D+R
International

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2020 Annual Report

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

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EXECUTIVE SUMMARY

In 2012, the pay television industry, led by NCTA - The Internet & Television Association, the Consumer Technology Association, and CableLabs, signed the Voluntary Agreement for Ongoing Improvement to the Energy Efficiency of Set-Top Boxes with the goal of increasing the energy efficiency of set-top boxes while protecting rapid innovation and timely introduction of new features. Signatories include major manufacturers of set-top boxes and the largest cable, satellite, and telco service providers, serving 74.1 million U.S. video subscribers and accounting for 95% of the traditional pay-TV market in 2020. In 2013, leading Energy Advocates joined with the pay television industry in an expanded version of the Voluntary Agreement. One of the requirements of the Voluntary Agreement is the publication of an annual report by D+R International (D+R), acting as Independent Administrator and Independent Auditor of the Agreement. This eighth annual report provides a summary of developments for the previous calendar year, 2020. Annual reports for the previous seven years as well as this report can be found at www.energy-efficiency.us.

This report is the first to review the signatories' implementation of new, more rigorous "Tier 3" efficiency levels that became effective January 1, 2020. At the time of their adoption, the signatories estimated that the Tier 3 levels are 20% more efficient, on average, than previous Tier 2 levels. In 2020, 96.9% of service providers' set-top box purchases met these new Tier 3 levels.1 All but one of the service providers met the 90% commitment individually, and in accordance with the terms of the Voluntary Agreement, that signatory is currently developing a remediation plan that will make up for the lost energy savings that will be overseen by the Independent Administrator and a subcommittee that includes the Energy Advocates.

With the successful initial implementation of Tier 3, national set-top box annual energy consumption has now been reduced by more than half under the Voluntary Agreement, declining by 52% from 32 TWh in 2012 to 15.2 TWh in 2020, even as functionality and features of set-top boxes have increased. While declines in the number of pay-TV subscribers is a contributing factor to the energy savings, even on a per subscriber basis, the average weighted power of annual new set-top box purchases has fallen by nearly half since 2013, from more than 120 kWh/year to less than 64 kWh/year.

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1 - As set forth below, this calculation is based on 2020 procurement data submitted to D+R by service providers and corroborated by the results of independent verification testing from previous years and by the procurement audit conducted by D+R.

Figure ES-1: Annual Energy Used by Set-Top Boxes
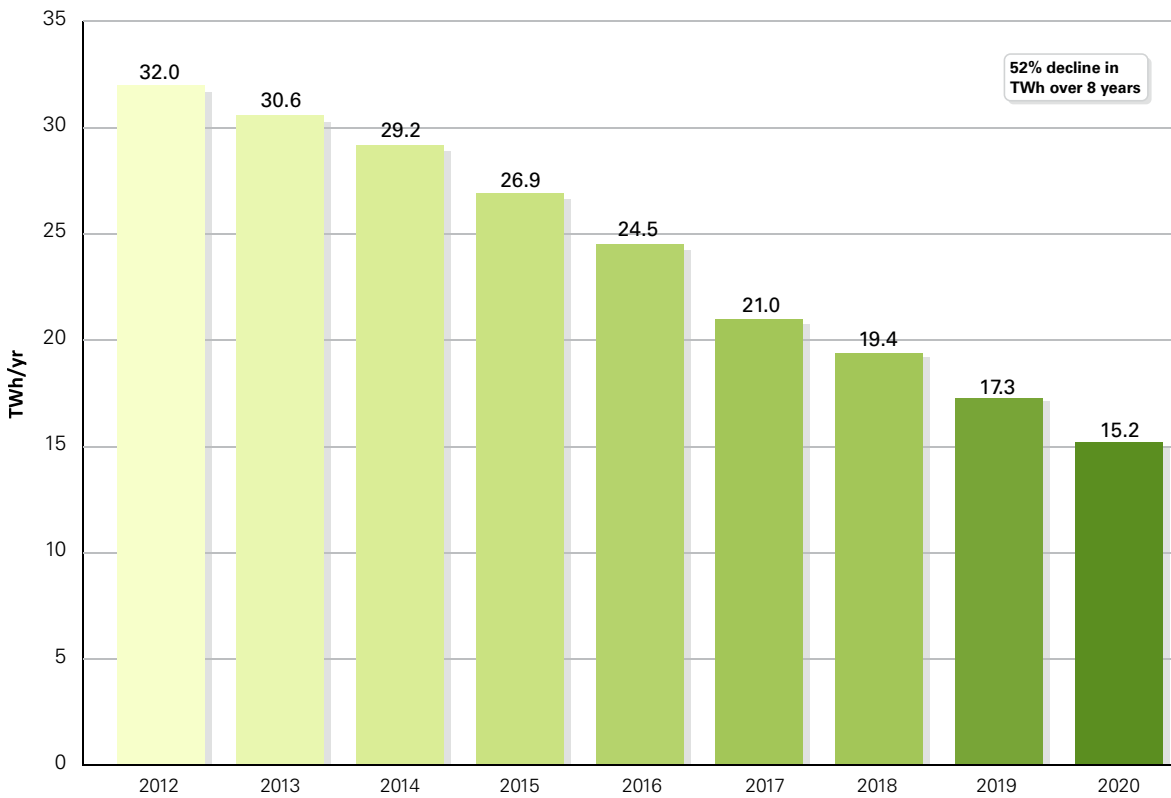
This 16.8 TWh reduction is nearly equivalent to the power generated by five and a half typical 500-megawatt coal-run power plants in a year.[2] In 2020 alone, consumers saved more than $2.2 billion[3] on their utility bills and nearly 11.9 million metric tons of CO_2 emissions from power plants were avoided.[4] The following table and figure present the cumulative effect of these year-over-year declines during the eight years of the Voluntary Agreement, during which time energy consumption has been reduced by an estimated 71.9 TWh, saving consumers approximately $9.3 billion and avoiding nearly 50.9 million metric tons of CO_2 emissions. The energy saved during this eight-year period is enough to power all homes in the entire state of California with electricity for more than nine months.[5]

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

3 - This calculation is based on national average energy cost of 13.20 cents per kWh. See U.S. Energy Information Administration, *Electric Power Monthly*, https://www.eia.gov/outlooks/steo/report/electricity.cfm.

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

5 - EIA State Energy Data System (SEDS): 2019 (updates by energy source), Table F20, Electricity Consumption Estimates, 2019, Residential (December 18, 2020) (estimating California's annual residential electricity consumption at 87.5 TWh), https://www.eia.gov/state/seds/sep_fuel/html/pdf/fuel_use_es.pdf.

Table ES-1: Voluntary Agreement Energy Savings 2013-2020

	2013	2014	2015	2016	2017	2018	2019	2020	Lifetime of VA
National Energy Consumed (TWh/yr) Total	30.6	29.2	26.9	24.5	21.0	19.4	17.3	15.2	184.1
National Energy Saved (TWh/yr)	1.4	2.8	5.1	7.5	11.0	12.6	14.7	16.8	71.9
500 MW Power Plant Equivalents Saved (Rosenfelds)[a]	0.5	0.9	1.7	2.5	3.7	4.2	4.9	5.6	N/A
Electricity Costs Saved (Million$/yr)	$169.8	$350.6	$645.2	$941.3	$1,417.9	$1,621.6	$1,916.9	$2,218.9	$9,282.1
CO_2 Avoided (MMT)	1.0	2.0	3.6	5.3	7.8	8.9	10.4	11.9	50.9

[a]The electricity generated by a typical 500 MW power is measured in Rosenfelds, which represents annual electricity output. At the 2012 peak, set-top boxes used 10.7 Rosenfelds annually, and that figure declined to 5.1 Rosenfelds in 2020.

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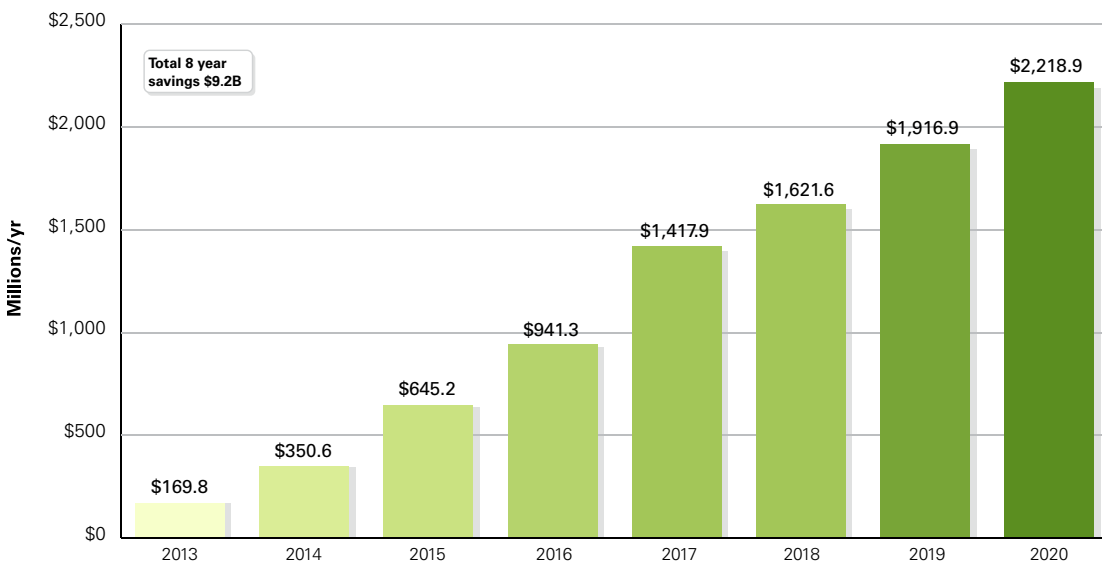
These savings are driven primarily by the service providers' commitment to procure energy-efficient set-top boxes. Under the Voluntary Agreement, 90% of new set-top boxes procured within a calendar year by service providers must meet the applicable efficiency levels. Tier 1 procurement requirements applied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

- Purchases of DVRs, the most energy-intensive category of set-top boxes, have plummeted from 12.7 million in 2014 to only 1.7 million in 2020 as service providers have shifted from deploying a DVR for each television, to whole-home DVR services that use one DVR per home or to cloud DVR services that do not use DVR set-top boxes at all.

- Service providers have typically exceeded the 90% commitment in most years of the Voluntary Agreement, and in 2020, 96.9% of service providers' set-top box purchases met the Tier 3 levels.

- As a result of subscriber losses and consumer adoption of apps that enable viewing without set-top boxes, the total number of deployed set-top boxes has declined by 25% since 2012, and annual purchases in 2020 were 67% lower than in 2014.

- ○ Consumers used an estimated 56 million customer-owned and managed devices such as Smart TVs, smartphones, tablets, personal computers, and streaming devices to access the providers' video services via apps in 2020. The growth in adoption of app streaming solutions is expected to result in further reductions in the signatories' overall set-top box energy usage as customers reduce the number of boxes in their homes.

  - ○ An independent study to be performed in 2021 will generally compare the estimated energy usage and associated carbon emissions in service provider networks attributable to the delivery of video services via the service providers' apps that permit viewing on customer-owned Smart TV or streaming devices with the energy used to deliver video services via set-top boxes.

- New set-top boxes have been even more efficient than the energy levels of the Agreement, with energy usage of the three major categories of new set-top boxes declining by 59% (Non-DVR), 47% (Thin Client), and 46% (DVR) since 2012 as shown in Table ES-2 below.

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

Category	Weighted Average TEC (kWh/yr)		Percent Change in Weighted Average
	Pre-2013 Stock	2020 Purchases	Pre-2013 to 2020
DVR	267	144.8	-46%
Non-DVR	119	49.0	-59%
Thin Client	90	48.0	-47%

A summary of other Voluntary Agreement commitments is provided in Appendix A of this report, including deployment of automatic power down and whole-home systems, efforts to improve energy efficiency in future-generation equipment, and posting of information for consumers and other stakeholders at www.energy-efficiency.us and on company websites at the links listed in Appendix C of this report. D+R confirmed in 2021 that this information is readily available to the public through search engines but in some cases is not easy to find from the company home pages. D+R is working with respective signatories to facilitate improved accessibility to consumers.

The Voluntary Agreement prescribes verification testing of randomly selected set-top boxes from each reported category. Verification testing was postponed again in 2021 due to restrictions on travel and lab access as a result of the COVID-19 pandemic, but the energy usage of 95% of models procured in 2020 was previously validated in prior verification testing, and it is expected that verification testing will resume in time for inclusion in the next annual report. The signatories' performance in meeting their procurement commitments was also validated through D+R's review of procurement data of all signatories and D+R's successful detailed audit of one randomly-selected party's records.

In 2018, the largest service provider signatories committed to engage directly with their supply chains, including component suppliers, to explore approaches to further improve the energy efficiency of set-top boxes in all power states. As a result of these efforts, in March 2021, the signatories unanimously amended the Voluntary Agreement and extended its term for an additional four years through the end of 2025 with new, more rigorous Tier 4 energy levels that will become applicable to the 90% procurement commitment in 2023. The signatories have estimated that by the end of the extended term of the agreement, the total energy used by set-top boxes in the United States will be only one-third of the energy used by set-top boxes in 2012 when the agreement was initially signed. The Independent Administrator will continue to monitor these developments and publish these annual reports through the 2025 report, to be issued in 2026.

OVERVIEW OF THE VOLUNTARY AGREEMENT

Cable, satellite, and telco service providers offer pay television to approximately 74.1 million U.S. households.[6] These services historically have relied upon the use of customer premises equipment, often referred to as set-top boxes, to make the services accessible to consumers' televisions. 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 as the service providers introduce new services.

As with all electronic devices, set-top boxes must utilize power in order 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.[7] To reduce the amount of energy consumed by set-top boxes while protecting rapid innovation and timely introduction of new features, the pay television industry crafted the Voluntary Agreement for Ongoing Improvement to the Energy Efficiency of Set-Top Boxes. The Voluntary Agreement provides a framework for the pay television industry to deliver market-based energy-efficiency gains that keep pace with technological innovation. The signatories of the Voluntary Agreement represent all of the major pay-TV service providers, equipment vendors, and related industry organizations in the United States. Combined, these companies reported providing multichannel video service to approximately 70.2 million American households in 2020, accounting for 95% of the traditional live pay-TV market.

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

The parties have twice unanimously extended the Voluntary Agreement, with the latest amendment extending its commitments through 2025. The most recent amendment defines more rigorous Tier 4 energy levels that will take effect in 2023. The reductions in the new allowance levels are particularly significant for Internet Protocol (IP) Non-DVR set-top boxes, which are projected to represent an increasing portion of new set-top box purchases. Service providers are encouraged to adopt Tier 4 levels prior to the effective date and early adoption percentages will be reported in the 2021 and 2022 annual reports.

This report covers the first year (2020) in which Tier 3 levels were in effect, and the signatories had estimated that the Tier 3 levels are 20% more efficient, on average, than previous Tier 2 levels.

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.

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6 - Based on data provided by NCTA and CTA. These numbers do not include customer counts for third-party streaming services.

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

The signatories originally estimated that consumers would save $1.6 billion annually in energy costs once the benefits of the Tier 3 commitments are fully realized. In the first year of the Tier 3 energy levels, the signatories already achieved more than $2.2 billion in annual savings.[8] These 2020 energy savings are nearly equivalent to the power generated by six typical 500-megawatt coal-run power plants[9] annually and avoided nearly 12 million metric tons of CO_2 emissions per year compared to the national set-top box energy use and related emissions from the base year of 2012.[10]

Voluntary Agreement Signatories and Steering Committee

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

Energy Advocates

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

Cable Service Providers

- Altice
- Charter Communications ("Spectrum")
- Comcast
- Cox Communications

Satellite Service Providers

- AT&T/DIRECTV
- DISH Network

Telco Service Providers

- AT&T
- Frontier
- Verizon

Other Organizations

- CommScope
- Technicolor
- 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 technological landscape changes.

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8 - U.S. Energy Information Administration, *supra*, note 3.
9 - Scientific American, *supra*, note 2.
10 - U.S. Environmental Protection Agency, *supra*, note 4.

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, and D+R has continued in this role.

The Voluntary Agreement requires that the Steering Committee meet at least once annually. The Steering Committee convened on June 3, 2020 and August 10, 2020, and subcommittees also were active during the year. The Committee also conducted an electronic ballot vote on an amendment to the Voluntary Agreement that was completed on January 22, 2020.

Representatives of the signatories have continued to provide updates to state and federal regulators and other stakeholders regarding the ongoing execution of the Voluntary Agreement.

CTA and NCTA are required to provide the following two reports to the Independent Administrator, both of which they provided on time in 2020:

- 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); and
- Information on progress with respect to other energy-efficiency commitments (due by May 1 of each year).

Service Provider Commitments

The primary service provider commitment is that at least 90% of its set-top box purchases will meet specified energy-efficiency levels. The original levels were replaced by Tier 2 levels for devices purchased after December 31, 2016, which were then replaced with Tier 3 energy levels for models procured after December 31, 2019. This is the first Annual Report in which the Tier 3 levels were in effect. Service providers also committed to public posting of energy-efficiency information for consumers. Additional information on other service provider commitments is outlined in Progress on Other Energy-Efficiency Commitments, below, and in Appendix A.

Independent Administrator and Auditor Role

The Voluntary Agreement obligates the Steering Committee to designate an Independent Administrator and an Independent Auditor. The Steering Committee designated D+R as the Independent Administrator and Auditor in 2013. D+R has continued in this role since its appointment. Under the Voluntary Agreement, the Independent Administrator must aggregate and compile confidential procurement data submitted by service providers and assess whether there is substantial compliance with the service provider commitments. If these commitments are not met, the Independent Administrator initiates a remedial process following the procedures set out in the Voluntary Agreement. The Independent Administrator is required to publish its findings in an annual report. The 2020 Annual Report is the eighth report published. D+R is also required to conduct a random audit of one service provider's procurement figures each year. The 2020 audit report is presented in Appendix D.

New Feature Allowances

The Voluntary Agreement includes a process that 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. No new feature allowances were submitted for the 2020 reporting period.

INCREASED ENERGY EFFICIENCY OF SET-TOP BOXES

Table 1 demonstrates the progress made by the signatories in improving the energy efficiency of set-top boxes. The significant year-over-year reduction in energy consumption of new devices in the Non-DVR category appears to reflect a shift within that broad category to lower-power IP Non-DVR devices, the newer models of which can more closely resemble Thin Clients in power usage and consumer functionality. This trend is illustrated in Table 1 by the 59% drop from 2012 to 2020 in the weighted average TEC for Non-DVR units. As reported in the Progress on Other Energy-Efficiency Commitments section below, such Non-DVR devices are also replacing high-energy DVR devices in facilitating whole-home systems that provide content to multiple devices without the need for multiple set-top box units throughout the home.

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

Category	Weighted Average TEC (kWh/yr)									Percent Change in Weighted Average
	Pre-VA	2013	2014	2015	2016	2017	2018	2019	2020	2012 to 2020
DVR	267	195.4	179.4	170.6	161.3	142.9	138.7	134.4	144.8	-46%
Non-DVR	119	108.6	103.3	92.6	85.6	90.8	91.8	74.1	49.0	-59%
Thin Client	90	51.4	50.0	49.1	46.9	44.3	45.4	45.4	48.0	-47%

MSGs were each purchased only by one service provider in 2020 in relatively small quantities.

While there was an uptick in 2020 in the average power of new DVRs and Thin Clients, these categories have declined by nearly 50% overall. The aberration in the long-term downward trend was not caused by the introduction of new higher-powered models, but instead reflects changes in the mix of models purchased in a year in which purchases in both categories dramatically declined as shown in Table 6 below.

Another indication of the progress of the Voluntary Agreement is the nearly 50% decline in the average weighted TEC of aggregate set-top box purchases year-over-year, as shown in Figure 1 below. The downward trend reflects the improved energy efficiency of the new set-top boxes purchased each year and shifts in purchase quantities to lower-power Non-DVR and Thin Client models. The decline from more than 120 kWh/year in the first reported purchases in 2013 to under 64 kWh/year corroborates the national energy consumption estimated savings of over 50%, as this metric is independent of stock estimates and subscriber count adjustments.

Figure 1: Weighted Average TEC of Purchased Set-top Boxes by Year
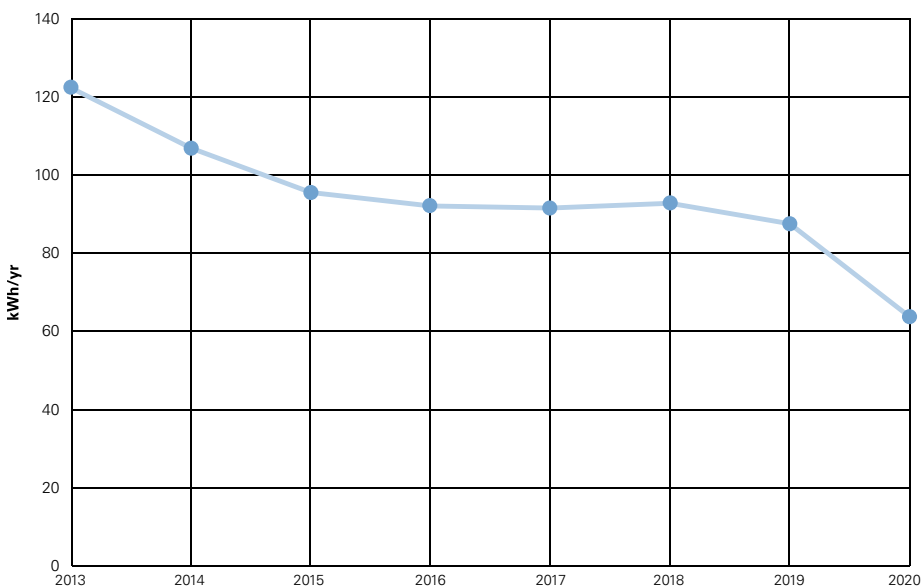
REPORT ON PROCUREMENT COMMITMENTS

Under the Voluntary Agreement, the service providers committed that 90% of set-top boxes they purchased after December 31, 2019, would meet the Tier 3 efficiency levels. This is the first year in which this Tier 3 procurement commitment has been evaluated, and the seventh year in which the procurement commitment is in force.

96.9% of all set-top boxes purchased by the service provider signatories in 2020 met the Tier 3 commitment levels. The total procurement figures for the major categories of set-top boxes are shown in Table 2 below.[11]

Table 2: Set-Top Box Procurement by Set-Top Box Category in 2020

Category	Units Procured
DVR	1,719,840
Non-DVR	10,537,923
Thin Client	1,473,453
DTA	86,959
Total	**13,731,216**

In 2020, Multi-Service Gateway devices were reported by only one signatory, so these have been removed.

The Voluntary Agreement prescribes that if a service provider signatory fails to meet a procurement commitment, it shall implement a remedial plan with new savings measures that offset the extra energy associated with the set-top boxes that caused it to miss its commitment. All but one of the service providers met the Voluntary Agreement procurement commitment in 2020. The remediation plan for the other signatory in 2020 is currently under development, which will be approved and overseen by the Independent Administrator and a subcommittee that includes the Energy Advocates.

IMPACT ON NATIONAL ENERGY CONSUMPTION

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

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11 - MSGs were procured only by one service provider in 2020 in relatively small quantities. Section 8.6 of the Voluntary Agreement seeks to protect the confidentiality of these service providers' model procurement figures by precluding this report from disclosing the number of MSG units purchased in 2020, which could readily be deduced if a total national figure were reported. The quantity of MSGs purchased was factored into the overall national energy consumption of set-top boxes in this report.

Table 3: Base Case – 2012 Estimated Energy Consumption

Segment	Category	TEC (kWh/yr)	Units (Millions)	National Energy Consumption (TWh/yr)	500 MW Power Plant Equivalents (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 that newly purchased devices generally replace older (less energy-efficient) equipment from the same category rather than add to total deployed stock. However, the total deployed stock estimate is adjusted to account for changes in subscriber levels as shown in Table 4 below.

Table 4: Change in Subscribers from 2012-2020

Segment	Percent Change[a]								
	2012 to 2013	2013 to 2014	2014 to 2015	2015 to 2016	2016 to 2017	2017 to 2018	2018 to 2019	2019 to 2020	2012 to 2020
Cable	-4.5%	-0.3%	-0.5%	-1.7%	-3.7%	-2.2%	-1.3%	-4.1%	-17.0%
Satellite	1.0%	0.1%	-1.9%	3.0%	-9.2%	-7.5%	-11.6%	-11.9%	-33.3%
Telco	25.4%	8.2%	-0.9%	-20.9%	2.0%	-3.5%	-13.6%	-12.1%	-20.4%

[a] Based on data provided by the Steering Committee (for 2012) and service providers (for 2013-2020).

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

Table 5: Estimates of Total Deployed Units in the Market in 2013-2020

Category	Units[a]							
	2013	2014	2015	2016	2017	2018	2019	2020
DVR	54,038,000	54,599,000	53,890,000	52,674,000	49,892,000	47,672,000	44,412,000	40,901,000
Non-DVR	130,344,000	122,650,000	112,668,000	96,327,000	92,563,000	89,139,000	83,572,000	77,440,000
Thin Client	10,561,000	20,299,000	28,774,000	39,784,000	34,958,000	32,447,000	28,625,000	25,208,000
DTA	31,633,000	31,543,000	31,396,000	30,866,000	29,722,000	29,074,000	28,683,000	27,494,000
Total	226,576,000	229,092,000	226,727,000	219,651,000	207,135,000	198,331,000	185,293,000	171,043,000

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

The next step in estimating national energy consumption is to account for products procured in 2020. The signatories purchased nearly 5 million fewer set-top boxes in 2020 than in 2019. This reduction may be due in part to a decline in subscribership and also to the increasing prevalence and usage of options for customers to watch their programming without a set-top box, as discussed below.

Table 6: Total Signatory Set-Top Box Units Procured in 2014 and from 2018-2020

| Category | Total Units Procured | | | | Percent Change |
	2014	2018	2019	2020	2014 to 2020
DVR	12,710,777	6,304,346	5,848,219	1,719,840	-86%
Non-DVR	18,646,064	10,066,928	8,319,044	10,537,923	-43%
Thin Client	9,738,163	6,316,550	4,592,236	1,473,453	-85%
DTA	5,201,332	427,480	127,850	86,959	-98%
Total	41,095,004	22,687,824	18,759,499	13,731,216	-67%

D+R subtracts 2020 set-top box procurements from the total units listed in Table 6, using the new replacement assumptions described above. This methodology yields multiple sets of stock – one for each purchase year – each with its own weighted average TEC values. The remaining stock estimates for each of the purchase year sets are shown in Figure 2.

Figure 2: Distribution of Current Inventory by Year of Procurement (Percentage of Units)

Legend:
- 2020 Shipments
- 2019 Shipments
- 2018 Shipments
- 2017 Shipments
- 2016 Remaining Stock
- 2015 Remaining Stock
- 2014 Remaining Stock
- 2013 Remaining Stock
- Pre-VA
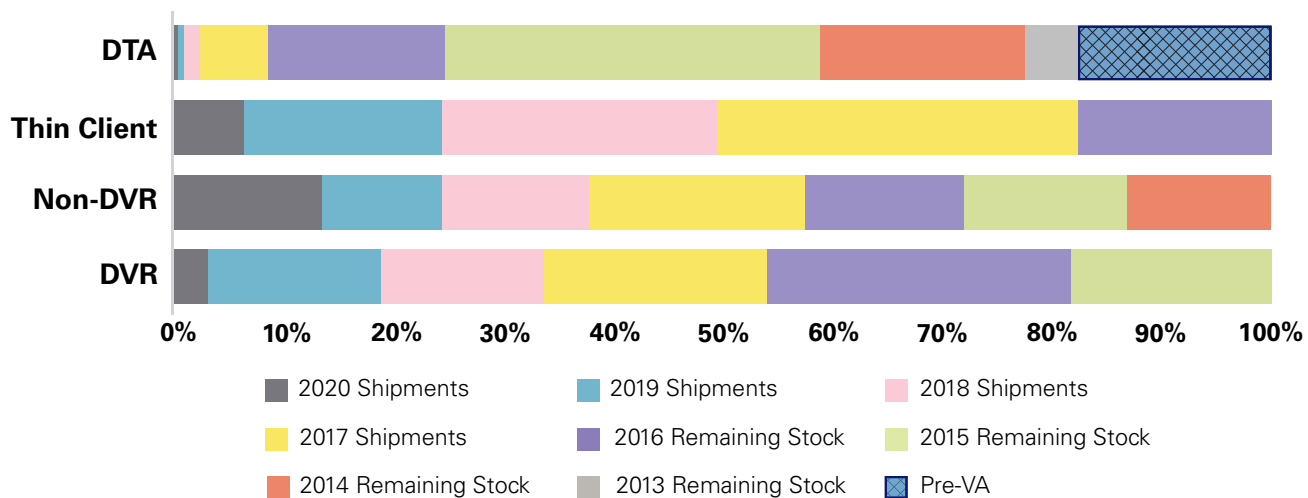
Figure 2 has been corrected from previous reports to differentiate between new shipments and remaining stock. Based on this model, new devices have yet to replace the 2017 units in the field, so units sold in 2017 are still referred to as "Shipments." However, models from 2016 and prior that are still in the field are being replaced by newly-procured products, and will now be described as "Remaining Stock."

Multiplying the number of units purchased each year that still remained in the field at the end of 2020 and the average TEC for that category of device at the time of its purchase produces the estimated national energy consumption shown in Table 6. Table 7 displays the results of this calculation year-over-year for the lifetime of the Voluntary Agreement.

Table 7: 2020 National Energy Consumption Calculation

Category	Pre-VA (before 2013)	2013	2014	2015	2016	2017	2018	2019	2020	2020 National Energy Consumption (TWh)
DVR Purchases from Each Year Remaining in Field	0	0	0	7,540,600	11,219,933	8,268,205	6,304,346	5,848,219	1,719,840	
DVR TEC Average (kWh/yr)	267.0	195.4	179.4	170.6	161.3	142.9	138.7	134.4	144.8	6.2
Non-DVR Purchases from Each Year Remaining in Field	0	0	10,612,281	10,977,499	11,535,694	15,390,556	10,066,928	8,319,044	10,537,923	
Non-DVR TEC Average (kWh/yr)	119.0	108.6	103.3	92.6	85.6	90.8	91.8	74.1	49.0	6.6
Thin Client Purchases from Each Year Remaining in Field	0	0	0	0	4,538,506	8,287,414	6,316,550	4,592,236	1,473,453	
Thin Client TEC Average (kWh/yr)	90.0	51.4	50.0	49.1	46.9	44.3	45.4	45.4	48.0	1.1
DTA Purchases from Each Year Remaining in Field	4,976,159	1,334,238	5,201,332	9,169,913	4,831,980	1,337,930	427,480	127,850	86,959	
DTA TEC Average (kWh/yr)	39.0	57.6	49.3	46.5	49.9	54.9	55.8	51.2	51.4	1.3
Total 2020 National Energy Consumption (TWh)										15.2

Table 8: National Energy Consumption of Installed Set-Top Boxes 2012-2020

	2012 (Pre-VA)	2013	2014	2015	2016	2017	2018	2019	2020
Estimate of Total Deployed Units in the Market	225,000,000	226,576,000	229,092,000	226,727,000	219,651,000	207,135,000	198,331,000	185,293,000	171,043,000
National Energy Consumed (TWh/yr)	32.0	30.6	29.2	26.9	24.5	21.0	19.4	17.3	15.2
500 MW Power Plant Equivalents (Rosenfelds)	10.7	10.2	9.7	9.0	8.2	7.0	6.5	5.8	5.1
CO_2 Emitted (MMT)	22.6	21.6	20.6	19.0	17.3	14.9	13.7	12.2	10.7

These improvements in energy efficiency spurred by the Voluntary Agreement have had an increasingly significant role in reducing national energy consumption, and do not appear to be slowing down. Set-top box energy consumption decreased by a larger percentage in the past year (from 17.3 TWh to 15.2 TWh, or 12%) than in the first three years of the Voluntary Agreement (from 32 TWh to 29.2 TWh, or 8%). The overall 16.8 TWh reduction in usage in 2020 compared to 2012 represents consumer savings of over $2.2 billion[12] and avoidance of over 11.9 million metric tons of CO_2 in 2020 alone.[13] As shown in Figure 3 below, during the eight years of the Voluntary Agreement, cumulative energy consumption has declined by an estimated 71.9 TWh, saving consumers approximately $9.3 billion and avoiding over 50.8 million metric tons of CO_2 emissions.

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12 - U.S. Energy Information Administration, *supra*, note 3.

13 - U.S. Environmental Protection Agency, *supra*, note 4.

Figure 3: Annual Energy Saved by the Voluntary Agreement Procurement Commitments

Total 8 year savings 71.9 TWh

Year	TWh/yr
2013	1.4
2014	2.8
2015	5.1
2016	7.5
2017	11.0
2018	12.6
2019	14.7
2020	16.8
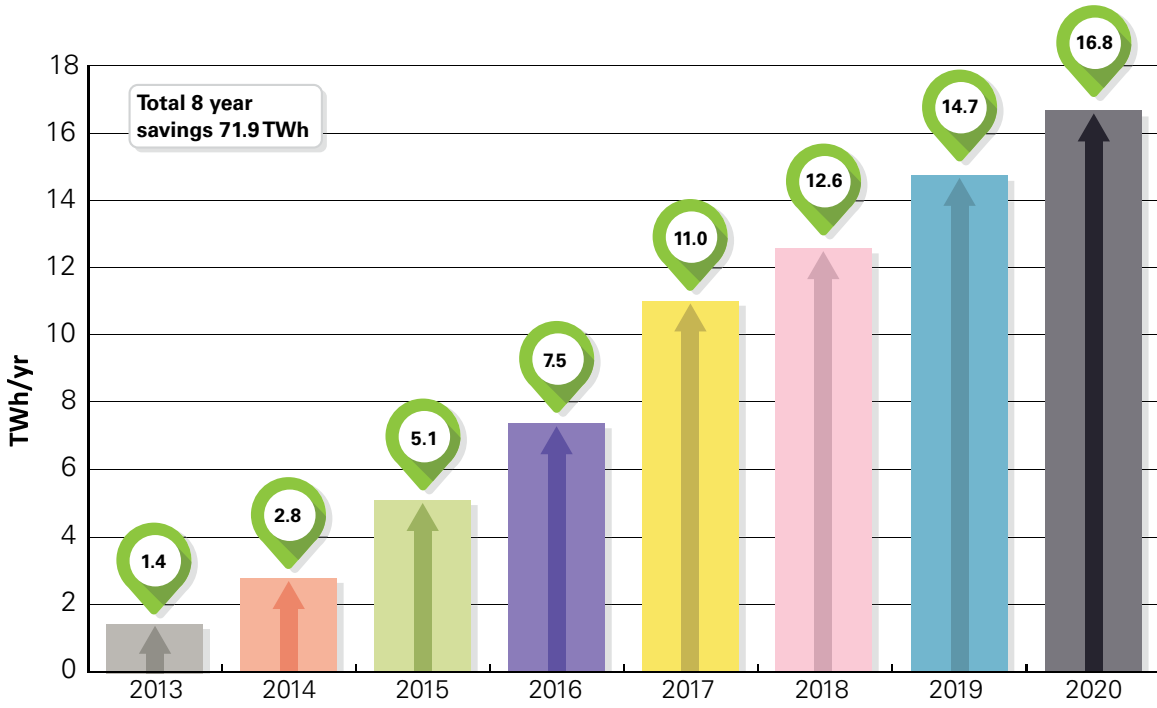
AUDIT AND VERIFICATION

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 2020 reporting year is presented in Appendix D. D+R determined that the data submitted by the service provider for the audit is consistent with the annual report submitted by that service provider.

Verification Testing

The Voluntary Agreement prescribes third-party verification testing of models chosen by the Independent Administrator. This testing was scheduled to occur during the spring of 2020 and again in 2021 but had to be postponed due to restrictions on travel and lab access as a result of the COVID-19 pandemic. That being said, 95% of the unique models purchased in 2020 have already passed independent third-party verification (lab verification or the earlier field verification program) in previous years of the Voluntary Agreement.

D+R previously found that those prior test results confirmed that the energy usage of service providers' set-top boxes observed by the independent third parties is consistent with the energy information provided to consumers and is in substantial compliance with the procurement commitments of the Voluntary Agreement. It is anticipated that third-party lab verification will resume in time to produce results for the next annual report, subject to further direction from the Steering Committee.

PROGRESS ON OTHER ENERGY-EFFICIENCY COMMITMENTS

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

Automatic Power Down

The satellite signatories committed that, effective January 1, 2013, at least 90% of new satellite set-top boxes will include an "Automatic Power Down" (APD) feature with a default value of four hours or less. Automatic power down (APD) monitors parameters related to viewing and user activity. If the parameters indicate that no user activity or viewing is occurring, APD enables the device to transition to an off or sleep mode. In every year from 2013 through 2020, 100% of the satellite set-top boxes purchased by DISH and DIRECTV met this requirement. These commitments have been deemed completed and will no longer be included in future reports.

Whole-Home Systems

Whole-home architectures use home network interfaces (HNIs) to serve content to multiple client devices within a consumer's home more efficiently than configurations involving multiple DVR set-top boxes throughout the home. The satellite and telco signatories have met their commitments under the Voluntary Agreement to make energy-efficient whole-home architectures available to all new and existing subscribers every year since 2013, and these energy-saving offerings have now been widely adopted by consumers. Although not required by the Voluntary Agreement, cable operators have also deployed new whole-home solutions. These commitments have been deemed completed and will no longer be included in future reports.

Consumer Access to Energy-Efficiency Information

All service providers committed to provide subscribers and potential customers with reasonable access to energy-efficiency information for set-top boxes purchased since January 1, 2014. This information makes it easier for consumers to learn about energy-efficient set-top boxes and typical set-top box energy consumption. This information is posted on company websites from the links listed in Appendix C of this annual report and at www.energy-efficiency.us, which offers a single site from which the public may conveniently link to each provider's information, the Independent Administrator's Annual Reports, the Voluntary Agreement, and related news and information. D+R confirmed in 2021 that this information is readily available to the public through search engines, but in some cases is not easy to find from the company home pages. D+R is working with respective signatories to facilitate improved accessibility to consumers.

Next-Generation Video Delivery

In 2018, the largest service provider signatories committed to engage directly with their supply chains, including component suppliers, to explore approaches to further improve the energy efficiency of set-top boxes in all power states. As a result of these efforts, in March 2021, the signatories unanimously amended the Voluntary Agreement and extended its term for an additional four years through the end of 2025 with new, more rigorous Tier 4 energy levels that will become applicable to the 90% procurement commitment in 2023. Tier 4 significantly reduces allowances particularly for IP Non-DVR set-top boxes that are expected to represent an increasing portion of new set-top box purchases.

VIEWING WITHOUT OPERATOR-SUPPLIED SET-TOP BOXES

All of the service provider 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. These apps can be used on hundreds of millions of consumer-owned Internet-connected devices, such as smartphones, tablets, personal computers, select Smart TVs, game consoles, and low-power streaming devices such as Apple TV, Roku, Google Chromecast and Amazon Fire. Nearly all U.S. TV households have at least one of these devices.

Signatories reported that the number of unique customer-owned and managed devices used to access video services via apps increased to 56 million in 2020. This figure represents almost 30% more devices than in 2019, and over a 50% increase from 2017 despite the decrease in the number of subscribers.

Table 9 lists the supported TV and other platforms and devices used by consumers to view each service provider's content using its app without operator-supplied set-top boxes in 2020. The table indicates whether the service provider's app on each platform supports access to linear (live TV) content, on demand content, and/or recording capability, which are among the features that help make apps an attractive alternative to a set-top box. There remain some differences in functionality and visibility between apps and set-top boxes that may encourage most customers to continue to use set-top boxes, but the service provider signatories are continuing to work to enhance the functionality of their apps such as through new support for cloud DVR offerings, and investing in customer education and employee training to promote the use and awareness of apps.

App usage can replace or reduce demand for set-top boxes in a variety of ways. For example, the use of apps to view pay-TV and other video content on televisions can render a set-top box unnecessary for that television. New models of Samsung, LG, Roku and Amazon Fire Smart TVs can access select service provider apps without set-top boxes. Seventy percent of American households now have at least one Smart TV, and Smart TVs now represent a majority of all televisions used in the United States.[14] As we previously reported, a 2020 study found that 82% of smart TVs are used to access video directly without a set-top box or streaming device.[15]

Streaming devices connected to a television also can eliminate the need and demand for a set-top box for that television. While the growth of streaming devices has slowed as consumers turn to Smart TVs that embed that functionality, in 2020 the number of these devices deployed in the United States topped 100 million,[16] and 57% of consumers use these streaming devices to watch some type of video service on their televisions.[17]

App usage on other devices can replace set-top boxes as well. Nearly 40% of all video is now watched on devices other than televisions, such as tablets, smartphones and computers.[18] Use of these non-TV mobile devices inside the home reduces the demand for additional set-top boxes on additional rooms around the house.

In addition, as of the end of 2020, more than 3 million consumers subscribed to DISH's SlingTV service or AT&T TV Now/AT&T TV service which are accessed through Smart TVs, tablets, or low-power streaming devices. Charter's similar "TV Essentials" service is available to its Internet customers on a variety of customer-owned devices. The energy-efficient IP streaming devices used to receive these services, which may be purchased at retail or provided by the service provider, further reduce the overall energy used by set-top boxes.

14 - Hub Entertainment Research, Connected Home 2021 (March 2021).

15 - Kagan Market Intelligence, *US Ownership of Smart TVs, SMPs, Smart Speaker Devices Continues to Climb* (Jan. 17, 2020).

16 - Kagan Market Intelligence, *Cable, telco and DBS set-tops stream out of US homes in 2020 forecast* (July 22, 2020)

17 - Consumer Technology Association, *Content in the COVID-19 Era: Current Realities and Future Opportunities* (September 2020).

18 - Consumer Technology Association, *Content in the COVID-19 Era: Current Realities and Future Opportunities* (September 2020).

The confluence of these changes results in fewer homes with set-top boxes and fewer set-top boxes per home in the homes that use them. D+R has previously reported a nearly 25% decline in deployed set-top box inventory since 2015,[19] and there are projections of even steeper declines ahead.[20] These trends, when coupled with more energy-efficient devices, results in a lower energy footprint of set-top boxes.

19 - As noted in Table 5, D&R estimates that there were 171 million set-top boxes deployed at the end of 2020.
20 - *See* Kagan Market Intelligence, *Cable, telco and DBS set-tops stream out of US homes in 2020 forecast* (July 22, 2020) (estimating as few as 100 million deployed set-top boxes in the United States by the end of 2024).

Table 9: Platforms and Apps Used by Customers to View Content Without Set-Top Boxes

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

Table 9: Platforms and Apps Used by Customers to View Content Without Set-Top Boxes (cont.)

Service Provider	Platform	App Name	Live TV	On-Demand	DVR
			Yes/No		
DISH	AirTV Mini	SlingTV	Yes	Yes	Yes
	AirTV Player (AndroidTV)	SlingTV	Yes	Yes	Yes
	Amazon Fire TV	SlingTV	Yes	Yes	Yes
	Android	DISH Anywhere	Yes	Yes	Yes
	Android	SlingTV	Yes	Yes	Yes
	AndroidTV	SlingTV	Yes	Yes	Yes
	Apple iOS	DISH Anywhere	Yes	Yes	Yes
	Apple TV	SlingTV	Yes	Yes	Yes
	Chrome (Mac)	DISHAnywhere.com (website)	Yes	Yes	Yes
	Chrome (Windows)	DISHAnywhere.com (website)	Yes	Yes	Yes
	Edge (Windows)	DISHAnywhere.com (website)	Yes	Yes	Yes
	Fire OS	DISH Anywhere	Yes	Yes	Yes
	Firefox (Mac)	DISHAnywhere.com (website)	Yes	Yes	Yes
	Firefox (Windows)	DISHAnywhere.com (website)	Yes	Yes	Yes
	Google Chromecast	SlingTV	Yes	Yes	Yes
	Internet Explorer (Windows)	DISHAnywhere.com (website)	Yes	Yes	Yes
	LeEco (AndroidTV)	SlingTV	Yes	Yes	Yes
	LG TV	SlingTV	Yes	Yes	Yes
	Roku	SlingTV	Yes	Yes	Yes
	Safari (Mac)	DISHAnywhere.com (website)	Yes	Yes	Yes
	Samsung TV	SlingTV	Yes	Yes	Yes
	XBOX ONE	SlingTV	Yes	Yes	Yes
	Xiaomi Mi (AndroidTV)	SlingTV	Yes	Yes	Yes
	ZTE (Android)	SlingTV	Yes	Yes	Yes
Frontier	Android	Frontier TV	Yes	Yes	Yes
	Apple iOS	Frontier TV	Yes	Yes	Yes
	MAC	Frontier TV	Yes	Yes	Yes
	PC	Frontier TV	Yes	Yes	Yes
Verizon	Amazon Fire TV	fiostv	Yes	Yes	Yes
	Android	fiostv	Yes	Yes	Yes
	Apple iOS	fiostv	Yes	Yes	Yes
	MAC	tv.verizon.com	Yes	No	No
	PC	tv.verizon.com	Yes	Yes	No
Number of unique, customer-owned and managed devices that have accessed video services via apps during Reporting Period			**55,529,666**		

D+R's prior report noted that it lacks data on the incremental energy use associated with the signatories' system infrastructure employed to store and transmit video content to the home, but speculated that it is reasonable to expect that the shift to apps and away from set-top boxes is net positive from an energy-efficiency perspective. Any increase in energy to support streaming will most likely be more than offset by the significant energy savings resulting from decreased manufacturing, distribution, and operation of multiple set-top boxes (including DVRs that have the highest energy use) in subscriber homes.

The signatories have committed to arrange for a one-time study to be performed in 2021 by an independent third party that will generally compare the estimated energy usage and associated carbon emissions in service provider networks attributable to the delivery of video services via the service providers' apps that permit viewing on customer-owned Smart TV or streaming devices with the energy used to deliver video services via set-top boxes.

CONCLUSION

In 2020, 96.9% of set-top boxes purchased by the signatories met the Tier 3 energy-efficiency levels of the Voluntary Agreement. All but one service provider met the 90% procurement commitment under the Agreement in the first year of Tier 3. The service provider that missed its 2020 procurement commitment is currently developing a remediation plan. All other commitments were met, though D+R is working with signatories to facilitate improved accessibility of set-top box energy information to consumers.

As a result, the Voluntary Agreement reduced national energy consumption of set-top boxes from 32 TWh/year in 2012 to 15.2 TWh/year in 2020, a reduction of 52%, even as the functionality of set-top boxes increased. As of January 1 2021, consumers are now saving over $2.2 billion annually in energy costs, and the more rigorous Tier 4 energy levels will promote additional savings in the future. The savings have been confirmed year-by-year through an analysis of independent verification testing and procurement audits. Meanwhile, the total energy footprint of set-top boxes in customers' homes used to access traditional pay-TV services continues to decline as a result of improved energy efficiency, declining subscribership, and increased consumer use of apps as an alternative to set-top boxes.

APPENDIX A: VOLUNTARY AGREEMENT COMMITMENTS

Table 10 lists the commitments of the signatories of the Voluntary Agreement along with the status of the signatories' progress toward these commitments.

Table 10: Voluntary Agreement Commitments

Commitments	Group	Status
90% of set-top boxes purchased after December 31, 2019, meet Tier 3.	All Service Providers	All but one signatory met its 90% commitment individually. Overall, 97% of set-top boxes purchased by the signatories in 2020 met Tier 3.
Prepare annual procurement report for prior year by April 1.	All Service Providers	All service providers submitted reports to the Independent Administrator for 2020.
Provide energy-efficiency information to subscribers and potential subscribers of set-top boxes purchased since January 1, 2014.	All Service Providers	D+R verified that the information is available from the website energy-efficiency.us and company websites listed in Appendix C, and followed up and confirmed changes with the signatories that needed to update the information. D+R is working with signatories to facilitate improved accessibility of set-top box energy information to consumers.
90% procurement of set-top boxes with automatic power down feature.	Satellite	100% of new satellite set-top box purchases in 2020 include an automatic power down feature.
Make whole-home servers and clients available to all new and existing subscribers.	Satellite	Offered to satellite customers throughout the United States 2013-2020.
Work with suppliers to develop set-top boxes with next-generation power management, and deploy such economically feasible new models that successfully perform on a cable operator's network and support all of the operator's services in its ordinary set-top box replacement cycle. In addition to or in lieu of the foregoing efforts in regards to traditional QAM set-top boxes, a cable operator may pursue strategies to reduce the overall energy usage in typical homes through other means such as IP delivery or architectures that reduce the number of operator-supplied devices in the home.	Cable	The cable operators previously-reported engagement with key suppliers in 2019 facilitated the successful development of new Tier 4 standards that were adopted in 2021. Charter and Altice are offering Apple TV as an equipment option. Comcast and Cox are offering very low-power IP client devices for secondary TVs. Altice has integrated the modem, router, and set-top box into a single device. All of the service provider signatories are supporting apps that enable customers to access live and on-demand content on a screen such as a television or tablet without any operator-supplied set-top box.
Use reasonable efforts to design and manufacture equipment to enable improved set-top box energy efficiency while meeting the service providers' functional and operational specification.	Equipment Manufacturers	Manufacturers' efforts to date are reflected in the energy savings reported by service providers, and there is ongoing development of next-generation set-top boxes with lower-power silicon solutions.
Whole home architectures will be available to all new and existing subscribers. Whole-home architectures serve content to multiple remote or client devices within a consumer's home more efficiently than configurations involving multiple DVR Set-Top Boxes throughout the home.	Telco	Deployed throughout the United States 2014-2020.

APPENDIX B: SET-TOP BOXES PURCHASED BY VOLUNTARY AGREEMENT SIGNATORIES IN 2020

Table 11 lists the reported typical energy consumption (TEC) for each model of set-top box purchased by Voluntary Agreement signatories in 2020. These values are reported TEC, rather than calculated TEC. In the Voluntary Agreement, service providers have the option to publish a "reported TEC" that rounds up calculated TEC values for reporting purposes to account for production variances. Reported TEC figures in this Appendix are rounded up to the next one-tenth digit (e.g., 99.11 kWh/year would be rounded up to 99.2 kWh/year). Please note that the same model could have variances in TEC for several reasons, including differences in reported versus calculated TEC, enabling of different product features, and/or deployment of the device by service providers running different software. The Voluntary Agreement calculates maximum allowable TEC for a product using the base-type allowances outlined in Table 11 and the feature allowances outlined in Table 12. Table 12 also includes descriptions of the features abbreviated in Table 11 in the "Claimed Allowances" column. The Voluntary Agreement sets forth rules for claiming 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/Set-top-Box-Voluntary-Agreement-2021.pdf. 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 have been evaluated through third-party verification testing in previous years under the Voluntary Agreement.

Table 11: Set-Top Boxes Procured by Voluntary Agreement Signatories in 2020

Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	Modal Characteristics (W)		TEC (kWh/yr)	Meets Tier 3
						On	Sleep		
Altice	Cable	Multi-Service Gateway	Sagemcom	DGCI384*	APD, Adv Video-A, D3 above 8x4(4), Multi-room, MS, MS-A, WiFi (n) HP, WiFi (ac) HP, WiFi Addl HP(3), AP, HEVP, UHD-4, TELE	28.50	26.44	237.0	Yes
Altice	Cable	Non-DVR	Sagemcom	DCIWA384*	APD, Adv Video-A, HNI, MS, WiFi (n) HP, WiFi (ac) HP, WiFi Addl HP(3), HEVP, UHD-4	10.88	9.05	84.0	Yes
Altice	Cable DTA	Cable DTA	Coship	N8783C	APD	6.00	2.90	35.0	Yes
Altice	IP	Non-DVR	Apple TV	A1842*	HNI, WiFi (ac) LP, WiFi (n) HP, WiFi (ac) HP, WiFi Addl HP, HEVP	2.90	1.00	20.0	Yes
AT&T/DIRECTV	Satellite	DVR	DIRECTV	HR54-500*	APD, DVR, DVR-A, HNI, M-HNI, Multi-room, MS, MS-A	12.66	12.64	110.8	Yes
AT&T/DIRECTV	Thin Client	Thin Client	DIRECTV	C61-500*	APD, HNI, M-HNI	5.43	4.22	40.1	Yes
AT&T/DIRECTV	Thin Client	Thin Client	DIRECTV	C61W-400*	APD, HNI, WiFi (ac) LP, WiFi Addl LP(2)	6.53	5.03	47.9	Yes
AT&T/DIRECTV	Thin Client	Thin Client	DIRECTV	C61W-700*	APD, HNI, WiFi (ac) LP, WiFi Addl LP(2)	6.56	5.22	49.2	Yes
AT&T/DIRECTV	Satellite	DVR	DIRECTV	H44-500*	APD, DVR, DVR-A, HNI, M-HNI, Multi-room, MS, MS-A	10.37	9.37	84.7	Yes
AT&T/DIRECTV	Satellite	DVR	DIRECTV	HS17-500*	APD, DVR, DVR-A, M-HNI, Multi-room, MS, MS-A, XCD, WiFi (ac) HP, WiFi Addl HP(2), UHD-4	19.48	18.34	163.6	Yes
AT&T/DIRECTV	IP	DVR	ARRIS	VIP 2262V2*	Adv Video-A, DVR, HNI, S-DVR, MS, MS-A	12.06	10.33	99.4	Yes
AT&T/DIRECTV	IP	Non-DVR	MOTOROLA	VIP 2500*	Adv Video-A, HNI, MS, WiFi (ac) LP, WiFi Addl LP(2)	11.73	11.40	102.0	No
AT&T/DIRECTV	IP	Non-DVR	AT&T TV	C71KW-400*	HNI, WiFi (ac) LP, WiFi Addl LP(2), HEVP, UHD-4	5.86	4.13	45.0	Yes
Charter	Cable	Non-DVR	ARRIS	110A*	APD, D3 above 8x4(2), HEVP	13.02	12.13	112.0	Yes
Charter	Cable	DVR	ARRIS	210A*	APD, DVR, D3 above 8x4(2), MS, MS-A, HEVP	17.26	13.68	130.0	Yes
Charter	Cable	Non-DVR	Humax	110H*	APD, D3 above 8x4(2), HEVP	13.09	12.24	112.0	Yes
Charter	Cable	DVR	Humax	210H*	APD, DVR, D3 above 8x4(2), MS, MS-A, HEVP	17.29	16.02	146.0	Tier 3
Charter	Cable	Non-DVR	Technicolor	110T*	APD, D3 above 8x4(2), HEVP	13.96	13.30	120.0	Yes
Charter	Cable	DVR	Technicolor	210T*	APD, DVR, D3 above 8x4(2), MS, MS-A, HEVP	17.43	13.15	127.0	Yes
Charter	IP	Non-DVR	Apple	A1842*	HNI, WiFi (n) HP, WiFi (ac) HP, WiFi Addl HP, HEVP	2.91	0.82	20.0	Yes
Comcast	Cable DTA	Cable DTA	Evolution	DMS2004UHDW		6.27	6.27	60.0	No
Comcast	Cable	DVR	ARRIS	AX014ANM*	DVR, M-HNI, Multi-room, MS, MS-A	16.92	15.58	158.0	Yes
Comcast	Cable	DVR	ARRIS	AX014ANC*	CableCARD, DVR, M-HNI, Multi-room, MS, MS-A	17.35	15.96	162.0	Yes
Comcast	Cable	Non-DVR	Pace	PX022ANM*	CableCARD, M-HNI, Multi-room, MS, MS-A	15.12	13.78	135.0	Yes
Comcast	Cable	Non-DVR	Pace	PX022ANC*	CableCARD, M-HNI, Multi-room, MS, MS-A	15.22	14.14	135.0	Yes

Table 11: Set-Top Boxes Procured by Voluntary Agreement Signatories in 2020 (cont.)

Service Provider	Base Type	Primary Function	Brand	Model No.	Claimed Allowances	Modal Characteristics (W)		TEC (kWh/yr)	Meets Tier 3
						On	Sleep		
Comcast	IP	Non-DVR	Pace	PXD01ANI*	HNI, M-HNI	5.64	4.55	54.0	Yes
Comcast	IP	Non-DVR	ARRIS	AX061AEI*	HNI, WiFi (n) LP, WiFi (ac) LP	4.33	3.46	40.0	Yes
Comcast	IP	Non-DVR	Technicolor	TX061AEI*	HNI, WiFi (n) LP, WiFi (ac) LP	4.28	3.38	40.0	Yes
Cox	IP	Non-DVR	ARRIS	AX061AEI*	HNI, WiFi (n) LP, WiFi (ac) LP, HEVP, UHD-4	5.10	3.40	40.0	Yes
DISH	Satellite	DVR	DISH	Hopper 3*	APD, Adv Video-A, DVR, DVR-A(2), M-HNI, Multi-room, MS, MS-A(2), XCD, XCD-A, WiFi (n) LP, HEVP, UHD-4	24.23	22.50	197.0	Yes
DISH	Thin Client	Thin Client	DISH	Wireless Joey*	APD, HNI, WiFi (ac) HP, WiFi Addl HP	7.83	7.49	65.0	No
DISH	Thin Client	Thin Client	DISH	Joey 3*	APD, HNI, M-HNI, HEVP	5.10	4.81	43.0	Yes
DISH	Satellite	Non-DVR	DISH	Wally*	APD, HEVP	7.99	7.77	69.0	No
DISH	Satellite	DVR	DISH	Hopper Duo*	APD, Adv Video-A, DVR, M-HNI, Multi-room, MS, WiFi (n) LP, HEVP	14.19	13.75	122.0	Yes
Verizon	Cable	DVR	CommScope	VMS4100*	APD, Adv Video-A, DVR, M-HNI, Multi-room, MS, MS-A, XCD, XCD-A, HEVP, UHD-4	19.68	15.44	146.1	Yes
Verizon	Cable	DVR	CommScope	VMS4100P2	APD, Adv Video-A, DVR, M-HNI, Multi-room, MS, MS-A, XCD, XCD-A, HEVP, UHD-4	19.68	15.44	146.1	Yes
Verizon	IP	Non-DVR	CommScope	IPC4100*	APD, HNI, WiFi (ac) HP, WiFi Addl HP(2), HEVP, UHD-4	8.78	5.99	59.7	Yes

Table 12 presents the base allowances for set-top boxes under Tier 3.

Table 12: Set-Top Box Base Allowances

Base Type (Use topmost if multiple apply)	Tier 3 Allowance (kWh/yr)
DTA	40
Cable (CBL)	50
Satellite (SAT)	55
Internet Protocol (IP)	40
Thin Client (TC)	25

Table 13 sets forth the features listed for set-top boxes and outlines the feature allowances under Tier 3.

Table 13: Set-Top Box Feature Allowances

Set-Top Box Feature Allowances		
Feature	**Description**	**Tier 3 TEC Allowance (kWh/yr)**
Adv Video-A	Advanced Video Processing	8
AP	WiFi Access Point	8
APD (hrs)	Automatic Power Down (4 hrs)	-
CableCARD	CableCARD	15
D3	DOCSIS 3.0	45
D3 above 8x4	DOCSIS 3.0 above 8x4	11
DVR	Digital Video Recorder (DVR)	20
DVR-A	DVR Additional	15
HEVP	High Efficiency Video Processing	10
HNI	Home Network Interface	10
M-HNI	MoCA HNI	12
MS	Multi-stream	8
MS-A	Multi-stream Additional	8
Multi-room	Multi-room	25
S-DVR	Shared DVR	20
WiFi (ac) HP	WiFi (ac) HP	22
WiFi (ac) LP	WiFi (ac) LP	19
WiFi (n) HP	WiFi (n) HP	11
WiFi (n) LP	WiFi (n) LP	9
WiFi Addl HP	WiFi above 2x2 HP	4
WiFi Addl LP	WiFi above 2x2 LP	3
XCD	Transcoding Base	13
XCD-A	Transcoding Additional	5

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

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

Table 14: Links for Consumer Access to Energy-Efficiency Information

Service Provider	Consumer Information Location
Altice	https://energy.cablelabs.com/cablevision/
AT&T/DIRECTV	https://www.att.com/ecms/dam/att/consumer/help/pdf/ATT-Receiver-Products-ENERGY-STAR.pdf
Charter	https://www.spectrum.net/support/tv/digital-receiver-energy-use/
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/fiber-optic-tv/set-top-box-equipment-efficiency.ashx
Verizon	https://www.verizon.com/support/residential/tv/equipment/stb-dvr

APPENDIX D: 2020 PROCUREMENT AUDIT REPORT

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

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

D+R conducted an audit of the 2020 procurement data, which was used to develop the findings published in the 2020 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 determined that the data submitted by the service provider for the audit is consistent with the annual report submitted by that service provider.