D+R International

2016 Annual Report

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

Prepared on behalf of the
Steering Committee by:
D+R International
1100 Wayne Avenue, Suite 700
Silver Spring, Maryland 20910

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EXECUTIVE SUMMARY

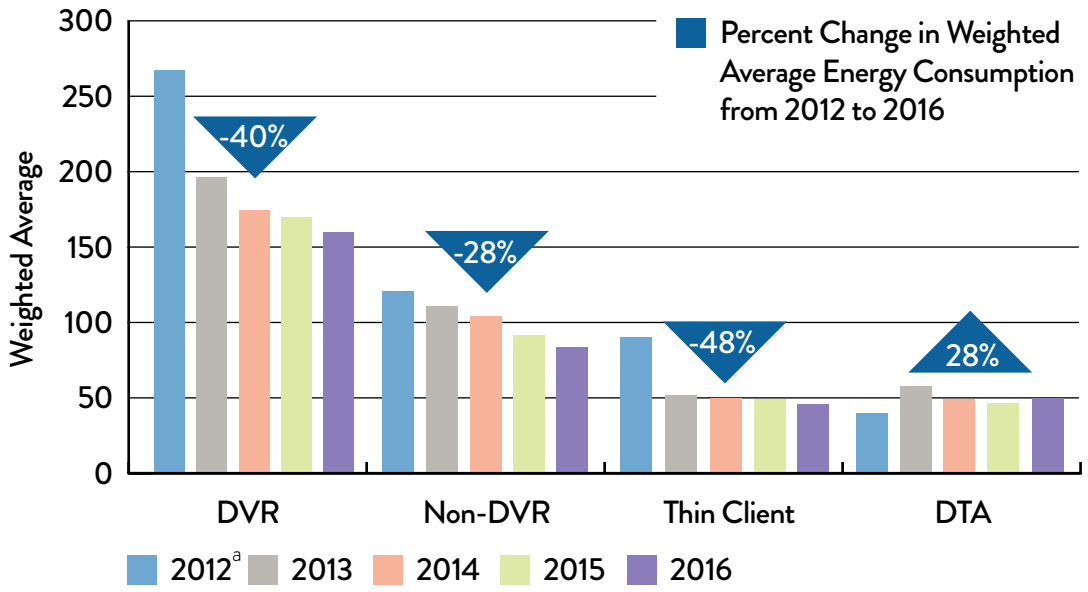
In 2012, the pay television industry led by NCTA - The Internet & Television Association and the Consumer Technology Association signed the Voluntary Agreement for Ongoing Improvement to the Energy Efficiency of Set-Top Boxes with the goal of increasing the energy efficiency of set-top boxes while protecting 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 90 million U.S. video subscribers, accounting for 92.2% of the market in 2016. 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 fourth annual report provides a summary of developments for the previous calendar year, 2016. Annual reports for the previous three years can be found at http://www.energy-efficiency.us.

Under the Voluntary Agreement, 90% of set-top boxes procured by service providers after December 31, 2013 must meet the efficiency standards established for ENERGY STAR® Version 3.0, referred to as the "Tier 1" standards of the Voluntary Agreement. After December 31, 2016, 90% of set-top boxes procured by participants must meet more-efficient standards, referred to as "Tier 2". In 2016, 98.6% of service providers' set-top box purchases met the Tier 1 standards, thereby meeting the procurement commitments in the Voluntary Agreement.[1] Service providers also reported early adoption of Tier 2[2] performance levels in 62.3% of set-top boxes procured in 2016.

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:

Figure ES-1 Weighted Total Energy Consumption Average of Set-Top Boxes Purchased 2013-2016



[a] 2012 data represents the baseline estimated per unit energy consumption. It was developed using data from the service providers and energy efficiency advocates.

Note: Data used to create this chart is available in Table 6.

1 - As set forth below, this calculation is based on 2016 procurement data submitted to D+R International 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.

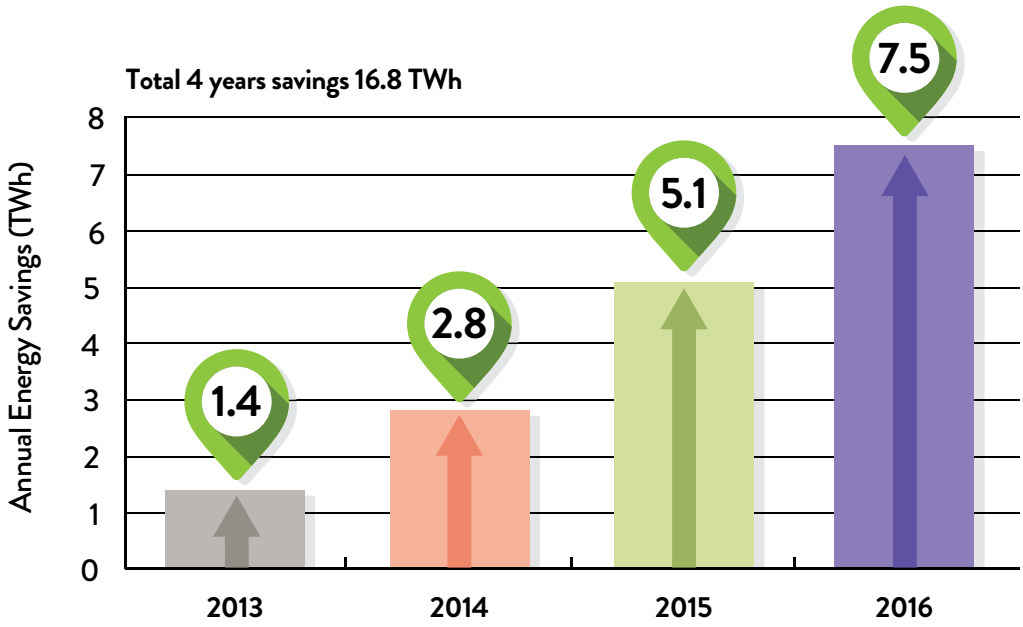
2 - Most products indicating Tier 2 performance have been tested using Tier 1 (ENERGY STAR Version 3.0) test procedures. The Voluntary Agreement does not require the use of Tier 2 test procedures until reporting for 2017.

It should be noted that 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 2016 included high definition (HD) and advanced video processing (AVP) capabilities, which increased energy usage. However, DTA energy usage has declined since 2013, and 99.97% of the DTA models purchased in 2016 met the Tier 1 standards.

Based on the improved energy efficiency of the set-top boxes procured in 2016, it is estimated that the Voluntary Agreement reduced national set-top box annual energy consumption from 32 TWh in 2012 to 24.5 TWh in 2016, a reduction of 23.4%, even as energy-consuming functionality of set-top boxes has increased.[3] This 7.5 TWh reduction represents consumer savings of approximately $941 million[4] and prevention of 5.2 million metric tons of CO2 emissions last year alone.[5]

During the four years of the Voluntary Agreement, energy consumption has been reduced by an estimated 16.8 TWh, saving consumers approximately $2.1 billion and avoiding 11.8 million metric tons of CO2 emissions.[6] The cumulative energy saved during this period is equivalent to the energy used by all of the homes in both Washington, DC, and Chicago combined, for one year; or the equivalent of removing the carbon emissions caused by nearly 2.5 million passenger cars for a full year.[7]

Figure ES-2 Energy Saved by the Voluntary Agreement Procurement Commitments



3 - Estimated stock was calculated using the change in subscribership from 2012 to 2016. In 2013, the estimated national set-top box energy consumption was 30.6 TWh, in 2014 it was 29.2 TWh, and in 2015 it was 26.9 TWh.
4 - This calculation is based on national average energy cost of $0.1255 per kWh, Electric Power Monthly U.S. Energy Information Administration, available at https://www.eia.gov/outlooks/steo/report/electricity.cfm
5 - 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.
6 - See D+R International, 2015 Annual Report, Voluntary Agreement for the Energy Efficiency of Set-Top Boxes (2015 Annual Report) at 5 (estimating 5.1 TWh reduction in energy in 2015, 2.8 TWh 2014, 1.4 TWh reduction in 2013).
7 - 16.8 TWh is equivalent to the annual energy usage of 1,246,741 households and the annual electricity usage of 1,743,449 households. See https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

Compared to earlier projections of unabated proliferation of digital video recorders (DVRs) in the absence of the Voluntary Agreement, which represents the second base case assessed, savings were nearly twice that amount, and all of the signatories now employ strategies that reduce consumers' reliance on energy-consuming hardware in the home, such as multi-room DVR functionality and apps.

The Voluntary Agreement also contains additional commitments. A summary of these commitments and the progress made to date on each is presented below.

Automatic Power Down. The satellite signatories committed to including automatic power down (APD) in at least 90% of set-top boxes purchased after January 1, 2013. All set-top boxes purchased by the satellite signatories since 2013, including those purchased in 2016, met this requirement.

Whole-Home Systems. Whole-home systems can result in lower overall household set-top box energy use, as homes can receive DVR capabilities on all TVs without requiring a DVR on each one. Instead, a thin client or other set-top box consuming less energy is used on the second and third TVs in the home. The satellite signatories committed to making whole-home systems available to all subscribers in 2013; this commitment continued to be met in 2016. Telco Internet Protocol television (IPTV) providers made and met similar commitments to provide whole-home capability for every household with a DVR in 2014. During 2016, they continued to provide whole-home DVR capability for every household equipped with a DVR. Although not required by the Voluntary Agreement, some cable operators have also deployed whole-home solutions.

Next-Generation Set-Top Boxes. The cable operator signatories committed to beginning field tests of set-top boxes that include next-generation power management by December 31, 2014 and if successful to deploy them in their ordinary set-top box replacement cycle. Next-generation power management allows parts of the device to operate in a reduced-power consumption mode while still functioning with cable system architectures and meeting consumer expectations for quick start-up time and other required functions. One cable operator signatory has introduced a new deeper-sleep option to customers using one of its client models with more models to follow this year, and another signatory initiated deployment of next-generation DVRs and non-DVR set-top boxes that include new energy-saving power-scaling capabilities.

Consumer-Facing Energy Efficiency Information. Each service provider committed to providing reasonable access to energy efficiency information for set-top boxes purchased after January 1, 2014. All service providers met this commitment by posting this information on the web pages listed in Appendix C, but D+R found that some of the information could be difficult to locate, so the service providers have agreed to work to improve consumer access to the information. These links are also available to consumers at www.energy-efficiency.us.

DOCSIS Allowance. Section 10.2.4 of the Voluntary Agreement states that, "The Signatories agree to review the energy use of Set-Top Boxes that incorporate DOCSIS 3.0 8x4 mode and greater by October 2015 and to modify the Additional Functionality TEC Allowance as appropriate." In 2016, the Steering Committee's technical working group reopened its evaluation and again found that there was insufficient information on which to proceed. The signatories will continue to monitor developments in this area.

Annual Procurement Data. All service providers submitted their annual procurement reports to the Independent Administrator on time.

Field Verification. Intertek Testing Services NA Inc., an internationally recognized energy-testing firm, was retained to conduct field verification as required by the Voluntary Agreement. Testing in both "on" and "standby" modes was performed on a representative group of 98 set-top boxes in 83 homes located in California, Nevada, New Jersey, New York and Pennsylvania in October and November 2016. The test results 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 compliance with the procurement commitments of the Voluntary Agreement, accounting for expected variability for conditions within a home. The overall average total energy consumption (TEC) measured in field verification was 3.98 kWh/year below reported values for the models tested.[8]

Random Audit. The Independent Auditor is required to conduct a random audit of one service provider's procurement figures each year. D+R randomly selected one service provider, and reviewed its raw procurement data, invoice data, purchase order data, product specification sheets, and screenshots from its purchase order systems. After cross-checking these datasets, D+R confirmed the accuracy of its report. The audit report is attached hereto as Appendix D.

8 - Calculation based on the Field Measured TEC - Reported TEC.

OVERVIEW OF THE VOLUNTARY AGREEMENT

Cable, satellite, and telco service providers offer pay television to approximately 97.7 million U.S. households using customer premises equipment, often referred to as set-top boxes.[9] 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 consumed an estimated 31 TWh of electricity in 2013, 18% of residential consumer electronics electricity consumption, and 2.2% of all residential electricity consumption.[10] 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 in 2012. The 15 industry leaders that signed the original Voluntary Agreement represent all of the major service providers, equipment vendors, and industry organizations in the United States. Combined, these companies provided video service to 90 million American households in 2016, accounting for 92.2% of all multichannel video consumers.[11] 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 that included new signatories was launched in 2013. The U.S. Department of Energy (DOE), 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 includes 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.

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 have estimated that, once set-top boxes meet the Tier 2 standards, consumers will save at least $1 billion annually in energy costs compared to the set-top boxes in use in 2012. The signatories are on track to realize and surpass those projected savings, having already reached $941 million in annual savings in 2016. These energy savings are equivalent to almost as much power generated by three average power plants[12] (500 MW each) annually and will prevent 5 million metric tons of CO2 emissions per year.

9 - Based on data provided by the NCTA and the Consumer Technology Association.
10 - 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).
11 - See supra note 9.
12 - 1 Rosenfeld = 3 billion Kilowatt hours per year (3 Terawatt hours per year), is the same amount of electricity generated by a conventional 500 Megawatt coal-run power plant https://www.scientificamerican.com/article/rosenfeld-energy-savings/.

Voluntary Agreement Signatories and Steering Committee

The current signatories to and participants in the Voluntary Agreement are listed below. Each signatory and participant organization marked with an asterisk has one voting member serving on the Steering Committee; each signatory and participant organization marked with a dagger has one representative who participates on the Steering Committee as a non-voting observer.

Energy Efficiency Advocates

- American Council for an Energy-Efficient Economy (ACEEE)*
- Appliance Standards Awareness Project (ASAP)†
- Natural Resources Defense Council (NRDC)*

Cable Service Providers

- Comcast*
- Cox Communications*
- Charter Communications* (including Time Warner Cable and Bright House Networks)
- Cablevision Systems Corp. d/b/a Optimum*

Satellite Service Providers

- AT&T/DIRECTV*
- DISH Network*

Telco Service Providers

- AT&T*
- Verizon*
- CenturyLink*

Other Organizations

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

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 2015, AT&T acquired DIRECTV, and in 2016, Charter acquired Time Warner Cable and Bright House Networks, and ARRIS acquired Pace.

The Voluntary Agreement obligates the Steering Committee to designate an Independent Administrator and publish an annual report. The Steering Committee designated D+R International, Ltd. as the Independent Administrator and Auditor in 2013. D+R International continued in this role in 2014, 2015, and 2016. This report is the fourth annual report.

In 2016, in accordance with its 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, Independent Auditor, 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 2016:

- 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 to procure energy efficient set-top boxes. Specifically, at least 90% of set-top boxes purchased after December 31, 2013 shall meet the efficiency standards established for ENERGY STAR Version 3.0, described in the Voluntary Agreement as Tier 1. After December 31, 2016, the Voluntary Agreement designates new, more stringent efficiency levels, designated as Tier 2.[13] The procurement commitment under Tier 2 is also 90%. Progress on these commitments is discussed in Progress 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: Voluntary Agreement Commitments.

Independent Administrator and Auditor Role

The Independent Administrator and Auditor (or Independent Administrator) is a third party appointed and overseen by the Steering Committee. Under the Voluntary Agreement, the Independent Administrator must aggregate and compile confidential procurement data submitted by service providers and provide a draft report to the Steering Committee by May 31 of each year. With the service provider commitments in effect, the Independent Administrator must also assess whether there is substantial compliance with the service provider procurement commitments. If these commitments are not met, the Independent Administrator has the authority to take appropriate action following the procedures set out in the Voluntary Agreement.

The Independent Administrator is required to conduct a random audit of one service provider's procurement figures each year. The final 2016 audit report is presented in Appendix D.

13 - Tier 2 allowances are similar to ENERGY STAR Version 4.1.

Field Verification

Beginning in 2014, the Steering Committee retained Intertek Testing Services NA, Inc. to perform field verification of the energy usage of selected set-top boxes in 80-100 homes per year to ensure set-top boxes are performing as reported. The first round of field verification testing was conducted between August and October 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 testing was conducted between September and October 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 testing was conducted between October and November 2016, with 98 set-top boxes tested in 83 homes in California, Nevada, New Jersey, New York and Pennsylvania. 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 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.

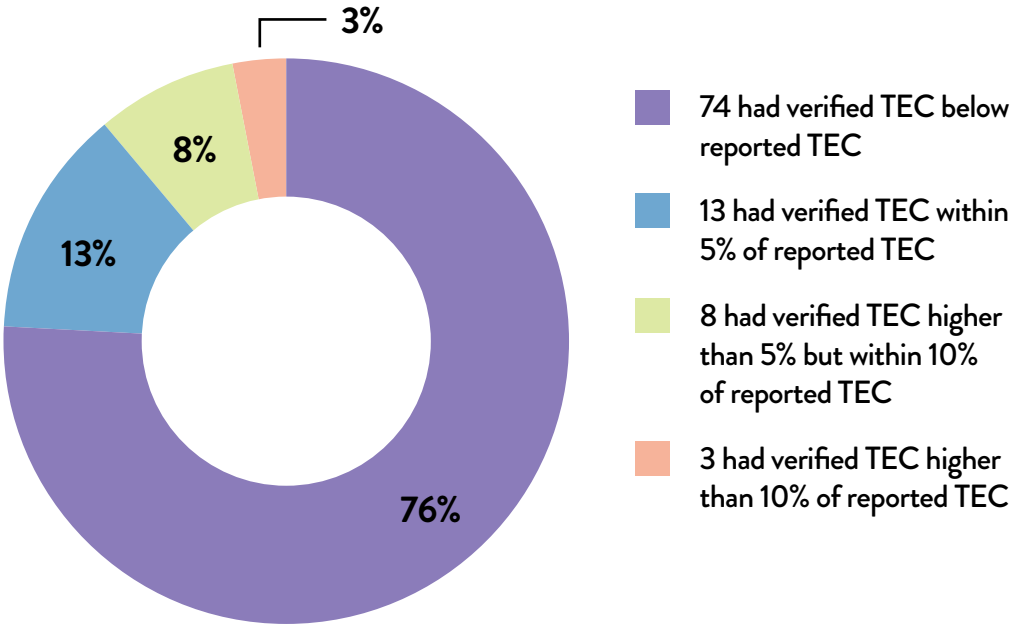
To account for potential variability of conditions within a home, the Steering Committee adopted tolerance levels by which a set-top box field test result may exceed a reported or permitted energy level. The adopted tolerance levels are the lower of 10% or 20 kWh/year for set-top boxes with an on-power 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 standards 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 Tier 1 Standards. Of the 98 set-top boxes tested, 96 tested within the Tier 1 allowances with the tolerances applied, and the remaining two tests were of the same model that had been expected to test in excess of the Tier 1 levels because it had been reported by the service provider to exceed such levels (i.e., the model was not used to meet procurement commitments). Five additional models tested above the Tier 1 allowances without tolerances applied but below the Tier 1 allowances with the tolerances applied, and were within tolerance of their reported values.

Testing Against Reported Values. 95 of the 98 units tested below reported values with tolerances applied. Two of the three models that tested above were also tested within tolerance of the reported values in a separate field test, and the third issue was remedied with a software modification. Even without tolerances, 76% of the test results were less than the reported values, and 89% were within 5% of reported values, as shown below:

Figure 1- 2016 Field Verification Results



These test results corroborate the energy savings calculations set forth in this 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. The overall average TEC difference (Field Measured TEC - Reported TEC) was 3.98 kWh/year below reported values for the 98 field tests conducted by Intertek, without any credit for tolerances, suggesting that the energy savings achieved by the Voluntary Agreement's procurement commitment may be larger than the estimates set forth in this report. The average TEC varied by device type. For DVRs, the average TEC was 3.55 kWh/year less than the reported values, while for non-DVRs and thin clients the average TEC was 4.34 kWh/year and 4.07 kWh/year, respectively, less than the reported values. For DTAs, the average TEC was 4.55 kWh/year less than the reported values.

NEW FEATURE ALLOWANCES

The Tier 2 standards 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.[14] 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 service provider will 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 then within six months establish an initial allowance and effective date. In 2016, this process was invoked and on December 13, 2016, the Steering Committee established new allowances for Ultra High Definition – 4K, High Efficiency Video Processing (HEVP), and support for analog telephone service through one or more RJ11 or RJ14 jacks. These new allowances are posted at http://www.energy-efficiency.us/library/pdf/STB-ApprovedNewFeatureAllowances.pdf.

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 Electricity Consumption for Major Set-Top Box Categories[15]

Category	TEC (kWh/yr)					Percent Change in Weighted Average			
	2012 Base Case	Procurement Data							
	Weighted Average	Weighted Average				2012 to 2016	2013 to 2016	2014 to 2016	2015 to 2016
		2013	2014	2015	2016				
DVR	267	195.4	179.4	170.6	161.2	-40%	-17%	-10%	-5%
Non-DVR	119	108.6	103.3	92.4	85.6	-28%	-21%	-17%	-8%
Thin Client[a]	90	51.4	50.0	49.1	46.9	-48%	-9%	-6%	-5%
DTA[b]	39	57.6	49.3	46.5	49.9	28%	-13%	1%	7%

[a] The 2012 Base Case included Thin Clients only from cable operators, but since 2013, reports have included thin clients from non-cable service providers.

[b] A 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 in 2013, 2014, 2015, and 2016 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 STAR Version 3.0) energy efficiency requirements. In 2016, 99.97% of the DTAs purchased met the Tier 1 requirements.

14 - According to Section 10.2.4 of the Voluntary Agreement, "The Signatories agree to review the energy use of Set-Top Boxes that incorporate DOCSIS 3.0 8x4 mode and greater by October 2015 and to modify the Additional Functionality TEC Allowance as appropriate." In the second quarter of 2015, the Steering Committee convened a working group including technical representatives from cable service providers, set-top box manufacturers, and component manufacturers to address this review. The working group concluded that there were not enough set-top boxes with DOCSIS 3.0 Cable Modem configurations greater than 8x4 to propose a new allowance at that time. At its June 11, 2015 meeting, the Steering Committee voted to conclude the review process and to initiate a reassessment of the allowance by the end of 2016. In 2016, the Steering Committee's technical working group reopened its evaluation and again found that there was insufficient information on which to proceed. The signatories will continue to monitor developments in this area.

15 - Multi-service gateway products were only reported in 2013. There were 232 units, which had a weighted average energy consumption of 219 kWh/year.

PROGRESS ON PROCUREMENT COMMITMENTS

Under the Voluntary Agreement, 90% of set-top boxes procured by participants after December 31, 2013 must meet the efficiency standards established for ENERGY STAR Version 3.0 (Tier 1). This is the fourth year in which the procurement commitment has been evaluated, and the third in which the procurement commitment is in force. All service providers who signed the Voluntary Agreement submitted procurement data for 2016 on time. These providers are: AT&T Services Inc., Cablevision Systems Corp. d/b/a Optimum.; Charter Communications, Inc. (including Bright House Networks, LLC and Time Warner Cable Inc., which it acquired in 2016); Comcast Cable Communications, LLC; Cox Communications, Inc.; CenturyTel Broadband Services, LLC (d/b/a CenturyLink); Verizon Communications, Inc.; DIRECTV, LLC; and DISH Network LLC. Details about the set-top boxes purchased by these providers are provided in Appendix B: Set-Top Boxes Purchased by Voluntary Agreement signatories in 2016. 98.6% of the set-top boxes purchased by service providers met the ENERGY STAR Version 3.0 (Tier 1) commitment, with all providers meeting the 90% procurement commitment.

In 2014 one service provider failed to meet its procurement commitment that required 90% of its set-top box purchases to meet the Tier 1 energy standards. Only 48% of the devices it purchased in 2014 met the Tier 1 levels. (The service provider did meet the procurement commitment in 2015, with more than 98% of its set-top box purchases meeting Tier 1 standards.) The service provider proposed a remedial plan to offset the extra energy use from the 2014 deployments and this plan was reviewed and unanimously approved (conditionally, subject to verification) by a three-member "Review Panel" of Steering Committee members that included an energy efficiency advocate. The plan consisted of two elements: a) in January 2015, the service provider successfully performed a software download to all of its deployed units of one of the two models that caused it not to meet the commitment, and independent field verification conducted under the auspices of the Agreement confirmed that the model now meets the Tier 1 standards; and b) the service provider committed that 100% of its 2016 purchases would meet the more rigorous Tier 2 standards, a year before those standards become applicable in 2017. In measuring the sufficiency of the proposed remedial plan, D+R determined that savings of 8 million kWh/year would be needed (in addition to the savings from the software download) to offset the 2014 devices that exceeded the energy usage permitted under the procurement commitment. The Review Panel required the service provider to submit quarterly reporting of purchases, additional field verification, and a final report in February 2017 to show that it met the plan's commitments and that the plan resulted in the required savings. D+R reviewed the provider's remedial report and determined that the required energy savings had been achieved.

A different service provider missed the 2015 procurement commitment, with 85% of its 2015 purchases meeting the Tier 1 standards, instead of the required 90%. D+R determined that savings of 570,000 kWh/year would be needed to offset the extra energy usage of the devices that exceeded the quantity permitted under the procurement commitment. The Review Panel unanimously approved (conditionally, subject to verification) a remedial plan that required the service provider to perform an energy-saving software download to all new deployments of the single model that caused it not to meet the commitment, as well as to a sufficient number of previously deployed devices to recoup the 570,000 kWh/year. The Review Panel required the service provider to submit additional field verification to validate the savings and to provide a final report to show that it met the plan's commitments and that the plan resulted in the required savings. D+R reviewed the provider's remedial reports and determined that several times the required energy savings had been achieved.

In both instances, the provider indicated that it missed the commitment due to an unexpected temporary delay in the readiness of new software that enabled more of its devices to qualify toward the commitment. The models that these two providers purchased in the year of their missed commitment that did not meet the Tier 1 standards, as deployed at the time, used an average of 10% more energy than afforded by the applicable Tier 1 allowances.

In 2016, all service providers met the Voluntary Agreement requirements by procuring at least 90% of set-top boxes that meet the Tier 1 commitments shown in Table 2. The overall share of units meeting the ENERGY STAR Version 3.0 (Tier 1) commitment declined from 99.5% in 2015 to 98.6% in 2016.[16]

16 - In 2013 and 2014, 85% and 95% respectively, of purchased units met the ENERGY STAR Version 3.0 (Tier 1) commitment.

Table 2: Voluntary Agreement Signatory Set-Top Box Procurement (2013 - 2016)

Category	Units		Percent Meeting ENERGY STAR Version 3.0 Levels (Tier 1)
	Total Procured	Number Meeting ENERGY STAR Version 3.0 Levels (Tier 1)	
DVR	12,209,976	8,690,001	71%
	12,710,777	11,267,511	89%
	11,671,180	11,513,700	99%
	11,219,933	10,774,353	95%
Non-DVR	12,360,006	10,857,191	88%
	18,646,064	17,777,790	95%
	10,977,499	10,950,399	100%
	11,535,694	11,535,694	100%
Thin Client	8,994,794	8,994,794	100%
	9,738,163	9,738,163	100%
	8,474,667	8,474,667	100%
	11,010,506	11,010,506	100%
DTA	1,334,238	1,217,148	91%
	5,201,332	5,201,332	100%
	9,169,913	9,169,913	100%
	4,831,980	4,821,393	99.97%
U.S. Totals	34,899,246	29,759,134[a]	85%
	46,296,336	43,984,796	95%
	40,293,259	40,108,679	99.5%
	38,598,113	38,141,946	98.6%

2013
2014
2015
2016

[a] In 2013, 232 Multi-Service Gateway devices were reported. These have been included in the total procured number. There were no Multi-Service Gateway devices procured in 2014,2015, nor 2016. None of the 232 devices procured in 2013 met the Tier 1 levels.

Service providers committed to meet Tier 2 levels in 90% of set-top boxes procured after December 31, 2016. Although Tier 2 procurement commitments did not take effect until 2017, participants were encouraged to accelerate adoption. Based on the data provided by service providers, an estimated 62.3% of set-top boxes purchased in 2016 meet Tier 2 performance levels, a slight decrease from 67.6% in 2015.[17] The service providers had projected that a decrease could occur as they have added new features to meet consumer demand, but remain committed to achieving a 90% procurement rate in 2017.[18]

17 - Products indicating Tier 2 performance may have been tested using Tier 1 (ENERGY STAR Version 3.0) test procedures. The Voluntary Agreement does not require the use of Tier 2 test procedures until 2017.
18 - 2014 Annual Report, http://www.energy-efficiency.us/library/pdf/SetTopBox-AnnualReport-2014.pdf at page 10.

PROGRESS ON OTHER ENERGY EFFICIENCY COMMITMENTS

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

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 has occurred for a period of time, APD enables the device to transition to an off or sleep mode. The two satellite signatories – DISH and DIRECTV – committed that, effective January 1, 2013, at least 90% of new set-top boxes purchased will include an APD feature with a default value of four hours or less. In 2016, DISH and DIRECTV reported that 100% of the set-top boxes purchased met this requirement. All of these devices are shipped to default to activate APD after four hours of inactivity and the service providers' installers are instructed not to modify this setting. The Typical Energy Consumption of these devices are lower as a result of the increased time that they are in standby power level instead of the on-power level. Customers may deactivate or modify APD settings if they wish; for example DISH customers can change the APD timeout between 1 to 8 hours.

Whole-Home Systems

Whole-home set-top boxes use home network interfaces (HNI) to share content with other video client devices over a high-bandwidth home network. HNIs enable consumers to receive the following functions while consuming much less energy than 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

With the installation of whole-home systems, the second, third, and any additional TVs use a non-DVR set-top box or thin client, both of which use considerably less energy than a DVR.

The satellite signatories committed to making energy efficient whole-home servers and clients available to all current and new subscribers in 2013, and each met its commitment. Since 2013, DIRECTV and DISH have offered nationwide availability of the DIRECTV "Genie" (www.DIRECTV.com/genie) and DISH "Hopper" and "Joey" (http://www.dish.com/hopper) whole-home DVR servers and clients, and these energy-saving devices have been widely adopted by consumers. DIRECTV's newest HR54 whole-home solution reduces energy consumption by more than one-third relative to the ENERGY STAR certified HR44 predecessor model. DIRECTV estimates that its current whole-home architecture uses 80% less energy to provide high-definition recording functionality to a three-TV home than three of its HD DVRs used ten years ago. DISH's newest whole-home gateway, the Hopper 3, has sixteen tuners so that homes requiring more tuners no longer need multiple whole-home DVRs.

AT&T's telco unit and CenturyLink made similar commitments to deploy energy efficient whole-home DVRs. During 2014, 2015, and 2016, they provided whole-home DVR capability for all of their DVR subscriber households. 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, in April 2014, the company launched 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, some cable operators have also deployed whole-home solutions. For example, approximately 4.25 million Comcast customers have both an X1 DVR and additional Comcast non-DVR set-top boxes, which enables them to use the X1 whole-home capabilities to perform recording and playback functions from their non-DVRs rather than needing additional DVRs. This is an increase of half a million customers from 2015. A majority of Cox's new installations in 2016 using its New Contour platform include whole-home capabilities. Cablevision has altogether eliminated DVR hard disk drives for new installations through the use of cloud DVR services available to all of its set-top boxes within the home.

Consumer-Facing 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 websites. However, in 2017, 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. 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 readily available to consumers.

Next-Generation Set-Top Boxes

The cable operator signatories committed to commence field tests by December 31, 2014 of set-top boxes that include next generation power management allowing parts of the device to operate in a reduced power consumption mode while still functioning with cable system architectures and meeting consumer expectations for quick start-up time and other required functions. The Voluntary Agreement further provides that "if a next generation set-top box has been field tested and it successfully performs on a cable operator's network, the embedded next generation system-on-a-chip supports all of a cable operator's services, and utilization of that next generation set-top box is economically feasible, then the cable operator will begin deployment of that next generation set-top box in its ordinary set-top box replacement cycle." The Voluntary Agreement further states that the parties "anticipate deployment of such successfully tested Next Generation Set-Top Boxes during 2016," but this date was not a commitment and is contingent upon the prerequisites above.

Initial field trials revealed operational challenges that required modifications before these power scaling features could be released to the larger customer base. For example, in some instances, important maintenance and software updates could not be timely delivered to devices in reduced-power sleep modes, resulting in the need to develop the capability for cable operators to remotely wake devices from sleep. Based on previous experience, if the time required to wake devices from deeper sleep modes is too long, dissatisfied customers will seek to disable sleep modes altogether. Customer education is important, particularly when automatic power down is programmed to occur by default. The cable operators and manufacturers have learned valuable lessons from a series of field trials, which remain ongoing.

In 2016, Comcast made a new deeper-sleep option available to customers using its Xi3 client, of which approximately 1.75 million have now been deployed. In this deep sleep mode, the client draws less than 3 watts. Comcast is engaged in additional trials and development to expand this feature to its XiD and Xi5 clients, but not to DVRs at this time.[19] At this time, deep sleep is only activated if the customer opts-in to this additional option, and Comcast reports that customer

19 - In Comcast's multiroom DVR architecture, the clients cannot access video services if the DVR is not active and Comcast's clients do not have the ability to wake the DVR. Therefore, if the DVR went into deep sleep and the customer tried to use a client, they could not access services until they moved to another room to wake the DVR and then return to the room with the client.

usage remains low, principally due to the time required to wake the client from deep sleep. Comcast is continuing to work to improve the user experience to make deep sleep more attractive to customers, and in the meantime it has sought to increase energy savings by having newly deployed devices default to entering into a reduced power lighter sleep mode automatically after a period of inactivity.

In early 2017, Charter initiated deployment of its next-generation Worldbox DVR and non-DVR set-top boxes that include new energy-saving power-scaling capabilities. The deeper-sleep capabilities of these devices are under study and Charter hopes to activate these features for customers after the completion of the trial. In this trial, Charter's new devices have been tested as drawing as much as approximately 30- 40% less power in the deeper sleep mode compared to on mode. Charter is trialing a fast wake time to make utilization of the feature more attractive to customers, rather than an even deeper sleep state that would have a lower power draw but might be used less frequently by customers.

Cox's New Contour platform utilizes the same family of client devices as Comcast's X1 architecture and plans to support deep sleep on its XiD clients once Comcast activates that functionality.

Other Energy-Saving Strategies

In addition to the above commitments, signatories will evaluate other ways to save energy. For example, several service providers are offering cloud-based recording capability that enables customers to enjoy DVR capability without energy-consuming spinning hard disks in the home. Verizon has implemented a dormant/off mode for selected components when not in use within its whole-home FiOS Quantum system, and it continues to work on developing further reductions in energy consumption for its customer equipment.

While many set-top boxes are now programmed to move into a lower-powered sleep state after a period of inactivity or during certain hours, there are also other approaches to save energy based on when a set-top box does not require full power In 2016, Comcast launched an "HDMI Link" feature that puts certain client devices into the selected power-saver state immediately when the TV is turned off, rather than waiting for a specified period of inactivity. The clients still draw power in sleep mode, as reported in Appendix A, but at a reduced rate. Comcast is exploring other power synchronization options that could further reduce the amount of time set-top boxes are in full-power mode, to gain additional energy savings during periods of inactivity.

Charter initiated a new program in 2016 to upgrade thousands of existing DVR set-top boxes when they are returned to inventory with its new Spectrum guide, which saves energy by enabling auto-power-down (APD) that spins down hard drives and shuts off output ports after a period of inactivity. Although only a few months into this campaign, Charter estimates that the upgrades have already secured savings in excess of 2 million kWh per year for the remaining life of these devices.

VIEWING WITHOUT SET-TOP BOXES

The signatories are continuing to enable their customers to watch video programming without the use of operator-supplied set-top boxes. In 2016, for the first time ever, streaming video subs and usage equaled pay TV. According to a new study, The Changing Landscape for Video and Content, the number of free or paid streaming video subscribers in the U.S. (68%) has caught up to the number of pay TV subscribers (67%), and the time spent watching video content on all other consumer technology devices, including laptops, tablets and smartphones (49%) is now equal to - within the sampling margin of error - time consumers spend watching video content on TVs (51%).[20]

20 - Consumer Technology Association (CTA), Content Consumption Milestone: Number of Streaming Video Viewers Now Equal to Paid TV Subscribers, Says CTA (Mar. 7, 2017), https://cta.tech/News/Press-Releases/2017/March/Content-Consumption-Milestone-Number-of-Streaming.aspx.

These trends have been facilitated through the signatory service providers' support. Consumers have downloaded millions of apps offered by all of the signatory service providers, for viewing their programming on tablets, smartphones, game consoles, PCs, SmartTVs and other devices as described in our prior year report, all without the use of a set-top box. More than 20% of cable subscribers utilize "TV Everywhere" apps.[21] Comcast and Charter customers can now access their cable service through an app accessible from a low-powered Roku streaming device. DISH's SlingTV service and the DIRECTV Now service offer access to streamed programming through SmartTVs and low-powered streaming devices.

These options enable consumers to access video without a set-top box, instead using only their broadband Internet access equipment and in some cases an additional low-powered streaming device. D+R does not have data on the number of customers that have replaced set-top boxes as a result of their use of apps and streaming services, relative to the number that still have as many set-top boxes. However, over time it is reasonable to expect that more and more consumers will take fewer set-top boxes than they otherwise would have if these alternatives were not available. The trend to replace set-top boxes may accelerate as streaming alternatives become more robust.

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 two base case scenarios. These base cases are published in the Voluntary Agreement. The first base case, shown in Table 3, represents the market in 2012.

Table 3: Base Case – 2012 Estimated Energy Consumption

Segment	Category	UEC[a]	Units	TEC[b]	Power Plants
		kWh/yr	Millions	TWh/yr	Rosenfelds
Cable	DVR	282	27	7.5	2.5
	Non-DVR[c]	139	57	7.9	2.6
	Thin Client[d]	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**

[a] While the base case refers to the annual consumption of a single device as the Unit Energy Consumption (UEC), the ENERGY STAR Version 3.0 specification uses the term typical energy consumption (TEC) when referring to annual consumption of a single device. To remain consistent with the ENERGY STAR specifications, this report refers to the annual consumption of a single device as TEC.

[b] While the base case refers to the aggregate annual consumption of deployed devices as TEC, the ENERGY STAR Version 3.0 specification uses TEC when referring to annual consumption of a single device. To prevent confusion, this report refers to the aggregate annual consumption of deployed devices as national energy consumption.

[c] The originally published base case uses the term "receiver," however, "non-DVR" is more accurate.

[d] Thin clients were only available from cable service providers at the time the 2012 Base Case was being developed, but 2013 to 2016 procurement reports included thin clients from non-cable service providers as well.

21 - Adobe, Adobe Digital Insights 2017: The State of Digital Video (Apr. 18, 2017) at 14, https://www.slideshare.net/adobe/adi-state-of-digital-video/1.

To gauge the Voluntary Agreement's impact on energy consumption at the national level, D+R estimated energy savings over the first base case. To do this, D+R used changes in video subscriber levels across the major segments (Table 4) to estimate changes in set-top box stock levels.

Table 4: Change in Subscribers from 2012 to 2016

Segment	Percent Change[a]			
	2012 to 2013	2013 to 2014	2014 to 2015	2015 to 2016
Cable	-4.5%	-0.3%	-0.5%	-2%
Satellite	1.0%	0.1%	-1.9%	3%
Telco	25.4%	8.2%	-0.9%	-21%

[a] Based on data provided by the Steering Committee (for 2012) and service providers (for 2013-2016)

By multiplying the unit data presented in Table 3 by these percentages, D+R arrived at the total 2016 stock levels shown in Table 5. The 2013, 2014, and 2015 unit estimates are included as reference points.

Table 5: Estimates of Total Units in the Market in 2013- 2016

Category	2013 Units[a]	2014 Units[a]	2015 Units[a]	2016 Units[a]
DVR	54,038,000	54,599,000	53,889,000	53,121,000
Non-DVR	130,343,000	122,650,000	112,668,000	103,341,000
Thin Client	10,561,000	20,299,000	28,773,000	39,784,000
DTA	31,632,000	31,543,000	31,395,000	30,866,000
U.S. Totals	**226,574,000**	**229,091,000**	**226,725,000**	**227,112,000**

[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.

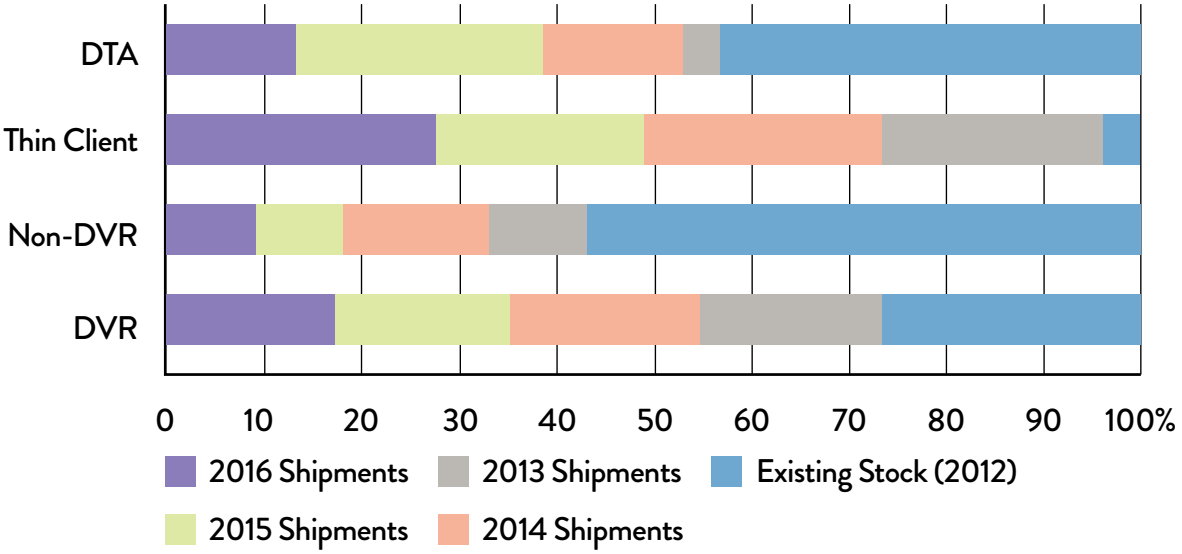
Under the terms of the Voluntary Agreement, D+R does not collect a census of deployed legacy equipment. The signatories purchased 1.6 million fewer set-top boxes in 2016 than in 2015. The model described below assumes that newly purchased devices replaced existing devices. This assumption reflects a relatively stable number of pay-TV subscribers, retirement of older (less energy efficient) and broken equipment, replacement of older devices to satisfy consumer demand for new devices in a competitive marketplace, and loss of small units like DTAs, which are often not returned when consumers cancel service.[22] The estimate produced by this model serves as a sound basis for reporting overall gains in national energy efficiency, and the signatories will continue to evaluate options for estimating overall stock for future annual reports.

22 - The increase in the number of DTAs purchased in 2015 compared to 2013 and 2014 likely reflects a shift by some operators from non-DVRs to DTAs and loss and breakage of DTAs.

The next step in estimating national energy consumption was to account for products procured in 2016. To arrive at the existing and new stock split, D+R subtracted 2016 set-top box procurements from the total units listed in Table 6. In general, D+R assumed that each new product replaced a product of the same type (i.e., a new DVR replaced an existing DVR). However, satellite thin clients and telco thin clients were not included in the base case scenarios. Thin clients and DTAs do not offer DVR capabilities, so D+R assumed that these product types replaced non-DVRs. These assumptions do not account for households upgrading from a non-DVR to a DVR. D+R also made no assumptions in this calculation about whole-home DVRs eliminating customer demand for additional DVRs. This methodology yielded 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.

Figure 2 presents the breakdown of new and pre-existing stock for each set-top box category.

Figure 2: Pre-existing Stock Versus New Procurements, 2013-2016 (Percent of Units)



Multiplying the number of units by the TEC produces the estimated national energy consumption shown in Table 6.

Table 6: National Energy Consumption for New and Pre-existing Stock

Category	2012 Units				2012 TEC	New Stock (Units)	Weighted TEC Average Based on Procurement Data (kWh/yr)	National Energy Consumption (TWh/yr)
	Existing Stock in 2013	Existing Stock in 2014	Existing Stock in 2015	Existing Stock in 2016				
DVR	41,828,000	29,678,000	17,297,000	5,223,000	267	12,210,208	195.4	13.5
						12,710,777	179.4	12.6
						11,671,180	170.6	11.3
						11,219,933	161.2	9.9
Non-DVR	117,866,000	91,644,000	70,684,000	49,822,000	119	12,360,006	108.6	15.3
						18,646,064	103.3	14.2
						10,977,499	92.4	12.7
						11,535,694	85.6	11.2
Thin Client	1,566,000	1,566,000	1,566,000	1,566,000	90	8,994,794	51.4	0.6
						9,738,163	50.0	1.1
						8,474,667	49.1	1.5
						11,010,506	46.9	2.0
DTA	30,299,000	25,007,000	15,690,000	10,328,000	39	1,334,238	57.6	1.3
						5,201,332	49.3	1.3
						9,169,913	46.5	1.4
						4,831,980	49.9	1.4
U.S. Totals	**191,559,000**	**147,895,000**	**105,237,000**	**66,939,000**	–	**34,899,478**[a]	-	**30.6**
						46,296,336	-	**29.2**
						40,293,259	-	**26.9**
						38,598,113	-	**24.5**

[a] In 2013, 232 Multi-Service Gateway devices were reported. These have been included in the total procured number. There were no Multi-Service Gateway devices procured in 2014,2015, nor 2016. None of the 232 devices procured in 2013 met the Tier 1 levels. The average energy consumption of those products was 219 kWh/year.

2013 **2014** **2015** **2016**

As Table 6 shows, the improvements in energy efficiency spurred by the Voluntary Agreement have had an increasingly large impact on national energy consumption. The Voluntary Agreement reduced national set-top box energy consumption from 32 TWh/year in 2012, to 30.6 TWh/year in 2013, to 29.2 TWh/year in 2014, to 26.9 TWh/year in 2015, and to 24.5 TWh/year in 2016, which is a reduction of 23.4%. This 7.5 TWh reduction represents consumer savings of approximately $941 million[23] and CO2 emission savings of 5.2 million metric tons in 2016 alone.[24] During the four years of the Voluntary Agreement, cumulative energy consumption has been reduced by an estimated 16.8 TWh, saving consumers approximately $2.1 billion and avoiding 11.8 million metric tons of CO2 emissions.[25] The energy saved during the four years is the equivalent to the energy used by all of the homes in both Washington, DC, and Chicago combined, for one year.[26]

The Voluntary Agreement also requires a comparison to a second base case that assumes a market without the Voluntary Agreement and with unabated DVR proliferation. Using this methodology, national set-top box energy usage in 2016 would have been 38 TWh, with the estimated number of DVRs at 149 million (out of 237 million set-top boxes), up from 54 million DVRs (out of 225 million set-top boxes) in 2012.[27] The actual national energy consumption calculated for 2016, based on the 2016 procurement data is 24.5 TWh/year. This means that the signatories to the Voluntary Agreement will have avoided 13.5 TWh in national energy consumption in 2017 that would have occurred with unabated DVR proliferation, saving consumers approximately $1.7 billion[28] and avoiding 9.4 million metric tons of CO2 emissions.[29] The four-year estimated savings using this methodology is 31.8 TWh, which saved consumers approximately $4.0 billion and prevented 22.3 million metric tons of CO2 emissions.[30] This second base case comparison by its nature is not offered as a precise estimate of savings, but illustrates the significance of averting a scenario that the Voluntary Agreement was developed to prevent.

CONCLUSION

In 2016, 98.6% of set-top boxes purchased by the signatories met the energy-efficiency standards of the Voluntary Agreement. Nearly two-thirds of these devices met the more rigorous Tier 2 performance levels that will become applicable in 2017.

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 progress toward the implementation of next-generation set top boxes. 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. The signatories also are working toward additional savings by field testing set-top boxes that include next-generation power management.

The Voluntary Agreement reduced national energy consumption of set-top boxes from 32 TWh/year in 2013 to 24.5 TWh/year in 2016, a reduction of 23.4%, even as the functionality of set-top boxes increased. Compared to earlier projections of unabated proliferation of digital video recorders (DVRs) in the absence of the Voluntary Agreement, savings were nearly twice that amount.

23 - See supra note 6.
24 - See supra note 7.
25 - See D+R International, 2013 Annual Report, Voluntary Agreement for the Energy Efficiency of Set-Top Boxes (2013 Annual Report) at 14 (estimating 1.4 TWh reduction in energy usage).
26 - 16.8 TWh is equivalent to the annual energy usage of 1,246,741 households and the annual electricity usage of 1,743,449 households. See https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.
27 - This base case provides two national energy consumption data points: 32 TWh/year for 2013 and 47 TWh/year for 2023. Because the second base case is based on linear growth trends for DVR units and energy consumption, D+R calculated the annual incremental increase in national energy consumption by dividing the change in national energy consumption (47 TWh/year – 32 TWh/year = 15 TWh/year) by the number of years elapsed (2023 – 2013 =10 years), yielding an increase of 1.5 TWh/year. D+R calculated the national energy consumption for 2017 under the second base by adding the incremental energy consumption increase (1.5 TWh/year) to the 2016 baseline national energy consumption (36.5 TWh/year).
28 - See supra note 6.
29 - See supra note 7.
30 - See D+R International, 2015 Annual Report, Voluntary Agreement for the Energy Efficiency of Set-Top Boxes (2015 Annual Report) at 5 (estimating 5.1 TWh reduction in energy usage in 2015, 2.8 in 2014, and1.4 TWh reduction in 2013).

APPENDIX A: VOLUNTARY AGREEMENT COMMITMENTS

Table 7 lists the commitments of the signatories to the Voluntary Agreement along with the status of the signatories' progress toward these commitments.

Table 7: Voluntary Agreement Commitments

Commitments	Group	Status
90% procurement of set-top boxes meeting Tier 1 (ENERGY STAR Version 3.0) after December 31, 2013 (for calendar years 2014, 2015, and 2016).	All Service Providers	97.6% procurement after December 31, 2013.
Prepare a confidential annual procurement report for the prior year by April 1 of the following year beginning in 2014.	All Service Providers	100% filed on time with Independent Administrator in 2016.
Provide energy efficiency information to subscribers and potential subscribers no later than January 1, 2014.	All Service Providers	Complete. Energy efficiency information provided by all service providers is available from the website www.energy-efficiency.us.
Enable light sleep capabilities in certain new models deployed after January 1, 2013, with a default inactivity period of 4 hours where doing so does not degrade customer experience.	Telco (Verizon)	A 2013 regional trial of an APD to light-sleep mode resulted in significant customer dissatisfaction such that the mode was disabled; Verizon is still working on delivering set-top boxes with energy efficient modes that do not substantially degrade the customer experience.
Offer and deploy whole-home servers and clients as appropriate.	Telco (Verizon)	Complete. Verizon has offered its FiOS Quantum whole-home DVR since 2014
90% procurement of set-top boxes with automatic power down feature.	Satellite	Complete. 100% deployment in 2014-2016.
Make whole-home servers and clients available to all new and existing subscribers in 2013.	Satellite	Complete. Offered throughout the United States 2013-2016.
90% procurement of set-top boxes meeting Tier 2 after December 31, 2016 (for calendar year 2017).	All Service Providers	63% procurement rate of set-top boxes indicating performance at Tier 2 levels after December 31, 2013.
Review the energy use of set-top boxes that incorporate DOCSIS 3.0 8x4 mode and greater by October 2015 and to modify the Additional Functionality TEC Allowance as appropriate.	All Signatories	Completed June 2015. The Steering Committee continues to monitor developments in this area.
Work with suppliers to develop set-top boxes with next-generation power management, begin field testing of these set-top boxes by December 31, 2014, and begin deploying them in later years under conditions set forth in the Voluntary Agreement.	Cable	Comcast and Charter have deployed set-top boxes with next-generation power management capabilities. Additional testing and development is ongoing.
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.

Commitments	Group	Status
Pursue reasonable strategies to reduce energy consumption.	Telco (Verizon)	Ongoing. For example, Verizon deployments have transitioned to the FiOS Quantum platform, which has implemented new capabilities (e.g., a dormant/off mode for selected components) that reduce energy consumption without compromising the customer experience. Verizon continues to work on developing further reductions in energy consumption for its customer equipment.
Continue to deploy set-top boxes with light sleep capabilities.	Telco (IPTV)	Continued deployment in 2016.
Deploy whole-home DVR set-top boxes.	Telco (IPTV)	Deployed throughout the United States throughout 2014-2016.
Evaluate options for further reducing inactive-state energy consumption.	Telco (IPTV)	Ongoing
Provide periodic updates to government and energy-advocate stakeholders.	Telco (IPTV)	Updates were provided to federal and state regulators and to energy-efficiency advocate stakeholders. The Steering Committee published its annual report and established a website at www.energy-efficiency.us to disseminate information to the public.
Continue the deployment, which began in September 2012, of new set-top boxes with light sleep capabilities and software updates enabling light sleep to certain models of deployed DVRs.	Cable	Complete, as indicated in 2015 report. Millions of devices deployed prior to the Voluntary Agreement were upgraded to support light sleep. New deployments now generally include light sleep capability.

APPENDIX B: SET-TOP BOXES PURCHASED BY VOLUNTARY AGREEMENT SIGNATORIES IN 2016

Table 8 lists the reported total energy consumption (TEC) for each model of set-top box purchased by Voluntary Agreement signatories in 2016. These values are reported TEC, rather than calculated TEC (called "measured TEC" in the ENERGY STAR Version 3.0 specification). Under the ENERGY STAR Version 3.0 specification, 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. ENERGY STAR Version 3.0 (Tier 1) calculates maximum allowable TEC for a product using the base-type allowances outlined in Table 9 and the feature allowances outlined in Table 10. Table 10 also includes descriptions of the features abbreviated in Table 9 in the "Claimed Allowances" column. ENERGY STAR Version 3.0 has 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 Excel template used to collect product data used algorithms to calculate maximum allowable TEC according to the ENERGY STAR Version 3.0 rules and the service provider reported features before assessing whether a product met ENERGY STAR Version 3.0 (Tier 1). Service providers had the opportunity to review Table 8 to ensure that the data presented here is accurate. 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. Set-top boxes are subject to field verification of energy performance data. An asterisk indicates units that were evaluated through field verification in 2014, 2015, and/or 2016.

Table 8: Set-Top Boxes Procured by Voluntary Agreement Signatories in 2016

Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	Modal Characteristics (W)		TEC[a] (kWh/yr)	Meets ENERGY STAR Version 3.0 (Tier 1)
						On	Sleep		
AT&T	Satellite	Non-DVR	DIRECTV	H25-100*	APD, AVP, HD, HNI	10.32	8.42	78.61	YES
AT&T	Satellite	DVR	DIRECTV	HR44-200*	APD, AVP, DVR, HD, HNI, Wi-Fi-HNI, MR, MS CBL/Sat	19.29	18.03	161.16	YES
AT&T	Satellite	DVR	DIRECTV	HR44-500*	APD, AVP, DVR, HD, HNI, Wi-Fi-HNI MR, MS CBL/Sat	18.94	17.87	159.29	YES
AT&T	Satellite	DVR	DIRECTV	HR44-700*	APD, AVP, DVR, HD, HNI, Wi-Fi-HNI, MR, MS CBL/Sat	18.46	17.42	155.26	YES
AT&T	Thin Client / Remote	Thin Client	DIRECTV	C61-100	APD, AVP, HD, HNI	5.40	4.25	40.17	YES
AT&T	Thin Client / Remote	Thin Client	DIRECTV	C61-500	APD, AVP, HD, HNI	5.43	4.22	40.04	YES
AT&T	Thin Client / Remote	Thin Client	DIRECTV	C61-700*	APD, AVP, HD, HNI	5.28	4.10	38.93	YES
AT&T	Thin Client / Remote	Thin Client	DIRECTV	C41W-100*	APD, AVP, HD, HNI, Wi-Fi-HNI, MIMO-5	7.20	5.57	52.96	YES
AT&T	Thin Client / Remote	Thin Client	DIRECTV	C41W-500*	APD, AVP, HD, HNI, Wi-Fi-HNI, MIMO-5	7.17	5.73	53.87	YES
AT&T	Thin Client / Remote	Thin Client	DIRECTV	C51-100*	APD, AVP, HD, HNI	6.38	3.72	39.38	YES
AT&T	Thin Client / Remote	Thin Client	DIRECTV	C51-500*	APD, AVP, HD, HNI	5.64	3.64	37.00	YES
AT&T	Thin Client / Remote	Thin Client	DIRECTV	C51-700*	APD, AVP, HD, HNI	6.10	4.22	41.77	YES
AT&T	Thin Client / Remote	Thin Client	DIRECTV	C61K-700*	APD, AVP, HD, HNI	9.50	4.10	49.71	YES
AT&T	Satellite	DVR	DIRECTV	HR54-200*	APD, AVP, DVR, HD, HNI, MR, MS CBL/Sat	12.20	11.10	99.86	YES
AT&T	Satellite	DVR	DIRECTV	HR54-500*	APD, AVP, DVR, HD, HNI, MR, MS CBL/Sat	12.66	12.64	110.78	YES
AT&T	Satellite	DVR	DIRECTV	HR54-700*	APD, AVP, DVR, HD, HNI, MR, MS CBL/Sat	12.10	11.01	99.22	YES

Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	Modal Characteristics (W)		TEC[a] (kWh/yr)	Meets ENERGY STAR Version 3.0 (Tier 1)
						On	Sleep		
AT&T	Satellite	DVR	DIRECTV	H44-100*	APD, AVP, DVR, HD, HNI, MR, MS CBL/Sat	9.79	9.05	81.17	YES
AT&T	Satellite	DVR	DIRECTV	H44-500*	APD, AVP, DVR, HD, HNI, MR, MS CBL/Sat	10.37	9.37	84.64	YES
Cablevision Systems Corp. d/b/a Optimum	Cable	DVR	Samsung	SMT-5320	AVP, DOCSIS, HD	18.20	17.20	156.00	YES
CenturyLink	Internet Protocol (IP)	DVR	ARRIS	2262*	AVP, DVR, HD, HNI, MS Terr/IP	11.76	10.51	102.07	YES
CenturyLink	Internet Protocol (IP)	Non-DVR	ARRIS	2502*	AVP, HD, HNI, MS Terr/IP	11.75	11.68	104.72	YES
CenturyLink	Internet Protocol (IP)	DVR	PACE	8005*	AVP, DVR, HD, HNI, MS Terr/IP	11.28	8.18	89.98	YES
CenturyLink	Internet Protocol (IP)	DVR	PACE	8010*	AVP, DVR, HD, HNI, MS Terr/IP	10.99	8.03	88.09	YES
CenturyLink	Internet Protocol (IP)	Non-DVR	PACE	8000*	AVP, HD, HNI, MS Terr/IP	9.09	7.58	76.34	YES
Charter	Cable	DVR	Technicolor	9865HDC*	APD, AVP, CC, DVR, DOCSIS 3.0, HD, MR, MS CBL/Sat	26.44	25.97	230.00	YES
Charter	Cable	Non-DVR	Technicolor	4742HDC*	APD, AVP, CC, DOCSIS, HD, HNI	19.42	14.70	141.00	YES
Charter	Cable	DVR	Arris	DCX3600M*	APD, AVP, CC, DVR, DOCSIS 3.0, HD, MR, MS CBL/Sat	26.87	24.86	225.00	YES
Charter	Cable	DVR	Samsung	SMT-H4372*	APD, AVP, CC, DVR, DOCSIS 3.0, HD, MR, MS CBL/Sat	24.58	23.59	220.00	YES
Charter	Cable	Non-DVR	Technicolor	101-T	APD, AVP, DOCSIS 3.0, HD	12.79	12.30	115.00	YES
Charter	Cable	Non-DVR	Arris	DCX-3200MP3-ODN*	APD, AVP, CC, DOCSIS, HD, HNI	14.09	11.81	112.00	YES
Charter	Cable	Non-DVR	Arris	DCX-3200MP3-iGuide*	AVP, CC, DOCSIS, HD	12.58	12.43	112.00	YES
Charter	Cable	Non-DVR	Arris	DCX-3200MP3-Spectrum*	AVP, CC, DOCSIS, HD	12.78	12.44	112.00	YES

Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	Modal Characteristics (W)		TEC[a] (kWh/yr)	Meets ENERGY STAR Version 3.0 (Tier 1)
						On	Sleep		
Charter	Cable	Non-DVR	Samsung	SMT-H3362*	APD, AVP, CC, DOCSIS, HD, HNI	14.49	13.54	122.00	YES
Charter	Cable	Non-DVR	Technicolor	4742HDC2*	APD, AVP, CC, DOCSIS, HD, HNI	15.43	12.55	122.00	YES
Charter	Cable DTA	Cable DTA	Technicolor	DTA271*	HD	5.66	5.59	55.00	YES
Charter	Cable	DVR	Technicolor	8640HDC2*	APD, AVP, CC, DVR, DOCSIS, HD, MS CBL/Sat	20.33	16.84	160.00	YES
Charter	Cable	Non-DVR	Technicolor	4640HDC2*	APD, AVP, CC, DOCSIS, HD	12.88	8.53	90.00	YES
Charter	Cable	Non-DVR	Arris	DCX3220E-iGuide*	AVP, DOCSIS, HD	11.67	11.20	105.00	YES
Charter	Cable	Non-DVR	Arris	DCX3220E-Spectrum*	AVP, DOCSIS, HD	12.06	11.72	107.00	YES
Charter	Cable	DVR	Arris	DCX3520M-E I-Guide*	AVP, DVR, DOCSIS, HD, MS CBL/Sat	22.15	21.12	190.00	NO
Charter	Cable	DVR	Arris	DCX3520M-E-Spectrum*	APD, AVP, DVR, DOCSIS, HD, MS CBL/Sat	20.99	17.71	164.00	YES
Charter	Cable	DVR	Arris	DCX3510M-E-iGuide*	AVP, CC, DVR, DOCSIS, HD, MS CBL/Sat	22.20	20.37	190.00	YES
Charter	Cable	DVR	Arris	DCX3510M-E-Spectrum*	APD, AVP, CC, DVR, DOCSIS, HD, MS CBL/Sat	21.08	17.91	165.00	YES
Charter	Cable	DVR	Technicolor	201T	APD, AVP, DVR, DOCSIS 3.0, HD, MS CBL/Sat	16.18	13.14	130.00	YES
Charter	Cable	DVR	Humax	200H	APD, AVP, DVR, DOCSIS 3.0, HD, MS CBL/Sat	17.86	16.50	155.00	YES
Comcast	Cable DTA	Cable DTA	Pace	PXD01ANI DTA*	HD	6.20	6.05	55.00	YES
Comcast	Cable DTA	Cable DTA	Evolution	DMS2004UH-DW 000	HD	6.65	6.65	59.00	YES
Comcast	Internet Protocol (IP)	Non-DVR	Pace	PXD01ANI*	AVP, HD, HNI	5.99	5.09	54.00	YES

Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	Modal Characteristics (W)		TEC[a] (kWh/yr)	Meets ENERGY STAR Version 3.0 (Tier 1)
						On	Sleep		
Comcast	Internet Protocol (IP)	Non-DVR	Technicolor	CXD01ANI*	AVP, HD, HNI	6.35	4.76	54.00	YES
Comcast	Cable	Non-DVR	Samsung	SX022ANM*	AVP, CC, DOCSIS 3.0, HD, MR, MS CBL/Sat	15.17	13.91	130.00	YES
Comcast	Cable	Non-DVR	Samsung	SX022ANC	AVP, CC, DOCSIS 3.0, HD, MR, MS CBL/Sat	15.98	14.63	140.00	YES
Comcast	Cable	Non-DVR	Pace	PX022ANM*	AVP, CC, DOCSIS 3.0, HD, MR, MS CBL/Sat	14.78	13.84	135.00	YES
Comcast	Cable	Non-DVR	Pace	PX022ANC*	AVP, CC, DOCSIS 3.0, HD, MR, MS CBL/Sat	15.33	13.84	135.00	YES
Comcast	Cable	DVR	Arris	AX013ANM*	AVP, CC, DVR, DOCSIS 3.0, HD, MR, MS CBL/Sat	22.56	21.28	200.00	YES
Comcast	Cable	DVR	Arris	AX013ANC*	AVP, CC, DVR, DOCSIS 3.0, HD, MR, MS CBL/Sat	22.36	21.13	200.00	YES
Comcast	Cable	DVR	Pace	PX013ANM*	AVP, CC, DVR, DOCSIS 3.0, HD, MR, MS CBL/Sat	23.92	22.32	210.00	YES
Comcast	Cable	DVR	Pace	PX013ANC*	AVP, CC, DVR, DOCSIS 3.0, HD, MR, MS CBL/Sat	24.34	23.01	210.00	YES
Comcast	Internet Protocol (IP)	Non-DVR	Pace	PX051AEI	AVP, HD, HNI, Wi-Fi-HNI, MIMO-5	6.96	5.64	60.00	YES
Cox	Cable	Non-DVR	Technicolor	4642HDC*	APD, AVP, CC, DOCSIS, HD, HNI	17.20	12.60	131.00	YES
Cox	Cable	Non-DVR	Technicolor	4742HDC*	APD, AVP, CC, DOCSIS, HD, HNI	18.63	14.07	136.00	YES
Cox	Cable	DVR	Technicolor	8742HDC*	APD, AVP, CC, DVR, DOCSIS, HD, MR, MS CBL/Sat	22.64	18.74	175.00	YES
Cox	Cable	DVR	Technicolor	9865HDC*	APD, AVP, CC, DVR, DOCSIS 3.0, HD, MR, MS CBL/Sat	28.03	25.32	230.00	YES

Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	Modal Characteristics (W)		TEC[a] (kWh/yr)	Meets ENERGY STAR Version 3.0 (Tier 1)
						On	Sleep		
Cox	Cable	DVR	Arris	AX013ANM*	AVP, CC, DVR, DOCSIS 3.0, HD, MR, MS CBL/Sat	24.20	23.00	212.00	YES
Cox	Cable	DVR	Arris	AX013ANC*	AVP, CC, DVR, DOCSIS 3.0, HD, MR, MS CBL/Sat	24.70	23.50	217.00	YES
Cox	Cable	Non-DVR	Pace	PX022ANM*	AVP, CC, DOCSIS 3.0, HD, MR, MS CBL/Sat	15.20	13.80	130.00	YES
Cox	Cable	Non-DVR	Pace	PX022ANC*	AVP, CC, DOCSIS 3.0, HD, MR, MS CBL/Sat	15.70	14.30	137.00	YES
Cox	Internet Protocol (IP)	Non-DVR	Pace	PXD01ANI*	AVP, HD, HNI	5.90	5.10	54.00	YES
Cox	Cable DTA	Cable DTA	Technicolor	DTA250HD*	HD	4.90	4.90	45.00	YES
Cox	Cable DTA	Cable DTA	Evolution	"DMS2344UHDS* & DMS2444UHDS"	HD	6.83	6.83	60.00	YES
Cox	Cable	DVR	Technicolor	9865HDC-RDK*	AVP, CC, DVR, DOCSIS 3.0, HD, MR, MS CBL/Sat	25.26	19.77	206.00	YES
Cox	Cable	Non-DVR	Samsung	GX-CX800CK	AVP, CC, DOCSIS 3.0, HD, MR, MS CBL/Sat	15.41	14.07	135.00	YES
Cox	Cable	Non-DVR	Samsung	GX-CX801CK	AVP, CC, DOCSIS 3.0, HD, MR, MS CBL/Sat	15.46	14.50	136.00	YES
Cox	Internet Protocol (IP)	Non-DVR	Technicolor	CXD01ANI*	AVP, HD, HNI	5.78	4.51	54.00	YES
DISH	Thin Client / Remote	Thin Client	DISH	Joey (HWID = ZBxx)*	APD, AVP, HD, HNI	6.90	6.80	60.00	YES
DISH	Satellite	DVR	DISH	"Hopper with Sling (HWID = Nexx)*"	APD, AVP, DVR, HD, MR, MS CBL/Sat, XCD	22.00	21.50	190.00	YES
DISH	Thin Client / Remote	Thin Client	DISH	Wireless Joey*	APD, AVP, HD, HNI, MIMO-5	7.80	7.50	65.00	YES
DISH	Thin Client / Remote	Thin Client	DISH	4k Joey*	APD, AVP, HD, HNI, UHD	9.60	8.40	77.00	YES

Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	Modal Characteristics (W)		TEC[a] (kWh/yr)	Meets ENERGY STAR Version 3.0 (Tier 1)
						On	Sleep		
DISH	Satellite	DVR	DISH	Hopper 3*	APD, AVP, DVR, HD, MR, MS CBL/Sat, XCD, UHD, HEVP	23.27	22.11	197.00	YES
DISH	Satellite	Non-DVR	DISH	Wally*	APD, AVP, HD, HEVP	7.85	7.79	69.00	YES
Verizon	Cable	DVR	Arris	VMS 1100*	AVP, CC, DVR, HD, MR, MS-C/S, XCD	22.70	22.70	198.85	YES
Verizon	Internet Protocol (IP)	Thin Client	Arris	IPC 1100 P2*	AVP, HD, HNI	7.00	7.00	61.32	YES
Verizon	Cable	Cable DTA	Arris	DCT-700		9.00	9.00	78.84	NO

[a] These values are reported TEC, rather than calculated TEC (called "measured TEC" in the ENERGY STAR Version 3.0 specification). Under the ENERGY STAR Version 3.0 specification, service providers have the option to round up calculated TEC values for reporting purposes to account for production variances. These values are referred to as reported TEC. The reported TEC and modal power 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).

* Indicates models that have been verified through independent field verification in 2014, 2015 and/or 2016.

Table 9 presents the base allowances for set-top boxes under ENERGY STAR Version 3.0 (Tier 1).

Table 9: Set-Top Box Allowances

Base Type (Use topmost if multiple apply)	Tier 1 Allowance (kWh/yr)
DTA	35
Cable (CBL)	60
Satellite (SAT)	70
Internet Protocol (IP)	50
Thin Client (TC)	35

Table 10 sets forth the features listed for set-top boxes and outlines the feature allowances under ENERGY STAR Version 3.0 (Tier 1).

Table 10: Set-Top Box Feature Allowances

Feature	Description	ENERGY STAR Version 3.0 (Tier 1) TEC Allowance
AVP	Advanced video processing (AVP) enables set-top box to encode, decode, and/or transcode audio/video signals	12
CC	CableCARD™ gives set-top boxes the capacity to decrypt premium audio/video content and services as well as other network control functions	15
DVR	A digital video recorder (DVR) allows set-top boxes to store digital video files to a rewritable disk or other integrated storage device	45
DOCSIS	Data Over Cable Service Interface Specifications (DOCSIS) enable set-top boxes to distribute data and audio/video content over cable infrastructure	20
HD	High definition (HD) makes set-top boxes capable of transmitting video signals with resolution greater than or equal to 720p	25
HNI	Home network interfaces (HNIs) allow set-top boxes to interface with external devices via a high-bandwidth local area network	10
MR	Multi-room (MR) functionality enables set-top boxes to provide independent audio/video content to multiple devices within a single household	40
MS-C/S	Multi-stream (MS) for cable and satellite (C/S) is the capability to deliver multiple simultaneous audio/video streams to a single display, thin-client/remote set-top box, or recording device over coax or via satellite	16
MS-T/I	Multi-stream (MS) for terrestrial and Internet protocol (T/I) delivers multiple simultaneous audio/video streams through a LAN or Internet protocol home network	8
RMP	Removable media player (RMP) gives a set-top box the ability to decode digitized audio/video signals on DVD or Blu-ray discs	8
RMR	Removable media player/recorder (RMR) gives a set-top box the ability to decode and record digitized audio/video signals on DVD or Blu-ray discs	10
Tier 2 Allowances that are included as Tier 1 New Feature Allowances		
DOCSIS 3.0	Data Over Cable Service Interface Specifications (DOCSIS) enable set-top boxes to distribute data and audio/video content over cable infrastructure (protocol version 3.0 up to an 8x4 configuration)	50
XCD	Enables STB to change format of video content for playback on additional devices.	13

Feature	Description	ENERGY STAR Version 3.0 (Tier 1) TEC Allowance
Wi-Fi-HNI	Home Network Interface (HNI) using Wi-Fi technology to distribute or receive video. MIMO allowances are taken in addition to this allowance.	15
MIMO-5	Multi-Input Multi-Output (MIMO) Wireless HNI that supports more than one spatial stream at 5 GHz to send and receive information.	4 (per spatial stream)
UHD-4[c]	Ultra High Definition (UHD)	5
HEVP[c]	High Efficiency Video Coding (HEVC)	10
Other Allowances		
DCA[a]	Downloadable Conditional Access (DCA)	15
nDVR[b]	Networked DVR	85

[a] The Steering Committee approved a Tier 1 subtraction approach of 15 kWh/yr for a device with conditional access on June 19, 2014.

[b] The Steering Committee approved a Tier 1 subtraction approach for networked DVR, resulting in multi-room DVR functionality, of 85 kWh/yr (DVR: 45 and Multi-Room: 40) on June 19, 2014.

[c] Proposed new feature allowance by service provider in 2015, approved by the Steering Committee in December, 2016.

APPENDIX C: CONSUMER 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.

Service Provider	Consumer Information Location
AT&T	https://www.att.com/shop/u-verse/modals/uf/ATT-IP-Set-Top-Box-STB-Energy-Information.html
Cablevision Systems Corp. d/b/a Optimum	http://optimum.custhelp.com/app/answers/detail/a_id/2809/~/cable-equipment-energy-consumption
CenturyLink	https://promotions.centurylink.com/prism/existing/#STB_energy
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
DirecTV	http://cdns.directv.com/cms3/about/sustainability/DIRECTV_products_Energy_Star.pdf
DISH Network	https://www.mydish.com/support/energy-efficiency
Spectrum (Charter Communications, Time Warner Cable, and Bright House Networks)	http://www.spectrum.net/support/tv/digital-receiver-energy-use/?domain-redirect=true
Verizon	https://www.verizon.com/Support/Residential/Tv/FiosTv/Receivers/User+Guides/User+Guides.htm#energy

D+R International

2016 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 for Ongoing Improvement to the Energy Efficiency of Set-Top Boxes include 11 cable, satellite, and telco service providers, 4 major set-top box manufacturers, energy-efficiency advocates, and other organizations.

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 International conducted an audit of the 2016 procurement data, which was used to develop the findings published in the 2016 Annual Report (released August 2, 2017). D+R randomly selected the service provider by creating an Excel spreadsheet and using the "random" function. (The Voluntary Agreement stipulates that the service provider audited in 2017 be eliminated from consideration for next year's random audit.)

D+R requested raw data from the selected service provider to verify the procurement data submitted. Over the course of two months, D+R worked with the service provider to collect additional information and reviewed the submitted data, which included invoice data, test reports, and specification sheets.

D+R, as the Independent Administrator, 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 2, 2017

D+R International

phone: 301.588.9387 web: www.drintl.com
1100 Wayne Ave. · Suite 700 · Silver Spring · MD · 20910