



2017 Annual Report

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

Prepared on behalf of the
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EXECUTIVE SUMMARY

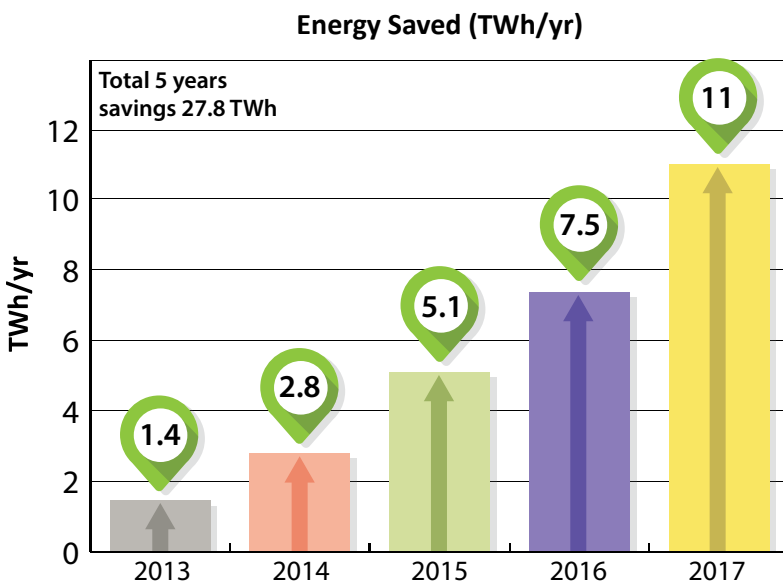
In 2012, the pay television industry, led by NCTA - The Internet & Television Association and the Consumer Technology Association, signed the [Voluntary Agreement for Ongoing Improvement to the Energy Efficiency of Set-Top Boxes](#) with the goal of increasing the energy efficiency of set-top boxes while 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 84.7 million U.S. video subscribers, accounting for 93.1% of the market in 2017. In 2013, leading energy efficiency 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. This fifth annual report provides a summary of developments for the previous calendar year, 2017. Annual reports for the previous four years as well as this report can be found at <http://www.energy-efficiency.us>.

Based on the improved energy efficiency of the set-top boxes procured in 2017, it is estimated that the Voluntary Agreement reduced national set-top box annual energy consumption from 32 TWh in 2012 to 21 TWh in 2017, a reduction of 34%, even as functionality and features of set-top boxes have increased. This 11 TWh reduction, equivalent to almost as much power generated by four typical 500 megawatt coal-run power plants,¹ represents consumer savings of over \$1.4 billion² and prevention of 8.1 million metric tons of CO₂ emissions in 2017 alone.³

During the five years of the Voluntary Agreement, cumulative energy consumption has been reduced by an estimated 27.8 TWh, saving consumers approximately \$3.5 billion and avoiding 20.6 million metric tons of CO₂ emissions. The energy saved during this five-year period is enough to power all homes in Los Angeles County with electricity for almost a year.⁴

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



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. See <https://www.scientificamerican.com/article/rosenfeld-energy-savings/>.

2 - This calculation is based on national average energy cost of \$0.1290 per kWh. See U.S. Energy Information Administration, Electric Power Monthly, available at <https://www.eia.gov/outlooks/steo/report/electricity.cfm>.

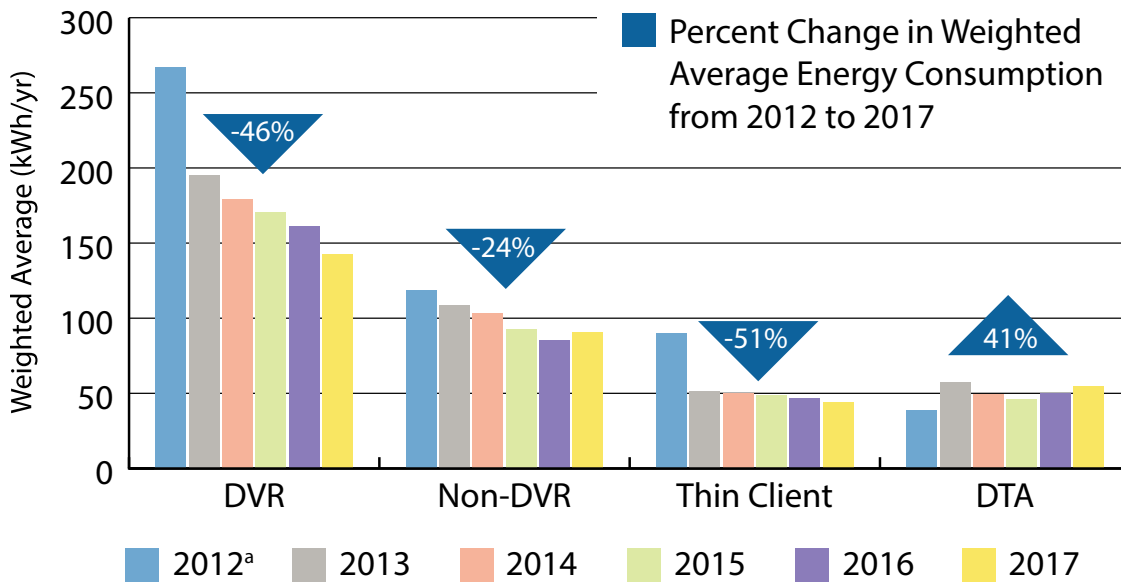
3 - Emission reduction estimates in this report are based on the U.S. Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator, available at <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>.

4 - 27.8 TWh is equivalent to the annual energy usage of 2,234,017 households and the annual electricity usage of 3,100,904 households. See <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>.

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 by service providers after December 31, 2016 must meet the efficiency levels referred to as "Tier 2" in the Voluntary Agreement, replacing the Tier 1 levels that became effective in 2014. This is the first annual report in which the Tier 2 levels were in effect. In 2017, 97.4% of service providers' set-top box purchases met the Tier 2 levels, thereby meeting the procurement commitments in the Voluntary Agreement.⁵ All but one of the service providers met the 90% commitment individually, and that service provider has proposed a remedial plan to offset the energy deficit associated with the missed commitment.

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, as shown in the following figure and table:

Figure ES-2: Weighted Typical Energy Consumption Average of Set-Top Boxes Purchased 2013-2017



^a2012 data represents the baseline estimated per unit energy consumption. The baseline was developed using data from the service providers and energy efficiency advocates.
 Notes: - Data used to create this chart is available in Table 1.
 - One service provider purchased one model of a Multi-Service Gateway in 2017. That model is excluded from the above figure because there is no available baseline data to compare its energy savings.

5 - As set forth below, this calculation is based on 2017 procurement data submitted to D+R by service providers and corroborated by the results of independent field verification conducted of set-top boxes in consumer homes and by the procurement audit conducted by D+R.

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

Category	TEC (kWh/y)		Percent Change in Weighted Average
	Pre-VA (Existing Stock)	2017 Stock	
	Weighted Average		Pre-VA to 2017
DVR	267	142.90	-46%
Non-DVR	119	90.83	-24%
Thin Client	90	44.33	-51%
DTA	39	54.86	41%

It should be noted that the small increase in energy consumption in the non-DVR category between 2016 and 2017 after years of declines is likely attributable to new functionalities such as Ultra High Definition 4K Video, High Efficiency Video Processing, and multiple tuners to stream live video to client devices. As prior reports have noted, while energy consumption in the Digital Transport Adapter (DTA) category increased since the 2012 estimate, this increase can be explained by the fact that most DTAs purchased from 2013 through 2017 included high definition (HD) and advanced video processing capabilities, which increased energy usage. However, 94% of the DTA models purchased in 2017 met the Tier 2 levels.

The Voluntary Agreement also 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 and on company websites, independent verification of the energy usage of set-top boxes deployed in consumers' homes, and an audit of a randomly-selected service provider's set-top box procurements. All of the verification results support the overall findings of this report that the signatories met their commitments in 2017, including that the audit of the randomly-selected signatory verified its reported data, and that 100% of the third-party energy test results from 95 signatory set-top boxes measured in customer's homes via field verification were within the accepted tolerances of the measurements reported by the companies.⁶ The details of the field verification results and an update on each of these measures are presented in the full report below.

The version of the Voluntary Agreement in effect in 2017 expired at the end of the year, with provisions for this annual report to be issued in 2018. 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 new, more rigorous Tier 3 energy levels that will become applicable to the 90% procurement commitment in 2020. The signatories have estimated that these new levels are on average 20% more efficient than the current Tier 2 levels and will save consumers an additional \$600 million annually once the benefits of the Tier 3 commitments are fully realized.

6 - The consistency of field tests in customer homes with lab test results over the past four years has demonstrated that lab tests conducted in accordance with the Voluntary Agreement test method are reliable measures of the energy usage actually experienced by customers. The signatories have indicated that field verification is time-consuming, disruptive to customers, expensive, and it requires substantial energy use to transport heavy testing equipment and personnel around the country each year. Accordingly, the revised Voluntary Agreement has replaced the field verification program with a lab verification program.

As part of the revised Voluntary Agreement, the largest service provider signatories agreed 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 in advance of starting discussions in late 2019 to develop proposed Tier 4 energy levels. These commitments represent an evolution of the cable operators' commitment in the 2013 Voluntary Agreement to field test, and if successful, deploy set-top boxes with power scaling that enables parts of devices to operate in a reduced-power consumption mode while still functioning and meeting consumer expectations. While some power scaling successes have been achieved, set-top boxes in "light" sleep mode typically use much of the power that they consume in on mode, and trialed "deep" sleep modes had re-start times too lengthy to be tolerated by consumers. Notwithstanding significant challenges in improving standby power savings without undermining network requirements and customer expectations, the cable operators are continuing to work with their suppliers on this effort. The commercial signatories also intend to explore a wider variety of approaches to further improve energy efficiency. These approaches include efficiencies in on mode that will also reduce standby power and architectures such as whole-home DVR and IP delivery that can reduce the energy used by operator-supplied devices to support secondary televisions and other displays in the home.

Some of the provisions of the revised Voluntary Agreement have been implemented early and are reflected in this report:

- *Refined Total Stock Estimates.* The 2018 revision to the Voluntary Agreement committed the parties to "review available information and consider whether to make an adjustment to the Independent Administrator's estimate of the total number and distribution by Category of deployed Set-Top Boxes" and to "review the model used in the annual report for accounting for replacement of devices with new procurements." The parties refined D+R's approach to estimating existing stock by adjusting the figures based upon a decline in the number of pay-TV subscribers and by changing to an assumption that new thin client purchases replace older thin clients, rather than non-DVRs.
- *App Availability and Usage.* The revised Voluntary Agreement requires new reporting on the availability and use of apps that offer consumers an alternative to using set-top boxes for every screen. Consumers can access pay-TV video content through Smart TVs, low-power sticks or devices that connect to TVs, tablets, smartphones, and personal computers via apps on a wide variety of TV and other retail platforms without the use of an operator-supplied set-top box. The service provider signatories reported that consumers used nearly 103 million unique customer-owned and managed devices to access the providers' video services in 2017. A list of each supported platform is included in this report. While many consumers today use apps in addition to one or more set-top boxes in their home, app usage can replace or reduce demand for set-top boxes in a variety of ways. Future reports will monitor for trends toward increased consumer use of apps, which may reduce demand for set-top boxes and further reduce the overall energy used in the delivery of pay-TV services.

Under the extension of the Voluntary Agreement, the Independent Administrator will continue to compile 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 91 million U.S. households using customer premises equipment, often referred to as set-top boxes.⁷ 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.⁸ 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 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 84.7 million American households in 2017, accounting for 93.1% of the market.⁹ The Voluntary Agreement provides a framework for the pay television industry to deliver market-based energy efficiency gains that keep pace with technological innovation.

After extensive negotiations among the initial signatories and energy efficiency 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 (f/k/a the National Cable & Telecommunications 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 efficiency advocates in the Steering Committee for the Voluntary Agreement. The U.S. Department of Energy praised the Voluntary Agreement as “a collaborative approach among the Energy Department, the pay-TV industry and energy efficiency groups” that “will save families money by saving energy, while delivering high quality appliances for consumers that keep pace with technological innovation.”¹⁰

That version of the Voluntary Agreement expired at the end of 2017, with provisions for this annual report to be issued in 2018. 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 new, more rigorous Tier 3 energy levels that will become applicable to the 90% procurement commitment in 2020. The signatories have estimated that these new levels are 20% more efficient, on average, than the current Tier 2 levels and will save consumers an additional \$600 million annually once the benefits of the Tier 3 commitments are fully realized. The four largest service provider signatories also agreed 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 in advance of starting discussions in late 2019 to develop proposed levels for a Tier 4.

7 - Based on data provided by NCTA and CTA.

8 - Urban, Bryan; Shmakova, Victoria; Lim, Brian; and Roth, Kurt, 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.

9 - See *supra* note 7.

10 - U.S. Department of Energy, U.S. Energy Department, Pay-Television Industry and Energy Efficiency Groups Announce Set-Top Box Energy Conservation Agreement; Will Cut Energy Use for 90 Million U.S. Households, Save Consumers Billions (2013), available at <https://www.energy.gov/articles/us-energy-department-pay-television-industry-and-energy-efficiency-groups-announce-set-top>.

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. But because Tier 2 levels were met by the majority of set-top box purchases in 2015 and 2016 and by nearly all set-top boxes purchased in 2017, that objective has been achieved earlier than expected, with over \$1.4 billion in annual savings in 2017.¹¹ These 2017 energy savings are equivalent to almost as much power generated by four typical 500 megawatt coal-run power plants¹² annually and will avoid 8.1 million metric tons of CO₂ emissions per year.¹³

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.¹⁴

Energy Efficiency Advocates

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

Cable Service Providers

- Comcast
- Charter
- Cox Communications
- Cablevision (Optimum)
- Time Warner Cable

Satellite Service Providers

- DIRECTV
- DISH Network

Telco Service Providers

- AT&T
- CenturyLink
- Frontier
- Verizon

11 - See *supra* note 2. This calculation is based on national average energy cost of \$0.1290 per kWh. See U.S. Energy Information Administration, Electric Power Monthly, available at <https://www.eia.gov/outlooks/steo/report/electricity.cfm>.

12 - See *supra* note 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. See <https://www.scientificamerican.com/article/rosenfeld-energy-savings/>.

13 - See *supra* note 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>.

14 - AT&T and DIRECTV merged in 2015, and Time Warner Cable merged with Charter in 2016. Each of these entities retains separate Steering Committee memberships under the Voluntary Agreement pursuant to its section 10.2.

Other Organizations

- ARRIS
- Technicolor
- NCTA – The Internet & Television Association
- Consumer Technology Association (CTA)
- Cable Television Laboratories (CableLabs)

Frontier joined the Voluntary Agreement in 2017, and this is the first time its purchases are included in the annual report.

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 2017, in accordance with their commitments, representatives of the signatories provided 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 and field verification contractor
- 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 2017:

- 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 boxes 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 first annual report in which the Tier 2 levels were in effect. Progress on these commitments is discussed in Report on Procurement Commitments, below. Service providers also made commitments relating to light sleep, automatic power down, whole-home systems, field testing of set-top boxes that include next-generation power management, other energy-saving strategies, 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 International, Ltd. (“D+R”) as the Independent Administrator and Auditor in 2013. D+R 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. This is the fifth annual report. D+R is also required to conduct a random audit of one service provider’s procurement figures each year. The 2017 audit report is presented in Appendix D.

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 secure the competitive benefits of first-mover advantages and so that consumers are not delayed from accessing new features. 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. The Steering Committee must, within six months, establish an initial allowance and effective date.

INCREASED ENERGY EFFICIENCY OF SET-TOP BOXES

Table 1 highlights the progress made by the signatories toward increased energy efficiency for each set-top box product category.

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

Category	TEC (kWh/y)					Percent Change in Weighted Average					
	2012 Base Case	Procurement Data					2012 to 2017	2013 to 2017	2014 to 2017	2015 to 2017	2016 to 2017
	Weighted Average	Weighted Average									
		2013	2014	2015	2016	2017					
DVR	267	195.37	179.39	170.61	161.28	142.90	-46%	-27%	-20%	-16%	-11%
Non-DVR	119	108.55	103.27	92.57	85.61	90.83	-24%	-16%	-12%	-2%	6%
Thin Client	90	51.42	49.98	49.13	46.91	44.33	-51%	-14%	-11%	-10%	-5%
DTA ^a	39	57.60	49.26	46.50	49.91	54.86	41%	-5%	11%	18%	10%

^aA digital transport adapter (DTA) is a minimally configured unidirectional set-top box without recording functionality that can receive and decode video content as delivered from a coaxial or hybrid fiber coaxial system. Most DTAs purchased since 2013 likely included HD and advanced video processing (AVP) capabilities, both of which increase TEC. DTAs offered before 2013 were less likely to include these features. At the same time, 91% of DTAs purchased in 2013 and 100% of those purchased in 2014 and 2015 met the Tier 1 energy efficiency requirements. In 2016, 99.7% of the DTAs purchased met the Tier 1 requirements. In 2017, 94% of the DTAs purchased met Tier 2 requirements.

Note: One service provider purchased one model of a Multi-Service Gateway in 2017. That model is excluded from the above table because there is no available baseline data to compare its energy savings.

The increase in energy consumption in the non-DVR category between 2016 and 2017 after the downward trend in previous years is likely attributable to new functionalities such as Ultra High Definition 4K Video, High Efficiency Video Processing, and multiple tuners to stream live video to client devices.

One service provider, Cablevision, reported the purchase of multi-service gateways in 2017 that met the applicable Tier 2 levels, as noted in Appendix B. The multi-service gateway category is excluded from the above table because there is no baseline with which to compare these devices. In accordance with the confidentiality requirements of the Voluntary Agreement, this report also excludes multi-service gateways from all calculations showing the number of units purchased by category because that figure would reveal Cablevision's individual purchase figures.¹⁵ The model is reported in Appendix B and meets the applicable Tier 2 levels, and the relatively small quantity purchased would not have a material impact on this report's assessment of the overall national energy consumption of set-top boxes.

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 first year in which this Tier 2 procurement commitment has been evaluated,¹⁶ and the fourth year in which the procurement commitment is in force. All service providers that signed the Voluntary Agreement submitted procurement data for 2017 on time. These providers are: AT&T, Cablevision (Optimum), Charter Communications, Comcast, Cox Communications, CenturyLink, DIRECTV, DISH Network, Frontier, and Verizon. Details about the set-top boxes purchased by these providers are shown in Appendix B. 97.4% of the set-top boxes purchased by these service providers met the Tier 2 commitment, as shown in Table 2 below.

¹⁵ - Section 8.6 of the Voluntary Agreement seeks to protect the confidentiality of Cablevision's procurement figures by precluding this report from disclosing the number of units it purchased in 2017, which could readily be deduced if a total national figure were reported.

¹⁶ - In the previous four years, procurement commitments were evaluated against Tier 1 levels. Tier 2 levels became applicable in 2017.

Table 2: Voluntary Agreement Signatory Set-Top Box Procurement 2017

Category	Units		Percent Meeting Tier 2
	Total Procured	Number Meeting Tier 2 ^a	
DVR	8,268,205	8,106,349	98.0%
Non-DVR	15,390,556	14,786,116	96.1%
Thin Client	8,287,414	8,287,414	100.0%
DTA	1,337,930	1,253,400	93.7%
Totals	33,284,105	32,433,279	97.4%

^a In 2017, all reported Multi-Service Gateway devices met Tier 2 levels.

All but one of the service providers met the Voluntary Agreement procurement commitment in 2017. That service provider had 71% of its procured set-top boxes meet the Tier 2 levels instead of the required 90%. That service provider has developed a remedial plan to offset the energy deficit associated with the missed procurement commitment, the implementation of which will be overseen by the Independent Administrator and a subcommittee that includes the energy efficiency advocates.

IMPACT ON NATIONAL ENERGY CONSUMPTION

In 2012, service providers began working with energy efficiency 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	Power Plants
		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
U.S. Total		-	225	32	10.6

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 a “relatively stable number of pay-TV subscribers,” such that newly purchased devices replace older (less energy-efficient) and broken equipment rather than add to total deployed stock. From 2013 to 2016, purchases of thin clients were assumed to replace non-DVRs since this category was relatively new to the market.

The 2018 revision to the Voluntary Agreement committed the parties to “review available information and consider whether to make an adjustment to the Independent Administrator’s estimate of the total number and distribution by Category of deployed Set-Top Boxes” and to “review the model used in the annual report for accounting for replacement of devices with new procurements.”¹⁷ One appropriate adjustment to the estimates is to apply a more significant downward correction to the total number of deployed set-top boxes to reflect the decrease in the number of pay-TV subscribers since the start of the Voluntary Agreement, as shown in Table 4 below.

Table 4: Change in Subscribers from 2012-2017

Segment	Percent Change ^a					
	2012 to 2013	2013 to 2014	2014 to 2015	2015 to 2016	2016 to 2017	2012 to 2017
Cable	-4.5%	-0.3%	-0.5%	-1.7%	-3.7%	-10.3%
Satellite	1.0%	0.1%	-1.9%	3.0%	-9.2%	-7.3%
Telco	25.4%	8.2%	-0.9%	-20.9%	2.0%	8.4%

^a Based on data provided by the Steering Committee (for 2012) and service providers (for 2013-2017)

Note: The fluctuation in the Telco subscriber figures is partly attributable to the fact that Frontier joined the Voluntary Agreement as a new signatory in 2017, but many of Frontier’s video subscribers are in systems the company purchased from Verizon in 2016 and from AT&T in 2014. Without Frontier, the 2016-2017 Telco percentage change is -8.4%, and the 2012-2017 Telco percentage change is -2.6%.

In addition, it is now more reasonable to assume that thin clients are generally replacing like devices, rather than non-DVRs, since the earlier generations of these categories of set-top boxes have reached replacement age. As a result of the changes in subscribership levels and replacement assumptions, D+R estimates total stock levels as shown in Table 5.¹⁸

Table 5: Estimates of Total Units in the Market in 2013-2017

Category	2013 Units ^a	2014 Units ^a	2015 Units ^a	2016 Units ^a	2017 Units ^{a,b}
DVR	54,038,000	54,599,000	53,889,000	52,673,000	49,891,000
Non-DVR	130,343,000	122,650,000	112,668,000	96,326,000	92,563,000
Thin Client	10,561,000	20,299,000	28,773,000	39,784,000	34,958,000
DTA	31,632,000	31,543,000	31,395,000	30,866,000	29,722,000
Total	226,574,000	229,091,000	226,725,000	219,649,000	207,134,000

^a Units are rounded to the nearest thousand for this table, but D+R did not round any figures during the calculation and analysis process.

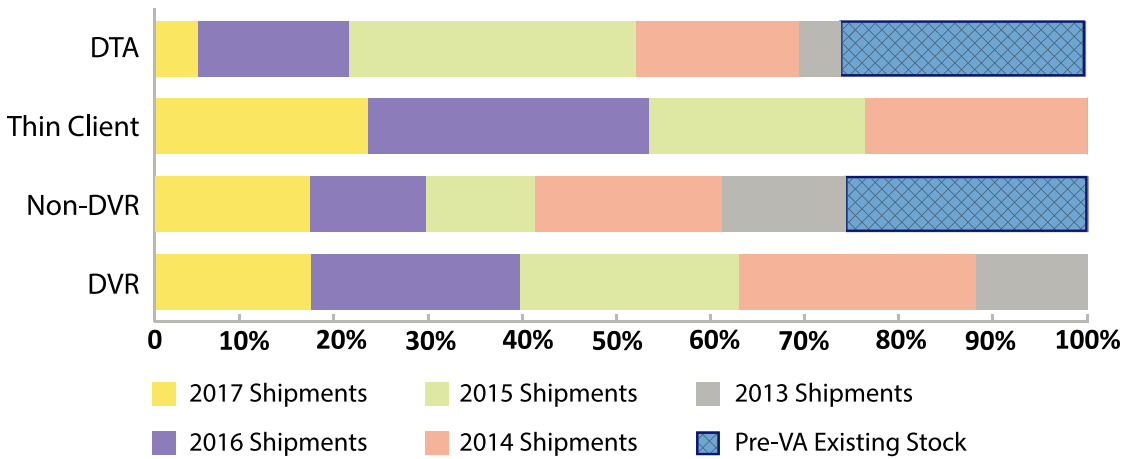
^b Cablevision’s Multi-Service Gateways purchased in 2017 are excluded from this table. See supra note 15.

The next step in estimating national energy consumption is to account for products procured in 2017. The signatories purchased 5.2 million fewer set-top boxes in 2017 than in 2016, likely due at least in part to a decline in subscribership. To arrive at the existing and new stock split, D+R subtracts 2017 set-top box procurements from the total units listed in Table 6, using the new replacement assumptions described above. This methodology yields two sets of stock – existing and new – each with its own TEC values. The weighted average TECs for the existing and new stock are shown in Table 1.

17 - Voluntary Agreement, Section 8.6.7

18 - This table also adjusts the estimated stock levels for 2016 to properly reflect this approach to reduce deployed inventory as a result of subscriber losses. D+R’s 2016 annual report estimated an increase in deployed set-top boxes even though overall pay-TV subscribership declined that year. While this adjustment could be used to support an increased estimate of 2016 energy savings over the figures in the 2016 annual report, the previously-reported prior-year savings figures have not been revised.

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 2017, by 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 6: National Energy Consumption for New and Pre-existing Stock

Category	Pre-VA (before 2013)	2013	2014	2015	2016	2017	2017 National Energy Consumption (TWh/yr)
DVR Purchases from Each Year Remaining in Field	0	6,021,453	12,710,777	11,671,180	11,219,933	8,268,205	
DVR TEC Average (kWh/yr)	267	195.4	179.4	170.6	161.3	142.9	8.44
Non-DVR Purchases from Each Year Remaining in Field	23,653,409	12,360,006	18,646,064	10,977,499	11,535,694	15,390,556	
Non-DVR TEC Average (kWh/yr)	119	108.6	103.27	92.57	85.61	90.72	9.48
Thin Client Purchases from Each Year Remaining in Field	0	0	7,185,809	8,474,667	11,010,506	8,287,414	
Thin Client TEC Average (kWh/yr)	90	51.4	49.98	49.13	46.91	44.33	1.66
DTA Purchases from Each Year Remaining in Field	7,846,915	1,334,238	5,201,332	9,169,913	4,831,980	1,337,930	
DTA TEC Average (kWh/yr)	39	57.6	49.26	46.5	49.91	54.86	1.38
Total 2017 National Energy Consumption (TWh/yr)							21.0

These improvements in energy efficiency spurred by the Voluntary Agreement have had an increasingly significant role in reducing national energy consumption. The Voluntary Agreement reduced national set-top box energy consumption from 32 TWh/year in 2012, to 21 TWh/year in 2017, which is a reduction of 34%. This 11 TWh reduction represents consumer savings of over \$1.4 billion¹⁹ and avoidance of 8.1 million metric tons of CO₂ in 2017 alone.²⁰ During the five years of the Voluntary Agreement, cumulative energy consumption has been reduced by an estimated 27.8 TWh, saving consumers approximately \$3.5 billion and avoiding 20.6 million metric tons of CO₂ emissions. The energy saved during the five years is enough to power all homes in Los Angeles County with electricity for almost a year.²¹

19 - See *supra* note 2.

20 - See *supra* note 3.

21 - 27.8 TWh is equivalent to the annual electricity usage of 3,100,904 households. See <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>. Los Angeles County had an estimated 3,281,845 households in 2017. See U.S. Census Bureau, Quick Facts, Los Angeles County, available at <https://www.census.gov/quickfacts/fact/table/losangelescountycalifornia,US/PST045217>.

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 2017 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.

Field Verification

Beginning in 2014, the Steering Committee retained Intertek Testing Services NA, Inc. to perform annual field verification of the energy usage of selected set-top boxes in consumer homes to ensure set-top boxes are performing as reported. The fourth round of field verification testing was conducted between October and December 2017, with 95 set-top boxes tested in 67 homes in California, Nevada, New Jersey, New York, Pennsylvania, North Carolina, and Missouri. In accordance with the requirement in the Voluntary Agreement, more than 12% of these homes were located in California.

The objective of the field verification testing is to compare observed energy usage in homes to the modal power and annual energy use values reported by the Service Providers to the Independent Administrator and to the energy levels applicable to the procurement commitment. As demonstrated below, the 2017 test results submitted by Intertek to D+R confirmed that the energy usage of service providers' set-top boxes in the home is consistent with the energy information provided to consumers and is in substantial compliance with the procurement commitments of the Voluntary Agreement.

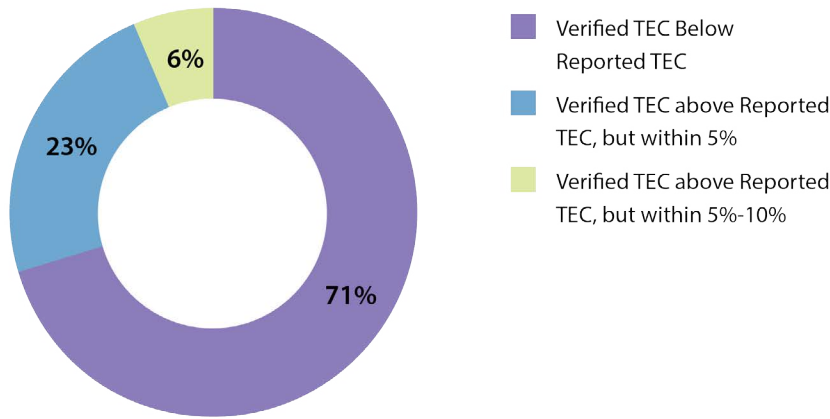
To account for potential variability of conditions within a home, the Steering Committee adopted tolerance levels by which a set-top box field test result may exceed a reported or permitted energy level. The adopted tolerance levels are the lower of 10% or 20 kWh/year for set-top boxes with an on-power mode of at least 10 watts, and 10 kWh/year for lower-power devices.

The field test results are measured in two ways: against the Voluntary Agreement's energy allowances and also against the energy levels reported by the service providers. The first measurement assures compliance with the Voluntary Agreement's procurement commitment, and the second assures the accuracy of the savings calculations included in this report, as well as the accuracy of figures reported to consumers.

Testing Against Voluntary Agreement Allowances. Overall, 95 tests were conducted in 67 homes. 84 of the set-top boxes tested in the field were performed on 56 models that were reported by the service providers as meeting Tier 2 and were counted toward fulfillment of their 90% procurement commitment for 2017. One hundred percent (100%) of these set-top boxes tested in the field measured within the tolerances of the applicable Tier 2 allowances. 55 of these 56 models (98%) tested within the Tier 2 allowances even without any tolerance applied. The remaining 11 tests were performed on ten older models that were purchased in 2017 but were reported by service providers as not meeting Tier 2 levels, and therefore were counted against fulfillment of the service providers' Tier 2 commitments.

Testing Against Reported Values. One hundred percent (100%) of the 95 set-top boxes tested in the field measured within the tolerances of the energy levels reported by the service providers. Even without tolerances, 67 of the 95 field test measurements (71%) were below the energy levels reported by the service providers, and 94% were within 5% of reported values, as shown in Figure 2 below.

Figure 2: 2017 Field Verification Results Compared to Reported Values



The TEC measured in the field across all of the 95 tests performed by Intertek in 2017 was 5.52 kWh/year less than the TEC levels reported by the service providers, compared to 3.98 kWh/year less in 2016 field verification results.²² These test results corroborate the energy savings calculations to be included in the Independent Administrator’s annual report because they suggest that the actual energy usage of the new-model set-top boxes in the home are, on average, less than have been reported by the service providers.

While the Voluntary Agreement had called for field verification to occur in at least 80 homes in 2017, the successful testing of 84 units representing nearly three-fourths (56 of 75) of the set-top box models reported by the Service Providers as meeting Tier 2 levels was sufficient to demonstrate the reliability of this report’s conclusions. Additional field verification is not necessary to support D+R’s findings that the signatories are in substantial compliance with their procurement and reporting commitments under the Agreement.

Conclusion of the Field Verification Program. The consistency of the more than 400 field tests in consumer homes with lab test results over the past four years has demonstrated that lab tests conducted in accordance with the Voluntary Agreement test method are reliable measures of the energy usage actually experienced by consumers.²³ The signatories have indicated that field verification is time-consuming, disruptive to customers, and expensive. Moreover, field testing consumes substantial energy to transport heavy testing equipment and personnel around the country each year. Accordingly, the revised Voluntary Agreement has replaced the field verification program with a lab verification program. To assure the continued credibility of the results, testing will be either conducted in a third party laboratory or under a supervised signatory testing program with an accredited independent observer.

22 - The average TEC varied by device type. For DVRs, the average TEC was 7.22 kWh/year less than the reported values, while for non-DVRs and thin clients the average TEC was 5.32 kWh/year and 3.71 kWh/year, respectively, less than the reported values. For DTAs, the average TEC was 2.09 kWh/year more than the reported values.

23 - As noted in prior reports, the first round of field verification was conducted in 2014, with 94 set-top boxes tested in 85 homes in the New York City, Los Angeles, Washington, DC, and Denver metropolitan areas. The second round of field verification was conducted in 2015, with 115 set-top boxes tested in 93 homes in the Tampa, Orlando, Syracuse, Philadelphia, St. Louis, and Los Angeles metropolitan areas. The third round of field verification in 2016 tested 98 set-top boxes in 83 homes in California, Nevada, New Jersey, New York and Pennsylvania.

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 DIRECTV and DISH have offered nationwide availability of their DIRECTV "Genie" (www.DIRECTV.com/genie) and DISH "Hopper" and "Joey" (<https://www.dish.com/equipment/dvrs/hopper-3/#>) whole-home DVR servers and clients, and these energy-saving devices have been widely adopted by consumers. These configurations continue to become even 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."²⁴

In addition to efficiencies reported in prior years, in 2017, DISH reported that it updated the software for its Joey 2 thin client that reduced the devices' energy consumption by 16% in both new and previously deployed units, creating an additional thirty million kWh/year in annual energy savings.

AT&T's telco unit and CenturyLink made similar commitments to deploy energy-efficient whole-home DVRs. During 2016, they continued to provide whole-home DVR capability for every household equipped with a DVR. More information about AT&T's whole-home DVR service is available at <https://www.att.com/shop/u-verse/total-home-dvr.html> and details about the CenturyLink whole-home DVR service can be found at <http://www.centurylink.com/prismtv>. Verizon committed to offering and deploying whole-home service and clients as appropriate and, since April 2014, has offered the FiOS Quantum whole-home system. Information about this system is available at <http://www.verizon.com/home/fiosquantumtv>.

Although not required by the Voluntary Agreement, cable operators have also deployed new whole-home solutions. Comcast and Cox offer non-DVRs for secondary televisions that can perform recording and playback functions through a single DVR in the home. Cablevision 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 lower energy usage of these providers' non-DVRs compared to typical DVRs can be made from Appendix A.

24 - U.S. Environmental Protection Agency, Set-Top Boxes, available at 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 prospective 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. All providers met this commitment, and this information has been posted and is available to consumers as shown in Appendix C. In 2015, service providers worked to make this information more prominently available and enhance the accessibility of such information on their company websites. In 2016, links to the model information for each service provider signatory were posted at www.energy-efficiency.us and this site appears near the top of web search results for related terms and is therefore considered readily available to consumers. However, in 2018, D+R found that in some cases the information could still be difficult to locate when searching on a service provider's website. Further improvement is warranted, such as further efforts to optimize related terms in their websites' internal search tools. The Steering Committee agreed to continue to encourage and monitor progress toward improved accessibility.

Next-Generation Set-Top Boxes

In the 2013 Voluntary Agreement, the cable operator signatories committed to field test, and if successful, deploy set-top boxes that include next-generation power management that enables parts of devices to operate in a reduced-power consumption mode while still functioning and meeting consumer expectations. Prior annual reports have reported on the results of these tests and deployments. While some power scaling successes have been achieved, set-top boxes in "light" sleep mode typically use much of the power that they consume in on mode, and trialed "deep" sleep modes had re-start times too lengthy to be tolerated by consumers. As shown in Appendix A, while some models are reported in the range of 5 watts lower in sleep mode, a 1-2 watt reduction is more typical. Further reductions in set-top box power when the customer is not actively using the device have been challenging. Set-top boxes need to be ready to receive important maintenance and software updates, and to wake quickly at the customer's request. If the time required to wake devices from deeper sleep modes is too long, dissatisfied customers will seek to disable sleep modes altogether. The cable operators and their suppliers have therefore devoted substantial focus to reducing the power draw of devices in on mode, which has the effect of reducing power in all modes at all times.

Notwithstanding significant challenges in improving standby power savings without undermining network requirements and customer expectations, the signatories are continuing to pursue opportunities to further reduce the energy consumption of set-top boxes during periods when the devices do not require use of all of their capabilities. As part of the revised Voluntary Agreement, the four largest service provider signatories accordingly 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, with a special emphasis on efficiencies in standby power, while preserving a good consumer experience." D+R will continue to track progress in this area as the parties begin preparations to start discussing Tier 4 allowances by late 2019.

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 automatically to sleep mode, which typically results in a savings of at least 1-2 watts. The satellite signatories committed that, effective January 1, 2013, at least 90% of new set-top boxes will include an "Automatic Power Down" (APD) feature with a default value of four hours or less. In 2017, 100% of the set-top boxes purchased by DISH and DIRECTV met this requirement.

VIEWING WITHOUT OPERATOR-SUPPLIED SET-TOP BOXES

The signatories are continuing to enable their customers to watch video programming without the use of operator-supplied set-top boxes through their support of apps. Nearly three-quarters (74%) of U.S. TV households now have at least one television connected in some way to the Internet, and the number of adults using these connected TV devices to access streamed video content on a daily basis has increased by more than 50% since 2016. The revised Voluntary Agreement is keeping pace with this evolution by requiring new reporting on the availability and use of apps that offer consumers an alternative to using set-top boxes for every screen. Although the new terms were adopted in 2018, the signatories agreed to provide this information for 2017 to make this information available to consumers and other stakeholders more rapidly.

The service providers reported that consumers used 102,957,737 unique customer-owned and managed devices to access the providers' video services via apps in 2017. These devices include Smart TVs, low-power sticks or devices that connect to TVs, tablets, smartphones, and personal computers, all without the use of an operator-supplied set-top box. Table 7 lists the supported TV and other platforms and devices being used by consumers to view content without set-top boxes.

Table 7: Platforms and Apps Used by Customers to View Content Without Set-Top Boxes

Service Provider	Platform	App Name	Linear (YES/NO)	On-Demand (YES/NO)	DVR (YES/NO)
AT&T/DIRECTV	PC	DIRECTV, U-Verse, DIRECTV Now	YES	YES	YES
	MAC	DIRECTV, U-Verse, DIRECTV Now	YES	YES	YES
	Apple iOS	DIRECTV, U-Verse, DIRECTV Now	YES	YES	YES
	Android	DIRECTV, U-Verse, DIRECTV Now	YES	YES	YES
	Amazon Kindle Fire HD	DIRECTV, U-Verse	YES	YES	YES
	Amazon Fire TV	U-Verse, DIRECTV Now	YES	YES	NO
	Roku	DIRECTV Now	YES	YES	NO
	Apple TV	DIRECTV Now	YES	YES	NO
	Google Chromecast	DIRECTV Now	YES	YES	NO
	Android TV	DIRECTV Now	YES	YES	NO
	Roku TV	DIRECTV Now	YES	YES	NO
Cablevision d/b/a Optimum	Apple iOS	Optimum	YES	YES	NO
	Android	Optimum	YES	YES	NO
	Amazon Kindle Fire HD	Optimum	YES	YES	NO
	PC	Optimum	YES	YES	NO
CenturyLink	Apple iOS	Prism TV app	YES	YES	NO
	Android	Prism TV app	YES	YES	NO
	Roku	Prism TV app	YES	YES	NO
	Amazon Kindle Fire HD	Prism TV app	YES	YES	NO
	Roku TV	Prism TV app	YES	YES	NO
Charter	PC	Spectrum.net	YES	YES	NO
	MAC	Spectrum.net	YES	YES	NO
	Apple iOS	Spectrum TV	YES	YES	NO
	Android	Spectrum TV	YES	YES	NO
	Amazon Kindle Fire HD	Spectrum TV	YES	YES	NO
	Roku	Spectrum TV	YES	YES	NO
	Xbox One	Spectrum TV	YES	YES	NO
	Samsung TV	Spectrum TV	YES	YES	NO
	Roku TV	Spectrum TV	YES	YES	NO
Comcast	PC	Stream	YES	YES	YES
	MAC	Stream	YES	YES	YES
	Roku	Stream	YES	YES	YES
	Apple iOS	Stream	YES	YES	YES
	Android	Stream	YES	YES	YES
	Amazon Kindle Fire HD	Stream	YES	YES	YES

Service Provider	Platform	App Name	Linear (YES/NO)	On-Demand (YES/NO)	DVR (YES/NO)
Cox Communications	PC	Contour	YES	YES	NO
	MAC	Contour	YES	YES	NO
	Apple iOS	Contour	YES	YES	NO
	Android	Contour	YES	YES	NO
DISH Network	Amazon Fire TV	SlingTV	YES	YES	YES
	Amazon Kindle Fire HD	DISH Anywhere	YES	YES	YES
	Android	DISH Anywhere, SlingTV	YES	YES	YES
	Android TV	SlingTV	YES	YES	YES
	Apple iOS	DISH Anywhere	YES	YES	YES
	Apple TV	SlingTV	YES	YES	YES
	Google Chromecast	SlingTV	YES	YES	YES
	LG TV	SlingTV	YES	YES	YES
	MAC	DISHAnywhere.com, SlingTV	YES	YES	YES
	PC	DISHAnywhere.com, SlingTV	YES	YES	YES
	Roku	SlingTV	YES	YES	YES
	Roku TV	SlingTV	YES	YES	YES
	Samsung TV	SlingTV	YES	YES	YES
	Xbox One	SlingTV	YES	YES	YES
Frontier	Apple iOS	FrontierTV	YES	YES	YES
	Android	FrontierTV	YES	YES	YES
	PC	tv.frontier.com	YES	YES	NO
	MAC	tv.frontier.com	YES	YES	NO
Verizon	Apple iOS	Fios TV	YES	YES	YES
	Android	Fios TV	YES	YES	YES
	Amazon Kindle Fire HD	Fios TV	YES	YES	YES
	PC	tv.verizon.com	YES	YES	NO
	MAC	tv.verizon.com	YES	NO	NO
Number of unique customer owned and managed devices that have accessed video services via apps during Reporting Period			102,954,737		

While many consumers today use apps in addition to one or more set-top boxes in their home, app usage can replace or reduce demand for set-top boxes in a variety of ways. For example, the use of apps to view the service providers' content on televisions can render a set-top box unnecessary for that television. It was estimated that in 2017, for the first time, a majority of all streaming content is viewed on televisions rather than PCs and mobile devices. One analyst concluded that "there has been an enormous surge in the use of connected televisions" and that "[n]ew data shows many subscribers prefer the app experience" to operator set-top boxes even on their TVs. Apps usage on other devices can replace set-top boxes as well. While the use of apps on mobile devices outside the home typically would expand consumer access to providers' video services rather than replace set-top boxes, mobile devices are also often used by consumers inside the home to watch programming in rooms that do not have, and now do not need, a set-top box.

In addition, as of the end of 2017, approximately 3.4 million consumers subscribed to DISH's SlingTV service or DIRECTV Now service that do not use any service-provider supplied set-top box. These consumers access these video services using only their broadband Internet access equipment and whatever third-party platform they use to watch the content, such as a Smart TV or a lower-power device identified in the platform column of Table 3 above. Subscriptions to these and other app-based "virtual MVPD" service offerings are expected to increase.

A trend toward increased consumer use of apps will reduce demand for set-top boxes and further reduce the overall energy used in the delivery of pay-TV services.

CONCLUSION

In 2017, 97.4% of set-top boxes purchased by the signatories met the new Tier 2 energy-efficiency levels of the Voluntary Agreement, with all but one service provider meeting the individual 90% commitment. As a result, the Voluntary Agreement reduced national energy consumption of set-top boxes from 32 TWh/year in 2013 to 21 TWh/year in 2017, a reduction of 34%, even as the functionality of set-top boxes increased.

The signatories also substantially satisfied their other commitments under the Voluntary Agreement, though with room for continued improvement as noted in this report, such as improved consumer access to set-top box energy information on their webpages and additional energy savings from power scaling. The signatories have fulfilled their commitments to deploy light sleep to pre-Agreement set-top boxes, incorporate automatic power down in satellite set-top boxes, make whole-home systems available to subscribers, and provide reasonable access to energy efficiency information for set-top boxes purchased after January 1, 2014. Their reported energy consumption figures were confirmed as accurate by independent field verification.

APPENDIX A: VOLUNTARY AGREEMENT COMMITMENTS

Table 8 lists the commitments of the signatories to the Voluntary Agreement along with the status of the signatories' progress toward these commitments.

Table 8: Voluntary Agreement Commitments

Commitments	Group	Status
90% of set-top boxes purchased in 2017 meet Tier 2.	All Service Providers	97.4%
Prepare annual procurement report for prior year.	All Service Providers	All service providers submitted to Independent Administrator in 2017.
Provide energy efficiency information to subscribers and potential subscribers of set-top boxes purchased since January 1, 2014.	All Service Providers	Energy efficiency information provided by all service providers is available from the website www.energy-efficiency.us .
90% procurement of set-top boxes with automatic power down feature beginning in 2013.	Satellite	Complete. 100% deployment in 2017.
Make whole-home servers and clients available to all new and existing subscribers in 2013.	Satellite	Complete. Offered throughout the United States 2013-2017.
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	Comcast and Charter have deployed set-top boxes with next-generation power management capabilities. Cablevision released a multi-service gateway that combines set-top box, broadband modem, and router functionality in one device, replacing three separate devices and reducing overall energy usage by more than 28%. While some power scaling successes have been achieved, set-top boxes in "light" sleep mode typically use much of the power that they consume in on mode, and trialed "deep" sleep modes had re-start times too lengthy to be tolerated by consumers.
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 throughout 2014-2017.

APPENDIX B: SET-TOP BOXES PURCHASED BY VOLUNTARY AGREEMENT SIGNATORIES IN 2017

Table 9 lists the reported typical energy consumption (TEC) for each model of set-top box purchased by Voluntary Agreement signatories in 2017. 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. Modal power and 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 10 and the feature allowances outlined in Table 11. Table 11 also includes descriptions of the features abbreviated in Table 11 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/IA-2017-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 field verification in 2014, 2015, 2016, and/or 2017.

Table 9: Set-Top Boxes Procured by Voluntary Agreement Signatories in 2017

STBs Procured by Voluntary Agreement Signatories in 2017						Modal Characteristics (W)		TEC (kWh/yr)	Meets Tier 2
Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	On	Sleep		
						AT&T/DirecTV	Satellite	DVR	DIRECTV
AT&T/DirecTV	Satellite	DVR	DIRECTV	HR44-500*	APD, Adv Video, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A	19.0	17.9	160.0	YES
AT&T/DirecTV	Satellite	DVR	DIRECTV	HR44-700*	APD, Adv Video, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A	18.5	17.5	156.0	YES
AT&T/DirecTV	Thin Client/Remote	Thin Client	DIRECTV	C61-100*	APD, Adv Video, HD, HNI, M-HNI	5.4	4.3	40.2	YES
AT&T/DirecTV	Thin Client/Remote	Thin Client	DIRECTV	C61-500*	APD, Adv Video, HD, HNI, M-HNI	5.5	4.3	40.1	YES
AT&T/DirecTV	Thin Client/Remote	Thin Client	DIRECTV	C61-700*	APD, Adv Video, HD, HNI, M-HNI	5.3	4.1	39.0	YES
AT&T/DirecTV	Thin Client/Remote	Thin Client	DIRECTV	C41W-100*	APD, Adv Video, HD, HNI, W-HNI, MIMO-5(4)	7.2	5.6	53.0	YES
AT&T/DirecTV	Thin Client/Remote	Thin Client	DIRECTV	C41W-500*	APD, Adv Video, HD, HNI, W-HNI, MIMO-5(4)	7.2	5.8	53.9	YES
AT&T/DirecTV	Thin Client/Remote	Thin Client	DIRECTV	C51-100*	APD, Adv Video, HD, HNI, M-HNI	6.4	3.8	39.4	YES
AT&T/DirecTV	Thin Client/Remote	Thin Client	DIRECTV	C51-500*	APD, Adv Video, HD, HNI, M-HNI	5.7	3.7	37.0	YES
AT&T/DirecTV	Thin Client/Remote	Thin Client	DIRECTV	C51-700*	APD, Adv Video, HD, HNI, M-HNI	6.1	4.3	41.8	YES
AT&T/DirecTV	Thin Client/Remote	Thin Client	DIRECTV	C61K-700*	APD, Adv Video, HD, HNI, M-HNI	9.5	4.1	49.8	YES
AT&T/DirecTV	Satellite	DVR	DIRECTV	HR54-200*	APD, Adv Video, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A	12.2	11.1	101.0	YES
AT&T/DirecTV	Satellite	DVR	DIRECTV	HR54-500*	APD, Adv Video, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A	12.7	12.7	111.0	YES
AT&T/DirecTV	Satellite	DVR	DIRECTV	HR54-700*	APD, Adv Video, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A	12.1	11.1	99.3	YES
AT&T/DirecTV	Satellite	DVR	DIRECTV	H44-100*	APD, Adv Video, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A	9.8	9.1	81.2	YES
AT&T/DirecTV	Satellite	DVR	DIRECTV	H44-500*	APD, Adv Video, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A	10.4	9.4	84.7	YES
AT&T/DirecTV	Satellite	DVR	DIRECTV	HS17-100*	APD, Adv Video, DVR, HD, M-HNI, Multi-room, MS, MS-A, XCD, MIMO-5(4), UHD-4	20.2	19.0	170.0	YES

* Indicates models that have been verified through independent field verification in 2014-2017.

STBs Procured by Voluntary Agreement Signatories in 2017						Modal Characteristics (W)		TEC (kWh/yr)	Meets Tier 2
Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	On	Sleep		
						AT&T/DirecTV	Satellite	DVR	DIRECTV
AT&T/DirecTV	Thin Client/Remote	Thin Client	DIRECTV	C61-200*	APD, Adv Video, HD, HNI, M-HNI	5.5	4.3	40.1	YES
AT&T/DirecTV	Thin Client/Remote	Thin Client	DIRECTV	C61W-700	APD, Adv Video, HD, HNI, W-HNI, MIMO-5(4)	6.6	5.3	49.2	YES
AT&T/DirecTV	Thin Client/Remote	Thin Client	DIRECTV	C61W-400	APD, Adv Video, HD, HNI, W-HNI, MIMO-5(4)	6.6	5.1	47.9	YES
Cablevision d/b/a Optimum	Cable	Multi-Service Gateway	Sagemcom	DGCI384*	APD, Adv Video(2), D3, HD, Multi-room, MS, MS-A, W-HNI, MIMO-2.4(3), MIMO-5(4), RTG, HEVP, UHD-4, TELE	27.8	26.3	234.0	YES
Cablevision d/b/a Optimum	Cable	Non-DVR	Sagemcom	DCIWA384*	APD, Adv Video(2), HD, HNI, MS, W-HNI, MIMO-2.4(3), MIMO-5(4), HEVP, UHD-4	13.9	11.7	109.0	YES
Cablevision d/b/a Optimum	Cable	Non-DVR	Samsung	C5320	Adv Video, CableCARD, D2, HD	18.2	17.2	156.0	NO
Charter d/b/a/Spectrum	Cable	Non-DVR	Humax	101H	APD, Adv Video, D3, HD, HEVP	13.0	12.6	113.0	YES
Charter d/b/a/Spectrum	Cable	DVR	Humax	201H	APD, Adv Video, DVR, D3, HD, MS, MS-A, HEVP	16.6	16.2	145.0	YES
Charter d/b/a/Spectrum	Cable	Non-DVR	Technicolor	101T*	APD, Adv Video, D3, HD, HEVP	13.6	11.6	109.0	YES
Charter d/b/a/Spectrum	Cable	DVR	Technicolor	201T*	APD, Adv Video, DVR, D3, HD, MS, MS-A, HEVP	16.6	14.6	135.0	YES
Charter d/b/a/Spectrum	Cable	DVR	Arris	DCX3600M*	APD, Adv Video, CableCARD, DVR, D3, HD, HNI, M-HNI, S-DVR, MS-A	24.8	22.8	207.0	YES
Charter d/b/a/Spectrum	Cable	Non-DVR	Technicolor	4742HDC2*	APD, Adv Video, CableCARD, D2, HD, HNI, M-HNI	15.3	12.5	119.0	YES
Charter d/b/a/Spectrum	Cable	DVR	Technicolor	8640HDC2*	APD, Adv Video, CableCARD, DVR, D2, HD, MS	20.1	15.7	150.0	YES
Charter d/b/a/Spectrum	Cable	Non-DVR	Technicolor	4640HDC2*	APD, Adv Video, CableCARD, D2, HD	12.7	9.6	94.0	YES
Charter d/b/a/Spectrum	Cable	Non-DVR	Arris	DCX3200M/P3* ODN	APD, Adv Video, CableCARD, D2, HD, HNI, M-HNI	14.5	12.2	115.0	YES
Charter d/b/a/Spectrum	Cable	Non-DVR	Arris	DCX3200M/P3* iGuide	Adv Video, CableCARD, D2, HD	13.8	13.7	122.0	NO
Charter d/b/a/Spectrum	Cable	Non-DVR	Arris	DCX3200M/P3* Spectrum	APD, Adv Video, CableCARD, D2, HD	13.0	12.5	112.0	NO
Charter d/b/a/Spectrum	Cable	DVR	Arris	DCX3520E* iGuide	Adv Video, DVR, D2, HD, MS	22.2	20.9	191.0	NO
Charter d/b/a/Spectrum	Cable	DVR	Arris	DCX3520E* Spectrum	APD, Adv Video, DVR, D2, HD, MS	20.9	18.3	168.0	NO
Charter d/b/a/Spectrum	Cable	DVR	Technicolor	9865HDC*	APD, Adv Video, CableCARD, DVR, D3, HD, HNI, M-HNI, S-DVR, MS, MS-A	25.9	22.6	208.0	YES
Charter d/b/a/Spectrum	Cable	Non-DVR	Samsung	SMT-3362H	APD, Adv Video, CableCARD, D2, HD, HNI, M-HNI	14.3	13.5	122.0	YES

* Indicates models that have been verified through independent field verification in 2014-2017.

STBs Procured by Voluntary Agreement Signatories in 2017						Modal Characteristics (W)		TEC (kWh/yr)	Meets Tier 2
Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	On	Sleep		
						Charter d/b/a/ Spectrum	Cable	Non-DVR	Arris
Charter d/b/a/ Spectrum	Cable	Non-DVR	Arris	DCX3220E* Spectrum	APD , Adv Video, D2, HD	11.8	11.0	99.0	NO
Charter d/b/a/ Spectrum	Cable	DVR	Arris	DCX3510*	APD , Adv Video, CableCARD, DVR, D2, HD, HNI, M-HNI, S-DVR, MS	21.3	16.4	158.0	YES
Comcast	Internet Protocol (IP)	Non-DVR	Pace	PX051AEI	Adv Video, HD, HNI, W-HNI, MIMO-5(4), HEVP	6.9	4.2	56.0	YES
Comcast	Cable	DVR	Arris	AX013ANC*	Adv Video, CableCARD, DVR, D3, HD, M-HNI, Multi-room, MS, MS-A	22.4	20.9	200.0	YES
Comcast	Internet Protocol (IP)	Non-DVR	Pace	PXD01ANI*	Adv Video, HD, HNI, M-HNI	6.0	5.1	54.0	YES
Comcast	Cable DTA	Cable DTA	Pace	PXD01ANI DTA*	Adv Video, HD, HNI	6.3	6.2	55.0	YES
Comcast	Internet Protocol (IP)	Non-DVR	Cisco	CXD01ANI*	Adv Video, HD, HNI, M-HNI	6.0	4.7	54.0	YES
Comcast	Cable	DVR	Arris	AX014ANM*	Adv Video, DVR, D3, HD, M-HNI, Multi-room, MS, MS-A	16.7	14.7	155.0	YES
Comcast	Cable	DVR	Arris	AX014ANC*	Adv Video, CableCARD, DVR, D3, HD, M-HNI, Multi-room, MS, MS-A	17.2	15.6	160.0	YES
Comcast	Cable	Non-DVR	Pace	PX022ANM*	Adv Video, CableCARD, D3, HD, M-HNI, Multi-room, MS, MS-A	14.5	13.2	135.0	YES
Comcast	Cable	Non-DVR	Pace	PX022ANC*	Adv Video, CableCARD, D3, HD, M-HNI, Multi-room, MS, MS-A	15.6	14.0	135.0	YES
Comcast	Cable DTA	Cable DTA	Evolution	DMS2004UHD*	Adv Video, HD	7.1	7.0	62.0	NO
Comcast	Cable	Non-DVR	Samsung	SX022ANM*	Adv Video, CableCARD, D3, HD, M-HNI, Multi-room, MS, MS-A	15.2	14.0	135.0	YES
Comcast	Cable	Non-DVR	Samsung	SX022ANC*	Adv Video, CableCARD, D3, HD, M-HNI, Multi-room, MS, MS-A	16.0	14.7	140.0	YES
Comcast	Cable	DVR	Arris	AX013ANM*	Adv Video, CableCARD, DVR, D3, HD, M-HNI, Multi-room, MS, MS-A	22.6	21.3	200.0	YES
Comcast	Cable	DVR	Pace	PX013ANM*	Adv Video, CableCARD, DVR, D3, HD, M-HNI, Multi-room, MS, MS-A	24.0	22.4	210.0	YES
Comcast	Cable	DVR	Pace	PX013ANC*	Adv Video, CableCARD, DVR, D3, HD, M-HNI, Multi-room, MS, MS-A	24.4	23.1	210.0	YES
Cox	Internet Protocol (IP)	Non-DVR	Pace	PXD01ANI*	Adv Video, HD, HNI, M-HNI	7.0	5.4	60.0	YES
Cox	Internet Protocol (IP)	Non-DVR	Cisco	CXD01ANI*	Adv Video, HD, HNI, M-HNI	6.0	4.6	53.0	YES

* Indicates models that have been verified through independent field verification in 2014-2017.

STBs Procured by Voluntary Agreement Signatories in 2017						Modal Characteristics (W)		TEC (kWh/yr)	Meets Tier 2
Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	On	Sleep		
						Cox	Cable	DVR	Arris
Cox	Cable	DVR	Arris	AX013ANM*	Adv Video, CableCARD, DVR, D3, HD, M-HNI, Multi-room, MS, MS-A	23.9	22.2	208.0	YES
Cox	Cable	Non-DVR	Pace	PX022ANC*	Adv Video, CableCARD, D#, HD, M-HNI, Multi-room, MS, MS-A	16.5	14.5	142.0	YES
Cox	Cable	Non-DVR	Pace	PX022ANM*	Adv Video, CableCARD, D#, HD, M-HNI, Multi-room, MS, MS-A	15.5	13.5	133.0	YES
DISH	Satellite	DVR	DISH	Hopper 3*	APD, Adv Video(2), DVR, HD, M-HNI, Multi-room, MS, MS-A, XCD, HEVP, UHD-4	24.3	22.5	208.0	YES
DISH	Thin Client/Remote	Thin Client	DISH	Wireless Joey 2	APD, Adv Video, HD, HNI, W-HNI, MIMO-5(3)	7.9	7.5	68.0	YES
DISH	Satellite	Non-DVR	DISH	Wally*	APD, Adv Video, HD, HEVP	8.0	7.8	72.0	YES
Frontier	Cable	DVR	Arris	VMS1100*	APD, Adv Video, CableCARD, DVR, HD, M-HNI, Multi-room, MS, MS-A, XCD	20.2	20.2	186.7	YES
Frontier	Thin Client/Remote	Thin Client	Arris	IPC815W*	APD, Adv Video, HD, HNI, M-HNI, W-HNI, MIMO-5(3)	6.6	6.6	61.2	YES
Frontier	Internet Protocol (IP)	DVR	Arris	VIP5662	APD, Adv Video, DVR, HD, HNI, S-DVR, MS, MS-A, W-HNI, MIMO-5(4), HEVP, UHD-4	13.7	13.7	125.7	YES
Frontier	Internet Protocol (IP)	Non-DVR	Arris	VIP4402	APD, Adv Video, HD, HNI, W-HNI, MIMO-5(2), HEVP	6.4	6.4	60.1	YES
Verizon	Cable	DVR	Arris	VMS 1100*	APD, Adv Video, CableCARD, DVR, HD, HNI, M-HNI, Multi-room, MS, MS-A, XCD	22.7	22.7	198.9	YES
Verizon	Internet Protocol (IP)	Non-DVR	Arris	IPC 1100 P2*	APD, Adv Video, HD, HNI, M-HNI	7.0	7.0	61.4	YES

* Indicates models that have been verified through independent field verification in 2014-2017.

Table 10 presents the base allowances for set-top boxes under Tier 2.

Table 10: 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 11 sets forth the features listed for set-top boxes and outlines the feature allowances under Tier 2.

Table 11: Set-Top Box Feature Allowances

Set-Top Box Feature Allowances		
Feature	Description	Tier 2 TEC Allowance (kWh/yr)
Adv Video	Advanced Video Processing	8
Cable CARD	CableCARD	15
DVR	Digital Video Recorder (DVR)	45
D2	DOCSIS 2.0	20
D3	DOCSIS 3.0	50
HD	High Definition (HD)	12
HNI	Home Network Interface	10
M-HNI	MoCA HNI	12
S-DVR	Shared DVR	20
Multi-room	Multi-room	40
MS	Multi-stream	8
MS-A	Multi-stream Additional	8
XCD	Transcoding Base	13
XCD-A	Transcoding Additional	5
W-HNI	WiFi HNI	15
MIMO-2.4	MIMO WiFi HNI 2.4	2
MIMO-5	MIMO WiFi HNI 5	4
RTG	Routing	27
HEVP	High Efficiency Video Processing	10
UHD-4	Ultra High Definition - 4K	5
TELE	Telephony	4

APPENDIX C: CONSUMER-FACING SET-TOP BOX ENERGY EFFICIENCY INFORMATION

Set-top box energy information for consumers is available at www.energy-efficiency.us, and for each service provider at the links below.

Table 12: Consumer-Facing Energy Efficiency Information

Service Provider	Consumer Information Location
AT&T/DIRECTV	https://www.att.com/ecms/dam/att/consumer/help/pdf/ATT-Receiver-Products-ENERGY-STAR.pdf
Cablevision Systems Corp. d/b/a Optimum	http://optimum.custhelp.com/app/answers/detail/a_id/2809/~/_cable-equipment-energy-consumption
CenturyLink	http://www.centurylink.com/home/help/television/prismtv/prism-set-top-boxes-save-energy.html
Charter d/b/a Spectrum	http://www.spectrum.net/support/tv/digital-receiver-energy-use/?domain-redirect=true
Comcast	https://www.xfinity.com/support/cable-tv/set-top-box-energy-usage/
Cox Communications	https://www.cox.com/residential/support/conserving-energy-with-your-digital-receiver.html
DISH Network	https://www.mydish.com/support/energy-efficiency
Frontier	https://frontier.com/~media/HelpCenter/Documents/tv/fios/set-top-box-equipment-efficiency.ashx
Verizon	https://www.verizon.com/Support/Residential/Tv/FiosTv/Receivers/User+Guides/User+Guides.htm#energy



2017 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 efficiency 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 is 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 2017 procurement data, which was used to develop the findings published in the 2017 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 9, 2018

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