Elements of Strategic Design:

A Brief Review of Strategic Design Options That Add Value to Community Solar

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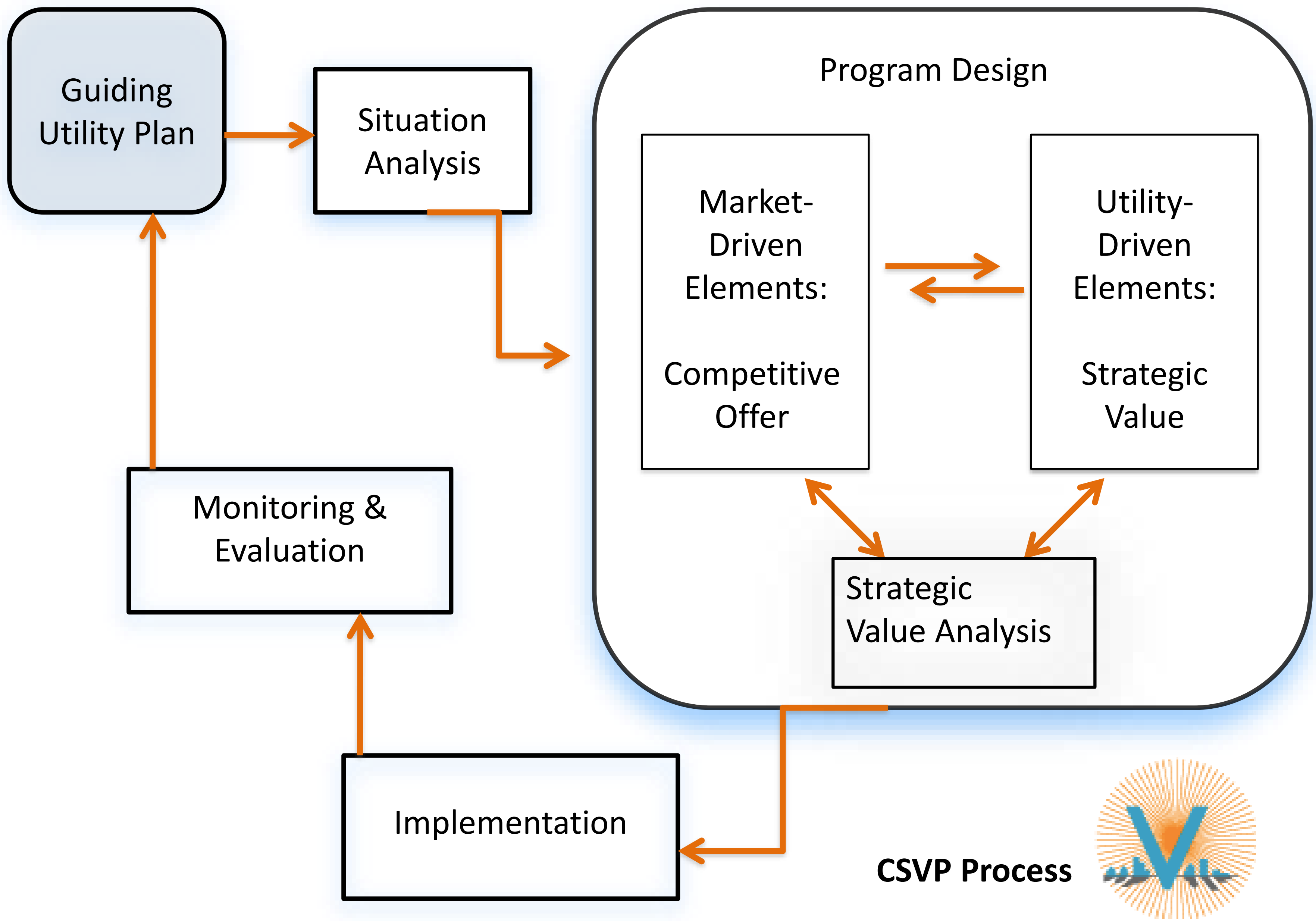
Distributed Community Solar Vs. Central PV

For some utilities, the first decision is between community-scale PV and central PV. Benefits at the local, distribution scale (500-kW to 10 MW) are often overlooked.

	PROS	**CONS**
Distributed CS PV	• Avoided wholesale energy and capacity purchases • Potentially avoided or deferred new generation capacity investment • Avoided transmission line losses • Avoided transmission ancillary service costs • Reduced distribution line losses • Can provide distribution ancillary service support • Can improve distribution line capacity utilization and defer equipment upgrades and O&M • Enhance grid resiliency / support disaster recovery • Can take advantage of geographic dispersion to mitigate intermittency issues • Increased flexibility in system siting, design, and operation to capture strategic benefits • Can be paired with other strategic elements to capture more value (i.e., demand response, storage, EV charging) • Increased visibility in the community	• Higher system cost on a $/watt basis and/or higher LCOE/PPA price • Higher integration costs • Program administration costs • Risk of under-subscription to the CS program • Potential distribution grid management issues with high penetration PV
Central Station PV	• Lower system cost on a $/watt basis and/or lower LCOE/PPA price due to economies of scale	• Higher interconnection costs at transmission system level • Transmission/ancillary service costs and risks • No distribution system benefits • Land intensive • May induce higher emissions from fossil fuel plants due to higher line losses • Longer permitting / development timeline

The identification of appropriate, strategic design elements for a community-scale array depends on:

- Available sites
- Business model selected
- Design-team coordination with other work groups within the utility; creating a collaborative process
- Design-team recognition of different ways of achieving economies of scale (e.g., fleet pricing)
- Wholesale power acquisition agreements (e.g., limitations set by some G&Ts or JAAs) and good communications
- Utility goals regarding resource integration, load management, grid modernization, etc.
- Customer values, needs and limitations


Guiding Utility Plan
Situation Analysis
Program Design
Market-Driven Elements:
Competitive Offer
Utility-Driven Elements:
Strategic Value
Strategic Value Analysis
Monitoring & Evaluation
Implementation
CSVP Process

Sample High-Value Design Options for CS Projects

Strategic Design Component	Discussion of Value Enhancement
<u>Siting / Location</u>	
• Site Characteristics	As with all distributed solar projects, potential CSS sites can maximize value by selecting sites that are relatively flat and suitable for ground-mounted systems to reduce site prep costs. Sites should also have good solar access with no shading obstructions. To minimize interconnection costs, it is preferable to select sites that are properly zoned and adjacent to (or near) the distribution system interconnection point. The cost of the land is also a value driver, and siting projects on utility-owned or partner-owned land can minimize costs.
• Strategic Siting for Distribution System Benefits	Value enhancement of CSS projects via strategic siting to maximize distribution system benefits is one of the most important components of strategic design. It has also been one of the most confusing. The benefits of strategic siting are highly specific to the distribution feeder the project is sited on, as well as the location of the project along the feeder line. Utilities seeking to maximize the benefits of strategic siting should conduct detailed power flow analyses to identity the feeders that may provide the highest benefits from strategic siting of solar projects, and then the best locations along those feeders. Examples of strategic siting include locating projects on feeder lines that are nearing capacity and/or slated for upgrades, and lines that can benefit from additional reactive power and/or voltage support or other ancillary services provides by solar projects. Additional examples include siting projects near substations to reduce integration costs, siting projects at the end of long radial feeders to provide reactive power and voltage support, and siting near large loads to reduce line capacity loading.
• Dispersed Siting to Take Advantage of Geographic Diversity of Multiple Projects	Rather than siting one large project at a single location, it may be beneficial to site multiple smaller projects throughout the service area to minimize the intermittency issues associated with solar projects. Through the strategy of geographic dispersion, issues associated with the “passing cloud effect” are greatly minimized due to the widespread distribution of projects throughout the service area.

Sample High-Value Design Options for CS Projects (cont.)

Strategic Design Component	**Discussion of Value Enhancement**
<u>PV System Components</u>	
• Single-Axis Tracking Mount	Single-axis tracking mounting structures track the sun on a daily basis, and result in higher capacity factors, higher annual energy production, and more energy production during the late afternoon hours which often correlate better to utility peak demand periods. Trackers also produce more energy during the summer months when energy prices are highest for many utilities. While solar generation from trackers (as well as fixed tilt) systems may not always match with utility's peak demand, there is significant value to be added from solar generation during the peak hours of the day, when wholesale energy is most expensive. Today, SAT pricing is very competitive.
• Optimized Orientation and Tilt Angle of Fixed-Tilt Mount	For fixed-tilt mount CSS projects, there may design strategies that can drive additional value from the project. For example, orienting the arrays in a southwest orientation rather than due south will result in more energy production during the afternoon hours when utility wholesale energy costs are often higher. As another example, tilting the arrays at a lower angle will result in more energy production during the summer months when many utilities experience higher energy costs. These two design strategies can be employed separately or together, depending upon the amount of strategic value added by the design configuration(s). However, these fixed-tilt design strategies both result in lower annual energy production, which reduces the value to the customer-subscriber of the the CSS project. To mitigate this value reduction, the utility could offer innovative pricing for participation in the project that shares some of the strategic siting value with the customer and that makes up for the lost annual energy production.
• Matching Cell Types to Geographic / Site Conditions	In some cases, certain PV cell types may provide a higher value in terms of energy production in certain geographic areas. For example, thin film cells outperform crystalline cells in diffuse light conditions (i.e., high humidity). Cadmium–Telluride cells may produce more energy in high heat conditions (i.e., hot desert climates), but they also have a higher annual output degradation rate, so the tradeoffs need to be evaluated on a site-specific basis. As another example, rooftops with limited array space may need to specify more efficient panels, such as mono-silicon, in order to maximize the output of the available roof area.

Sample High-Value Design Options for CS Projects (cont.)

Strategic Design Component	Discussion of Value Enhancement
<u>PV System Components (cont.)</u>	
• Smart Inverters	Smart inverters for PV projects are rapidly gaining market share. The enhanced functionality of these new generation inverters can provide increased value in a number of areas for little incremental cost. The two major sources of new value from these inverters is the ability to provide power factor correction services (rather than operate at unity power factor as traditional inverters do), and voltage support to the distribution system. Additional value-added functions provided by smart inverters include: connect/disconnect settings, anti-islanding, maximum generation limit, fixed power factor, intelligent volt-VAR, volt-Watt, frequency-Watt, Watt-power factor, low/high frequency ride through, low/high voltage ride through, dynamic reactive current, real power smoothing, dynamic volt-Watt, peak power limiting, load and generation following.
<u>Companion Technology Strategies*</u>	**See CSVP Guides focused on DR & storage companion measures*
• Energy Storage, utility side batteries • Energy Storage, customer-side batteries • Energy Storage, customer-side thermal • Other	Energy storage is one of the fastest growing technologies in the energy industry. Advances in technology and reductions in price have combined to make this strategy more attractive. With the ability to store energy from CS projects, energy can be discharged to smooth out the production of the system and mitigate intermittency issues; and with the use of smart inverter software, stored energy can be dispatched during periods of high wholesale power costs or to ease loading on a distribution feeder line, if needed. The ability to dispatch energy from storage to meet a number of strategic utility needs is relatively new source of value for CSS projects.
• Demand Response (DR)	The usage of Demand Response (DR) to aid CSS project integration is a relatively novel concept. Traditionally, DR programs have been designed to help utilities meet peak load requirements, alleviate local distribution system constraints or mitigate grid emergencies. Responding to notification by the operator, customers or aggregators reduce load providing relief for a variety of system problems. DR Strategies include load curtailment, automated demand response, direct load control, and rates and tariffs (i.e., critical peak pricing, TOU).

Strategic Design Components for Increased Value of CSS Projects (cont.)

Strategic Design Component	**Discussion of Value Enhancement**
Companion Technology Strategies	
• Electric Vehicle Charging	Electric Vehicles and solar generation are a natural match, as zero emission vehicles are charged with a zero emission electricity resource. Target marketing of CSS project participants may provide value added benefits and increased customer satisfaction. In addition, there may be opportunities for siting CSS projects as anchor sites for charging EVs in commercial applications.
• Energy Efficiency / Demand-Side Management	Similar to the demand-response strategy, energy efficiency and other demand-side management measures targeted to subscribers of a CSS project can provide low-cost strategic benefits to the utility and additional bill savings to the customer.
Financing / Procurement Strategies	
• Business Model Selection	Selection of the most appropriate business model for procuring solar resources can have significant impacts on the value of a CSS project. Matching business models to the needs, characteristics, and resources of the utility can result in lower project costs via maximizing the value of tax benefits, lower financing rates, and optimal finance terms.
• Procurement Innovations	CS Project costs may be lowered through mechanisms such as bundled, multi-project deals or "collaborative procurements," where utilities aggregate multiple projects and put them out to bid under one procurement.
Programmatic Strategies	
• Low-Income Participation	Potentially allows lower income customers to decrease their energy bills, which increases their ability to pay their electric bill.
• Innovative Pricing Strategies	Innovative pricing strategies for CSS project participants such as real-time, TOU, and other rate tariffs that mirror real time pricing can benefit both the utility and customer. While some system design strategies may reduce annual energy output of the system, the timing of the generation may have higher economic value. Innovative pricing strategies allow these benefits to be shared between the utility and the customer.

Community-Solar Value Map

		Established	Piloted	Emerging
Improving Procurement	Local soft costs and customer acquisition	• Leverage economies of scale • Leverage utility and community networks	• Replication of standardized designs • Customer recognition, value-added to community • Adapt successful green power marketing tactics	• Specify cost-reduction goals or specs for 3rd-party provider • Build project into local development or redevelopment plans • New site-lease arrangements with utility partners
	Financing and acquisition	• Utility enters PPA with third-party project developer • Leasing models	• Crowd-source variations • Financing models favoring long-term utility ownership	• Utility leverages new financing models • Solar-plus projects with added development partners
Increasing Net Solar Production Benefits	Timing	• Solar designed for optimal tracking	• Site projects for maximum (peak) value • Add flexible generation (i.e. battery storage) • Incorporate thermal storage	• Integrate flexible demand with DR; possibly EE, EVs • Engage customers in storage strategies
	Location	• Focus on visibility and ease of interconnection	• Passive capacity deferral • Targeting locations based regional (LMP) value	• Active deferral of distribution upgrades or inclusion in new development plans • Active deferral including storage; DR • Address integration needs with DR/storage locally
Improving the Offer	Pricing and program design	• Credit based on rate • Virtual net-energy metering • Compensated for generation aspects while charging for power delivery	• Value-based pricing approaches • Participants encouraged or required to opt-in to time-of-use rate	• Price discounts or credit enhancements based on complementary resources (DR, EE) installed • Integrated DR/solar program designs

Source: RMI ISBM Project, 2014 - with modifications by the Community Solar Value Project. June 2015.

Hypothetical Example: High-Value Strategic Design of CSS Project

- Strategic design strategies for CSS projects are highly specific to the wholesale power acquisition structure, distribution system characteristics, and geographic location of a utility. The following example is provided to illustrate a hypothetical utility scenario and an example CSS strategic design solution.

<u>UTILITY SCENARIO</u>

- Summer peaking utility with high avoided wholesale energy and capacity costs during afternoon/early evening hours
- Located in central/southern latitudes (i.e., below 40^{o}latitude)
- Utility has several distribution line feeders that are scheduled for upgrades within the next 5 years due to localized load growth on the line
- Utility has estimated demand of 3 MW from potential subscribers to CSS program

<u>POTENTIAL CSS STRATEGIC DESIGN SOLUTIONS</u>

- 3 x 1 MW CSS projects geographically dispersed throughout utility service area.
- Each CSS project strategically sited at an optimal location on the distribution feeder (as determined via power flow analyses) to maximize benefits (i.e., adjacent to large customer load to minimize line losses, line loading, and ancillary service benefits); large customer could potentially be anchor customer for the CSS project
- Employ single-axis tracking mounts to increase capacity factor, annual and summer energy output, and extend summer daily production into the late afternoon hours
- Utilize smart inverters to provide ancillary service support
- Integrate demand-response measures with CSS project participants
- Conduct business model analyses to determine the optimal financing mechanism to maximize project value
- Design and offer an innovative rate structure for CSS participants that allows them to share in the benefits of utility strategic design options

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