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Mail Station 9712
PO Box 53999
Phoenix, Arizona 85072-3999
Tel 602-250-3341
Kerri.Carnes@aps.com

March 8, 2017

Arizona Corporation Commission

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MAR 8 2017

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Docket Control
Arizona Corporation Commission
1200 W. Washington
Phoenix, AZ 85007

RE: Arizona Public Service Company 2016 DSM Annual Progress Report
Measurement, Evaluation, and Research (MER) Reports
Docket No. E-00000U-17-0057

In accordance with the Commission's Energy Efficiency Standard:

A.A.C. R14-2-2415: An affected utility shall monitor and evaluate each DSM program and DSM measure. . .

A.A.C. R14-2-2404(E): An affected utility may count toward meeting the standard up to one third of the energy savings, resulting from energy efficiency building codes that are quantified and reported through a measurement and evaluation study undertaken by the affected utility.

and Decision No. 73089:

. . .up to one third of any energy savings quantified and reported through a measurement and evaluation study undertaken by Arizona Public Service Company, and resulting from improved energy efficiency appliance standards that Arizona Public Service Company counts toward meeting its Energy Efficiency Standard. . .

APS hereby files its MER Verification Report (Attachment A) and its Codes and Standards MER Report (Attachment B) for the DSM Program Year 2016. If you have any questions, please contact me at (602)250-3341.

Sincerely,

Kerri A. Carnes

KC/ks

cc: Elijah Abinah
Candrea Allen
Barbara Keene
Terri Ford

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Attachment A



APS MER Verification Report

Program Year 2016

Prepared for:

Arizona Public Service Company



Submitted by:
Navigant Consulting, Inc.
1375 Walnut Street
Suite 100
Boulder, CO 80302

303.728.2500
navigant.com

February 27, 2017

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Disclaimer

This report was prepared by Navigant Consulting, Inc. (Navigant) for Arizona Public Service. The work presented in this report represents Navigant's professional judgment based on the information available at the time this report was prepared. Navigant is not responsible for the reader's use of, or reliance upon, the report, nor any decisions based on the report. **NAVIGANT MAKES NO REPRESENTATIONS OR WARRANTIES, EXPRESSED OR IMPLIED.** Readers of the report are advised that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the report, or the data, information, findings and opinions contained in the report.

Introduction

Navigant has completed a review and verification of the energy savings resulting from APS's Demand-Side Management (DSM) programs for calendar year 2016. This report contains the results from that verification, which can be summarized as follows:

- Navigant found that APS accurately applied Navigant verified savings in the work papers that support their 2016 Annual Progress Report.
- APS slightly understated the savings for the Solutions for Business program resulting in a realization rate of 100.2%. The realization rate for the APS portfolio overall is 100.1%. This results in a verified addition of 456 MWh (0.08% of the total savings) for the portfolio for the entire year.
- Savings for the Solutions for Business program should be increased by 456 MWh to account for small tracking discrepancies that affected several measures, including: programmable thermostats, anti-sweat heater controls, and occupancy sensors.
- Navigant finds that the reported savings for the total portfolio of DSM programs for calendar year 2016 should be adjusted upward by 456 MWh, from 572,768 MWh reported in the supporting work papers to 573,225 MWh verified in this Savings Verification Report.

Verification of 2016 APS Reported Savings

Navigant verified that APS' reported energy savings for calendar year 2016 are consistent with evaluation results and recommendations provided as part of the annual MER process. Verification consisted of comparing measure level savings estimates from APS work papers¹ with recommended savings provided to APS by Navigant as part of the 2016 MER process. Specifically, Navigant reviewed APS savings estimates for consistency with a) baseline efficiency changes, b) program implementation modifications, c) new measures approved by the Arizona Corporation Commission for implementation in 2016², and d) any discrepancies between APS estimates and Navigant verified recommendations.

The results of Navigant's verification are presented in Table 1. The following describes the reported values in each column:

- Column A – Reported savings for 2016 program activity as outlined in APS work papers that support the Annual DSM Progress Report that was submitted on March 1, 2017.
- Column B - Reported savings for program activity occurring January through June 2016 as outlined in APS work papers.
- Column C - Reported savings for program activity occurring July through December 2016 as outlined in APS work papers.
- Column D - Navigant verified adjustments to APS work papers accounting for discrepancies between APS estimates and Navigant recommendations.
- Column E – Verified reported savings estimates for 2016 APS program activity based on Navigant verified findings and adjustments listed in Column D. Values are calculated by adding Column A and D.

¹ Work papers supporting end-of-year filings with the Arizona Corporation Commission.

² The ACC approved new measures for the Solutions for Business Program, including: smart thermostats, linear LED lamps, Western Cooling Control, and EC Motors for HVAC units. The ACC approved similar measures for the residential programs including: smart thermostats for the Consumer Products Program and Western Cooling Control for the Residential HVAC and Home Performance with Energy Star programs.

- Column F – The realization rate – or ratio of verified to reported savings – used to quantify the accuracy of APS reporting (i.e. a value of 100% is the most accurate). The realization rate is calculated by dividing the verified estimate by the reported value (i.e. Column E/Column A).

The realization rate of nearly 100% for all programs demonstrates that APS accurately incorporated Navigant recommendations in the work papers that support the 2016 Annual Progress Report of annual energy savings at the generator. However, APS slightly understated annual savings for the Solutions for Business program, resulting in a realization rate of 100.2% for the Solutions for Business Program and a portfolio level realization rate of 100.1%. Through this process, Navigant validated that the 572,768 MWh savings claimed in the supporting work papers should be adjusted up by 456 MWh (0.08% of the total savings) to 573,225 MWh.

The Measurement, Evaluation and Research (MER) Process

Navigant conducts research concurrent with the implementation of energy efficiency programs by APS. This formal evaluation process provides research-based findings on the estimated savings for programs and measures in the APS portfolio of DSM programs. MER research findings are based on extensive measurement and verification activities including engineering analysis, field metering, on-site inspection, customer surveys, contractor and trade ally interviews, focus groups, billing records analyses, and review of implementation tracking databases and documentation. Through the MER process, Navigant provides ongoing evaluation to APS in separate measure-analysis spreadsheets, analytic databases, memos, reports, and presentations. The research provided to APS is used to:

- Assess and verify non-coincident demand savings, coincident demand savings, annual energy savings, and lifetime energy savings claimed by APS in the previous year. In doing so, the accuracy of program savings results are verified through detailed analysis and performance measurement of savings as reported in APS' annual filing with the Arizona Corporation Commission (ACC).
- Calculate cost-effectiveness at the program and portfolio level based on the societal cost test (SCT).
- Drive planning for MER activities for the current program year.
- Refine savings and cost estimates at the program and measure level for the current program year. MER findings and recommendations inform APS savings claims, cost-effectiveness estimates, lost fixed cost recovery, and performance incentives for the current program year.
- Inform program planning savings and cost estimates to support APS implementation plan for the following program year.

Table 1. APS Reported and 2016 MER Report Verified Annual Energy Savings (MWh) and Realization Rates – January through December 2016

Program	APS Reported Savings			MER Verified Adjustments and Savings		
	(A) January-December (MWh) ³	(B) January - June (MWh)	(C) July - December (MWh)	(D) 2016 Adjustments (MWh) ⁴	(E) 2016 Verified (MWh)	(F) Realization Rate ⁵
RESIDENTIAL PROGRAMS						
Consumer Products Program	120,447	56,910	63,537	0	120,447	100.0%
Residential Existing HVAC	21,397	10,313	11,084	0	21,397	100.0%
Home Performance with Energy Star	6,042	2,738	3,305	0	6,042	100.0%
Residential New Construction	10,220	4,720	5,501	0	10,220	100.0%
Residential Behavioral	60,433	30,217	30,217	0	60,433	100.0%
Multifamily	9,567	3,070	6,497	0	9,567	100.0%
Low Income	996	498	498	0	996	100.0%
Prepay	1,243	622	622	0	1,243	100.0%
Total Residential	230,347	109,086	121,260	0	230,347	100.0%
SOLUTIONS FOR BUSINESS PROGRAMS						
Large Existing	172,672	58,982	113,690	-150	172,521	99.9%
Small Business	15,387	7,311	8,075	-48	15,339	99.7%
New Construction	33,376	4,482	28,894	-200	33,176	99.4%
Schools	18,451	4,338	14,112	854	19,305	104.6%
Energy Information Services	33	24	9	0	33	100.0%
Total Solutions For Business	239,918	75,137	164,781	456	240,374	100.2%
Total EE Programs	470,265	184,223	286,041	456	470,721	100.1%
Codes & Standards	41,539	N/A	N/A	N/A	41,539	100.0%
System Savings	4,752	N/A	N/A	N/A	4,752	100.0%
DR Contribution	56,213	N/A	N/A	N/A	56,213	100.0%
DSM Total	572,768	184,223	286,041	456	573,225	100.1%

Source: Navigant Analysis

³ As reported in Annual Progress Report – March 2017.

⁴ Adjustments account for changes and any discrepancies between APS estimates and Navigant recommendations.

⁵ Realization Rate is calculated by dividing verified savings (Column E) by annual reported savings (Column A).

2016 Verification Findings by Program

Navigant's findings from the review of APS work papers are as follows:

- Consumer Products Program
 - APS accurately reported savings based on Navigant evaluation results and recommendations provided as part of the annual MER process.
 - APS accurately accounted for updated LED and CFL in-service rate adders in calculating annual lifetime energy savings.
 - APS accurately adjusted savings for retail and giveaway LEDs and CFLs to reflect appropriate measure lifetimes and leakage rates.
- Residential Existing HVAC
 - APS accurately updated savings values for the duct test and repair, western cooling control, prescriptive duct repair, quality installation, and advanced diagnostic tune up measures for 2016.
 - APS accurately accounted for all baselines including the updated federal minimum standard for air conditioners and heat pumps installed through the quality installation measure. This affected the savings starting in mid-2016. The new federal minimum standards do not affect the baseline of any other measures.
- Residential New Construction
 - APS accurately accounted for updated baselines resulting from increased adoption of more efficient building energy codes for single family homes for jurisdictions within APS service territory.
- Home Performance with Energy Star
 - APS accurately reported savings for showerheads, LEDs, western cooling control, online audits, duct test and repair, attic insulation and air sealing based on Navigant evaluation results and recommendations provided as part of the annual MER process.
 - Navigant updated the customer incremental costs for audits to reflect current market value in APS service territory. APS cost effectiveness calculations accurately reflect these findings.
- Residential Behavioral
 - APS accurately reported savings based on Navigant evaluation results and recommendations provided as part of the annual MER process.
- Multi-Family Energy Efficiency Program
 - APS accurately reported savings for showerheads, aerators, CFLs and LEDs based on Navigant evaluation results and recommendations provided as part of the annual MER process.
 - APS accurately updated savings estimates for builder option packages for the second half of 2016 based on updated multifamily building energy models that are calibrated to energy use data from recent participants.
- Low Income Weatherization Program
 - This program is not evaluated as part of Navigant's MER contract. Values listed in the tables are based on APS reported savings.
- Pre-Pay
 - APS accurately reported savings for pre-pay pilot program participants based on Navigant evaluation results and recommendations provided as part of the annual MER process.
- Solutions for Business Program
 - Navigant adjusted savings to account for differences in tracked values for the following measures: programmable thermostats, occupancy sensors, and low and medium temperature anti-sweat heater controls. For example, Navigant found that the implementation contractor had incorrect energy savings values for programmable

- thermostats. The adjustments resulted in a realization rate of 112% for programmable thermostats.
- Navigant found that APS correctly incorporated impact estimates for the two new measures that saw participation in 2016; smart thermostats and linear LEDs.
 - The adjustments for all tracking differences increased the total reported Solutions for Business savings by 0.2%.
 - Energy Information Services Program
 - APS accurately reported savings based on Navigant evaluation results and recommendations provided as part of the annual MER process.
 - Codes and Standards Program
 - Navigant updated savings for building energy codes based on new meter set data provided by APS, as well as updated savings for national efficiency standards for residential air conditioners and heat pumps based on HARDI sales data provided by APS.
 - System Savings
 - APS accurately accounted for savings resulting from new conservation voltage reduction projects implemented in 2016. Navigant will conduct evaluation activities for this program in 2017.
 - Demand Response Contribution
 - APS accurately accounted for the demand response contribution to energy savings for the portfolio.

Attachment B



APS Codes and Standards Report

Program Year 2016

Prepared for:

Arizona Public Service Company



Submitted by:

Navigant Consulting, Inc.
1375 Walnut Street
Suite 100
Boulder, CO 80302

303.728.2500
navigant.com

Reference No.: 139948
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EXECUTIVE SUMMARY

This report presents Navigant Consulting, Inc.'s (Navigant's) results and analysis of energy and demand savings from improved energy efficiency appliance standards and building codes claimable by Arizona Public Service (APS) in 2016. As stated in section R14-2-2404 part E of the Electric Energy Efficiency Standards:¹

An affected utility may count toward meeting the standard up to one third of the energy savings, resulting from energy efficiency building codes, that are quantified and reported through a measurement and evaluation study undertaken by the affected utility.

Furthermore, the Arizona Corporation Commission (ACC) allows APS to include savings "resulting from improved energy efficiency appliance standards."²

The savings presented in this report reflect increased adoption of federal, state, and jurisdictional codes and standards (C&S) that are directly influenced by APS' portfolio of demand-side management (DSM) programs. This increased adoption results in more efficient baselines that, in addition to driving greater savings for C&S programs, reduce the savings potential for measures currently incentivized by APS' DSM programs. Therefore, each year APS adjusts its savings accordingly to reflect these baseline changes, which drives APS to pursue new program opportunities focused on the latest, most efficient technologies.

The following tables summarize the C&S analyzed and the savings claimed by APS for 2016. Table 1 presents the C&S related to the APS programs and measures discussed in this report. Table 2 summarizes the C&S energy and demand savings claimable by APS for 2016. Navigant applied the ACC prescribed allowance of one-third to calculate C&S program savings for all C&S under consideration. Navigant calculated lifetime energy savings by multiplying the annual energy savings by the effective useful lifetime for each measure.

¹ Docket No. RE-00000C-09-0427 (Electric Energy Efficiency Rules) Title 14, Chapter 2, Article 24, section R14-2-2404.

² Docket No. E-01345A-11-0232; Decision No. 73089 pg. 56 Line 11

Table 1. C&S Updates in APS Territory

Measure/ End Use	Relevant APS Program	Relevant APS Measure	Old Code	New Code	Authority	Effective Year
General Service Lamps (GSLs)	Consumer Products	Compact Fluorescent Light Bulbs	None	EISA ³	Federal	2012, 2013, 2014
Linear Fluorescent Lamps (LFLs)	Solutions for Business	Premium T8s and T5s	EPACT 1992	DOE Federal Rulemaking ⁴	Federal	2012
Residential Air Conditioners and Heat Pumps	Residential HVAC	Residential Air Conditioners and Heat Pumps	DOE Federal Rulemaking ⁵	DOE Federal Rulemaking ⁶	Federal	2015
Motors	Solutions for Business	NEMA Premium Motors	EPACT 1992	EISA	Federal	2010
Residential New Construction	ENERGY STAR Homes	ENERGY STAR Version 3 Homes	IECC 2003, 2006, 2009	IECC 2006, 2009, 2012	Jurisdictional	Various
Commercial New Construction	Solutions for Business	Whole Building Design	ASHRAE 90.1 2007, 2010	ASHRAE 90.1 2010, 2013	Jurisdictional	Various

Source: Navigant analysis

³ Energy Independence and Security Act of 2007 (EISA). Public Law 110-140, 110th Congress. December 19, 2007. <http://www.gpo.gov/fdsys/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf>

⁴ US Department of Energy (DOE). "Energy Conservation Program: Energy Conservation Standards and Test Procedures for General Service Fluorescent Lamps and Incandescent Reflector Lamps; Final Rule." July 14, 2009. http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/74fr34080.pdf

⁵ US DOE. "Energy Conservation Program for Consumer Products: Central Air Conditioners and Heat Pumps Energy Conservation Standards; Final Rule; technical correction." <http://www.regulations.gov/#!documentDetail:D=EERE-2006-STD-0089-0398>

⁶ US DOE. "Energy Conservation Program: Energy Conservation Standards for Residential Furnaces and Residential Central Air Conditioners and Heat Pumps; Direct Final Rule." <http://www.regulations.gov/#!documentDetail:D=EERE-2011-BT-STD-0011-0001>

Table 2. Energy and Demand Savings at Generator⁷ for C&S Program: 2016

Measure/End Use	Annual Energy Savings (MWh)	Lifetime Energy Savings (MWh)	Demand Savings (MW)
GSLs	18,628	37,256	2.76
LFLs	8,846	132,694	2.27
Residential Air Conditioners and Heat Pumps	4,242	76,359	2.06
Motors	987	14,799	0.36
Residential New Construction	4,539	90,773	2.30
Commercial New Construction	4,297	85,954	0.98
Total	41,539	437,832	10.74

Source: Navigant analysis

Findings and Results by Measure Category

This section provides more detail on each measure or end-use category listed in Table 2 and its corresponding code or standard. Each subsection presents a short description of the code or standard, the general approach for calculating savings, and a summary of the savings calculated.

General Service Lamps

GSL savings were driven by the market shift from incandescent technology to more efficient halogen technology, which was the result of standards set forth by the Energy Independence and Security Act of 2007 (EISA).⁸ EISA requires lamps to use approximately 25% to 30% less energy than typical incandescent lamps. Figure 1 shows the shift in technology that occurred in 2016 as a result of the EISA standards. If EISA had not been enacted (i.e., the base case), incandescent sales would have represented 53% of the incandescent/halogen market. However, because of EISA, the market baseline shifts to 100% halogen technology (i.e., the standards case).

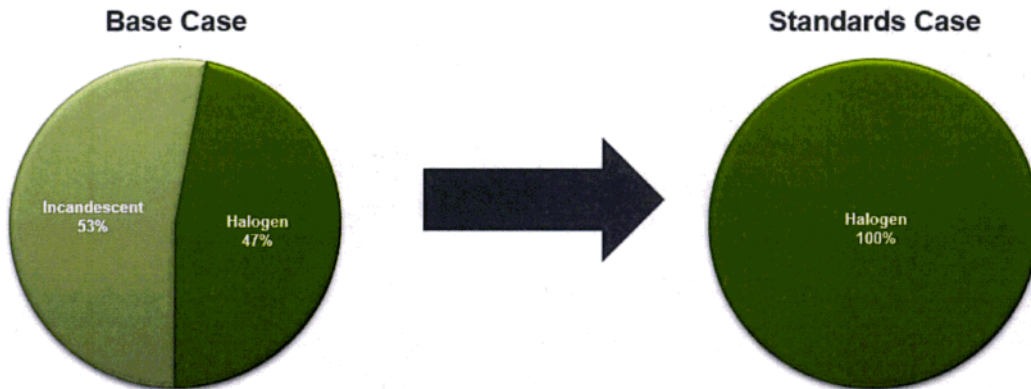
Navigant used a national analysis of the EISA standard conducted by the US Environmental Protection Agency (EPA)⁹ to determine the market share for incandescent (non-compliant) and halogen (compliant) bulbs for the standards case through 2014. Navigant assumed that full compliance was reached in 2016. Navigant also consulted internal lighting market experts to estimate how the market would have progressed absent the EISA standard to determine shares for the base case.

⁷ Generator savings are calculated using a line loss factor of 7% and 11.7% for energy and demand, respectively, and a capacity reserve margin assumption of 15%.

⁸ EISA. Public Law 110-140, 110th Congress. <http://www.gpo.gov/fdsys/pkg/PLAW-110publ140/html/PLAW-110publ140.htm>

⁹ EPA. *Next Generation Lighting Programs: Opportunities to Advance Efficient Lighting for a Cleaner Environment*. http://www.energystar.gov/ia/partners/manuf_res/downloads/lighting/EPA_Report_on_NGL_Programs_for_508.pdf

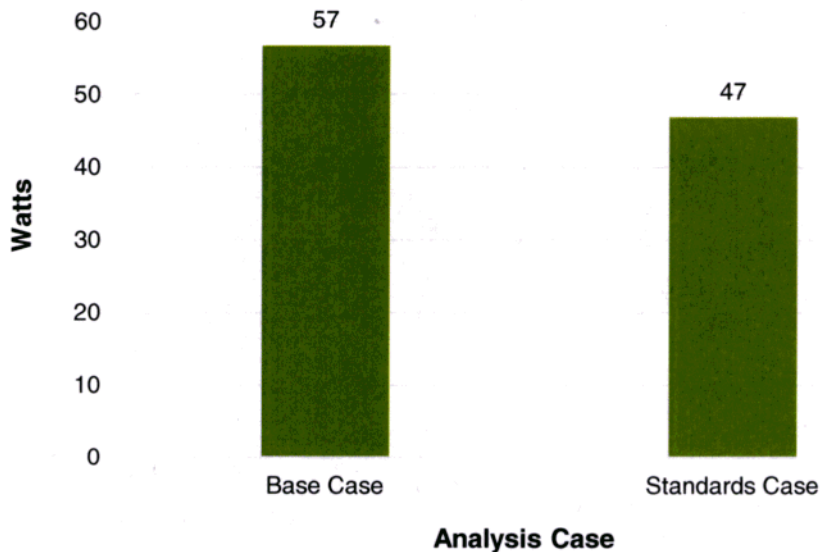
Figure 1. Base Case and Standards Case GSL Incandescent/Halogen Market Shares: 2016



Source: Navigant analysis

Navigant’s analysis resulted in an average reduction in lamp wattage of 10W for GSLs sold in APS territory (Figure 2) between the base case and the standards case in 2016. This accounted for the market share of each lamp technology, average wattages for each technology based on its lumen output, and the percentage of sales in each lumen bin derived consistently with APS program activity. The reduction was largely driven by sales of 750-1049 lumen output lamps, which accounted for roughly two-thirds of lamp sales.

Figure 2. GSL Weighted Average Wattages: 2016



Source: Navigant analysis

Navigant derived final savings by combining this wattage reduction with GSL lamp sales in APS territory and APS-specific hours of use for lighting applications in both the residential and commercial sectors.

Lamp sales were derived from National Electric Manufacturers Association (NEMA) sales data¹⁰ and the US Department of Energy (DOE) standards rulemaking process¹¹ and adjusted based on the number of APS customers relative to the nationwide population.¹² Hours of use were based on field-metered data of residential and commercial applications of APS customers. Table 3 presents the 2016 energy and demand savings for GSLs for both residential and commercial applications.

Table 3. Energy and Demand Savings at Generator¹³ for GSL Standards: 2016

Sector	Annual Energy Savings (MWh)	Lifetime Energy Savings (MWh)	Demand Savings (MW)
Residential	13,635	27,270	1.87
Commercial	4,993	9,986	0.89
Total	18,628	37,256	2.76

Source: Navigant analysis

Linear Fluorescent Lamps

LFL savings were driven by the market shift from T12 and 700 series T8 lamps to the more efficient 800 series T8 technology, which was the result of DOE standards¹⁴ enacted in 2012. This standard requires lamps to use approximately 9% to 21% less energy than previously required. Figure 3 shows the shift in technology that occurred in 2016 as a result of the standards. If the standards had not been enacted (i.e., the base case), T12 sales would have represented 15% of the T12/T8 market. However, because of standards, the market shifts to 10% T12 sales. (i.e., the standards case). Navigant used national sales data from the NEMA sales indices¹⁵ and the DOE standards rulemaking process¹⁶ to determine the market share of T12 and T8 lamps in the base case and the standards case.

¹⁰NEMA. "Incandescent Lamp Shipment Index." October, 2013 <http://www.nema.org/news/Pages/Incandescent-Lamp-Shipment-Wane-During-Second-Quarter.aspx>

¹¹ DOE. "General Service Incandescent Lamps Rulemaking." http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/61

¹² US Energy Information Administration (EIA). Electricity Utility Sales and Revenue—EIA-826 Detailed Data File. <http://www.eia.gov/electricity/data/eia826/>

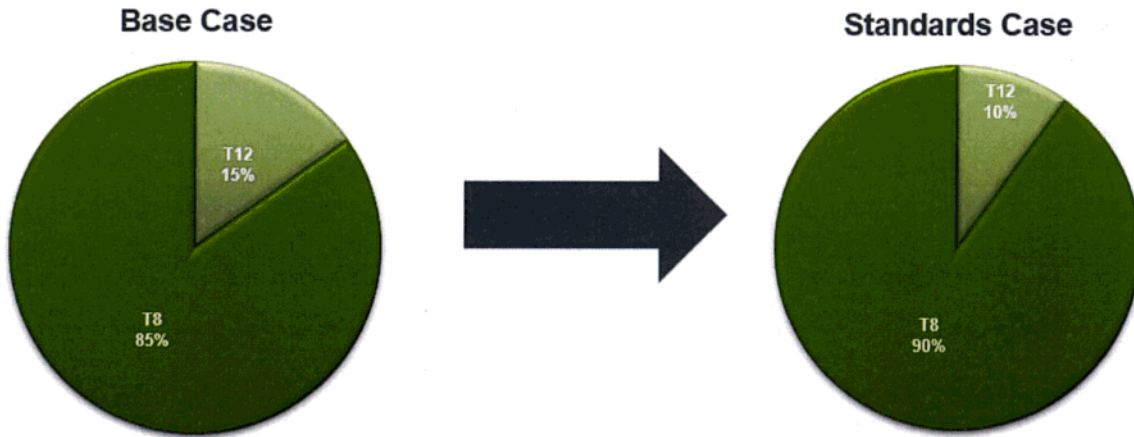
¹³ Generator savings are calculated using a line loss factor of 7% and 11.7% for energy and demand, respectively, and a capacity reserve margin assumption of 15%.

¹⁴ DOE. "Energy Conservation Program: Energy Conservation Standards and Test Procedures for General Service Fluorescent Lamps and Incandescent Reflector Lamps; Final Rule." July 14, 2009. http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/74fr34080.pdf

¹⁵ NEMA. "T5/T8/T12 Lamp Shipment Index." <http://www.nema.org/intelligence/pages/lamp-indices.aspx>

¹⁶ DOE. "General Service Fluorescent Lamps Rulemaking." http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/70

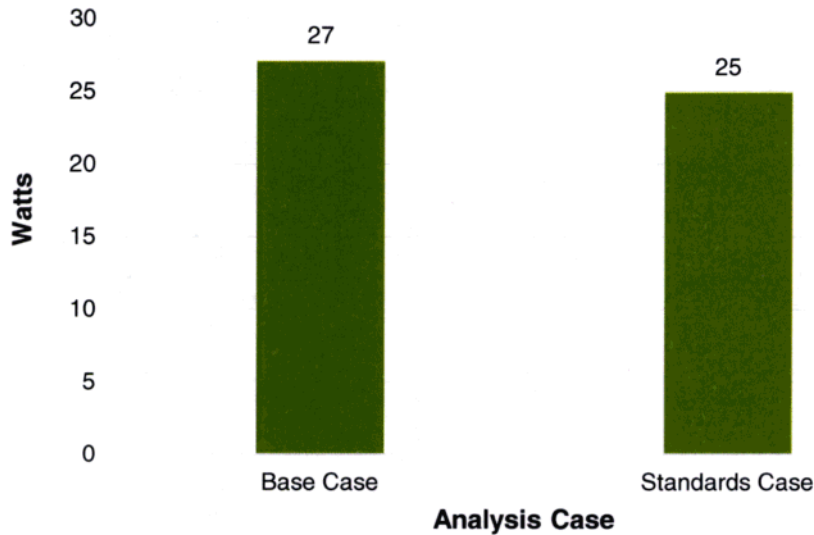
Figure 3. Base Case and Standards Case LFL T8 and T12 Market Shares: 2016



Source: Navigant analysis

Navigant’s analysis resulted in an average reduction in lamp wattage of 2W for LFLs sold in APS territory (Figure 4) between the base case and the standards case in 2016. This accounted for the market share of each lamp technology, average wattages for each technology, and the percentage of sales in each sector from NEMA. The reduction was largely driven by the shift from higher wattage T12 lamps to lower wattage T8 lamps, though some savings were driven by the required increase in efficiency of T8 lamps.

Figure 4. LFL Weighted Average Wattages



Source: Navigant analysis

Navigant derived final savings by combining this wattage reduction with LFL lamp sales in APS territory and APS-specific hours of use for lighting applications. Lamp sales were derived from NEMA sales data¹⁷

¹⁷ NEMA. "T5/T8/T12 Lamp Shipment Index." <http://www.nema.org/intelligence/pages/lamp-indices.aspx>

and adjusted based on the number of APS customers relative to the nationwide population.¹⁸ Hours of use were based on field-metered data of residential and commercial applications of APS customers. Table 4 presents the 2016 energy and demand savings for LFLs for both residential and commercial applications.

Table 4. Energy and Demand Savings at Generator¹⁹ for LFL Standards: 2016

Sector	Annual Energy Savings (MWh)	Lifetime Energy Savings (MWh)	Demand Savings (MW)
Residential	362	5,437	0.04
Commercial	8,484	127,257	2.24
Total	8,846	132,694	2.27

Source: Navigant analysis

Residential Air Conditioners and Heat Pumps

The savings for residential air conditioners (ACs) and heat pumps (HPs) were driven by the market shift from Seasonal Energy Efficiency Ratio (SEER) 13 units to more efficient SEER 14 units, which was the result of DOE standards²⁰ enacted in 2015. This standard requires ACs and HPs to use approximately 4% to 7% less energy than previously required. Figure 5 shows the shift in technology that occurred in 2016 as a result of the standards. If the standards had not been enacted (i.e., the base case), SEER 13 sales would have represented 60% of the market. However, because of the standard, the market shifts to only 18% SEER 13 sales, with other sales shifting to efficiency levels of SEER 14 and greater (i.e., the standards case). Navigant used Heating, Air-conditioning & Refrigeration Distributors International (HARDI) data obtained from APS and data from the DOE standards rulemaking analysis²¹ to determine the market share of SEER 13, SEER 14, and higher SEER ACs and HPs in the base case and the standards case.

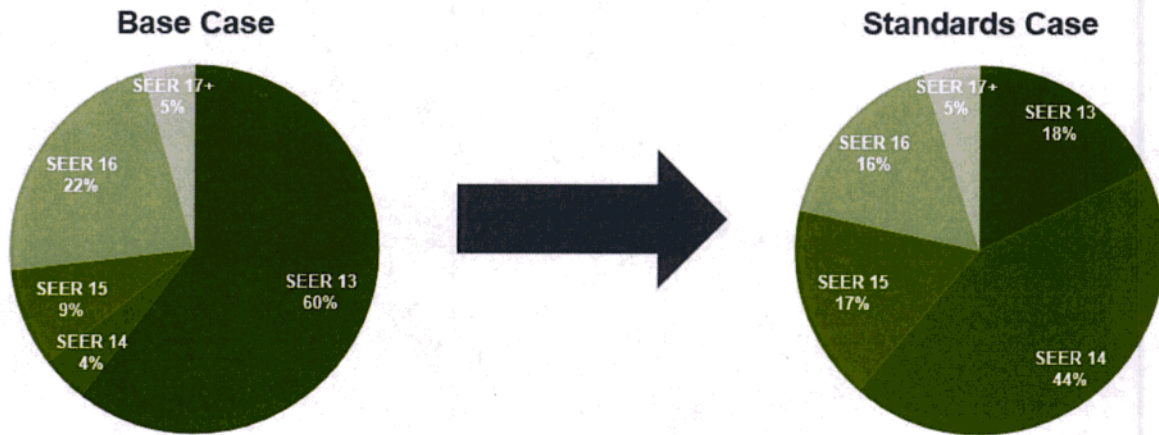
¹⁸ US EIA Electricity Utility Sales and Revenue—EIA-826 Detailed Data File. <http://www.eia.gov/electricity/data/eia826/>

¹⁹ Generator savings are calculated using a line loss factor of 7% and 11.7% for energy and demand, respectively, and a capacity reserve margin assumption of 15%.

²⁰ DOE. "Energy Conservation Program: Energy Conservation Standards for Residential Furnaces and Residential Central Air Conditioners and Heat Pumps." <https://www.regulations.gov/docket?D=EERE-2011-BT-STD-0011>

²¹ Ibid.

Figure 5. Base Case and Standards Case Residential AC and HP SEER Market Shares: 2016



Source: Navigant analysis

Navigant’s analysis resulted in an average reduction in annual energy consumption, also referred to as unit energy consumption (UEC), of 116 kWh for ACs and HPs sold in APS territory (Figure 6) between the base case and the standards case in 2016. This accounted for the market share of each SEER level, average UEC for each SEER level, and the percentage of sales in each sector and product class for each product type from the DOE.²² The reduction was largely driven by the shift from higher consumption SEER 13 units to lower consumption SEER 14 units, though the standards also caused combined market shares of efficiency levels of SEER 15 and greater to increase as well. The standard resulted in a 2% reduction in annual energy use.

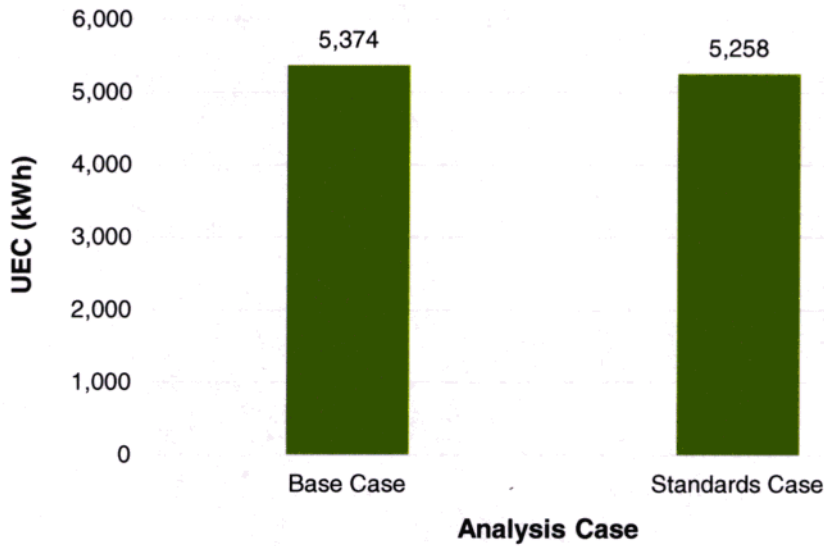
Navigant derived final savings by combining this UEC reduction with AC and HP sales in APS territory. Unit sales were derived from national DOE sales data²³ and adjusted based on the number of APS customers relative to the nationwide population.²⁴ Table 5 presents the savings for single-phase heating, ventilation, and air conditioning (HVAC) equipment in both residential and commercial applications.

²² Ibid.

²³ Ibid.

²⁴ US EIA. Electricity Utility Sales and Revenue—EIA-826 Detailed Data File. <http://www.eia.gov/electricity/data/eia826/>

Figure 6. AC and HP Weighted Average UEC: 2016



Source: Navigant analysis

Table 5. Energy and Demand Savings at Generator²⁵ for AC and HP Standards: 2016

Sector	Annual Energy Savings (MWh)	Lifetime Energy Savings (MWh)	Demand Savings (MW)
Residential	3,633	65,393	1.90
Commercial	609	10,966	0.17
Total	4,242	76,359	2.06

Source: Navigant analysis

Motors

Increased efficiency requirements from DOE standards²⁶ that went into effect in 2016 for electric motors resulted in motors consuming 0.4% to 1.7% less energy than previous requirements under EISA.²⁷ Figure 7 shows the change in annual motor energy consumption (i.e., UEC) that occurred in 2016 as a result of the standards for each horsepower bin. If the 2016 DOE standards had not been enacted (i.e., the base case), the UECs would have remained at their original EISA levels. However, because of the standard, motors consumed less energy overall (i.e., the standards case). Navigant used the DOE standards rulemaking process²⁸ to determine the change in UECs between the base case and the standards case.

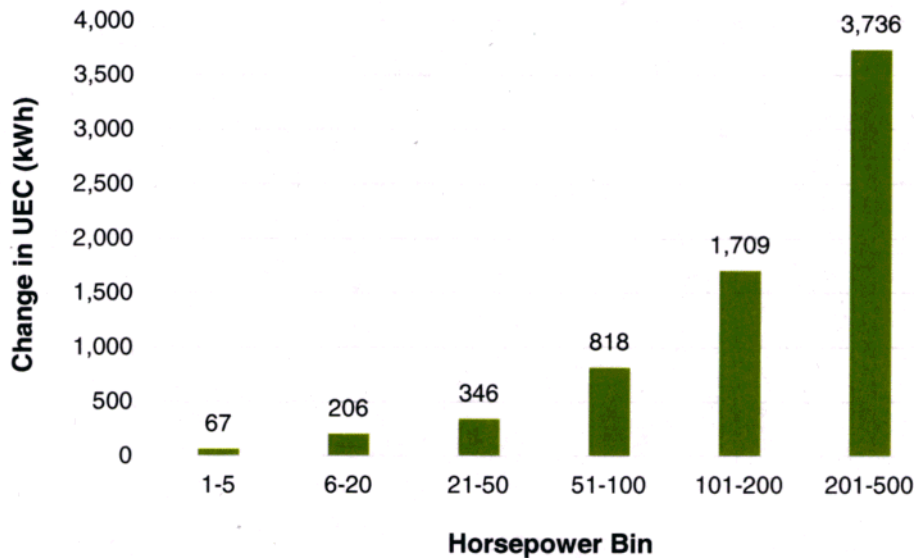
²⁵ Generator savings are calculated using a line loss factor of 7% and 11.7% for energy and demand, respectively, and a capacity reserve margin assumption of 15%.

²⁶ DOE. 2014 Electric Motors Final Rule. Available at <http://www.regulations.gov/#!docketDetail;D=EERE-2010-BT-STD-0027>.

²⁷ EISA. Public Law 110-140, 110th Congress. <http://www.gpo.gov/fdsys/pkg/PLAW-110publ140/html/PLAW-110publ140.htm>

²⁸ DOE. 2014 Electric Motors Final Rule. Available at <http://www.regulations.gov/#!docketDetail;D=EERE-2010-BT-STD-0027>.

Figure 7. Change in UECs for Motors by Horsepower Bin: 2016



Source: Navigant analysis

Although the 201-500 horsepower bin had the largest change in UEC, it represented the lowest market share in terms of horsepower bin sales, as shown in Figure 8. Further, market share—in terms of number of motors sold—decreased as horsepower increased. Thus, overall energy savings were tempered by this trend.

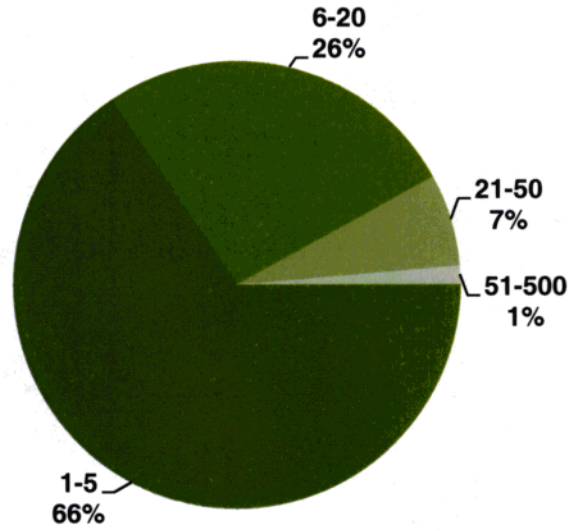
Navigant’s analysis resulted in an average UEC reduction of 139 kWh for motors sold in APS territory (Figure 9) between the base case and the standards case in 2016. This accounted for the market share of each horsepower bin, average UECs for each horsepower bin, and the percentage of sales in each sector from the DOE. The reduction was driven by both a large number of motors with a small change in UEC and a small number of motors with a large change in UEC. The standard resulted in a 1% reduction in annual energy use.

Navigant derived final savings by combining this UEC reduction with motor sales in APS territory. Motor sales were derived from national DOE sales data²⁹ and adjusted based on the number of APS customers relative to the nationwide population.³⁰ Table 6 presents savings from motors in industrial and commercial applications.

²⁹ Ibid.

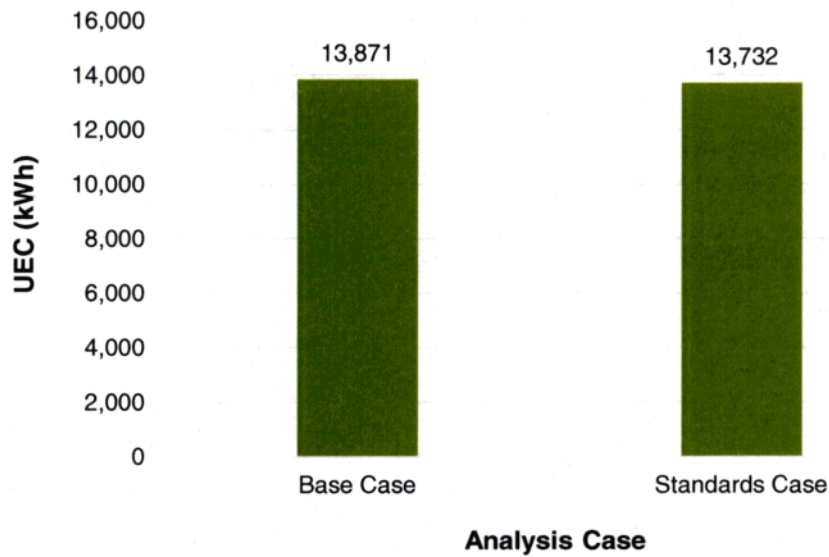
³⁰ US EIA. Electricity Utility Sales and Revenue—EIA-826 Detailed Data File. <http://www.eia.gov/electricity/data/eia826/>

Figure 8. Sales Percentages of Each Motors Horsepower Bin: 2016



Source: Navigant analysis

Figure 9. Motors Weighted Average UEC: 2016



Source: Navigant analysis

Table 6. Energy and Demand Savings at Generator³¹ for Motor Standards: 2016

Sector	Annual Energy Savings (MWh)	Lifetime Energy Savings (MWh)	Demand Savings (MW)
Industrial	23	347	0.01
Commercial	963	14,452	0.35
Total	987	14,799	0.36

Source: Navigant analysis

Residential New Construction

Energy savings in the residential new construction (RNC) market resulted from increased adoption of more efficient vintages of the International Energy Conservation Code (IECC) across APS' service territory. The IECC is updated at 3-year intervals with recent advances in energy efficient design and construction techniques. Navigant used newly installed meters in 158 jurisdictions in APS territory in 2016 as a proxy for the number of RNC projects in conjunction with the IECC vintage adopted in each jurisdiction to determine how the RNC market efficiency changed in 2016. This section compares savings estimates from 2015 and 2016 to elucidate how the market shifted in 2016.

Table 7 shows that the number of new residential homes increased from 2015 to 2016. Specifically, new construction of single family homes increased by 24.4% in 2016 over 2015, while multifamily new construction activity decreased by 13.4% compared to 2015. Overall, new construction activity increased by 12.5% relative to 2015, which is one important driver for increased energy savings in 2016.

Table 7. APS New Residential Meter Installations: 2015, 2016

Year	Single Family	Multifamily	Total New Meters
2015	9,009	4,194	13,203
2016	9,604	3,073	12,677

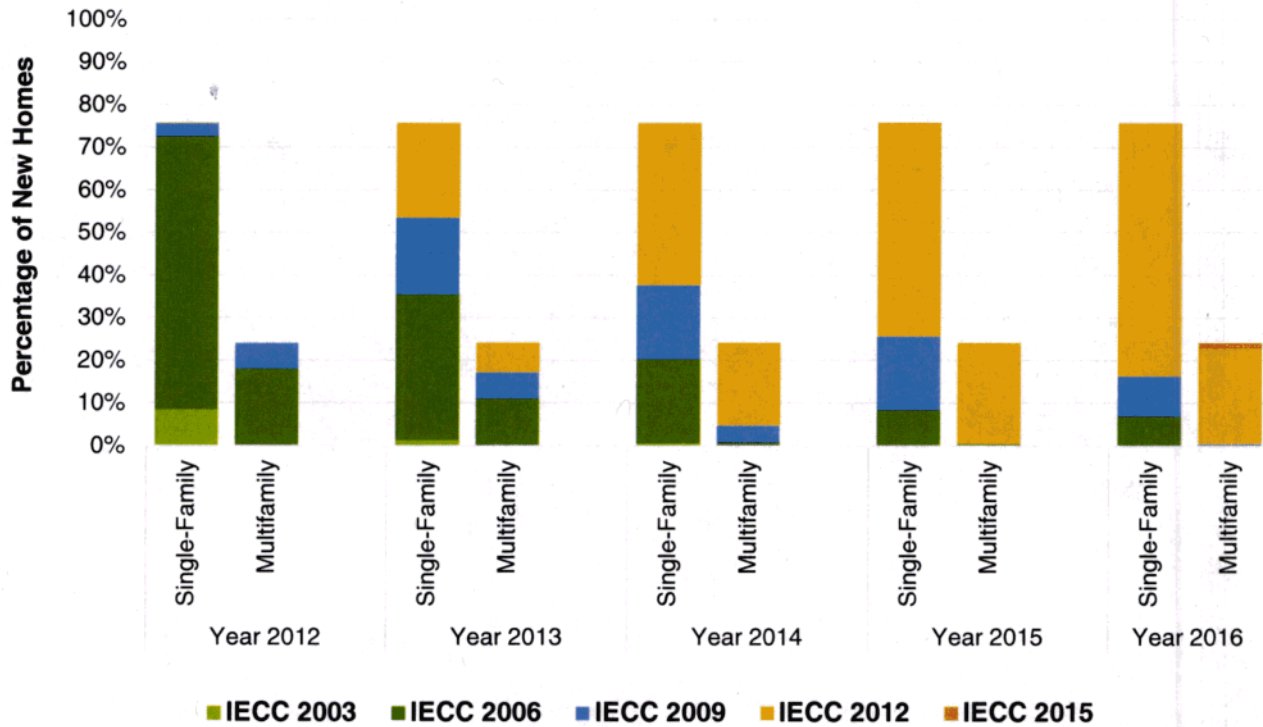
Source: APS meter set data

Navigant calculated the net annual energy savings by subtracting the annual efficient consumption from the annual baseline consumption. The consumption per home varied in the baseline and efficient cases, with the baseline case based on the IECC vintage from 3 years ago and the efficient case based on the current IECC vintage adopted by a certain jurisdiction. (As codes advance, newer vintages are more efficient, thus driving savings.) The total market consumption was calculated by multiplying the consumption per home for each case by the number of homes constructed, and then summing them for each jurisdiction within APS territory.

Figure 10 demonstrates the IECC vintage shift from 2012 to 2016, by applying the total number of single family and multifamily new construction projects for 2016 for each year. Each bar shows the percentage distribution of new housing starts in each IECC vintage. Overall, in the last 4 years there was a shift in the market away from older vintages toward more recent vintages—especially IECC 2012.

³¹ Generator savings are calculated using a line loss factor of 7% and 11.7% for energy and demand, respectively, and a capacity reserve margin assumption of 15%.

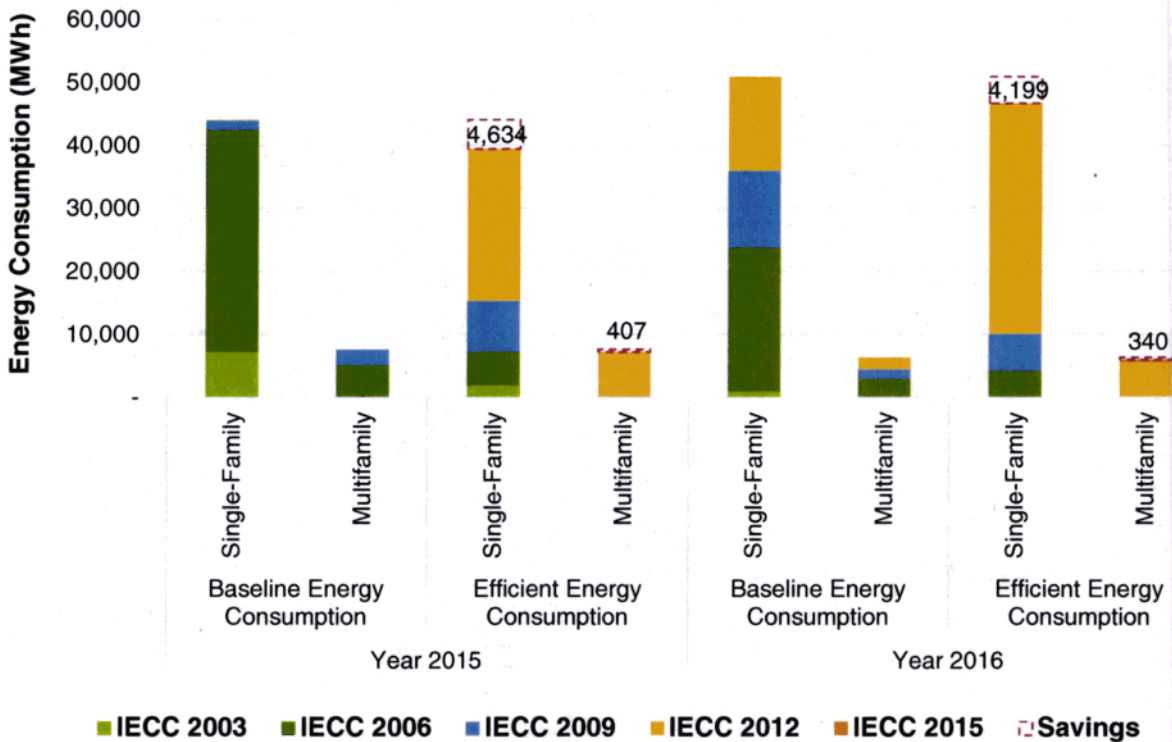
Figure 10. New Home Number Percentage Subject to Vintage Code for RNC: 2012-2016



Source: Navigant analysis

Figure 11 shows the baseline and efficient energy consumption of the RNC market in both 2015 and 2016, as well as the respective energy savings for both years. Single family energy consumption in 2016 was higher, whereas consumption for the multifamily market was lower, due primarily to the number of new homes constructed each year, as shown in Table 7. Although 2016 had more single family construction activity than 2015, it yielded less savings than 2015 because its corresponding base year vintage distribution was more efficient. In other words, because the baseline was more efficient, there was less opportunity for savings. In 2016, multifamily energy savings also decreased relative to 2015, which was consistent with the decreased number of multifamily meters in 2016 and the more efficient baseline.

Figure 11. Baseline and Efficient Energy Consumption by Vintage Type for RNC: 2015, 2016



Source: Navigant analysis

As shown in Table 8, the net C&S program savings are the final savings claimed by APS and include the one-third allowance adjustment. In 2016, APS can claim 4,539 MWh of annual energy savings, 90,773 of lifetime energy savings, and 2.30 MW of demand savings from the jurisdictional IECC residential building codes.

Table 8. Energy and Demand Savings at Generator³² for RNC: 2015, 2016

Year	Net C&S Program		
	Annual Energy Savings (MWh)	Lifetime Energy Savings (MWh)	Demand Savings (MW)
2015	5,041	100,830	2.56
2016	4,539	90,773	2.30

Source: Navigant analysis

Commercial New Construction

Energy savings in the commercial new construction (CNC) market resulted from increased adoption of more efficient vintages of ASHRAE 90.1 across APS' service territory. ASHRAE 90.1 is updated at 3-year

³² Generator savings are calculated using a line loss factor of 7% and 11.7% for energy and demand, respectively, and a capacity reserve margin assumption of 15%.

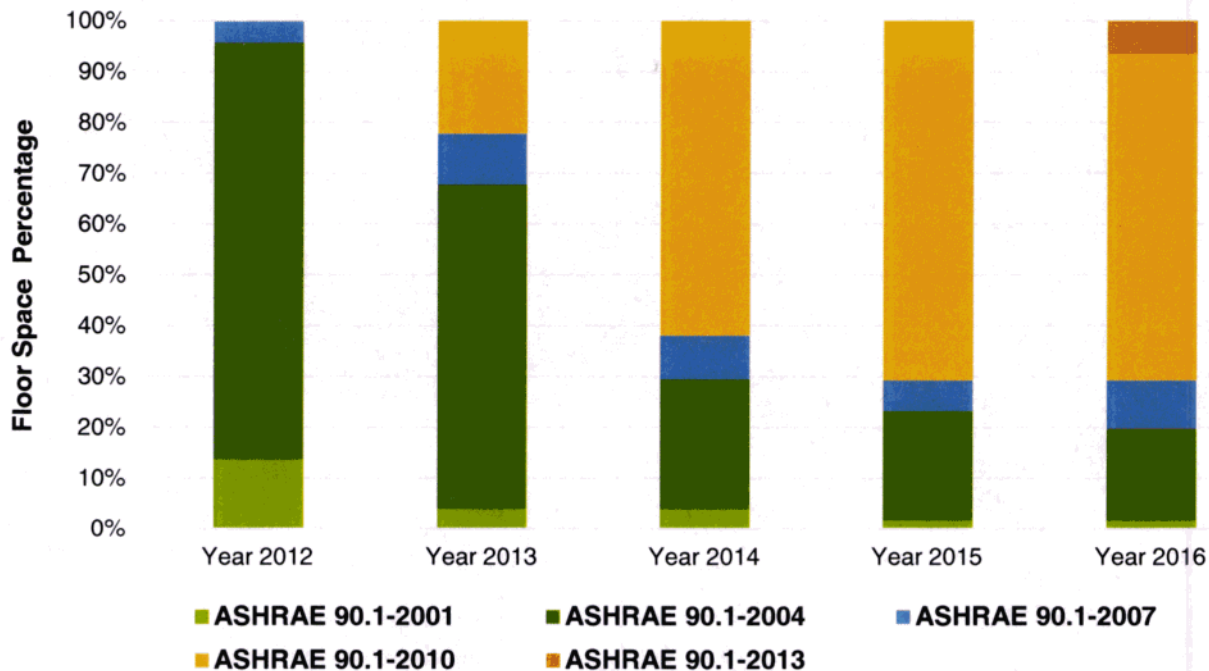
intervals with recent advances in energy efficient design and construction techniques. Navigant's analysis relied on the number of new commercial buildings constructed in APS territory in 2016, the vintage of ASHRAE 90.1 adopted by each jurisdiction and the corresponding energy consumption of ASHRAE 90.1 by building type for the base and standard cases. This section compares savings estimates between 2015 and 2016 to elucidate how the market shifted in 2016.

Navigant used newly installed meters in 158 jurisdictions in APS territory in 2016 as a proxy for the number of CNC projects. APS installed 434 and 469 commercial meters in 2015 and 2016, respectively, yielding an 8.1% increase in construction activity.

Navigant calculated the net annual energy savings by subtracting the annual efficient consumption from the annual baseline consumption. The consumption per building varied in the baseline and efficient cases, with the baseline case based on the ASHRAE 90.1 vintage from 3 years ago and the efficient case based on the current ASHRAE 90.1 vintage adopted by a certain jurisdiction. (As codes advance, newer vintages generally become more efficient, thus producing savings.) The total market consumption was calculated by multiplying the consumption per building for each case by the number of buildings constructed, and then summing them for each jurisdiction within APS territory.

Figure 12 shows the ASHRAE 90.1 vintage shift from 2012 to 2016 by applying the total square footage of CNC floor area in 2016 to each year. Each bar shows the percentage distribution of square feet of floor space for each ASHRAE 90.1 vintage. The largest market shifts occurred in 2013 and 2014.

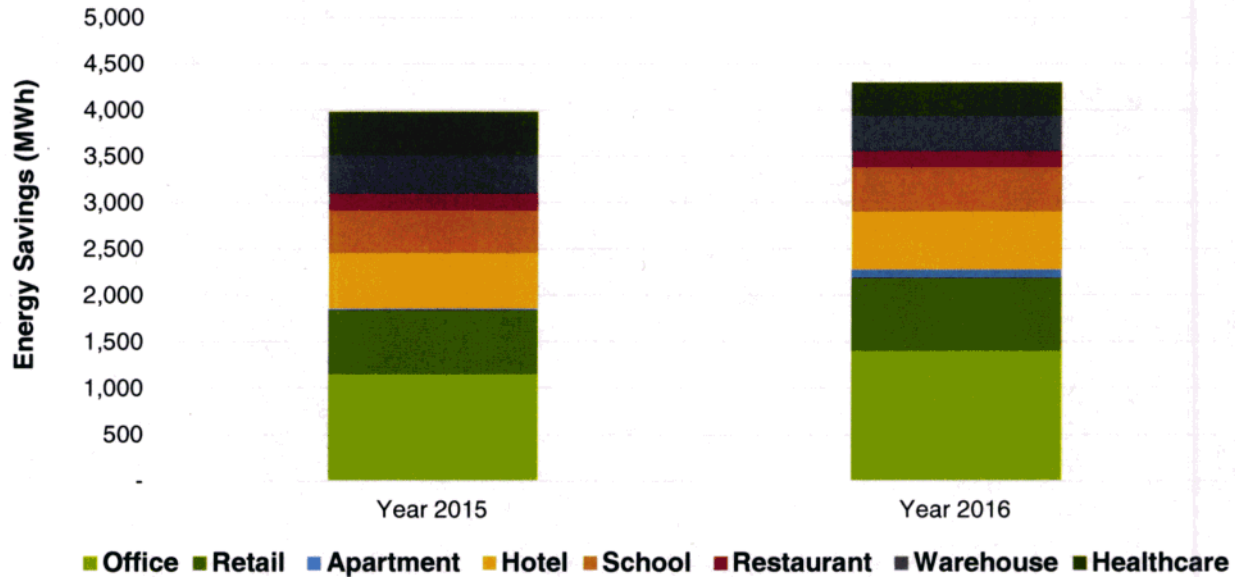
Figure 12. Percentage of Floor Area Subject to Code Vintage for CNC: 2012-2016



Source: Navigant analysis

The analysis used 16 DOE designations,³³ each of which have different typical floor areas and building energy intensities (i.e., kWh/year-sq. ft.). Figure 13 shows energy savings by building type in 2015 and 2016 for the CNC market in APS territory. Greater total floor area in 2016 compared to 2015, in addition to the adoption of more efficient codes, contributed to higher savings. Office, retail, apartment, hotel, and school buildings achieved greater savings in 2016 due to a higher percentage of new construction projections for those building types. Healthcare, warehouse, and restaurant buildings achieved less savings due to fewer new construction projects for those building types.

Figure 13. Energy Savings by Building Type: 2015, 2016



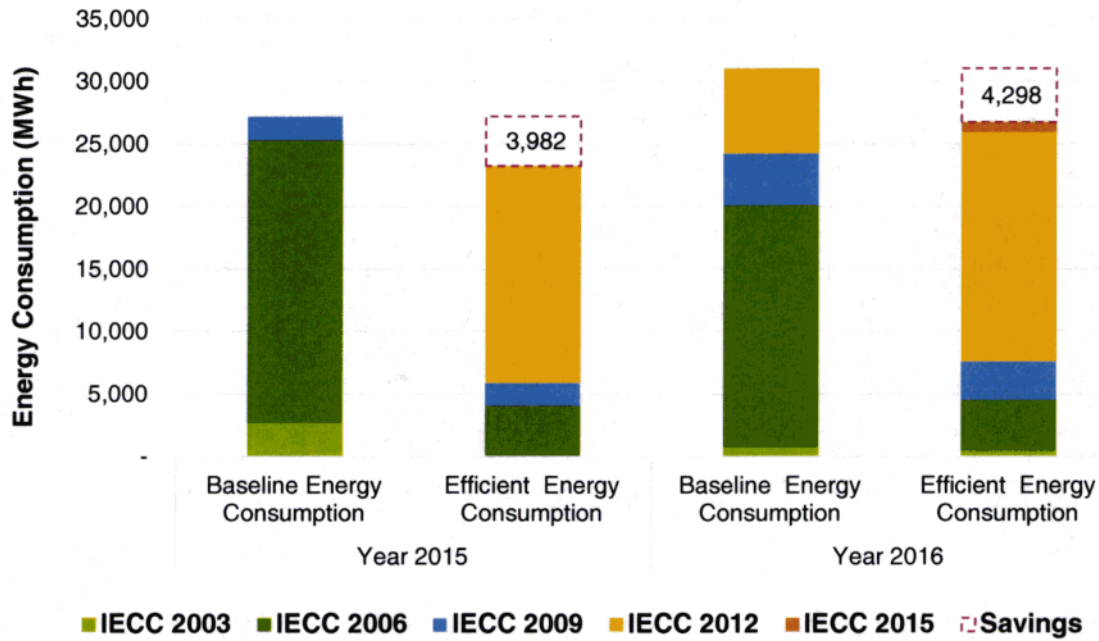
Source: Navigant analysis

Figure 14 shows baseline and efficient energy consumption for CNC codes in 2015 and 2016. The baseline and efficient energy consumption was higher in 2016 than 2015, which can be explained primarily by the increased new construction activity and secondarily by the code vintage shift.

³³ DOE. Building Energy Codes Program. ANSI/ASHRAE/IES Standard 90.1.

https://www.energycodes.gov/development/commercial/prototype_models.

Figure 14. Baseline and Efficient Energy Consumption for CNC Codes: 2015, 2016



Source: Navigant analysis

Table 9 shows the energy and demand savings at Generator for CNC codes in 2015 and 2016. The net C&S program savings are the final savings claimed by APS and include the one-third allowance adjustment. In 2016, APS can claim 4,298 MWh of annual energy savings, 85,954 MWh of lifetime energy savings, and 0.98 MW of demand savings from the jurisdictional ASHRAE 90.1 commercial building codes.

Table 9. Energy and Demand Savings at Generator³⁴ for CNC: 2015, 2016

Year	Net C&S Program		
	Annual Energy Savings (MWh)	Lifetime Energy Savings (MWh)	Demand Savings (MW)
2015	3,982	79,654	0.88
2016	4,298	85,954	0.98

Source: Navigant analysis

³⁴ Generator savings are calculated using a line loss factor of 7% and 11.7% for energy and demand, respectively, and a capacity reserve margin assumption of 15%.