Advanced Grid-Interactive Storage: Finance Mechanisms

California Solar Initiative
Research, Development, Demonstration,
and Deployment Program

Project Partners:

TESLA MOTORS

Pacific Gas and Electric Company

Renewable & Appropriate Energy Laboratory

ENERGY AND RESOURCES GROUP

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Introduction

Electricity supports more and more of the economic and social lives of Californians, yet the aging infrastructure that transports and regulates this resource is struggling to keep up. California's renewables integration and greenhouse gas reduction goals provide an opportunity to update existing infrastructure in pursuit of these goals. New technologies like PV and grid interactive storage can achieve substantially larger cost savings for utilities and end customers and reduce carbon emissions to a far greater degree than either PV or storage could achieve on their own, while also helping ease the strains on aging utility infrastructure. The key to unlocking these benefits is overcoming the barriers to adoption, including upfront costs.

Remote, fully bidirectional control of distributed storage assets that can stabilize or 'firm' otherwise intermittent renewable resources will enable both site-specific peak demand reduction benefits and system-wide grid network benefits that will reduce costs and carbon emissions and improve grid reliability. As the penetration of photovoltaic (PV) systems increases, firming local solar electricity production will diminish the need to operate voltage regulating equipment in the distribution system (and thereby increase the lifetime of these devices). Distributed storage also reduces the need for ancillary services from the California Independent System Operator (CAISO), and renders additional capacity in the real time economic dispatch stack unnecessary. These measures hold significant promise for reducing the grid integration costs of distributed PV, and could also decrease grid-level emissions by moving the supply side to a more efficient operating state. Distributed, firmed PV presents a path to secure, long-term and low cost carbon abatement, which can help the state meet its renewable integration and AB32 climate goals.

The value of PV and storage spans multiple services and beneficiaries. For the site owner, storage provides backup power and savings on retail rates through reduced demand charges and energy charges. For a utility, storage reduces congestion and defers transmission and distribution equipment upgrades. For a Load Balancing Authority such as CAISO, storage offers additional capacity for resource adequacy planning, wholesale energy arbitrage, and ancillary services like voltage regulation that all improve grid reliability and reduce carbon emissions. Despite the clearly identified value, there exist few viable technologies and market mechanisms that enable the beneficiaries to capture the value of combined PV and storage.

SolarCity has demonstrated that a zero-down, cash-flow-positive finance mechanism can enable rapid adoption and deployment of PV. SolarCity's finance products direct private sector tax equity investments toward financing PV system installations. When structured appropriately, these investment mechanisms enable many host customers to benefit from PV for no upfront cost, with an accompanying monthly finance payment that may be lower than their offset utility bill. SolarCity found that one of the key barriers to deploying PV was a high upfront cost. These finance mechanisms eliminate or reduce this barrier. Since 2008 when SolarCity launched its first residential finance product, the proportion of financed residential systems in California has grown from 0% to more than 65%,, according to the GTM Research Solar Market Insight Report from Q4 2012. Overall, the US residential market has grown substantially installing more in one quarter in 2012 than was installed in all of 2009.[1] In a related development, the prevalence of solar financing models has coincided with a dramatic increase in adoption of solar in lower and middle income areas. A June 2012 study from the California Public Utilities Commission reported a 364% increase in applications since the program's inception from households in zip codes with median incomes of less than $50,000, and a 445% increase in applications from households in zip codes with median incomes between $50,000 and $75,000. The report notes that *"the upward trend in CSI participation in lower and middle income areas is likely due to a sharp increase in third party owned systems that have received CSI incentives. Third party ownership models, such as solar leases and power purchase agreements (PPAs), allow households who cannot afford to own a PV system to go solar."*[2]

Many of the lessons from PV financing could be applied to create a successful finance program for distributed storage installations. Similar structures, contracts, and sales and marketing

[1] http://www.greentechmedia.com/articles/read/U.S.-Solar-Market-Spikes-with-742-MW-in-Solar-Installations-in-Q2-2012/

[2] http://www.cpuc.ca.gov/NR/rdonlyres/0C43123F-5924-4DBE-9AD2-8F07710E3850/0/CASolarInitiativeCSIAnnualProgAssessmtJune2012FINAL.pdf

techniques could apply to storage. As a result, the right financing models could accelerate the deployment of storage systems just as they have accelerated the adoption of PV.

Background

Distributed energy storage has enormous potential to shape the future of high efficiency energy management. The Electric Power Research Institute (EPRI) published a study in December 2010[3] that identified many of the potential benefits of energy storage:

Value Chain	Benefit
End User	Power Quality
	Power Reliability
	Retail Time of Use Energy Charges
	Retail Demand Charges
Distribution	Voltage Support
	Defer Distribution Investment
	Distribution Losses
Transmission	VAR Support
	Transmission Congestion
	Transmission Access Charges
	Defer Transmission Investment
System	Local Capacity
	System Capacity
	Renewable Energy Integration
Independent System Operator (ISO) Markets	Fast Regulation (1 hr)
	Regulation (1 hr)
	Spinning Reserves
	Non-Spinning Reserves
	Black Start
	Price Arbitrage

Despite these benefits, the high upfront cost of new technologies often prohibits wide-scale deployment. As a result, the ability to inexpensively finance new technologies is critical in the path to broader adoption.

Grid interactive storage is a less developed industry than PV and there is significantly less data on the performance of storage systems over time. Financing new technologies requires a strong

[3] Electric Power Research Institute. *Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits.* Technical Update, December 2010.

understanding of future cash flows and the risks surrounding the collectability of those cash flows. As a result, the first step toward financing a technology should involve gaining a firm understanding of the technology in order to quantify the value and identify of risks. The following discussion attempts to quantify the value proposition and identify the risks for firm PV.

Discussion

The value of distributed energy storage can be grouped into three main categories, as summarized in the following table:

Value Proposition	Benefit
Renewable Integration	Decreased reliance on other energy sources, through a sustainable and free power source (the sun)
Distributed Infrastructure Support	Grid transmission and distribution support from centrally managed systems able to charge, store, and provide power to the grid
Local Energy Management	Reliable backup power for an energy user with the potential to shift time of use energy and demand charges

In order to obtain financing for energy storage, we need to first understand the timing and amount of benefits generated. In addition, financier concerns stem from the certainty of repayment, which requires a risk-adjusted reward. As a result, we need to assess the certainty that the potential benefits will be realized at the amount and time anticipated.

Renewable Integration

The monetary value of renewable integration is set by the market demand for clean energy. In other words, the monetary value of renewable integration is set by a simple question: "What would an individual, a utility, a corporation, or any other entity pay for clean energy?" Environmental motivations, while important to the demand for clean energy sources, have fallen short in driving renewable integration in areas where the cost of adoption is economically challenging (i.e. because other energy sources are currently less expensive and the cost of pollution and/or the depletion of natural resources are incorrectly priced, or the myriad benefits of distributed renewable generation are not properly accounted for). In response, many states have created clean power mandates, also referred to as Renewable Portfolio Standards (RPS), in an attempt to increase the demand for renewable integration.

To facilitate a pricing and trading market for renewable energy, states with RPS mandates often award Renewable Energy Certificates (RECs) based on the generation of power from an approved energy source and provide liquidity for an otherwise illiquid market. While helpful in spurring renewable integration, RPS programs exist only in select states and REC bidding prices have been historically volatile, which impairs the ability to finance a new technology because the future cash flow is difficult to predict.

Distributed Infrastructure Support

The EPRI study on energy storage referenced above attempted to quantify the potential value of infrastructure support. Financing distributed infrastructure support has proven particularly challenging because the regulatory environment has not yet evolved to allow, utilize, or efficiently price the potential infrastructure benefits for storage.

Local Energy Management

Local energy management is arguably easier to finance than the benefits of renewable integration or distributed infrastructure support, since a storage provider could enter into a contract with a building owner to provide energy management services over a specified time. The pricing for a local energy management contract would be based on determining the potential value to the energy user from two main benefits: 1) energy management to reduce time-of-use (TOU) energy costs and demand costs and 2) the ability for energy storage devices to provide power when the grid is otherwise down. The resulting contract with the building owner could, in turn, be financed. In this scenario, the credit-worthiness of the building owner could be an indicator of the certainty of collectability from a financing perspective. Additionally, the storage installation could serve as collateral in the event of default.

Regardless of the value proposition, additional uncertainties may impair the ability to finance storage. These uncertainties are inherent in emerging categories where early adopters and financiers are often required to predict which technologies will ultimately succeed or fail to become both commercially viable and widely adopted. Additionally, newer technologies have limited performance history, which inhibits the developer’s ability to prove that the technology will function as intended.

In summary, the challenges of financing storage are as follows:

Value Proposition	Financing Challenge
Renewable Integration	• Amount and collectability of REC income is difficult to predict due to volatility of bidding prices • Many states do not have regulations that require renewable integration • The technology may not perform as intended • The industry may adopt a different technology
Distributed Infrastructure Support	• Regulatory environment needs to change before the infrastructure benefits can be efficiently realized and priced/financed • The technology may not perform as intended • The industry may adopt a different technology
Local Energy Management	• Determining the value of local energy management is difficult due to the lack of a large, well-developed and transparent marketplace • The technology may not perform as intended • The industry may adopt a different technology

An effective finance structure can overcome these barriers by allocating risk and return and distributing incentives and benefits to the optimal parties.

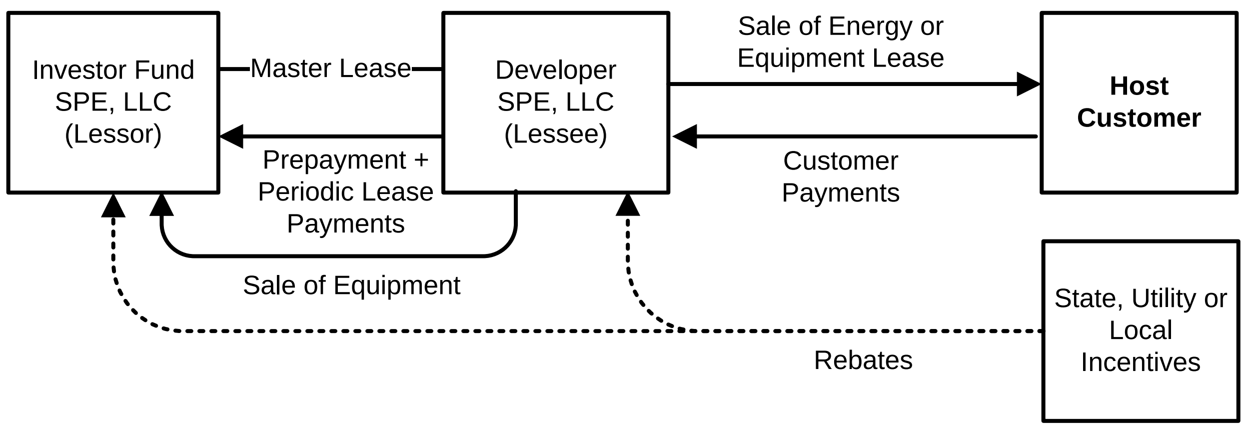
As with PV, there are a variety of potential incentives (in addition to the value identified above) that could enhance the financial incentive to deploy storage systems. These include state and local utility cash rebate programs like the Self-Generation Incentive Program in California, which pays eligible storage technologies up to $1.80/Watt installed in 2013.[4] In addition, the owners of these systems may capture depreciation benefits and accelerated depreciation for some classes of assets.

There are a number of potential methods of financing high-cost assets like batteries that otherwise may be difficult to finance on a corporate balance sheet, or may be more attractive to finance independently. Typically, some combination of project equity and debt is used to fund installations of assets like batteries. Where tax incentives exist, tax equity may be tapped as well. The three primary project equity finance structures used to finance solar photovoltaic projects in the US today are the sale leaseback, the inverted lease, and the partnership flip.

[4] http://www.pge.com/includes/docs/pdfs/shared/newgenerator/selfgeneration/SGIP_Handbook_2012.pdf

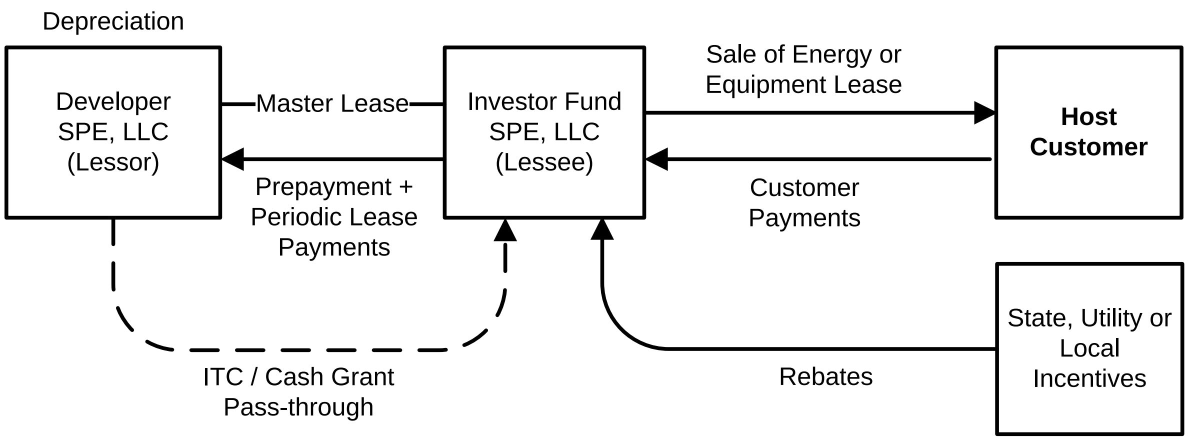
Sale Leaseback

In a sale leaseback structure, the project developer installs the system and then sells it back to the equity investor. The equity investor then leases the system back to the developer who uses some of the customer payments to pay rent to the investor, as lessor. The investor is able to claim any tax or depreciation benefits or rebates that accrue. At the end of the lease term, the investor can either retain ownership of the system or, if the Developer, as lessee, elects to exercise its purchase option, sell it to the developer at the market value.



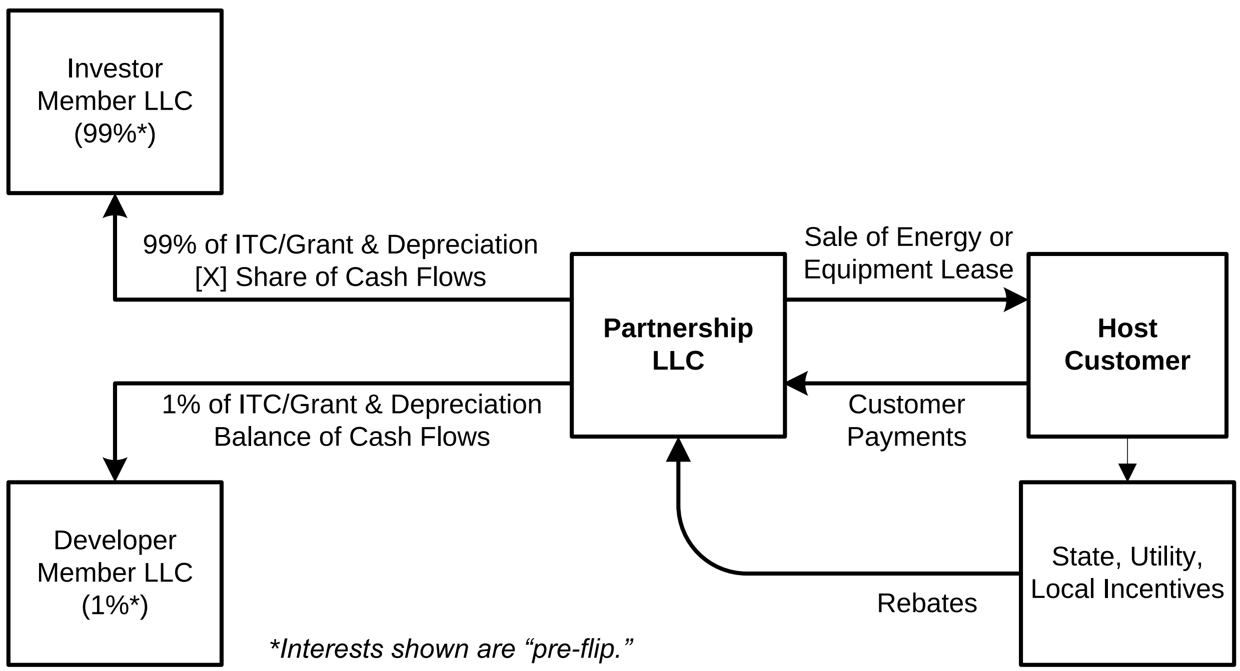
Inverted Lease

In an inverted lease, the developer installs and owns the system, which it leases to the investor, who in turn sub-leases the system to customers. The developer, as lessor, retains any depreciation benefits as the owner of the asset. The investor makes master lease payments to the developer and keeps the rent payments that come from the end customer. If there is an applicable tax incentive, it can be passed through to the investor.



Partnership Flip

In a partnership flip, the investor and developer create a partnership through which they co-own the asset. The partners agree on the proportion of cash and tax benefits that accrue to each party and a target rate of return required by the investor. Often the investor retains a 99% interest in the revenue and tax credits as well a share of cash until achieving a pre-negotiated target return. Once the investor reaches the target return, the partnership interest “flips” so that the developer gets typically 95% of the benefits thereafter with an option to purchase the investor’s remaining 5% interest at the market value. If the purchase option is exercised, the developer may retain full ownership of the asset.



The selection of the best structure for a given project depends on many factors. These can include the credit rating of the end customer, the technology’s track record in existing deployments; the efficacy of utilizing the technology in delivering proven economic value to customers; market conditions; availability of specific sources of financing; and the applicable technology’s eligibility for tax credits and/or rebates. All of the above equity structures may be supplemented with or replaced by some form of debt. Clearly there are many viable options to choose from.

Conclusion

The combination of PV and grid interactive storage can achieve substantial cost savings for utilities and end customers—and reduce carbon emissions to a far greater degree than either PV or storage could achieve on their own—while helping ease the strains on aging utility infrastructure. The key to unlocking these benefits is overcoming the barriers to adoption including upfront costs. Financing can enable broader adoption rates of a technology like storage with high upfront capital costs by allowing customers to align periodic payments over the creation of benefit. The same innovative finance mechanisms that have enabled recent growth in the distributed solar PV industry may well ease growth in deployments of distributed energy storage systems.