Scope of Work: 2016 Energy Efficiency Potential Study

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Scope of Work

General Purpose

The Public Service Commission of Wisconsin (PSC), in association with Focus on Energy (Focus), is preparing for the next quadrennial (2019-2022) planning cycle. An energy efficiency potential study can inform program planning by:

1. Assessing the remaining energy savings potential for measures offered through existing PSC programs.
2. Identifying measures with high savings potential but not currently offered by Focus on Energy and utility voluntary programs.
3. Estimating the achievable energy savings potential for different spending levels, including a business-as-usual scenario which assumes spending of approximately $100 million per year (defined by current statute) and alternate "unconstrained" scenarios that assume no spending limits.[1]
4. Identifying the mixture of measures and programs under each spending scenario that meets PSC planning objectives and delivers high cost-effective energy savings

The study outlined in this work plan satisfies these four primary objectives, producing rigorous estimates of energy efficiency potential in a cost-effective manner that leverage Cadmus' existing evaluation research efforts. The study will assess different spending levels, help identify the optimal mixture of programs and measures, and meet the following secondary objectives:

1. Use primary data to characterize the current energy consumption of homes, businesses, and industries in Wisconsin.
2. Estimate the energy and demand savings potential for a comprehensive list of measures spanning different sectors, market segments, and end uses. Consider all commercially viable and emerging measures including various equipment upgrades, retrofits, and behavioral measures.
3. Estimate the impact of building energy codes and standards on future energy consumption and savings potential.
4. Assess the savings potential from market transformation.
5. Perform sensitivity analysis for different economic assumptions, including discount rates, avoided costs (such as alternate carbon price forecasts).
6. Incorporate input from Wisconsin's diverse stakeholders which could include PSC staff, the program administrator, program implementers, members of the evaluation working group, consumer advocate groups, locally based experts (such as other evaluation firms), and other organizations that have a vested interest in the study.

[1] Statute requires each investor owned energy utility to spend 1.2 percent of annual operating revenues to fund programs. Each municipal utility must spend $8/meter. Historically, this is roughly equal to $100 million per year. Cadmus will work with PSC staff to determine the appropriate spending cap.

7. Provide estimates of energy efficiency potential through 2030 to inform long-term program planning and resource planning

Stakeholder Involvement

Cadmus prides itself on its ability to work with multiple stakeholders, building such collaboration on an understanding of shared objectives (i.e., maximizing energy efficiency programs' effectiveness in achieving goals and targets), clearly defined roles and responsibilities, and transparency in communication and analysis. This collegial approach improves the flow of information between planners and regional stakeholders, providing regional insights and allowing access to data that otherwise might not have been identified.

Cadmus' projects often involve a large number of stakeholders with diverse, potentially conflicting interests and objectives. Through such experience, Cadmus has have learned that effective stakeholder engagement—including consumer groups, regulators, and policy makers—requires deliberate planning and a thoughtful approach. This begins with defining clear objectives, understanding the perspectives of those involved, and implementing approaches that ensure a representative sample of voices are heard and all relevant information is brought to light.

Cadmus will facilitate and present progress reports for PSC stakeholders, represented by the following two proposed working groups: an oversight committee (OSC) and a technical advisory committee (TAC).

- OSC attendees will likely include program administrator, program implementers, and Focus staff, consumer advocate groups, locally based experts, and other organizations with a vested interest in this study. Cadmus proposes three in-person discussion sessions with PSC regional stakeholders—one session for each major milestone: (1) the study overview and scope; (2) primary data collection results and achievable potential; and (3) the final report.
- TAC attendees primarily will include program staff with technical experts from implementers, evaluation teams, and policy makers on as-needed basis, depending on agenda topics. These meetings will occur regularly throughout the project, ideally on a bimonthly basis via web conferences. Cadmus intends to hold at least five TAC meeting throughout this study.

Cadmus will work with the PSC to prepare agendas and materials in advance of these sessions and to facilitate appropriate feedback and answer questions. The timing of these (OSC and TAC) meetings will be spaced appropriately to allow adequate time for feedback from stakeholders to help guide and enhance this study. Jane Colby and Travis Walker will attend OSC sessions as presenters. An additional Cadmus staff may attend to address key agenda topics for a particular session. Cadmus' staff Ann Sojka will facilitate and coordinate meeting preparation and follow-up.

Following the conclusion of the stakeholder meetings, Cadmus will deliver meeting notes documenting the discussion and any required follow-up identified through the meeting. Throughout this SOW within each task's milestones and deliverables, working group action items are highlighted.

Organization of this Scope of Work

The potential study will involve the following six tasks

- Task 0. Project Initiation
- Task 1. Data Collection
- Task 2. Measure Characterization
- Task 3. Potential Modeling
- Task 4. Program Analysis
- Task 5. Reporting

The scope also describes the study's approach for the following cross-cutting tasks (Task 6):

- Project management
- Reporting greenhouse gas (GHG) emissions from energy efficiency

Task 0. Project Initiation

Cadmus will organize an in-person kick-off meeting between key Cadmus project team members, PSC staff, Focus staff, Evaluation Working Group (EWG) members, and program implementers to initiate the project. One week before the meeting, Cadmus will submit the following to PSC staff: a draft agenda, a draft work plan, and a list of the study's data requirements. Meeting objectives will include the following:

- Introduce Cadmus' to PSC's project management team and determine the schedule and preferred methods of communication between the teams. Cadmus recommends key potential study staff attend regularly scheduled evaluation update conference calls to discuss the project's progress, ensuring the final project meets PSC's needs.
- Review and finalize the project's work plan:
  - Due to Cadmus' long standing evaluation work, the project team has already identified relevant reports and data inputs for the study (for example: saturation surveys, market research studies, end-use studies, audit studies, program evaluation studies, historical forecasts, and sales forecasts). Cadmus will compile this list and share it with the PSC staff, the Focus administrator, and program implementers to ensure collection of an exhaustive list of already completed work.
  - Review the initial list of energy efficiency technologies measures.
  - Finalize the primary data collection activities and the sampling plan.
- Review examples of potential study results with PSC staff:
  - Establish data transfer protocols and timelines for future meetings and deliverables.

Cadmus will prepare and submit a memorandum that documents the discussions, decisions made, protocols established, and any issues that may require resolution. Cadmus will address comments on the draft work plan from the kick-off meeting participants and submit a final work plan within 14 days after the project initiation meeting. Cadmus also will send a draft outline of the final report, which will include sample tables and figures to PSC's review.

Task 0 Milestones and Deliverables

- In-person Kick-off Meeting
  - ⇒ Working Group: OSC Attending
- Provide Post-Meeting Memorandum
- Draft and Final Work Plans and Report Outlines

Task 1. Data Collection

Task 1.1. Primary Data Collection

Energy efficiency potential assessments require detailed information on building characteristics and end-use consumption in homes, commercial buildings, and industrial facilities. To gather this information, Cadmus recommends conducting primary research to develop a robust baseline forecast tailored to the homes, businesses, agriculture and industrial facilities in Wisconsin that are eligible for the Focus program. This will include specific building characteristics and information to gauge acceptance of energy efficiency measures. Cadmus will perform primary data collection in each market sector *and* will leverage existing data from Focus' program evaluations, baseline studies, and program implementer data. Primary data collection will involve site visits and phone surveys in the residential, commercial, agriculture, and industrial sectors. Industry best practices towards sample design, surveying and recruitment will help ensure the primary data collection effort is a representative sample of Wisconsin. Where applicable and able, Cadmus will compare customer demographics to known census and similar data and apply weighting if needed.

Cadmus' data collection will involve the following:

1. A phone survey will collect information on the customers' attitudes towards energy efficiency and willingness to adopt efficiency measures.
2. A site assessment will collect comprehensive information on building characteristics, energy-consuming end uses, and equipment efficiencies.

Cadmus will complete the brief phone survey when recruiting for site assessment participants. The phone survey sample may exceed the site assessment sample if there is site assessment attrition. After identifying high-priority items (e.g., measures, programs, and market segments) with the PSC and stakeholders, Cadmus will revisit the initial number of surveys and site visits.

Existing Primary Focus Data

Cadmus will leverage existing Focus data to enhance this study and to promote cost sharing with current and past evaluations. The Focus data include the following:

- Residential Longitudinal Lighting Study (n=124)
- CREED 2015 residential lighting sales and panel data
- D&R Residential HVAC Wisconsin region sales data
- Home Performance with ENERGY STAR audit data
- Small business audit data (Energy Snapshot data)
- Evaluation survey demographic components
- 2013 baseline study
- Technical Reference Manual (TRM) and specific measurement studies
- The latest evaluation report at the time of the study.

Cadmus will share this list with the program administrator and implementers to identify additional missed and available data sources. Where applicable, data from these sources will be incorporated, while ensuring data used in the potential study have been collected consistently and without introducing bias.

After an initial review of Focus data, Cadmus believes the random sample found in the Residential Longitudinal Lighting Study eliminates such potential bias. Cadmus will use the data collected from the Residential Longitudinal Lighting Study for the single-family site visits. If, after review, any data are missing, the evaluation will collect the required information when returning to the sites this spring/summer. This will presents a low cost solution to the potential study as Cadmus plans these revisits under the current evaluation. Any additional site visit costs made through this expanded scope will be accounted for within the evaluation.

Telephone Surveys

Cadmus will use phone surveys to assess customers' willingness to adopt energy efficiency measures and their attitudes to energy conservation. For the residential sector, the study will consider single-family, multifamily, and manufactured homes. For nonresidential sectors, the study will stratify by business types (e.g., office, warehouse, retail). These efforts will seek to produce estimates that achieve the following:

- 90% confidence, with at least ±5% precision for each sector; and
- 90% confidence with ±10% precision for the key market segments.

After the project kickoff, Cadmus will submit the recruitment script and phone survey instrument for the PSC's and the Administrator staff's review. After PSC approves the survey instrument and sample design, Cadmus will field the phone surveys. Either Nexant or St. Norbert College Strategic Research Institute (current subcontractors for the Cadmus evaluation) will conduct surveys and recruit for site visits.

Cadmus will analyze the survey results and, in concert with existing data and secondary data, use the findings to develop inputs for the energy efficiency potential study. Surveys generally provide sufficient data on fuel shares and equipment saturation; however, collecting efficiency data can be challenging because customers often do not know the efficiency ratings of their equipment.

Cadmus will ask questions that customers typically can answer about their energy use, but will use other data—such as site visits (discussed below), building codes, sales data, and federal equipment efficiency standards—to estimate current efficiency levels. Cadmus also will ask survey questions to gauge customers' attitudes toward energy efficiency and their willingness to pay for measures. This will help us estimate the achievable potential.

Site Visits

Cadmus' objectives for collecting on-site data seek to achieve a current and focused understanding of end-use equipment in PSC's service territory. After analyzing secondary data sources and feedback from PSC as well as from stakeholders to determine the facility types with the largest energy footprints within PSC's service territory, Cadmus will focus site visits on these facility types. Based on previous experience, Cadmus has have found facility managers provide high-quality estimates of equipment saturations. However, as large facilities represent a large portion of overall energy consumption, Cadmus recommends focusing site visits at large nonresidential customers to help characterize existing efficiency levels.

Cadmus will recruit customers by telephone and send experienced field staff to conduct a building walk-through for those agreeing to a site visit. Field staff will collect information on HVAC systems, interior and exterior lighting, and major building shell characteristics. Data collected during the site visits will be collected in a database and used to supplement secondary data sources for developing a baseline energy forecast and measure characterization.

Sample Design

The Focus potential study's key objective is to define stock energy usage for several end-use categories across the residential, commercial/government, agriculture and industrial sectors. Surveys and site visits will enhance existing customer demographic data, saturation rates, operating hours, and equipment performance. These metrics will be used to develop a stock assessment and to estimate savings potential for current and future Focus programs.

Overview of Sampling Methodology

The following section describes the proposed design for the sampling approach:[2]

Describe population structure and confidence and precision requirements. Sampling will include all residential, commercial/government, agriculture and industrial sector customers in areas served by Wisconsin utilities that participate in Focus on Energy. Cadmus will follow criteria of 90/10 confidence and precision for the sample size. This sampling plan will utilize information available from current tracking data to describe the structure of each population of interest.

Identify basic sampling domains and determine appropriate stratification. The basic sampling domains for this study consist of the residential, commercial/government, agriculture and industrial sectors. Selection of sampling methods depends on target population's degree of homogeneity or heterogeneity. Cadmus feels that a stratified sampling plan would provide the most appropriate method for capturing variability within the residential and commercial/government sectors.

With that said, Cadmus will define the final residential and nonresidential stratified sampling plan for the surveys and site visits after reviewing the existing data and receiving feedback from PSC staff as well as from OSC and TAC members during the initial kick-off meeting. For example, discussions on what the priorities are for this study may be focus on building types that account for the majority of consumption in each respective sector, segments with limited existing data, or segments with the most overlap to existing Focus programs.

To address these multiple priorities, Cadmus proposes two options to facilitate this discussion. Both options are budget neutral.

Option 1 Cadmus proposes divide the population for each sector into the following strata where the commercial/government sector(s) are based a preliminary prediction of what building types account for the majority of consumption:

1. Residential—by home type
   a. Single-Family
   b. Manufactured Homes
   c. Multifamily
2. Commercial/Government—by segment
   a. Office
   b. Retail
   c. Education (K-12 and Universities)
   d. Hospitals

[2] Cadmus has already estimated sample sizes for the various segments, but feels, upon receiving additional information (e.g., end uses of specific interest), the design can be improved, either reducing sampling error or achieving better confidence and precision levels.

    e. Other
3. Industrial—no further stratification
4. Agriculture—no site visits, survey only

Option 2 Cadmus proposes divide the population for each sector into the following strata where there is a larger emphasis within nonresidential sectors such as adding grocery and agriculture site visits. Cadmus also reviewed Census housing data and found a relatively small portion of homes are manufactured (~4%). This option proposes removing the manufactured homes strata and allocating those funds to nonresidential site assessments:

1. Residential—by home type
    a. Single-Family
    b. Multifamily
2. Commercial/Government—by segment
    a. Office
    b. Retail
    c. Education (K-12 and Universities)
    d. Hospitals
    e. Grocery
    f. Other
3. Industrial—no further stratification
4. Agriculture— no further stratification

Improve sampling efficiency based on a priori Coefficient of Variation (CV) values. Cadmus typically bases CV values on previous evaluations to achieve optimal sample designs. Use of *a priori* CV's ensures appropriate allocation of sample sizes, increasing sampling efficiency by reducing the chance of oversampling or undersampling within each sampling domain. Cadmus recently developed *a priori* CV values for the three residential home types addressed in this study, based on a review of end uses with the highest savings potential, as recommended by the Northwest Council 7th power plan[3] and by the Regional Technical Forum.

Cadmus computed CVs for each end-use category using energy usage estimates in the Northwest Energy Efficiency Alliance's 2011–2012 Residential Building Stock Assessment.[4] This included considering the following end-use categories during *a priori* CV development: home characteristics, appliances, heat loss, tightness, lighting, water heating, HVAC, and electronics. Cadmus found average CVs as follows: 0.627 for single-family homes, 0.624 for manufactured homes, and 1.150 for multifamily (residential

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[3] https://www.nwcouncil.org/energy/powerplan/7/draftplan/

[4] http://neea.org/resource-center/regional-data-resources/residential-building-stock-assessment

units only). Cadmus proposes using these CVs for best allocating the available sample to the residential strata.

In the absence of prior information on variability within a sampling domain (or if existing information no longer proves relevant), Cadmus assumes the standard deviation would be about one-half the size of the mean, resulting in a CV of 0.5. Thus, Cadmus proposes using this default CV for sample size calculations within the commercial/government and industrial/agriculture sectors.

Survey and Site Visit Sampling Options

In developing this SOW and budget, Cadmus used a combination of *a* priori CVs for the residential sector and conservative CV estimates for the commercial/government, and industrial/agriculture sectors, together with industry-standard confidence/precision targets of 90/10. In addition, Cadmus understands the multiple priorities that may be present and proposes Option 1 and Option 2 for sample plan of the surveys and site visits.

Option 1 are present in Table 1 and Table 2 with the initial sample sizes. The adjusted sample for residential sector reflects the desire to limit the budget and scope since multifamily represents a smaller portion of the overall residential sector while achieving reasonable confidence. Similarly, the adjusted sample for the nonresidential sectors reflects a limited scope for industrial and agricultural sectors.

Table 1. Option 1 Sample Sizes for the Residential Segments

Strata	CV	Initial Sample Size	Adjusted Sample Size	Precision at 90% Confidence
Single-Family	0.627	106	106*	10.0%
Manufactured Homes	0.624	105	105	10.0%
Multifamily	1.150	358	180	14.1%
Total Residential	**-**	**570**	**391**	**-**

*Cadmus will use the data collected from the Residential Longitudinal Lighting Study for the single-family site visits.

Table 2. Option 1 Sample Sizes for the Nonresidential Segments

Strata	CV	Initial Sample Size	Adjusted Sample Size	Precision at 90% Confidence
Office	0.5	68	70	9.8%
Retail	0.5	68	70	9.8%
Education (K-12 and Universities)	0.5	68	70	9.8%
Health Care (Hospitals and Out Patient)	0.5	68	70	9.8%
Commercial Other	0.5	68	70	9.8%
Industrial/Agriculture*	0.5	68	40/70*	13.0%/9.8%*
Total Nonresidential	**-**	**408**	**390****	**-**

*Agriculture represents survey only data collection and does not include site visits.

**Represents the total number of site visits. The total number of proposed surveys is 420.

Option 2 are present in Table 3 and Table 4 with the initial sample sizes where there is a larger emphasis within nonresidential sectors such as adding grocery and agriculture site visits. The adjusted sample for residential sector reflects the desire to further limit the budget and scope since multifamily represents a smaller portion of the overall residential sector. This allows more funds to be allocated for the nonresidential sector.

Table 3. Option 2 Sample Sizes for the Residential Segments

Strata	CV	Initial Sample Size	Adjusted Sample Size	Precision at 90% Confidence
Single-Family	0.627	106	106*	10.0%
Multifamily	1.150	358	70	22.6%
Total Residential	**-**	**570**	**391**	**-**

*Cadmus will use the data collected from the Residential Longitudinal Lighting Study for the single-family site visits.

Table 4. Option 2 Sample Sizes for the Nonresidential Segments

Strata	CV	Initial Sample Size	Adjusted Sample Size	Precision at 90% Confidence
Office	0.5	68	70	9.8%
Retail	0.5	68	70	9.8%
Education (K-12 and Universities)	0.5	68	70	9.8%
Health Care (Hospitals and Out Patient)	0.5	68	70	9.8%
Grocery	0.5	68	70	9.8%
Commercial Other	0.5	68	70	9.8%
Industrial	0.5	68	30*	15.0%
Agriculture	0.5	68	35*	14.0%
Total Nonresidential	**-**	**544**	**485**	**-**

*Cadmus recommends having some flexibility with the right mix of completes between industrial and agricultural sites. Completions will be very tied to customers agreeing to the audit. Cadmus is recommending sitting down with the program administrator and other program implementers to understand what the most reasonable expectation is.

With the aid of feedback solicited from the PSC and the OSC/TAC, Cadmus will discuss these options presented above. Cadmus will refine the sample sizes and data collection budget accordingly after kick-off meeting.

Task 1.2. Collect Utility Data and Perform Secondary Research

Cadmus will request the following data through the PSC:

- **Utility Sales and Customer Data.** Base-year, forecast customers, and sales offer crucial inputs in calculating potential. These data—defining the eligible population and load—provide the basis for calibrating the model to verify the validity of end-use consumption and equipment saturation estimates. Cadmus will require utility forecasts for each sector through 2030. If utility forecasts are unavailable, Cadmus will rely on MISO forecasts. Cadmus will work closely with PSC staff to understand the data available and to determine the best method to extract the data needed for this assessment.
- **Existing Market Research.** This includes any additional studies not discussed above. Saturation studies, other market research (such as the customer acceptance for load cycling), and energy audit data may serves as rich input sources for the study. Cadmus will review available existing research and mine this for specifics on end-use and equipment-type saturations.
- **Additional Sources.** In addition to PSC's data, Cadmus will use secondary sources, such as publicly available results from similar regional potential studies and the U.S. Department of Energy's Energy Information Agency's Manufacturing Energy Consumption Survey for end-use consumption estimates, saturations, fuel shares, and efficiency shares. The PSC's TRMs also will serve as key resources, and, where appropriate, the study will consider national benchmark data.
- **Economic Assumptions and Data.** The study requires certain economic data to assess cost-effectiveness at the energy efficiency measures level, such as the following: inflation and discount rates; line losses; electric, gas and water avoided costs; and program approaches (including incentive strategies for the utility cost test analysis). Cadmus will work with the PSC to decide on the appropriate time-varied avoided costs, iterating these as needed for varying achievable energy efficiency forecasts.

Task 1 Milestones and Deliverables

- Review Collected Data and Assumptions
  - ⇒ Working Group: TAC Review
- Summary of Data Sources for Each Input

Task 2. Measure Characterization

Task 2.1. Define the Markets

Cadmus will use the following definitions for sectors, market segments, vintages, and end uses for PSC's service territory:

- **Customer sectors:** residential (including single family and multifamily), commercial, government/schools, agriculture, and industrial.
- **Market segments:** (see Table 4)

- *Residential:* single-family, manufactured, and multifamily.
- *Commercial:* segments will be based on business types and customer size.
- *Government and Schools:* segments will include major building types, such as offices, K-12 education, and universities.
- *Industrial:* manufacturing segments based upon those present in PSC's service territory.
- *Agricultural:* dairy, irrigation, poultry, and other

- **Building vintages:** existing and new (for residential and commercial sectors only).
- **End uses:** applicable to interior and exterior lighting, HVAC, building shell, refrigeration, cooking, freezer, dryer, water heating, plug loads, processes, data centers, motors, compressed air (see Table 6)

Table 5 shows an example of potential study market segmentation. Using the utilities' customer databases, evaluation results, and secondary market research, Cadmus will refine this list as needed to determine a final list of market segments. For example, industrial segments will be tailored, including or omitting industries to characterize the potential in a manner that will assist PSC in setting appropriate energy-efficiency goals and targets. Cadmus can break out commercial, government, and schools segments by size or by more granular use types (such as education K-12 and universities). Cadmus will review utility and program data and solicit feedback from stakeholders to determine the final market segments.

Table 5. Example of Potential Market Segments

Residential Segments	Commercial Segments	Government and Schools	Industrial Segments	Agricultural Sectors
Single-family	School K-12	School K-12	Chemical Mfg.	Dairy
Manufactured	Universities	Universities	Computer/Electronic Product Mfg.	Irrigation
Multifamily	Grocery	Offices	Food Mfg.	Poultry
	Hospitals	Other	Electrical Equipment Mfg.	Other
	Health Care Out Patient		Fabricated Metal Product Mfg.	
	Lodging		Furniture Mfg.	
	Office		Machinery Mfg.	
	Restaurant		Nonmetallic Mineral Product Mfg.	
	Retail		Paper Mfg.	
	Warehouse		Plastics/Rubber Products Mfg.	
	Other		Primary Metal Mfg.	
			Printing	
			Transportation Equipment Mfg.	
			Wood Product Mfg.	
			Water/Waste Water Treatment	
			Other	

Table 6 shows an example of potential study electric and gas end uses associated to each sector. Similar to the determining the market segments, Cadmus will refine this list as needed to determine a final list of end uses. For example, Cadmus will want to prioritize these end uses with the data collection efforts.

Table 6. Example of Potential End Uses by Sector

Residential End Uses	Commercial/Government End Uses	Industrial End Uses	Agricultural End Uses
Computer	Compressed Air	Fans	Fans
Cooking Oven	Computers	HVAC	HVAC
Cooking Range	Cooking	Indirect Boiler	Lighting
Cool Central	Cooling Chillers	Lighting	Motors Other
Cool Room	Cooling DX/Evap	Motors Other	Other
Copier	Data Center	Other	Process Refrig and Cooling
Dehumidifier	Fax	Process Compressed Air	Pumps
Dryer	Flat Screen Monitors	Process Heat	
DVD	Freezers	Process Other	
Freezer	Heat Pump	Process Refrig and Cooling	
Heat Central	Lighting Exterior	Pumps	
Heat Central Boiler	Lighting Interior Fluorescent		
Heat Central Furnace	Lighting Interior HID		
Heat Pump	Lighting Interior Other		
Heat Room	Lighting Interior Screw Base		
Home Audio System	Other		
Lighting Exterior	Other Plug Load		
Lighting Interior Specialty	Package Terminal AC		
Lighting Interior Standard	Package Terminal HP		
Monitor	Photo Copiers		
Multifunction Device	Pool Heat		
Other	Pool Pump		
Plug Load Other	Printers		
Pool Heat	Refrigeration		
Pool Pump	Refrigerators		
Printer	Room Cool		
Refrigerator	Room Heat		
Set Top Box	Servers		
TV	Space Heat		
Ventilation And Circulation	Space Heat Boiler		
Water Heat > 55 Gal	Space Heat Furnace		
Water Heat < 55 Gal	Vending Machines		
	Ventilation And Circulation		
	Water Heat > 55 Gal		
	Water Heat < 55 Gal		

Task 2.2. Screen the Sectors, Segments, and End Uses for Eligibility

Cadmus will perform a qualitative screening of market segments and end uses for the applicability of specific energy-efficient strategies. For example, this may exclude certain commercial end uses (such as cooking loads) that do not prove appropriate for segments such as offices and warehouses. Similarly, some equipment sizes may not be applicable to certain segments, even if the end use is present.

Cadmus's final datasets will provide the final segmentation documentation, including square feet, energy consumption, applicable end uses, end-use consumptions, and saturations for each building type. The study will use these values to model and develop a base-case forecast.

Task 2.3. Develop Comprehensive Energy Efficiency Measures List

Cadmus will compile a comprehensive database of technical and market data on all energy efficiency measures that apply to eligible end uses in each market segment. At a minimum, this will contain the following:

- All measures currently included in PSC's programs;
- Measures included in Focus' TRM and SPECTRUM databases;
- Measures included in regional or national databases (such as the RTF [in the Northwest], the Database for Energy Efficient Resources [DEER], and ENERGY STAR®) and applicable TRMs;
- Measures from Cadmus' extensive measures database.

Cadmus will assess any newly commercialized technologies, such as heat pump dryers. The initial measure list will provided to PSC administrator and TAC working group for feedback.

Qualitative Screening

Using all feasible measures, Cadmus will conduct a qualitative screen to evaluate the applicability of measures to Wisconsin. This approach creates a transparent process to show why certain measures might not be considered in the technical or economic potential. This eliminates unnecessary data gathering and analysis and ensures a more streamlined study. Cadmus may exclude a measure from analysis if it is not commercially available, does not benefit the utilities' systems, increases peak demand, proves unrealistically expensive to install, or operates or falls below prevailing code. Some measures that pass the initial qualitative screen may be later eliminated if reliable data on savings or costs prove unavailable.

Cadmus will submit a preliminary energy efficiency measures list, along with screening results, for PSC's review, and will finalize this list based upon PSC's and the TAC's feedback.

Task 2.4. Develop the Base-Case Impacts and Costs

For each energy efficiency measure on the final list, Cadmus will document the base-case equipment and practices, and will explain why a particular base case provided the best representation. The study will develop base-case assumptions and data using a combination of primary (from site visits in Task 1) and secondary research. This informs, for example, base-case existing efficiency levels for HVAC equipment. With that said, Focus has established market-based baselines (Standard Market Practice) for a number of measures and Cadmus will incorporate these market baselines for the associated measures. For measures that currently did not have an established market baseline, Cadmus will conduct research to ensure the base case incorporates all current and approved future codes and standards (e.g., local and federal). Cadmus will use the state building energy code of the International Energy Conservation Code (IECC), 2009 edition for commercial, including Wisconsin amendments and the Wisconsin Uniform Dwelling Code for residential (similar to 2006 IECC). Current and pending federal codes and standards will be used for HVAC, lighting, water heating, motors, and other appliances.

Table 7 and Table 8 lists the standards Cadmus will consider: enacted or pending standards accounted for in the commercial and residential sectors for electric and gas end uses. Cadmus also will incorporate other standards recently becoming effective for equipment such as the following: commercial clothes washers; clothes dryers; commercial package air conditioners and heat pumps; cooking ovens; dehumidifiers; fluorescent linear lamps and ballasts; ice makers; incandescent reflector lamps; motors; packaged terminal air conditioners and heat pumps; and vending machines. For measures where a future standard is higher in efficiency than a current standard market practice baseline, the baseline will be adjusted to the new federal standard.

Table 7. Current and Pending Electric Standards by End Use

Equipment Electric Type	Existing (Baseline) Standard	New Standard	Sectors Impacted	Study Effective Year
Appliances				
Clothes washer	Federal standard 2007	Federal standard 2015	Residential	2016[1]
Clothes washer	Federal standard 2007	Federal standard 2018	Residential	2018
Clothes washer	Federal standard 2013	Federal standard 2018	Commercial	2018
Cooking				
Microwave	Existing conditions (no federal standard)	Federal standard 2016	Residential	2016
HVAC				
Heat pump (air source)	Federal standard 2006	Federal standard 2015	Residential	2017[2]
Residential Furnace Fans	Existing conditions (no prior federal standard)	Federal standard 2019	Residential	2020[1]
Small, Large, and Very Large Commercial Package Air Conditioners and Heat Pumps	Federal standard 2010-2014	Federal standard 2016-2020	Commercial	2017-2021[1,3]
Lighting				
General Service Fluorescent Lamps	Federal standard 2012	Federal standard 2018	Commercial	2018
Lighting general service lamp (EISA backstop provision)	Existing conditions (no federal standard prior to EISA 2007)	Federal standard 2020	Commercial/ Residential	2020
Metal halide lamp fixtures	Federal standard 2009	Federal standard 2017	Commercial	2018[1]
Motors				
Electric Motors	Federal standard 2010	Federal standard 2016	Commercial	2017[1]
Small Electric Motors	Federal standard 1987	Federal standard 2015	Commercial	2016[1]
Transformers				
Distribution Transformers	Federal standard 2007/2010	Federal standard 2015	Commercial	2016
Refrigeration				
Walk-In Coolers and Walk-In Freezers	Federal standard 2009	Federal standard 2017	Commercial	2018[1]
Commercial Refrigeration Equipment	Federal standard 2010/2012	Federal standard 2017	Commercial	2018[1]

Equipment Electric Type	Existing (Baseline) Standard	New Standard	Sectors Impacted	Study Effective Year
Automatic Commercial Ice Makers	Federal standard 2010	Federal standard 2018	Commercial	2018
Water Heaters				
Water heater > 55 gallons	Federal standard 2004	Federal standard 2015	Commercial/ Residential	2016[1]
Water heater ≤ 55 gallons	Federal standard 2004	Federal standard 2015	Commercial/ Residential	2016[1]

[1]To estimate the potential, Cadmus assumed standards taking effect mid-year will start on January 1 of the following year.

[2]Due to the uncertainty created by the litigation, DOE will not enforce this standard until July 1, 2016.

[3]Pre-publication estimated effective date; the standard will become final in early 2016.

Table 8. Current and Pending Gas Standards by End Use

Equipment Gas Type	Baseline	Standard	Sector	Study Year Effective
Water Heat				
Water Heater > 55 gallons	Federal standard 2004	Federal standard 2015	Commercial / Residential	2016[1]
Water Heater ≤ 55 gallons	Federal standard 2004	Federal standard 2015	Commercial / Residential	2016[1]
HVAC				
Furnace	Federal standard 1992	Federal Standard 2015	Residential	2016[1]
Boiler	Federal standard 2012	Federal Standard 2021	Residential	2021[2]

[1]To estimate the potential, Cadmus assumed standards taking effect mid-year will start on January 1 of the following year.

[2]Pre-publication estimated effective date; the standard will become final in early 2016.

Task 2.5. Develop Energy Efficiency Measure Impacts and Costs

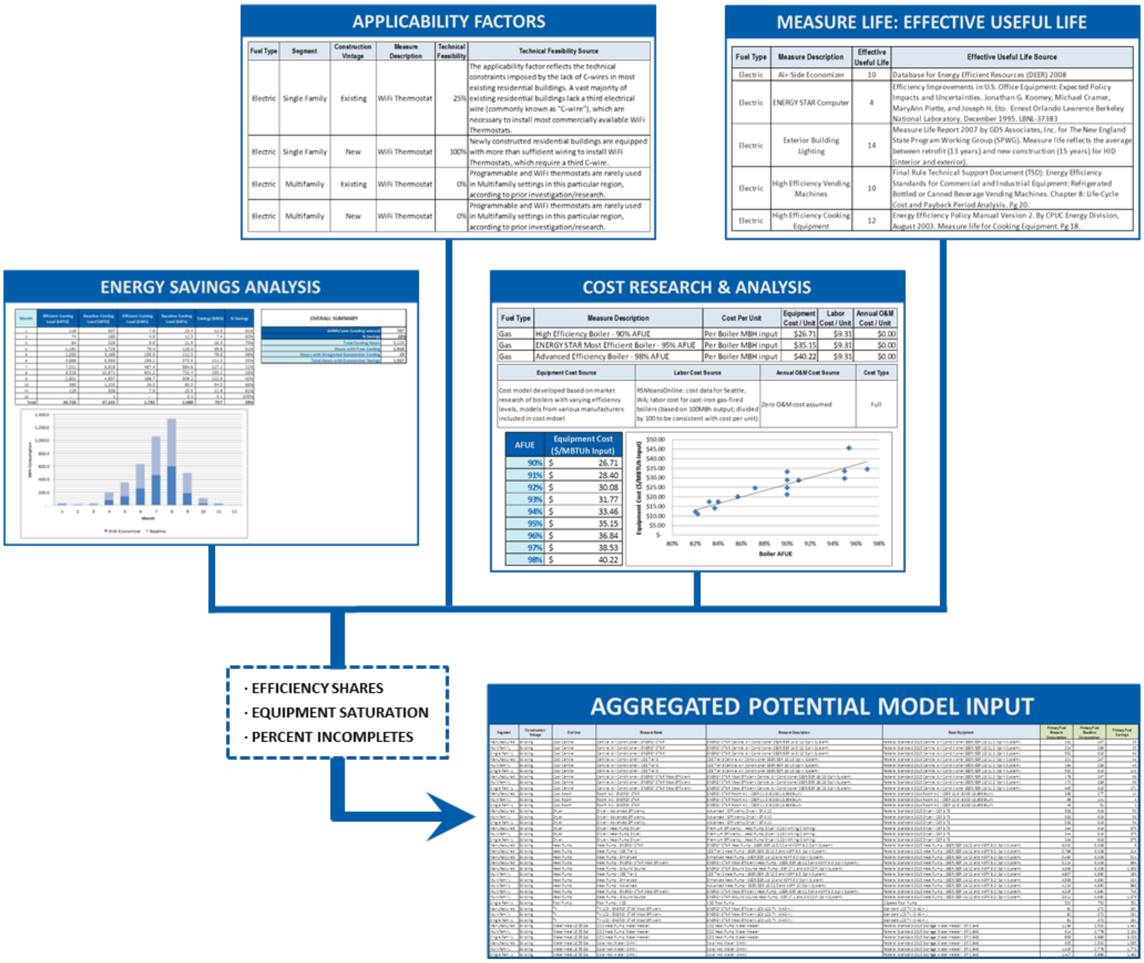
Cadmus will leverage Focus' vast measure data resources, notably including the Wisconsin TRM and SPECTRUM database. The impact analysis will incorporate all applicable primary data collected from site visits, current evaluation activities, and Focus' existing market research, including audit data from various programs. This will ensure consistency between Focus' current programs and the estimate potential provided by Cadmus.

Cadmus recognizes data gaps inevitably will appear in PSC-specific data or data collected through the primary research. As necessary, these data will be supplemented with other regional and national sources, including Cadmus' database of evaluated program results. Cadmus will research secondary sources for supplemental data in numerous resources, including the following:

- U.S. Census Bureau information on housing, demographics, and firmographics;
- The U.S. Energy Information Administration's Residential Energy Consumption Survey;
- The Commercial Buildings Energy Consumption Survey;
- The Manufacturing Energy Consumption Survey; and
- Measure data from national databases (DEER and ENERGY STAR®), TRMs, the Federal Energy Management Program, the Lawrence Berkeley National Laboratory's National Residential Efficiency Measures Database; the American Council for an Energy-Efficient Economy; and the Consortium for Energy Efficiency.

Cadmus will provide all energy efficiency measure assumptions (e.g., energy savings, demand savings, costs, lifetime, and applicability) to PSC staff and will include these materials in an appendix to the final report. As shown in Figure 1, the study will characterize the underlining energy efficiency measures' assumptions and analysis in Excel workbooks (by measure). As previously stated, Cadmus will use the Wisconsin TRM and SPECTRUM as the primary measure data methodology and reference these data within the measure workbooks. Measure workbooks will contain detailed saving calculations, cost research, effective useful life data, applicability factor values, and measure assumptions (with well-documented source descriptions). Cadmus will aggregate all measure data into a final master input file for the potential model.

Figure 1. Example of Energy Efficiency Measures Technical Workbooks



Cadmus will provide Excel measure workbooks containing savings analysis, cost research, and other conservation measures assumptions as part of this project's final deliverable. Prior to the final deliverable, Cadmus will present a sample of these workbooks for PSC administration staff and the TAC on how these workbooks are structured.

Task 2.6. Compile Measure Data and Populate Model

Cadmus will match measures passing the qualitative screen to applicable fuels, sectors, market segments, and end uses. This list will be expanded to incorporate the complete database of measures. For each measure, Cadmus will populate the database using the following data:

- Measure name and type;
- Baseline and efficient option annual electric consumption (kWh), peak demand (kW), hours of operation, gas consumption (therms), water consumption (gal), and measure life;
- Typical hourly and seasonal load shapes;
- Existing market saturation assumptions;

- Retrofit, new, or replace-on-burnout;
- Estimate of the technical maximum number of units per year;
- Disaggregated consumption data (where the same measure yields different results between customer assumptions);
- Costs (full or incremental, depending on the measure);
- Adjustments for interactions with other end uses (for example, lighting and HVAC); and
- Competition with other measures to avoid double-counting of savings.

Cadmus will compile these data from a variety of sources, thoroughly documenting each sources. This will result in creation of an Excel workbook, containing all energy efficiency measure-level inputs, for PSC's review.

Task 2 Milestones and Deliverables

- Review Measure List and End-Use Models
    - ⇒ Working Group: TAC Review
- Complete Summary of Segmentation Results, Baseline Data, and Assumptions
- Complete Measure List, Characterization, and End-Use Assumptions

Task 3. Potential Modeling

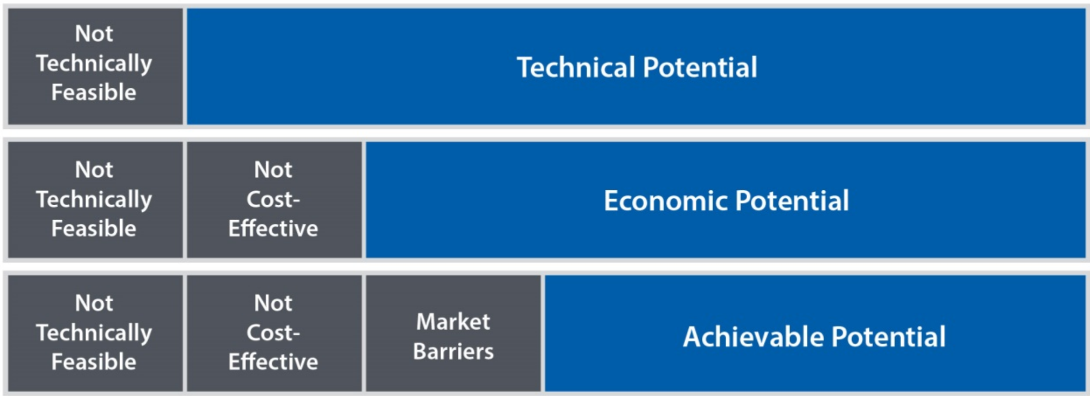
Cadmus bases its approach to estimating energy-efficiency using the following assumptions:

- Models require high-quality and utility-specific data to produce meaningful results.
- Results should be comprehensive, easy to interpret, and actionable (for inclusion in energy-efficiency program plans).

The chosen approach follows the industry-accepted framework by estimating types of energy efficiency potential as defined in the U.S. Environmental Protection Agency's *Guide for Conducting Energy Efficiency Potential Studies*, which serves as a resource for the *National Action Plan for Energy Efficiency.*[5] Figure 2 shows these definitions of energy efficiency potential.

[5] Philip Mosenthal and Jeffrey Loiter, Optimal Energy, Inc. *Guide for Conducting Energy Efficiency Potential Studies.* U.S. Environmental Protection Agency. National Action Plan for Energy Efficiency. 2007. Available at www.epa.gov/eeactionplan

Figure 2. Definitions of Energy Efficiency Potential



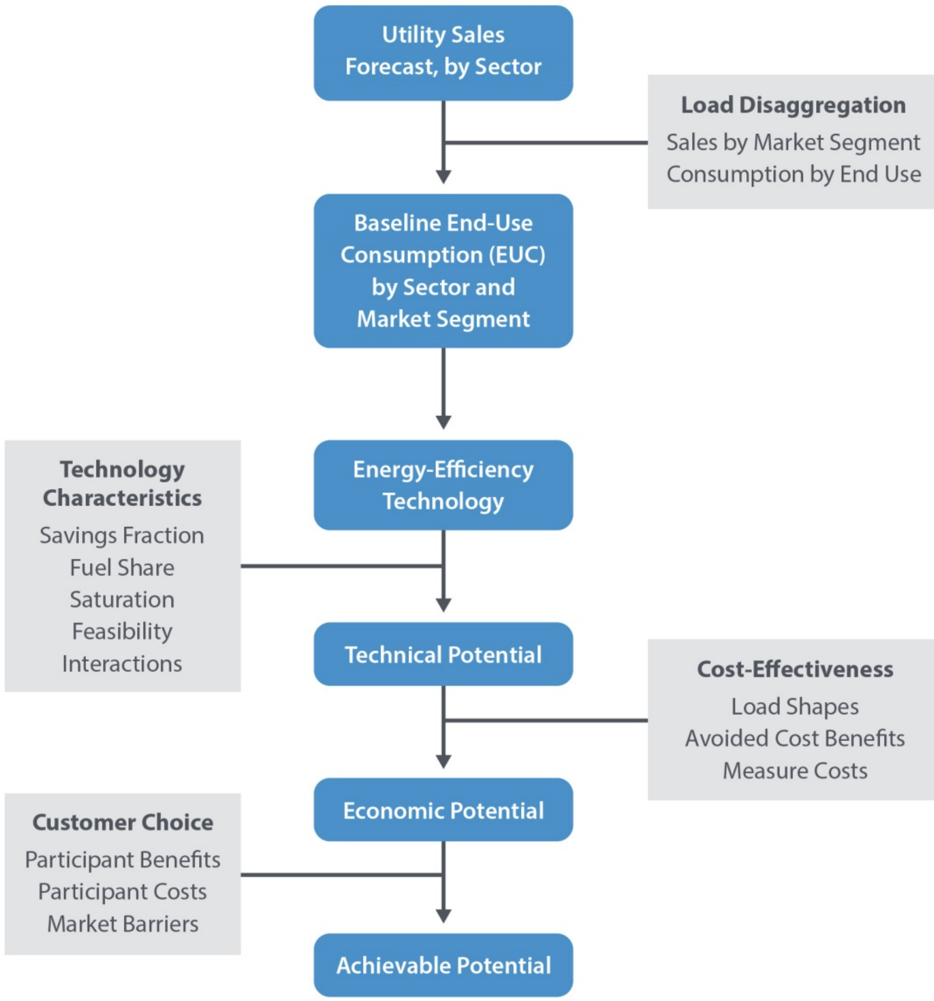
EPA – National Guide for Resource Planning

Specifically, Cadmus defines each potential level as follows:

- **Technical potential** assumes all technically feasible energy-efficiency measures are implemented, regardless of their costs or market barriers.
- **Economic potential** represents a subset of technical potential, consisting only of measures meeting cost-effectiveness criteria.
- **Achievable potential** represents the portion of long-run economic potential assumed reasonably achieved under different acquisition scenarios, accounting for barriers to customers' ability and willingness to participate in utility programs. Unlike technical and economic potential, achievable potential represents a range of estimates (from low to maximum) that reflect different levels of spending on energy efficiency.

Figure 3 illustrates the relationships between the various types of potential and Cadmus' approach in estimating these.

Figure 3. Methodology for Estimating Energy Efficiency Potential



As shown, this results in a largely linear process. Cadmus first will produce forecasts of each utility's baseline sales. After characterizing costs, savings, and potential applicability for a comprehensive set of energy efficiency measures, Cadmus will estimate technical, economic, and achievable potential. The approach will address the process as four distinct tasks, described in the following sections:

- Develop baseline forecasts (Task 3.1)
- Characterize energy efficiency measures (Task 2)
- Estimate technical and economic potential (Task 3.2 and Task 3.3)
- Estimate achievable potential and scenario analysis(Task 3.4)

Task 3.1. Develop the Baseline Forecast

Cadmus employs a bottom-up approach, which requires statewide end-use load forecasts for each sector and fuel. Depending on available data, Cadmus will either aggregate utility forecasts to develop the sector and fuel-specific statewide forecasts, or we will rely on MISO data. Utility forecasts, however, often are developed using either purely econometric methods or mixed econometric and end-use methods (e.g., a statistically adjusted engineering model). Any potential study will face a challenge in properly disaggregating each utility's forecast into segments and end uses, based on actual consumption. Thus, Cadmus will first disaggregate each utility's sales into meaningful market segments, as described in Task 3.

Typically, utility customer information system (CIS) data provide the basis for disaggregating sales. For nonresidential sectors, if available, Cadmus will use SIC and NAICS designations in each utility's CIS data to identify the distribution of sales by segment.

Although Cadmus prefers to rely on actual sales and customer counts to segment the residential sector, few utilities track each residential customer's home type in CIS data. If home types are not available in the residential CIS, Cadmus will summarize U.S. Census Bureau American Community Survey estimates of the number of homes in each segment for each zip code within each Wisconsin. Cadmus then will aggregate zip code-level estimates up to utility-level estimates. This recognizes that Wisconsin utility service territories span a wide and not always contiguous geography. Consequently, starting at the zip code level should yield the most meaningful results.

After establishing the appropriate market segmentation, Cadmus will create a baseline forecast that does not include future energy efficiency from Focus-related activities. This bottom-up forecast provides the basis for estimating technical potential for each sector, market segment, and end use, based on the following elements:

- Current customer counts by sector (from the segmentation step described above)
- Base-year conditions (e.g., equipment and measure saturations, fuel shares)
- New construction forecasts
- Natural equipment turnover rates
- Future codes and standards[6]

The baseline forecasts will rely heavily on end-use data collected from Task 1.

To validate the underlying assumptions, Cadmus will compare this baseline forecast to the aggregated utility forecasts, though the forecast likely will not match utility forecasts exactly due to the following reasons:

- Utility forecasts typically do not account for effects from changes to codes and standards (as code changes may take effect after the forecast or the codes cannot be modeled accurately within the forecasting framework).
- Utility forecasts might include implicit efficiency trends tied to historical program accomplishments. Many forecasting methods rely on historical trends to predict future

[6] The baseline forecast will include codes and standards already established, even if these do not take effect until future years, though it will predict how codes and standards might change.

consumption. Thus, the forecast may understate sales in the absence of future energy efficiency programs.

- Utility forecasts might be explicitly adjusted for expected future program savings.

Thus, it will prove essential to create an independent end-use forecast, tied to utility customer forecasts but not to sales. Otherwise, the study risks double-counting savings and underestimating available potential.

About Naturally Occurring Potential

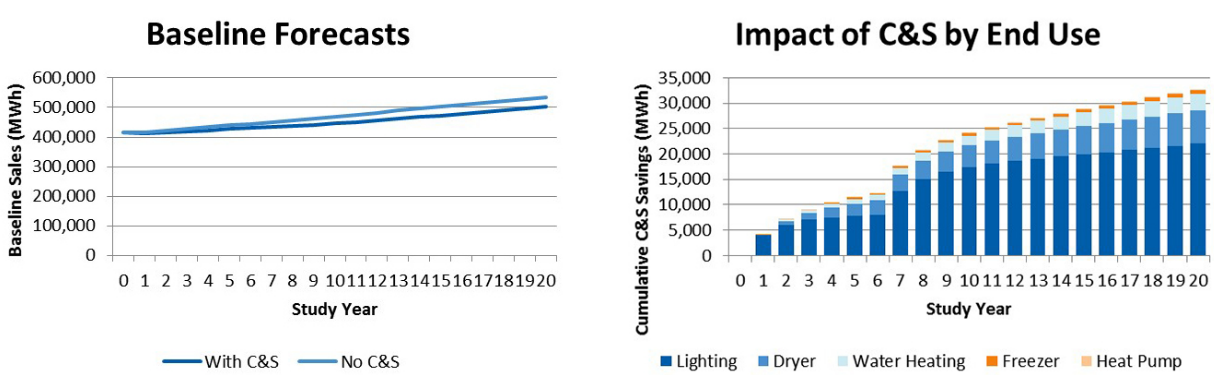
Naturally occurring potential refers to reductions in energy use due to normal market forces (e.g., technological changes, energy prices, market transformation efforts, equipment turnover, and improved energy codes and standards).

As discussed, Cadmus' baseline forecasts include impacts of natural equipment turnover and established future codes and standards. By accounting for naturally occurring potential in baseline forecasts, Cadmus avoids double-counting savings and underestimating technical, economic, available, and programmatic potential.

Estimating the Impact of Codes and Standards

It is important to develop a baseline forecast that accounts for future codes and standards (C&S) to avoid overstating the potential for energy efficiency measures. However, the PSC needs to understand the impact of codes and standards over the study timeframe. To quantify expected savings from codes and standards, Cadmus will produce two baseline forecasts—one that assumes existing codes and standards remain for the life of the study (a no C&S scenario) and another that assumes the federal government enacts all C&S listed in Table 7 and Table 8. The difference between these two forecasts will represent the impact of the codes and standards. Cadmus will provide summaries of the impact of C&S by sector and end use for each year of the study, as shown in Figure 4.

Figure 4. Example of Baseline Forecasts and the Impacts of Standards by End Use



A section of Cadmus' final report will discuss the results of the C&S analysis. Specifically we will:

- Describe all recently enacted and pending federal equipment standards.

- Perform a review of possible modifications to building energy codes.
- Quantify potential savings from codes and standards for each market segment and fuel.
- Discuss the potential impact of new codes and standards on efficiency programs.

Task 3.2. Estimate the Technical Potential

Technical potential refers to the theoretical maximum amount of energy and capacity that could be displaced by efficiency, regardless of costs and other barriers that may prevent installation or adoption of energy efficiency measures. Such potential is constrained only by factors such as technical feasibility and the applicability of measures.

Cadmus' uses a method for estimating technical potential based on the industry-standard, bottom-up approach. This estimates technical potential by introducing all technically feasible measures into the baseline forecast and calculating the resulting impacts. For modeling purposes, this requires separating measures into two distinct classes:

- **Equipment measures** save energy by upgrading the efficiency of end-use equipment at the time that the equipment would naturally be replaced. The technical potential assumes all customers will install the most efficient, technically feasible option at the time that equipment must be replaced.
- **Retrofit measures** save energy by reducing end-use consumption without affecting equipment efficiency. Examples include insulation, faucet aerators, and lighting controls. For measures competing for the same savings (e.g., different insulation levels), the technical potential assumes the most efficient option will be installed, wherever doing so proves technically feasible.

In developing end-use level savings, Cadmus will capture interactive effects associated with installations of multiple measures, between and within the measure classes described above.

The equipment measure analysis accounts for the exclusivity of high-efficiency measure installations. For example, a residential customer cannot replace a single air conditioner with two air conditioners at different efficiency levels; otherwise, the potential would be double-counted, in addition to the effects of retrofit measure installations on their potential.

The retrofit analysis accounts for consumption reductions due to high-efficiency equipment installation, while accounting for interactive effects and competition between different retrofit measures applied to the same end use.

Cadmus will conduct the technical potential analysis using an Excel-based model, providing the PSC with a workbook containing all inputs, outputs, and calculations. This workbook will include the assumed number of installations in each year and the annual incremental and cumulative savings at each end use, allowing for summarization by sector, segment, end use, and construction vintage.

Estimate Market Transformation Potential

Market transformation refers to market interventions that remove barriers to energy efficiency and encourage the adoption of energy efficiency as standard practice. This can include "involuntary" measures, such as the adoption of codes and standards. It can also include "voluntary" measures such as upstream interventions (with retailers and/or manufacturers) which encourage the adoption of more efficient technology. Because Cadmus will assess codes and standards potential in Task 3.1, this subtask will only include voluntary interventions. Examples of voluntary market transformation interventions include:

- **New construction programs** that encourage builders to adopt efficient designs as standard practice.
- **Upstream interventions** that encourage and/or manufacturers to produce and sell efficient products. These interventions may also include the introduction of certain emerging technologies to Wisconsin.

Because estimates of technical potential are not constrained by economic or market barriers, estimates of technical potential include potential savings from market transformation. Cadmus will use the following process to identify the portion of technical potential that can be realized through market transformation:

1. **Identify energy efficiency measures eligible for market transformation:** We will first consider measures that have been a part of successful regional and national market transformation initiatives. Examples include residential and commercial new construction measures, efficient lighting, efficient appliances, and efficient consumer electronics.
2. **Determine the portion of technical potential that can be realized through market transformation:** We will review market transformation initiatives both in the Midwest and from other regions to determine how interventions can shift standard market practice. For instance, since NEEA enacted its 80 PLUS commercial desktop program in 2005, the share of office computers with efficient power supplied increased from 0% in 2005 to 70% in 2012. For this measure, as much as 70% of savings may be attributed to market transformation and 30% of the potential savings will be included in "programmatic" technical potential.
3. **Use proportions from step 2 to disaggregate estimates of technical potential into "market transformation" and "programmatic" potential.** Market transformation potential will include likely savings from upstream interventions, while programmatic potential would require utility incentives to be realized.

Cadmus will dedicate a section of the final report to market transformation potential. The chapter will describe the process used to identify market transformation measures and the approach used to allocate technical potential to market transformation. The section will include a review of successful market transformation initiatives from across the country and assess whether these interventions are suitable for Wisconsin.

Task 3.3. Estimate the Economic Potential

Cadmus will estimate economic potential by applying cost-effectiveness criteria based on the commission-approved TRC test, which includes emissions benefits and uses commission-approved values for discount rates and line losses. This test compares the full life-cycle cost of each technically feasible measure to the value of its savings in terms of time-differentiated avoided energy, capacity, and secondary fuel savings over the measure's expected useful life. In estimating economic potential, this uses the assumption that, where two or more technically feasible and cost-effective measures compete for the same end use, the one with the highest savings will be installed first.

As with technical potential, Cadmus will perform the cost-effectiveness screening and calculation of economic potential in using an Excel-based model. All files will be linked with live calculations; so the PSC and interested stakeholders can perform sensitivity or scenario analysis around any input, including avoided costs, discount rates, measure costs and savings, and effective useful life.

Task 3.4. Estimate the Achievable Potential

Estimating achievable energy efficiency potential presents a fundamental challenge: it requires taking the largely theoretical estimate of economic potential—the total amount of cost-effective energy savings—and turning it into an estimate the can be readily used to develop program plans.

Cadmus' approach heavily relies on existing program data, primary market research, and market diffusion theory, seeking to provide realistic estimates of cost-effective savings PSC and Focus Administrator and Implementers can achieve.

Cadmus will first identify barriers to adopting energy efficiency faced by Wisconsin customers. These may include the following:

- **Financial.** The incremental cost of an efficient measure compared to the baseline measure often proves sufficient to deter a customer from participating in utility-sponsored programs. Focus can, however, overcome this barrier for many customers by providing higher incentives or financing.
- **Infrastructure.** Though programs require trade ally networks and a large pool of contractors to achieve aggressive targets, aggressively ramping of programs poses inherent infrastructure constraints: developing and implementing programs takes time. Studies of achievable potential must characterize the rate at which PSC can realistically acquire savings, given infrastructure limitations.

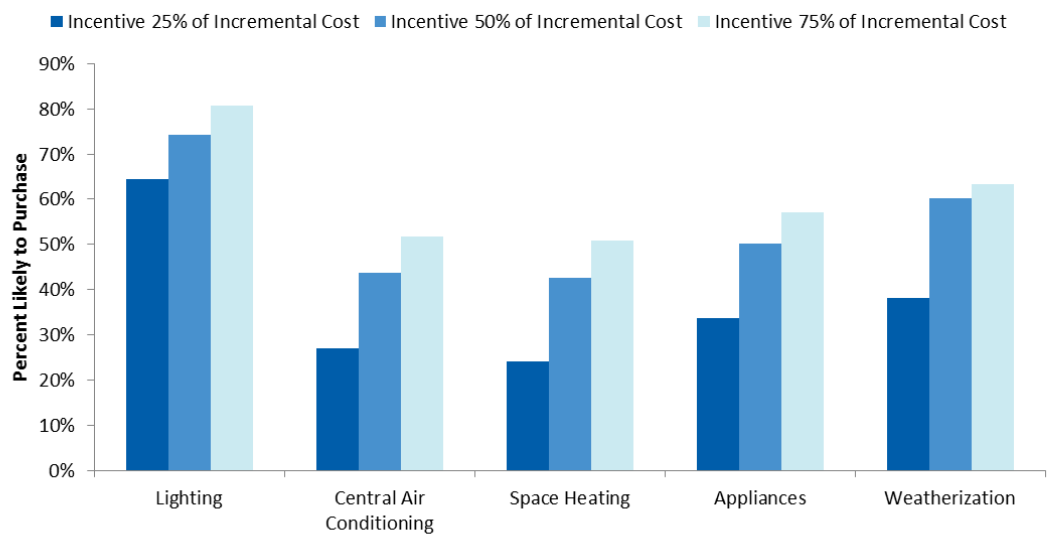
Cadmus will employ the following two-step approach to capture market barriers when estimating achievable potential:

1. Estimating of long-term market penetration for low, medium, and high levels of spending.
2. Applying ramp rates to each measure to align acquisition of savings with events likely to occur, given barriers faced by implementers, program administrators, contractors, and trade allies.

Estimate Long-Term Maximum Market Penetration

Each survey described in Task 1.2 will include a battery of questions designed to capture the respondents' willingness to adopt an efficient measure, given a certain incentive amount. Cadmus will consider three incentive scenarios equivalent to 25%, 50%, and 75% of incremental measure costs. Using survey feedback, the percentage of customers who will adopt an efficient option can be assessed. Figure 5 shows an example of survey results assessing residential customers' willingness to adopt measures.

Figure 5. Example: Customers' Willingness to Adopt an Efficiency Measure



This approach captures *financial* barriers to energy efficiency as it quantifies the percentage of customers who will participate in programs upon removable of those barriers. Key benefits of this approach include the following:

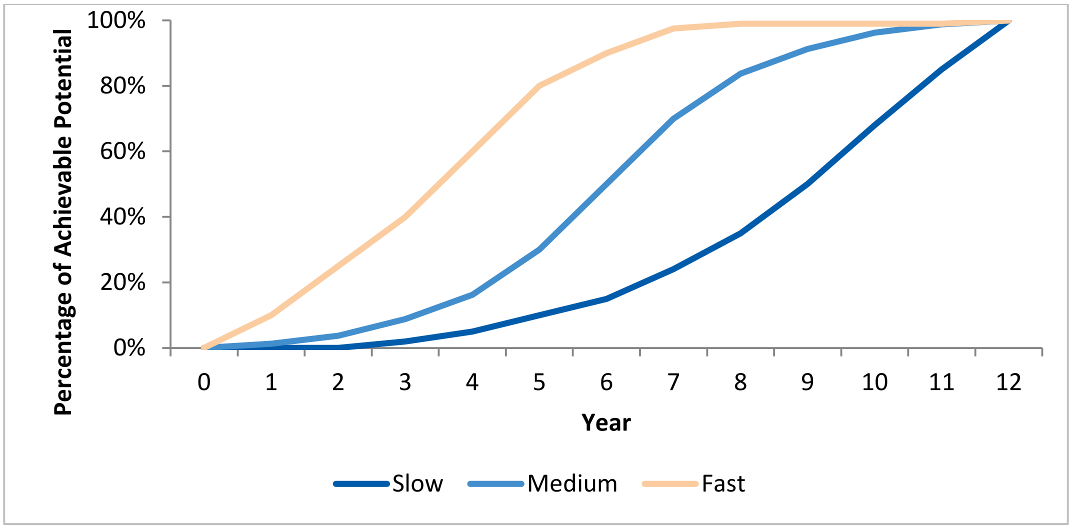
- **Producing granular estimates of market penetration**. This approach yields different market penetration estimates for different sectors (commercial and residential), customer types (income-qualified and standard income), and measure types (those shown in Figure 5).
- **Using data specific to Wisconsin.** Other approaches to estimating achievable potential rely on benchmarking against other utility programs. While such approaches may be suitable for utilities with long histories of energy efficiency and in similar climate regions, Cadmus recommends using primary data when possible.
- **Supported by standard market theory.** In fielding numerous willingness-to-participate surveys, Cadmus has found the relationship between participation and incentives does not take a linear form: the marginal effect of incentives diminishes as incentive amounts increase.

After determining the share of customers willing to adopt an efficient measure under the three incentive scenarios, Cadmus will determine the timing of savings over the study horizon by developing and applying ramp rates.

Apply Ramp Rates

Ramp rates are acquisition curves that indicate the time required for a measure to reach its long-term, achievable market penetration. Figure 6 shows examples of slow, medium, and fast ramp rates.

Figure 6. Ramp Rate Examples



Typically, studies of achievable potential employ generic ramp rates, such as those shown in Figure 6. In this case, Cadmus will conduct interviews with TAC members to guide the development of ramp rates. Specifically, Cadmus seek to understand the time required to develop mature programs.

Task 3.5. Scenario Analysis

Cadmus will assess potential for maximum, high, medium, and low achievable energy efficiency peak demand and energy savings scenarios, based on different incentive levels offered—incentive levels will correspond to different fractions of incremental cost, ranging from 25% of incremental costs in the low scenario to 100% of incremental costs in the maximum scenario. Each of these scenarios will be "unconstrained" in that they will not be restricted by the $100 million statutory spending cap. These scenarios will provide the PSC with a range of estimates and expenditures that are realistically achievable.

Cadmus will then produce a "business-as-usual" scenario with modified incentive levels to produce estimates that reflect this spending limit. Incentive levels for this scenario will reflect Focus' program history and will vary by measure type. This will be the primary scenario Cadmus reports.

In addition to the "unconstrained" achievable scenarios and the "constrained" business-as-usual achievable scenarios, Cadmus will perform sensitivity analysis on key inputs such as discount rates and avoided costs. During the project kickoff meetings, Cadmus will speak with PSC staff and stakeholders to identify the most important variables for this sensitivity analysis.

Cadmus will provide the results of our economic assessment and scenario analysis for PSC's review, updating the analysis based on feedback.

Task 3 Milestones and Deliverables

- Review Measure Details and Potential Results
    - ⇒ Working Group: OSC and TAC Draft Presentation
- Provide Scenario Analysis Results
- Develop a Database of Measures
- Memorandum on Draft Potential Study Results

Task 4. Program Analysis

4.1 Review Existing Programs

Cadmus will compare Focus' existing and proposed set of programs to program portfolios offered by Focus' peers. This will require conducting benchmarking research to compare Focus' program attributes to similar programs in other utility jurisdictions. To conduct this research, Cadmus will rely on its proprietary benchmarking database, which includes metrics on energy efficiency programs drawn from extensive program design and evaluation experience.

Cadmus also will work with Focus to identify up to five peer portfolios that can be compared in regards to the overall size and type of programs offered. This effort will include researching publicly available information on PSC and supplementing this, if needed, by interviewing a utility representative. Cadmus will document the types of programs offered, participation rates, savings, and best practices. In reviewing the results of this research with PSC, program adjustments may be identified that offer potentially improved program efficiency, support expansion, or capture higher energy savings as programs and market continue to evolve and as the study identifies new programs.

Cadmus will consider each best practice strategy based on its ability to cost-effectively contribute to PSC's program goals and within the context of PSC market conditions and program characteristics.

4.2 Gap Analysis

Once completed, Focus' potential study will provide much of the information needed to define local markets. Cadmus will analyze each component of existing Focus' programs against findings from the potential study to identify gaps, such as untapped potential or opportunities. The research will seek to increase customer participation and the depth of savings by incorporating new market sectors, technologies, or delivery strategies.

Cadmus will prepare a gap analysis, comparing the Focus' current program savings to savings identified in potential studies and to peer utilities' savings identified in the benchmark analyses.

Task 4 Milestones and Deliverables

- Provide Benchmarking and Gap Analysis Results
- Estimate Program Potential and Provide Program Scenario Results
- Memorandum on Program Findings and Recommendations

Task 5. Reporting

At the project's conclusion, Cadmus will submit a draft report for PSC's and interested stakeholder comment. The report will be organized in two volumes:

- **Volume I** will provide an executive summary of study findings, an introduction to the study, and results from Tasks 1 through 5.
- **Volume II** will contain appendices documenting the data and tools underlying the results (including survey instruments, baseline data, and measure and technology costs and savings).

Cadmus believes that a successful study requires ongoing reporting. While the final report will be Cadmus' primary deliverable, interim reports are vital to solicit feedback from commission staff and stakeholders. We propose:

- **Monthly written progress reports.** These reports will include descriptions of work completed to date, upcoming tasks/deliverables, and updates on the project's timeline
- **Memos following the completion of each tasks.** These memos will include descriptions of the methodology and results for each tasks. The memos will be the starting point for each report chapter.

Cadmus will also deliver in-person presentations and webinars to TAC and OSC members throughout the course of this project. This includes

- **Three OSC meetings**: The first meeting will be held during the project initiation, the second after Cadmus develops initial estimates of potential, and the final meeting will be at the conclusion of the project.
- **Five TAC meetings**: These will be held after the completion of key deliverables in each task.

Task 5 Milestones and Deliverables

- Monthly Progress Reports
- Review Draft Report
- Final Report
- Report Presentation to PSC

⇒ Working Group: OSC Attending

Task 6. Cross-Cutting Tasks

Task 6.1. Project Management

Cadmus will manage the project to meet milestones, submit deliverables on time, ensure the work's quality meets or exceeds the PSC's needs, and efficient use of all resources. Consequently, in addition to performing the numbered tasks, Cadmus will provide the following general services for the duration of the project:

- Manage the project effectively
- Provide timely, relevant communications to PSC
- Perform quality reviews on all processes and deliverables

A fundamental effort, project management will last for the duration of a project, encompassing one-time events (e.g., the project kick-off meeting) and ongoing activities (e.g., communication and quality assurance). Cadmus has assigned a dedicated principal and an experienced project manager for day-to-day management activities. These individuals will work closely with Cadmus' Focus on Energy evaluation management to ensure consistency and create efficiencies.

Management Structure

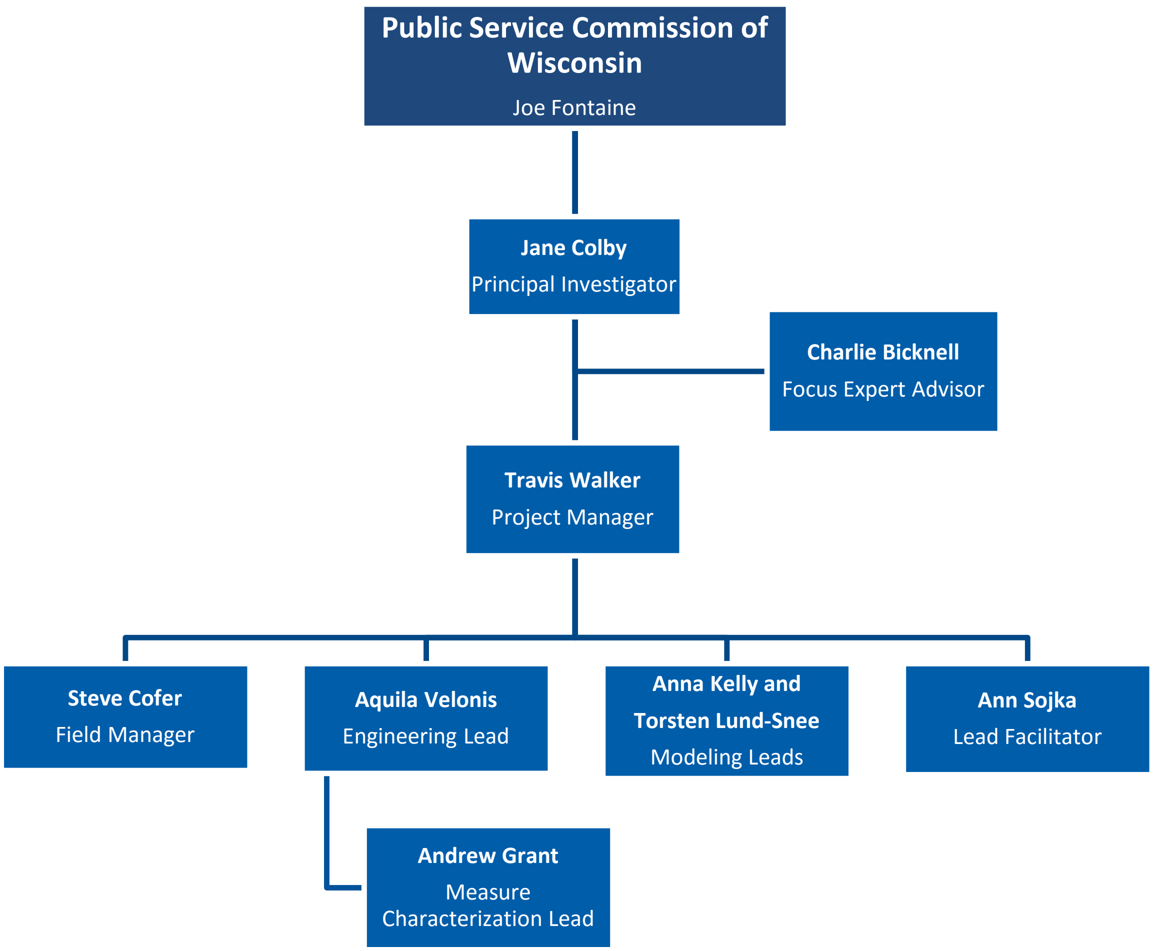
Figure 7 shows the general project management structure proposed to meet the study's needs. The following team will be supported by Cadmus' experienced staff of engineers, data analysts, and industry experts in potential assessment:

- ***Mr. Charles Bicknell*** will serve as an overall project advisor. Mr. Bicknell has years of experience working within the PSC and Focus environments and currently serves as Cadmus' principal investigator for Focus evaluations.
- ***Ms. Jane Colby*** will serve as the principal investigator on this project. Ms. Colby leads Cadmus' Planning and Assessment team; she has extensive DSM and IRP planning experience from her previous work at Public Service Company of Colorado. Ms. Colby will oversee the quality assurance, analytic rigor, and transparency of project deliverables.
- ***Mr. Travis Walker*** will serve as the primary project manager. He has managed over ten potential studies during the past five years. He also trains staff on Excel-based models for estimating technical, economic, and achievable energy efficiency potential, and will therefore perform the models' final quality control review.
- ***Mr. Aquila Velonis*** will serve as engineering lead and secondary project manager for the study. With his work at Cadmus including more than 20 potential studies, Mr. Velonis is skilled in integrating primary and secondary data.
- ***Mr. Andrew Grant*** has worked on more than 15 potential studies for electric and gas utilities across the country, focusing on potential characterization from small renewable energy projects

and emerging technology measures. He will lead the engineering analysis of the measure characterization task.

- ***Ms. Anna Kelly*** and ***Mr. Torsten Lund-Snee*** will serve as the lead modelers for the residential and commercial sectors, respectively. They specialize in model development for potential studies of electric and gas utilities.
- ***Ms. Ann Sojka*** will serve as the lead facilitator and coordinator of the stakeholder meetings.
- ***Mr. Steve Cofer*** will serve as the primary point person for ensuring consistency between current and past evaluation efforts and in addition he will oversee field data collection task. He currently is the senior manager for Focus evaluations.

Figure 7. Project Management Structure



Task 6.2. Greenhouse Gas Emissions from Energy Efficiency

Cadmus has extensive experience in quantifying non-energy benefits of energy efficiency programs and keenly understands the best practice methods for calculating GHG emissions impacts. For example, Cadmus uses its expertise to review new emission quantification tools, such as serving as one of the few beta-testers for the EPA's Avoided Emissions and Generation Tool.

Quantifying the value of emissions avoided or displaced through energy efficiency measures requires identifying three key parameters: emissions factors by fuel type, projected energy savings from the potential study, and the dollar value of displaced emissions. Calculating this value used the following basic equation:

Value of Potential Displaced Emissions =
[Emissions Factor x Projected Saved Energy x Value of Emissions Allowance]

Where:

- Emissions factors are the rate at which pollutants are emitted per unit of energy. Emissions factors are most often expressed in tons of pollutant per energy unit (for electric, this is tons/MWh; for gas, this tons/MThm).
- The product of the emissions factor and the energy-savings potential for a given sector or program equals the total weight (in tons) of air pollutant projected as offset or displaced by the sector or program.
- The product of the total tonnage of pollutant projected as displaced and the dollar value of the displaced emissions per ton equals the value of the displaced emissions benefit.

In completing these calculations, Cadmus relies on several assumptions. First, the amount of projected GHG displacement is an estimate, based on available best-practice tools. As no singular method currently exists for calculating displaced GHG emissions, calculations could vary slightly upon using another tool. Each calculation method also has its own set of variables (e.g., temperature, measures and fuel types included, emissions factors, and methods), thus outputs could vary. In the future, depending on legislation and the progress of studies in this area, emissions factors will likely be updated, possibly altering the amount of GHG displaced over the lifetime of each project.

Cadmus will express energy and GHG intensities for each sector and market segment for technical, economic, and achievable potential.

Project Schedule and Budget

Table 9 shows a list of subtasks and tentative completion dates. Table 10 shows a timeline with the proposed OSC and TAC meetings.

Table 9. Schedule of Tasks, Milestones, and Deliverables

Task	Milestone	Subtask	Tentative Start Date	Tentative End Date
0.Project Initiation	0.1	Initial Data Request	3/15/2016	3/22/2016
	0.2	Draft Work Plan	3/15/2016	3/22/2016
	0.3	In-Person Kickoff	3/22/2016	3/29/2016
	0.4	Final Work Plan	3/29/2016	4/5/2016
		Task Completion	**3/15/2016**	**4/5/2016**
1.Data Collection	1.1	Project Initiation Interviews	3/22/2016	5/17/2016
	1.2	Review data and define objectives	3/22/2016	4/5/2016
	1.3	Sample Design	4/5/2016	4/19/2016
	1.4	Develop Data Collection Instruments	4/5/2016	5/10/2016
	1.5	Phone Surveys and Site Recruitment	5/10/2016	5/31/2016
	1.6	Perform Surveys and Site Assessments	5/31/2016	9/8/2016
	1.7	Analyze Survey and Site Data	9/8/2016	9/29/2016
	1.8	Reporting	9/8/2016	10/13/2016
		Task Completion	**3/22/2016**	**10/13/2016**
2. Measure Characterization	2.1	Define the Market Classes	3/22/2016	4/19/2016
	2.2	Screen the Sectors, Segments, and End Uses for Eligibility	3/22/2016	4/26/2016
	2.3	Develop Comprehensive DSM Measure List	4/19/2016	5/3/2016
	2.4	Develop the Base Case Impacts and Costs	5/3/2016	10/20/2016
	2.5	Develop DSM Measure Impacts and Costs	5/3/2016	10/20/2016
	2.6	Compile Measure Data and Populate Model	5/3/2016	10/27/2016
		Task Completion	**3/22/2016**	**10/27/2016**
3. Estimate Energy Efficiency Potential	3.1	Develop Baseline Forecast	10/27/2016	11/10/2016
	3.2	Estimate Technical Potential	11/10/2016	11/24/2016
	3.3	Estimate Economic Potential	11/10/2016	11/24/2016
	3.4	Estimate Achievable Potential	11/24/2016	12/8/2016
	3.5	Develop Achievable Potential Scenarios	11/24/2016	12/8/2016
	3.6	Reporting (in-person)	10/27/2016	12/15/2016
		Task Completion	**10/27/2016**	**12/15/2016**
4. Program Potential and Scenarios	4.1	Review Focus' Existing Programs	4/5/2016	6/2/2016
	4.2	Gap Analysis	12/8/2016	1/6/2017
	4.3	Reporting	1/6/2017	1/26/2017
		Task Completion	**4/5/2016**	**1/26/2017**
5. Reporting	5.1	Draft Report	4/5/2016	2/9/2017
	5.2	Draft Presentation (webinar)	2/16/2017	2/16/2017
	5.3	Final Report	2/16/2017	3/2/2017
	5.4	Final Presentation (in-person)	3/9/2017	3/9/2017
	5.5	Delivery of Models	3/9/2017	3/23/2017
		Task Completion	**4/5/2016**	**3/23/2017**

Dates subject to change base upon agreement between Cadmus and PSC. All cross-cutting tasks are on-going through-out this study.

Table 10. Timeline Chart

Task	March	April	May	June	July	August	September	October	November	December	January	February	March
0. Project Initiation	■												
1. Data Collection	■	■	■	■	■	■	■						
2. Measure Characterization	■	■	■	■	■	■	■						
3. Estimate Energy Efficiency Potential							■	■	■				
4. Program Potential and Scenarios		■	■	■	■				■	■	■		
5. Reporting											■	■	■
6. Cross-cutting	OSC	TAC	TAC	■	TAC	■	TAC	■	OSC	■	TAC	■	OSC
Optional 1. Market Transformation							■	■	■				
Optional 2. Behavior/Training Programs							■	■	■				
Optional 3. Codes and Standards						■	■	■					

OSC = Oversight committee briefing
TAC = Technical advisory committee meeting

Table 11 shows the total budget by task. As discussed in this scope of work, Cadmus will refine the data collection budget accordingly after receiving feedback from PSC staff and members from the OSC and TAC.

Table 11. Budget

Cadmus Task	Total Cost
Task 0: Project Initiation	$37,000
Task 1: Data Collection	$834,000
Task 1.2: Utility Data and Research	$16,000
Task 2: Measure Characterization	$172,000
Task 3: Estimate Potential	$101,000
Task 4: Program Potential	$32,000
Task 5: Reporting	$90,000
Task 6: Cross-cutting (Management, Stakeholder Meetings, GHG)	$76,000
Total	$1,358,000