# OpenADR Deployments Survey

*DR18.10 & DR18.11*

*Prepared by: Energy Solutions for*

*Emerging Markets and Technology Program*
*Customer Programs and Services*
*Southern California Edison*

*November 2021*

SOUTHERN CALIFORNIA EDISON®
An EDISON INTERNATIONAL® Company

**Acknowledgements**

Southern California Edison's (SCE) Emerging Markets and Technology (EM&T) program is responsible for this project. It was developed as part of the EM&T 2018-2022 research portfolio under internal project number <DR18.10 & DR18.11>. Navniel Pillay of SCE conducted this technology evaluation in collaboration with Energy Solutions with overall guidance and oversight from Mark Martinez, EM&T portfolio manager. For more information on this project, contact *navniel.n.pillay*@sce.com.

# EXECUTIVE SUMMARY

Enabling demand flexibility for electrical end uses and whole building loads has become increasingly important as renewable generation increases, as utilities change their retail rate structures, and as more distributed energy resources are introduced on the distribution grid. California's state and local agencies are aligned on energy policy to leverage flexible demand resources to support greater grid reliability and the state's goal of 100% zero carbon energy sources by 2045. California's electric investor owned utilities (IOUs) have adopted OpenADR as the secure protocol for automating demand response communications and are providing financial incentives to facilitate customer participation in demand response programs that utilize OpenADR.

Intelligent energy controls in the commercial market already include advanced sensors, connectivity, communication, scheduling and programming capabilities. However, research conducted by Energy Solutions with heating, ventilation, and air conditioning (HVAC) distributors and variable refrigerant flow (VRF) manufacturers indicated that the control functions are not sufficiently integrated to perform automated demand response (ADR).[1,2] These stakeholders indicated that a demonstration of market demand for ADR, along with stronger and clearer guidance from utilities on OpenADR signaling requirements, are both needed for them to justify additional investments in OpenADR certified technologies.

This project thus seeks to update the list of utilities, municipalities, system operators, major customers, and other organizations with active OpenADR deployments in programs and pilots currently certified by the OpenADR Alliance.The hypothesis from Southern California Edison (SCE) was that OpenADR deployments have grown since the last time the markets were surveyed. To test that hypothesis, SCE commissioned Energy Solutions to conduct a survey of OpenADR market participants, stakeholders, utilites and manufacturers to collect more up-to-date information on the latest OpenADR deployments.

This report details the results and findings of the OpenADR Deployments Survey, conducted for SCE by Energy Solutions in collaboration with the Alliance. SCE initiated this project to provide its demand response (DR) program participants and stakeholders with the most recent data on OpenADR activities in the retail and wholesale energy markets.

In order to gather information on current OpenADR deployments, the team surveyed utilities, virtual end node (VEN) manufacturers, virtual top node (VTN) manufacturers, aggregators, and other industry stakeholders from a range of geographic areas where OpenADR is actively utilized or encouraged. The survey targeted active members of selected organizations involved in researching, analyzing, and developing projects related to OpenADR.

Eighty-four unique organizations responded to the survey. The survey results show a significant uptake in OpenADR deployments and activities since the last time the market

[1] Southern California Edison. 2019. *ADR Solution Development and Deployment for HVAC Distributors.* Project DR18.10.

[2] Southern California Edison. 2019. *ADR Capabilities of VRF Technology: Manufacturer Outreach*. Project DR18.11.

was surveyed in 2014. Survey respondents identified over 30 utilities with OpenADR programs or pilots and demonstration projects across 25 states and six countries, with the utilities reporting 265 enrolled and 355 planned megawatts in programs and pilots using OpenADR, for a total of 620 MW. Manufacturers also reported over 76,000 unit sales across the U.S. and internationally. Table 1 compares the total deployments between this survey and the deployments data in 2014.

**TABLE 1. GROWTH IN OPENADR DEPLOYMENTS SINCE 2014**

| CATEGORY | 2021 DEPLOYMENTS SURVEY | 2014 DEPLOYMENTS DATA |
|---|---|---|
| Number of Programs Identified | 201 | 34 |
| Number of U.S. Utilities Identified | 21 | 10 |
| Number of International Utilities Identified | 11 | 4 |
| Number of U.S. States Identified | 25 | 8 |
| Number of Countries Identified | 6 | 8 |

As we are only able to report on the data collected, this dataset of survey responses is not representative of all OpenADR activities. It is difficult from this small sample to infer the full market size, and was not intended to be a comprehensive market assessment. However, the survey shows a very positive trend in the deployments.

The data shared in this report will be used to update the Alliance's deployments website and will be shared with energy equipment manufacturers, existing and potential ADR customers, utilities, and other load management industry stakeholders to encourage continued investment in ADR-capable controls and projects. The information is meant to help drive further growth in number and diversity of OpenADR certified solutions, as well as customer participation in DR programs in California and other states. The ADR incentive program in California has been found to be a strong driver of sustained engagement with DR programs since most customers that receive the incentive remain ongoing DR participants[3].

[3] Energy Solutions. August 6, 2020. Automated Demand Response Non-Residential Incentive Structure Research Project Report. https://www.etcc-ca.com/reports/automated-demand-response-non-residential-incentive-structure-research-project.

# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ADR | Automated Demand Response |
| DERMS | Distributed Energy Resources Management System |
| EV | Electric Vehicle |
| HVAC | Heating, Ventilation, and Air Conditioning |
| IEEE | Institute of Electrical and Electronics Engineering |
| LBNL | Lawrence Berkeley National Laboratory |
| MW | Megawatt |
| OEM | Original Equipment Manufacture |
| PLMA | Peak Load Management Alliance |
| SCE | Southern California Edison |
| VEN | Virtual End Node |
| VTN | Virtual Top Node |
| VRF | Variable Refrigerant Flow |

# CONTENTS



# FIGURES

# TABLES

This page intentionally blank

# INTRODUCTION

Making building loads more flexible has become increasingly important as renewable generation increases on the grid, as customers are impacted by changes in retail rate structures, and as more distributed energy resources are introduced on the grid. In the 2025 California Demand Response Potential Study, Lawrence Berkeley National Laboratory (LBNL) stated that innovative end-use enabling technologies that can "shift and shimmy" will be essential for developing the pathways for future program and portfolio design for cost-effective DR resources in California.[4] California Public Utility Commission policy supports greater alignment of efficiency and demand response, as a cost effective strategy to address peak energy demand, reduce energy use, and lower the costs of reducing emissions and meeting clean energy goals.[5]

Variable refrigerant flow (VRF) manufacturers and heating, ventilation, and air conditioning (HVAC) distributors interviewed in Southern California Edison (SCE) Projects DR18.10 and DR18.11 regularly asked "who else is implementing OpenADR?". These stakeholders noted that they sell products worldwide and that they can't tailor products just for a single utility territory in one state. Separately, the energy manager of a large international retailer noted that it in order to justify the investment in OpenADR certification he needed to show his management that the solution could be applied to other projects beyond a single utility program outside SCE. The distributors and manufacturers said that if OpenADR adoption is prevalent that would motivate HVAC and VRF trade allies to invest more in developing controls that are more plug and play for Auto-DR out of the box.

Limited market information was available at the time of the earlier OpenADR projects as to the scale of both the number and locations of OpenADR certified products and utility incentive programs. To address that challenge, LBNL created an OpenADR Deployments Map in 2012. The online website included a table and a map highlighting the locations of OpenADR deployments around the world. Users could click on the map markers to get more information on the OpenADR program name, deployment status, target sector, and profile type.

The OpenADR Alliance (the Alliance) assumed ongoing maintenance of the online map from LBNL in 2014, though limited updates were made on new OpenADR deployments. Many industry stakeholders were reluctant to share deployments information, which were considered sensitive. The hypothesis from SCE was that OpenADR deployments have grown since that time. Furthermore, an updated dataset showing increased market penetration of the OpenADR protocol would help manufacturers justify investment in OpenADR, leading to growth of certified solutions and ADR program enrollments. To test that hypothesis, SCE

[4] Lawrence Berkeley National Laboratory, Energy and Environmental Economics, Inc. and Nexant. March 1, 2017. *2025 California Demand Response Potential Study. Charting California's Demand Response Future. Final Report on Phase 2 Results*. Prepared for California Public Utilities Commission. Downloaded from: http://www.cpuc.ca.gov/General.aspx?id=10622

[5] National Governors Association. August 2016. Aligning Energy Efficiency and Demand Response to Lower Peak Electricity Demand, Reduce Costs and Address Reliability Concerns. https://www.nga.org/files/live/sites/NGA/files/pdf/2016/1608LowerPeakElectricity.pdf

commissioned a survey of OpenADR market participants, stakeholders, utilities and manufacturers to collect more up-to-date information on the latest OpenADR deployments. The survey was targeted at active members of selected organizations involved in researching, analyzing, and developing projects related to OpenADR, and was not intended to be a comprehensive market assessment. Additional information on the study methodology is provided in the Methodology section.

# BACKGROUND

This study builds upon recent work in 2018-2019 with SCE's Emerging Markets & Technology Group. Aimed at encouraging the market development and deployment of plug-and-play controls for automated demand response (ADR), these two projects engaged VRF manufacturers and HVAC distributors. These stakeholders indicated that a demonstration of market demand for ADR, along with stronger and clearer guidance from utilities on OpenADR signaling requirements, are both needed for them to justify additional investments in OpenADR certified technologies.

The number of products certified by the Alliance has grown significantly from roughly 50 products in 2011 to over 250 products today. Similarly, the number of manufacturers making products certified by the Alliance has grown from 30 to 100 over the same period. ADR technologies have evolved from the very first OpenADR installations using CLIR boxes through to the latest OpenADR 2.0b protocols. OpenADR 2.0 communication protocol was released in 2012 (2.0a) and 2013 (2.0b). However, there is limited information on where these certified technologies are deployed and at what scale. The HVAC distributors and VRF manufacturers interviewed had the impression that OpenADR protocol and products are used only in California.

Building controls products on the market already include advanced sensors, connectivity, communication, scheduling and programming capabilities. However, research indicates that the control functions are not sufficiently integrated to perform automated demand response. Plug-and-play controls for demand response should include at minimum: 1) a demand response mode user display that is easily accessible, 2) two to three load control options ideally with a default option pre-set from the factory, and 3) an OpenADR virtual end node solution either integrated with the controls or as a readily available add-on. Past interviews with major HVAC manufacturers revealed that products are designed to be sold worldwide.[6] There was a need by manufacturers to see clear market demand for ADR capability before upper management would authorize additional development investment.[7]

[6] Southern California Edison. 2019. *ADR Capabilities of VRF Technology: Manufacturer Outreach*. Project DR18.11.

[7] Ibid.

# ASSESSMENT OBJECTIVES

This project will update the list of utilities, municipalities, independent system operators, and other organizations that are using OpenADR. While LBNL created the first OpenADR Deployments Map[8] in 2012, the last deployment was documented in 2014 and has been minimally updated since handing it off to OpenADR Alliance. LBNL[9] has stated that they do not intend to update the OpenADR Deployments map further.

By updating the list of OpenADR deployments, the anticipated project outcomes are that the results will help equipment manufacturers, controls manufacturers, and customers justify investment in OpenADR certification to their management. This would lead to growth in quantity and diversity of OpenADR certified solutions, as well as customer applications in California's ADR programs.

[8] See https://drrc.lbl.gov/openadr-deployments

[9] Mary Ann Piette. Email communication, 12 September 2019. Re: OpenADR Deployments update.

# TECHNICAL APPROACH/TEST METHODOLOGY

The survey distribution list was developed by Energy Solutions, the Alliance, and Peak Load Management Alliance (PLMA) in close collaboration with SCE. The Alliance contributed a list of main contacts – primarily VEN and controls manufacturers. PLMA contributed a list of key contacts based on their membership; primarily utilities and regional transmission organizations (RTOs). Energy Solutions contributed a range of trade allies and utility contacts. SCE contributed a list of customer participants in their Auto-DR program.

The team also developed a target list for high-priority respondents. This included utilities and other service providers that are known to administer OpenADR programs and manufacturers of OpenADR-certified technologies with whom the survey team has interacted previously. Care was taken to include at least one contact from each of these organizations in the survey distribution list, and outreach was conducted as needed to find contacts. In total, the combined survey distribution list included 431 contacts representing 361 organizations.

Survey socialization began in February 2021. The Alliance sent an announcement ahead of the survey in their February newsletter. Directly prior to distributing the survey via Survey Monkey in early March 2021, the survey team sent personalized emails to each contact on the priority target list, letting them know to expect the survey and that their participation is highly valued.

Surveys were sent out via Survey Monkey in early and mid-March 2021 – the later distributions due to additional contacts being shared after the first distribution. After each distribution, the survey team sent out survey invitations to alternate contacts in those organizations where the primary email contact bounced or was undeliverable, to the extent that those alternate contacts could be identified, prioritizing those organizations on the high-priority target list. This list refers to utilities and manufacturers with known or likely programs and pilots utilizing OpenADR, based on past direct conversations with this team or references in industry presentations. Reminder emails were sent out in late March 2021 and early April 2021 via Survey Monkey and via email to personal contacts. To gather additional responses, the Alliance also sent the survey invitation to their entire distribution list, which consisted of approximately 4,000 contacts, three times, including a reminder and a last-day reminder.

The survey team also conducted follow up whenever a response needed clarification. For example, some respondents did not complete all questions, provided region instead of state, or identified as "Other" for stakeholder type and were not prompted to complete the full survey.

# SUMMARY OF SURVEY RESULTS

A total of 93 survey responses were collected. Of these responses, eight were removed as duplicates (multiple responses from the same organizations). An additional 11 responses were nearly wholly incomplete – respondents identified as belonging to a particular stakeholder group and answered yes or no for implementing OpenADR but went no further. Their responses are included in the results for those two questions. The remaining 74 responses were fairly complete, though nearly half of utilities and other program-focused organizations did not provide program information.

The most prevalent respondent group was Controls/Original Equipment Manufacturers (OEMs), with Utility and VEN Manufacturer in close second and third. Of the 84 unique organizations responding to the survey, 71 said they are implementing or planning to implement OpenADR, and 13 are not. Of those 13, four respondents indicated they were planning to implement OpenADR in the future, and five were unsure about future plans. Thirty-one respondents use both 2.0a and 2.0b. Twenty-three respondents use only 2.0b, while only four respondents only use 2.0a.

Program-focused organizations (utilities, VTN and DERMs providers, system operators, service providers and consultants, and aggregators) identified over 200 programs using OpenADR-certified technologies in the U.S. and internationally, but only provided details (e.g., number of connected VENs) on 19 of them. The utilities with active programs and pilots are listed in Table 2 and Table 3. Across the 19 programs with details, respondents estimated 14,694 connected VENs, 265 enrolled megawatts, and 365 planned megawatts were reported across all customer sectors: residential, commercial, agricultural, and industrial.

**TABLE 2. CONFIRMED U.S. UTILITIES WITH ACTIVE OPENADR PROGRAMS AND PILOTS**

| |
|---|
| Austin Energy |
| City of Tallahassee Electric & Gas Utility |
| Consolidated Edison |
| CPS Energy |
| Eversource |
| Fort Collins Utilities |
| Hawaiian Electric Company |
| National Grid |
| New Hampshire Electric Cooperative |
| NV Energy |
| Pacific Gas and Electric |
| Portland General Electric |
| Sacramento Municipal Utility District |
| Salt River Project |
| San Diego Gas & Electric |
| Southern California Edison |

**TABLE 3. CONFIRMED INTERNATIONAL UTILITIES WITH ACTIVE OPENADR PROGRAMS AND PILOTS**

| |
|---|
| Tokyo Electric Power Company |
| Kansai Transmission and Distribution |
| Taipower |
| Transpower New Zealand |

Of the 39 Controls/OEM and VEN manufacturer respondents, 29 provided sales data. The majority, or 14 of those respondents identified as having sold 0-1000 OpenADR certified devices, though 10 respondents reported products sold in the higher ranges, including "Over 25,000". Nearly 99% of reported sales were cloud based VENs, and 2.0a sales were reported at more than double the volume of 2.0b sales. This can likely be explained by historical sales and is likely not representative of the balance between 2.0a and 2.0b going forward.

Manufacturers reported sales and deployments in 25 different US states as well as six international countries. Manufacturers also reported over 30 unique utility territories worldwide within which their products are deployed. However, we only listed those utilities with whom we could confirm directly through the survey or program websites.[10] California is the state with by far the highest number of unique manufactures with OpenADR deployments. Japan and Texas are tied in 2nd place, and New York and New Jersey are tied for 3rd place. Energy Management Systems are the most targeted technology reported by manufacturers with 17 unique manufacturers. Thermostats and EVSE are the next most common with 10 unique manufacturers each.

Controls/OEM also mentioned utilities and territories in which their OpenADR certified VENs and devices were sold. In addition to the utilities listed in Table 2, OEMs mentioned five additional U.S. utilities and 11 international utilities. However, we were not able to confirm directly with those utilities if they were using OpenADR certified VENs in programs or pilots.

[10] One website summarizing programs providing incentives for OpenADR equipment include https://www.gridfabric.io/oadr-programs/

# DISCUSSION

It is important to keep in mind is that this dataset is not representative of all OpenADR activities, as we are only able to report on the data collected. Furthermore, not all responses lend themselves to inclusion in the datasets as will be explained further in this section. This survey dataset helps to give an idea of the scale and nature of current OpenADR activities only.

The design of the survey also traded off between simplicity and completeness to balance ease of participation with gathering the information necessary to paint the picture of current OpenADR program activity and deployments. As such, there are several caveats to the data collected and displayed.

Survey respondents were allowed to self-identify as multiple types of stakeholders. Just over one third of respondents identified as belong to more than one stakeholder group – for example both a VEN and VTN manufacturer, or VEN manufacturer and aggregator, or all three. To limit the number of survey design pathways, respondents were grouped into three main categories: manufacturers (VEN, OEM), program-focused organization (utilities, VTN and DERMs providers, system operators, service providers and consultants, and aggregators), and end customers.

For respondents that identified as more than one stakeholder group, we prioritized collecting sales and deployment info. Any respondent that identified as a VEN manufacturer or OEM in addition to other stakeholder groups was classified as VEN/OEM and directed to take the manufacturer survey. Everyone else besides end user customers was designated as a program implementer and took the program-focused survey. This means that there is some program information we did not capture from the organizations that identified as being both in the manufacturer and implementer groups.

Another caveat is that program-focused organization data and manufacturer data are independent and should not be interpreted as being additive, due to the survey design. For example, several California utilities provided program information with the number of enrolled VENs and devices. Many manufacturers also reported deployments in California but not the number of deployments that are participating in programs or pilots. [11] The survey therefore does not identify the extent to which these datapoints overlap. Manufacturer data and implementer data should therefore be treated as entirely different datasets – apples to oranges.

Reported program and deployments data represent information from respondents only, and further, only represent the subset of collected information which could be integrated into the dataset. The Survey Team is aware of two additional utilities implementing OpenADR programs who did not respond to the survey.[12] Additionally, the Alliance database includes over 235 certified products from more than 100 unique manufacturers – a subset of whom responded to the survey. The survey data we did collect is also conservative in its nature.

---

[11] Manufacturers who reviewed our survey during the design phase mentioned that they can report the total number of VENs or devices they sold to a utility customer or service territory but would not know how many of those devices were installed, enabled, and enrolled into a program or pilot.

[12] See for example https://www.gridfabric.io/oadr-programs/, which lists Hawaiian Electric and Salt River Project.

Questions asking for numerical data such as number of deployments, number of enrolled megawatts and devices, etc., included non-answers such as "can't disclose", "not readily available", or "I don't know", etc. When quantitative ranges or order of magnitude such as "100's" were provided, the low end of the range was used for compiling and integrating the results (ex: used 100 when "100's" was reported).

Additionally, several survey respondents represented organizations with business models that could not be integrated into the dataset. For example, two respondent organizations develop OpenADR-certified software that manufacturers can purchase to integrate into their existing products. As such, these respondents were unable to provide information on deployments and end-uses. Several respondents identified as "Other" for the stakeholder group and included researchers working on cutting edge applications of OpenADR, such as EV smart charging, and were in the pre-deployments phase. The survey results do not capture these types of activities.

# FULL SURVEY RESULTS

The figures in this section summarize the data collected for all survey questions. Figures are organized into five sections: all respondents, all respondents using OpenADR, all respondents not using OpenADR, program-focused organizations (utilities, VTN and DERMs providers, system operators, service providers and consultants, and aggregators) using OpenADR, and manufacturers using OpenADR.

## SURVEY PARTICIPATION TOTALS (ALL RESPONDENTS)

Over one third of respondents identified as belonging to more than one stakeholder group and checked multiple boxes in the survey to the stakeholder question. These results are shown in Figures 1 and 2. Figure 1 simply counts the number of responses in each stakeholder group. Figure 2 sorted respondents into one primary stakeholder group, and therefore represents the number of respondents. Respondents who included VEN or OEM as one of their categories were grouped into the VEN/OEM category to prioritize the collection of sales and deployment data.

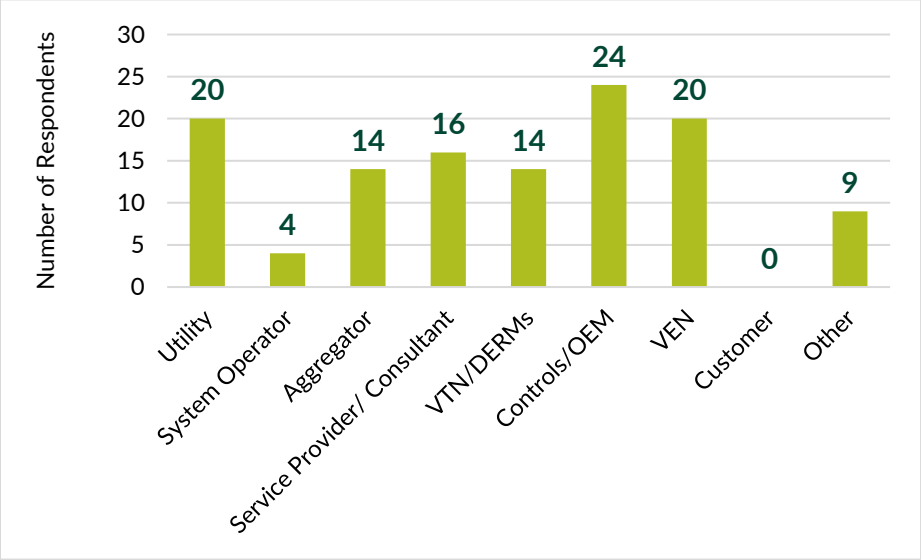


FIGURE 1. SURVEY RESPONDENTS BY STAKEHOLDER TYPE – MULTIPLE

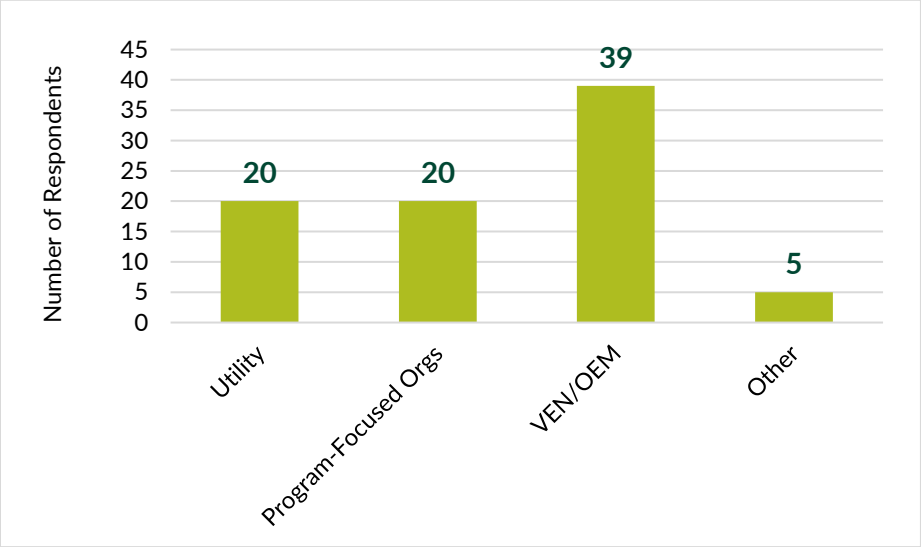


**FIGURE 2. SURVEY RESPONDENTS BY STAKEHOLDER TYPE – PRIMARY**

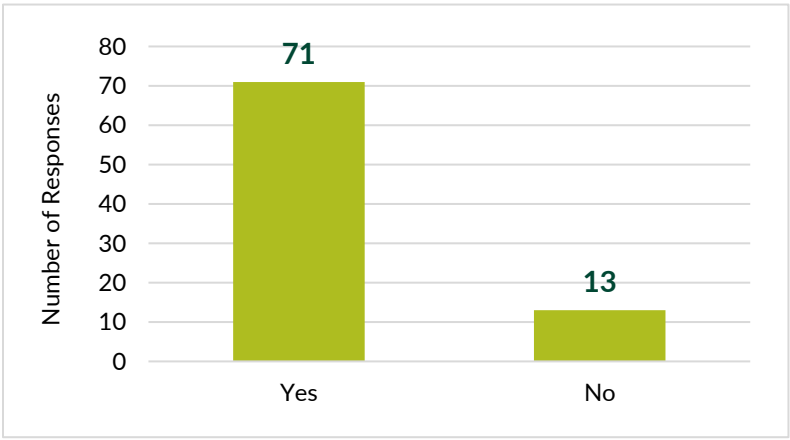


**FIGURE 3 SURVEY RESPONDENTS IMPLEMENTING OR PLANNING TO IMPLEMENT OPENADR**

# ALL RESPONDENTS USING OPENADR

Among the 71 respondents who said they are implementing or planning to implement OpenADR, Figure 4 shows that most survey respondents across all stakeholder type have OpenADR 2.0b capability or both 2.0a and 2.0b. However, stakeholders may not use or apply all the capabilities available in 2.0b. In Figure 5, IEEE 2030.5 was the most common load management protocol in use besides OpenADR, followed by other protocols and CTA-2045. For the other protocols, respondents wrote in SEP 2.0, zigbee, OpenADR 1.0, and a variety of proprietary protocols.

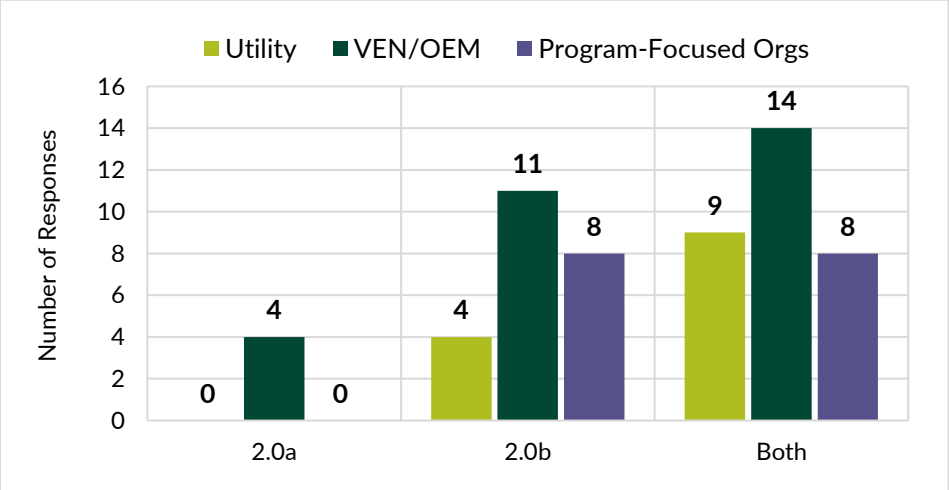


**FIGURE 4. OPENADR ADOPTION BY STAKEHOLDER TYPE**

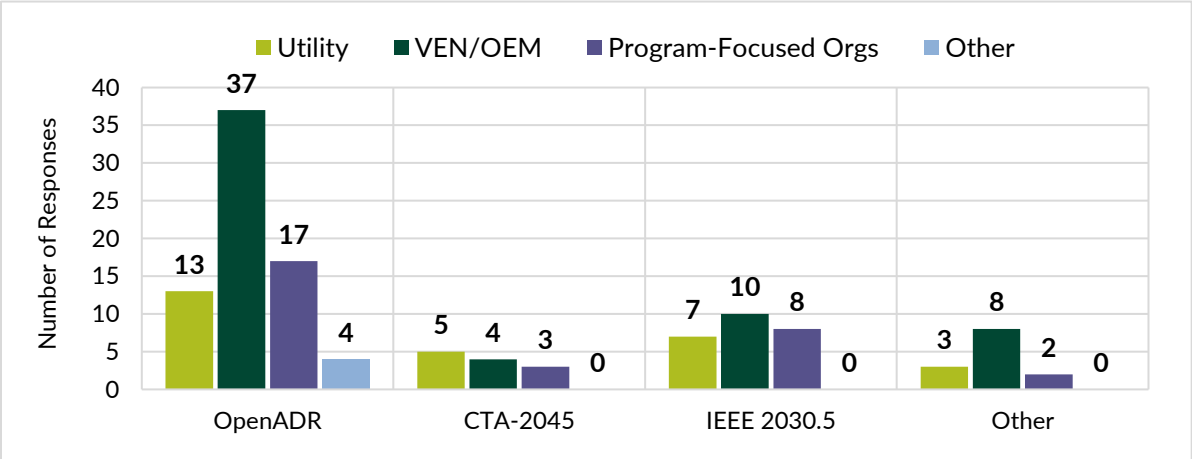


**FIGURE 5. ADOPTION OF OTHER LOAD MANAGEMENT PROTOCOLS, BY STAKEHOLDER TYPE**

# RESPONDENTS WHO DO NOT USE OPENADR

Respondents who answered "not using OpenADR" were asked to share a reason for the decision. These responses are shown in Figure 6. The largest number of respondents (7) selecting "other" mentioned a variety of reasons ranging from "we are convening stakeholders to discuss", "analyzing", "too complex", "not well known", and "I would have no control over the system that could use it." Most respondents who are not using OpenADR are not using any other load management protocols (Figure 7). Encouragingly, some respondents are considering OpenADR in the future (Figure 8).

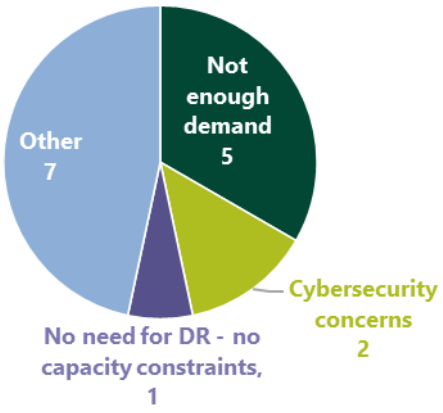


FIGURE 6 - REASONS FOR NOT IMPLEMENTING OPENADR

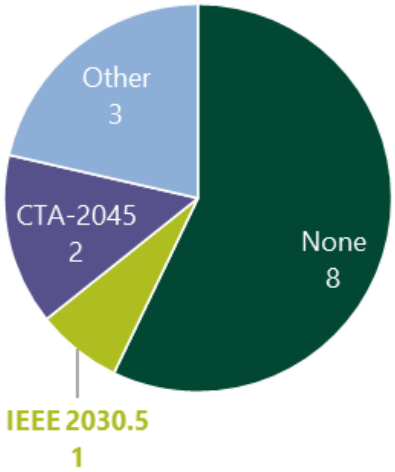


FIGURE 7 - CONSIDERATION OF OTHER LOAD MANAGEMENT PROTOCOLS

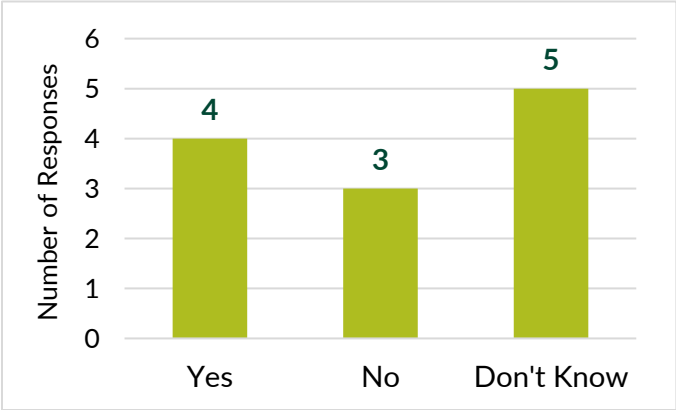


FIGURE 8 – CONSIDERATION OF FUTURE OPENADR IMPLEMENTATION

# Survey Results for Utilities and Other Program-Focused Organizations

Program-focused organizations refer to utilities, service providers, aggregators, VTN and DERMS providers, consultants, and electric grid system operators who either administer, implement, or interact with utility programs. These respondents identified over 200 active programs and pilots using OpenADR, shown in Figure 9. Outside of the western region, respondents reported 21 active programs and pilots.

As noted in Summary of Survey Results, manufacturers also reported over 30 unique utility territories worldwide where their products are deployed. On the other hand, respondents only provided details of 19 programs shown in Figure 10 and Figure 11 aggregated by region. Respondents did not always complete all the program questions asked in the survey and less than half or just 17 out of the 41 program-focused organizations provided program details. As such, the data in Figure 10 and Figure 11 underrepresent total OpenADR program activity.

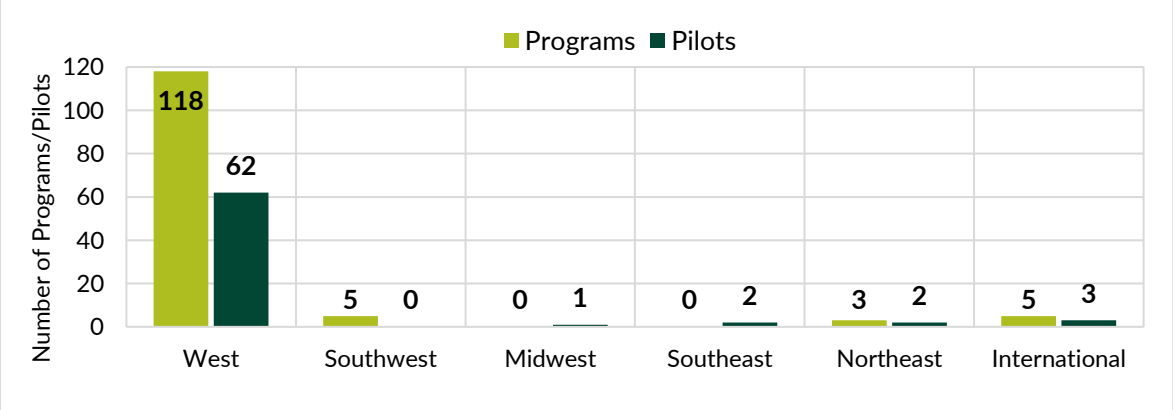


**Figure 9 - Active OpenADR Programs and Pilots**

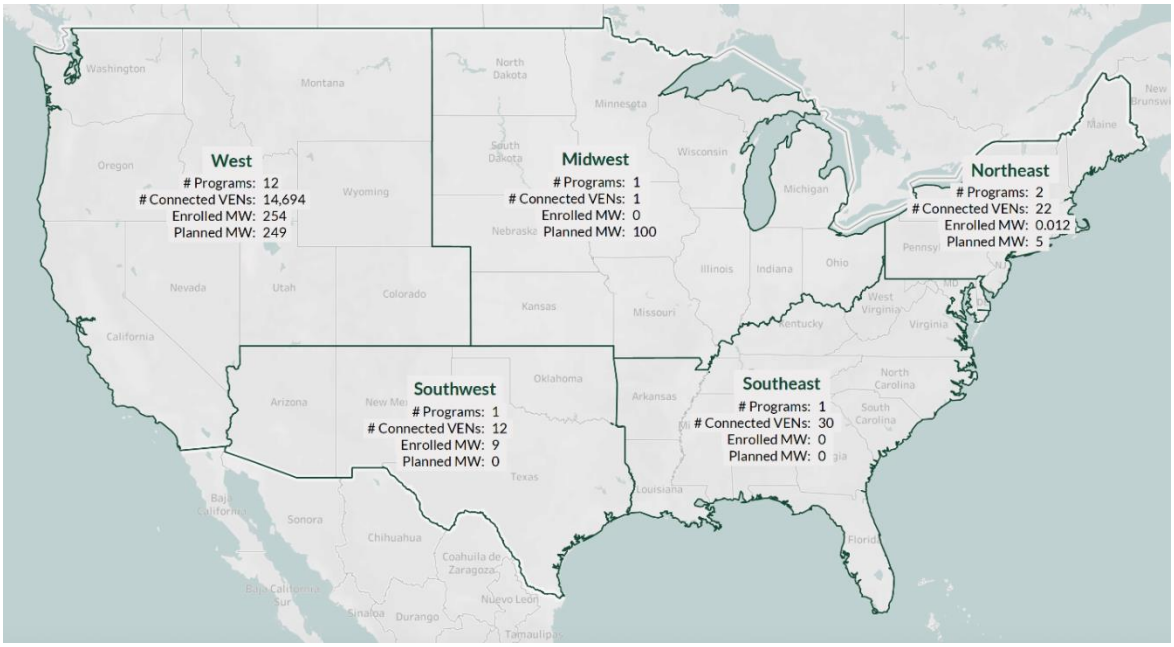


**FIGURE 10: SUBSET OF OPENADR PROGRAMS IN THE U.S. WHERE SURVEY RESPONDENTS PROVIDED DETAILS**


**FIGURE 11. SUBSET OF INTERNATIONAL OPENADR PROGRAMS WHERE RESPONDENTS PROVIDED DETAILS**

Many programs target more than one customer segment and/or end-use technology. Figure 12 and Figure 13 counts all the customer segments and technologies that programs and pilots targeted. The totals shown in Figure 12 and Figure 13, therefore, exceed the number of programs and pilots.

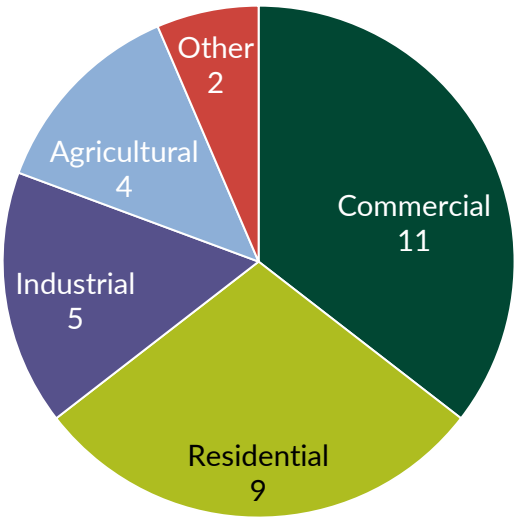


**FIGURE 12 – SUBSET OF REPORTED PROGRAMS WITH DETAILS ON TARGETED MARKET SECTORS**

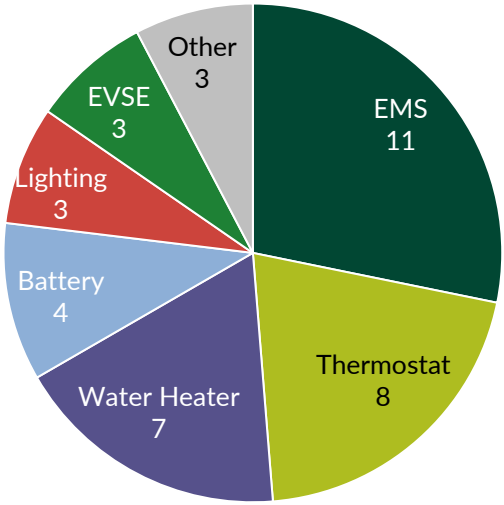


**FIGURE 13 - SUBSET OF REPORTED PROGRAMS WITH DETAILS ON TARGETED END-USE TECHNOLOGY**

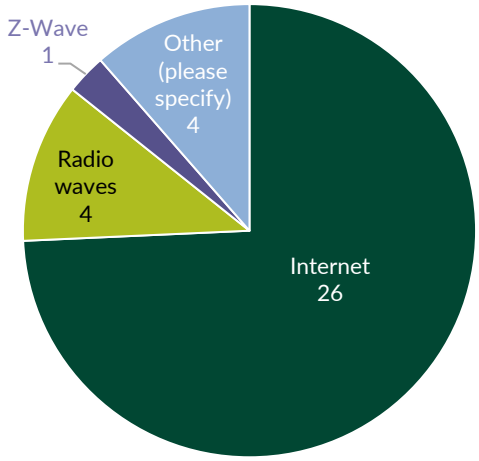


FIGURE 14. EVENT COMMUNICATION METHOD FROM VTN OR DR SERVER

## SURVEY RESULTS FOR VEN AND DEVICE MANUFACTURERS

Twenty-nine manufacturers reported sales data totaling more than 76,000 VEN and devices across the U.S. and worldwide, shown in Figure 15 and Figure 16. Manufacturers reported deployments in 25 U.S. states and six countries shown in Figure 17 and Figure 18, with 2 VEN and device manufacturers opting not to disclose deployment location information.

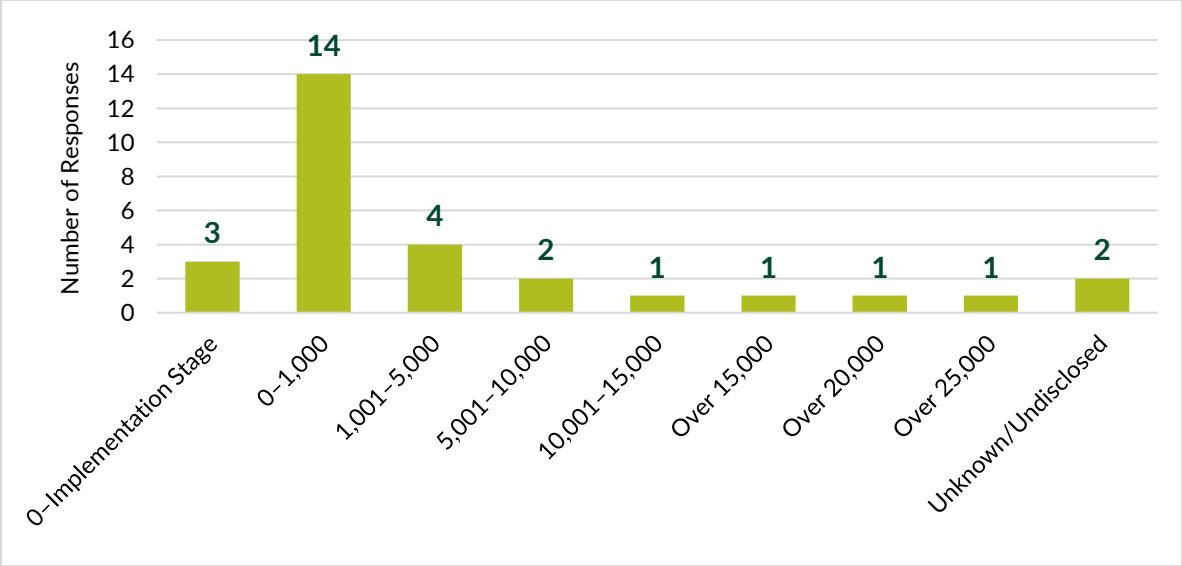


FIGURE 15 - MANUFACTURERS REPORTING VEN SALES NUMBERS WITHIN SPECIFIED RANGES

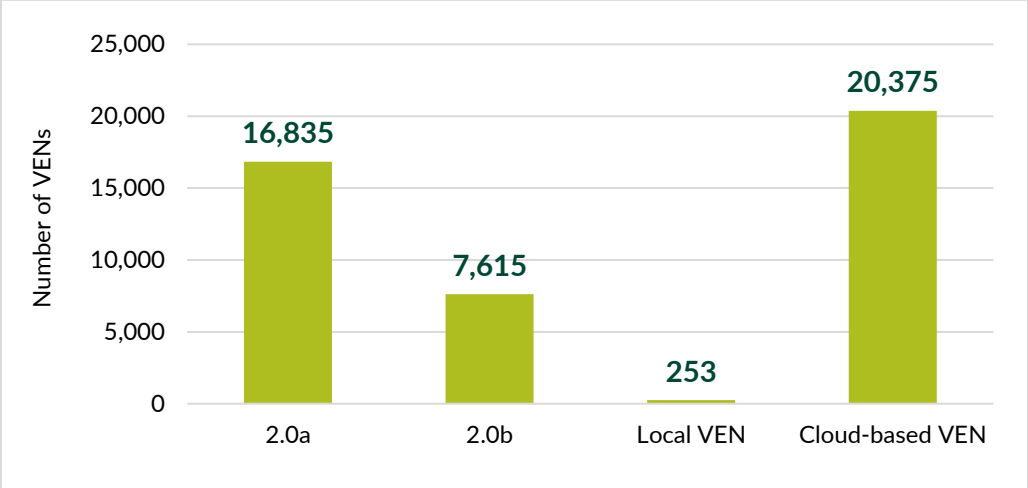


**FIGURE 16 – REPORTED SALES NUMBERS BY VEN TYPE**

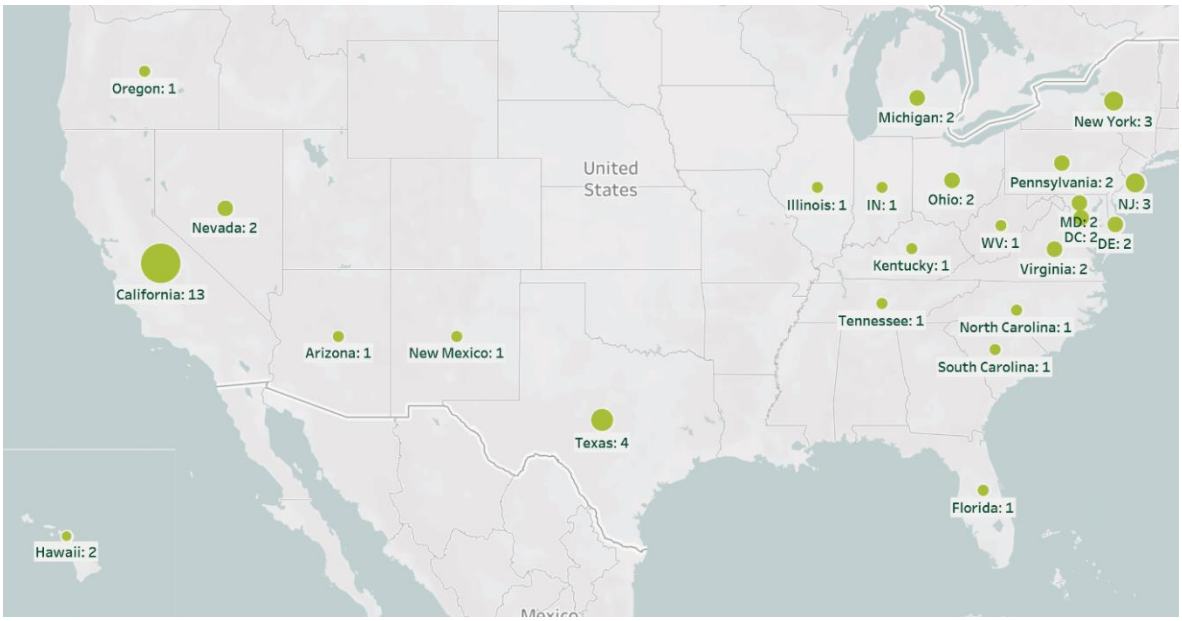


**FIGURE 17 – UNIQUE MANUFACTURERS WITH DEPLOYMENTS BY STATE**


**FIGURE 18 - UNIQUE MANUFACTURERS WITH DEPLOYMENTS INTERNATIONALLY**

OpenADR manufacturers target more than one customer segment and/or end-use technology. Figure 19 and Figure 20 count all the customer segments and technologies that manufacturers targeted. The totals shown in Figure 19 and Figure 20 therefore exceed the number of manufacturer respondents.

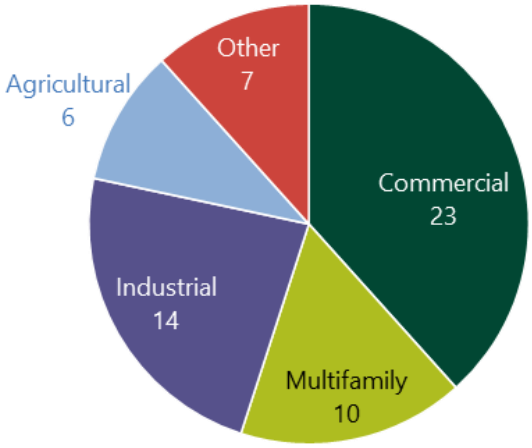


**FIGURE 19 – MANUFACTURERS TARGETING EACH MARKET SECTOR**

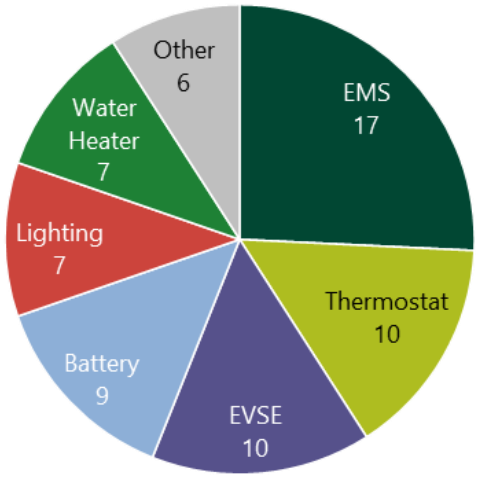


**FIGURE 20 – MANUFACTURERS TARGETING EACH END-USE TECHNOLOGY**

# CONCLUSIONS

The survey results show a significant uptake in OpenADR deployments and activities since the last time the market was surveyed in 2014. Table 4 compares the total deployments between this survey and the deployments data in 2014. The flexible load resource reported by utilities is also significant, with over 265 enrolled and 355 planned megawatts in programs and pilots using OpenADR, for a total of 620 MW.

Manufacturers also reported over 76,000 unit sales across the U.S. and internationally. Survey respondents identified 32 utilities with OpenADR programs or pilots and demonstration projects, across 25 states six countries. There has also been significant recent growth in EVSE and battery adoption of OpenADR VENs, as indicated in the OEM survey results for targeted technologies. These are two trends to watch.

**TABLE 4. GROWTH IN OPENADR DEPLOYMENTS SINCE 2014**

| CATEGORY | 2021 DEPLOYMENTS SURVEY | 2014 DEPLOYMENTS DATA |
|---|---|---|
| Number of Programs Identified | 201 | 34 |
| Number of U.S. Utilities Identified | 21 | 10 |
| Number of International Utilities Identified | 11 | 4 |
| Number of U.S. States Identified | 25 | 8 |
| Number of Countries Identified | 6 | 8 |

The survey results show that OpenADR projects and programs have been deployed in about half of the states in the U.S., confirming that deployments exist beyond just in California. The updated and expanded list of OpenADR deployments is meant to help equipment manufacturers, controls manufactures, and customers justify investment in OpenADR certification to their management. For those stakeholders who are also members of OpenADR Alliance, these survey results can be used to help plan and prioritize additional business opportunities. The objective is to drive further growth in number and diversity of OpenADR certified solutions, as well as customer applications in ADR programs in California and other states.

# APPENDIX 1: COMMUNICATION PROTOCOLS FOR AUTOMATED DEMAND RESPONSE

With automated demand response, building equipment controls receive a communication signal directly from the utility server with no human intervention. The signal identifies a demand response need and, as appropriate, additional data such as the timing of the DR event, the DR program being triggered, the price for load reduction, etc. Typical parameters requiring definition are start and end times for load reduction/modification, quantity needed, ramp rates (if critical), and associated prices or indicators of level of need.

To facilitate the automated response, the building equipment should be able to receive the secure signal consistently and translate it to an action consistent with the request and the local needs for the equipment use. As a fundamental tenet of most DR programs is the ability for the customer to opt-out of any grid request (in contrast with direct load control), the communication should support that action as needed, including recording when such opt-outs occur if that opt-out influences some aspect of tariff compensation.

Essential DR communication from utility to end use has historically been via OpenADR 2.0 A/B (IEC 62746-10-1) or Smart Energy Profile 2.0 (IEEE 2030.5), with the latter specified by California Rule 21 for control of loads involving an inverter (typically distributed energy resources). ANSI/CTA 2045 is being rolled out now to provide a common physical interface for DR communications with appliances, for which this port can be incorporated at the time of manufacture. Efforts are underway to coordinate OpenADR2.0 signals with actions controlled out of this interface. Table 5 lists common communication standards and categorizes their uses.

**TABLE 5. COMMUNICATION PROTOCOLS**

| COMMUNICATION PROTOCOLS | LATEST STANDARD VERSION (YEAR) | (DER/DR) | USE CASES | GRID-TO-CUSTOMER | CUSTOMER-TO-END-USE/**DEVICE** |
|---|---|---|---|---|---|
| OpenADR 2.0 | OpenADR 2.0 (2015) | DR | Commercial and Industrial ADR | OpenADR 1.0/2.0 | Via facility protocols (BACnet, Modbus, LonWorks, DALI, Zigbee, CTA-2045, TCP/IP) |
| OpenADR and SEP 2.0 | SEP 2.0 (2018) | DR | Electric vehicle smart charging | OpenADR 2.0 and SEP 2.0 | (1) Electric Vehicle Service Providers communication to vehicle (2) Direct access to device via SEP 2.0 (customized) |
| SEP 1.x Also possible in | | DR | Residential end-use device, i.e., | Two-way communications via existing | Direct access to device |

| Communication Protocols | Latest Standard Version (Year) | (DER/DR) | Use Cases | Grid-to-Customer | Customer-to-End-use/**Device** |
|---|---|---|---|---|---|
| IEEE 2030.5 (SEP 2.0) | | | remote load switch of AC unit, pool pump | ZigBee enabled meters | |
| IEEE 2030.5 (SEP 2.0) | 2018 | DR | Residential end-use device, i.e., dynamic price | Two-way communications via existing ZigBee enabled meters | Direct access to device |
| ANSI/CTA-2045-B | 2021 | DR | Residential end-use device, i.e., water heater, thermostat, pool pump | FM Radio Broadcast Data System (RBDS) | Direct access to device via CTA-2045 |
| IEC 61850 | 2021 | DER/DR | Utility DER/DR-related | 61850-MMS | Industrial control protocols |
| IEEE 2030.5 (SEP 2.0) | 2018 | DER | Utility DER-related<br>Facility DER management system<br>Residential or small commercial DER system | IEEE 2030.5 (SEP 2.0)<br>IEEE 2030.5 (SEP 2.0)<br>IEEE 2030.5 (SEP 2.0) | Modbus or SunSpec, GOOSE<br>Facility protocols (SEP2 or BACnet)<br>Direct access to device via SEP 2.0 |
| IEEE 1547 (DNP3) | 2018 | DER/DR | Utility DER-related | IEEE 1547 (DNP3) | Modbus or SunSpec, GOOSE |

# APPENDIX 2: SURVEY QUESTIONS

Required questions are denoted with an asterisk. Multiple choice questions and yes/no questions are labeled as such – all others are either fill in the blank or option to select one choice from a list of options.

## INTRODUCTION, DEFINITIONS, AND STAKEHOLDER INFORMATION QUESTIONS (UNIVERSAL)

### INTRODUCTION:

You have been identified as an industry expert to lend approximately 20 minutes of your time to impart your knowledge of OpenADR-enabled devices. Conducted with OpenADR Alliance by Energy Solutions on behalf of Southern California Edison, the survey objective is to update the current list of OpenADR deployments presented on the OpenADR Alliance website. This deployment information will help inform utilities, manufacturers, customers, and industry stakeholders of the prevalence of OpenADR products.
The results of the survey will be confidential, and your answers will not be linked to you or your organization. The survey team values your input, which contributes directly to the usefulness of the results. At the end of the survey, you may elect to receive a copy of the results directly.

### DEFINITIONS:

- Virtual Top Node (VTN) – Typically a "server" that sends or transmits OpenADR signals to end nodes, including devices or other intermediate servers.
- Virtual End Node (VEN) – The virtual end node receives and accepts the OpenADR signal from a server or top node. A VEN is traditionally a building energy controller such as a thermostat or an energy management system. A VEN can also be another server often referred to as a "cloud-based VEN" that serves as an intermediary between the top node and the building energy controller.
- Device – A generic term for a building energy controller such as a thermostat or an energy management system for heating and cooling equipment. Other examples include energy controllers for water heaters, batteries, or electric vehicle chargers.
- Cloud – Refers to servers or data centers located remotely from the building that provide demand response, load management, data storage and other computer system services for automated devices in a building. The devices communicate with the cloud typically through the Internet.

1. * Please select category below that best represents your role in the industry *(Multiple Choice):*
    - Utility – Investor-Owned, Municipality, Rural and Electric Co-op, Community Choice Aggregator, Transmission and Distribution
    - Controls Manufacturer/Original Equipment Manufacturer
    - Virtual End Node (VEN) Manufacturer

- Virtual Top Node (VTN) Solution and/or Distributed Energy Resources Management System (DERMS) Solution Provider
- System Operator
- Customer (Building Owner or Manager)
- Aggregator
- Service Provider/Consultant
- Other (Please specify)

2. * Please enter your organization name (we are interested in locational and industry information; the published results will be anonymous).
3. What is your role within the organization?
4. * Have you implemented or are you planning on implementing OpenADR? Or do you provide services that use OpenADR? Or do you provide services that use OpenADR? *(yes/no)*

**End of survey questions:**

5. *What is your name and email? *(Published results will be anonymous – we just need this information to avoid double counting responses from multiple stakeholders listing the same OpenADR program/product.)*
6. *Can we follow up with you to clarify any responses?
7. *Would you like to receive a copy of the survey results?

## NON-OPENADR RESPONDENTS SURVEY

1. *What is preventing you from doing so? Select all that apply. *(Multiple Choice):*
   - Too expensive
   - Not enough demand for it
   - Cybersecurity concerns
   - No need for demand response - no capacity constraints
   - Other (please specify)
2. *Is your organization using or planning to utilize any other demand response protocols? If yes, please identify which one(s). *(Multiple Choice):*
   - No
   - Yes - CTA-2045
   - Yes - IEEE 2030.5
   - Yes - Other (please specify)
3. *Are you considering implementing/using OpenADR in the future?
   - Yes
   - No
   - Don't know

# UTILITY AND PROGRAM-FOCUSED ORGANIZATIONS SURVEY

1. *Do you use OpenADR 2.0a or 2.0b, or both?
   - 2.0a
   - 2.0b
   - Both
2. *How does your OpenADR virtual top node (VTN) communicate with the virtual virtual end nodes (VENs) or devices (e.g. thermostats)? *(Multiple Choice):*
   - Internet
   - Radio Waves
   - Z-Wave
   - Other (please specify)
3. *Is your organization using or planning to utilize any other demand response protocols? If yes, please identify which one(s). *(Multiple Choice):*
   - No
   - Yes - CTA-2045
   - Yes - IEEE 2030.5
   - Yes - Other (please specify)
4. *What is the total number of active full-scale programs/products using OpenADR? (approximate is fine)
5. *What is the total number of active demonstrations and pilot programs/products using OpenADR? (approximate is fine)
6. *Please list the active programs/pilots or product names that are using OpenADR. Do this one program at a time - there will be an option to provide information for additional programs.

   If there are more than 5 programs/products, please list at least the top 5. If you also operate with OpenADR internationally, please list at least the top 5 international programs/products.
   Approximations and/or ranges are fine. If you don't know the answer to any question in this set, leave it blank.
   - Program/product name
   - State/province
   - MW enrolled using OpenADR
   - MW planned using OpenADR
   - Market sector(s) involved (e.g. residential, commercial, industrial, agriculture) - list all that apply.
   - Type(s) of devices targeted (e.g., thermostat, energy management system, lighting, water heater, battery, EV charger) - list all that apply.
   - Which technology is your main focus?
   - How many OpenADR virtual end nodes (VENs) are connected or installed for this program/product?
   - How many of those VENs are Cloud?
   - How many of those VENs are Non-cloud/local on-site?
   - How many OpenADR devices are connected or installed?

# MANUFACTURER SURVEY

1. *Do you use OpenADR 2.0a or 2.0b, or both?
   - 2.0a
   - 2.0b
   - Both
2. *Is your organization using or planning to utilize any other demand response protocols? If yes, please identify which one(s). *(Multiple Choice):*
   - No
   - Yes - CTA-2045
   - Yes - IEEE 2030.5
   - Yes - Other (please specify)
3. *Please list the top 5 utilities or states in which your OpenADR devices are sold or deployed. Order does not need to be exact. List more if applicable and you feel inclined to. If you also operate with OpenADR internationally, please list at least the top 5 utilities or provinces/countries.
4. *How many total OpenADR 2.0a or 2.0b devices have you sold or deployed? Include all connected devices, even those with a cloud-based VEN.
   - 0 – 1,000
   - 1,001 - 5,000
   - 5,001 – 10,000
   - 10,001 – 15,000
   - Over 15,000
   - Option to provide the exact/approximate number:
5. *If you have additional information, please provide the total number sold or deployed (approximate is fine) which are:
   - 2.0a
   - 2.0b
   - Local VEN
   - Cloud-based VEN
6. *What market sector(s) does your OpenADR product target? (select all that apply) *(Multiple Choice):*
   - Residential
   - Commercial
   - Multifamily
   - Agricultural
   - Industrial
   - Other (Please Specify)
7. *What devices or technologies does your OpenADR product work with? (select all that apply) *(Multiple Choice):*
   - Thermostat
   - Energy Management System
   - Lighting
   - Battery
   - Water Heater
   - Electric Vehicle Supply Equipment
   - Other (please specify)

# CUSTOMER SURVEY

1. *Do you use OpenADR 2.0a or 2.0b, or both?
   - 2.0a
   - 2.0b
   - Both
   - Not sure
2. *Is your organization using or planning to utilize any other demand response protocols? If yes, please identify which one(s). *(Multiple Choice):*
   - No
   - Yes - CTA-2045
   - Yes - IEEE 2030.5
   - Yes - Other (please specify)
3. *What is the total number of programs using OpenADR that you've participated in? (approximate is fine)
4. *Please list the active programs/pilots or product names that are using OpenADR. Do this one program at a time - there will be an option to provide information for additional programs.

   If there are more than 5 programs/products, please list at least the top 5. If you also operate with OpenADR internationally, please list at least the top 5 international programs/products.
   Approximations and/or ranges are fine. If you don't know the answer to any question in this set, leave it blank.
   - Program/product name
   - State/province
   - MW enrolled using OpenADR
   - MW planned using OpenADR
   - Market sector(s) involved (e.g. residential, commercial, industrial, agriculture) - list all that apply.
   - Type(s) of devices targeted (e.g., thermostat, energy management system, lighting, water heater, battery, EV charger) - list all that apply.
   - Which technology is your main focus?
   - How many OpenADR virtual end nodes (VENs) are connected or installed for this program/product?
   - How many of those VENs are Cloud?
   - How many of those VENs are Non-cloud/local on-site?
   - How many OpenADR devices are connected or installed