NOVEMBER 2020

The Soft Costs of Distributed Solar: Best Practice Recommendations for Cost Reduction

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What are the soft costs of adopting distributed solar?

This report reviews the existing soft costs of adopting distributed solar in the United States. The author discusses existing literature and information on soft costs, and highlights areas where helpful information is lacking. Adopting cost-effective policies to reduce soft costs will play a key role in making distributed solar more competitive and building a more resilient, carbon-free economy.

ACKNOWLEDGEMENTS

I would like to thank Elizabeth Marshall and Professor Bill Shobe for their guidance, support, and assistance throughout the process of researching and writing this paper.

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EXECUTIVE SUMMARY

Distributed solar generation can contribute to the decarbonization of state economies. But relatively high soft costs – all of the non-hardware expenses of installing a solar system – remain a key barrier to more widespread deployment of distributed generation.

In 2018, the average cost of a residential rooftop PV system in the U.S. was $2.70/W (Fu, D. Feldman, and R. Margolis, 2019). At an average of $1.72/W, soft costs make up 63% of the total price tag that homeowners can expect to pay when installing a new system (Fu, D. Feldman, and R. Margolis, 2019). As hardware costs have fallen rapidly over the last decade – from $3.64/W to $0.99/W – soft costs make up an increasing share of total cost.

In order to maximize distributed solar development, continued efforts must be taken to understand and reduce soft costs. It can still be difficult to find detailed, state-level information that addresses both the magnitude of soft costs and how to reduce them. In this report, I review the existing literature and suggest areas where more data would be useful in supporting state policy initiatives.

Numerous groups and agencies, including the National Renewable Energy Laboratory (NREL) and US Department of Energy Solar Energy Technologies, have conducted research and launched programs designed to analyze and reduce soft costs, including the SolSmart and SunShot Initiatives.

NREL identifies seven distinct categories of soft costs: Permitting, Inspection and Interconnection, Install Labor, Sales Tax, Overhead, Net Profit, Customer Acquisition, and Supply Chain Costs. Customer acquisition is the most expensive category. It is interesting that permitting, inspection and interconnection (PII) typically receives the most attention when it comes to soft cost reduction (Fu, D. Feldman, and R. Margolis, 2019). This is because PII often involves regulatory requirements, making it a share of costs over which policy makers have direct control.

Policy makers are in a position to reduce soft costs, as many cost elements, such as permitting, inspection, and taxes, are influenced by state and local policy.

An increasing consensus among experts points to a set of best practices that states and localities can follow to reduce soft costs. For example, online permitting, standardization across jurisdictions, and reducing wait times and fees can all contribute to lower costs. Other actions that could lower soft costs include reducing federal solar import tariffs, creating financial incentives, and supporting group purchasing campaigns.

Which specific combination of cost reduction strategies that will work best will differ by state and locality, and additional research and data is needed to analyze the options. Regardless of the strategies employed, reducing the cost of distributed solar will make it a more competitive energy option, and encourage more widespread adoption. In this way, soft cost reduction can help build a more resilient, carbon-free economy.

1 Introduction

In the past decade the solar industry has seen rapid growth. Price declines as well as advances in technology have encouraged more and more home and business owners to invest in solar photovoltaic (PV) systems. These small-scale systems are referred to as distributed generation (DG) solar, as they generate electricity at or near its end use, generally on the customer-side of the electricity meter. DG systems can be either residential or commercial and are generally installed on rooftops, but can also can be ground-mounted. Solar installations offer a number of benefits such as reduction of energy costs, increase in property value, and reduction of carbon footprint. Importantly, DG systems are typically grid-connected, allowing customers to supply their excess power back to the local utility for credit on their energy bill.

Despite the expansion of DG solar, barriers still remain that impede more widespread deployment. The focus of this paper is to analyze one of the most significant barriers – soft costs. This paper provides information about what soft costs are and why they are important to the adoption of DG solar. With that as context, the paper also explores what best practices exist to reduce soft costs and opportunities for future research and policy development. The policy recommendations in this paper are based on previous efforts related to soft cost reduction, the existing national data, and interviews with industry members.

2 What are Soft Costs

The total cost of a distributed generation solar PV project includes two main categories of expenses – hardware costs and soft costs. Hardware costs reflect the physical components of the system, such as the module, inverter, and mounting system. Conversely, soft costs are all of the non-hardware expenses, such as permit fees, taxes, and financing. While one might assume that the panels themselves are the most expensive aspect of installation, this is typically not the case. Most of what customers are actually paying for are soft costs.

When thinking about soft costs it is important to understand exactly how expensive they are as a whole, as well as which specific soft costs add the most to total system price. It is equally important though to consider which soft costs are most influenced by policy, and therefore have the most potential for reduction. For example, customer acquisition makes up the largest proportion of soft costs. On the other hand, permitting, inspection, and interconnection is the smallest category of soft costs, yet it the most easily influenced by policy. Both of these soft cost categories will therefore be focuses of this paper, though they are important in different ways.

3 Valuing Total Soft Costs

According to the National Renewable Energy Laboratory (NREL), the average cost to consumers of a new residential solar project in the U.S. in 2018 was $2.70/W. Of that, hardware costs represent an average of $0.99/W and soft costs represent an average of $1.72/W (Fu, D. Feldman, and R. Margolis, 2019). Therefore, 63% of the total price can be attributed to soft costs (Fu, D. J. Feldman, and R. M. Margolis, 2018). Costs for new commercial systems are typically lower, averaging $1.83/W with 56% being soft costs. When it comes to utility scale solar, on average only 35% of system costs are soft costs, demonstrating that soft cost are a greater concern for distributed generation (Fu, D. Feldman, and R. Margolis, 2019).

Despite recent declines in PV module and inverter prices, distributed solar remains relatively expensive per watt compared to utility scale solar. This is partially due to soft costs not decreasing as rapidly as hardware costs. While residential soft costs decreased by 116% between 2010 and 2018, hardware costs decreased by 267% (see Table 1). So although soft costs are decreasing, they make up an increasingly large share of total costs. This is demonstrated in Figures 1 and 2.[1]

Table 1: Residential PV Cost Summary

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Hardware Costs	$3.64	$3.39	$2.09	$1.75	$1.57	$1.37	$1.26	$0.91	$0.99
Soft Costs – Install Labor	$1.14	$0.72	$0.68	$0.84	$0.34	$0.35	$0.31	$0.31	$0.27
Soft Costs – Other	$2.56	$2.32	$1.78	$1.38	$1.58	$1.51	$1.46	$1.62	$1.45
Total Costs	$7.34	$6.44	$4.55	$3.97	$3.49	$3.23	$3.02	$2.84	$2.70

NOTES: 2017 REAL USD/W. SOURCE: FU, D. FELDMAN, AND R. MARGOLIS, 2019

Table 2: Commercial PV Cost Summary

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Hardware Costs	$3.66	$3.34	$2.15	$1.65	$1.35	$1.22	$1.14	$0.77	$0.81
Soft Costs – Install Labor	$0.32	$0.33	$0.31	$0.30	$0.22	$0.20	$0.19	$0.17	$0.16
Soft Costs – Other	$1.45	$1.37	$1.01	$0.87	$1.23	$0.88	$0.87	$0.94	$0.86
Total Costs	$5.43	$5.04	$3.47	$2.82	$2.80	$2.30	$2.20	$1.88	$1.83

NOTES: 2017 REAL USD/W. SOURCE: FU, D. FELDMAN, AND R. MARGOLIS, 2019

[1] Note: Figures 1-3 use only residential data

Figure 1: Total Soft Costs

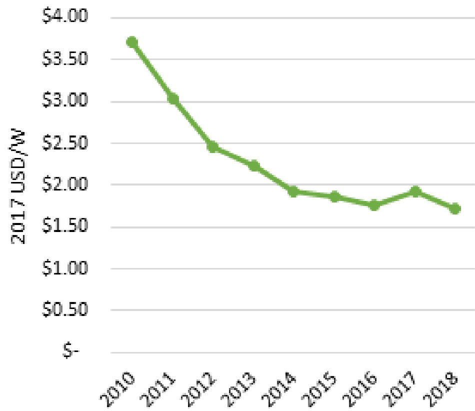
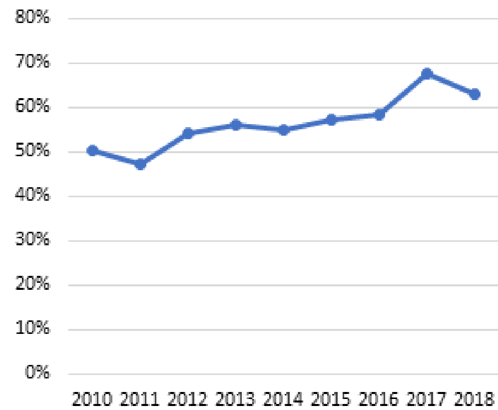
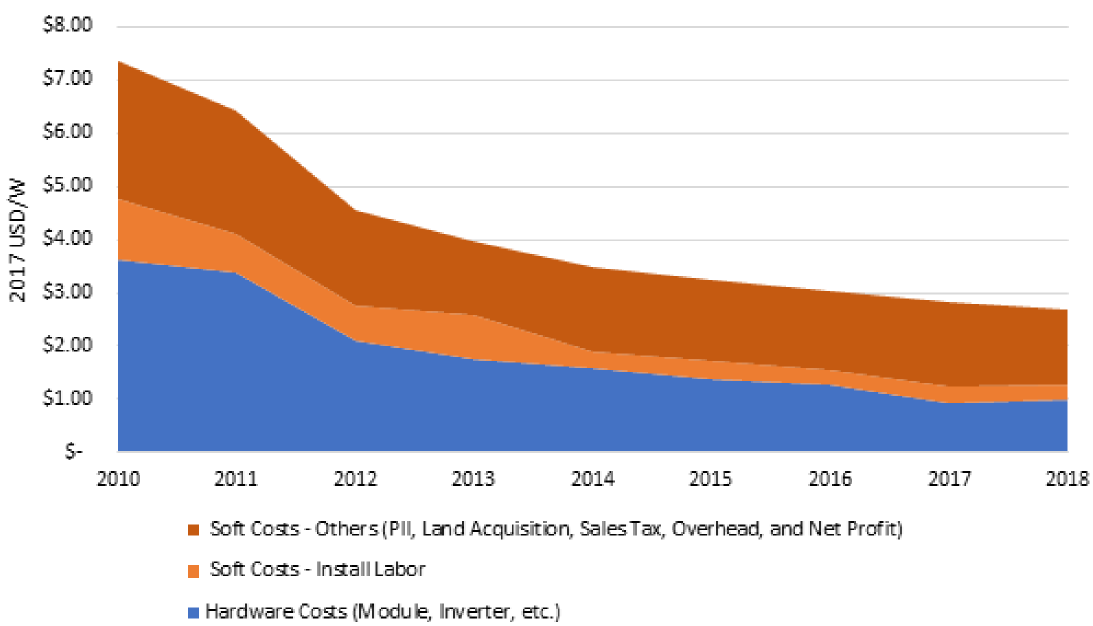


Figure 2: Soft Cost % of Total Cost



Source: Fu, D. Feldman, and R. Margolis, 2019

Figure 3: Residential PV Cost Breakdown



Source: Fu, D. Feldman, and R. Margolis, 2019

These data are based on national averages. There is substantial variation among states and individual solar installers. There are few data available for the state of Virginia specifically. According to one estimate, as of September 2020 the average cost of solar panels in Virginia is $2.66/W (SolarReviews, n.d.). The same source estimated that the national average is $2.60/W, making Virginia prices higher than average. In interviews conducted for this paper, multiple installers reported that their companies cost breakdowns differed at least slightly from the 2018 NREL data. One small Virginia installer reported experiencing both higher hardware costs than $0.99/W and higher overall costs than the $2.70/W national average. A national installer reported that soft costs made up a much lower percentage of total system costs than the 63% residential average. Although the data are not currently available, there is opportunity for further research on Virginia soft costs and how it compares to the national average.

4 Why Focus on Soft Cost Reduction?

Reducing soft costs is essential to facilitating the widespread development of distributed solar. According to SEIA, growth in solar has been led by falling prices (*Solar Industry Research Data* n.d.). As hardware prices continue to fall, soft costs will make up an increasingly large share of total costs. As soft costs are more easily influenced by policy than hardware costs, it is an area where policy makers can make the most change.

Efforts to-Date

The U.S. Department of Energy has funded numerous agencies and organizations across the U.S., such as The Solar Foundation, Solar Energy Industries Association (SEIA), NREL, and others to address soft costs reduction and to advance the adoption of DG solar. Much of the research and work to date has focused on increasing technological innovation and decreasing the soft costs associated with going solar. Below are a few key examples:

Solarize. Solarize campaigns began in 2009 when a group of Portland residents decided to "go solar" together and purchase their systems collectively in order to gain a discount. The residents were able to successfully reduce costs through purchasing in bulk. After a successful few years of campaigns, the DOE published the first Solarize Guidebook in 2011, resulting in many communities across the U.S. starting their own group purchasing programs. The Solarize Guidebook offers insight into how collective purchasing can be implemented to reduce costs and complexity.

SunShot Initiative. Established in 2011 by the DOE, the SunShot Initiative's mission was to reduce the total costs of solar energy by 75% between 2010 and 2020 (*The SunShot Initiative* n.d.). For residential solar, this meant reducing costs from 52 cents/kWh to 20 cents/kWh. For commercial solar, the target reduction was 40 cents/kWh to 8 cents/kWh. In terms of soft cost reduction, SunShot works with state and local governments to ease the process of going solar. According to the DOE SunShot also supports the development of technology that “increases market transparency, enhances consumer protection, and improves access to low cost financing” (*The SunShot Initiative: Soft Costs* n.d.). In 2017, the DOE announced that the SunShot Initiative had successfully accomplished its goals three years in advance. SunShot goals for 2030 distributed solar costs include 5 cents/kWh for residential and 4 cents/kWh for commercial solar. Achieving these goals will make distributed generation even more competitive with traditional energy sources.

SunShot National Laboratory Multiyear Partnership (SuNLaMP). Started in 2016 and built on the work of SunShot, SuNLaMP was a funding program with awards going to national laboratories researching technology innovation and soft cost reduction. SuNLaMP has partnered with research organizations such as NREL and Berkley Lab, both of which are referenced in this paper. In providing research funding SuNLaMP helped achieve the 2020 SunShot initiative goals.

SolSmart. Established in 2016, SolSmart is a national program that provides no-cost technical assistance to communities looking to eliminate barriers to solar development and reduce soft costs. SolSmart delivers community-specific assistance via its network of advisors and develops research-based resources such as toolkits, guides, and educational webinars. Depending on the criteria that they meet, solar-friendly communities can be recognized with Gold, Silver, or Bronze designations (SolSmart, n.d.[e]). To-date, over 300 communities in the U.S. have become SolSmart designees. Eighty-two million people, or one in four people in the US, now live in one of these communities (SolSmart, n.d.[a]). The SolSmart program is organized around eight categories of services; much of the work of this report is based off of SolSmart’s categories framework and their best practice recommendations (SolSmart, n.d.[d]).

Solar Automated Permit Processing platform (SolarAPP). First announced in 2018, the SolarAPP is an online solar permitting tool currently in development by The Solar Foundation and NREL. The program will come at no expense to AHJs and will provide flexible, standardized permitting with less time and cost (*SolarAPP* n.d.). Currently the SolarAPP is in a staged piloting process, with focus on California. Although no Virginia locations are currently being tested, the goal is eventually to have widespread use of the SolarAPP. The Solar Foundation has claimed that in five years the SolarAPP will have resulted in 2.4 million solar homes, $7,000 in savings per solar system, and about 30,000 solar jobs.

Future Research Opportunities

These examples outline some of the major research and programs launched in recent years; this list is by no means exhaustive. While there has been considerable work on soft cost reduction, there appears to be large room for improvement. NREL and Berkley Lab provide national data regarding residential solar cost breakdowns, yet little information is publicly available by state. As soft costs make up an increasing percentage of total cost, this lack of state data will become even more relevant. Soft costs are heavily influenced by state and local policy. Having access to data will allow the effectiveness of policy models to be evaluated.

5 Types of Soft Costs

The term "soft costs" refers to all of the non-hardware costs associated with a solar project, and in fact, there are many different types of soft costs. NREL identifies seven distinct categories of soft costs: Permitting, Inspection and Interconnection, Sales Tax, Install Labor, Supply Chain Costs, Overhead, Net Profit, and Customer Acquisition. Using 2018 data from NREL, Table 3 and its associated Figure 4 (below) break down the different soft cost categories and associated history of cost for the U.S. overall and the other states NREL provides data on.

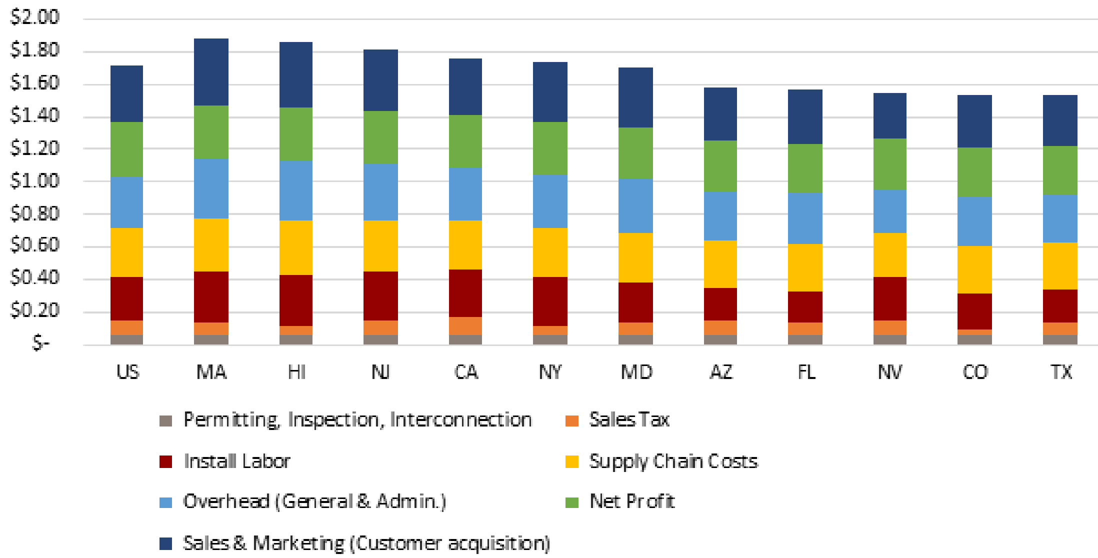
Table 3: Soft Cost Breakdown by State and Type

	US	MA	HI	NJ	CA	NY	MD	AZ	FL	NV	CO	TX
PII	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06
Sales Tax	$0.09	$0.08	$0.05	$0.09	$0.11	$0.05	$0.08	$0.08	$0.08	$0.09	$0.04	$0.08
Install Labor	$0.27	$0.31	$0.32	$0.30	$0.29	$0.30	$0.24	$0.21	$0.19	$0.27	$0.23	$0.20
Supply Chain Costs	$0.30	$0.33	$0.33	$0.31	$0.30	$0.31	$0.31	$0.29	$0.30	$0.27	$0.29	$0.29
Overhead	$0.32	$0.37	$0.37	$0.34	$0.32	$0.33	$0.33	$0.30	$0.31	$0.26	$0.30	$0.29
Net Profit	$0.33	$0.33	$0.33	$0.33	$0.33	$0.32	$0.32	$0.31	$0.31	$0.32	$0.30	$0.31
Customer acquisition	$0.35	$0.40	$0.41	$0.37	$0.35	$0.36	$0.36	$0.33	$0.34	$0.29	$0.33	$0.32
Total Soft Cost	$1.71	$1.88	$1.86	$1.81	$1.76	$1.73	$1.70	$1.58	$1.57	$1.55	$1.54	$1.54

NOTES: 2017 REAL USD/W. SOURCE: FU, D. FELDMAN, AND R. MARGOLIS, 2019

As Table 3 and Figure 4 illustrate, customer acquisition, net profit, overhead, supply chain, and install labor costs are all significant expenses. Installation labor is a separate and complex issue that will not be addressed in this report. The Rocky Mountain Institute though has published a report focused specifically on reducing installation labor costs (Morris and Calhoun, 2013). Similarly, supply chain, net profit and overhead costs are typically expenses that businesses disclose little information about and are not often highly impacted by policy. This report will briefly describe these costs, but the focus of this report will be on the two categories of soft costs that are highly influenced by public policy and for which there is a body of available research, data, proven best practices, and case studies.

Figure 4: Residential PV Soft Cost Breakdown



Source: Fu, D. Feldman, and R. Margolis, 2019

5.1 Net Profit & Overhead Costs

It is important to remember that the installer does not just charge the overhead that they have incurred for the project. Some of the price goes to profit. Profit is necessary for installers to be able to sustain or expand their business. In 2016, The Office of Energy Efficiency & Renewable Energy found that this profit makes up 9% of soft costs, with much variation among studies and locations (Ulrich, 2016). NREL found in 2018 that profit can make up about 19% of the price customers pay for solar. The study showed the average cost for profit in the U.S. to be $0.33/W, making profit the second largest soft cost category, behind only customer acquisition (Fu, D. Feldman, and R. Margolis, 2019). Similarly, overhead costs add on average $0.32/W to the cost of DG solar. This is also about 19% of the price customers pay for solar. Despite their large shares of total cost, profit and overhead do not typically fall within the purview of public policy except for ensuring that the market for solar installation services is competitive. As the industry matures, if the market for installers is reasonably competitive, the average rate of return on investor's capital should approach that of other, similar assets.

5.2 Supply Chain Costs

Supply chain costs refer to the expenses for procuring, transporting, and storing hardware. Supply chain expenses are one of the largest categories of soft costs; in 2018 NREL found that they make up about 18% of PV soft costs (Fu, D. Feldman, and R. Margolis, 2019). In the U.S. that is about $0.30/W. The solar industry has a global supply chain, with most component manufacturing taking place in China, Taiwan, and Southeast Asia (*Solar Supply Chain and Industry Analysis* n.d.). Logistics can be costly and time consuming; and in states with more complex shipping needs, such as Hawaii, the price is typically higher (see Table 3). It is also important to consider that supply chain costs for distributed solar can be higher than utility-scale solar due to economies of scale achievable by larger systems. Module and inverter procurement is more costly when not done in bulk (Reiter et al., 2016).

5.3 Permitting, Inspection, & Interconnection

Permitting and inspection are categories of soft costs involving the regulatory requirements that installers must follow for PV projects. To ensure that that minimum performance standards and codes are met, interactions typically occur between the installer and Authority Having Jurisdiction (AHJ) personnel. Before projects are installed permitting insures that PV systems will be compliant with electrical, building, and fire codes. This is necessary to ensure public safety (Taylor, 2017). Depending on the processes set by the AHJ, the installer will either submit the required documents in person or online, as well as a permitting fee. Once the installer has met the requirements and gained approval, installation can begin. When construction is complete the AHJ typically oversees an inspection process to confirm that the requirements were in fact met before granting approval on the system (Taylor, 2017).

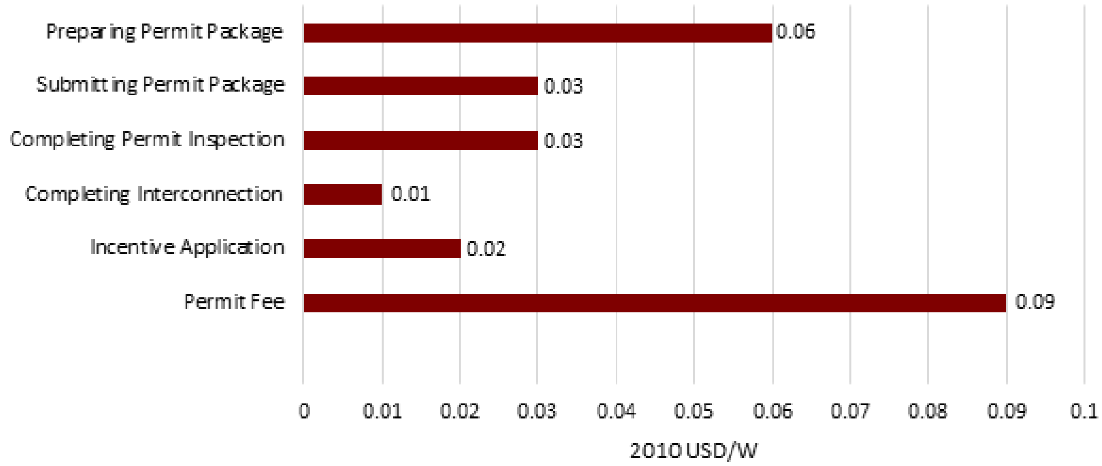
Interconnection refers to the process by which the PV system is connected to the electric grid. Integrating distributed solar into the grid allows for homeowners to contribute their excess power into their local distribution network. This results in a billing mechanism called “net metering” in which homeowners are credited for energy that they supply to the utility (NREL, 2002). Homeowners can also draw from the grid when their systems are not producing enough to meet their energy needs. The interconnection process typically involves interactions between the installer and the local distribution system operator or utility. The installer has to gain approval from both the utility and AHJ before the system is able to operate (SolSmart, n.d.[c]).

Appropriate permitting, inspection, and interconnection is necessary to ensure the safety and functionality of the system. At the same time, the permit process in the U.S. is often quite time consuming and costly and varies among jurisdictions. This can be a burden for installers and customers, and complicates development. There is little standardization within the U.S., with PII processes varying not only by state but also by city or locality. In the U.S. there are over 18,000 jurisdictions that oversee residential PV permitting and 5,000 utility service territories (Bergoo, 2014). Each municipality might have their own set of requirements. Therefore, installers have to familiarize themselves with the permitting processes of each jurisdiction that they work in, which can be time consuming, burdensome, and costly, and can even deter installers from working in those jurisdictions. One major consequence of difficult permitting is that it impedes development. According to a study from the Green Energy Institute in 2014, one third of installers avoided jurisdictions with challenging permit requirements (Lawton, 2014). In an interview conducted for this report one small Virginia installer explained that although their company has debated avoiding difficult counties, doing so would result in significant reductions of their customer base. Regardless, this is slowing the rate at which distributed solar PV is adopted.

Lengthy, complicated PV permitting processes can also increase the amount of time that it takes for a project to be completed. Nationally, a typical installer can expect to wait up to nine days to have their permit application approved (O'Shaughnessy, Barbose, and Wiser, 2020). Permit wait times vary significantly based on location. One study from Berkley Lab found that customers wait between 25-100 days from permit application until inspection on an installed system (O'Shaughnessy, Barbose, and Wiser, 2020). This is also something that varies depending on the specific regulations of the jurisdiction. For example, the SolSmart program recognizes jurisdictions that have taken steps to streamline their processes and encourage solar development. The gold-designated communities pass inspection seven days earlier on average after being issued permits than undesignated communities. Similarly, jurisdictions that require onsite inspections and not virtual ones take longer to pass inspection.

Permitting, Inspection, and Interconnection is a costly part of solar development. While NREL data from 2018 valued the cost of PII to be $0.06/W, some estimates are much higher. In 2013 The Solar Foundation found that PII currently adds about $1.00/W to the cost of a residential PV (*SolarAPP* n.d.). The specific PII costs are broken down in Figure 5 below. The permit fee itself is typically the largest portion of PII costs. Some states have regulations in place to keep fees down; for example, Colorado which caps residential permitting costs at $500, and commercial costs at $1000 (*Local Solar Permitting* n.d.).[2]

Figure 5: Residential Solar PII Cost Breakdown



Source: Seel, Barbose, and Wiser, 2013

5.4 Customer Acquisition

Customer acquisition is a broad term that refers to marketing and advertising, project screening, site visits, and other expenses the installer incurs to obtain new projects. According to NREL, customer acquisition added $0.35/W to the price of residential PV installations in 2017. That is nearly 13% of the total system cost. Some residential solar installers, such as SunRun, spend much more. According to their Q1 2020 Earnings Release, sales and marketing adds $0.76/W in cost, for a total system price of $3.09/W (*Sunrun Reports First Quarter 2020 Financial Results* 2020). That is 24.5% of total system cost for residential PV.

While the majority of customer acquisition costs are devoted to marketing and advertising, potential customers also have to have their projects screened for viability. This might involve steps such as phone calls or site visits to gain information about the property and viability of the project (Lawton, 2014). These steps, as well as the system design are taken before any contract with the customer is signed. According to Google's Project Sunroof, 79% of all U.S. rooftops are solar viable (Dietz, 2017). Although this is certainly a high percentage, there are still ultimately some projects that are not viable. Expenses related to projects that don't pan out must be passed on to other projects.

[2]Note: It is important to consider that this is from 2013 and is therefore not representative of changes that have occurred since then.

5.5 Taxes and Tariffs

Although there is much variation by state, taxes are another category of soft costs that increase the price of distributed solar. This includes sales tax on the hardware and system, payroll tax on the labor, and property taxes (Lawton, 2014). The total amount of these costs depends heavily on the state and jurisdiction of the installation. For example, in 2018 California sales tax added $0.11/W to the cost of residential solar. In Colorado, it was less than half of that at $0.04/W. Breakdowns by state can be seen in Table 3.

While in some states taxation on solar development is an inconvenience, others have adopted various tax exemptions and incentives for solar. There are 25 states that offer some sales tax exemptions, and 36 that offer property tax exemptions for solar (*Solar Tax Exemptions* n.d.). Like many other states, Virginia has a law stating that solar energy equipment is exempt from local property taxes. The Database of State Incentives for Renewables (DSIRE) is one resource for learning about tax incentives.

Similar to taxes, one Virginia based installer reported in an interview that national tariffs on imported solar PV equipment were harming the solar industry. In February of 2018 new tariffs were imposed on imported solar equipment. The tariffs started at 30%, with 5% reductions each year for four years (Fields, 2020). As a result of the tariffs solar industry prices have increased, passing on the tariffs to customers. According to a 2018 study from SEIA, tariffs are partially responsible for solar prices in the U.S. being 50% higher than abroad (*The Adverse Impact of Section 201 Tariffs* n.d.).

6 Best Practices and Cost Reduction Pathways

As there are many sources of soft costs, there are a number of different paths to reducing them. Which approach is best will vary depending on the region, or even by AHJ. For example, according to the NREL data shown in Table 3 sales tax is higher in California than in Massachusetts. Yet, customer acquisition costs are higher in Massachusetts than California. Therefore, one might come to the conclusion that California could benefit from reducing PV taxes and Massachusetts could benefit from reducing customer acquisition costs. Different cost reduction pathways will work for different locations.

Along the same line, when considering cost reduction strategies, it is important to remember the proportions of cost categories to the overall soft cost. Specifically, NREL reports that PII costs make up only about 4% of total soft costs (Fu, D. Feldman, and R. Margolis, 2019). In fact, this is the smallest category of soft costs. This is surprising as PII is often the area receiving the most attention for soft cost reduction. Perhaps this is because PII costs can be influenced by policy changes. For this reason reducing PII costs is definitely important, yet it is also critical to remember where it fits into the overall picture of soft cost reduction; it is a smaller portion than one might initially expect. But in interviews with installers, PII was always a main concern for developers.

Unfortunately, some of the largest sources of soft costs are also the most challenging to reduce. Labor, overhead, and supply chain costs are typically harder to directly influence with policy. The next sections will explore eight different categories of soft cost reduction, including PII. These categories are based on the 2020 SolSmart designation application, and many of the best practices come from SolSmart's recommendations.

6.1 Permitting and Inspection

Permitting and inspection is one of the most well researched areas of soft cost reduction, even though these costs only make up about 4% of total soft costs (Fu, D. Feldman, and R. Margolis, 2019). Why then does this category receive so much attention from communities looking to reduce PV cost? It is probably because PII costs are heavily influenced by policy decisions; it may the largest share of costs over which localities have direct control.

There are a number of best practices that municipalities can follow to help reduce PII costs and promote the development of solar in their communities. SolSmart provides a thorough list of possible actions that can be taken. Although there is little data that explicitly links permitting best practices to soft cost reduction, the following recommendations are based on expert consensus. The expectation is that permitting and inspection policy has the ability to reduce soft costs by reducing administrative steps, fees, and the length of the process.

Online Checklists. One essential best practice is increasing the transparency of the process and requirements. All communities should have an easily accessible, online checklist that explains the permitting and inspection process. A checklist can help installers prepare for the inspection in advance, reducing the amount of time that it takes to pass inspection (Stanfield and Hughes, 2013). It will also make it much easier for developers working in new areas to fully understand the process and requirements. Online checklists can be easily updated, especially as requirements are constantly subject to change.

Checklists could even contain a “common mistakes” section to help draw the attention of both installers and inspectors to specific issues (Stanfield and Hughes, 2013).

Online Permit Application. In order to streamline the process, communities should also consider having an online option for permit applications. Submitting the permit application online will save developers time and therefore money. Online permitting also has the potential to simplify the process for AHJ personnel that have to review and approve applications.

Reviewed Permitting Language. Permit applications should be short and clear, and one best practice recommendation is to review and refine permit language. The documents and requirements should be straight-forward enough so that someone new or unfamiliar to the process is able to understand what is needed of them.

Reduced Wait Times and Fees. Another best practice recommendation is for municipalities to commit to reducing wait times and fees. Permit fees would ideally be used only for cost recovery, and not as a source of revenue. California Government Code Section 66015 states that a city or county “shall not charge a residential permit fee that exceeds the estimated reasonable cost of providing the service for which the fee is charged” (Friedman, 2017). For residential systems fees are capped at $450. For commercial systems it is $1000 (Friedman, 2017). Likewise, reducing permit approval wait times to three days or fewer would save time for developers. This builds certainty into the process and project timeline, which in turn reduces soft costs. Installers with good track records in the area could even be eligible for quicker, expedited permitting (Lawton, 2014).

Remote Inspections. Similar to the online application recommendation, the ability to have remote inspections are an emerging best practice. Remote options are not only less time consuming for both the inspector and developer, but have also proven useful for the COVID-19 pandemic. Having remote inspection capability has allowed work to continue remotely, minimizing disruptions and delays.

Standardization. Standardization of the permitting and inspection refers to creating consistency across AHJs that installers work in. Having a unified solar permit would make it much easier for developers. SolSmart references Solar ABC’s as a possible standard solar permit. Solar ABC has worked to create an expedited solar permit process for small PV systems. It provides a standard framework for how systems of less than 10 to 15 kW can be quickly and easily permitted (Brooks, 2012). With the latest version published in 2015, however, these reports can be outdated. Currently, the Solar Foundation and NREL are working to roll out the Solar Automated Permit Processing Platform (SolarAPP). Although it is still in the testing phase, the SolarAPP will provide a low-cost, online solar permitting tool that could be used across AHJs.

6.2 Planning and Zoning

The best practices in this section address the ways in which planning and zoning policy can be developed in a way that reduces soft costs. Similar to permitting and inspection, planning and zoning requirements have the potential to either encourage or impede solar development. Policies that are not advantageous to DG solar can result in extra steps, time, and effort from the installer – all of which will increase total costs to the customer.

Reviewed Requirements. For example, an important best practice is reviewing and revising restrictive zoning requirements. Zoning requirements such as height or aesthetic restrictions often create unnecessary barriers for developers to face (SolSmart, n.d.[d]). For example, California Government Code Section 65850.5 states that local agencies cannot adopt ordinances that create unreasonable barriers to PV installation such as "design review for aesthetic purposes" (*California Government Code Title 7 Division 1 Chapter 4 Article 2* 2019). Allowing property owners to optimize their roof space is also essential for successful development (SolSmart, n.d.[b]).

Solar by-right Accessory Use. Solar by-right accessory use is also an essential zoning best practice. This means that property owners have the right to develop solar on their land with standard permits and do not need special permission (SolSmart, n.d.[b]). This helps developers avoid having to file for additional permits, streamlining the process.

6.3 Building Codes

Reviewed Code. Reviewing building codes on a state and local level is another essential best practice. Solar systems are designed to comply with local codes and standards. Unnecessary requirements increase installation costs. One of the code bodies that affects solar development the most is the National Electrical Code (NEC), a set of guidelines and standards for electrical installations. It is required in all but three states. Virginia currently follows the 2014 edition of the NEC but is in the process of updating to the 2017 edition (*NEC® enforcement* n.d.).

One NEC requirement that adds cost to solar systems is rapid shutdown. Rapid shutdown is a rule that requires solar systems to have the ability to de-energize instantaneously. It was first added to NEC in 2014 to improve fire safety and decrease risk to first responders (Pickerel, 2016). Since then, NEC 2017 has increased rapid shutdown capability requirements to further increase safety. Not only does this requirement add complexity to the system, but it also increases hardware costs as new components are necessary for systems to be compliant.

Throughout Europe rapid shutdown is rarely required (Knopf, 2015). Despite the fact that rapid shutdown is not mandated, a study by research organization Fraunhofer concluded that to date no firefighter in Germany has been injured by PV power while putting out a fire (Wirth and Schneider, 2015). So while it is important to consider first responder safety, such requirements sometimes come at a significant cost to installers.

The evidence from the European experience points to the need for a full technical re-evaluation of the rapid shutdown requirement. Virginia may wish to take an active role in pushing for such a reassessment.

Solar Mandates. Solar mandates are building codes that require certain new construction projects to have a solar system. The specific requirements can vary widely depending on the property or building type. For example, starting on January 1, 2020, the state of California has required that new single-family homes and low-rise apartments must have a solar PV system. Solar mandates could help reduce customer acquisition costs by providing new customers to installers. This is significant as customer acquisition makes up more than 20% on average of total soft costs (Fu, D. Feldman, and R. Margolis, 2019). Solar mandates could also help reduce costs by allowing developers to achieve economies of scale. Economies of scale occurs when companies increase production, spreading fixed costs over a larger number of output. In the case of solar, mandates would certainly increase the number of installations. As installations increase the developers will be able to spread overhead and other costs over a larger number of systems. According to NREL overhead makes up about 19% of total soft costs (Fu, D. Feldman, and R. Margolis, 2019). This use of economies of scale is one of the factors that currently makes utility-scale solar more efficient than DG.

Solar mandates are almost certainly not an appropriate option for Virginia and could end up increasing the total costs of distributed solar by forcing its use in low-value circumstances (Heutel, 2018). There is also concern that solar mandates could increase housing prices. Considering these points, it is fair to say that creating mandates probably does not make sense in many places. In areas such as southern California, Arizona, Nevada, New Mexico, or Florida – which have high average solar radiation – some solar-ready mandates may have the potential to lower soft costs.

6.4 Solar Rights

Solar rights ensure that home and business owners have the ability to install solar on their property and are protected when they do so. Solar rights best practices can help reduce soft costs by making consumers feel more comfortable and confident with their choice to invest in solar. This assurance makes solar a more appealing option, thus indirectly reducing the soft costs associated with customer acquisition.

Consumer Protection. Jurisdictions have a responsibility to ensure that property owner and consumer rights are sufficiently protected before, during, and after the solar installation process. SolSmart recommends that communities should not only review solar rights policies, but also make this information available to the public. Consumer protection information could be posted online in order to increase accessibility and encourage reputable installers. As a result of the customers feeling more confident and informed, the reputable installers could see decreased customer acquisition costs.

Ordinances and Easements. Protection of solar access through easements and ordinances can help reduce potential problems for solar customers, but this, of course, comes at the expense of the rights of others. Solar access ordinances allow property owners to protect their right to access sunshine. This typically is in reference to potential shading from neighboring structures (Kettles, 2008). For example, a solar access ordinance might restrict a neighbor from building on their property in a way that blocks sunlight from your property or solar panels. Because such an ordinance may place substantial burdens on neighboring property, solar access ordinances may only make sense in special circumstances, and in any event, should be subject to wide community acceptance before being adopted. A solar easement, on the other hand, is typically a voluntary agreement between neighbors that ensure solar access (Kettles, 2008). Easements are often relevant when it comes to homeowners associations. These mechanisms ensure that customers that make investments in solar equipment will continue to have access to sunlight in the future. Since these transfers of rights are arranged through a voluntary exchange, the issue of placing unwelcome burdens on neighboring properties does not arise.

6.5 Utility Engagement

Effective utility engagement is critical as proposed new systems typically need approval from the utility before they can be connected to the grid. Though the amount of utility oversight varies, healthy partnerships between installers, AHJs, and local utilities ensures that receiving permission to operate does not take any longer than necessary. After all, time is money for solar installers. Delays can add soft costs to a project, and result in lost energy generation for the customer. In 2015, the Department of Energy estimated that a one day delay for every residential system installed that year would translate to $4 million in lost generation (*The SunShot Initiative: Race to 7-Day Solar* n.d.). Considering that installed residential solar capacity has increased by 232% between 2015 and 2020 (expected), the losses caused by delays now are certainly much larger (*Solar Industry Research Data* n.d.).

Coordinate Inspections AHJs and utilities typically have separate approval processes for new systems (Newsom et al., 2019). As a result of the processes being separate, multiple inspections are often performed on the same system. A best practice recommendation is therefore coordinating utility and AHJ inspections (SolSmart, n.d.[d]). Reducing the number of inspections that installers have to be involved in cuts costs. Not only will there be fewer logistics for the utility, but time can potentially be saved.

6.6 Community Engagement

Policy makers can support solar development by initiating conversations in their community that increase awareness about distributed generation. Educating local residents about solar energy can help to clear up any concerns or misconceptions that might prevent them from considering solar (Dillemuth et al., 2012). Lack of understanding of the technology is also a barrier that can be addressed through community conversations. If policy makers are proactive about facilitating these conversations, then solar installers will have the opportunity to work with more educated customers. This has the potential to decrease customer acquisition costs.

Create Online and Printed Resources. In terms of community engagement, the most basic best practice recommendation for local governments is to provide residents with consistent, reliable information about solar energy. This can be achieved by curating a set of resources that are widely and easily accessible to all members of the community. Dedicating a page on the local government website to solar development would provide residents with a one-stop center for information (Dillemuth et al., 2012). This would include facts such as economic viability, potential benefits, programs, local and state incentives, as well as details about requirements (Dillemuth et al., 2012). SolSmart recommends that the page also include the community's solar goals (SolSmart, n.d.[d]).

A webpage would also be a smart place to give community members guidance on how to choose an installer – a potentially challenging aspect of going solar. Giving direction to residents could ease the process and address any concerns. Importantly, this guidance could help reputable installers acquire more customers. For this reason, educating residents could therefore help decrease customer acquisition costs.

Another issue that could be addressed on the web page is how to determine the viability of a project. Interactive solar maps, for example, could allow residents to compare their potential projects with existing ones (Dillemuth et al., 2012). Providing links to estimation tools such as Google's Project Sunroof, which allows anyone to enter their address and get a savings analysis, could also be helpful.

Similar to a webpage, distributing printed resources such as brochures or fact sheets is also a best practice recommendation (Dillemuth et al., 2012). Such educational materials would include similar information to a web page. Providing residents with both online and printed resources has the potential to increase awareness, promote solar, and create educated customers. This ultimately helps installers and customers alike by reducing how much energy has to be put into customer acquisition – the largest category of soft costs.

Support Group Purchasing. Group purchasing is a community approach to going solar in which a group of neighbors agree to collectively purchase solar together. According to the Solarize guidebook, this type of purchasing allows a group of people to "collectively make an informed purchase and negotiate a volume discount" (Irvine, Sawyer, and Grove, n.d.). Group members are therefore able to get a better price from the installer than they would have as an individual. Programs that do this are typically referred to as Solarize campaigns, and the Solarize Guidebook offers insight into how collective purchasing can be implemented to reduce costs and complexity (Irvine, Sawyer, and Grove, n.d.). Solar United Neighbors, a nonprofit that helps people go solar together, works in eleven states to organize solar co-ops of 50 to 100 neighbors (Neighbors, n.d.). In Virginia they have already organized 31 of these co-ops, achieving average discounts between 15 and 30% of the system cost for their group members (Neighbors, n.d.). This is possible as bulk purchasing helps to achieve economies of scale. It is cost effective for installers to work on multiple systems in one area. Efficiencies are achieved when it comes to permitting, labor, site visits, as well as customer acquisition. For these reasons communities ideally would support and host group purchasing programs.

6.7 Market Development and Finance

Financial Incentives. Rooftop solar installations involve relatively large up-front capital expenditure that provides a long, future stream of savings. Many households have limited access to the capital necessary to finance a solar installation. So, even if the installation has a positive net present value, many families cannot obtain the financing. Property assessed clean energy financing uses a locality's access to capital to finance home solar installations based on the anticipated energy cost savings over 10 or 20 years. Property owners borrow money to fund their PV system installation, then pay the costs back over time on their property taxes (EERE, n.d.). The primary reason many property owners wish to install solar is as an investment, but limited access to capital restricts the size of the market.

Cut Tariffs. Current federal tariffs on imported solar equipment raises the cost of solar for homeowners and businesses. The solar supply chain is global, and much of the manufacturing takes place in China, Taiwan, and Southeast Asia (*Solar Supply Chain and Industry Analysis* n.d.). In February of 2018, new tariffs were imposed on imported solar goods, starting at 30% and decreasing 5% each year for four years (Fields, 2020). According to a 2018 study from SEIA, tariffs are partially responsible for solar prices in the U.S. being 50% higher than abroad (*The Adverse Impact of Section 201 Tariffs* n.d.). As tariffs tend to be passed onto consumers, lowering them can expect to reduce prices for consumers. In an interview conducted for this paper, a national solar installer felt that reducing tariffs is one of the best policy options for reducing soft costs. Localities interested in boosting solar installations can advocate for reduced tariffs on solar equipment.

7 Conclusions and Next Steps

As hardware costs continue to fall, soft costs will make up an increasingly large share of total costs. Soft cost reduction will therefore be essential to facilitating widespread deployment of distributed solar. There are many sources of soft costs – such as PII, customer acquisition, and overhead. Therefore, there are a number of different paths to reducing them. The best practice recommendations set forth in this paper however can serve as a guide of potential policy options. The recommendations range from simple changes such as online permitting, to more complex policy options such as reduced federal tariffs. Which approach is best will vary depending on the state or AHJ.

This paper is only a small piece of the greater effort to reduce the soft costs of distributed solar. Solarize, SolSmart, and SolarAPP are three examples of the work that is being done on this issue. In terms of moving forward, increased access to state data would help allow the effectiveness of specific policies to be evaluated. We hope that follow-up work can help narrow in on the effectiveness of specific best practices and continue to help reduce soft costs.

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The Energy Transition Initiative

The Energy Transition Initiative at the University of Virginia consists of a team of researchers at UVA's Weldon Cooper Center for Public Service exploring clean energy sourcing in response to new legislation mandating net carbon emission neutrality in Virginia by 2050. We advance these goals by researching clean energy and sustainability practices; by developing and maintaining tools to help localities understand the process, costs, and benefits of adopting cleaner energy technologies; and by engaging directly with policymakers, energy providers, entrepreneurs, consumers, and other interested stakeholders to smooth the transition to a sustainable energy economy.

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