



# 2019 Annual Report

## Voluntary Agreement for Ongoing Improvement to the Energy Efficiency of Set-Top Boxes

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August 18, 2020

# TABLE OF CONTENTS

- Executive Summary..... 3
- Overview of the Voluntary Agreement ..... 7
  - Voluntary Agreement Objectives ..... 8
  - Voluntary Agreement Signatories and Steering Committee ..... 8
  - Service Provider Commitments..... 9
  - Independent Administrator and Auditor Role..... 10
  - New Feature Allowances ..... 10
- Increased Energy Efficiency of Set-Top Boxes .....11
- Report on Procurement Commitments .....11
- Impact on National Energy Consumption ..... 12
- Audit and Verification ..... 15
  - Procurement Audit..... 15
  - Verification Testing ..... 15
- Progress on Other Energy-Efficiency Commitments..... 16
  - Whole-Home Systems..... 16
  - Consumer Access to Energy-Efficiency Information..... 17
  - Next-Generation Video Delivery..... 17
  - Automatic Power Down..... 18
- Viewing Without Operator-Supplied Set-Top Boxes ..... 19
- Conclusion..... 23
- Appendix A: Voluntary Agreement Commitments..... 24
- Appendix B: Set-Top Boxes Purchased by Voluntary Agreement Signatories in 2019 ..... 25
- Appendix C: Consumer Access to Set-Top Box Energy-Efficiency Information ..... 29
- Appendix D: 2019 Procurement Audit Report..... 30

## LIST OF TABLES

Table ES-1: Voluntary Agreement Energy Savings 2013-2019.....	3
Table ES-2: Weighted Average Typical Energy Consumption (TEC) for Major Set-Top Box Categories.....	5
Table 1: Weighted Average Typical Energy Consumption for Major Set-Top Box Categories.....	11
Table 2: Set-Top Box Procurement for Major Set-Top Box Categories in 2019 .....	11
Table 3: Base Case – 2012 Estimated Energy Consumption .....	12
Table 4: Change in Subscribers from 2012-2019.....	12
Table 5: Estimates of Total Deployed Units in the Market in 2013-2019 .....	13
Table 6: National Energy Consumption for Devices Based Upon Year of Purchase .....	14
Table 7: National Energy Consumption of Installed Set-Top Boxes 2012-2019 .....	14
Table 8: Platforms and Apps Used by Customers to View Content Without Set-Top Boxes .....	20
Table 9: Voluntary Agreement Commitments.....	24
Table 10: Set-Top Boxes Procured by Voluntary Agreement Signatories in 2019 .....	25
Table 11: Set-Top Box Base Allowances.....	28
Table 12: Set-Top Box Feature Allowances .....	28
Table 13: Links for Consumer Access to Energy-Efficiency Information.....	29

## LIST OF FIGURES

Figure ES-1 Annual Energy Saved by the Voluntary Agreement Procurement Commitments .....	4
Figure 1: Distribution of Current Inventory by Year of Procurement (Percentage of Units) .....	13

## EXECUTIVE SUMMARY

In 2012, the pay television industry, led by NCTA - The Internet & Television Association, the Consumer Technology Association, and CableLabs, signed the [Voluntary Agreement for Ongoing Improvement to the Energy Efficiency of Set-Top Boxes](#) with the goal of increasing the energy efficiency of set-top boxes while protecting rapid innovation and timely introduction of new features. Signatories include major manufacturers of set-top boxes and the largest cable, satellite, and telco service providers, serving 75.9 million U.S. video subscribers and accounting for 94% of the traditional pay-TV market in 2019. In 2013, leading Energy Advocates joined with the pay television industry in an expanded version of the Voluntary Agreement.

One of the requirements of the Voluntary Agreement is the publication of an annual report by D+R International (D+R), acting as Independent Administrator and Independent Auditor of the Agreement. This seventh annual report provides a summary of developments for the previous calendar year, 2019. Annual reports for the previous six years as well as this report can be found at [www.energy-efficiency.us](http://www.energy-efficiency.us).

Under the Voluntary Agreement, national set-top box annual energy consumption has declined by 46% from 32 TWh in 2012 to 17.3 TWh in 2019, even as functionality and features of set-top boxes have increased. This 14.7 TWh reduction is nearly equivalent to the power generated by five typical 500 megawatt coal-run power plants in a year.<sup>1</sup> In 2019 alone, consumers saved more than \$1.9 billion<sup>2</sup> on their utility bills and nearly 10.4 million metric tons of CO<sub>2</sub> emissions from power plants were avoided.<sup>3</sup> The \$1.9 billion in annual consumer energy savings in the third year of the Tier 2 energy levels of the Agreement is nearly double the \$1 billion annual savings goal that the parties set when they adopted Tier 2 in 2013.

During the seven years of the Voluntary Agreement, cumulative energy consumption has been reduced by an estimated 55.1 TWh, saving consumers approximately \$7.1 billion and avoiding nearly 39 million metric tons of CO<sub>2</sub> emissions. The energy saved during this seven-year period is enough to power all homes in the entire state of California with electricity for more than seven months.<sup>4</sup>

**Table ES-1: Voluntary Agreement Energy Savings 2013-2019**

	2013	2014	2015	2016	2017	2018	2019	Lifetime of VA
<b>National Energy Consumed (TWh/yr) Total</b>	30.6	29.2	26.9	24.5	21.0	19.4	17.3	168.9
<b>National Energy Saved (TWh/yr)</b>	1.4	2.8	5.1	7.5	11.0	12.6	14.7	55.1
<b>500 MW Power Plant Equivalents Saved (Rosenfelds)</b>	0.5	0.9	1.7	2.5	3.7	4.2	4.9	18.4 <sup>a</sup>
<b>Electricity Costs Saved (Millions\$/yr)</b>	\$169.8	\$350.6	\$645.2	\$941.3	\$1,417.9	\$1,621.6	\$1,916.9	\$7,063.2
<b>CO<sub>2</sub> Avoided (MMT)</b>	1.0	2.0	3.6	5.3	7.8	8.9	10.4	39.0

<sup>a</sup>The electricity generated by a typical 500 MW power is measured in Rosenfelds, which represents annual electricity output. Even at the 2012 peak, set-top boxes used 10.7 Rosenfelds annually, and that figure declined to 5.8 Rosenfelds in 2019. The Agreement has not replaced annual demand of 18 distinct power plants.

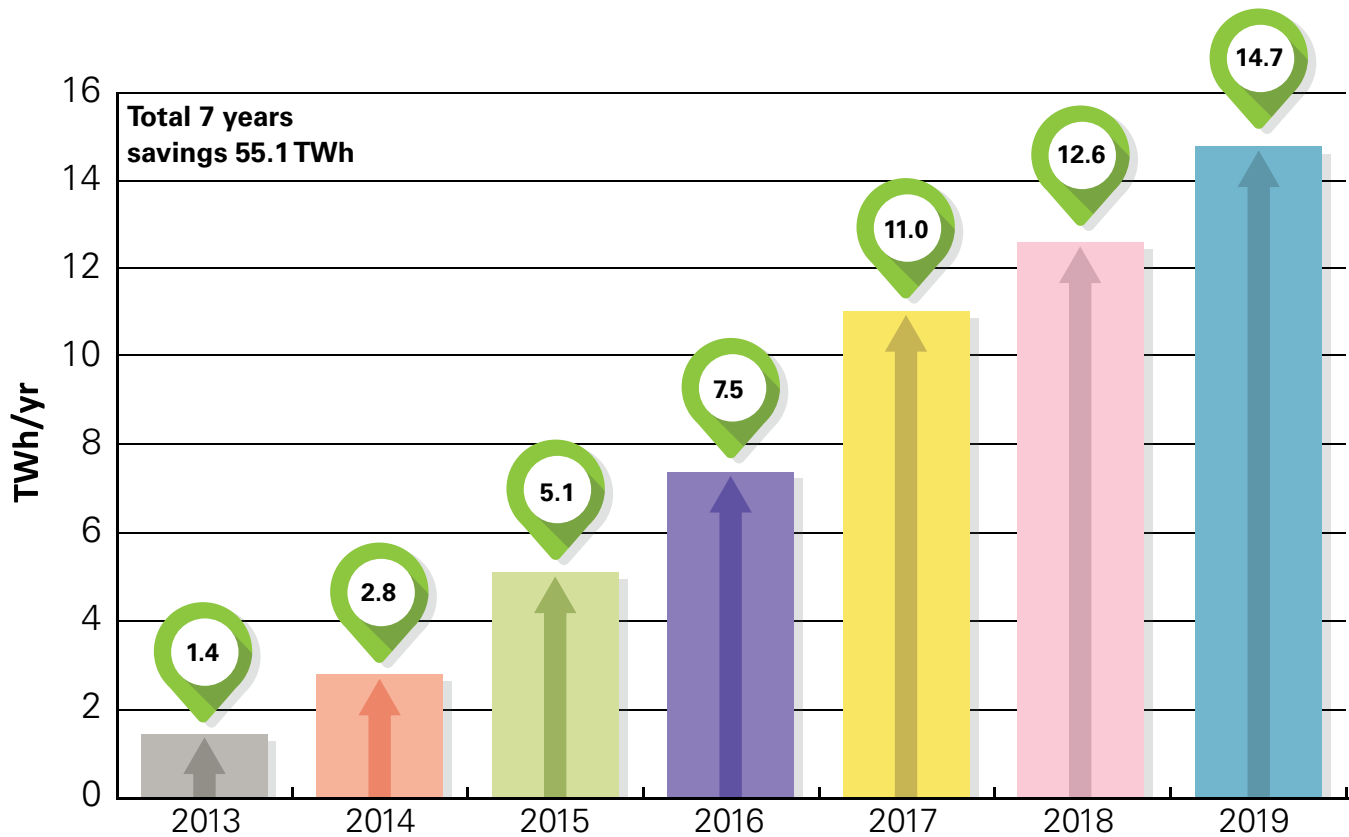
1 - A common unit in measuring energy-efficiency savings is the "Rosenfeld" (3 terawatt hours per year), the same amount of electricity generated by a conventional 500 megawatt coal-run power plant each year. See <https://www.scientificamerican.com/article/rosenfeld-energy-savings>.

2 - This calculation is based on national average energy cost of \$0.1304 per kWh. See U.S. Energy Information Administration, Electric Power Monthly, available at <https://www.eia.gov/outlooks/steo/report/electricity.cfm>.

3 - Emission reduction estimates in this report are based on the U.S. Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator, available at <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>.

4 - EIA State Energy Data Systems (SEDS): 1960-2018 (complete), Table C17, Electricity Retail Sales, Total and Residential, Total and per Capita, Ranked by State, 2018 (June 26, 2020) (estimating California's annual residential electricity consumption at 89.1 TWh), available at [https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep\\_sum/html/rank\\_es\\_capita.html&sid=US](https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/rank_es_capita.html&sid=US).

**Figure ES-1: Annual Energy Saved by the Voluntary Agreement Procurement Commitments**



These savings are driven primarily by the service providers' commitment to procure energy-efficient set-top boxes. Under the Voluntary Agreement, 90% of new set-top boxes procured within a calendar year by service providers must meet the applicable efficiency levels. Tier 1 procurement requirements applied as of January 1, 2014, Tier 2 as of January 1, 2017 and Tier 3 as of January 1, 2020. The allowable energy use for each specific type of box is reduced with each new tier. The reasons that the signatories have exceeded the earlier savings projections for the Voluntary Agreement include:

- 99.7% of service providers' set-top box purchases met the Tier 2 levels in 2019, well above the 90% commitment, and all service providers met the 90% commitment individually;<sup>5</sup>
- New set-top boxes have been even more efficient than the energy levels of the Agreement, with energy usage of the three major categories of new set-top boxes declining by 50% (DVR), 50% (thin client) and 38% (non-DVR) since 2012 as shown in Table ES-2 below;
- 95% of set-top box purchases in 2019 met Tier 3 a year ahead of schedule; and
- The aggregate energy usage of set-top boxes has fallen due to a decrease in the number of deployed DVRs as a result of whole-home architectures and cloud DVR offerings, and in the total number of deployed set-top boxes as a result of subscriber losses and consumer adoption of apps that enable viewing without set-top boxes.

5 - As set forth below, this calculation is based on 2019 procurement data submitted to D+R by service providers and corroborated by the results of independent verification testing and by the procurement audit conducted by D+R.

The procurement of energy-efficient set-top boxes under the Voluntary Agreement has resulted in a substantial decrease in average energy consumption by the major types of set-top boxes. In particular, the new-unit average power usage of the most energy-intensive type of set-top box, the DVR, has fallen by 50% since 2012, and as noted above the number of DVR devices in homes has declined through support for whole-home and/or cloud DVR offerings. In addition, the energy usage of each of the other two major categories of set-top boxes has also fallen sharply over that time, as shown in Table ES-2.

**Table ES-2: Weighted Average Typical Energy Consumption (TEC) for Major Set-Top Box Categories**

Category	TEC (kWh/y)		Percent Change in Weighted Average
	Pre-2013 Stock	2019 Purchases	
	Weighted Average		Pre-2013 to 2019
<b>DVR</b>	267	134.4	-50%
<b>Non-DVR</b>	119	74.1	-38%
<b>Thin Client</b>	90	45.4	-50%

Digital Transport Adapters (DTAs) and Multi-Service Gateways (MSGs) were each purchased only by one service provider in 2019 in relatively small quantities.

2019 is the second consecutive year that all of the service provider signatories have each met the 90% procurement commitment. The service provider that missed its 2017 procurement commitment successfully completed a remedial plan in 2019 under the supervision of D+R and the Energy Advocates that secured incremental additional energy savings of approximately 25% more energy than is projected to be used over the lifetime of the set-top boxes that exceeded its commitment.

The number of new set-top boxes declined again in 2019, down 18% from the prior year and nearly 60% since the Agreement's commitments began. The signatories purchased only 19 million new set-top boxes in 2019, compared to 23 million in 2018 and 46 million in 2014 (the first year of the Voluntary Agreement's commitments). This decline is likely attributable to a mix of factors, including the completion of technology migrations to whole-home and all-digital architectures, subscriber losses, and the increasing prevalence and usage of apps for watching programming rather than through an operator-supplied set-top box. Consumers used nearly 43 million customer-owned and managed devices such as Smart TVs, smartphones, tablets, personal computers, and streaming devices such as Apple TV, Roku, Google Chromecast and Amazon Fire to access the providers' video services via apps in 2019. The service provider signatories are continuing to work to enhance the functionality of their apps such as through new support for cloud DVR offerings and investing in customer education and employee training to promote the use and awareness of apps. The growth in adoption of app streaming solutions may present an opportunity for further reductions in the overall energy used by the signatories' set-top boxes as customers reduce the number of boxes in their homes, although a fraction of these savings may be offset by increased energy usage in the service providers' networks to support apps and cloud services.

The Voluntary Agreement contains additional commitments and verification tools, including deployment of automatic power down and whole-home systems, efforts to improve energy efficiency in future-generation equipment, posting of information for consumers and other stakeholders at [www.energy-efficiency.us](http://www.energy-efficiency.us) and on company websites, verification testing of randomly selected set-top boxes from each reported category, and an audit of a randomly-selected service provider's set-top box procurements. Verification testing was postponed due to restrictions on travel and lab access as a result of the COVID-19 pandemic, but the signatories' satisfaction of all of the other commitments are summarized in Table 9 in Appendix A of this report.

As part of the revised Voluntary Agreement, the largest service provider signatories committed to engage directly with their supply chains, including component suppliers, to explore approaches to further improve the energy efficiency of set-top boxes in all power states. Building upon the extensive meetings and engagement with key suppliers and the Energy Advocates in 2018 referenced in the prior annual report, the parties made additional progress that enabled them in September 2019 to initiate discussions regarding new Tier 4 energy levels. That process remains ongoing.

The Independent Administrator will continue to monitor these developments and publish these annual reports through the 2021 report to be issued in 2022.

## OVERVIEW OF THE VOLUNTARY AGREEMENT

Cable, satellite, and telco service providers offer pay television to approximately 80.8 million U.S. households using customer premises equipment, often referred to as set-top boxes.<sup>6</sup> Each device contains hardware and software to receive television programming and related services from service providers and process them for home networks, display devices, and recording devices. The underlying delivery network and the types of service provided vary widely among service providers. As a result, set-top boxes operate as highly specialized components, and the devices change frequently as the service providers introduce new services.

All set-top boxes have one thing in common: they require power to operate. In aggregate, set-top boxes in the United States consumed an estimated 32 TWh of electricity in 2012, constituting 18% of residential consumer electronics electricity consumption and 2.2% of all residential electricity consumption.<sup>7</sup> To reduce the amount of energy consumed by set-top boxes while protecting rapid innovation and timely introduction of new features, the pay television industry crafted the [Voluntary Agreement for Ongoing Improvement to the Energy Efficiency of Set-Top Boxes](#). The Voluntary Agreement provides a framework for the pay television industry to deliver market-based energy-efficiency gains that keep pace with technological innovation. The signatories of the Voluntary Agreement represent all of the major pay-TV service providers, equipment vendors, and related industry organizations in the United States. Combined, these companies provided multichannel video service to approximately 75.9 million American households in 2019, accounting for 94% of the traditional pay-TV market.<sup>8</sup>

After extensive negotiations among the initial signatories and Energy Advocates, an expanded Voluntary Agreement was launched in 2013. The Natural Resources Defense Council (NRDC), the American Council for an Energy-Efficient Economy (ACEEE), the Appliance Standards Awareness Project (ASAP), the Consumer Technology Association (CTA), and NCTA - The Internet & Television Association announced this expansion in December 2013. The revised Voluntary Agreement included additional energy-efficiency commitments, coverage of whole-home multifunction gateway devices, expanded provisions for transparency and accountability, and participation by Energy Advocates in the Steering Committee for the Voluntary Agreement.

That version of the Voluntary Agreement expired at the end of 2017. In March 2018, the signatories unanimously amended the Voluntary Agreement and extended its term for an additional four years through the end of 2021. The revised Voluntary Agreement includes more rigorous Tier 3 energy levels that became applicable to the 90% procurement commitment in 2020, and a commitment to discuss future Tier 4 levels that would deliver additional energy savings. The signatories had estimated that the Tier 3 levels are 20% more efficient, on average, than the current Tier 2 levels. The four largest service provider signatories committed to continued engagement with the Energy Advocates, the manufacturer signatories, component suppliers and software developers to explore approaches to further improve the energy efficiency of set-top boxes in all power states, with a special emphasis on efficiencies in standby power, while preserving a good consumer experience. The cable operators committed, as they had under the prior version of the Voluntary Agreement adopted in 2013, to continue to work with suppliers to develop specifications for new model set-top boxes that operate in a reduced power consumption mode when the user is not watching or recording a show, while still functioning with cable system architectures and meeting consumer expectations for quick start-up time and functionality.

6 - Based on data provided by NCTA and CTA.

7 - Bryan Urban; Victoria Shmakova; Brian Lim; Kurt Roth, Energy Consumption of Consumer Electronics in U.S. Homes in 2013, Final Report to the Consumer Electronics Association (CEA®), Fraunhofer USA Center for Sustainable Energy Systems (2014). This report estimated 31 TWh of use in 2013, which is consistent with the annual report's estimate of ongoing declines under the Voluntary Agreement since set-top boxes used 32 TWh in 2012.

8 - See *supra* note 6.



## Voluntary Agreement Objectives

The primary objective of the Voluntary Agreement is to continue improvements in the energy efficiency of set-top boxes without jeopardizing their intended uses and functionalities. Further, energy-efficiency improvements are expected to preserve or enhance the customer experience and be sufficiently flexible to adapt to technological innovations and market competition, while also improving functionality, offering service enhancements, and fostering rapid innovation.

The signatories originally estimated that consumers would save at least \$1 billion annually in energy costs several years after the 2017 effective date of Tier 2, once Tier 2 set-top boxes had largely replaced the set-top boxes in use in 2012. The parties have nearly doubled that objective, with more than \$1.9 billion in annual savings estimated in 2019.<sup>9</sup> These 2019 energy savings are nearly equivalent to the power generated by five typical 500 megawatt coal-run power plants<sup>10</sup> annually and will avoid close to 10.4 million metric tons of CO<sub>2</sub> emissions per year.<sup>11</sup>

## Voluntary Agreement Signatories and Steering Committee

The current signatories and participants in the Voluntary Agreement are listed below. Each of these entities participates in the Steering Committee.

### Energy Advocates

- American Council for an Energy-Efficient Economy (ACEEE)
- Natural Resources Defense Council (NRDC)

### Cable Service Providers

- Altice
- Charter Communications (“Spectrum”)
- Comcast
- Cox Communications

### Satellite Service Providers

- AT&T/DIRECTV
- DISH Network

### Telco Service Providers

- AT&T
- Frontier
- Verizon

### Other Organizations

- CommScope (formerly ARRIS)
- Technicolor
- NCTA – The Internet & Television Association
- Consumer Technology Association (CTA)

9 - See *supra* note 2.

10 - See *supra* note 1.

11 - See *supra* note 3.

- Cable Television Laboratories (CableLabs)

Effective January 1, 2019, Altice USA, Inc. (the parent company of original signatory Cablevision Systems Corp.) signed the Voluntary Agreement. This action had the effect of bringing into the Voluntary Agreement the cable systems operated by another of Altice's subsidiaries, Cequel Communications, LLC d/b/a Suddenlink Communications. Suddenlink was previously the largest non-participating pay-TV provider in the United States, so its admission has meaningfully increased the percentage of U.S. consumers covered by the Agreement. Its systems previously used a different mix of set-top boxes than Altice's Cablevision system, but in connection with its entry into the Agreement, Altice committed to accelerate the deployment in its Suddenlink systems of the more energy-efficient equipment used in its Cablevision system.

CenturyLink has withdrawn as a signatory because it is no longer offering pay-TV video services to new customers and did not purchase any set-top boxes in 2019. CenturyLink remains committed to energy efficiency and continues to participate in the Voluntary Agreement for Ongoing Improvement to the Energy Efficiency of Small Network Equipment. The composition of the Steering Committee allows the Voluntary Agreement to offer a multi-stakeholder approach while permitting rapid adjustments as the technology landscape changes.

In 2019, representatives of the Signatories have continued to provide updates to state and federal regulators and other stakeholders regarding the ongoing execution of the Voluntary Agreement.

Additional responsibilities of the Steering Committee include the following:

- Managing the Voluntary Agreement
- Hiring the Independent Administrator
- Reviewing proposals for energy allowances based on new features, which the Steering Committee can approve, reject, or add to the Voluntary Agreement, as appropriate
- Evaluating the effectiveness of the Voluntary Agreement in achieving its purposes
- Adopting new or revised efficiency measures, courses of action, and amendments to the Voluntary Agreement as technologies advance

In accordance with their obligations under the Voluntary Agreement, CTA and NCTA provided the following two reports to the Independent Administrator for 2019:

- The estimated total number of U.S. residential multichannel video subscribers and the number served by service providers participating in the Voluntary Agreement during the reporting period (due by April 1 of each year, beginning in 2014).
- Information on progress with respect to other energy-efficiency commitments (due by May 1 of each year, beginning in 2014).

## Service Provider Commitments

The primary service provider commitment is that at least 90% of its set-top box purchases will meet specified energy-efficiency levels. The original levels were replaced by a more rigorous Tier 2 set of levels for devices purchased after December 31, 2016. This is the third Annual Report in which the Tier 2 levels were in effect. Progress on these commitments is discussed in the [Report on Procurement Commitments](#), below. Service providers also made commitments relating to automatic power down, whole-home systems, engagement with the Energy Advocates and key vendors to explore approaches to further improve the energy efficiency of set-top boxes in all power states in the 2020s, and public posting of energy-efficiency information for consumers. Additional information on these commitments is outlined in [Progress on Other Energy-Efficiency Commitments](#), below. All service provider commitments are outlined in Appendix A.

## Independent Administrator and Auditor Role

The Voluntary Agreement obligates the Steering Committee to designate an Independent Administrator and an Independent Auditor. The Steering Committee designated D+R as the Independent Administrator and Auditor in 2013. D+R has continued in this role since its appointment. Under the Voluntary Agreement, the Independent Administrator must aggregate and compile confidential procurement data submitted by service providers and assess whether there is substantial compliance with the service provider commitments. If these commitments are not met, the Independent Administrator initiates a remedial process following the procedures set out in the Voluntary Agreement. The Independent Administrator is required to publish its findings in an annual report. The 2019 Annual Report is the seventh report published. D+R is also required to conduct a random audit of one service provider's procurement figures each year. The 2019 audit report presented in Appendix D concluded that the service provider data supported this report's conclusion of substantial compliance with its commitments.

## New Feature Allowances

The Tier 2 levels were adopted in 2013, long before they first became effective in 2017. To assure that the Voluntary Agreement did not deprive consumers of the benefits of innovation, the Tier 2 program includes a process for establishing allowances for new energy-efficient features. This process enables new features to be deployed without advance notice or permission, so that companies can proceed with "permissionless" innovation, secure the competitive benefits of first-mover advantages, and enable consumers to benefit from new features without delay. At the same time, the process assures that such new features are promptly and transparently brought within the bounds of the Voluntary Agreement's commitments to energy efficiency.

If a service provider deploys a set-top box that includes a new feature with no allowance, and the presence of the feature causes the set-top box to exceed the allowable TEC, the new feature process permits the service provider to set and report an appropriate initial allowance based upon its best estimate of the amount of energy consumed by the new feature. No new feature allowances were submitted for the 2019 reporting period.

## INCREASED ENERGY EFFICIENCY OF SET-TOP BOXES

Table 1 highlights the progress made by the signatories in improving the energy efficiency for each set-top box product category. The significant year-over-year reduction in energy consumption of new devices in the non-DVR category appears to reflect a shift within that broad category to lower-powered IP (internet protocol) non-DVR devices, the newer models of which can more closely resemble Thin Clients in power usage and consumer functionality.

**Table 1: Weighted Average Typical Energy Consumption for Major Set-Top Box Categories**

Category	TEC (kWh/yr)								Percent Change in Weighted Average						
	Pre-2013 Stock	Procurement Data													
	Weighted Average	2013	2014	2015	2016	2017	2018	2019	2012 to 2019	2013 to 2019	2014 to 2019	2015 to 2019	2016 to 2019	2017 to 2019	2018 to 2019
<b>DVR</b>	267	195.4	179.4	170.6	161.3	142.9	138.7	134.4	-50%	-31%	-25%	-21%	-17%	-6%	-3%
<b>Non-DVR</b>	119	108.6	103.3	92.6	85.6	90.8	91.8	74.1	-38%	-32%	-28%	-20%	-13%	-18%	-19%
<b>Thin Client</b>	90	51.4	50.0	49.1	46.9	44.3	45.4	45.4	-50%	-12%	-9%	-8%	-3%	2%	0%

DTAs and MSGs were each purchased only by one service provider in 2019 in relatively small quantities.

## REPORT ON PROCUREMENT COMMITMENTS

Under the Voluntary Agreement, the service providers committed that 90% of set-top boxes they purchased after December 31, 2016 would meet the Tier 2 efficiency levels. This is the third year in which this Tier 2 procurement commitment has been evaluated, and the sixth year in which the procurement commitment is in force. All service providers that signed the Voluntary Agreement submitted procurement data for 2019 on time. These providers are: Altice, AT&T (separately for AT&T/DIRECTV and its U-verse telco services), Charter, Comcast, Cox, DISH, Frontier, and Verizon. Details about the set-top box models purchased by these providers are shown in Appendix B.

Every model of DVR, Non-DVR, Thin Client and Multi-Service Gateway, as well as 99.7% of all set-top boxes purchased by these service providers met the Tier 2 commitment levels. The total procurement figures for the major categories of set-top boxes are shown in Table 2 below.<sup>12</sup>

**Table 2: Set-Top Box Procurement for Major Set-Top Box Categories in 2019**

Category	Units Procured
<b>DVR</b>	5,848,219
<b>Non-DVR</b>	8,319,044
<b>Thin Client</b>	4,592,236
<b>Totals</b>	<b>18,759,499</b>

All service providers met the Voluntary Agreement procurement commitment in 2019.

<sup>12</sup> - DTAs and MSGs were each procured only by one service provider in 2019 in relatively small quantities. Section 8.6 of the Voluntary Agreement seeks to protect the confidentiality of these service providers' model procurement figures by precluding this report from disclosing the number of MSG and DTA units purchased in 2019, which could readily be deduced if a total national figure were reported. The quantities of DTAs and MSGs purchased were factored into the overall national energy consumption of set-top boxes in this report.

The Voluntary Agreement prescribes that if a service provider signatory fails to meet a procurement commitment, it shall implement a remedial plan approved by a review panel that includes the Energy Advocates and the two trade association members of the Steering Committee with new savings measures that offset the extra energy associated with the set-top boxes that caused it to miss its commitment. As previously reported, the review panel approved a remedial plan proposed by the service provider that missed its 2017 procurement commitment that would save more than the 7 million kWh/year offset requirement calculated by D+R. The review panel monitored the party's progress on a quarterly basis until concluding that, by the end of 2019, the service provider's remediation had exceeded the energy savings objective of its plan by more than 25%. D+R reviewed the provider's remedial report and determined that the required energy savings had been achieved.

## IMPACT ON NATIONAL ENERGY CONSUMPTION

In 2012, service providers began working with Energy Advocates to estimate the energy consumption of set-top boxes and the number of units installed in subscriber households. Using service provider and energy-efficiency advocate reports and data on product trends, the signatories developed the base case shown in Table 3, representing the market in 2012.

**Table 3: Base Case – 2012 Estimated Energy Consumption**

Segment	Category	TEC	Units	National Energy Consumption	500 MW Power Plant Equivalents
		kWh/yr	Millions	TWh/yr	Rosenfelds
Cable	DVR	282	27	7.5	2.5
	Non-DVR	139	57	7.9	2.6
	Thin Client	90	2	0.1	0.0
	DTA	39	33	1.3	0.4
Satellite	DVR	283	21	5.9	2.0
	Non-DVR	110	58	6.4	2.1
Telco	DVR	140	6	0.8	0.3
	Non-DVR	90	21	1.9	0.6
<b>U.S. Total</b>		-	<b>225</b>	<b>32</b>	<b>10.6</b>

To gauge the Voluntary Agreement's impact on energy consumption at the national level, D+R estimates energy savings over the base case. The first step is to estimate changes in set-top box stock levels. Under the terms of the Voluntary Agreement, D+R does not collect a census of deployed legacy equipment. Instead, it has employed a model that assumes that newly purchased devices generally replace older (less energy-efficient) and broken equipment from the same category rather than add to total deployed stock. However, the total deployed stock estimate is adjusted to account for changes in subscriber levels as shown in Table 4 below.

**Table 4: Change in Subscribers from 2012-2019**

Segment	Percent Change <sup>a</sup>							
	2012 to 2013	2013 to 2014	2014 to 2015	2015 to 2016	2016 to 2017	2017 to 2018	2018 to 2019	2012 to 2019
Cable	-4.5%	-0.3%	-0.5%	-1.7%	-3.7%	-2.2%	-1.3%	-13.4%
Satellite	1.0%	0.1%	-1.9%	3.0%	-9.2%	-7.5%	-11.6%	-24.2%
Telco	25.4%	8.2%	-0.9%	-20.9%	2.0%	-3.5%	-13.6%	-9.5%

<sup>a</sup>Based on data provided by the Steering Committee (for 2012) and service providers (for 2013-2019).

As a result of the changes in subscribership levels and replacement assumptions, D+R estimates total stock levels as shown in Table 5.

**Table 5: Estimates of Total Deployed Units in the Market in 2013-2019**

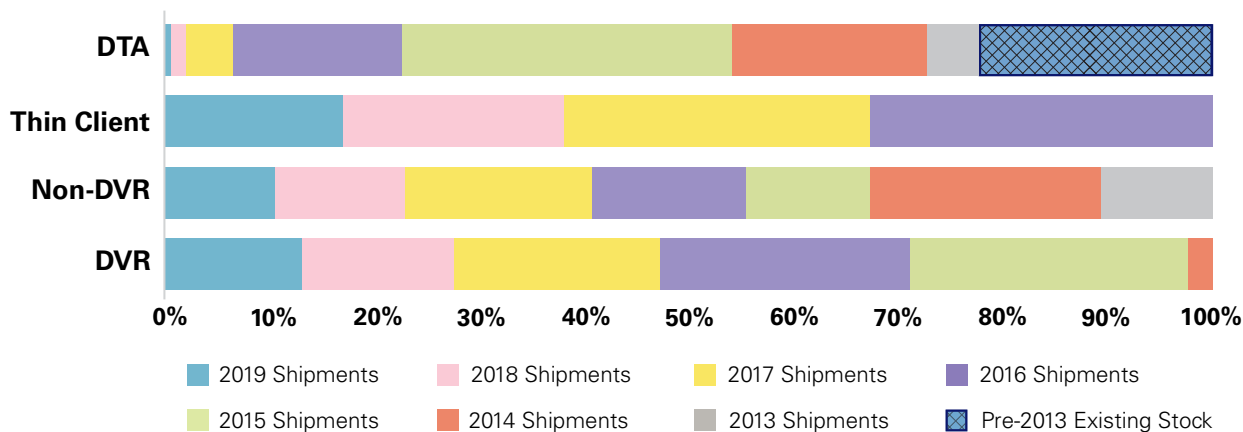
Category	Units						
	2013 <sup>a</sup>	2014 <sup>a</sup>	2015 <sup>a</sup>	2016 <sup>a</sup>	2017 <sup>a,b</sup>	2018 <sup>a,b</sup>	2019 <sup>a,b</sup>
<b>DVR</b>	54,038,000	54,599,000	53,890,000	52,674,000	49,892,000	47,672,000	44,412,000
<b>Non-DVR</b>	130,344,000	122,650,000	112,668,000	96,327,000	92,563,000	89,139,000	83,572,000
<b>Thin Client</b>	10,561,000	20,299,000	28,774,000	39,784,000	34,958,000	32,447,000	28,625,000
<b>DTA</b>	31,633,000	31,543,000	31,396,000	30,866,000	29,722,000	29,074,000	28,683,000
<b>Total</b>	<b>226,576,000</b>	<b>229,092,000</b>	<b>226,727,000</b>	<b>219,651,000</b>	<b>207,135,000</b>	<b>198,331,000</b>	<b>185,293,000</b>

<sup>a</sup>Units are rounded for this table, but D+R did not round any figures when calculating the national footprint estimate.

<sup>b</sup>MSGs purchased in 2017, 2018, and 2019 are excluded from this table. See *supra* note 12.

The next step in estimating national energy consumption is to account for products procured in 2019. The signatories purchased 4 million fewer set-top boxes in 2019 than in 2018, likely due at least in part to a decline in subscribership and also to the increasing prevalence and usage of options for customers to watch their programming without a set-top box, as discussed below. D+R subtracts 2019 set-top box procurements from the total units listed in Table 6, using the new replacement assumptions described above. This methodology yields multiple sets of stock – one for each purchase year – each with its own weighted average TEC values. The weighted average TEC values for each of the purchase year sets are shown in Figure 1.

**Figure 1: Distribution of Current Inventory by Year of Procurement (Percentage of Units)**



Multiplying the number of units purchased each year that still remained in the field at the end of 2019 and the average TEC for that category of device at the time of its purchase produces the estimated national energy consumption shown in Table 6. Table 7 displays this calculation year over year for the lifetime of the Voluntary Agreement.

**Table 6: National Energy Consumption for Devices Based Upon Year of Purchase**

Category	Pre-VA (before 2013)	2013	2014	2015	2016	2017	2018	2019	2019 National Energy Consumption (TWh)
DVR Purchases from Each Year Remaining in Field	0	0	1,100,429	11,671,180	11,219,933	8,268,205	6,304,346	5,848,219	
DVR TEC Average (kWh/yr)	267.0	195.4	179.4	170.6	161.3	142.9	138.7	134.4	6.8
Non-DVR Purchases from Each Year Remaining in Field	0	8,636,698	18,646,064	10,977,499	11,535,694	15,390,556	10,066,928	8,319,044	
Non-DVR TEC Average (kWh/yr)	119.0	108.6	103.3	92.6	85.6	90.8	91.8	74.1	7.8
Thin Client Purchases from Each Year Remaining in Field	0	0	0	0	9,429,014	8,287,414	6,316,550	4,592,236	
Thin Client TEC Average (kWh/yr)	90.0	51.4	50.0	49.1	46.9	44.3	45.4	45.4	1.3
DTA Purchases from Each Year Remaining in Field	6,251,909	1,334,238	5,201,332	9,169,913	4,831,980	1,337,930	427,480	127,850	
DTA TEC Average (kWh/yr)	39.0	57.6	49.3	46.5	49.9	54.9	55.8	51.2	1.3
<b>Total 2019 National Energy Consumption (TWh)</b>									<b>17.3</b>

**Table 7: National Energy Consumption of Installed Set-Top Boxes 2012-2019**

	2012 (Pre-VA)	2013	2014	2015	2016	2017	2018	2019
Estimate of Total Deployed Units in the Market	225,000,000	226,576,000	229,092,000	226,727,000	219,651,000	207,135,000	198,331,000	185,293,000
National Energy Consumed (TWh/yr)	32.0	30.6	29.2	26.9	24.5	21.0	19.4	17.3
500 MW Power Plant Equivalents (Rosenfelds)	10.7	10.2	9.7	9.0	8.2	7.0	6.5	5.8
CO <sub>2</sub> Emitted (MMT)	22.6	21.6	20.6	19.0	17.3	14.9	13.7	12.2

These improvements in energy efficiency spurred by the Voluntary Agreement have had an increasingly significant role in reducing national energy consumption. Set-top box energy consumption has decreased by 46% from 32 TWh/year when the Voluntary Agreement was signed in 2012 to 17.3 TWh/year in 2019. Most, but not all, of the reduction is the result of the Voluntary Agreement.<sup>13</sup> This 14.7 TWh reduction represents consumer savings of over \$1.9 billion<sup>14</sup> and avoidance of nearly 10.4 million metric tons of CO<sub>2</sub> in 2019 alone.<sup>15</sup> During the seven years of the Voluntary Agreement, cumulative energy consumption has declined by an estimated 55.1 TWh, saving consumers approximately \$7.1 billion and avoiding nearly 39 million metric tons of CO<sub>2</sub> emissions.

13 - While the reduction is principally the result of the improvements in energy efficiency spurred by the Voluntary Agreement, it is also partly attributable to a decline in the overall number of set-top boxes. Set-top box use has declined because of subscriber losses and a shift to accessing video through apps. A fraction of the energy reduction is offset by energy used to support Internet and cloud-based video and services, including data centers and the home Internet devices covered by the Voluntary Agreement for Ongoing Improvement to the Energy Efficiency of Small Network Equipment.

14 - See *supra* note 2.

15 - See *supra* note 3.

## AUDIT AND VERIFICATION

### Procurement Audit

D+R is required to conduct an audit of one randomly-selected service provider's procurement figures each year. The audit report for the 2019 reporting year is presented in Appendix D. D+R determined that the data submitted by the service provider for the audit is consistent with the annual report submitted by that service provider.

### Verification Testing

The Voluntary Agreement prescribes third-party verification testing of models chosen by the Independent Administrator. This testing was scheduled to occur during the spring of 2020 but had to be postponed due to restrictions on travel and lab access as a result of the COVID-19 pandemic. That being said, 88% of the unique models purchased in 2019 have already passed independent third-party verification (lab verification or the earlier field verification program) in previous years of the Voluntary Agreement. Third-party lab verification is currently expected to resume by early 2021, subject to further direction from the Steering Committee.



## PROGRESS ON OTHER ENERGY-EFFICIENCY COMMITMENTS

The Voluntary Agreement established other energy-efficiency commitments, some of which are specific to certain industries or providers.

### Whole-Home Systems

Whole-home set-top boxes use home network interfaces (HNIs) to share content with other video client devices over a high-bandwidth home network. HNIs can provide the following functions while consuming a fraction of the energy required by stand-alone fully-featured set-top boxes with built-in tuners and DVRs:

- Shared DVR functionality to set-top boxes without DVR capability
- Transcoding to serve a variety of customer-owned video devices
- Channel tuning capabilities to thin client devices that do not need to connect directly to the service provider's headend

The satellite signatories committed to make energy-efficient whole-home servers and clients available to all new and existing subscribers in 2013, and since then AT&T/DIRECTV and DISH have offered nationwide availability of their DIRECTV "Genie" and DISH "Hopper" and "Joey" whole-home DVR servers and clients, and these energy-saving devices have been widely adopted by consumers. These configurations continue to become more energy-efficient. The EPA ENERGY STAR® program has noted the efficiency of whole-home architectures, stating that households "can experience significant energy savings through the deployment of multi-room thin-client devices in homes that are currently served by two or three high-power STBs with DVR functionality."<sup>16</sup>

AT&T (with respect to its U-verse services), Frontier, and Verizon continued to meet their commitment that energy-efficient whole-home architectures will be available to all new and existing subscribers. Whole-home architectures serve content to multiple remote or client devices within a consumer's home more efficiently than configurations involving multiple DVR set-top boxes throughout the home.

Although not required by the Voluntary Agreement, cable operators have also deployed new whole-home solutions. Comcast customers can use the whole-home capabilities of a single X1 DVR to perform recording and playback functions from their non-DVRs rather than needing additional DVRs. Cox continues to employ a similar arrangement in a majority of its New Contour installations. Altice has eliminated DVR hard disk drives in the home altogether for new installations through the use of cloud DVR services available to all of its set-top boxes within the home.

The successful implementation of whole-home DVRs or cloud DVR in most of the signatories' systems has likely contributed to a decline in the purchases of new DVRs over the past three years. From 2013 through 2016, the signatories purchased between 11.2 and 12.7 million DVRs annually. In the early years of whole-home DVR, the decline in the number of DVRs deployed per DVR household was at least partly offset by increased demand for DVR functionality. However, with DVR adoption now more mature and stable, DVR purchases have steadily declined over the last few years to 5.8 million in 2019. While new DVRs in 2019 are much more energy-efficient than in 2012 (using 50% less power as calculated above), DVRs with hard-drives are still the most energy-intensive set-top boxes in a home, so their replacement with non-DVRs, thin clients or apps saves even more energy.

16 - U.S. Environmental Protection Agency, Set-Top Boxes, available at [https://www.energystar.gov/products/electronics/set\\_top\\_boxes\\_cable\\_boxes](https://www.energystar.gov/products/electronics/set_top_boxes_cable_boxes).

## Consumer Access to Energy-Efficiency Information

All service providers committed to provide subscribers and potential customers with reasonable access to energy-efficiency information for set-top boxes purchased since January 1, 2014. This information makes it easier for consumers to learn about energy-efficient set-top boxes and typical set-top box energy consumption. This information has been posted on company websites since 2014. In 2015, service providers worked to enhance the accessibility of such information on their websites, for example by optimizing related terms in their search tools. D+R annually confirms that this information is readily available to the public from the links listed in Appendix C of this report. D+R, again, reviewed all links provided by the signatories to ensure that they still worked and presented the required information. D+R also searched each signatory's website to verify that customers would be able to find the energy information. Two signatories were asked to improve the accessibility of the information as a result of the review in 2020, and D+R verified that satisfactory changes were made. The signatories also maintain a website, [www.energy-efficiency.us](http://www.energy-efficiency.us), which offers a single site from which the public may conveniently link to each provider's information, the Independent Administrator's annual reports, the Voluntary Agreement, and related news and information.

## Next-Generation Video Delivery

The four largest service provider signatories committed to continue to engage with the Energy Advocates, the manufacturer signatories, component suppliers and software developers to explore approaches to further improve the energy efficiency of set-top boxes in all power states, with a special emphasis on efficiencies in standby power, while preserving a good consumer experience. The cable operators committed, as they had under the prior version of the Voluntary Agreement adopted in 2013, to continue to work with suppliers to develop specifications for new model set-top boxes that operate in a reduced power consumption mode while still functioning with cable system architectures and meeting consumer expectations for quick start-up time and functionality.

The efforts undertaken to date under the Voluntary Agreement to reduce set-top box power in standby modes have contributed to significant improvements in energy efficiency, though not always in the ways that were initially envisioned. Pursuant to their 2013 commitments, the cable operators attempted to develop "deep sleep" modes in which most functionalities were turned off, with a goal of reducing power draw to approximately three watts or less. Trials of set-top boxes in these deep sleep modes were unsuccessful because the length of time for the devices to wake and display video services would be unacceptable for most customers. When the time required to wake devices from deeper sleep modes is too long, dissatisfied customers seek to disable sleep modes altogether. However, associated development efforts led to improved abilities to tailor and reduce power usage for various functions even when the set-top box is turned on. As a result, the power usage of newer model set-top boxes in all modes has declined significantly since adoption of the initial Voluntary Agreement.

Nonetheless, while many newer-model IP set-top boxes have sleep power modes that measure less than 5 watts, most traditional (non-IP) set-top boxes continue to draw almost as much power in sleep mode as in active use. While the service provider signatories remain committed to exploring approaches to improve the energy efficiency of set-top boxes in standby power modes, the Voluntary Agreement also recognizes emerging technology changes in the video marketplace by providing that in addition or in the alternative to the above power scaling commitment, cable operators may pursue strategies to reduce the overall energy usage in typical homes through other means such as IP delivery or architectures that reduce the number of operator-supplied devices in the home. Charter and Altice now offer low-power Apple TV IP devices as an equipment option.<sup>17</sup> Comcast and Cox now offer very low-power IP clients; these devices currently connect through a single higher-powered DVR or non-DVR gateway set-top box, but that gateway will become unnecessary when the companies complete their transitions to all-IP delivery. Altice offers a One Box that combines the modem, Wi-Fi router, primary cable set-top box and telephone adapter all into a single device that uses less energy than its features would as separate devices. As detailed in the next section, all of the service provider signatories are supporting apps that enable customers to access live and on-demand content on a screen such as a television or tablet without any operator-supplied set-top box. The service providers are committed to continuing to pursue these strategies that improve the overall energy efficiency in the delivery of their services. Building upon the extensive meetings and engagement with key suppliers and the Energy Advocates in 2018 referenced in the prior annual report, the parties made additional progress that enabled them in September 2019 to initiate discussions regarding new Tier 4 energy levels. That process remains ongoing.

### Automatic Power Down

Automatic power down (APD) monitors parameters related to viewing and user activity. If the parameters indicate that no user activity or viewing is occurring, APD enables the device to transition to an off or sleep mode. The satellite signatories committed that, effective January 1, 2013, at least 90% of new satellite set-top boxes will include an APD feature with a default value of four hours or less. In 2019, 100% of the satellite set-top boxes purchased by DISH and DIRECTV met this requirement.

<sup>17</sup> - Altice's first purchase of Apple TV devices occurred in 2020 so they are not included in its annual report for 2019.

## VIEWING WITHOUT OPERATOR-SUPPLIED SET-TOP BOXES

While most pay-TV customers still rely on set-top boxes from the service providers to watch that provider's content most of the time, evidence continues to emerge that consumers are increasingly experimenting with and using the service provider signatories' apps that enable their customers to watch video programming without the use of operator-supplied set-top boxes. These apps can be used on hundreds of millions of consumer-owned Internet-connected devices, such as smartphones, tablets, personal computers, select Smart TVs, game consoles, and streaming devices such as Apple TV, Roku, Google Chromecast and Amazon Fire. Nearly all U.S. TV households have at least one of these devices, and the average household has one Smart TV and one streaming device that enable viewing that resembles the traditional pay-TV television experience.<sup>18</sup>

The signatories' apps were used by their customers to watch their video services on more than 43 million of these customer-owned and managed devices in 2019, an increase of nearly 20% from 2018 and nearly 60% from 2017 even as the number of subscribers declined. Table 8 lists the supported TV and other platforms and devices used by consumers to view each service provider's content using its app without operator-supplied set-top boxes in 2019. The table indicates whether the service provider's app on each platform supports access to linear (live TV) content, on demand content, and/or recording capability, which are among the features that help make apps an attractive alternative to a set-top box. There remain some differences in functionality and visibility between apps and set-top boxes that may encourage most customers to continue to use set-top boxes, but the service provider signatories are continuing to work to enhance the functionality of their apps such as through new support for cloud DVR offerings, and investing in customer education and employee training to promote the use and awareness of apps.

<sup>18</sup> - Kagan Market Intelligence, *US Ownership of Smart TVs, SMPs, Smart Speaker Devices Continues to Climb* (Jan. 17, 2020).

**Table 8: Platforms and Apps Used by Customers to View Content Without Set-Top Boxes**

Service Provider	Platform	App Name	Live TV (Yes/No)	On-Demand (Yes/No)	DVR (Yes/No)
<b>Altice</b>	Android	Altice One	Yes	Yes	Yes
	Apple iOS	Altice One	Yes	Yes	Yes
	Apple TV	Altice One	Yes	Yes	Yes
	MAC	Altice One	Yes	Yes	Yes
	PC	Altice One	Yes	Yes	Yes
<b>AT&amp;T</b>	Amazon Fire TV	U-Verse, AT&T TV, AT&T TV Now, AT&T WatchTV	Yes	Yes	Yes
	Amazon Kindle Fire HD	DIRECTV, U-Verse	Yes	Yes	Yes
	Android	DIRECTV, U-Verse, AT&T TV, AT&T TV Now, AT&T WatchTV	Yes	Yes	Yes
	Android TV	AT&T TV, AT&T TV Now	Yes	Yes	Yes
	Apple iOS	DIRECTV, U-Verse, AT&T TV, AT&T TV Now, AT&T WatchTV	Yes	Yes	Yes
	Apple TV	AT&T TV, AT&T TV Now, AT&T WatchTV	Yes	Yes	Yes
	Google Chromecast	AT&T TV, AT&T TV Now, AT&T WatchTV	Yes	Yes	Yes
	MAC	DIRECTV, U-Verse, AT&T TV, AT&T TV Now, AT&T WatchTV	Yes	Yes	Yes
	PC	DIRECTV, U-Verse, AT&T TV, AT&T TV Now, AT&T WatchTV	Yes	Yes	Yes
	Roku	AT&T TV, AT&T TV Now	Yes	Yes	Yes
	Roku TV	AT&T TV, AT&T TV Now	Yes	Yes	Yes
	Samsung TV	AT&T TV, AT&T TV Now	Yes	Yes	Yes
<b>Charter</b>	Android	Spectrum TV	Yes	Yes	Yes
	Apple iOS	Spectrum TV	Yes	Yes	Yes
	Apple TV	Spectrum TV	Yes	Yes	Yes
	MAC	Spectrum.net	Yes	Yes	Yes
	PC	Spectrum.net	Yes	Yes	Yes
	Roku	Spectrum TV	Yes	Yes	Yes
	Roku TV	Spectrum TV	Yes	Yes	Yes
	Samsung TV	Spectrum TV	Yes	Yes	Yes
	Xbox One	Spectrum TV	Yes	Yes	Yes
<b>Comcast</b>	Amazon Kindle Fire HD	Stream	Yes	Yes	Yes
	Android	Stream	Yes	Yes	Yes
	Apple iOS	Stream	Yes	Yes	Yes
	LG TV	Stream	Yes	Yes	Yes
	MAC	Stream	Yes	Yes	Yes
	PC	Stream	Yes	Yes	Yes
	Roku	Stream	Yes	Yes	Yes
	Samsung TV	Stream	Yes	Yes	Yes
<b>Cox</b>	Android	Contour	Yes	Yes	Yes
	Apple iOS	Contour	Yes	Yes	Yes
	MAC	Contour	Yes	Yes	Yes
	PC	Contour	Yes	Yes	Yes

**Table 8: Platforms and Apps Used by Customers to View Content Without Set-Top Boxes (cont.)**

Service Provider	Platform	App Name	Live TV (Yes/No)	On-Demand (Yes/No)	DVR (Yes/No)
<b>DISH</b>	Amazon Fire TV	SlingTV	Yes	Yes	Yes
	Android	DISH Anywhere, SlingTV	Yes	Yes	Yes
	AndroidTV	SlingTV	Yes	Yes	Yes
	Apple iOS	DISH Anywhere	Yes	Yes	Yes
	Apple TV	SlingTV	Yes	Yes	Yes
	MAC	DISHAnywhere.com	Yes	Yes	Yes
	PC	DISHAnywhere.com	Yes	Yes	Yes
	Fire OS	DISH Anywhere	Yes	Yes	Yes
	Google Chromecast	SlingTV	Yes	Yes	Yes
	LG TV	SlingTV	Yes	Yes	Yes
	Roku	SlingTV	Yes	Yes	Yes
	Samsung TV	SlingTV	Yes	Yes	Yes
Xbox One	SlingTV	Yes	Yes	Yes	
<b>Frontier</b>	Android	Frontier TV	Yes	Yes	Yes
	Apple iOS	Frontier TV	Yes	Yes	Yes
	MAC	Frontier TV	Yes	Yes	Yes
	PC	Frontier TV	Yes	Yes	Yes
<b>Verizon</b>	Amazon Kindle Fire HD	Fios TV	Yes	Yes	Yes
	Android	Fios TV	Yes	Yes	Yes
	Apple iOS	Fios TV	Yes	Yes	Yes
	MAC	tv.verizon.com	Yes	No	No
	PC	tv.verizon.com	Yes	Yes	No
<b>Number of unique, customer-owned, and managed devices that have accessed video services via apps during Reporting Period</b>			<b>42,912,613</b>		

App usage can replace or reduce demand for set-top boxes in a variety of ways. For example, the use of apps to view pay-TV and other video content on televisions can render a set-top box unnecessary for that television. New models of Samsung and LG Smart TVs can access the programming of the above-noted service providers without set-top boxes. The Roku TV and Amazon Fire TV platforms listed above likewise are televisions that are shipped with internal Roku and Amazon platform software that allow the user to access the video content of the supporting signatories noted above. Streaming sticks connected to a television also can eliminate the need and demand for a set-top box for that television.<sup>19</sup>

App usage on other devices can replace set-top boxes as well. A study published in January 2020 found that a majority of adults now report watching video on a non-TV device *daily*, with more than three-fourths of them watching most often inside their homes.<sup>20</sup> Over time, as app functionality improves and customer adoption grows, use of non-TV mobile devices inside the home could reduce the demand for additional set-top boxes in additional rooms around the house.

In addition, as of the end of 2019, approximately 3.5 million consumers subscribed to DISH’s SlingTV service or AT&T TV Now service, which are accessed through Smart TVs, tablets, or low-powered streaming devices. In March 2019, Charter Communications launched a similar “TV Essentials” service available to its Internet customers on a variety of customer-owned devices. The energy-efficient IP streaming devices used to receive these services, which may be purchased at retail or provided by the service provider, further reduce the overall energy used by set-top boxes.

19 - Streaming sticks and devices appear likely to decline with the rise in the use of Smart TVs to access content directly. Nearly all new TV purchases are now Smart TVs, and a recent study found that 82% of smart TVs are used to access video directly without a set-top box or streaming device. Kagan Market Intelligence, *US Ownership of Smart TVs, SMPs, Smart Speaker Devices Continues to Climb* (Jan. 17, 2020).

20 - Leichtman Research Group, *The 2010s in Hindsight* (Jan. 2020), available at <https://www.leichtmanresearch.com/wp-content/uploads/2020/01/LRG-Research-Notes-4Q-2019.pdf>.

While the most popular means of everyday access for pay-TV services continues to be operator-supplied set-top boxes, consumers are increasingly comfortable with using the alternative platforms as primary devices for accessing Internet-delivered video on a daily basis. Recent studies have found that nearly 80% of U.S. consumers watch Internet-delivered video on their televisions.<sup>21</sup> The more that the signatories promote the availability and functionality of their app alternatives, the more consumers can be expected to demonstrate the same willingness to use apps on their Smart TVs and other customer devices in lieu of set-top boxes.

These new options help to explain the 20% decline in deployed set-top box inventory previously reported since 2016,<sup>22</sup> and that figure is projected to decline by another 25-30% by 2023.<sup>23</sup> By 2019, only 47% of all TV sets in use have a pay-TV set-top box, the lowest figure ever in the era of all-digital cable television.<sup>24</sup> Continuation of this decline would reduce both the energy footprint of pay-TV set-top boxes and also the aggregate energy savings potential that could be secured by further efficiency improvements in traditional set-top box devices.

The scope of the Voluntary Agreement is limited to the energy use of set-top boxes in subscriber homes. The Voluntary Agreement does not collect data on the incremental energy use associated with the signatories' system infrastructure used to store and transmit video content to the home, which may be sizable. Generally speaking, it is reasonable to expect that the shift to apps and away from set-top boxes will be net positive from an energy perspective. Any increase in energy to support streaming will most likely be more than offset by the significant energy savings resulting from decreased manufacturing, distribution, and operation of multiple set-top boxes (including DVRs that have the highest energy use) in subscriber homes.

21 - Kagan Market Intelligence, *Smart TVs Surpass SMPs for TV Streaming* (Oct. 16, 2019). In 2019, for the first time, the most popular means of access to Internet-delivered video is through Smart TV software with no set-top box at all.

22 - See D+R International Ltd., *2018 Annual Report*, Voluntary Agreement for Ongoing Improvement to the Energy Efficiency of Set-Top Boxes (indicating 20% decline from 2016 to 2018).

23 - Kagan Market Intelligence, *Cable, Telco and DBS Set-Tops Dwindle in US Installed Forecast* (July 16, 2019).

24 - Leichtman Research Group, *The 2010s in Hindsight* (Jan. 2020), available at <https://www.leichtmanresearch.com/wp-content/uploads/2020/01/LRG-Research-Notes-4Q-2019.pdf>. Set-top box penetration was lower when many cable services were analog and did not require a set-top box.

## CONCLUSION

In 2019, 99.7% of set-top boxes purchased by the signatories met the Tier 2 energy-efficiency levels of the Voluntary Agreement. All service providers met all of their commitments under the Agreement for the second consecutive year, including the 90% procurement commitment and the requirement to provide energy information to consumers. The service provider that missed its 2017 procurement commitment successfully completed a remedial plan in 2019 that secured incremental additional energy savings of approximately 25% more energy than is projected to be used over the lifetime of the set-top boxes that exceeded its commitment.

As a result, the Voluntary Agreement reduced national energy consumption of set-top boxes from 32 TWh/year in 2013 to 17.3 TWh/year in 2019, a reduction of 46%, even as the functionality of set-top boxes increased. Consumers are now saving nearly \$2 billion annually in energy costs, which is double the initial estimate projected by the signatories when Tier 2 was developed in 2013. These savings have been confirmed year-by-year through independent verification testing and procurement audits. The signatories are expected under the terms of the Voluntary Agreement to continue to work toward additional savings through their implementation of Tier 3 efficiency levels in 2020 and continued efforts to improve the energy efficiency of set-top boxes in all power states through the ongoing development of Tier 4 energy levels. Meanwhile, the total energy footprint of set-top boxes in customers' homes used to access traditional pay-TV services continues to decline as a result of improved energy efficiency, declining subscribership, and increased consumer use of apps as an alternative to set-top boxes.



## APPENDIX A: VOLUNTARY AGREEMENT COMMITMENTS

Table 9 lists the commitments of the signatories of the Voluntary Agreement along with the status of the signatories' progress toward these commitments.

**Table 9: Voluntary Agreement Commitments**

Commitments	Group	Status
90% of set-top boxes purchased after December 31, 2016 meet Tier 2.	All Service Providers	Each signatory met its 90% commitment individually. Overall, 100% of set-top boxes purchased by the signatories in 2019 met Tier 2.
Prepare annual procurement report for prior year by April 1.	All Service Providers	All service providers submitted to the Independent Administrator in 2019.
Provide energy efficiency information to subscribers and potential subscribers of set-top boxes purchased since January 1, 2014.	All Service Providers	D+R verified that the information is available from the website <a href="http://energy-efficiency.us">energy-efficiency.us</a> and company websites listed in Appendix C, and followed up and confirmed changes with the signatories that needed to update the information.
90% procurement of set-top boxes with automatic power down feature.	Satellite	100% of new satellite set-top box purchases in 2019 include an automatic power down feature.
Make whole-home servers and clients available to all new and existing subscribers.	Satellite	Offered to satellite customers throughout the United States 2013-2019.
Work with suppliers to develop set-top boxes with next-generation power management, and deploy such economically feasible new models that successfully perform on a cable operator's network and support all of the operator's services in its ordinary set-top box replacement cycle. In addition to or in lieu of the foregoing efforts in regards to traditional QAM set-top boxes, a cable operator may pursue strategies to reduce the overall energy usage in typical homes through other means such as IP delivery or architectures that reduce the number of operator-supplied devices in the home.	Cable	The cable operators had extensive meetings and engagement with key suppliers in 2019 to pursue continued improvements in energy efficiency in all power states. Charter and Altice are offering Apple TV as an equipment option. Comcast and Cox are offering very low-power IP client devices for secondary TVs. Altice has integrated the modem, router, and set-top box into a single device. All of the service provider signatories are supporting apps that enable customers to access live and on-demand content on a screen such as a television or tablet without any operator-supplied set-top box.
Use reasonable efforts to design and manufacture equipment to enable improved set-top box energy efficiency while meeting the service providers' functional and operational specification.	Equipment Manufacturers	Manufacturers' efforts to date are reflected in the energy savings reported by service providers, and there is ongoing development of next-generation set-top boxes with lower-power silicon solutions.
Whole home architectures will be available to all new and existing subscribers. Whole-home architectures serve content to multiple remote or client devices within a consumer's home more efficiently than configurations involving multiple DVR set-top boxes throughout the home.	Telco	Deployed throughout the United States 2014-2019.

## APPENDIX B: SET-TOP BOXES PURCHASED BY VOLUNTARY AGREEMENT SIGNATORIES IN 2019

Table 10 lists the reported typical energy consumption (TEC) for each model of set-top box purchased by Voluntary Agreement signatories in 2019. These values are reported TEC, rather than calculated TEC. In the Voluntary Agreement, service providers have the option to publish a “reported TEC” that rounds up calculated TEC values for reporting purposes to account for production variances. Reported TEC figures in this Appendix are rounded up to the next one-tenth digit (e.g., 99.11 kWh/year would be rounded up to 99.2 kWh/year). Please note that the same model could have variances in TEC for several reasons, including differences in reported versus calculated TEC, enabling of different product features, and/or deployment of the device by service providers running different software. The Voluntary Agreement calculates maximum allowable TEC for a product using the base-type allowances outlined in Table 11 and the feature allowances outlined in Table 12. Table 12 also includes descriptions of the features abbreviated in Table 10 in the “Claimed Allowances” column. The Voluntary Agreement sets forth rules for how to claim feature allowances, so the column for claimed allowances lists only the features used when calculating the maximum allowable TEC for the specific product.

The template used to collect the information reported in this Appendix is posted at <https://www.energy-efficiency.us/library/pdf/2019-STB-VA-Reporting-Template.xlsx>. Procurement data submitted by service providers is subject to one random audit per year and the Steering Committee has the option to direct the Independent Administrator to conduct additional audits as necessary. An asterisk indicates models that were evaluated through third-party verification testing under the Voluntary Agreement.

**Table 10: Set-Top Boxes Procured by Voluntary Agreement Signatories in 2019**

Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	Modal Characteristics (W)		TEC (kWh/yr)	Meets Tier 2
						On	Sleep		
<b>Altice</b>	Cable	Multi-Service Gateway	Sagemcom	DGCI384	Adv Video(2), APD, D3, HD, Multi-room, MS, MS-A, W-HNI, MIMO-2.4(3), MIMO-5(4), AP, HEVP, UHD-4, TELE	28.50	26.44	237.0	Yes
<b>Altice</b>	Cable	Non-DVR	Sagemcom	DCIWA384	Adv Video(2), APD, HD, HNI, MS, W-HNI, MIMO-2.4(3), MIMO-5(4), HEVP, UHD-4	10.88	9.05	84.0	Yes
<b>AT&amp;T</b>	IP	DVR	ARRIS	VIP 2262V2	Adv Video(2), DVR, HD, HNI, S-DVR, MS, MS-A	12.06	10.33	99.4	Yes
<b>AT&amp;T</b>	IP	Non-DVR	Motorola	VIP 2500	Adv Video(2), HD, HNI, MS, W-HNI, MIMO-5(2)	11.73	11.40	102.0	Yes
<b>AT&amp;T</b>	Satellite	DVR	DIRECTV	HR54-200	Adv Video, APD, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A	12.20	11.10	100.0	Yes
<b>AT&amp;T</b>	Satellite	DVR	DIRECTV	HR54-500	Adv Video, APD, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A	12.66	12.64	110.8	Yes
<b>AT&amp;T</b>	Satellite	DVR	DIRECTV	HR54-700	Adv Video, APD, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A	12.10	11.01	99.3	Yes
<b>AT&amp;T</b>	Satellite	DVR	DIRECTV	H44-500	Adv Video, APD, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A	10.37	9.37	84.7	Yes
<b>AT&amp;T</b>	Satellite	DVR	DIRECTV	HS17-100	Adv Video, APD, DVR, HD, M-HNI, Multi-room, MS, MS-A, XCD, MIMO-5(4), UHD-4	20.20	18.92	169.1	Yes
<b>AT&amp;T</b>	Satellite	DVR	DIRECTV	HS17-500	Adv Video, APD, DVR, HD, M-HNI, Multi-room, MS, MS-A, XCD, MIMO-5(4), UHD-4	19.48	18.34	163.6	Yes
<b>AT&amp;T</b>	Thin Client	Thin Client	DIRECTV	C61-500	Adv Video, APD, HD, HNI, M-HNI	5.43	4.22	40.1	Yes
<b>AT&amp;T</b>	Thin Client	Thin Client	DIRECTV	C61K-700	Adv Video, APD, HD, HNI, M-HNI, HEVP, UHD-4	9.50	4.10	49.8	Yes

**Table 10: Set-Top Boxes Procured by Voluntary Agreement Signatories in 2019 (cont.)**

Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	Modal Characteristics (W)		TEC (kWh/yr)	Meets Tier 2
						On	Sleep		
AT&T	Thin Client	Thin Client	DIRECTV	C61W-400	Adv Video, APD, HD, HNI, W-HNI, MIMO-5(4)	6.53	5.03	47.9	Yes
AT&T	Thin Client	Thin Client	DIRECTV	C61W-700	Adv Video, APD, HD, HNI, W-HNI, MIMO-5(4)	6.56	5.22	49.2	Yes
AT&T	IP	Non-DVR	AT&T	AT&T TV C71KW-400	Adv Video, HD, HNI, W-HNI, MIMO-5(4), HEVP, UHD-4	5.86	4.13	45.0	Yes
Charter	Cable	Non-DVR	ARRIS	110A	Adv Video, D3, HD, HEVP	13.20	12.47	111.6	Yes
Charter	Cable	Non-DVR	Humax	110H	Adv Video, D3, HD, HEVP	13.24	12.40	111.2	Yes
Charter	Cable	Non-DVR	Technicolor	110T	Adv Video, D3, HD, HEVP	14.25	13.47	120.1	Yes
Charter	Cable	DVR	ARRIS	210A	Adv Video, DVR, D3, HD, MS, MS-A, HEVP	17.38	13.72	128.3	Yes
Charter	Cable	DVR	Humax	210H	Adv Video, DVR, D3, HD, MS, MS-A, HEVP	16.95	13.33	126.0	Yes
Charter	Cable	DVR	Technicolor	210T	Adv Video, DVR, D3, HD, MS, MS-A, HEVP	16.89	13.04	124.7	Yes
Charter	IP	Non-DVR	AppleTV	A1842	Adv Video, HD, HNI, W-HNI, MIMO-2.4(2), MIMO-5(2), HEVP	2.50	0.85	15.9	Yes
Comcast	Cable	Non-DVR	Pace	PX022ANM	Adv Video, CableCARD, D3, HD, M-HNI, Multi-room, MS, MS-A	14.31	13.57	122.7	Yes
Comcast	Cable	Non-DVR	Pace	PX022ANC	Adv Video, CableCARD, D3, HD, M-HNI, Multi-room, MS, MS-A	14.52	13.73	124.3	Yes
Comcast	Cable	DVR	ARRIS	AX014ANC	Adv Video, CableCARD, DVR, D3, HD, M-HNI, Multi-room, MS, MS-A	17.41	16.98	150.9	Yes
Comcast	Cable	DVR	ARRIS	AX014ANM	Adv Video, DVR, D3, HD, M-HNI, Multi-room, MS, MS-A	17.00	16.60	147.5	Yes
Comcast	Cable DTA	Cable DTA	Evolution	DMS2004UHDW	Adv Video, HD	6.31	6.31	55.3	No
Comcast	Cable DTA	Cable DTA	Pace	PXD01ANI DTA	Adv Video, HD, HNI	5.54	5.58	48.7	Yes
Comcast	IP	Non-DVR	Pace	PXD01ANI	Adv Video, HD, HNI, M-HNI	6.32	5.51	52.4	Yes
Comcast	IP	Non-DVR	Cisco	CXD01ANI	Adv Video, HD, HNI, M-HNI	6.13	4.83	49.0	Yes
Comcast	IP	Non-DVR	ARRIS	AX061AEI	Adv Video, HD, HNI, W-HNI, MIMO-2.4(2), MIMO-5(2)	4.16	3.69	34.7	Yes
Comcast	IP	Non-DVR	Technicolor	TX061AEI	Adv Video, HD, HNI, W-HNI, MIMO-2.4(2), MIMO-5(2)	4.10	3.45	33.5	Yes
Comcast	IP	Non-DVR	Pace	PX051AEI	Adv Video, HD, HNI, W-HNI, MIMO-5(4)	6.97	5.88	57.1	Yes
Cox	Cable	Non-DVR	Pace	PX022ANC	Adv Video, CableCARD, D3, HD, M-HNI, Multi-room, MS, MS-A	16.50	14.50	137.2	Yes
Cox	Cable	Non-DVR	Pace	PX022ANM	Adv Video, CableCARD, D3, HD, M-HNI, Multi-room, MS, MS-A	15.50	13.50	128.5	Yes
Cox	Cable	DVR	ARRIS	MX013ANC	Adv Video, CableCARD, DVR, D3, HD, M-HNI, Multi-room, MS, MS-A	24.90	23.20	211.9	Yes
Cox	IP	Non-DVR	Pace	PXD0ANI	Adv Video, HD, HNI, M-HNI	7.00	5.40	55.5	Yes
Cox	IP	Non-DVR	Cisco	CXD0ANI	Adv Video, HD, HNI, M-HNI	6.00	4.60	47.5	Yes
Cox	IP	Non-DVR	ARRIS	AX061AEI	Adv Video, HD, HNI, W-HNI, MIMO-2.4(2), MIMO-5(2), HEVP	5.10	3.40	38.5	Yes
DISH	Satellite	DVR	DISH	Hopper Duo	Adv Video(2), DVR, HD, HNI, M-HNI, Multi-room, MS, HEVP	14.19	13.75	121.4	Yes
DISH	Satellite	DVR	DISH	Hopper 3	Adv Video(2), DVR, HD, HNI, M-HNI, Multi-room, MS-A, XCD, HEVP, UHD-4	24.23	22.50	201.8	Yes
DISH	Satellite	Non-DVR	DISH	Wally	Adv Video, HD, HEVP	7.99	7.77	68.5	Yes
DISH	Thin Client	Thin Client	DISH	Joey 3	Adv Video, HD, HNI, M-HNI, HEVP	5.10	4.81	42.8	Yes
DISH	Thin Client	Thin Client	DISH	Wireless Joey	Adv Video, HD, HNI, W-HNI, MIMO-5(3)	7.83	7.49	66.2	Yes

**Table 10: Set-Top Boxes Procured by Voluntary Agreement Signatories in 2019 (cont.)**

Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	Modal Characteristics (W)		TEC (kWh/yr)	Meets Tier 2
						On	Sleep		
Frontier	Cable	DVR	ARRIS	VMS1100	Adv Video, CableCARD, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A, XCD	20.14	20.14	176.4	Yes
Frontier	IP	DVR	ARRIS	VIP5662EW	Adv Video, DVR, HD, HNI, S-DVR, MS, MS-A, W-HNI, MIMO-5(4), HEVP, UHD-4	14.17	14.17	124.1	Yes
Frontier	IP	Non-DVR	ARRIS	VIP4402W	Adv Video, HD, HNI, W-HNI, MIMO-5(2), HEVP	6.06	6.06	53.1	Yes
Frontier	IP	Non-DVR	ARRIS	IPC4100	Adv Video, HD, HNI, W-HNI, MIMO-5(4), HEVP, UHD-4	4.70	4.70	41.2	Yes
Verizon	Cable	DVR	ARRIS	VMS4100	Adv Video, DVR, HD, M-HNI, Multi-room, MS, MS-A, XCD, XCD-A(2), HEVP, UHD-4	19.68	15.44	146.1	Yes
Verizon	IP	Non-DVR	ARRIS	IPC4100	Adv Video, HD, HNI, W-HNI, MIMO-5, HEVP, UHD-4	8.78	5.99	59.6	Yes

Table 11 presents the base allowances for set-top boxes under Tier 2.

**Table 11: Set-Top Box Base Allowances**

Base Type (Use topmost if multiple apply)	Tier 2 Allowance (kWh/yr)
DTA	25
Cable (CBL)	45
Satellite (SAT)	50
Internet Protocol (IP)	45
Thin Client (TC)	12

Table 12 sets forth the features listed for set-top boxes and outlines the feature allowances under Tier 2.

**Table 12: Set-Top Box Feature Allowances**

Set-Top Box Feature Allowances		
Feature	Description	Tier 2 TEC Allowance (kWh/yr)
Adv Video	Advanced Video Processing	8
APD	Automatic Power Down (4 hrs)	-
CableCARD	CableCARD	15
D3	DOCSIS 3.0	50
D3 above 8x4	DOCSIS 3.0 above 8x4	11
DVR	Digital Video Recorder (DVR)	45
HD	High Definition (HD)	12
HEVP	High Efficiency Video Processing	10
HNI	Home Network Interface	10
M-HNI	MoCA HNI	12
MIMO-2.4	MIMO WiFi HNI 2.4	2
MIMO-5	MIMO WiFi HNI 5	4
MS	Multi-stream	8
MS-A	Multi-stream Additional	8
Multi-room	Multi-room	40
RTG	WiFi Access Point	8
S-DVR	Shared DVR	20
TELE	Telephony	4
UHD-4	Ultra High Definition - 4K	5
W-HNI	WiFi HNI	15
XCD	Transcoding Base	13
XCD-A	Transcoding Additional	5
AP	WiFi Access Point	8

## APPENDIX C: CONSUMER ACCESS TO SET-TOP BOX ENERGY-EFFICIENCY INFORMATION

Set-top box energy information for consumers is available at [www.energy-efficiency.us](http://www.energy-efficiency.us), and for each service provider at the links below.

**Table 13: Links for Consumer Access to Energy-Efficiency Information**

Service Provider	Consumer Information Location
<b>Altice</b>	<a href="https://energy.cablelabs.com/cablevision/">https://energy.cablelabs.com/cablevision/</a>
<b>AT&amp;T/DIRECTV</b>	<a href="https://www.att.com/ecms/dam/att/consumer/help/pdf/AT-Receiver-Products-ENERGY-STAR.pdf">https://www.att.com/ecms/dam/att/consumer/help/pdf/AT-Receiver-Products-ENERGY-STAR.pdf</a>
<b>Charter</b>	<a href="http://www.spectrum.net/support/tv/digital-receiver-energy-use/?domain-redirect=true">http://www.spectrum.net/support/tv/digital-receiver-energy-use/?domain-redirect=true</a>
<b>Comcast</b>	<a href="https://www.xfinity.com/support/cable-tv/set-top-box-energy-usage/">https://www.xfinity.com/support/cable-tv/set-top-box-energy-usage/</a>
<b>Cox Communications</b>	<a href="https://www.cox.com/residential/support/conserving-energy-with-your-digital-receiver.html">https://www.cox.com/residential/support/conserving-energy-with-your-digital-receiver.html</a>
<b>DISH Network</b>	<a href="https://www.mydish.com/support/energy-efficiency">https://www.mydish.com/support/energy-efficiency</a>
<b>Frontier</b>	<a href="https://frontier.com/~media/HelpCenter/Documents/tv/fios/set-top-box-equipment-efficiency.ashx">https://frontier.com/~media/HelpCenter/Documents/tv/fios/set-top-box-equipment-efficiency.ashx</a>
<b>Verizon</b>	<a href="https://www.verizon.com/support/residential/tv/equipment/stb-dvr">https://www.verizon.com/support/residential/tv/equipment/stb-dvr</a>



# 2019 Annual Report Audit Results

In 2012, the pay television industry signed a Voluntary Agreement with the goal of increasing the energy efficiency of set-top boxes, while protecting rapid innovation and timely introduction of new features. Signatories of the Voluntary Agreement include major manufacturers of set-top boxes and the largest cable, satellite, and telco service providers and leading Energy Advocates.

The Voluntary Agreement requires the service providers to submit annual procurement data to an Independent Administrator, who collects and analyzes the data, then publishes the findings in an annual report. Data from the individual service providers are aggregated for publication in the annual report to protect this highly confidential information. To verify the accuracy of the reported procurement data, the Voluntary Agreement requires a random audit of one service provider each year. In accordance with the confidentiality requirements of the Voluntary Agreement, the name of the service provider is not published.

D+R conducted an audit of the 2019 procurement data, which was used to develop the findings published in the 2019 Annual Report. D+R randomly selected the service provider by creating an Excel spreadsheet and using the “random” function, after excluding the signatory that was successfully audited last year in accordance with the terms of the Voluntary Agreement.

D+R requested raw data from the selected service provider to verify the procurement data submitted, which included invoice data and specification sheets. D+R has determined that the data submitted by the service provider for the audit is consistent with the annual report submitted by that service provider.

August 18, 2020

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