



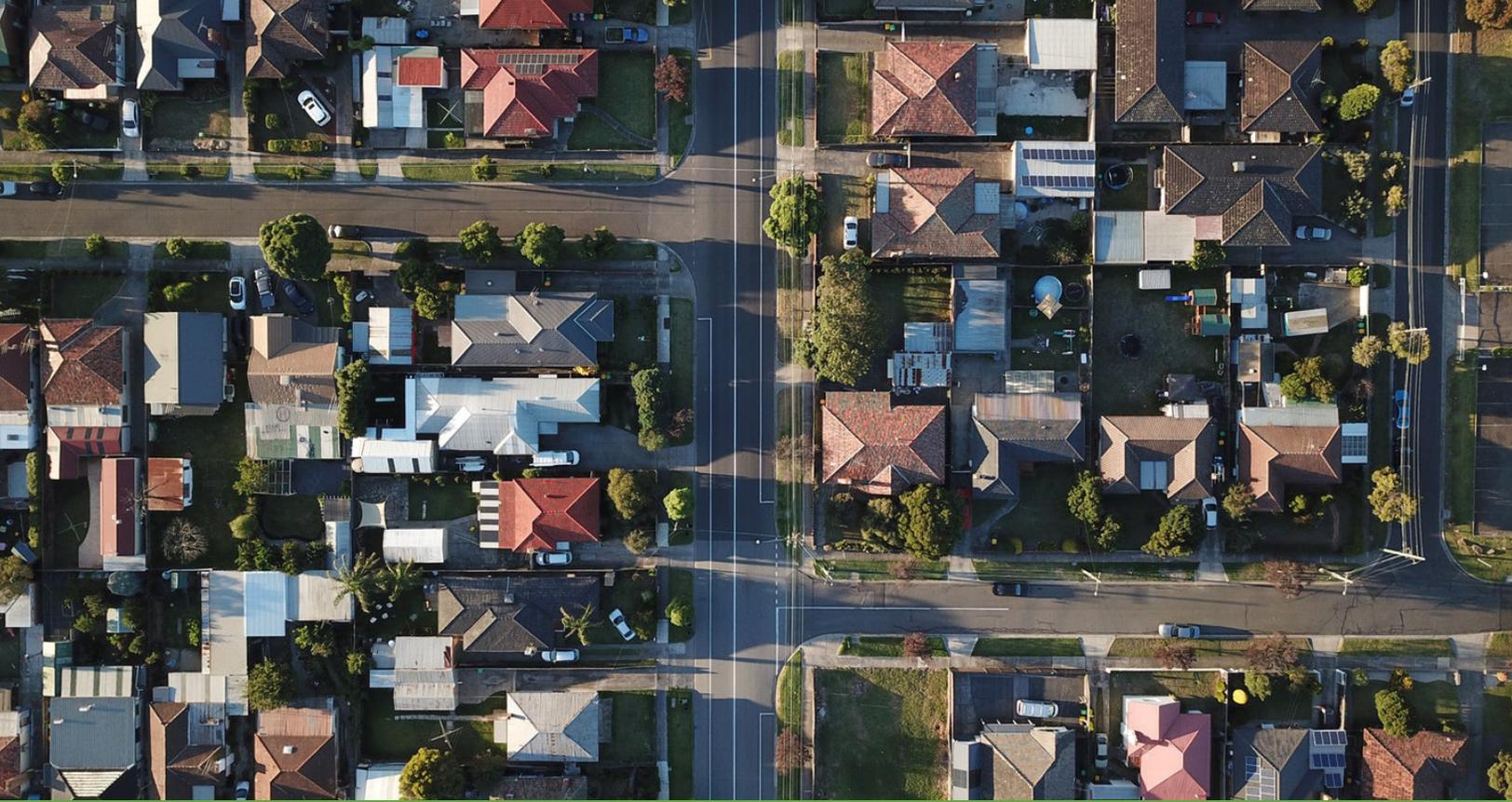
**BUILDING  
PERFORMANCE**  
ASSOCIATION

# **BUILDING A SUSTAINABLE RESIDENTIAL INFRASTRUCTURE:**

**Opportunities, challenges, and policy strategies to drive residential energy efficiency and decarbonization through advanced technologies and approaches**



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While any report that aims to capture a moment in time of an evolving industry will soon be out of date, we hope this report will help to challenge and inform some of that change and support a robust home performance industry of the future. Any errors, omissions, views, opinions, or premature conclusions made here are ours alone.

## Guide to Reading this Report

The research process for this report took place before the development or passage of the federal Infrastructure Investment and Jobs Act, the new law passed in November of 2021 which provides substantial funding to implement new and expand existing energy efficiency and building decarbonization programs and sets a historic new backdrop for our findings. At the time of publication of this report, Congress is poised to pass the 2022 budget reconciliation bill which is the largest climate spending package in U.S. history and includes nearly \$9 billion dollars specifically for residential energy efficiency and electrification rebates and training in addition to billions of dollars in tax credits. The results of this research, aimed at identifying the greatest opportunities and challenges to advance residential energy efficiency and home performance, may be used by Federal, state, and local entities to help absorb this influx of Federal funding and maximize implementation of energy efficiency initiatives for homes.

A key recommendation that emerged from this report was for additional research to identify successful ways for state policymakers and programs to be stacking energy program money and best leveraging different and often complex funding streams. At the residential level, as noted in this report, simplicity is key for contractors and customers. A forthcoming report to be published by ACEEE is aimed at addressing these questions and concerns for implementing residential programs.

**Reader Tip:** Interviewees are identified by their full name and organization only in the initial citation. For the full list of interviews please see *Appendix: Summary of Research, Methodology, and Context*.

## I. Setting the Stage

The development of this report has coincided with historic new federal action on infrastructure with the passage of the Bipartisan Infrastructure Law, formally known as the Infrastructure Investment and Jobs Act (IIJA), which will send billions of dollars in new funding to state energy offices and organizations to advance clean energy technology deployment, financing, and program implementation. This historic opportunity to ramp up existing energy efficiency and home performance programs to fundamentally change the way that energy is used in homes across America emerges before a background of energy security concerns, a growing urgency to address the climate crisis through rapid decarbonization, as well as persistent housing inequalities and disparate energy burdens hurting underinvested and marginalized communities. New funding also presents a significant challenge for states who will need to quickly build necessary capacity, streamline different funding sources and design effective programs in order to deliver on the opportunity. As policymakers and regulators look ahead at their own state energy planning and how to prioritize and leverage investments with federal infrastructure funding, this report offers insights, best practices, and guidance on ways to support and scale innovation in home performance to advance climate goals and environmental justice while supporting state policy priorities. The report—built on extensive research, industry needs assessment, and interviews with stakeholders and experts prior to the law’s passage—is intended to serve as a resource for any state or other entity looking for opportunities and approaches to scale residential energy efficiency efforts and programs.

*\*\*\*At the time of publication of this report, Congress is voting on the Inflation Reduction Act as 2022 budget reconciliation. HOPE for HOMES, key federal legislation highlighted in this report, is included in the package at a \$4.5 billion funding level, alongside an additional \$4.5 billion for a High-Efficiency Electric Home Rebate Program. If enacted, both new programs could dramatically advance opportunities to implement the innovative technologies and approaches outlined in this report. More information on the opportunities with this historic funding and how it can be combined with IIJA and other state and utility funding sources will be detailed by the authors in a future report anticipated for release before the end of the year.*

## II. The Infrastructure Opportunity

Homes are an important part of our nation’s energy and physical infrastructure with a unique connection to the lives of Americans. Residential buildings also remain a largely untapped resource for carbon reductions. Research shows that retrofitting all U.S. homes constructed before 2000 would reduce emissions by 242 million tons per year and save \$66 billion on energy bills, while also creating over one million full-time jobs for ten years.<sup>1</sup> Advancing residential energy efficiency at the speed necessary to meet U.S. climate goals will depend on the ability to scale successful models and implement innovative strategies to improve home performance and advance decarbonization. Understanding the challenges and barriers that are impeding the speed and scale of adoption of advanced technologies and approaches, and identifying current industry needs, can inform efforts to advance residential energy efficiency at a local, regional, and national scale.

The Infrastructure Investment and Jobs Act (IIJA) signed into law in November of 2021 provides billions of dollars in new funding to invest in energy infrastructure and energy efficiency and presents a significant and historic new opportunity to scale up home performance and residential decarbonization at the speed and scale needed to address climate, resilience, energy security and affordability, and environmental justice. The following are key provisions from IIJA which are positioned to help advance home performance across America:

<sup>1</sup> [https://e4thefuture.org/wp-content/uploads/2021/10/Energy-Efficiency-Jobs-in-America\\_National-Summary-2021.pdf](https://e4thefuture.org/wp-content/uploads/2021/10/Energy-Efficiency-Jobs-in-America_National-Summary-2021.pdf)

- **\$250 million for the Energy Efficiency Revolving Loan Fund (RLF) Capitalization Grant Program** to provide grants to State Energy Offices to administer revolving loan funds for energy audits, upgrades, and retrofits for both residential and commercial buildings.
- **\$40 million for an Energy Auditor Training Grant Program** to provide State Energy Offices up to \$2 million through competitive grants to train individuals to receive certifications to conduct energy audits or surveys of commercial and residential buildings.
- **\$500 million to the State Energy Program (SEP)** providing formula-based funding to state energy offices which can be used to support energy efficiency programs, among other eligible activities to advance energy security and state-led energy initiatives.
- **\$3.5 billion for the Weatherization Assistance Program (WAP)** to provide weatherization services to low-income households, including insulation and air sealing. (The 2020 reauthorization of WAP also broadened allowable uses of funds to include home energy management systems and smart devices.)
- **\$550 million for the Energy Efficiency Conservation Block Grant Program (EECBG)** which provides grants to State and local governments to implement and manage energy efficiency and conservation programs for buildings and other sectors.
- **\$3 billion for the Smart Grid Investment (SGIG) Matching Grant Program** to provide Federal matching funds for 50% of the costs to adopt smart grid devices, advanced metering infrastructure and software in commercial and residential buildings which facilitate demand flexibility, the aggregation of distributed energy resources, and two-way grid communications.

These significant new federal investments could help turbocharge deployment of clean energy and energy efficiency across the country and usher in a new era for home performance. They are also part of a broader renewed focus on upgrading the nation's residential building stock to advance decarbonization, resilience, affordability, and equity.

The Biden Administration has outlined new national goals to decarbonize every sector of the economy. In his first 100 days in office, the President issued an Executive Order setting a nationwide target to reach net-zero carbon emissions by 2050. To achieve this goal, the Administration has underscored the critical role of the residential building sector, announcing a set of initiatives and policies to spur advancements in home performance and eliminate emissions from the nation's homes. In March of 2021, President Biden released the American Jobs Plan which set a goal to build, rehabilitate, and retrofit more than two million affordable, accessible, energy efficient, and resilient homes over four years.<sup>2</sup> The President's Fact Sheet on Making American Buildings More Affordable and Resilient, released in May of 2021, also outlined a host of federal investments from the U.S. Department of Energy (DOE) and the Environmental Protection Agency (EPA) to increase deployment of high-efficiency electric home appliances, grid-interactive efficient building technologies, and a skilled energy efficiency workforce. The White House fact sheet announced \$30 million in new funding for technical assistance and grants to support a diverse workforce to retrofit and construct high performance buildings and \$10 million to accelerate the research and adoption of high efficiency heat pumps and water heaters.<sup>3</sup>

Meanwhile, as of July of 2022, Congress continues to consider additional measures beyond IIJA to address national climate goals and advance clean energy, including substantial investment targeted directly for residential energy efficiency upgrades. In particular, the HOPE for HOMES Act,<sup>4</sup> which was passed by the U.S. House of Representatives in 2021 and remains under consideration in Budget Reconciliation discussions, would provide \$6.25 billion in residential energy efficiency rebates—with

<sup>2</sup> <https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/>

<sup>3</sup> <https://www.whitehouse.gov/briefing-room/statements-releases/2021/05/17/fact-sheet-biden-administration-accelerates-efforts-to-create-jobs-making-american-buildings-more-affordable-cleaner-and-resilient/>

<sup>4</sup> The Home On-line Performance-Based Energy-Efficiency (HOPE) training and Home Owners Managing Energy Savings (HOMES) legislation was introduced in 2020 as S. 4052 and provided inspiration for the legislation found in Budget Reconciliation.

options for measured or modeled savings requirements—and training grants. HOPE for HOMES is linked with an additional \$6.25 billion “High-Efficiency Electric Home Rebate Program” to provide homeowners rebates for electric systems and appliances. Together, the \$12.5 billion in rebates and training would build on the IIJA provisions and increase their impact almost three-fold.

This historic focus on energy infrastructure investments and renewed focus on homes is also being made at a time when national security, dependence on foreign oil, and support for energy independence is paramount.<sup>5</sup> The U.S. faces a crucial opportunity to bring the country’s housing stock into the 21st century and support U.S. energy security and decarbonization while improving affordability, health, comfort, and security for American families. To be successful, implementation of these new funds and programs will require an all-hands-on-deck strategy and thoughtful coordination and collaboration with existing industry infrastructure to build capacity, design effective programs, and rapidly accelerate home performance and residential energy efficiency efforts.

This report is intended to serve as a resource for state policymakers, regulators, and others involved with the implementation of new and expanded residential energy efficiency efforts. They will need to be equipped with information, best practices, and lessons learned from existing program models and businesses who are implementing home performance projects on the ground today. Built on a foundation of market and policy research, industry surveys, and expert interviews, this report examines opportunities for innovative technologies and approaches to advance and scale home performance and identifies policy and market levers that can help clear the path forward.

As policymakers and energy officials face critical decisions ahead on how to prioritize infrastructure investments and plan for a secure and equitable energy future, this report can help inform and guide decision making, policy and program design, and implementation to maximize impact and drive forward residential energy efficiency.

### III. Findings: Deep Dives on Technologies & Innovative Approaches

#### a. Heat Pumps & Heat Pump Water Heaters (HPWHs)

Heat pumps and HPWHs have become an increasingly key part of the conversation on decarbonizing the residential building stock, in terms of both providing higher efficiency and demand flexibility, as well as a strategic electrification solution for regions looking to leverage a cleaner grid to meet emissions reductions targets. Heat pumps and HPWHs are high-efficiency and low-carbon solutions for the two largest energy end-uses: heating/cooling and water heating. When coupled with demand response programs or time-varying rates that appropriately value the load shaping that heat pumps and HPWHs can provide (through smart, grid-connected functionality and automation), these technologies can provide substantial cost savings to the customer.

Heat pumps have been used widely for many years in moderate climate zones such as the Southwest and Southeastern parts of the U.S. In colder climates, however, the technology still faces significant challenges—real and perceived—with performance, affordability, and comfort. In addition, the power generation mix, cost of electricity, and availability of natural gas in a given region all impact the cost-effectiveness and feasibility of implementing heat pumps.

Across the industry, contractors, policymakers, and stakeholders see heat pumps and HPWHs as a promising solution for the present and future. However, there is not a one-size-fits-all approach, and more work needs to be done to improve equitable access to these technologies, support a trained contractor workforce, and fine tune business models and retrofit approaches that optimize

<sup>5</sup> On February 24, 2022, Russia, the world’s largest producer of crude oil, invaded Ukraine in a move condemned as unprovoked and unjustified by the United Nations. It also began a spike in gas prices in the U.S.

performance, comfort, safety, and affordability while supporting emissions reductions. Now, with historic levels of energy efficiency funding from IIJA, there is a new opportunity for states to drive increased investment in heat pumps and HPWHs and dramatically scale the deployment of these technologies in homes. As one example, the RLF capitalization grant program authorized and funded under IIJA could be used by States to help address cost barriers. States may also leverage increased federal allocations for programs like SEP, WAP and EECBG from the infrastructure law to deploy new and scale up existing heat pump installation programs while investing in the necessary workforce training and consumer education to support success.

## Cold Climates

While heat pump technology has improved tremendously over the last decade or so—making it possible to heat a tight, well-insulated home in Maine or Connecticut without relying on back-up fuel heating—challenges remain with ensuring adequate performance through extreme cold and overcoming apprehension among consumers as well as contractors.

“In the Northeast, people still think of poor performing, expensive electric heat. There is a hurdle to adoption for consumers who grew up with faulty electric heat.”  
– Paula Glover (Alliance to Save Energy)

“Many homeowners in cold climates may not want to be completely reliant on electric—especially in rural areas. Having backup heating with a dual fuel system may be high on their list of priorities.”  
– David Terry (NASEO)

Pilot programs are continuing to test out performance of heat pumps in colder climates. In Illinois for example, ComEd ran a multi-family heat pump pilot program in 2020 to understand the energy impact for cold climate ductless heat pumps in Illinois. The pilot ultimately demonstrated the viability of heat pumps in cold climates and multifamily buildings. Even with extreme below-zero temperatures, the program received very few complaints or flags on performance and achieved 25% energy savings across all units.<sup>6</sup> Pilots like these can serve as a tested model with proven approaches that states can build on and scale up using new federal funding.

## Consumer Education & Contractor Training

Consumer education was identified as one key approach to bridging the gap between perception/fears and the reality of current technological capabilities.

“Education is needed about cold-climate heat pumps. Everyone is still thinking about their grandpa’s heat pump, and there is an opportunity for education to show how much better they are now.”  
– Steve Nadel (ACEEE)

“Some of it is overcoming perceptions of older equipment that didn’t work well. The technology – not necessarily from an operating cost perspective – is sufficient for a high-performing well-insulated home especially for those homes built to meet recent building energy codes.”  
– David Terry (NASEO)

<sup>6</sup> Remarks by Steven Labarge, ComEd (Exelon Utilities). BPA 2021 National Home Performance Conference, “Income Eligible Heat Pump Water Heater & Multifamily Ductless Heat Pump Pilot Programs.”

There is a gap among residential contractors as well, having the training and skills necessary to size and install heat pump units properly and ensure that the home also has adequate insulation and air sealing to maintain comfort and safety on the coldest days of winter. Many contractors we spoke to pointed to the need for improved access to training as one of the primary barriers standing in the way of wider implementation. Steven Labarge of ComEd also noted that adoption of heat pumps in Illinois has been slow because of the lack of trained contractor networks.<sup>7</sup> Heat pumps remain unfamiliar to many contractors, and they are both expensive and complicated to install, and it is easy to make mistakes according to Bob Davis, Senior Research Engineer at Ecotope.<sup>8</sup> Many homes also require duct resizing in order to work with the heat pump inverters and achieve the highest performance possible. Hal Smith, CEO of Halco in New York, says “you need to be able to specialize or have some expertise in duct work to perform that necessary work, otherwise the installation cannot happen.”<sup>9</sup>

“It’s not an easy transfer of knowledge, because the skills needed for heat pumps are different from skills insulation contractors need. That was our main reason for not jumping into it. We decided to focus on the insulation side.”

– Mark Tajima (Energia)

New federal funding opportunities for efficiency workforce training could be used to help alleviate these gaps. IIJA provides new training and technical assistance allocations for workforce development activities under WAP to ensure workers receive comprehensive training on a regular basis. In addition, in the March 2022 Program Notice on IIJA grants for WAP, DOE encourages braiding funds to increase deployment of additional technologies (including electrification) and workforce expansion.<sup>10</sup> State WAP agencies could use these funds to train more contractors in high-efficiency heat pumps and HPWHs, which would help more low-income households access the technologies paired effectively with weatherization upgrades.

Additional proposed federal legislation, the “HOPE” portion of the HOPE for HOMES Act which passed the U.S. House of Representatives in 2021, would provide millions more in targeted funds for residential efficiency retrofit training including installation of high-efficiency equipment like heat pumps. These proposed additional funds could support more comprehensive workforce training targeted to equip more workers with the skills to install heat pumps and help contractor businesses expand their business models to include them.

## Natural Gas

Heat pumps are most cost-effective in natural gas constrained locations, especially where they replace inefficient and costly oil and propane furnaces. In other areas, low gas prices and legacy infrastructure make the economics of switching to heat pumps more difficult. Some industry representatives caution that heat pumps are not able to cost compete with an efficient natural gas furnace yet, especially in those areas where gas is the cheapest and most accessible energy option. This is a concern especially for low- and moderate-income households from an equity and affordability standpoint, when the operating costs alone for a heat pump are significantly more expensive than staying on natural gas.

<sup>7</sup> Remarks by Steven Labarge, ComEd (Exelon Utilities). BPA 2021 National Home Performance Conference, “Income Eligible Heat Pump Water Heater & Multifamily Ductless Heat Pump Pilot Programs.”

<sup>8</sup> Remarks by Bob Davis, Ecotope. BPA 2021 National Home Performance Conference, “Barriers & Solutions to Heat Pumps as a Decarbonization Strategy.”

<sup>9</sup> Remarks by Hal Smith, Halco. BPA 2021 National Home Performance Conference, “Selling Heat Pumps: What Works with Electrification?”

<sup>10</sup> This guidance was released by DOE’s WAP Program Notice for implementation of the Bipartisan Infrastructure Law for the Weatherization Assistance Program, March 30, 2022. <https://www.energy.gov/sites/default/files/2022-03/wpn-bil-22-1.pdf>

In some cases, policies that prohibit fuel switching may stand in the way of a heat pump upgrade even when it is the more efficient and cost-effective option. In Virginia, for example, WAP installs heat pumps in low-income homes as a replacement to less efficient electric heating systems, but fuel switching has only been permitted on a case by case basis, making it very challenging to switch a gas-heated home over to an electric heat pump or HPWHs.<sup>11</sup> Even in states like California that are aggressively pursuing beneficial electrification, California contractor of Best Techs Contracting, Jason Scheurer posits that consumers need more education on the health risks of gas systems before they will opt to fully remove gas from the home. Scheurer says that he has seen many homes with gas furnaces or water heaters that were leaking carbon monoxide or had other safety issues.<sup>12</sup>

Across climate zones, contractors and stakeholders we interviewed agreed that an effective strategy for advancing heat pumps would be not to try to go head-to-head with natural gas, but instead focus on areas with greater opportunity to see immediate benefit from switching to a heat pump: homes with old, inefficient electric heating systems; rural areas that depend on oil and propane; and natural gas-constrained areas and/or where cleaner, more affordable electricity options are available.

### Dual Fuel

In some areas, due to extreme cold and consumer wariness, dual fuel systems that combine a heat pump with a gas (or even oil or propane) furnace as a backup heating source are emerging as the preferred model. Experts have noted that while heat pumps work well through extreme cold temperatures with gas or other fuel backup, better controls are needed to ensure that the homes are not just relying on the backup furnace and erasing the potential efficiency and emissions benefits of the heat pump.

### Low-Income Access

Price is a major obstacle standing in the way of wider access to and adoption of heat pumps and HPWHs. For HPWHs in particular, the upfront cost can be at least twice as high as a standard natural gas water heater. In addition, there are lingering unknowns or concerns about the durability of HPWHs and the lifecycle operating costs (particularly in areas where natural gas may still be the more affordable option). In April 2021, when he was Energy Bureau Chief at the Connecticut Department of Energy and Environmental Protection (DEEP), Michael Li noted that the state is trying to get HPWHs incorporated into WAP but there is hesitation because HPWHs are “so much more expensive than any other water heaters,” and there are concerns about reliability and having an adequate contractor network to service them.<sup>13</sup>

Meanwhile, some initial pilots have also shown promise in providing significant cost savings and energy burden reduction for low-income households. The Energize Connecticut program recently ran an income eligible HPWH pilot to address disproportionate energy bills and support increased access to efficiency. Ultimately, the program achieved annual savings of 91,505 kWh, an average of \$2,681 savings per household.<sup>14</sup> The program specifically focused on homes with an existing electric resistance water heater and also enrolled customers with Wi-Fi in a demand response program.

<sup>11</sup> Virginia Weatherization Assistance Program Operations Manual, April 2021.

<sup>12</sup> Jason Scheurer, BEST Techs Contracting, interview, March 2021.

<sup>13</sup> Michael Li, former Energy Bureau Chief at Connecticut DEEP, interview, April 2021.

<sup>14</sup> Remarks by Alysse Rodrigues, Avangrid. BPA 2021 National Home Performance Conference, “Income Eligible Heat Pump Water Heater & Multifamily Ductless Heat Pump Pilot Programs.”

Home performance contractor and trainer Xavier Walter, who now serves as State Outreach Coordinator for the Building Performance Association (BPA), sees HPWHs “taking off like hot cakes” in West Virginia but notes that there is a significant disparity between higher- and lower-income households. Walter says that for households investing in solar who are willing to “spend a good chunk of money on a nice heat pump,” HPWHs are low-hanging fruit to electrify and help lower the baseload, but there are as just as many people who do not care at all what the technology is because cost is the biggest concern.<sup>15</sup>

Low-income focused programs and enhanced incentives will be needed to support improved access to heat pumps and HPWHs for households where it makes sense as a reliable, cost-effective, efficient solution but the upfront cost limits adoption. The \$3.5 billion in additional funding for WAP under IIJA could help more states address barriers to heat pump and HPWH adoption in low-income homes including in cases where fuel switching is entailed. Cost-effective fuel switching installations are allowed to be performed using WAP funds, and in a March 2022 Program Notice on IIJA WAP funding, DOE indicated that they will continue to work to address additional barriers and improve ability to braud funds increase use of additional technologies including electrification in an effort to achieve the Administration’s goal of delivering equitable clean energy.<sup>16</sup>

### Policy Recommendations:

- Establish **quantifiable goals** for heat pump and HPWH implementation to create a market signal for investment in greater manufacturing capacity, contractor training, and other enabling infrastructure.
- Create more **direct incentives** for contractors as well as homeowners.
- Provide funding for **contractor training & education** on heat pumps and HPWHs (including grid-interactive systems).
- Support implementation of heat pumps and HPWHs in low-income households, particularly in gas constrained areas, through the **Weatherization Assistance Program**.
- Ensure a home is well weatherized when installing a heat pump in cold climates so it can maintain comfortable temperatures in the winter.  
Address **standards for new buildings that can be built to include full electrification** without putting the same standards on existing buildings that may require deep retrofits to meet the same thermal envelope. Allow these parallel policies to make progress in electrification while maximizing efficiency and cost-effectiveness.
- Set **standards for load-flexibility and grid-interactive capabilities** to ensure heat pumps and HPWHs can also be called upon to support reliability, affordability, and emissions reductions through demand response and load shifting.

### Areas for Further Research:

- **Develop strategies to manage operational costs** of heat pumps where electricity rates are higher, particularly for low-income households.
- **Map gas constrained areas** where homes rely on more expensive oil and propane for heat, to identify prime targets to cost-effectively switch to heat pumps (with consideration for different climate zones).
- **Identify ways to overcome the space requirement barriers** for heat pumps and HPWHs, which limits access for homes without free space.

<sup>15</sup> Xavier Walter, Building Performance Association (formerly with Energy Partners LLC), interview, May 2021

<sup>16</sup> DOE WAP Program Notice for implementation of the Bipartisan Infrastructure Law for the Weatherization Assistance Program, March 30, 2022. <https://www.energy.gov/sites/default/files/2022-03/wpn-bil-22-1.pdf>

- **Conduct workforce assessments** to identify whether particular jurisdictions have sufficient trained workforce to deliver installation, maintenance, and other necessary services for heat pumps and HPWHs.
- **Comprehensive lifecycle and operation cost analysis** for heat pumps and evaluate the durability and reliability of HPWHs and whether it is comparable to that of natural gas water heaters.

## b. Smart Home Devices & Technologies

Smart home devices encompass the broad swath of technologies which enable monitoring, automation and energy management of the home and its end-uses, as well as enabling demand flexibility to respond to grid conditions and reduce peak load through grid-interactive functionality. In addition to providing advanced control and supporting grid services, smart home technology bundles can provide numerous co-benefits to homeowners, including convenience, energy bill savings, comfort, health, and safety.

Home energy management systems (HEMS) describes a category of smart technologies specifically used for residential energy management, which may include advanced controls, sensors, models, software, analytics and/or machine learning. HEMS use data and analytics for optimization and can manage command or price signals sent via the utility or third party to enable demand response and load shifting. Smart thermostats, for example, offer monitoring, control, and optimization of HVAC systems to take advantage of energy saving opportunities (e.g., via learned schedules and low energy “away” modes).<sup>17</sup> Smart thermostats are also one of the most common smart home devices being deployed for efficiency and demand response programs. Advanced metering infrastructure (AMI) and home energy monitors are examples of other smart technologies that track energy consumption data at a granular level and can be used to measure performance, facilitate time-varying rates, and support more targeted energy efficiency and demand response solutions.

### Grid-Interactive Efficient Buildings & Load Flexibility

Increasingly, the value proposition of smart home technologies is moving beyond energy savings towards the load flexibility and grid-responsiveness they can provide to support the clean grid of the future that uses variable renewable generation and distributed energy resources while maintaining energy affordability and reliability. Lieko Earle, Senior Research Engineer at the National Renewable Energy Laboratory (NREL), describes the role for smart homes moving forward as “responding dynamically to the grid’s needs and pricing signals” and being “compatible, flexible and efficient from a whole grid and utility load perspective.” The emphasis is shifting from how much energy we use to when we use that energy through load flexibility — a concept which has profound implications on our renewable energy capabilities and increasing importance with national goals for 100% carbon free national grid by 2035.<sup>18</sup>

Many experts have noted that electrification and moving towards advanced end uses like heat pumps and EVs requires the integration of smart technologies for active demand management and flexibility, otherwise we face very large and costly grid buildout to meet skyrocketing demand. David Littell, Senior Advisor at the Regulatory Assistance Project and former commissioner of the Maine Public Utilities Commission, explains that without flexibility built into the distribution system, unnecessary huge costs will be incurred to serve greater demand.<sup>19</sup> David Terry, Executive Director

<sup>17</sup> For more information on how smart technologies can be integrated with traditional efficiency measures and used to manage distributed energy resources (DERs) in the home, see the Residential Grid-Interactive Efficient Building Report: <https://naseo.org/data/sites/1/documents/publications/AnnDyl-NASEO-GEB-Report.pdf>.

<sup>18</sup> Remarks by Lieko Earle, NREL. BPA 2021 National Home Performance Conference, “Smart on Smart Workshop: Products, People, Policy & Possibilities,” April 27, 2021.

<sup>19</sup> Remarks by David Littell, RAP. BPA 2021 National Home Performance Conference, “Access to Utility Data! Why Contractors Need It, Consumers Deserve It, and Utilities Should Provide It.”

of NASEO, agrees and says “Advancing beneficial electrification without smart devices will limit the long-term efficacy of such policies. Fairly sophisticated demand side controls are essential.”<sup>20</sup> As EV adoption increases, AMI and HEMS can enable smart charging so that the EV charges when it is cheapest and can even support peak demand reduction by acting as distributed battery storage. More states and utilities are beginning to explore opportunities for smart EV charging, recognizing that otherwise growing numbers of EVs will have a huge and costly demand impact on the grid. Commissioner Ann McCabe, of the Illinois Commerce Commission, says that because of that need for management and load flexibility, “policies to advance those DERs like EVs, and combinations of DERs like solar and storage, will help drive smart technologies.”<sup>21</sup>

## Challenges with Early Market Phase

The smart home device market remains in the early adoption phase, having only reached about 20% of homes across the U.S. (with smart thermostats, one of the most popular smart energy management technologies, only at around 13%). Contractors, policymakers, and industry experts alike point to the market fragmentation, lack of interoperability, and even costs as key challenges with current smart technology that are preventing more widespread deployment.

Michael Li, says that Connecticut is very interested, but “the fragmented market makes it hard for the smart home or HEMS framework to gain a lot of traction.”<sup>22</sup> According to Li, if the market coalesces around a few providers it would create standardization. This would make it easier for homeowners and contractors to seamlessly integrate different technologies into a coordinated smart home energy management system.

Jeff Boone is an insulation contractor in Kansas and president of NorthStar Comfort Services who is interested in future opportunities for smart technologies but says “I am still waiting for one system fits all – not necessarily a monopoly but having all pieces fit under one system.”<sup>23</sup> Scheurer sees a similar barrier: “We really need one centralized system to monitor the whole house without costing so much to install. The smart device needs to get to the same accessibility as an iPhone or Android or other common household technology.”<sup>24</sup>

While smart technologies may be cheaper than a heat pump or a deep energy retrofit, experts say there is still room for costs to come down to improve the value proposition. Steve Nadel, Executive Director of the American Council for an Energy-Efficient Economy (ACEEE), believes we need simpler, lower cost systems. Nadel notes that smart thermostats, while still a minority, are starting to take off “because people see benefits and costs aren’t too great,” so the question is “can you provide 50% more benefit at just twice the cost, as opposed to ten times the cost?”<sup>25</sup> Scheurer agrees, saying that his company is still looking for a more affordable, entry-level system. Scheurer works with comprehensive smart home control systems in high-end homes that can connect to everything from the HVAC to water, lights, blinds, and even the garage, but are prohibitively expensive for many people.<sup>26</sup>

Challenges with interoperability in the fragmented smart home market also present a roadblock to participating in utility demand response and active load management strategies. Many high-end HVAC systems only work with proprietary thermostats and communicating devices. Arizona contractor and co-owner of Ideal Air Conditioning and Insulation, Elena Chrimat, notes that is a barrier “because [the manufacturers] won’t open it up for the utilities to access or communicate with the devices.”<sup>27</sup>

<sup>20</sup> David Terry, NASEO, interview, March 2021.

<sup>21</sup> Ann McCabe, former and current commissioner at Illinois Commerce Commission, interview, March 2021.

<sup>22</sup> Michael Li, former Energy Bureau Chief at Connecticut DEEP, interview, April 2021.

<sup>23</sup> Jeff Boone, NorthStar Comfort Services, interview, April 2021.

<sup>24</sup> Jason Scheurer, BEST Techs Contracting, interview, March 2021.

<sup>25</sup> Steve Nadel, ACEEE, interview, April 2021.

<sup>26</sup> Jason Scheurer, BEST Techs Contracting, interview, March 2021.

<sup>27</sup> Elena Chrimat, Ideal Air Conditioning and Insulation, interview, March 2021.

New federal funding through the Smart Grid Investment Grant program (SGIG) could be used to help overcome existing challenges associated with the early market phase of smart technology and boost deployment of smart grid devices and software in homes. The SGIG program was originally established through DOE in 2009 to promote investments in smart grid technologies, tools, and techniques that increase flexibility, functionality, interoperability, cyber security, situational awareness, and operational efficiency through Federal matching funds.<sup>28</sup> Along with \$3 billion in new funding for the program, IIJA expanded eligible uses of SGIG funds to include smart devices and software that enable demand flexibility in buildings and to facilitate the aggregation of distributed energy resources.<sup>29</sup> Electric utilities will therefore be able to leverage significant federal funding to provide smart devices to customers to enable demand response, load flexibility, and energy management. Importantly, these devices may need access to electric and gas data at the meter to allow more deep measurements and management opportunities.

### **Consumer Awareness & Acceptance**

Improved customer awareness about the smart home is needed to drive further adoption of these technologies. There are a wide range of customer concerns currently standing in the way. In 2020 Beth Karlin, CEO of See Change Institute, partnered with Uplight, a leading national marketplace for smart home devices, to survey a representative sample of 1,000 customers across varying incomes and geographic locations to gauge the greatest behavioral motivators and inhibitors to smart home device purchases. The survey showed that there is still much confusion and hesitance in the marketplace. The two most common reasons why customers did not purchase home devices were lack of understanding or confidence on how to install, operate, and maintain them, and skepticism regarding how they provide value or produce further benefits beyond the devices they already had. Some customers also expressed concern that the devices would not be durable or require frequent replacement, while others did not want to crowd their home with complex technology.<sup>30</sup>

These market reservations can be addressed through investments in consumer education to clearly demonstrate the value of the technologies, provide customer support throughout the lifecycle of the products, and align marketing and public incentives with customer values. Administering educational resources that are simple and concise from reliable sources such as DOE and State Energy Offices (SEOs) could help to open up the smart home device market to homeowners who are confused or reluctant.

### **Contractor Training**

In tandem with ongoing homeowner support, increased education for contractors can help integrate smart home devices into standard weatherization and energy efficiency services. Speaking on the keys to smart device expansion in the Southeast, Xavier Walter, says “Contractor education is important. The new technologies and the manufacturers have not brought training into community colleges and vocational training, and so the instructors are not using the new modern way to teach the trade technician yet.” As homeowner awareness and appetite for smart devices increases, accessible training opportunities for local contractors will prepare the workforce to expand their business into the market and deliver installation, monitoring, and maintenance solutions.

<sup>28</sup> The SGIG Program was initially created under the American Recovery and Reinvestment Act of 2009. For more information on the creation and purpose of the program, see the SGIG Program Overview at [https://www.smartgrid.gov/recovery\\_act/overview/smart\\_grid\\_investment\\_grant\\_program.html](https://www.smartgrid.gov/recovery_act/overview/smart_grid_investment_grant_program.html)

<sup>29</sup> See Section 40107 of the [Infrastructure Investment and Jobs Act](#) for full details on SGIG Program eligibility and funding uses.

<sup>30</sup> Remarks by Beth Karlin, See Change Institute. BPA 2021 National Home Performance Conference, “Smart on Smart Workshop: Products, People, Policy & Possibilities,” April 27, 2021.

Ongoing contractor engagement and training can also be crucial to ensuring homeowners receive the support and information needed throughout the lifecycle of their smart home devices. “Creating engagement and support along the entire technology cycle—from manufacturing to marketing to delivery to maintenance—will really help drive education and customer loyalty,” according to a representative from Uplight.<sup>31</sup> Focusing on this demand, Uplight provides direct links through their smart device marketplace to contractors in the local area to assist customers who are not comfortable installing and monitoring their devices. These contractors can then establish a trusted relationship with the homeowner, optimizing installation and helping to address any maintenance obstacles through continual monitoring. Easy access to local contractor support through marketplace networks and utility program administrators can ease the technological hesitance from consumers and drive greater adoption of smart devices.

## Data Access

Lack of data access and interoperability issues are two key barriers preventing the home performance industry from unlocking the full value of smart home technologies and devices for energy management and residential decarbonization. With smart devices and granular near-real-time data from AMI, contractors and service providers can gain powerful insights into home energy usage and opportunities for savings, but it requires secure and seamless access to utility data as well as interoperability across devices and communications protocols.

Data access, including the ability for residential customers to assign third-party access, enables competition and innovation to provide the best energy management services to customers. A 2019 report from Mission: data, entitled “3rd Parties and Beyond: Promoting Innovation Through Energy Data Sharing With ‘Nth’ Parties,” discusses current barriers preventing secure access to utility data for home energy management: “The spread of new digital services in the energy sector — such as smartphone ‘apps’ for home energy management, and the Internet of Things (IoT) — is exciting, but many privacy rules imposed by state regulators on utilities are outdated or crudely constructed, limiting customer choice without meaningfully increasing privacy.”<sup>32</sup> For example, David Littell, Senior Advisor at the Regulatory Assistance Project points out that “Non-Disclosure Agreements (NDAs) can be an impediment for pushing state data access policies because many groups looking to export energy data to optimize home performance are not accustomed to working with these documents. Some states are looking to create statewide NDAs while other states are considering automatic data releases on an anonymized level.”<sup>33</sup>

Policies and best practices for standardized and secure data access will also help to reassure homeowners concerned about data privacy and even cyber security. Scott Taylor with Sense, the home energy monitor manufacturer, highlights data privacy as a key issue that his company is navigating “because we know a lot about what is going on in the house and we want to protect this data and distribute securely.”<sup>34</sup> At the BPA 2021 Smart on Smart Workshop, hosted virtually on April 27, 2021, contractors and program administrators shared that they are increasingly hearing concerns from customers about cyber risks and the possibility of smart thermostats being hacked.<sup>35</sup> Beth Karlin describes the most effective strategies to overcome data privacy concerns according to research:

<sup>31</sup> Remarks by Kristen Kadetsky, Uplight. BPA 2021 National Home Performance Conference, “Marketing the Smart Home, Insights and Opportunities, Engaging Consumers in Their Quest for Smart Technology.”

<sup>32</sup> <https://static1.squarespace.com/static/52d5c817e4b062861277ea97/t/5ddd6e30a4a0c049553154ee/1574792761671/ThirdPartiesAndBeyond.pdf>

<sup>33</sup> Remarks by David Littell, RAP. BPA 2021 National Home Performance Conference, “Access to Utility Data! Why Contractors Need It, Consumers Deserve It, and Utilities Should Provide It.”

<sup>34</sup> Remarks by Scott Taylor, Sense. BPA 2021 National Home Performance Conference, “Smart on Smart Workshop: Products, People, Policy & Possibilities,” April 27, 2021.

<sup>35</sup> BPA 2021 National Home Performance Conference, “Smart on Smart Workshop: Products, People, Policy & Possibilities,” Lightning Round Breakout Rooms, April 27, 2021.

“absolute transparency is the best way to deal with privacy and data ownership: make it clear, simple, and show that the data is safe and will not be exploited.”<sup>36</sup>

Ensuring fair and transparent data access is critical to the development and implementation of any new federal funding which supports smart home technology deployment. IJJA allocates billions of dollars in new funding available to support deployment of smart grid technologies including smart devices and HEMS which enable demand flexibility in homes. However, the value of these investments can only be fully accessed if the technology is directly attached to policies which ensure secure, transparent, and portable data.

### “Economics Aren’t There Yet” & Incentives not Aligned

“The current economics alone are not enough to motivate most customers. A typical consumer is unlikely to do this until rates reflect all of the different pieces of the value stack.”

- Commissioner Andrew McAllister, California Energy Commission (CEC)

To gain demand flexibility, there needs to be not only broader adoption of smart technologies but also participation in load shifting and management efforts, whether through demand response programs or time-varying rates. The problem is that in many areas customers are not rewarded for allowing smart technology to control their end uses and move usage to less expensive off-peak times, because the cost of energy generation at different times is not reflected in customer rates. E4TheFuture president Steve Cowell points out, “In New England the cost per kWh is 10-15 times more in some hours than others. So why aren’t we doing time-of-use rates that allow people to cut energy costs by moving usage around?”<sup>37</sup>

Meanwhile, even in jurisdictions with time-of-use rates in effect or other load-shifting or demand response programs the incentive is not necessarily significant enough for it to make economic sense for many consumers to invest in load shifting. In Arizona, both main utilities Arizona Public Service (APS) and Salt River Project (SRP) are also increasingly focusing on demand response and the time-value of efficiency over kWh savings, but Elena Chrimat says, “I have not seen a ton of traction in that direction with our customers. We have proposed having the utility control the thermostat and many customers do not like that.”<sup>38</sup>

To move economics in the right direction for the contractor and homeowner, federally funded programs which provide financial assistance must be aligned and stacked with state and local incentives to improve affordability and availability for broad-scale adoption of smart technologies. States can design and administer programs to ensure that customers and installers also qualify for local utility and state incentives to underscore the value of residential smart devices. Commissioner Andrew McAllister asserts, “If you get incentives right, the market will step in and make it work. That is when solar took off. That is why ratemaking is important to get the incentives to go to customers and aggregators. There is an ecosystem of technology and methods that could step in, but we need a better value proposition for customers.”<sup>39</sup>

<sup>36</sup> Remarks by Beth Karlin, See Change Institute. BPA 2021 National Home Performance Conference, “Marketing the Smart Home, Insights and Opportunities, Engaging Consumers in Their Quest for Smart Technology.”

<sup>37</sup> Steve Cowell, E4TheFuture, interview, March 2021.

<sup>38</sup> Elena Chrimat, Ideal Air Conditioning and Insulation, interview, March 2021.

<sup>39</sup> Commissioner Andrew McAllister, California Energy Commission, interview, April 2021.

## Paying for Performance

Many industry experts point to Pay-for-Performance (P4P) program models as a solution to providing a better value proposition to customers and contractors, while also driving energy savings. P4P can be implemented across energy efficiency and demand response programs using the wealth of data provided by AMI and other smart technologies to measure actual savings, and when and where they occur, and then providing payment based on that real value. P4P is both enabled by and will help to advance effective smart home devices by testing their performance in real-world conditions and allowing the best technologies to rise to the top by rewarding performance. According to Matt Golden, founder and CEO of Recurve, “There is an influx of smart device and AMI products all competing for space in the market, and utilities should not be picking winners or losers in the markets. The products need to compete through pay for performance to determine what is really effective and what is not.”<sup>40</sup>

In addition, some states are looking at performance-based regulation or ratemaking (PBR), an emerging regulatory framework that rewards utilities for achieving goals through a variety of mechanisms, as a way to incentivize more investment in non-traditional resources like smart technologies for demand flexibility that provide benefit for customers and the grid. Similar to P4P program models, PBR can help enable innovative approaches for achieving broader goals of carbon abatement, reliability, and affordability, and allow smart technologies for demand-side management to fairly compete alongside traditional utility investments (like poles and wires) as solutions.

## Access to Broadband

Finally, with all of these other challenges and opportunities for advancing smart technologies, it is important to keep in mind that a strong Wi-Fi connection is foundational to having access to these solutions. Many communities across the country, particularly in rural areas, still do not have access to a broadband connection—some are still on satellite Wi-Fi. Addressing this broadband gap will be fundamental to supporting equitable expansion of the smart home.

“Communities that aren’t connected are left out of the picture. Increased reliance on broadband and 5G rollout is key if we really want to see smart technology adoption. It’s about accessibility and foundational infrastructure.”

– Paula Glover, Alliance to Save Energy

Beverly Deel, who worked for the Weatherization Assistance Program (WAP) in Virginia, sees that inaccessibility every day in her work. Deel says smart devices “just do not make sense at most of our homes. A lot of places that we go to do not have Wi-Fi or broadband network and that is a huge barrier.”<sup>41</sup> Xavier Walter adds, “Many people have a Wi-Fi signal in the house, but the bandwidth is not high enough to support smart home devices.”<sup>42</sup> Investing in broadband for these rural areas and communities with connectivity issues will enable broader access to smart home devices for households who would benefit but do not currently have the proper broadband infrastructure.

IJJA funds a host of programs to provide grants and other financing for broadband buildout particularly in underserved and rural communities. New programs including the Broadband Equity, Access, and Deployment Program and the Enabling Middle Mile Broadband Infrastructure Program will deliver formula-based and competitive grants to states to reduce the costs of and enable greater access to high-speed broadband for underserved Americans. These measures could be used to help

<sup>40</sup> Remarks by Matt Golden, Recurve. BPA 2021 National Home Performance Conference, “Measuring Performance: Using Smart Devices to Combat Climate Change and Value Efficiency.”

<sup>41</sup> Beverly Deel, formerly with People Inc., interview, April 2021.

<sup>42</sup> Xavier Walter, Building Performance Association (formerly with Energy Partners LLC), interview, May 2021.

achieve nationwide access to broadband and greater access and utilization of internet-connected smart devices in homes.<sup>43</sup>

### Policy Recommendations:

- Support **contractor training** on smart technologies, including online training resources for areas where there are fewer training opportunities (see HOPE training component of the HOPE for HOMES Act of 2021, S.1768/H.R.3456).
- Invest in high-speed internet for rural areas to help **close the broadband gap**.
- Implement **time-varying rates** that provide sufficient incentive for residential customers to shift demand to off-peak hours.
- Adopt best practices and policies to enable **data access** (see the federal “E-Access” Act, H.R.8519).
- Establish **interoperability requirements** for smart home technologies including open standards for communication protocols and data sharing.
- Advance **residential AMI rollout** with requirements for full utilization and ensuring customer benefits.
- Enable **Pay-for-Performance** program models that foster market competition and help keep costs down while providing more offerings to customers (see measured performance rebates in the HOPE for HOMES Act of 2021, S.1768/H.R.3456).
- Adopt **performance-based regulation** to incentivize utilities to address demand flexibility needs and increase adoption of proven smart technologies.

### Areas for Further Research:

- **Conduct market research and curriculum development** to train contractors on incorporating smart home technologies into home performance retrofits.
- **Identify cyber security risks and best practices** associated with smart home technologies.
- **Research, development, deployment** for simpler, lower cost systems that support whole-home energy management, grid-connectivity and interoperability.

## c. Remote Monitoring/Diagnostics & Virtual Assessment

Remote monitoring and virtual assessment approaches are increasingly being explored in response to the pandemic and social distancing requirements, and as a solution to help address cost and time barriers of in-person assessment or other challenges to accessing a home. Smart home devices and technologies—such as the home energy monitors, smart thermostats, and software applications discussed in the previous section—can support these remote approaches. In addition, there is a growing opportunity with automated fault detection and diagnostics (AFDD) tools which can not only verify proper installation of HVAC systems but can also support remote monitoring and diagnostics through embedded technologies. Finally, virtual assessment can be conducted using a smartphone – having the homeowner take photos and videos or utilize livestream video conferencing to verify mechanical equipment (e.g., make model, installation date), house size and configuration, and potentially even the presence of insulation and air sealing.<sup>44</sup>

Remote and virtual approaches can provide cost savings, improve access to efficiency, provide lead generation and new business for contractors, and even support Measurement & Verification (M&V) and pay-for-performance (P4P) program models. But these emerging opportunities have faced challenges as well, including workforce resistance, consumer technology barriers and privacy concerns—including

<sup>43</sup> Additional information on these programs can be found in Section 60102 and 60401 of [the Infrastructure Investment and Jobs Act](#).

<sup>44</sup> <https://www.energy.gov/eere/buildings/2020-peer-preview-virtually-good-real-thing-remote-inspections-webinar-text-version>

the same broadband constraints facing smart home technologies, and figuring out the extent to which they can replace in-person assessments and audits.

## Pandemic was a Catalyst

While policymakers and programs were looking at virtual assessment and monitoring opportunities even before the pandemic to lower costs and improve access, COVID-19 shutdowns launched these tools into a new prominence. When energy efficiency work came to a crashing halt in the spring and summer of 2020, program administrators and policymakers were forced to be flexible and innovative in how they could continue to reach homeowners. In Minnesota, the Center for Energy and Environment (CEE) launched a remote assessment program in 2020 in response to the COVID-19 shutdown and customer cancellations of on-site visits. CEE found that the program helped reach rural customers faster and was also a good tool for customer engagement.<sup>45</sup> According to a follow-up survey of 35 program participants, 85% of customers appreciated the convenience and the ability to ask specific questions and troubleshoot specific issues without needing to be in-person. Other states have made similar adaptations to energy efficiency and weatherization programs during the pandemic, and some are seeing it as a paradigm shift that is here to stay. In Virginia, WAP has started doing remote home inspections using live video feed streamed directly to the state inspector.<sup>46</sup> Meanwhile, Connecticut started virtual pre-assessments in 2020, which are like an audit. Michael Li, believes that the state will continue to provide the virtual option even when the pandemic is over.<sup>47</sup>

## Contractors Have Mixed Feelings

Many of the contractors that HPC interviewed saw remote assessment and monitoring as a promising opportunity, but they stressed that there is a very important role for in-person audits that cannot be replaced with virtual approaches. Some contractors are wary of making the transition, while others note that these tools are not feasible yet in their programs or communities.

“I can see [remote monitoring and virtual assessment] as an opportunity, but I do not love them. Nothing beats seeing exactly what it is, and you can miss something big if you do not see it in person. Just the other day, I caught something that other contractors missed because I wasn’t trying to move too quickly or on a sales call.”

– Jeff Boone, Kansas contractor (NorthStar Comfort Services)<sup>48</sup>

When Connecticut launched the virtual pre-assessment program it was very controversial among some contractors who were nervous about being put out of business.<sup>49</sup> Cowell notes that this was in large part because Connecticut hired a third-party entity to conduct the virtual assessments, whereas in other states like Massachusetts the programs chose to train existing contractors to do them. Michael Li explains that initially, when the idea of virtual audits was proposed, there was significant concern expressed by the contractors, which is why the virtual audits were renamed “virtual pre-assessments.” Over time, at least some of the contractors came to see value in the virtual pre-assessments, according to Li.<sup>50</sup>

Emmett Leffel, owner of Alaska Thermal Imaging which specializes in energy audits, sees virtual assessments as an opportunity to improve access to efficiency services. Leffel says, “I think there is a need for it especially in rural locations where there are not any inspectors.”<sup>51</sup> Many contractors describe

<sup>45</sup> Remarks by Rebecca Olson, CEE. BPA 2021 National Home Performance Conference, “LIVE: Virtual Audits Are the Real Deal.”

<sup>46</sup> Beverly Deel, formerly with People Inc., interview, April 2021.

<sup>47</sup> Michael Li, former Energy Bureau Chief at Connecticut DEEP, interview, April 2021.

<sup>48</sup> Jeff Boone, NorthStar Comfort Services, April 2021.

<sup>49</sup> Steve Cowell, E4TheFuture, interview, March 2021.

<sup>50</sup> Michael Li, former Energy Bureau Chief at Connecticut DEEP, interview, April 2021.

<sup>51</sup> Emmett Leffel, Alaska Thermal Imaging, interview, April 2021.

how remote monitoring and virtual assessments enable them to better serve the houses they already reach and access a greater segment of their service territory. Others point to the shortage of skilled contractors across the country to underscore the need for tools that do a first pass at diagnosing an issue and identifying improvement opportunities in advance of an on-site visit. When utilizing Federal funding to design and implement energy efficiency workforce programs, States can enable training for virtual remote monitoring and assessments to help expand energy efficiency services in underserved areas. Federal programs like the Energy Auditor Training Program, authorized by IIJA, and HOPE for HOMES, currently under consideration in Congress, could provide millions to implement online and in-person training programs for the residential energy efficiency workforce. By designing training to incorporate remote and virtual services, these programs can help address shortages in the energy efficiency workforce and provide more access to residential energy audits and upgrades.

## New Business Models & Lead Generation

While there are challenges, many in the industry see new opportunities to target customers and provide enhanced services using virtual tools. Steve Cowell notes that while virtual assessments do not provide enough information to replace an in-person energy audit, they can be a useful initial screening tool to help prioritize homes that might be most in need of assistance.<sup>52</sup> In fact, the CEE program in Minnesota found that 45% of remote assessments led to on-site visits.<sup>53</sup>

“[Remote monitoring and virtual assessment tools] will have a significantly growing role, because they are so much less expensive than sending someone out to the site. I don’t think they will fully replace on-site but can dramatically refine who really needs to be on site. Contractors who do it well will be prosperous.”

– Steve Nadel (ACEEE)

Rob Minnick, CEO and President of Minnick’s in Maryland, sees remote monitoring, and AFDD in particular, as a valuable new expansion and evolution of his HVAC and home performance business model.<sup>54</sup> His company uses Sensi Predict from Emerson for continuous remote monitoring of customer HVAC systems. When something goes wrong, or the system is due for maintenance, Minnick’s and the customer both get an alert. If a replacement part is needed, Sensi identifies that part through automatic diagnostics and then the HVAC company can ensure they have the right parts on the truck when they send a technician. Minnick sees this as a dramatic improvement from the traditional HVAC service model.

“Most customers aren’t getting the service and maintenance they actually need. Traditional HVAC maintenance agreements require technicians to drive out to every customer and run diagnostics in person and then address necessary repairs on the spot. 14 calls in a day and 20 minutes per call is killing the technicians, and it doesn’t give them enough time to fully investigate and do the work properly. Remote monitoring means you don’t have to go out and do a maintenance twice per year. These technologies can lead to better engagement and customer relationships.”

– Rob Minnick (Minnick’s)

Minnick explains that AFDD technologies like Sensi not only enable contractors to provide better service, but they also help build trust for the customer. The technology acts as an independent and automatic third-party monitoring and verification system, diagnosing problems and also verifying that the HVAC technician fixed the system properly after the fact. With both service calls and new installs Sensi tests out the system to make sure everything has been installed properly. Elena Chrimat also

<sup>52</sup> Steve Cowell, E4TheFuture, interview, March 2021.

<sup>53</sup> Remarks by Rebecca Olson, CEE. BPA 2021 National Home Performance Conference, “LIVE: Virtual Audits Are the Real Deal.”

<sup>54</sup> Rob Minnick, Minnick’s, interview, March 2021.

uses AFDD on HVAC systems and allows customers to opt in for remote monitoring. “If they opt in, our office will get alerts to come take a look or fix anything. A lot of customers like it because it can prevent costly failures.”<sup>55</sup>

Emmett Leffel also sees remote monitoring as a potentially useful bridge to in-person work that also provides new efficiencies to streamline diagnosing and addressing issues. “I could see where the [remote] monitoring could facilitate a consultant or technician coming in and taking a look at a specific system or need after already having the remote monitoring or smart energy tracing in real time. Just being able to monitor and see in real-time what the problem is would really help.” In Massachusetts, Mark Tajima, owner of insulation contracting company Energia LLC, agrees that smart devices and remote monitoring capabilities could help his company identify leaky homes and do targeted customer outreach.<sup>56</sup> While Energia has not implemented these approaches yet, several years ago they flew a helicopter over towns and used an infrared camera to identify particularly leaky homes. Mark took pictures of each house, later sending them as postcards to customers, and he says the project worked well as marketing and lead generation for his company’s insulation services. Looking ahead, Mark sees remote monitoring and M&V 2.0 approaches using smart devices and cloud computing as a great opportunity to send alerts to customers and generate new leads.

Steve Nadel agrees that fault detection is a “low-cost obvious solution to help equipment perform better and potentially provide more work for contractors.” According to Rob Minnick, his company is currently able to install Sensi on every system except the high-end communicating systems. So, there is a significant opportunity currently for expansion and market transformation to implement these proven technologies into more homes. Jeff Boone sees remote monitoring as a down-the-road opportunity for his insulation and air sealing business. “I would love to be able to take a customer and do some improvements and just monitor from afar. We are one of the trades where people are asking what the payback is.”<sup>57</sup> Opportunities to use remote monitoring tools to measure performance and evaluate home performance work is discussed further in the next section.

## **EM&V and Pay-for-Performance**

Advanced metering infrastructure (AMI) and other tools for remote monitoring and assessment are also enabling new program models and opportunities to advance home performance. Automated evaluation, measurement and verification (EM&V 2.0) using smart meter interval data and cloud-computing has enormous potential to streamline programs by providing more immediate and precise energy savings estimates at a lower cost, and this same granular data coupled with analytics tools has enabled pay-for-performance (P4P) programs that reward contractors and implementors for actual measured energy savings and peak demand reductions.

In California, Commissioner McAllister says that the state is working on expanding these uses of AMI data and is working to facilitate appropriate access to data by customers and service providers in order to reduce time and costs and create a seamless ecosystem for innovation.<sup>58</sup> Scheurer also sees an opportunity to turn to performance-based efficiency programs to reward contractors and consumers for actual measured energy savings. By “measuring and testing work before, during, and after, contractors can get rewarded for meeting [energy performance] standards.”<sup>59</sup> Jason also contends that utility programs have not focused enough on rewarding homeowners for performance-based efficiency and that there should be incentives for the ongoing optimization of home performance through smart technologies and virtual tools.

<sup>55</sup> Elena Chrimat, Ideal Air Conditioning and Insulation, interview, March 2021.

<sup>56</sup> Mark Tajima, Energia LLC, interview, March 2021.

<sup>57</sup> Jeff Boone, NorthStar Comfort Services, interview, April 2021

<sup>58</sup> Commissioner Andrew McAllister, California Energy Commission, interview, April 2021.

<sup>59</sup> Jason Scheurer, BEST Techs Contracting, interview, March 2021.

There are examples of virtual approaches for P4P models in other parts of the country as well. In the Northeast, Sealed offers a performance-based payment plan for home performance services so that there is no upfront cost to the customer. The company has developed a virtual customer acquisition model for residential energy efficiency upgrade projects where the pre-qualification, assessment, energy audit, and project scoping all happen virtually. Once that process is completed, they do a home visit to confirm the scope and execute the project.

### **Key Barriers: Broadband, Data Access & Portability, Privacy Concerns**

Many of the opportunities with remote monitoring and virtual assessment confront similar challenges facing advancement of smart home devices and technologies discussed in the previous section.

Contractors, policymakers, and customers across the nation have emphasized that lack of broadband access is a widespread and critical impediment to deploying virtual assessments and monitoring. Xavier Walter agrees that there are opportunities for remote monitoring and assessments but notes that lack of broadband is a major barrier in the communities where he works in West Virginia. “We cannot get our customers to hop on the phone and do virtual audits because there are such broadband issues. Most people have a Wi-Fi signal in the house, but the bandwidth is not high enough to even enable smart devices to send out proper notifications.”<sup>60</sup> Lack of broadband is also a huge barrier for the communities helped by WAP in Virginia, according to Beverly Deel.<sup>61</sup> The expansion of broadband access to ensure that all homes across the U.S. are Wi-Fi enabled is essential to laying the groundwork for remote monitoring and virtual assessments, in addition to the smart home technologies described in the previous section. Contractors and homeowners may see the value of these tools, but they cannot employ them without broadband buildout.

Access to utility data is also key to enable third parties to use these rich real-time datasets for virtual audits and ongoing monitoring, translating the information into actionable insights. Steve Nadel, says “We need somebody to extract and simplify the meter data. P4P in California could be an example to get the data into a format that’s consumable.”<sup>62</sup>

Finally, privacy and data security present continued challenges, due to both real and perceived risks. Paula Glover, President of the Alliance to Save Energy, summarizes that while there is a tremendous opportunity in doing many things remotely, there are real challenges around how permissions are enabled, data sharing, privacy, and security. The question becomes ‘What are you doing with my data?’ and Glover says “different customers think about it differently (as do regulators) and I do not know if anybody is on the same page.”<sup>63</sup>

### **Policy Recommendations:**

- **Enable virtual assessments/audits** for energy efficiency programs.
- Support **contractor training** on remote monitoring, virtual assessment, and AFDD technologies and best practices (see Energy Workforce Grant Program in the federal Blue Collar to Green Collar Jobs Act, H.R. 156).
- Invest in high-speed internet for rural areas to help **close the broadband gap**.
- Adopt best practices and policies to enable **data access** (see the federal “E-Access” Act, H.R.8519).

<sup>60</sup> Xavier Walter, Building Performance Association (formerly with Energy Partners LLC), interview, May 2021.

<sup>61</sup> Beverly Deel, formerly with People Inc, interview, April 2021.

<sup>62</sup> Steve Nadel, ACEEE, interview, April 2021.

<sup>63</sup> Paula Glover, Alliance to Save Energy, interview, April 2021.

## Areas for Further Research:

- Assess need for **standardization of virtual assessment approaches** in energy efficiency programs.
- **Identify cyber security risks and best practices** associated with smart home technologies and remote monitoring.
- **Research, development, deployment** for simpler, lower cost systems that support whole-home energy management, grid-connectivity and interoperability.

## d. Integration of Insulation and Air Sealing with Roofing Projects and Solar Photovoltaic

Finally, our research explored potential synergies between attic insulation and weatherization (traditional efficiency) and other projects that homeowners may undertake for their roof, including installation of solar photovoltaic (PV). DOE's Building America Solution Center contains guides to installing insulation and ensuring water, air, and vapor barrier continuity during re-roofing.<sup>64</sup> In addition, when installing rooftop solar arrays, there are important considerations to ensure the roof is secure and solar-ready, and after installation that the bracket holes.<sup>65</sup> As rooftop solar continues to grow as a distributed energy resource alongside traditional energy efficiency measures, the integration of roofing work with solar installation, and insulation and air sealing, is emerging as an opportunity to achieve a comprehensive solution for deep decarbonization of homes. Combining these home energy solutions and improvement projects can help optimize the use of resources, by ensuring a new roof is properly weatherized and solar-ready and lowering the house's energy load through efficiency measures to reduce the solar capacity needed. The opportunities are complicated, however, by the need for distinct technical expertise and specific licensing requirements across the distinct trades, and challenges with upfront costs and creating successful business models.

### Contractor Perspectives & Business Models

From a contractor perspective, the integration of roofing with insulation, air sealing, and solar power requires proper funding, training, adequate workforce and coordination across multiple trades. Distinct skill sets and licensing requirements and the fact that efficiency, solar, and home improvement contractors remain siloed, makes it difficult to achieve these integration opportunities.

Many of the contractors and companies who are doing combined projects are thinking about whole-home approaches to deep decarbonization, supporting health, comfort, and energy savings. BEST Techs Contracting in California is one example of a company that takes a whole-home approach specializing in green building and energy efficient design, building, and remodeling—including net-zero energy homes that combine deep energy retrofits with solar installation. Scheurer explains, “We are trying to shift the industry to build 100-year homes with building sealing, smaller HVAC system, heat pumps.”<sup>66</sup> Also in California, Dan Thomsen, president and founder of Building Doctors, Inc., agrees that “it is about creating a whole home package with solar panels on the roof, EVs in the driveway, and heat pumps in the house. This package will really emphasize the complete benefits.”<sup>67</sup> Steve Cowell says he

<sup>64</sup> U.S. Department of Energy, Building Technologies Office, Building America Solution Center, “Water Managed Roof - Re-Roofing and Adding Insulation Over a Sloped Roof,” <https://basc.pnnl.gov/resource-guides/water-managed-roof-re-roofing-and-adding-insulation-over-sloped-roof#edit-group-description>; “Roof/Attic to Exterior Wall Air Control Upgrade,” <https://basc.pnnl.gov/resource-guides/roofattic-exterior-wall-air-control-upgrade#edit-group-description>.

<sup>65</sup> U.S. Department of Energy, Building Technologies Office, Building America Solution Center, “Solar Orientation For Solar Arrays and Panels,” <https://basc.pnnl.gov/resource-guides/solar-orientation-solar-arrays-and-panels#edit-group-description>; “Flashing of Penetrations in Existing Roofs,” <https://basc.pnnl.gov/resource-guides/flashing-penetrations-existing-roofs#edit-group-scope>.

<sup>66</sup> Jason Scheurer, BEST Techs Contracting, interview, March 2021.

<sup>67</sup> Remarks by Dan Thomsen, Building Doctors, Inc., National Home Performance Conference 2021, “Selling Heat Pumps: What Works with Electrification.”

also knows of home performance contractors in the Northeast who want to incorporate solar into their business model.<sup>68</sup>

Across the country, however, leading home performance contractors point to the challenges of incorporating solar and roofing projects, and the distinct expertise required for each, into their business models. Rob Minnick in Maryland, says, “I don’t want to be the jack of all trades. Sometimes I do insulation, though when we have whole-attic insulation jobs I would subcontract that work that out. The solar guy I use does roofs—so, if I need a vent through a roof, he will do it.”<sup>69</sup> Similarly, Mark Tajima did some work with solar projects earlier on in his career, but he says, “I found that I wanted to focus on insulation.”<sup>70</sup> Tajima says that ultimately the solar and insulation business model was not hugely profitable. Scheurer also points to cost issues: “We subcontract most of our solar out because it is too expensive to own all the equipment in solar, HVAC, and energy efficiency all at once.”<sup>71</sup> Meanwhile, operating from a leading solar state of Arizona, Elena Chrimat says, “If I had the bandwidth, [partnering with solar] would be a thought down the line [...] I don’t like the business model just because I don’t have full control over the quality of the installation of solar using subcontractors and I have enough work as it is. Many contractors here in Arizona just sell solar, but they don’t actually install it. I don’t want to be just another solar sales outfit that offers a sub-par deliverable to our valued customers. If we ever do end up offering solar, it will all be done in house.”

The contractors we spoke with argue that a model to support better integration is to have a home performance contracting company as lead, bringing on subcontractors to do the solar and roofing. In California, “There are some specialty home performance contractors that are doing this type of work on a daily basis, such as building towards Passive House Standards and implementing Net Zero Energy into each and every project,” says Scheurer. He explains, “Our company does work that includes what we call Deep Energy Retrofits, which involves bringing the attic into conditioned space, which includes moving the attic insulation to the roof rafters, cool roof installation techniques, smaller HVAC systems that are designed, measured, and balanced towards manufacturer specifications. When we work with solar installers, we help assess the condition of the roof rafters for their work. We have to facilitate all of it as a general contractor and then manage the sub-trades to make sure they are doing their portion of the job right and efficient. Constant testing, measuring and proving we are doing the work right is critical not only for our company, but for our clients that are investing with us to bring their home into the future.” Maryland HVAC and home performance contractor Rob Minnick agrees that his company can play a key role in managing subcontractors for integrated projects: “When you get all these different people, we all need to be on the same page for the outcome – that’s why we manage the whole house when we subcontract out. Having one person oversee the whole outcome is important.”<sup>72</sup> Chrimat believes this would be the model she would undertake if she does decide to work on solar projects in the future: “We have had a lot of solar companies approach us to do the duct work and insulation. But for me, explaining how to price it all out and get them their profit, it is not worth it. I want to be the contractor, not the subcontractor. The only way it could work is if I did everything and brought solar in house within our company.”<sup>73</sup>

Meanwhile, there remains significant opportunity and need for improved coordination and integration. Part of the problem is that the different trades that work on homes are siloed and do not share the same knowledge of building science and best practices to apply to their work. Efficiency and solar have also generally been addressed separately by policymakers and regulators, and in utility programs, and incentives tend to target specific technologies rather than integrating home energy solutions and tying them to non-energy home improvements like roofing. Workforce training and consumer

<sup>68</sup> Steve Cowell, E4TheFuture, interview, March 2021.

<sup>69</sup> Rob Minnick, Minnick’s, interview, March 2021.

<sup>70</sup> Mark Tajima, Energia LLC, interview, March 2021.

<sup>71</sup> Jason Scheurer, BEST Techs Contracting, interview, March 2021.

<sup>72</sup> Rob Minnick, Minnick’s, interview, March 2021.

<sup>73</sup> Elena Chrimat, Ideal Air Conditioning and Insulation, interview, March 2021.

education are needed, along with resources and funding to effectively address overlapping issues across roofs, weatherization and opportunities for solar. Ultimately, efficiency, solar, and general roofing improvements could be very closely aligned, mutually supporting deep energy savings and decarbonization, while also supporting greater resilience for the home. The question then is how to foster greater collaboration and synergy?

Emerging Federal clean energy and energy efficiency programs present the opportunity to focus on cross-sector initiatives that enable whole-home approaches. Incentive dollars should be leveraged and stacked for complementary programs that address residential decarbonization, whether through solar, HVAC, weatherization, or grid-interactive demand flexibility. New training funding could also be used to grow the workforce of contractors trained in building science principles and equipped to implement whole-home approaches.

### **Workforce Challenges: Siloed Trades & Lack of Education**

Home performance contractors often confront issues and hazards with the roof and attic stemming from myopic planning or improperly executed construction and retrofits in their work. They say there is a lack of knowledge among the trades about energy efficiency and how building systems fit together. Scheurer puts it simply, “Roofers are there to focus on roofs. They don’t understand efficiency,” and insulators, inversely, don’t know much about roofing.<sup>74</sup> Rob Minnick adds that while he sees some roofing companies doing insulation and air sealing, he does not think they are doing a very good job: “They are against encapsulation, spraying the underside of the roof, because they say shingles won’t last and say it will cause moisture problems.”<sup>75</sup> Emmett Leffel says, “There are always roofing issues. We do a lot of diagnostics and so often attic bypasses are the key issue. There is a degradation impact to the building caused by heat loss to the attic space and that leads to ventilation and moisture issues.”<sup>76</sup> Leffel sees customers who just had their roof replaced but are still dealing with leakage or condensation issues or may have missed a big opportunity to make the house solar-ready. Jeff Boone sees older houses that did not have attic ventilation where “someone came along and put in spinning or turtle vents, and they are just sucking AC out of the house.”<sup>77</sup> Boone thinks the issue is that people are looking at the small fix. The crew comes out and does their job without giving second thought to the big picture.

“There is a missed opportunity there because of a lack of understanding in the public regarding how to actually fix these issues with the right contractors.”

– Emmett Leffel, Alaska Thermal Imaging

These same contractors pointed to inertia and a business-as-usual approach among the existing contractor workforce and trades as one of the biggest barriers. “In Alaska, it is so hard to get a contractor on board to do anything different than what they’ve done over the last ten years,” says Emmett Leffel.<sup>78</sup> Echoing that perspective, Scheurer has found that “it is very hard to explain to many of the contractors how to do it if they’re not on board. They have been doing one craft for 15 years and explaining to them details to change behavior and trade is difficult.”<sup>79</sup>

Jeff Boone says “There are opportunities [to install insulation] with roofers as well, particularly after damage from hailstorms or extreme weather. It is just a mindset change. A few [contractors] see the opportunities, most do not.”

<sup>74</sup> Jason Scheurer, BEST Techs Contracting, interview, March 2021.

<sup>75</sup> Rob Minnick, Minnick’s, interview, March 2021.

<sup>76</sup> Emmett Leffel, Alaska Thermal Imaging, interview, April 2021.

<sup>77</sup> Jeff Boone, NorthStar Comfort Services, interview, April 2021.

<sup>78</sup> Emmett Leffel, Alaska Thermal Imaging, interview, April 2021.

<sup>79</sup> Jason Scheurer, BEST Techs Contracting, interview, March 2021.

“Everyone is focused on business as usual. I do not see the big builders, building the majority of homes, on board for efficiency and green innovation. We all want to make money but let’s do it right so when we build something we’re not getting a call back because something went wrong.”  
- Jason Scheurer, BEST Techs Contracting

Differing priorities can also be a barrier to the integration of solar with insulation and other efficiency measures. David Terry sees an inherent tension between the solar industry, which wants to sell lots of PV modules, and the goal of first making the house more energy efficient — to lower homeowner costs — which could mean fewer modules. From his work in California, Scheurer agrees that the solar trade largely does not want to install insulation because “more energy efficiency means less solar.”<sup>80</sup> Elena Chrimat in Arizona sees solar vendors attempting to offer insulation and duct sealing to customers, but still failing to fully address the efficiency needs. “It doesn’t work because they want to throw insulation and/or duct sealing in for free. We’ve seen quotes for solar integrators offering to insulate homes for \$800 but that’s not how reality works. Insulating and air sealing homes properly costs much more than \$800 — in fact, it can cost somewhere between \$2000 - \$6000 depending on the scope of work. If they really want to solve the problem and not just seem like they are sweetening the deal to their solar customers, they need to do more than just throw in insulation and fake duct sealing for free; they need to solve problems.”<sup>81</sup>

Finally, the inherent complexity of home performance work and the skill sets required across insulation, roofing, and solar work also ultimately make it a tough nut to crack. David Terry says that because efficiency product installation and solar installation are typically two different skill sets, different crews and/or partnerships among trades are needed.<sup>82</sup> Cowell points out that in many states, the policy initiatives have included expanded and better coordination between HVAC/heat pump installations and solar with basic home energy assessments and weatherization. This is important to determine the depth and range of connection between the critical electrification and decarbonization strategies. More efficient homes can be more effectively served by both heat pumps and solar and better coordination will help but will require training, education and customer education as well as test driving business models and relationships. Mark Tajima reflects that while there are synergies between their work and solar or roofing projects, ultimately those jobs require electrical and carpentry skills which his company does not have.<sup>83</sup>

“The challenge is how to connect all these very divided industries. If you want to call the roofing company and inquire about solar that does not exist right now.”  
- Michael Li, Connecticut Department of Energy and Environmental Protection

## Support for Training & Consumer Education

Contractors highlight workforce training and consumer education as two key levers that would help advance these opportunities. Jason Scheurer, whose California contracting company specializes in passive house design, believes that trade workers will need to know multiple trades: “Hopefully there will be a lot more training in the next four years to where contractors understand they’re not just roofers anymore. They need to know air ducts, insulation, etc.”<sup>84</sup>

“We need to see more commercials, more advertisements. However, until more people are trained to do the right thing, it will be a long road.”  
- Jason Scheurer, BEST Techs Contracting

<sup>80</sup> Jason Scheurer, BEST Techs Contracting, interview, March 2021.

<sup>81</sup> Elena Chrimat, Ideal Air Conditioning and Insulation, interview, March 2021.

<sup>82</sup> David Terry, NASEO, interview, March 2021.

<sup>83</sup> Mark Tajima, Energia LLC, interview, March 2021.

<sup>84</sup> Jason Scheurer, BEST Techs Contracting, interview, March 2021

Emmett Leffel in Alaska adds, “I have seen over the last decade that change always comes from customer demand — it has to be homeowner driven. I have to show the customer how the improvements should be made because the homeowner and even the contractors do not know how to execute. If the homeowner understands the improvement and how to follow through, then that’s the only chance to actually get it done and show the value of these measures.”<sup>85</sup> Scheurer believes that customer education is also essential in order to help shift the industry. “With solar on the house and proper efficiency related measures, you have free energy in the home. If we were educating our clients about this, it would be much easier in the long run to achieve whole home improvements,” says Scheurer.<sup>86</sup>

### **Supporting Broader Access & Adoption: Addressing Upfront Costs, Equity**

Education alone will not be enough to advance combined roofing, efficiency, and solar projects though. As Commissioner McAllister summarizes, “Most homeowners aren’t actively pursuing \$30,000 total integrated upgrades with insulation and mechanical, and a roof and solar all at once, or even parts of that.” A lot of these projects are event-driven, when issues arise or equipment breaks.<sup>87</sup> There is a need for solutions to ease the upfront costs and help homeowners identify integration opportunities that provide the most bang for their buck. Through implementation of the new infrastructure law, State governments can craft programs which combine incentives with accessible financing options to facilitate comprehensive building solutions and achieve healthier, more efficient, and decarbonized homes, particularly in low- and moderate-income communities.

In addition, greater coordination across efficiency programs and incentives would also help homeowners access these synergies between different home energy solutions. Connecticut currently is looking to create a one-stop-shop to connect the different pieces of the puzzle. Michael Li explains, “We are thinking about creating an energy concierge service to connect all the different parts of energy system. It would probably direct the utilities to run the program and coordinate with different contractors.” The concept is being considered for Connecticut’s next three-year plan that will begin in 2022.

Specifically addressing equity and supporting access for lower income households, Li says Connecticut is “in the process of doing efficiency, renewables, and health hazards altogether in the same homes.” Connecticut also currently has a successful Solar for All program which pairs energy efficiency measures with rooftop solar to maximize savings and benefits for low- and moderate-income homeowners. That program is delivered by the Connecticut Green Bank in partnership with Posigen. Meanwhile, in Florida the Office of Energy at the Florida Department of Agriculture and Consumer Services (FDACS) launched a low-income residential energy efficiency grant program for counties in 2020. According to FDACS Energy Director Kelley Smith Burk, her office has prioritized “how efficient the structure itself is and we are looking to start at the building envelope level, before installing solar.”<sup>88</sup> Burk says the grant program for low-income housing is the first step, and her office’s first foray into addressing efficiency in the residential sector, and then they will look to solar next.

Roofing problems are a critical barrier preventing low-income families from being able to access weatherization services. Beverly Deel estimates that “25% of houses we go to need a new roof and we have to deny them. The majority of houses with roof issues have several roof leaks or shingles

<sup>85</sup> Emmett Leffel, Alaska Thermal Imaging, interview, April 2021.

<sup>86</sup> Jason Scheurer, BEST Techs Contracting, interview, March 2021.

<sup>87</sup> Commissioner Andrew McAllister, California Energy Commission, interview, April 2021.

<sup>88</sup> Kelley Smith Burk, Florida Department of Agriculture and Consumer Services (FDACS) Office of Energy, interview, April 2021.

missing or metal roofs misplaced, and it is just too far gone. It needs full repair. We would need more funding to address those needs. The people that need us the most we have to turn away.”<sup>89</sup> Deel says Virginia is looking to start a new roofing program to start to address these issues, as well as discussing incorporating solar into the WAP program. The biggest barriers she sees are securing funding for those programs and a lack of a local trained workforce—in the counties she manages there are only two or three contractors who are certified to do weatherization work.

Initial guidance from DOE on implementation of WAP IIJA funding places particular emphasis on workforce development, requiring that States submit plans which “detail the required or needed Grantee staff and Subgrantee network training to ramp up the workforce to perform the weatherization work.”<sup>90</sup> With widespread challenges to mobilize a trained workforce to administer residential services, States must assess current and future workforce needs and apply for boosted WAP funding under IIJA to expand weatherization contractor networks and education.

### Policy Recommendations:

- Fund **workforce training programs** to provide building science education and help develop a skilled workforce (see Energy Auditor Training Program under IIJA; HOPE training component of the HOPE for HOMES Act of 2021, S.1768/H.R.3456; Energy Workforce Grant Program in the federal Blue Collar to Green Collar Jobs Act, H.R. 156).
- Prioritize **Integrated Demand Side Management** approaches that bring together energy efficiency and solar (along with other DERs)—including combined incentives.
- Invest in **outreach and educational campaigns** which highlight the benefits of deep, comprehensive home energy improvements (e.g., ENERGY STAR advertising campaign focused on marketing to customers).
- **Develop central databases** to provide homeowners with centralized access to contractors who work across roofing, insulation, air sealing, and solar.
- Allow **LIHEAP funds to go to addressing health & safety barriers** in weatherization homes.

### Areas for Further Research:

- Undertake **small pilots** exploring integrated approaches for solar, roofing and energy efficiency upgrades, including addressing unique needs of the locality.
- **Study homeowner experiences and motivations** for undertaking integrated energy retrofit projects and identify key decision points.
- **Analysis of the long-term energy and cost savings** associated with the integration of these measures.

<sup>89</sup> Beverly Deel, formerly with People Inc., interview, April 2021.

<sup>90</sup>This guidance was released by DOE’s WAP Program Notice for implementation of the Bipartisan Infrastructure Law for the Weatherization Assistance Program, March 30, 2022.

## V. Conclusion and Recommendations

While there is diversity across region, technology type, and even perspectives and experiences within the home performance industry, several themes emerged from our research as overarching takeaways. First and foremost is the need for more support for training and workforce development programs to get more workers into the residential retrofit industry and prepare them with the skills to implement these advanced technologies and innovative approaches that take into account the whole house, as a system. Accessible resources, databases, and education campaigns were also highlighted as key strategies to improve public awareness and help consumers identify solutions that make sense for them and provide long-term solutions for their homes. Finally, addressing equity with a focus on the barriers that may extend beyond the scope of home performance or energy work but ultimately directly impact who is able to access these advanced technologies, particularly electrification, renewable energy and smart devices. Below are additional quotes from our interviews that drive home these topline findings.

### ***Need for training support and getting more people into the workforce:***

“Things that benefit contractors directly like workforce development/training will help advance all of these solutions. With ARRA everyone was getting BPI certifications. Three of our key managers wouldn’t have gotten into this if not for ARRA funding.”

– Mark Tajima (Energia)

“How do we get people the training and new people to enter into the industry and work with these technologies? That is the key and the biggest challenge. As a small business owner, I do not have the same capital as a larger company has to invest in new people and develop them if I don’t know for certain they’re going to stick around - we have to be pickier and more careful with who we bring on in order to ensure the dollars we invest in them are spent wisely in order for us to get the return on our investment. We don’t have the capital to start an in-house trade school, for example, like many other larger HVAC companies do.”

– Elena Chrimat (Ideal Air Conditioning and Insulation)

### ***Consumer outreach and education:***

“Education will be the biggest thing—having some master platform to inform customers and contractors about different tools and how they can help customers. For general adoption, nothing should be that complicated.”

– Jeff Boone (NorthStar Comfort Services)

“Any type of ENERGY STAR advertising campaign or any entity like that would be helpful to really reach the customer. ENERGY STAR was successful because they showed contractors that you can improve sales if you demonstrate benefits to consumers. Showing people why they should want energy efficiency and comfort drove sales.”

– Emmett Leffel (Alaska Thermal Imaging)

### ***Addressing equity:***

“The majority of Americans might not be able to afford the costs of more efficient technologies regardless of savings over time. We have the advanced technologies but if the cost is too high, it’s not accessible. If we fail to address the issues of access and affordability, then we won’t have adoption.”

– Vincent Barnes (Alliance to Save Energy)

“Low-income families are locked out from any advanced technologies and the broadband [gap] helps keep them locked out.”

- Xavier Walter (Building Performance Association, formerly with Energy Partners LLC)

“Additional investments have to happen on the front end with existing buildings. You have to start with the foundational infrastructure, [and] you have to recognize it will be expensive and complex.”

- Paula Glover (Alliance to Save Energy)

## Federal Role

We also asked each of our interviewees for thoughts on what the U.S. Department of Energy, or its programs, could specifically do to help advance these specific technologies and approaches. The following list of supportive activities was informed by their answers and insights. With the historic passage of IIJA, these recommendations have renewed importance as implementation guidelines are developed and states look for how to leverage the new funding for residential opportunities:

1. **Revamp engagement with the State Energy Advisory Board** - to foster improved coordination between state policymakers and the federal government.
2. **Technical assistance & pilots** - using the “laboratory of states” to offer pilot opportunities for states that test out specific applications of issues and trends that DOE is focused on, and coordinate across different states on applicable learnings.
3. **Provide flexible funding opportunities** - including keeping opportunities open to a variety of technologies and program models to allow states to focus on their specific needs.
4. **Support innovation and small businesses** - as new companies seek a presence in advancing education, awareness, and opportunity in the residential retrofit space, ensure DOE supports and complements rather than competes with private sector efforts.
5. **Encourage an equity focus in electrification** - such as working with public utility commissions and ratemaking structures to ensure that electrification efforts align with cost-effectiveness policies for low-income residents.
6. **Strengthen short-staffed state energy offices** - providing additional programmatic support to SEOs and WAP.
7. **Demonstration programs** - to give the public the opportunity to see and experience how a technology works (i.e. a home heated by a heat pump).
8. **Ensure funding optimizes technology to support public goods** - as with the SGIG program, ensuring that advanced technology funded with public dollars is optimized to advance public goods like secure utility data portability and consumer information and empowerment.
9. **Offer training opportunities to advance whole house retrofit education** - expanding training in weatherization and system efficiency to small businesses struggling to train their workforce can advance diversity, equity and inclusion while increasing pay and small business growth and opportunity.
10. **Support comprehensive study of energy resources, technology, and policy for the residential sector in each state** - to provide a cross-section of what existing residences look like and identify opportunities and gaps, including comparison with other states.

The mission of advancing home performance and the utilization of residential buildings as a grid resource is only becoming more important as we look to meet ambitious climate goals, address environmental justice, and support domestic clean energy jobs. New federal goals for ramping up building decarbonization technology underscore the importance of understanding how the advanced technologies and innovations discussed in this report are being adopted and where remaining challenges and further opportunities exist.

During opening remarks at the Building Performance Association’s national conference in April of 2022, DOE Secretary Granholm emphasized the importance of new Federal investment in energy efficiency and home performance to meet national energy and economic goals: “President Biden’s new infrastructure law allows us to really turbocharge residential energy efficiency and decarbonization in the U.S.” The Secretary went on to tout the additional \$3.5 billion for WAP to help families save on their home energy bills, \$40 million to train up energy auditors all across the country, and \$250 million for revolving loan fund and rebate programs to help low-income households access financing and direct assistance for energy efficiency. Emphasizing the potential opportunities to invest in residential building performance, Secretary Granholm concluded that we must keep “building a better America which calls for even more investments in energy efficiency, clean energy, and workforce development.”<sup>91</sup>

Meeting those goals will depend on accelerating deployment and scalable approaches for market adoption—efforts which must be informed by the contractors, local policymakers and regulators, and other stakeholders who bring on-the-ground insights. The authors’ hope is that this report will help to inform policies and implementation strategies and point to what questions decision makers should be asking in diverse contexts across the country to carve out a pathway to a transformed residential building sector.

<sup>91</sup> Jennifer M. Granholm, the United States Secretary of Energy, delivered a welcome message to attendees of the Building Performance Association’s 2021 National Home Performance Virtual Conference on Monday, April 12. The full speech can be accessed here: <https://www.building-performance.org/news-and-resources/news/us-secretary-energy-jennifer-m-granholm-deliver-welcome-address-building>

## Appendix: Summary of Research, Methodology, and Context

The goal of this research project was to better understand how certain key advanced technologies and approaches can be incorporated into home performance on a wider scale and help advance the industry to revamp and decarbonize the U.S. housing stock. Specifically, we focused on four categories of key innovative technologies and approaches.

1. Heat pumps & heat pump water heaters
2. Smart home devices
3. Remote monitoring/diagnostics & virtual assessment
4. Integration of insulation/air sealing with roofing projects and solar PV

The key research questions included: Where do we see these technologies in 5-10 years? What challenges are standing in the way of broader investment and implementation? Are there policies that are either blocking or could help hasten the speed of adoption?

For each of the technologies and approaches, we looked at the issue of scaling them to make a greater impact on residential energy efficiency/home performance. Our hypothesis was that for contractors to promote these technologies and for them to be successful in their business model, each technology needs to address: 1) Consumer demand, 2) Easy sell, 3) Subsidies that make the charge they pass on worth it to them and the customer.

Several key overarching themes emerged from our surveying and interviews. First, the importance of access to and funding for training was underscored by voices across the industry. WAP and market-rate contractors alike pointed to difficulty finding and hiring qualified workers, and various stakeholders also pointed to lack of education and appropriate training as one of the key barriers preventing better implementation of advanced and innovative technologies and solutions. Second, the importance of paying attention to diverse contexts and unique needs across different geographies and communities. This means understanding the role of climate and fuel mix in shaping both the opportunities and economics of different home performance solutions, but also considerations for equity and supporting access by addressing affordability and other barriers to adoption affecting low-income and disadvantaged communities. It also means paying attention to the diverse motivations—such as affordability, health and safety, resilience, climate and decarbonization—of consumers, contractors, and policymakers and how technology solutions can address those specific priorities (or where they may come in conflict).

Across each category, we have identified specific policy recommendations and areas for further research that emerged from our interviews, research, and surveys, and which are reflective of both specific on-the-ground insights as well as key focal points and broader trends from across the industry.

### Research Methodology

Our methodology was comprised of three different branches of information-gathering: surveys, interviews, and event analysis (each described in more detail below) to help get a pulse on current industry and stakeholder perspectives and discover the most promising innovative approaches and technologies that could improve implementation costs and quality of home performance upgrades. With the passage of IIJA in 2021, we initiated a second stage of our research, and looked out how our findings could be applied to implementation planning for the infrastructure law. The recommendations

and insights contained in this report are therefore presented through this new lens to guide policymakers on IIJA implementation planning and the significant new resources available to advance home performance.

## a. Industry Survey

HPC developed a survey for members to narrow down the technologies that we should focus on when investigating via our interviews in the spring. We sent the survey to approximately 10,000 industry stakeholders in November of 2020 and 415 responded.<sup>92</sup>

The survey covered several topics (for this contract and for other investigations). While the results were not statistically significant, they were directional as we had guidance not only from over 400 members of the industry, but we had information about who these members were (contractors, business owners, etc.) to help assist us in better understanding their objectives. The survey did not tell us what the majority of the industry believes or what the motivations, challenges, and opportunities are outside of the survey questions.

## b. Interviews

HPC conducted a series of targeted interviews with contractors, state energy officials, commissioners and other stakeholders from March through May of 2021 to gain a deeper understanding of the perceptions and experiences with the technologies among stakeholders and the marketplace as well as to test the reasons for their lack of wider adoption. We narrowed our initial target interview list to allow for longer, more comprehensive interviews.

The interviews were designed to be in-depth and conversational, and we used a list of questions as a springboard to guide the discussions. This had a cascading effect where we brought additional questions and theories that emerged from initial interviews to our subsequent conversations, providing multiple perspectives on a particular challenge or opportunity. Across the board, we asked stakeholders about each of the technologies and approaches, what barriers they see, and where opportunities exist to further advance their deployment. We also asked about policy—whether there are policies that are either impeding or could help hasten the speed of adoption.

The following is the final list of stakeholders we interviewed (20 total), selected with geographic diversity and breadth of expertise and experience in mind.

<sup>92</sup> Virtually every state in the U.S. was represented in the survey responses according to HPC analysis of a sample of 182 respondents who voluntarily provided their name, company, and contact info.

## Contractors

We interviewed contractors from **8 different states** across the U.S., and a mix of home performance, HVAC, and Weatherization (Wx) contractors as well as energy auditors.

1. AK - Emmett Leffel, Alaska Thermal Imaging
2. AZ - Elena Chrimat, Ideal Air Conditioning and Insulation
3. CA - Jason Scheurer, Best Techs Contracting
4. KS - Jeff Boone, NorthStar Comfort Services
5. MA - Mark Tajima, Energia LLC (Wx)
6. MD - Rob Minnick, Minnick's
7. VA - Beverly Deel, formerly with People Inc (Wx)
8. WV - Xavier Walter, Building Performance Association (formerly with Energy Partners LLC)

## Utility Commissioners

We interviewed current and former utility commissioners to provide a more well-rounded perspective, as it can be difficult to discuss open dockets and current issues under consideration with current commissioners.

9. HI - Commissioner Leodoloff R. Asuncion, Jr
10. IL - Commissioner Ann McCabe
11. MD - Commissioner Michael T. Richard

## State Energy Offices

We targeted directors of key state energy offices and attempted again to cover diverse regions of the U.S.

12. CA - Commissioner Andrew McAllister, joined by Senior Advisor Bill Pennington
13. CT - Energy Bureau Chief Michael Li
14. FL - Director Kelley Smith Burk

## Key stakeholders

Finally, HPC interviewed a series of industry leaders and experts, representing key non-profits and trade associations in the energy efficiency and building performance space.

15. David Terry (Executive Director, NASEO)
16. Ed Carley (Buildings Program Director, NASEO)
17. Steve Cowell (CEO, E4TheFuture)
18. Steve Nadel (Executive Director, ACEEE)
19. Paula Glover (President, Alliance to Save Energy)
20. Vincent Barnes (Senior Vice President of Policy & Research, Alliance to Save Energy)

## c. National Home Performance Virtual Conference & Smart-on-Smart Workshop

To broaden the scope and range of perspectives for our research we also surveyed a range of sessions pertaining to our four technologies at the 2021 National Home Performance Conference, the largest home performance conference in the U.S. which attracts over 2,000 attendees each year from across the industry spectrum. This year's conference was held virtually April 12-16 with both live and on-demand programming and provided additional insights on how the technologies are being considered and addressed among practitioners, who is partaking in these discussions, and what questions, experiences and insights are shared.

The Smart-on-Smart Workshop, held on April 27 and led by the authors of this report, provided another forum to engage with industry members on the smart home smart technologies and how they overlay the technology categories that were the subject of our research. HPC conducted a pre-workshop survey and a follow-up survey to gain further insight into how the audience is thinking about and engaging with these technologies in their work. While not statistically significant, these responses provide additional context and diverse anecdotal evidence to the findings in this report.

### *Pre-Workshop Survey*

In advance of the workshop, HPC conducted a survey to registrants to gauge the level of engagement and experience with smart technologies among participants and get their questions and top interests and hopes for the workshop. Although many of the respondents had not engaged in an HPC conference prior to this year, over half indicated that they would be participating in the full conference this year with the greatest interest in sessions focused on smart air quality monitors and HVAC performance monitoring devices. In addition, on average, respondents indicated that smart home technology was a significant part of their work (average level of importance of 4, on a scale of 1-5). These respondents also articulated that increased knowledge and familiarity with smart technologies was their major goal for the workshop.

### *Follow-up Survey*

Upon completion of the Smart-on-Smart Workshop, HPC also disseminated a survey to the 70 total attendees to understand to what extent each sector of the industry engages with smart technologies and sees value in them, and the greatest barriers and opportunities to advance home performance. In total, HPC received 16 responses from attendees with 13 expressing high interest and positive outlook for the value of smart devices. When asked about what the industry needs, these 16 respondents most commonly replied with workforce training, greater support through WAP, and incentives/rebates. However, over half of the respondents indicated that they did not currently work with any of the major technologies explored through this research, while the most commonly utilized technology was smart devices (such as thermostats and energy monitoring equipment). The post workshop survey also requested a breakdown of each respondents' familiarity with and prioritization of heat pumps, HPWHs, automated fault detection & diagnostics, remote monitoring tools, and rooftop solar, respectively. In response, industry stakeholders indicated the most familiarity with remote monitoring devices and rooftop solar while placing the greatest importance on heat pumps and smart devices as a means to advance home performance. Altogether, the post-workshop survey results are aligned with key takeaways that the industry is interested and enthused by technologies to advance home performance. However, greater resources and support for training, state and federal funding for programs such as WAP, and rebates can drive industry expertise, engagement, and deployment.

### *Smart-on-Smart Workshop Attendance*

Total attendees: 70 (excluding presenters)

- Contractors: 10
- Utilities: 12
- WAP (contractors or administrators): 9
- Other industry stakeholders (including consultants, researchers, etc.): 39
- Manufacturers (including presenters): 9