

**ENERGY EFFICIENCY/RENEWABLE ENERGY IMPACT
IN THE TEXAS EMISSIONS REDUCTION PLAN (TERP)**

**PRELIMINARY REPORT: INTEGRATED NOX
EMISSIONS SAVINGS FROM EE/RE PROGRAMS
STATEWIDE**

**Annual Report to the
Texas Commission on Environmental Quality
January 2019 – December 2019**



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ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION



**TEXAS A&M ENGINEERING
EXPERIMENT STATION**

ENERGY SYSTEMS LABORATORY

October 30, 2020

Mr. Robert Gifford
Air Quality Division
Texas Commission on Environmental Quality
Austin, TX 78711-3087

Dear Mr. Gifford:

The Energy Systems Laboratory (ESL) at the Texas A&M Engineering Experiment Station of the Texas A&M University System is pleased to provide this preliminary report, "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP): Integrated NOx Emissions Savings from EE/RE Programs Statewide," as required under Texas Health and Safety Code Ann. § 388.003 (e) (Senate Bill 5, 77R as amended 78 R & 78S).

The ESL is required to annually report the energy savings from statewide adoption of the Texas Building Energy Performance Standards in Senate Bill 5 (SB 5), as amended, and the relative impact of proposed local energy code amendments in the Texas non-attainment and near-non-attainment counties as part of the Texas Emissions Reduction Plan (TERP).

Please contact me at (979) 845-9213 should you or any of the TCEQ staff have any questions concerning this report or any of the work presently being done to quantify emissions reductions from energy efficiency and renewable energy measures as a result of the TERP implementation.

Sincerely,

A handwritten signature in black ink that reads "David E. Claridge".

David E. Claridge, Ph.D., P.E., FASHRAE
Director

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Disclaimer

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**PRELIMINARY REPORT:
INTEGRATED NOX EMISSIONS SAVINGS FROM EE/RE STATEWIDE**

**Energy Efficiency/Renewable Energy Impact
In The Texas Emissions Reduction Plan**

Executive Summary

The Energy Systems Laboratory (Laboratory), at the Texas A&M Engineering Experiment Station of the Texas A&M University System, in fulfillment of its responsibilities under Texas Health and Safety Code Ann. § 388.003 (e), submits this annual report, Energy Efficiency/Renewable Energy (EE/RE) Impact in the Texas Emissions Reduction Plan (Preliminary Report) to the Texas Commission on Environmental Quality.

This preliminary report shows the NOx emissions reductions from the energy-efficiency programs from multiple Texas State Agencies working under Senate Bill 5 and Senate Bill 7 in a uniform format to allow the TCEQ to consider the combined savings for Texas' State Implementation Plan (SIP) planning purposes. This required that the analysis should include the integrated savings estimation from all projects projected through 2024 for both the annual and Ozone Season Period (OSP)¹ NOx reductions. The year 2008 was used for the baseline year to estimate the emissions. The NOx emissions reductions from all these programs were calculated using estimated emissions factors for 2016 from the US Environmental Protection Agency (US EPA) eGRID database, which had been specially prepared for this purpose.

In 2019, the integrated total electricity savings from all programs are:

- Annual electricity savings is 75,002,911 MWh/year (32,028 tons-NOx/year) and
- OSP electricity savings are 223,470 MWh/day, which would be 9,311 MW average hourly load reduction during the OSP period (112.59 tons-NOx/day).

By 2024, the integrated total electricity savings from all programs are forecasted to be:

- Annual electricity savings 115,896,782 MWh/year (49,266 tons-NOx/year) and
- OSP electricity savings 343,818 MWh/day, which would be equivalent to 14,326 MW average hourly load reduction during the OSP period (172.27 tons-NOx/day).

A summary of the savings for 2019 and 2024 is presented in the table below using as baseline year 2008.

	2019	2024
Annual Electricity Savings (MWh/year)	75,002,911	115,896,782
Annual Emissions Reductions (tons NOx/year)	32,028	49,266
OSP Electricity Savings (MWh/day)	223,470	343,818
OSP Emissions Reductions (tons NOx/day)	112.59	172.27

¹ An ozone season period (OSP) represents the daily average emissions during the period that runs from May 1 to September 30.

Legislative Background

In 2001, the Texas Emissions Reduction Plan (TERP), established by the 77th Texas Legislature with the enactment of Senate Bill 5 (SB 5), identified that Energy Efficiency and Renewable Energy (EE/RE) measures make an important contribution to a comprehensive approach for meeting the minimum federal ambient air quality standards. In 2003 through 2007, the 78th, 79th and 80th Legislatures enhanced the use of EE/RE programs for meeting the TERP. The 78th Legislature enhanced the use of EE/RE programs for meeting TERP goals by requiring the Texas Commission on Environmental Quality (TCEQ) to promote EE/RE as a means to improve air quality standards and to develop a methodology for computing emissions reduction for use in the State Implementation Plan (SIP) from EE/RE programs.

The 79th Legislature expanded the scope of the SIP-eligible credits by adding savings from the State Renewable Portfolio Standards from the generation of electricity from renewable sources; specifically requiring the TCEQ to develop methods to quantify emissions reductions from renewable energy; and required the Laboratory to develop at least 3 alternative methods for achieving a 15 percent greater potential energy savings in residential, commercial and industrial construction.

In the 80th Legislature several new energy efficiency initiatives were introduced, including: requiring the Laboratory to provide written recommendations to the State Energy Conservation Office (SECO) about whether or not the energy efficiency provisions of latest published edition of the International Residential Code (IRC), or the International Energy Conservation Code (IECC), are equivalent to or better than the energy efficiency and air quality achievable under the editions adopted under the 2001 IRC/IECC; requiring the Laboratory to develop a standardized report format to be used by providers of home energy ratings; and encouraging the Laboratory to cooperate with an industry organization or trade association to develop guidelines for home energy ratings, including training.

The 81st Legislature (2009) extended the TERP to 2019 and required the TCEQ to contract with Laboratory to compute emissions reduction from wind and other renewable energy resources for the SIP.

The 82nd Legislature (2011), the Laboratory's responsibilities under TERP increased as new legislatively allocated energy efficiency initiatives were introduced.

The 83rd Legislatures (2013), the Laboratory's responsibilities under TERP were kept the same as previous years.

The 84th Legislatures (2015) changed to the Sec. 388.003. Adoption of Building Energy Efficiency Performance Standards, with the passage of HB 1736, affected the Laboratory's responsibilities under TERP.

The 85th and 86th Legislatures (2017, 2019 respectively) the Laboratory's responsibilities under TERP were kept the same as previous years.

Calculation of Integrated NO_x Emissions Reductions from Multiple State Agencies Participating in the Texas Emissions Reduction Plan (TERP)

In January 2005, the Laboratory was asked by the Texas Commission on Environmental Quality (TCEQ) to develop a method by which the NO_x emissions reductions from the energy-efficiency programs from multiple Texas State Agencies working under Senate Bill 5 and Senate Bill 7 could be reported in a uniform format to allow the TCEQ to consider the combined savings for Texas' State Implementation Plan (SIP) planning purposes. This required that the analysis should include the integrated savings estimation from all projects forecasted through 2024 for both the annual and Ozone Season Period (OSP) NO_x reductions. In 2019, the NO_x emissions reductions from all these programs were calculated using estimated emissions factors for 2016 from the US Environmental Protection Agency (US EPA) eGRID database, which had been specially prepared for this purpose. The different programs included in this 2019 integrated analysis are:

- ESL Single-family, Multi-family, and Commercial new constructions
- PUC Senate Bill 7 Program
- SECO Senate Bill 5 Program
- Electricity generated by renewables in Texas (ERCOT)²
- SEER 13 upgrades to Single-family and Multi-family residences

The Laboratory's single-family and multi-family programs include the energy savings attained by the construction of new residences in Texas. The baseline to estimate energy savings uses the published data on residential construction characteristics by the 2008 National Association of Home Builders (NAHB 2008) based on the 2006 IECC building code (2006 ICC). Annual electricity savings (MWh) are obtained from the Laboratory's Annual Reports to the TCEQ (Haberl et al., 2002 - 2019).

The Laboratory's commercial program includes the energy savings attained by constructing new commercial buildings in Texas, including office, apartment, healthcare, education, retail, food, and lodging as defined by Dodge building type (Dodge 2011). Energy savings were estimated from code-compliant buildings (ASHRAE Standard 90.1-2013) against pre-code buildings (ASHRAE Standard 90.1-2007) using the energy use intensity (EUI) in the USDOE report and constructed square footage in Dodge data (Dodge 2020).

The Public Utility Commission of Texas (PUC) Senate Bill 7 program includes the energy efficiency programs implemented by electric utilities under the Public Utility Regulatory Act §39.905. The PUC regulated energy efficiency program was adopted pursuant to 1999 legislation (SB 7) and subsequent legislation in 2001 (SB 5), 2007 (HB 3693), and 2011 (SB 1125). The energy efficiency measures include: high-efficiency HVAC equipment, variable speed drives, increased insulation levels, infiltration reduction, duct sealing, Energy Star Homes, etc. Annual electricity savings claimed by the utilities were reported for the different programs completed in the years 2001 through 2019.

The Texas State Energy Conservation Office (SECO) funds energy-efficiency programs that are directed towards school districts, government agencies, city and county governments, private industries and residential energy consumers. For the 2019 reporting year SECO submitted annual energy savings values for projects funded by SECO and by Energy Service projects.

² ERCOT is the Electric Reliability Council of Texas.

The *Electric Reliability Council of Texas (ERCOT) electricity production from currently installed green power generation* in Texas is reported. Actual measured electricity productions for 2001 through 2019 were included. For projections to 2024, the annual growth factor was estimated using the last six years installed power capacity.

Finally, NO_x emissions reductions from *the installation of SEER 13 air conditioners in existing residences* are also reported.

Description of the Analysis Method

Annual and Ozone Season Period (OSP) NO_x emissions reductions were calculated for 2019 and integrated from through 2024 using several factors to discount the potential savings. These factors include an annual degradation factor, a transmission, and distribution factor, a discount factor, and growth factors as shown in Table 1 and are described as follows:

Annual degradation factor: This factor was used to account for an assumed decrease in the performance of the measures installed as the equipment wears down and degrades. With the exception of electricity generated from renewables, an annual degradation factor of 2% was used for ESL Single-family, Multi-family, and Commercial programs and an annual degradation factor of 5% was used for all other programs³. The value of the 5% degradation factor was taken from a study by Kats et al. (1996).

Transmission and distribution loss: This factor adjusts the reported savings to account for the loss in energy resulting from the transmission and distribution of the power from the electricity producers to the electricity consumers. For this calculation, the energy savings reported at the consumer level are increased by 7% to give credit for the actual power produced that is lost in the transmission and distribution system on its way to the customer. In the case of electricity generated by renewables, the T&D losses were assumed to cancel out since renewable energy is displacing power produced by conventional power plants; therefore, there is no net increase or decrease in T&D losses.

Initial discount factor: This factor was used to discount the reported savings for any inaccuracies in the assumptions and methods employed in the calculation procedures. For the Laboratory's Single, Multi-family and Commercial program, the discount factor was assumed to be 20%. For PUC's Senate Bill 7 program, the discount factor was taken as 10%. For the savings in the SECO program, the discount factor used 60% before 2019, and since 2019, 30% is used. For the electricity from renewables, the discount factor was taken as 5%. In addition, the discount factor for SEER 13 single-family and multi-family program was 20%.

Growth factor: The growth factors shown in Table 1 were used to account for several different factors. Growth factors for single-family (4.1%), multi-family residential (6.1%), and commercial (5.3%) construction are projections based on the average growth rate for these housing types from recent U.S. Census data for Texas. The growth factor for renewable energy (8.5%) is a linear projection based on the installed renewable power generation capacity in 2019 from the Public Utility Commission of Texas. No growth was assumed for PUC programs, SECO, and SEER 13 entries.

³ A degradation of 5% per year would accumulate as a 5%, 10%, 15%...etc, degradation in performance. Although the assumption of this high level of degradation may not actually occur, it was chosen as a conservative estimate. For renewable energy, a degradation factor of 0% was used. The choice of a 0% degradation factor for renewables is based on the most recent four years of analysis of measured wind data from all Texas wind farms that shows no degradation.

Figure 1 shows the overall information flow that was used to calculate the NO_x emissions savings from the annual and OSP electricity savings (MWh) from all programs. For the Laboratory's single-family and multi-family code-implementation programs, the annual and OSP were calculated from DOE-2 hourly simulation models⁴. The base case is taken as the average characteristics of single- and multi-family residences for Texas published by the National Association of Home Builders for 2008 (NAHB 2008) based on the performance path of the 2006 IECC. The annual electricity savings from PUC's energy efficiency programs were calculated using PUC approved demand savings calculations and verification methods (PUC 2020). The SECO electricity savings were submitted as annual savings by project⁵. The electricity production from renewables in Texas was from the actual on-site metered data recorded at 15-minute intervals except for non-utility scale solar photovoltaic (PV) projects. The OSP consumption is the average daily consumption for the period between May 1 and September 30.

Integration of the savings from the different programs into a uniform format allowed for creditable NO_x emissions to be evaluated using different criteria as shown in Table 1. These include evaluation across programs, evaluation across individual counties by program, evaluation by SIP area, and evaluation for all ERCOT counties except Houston/Galveston.

Calculation Procedure

The electricity savings in this report were estimated based on the baseline year of 2008. In addition, the emissions estimation throughout this report was updated to the 2016 eGrid database, which is applied to the four different Competitive Load (CL) zones: Houston, North, West, and South as well as other counties in Texas. For all the programs, except renewable projects, the corresponding OSP emissions reductions were calculated using an annual daily average. The OSP emissions reductions from the electricity generated by renewables except non-utility scale solar PV and biomass projects were estimated by actual measured data.

ESL Single-family and Multi-family. The calculation of the annual electricity savings has been reported since 2002, which included the savings from code-compliant new housing in all 42 non-attainment and affected counties as reported in the Laboratory's annual report submitted by the Laboratory to the Texas Commission of Environmental Quality (TCEQ). From 2009 to 2019, based on year 2008, the annual electricity savings were calculated for new residential construction in all the counties in ERCOT region as well as other counties in Texas, which includes the 42 non-attainment and affected counties. These savings were then tabulated by county and program. Using the calculated values through 2019, savings were then projected to 2024 by incorporating the different adjustment factors mentioned above. In these calculations, it was assumed that the same amount of electricity savings from the code-compliant construction would be achieved for each year after 2019 through 2024⁶. The projected energy savings through 2024, according to county, were then divided into the CL zones in ERCOT as well as other counties in Texas in the 2016 eGRID. To determine which CL zone was to be used, or in counties with multiple CL zone, the allocation to each CL zone by county was obtained from CL zone's listing published in the Laboratory's 2018 annual report⁷.

⁴ These values are based on a performance analysis as defined by Chapter 4 of the 2006, 2009 and 2015 IECC, plus the corresponding NAHB and HIRL data.

⁵ The reporting requirements to the SECO did not require energy savings by project type, although for selected sites, energy savings by project type was available.

⁶ This includes the appropriate discount and degradation factors for each year.

⁷ Haberl et al., 2019, Annual Report Volume I, pp. 45.

For this 2019 annual NOx emissions calculations, the US EPA's 2016 eGRID was used. An example of the eGRID spreadsheet⁸ is given in the Table 2. The total electricity savings for each CL zone as well as other counties in Texas were used to calculate the NOx emissions reductions for each of the different counties using the emissions factors contained in eGRID. Similar calculations were performed for each year for which the analysis was required.

ESL-Commercial Buildings. The annual electricity savings have been reported for 2006 through 2019 for commercial buildings, which were obtained from the previous annual reports by the Laboratory to TCEQ and other data sources⁹. From 2009 to 2019, based on year 2008, the annual electricity savings were also calculated for new commercial construction by county. Using the calculated savings through 2019, savings were then projected to 2024 by incorporating the different adjustment factors mentioned above¹⁰. In the projected annual electricity savings, it was assumed that the same 2019 amount of electricity savings would be achieved for each year through 2024. Finally the projected energy saving numbers through 2024, by county, were allocated into the appropriate CL zones.

PUC-Senate Bill 7. For the PUC Senate Bill 7 program savings, the annual electricity savings for 2005 through 2019 were obtained from the Public Utility Commission of Texas. Using these values savings were projected through 2024 by incorporating the different adjustment factors mentioned above. Similar savings were assumed for each year after 2019 until 2024. The 2016 annual eGRID was also used to calculate the NOx emissions savings for the PUC-Senate Bill 7 program. The total electricity savings for each CL zone were used to calculate the NOx emissions reductions for each county using the emissions factors contained in the US EPA's eGRID spreadsheet, which then were used to estimate the integrated NOx emissions reductions for each county.

SECO Savings. The annual electricity consumption reported by political subdivisions for 2019 was obtained from the State Energy Conservation Office (SECO). Using the reported consumption, the annual and OSP electricity savings resulted from energy conservation projects were then calculated. To achieve this, the annual energy use intensity (EUI) for each county was estimated and the county's energy savings for each year against the baseline year of 2008 were then calculated¹¹. In addition, the savings through 2024 were projected using the different adjustment factors mentioned above. In a similar fashion to the previous programs, it was assumed that the same amount of electricity savings will be achieved for each year through 2024. The 2016 annual eGRID was also used to calculate the NOx emissions savings for the SECO program.

Electricity Generated by Renewables. The measured and estimated electricity production from renewables in Texas for 2008 through 2019 was obtained from reports *Statewide Air Emissions Calculations from Wind and Other Renewables (2009-2019)*. Using the reported numbers for 2019, savings through 2024 were projected incorporating the different adjustment factors

⁸ To use this spreadsheet electricity savings for each eGRID zone is entered in the bottom row of the spreadsheet (MWh). The spreadsheet then allocates the MWh of electricity savings according to the counties (blue columns) where the CL zone owned and operated a power plant. Totals for all CL zones are then listed on the far right columns (white columns). Similar spreadsheets for the 2016 eGRID exist for SOx and CO₂.

⁹ These savings include new construction in office, education, retail, food, lodging and warehouse construction as defined by Dodge building type (Dodge 2011), using energy savings from the US DOE's report (USDOE 2011), and data from CBECS (1995 - 2012) and Dodge (2019).

¹⁰ This also includes the appropriate discount and degradation factors for each year.

¹¹ In this report, EUI values were used to calculate the electricity savings. This calculation method was also applied to savings estimation for the previous years from 2009 to 2019.

mentioned above. The 2010 eGRID was used for the period of 2008 through 2016, and the 2016 eGRID was then used for the period of 2017 through 2024 to calculate the NO_x emissions reductions for the electricity generated by renewables in Texas. The total electricity savings for each CL zone were used to calculate the NO_x emissions reductions for each of the different counties.

SEER 13 Single-Family and Multi-Family. In January of 2006, Federal regulations mandated that the minimum efficiency for residential air conditioners be increased to SEER 13 from the previous SEER 10. Although the electricity savings from new construction reflected this change in values, the annual and OSP electricity savings from the replacement of the air conditioning units by air conditioners with an efficiency of SEER 13 in existing residences needed to be calculated. In this analysis, it was assumed that an equal number of existing houses had their air conditioners replaced, as reported for 2006, by the air conditioner manufacturers.¹² In this report, the annual and OSP electricity savings were calculated for all the counties in ERCOT region, which include the 42 non-attainment and affected counties, were calculated. Based on the energy use and electricity generated for 2008, the savings after 2009 until 2024 were projected by incorporating the appropriate adjustment factors¹³. The total electricity savings for each CL zone were used to calculate the NO_x emissions reductions for each of the different counties using the emissions factors contained in the 2016 eGRID. Integrated NO_x emissions reductions for each county by non-attainment and affected counties were also calculated.

Results

The total integrated annual and OSP electricity savings for all the different programs in the integrated format were calculated for 2009 through 2024 as shown in Table 3, using the adjustment factors shown in Table 1. Annual and OSP NO_x emissions reductions from the electricity savings for all the programs in the integrated format are shown in Table 4.

In 2019, the total integrated annual savings from all programs are 75,002,911 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 6,279,626 MWh/year (8.4% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 4,628,168 MWh/year (6.2%),
- Savings from SECO's Senate Bill 5 program are 1,691,059 MWh/year (2.3%),
- Electricity savings from renewable power generation are 62,168,032 MWh/year (82.9%), and
- Savings from residential air conditioner retrofits¹⁴ are 236,025 MWh/year (0.3%).

In 2019, the total integrated OSP savings from all programs are 223,470 MWh/day, which would be 9,311 MW average hourly load reduction during the OSP period. The integrated OSP electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 17,204 MWh/day (7.7%),

¹² In 2011, the U.S.DOE revised the energy conservation standards for residential HVAC systems. Beginning in January 2015, split-system central air conditioners installed in Texas must be at least SEER 14. NO_x emissions reductions from SEER 14 replacement air conditioners will be included in future TERP reports as statewide sales data can be evaluated.

¹³ Additional details about this calculation are contained in the Laboratory's 2008 Annual Report to the TCEQ, available at the ESL web site "<http://esl.tamu.edu/>".

¹⁴ This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

- Savings from the PUC's Senate Bill 7 programs are 12,680 MWh/day (5.7%),
- Savings from SECO's Senate Bill 5 program are 4,633 MWh/day (2.1%),
- Electricity savings from renewable power generation are 187,283 MWh/day (83.8%), and
- Savings from residential air conditioner retrofits are 1,670 MWh/day (0.7%).

By 2024, the total integrated annual savings from all programs will be 115,896,782 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 12,872,105 MWh/year (11.1% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 6,429,358 MWh/year (5.5%),
- Savings from SECO's Senate Bill 5 program will be 2,933,310 MWh/year (2.5%),
- Electricity savings from renewable power generation will be 93,479,378 MWh/year (80.7%), and
- Savings from residential air conditioner retrofits will be 182,632 MWh/year (0.2%).

By 2024, the total integrated OSP savings from all programs will be 343,818 MWh/day, which would be 14,326 MW average hourly load reduction during the OSP. The integrated OSP electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 35,266 MWh/day (10.2%),
- Savings from the PUC's Senate Bill 7 programs will be 17,615 MWh/day (5.1%),
- Savings from SECO's Senate Bill 5 program will be 8,036 MWh/day (2.3%),
- Electricity savings from renewable power generation will be 281,609 MWh/day (81.9%), and
- Savings from residential air conditioner retrofits will be 1,292 MWh/day (0.4%).

In 2019 (Table 4), the total integrated annual NO_x emissions reductions from all programs are 32,028 tons-NO_x/year. The integrated annual NO_x emissions reductions from all the different programs are:

- NO_x emissions reductions from code-compliant residential and commercial construction are 2,099 tons-NO_x/year (6.6% of the total NO_x savings),
- NO_x emissions reductions from the PUC's Senate Bill 7 programs are 1,547 tons-NO_x/year (4.8%),
- NO_x emissions reductions from SECO's Senate Bill 5 program are 546 tons-NO_x/year (1.7%),
- NO_x emissions reductions from renewable power generation are 27,757 tons-NO_x/year (86.7%), and
- NO_x emissions reductions from residential air conditioner retrofits are 79 tons-NO_x/year (0.2%).

In 2019, the total integrated OSP NO_x emissions reductions from all programs are 112.59 tons-NO_x/day. The integrated OSP NO_x emissions reductions from all the different programs are:

- NO_x emissions reductions from code-compliant residential and commercial construction are 6.13 tons-NO_x/day (5.4%),
- NO_x emissions reductions from the PUC's Senate Bill 7 programs are 4.62 tons-NO_x/day (4.1 %),
- NO_x emissions reductions from SECO's Senate Bill 5 program are 1.58 tons-NO_x/day (1.4%),

- NO_x emissions reductions from renewable power generation are 99.65 tons-NO_x/day (88.5%), and
- NO_x emissions reductions from residential air conditioner retrofits are 0.60 tons-NO_x/day (0.5%).

By 2024, the total integrated annual NO_x emissions reductions from all programs will be 49,266 tons-NO_x/year. The integrated annual NO_x emissions reductions from all the different programs are:

- NO_x emissions reductions from code-compliant residential and commercial construction will be 4,363 tons-NO_x/year (8.9% of the total NO_x savings),
- NO_x emissions reductions from the PUC's Senate Bill 7 programs will be 2,136 tons-NO_x/year (4.3%),
- NO_x emissions reductions from SECO's Senate Bill 5 program will be 969 tons-NO_x/year (2.0%),
- NO_x emissions reductions from renewable power generation will be 41,738 tons-NO_x/year (84.7%), and
- NO_x emissions reductions from residential air conditioner retrofits will be 61 tons-NO_x/year (0.1%).

By 2024, the total integrated OSP NO_x emissions reductions from all programs will be 172.27 tons-NO_x/day. The integrated OSP NO_x emissions reductions from all the different programs are:

- NO_x emissions reductions from code-compliant residential and commercial construction will be 12.77 tons-NO_x/day (7.4%),
- NO_x emissions reductions from the PUC's Senate Bill 7 programs will be 6.38 tons-NO_x/day (3.7%),
- NO_x emissions reductions from SECO's Senate Bill 5 program will be 2.81 tons-NO_x/day (1.6%),
- NO_x emissions reductions from renewable power generation will be 149.85 tons-NO_x/day (87.0%), and
- NO_x emissions reductions from residential air conditioner retrofits will be 0.47 tons-NO_x/day (0.3%).

Summary

This preliminary report presents the NO_x emissions reductions from the energy-efficiency programs from multiple Texas State Agencies working under Senate Bill 5 and Senate Bill 7 in a uniform format to allow the TCEQ to consider the combined savings for Texas' State Implementation Plan (SIP) planning purposes. This required that the analysis should include the integrated savings estimation from all projects projected through 2024 for both the annual and OSP NO_x reductions. The NO_x emissions reductions from all these programs were calculated using estimated emissions factors for 2016 from the US Environmental Protection Agency (US EPA) eGRID database, which had been specially prepared for this purpose.

In 2019, the integrated total electricity savings from all programs are:

- Annual electricity savings is 75,002,911 MWh/year (32,028 tons-NO_x/year) and
- OSP electricity savings are 223,470 MWh/day, which would be 9,311 MW average hourly load reduction during the OSP period (112.59 tons-NO_x/day).

By 2024, the integrated total electricity savings from all programs are:

- Annual electricity savings will be 115,896,782 MWh/year (49,266 tons-NO_x/year) and
- OSP electricity savings will be 343,818 MWh/day, which would be 14,326 MW average hourly load reduction during the OSP period (172.27 tons-NO_x/day).

The Laboratory has and will continue to provide leading-edge technical assistance to counties and communities working toward obtaining full SIP credit for the energy efficiency and renewable energy projects that are lowering NO_x emissions and improving the air quality for all Texans. The Laboratory will continue to provide superior technology to the State of Texas through efforts with the TCEQ and US EPA. The efforts taken by the Laboratory have produced significant success in bringing EE/RE closer to US EPA acceptance in the SIP for Texas.

If any questions arise, please contact us by phone at 979-845-9213.

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Table 1: Final Adjustment Factors used for the Calculation of the Annual and OSP NOx Savings for the Different Programs

	ESL-Single Family	ESL-Multifamily	ESL-Commercial	PUC (SB7)	SECO	Renewables-ERCOT	SEER13 Single Family	SEER13 Multi Family
Annual Degradation Factor	2.0%	2.0%	2.0%	5.0%	5.0%	0.0%	5.0%	5.0%
T&D Loss	7.0%	7.0%	7.0%	7.0%	7.0%	0.0%	7.0%	7.0%
Initial Discount Factor	20.0%	20.0%	20.0%	10.0%	60% / 30%	5.0%	20.0%	20.0%
Growth Factor	4.1%	6.1%	5.3%	0.0%	0.0%	8.5%	N.A.	N.A.
Weather Normalized	Yes	Yes	Yes	No	No	No	Yes	Yes

Note: For Renewables-ERCOT, the OSP energy consumption is the average daily consumption of the measured data from May 1 to September 30.
 In the SECO calculations, a 30% initial discount factor is used from 2019 and before 2019, a 60% initial discount factor was used for the estimations.

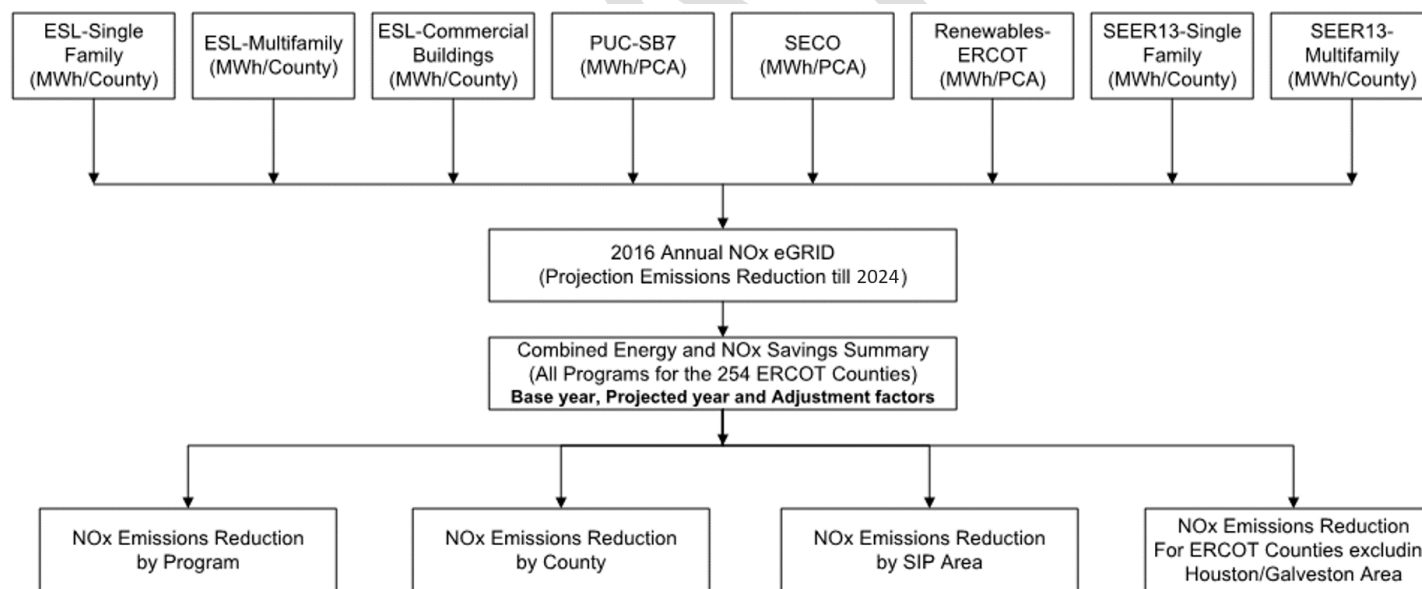


Figure 1: Process Flow Diagram of the NOx Emissions Reduction Calculations

Table 2: Example of NOx Emissions Reduction Calculations using 2016 eGRID

Area	County	ERCOT-H	NOx Reductions (lbs)	ERCOT-N	NOx Reductions (lbs)	ERCOT-W	NOx Reductions (lbs/year)	ERCOT-S	NOx Reductions (lbs)	SPP	NOx Reductions (lbs)	SERC	NOx Reductions (lbs)	WCC	NOx Reductions (lbs)	Total NOx Reductions (lbs)	Total NOx Reductions (Tons)
Houston-Galveston Area	Brazoria	0.061573	1995.95	0.000078	3.67	0.000004	0.02	0.0005769	201.30	0.000000	0.00	0.000000	0.00	0.000000	0.00	20179.93	10.99
	Chambers	0.0196236	6362.84	0.0000025	1.17	0.0000001	0.01	0.0001838	64.15	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	6438.17	3.21
	Fort Bend	0.071386	24364.50	0.0000095	4.48	0.0000005	0.02	0.0007039	245.64	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	24614.64	12.31
	Galveston	0.0135834	4404.56	0.0000017	0.81	0.0000001	0.00	0.0001273	44.41	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4449.78	2.22
	Harris	0.1216150	39434.96	0.0000154	7.25	0.0000007	0.03	0.0011294	397.58	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	39839.83	19.92
	Liberty	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Montgomery	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0448843	362.37	0.0000000	0.00
	Waller	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00
	Hardin	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00
	Jefferson	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.1794027	1448.40	0.0000000	0.00
Beaumont/Port Arthur Area	Orange	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2428943	1969.99	0.0000000	0.00	1969.99	0.98
	Colin	0.0001044	33.87	0.0006407	301.23	0.0000309	1.29	0.0000065	2.28	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	338.68	0.17
	Dallas	0.0020857	676.32	0.0127949	6015.31	0.006180	25.85	0.0001205	45.55	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	6763.04	3.38
	Denton	0.0015278	495.40	0.0097123	4406.21	0.004527	18.94	0.0000956	33.37	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4953.91	2.48
	Henderson	0.0002013	65.27	0.0012348	580.54	0.0000596	2.50	0.0000126	4.40	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	652.71	0.33
	Hood	0.0011288	366.02	0.0069245	3255.41	0.0003345	13.99	0.0000706	24.65	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3660.07	1.83
	Hurt	0.0000542	11.10	0.0002100	98.72	0.0000101	0.42	0.0000021	0.75	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	111.00	0.06
	Tarrant	0.0007507	243.41	0.0046949	2165.94	0.0002224	9.20	0.0000470	16.59	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2434.65	1.22
	Ellis	0.0009845	319.24	0.0060595	2839.58	0.0002917	12.20	0.0000616	21.50	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3192.23	1.60
	Johnson	0.0001392	45.14	0.0008539	401.45	0.0000412	1.73	0.0000087	3.04	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	451.53	0.23
Dallas/Fort Worth Area	Kaufman	0.0007857	903.31	0.0170891	8034.17	0.0008254	34.53	0.0001743	69.84	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	9032.84	4.52
	Parker	0.0006351	205.93	0.0038958	1831.56	0.0001882	7.87	0.0000397	13.87	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2059.23	1.03
	Rockwall	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Wise	0.0020208	914.66	0.0170309	8135.15	0.0008358	34.96	0.0001765	61.60	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	9146.38	4.57
	El Paso	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1.2221686	12000.15	12000.15	6.00
	Bexar	0.0156585	507.43	0.0010560	496.48	0.0000510	2.13	0.0120544	4368.37	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	49214.41	24.61
	Comal	0.0066238	137.45	0.0000286	13.41	0.0000014	0.06	0.0033848	1181.13	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1332.96	0.67
	Guadalupe	0.0025237	828.05	0.0017221	80.97	0.0000083	0.35	0.0030845	716.77	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	8036.14	4.01
	Wilson	0.0001742	56.48	0.0000117	5.52	0.0000006	0.02	0.0013511	483.42	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	547.43	0.27
	Bastrop	0.0020209	655.31	0.0001563	64.08	0.0000066	0.28	0.0161398	5632.08	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	6351.74	3.18
Austin Area	Caldwell	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Hays	0.0004570	148.18	0.0000308	14.49	0.0000015	0.06	0.0036495	1273.51	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1436.23	0.72
	Travis	0.0037244	1207.67	0.0002512	118.09	0.0000121	0.51	0.0297443	10379.42	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	11705.68	5.83
	Williamson	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Gregg	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0066563	60.40	0.0000000	0.00	0.0000000	0.00	60.40	0.03
	Harrison	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2877716	2411.51	0.0000000	0.00	0.0000000	0.00	2411.51	1.21
	Burn	0.0202090	7490.10	0.1417007	6682.20	0.0048444	20.51	0.0014477	504.48	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	7499.90	37.45
	Smith	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Upshur	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Corpus Christi Area	Huachupeco	0.0038446	1279.09	0.0002660	125.07	0.0000128	0.54	0.0315033	10993.22	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	12397.92
San Patricio	0.0065901	2136.90	0.0004444	208.95	0.0000215	0.90	0.0263006	18365.73	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	20712.47	10.36	
Victoria Area	Victoria	0.0013565	439.87	0.0000915	43.01	0.0000044	0.18	0.0108338	3780.50	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4263.57	2.13
Anderson	0.0000993	32.20	0.0006091	286.35	0.0000294	1.23	0.0000062	2.17	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	321.94	0.16	
Other ERCOT Counties	Angelina	0.0022609	765.56	0.0144832	6809.03	0.0006996	29.26	0.0001478	51.56	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	7655.42	3.83
	Atascosa	0.0056178	1821.65	0.0003789	178.12	0.0000183	0.77	0.0448662	19526.29	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	17656.83	8.83
	Bell	0.0003169	102.75	0.0014328	913.84	0.0000939	3.93	0.0000198	6.92	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1021.74	0.51
	Boisjourn	0.0007586	181.14	0.0034268	1611.06	0.0001655	6.92	0.0000250	12.20	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1811.32	0.91
	Brazos	0.0064309	204.57	0.0038702	1819.50	0.0001869	7.82	0.0000395	13.78	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2045.67	1.02
	Calhoun	0.0089052	2887.60	0.0006006	282.36	0.0000290	1.21	0.0711201	24817.72	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	27988.89	13.99
	Cameron	0.0003829	124.14	0.0002258	12.14	0.0000012	0.05	0.0030576	1066.96	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1203.30	0.60
	Cherokee	0.0003163	102.56	0.0019403	912.18	0.0000937	3.92	0.0000198	6.91	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1021.57	0.51
	Coke	0.0000186	6.03	0.0001140	33.59	0.0000014	0.06	0.0000012	0.41	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	869.68	0.43
	Colorado	0.0014238	461.67	0.0000960	45.14	0.0000046	0.19	0.0113706	3967.83	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4474.83	2.24
Other ERCOT Counties	Ector	0.0000875	28.39	0.0005370	225.48	0.0001920	814.68	0.0000055	1.91	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4097.46	2.05
	Fayette	0.0157346	4725.76	0.0006029	483.25	0.0000475	1.99	0.1162983	40617.39	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	42807.87	

Table 3: Annual and OSP Electricity Savings for the Different Programs (Base Year 2008)

PROGRAM	ANNUAL (MWh)																
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ESL-Single Family	0	25,031	47,000	74,109	153,562	215,164	275,535	360,010	533,473	722,595	967,082	1,212,227	1,463,313	1,720,666	1,984,624	2,255,535	2,533,763
ESL-Multifamily	0	50,784	108,018	200,414	332,835	527,292	774,578	1,225,617	1,856,682	2,472,527	3,151,036	3,962,565	4,811,210	5,699,485	6,630,048	7,605,717	8,629,478
ESL-Commercial*	0	0	24,066	83,255	119,422	247,952	400,015	559,947	696,924	850,020	983,858	1,104,834	1,215,437	1,330,862	1,451,373	1,577,272	1,708,863
PUC (SB7)	0	538,841	976,984	1,437,883	1,831,318	2,267,414	2,675,295	3,079,759	3,498,867	3,844,949	4,209,108	4,628,168	5,026,276	5,404,478	5,763,770	6,105,097	6,429,358
SECO**	0	74,198	157,524	349,845	512,539	713,477	1,015,815	1,019,507	1,117,717	1,296,153	1,402,040	1,691,059	1,965,627	2,226,467	2,474,265	2,709,672	2,933,310
Renewables-ERCOT	0	3,454,992	8,351,369	12,158,649	13,392,752	17,028,343	18,753,002	20,883,590	34,193,486	47,055,032	49,700,002	62,168,032	67,452,315	73,185,762	79,406,551	86,156,108	93,479,378
SEER13-Single Family**	0	363,440	345,268	328,005	311,605	296,024	281,223	267,162	253,804	241,114	229,058	217,605	206,725	196,389	186,569	177,241	168,379
SEER13-Multi Family**	0	30,765	29,227	27,766	26,377	25,059	23,806	22,615	21,485	20,410	19,390	18,420	17,499	16,624	15,793	15,003	14,253
Total Annual (MWh)	0	4,538,051	10,039,456	14,659,925	16,680,410	21,320,725	24,199,269	27,418,208	42,172,438	56,502,800	60,661,574	75,002,911	82,158,403	89,780,732	97,912,992	106,601,646	115,896,782

PROGRAM	OZONE SEASON PERIOD - OSP (MWh/day)																
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ESL-Single Family	0	69	129	203	421	589	755	986	1,462	1,980	2,650	3,321	4,009	4,714	5,437	6,180	6,942
ESL-Multifamily	0	139	296	549	912	1,445	2,122	3,358	5,087	6,774	8,633	10,856	13,181	15,615	18,165	20,838	23,642
ESL-Commercial*	0	0	66	228	327	679	1,096	1,534	1,909	2,329	2,696	3,027	3,330	3,646	3,976	4,321	4,682
PUC (SB7)	0	1,476	2,677	3,939	5,017	6,212	7,330	8,438	9,586	10,534	11,532	12,680	13,771	14,807	15,791	16,726	17,615
SECO**	0	203	432	958	1,404	1,955	2,783	2,793	3,062	3,551	3,841	4,633	5,385	6,100	6,779	7,424	8,036
Renewables-ERCOT***	0	15,037	26,234	30,736	32,528	31,695	46,338	63,604	86,957	96,446	145,063	187,283	203,202	220,474	239,214	259,548	281,609
SEER13-Single Family**	0	2,582	2,453	2,330	2,214	2,103	1,998	1,898	1,803	1,713	1,627	1,546	1,468	1,395	1,325	1,259	1,196
SEER13-Multi Family**	0	207	196	187	177	168	160	152	144	137	130	124	118	112	106	101	96
Total OSP (MWh)	0	19,713	32,482	39,130	43,000	44,846	62,581	82,763	110,011	123,464	176,172	223,470	244,464	266,863	290,794	316,396	343,818

Table 4: Annual and OSP NOx Emissions Reduction Values for the Different Programs (Base Year 2008)

PROGRAM	ANNUAL (in tons NOx)																
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ESL-Single Family	0	3	8	15	34	50	65	86	129	224	320	403	489	577	668	761	856
ESL-Multifamily	0	4	19	43	77	127	190	305	468	810	1,061	1,333	1,617	1,914	2,226	2,553	2,896
ESL-Commercial*	0	0	5	16	22	47	79	114	141	229	310	363	411	461	509	559	611
PUC (SB7)	0	135	246	362	460	567	669	770	874	1,326	1,410	1,547	1,677	1,801	1,918	2,030	2,136
SECO**	0	20	44	92	134	185	267	269	298	407	447	546	639	728	812	892	969
Renewables-ERCOT***	0	951	2,645	3,258	3,561	4,693	5,116	5,683	9,359	24,054	22,408	27,757	30,117	32,677	35,454	38,468	41,738
SEER13-Single Family**	0	86	81	77	73	70	66	63	60	72	77	73	69	66	63	60	57
SEER13-Multi Family**	0	7	7	7	6	6	6	5	5	6	6	6	6	5	5	5	5
Total Annual (Tons NOx)	0	1,205	3,054	3,870	4,369	5,744	6,457	7,294	11,335	27,127	26,039	32,028	35,025	38,230	41,655	45,327	49,266

PROGRAM	OZONE SEASON PERIOD - OSP (in tons NOx/day)																
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ESL-Single Family	0.00	0.01	0.02	0.04	0.09	0.14	0.18	0.24	0.35	0.62	0.93	1.18	1.43	1.68	1.94	2.21	2.49
ESL-Multifamily	0.00	0.01	0.05	0.12	0.21	0.35	0.52	0.83	1.28	2.24	3.09	3.88	4.70	5.57	6.47	7.42	8.42
ESL-Commercial*	0.00	0.00	0.01	0.04	0.06	0.13	0.22	0.31	0.39	0.64	0.91	1.07	1.22	1.38	1.54	1.70	1.87
PUC (SB7)	0.00	0.37	0.67	0.99	1.26	1.55	1.83	2.11	2.39	3.75	4.21	4.62	5.01	5.38	5.73	6.07	6.38
SECO**	0.00	0.05	0.12	0.25	0.37	0.51	0.73	0.74	0.82	1.14	1.30	1.58	1.85	2.11	2.35	2.58	2.81
Renewables-ERCOT***	0.00	4.15	7.53	8.42	8.91	9.03	12.87	17.55	24.11	50.25	78.80	99.65	108.13	117.32	127.29	138.11	149.85
SEER13-Single Family**	0.00	0.60	0.57	0.54	0.52	0.49	0.47	0.44	0.42	0.52	0.59	0.56	0.53	0.50	0.48	0.45	0.43
SEER13-Multi Family**	0.00	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.05	0.04	0.04	0.04	0.04	0.04	0.03
Total OSP (Tons NOx)	0.00	5.24	9.03	10.45	11.46	12.23	16.85	22.26	29.80	59.21	89.87	112.59	122.91	133.98	145.84	158.58	172.27

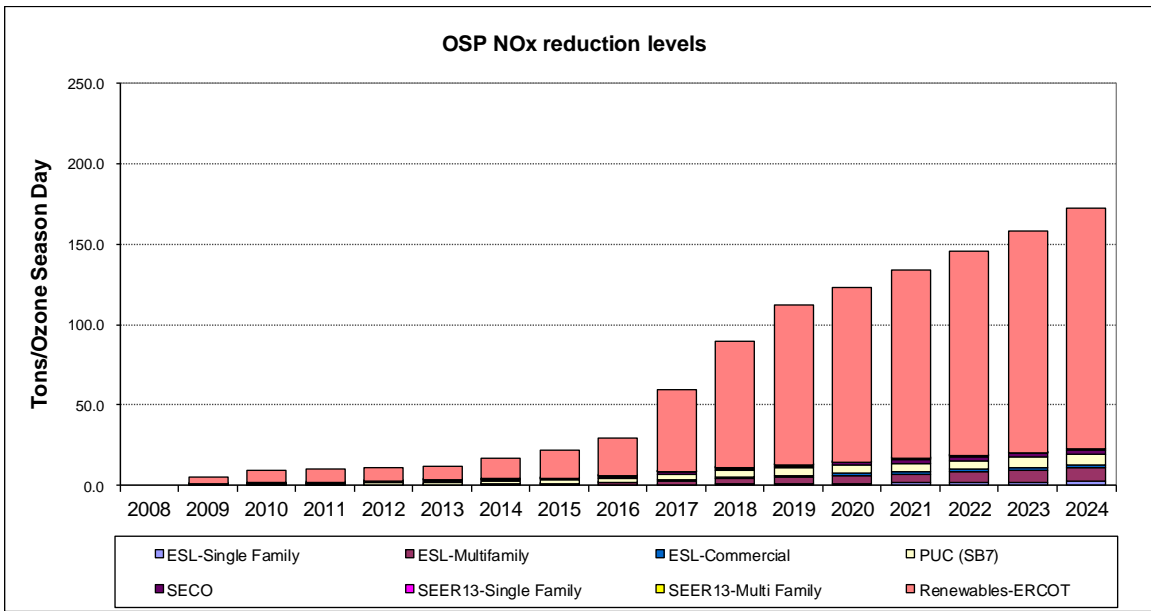


Figure 2: Integrated OSP NOx Emissions Reduction Projections through 2024 (Base Year 2008)

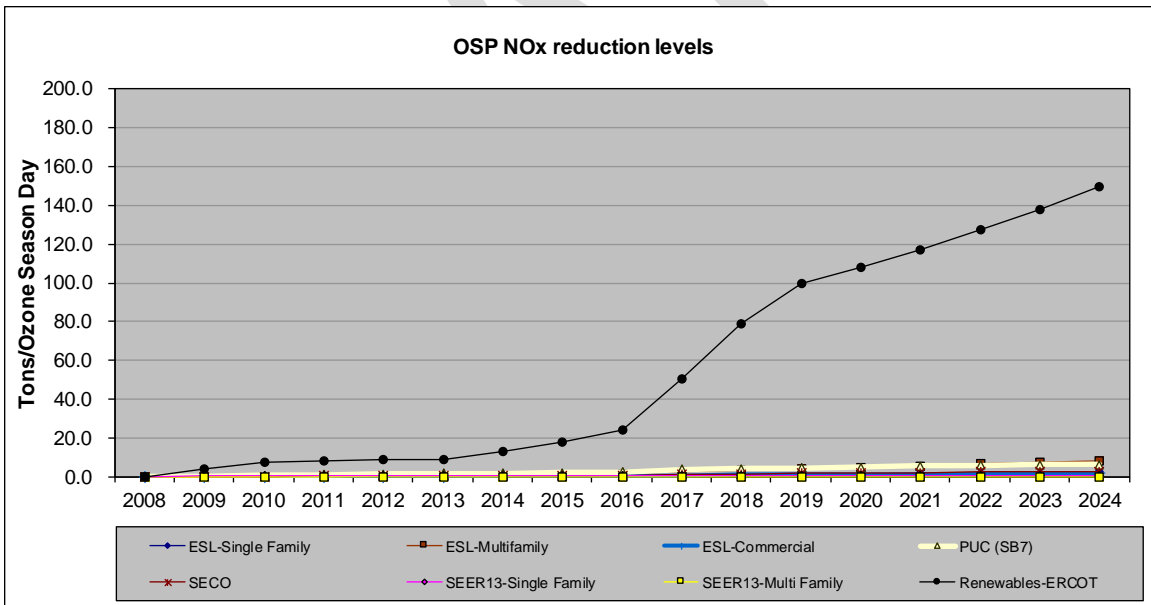


Figure 3: Integrated OSP Individual Programs NOx Emissions Reduction Projections through 2024 (Base Year 2008)

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