To:	Miles Ingram, Eversource
From:	Scott Dimetrosky and Katie Parkinson, Apex Analytics
Subject:	Review of Residential Virtual Pre-Assessment Options
Date:	June 23, 2020

Background

On April 24, 2020 the Connecticut Department of Energy and Environmental Protection (DEEP) issued a memo entitled "Approval of Virtual Pre-Assessment Proposal - COVID-19 Contingency Planning Initial Action Item #5 in the 2019-2021 Conservation and Load Management Plan" (the DEEP Order). While DEEP approved the Utilities' April 14th proposal regarding virtual audits, they required a number of modifications, including two items requiring a utility response by July 1, 2020:[1]

- Item #6: DEEP requests the Utilities submit a letter to DEEP evaluating the NEEP Energy Estimator tool, including whether the NEEP Energy Estimator tool might assist the Utilities in their Home Energy Score determinations.
- Item #8: The Utilities shall evaluate additional program models that use remote audits/assessments for delivering whole-home residential energy savings. Given that there are companies, like Sealed Inc., that have experience with remote audits, and that there are some HES vendors that may not be interested in participating in the Virtual Pre-Assessments (VPAs) approved herein, DEEP directs the Utilities to evaluate the viability of utilizing companies with this experience, in addition to the current procedures.

Apex Analytics prepared a response to these two DEEP requests. As part of our search we contacted VPA tool providers via email or phone and requested demonstrations when feasible. Apex assessed each available option across a number of factors, including (but not limited to)[2]:

- Type of audit: computer led, customer led, or technician led[3]
- Primary and secondary data sources

[1] Note there were a number of other items requiring utility responses; those are not included in the scope of work here.

[2] Apex also looked at conversion rates, or the effectiveness of converting participants from the audit to installing follow-on measures (e.g., insulation). This metric became problematic as (1) vendors were not always willing to provide this, (2) vendors calculated conversion rates differently, and (3) not all VPA types (such as customer or computer led) have a way of capturing this metric.

[3] See below for details on these types

- Vendor experience (e.g., how many years the software has been in use, by how many utilities, and across how many homes)
- Measures assessed through the VPA (i.e., the comprehensiveness of the assessment)
- Ability to align savings to match the Connecticut Program Savings Document (PSD)

NEEP and ClearlyEnergy Energy Estimator Tool Assessment

Item six of the DEEP Order asked utilities to review the NEEP Energy Estimator tool and assess if it might assist the Utilities in the Home Energy Score determination; Apex Analytics conducted this research through email and telephone interviews with NEEP staff. The NEEP Energy Estimator, as applied in Vermont, offers a computer led VPA, supplemented by homeowner data. The NEEP Energy Estimator model begins with tax assessor data for home characteristics, and layers in weather and building codes to offer modeled estimated energy costs, by end use, for each home. Energy Estimator also includes solar PV and home certification data from HELIX. Homeowners can refine these data by providing actual home attributes, including billing data, lighting types, and appliance information. These data are used to recommend home improvements. Recommendations also link to rebates and services that bring down the cost of the upgrades for the homeowner. The NEEP Energy Estimator also creates an efficiency scorecard for use by the homeowner or real estate agent to market efficiency upgrades and attributes of the home. The scorecard also includes home energy labels, certifications, and solar PV data, as applicable.

Energy Estimator collects some of the same information as required for the Department of Energy Home Energy Score (DOE HES score), but excludes the more technical measurements for ease of entry for untrained homeowners. Energy Estimator is built for homeowners to self-assess their energy usage, and as such, does not collect precise measurements required for the DOE HES score, such as square footage of windows or type and quantity of insulation for individual spaces. Conversely, Energy Estimator collects information relevant to energy usage that are not included in the calculation of the DOE HES score, such as lighting types, EV ownership, and temperature setpoints. Based on our review of the data each tool collects, the two tools are complementary, although they do collect some overlapping data.[4] If it saves cost or effort, the Utilities could utilize the information collected in Energy Estimator to prepopulate some of the information required to calculate the DOE HES score. Prepopulating these fields could also reduce customer burden for those that complete an Energy Estimator assessment prior to a technician led VPA. It could also allow the contractor to identify potential health and safety barriers in advance of the onsite assessment, thus reducing the need for a second visit. Furthermore, the contractor may be able to better ascertain the opportunity and scope of work so the length of the scheduled visit is more precise. However, the DOE HES score was developed to be used by a trained and certified professional. As such, it cannot be fully replicated in a customer led format such as Energy Estimator.

The Utilities' customer engagement platform (CEP) largely mimics and improves upon the activities of Energy Estimator. CEP is a customer-led platform that begins with customer billing data and is refined through customer input on their home. The result is home energy

[4] Appendix A illustrates the data collected by Energy Estimator and that included in the DOE HES Score.

consumption and cost information, disaggregated into end use categories, along with recommendations for energy savings. CEP also returns the VPA results back to the Utilities for follow-up and targeted marketing. Due to the significant overlap between the CEP and Energy Estimator, there is limited added value in adding Energy Estimator tool for conducting VPAs. Unlike Energy Estimator, CEP includes of billing information in place of usage estimates and sends feedback to Utilities. Finally, the Energy Estimator tool cannot replace the technician led audit tool as it does not capture the entirety of information in the DOE HES score (see Appendix).

VPA Research Results Summary

For item eight in the DEEP Order, Apex researched and categorized VPAs into three categories: technician led, customer led, and computer led. We based these categorizations on the primary mechanism used by the VPA to collect data; for example, the technician led VPA primarily relied on in-home data collected virtually by a trained technician to formulate results and recommendations. Nearly all VPAs also rely on more than one source of data in their energy analyses, however, these categories describe the primary mechanism.

- Technician Led: Technicians connect with homeowners via phone or video. Together, homeowners and technicians walk around the house to collect information and measurements needed for the audit. The technician inputs data into the data collection tool and provides recommended improvements to the homeowner. This method is most similar to the traditional in-home audit.
- Customer Led: Homeowners collect home information independently of a technician and input the data into an online tool. These data are generally less comprehensive than technician led data in order to make the data collection process more accessible to the typical homeowner. After the data is entered into the tool, it is either analyzed by a computer program or by a technician to make recommendations to the homeowner.
- Computer Led: Computer algorithms collect publicly available and/or utility data to create energy estimates and recommended improvements for a home. Most common data utilized are tax assessor records, google maps, and building codes. Often times, no homeowner input is required.

Apex started by reviewing tools that utilize experienced technicians to conduct on-site audits in a remote fashion (i.e., technician led). This type of VPA often employs secondary data such as utility bills, building codes, and/or tax assessor records to contribute to the body of knowledge on the house. However, the primary mechanism for data collection is conducted by a trained technician through a virtual interface with the homeowner. This method is becoming more common as implementation firms are unable to conduct in-home audits due to COVID-19. Both ClearResult and DNVGL offer technician led audits, however, because they do not offer the data collection tool to third parties, we did not include them in this analysis. We found relatively homogenous offerings through this review; they all offer roughly the same interface options: video (via zoom, facetime, or similar connections), or telephone with photo supplements. They offer recommendations for a variety of measures, and can request detailed data from the home, such as insulation quantities, measurements,

and light bulb types. We could not find any available[5] tools that automatically calculated measurements through video. As such, technician led VPA process can be labor intensive for the homeowner; not everyone can climb on a ladder to unscrew lightbulbs or climb into the crawlspace to assess insulation. There can also be technical constraints if there is unstable internet or the homeowners are less proficient with technology. Price estimates vary widely for technician led audits based on the depth of information and analysis conducted.

Apex then expanded the research to include customer led VPA options. Similar to technician led, customer led tools often utilize secondary data such as tax assessor records, building codes, or utility bills in the initial assessment, but the primary mechanism for data collection is conducted by the homeowner, independent of a trained technician. Typically, this means that homeowners answer questions about their home and occupants through an online questionnaire. The questions are often centered around age and condition of home equipment, providing inputs to modeled energy use estimates and recommendations for energy savings. The resulting recommendations are generally less precise than those from a technician as the data collected are less detailed, but the customer led VPAs are often less expensive because of a reduced amount of personal interaction. Customer led VPAs may have a lower conversion rate (conversion from VPAs to action) than technician led, simply because the homeowner cannot ask questions as readily and recommendations are not as personalized as with the technician interaction. Depending on the depth of data collected, these tools can assess the same measures as technician led VPAs, albeit with less confidence and precision than those measured by a technician. The most fruitful customer led VPAs would be those that include an immediate follow up by a trained technician to answer questions and assess any deficiencies in the data. We received estimated prices of $10,000-$12,000 per month for unlimited customer led audits.

Finally, we researched a third category of VPAs: automated, computer led audits. These rely primarily on computer models to assess energy usage and predict savings opportunities. The models disaggregate energy load into common end uses and create recommendations based on modeled buildings of similar age and build. The most common models are based on a combination of online maps, tax assessor data, and building codes. These recommendations will be the least precise as they do not account for upgrades, remodels, occupancy, or actual installed equipment. More complex models are based off thermal imaging, customer inputs, or hourly utility bills. In some cases, homeowners add in basic household and building data to further refine energy use estimates and savings recommendations. Computer led VPAs are often the least expensive VPA option as they are produced in bulk via algorithms for an entire territory at once. Computer led VPAs are especially useful for pre-screening homes; they can review the breadth of homes within a utility territory and recommend homes with higher than expected energy use to target for increased utility support and marketing. They also are the least intensive from a homeowner perspective, requiring very little (if any) effort from the homeowner. We received estimated prices of $1 to $25 per home for computer led audits.

While there are situations where this is not feasible, ideally utilities could offer all three types of VPAs as they complement each other and offer varying levels of support. For example, a technician led audit can be time and labor intensive for the homeowner but offers refined recommendations and significant attention from a trained technician. This

[5] Note that ClearResult is working on this functionality, but it is not yet available.

option may not be agreeable to homeowners that want to perform small upgrades with limited effort. In these instances, the customer led option more closely meets their needs. Finally, some customers are not motivated to perform energy efficiency improvements independently. Those customers can be recognized through a computer led VPA and targeted for improvements that would fit more directly. Computer led VPA has the benefit of a large breadth coverage and lower cost per home, which allows utilities to go after a broad set of potential participants with a "push" strategy for those who may not be predisposed or less aware of EE opportunities. In comparison, the customer or technician led are more demand "pull" approaches for customers who are already interested in making energy improvements.

The table below describes, in general terms, the cost, effort required by the homeowner, and precision of savings recommendations for the three categories of VPA. Individual tools may not fit into these generalizations.

Table 1. Summary of Virtual Pre-Audit Categories

Type of VPA	Cost per Customer	Homeowner Effort	Recommendation Accuracy	Breadth of Coverage
Technician Led	$ $ $			
Customer Led	$ $			
Computer Led	$			

Currently, the Utilities have developed a three-pronged approach to VPAs: a technician led, customer led, and a computer led VPA for prescreening homes. The technician led VPA is similar to a traditional in-home audit (although conducted through telephone or appropriate video teleconferencing tool); the customer and technician move around the home taking measurements and collecting data, while the technician documents findings in their data collection instrument. The customer led audit, the CEP, begins with prepopulated billing and participation data to educate customers on their energy use. Customers then enter housing specific information to refine disaggregated energy consumption and offer recommended actions to save energy. Finally, the Utilities also are implementing a tool that provides the functionality of a computer led audit to pre-screen homes that can most benefit by energy efficiency improvements. Through this tool, the Utilities analyze full CT residential customer monthly electric and gas usage data to identify non-participants that indicate good potential for weatherization savings for targeting/pre-screening. The Utilities use this tool across the entirety of their residential customer homes.

Matrix of VPAs

Apex conducted in-depth research on nine VPAs, including NEEP's Energy Estimator. We found the VPAs through internal contacts, internet searches, and Utility input. We excluded VPAs from this in-depth review if the implementer did not sell the tool to third party implementers, it was limited to nonresidential applications, or if the implementer was unresponsive. We collected these data through emails, website reviews, telephone calls and

demonstrations. This matrix offers details into the nine VPAs researched by Apex Analytics, followed by definitions of the provided attributes.

Table 2. Summary of Virtual Pre-Audit Categories

Vendor	Data source (primary mechanism)	Measures Assessed	Secondary data used	Can it calculate DOE Home Energy Score?	Can savings calculations be adjusted to PSD assumptions?	Firm Experience
CMC Energy Services	Technician-led	Insulation, Lighting, HVAC, Thermostats, Appliances, Water Heating	None	Yes	Yes	In use since 2019, 200 homes
EnergyX	Customer-led, technician-led, and computer-led options	HVAC, Insulation, Thermostats, Lighting, Shell, Appliances, Water Heating, Solar[6]	Optional to use billing data	No	Possibly	In use since 2016
Home Energy Analytics -Smart Audit	Computer-led AMI data[7]	Behavioral, Weatherization, Lighting, Thermostats, HVAC, Water Heaters, Appliances	Weather data, Zillow (house size)	No	No	In use since 2010, 14,000 homes
MyHeat Inc	Computer-led Thermal Imaging	Insulation, Air Sealing, Window Quality	Optional to incorporate billing data, property tax data, census tract data	No	No	In use since 2016, 3.4 million homes assessed

[6] Complete list of measures includes: HVAC primary and secondary, insulation, lighting, thermostats, air sealing, building envelope, standard and custom appliances, water heating, water flow devices, solar, electric vehicles and chargers, local building codes and weather, wireless capabilities, smart home controllers, ventilation.

[7] Note that Eversource does not collect AMI data, UI does.

Vendor	Data source (primary mechanism)	Measures Assessed	Secondary data used	Can it calculate DOE Home Energy Score?	Can savings calculations be adjusted to PSD assumptions?	Firm Experience
NEEP/ HELIX – Energy Estimator	Computer-led, customer customization	Weatherization, Lighting, Thermostats, HVAC, Water Heaters, Appliances, Solar	Tax assessor data, building codes, HER and HES scores, solar PV data	No	Yes	Modeled calculations on >40 million homes, 4,900 audits completed
Nexant iEnergy	Customer-led	Insulation, Lighting, HVAC, Thermostats, Lighting, Shell, Appliances, Water Heating	Optional to incorporate monthly billing data	Yes	Yes	In use since 2007, >600 programs and 5 million projects
Sealed	Customer-led, technician analyzed	Weatherization, Lighting, Thermostats, HVAC, Water Heating	Google maps, Zillow property records, billing data	No	Yes	In use since 2018, 5 utilities and 600-700 projects
Snugg Pro	Technician-led	Insulation, Lighting, Shell, Windows, Appliances, Air Sealing, HVAC, Water Heating[8]	Optional to incorporate billing data	Yes	Yes[9]	>10,000 homes per year
Uplight	Customer-led	HVAC, Insulation, Lighting, Thermostats, Air Sealing, Windows, Appliances, Water Heating	None	No	Possibly in the future	Used by over 25 utilities and EE firms, over 1 million assessments completed

[8] Full list of measures includes: attic insulation, knee wall insulation, radiant barriers, cool roofs, vaulted ceilings, air sealing, frame floor insulation, thermostat set points, HVAC, ductwork, freezer, refrigerator, dishwasher, clothes washer, lighting, doors, windows, crawlspace insulation, basement insulation, rim joist insulation, water heater temperature, water heater, pool pump, PV.

[9] https://snuggpro.com/help/article/residential-direct-install-programs

Matrix Attribute Definitions

- Data source: The research team divided the tools into three categories, according to how the audit data is collected: customer-led, technician-led, and computer-led.
- Measures Assessed: The measures that the tool is capable of assessing. Note that many firms stated that the measures they assess are program-specific and that they can assess measures that are not listed in the matrix.
- Secondary Data Used: Whether the firm incorporates any secondary data in addition to onsite data, such as AMI data, monthly billing data, weather data, etc.
- DOE Home Energy Score Calcs: Whether the tool can perform the Department of Energy's Home Energy score calculations.
- Firm Experience: Firms were asked how many years their tools have been in use and across how many homes and utilities.

Appendix A: Data Collected for Energy Estimator and DOE Home Energy Score

	DOE HES Score	Energy Estimator
Year Built	✓	✓
# of Bedrooms	✓	✓
Stories Above Grade	✓	
Ceiling Height	✓	
Conditioned Floor Area	✓	✓
Direction Faced by Front of house	✓	✓
Home Type	✓	✓
If Attached Home, Position of Unit	✓	✓
Annual Gas Bill		✓
Annual Electric Bill		✓
Number of Occupants		✓
Light Bulb Types		✓
Existence of Swimming Pool or Hot Tub		✓
EV Ownership		✓
Refrigerator Type, Age, ESTAR Rating		✓
Dishwasher Type, Age, ESTAR Rating		✓
Clothes Washer Type, Age, ESTAR Rating		✓
Clothes Dryer		✓
Cooking Fuel		✓
Air Tightness - Air Leakage Rate	✓	
Heating System Type	✓	✓
Heating Efficiency or Year	✓	✓
Heating System ESTAR Status		✓
Thermostat Type		✓
Cooling System Type	✓	✓
Cooling System Efficiency or Year	✓	✓
Cooling System ESTAR status		✓
Cooling and Heating System Set Points		✓
Duct Insulation and Sealing Coverage	✓	
Water Heater Type	✓	✓
Water Heater System Efficiency or Year	✓	✓
Water Heater ESTAR status		✓
Roof Construction	✓	
Roof Exterior Finish	✓	
Roof Color	✓	
Roof Insulation Level	✓	✓

	DOE HES Score	Energy Estimator
Attic Insulation Type	✓	
Attic Floor Insulation Level	✓	
Attic Square Footage	✓	
Foundation Type	✓	
Foundation Square Foot	✓	✓
Floor Insulation Level	✓	
Foundation Wall Insulation Level	✓	
Wall Construction	✓	
Wall Exterior Finish	✓	
Wall Insulation Level	✓	✓
Total Skylight Area	✓	
Skylight Number of Panes	✓	
Skylight Frame Type	✓	
Skylight Glazing Type	✓	
Window Panes	✓	
Window Frame Type	✓	
Window Glazing Type	✓	
Window Area Square Foot	✓	
Window Solar Screens	✓	
PV System Year Installed	✓	✓
Direction of PV Panels	✓	✓
PV Capacity		✓
Ownership of Panels		✓
PV Battery System		✓