SPEER

The South-central Partnership for Energy Efficiency as a Resource

Capturing the Multiple Benefits of Industrial Energy Efficiency

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Preface

South-central Partnership for Energy Efficiency as a Resource (SPEER)

SPEER is an Austin, Texas based non-profit organization dedicated to increasing and accelerating the adoption of energy efficient products, technologies, and services in Texas and Oklahoma. Much of SPEER's work focuses on finding the best market-based approaches to increase energy efficiency and overcoming persistent market barriers. The views expressed in this paper do not necessarily reflect the views of all of SPEER's members, funders, or supporters. For more information about SPEER, please visit: www.eepartnership.org.

Energy Systems Laboratory (ESL)

The Energy Systems Laboratory (ESL) is a division of the Texas A&M Engineering Experiment Station and a member of the Texas A&M University System. The ESL is affiliated with the Energy Systems Group in the Department of Mechanical Engineering (five faculty), as well as two faculty from the Department of Architecture in the College of Architecture and celebrated its 25th anniversary two years ago. The Lab focuses on energy-related research, energy efficiency, and emissions reduction. For more information about the ESL please visit: esl.tamu.edu.

Industrial Assessment Centers

The USDOE Industrial Assessment Centers (IAC) are teams of university-based faculty and student engineers that provide no-cost energy, productivity, and waste assessments to small and medium sized US manufacturers nationwide. After site visits, a comprehensive report is developed providing specific details on all cost-saving opportunities identified during the assessment, including applicable rebates and incentives.

The Texas A&M Industrial Assessment Center has been serving the central and east Texas communities and parts of Louisiana for 30 years completing over 700 assessments and providing annual potential resource savings of $50,000 per client. For more information about the Texas A&M IAC please visit: iac.tamu.edu.

The Oklahoma State University Industrial Assessment Center has served over 850 clients in their three state regions and conducted over 940 audits over the past 35 years. In FY 2015, they performed 30 assessments and identified potential savings of $3.8 million. For more information about the IAC program, please visit: http://iac.okstate.edu.

Executive Summary

The Federal Clean Air Act (CAA), with amendments that were signed into law by President Bush in 1990, authorizes EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants. Rapid economic and population growth has continued to create air quality challenges for this region, even as the new strategies in the Texas State Implementation Plan (SIP) have helped control air pollution. More recently, carbon reduction policies and goals may create opportunities for industrial energy efficiency to contribute, provided the efficiencies achieved are reported, measured and verified.

States have addressed the CAA with a number of policies and programs. Texas developed a number of programs to address their non-attainment with these standards (specifically to reduce NOx), including requiring utility directed, rate-payer funded energy efficiency programs, known as the Energy Efficiency Resource Standard (EERS). In 2007 the industrial consumers supported an "opt-out" provision, as they had the technical and economic ability to fund their own efficiency improvements. This makes it impossible to track the improvements and investments of a large segment of the market that contributes to air quality goals.

Since 2001, Texas A&M University's Energy Systems Laboratory (ESL) has been calculating emissions benefits of energy efficiency and the EPA has approved energy efficiency as an effective means to reduce emissions. With increasingly stringent air quality standards and proposed new emissions regulations, the Texas Commission on Environmental Quality (TCEQ), the Oklahoma Department of Environmental Quality (ODEQ), and impacted local communities will likely be looking for additional ways to reduce emissions.

Industry is certainly motivated by the bottom line savings that energy efficiency delivers, and more recently a majority of national corporations are also adopting carbon reduction goals. We believe providing industrial customers an avenue to voluntarily report verified energy efficiency (including their contribution toward reducing emissions) will act as a mechanism to acknowledge activities already underway, as well as provide additional motivations for energy efficiency investment in this sector in the Texas and Oklahoma energy markets.

We reported in our feasibility study [1] that a voluntary program to encourage implementation and reporting of these recommendations by small to medium-sized industries could reduce NO_X emissions in Texas by 750 metric tons annually, which is comparable to annual savings from the Texas Emissions Reduction Plan (TERP) programs. Broader implementation of a program to include large industries could potentially save Texas 17,300 metric tons of NO_X and 13.4 million tons of CO_2 annually. Savings will be proportionally similar in Oklahoma, demonstrating significant potential impact across the South-Central region. Reporting of these energy savings and their associated emissions reductions can be accomplished through a voluntary program, utilizing a mechanism such as the IAC database framework. With the addition of simple verification procedures, this would allow industries to calculate and report energy savings using a database where emissions are calculated automatically on a sub-regional, or state level.

1 Introduction

The Texas A&M Industrial Assessment Center (IAC) and the Energy Systems Laboratory (ESL) have completed a preliminary study to demonstrate the potential savings from industrial energy efficiency projects. This report details development of a new database framework under which commercial and industrial businesses can report energy savings and have their emissions reductions calculated automatically. The database would therefore enable companies to report environmental and energy improvements without the need for additional regulation. The framework was developed to expand the publically available IAC Database and integrate with data from other Department of Energy (DOE) programs.

1.1 Feasibility Analysis of Common Energy Efficiency Recommendations

The potential of common energy efficiency projects to significantly affect emissions output in the South-Central region was evaluated in a prior feasibility study published in March 2016 [1]. Data from the Industrial Assessment Center (IAC) Database was analyzed to identify and quantify energy and emissions savings for common efficiency recommendations. Analysis showed that in the South-Central region, half of all emission reductions from energy efficiency projects for small-to-medium sized manufacturers are related to just five common industrial systems: compressed air, lighting, motors, HVAC, and boilers. The data further showed that more than 75% of all implemented efficiency projects are related to these systems. These statistics helped to underscore that common recommendations can have a large impact on industrial emissions output as they are more likely to be implemented by manufacturers.

The report also identified several common efficiency measures from the IAC code manual [2] that had the greatest potential to reduce emissions (Tables 1-2). Measures were divided into three categories: equipment, operations, and behavior. Equipment changes were installations of new machinery to improve efficiency. Operational changes were modifications to existing equipment to reduce energy consumption. Behavioral changes were changes that could only be

Table 1: Identified Equipment Measures

Measure	**Rec. Rate**	**CO_2 per Rec. (kg/yr)**	**NO_x per Rec. (kg/yr)**
Insulation of Bare Equipment	36%	290,000	110
Installation of Energy Efficient Motors	18%	63,000	35
Repair of Compressed Air Leaks	78%	98,000	50
Replace Existing Lighting	78%	80,200	35
Replace HVAC Equipment	6%	115,3000	65

Table 2: Identified Operational Measures

Measure	Rec. Rate	CO_2 per Rec. (kg/yr)	NO_x per Rec. (kg/yr)
Tune Boiler Air/Fuel Ratio	7%	120,000	95
Install Variable/Multi-Speed Controls	14%	246,000	130
Reduce Compressed Air Setpoint Pressure	39%	36,000	20
Utilize Photocell/Occupancy Controls	17%	60,000	30
Install Timers/Thermostats for HVAC Control	6%	25,700	20

realized by changing employee behaviors and habits. Note that for this report, behavioral changes are not considered as savings are not persistent. Projects from each category were selected based on a combination of frequency of recommendation (rate) and emissions reduction potential. Criteria were chosen to capture small measures with aggregate impact and large measures that occur infrequently but have large savings.

The potential for broad implementation of the identified measures by small-to-medium manufacturers in Texas was calculated and compared to other state programs that incentivize reduced emissions. The Texas Commission for Environmental Quality (TCEQ) has successfully managed the Texas Emissions Reduction Program (TERP) since 2001. As part of their annual report, TCEQ compiles air quality data through calculation of nitrogen oxide reductions from energy efficiency and code compliance projects. A comparison with broad implementation of the identified common measures showed that reductions from industrial efficiency would cut emissions more than any other TERP program excluding wind power investment (Figure 1). These comparisons helped to establish the potential impact of emissions reductions that could be realized by focusing on industrial energy efficiency.

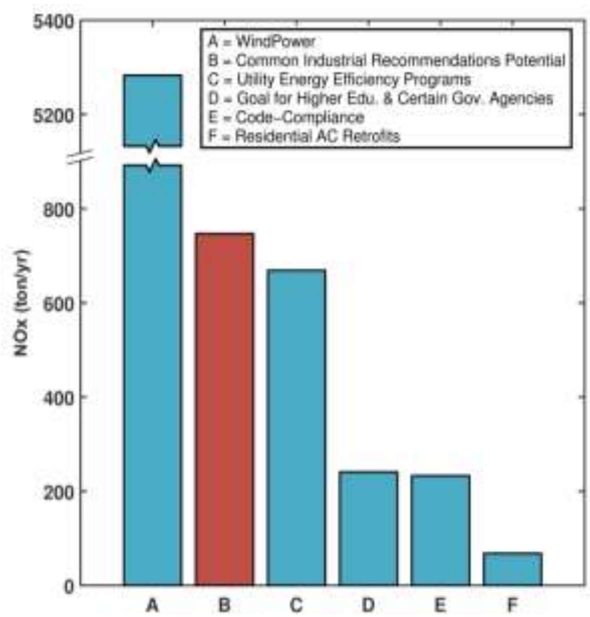

Figure 1: Comparison of savings from common efficiency projects and current TERP programs.

The feasibility of verifying energy and emissions savings was also presented in the report. Five on-site verification visits were conducted to former clients of the Texas A&M and Oklahoma State IACs to assess implementation of efficiency projects in the field. Savings were verified using simple procedures developed for each identified measure. In all, site visits established the viability of a voluntary program to conduct large scale verification and report the results. These findings informed the development of the Evaluation, Measurement, and Verification (EM&V) process for this program and the potential of reported savings.

1.2 Reporting of Industrial Emissions Reductions

The purpose of this project report is to establish a framework for verifying energy savings from industrial and commercial energy efficiency and report associated benefits. A preliminary database was established where savings can be reported and emissions reductions are automatically calculated. Towards these goals, the following tasks were completed:

Task 1: Database Framework

- Designing a framework for reporting of energy savings from efficiency projects.
- Development of a system to categorize projects, using basic manufacturer information, actual savings, and verification methods.
- Ensuring database is capable of accommodating industrial and commercial energy efficiency measures of any size.
- Developing a system to automatically calculate emissions reductions (CO_2 and NO_X) based on local emission factors.
- Collection of an initial dataset for the database framework that includes multiple energy efficiency programs including the IAC and other DOE efficiency initiatives.

Task 2: Presentation/Dissemination of Results

- Disseminate results from this report at conferences with broad stakeholder attendance to socialize the concept and gain project recognition.
- Document results from this report in conference papers.

The remainder of this report is as follows: A discussion of associated policies related to energy efficiency and emissions reductions at the national level and the state level is presented for Texas and Oklahoma. Next a discussion of methods to calculate energy savings from efficiency projects is followed by an explanation of emission factors and how they are used to estimate emissions reductions. The framework for the new energy efficiency verification database is discussed along with details on eligible participants and the verification process. Finally, details of statistics and results from completion of the above tasks and initial dataset are presented.

2 Industrial Energy Efficiency Policy

2.1 Texas Efficiency Policy

The Federal Clean Air Act, with amendments that were signed into law by President Bush in 1990, authorizes EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants. Rapid economic and population growth has continued to create air quality challenges for this Region, even as the new strategies in the Texas State Implementation Plan (SIP) have helped control air pollution. More recently, carbon reduction policies and goals may create opportunities for industrial energy efficiency to contribute, provided the efficiencies achieved are reported, measured and verified.

States have addressed the Clean Air Act with a number of policies and programs. Essentially, Texas developed the first state level Energy Efficiency Resource Standard (EERS) for electricity which requires utility-directed, rate-payer funded energy efficiency programs. In 2007 industrial consumers supported an "opt-out" provision for large consumers as they had the technical and economic ability to fund their own efficiency improvements. This makes it impossible to track improvements and investments that have been made by this large segment of the market. Similar opt-out programs are found in twelve other states including Oklahoma (Figure 2).

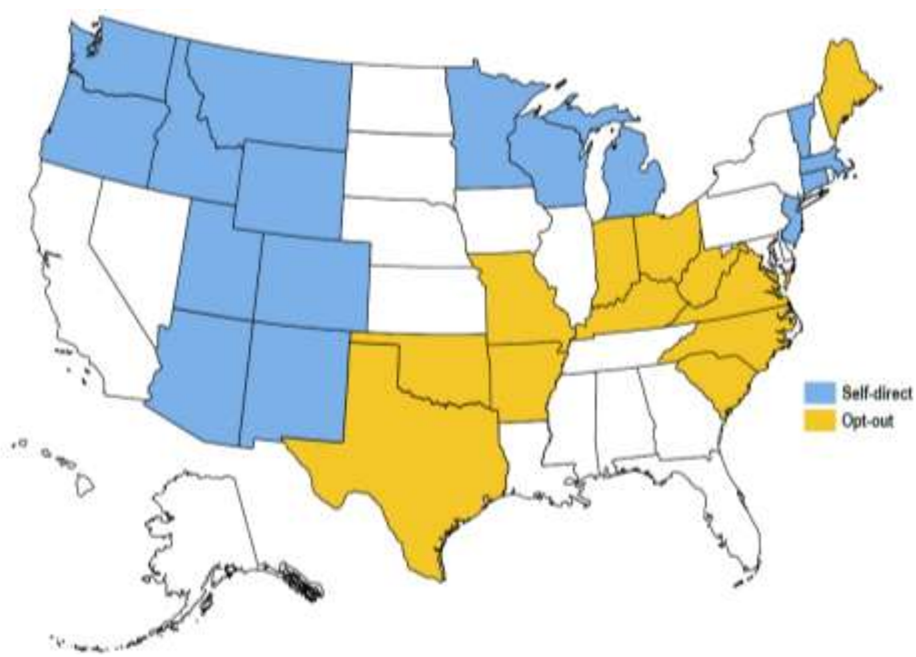

Figure 2: Reproduced from [3]. States with opt-out provisions allow large industries to claim exemption from industrial efficiency programs. Self-direct programs give more control of efficiency programs dollars to manufacturers and can increase project implementation and verification.

Essentially, Texas has responded to the Clean Air Act with a patchwork of programs to reduce emissions. In spite of those efforts, Houston and Dallas continue to be in severe non-attainment and other areas of the state are in near non-attainment with today's Air Quality Standards, which multiple studies have concluded poses a significant public health risk [4-5]. The 2001 Texas Emissions Reduction Plan (TERP) is a multi-pronged program that seeks to reduce NO_x emissions by funding several types of projects including energy efficiency [6]. Programs under the TERP umbrella include code compliance for new building construction, diesel emissions reduction incentives, utility efficiency programs, programs targeted for government agencies including schools and city buildings, and projects for renewable generation. Some of the most effective TERP programs have relied on voluntary participation or customer incentive programs.

Texas and Oklahoma are part of the nation’s leading industrial regions with substantial economic opportunity for energy efficiency. Texas was recently ranked first in the U.S. for industry’s potential to reduce CO_2 emissions through efficiency gains [7]. In addition, the feasibility study [1] for this pilot found that small to mid-sized industries could reduce NO_x emissions in Texas by 750 metric tons annually, and if large industry were also included, reductions of 17,300 metric tons of NO_x and 13.4 million tons of CO_2 are possible.

Voluntary reporting programs such as this one will allow leaders in industry to be recognized as contributors and their investments counted toward broader state efforts such as improving air quality, and while also ideally creating motivation for future investment. In the meantime, these companies may elect to participate and enjoy the benefit of verified savings to meet either corporate sustainability goals or other local goals for energy and emission reductions. It is important to reiterate that this program’s design does not call out individual contributors or their projects, but rather uses aggregated annual savings information to then calculate emissions reductions for broader benefit. Individual business data will be kept private and secure through the use of a third-party platform that specializes in warehousing such information.

Businesses that are within the service territory of a municipal or cooperative utility that offers these customers incentives would not be permitted to participate, to protect the data from being double counted.

2.2 Oklahoma Efficiency Policy

Although Oklahoma does not have an EERS, state utilities offer a portfolio of energy efficiency programs. Similar to Texas, any IOU utility customers with annual consumption greater than 15 million kWh and all transportation-only gas customers are eligible to "opt-out". According to ACEEE, approximately 90% of eligible customers opt-out, representing about 30% of total load [8]. Due to the similarity of state policy for industrial and manufacturing customer opt-out, SPEER believes that businesses in both Texas and Oklahoma would be willing to participate in a voluntary reporting program.

The Oklahoma Municipal Power Authority (OMPA) offers the Demand and Energy Efficiency Program (DEEP) to eligible commercial, industrial, and municipal government customers served by OMPA. This program encourages facilities to make energy efficient upgrades which cut summer peak demand and provides financial incentives for lighting, HVAC, food service equipment, motors, pumps, and measures. The maximum available incentive is $100,000 and customers must be willing to meet or exceed OMPA funding for these projects in order to be eligible [9]. Businesses that are within the service territory of a municipal or cooperative utility such as OMPA that offer these customers incentives, such as this one, would not be permitted to participate, to protect the data from being double counted.

2.3 Available Federal Programs to Accelerate Industrial Energy Efficiency

In addition to the state programs, several efficiency programs exist at the national level to promote adoption of efficiency projects. The US Department of Energy (DOE) currently sponsors seven Combined Heat and Power Technical Assistance Partnerships (CHP TAPs) across the country. These TAPs offer key services to facilities looking to utilize waste heat including market analysis and independent technical assistance [10]. The DOE also administers the Better Plants program which works with large manufacturers to reduce energy usage. Participants work with Better Plants personnel to reach a voluntary goal of 25% reduction in energy intensity over a ten year period. The program is currently working with 180 industrial companies composing 11.4% of total US manufacturing energy footprint [11]. Other programs include the Industrial Assessment Center Program (IAC) which has 28 centers across the country to conduct energy audits for small-to-medium industries. The DOE also sponsors six regional efficiency organizations, including the South Central Partnership for Energy Efficiency as a Resource (SPEER). Currently, however, none of these federally supported programs pay incentives for reported efficiency measures.

3 Energy Savings

3.1 Calculation of Deemed Savings

The basic level of energy savings calculation involves the collection of data including previous equipment specifications, installed equipment characteristics, and operation schedules. These data are used in accordance with pre-established calculation procedures approved by state agencies to estimate energy savings. Procedures include the Texas Technical Reference Manual (TRM) for measures in Texas [12] and any of the identified methods in the California Standard Practice Manual for measures in Oklahoma [13]. Calculated savings are therefore comparable with other energy efficiency programs. Verification through *deemed savings* simplifies the calculation of savings in the database framework, but savings calculated in this manner are conservative. Due to the simplification and conservative nature of deemed savings, it will provide a simplified process for early program participants.

3.2 Calculation of Detailed Savings

Data-driven verification of energy savings results in more accurate calculation of energy and emissions savings. Low cost data logging options are available to facilities looking to actively monitor energy consumption of equipment before and after implementation. Also certain state and regional utility providers have already installed smart metered connections for industrial clients [14]. Access to logged and/or 15-minute electrical demand data allows for more detailed analysis of a plant's energy savings. Calculations using data-driven methods are straight forward and result in the most accurate estimation of efficiency savings. While initial participants will use deemed savings procedures, future iterations of this program will allow for detailed calculation of energy savings.

3.3 Persistence of Energy Savings

For this project, energy savings from energy efficiency projects are separated into two categories based on the expected persistence of savings:

Long-term energy savings are the result of new equipment or retrofit installation (e.g. lighting upgrades, new chiller installation, etc.). These types of savings are realized for the lifetime of the equipment and represent a fundamental change in process or support energy consumption. Energy savings of this type are certified once during EM&V and are assumed to have full savings for at least seven years in accordance with DOE persistence standards.

Short-term energy savings are associated with improved operation of existing industrial equipment. Savings are the result of changing and/or optimizing equipment to ensure maximum efficiency (e.g. adjusting boiler exhaust air-fuel ratios). Because these savings are more transient than equipment upgrades, short-term savings are only counted for a single year. Annual reporting and verification of energy savings for projects with short-term savings would be required.

4 Emission Factors

Emission factors (EFs) are a widely used tool for calculating emissions based on reduced usage of primary fuels including coal and natural gas. These factors are usually averaged values that relate the amount of resource to an equivalent mass of pollutant, e.g. kg CO_2 per kWh of electricity. The factors used for this report focus on electric consumption (kWh) and natural gas (MMBtu). Although many pollutants and greenhouse gases can be tracked, the preliminary database will focus on nitrogen oxides (NO_X) which are important for regional air quality and carbon dioxide (CO_2) to address any carbon reduction goals.

Future innovation in smart grid technology has the potential to enable the development of more accurate emission factors than those currently used. As communication of real time data becomes more common, determination of a facility's instantaneous energy portfolio becomes possible. This includes knowing how energy is transmitted over the grid and the resources used to create it. Such data would allow for real time emission factors and an extremely accurate measure of pollutant output. However, such innovations are still under development and not available for current emission tracking projects. This section details several simplifying assumptions and methods used to calculate emission factors for energy efficiency projects.

4.1 Baseload Generation vs. Peak Generation

When calculating emission factors, attention must be paid to the effect of energy reductions on the electricity grid. These effects are related to the penetration of energy efficiency measures. In the near term, energy efficiency is usually projected to only effect power plants with highly variable output. Such plants are used to fill in power during peak grid demand and will have a different fuel/resource makeup than the grid as a whole. A high penetration of efficiency projects will result in a decrease in the baseload generation of a power grid. Emission factors for baseload reduction represent a different portfolio of power plants and would therefore have different emission factors. The preliminary database developed in this project uses peak load reduction factors as this is the most likely effect on the Texas and Oklahoma grids in the near future.

4.2 Average Emission Factors

Due to the complex flow of power through electric grids, many programs that estimate emission factors utilize average values. These factors can be calculated nationally, by state, or by region. The EPA eGrid Database [15] contains a list of all power generating plants in the US along with their location (state & county), primary fuel, capacity factor, and emission factors (NO_x, SO_2, CO_2, CH_4, etc.). For state-wide averages, eGrid divides total state generation by total emissions output. These factors are only suitable, however, for states that do not import significant amounts of power as out-of-state plant emissions will not be captured. In most cases using more regional emission factors is more accurate and will capture power flow effects. This report captures Oklahoma emissions reductions using the eGrid peak load reduction factor for the SPSO (southern Southwest Power Pool). Texas savings by county are captured using factors for the ERCOT (Electric Reliability Council of Texas), SRMV (Southern electric Reliability corporation Mississippi Valley), AZNM (southwest western electric coordinating council), and SPSO regions. Each of these zones is shown in Figure 3.

4.3 Emission Factors Using Sub-Grid Data

While state-wide averages are easy to compile and use, they are inherently less accurate. In an effort to provide more detailed estimates of emissions reductions, the Texas A&M Energy Systems Laboratory (ESL) developed a sub-grid methodology for tracking carbon dioxide and nitrogen oxides. The analysis was conducted under the Texas Emissions Reduction Plan (TERP) which aims to make Texas compliant with the Federal Clean Air Act. Full details of the methodology can be found in [16] and a summary is outlined below.

Figure 3: Map of eGrid sub-regions. The preliminary database uses SPSO for Oklahoma emission factors and AZNM, SPSO, ERCOT, and SRMV for Texas emission factors.

The Electric Reliability Council of Texas (ERCOT) manages the flow of electricity for approximately 24 million consumers in Texas covering 75% of the total land area and 90% of the state's electrical load [17]. ERCOT divides its grid into the four Congestion Management (CM) zones shown in Figure 4: North, South, West, and Houston. ERCOT tracks power generation in each zone and the flow of energy between zones. By solving a set of linear equations that balance generation and inter-zone flow, the ESL was able to determine how the total ERCOT grid is affected by energy efficiency projects in any zone. For example, the ESL found that reducing energy consumption in the Houston zone by 100 kWh would result in a 70 kWh reduction in the Houston zone, a 16 kWh reduction in the North zone, a 12 kWh reduction in the South zone, and a 2 kWh reduction in the West Zone. In this way, the state-wide impact of emissions cuts can be calculated on a sub-grid level.

Emission factors for each zone were found using the eGrid Database. The ESL assumed that production from nuclear, hydro-electric, and wind plants were not affected by reduced electrical consumption. They also assumed that any plant with a capacity factor of 80% or more was baseload generation that would not be affected by efficiency improvements. The remaining plants were then assigned a possible load reduction percentage based on their capacity factor. Emission factors for each plant were then calculated using the reduction potential. Finally, factors were tabulated across each ERCOT zone. This process results in emission factors that capture peak generation reduction on the sub-grid level.

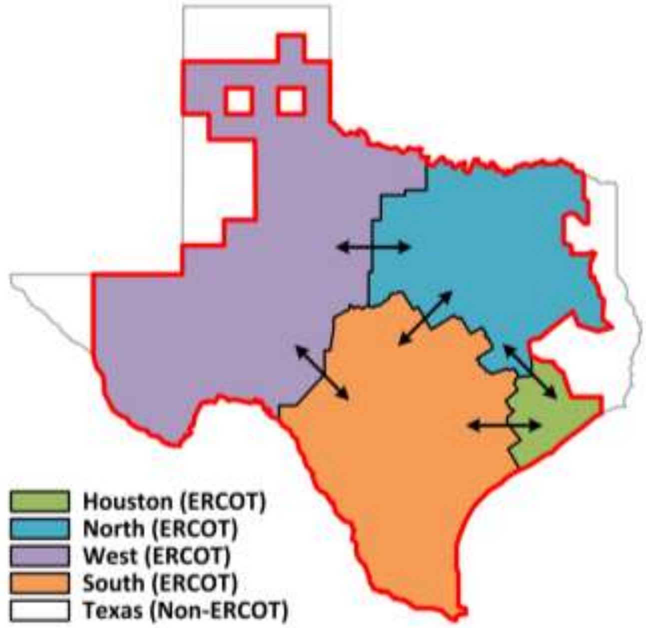

Figure 4: ERCOT (outlined in red) is divided into four congestion management zones. Power generation and energy flow between zones (arrows) is monitored and used to calculate emission factors.

4.4 Comparison of Emission Factor Methodologies

As discussed in the previous sections, there are numerous ways to formulate emission factors. To compare how results will differ based on what types of factors are used, Table 3 gives Texas emission factors for which eGrid average, eGrid non-baseload, and ESL sub-grid factors are all known.

The initial database framework uses eGrid non-baseload averages to calculate emission reductions. eGrid assumes that energy reductions will effect only fuel burning power plants by eliminating generation from emission-free sources such as hydro, wind, and solar. Removing these technologies causes the estimated emission factor to increase compared to average factors according to Equation 1:**Error! Reference source not found.** where E is emissions and P is power produced.

Table 3: Comparison of Emission Factors for Texas Grid

Source	Year	Type	NO_X (kg/kWh)	CO_2 (kg/kWh)
eGrid	2012	Non-Base	0.000435	0.595
eGrid	2012	Average	0.000317	0.545
ESL	2010	Non-Base (Houston)	0.000200	0.373
ESL	2010	Non-Base (North)	0.000212	0.344
ESL	2010	Non-Base (South)	0.000258	0.316
ESL	2010	Non-Base (West)	0.000279	0.365

$$EF = \frac{E_{Dirty}}{P_{Clean} + P_{Dirty}} \tag{1}$$

The desired level of accuracy and the type of program dictates which factor to use. This report seeks to quantify near term effects of energy efficiency on the grid and to integrate savings data from multiple programs. These goals are in line with using established eGrid database factors for sub-regional non-baseload emissions. Note that although the use of non-baseload factors may report slightly less conservative estimates of emission reductions, qualitative savings are the same no matter which factors are used. Also note that sub-state data is only available for Texas and not for other states including Oklahoma. As a result, the initial database uses eGrid as a consistent protocol for emissions reduction calculation so that the database can support potential application of similar programs across the country.

5 Framework for Energy Efficiency Reporting Database

The framework for the energy efficiency reporting database was based on the Department of Energy's IAC Database [18]. The IAC Database is a publically available dataset that contains industrial energy audit information for more than 17,000 facilities. Due to its open-source nature and wealth of information, the framework structure for this program was designed to expand that of the IAC database. By modeling the framework on an established database, adoption and maintenance of the new database will be simplified. Also, care has been taken to use the same or similar terminology as other DOE and EPA programs to facilitate inclusion of data from other DOE efficiency programs such as Technical Assistance Partnerships (TAPs) and Better Plants. Note that only non-identifiable, aggregate data will be published and all confidential data will be maintained on secure servers. Participation guidelines, new terminology, and descriptions of key tabs and data captured in the new database are presented in the remainder of this section.

5.1 Eligibility

Initial targets for participation in this energy efficiency reporting database are manufacturing or industrial facilities with transmission level service, and large commercial, industrial or manufacturing facilities which have chosen to "opt-out" of ratepayer funded utility energy efficiency programs [19]. In Texas and Oklahoma this includes those served by Investor Owned Utilities (IOU), but would exclude those with municipal or cooperative power providers which implement their own programs. The initial target covers large areas of Texas and Oklahoma and significant portions of industries in both states. Additionally, facilities must have fully implemented energy efficiency projects and provide sufficient documentation to at least calculate deemed savings.

5.2 Initial Application

Industrial or commercial facilities that wish to participate must first complete and submit the application form found in Supplemental Appendix S1. The questionnaire collects basic required information for participation such as contacts, location (ZIP), product information (SIC/NIAC), operating hours, annual utility spending, and utility service territory (or ESI ID). Additional information can be provided by IAC customers, for more detailed savings analysis including major equipment, production data, and consent to use monthly utility bills. Once the form has been completed and approved, a client can begin the verification process.

5.3 Verification Process

Data is then submitted to verify the purchase and installation of equipment, which can include invoices for the project, pictures of new equipment, or testing results of individual operational improvements. This information can be submitted by the building owner/manager, or a third-party energy service or management company. A more detailed analysis for IAC customer energy savings can be done through data logging, sub-metering, and/or through utility bills and demand data. Some additional follow-up or an on-site visit may be required to clarify data. Data provided will be used to certify energy savings and issue a verification report. Note that this process is the same for businesses of any size.

5.4 Certification

Upon review of the submitted verification data, participants will receive a certificate outlining calculated savings to include five (5) metrics: electric consumption reduction (kWh/yr), electric demand reduction (kW/yr), natural gas reduction (MMBtu/yr), carbon dioxide reduction (tons/yr), and nitrogen oxides reduction (kg/yr). Participant reports will include information outlining methodology and calculations. Results can be used by the industry participant for certification of internal efficiency or sustainability goals, reductions in emissions, etc.

5.5 Terminology

The database framework uses the following classifications for clients seeking to verify energy and emission reductions. Additional documentation on the structure of the database can be found in the Supplemental Appendices which are available by request.

Verifiable Measures:
This designation denotes any measure with an approved verification procedure. These recommendations include the identified common industrial recommendations from [1]. This category will expand as more procedures are developed.

Manufacturer Size:
Small (S) – Combined electric and gas utility spending between $20,000 and $200,000 per year.

Medium (M) – Combined utility spending between $200,000 and $2,000,000 per year.
Large (L) – Combined utility spending between $2,000,000 and $20,000,000 per year.
Exceptional (X) – Combined utility spending of more than $20,000,000 per year.

These designations allow for reporting of energy savings by industry size. Designations will help to determine the relative impact of savings from different segments of industrial manufacturing.

Verification Levels:
Self-Verified (SV) – Savings verified through submission of sufficient evidence of installation and operation. Evidence can include logged data, photos, and/or equipment purchase receipts.
Third Party Verified (3PV) – Savings verified by outside, independent organizations such as the IAC program, energy consultants, or Energy Service Companies (ESCOs).
Reported Ineligible (RI) – Savings claimed by facilities with incomplete documentation, which may require follow up or an on-site visit to verify.
On-site Verification (OV) – Additional designation indicating that installation and savings were verified by a third party, on-site verification visit.

Note that the database framework only includes *verified* energy savings from completed efficiency projects.

5.6 Aggregate Savings Reported

The information in the efficiency reporting database is used to compile aggregate energy and emissions savings. Five (5) annual savings figures are calculated: electric consumption reduction (kWh/yr), electric demand reduction (kW/yr), natural gas reduction (MMBtu/yr), carbon dioxide reduction (tons/yr), and nitrogen oxides reduction (kg/yr). These statistics may be included in reporting to national and state environmental agencies as well as electrical grid administrators.

6 Results from Preliminary Dataset

6.1 Preliminary Dataset

A large portion of the preliminary dataset came from the IAC Database [18] downloaded December 2016. The dataset was filtered to include only manufactures in Texas and Oklahoma that received an audit within the past two years. Only recommendations that reduced energy consumption were considered with behavioral modifications excluded. Additionally, the five clients selected for onsite visits in [1] were included. In total, data from 65 former IAC clients were used to populate the database. These clients represented over 400 individual efficiency projects that account for more than 22.8 million kWh of electrical consumption, 31,000 kW in electrical demand and 35,000 MMBtu in total annual energy savings as well as emissions reductions of 15 million kg (16,500 tons) of CO_2 and 12,500 kg (13.2 tons) of NO_x per year.

The database framework was created with flexibility to accommodate industrial clients of any size. To attempt to capture efficiency savings from large manufacturers outside the scope of the IAC program, contact was made with multiple DOE programs. The Better Plants program works with large manufacturers to meet voluntary long term efficiency goals and also maintains a large collection of client case studies [19]. Showcase clients receive recognition for implementation of efficiency projects and publicity for achieving energy saving goals. The Better Plants program tracks energy reductions in terms of energy intensity and utility spending and this data can integrate into the reporting database framework. The Better Plants program currently works with 180 companies with more than 2,400 facilities in the US.

Combined Heat and Power Technical Assistance Partnerships (CHP TAPs) are DOE programs that offer expert services to facilitate installation and implementation of CHP, waste heat recovery, and district heating projects. These partnerships help facilities save large amounts of energy by providing long term technical assistance and support. A Texas manufacturer with a recent CHP installation has been identified, and future phases of this efficiency reporting project will work with the client to obtain and verify energy and emissions savings from their CHP installation.

6.2 Lessons Learned from On-Site Visits

Two additional on-site verification visits to clients in the initial dataset were conducted during this phase of this project. These visits helped to establish the verification of energy savings procedures for this project, and verified the reasons why utility billing data or benchmarking by itself is not sufficient to verify actual energy savings.

Both on-site visits highlighted the degree to which facility energy use can change over relatively short periods of time. On the first visit, the facility had significantly downsized due to the current economy. Several production lines were closed and equipment idled. Although the company had not invested in upgraded lighting, they did disconnect lights in unused areas of the facility. Downsizing also indirectly reduced the facility's demand charges even though they had not pursued active demand reduction. Without upgrades to existing equipment, these savings were determined ineligible for reporting.

The second visit showed how the reverse economic situation could lead to false savings. The second facility had recently been bought by a larger company and was undergoing significant expansion, including the addition of a new extrusion line. Although the plant management had not implemented efficiencies in existing areas of the plant, they were pursuing energy efficiency solutions in their new construction. As new construction does not reduce current energy use or emissions, savings for these additions were determined not eligible, at least for this initial project phase.

7 Conclusion

In this project, a framework for reporting savings from industrial energy efficiency projects has been developed. The framework used the IAC Database as a starting point and was constructed to easily integrate with other existing Department of Energy efficiency programs including Better Plants and Technical Assistance Partnerships. This database uses established eGrid sub-regional peak-load emission factors to relate energy savings to CO_2 and NO_x emission reductions important for environmental and air quality standards. The framework was populated with 65 former IAC clients accounting for more than 400 individual efficiency projects with verified savings of more than 22.8 million kWh in electrical consumption and emissions reductions of 15,000 tons of CO_2 and 12,500 kg of NO_x per year.

SPEER is currently seeking additional funding and collaborative partners to launch a pilot in spring of 2017. SPEER is working to collaborate, convene, and socialize this demonstration project as a viable, large scale tool for this region to capture industrial efficiency in areas that customers have opted out of utility programs. This voluntary program would allow businesses to apply verified savings information to participation in broader company, state or regional efforts toward sustainability, air quality/public health, economic development, and emissions reductions efforts.

References

[1] C. Price and B. Rasmussen, "Emissions Reduction Potential from Common Energy Efficiency Projects in Small to Medium-Sized Industries", South-central Partnership for Energy Efficiency as a Resource (SPEER), Oct. 2016.

[2] M.R. Muller and D.J. Kaston. "Industrial Assessment Center Assessment Recommendation Code (ARC) Manual". Center for Advanced Energy Systems at Rutgers University. Version 9.1. https://iac.university/technicalDocs/ARC_list_9.1.pdf.

[3] American Council for an Energy-Efficient Economy (ACEEE). Factsheet. "Overview of Large-Customer Self-Direct Options for Energy Efficiency Programs." 2015.

[4] Centers for Disease Control and Prevention. Webpage. "Climate and Health: Air Pollution". http://www.cdc.gov/climateandhealth/effects/air_pollution.htm.

[5] Heidi Bethel. "A Close Look at Air Pollution in Houston: Identifying Priority Health Risks". US Environmental Protection Agency: Office of Water. https://www3.epa.gov/ttn/chief/conference/ei16/session6/bethel_pres.pdf.

[6] Texas Commission on Environmental Quality. Webpage. "Texas Emissions Reduction Plan (TERP): The Success Continues". 2014. https://www.tceq.texas.gov/publications/pd/020/2014/texas-emissions-reduction-plan-(terp)-the-success-continues.

[7] Alliance for Industrial Efficiency. Factsheet. "Texas' Carbon Dioxide Pollution could be Dramatically Reduced with Industrial Energy Efficiency and Combined Heat and Power".

https://eepartnership.org/wp-content/uploads/2016/09/Texas-Factsheet_AIE-State-Ranking-Report.pdf.
[8] American Council for an Energy-Efficient Economy (ACEEE). Webpage. “State and Local Policy Database: Oklahoma”. http://database.aceee.org/state/oklahoma.
[9] Database of State Incentives for Renewables & Efficiency (DSIRE). Webpage. “Oklahoma Municipal Power Authority – Commercial and Industrial Energy Efficiency Program”. http://programs.dsireusa.org/system/program/detail/4528.
[10] US Department of Energy (DOE) Advanced Manufacturing Office, Combined Heat and Power (CHP) Deployment Factsheet. http://energy.gov/sites/prod/files/2016/09/f33/CHP%20Deployment%20Program%20Fact%20Sheet_FINAL_compliant.pdf.
[11] US Department of Energy (DOE) Better Plants Program, “Frequency Asked Questions (FAQ)”. http://energy.gov/sites/prod/files/2015/01/f19/Better%20Plants%20FAQs.pdf.
[12] Public Utility Commission of Texas, “Texas Technical Reference Manual”, 2017. http://www.texasefficiency.com/images/documents/RegulatoryFilings/DeemedSavings/trm4v1.pdf.
[13] American Council for an Energy-Efficient Economy (ACEEE). “State and Local Policy Database: Evaluation, Measurement, & Verification”. http://database.aceee.org/state/evaluation-measurement-verification
[14] Oncor, “How to Access Meter Data”. Webpage. http://www.oncor.com/EN/Pages/How-To-Access-Meter-Data.aspx.
[15] eGrid Database. US Environmental Protection Agency, https://epa.gov/energy/egrid.
[16] J. Haberl, B. Yazdani, J.-C. Baltazar, S. L. Do, P. Parker, S. Ellis, G. Zilbertshtein, and D. Claridge. “Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP): Preliminary Report - Integrated NO_X Emissions Savings from EE/RE Programs Statewide”. Technical report, Texas A&M University Energy Systems Laboratory, 2014.
[17] Energy Reliability Council of Texas (ERCOT), “ERCOT Quick Facts”. http://www.ercot.com/ content/wcm/lists/89475/ERCOT_Quick_Facts_9916.pdf.
[18] Industrial Assessment Center Database. Maintained by the Center for Advanced Energy Systems at Rutgers University. https://iac.university/download.
[19] Better Buildings Energy Solutions Finder. U.S. Department of Energy (DOE) Better Buildings Program. https://betterbuildingssolutioncenter.energy.gov/search?f[0]=field_sector %3A38&f[1]=field_content_type%3A848.