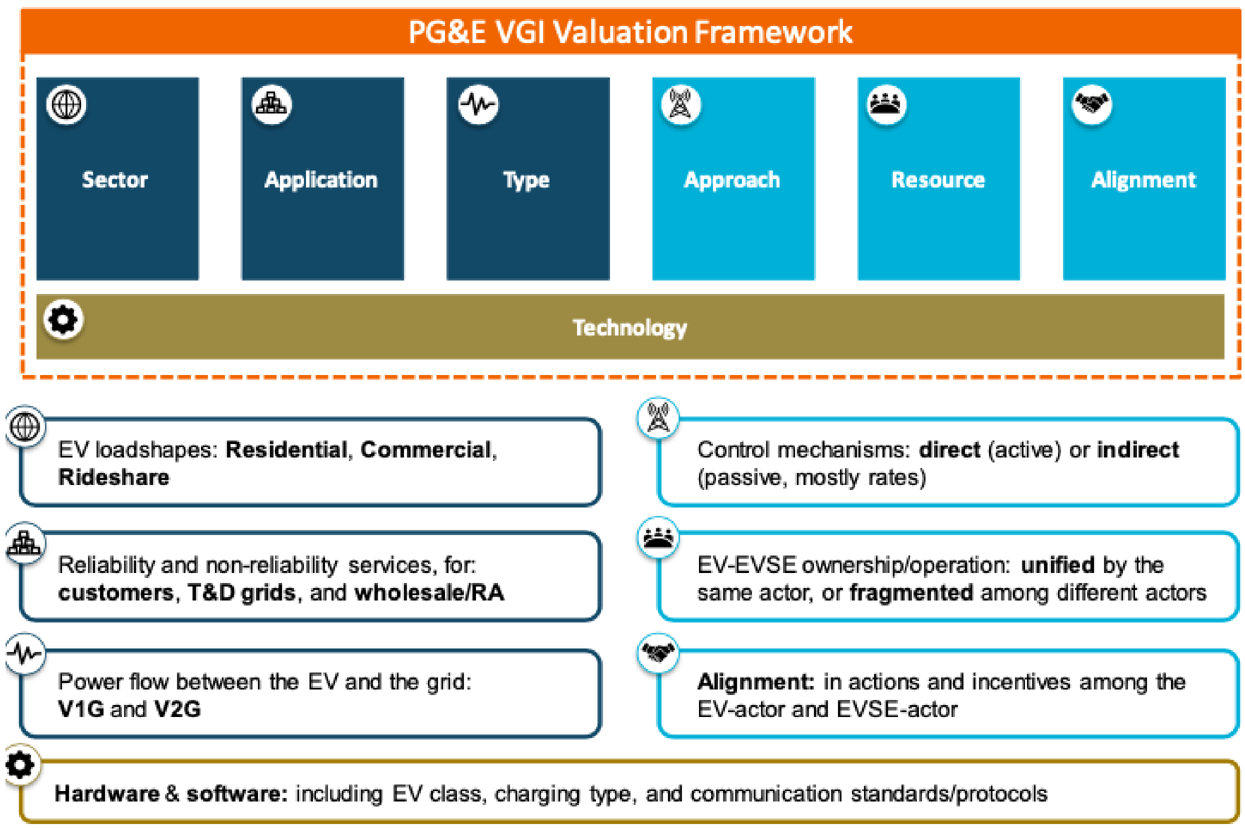
- **[Page 8-12]** Step 4: Proposed updates take into account stakeholder feedback during 09/26 WG Workshop #2 to have clearer definitions of benefits, costs, and implementability.

[6] IOU Perspective on VGI Use-cases Benefits and Costs: https://onedrive.live.com/?authkey=%21AEncszViF83uW0Q&cid=5891771FBA4AFF14&id=5891771FBA4AFF14%21487&parId=5891771FBA4AFF14%21440&o=OneUp

Appendix B

PG&E VGI Valuation Framework [7]

Building on the progress achieved during the California Public Utilities Commission VGI Working Group, PG&E took the initiative to develop a VGI framework that can help advance the work on VGI valuation. PG&E's VGI Valuation Framework identifies seven key dimensions along which VGI use-cases can be designed, and their value subsequently quantified. While this framework may still evolve as the industry progresses, it can significantly help different stakeholders think and communicate with clarity and accuracy about VGI.



The seven dimensions are described in more detail below:

1. **Sector:** It is important to define the sector where the vehicle is used and charged, because that most often determines the corresponding EV load shape and therefore the load management opportunity. Broadly speaking, the three main sectors with unique load shapes are residential (e.g. single-family or multi-unit dwellings), commercial (e.g. workplace, fleet, or public) and rideshare. For example, a residential light-duty vehicle charging profile looks very different from that of a

[7] PG&E's VGI Valuation Framework, as originally published in "*A Comprehensive Guide to Electric Vehicle Managed Charging*" SEPA, May 2019.

commercial-fleet medium- or heavy-duty vehicle. Different load profiles result in different load management actions and yield different VGI values, depending on the needs.

2. **Application**: Refers to the service(s) the EV is used to fulfill. PG&E breaks down applications into reliability and non-reliability services, which are further characterized at the customer-level (e.g., customer bill reduction), transmission and distribution grid level (e.g., capacity investment deferral), and the broader wholesale market level (e.g., ancillary services, capacity, renewable integration, etc.). An EV may fulfill, and therefore may get compensated for, one or more of these services. The prospect of "stacking" these services, and their values, is important and relevant not only to VGI but also to other DERs such as battery energy storage.

3. **Type:** This defines the power flow between the EV and the grid. A uni-directional flow (V1G) results in charging modulation (increase or decrease load) only, whereas a bi-directional flow (V2G) also allows discharging the EV back to the facility or all the way back to the grid. These different types have different associated capability sets and therefore result in different values.

PG&E's framework treats Sector, Application, and Type as "value creation" dimensions, since they determine how VGI value (both benefits and costs) is created and where it comes from. Value along these dimensions is additive: residential charging can be added to commercial charging; wholesale ancillary services can be added to capacity services, and managed charging can be added to managed discharging, resulting in additional benefits and/or costs from VGI.

4. **Approach:** Managed charging can be defined as both active (e.g. through demand response) and passive (e.g. through time-of-use rates). The control mechanisms by which load management is enabled have different associated costs and benefits. For example, DR events may result in limited load shifting during specific time periods on specific dates, whereas TOU rates may result in consistent load shifting on daily basis throughout the year. DR participation may result in high benefits per event while necessitating nontrivial investment in technological upgrades. On the other hand, TOU rates may result in consistent savings over time while imposing modest administrative costs to setup and run the program.

5. **Resource:** Defines whether the EVSE-EV actors are unified (e.g., a fleet operator that owns the vehicle and the charger) or fragmented (e.g., a workplace charger that doesn't control how EV-driving staff use the asset). When EVSE-EV actors are unified, it is easier to fulfil the VGI application and capture its value. When EVSE-EV actors are fragmented, further effort may be needed to ensure their alignment, which is the focus of the next VGI dimension.

6. **Alignment:** Alignment and Resource are tightly linked. When the EVSE and EV actors are unified, they are aligned by default. In the case that the EVSE and EV actors are fragmented, they may be either aligned or misaligned. Among other factors, incentive design is an important consideration to achieve alignment and guarantee the delivery of the VGI service. Absent this alignment, managed charging/discharging may never get to fulfill its purpose, and the value of VGI would be eroded.

PG&E's framework treats Approach, Resource, and Alignment as "value enablement" dimensions, since they determine how VGI value (both benefits and costs) can be unlocked and effectively captured. Value-enablement dimensions compliment value-creation dimensions to accurately characterize benefits and costs. For example, no matter how significant the potential net-benefits may be from leveraging managed charging of EV fleets for distribution-capacity deferral, that value may never been realized in real life if the approach is inappropriate, the resource is fragmented, and/or the actors are misaligned. Effectively, the value-enablement dimensions help inform the design of successful business models for the VGI use-cases, and they help identify any technological, policy, or market gaps that need to be resolved for that purpose.

7. **Technology:** includes the hardware and software to bring about the necessary capabilities to fulfill a VGI offering. Technology solution sets are diverse and span across the other six VGI dimensions. Examples of technology considerations could include the type of EV (e.g., light-duty vehicle versus heavy-duty vehicle, or plug-in hybrid vehicle versus battery electric vehicle; a battery electric vehicle typically has a larger battery capacity than a plug-in hybrid electric and therefore more opportunity for load shifting), the charger type (e.g., a networked L2 charger may be more expensive but allow higher charge/discharge rate than a networked L1 charger), and the corresponding communications protocols to pass information and commands between the vehicle and ultimately the grid.

PG&E sees the VGI landscape as a decision tree that keeps branching out, with each branch ultimately characterizing a unique use-case. A VGI use-case is defined by choosing a Sector, an Application, and a Type, then selecting a direct or indirect Approach, a unified or fragmented Resource, and the corresponding degree of Alignment.

The following are two examples of a VGI use-case:

• Residential (Sector) EV load decrease (Type) in the afternoon to avoid peak pricing and minimize monthly energy bill (Application) by setting charger timer based on TOU rate schedule (Approach), where both the charger and EV are owned by the meter customer (Resource and Alignment).

• Workplace (Sector) EV load increase (Type) to soak up excess renewable energy during the day (Application) via DR (Approach), where the EVSE and EV are operated by different actors (Resource and Alignment).

Ultimately, this framework yields hundreds of possible VGI use-cases. While all use-cases may be worthy of consideration, some will likely be more valuable and/or market-ready than others.
PG&E's approach helps clarify the granularity of the VGI use-cases while inclusively accounting for all of them, and then gathering the necessary information and data to quantify benefits and costs and to design successful programs. While some industry stakeholders can – and tend to – focus their business offerings on a limited set of use-cases, the utility needs to be able to assess, compare, and plan across the full range of feasible and implementable use-cases since they all eventually impact the grid.

Overall, the VGI Valuation Framework PG&E developed helps achieve three objectives: (1) defining a comprehensive list of VGI use-cases, (2) quantifying their value, and (3) aligning VGI policy and regulations with those impacting the broader transportation electrification goal and other DERs. Simply put, the framework serves as an accounting mechanism that charters a clear path for VGI valuation.