CESA Webinar

How Solar Knowledge Spreads: Who learns what, from whom, and how?

January 22, 2020

CleanEnergy States Alliance

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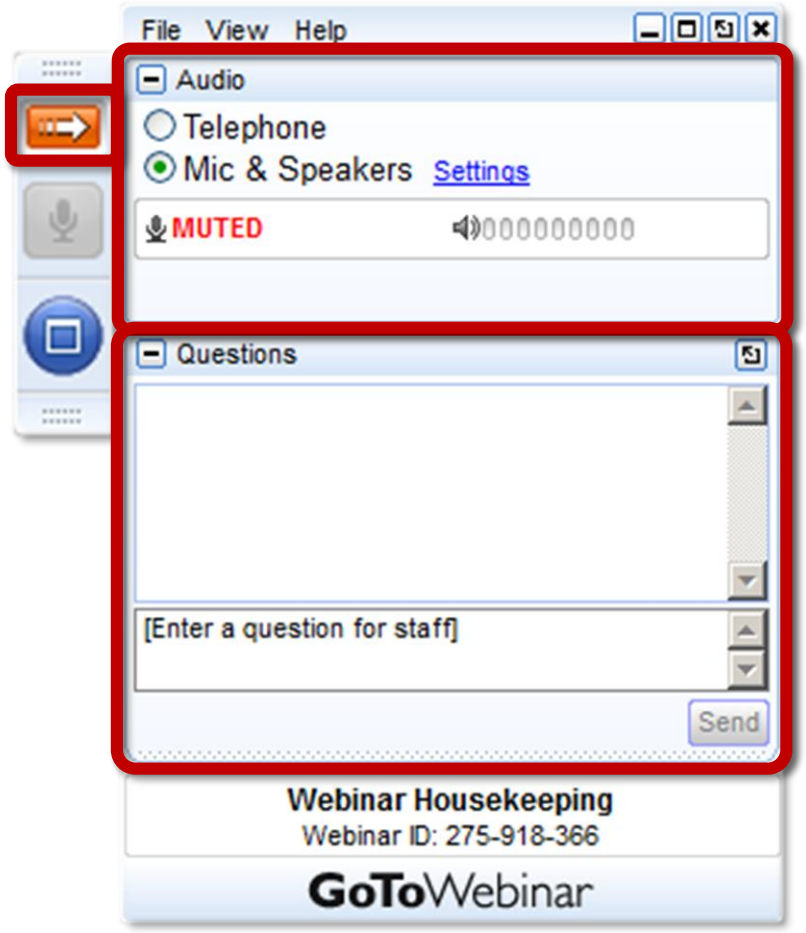

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Webinar Speakers

- **Zachary Eldredge**
  Technology Manager, U.S. Department of Energy Solar Energy Technologies Office

- **Varun Rai**
  Energy Institute Director and Associate Dean for Research at the LBJ School of Public Affairs, University of Texas at Austin

- **Ariane Beck**
  Research Fellow at the LBJ School of Public Affairs, University of Texas at Austin

- **Nate Hausman**
  Project Director, Clean Energy States Alliance (moderator)

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SOLAR ENERGY TECHNOLOGIES OFFICE

SEEDS 3
Notice of Intent

CESA Solar Knowledge Webinar

Zachary Eldredge, Technology Manager

Solar Energy Evolution and Diffusion Studies 3

- Following our SEEDS and SEEDS 2 research programs, SEEDS 3 continues to examine innovation and behavior in solar energy
- SEEDS 3 will study:
  - How knowledge spreads in the solar ecosystem
  - How solar adoption interacts with other energy technologies (storage, EVs, etc…)
- Goal: reduce non-hardware costs of solar energy by efficient knowledge dissemination

On Your Marks…Get Set…

- FOA awards are anticipated to have 1-5 year periods of performance.
- Further details will be provided if and when a FOA is released
- In anticipation of the FOA being released, potential applicants are advised to register in EERE Exchange and with other relevant federal computer systems as outlined in the full NOI.
- **All information is subject to change!**

How Solar Knowledge Spreads: Who learns what, from whom, and how?

Dr. Varun Rai (PI), *The University of Texas at Austin*

varun.rai@mail.utexas.edu

Team: Dr. Adam Henry (U. Arizona), Dr. Douglas Hannah and Dr. Ariane Beck (UT Austin), Dr. Greg Nemet (U. Wisconsin-Madison), Dr. William Rand (NCSU), Research Into Action

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LBJ SCHOOL OF PUBLIC AFFAIRS

Solar is a phenomenal growth story

- $17B investment in 2018, employs 242,000 people in the US.
- 71 GW total generating capacity as of Q3 2019; first or second largest share of new electrical generating capacity over the past six years.
- Policy and popular focus is on photovoltaic hardware; in fact, the bulk of the economic activity happens in a rich downstream ecosystem.
  - Around 60% of new solar capacity is in large utility-scale projects, the remaining 40% is “distributed” commercial and residential.
  - In residential, the top 1% of installers account for 60% of installations. But, there is a long tail: 2,400 active installers in 2016, 50% of whom specialize in solar.

https://www.seia.org/solar-industry-research-data

Soft costs account for up to 70% of the total cost of installed solar. The total share of costs attributable to soft costs is *flat or increasing*.

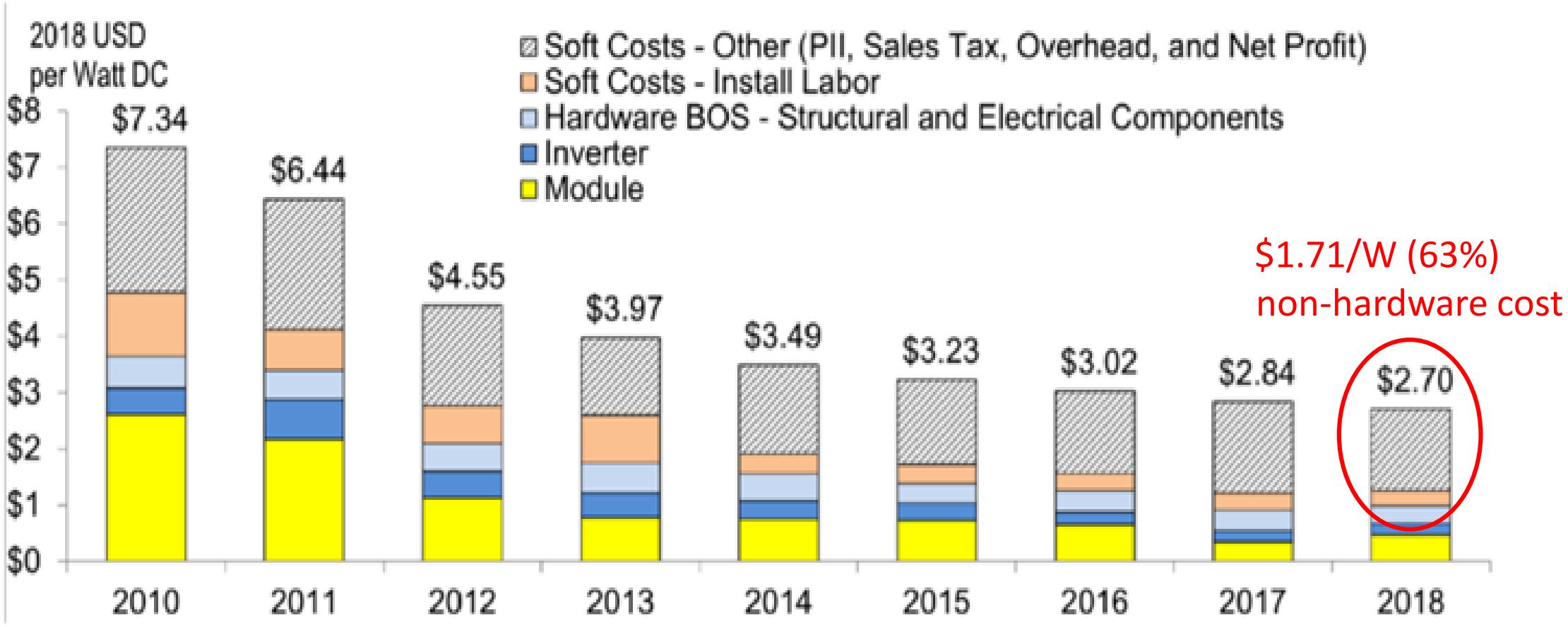
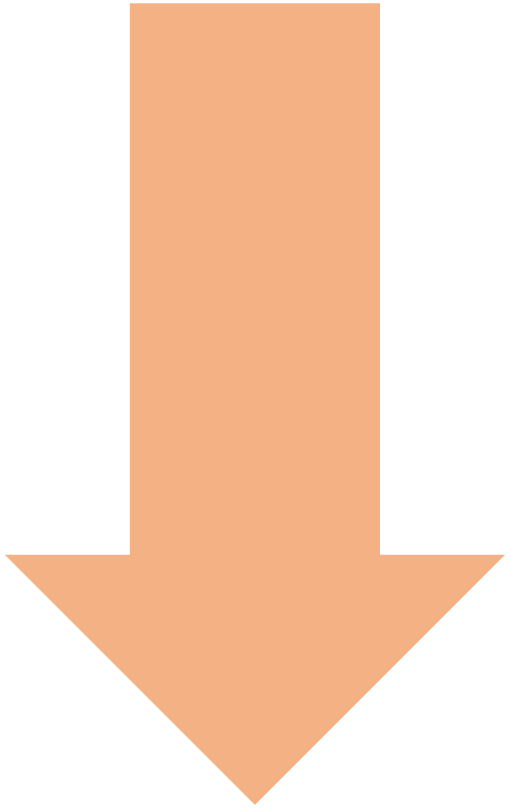


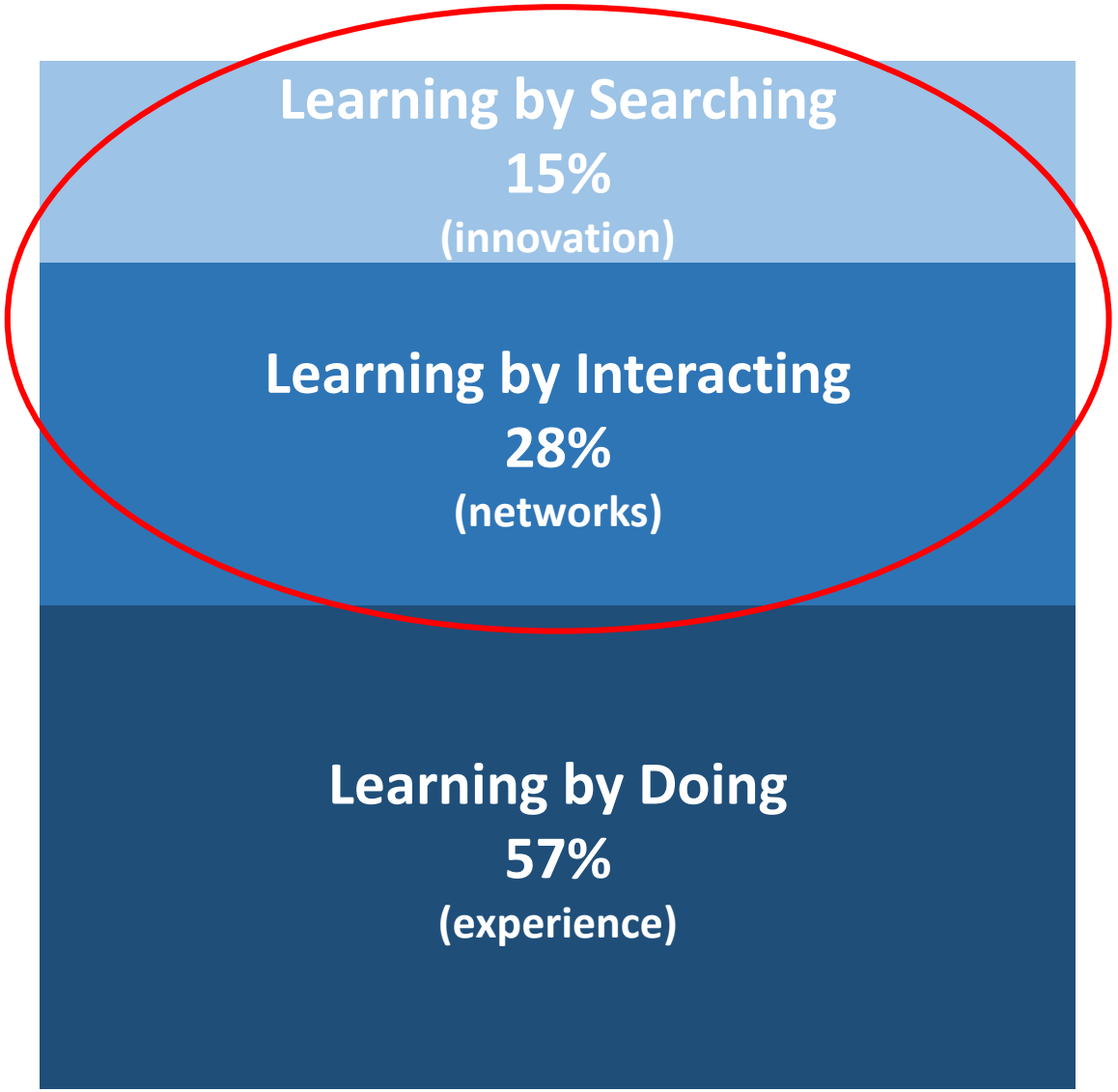
Figure 17. NREL residential PV system cost benchmark summary (inflation adjusted), 2010–2018

Learning contributes 21% of overall soft-cost reductions potential

Experience accumulation



Soft cost reductions

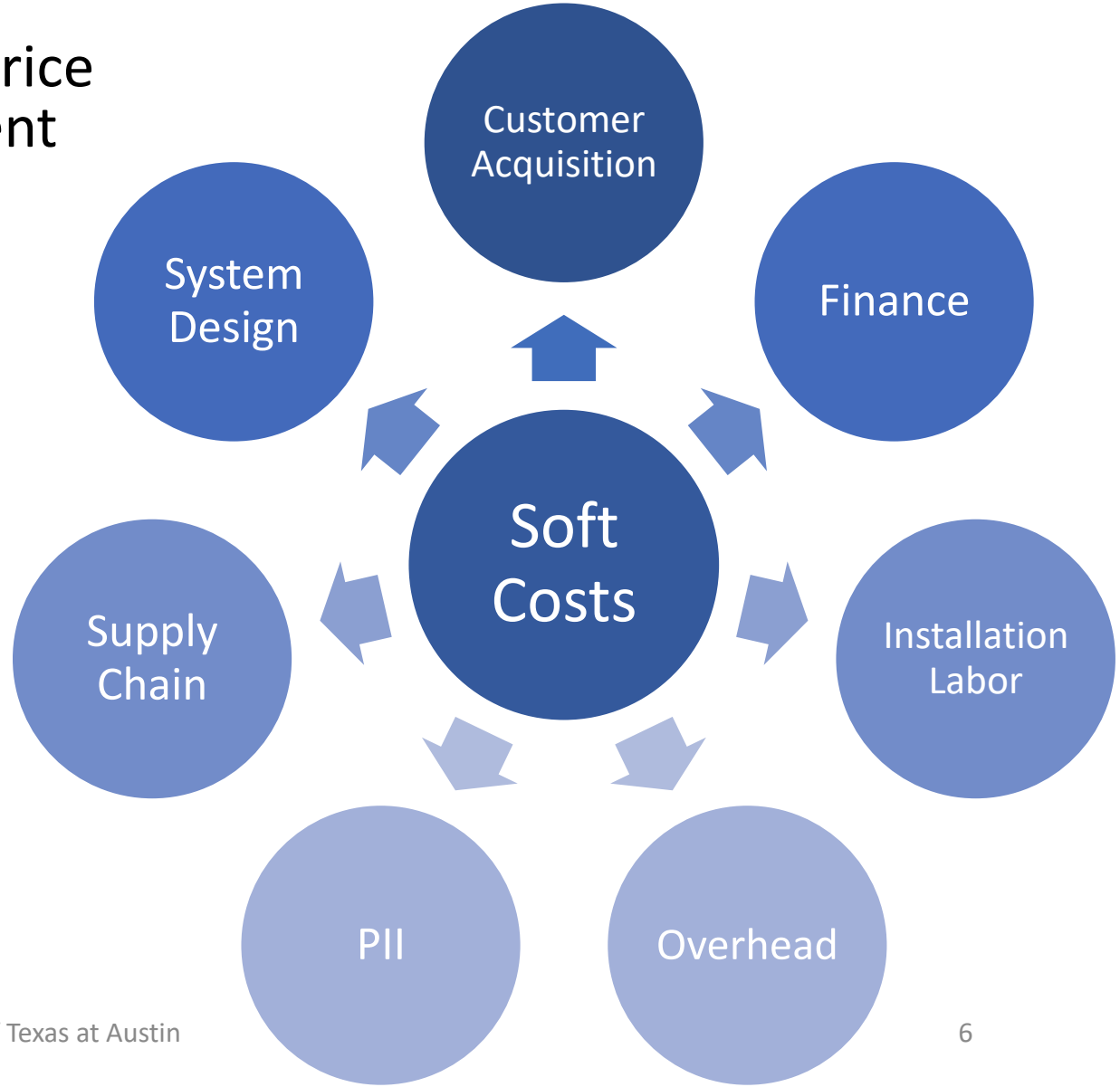


Who learns what (knowledge acquisition), from whom (knowledge production), and how (spillover mechanisms)?

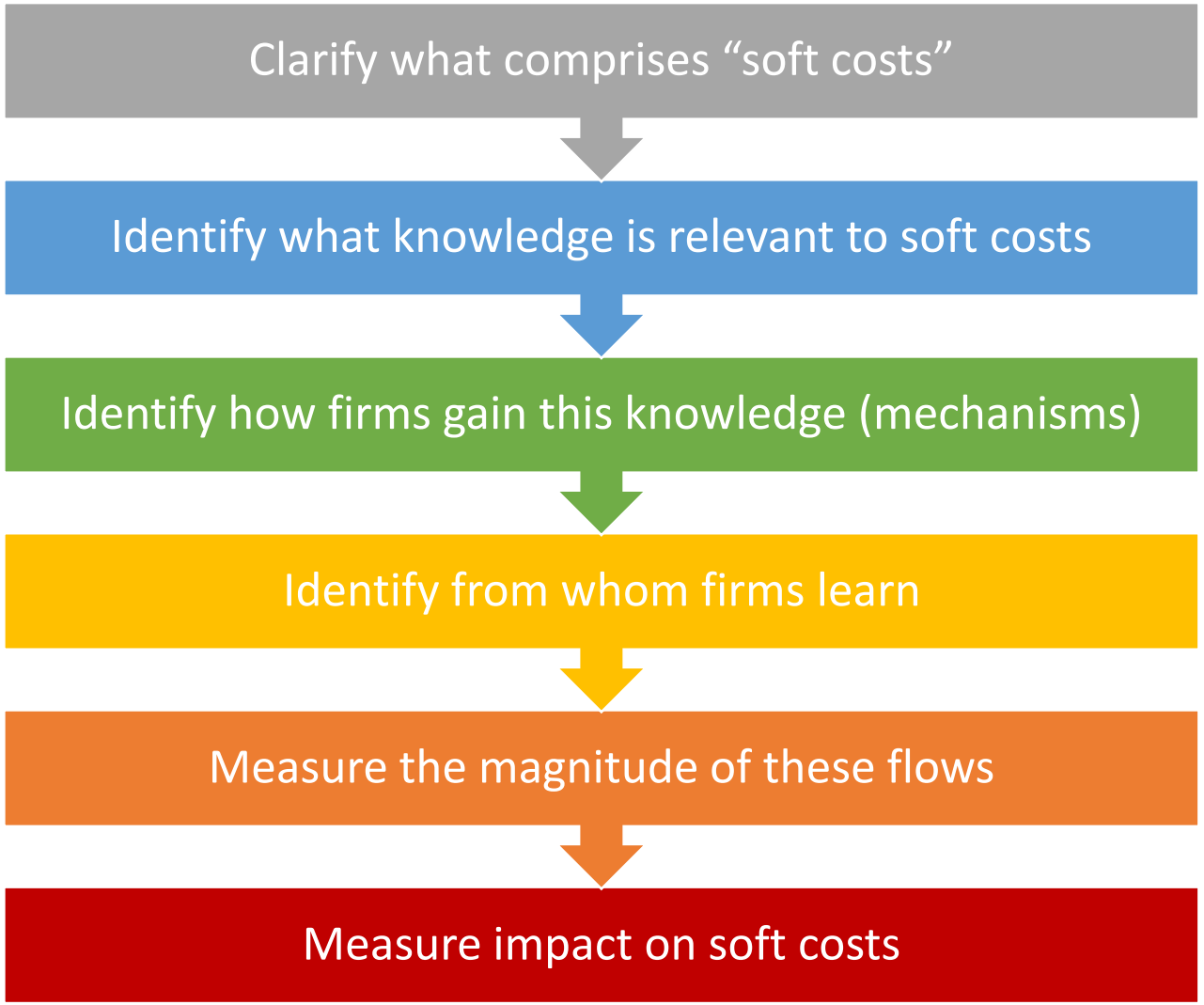
- Broadly, our work contributes to research on knowledge spillovers.
  - Knowledge spillovers occur when firms do not capture all of the benefits from investment in innovation and some "spills over" (Arrow, 1962; Gruber, 1985).
  - Spillovers in the solar industry are substantial: $15B cumulative from 2010-2015, $0.50 in social welfare / watt, substantial cost reductions (Newbery, 2018; Gillingham et al, 2016).
- While prior work demonstrates that spillovers are critical, questions remain particularly around knowledge flows and quantifying impacts

Soft costs are currently defined as *non-hardware costs*

- The difference between installation price (e.g., paid by customer) and equipment price (e.g., paid by installer).
- Many categorizations exist, most frequently:
  - Customer Acquisition
  - Finance
  - Installation Labor
  - PII
  - Sales Tax
  - Transaction cost
  - Profit margin
  - Supply Chain
  - Other



We used a multi-method approach to systematically identify solar soft costs and understand drivers to reducing soft costs



Data Sets

- Archival data set, 2000-2017
- Installer case studies, 2017-2018
- Complementary firm case studies, 2018
- Solar Soft Costs Survey, 2018
- Tracking the Sun Data (TTS), 2000-2015
- PV BOS Patent database, 2000-2015
- Network datasets

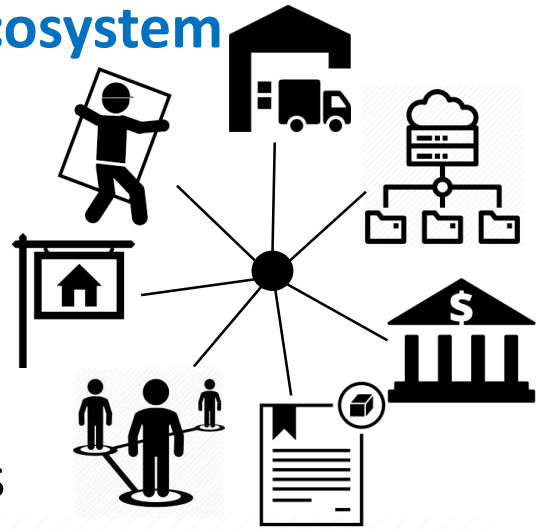
Key insights from the project

- Knowledge spillovers have significant potential to reduce solar PV soft costs
- Knowledge is a strategic asset, but successful pathways are complex and non-trivial
- Standard definitions of soft costs are needed to facilitate identification, research, discussion, and reductions of soft costs
- High variation in business practices and strategies is posing a fundamental limitation to soft costs reductions
- Regulatory and utility processes continue to create bottlenecks

Both top-down (policy) and bottom-up (individual and organizational) approaches can facilitate and accelerate potential soft cost reductions related to learning, experience, innovation, and strategic networking

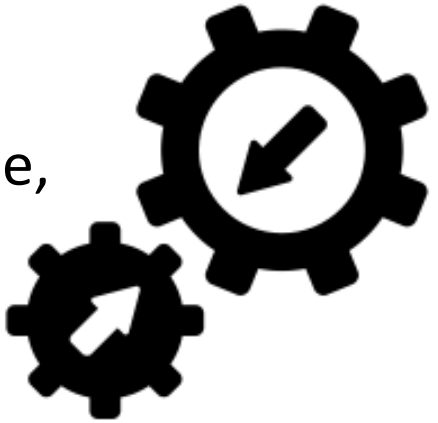
Support the whole ecosystem

Integrated policy should support installers, distributors, complementary sector, and facilitators



Look for opportunities to standardize

Fragmented policy and high variability in business practices reduces experience, increases PII costs, and creates barriers to complementary services

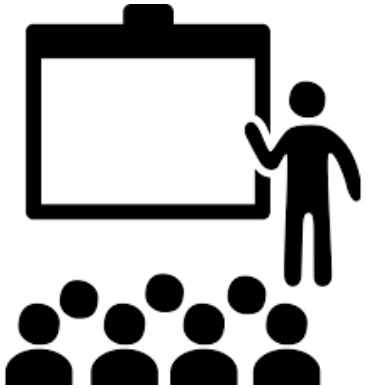


Foster experience

Policies supporting demand enable learning by doing and spillovers

Educate customers

High customer education costs create barriers and uncertainties in customer acquisition process



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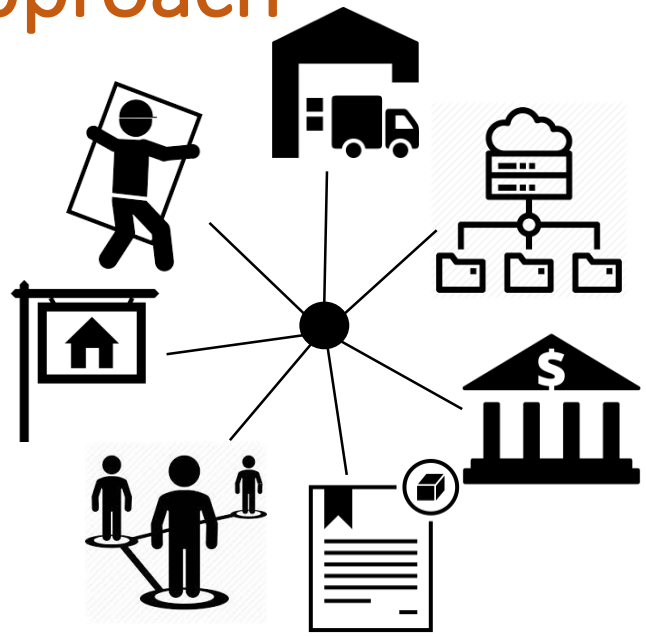
Support the whole ecosystem: An Integrated Approach



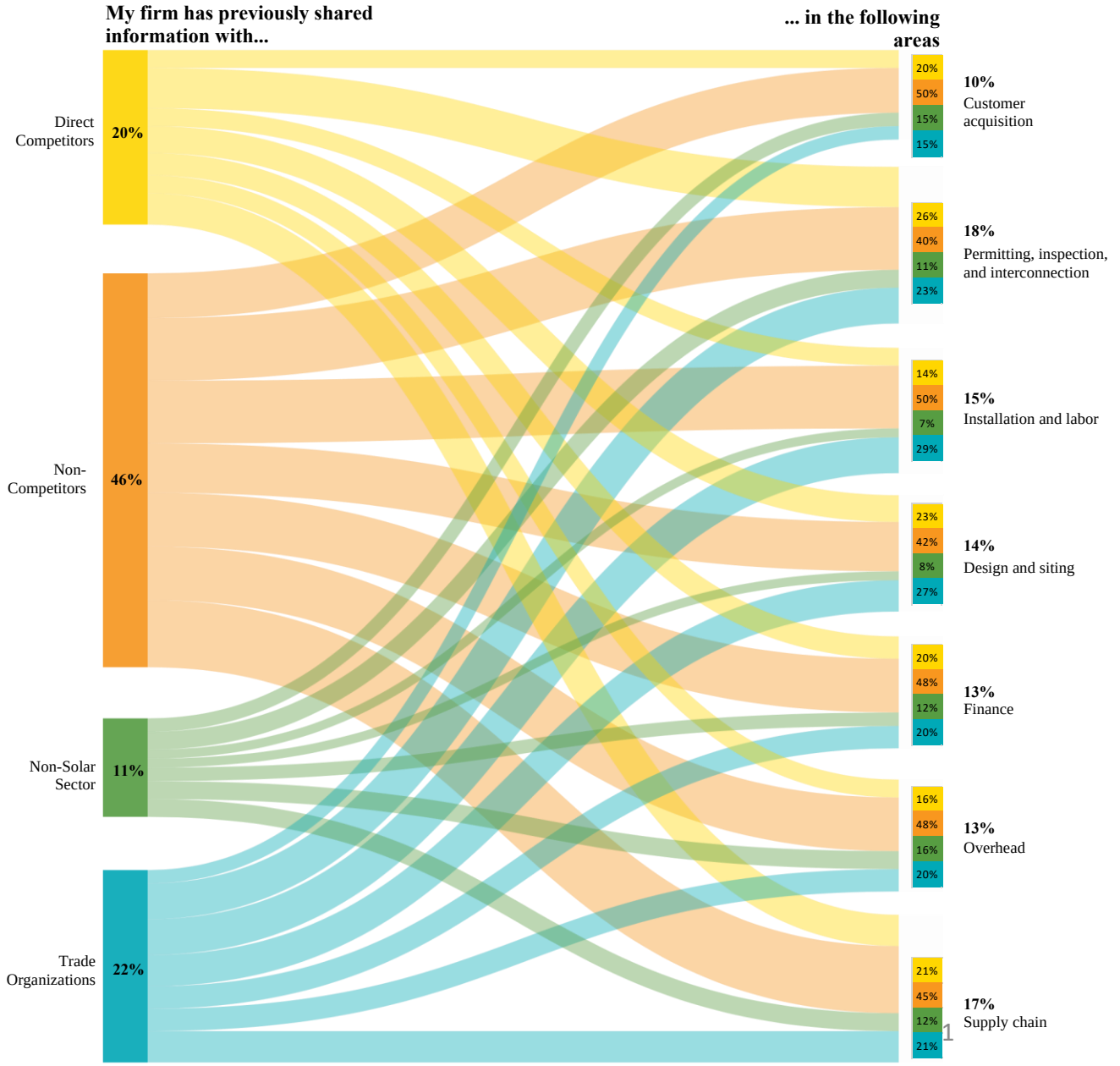
- "And really, why Amicus became important is information sharing, and best practices, and support group for very similar companies across the country." *–residential/commercial installer*
- "Because the bottom line is, they [manufacturer] got it to you when they could. Distribution is much more worried about the relationship and what they do and how it effects your relationship because they want your business." *–residential/commercial installer*
- "…what a stone age industry is freight. We've been in touch with all of the major carriers in the industry and no one really sticks their head above the others for the use of automation or use of advanced tools. We're working hard to add value in transit – to help reduce errors and increase reliability and replicability in the logistics phase." *–solar distributor*
- "All that stuff is done in house, not based on software, and we have continually checked, and there are products out there that do rapid layouts, rapid system designs, rapid wire takeoffs, rapid production estimates, and what we found is that they're just not flexible enough. They're not able to move as fast as we need them to move. They don't have the features we need. … they don't have that module, or they don't have that capability, … a really good example is …, it doesn't really understand the concept of skylights… by the time we teach it what to do, I could have done it just from scratch, … so we're just not finding that there's any efficiencies, and they're not flexible enough to keep up with us." *–commercial installer*
- "There's companies out there that are stupid simple, and there's companies out there that think you're financing a nuclear reactor. …it also has a humongous impact on the customer experience, in that it becomes basically impossible as an organization that you really start to ratchet down the umpteen rules that you have with a particular finance counter party. … and particularly where this really comes to bear is on change orders, which happen regularly on home improvement projects." *–residential installer*

Third-party actors critical, esp. for strategic elements

What firms learn varies with the *pathways* by which they learn

- **Distributors/suppliers:** Consumer tech, process improvements, admin best practice
- **Employee mobility:** Admin best practice, software tools
- **Trade shows:** Consumer tech, software tools
- **Industry groups:** Process improvements, software tools
- **Experimentation:** Process improvements

Information across the full scope of activities is more frequently shared with non-competitors: indirect flows are critical to complete the spillover of this knowledge to other installation firms.



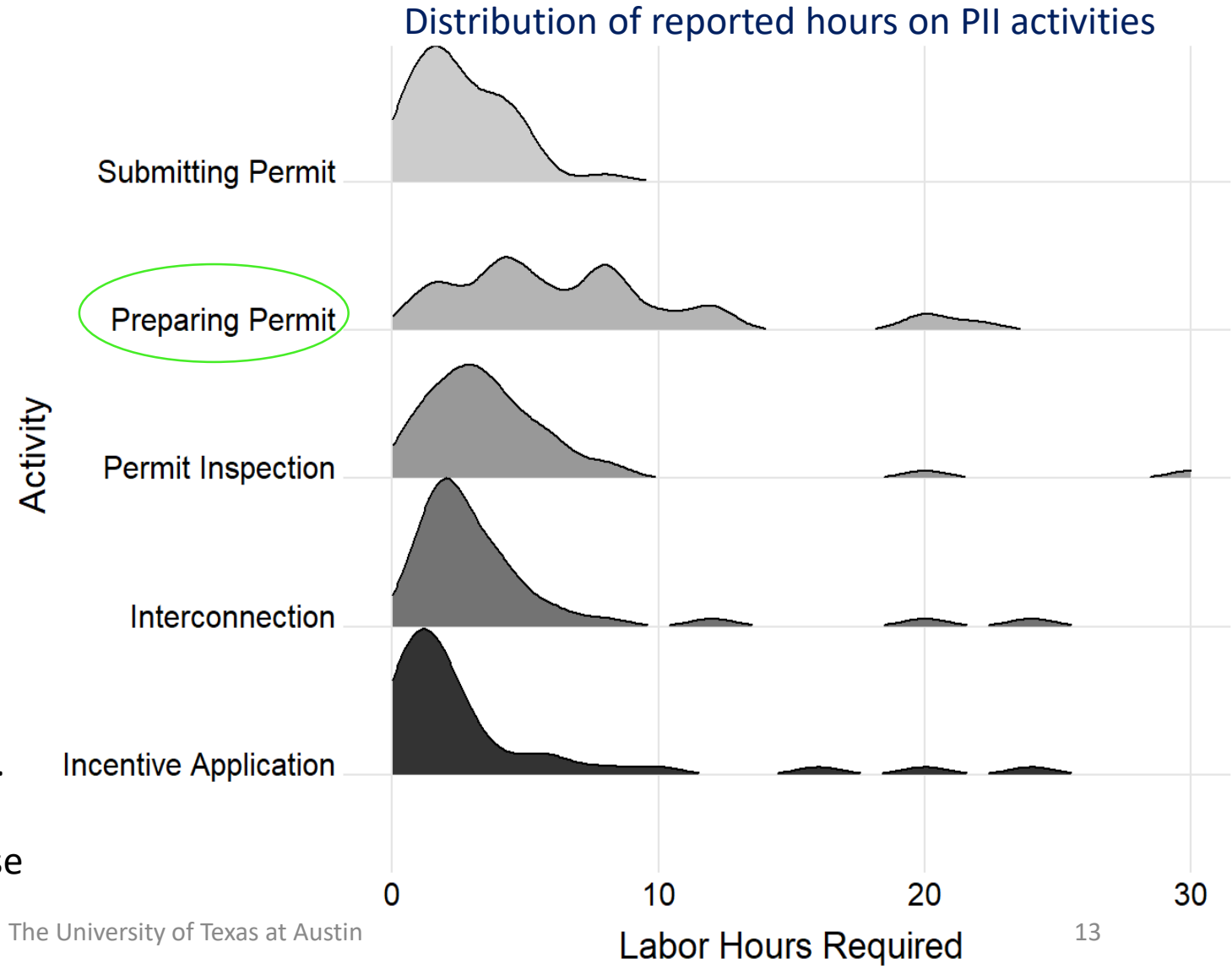
Look for opportunities to standardize

- "Every market is different with requirements and learning curves. … each one's got rules that are changing constantly and there's just so much to keep track of. I think that's where it becomes difficult, when you try to do this in different marketplaces." *–residential/commercial installer*
- "We had a home-grown database that was basically a database of all of the requirements and documentation that was ever required… for every jurisdiction that we worked in. You couldn't replicate that at a much smaller scale, right? We had to be at big scale to do that." *–residential/commercial installer*
- "Every time a utility changes something, we fix it in the database. It's a shared cost, we can count on building a business around it. But, there is a lot of duplication of effort there, and it's going to get worst before it gets better." *–SaaS provider*
- "Part of our pricing tool is that we have a database where one tab of it is all the towns, with what their specific weirdness's are. These guys require rough electrical. These guys require a stamped drawing in between racking and paneling. These guys... but every time it's a little different. So, literally, we have to build into our tool when we're pricing a project" *–residential/commercial installer*
- "When you're working state-wide it's really tricky because it's such a patchwork of municipal utilities, co-ops, rebates programs, deregulated markets. … every town has different requirements. Some want stamped drawings, some don't... Some have another PV meter you got to put in …, and where that's located in the system is different . There's a lot of nuances between the markets that the designer has to really be kind of on their toes with. Sometimes he's calling up to do some research to find out, because there's a million jurisdictions." *–residential/commercial installer*

Uneven regulatory environment is a source of constant frustration…and a competitive advantage for local firms.

- PII preparation
  - Preparing Permit is outlier
    - Distribution is broad, internally driven
    - Reflects variation in individual business practices
  - Other activities are uniformly distributed, reflecting external drivers
- Streamlining PII
  - Standardized permitting
  - Reducing approval times

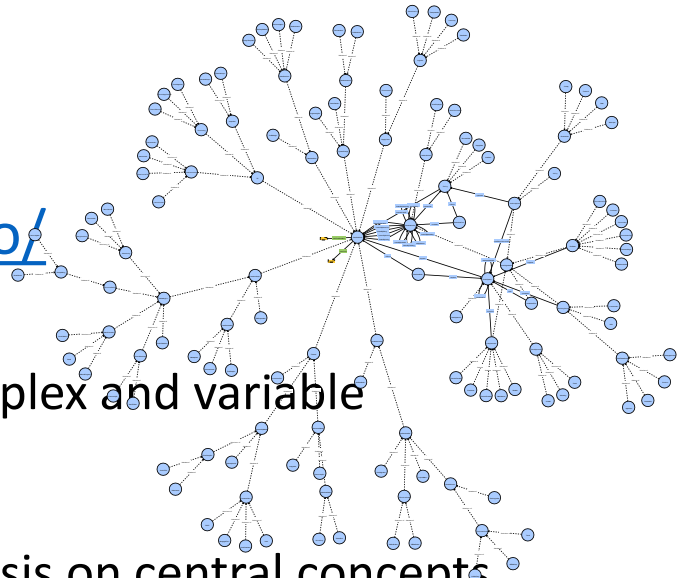
"I've only seen this expedited process in California. I haven't seen it anywhere else, but it was really nice. As part of that expedited permit, there's a website run by the State of California in which they had these documents of different permitting processes. Just open source." *–residential installer*



Creating software solutions for streamlining business processes is challenging due to high levels of variation (lack of standardization)

- Software design can reduce soft costs
  - Embed industry best practices
  - Reinforce company standard practices
  - Collect data in analyzable and actionable formats
- Barriers to software solutions
  - *For installation firms*
    - Time and expertise to develop tools
    - Technology lock-in to legacy systems
  - *For software providers*
    - Key operational differences, such as how firms acquire leads and structure sales and design flow
    - Complexity and variability in PII
    - Geographical variability limits customer base

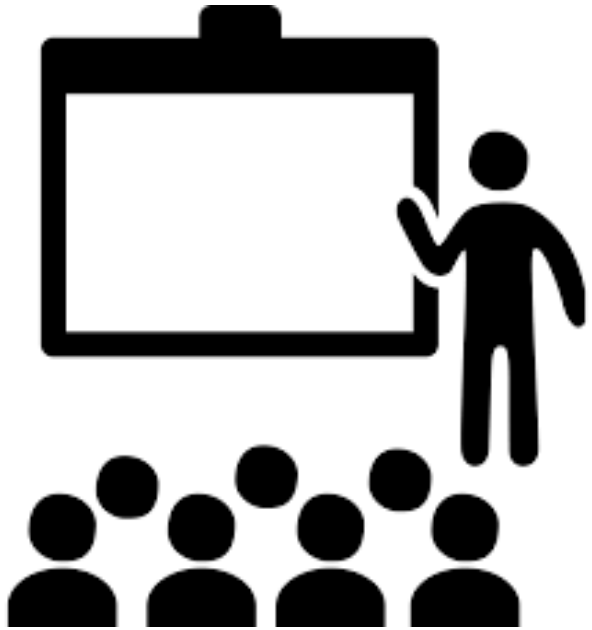
Solar Soft Cost Ontology (SSCO) Use Cases



- Available at: http://sites.utexas.edu/raigroup/category/projects/ssco/
- Researchers
  - High visibility into knowledge domain leveraging comprehensive view of complex and variable knowledge system
  - Gap analysis of research using machine-readable format
  - Interdisciplinary research design improved through simplified format, emphasis on central concepts, and elimination redundancy
- Policymakers
  - Target policy to reduce soft costs leveraging ontology's comprehensive view of solar sector knowledge domain and interrelationships can contribute to better allocated and directed resources
  - Identification of barriers to local industry to streamline updating and reporting for benchmarking soft costs and interventions, facilitating better evaluation of best practices and competitiveness
  - Landscape view of knowledge flows within solar ecosystem; how network actors create, share, and acquire knowledge of soft costs
- Solar Industry
  - Common vocabulary and translation layer for software solutions, leveraging machine-readable documentation
  - Data tracking for in-house analytics by linking accounting data from firm processes with soft costs

Educate customers

reduce customer acquisition costs and remove barriers



- "We spend a lot of time educating our customers. We don't try and do an accelerated close on our customers. We help them understand solar. We know that the odds are good or better they're going to talk to at least two vendors if not more. We'll never sell on price, it's just not what we do. What we do is we out-educate. We out-serve our competition. We try to be a company that is just too helpful to turn away." *–residential /commercial installer*

- "Our marketing costs are pretty reasonable. Our sales costs are pretty high because there's a lot of customer education needs to happen both with the incentives and how taxes work." *–residential/commercial installer*

- "It's like you're helping with the government initiative by talking to people about solar because that's a large part of the soft cost is educating people about solar. That is a large part of how we spend our time. Especially now with batteries coming up." *–residential/commercial installer*

Customer education is a continuing cost where benefits aren't necessarily captured by the initial educator

- Need for customer education (thus sales costs) increasing with new technologies, finance, and dynamic regulatory environment

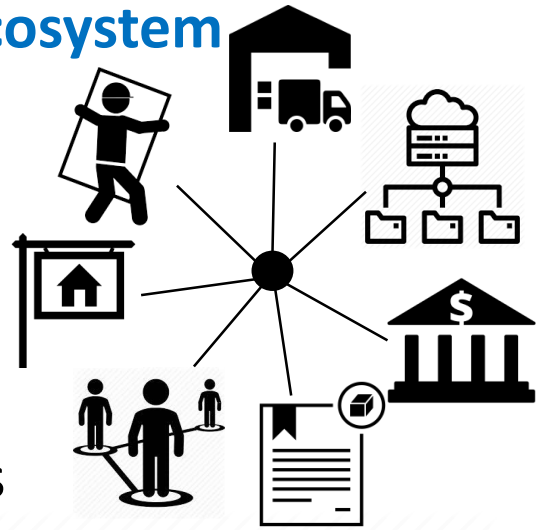
- Referral programs most frequently used
  - Lowest cost
  - Takes time to build pipeline
  - Imposes a constraint on growth rate

- The previous priorities – supporting the whole ecosystem, fostering experience, and standardizing – all have the potential to reduce barriers to customer acquisition by
  - reducing upfront costs,
  - simplifying the information customers need (e.g., regarding regulations and financing), and
  - reducing the uncertainty that results from changing or inconsistent information.

Both top-down (policy) and bottom-up (individual and organizational) approaches can facilitate and accelerate potential soft cost reductions related to learning, experience, innovation, and strategic networking

Support the whole ecosystem

Integrated policy should support installers, distributors, complementary sector, and facilitators



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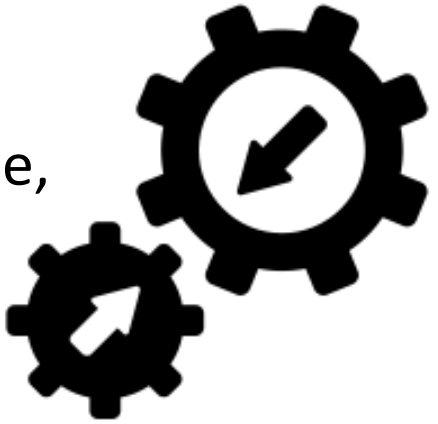

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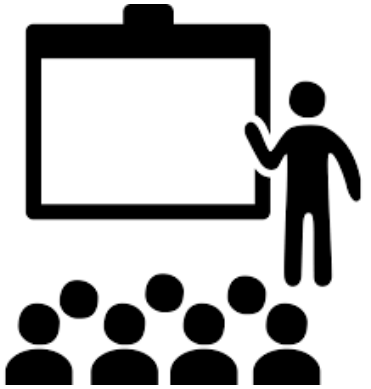

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Dr. Varun Rai (PI)

The University of Texas at Austin

http://www.utexas.edu/lbj/directory/faculty/varun-rai

Email: varun.rai@mail.utexas.edu

Phone: 512-471-5057 (work)

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