CADMUS

2010-2022 Industrial Plant Closure Study

THE CADMUS GROUP

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Prepared for:

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Acknowledgements

The Industrial Plant Closure Study was made possible through the significant support of Energy Trust of Oregon evaluation and program staff, along with staff from the program delivery contractors. Their collective assistance with customer outreach, ensuring that Cadmus had the necessary data and information to conduct our research was a tremendous help with this evaluation. Additionally, we would not have results without the participation of program customers. We sincerely thank each and all participants for their time and support.

Executive Summary

This study details Cadmus' research into the rate of closures in industrial and agricultural facilities within the Production Efficiency program from program years 2010 to 2022. This research was conducted to help inform Energy Trust assumptions of measure life through understanding the rate of plant closures, measure removals, and other impacts to measure and site persistence. This study is Energy Trust's second investigation of persistence and builds off of the previous study conducted by MetaResource Group on program years 2002 to 2009.

This evaluation involved sampling the population of 5,635 measures and 2,744 sites across six sectors: Agriculture, Indoor Agriculture, Industrial, Storage, Mixed Commercial and Other. These measures spanned twelve measure categories: custom pumps, custom compressed air, custom refrigeration, custom aerator, custom vfds, other custom measures, welders, battery chargers, HVAC, lighting (indoor agriculture), greenhouse, and other.

The previous study found a project removal rate, largely influenced by plant closure, of 1.7%[1]. This study used more in-depth research than the previous study and found a facility closure rate of 10.2%, which represents a 600% increase over the previous seven years.

Currently, Energy Trust uses a measure life of 15 years for many industrial measures. Although many measures outlive this assumed life, facility closures, acquisition, and measure removal affect the persistence of energy savings.

This study introduced horticulture lighting measures that Energy Trust has adopted since legalization of cannabis in 2015. This study examined these measures to identify any unique findings and gain deeper insight for this new category. These measures saw the highest rates of closure (26.15%) compared to other measures.

Lastly, the program years this study researched included unprecedented events that impacted not only Oregon but the world. The COVID-19 pandemic and resulting economic uncertainty impacted the industrial sector in many ways. However, because of the varied role different industries play in supporting the economy, this impact was unique to each site, industry, and region. This study found only a minor impact of the pandemic on site closures with three sites citing economic impact as the reason for shut down. The pandemic did impact measures resulting in equipment operating changes for a small set of sampled projects. Due to the limited number of sites with closures directly connected to the effects of the pandemic there is uncertainty of the overall impact to the population.

[1] The previous study only reported measure-level removal rates but stated these were mostly plant closures.

Memo

To: Energy Trust Board of Directors

From: Cody Kleinsmith, Evaluation Project Manager
Eric Braddock, Sr. Technical Manager – Industry and Agriculture
Adam Bartini, Sr. Program Manager – Industry and Agriculture
Kirstin Pinit, Sr. Program Manager – Industry and Agriculture
Laura Schaefer, Program Manager – Industry and Agriculture
Andi Nix, Engineer – Planning and Evaluation

cc:

Date: June 5th, 2024

Re: Staff Response to the 2010-2022 Industrial Plant Closure Study

The 2010-2022 Industrial Plant Closure Study assessed the rate of facility closure of Energy Trust Production Efficiency program participants who participated between 2010 and 2022. This study, which looked at closures through early 2024, was conducted as a follow-up to the 2002-2009 Industrial Plant Closure Study and had the primary goal of determining if changes to the Production Efficiency custom project default measure life are necessary. The previous edition of this study, completed in 2010, observed a plant closure rate of 1.7%, which resulted in Energy Trust increasing the custom project default measure life from 10 to 15 years. The results of this study show an overall closure rate of 10.2%, an increase of 8.5% from the previous study.

The study found a stable and low rate of facility closures between 2010 and 2020 that indicated a continuation of the closure rate found in the 2010 study. However, between 2021 and 2023 closure rates increased dramatically and significantly drove up the overall rate of facility closures. The study found three sites that directly attributed their closure during this period to impacts of the COVID-19 pandemic, and it is likely that many of the other closures during this period resulted from direct or indirect pandemic impacts such as supply chain and logistical barriers, staffing shortages or lockdown orders. Due to this trend and the likely impact of the pandemic on facility closures, Energy Trust will maintain the 15-year default custom project measure life for the Production Efficiency program.

In addition to the assessment of closure rates, the study interviewed facility operators at open sites to understand the frequency of operating status changes that may impact the effectiveness of installed measures. Changes were reported at 20 out of 118 interviewed sites, but no trends were found that would result in adjustments to custom project assumptions. Individual sites reported unique changes that, paired with their unique projects, had a range of impacts on the savings of their incentivized measures including a decrease in expected savings, an increase in expected savings, and no changes to expected savings.

Energy Trust will continue to investigate assumptions related to plant closures and custom project default measure lives in the Production Efficiency program but will shift away from the approach used in this study and its predecessor. Future facility closure rate research will be conducted as appropriate for individual market sectors or measure types instead of for the program as a whole to allow for more market or measure-specific assumptions to be evaluated and findings to be applied. Future research may reside within Production Efficiency evaluation projects or within measure development research projects.

Introduction

Energy Trust of Oregon contracted with Cadmus to conduct a study of closure rates of participating Production Efficiency (PE) program customers from program year 2010 to 2022. The PE program provides incentives to industrial and agricultural customers through two primary tracks: Standard and Custom.

One of the key considerations for the efficiency projects that Energy Trust funds and claims energy savings for is the measure life of equipment installed through the PE program. This is defined as the number of years Energy Trust expects half of the installed measures to remain in place, in use, and effective at reducing energy use in an industrial or agricultural process. For many PE measures, the measure life is set at 15 years, which was established as a standard after the previous plant closure study for program years 2002 to 2009[2]. This number incorporates the rate of industrial plant closures that Energy Trust expects to occur, because the measures installed in those closed facilities will no longer contribute to energy savings.

This new plant closure study excluded mega-projects (projects that exceed the project incentive cap), SEM track measures, and measure categories that have measure lives determined based on other approaches. The study involved sampling the population of 5,635 measures and 2,744 sites across six sectors: Agriculture, Indoor Agriculture, Industrial, Storage, Mixed Commercial, and Other. These measures spanned twelve measure categories: Custom – Pump, Custom – Compressed Air, Custom – Refrigeration, Custom – Aerator, Custom – VFDs, Custom – Other, Welder, Battery Charger, HVAC, Lighting (Indoor Agriculture), Greenhouse, and Other. A detailed table of our sector and measure mapping is located in Appendix A.

Our data collection methods included in-depth, site-specific research through multiple data sources, including utility data and project files for 265 sites, individual site interviews of 118 sites, and detailed data aggregation and analysis to address the research objectives.

[2] https://www.energytrust.org/wp-content/uploads/2016/12/Plant_Closure_Report_final_110620.pdf

Key Research Objectives

Cadmus' research objectives for the Industrial Plant Closure Study included the following:

- Identify the rate of industrial plant closures among sites that participated in the PE program between 2010 and 2022, stratified by measure and industry type.
- For sites that closed, identify the percentage of sites that reopened and began operating installed measures under new ownership and determine the average duration between closure and new site acquisition and operation.
- For sites that remained open, investigate the percentage that shifted operations (such as number of shifts, hours of operation, removal of measures, etc.) enough to impact the use and energy savings potential of previously installed measures.
- Identify the rate of plant closures and measure replacement in the horticulture lighting market for cannabis grow lights.
- Identify the differences in findings for the above project objectives during pre-COVID-19 and post-COVID-19 time periods.

Methodology

Sample

Cadmus sampled to estimate plant persistence rates with 90% confidence and ±10% relative precision for most of the identified market sectors, prioritizing accuracy for the agricultural and industrial market sectors and the custom and horticulture lighting measure categories.

We first sampled to achieve the desired market sector precision. Using simple random sampling at the site level, we sampled sites from each market sector according to its estimated sample size in the sampling plan. Because we sampled by site, we pulled all measures from each selected site. Cadmus continued sampling sites from specific market sectors until we satisfied the measure category sample plan for each market sector, as outlined in the sampling plan.

Cadmus developed sampling plans for market sectors (Table 1) and for measure categories (Table 2 and Table 3). For the market sector sampling plan (Table 1), we based our estimations for site persistence–between 70% and 90%–on the previous Industrial Closure study conducted in 2010 and our experience evaluating the 2018-2019 and 2020 Production Efficiency program. All market sector estimated samples (Table 2) have an expected coefficient of variation of 0.5, which is equivalent to an expectation of an 80% persistence rate in each sector. This is a more conservative sampling approach than in previous studies as we anticipated higher variation and closure rates due to the COVID-19 pandemic.

Cadmus estimated site closure at 90/10, which met the requirements of the sampling plan.

Table 1. Market Sector Proposed Sample Sizes (Number of Sites)

Market Sector	Total Number of Sites	Sample Size	Achieved Relative Precision
Agriculture	941	65	4%
Indoor Agriculture	246	54	8%
Industrial	1,263	65	8%
Storage	119	31	14%
Mixed Commercial	104	28	6%
Other Tracks	71	22	14%
Total	**2,742**	**265**	**3%**

Table 2. Measure Category Sample Sizes (Number of Measures)

Market Sector	Custom Pump	Custom Compressed Air	Custom Refrigeration	Custom Aerator	Custom VFDs	Custom Other	Welder	Battery Charger	HVAC	Lighting (Indoor Agriculture)	Greenhouse	Other
Agriculture	51	4	28	11	16	26	0	10	0	0	8	18
Indoor Agriculture	9	0	12	0	0	18	0	2	46	65	60	20
Industrial	109	71	47	13	34	208	82	62	12	0	0	28
Storage	9	15	39	8	9	13	12	11	0	0	0	6
Mixed Commercial	1	10	4	8	2	6	4	6	0	0	0	6
Other Tracks	11	3	0	2	3	3	0	0	0	0	0	8
Sample Total	**190**	**103**	**130**	**42**	**64**	**274**	**98**	**91**	**58**	**65**	**68**	**86**
Population Total	**1,409**	**880**	**664**	**234**	**203**	**1,285**	**421**	**539**	**195**	**191**	**144**	**357**

We also attempted to conduct interviews for 229 open sites and completed interviews for 119 of those sites (some of which we found to be closed) to investigate measure removal and operations related to our research objectives. This high response rate met or exceeded 90/20 for most measures and sectors.

Table 3 shows the interview targets to meet 90/20 at each cross section and Table 4 shows the distribution of interviewed sites with targets met in green and targets not met in red.

Table 3. Measure Category Interview Targets for 90/20 Confidence/Precision

Market Sector	Custom Pump	Custom Compressed Air	Custom - Refrigeration	Custom - Aerator	Custom - VFDs	Custom - Other	Welder	Battery Charger	HVAC	Lighting (Indoor Agriculture)	Greenhouse	Other
Agriculture	17	0	8	0	16	8	0	0	0	0	0	3
Indoor Agriculture	0	0	0	0	0	10	0	0	16	16	16	12
Industrial	17	17	17	16	16	17	17	17	4	0	0	17
Storage	0	4	17	0	0	5	0	17	0	0	0	0
Mixed Commercial	0	7	0	0	0	0	0	0	0	0	0	0
Other Tracks	5	0	0	0	0	0	0	0	0	0	0	0
Total	**39**	**28**	**42**	**16**	**32**	**40**	**17**	**34**	**20**	**16**	**16**	**32**

Table 4. Distribution of Interviews by Sector and Measure

Market Sector	Custom Pump	Custom Compressed Air	Custom Refrigeration	Custom Aerator	Custom VFDs	Custom Other	Welder	Battery Charger	HVAC	Lighting (Indoor Agriculture)	Greenhouse	Other
Agriculture	11	3	8	4	7	17	0	7	0	0	5	8
Indoor Agriculture	3	0	8	0	0	11	0	0	23	15	58	9
Industrial	49	38	10	3	18	110	18	6	4	0	0	16
Storage	6	0	24	2	2	5	2	0	0	0	0	1
Mixed Commercial	0	6	0	5	1	0	2	6	0	0	0	5
Other Tracks	2	0	0	2	2	0	0	0	0	0	0	5
Total	**71**	**47**	**50**	**16**	**30**	**143**	**22**	**19**	**27**	**15**	**63**	**44**

Research Methodology

Cadmus followed a phased approach for conducting research that involved first assessing each site's operating status and then evaluating open and closed sites separately.

Phase 1: Initial Data Collection

Cadmus conducted a thorough review of Energy Trust participation data, utility data, third-party datasets, and other resources to gather relevant information on each site. These data helped determine the site's operating status and identify any indicators of plant closure. Below is a list of data sources that we considered:

- Utility data
- State business registry
- Company websites
- News articles related to site closure
- County property data
- FastTrack Data
- InfoUSA
- Oregon Employment Department Data
- Oregon Department of Environmental Quality
- Feedback from the Program Delivery Contractors (PDCs)

Cadmus documented the primary sources we used to determine the operating status of the facility. These results were then compiled and aggregated by counting the number of times a source was cited in the review. Table 5 shows the percentage of total citations for each source. Note that multiple sources may have been cited for a given facility.

Table 5. Sources of Site Closure Determination

Source	Percentage Cited
News articles	6.9%
Company website	42.9%
Web search	3.1%
Interview	0.3%
State business registry	40.9%
Utility data	6.0%

From this review we produced a list of sampled open sites and of closed sites, with indeterminate sites categorized as open to progress them through further phases of the data collection process in hopes of determining their final status.

Most Phase 1 findings were determined through a company website or state business registry. In many cases the state business registry served as the initial source of information, which was then confirmed through the company website, utility data, or another source. A few sites that we initially categorized as either open or indeterminate during Phase 1 research were recategorized as closed after an interview in Phase 2. We shared results from Phase 1 with Energy Trust and the PMC to get any additional background information that could be shared about the sites. This confirmation step served as a thorough quality control of our initial findings and allowed us to select for interviews individual sites that we had originally classified as indeterminate in Phase 1 based on account manager or Energy Trust experience.

Phase 2a: Recruitment and Interviews

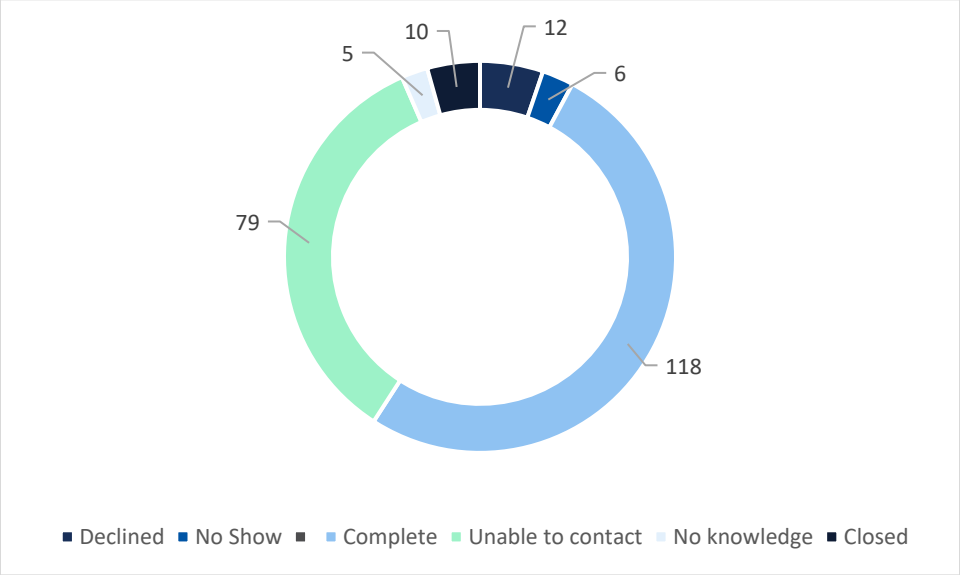
To proceed to the second phase of data collection of sampled sites categorized as open, Cadmus requested up-to-date contact information from Energy Trust and the PMCs. Cadmus determined in Phase 1 that 230 sites were open of the sample of 265. This subset served as our interview sample.

Cadmus' scheduling staff recruited sites by establishing initial contact through email that explained the study and requested an interview. To increase participation, we conducted follow-up contact through phone calls and emails to customers who had not responded to the initial email. Customers had the option to schedule an interview at their convenience through an online scheduling process that provided available times. After three attempts to reach a site contact, Cadmus requested support from Energy Trust and the PMC account managers who, through their existing relationships with the sites, conducted direct outreach via email.

Engineers familiar with industrial energy efficiency measures in the Production Efficiency program conducted interviews with site contacts to ensure that we captured any significant operational or procedural changes that might impact the evaluation metrics. Engineers reviewed project files for the incented measures prior to the interviews to understand operating characteristics of each measure and the facility as a whole.

After finding limited success with initial attempts through emails, Cadmus engineers began direct outreach to improve response rates. This approach yielded 118 responses for an overall response rate of 51.3%. Figure 1 shows the results of our outreach to 230 sites.

Figure 1. Response from Contacted Sites



To supplement interviews, we used the additional data sources listed in Phase 1 to evaluate changes that would affect facility operations. In addition to the in-depth facility operator interview, Cadmus conducted additional research based on the data collection plan developed as part of this project. This additional research was site specific and served to confirm and provide quality control for Phase 1 results.

Interview Guide

Cadmus developed a comprehensive interview guide, which is attached in Appendix B of this report. The interview guide was designed to investigate our four primary research questions:

- Changes to operating hours
- Changes to shift schedule
- Measure removal
- Other significant impacts to energy consumption and measure use

Phase 2b: Analysis and Review with Secondary Data

Cadmus evaluated sites we classified as closed to determine if the site had been occupied by a new business and if so, whether the new business could be assumed to be operating the incentivized measure in the same or similar manner. For example, if a lumber mill operating an incentivized kiln closes and is replaced with another lumber mill, the kiln would be assumed to be operating in a similar manner.

We used existing datasets, including utility data, Energy Trust participation data, and third-party datasets, along with online research to evaluate the continuity of measure operation. Cadmus did not directly contact any of the sites categorized as closed during phase 1 and relied only on secondary data.

Data Aggregation and Analysis

Once interviews were complete, Cadmus had two sets of data: one with site closures and one with open site interview responses. To roll up the results, Cadmus reviewed each interview response to determine overall impact to the four primary research questions. We also reviewed interview responses for any key details, interesting findings, and relevant information. Interviews were conducted at the site level, and in many cases, sites had implemented a significant number of measures. Because it was not feasible to obtain individual responses for each measure, Cadmus grouped measures and asked if there was an impact to those measures or projects. We documented and incorporated into our analysis all responses related to individual measure changes or removal.

Cadmus aggregated interview findings at the site level to the individual measure level adjusting for any individual responses from the interviews that related to specific measures or projects. In some instances, we made assumptions when responses were vague or unclear. This primarily affected the quantity of measures in a project that had changes. For example, if a customer noted an operating change to a measure that had duplicates, we assumed that the entire group was impacted by this change. Once these two datasets were rolled up, we were able to develop findings and results at the sector and measure level.

Research Results and Findings

Original Business Site Status Analysis

To assess site closure rates, Cadmus first researched the status of the original business, defined as the business occupying the given site at the time of the Energy Trust incentive. Table 6 provides our estimates by market sector of rates of business closure without a similarly operating business moving into the site.

Table 6. Sampled Original Business Closure Rates

Market Sector	Total	Closed		Open	
		#	% total	#	% total
Agriculture	65	4	6.15%	61	93.85%
Indoor Agriculture	54	8	14.81%	46	85.19%
Industrial	65	10	15.38%	55	84.62%
Storage	31	6	19.35%	25	80.65%
Mixed Commercial	28	2	7.14%	26	92.86%
Other Tracks	22	3	13.64%	19	86.36%
Total	**265**	**33**	**12.45%**	**233**	**87.55%**

Finding 1: We found the overall original business closure rate to be 12.45%, with 33 of 265 sites closed. The is a large increase from the 1.7% closure rate in the previous study conducted from 2002 to 2009.

Overall Site Closures

For sites operated by incented businesses, Cadmus analyzed each original business site closure to determine if a similar business was currently occupying the site. Cadmus defined a similar business as a business that it is reasonable to assume operates the incented equipment of the original business in a similar manner. For example, if a company operating a lumber processing site had closed but the site was purchased by another lumber processing company, the site was assumed to be operating similarly. Table 7 and Table 8 summarize the percentage of sites that are overall, or operationally, closed by sector and measure.

Table 7. Sampled Site Closure Rates

Market Sector	Closed		Open		Change from Table 6 Total
	#	% total	#	% total	#
Agriculture	3	4.62%	62	95.38%	-1
Indoor Agriculture	6	11.11%	48	88.89%	-2
Industrial	8	12.31%	57	87.69%	-2
Storage	6	19.35%	25	80.65%	0
Mixed Commercial	1	3.57%	27	96.43%	-1
Other Tracks	3	13.64%	19	86.36%	0
Total	**27**	**10.19%**	**238**	**89.81%**	**265**

Finding 2: The results for overall site closure rate by sector show rates ranging from the lowest rate of 3.57% for mixed commercial to 19.35% for storage sites, which saw the highest rate of closures.

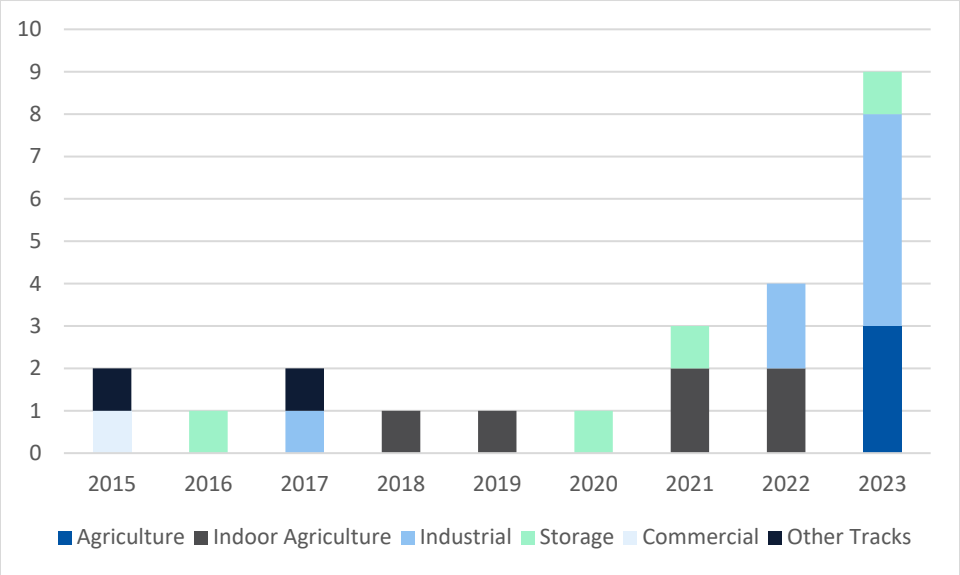
Table 8. Site Sample by Measure

Measure	Closed		Open		Total	
	#	% total	#	% total	#	% total
Custom – Pump	29	15.26%	161	84.74%	190	100%
Custom – Compressed Air	14	13.59%	89	86.41%	103	100%
Custom – Refrigeration	8	6.15%	122	93.85%	130	100%
Custom – Aerator	2	4.76%	40	95.24%	42	100%
Custom – VFDs	8	12.50%	56	87.50%	64	100%
Custom – Other	26	9.49%	248	90.51%	274	100%
Welder	5	5.10%	93	94.90%	98	100%
Battery Charger	0	0.00%	91	100.00%	91	100%
HVAC	2	3.45%	56	96.55%	58	100%
Lighting (Indoor Agriculture)	17	26.15%	48	73.85%	65	100%
Greenhouse	0	0.00%	68	100.00%	68	100%
Other	10	11.63%	76	88.37%	86	100%
Total	**121**	**9.54%**	**1,148**	**90.46%**	**1,269**	**100%**

Finding 3: The results for overall site closure rate by measure show rates ranging from 0% for greenhouse and battery chargers to 26.15% for indoor agriculture lighting, which saw the highest rate of closures.

When possible, Cadmus documented the year of site closure. This was informed by multiple sources including the state business registry, utility meter data, company websites, and news articles. This data was available for 24 of 33 sites. Figure 2 shows the distribution of site closure rates by year.

Figure 2. Site Closure Rate by Year and Sector



Finding 4: Site closure rates were relatively steady until 2021, at which point the number of sites that closed each year rapidly increased over a three-year period.

Measure Life by Site Closure Year

Cadmus analyzed the average life of each measure for sites that closed using the installed measure date and the year of site closure. Table 9 shows the average life for each measure.

Table 9. Measure Life for Sites that Closed

Measure Life	Average
Custom – Pump	10.8
Custom – Compressed Air	8.4
Custom – Refrigeration	7.3
Custom – Aerator	2.5
Custom – VFDs	6.8
Custom – Other	9.2
Welder	3.0
Battery Charger	-
HVAC	2.0
Lighting (Indoor Agriculture)	1.7
Greenhouse	-
Other	2.4
Total	**7.3**

Finding 5: Measure life for sites that closed was shortest for indoor agriculture lighting because this measure is the newest offering (only appearing in our sample starting in 2019), which skewed the installed date toward the end of the study period. Custom measures generally showed the longest average life at closed sites.

COVID-19 Impacts on Original Business Site Closures

Cadmus researched each of the original business site closures to identify if the COVID-19 pandemic was a cause of the closure. We determined that many sites had not been impacted by the pandemic because they had a pre-2020 closure date. Cadmus considered the COVID-19 pandemic date range to be from March 2020 to May 2023 which aligns with the public health emergency of international concern date range. Cadmus found that all but three businesses had not been impacted by COVID-19; these were a powder coating and sandblasting business, a metal fabrication business, and a window manufacturing business. These three sites closed at a time when COVID-19 could have impacted business operations; however, additional research showed no conclusive evidence relating the closure to COVID-19 impacts.

Cadmus did note an increase in site closures from pre-2020 to post-2020, which we attribute mainly to market conditions and more conservative site operation that can reasonably be assumed to be related to the high interest rates, inflation, and general economic uncertainty in the recovery from the COVID-19 pandemic.

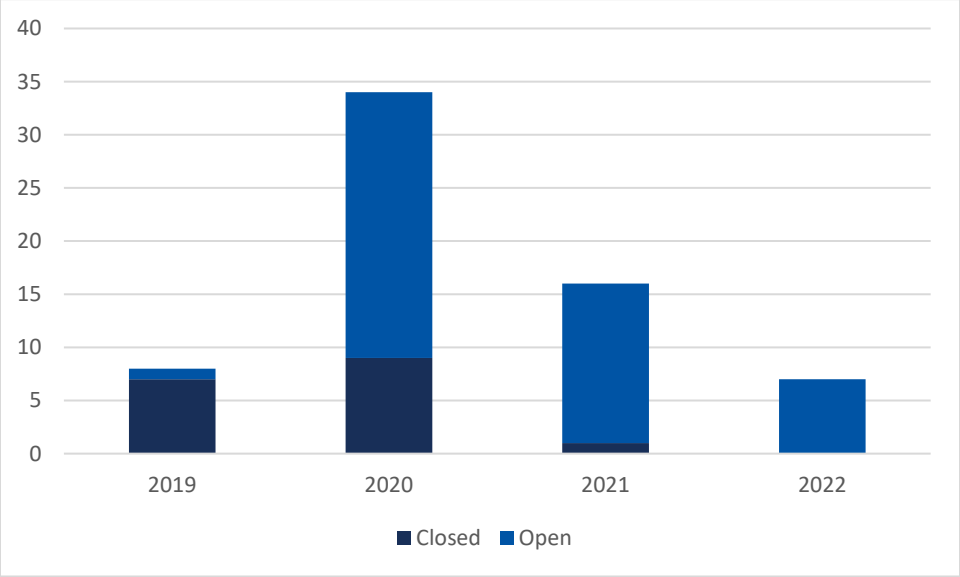
Finding 6: Three sites from the storage, mixed commercial, and industrial sectors were noted as having closed due to economic impact during or as a result of the COVID-19 pandemic.

While many of the industrial and agricultural businesses were significantly influenced by market conditions, very few of them seemed to be impacted directly by the COVID-19 lockdowns. In fact, many of the sites were considered essential and experienced no change in operations through direct COVID-19 impact.

Horticulture Lighting Site Impacts

The horticulture lighting offering is a custom lighting measure that developed in response to the legalization of cannabis agriculture in 2015. The earliest installed grow-light projects in our sample were completed in 2019. Figure 3 shows the distribution of indoor agriculture lighting measures by year.

Figure 3. Indoor Agriculture Lighting Measure Status by Install Year



Finding 7: A majority of indoor agriculture lighting projects in our sample were completed in 2020. The highest rate of closures involved measures completed in 2019, though this accounted for only eight measures across three projects. Table 10 Below shows the fixture quantities of open and closed sites by year.

Table 10. Fixture Quantities of Closed Horticulture Lighting Sites by Year

Year	Fixtures of Open Sites	Fixtures of Closed Sites
2019	121	230
2020	1107	382
2021	3,821	405
2022	787	0
Total	**5,836**	**1,017**

Indoor Agriculture lighting sites showed the highest closure rates of all measures (Table 11).

Table 11. Niche Lighting Market Site Closure Measure Sample

Market Sector/Breakdown	Closed		Open		Total	
	#	% total	#	% total	#	%
Indoor Agriculture (Lighting) – Measures	17	26.15%	48	73.85%	65	100%

Open Site Interview Measure Analysis

The following analysis includes the responses from 118 open sites that completed the interview process. Open sites with significant changes to operation hours, shift schedules, measure removals, and other

impacts on overall energy consumption are stratified by market sector and measure category in Table 12 and Table 13, respectively. Significant changes were defined as any changes that would impact the effectiveness and savings of the installed measures. Data for orientation of the changes is incomplete due to individual interview respondents varied knowledge or recollection of the projects.

Table 12. Open Sites with Significant Changes Stratified by Market Sector

Market Sector	Total Number of Open Sites		Operating Hours		Shift Schedule		Measure Removal		Impact in Energy Consumption	
	Open	Interviewed	#	%	#	%	#	%	#	%
Agriculture	61	32	6	18.75%	5	15.63%	3	9.38%	3	9.38%
Indoor Agriculture	46	21	0	0.00%	0	0.00%	3	14.29%	5	23.81%
Industrial	55	29	6	20.69%	6	20.69%	1	3.45%	7	24.14%
Storage	25	12	2	16.67%	1	8.33%	1	8.33%	3	25.00%
Mixed Commercial	26	15	3	20.00%	5	33.33%	5	33.33%	2	13.33%
Other Tracks	20	9	1	11.11%	1	11.11%	0	0.00%	0	0.00%
Total	**233**	**118**	**18**	**15.25%**	**18**	**15.25%**	**13**	**11.02%**	**20**	**16.95%**

Table 13. Open Sites with Significant Changes Stratified by Measure Category

Market Sector	Total Number of Open Sites		Operating Hours		Shift Schedule		Measure Removal		Impact in Energy Consumption	
	Open	Interviewed	#	%	#	%	#	%	#	%
Custom – Pump	161	71	10	14.08%	43	60.56%	4	5.63%	44	61.97%
Custom – Compressed Air	89	47	13	27.66%	10	21.28%	4	8.51%	17	36.17%
Custom – Refrigeration	122	50	19	38.00%	14	28.00%	19	38.00%	21	42.00%
Custom – Aerator	40	16	0	0.00%	4	25.00%	2	12.50%	1	6.25%
Custom – VFDs	56	30	9	30.00%	4	13.33%	5	16.67%	9	30.00%
Custom – Other	248	143	31	21.68%	55	38.46%	6	4.20%	37	12.87%
Welder	93	22	3	13.64%	17	77.27%	1	4.55%	3	13.64%
Battery Charger	91	19	0	0.00%	0	0.00%	0	0.00%	0	0.00%
HVAC	56	27	0	0.00%	1	3.70%	4	14.81%	5	18.52%
Lighting (Indoor Agriculture)	48	15	0	0.00%	0	0.00%	1	6.67%	0	0.00%
Greenhouse	68	63	1	1.59	1	1.59%	10	15.87%	22	34.92%
Other	76	44	9	20.45	10	22.73%	4	9.09%	4	9.09%
Total	**1148**	**547**	**95**	**17.37%**	**159**	**29.07%**	**60**	**10.97%**	**163**	**29.80%**

Finding 8: Of the 118 interviewed sites, 20 reported general impacts to the energy consumption of the incented measures. Similarly, operating hours and shift schedules were reported in equal quantities in most cases. The industrial, mixed commercial, and agriculture sectors were the most impacted.

The count of measures at sites reporting changes were collected at the site level but are reported here at the measure level. Many of the sites had multiple measures with an average of 4.5 measures per site for all sites interviewed and 7.5 measures per site for all sites that reported a significant change in operations. The large discrepancy between operating hours and shift schedule in the custom – other measure category can be attributed to two projects that had only shift schedule changes and counted for 40 measures.

Finding 9: The largest changes were seen at pump, refrigeration, compressed air, and greenhouse measures. The most common changes were other impacts to energy consumption like facility or demand changes and shift schedule changes.

Analysis of Sites with Significant Operational Changes

The following section looks at characteristics of sites that reported significant operational changes during the interview process. Sites that reported a significant change in operating hours of the measures installed are detailed in Table 14, sites that reported a significant change to shift schedules are detailed in Table 15, and sites that reported measure removals in Table 16.

Table 14. Sites that Reported a Significant Change to Operating Hours

Description of Change	Number of Sites Affected
Decrease in operating hours due to other equipment removal	6
Increase in operating hours to meet an increased demand	5
Decrease in measure operating hours	7

Five sites reported an increase in measure operating hours due to a significant increase in product demand, and one site reported being able to bring manufacturing back to the facility after the COVID-19 shutdown. Seven sites reported fewer measure operating hours, with three of the seven stating that the decrease in hours came from lowering equipment operations such as setpoints or by completely shutting down equipment when not in use.

Finding 10: In general, most of the impact to operating hours resulted in a decrease in energy consumption. In general, a decrease in operating hours typically reduces savings, however this is not the case with every measure.

Table 15. Sites that Reported a Significant Change to Shift Schedules

Description of Change	Number of Sites Affected
Decrease in shift hours due to other equipment removal	8
Increase in total number of shifts to meet an increased demand	2
Decrease in shift schedules/duration	4

Four sites reported a decrease in measure shift schedules, with two stating that the decrease was accomplished by implementing process improvements that resulted in more-efficient processes. One site reported a department shutdown, which eliminated the need for the equipment; however, the

business chose to keep the unused equipment because it anticipated starting a new product line using the existing equipment in the future.

Finding 11: In general, most of the impact to shift schedules resulted in a decrease in energy consumption. In general, a decrease in shift schedules typically reduces savings, however this is not the case with every measure.

Table 16. Sites that Reported Measure Removals

Description of Change	Number of Sites Affected
Removed at end of life	6
Change in operations, no longer needed	3
Defective/unusable equipment	1

Three sites reported that obsolete equipment was removed because of operational changes. One site removed one of two boilers that made up the facility's heating system. The remaining boiler was able to serve the heating system on its own with no change in heating demand. Another site reported that the grow lights purchased for the project were defective when received. Because of time constraints, the facility chose to purchase new similar lights and removed the original lights purchased. Six sites reported removing equipment at the end of its life, and five of these sites said they replaced the removed equipment with similar equipment.

Measures that were counted as removed but replaced with similar equipment are detailed in Table 17. This is not a comprehensive list of all replacements due to limitations in obtaining this information in interviews.

Table 17. Measure Replacements

Measure/Sector	Storage	Mixed Commercial	Industrial	Agriculture
Custom – Refrigeration (High Speed Doors [3])	Installed 2017 Replaced 2023			
Custom – VFDs (VFD Air Compressor)		Installed 2015 Replaced 2022	Installed 2015 Replaced 2023	Installed 2013 Replaced 2018
Custom – Pump (Irrigation Pump VFD)				Installed 2013 Replaced 2015

Four of the five replaced measures involved VFDs on air compressors or irrigation pumps. The equipment that was replaced had been installed between 2013 and 2017. One Irrigation pump was replaced about a year and a half after installation because of persisting issues with multiple VFD replacements.

Finding 12: These five replaced measures, found during interviews, ranged from 1.5 to 8 years old, which is significantly less than the 15-year assumed Estimated Useful Life (EUL).

Table 17 shows the interviewee descriptions of changes made by facilities and the general impact to energy consumption.

Table 18. Sites that Reported a Significant Change in Overall Energy Consumption

Description of Change	Impact to Energy Consumption	Number of Sites Affected
Increase in demand or facility expansion	Increase	9
Problems with equipment/measures	Increase	1
Decrease in equipment operations/decommissioning/installing more-efficient equipment	Decrease	5

One site reported an issue with insulation causing a large increase in energy consumption. The facility experienced leakage unrelated to the measures in the project list. Five sites reported a decrease in overall energy consumption due to operations, one site reported that this was caused by a shutdown of a department due to a large decrease in product demand.

Finding 13: Most sites that reported a significant change that impacted overall energy consumption had experienced a change in demand or facility expansion.

Indoor Agriculture Lighting Measures

Cadmus interviewed six sites that represented 15 total installed measures. Table 19 shows the changes as a percentage of all interview sites.

Table 19. Reported Indoor Agriculture Significant Operational Changes

Market Sector/Breakdown	Significant Change in Operating Hours		Significant Change Shift Schedule		Measure Removal		Significant Impact in Energy Consumption	
	#	% total	#	% total	#	% total	#	% total
Indoor Agriculture (Lighting) - Measures	0	0.00%	0	0.00%	1	6.67%	0	0.00%

One site reported a significant change in operation since measures were installed. The site purchased incentivized grow lights in 2021 that were defective and decided to purchase new lights resulting in removal of the old lights due to time constraints and defective products.

Additionally, not counted as an impact to energy consumption of the measures, one site reported that the facility remained operational 24/7 but increased production. Because the facility did not mention an impact to energy consumption, we did not include this in the tabulated result. Another facility reported that the LEDs provided great lighting and reduce energy bills but were not effective for growing and breeding, which caused the facility to fall short of expected yields.

Finding 14: Few indoor agriculture sites were impacted by changes, but for those that experienced changes, these changes were mostly a result of equipment operating issues that led to removal, replacement, or addition of equipment to meet additional demand.

COVID-19 Impact on Measures

Five facilities reported changed operations due to COVID-19, three of which experienced temporary changes and are back to normal operations now. One facility reported a permanent decrease (about four hours per day), and another a significant increase (37% more energy usage) that is permanent and a result of bringing back manufacturing post COVID-19. Table 20 provides the breakdown of the sectors and measures that were impacted.

Table 20. Open Sites' Impact Related to COVID-19

Measure/Sector	Industrial		Other Tracks		Total
	Sites	Measures	Sites	Measures	Measures
Welders	2	18	-	-	18
Custom – Pump	2	2	-	-	2
Custom – Compressed Air	2	2	-	-	2
Custom – Aerator	-	-	1	1	1
Custom – Other	1	2	-	-	2
Other	-	-	1	1	1

Three of the five sites were industrial sites, the other two were categorized as other tracks. A total of 26 measures across the five sites reported an impact on operations due to COVID-19.

Finding 15: Impacts due to COVID-19 were present but varied in direction for five sites and 26 measures.

Conclusions and Recommendations

Cadmus lists findings and related conclusions below:

Finding 1: We found the overall original business closure rate between 2010-2022 to be 12.45%, with 33 of 265 sites closed. The is a large increase from the 1.7% closure rate in the previous study conducted from 2002 to 2009.

Conclusion 1: The 2024 industrial closure study found a significant increase in site closures compared with the study completed in 2009. While there are complexities with normalizing data across two very different periods there are a few factors that may have contributed to these differences:

- The study uses different research methods that included direct outreach through interviews, site-specific detailed research, and secondary confirmation of site closures.
- The study involved more in-depth research with an increase in primary data collection. In some cases, plant closures were identified only after reviewing several sources of information.
- The increased rate of site closures could have been partially driven by the COVID-19 pandemic. The industrial closure rate due to COVID-19 varied significantly across different regions, industries, and time periods. During the initial phases of the pandemic in 2020, many industries experienced temporary closures or disruptions due to lockdowns, supply chain issues, and reduced consumer demand. However, the extent of closures and their impacts evolved over time as various initiatives were implemented to support economic recovery.
- The previous study period was significantly shorter at 7 years (2002-2009) compared to 13 years in this study (2010-2023).

Finding 2: The results for overall site closure rate by sector show rates ranging from the lowest rate of 3.57% for mixed commercial to 19.35% for storage sites, which saw the highest rate of closures.

Conclusion 2: Storage sites showed significant closure rates, which is likely due to the lack of specificity of the facility requirements and the lower capital costs for relocation. In many cases sites moved to other locations without another company picking up the abandoned facility. It is unclear what key drivers caused many of the facility closures. We were surprised to see that industrial facilities were a large percentage (12.31%) of the sampled of closed sites.

Finding 3: The results for overall site closure rate by measure show rates ranging from 0% for greenhouse and battery chargers to 26.15% for indoor agriculture lighting, which saw the highest rate of closures.

Conclusion 3: The team sampled a total of 68 greenhouse measures that were all confirmed as open. This was surprising, however, with the agriculture sector having one of the lowest closure rates it may have been that there were limited closed agriculture sites in general that also had greenhouse measures. Indoor agriculture lighting was impacted heavily by the closure rates, this is likely inflated due to the high concentration of this singular measure within this sector.

Finding 4: Site closure rates were relatively steady until 2021, at which point the number of sites that closed each year rapidly increased over a three-year period.

Conclusion 4: Based on the interviews conducted with open sites to verify measure operation, we believe economic factors resulting from the COVID-19 pandemic may have contributed to an increase in site closures over the three-year period between 2021 and 2023. These factors include high inflation, increased cost of goods, and a decrease in demand for certain goods, all of which can have a negative effect on industrial facilities. It is complex to pinpoint the reasons for recent rapid closures as we did not interview participants at closed facilities other than the cases where we found an open site to be closed, but the general trend and feedback we got from open sites suggests that the economic impacts were large for some industrial customers.

Finding 5: Measure life for sites that closed was shortest for indoor agriculture lighting because this measure is the newest offering, which skewed the installed date toward the end of the study period. The custom measures considered in this study generally showed the longest average life.

Conclusion 5: Measure life of indoor agriculture lighting was significantly shorter due to the measure being new and our sampling only having representation of those measure from 2019 onwards. Custom measures having the longest measure life agrees with our understanding that these measures involve significant investment and are specific to the site, which results in longer use.

Finding 6: Three sites from the storage, mixed commercial, and industrial sectors were noted as having closed due to economic impact of the COVID-19 pandemic.

Conclusion 6: We were able to verify through statements made directly by the company or articles quoting company representatives that at least three sites closed due to economic impacts of the COVID-19 pandemic. It is rare for industrial sites to shut down completely, and having three sites close due to economic impacts does suggest a significant change in economic climate. Many facilities experienced economic hardships, but many facilities were able to sustain operations through 2022.

Finding 7: A majority of indoor agriculture lighting projects in our sample were completed in 2020. The highest rate of closures were measures completed in 2019 though this only accounted for eight measures (230 fixtures) across three projects.

Conclusion 7: The closure and removal rates of the horticulture lighting market are unclear because indoor agriculture is a new sector. Cadmus suggests a more in-depth study to understand these projects in more detail.

Finding 8: Of the 118 interviewed sites, 20 reported general impacts to the energy consumptions of the incented measures. Similarly, operating hours and shift schedules were reported in equal quantities in most cases. The industrial, mixed commercial, and agriculture sectors were the most impacted.

Conclusion 8: Industrial sites are largely driven by individual demand in their industries. A general impact to energy consumption due to a facility change is very common. Facilities regularly experience expansion or changes in production throughput. Similarly, facilities will often change shifts or operating

hours to scale production. Large swings in economic uncertainty caused many sites to adjust operating hours after the installation of a measure. The adjustments in some cases resulted in an increase in potential energy savings while in other cases the resulting adjustments to the measure decreased the energy savings. As discussed earlier it is common to see adjustments in measure operation over the period of the measure life.

Finding 9: The largest changes were seen at pump, refrigeration, compressed air, and greenhouse measures. The most common changes were general changes that impacted energy consumption and shift schedule changes.

Conclusion 9: The measures listed are all highly variable measures that scale with production and are strongly correlated with demand. It is very unlikely that after one of these measures was implemented operation would remain at the same level over the useful life of the measure. The finding is not surprising and aligns with what we see in other jurisdictions. Even when conducting evaluation of a measure within the first year of installation it is common to find changes to the operating parameters of the measure.

Finding 10: In general, most of the impact to operating hours resulted in a decrease in energy consumption.

Conclusion 10: Most facilities that changed operating hours reduced hours likely in response to decreasing demand. This is in line with the observation of increased site closures likely driven by economic impacts resulting from the COVID-19 pandemic. Most of these changes are reversable and many industrial facilities are able to ramp up and down to meet the required demand for products.

Finding 11: In general, most of the impact to shift schedules resulted in a decrease in energy consumption.

Conclusion 11: Most facilities who changed shift schedules reduced shifts or shortened shifts likely to scale back with demand. In general shift schedules are correlated with operating hours and the reduction in shifts is a result of reduced operating hours of the facility.

Finding 12: The five replaced measures, found during interviews, ranged from 1.5 to 8 years old, which is significantly less than the 15-year assumed EUL.

Conclusion 12: Measure life of the replaced measures varied widely due to the unique characteristics of individual measure categories. Unsurprisingly custom measures had higher measure lives overall because of their high specificity and investment, while indoor agricultural lighting, which has only been an offering since 2015, had very low measure lives for those lights that were uninstalled. There are many considerations when determining measure life. Measure replacement, facility closure, and early failure are all factors when determining measure life. It is common to have some measures fail earlier than their listed life or get impacted by a facility closure or measure replacement.

Finding 13: Most sites that reported a significant change that impacted overall energy consumption had experienced a change in demand or facility expansion.

Conclusion 13: It is common for facilities to be operating at maximum feasible operating hours or shift schedules, so the only way to increase production to meet demand is to expand or increase equipment throughput. This explains why a facility would cite a change in operating hours more commonly as a decrease while an expansion or increase in throughput would be a general change instead of an increase in hours or shifts. Also notable is that although the previous study found an uptick in facility closures, the Cadmus team also observed facilities that expanded to increase production.

Finding 14: Few indoor agriculture sites were impacted by changes, but for those that experienced changes, these changes were mostly a result of equipment operating issues that led to removal, replacement, or addition of equipment to meet additional demand.

Conclusion 14: Multiple indoor agriculture lighting measures had equipment issues; it is unclear what is driving these issues and measure failures, but the broad range of products offered, various vendors and manufacturers, and the relatively new offering and technology could be causing issues with measure performance.

Finding 15: Impacts due to COVID-19 were present but varied in direction for five sites and 26 measures.

Conclusion 15: COVID-19 caused varied impacts due to the wide variety of industries served by Production Efficiency participants. Both increases and decreases were cited, however most of the impacts caused a reduction in energy consumption. Other than changes to the still operating measures, COVID-19 also impacted facility closure rates.

Recommendations on Measure Life and Future Research

The results of this study present additional information that could help inform site and measure persistence. Persistence of savings encompasses both the retention and the performance degradation of measures. This study explored both of these elements; however, the study was not designed to determine measure persistence. While the results provide directional recommendations, they should not be relied on exclusively for decision-making on measure life. Based on the analysis performance we recommend the following:

- Cadmus recommends that Energy Trust maintain a standard measure life of 15 years until further research and analysis can be conducted. While the site closure rate and measure removal were higher than previous studies, there was still a high percentage of measures installed and operational since 2010 and this suggests that there will be measures that continue to provide energy savings even beyond the 15-year measure life.
- Cadmus recommends investigating measure persistence at the individual measure level. This can be done by maintaining a database of measure life through a combination of literature review, benchmarking, manufacturing specifications, and periodic field studies to collect primary data. This is a common practice among other incentive programs for high-impact measures and programs that include a broad range of measures. For instance, measure life for LED grow lights is very different from that of a large industrial process. Individual investigation allows for individual assumptions of measure life and vendor measure life considerations. This individual

measure research can involve direct research methods like interviews or site visits and literature reviews to provide a well-rounded picture of measure life. For instance, sites that invest in a new and more efficient production line expect the measure to be operational for over 15 years. It is common for measure life for large equipment to exceed 20 years. Critical production equipment also tends to be better maintained because its functionality directly impacts product quality and can be easily observed and quickly corrected. If reviewing measure life for individual measures is not feasible, we would recommend developing groups of measures with similarities where a representative measure life can be applied. We would also recommend reviewing measure life for each of the largest projects in the Large and Complex program, because these projects contribute a large percentage of savings within the program.

- Two major limitations in this research are the individual measurement characteristics and sampling feasibility. Cadmus has experience evaluating measure persistence for individual, high-impact measures. Because this study involved a sample of sites with various measures and interview response rates reduced sampling numbers, the applicability of interview responses is influenced by nonresponse bias. Our recommendation is to track and update measure-specific EUL on a regular basis in a database form. As mentioned previously, EULs can be determined through a combination of vendor specifications, literature review, benchmarking, and supplemental data collection through field studies. Field studies should have specific objectives around confirming measure persistence for the PE program. Building on the EUL database regularly will help to continually refine measure lives, which will provide stronger assumptions for measure persistence.

Appendix A. Sector and Measure Mapping

Original Sector	Mapped Sector
Agriculture and Irrigation	Agriculture
Food Processing	Industrial
Indoor Agriculture	Indoor Agriculture
Logging and Wood Product Manufacturing	Industrial
Fabricated Metal Product Manufacturing	Industrial
General Manufacturing	Industrial
Beverage Production	Industrial
Metal and Machinery Manufacturing	Industrial
Computer and Electronic Product Manufacturing	Industrial
Warehousing and Storage	Storage
Industrial	Industrial
Refrigerated Warehousing and Storage	Storage
Greenhouse	Indoor Agriculture
Plastics and Rubber Products Manufacturing	Industrial
Nonmetallic Mineral Product Manufacturing	Industrial
Printing and Related Support Activities	Commercial
Transportation Equipment Manufacturing	Industrial
Site Built Home	Other Tracks
Chemical Manufacturing	Industrial
Office	Commercial
Commercial	Commercial
Dairy and Livestock	Agriculture
Paper Manufacturing	Industrial
Retail	Commercial
Repair/Maintenance Shop	Commercial
Textile and Apparel Manufacturing	Industrial
Natural Resources and Energy Distribution	Industrial
Food Service	Industrial
Manufactured Home	Other Tracks

Original Sector	Mapped Sector
Industrial Laundry Services	Industrial
Petroleum and Coal Products Manufacturing	Industrial
Single Family Home	Other Tracks
Waste Management and Remediation Services	Other Tracks
College/University	Other Tracks
Grocery	Other Tracks
Healthcare	Other Tracks
Non-Residential	Other Tracks
Lodging/Hotel/Motel	Other Tracks
All Markets	Other Tracks
Car Wash	Other Tracks
Arts, Entertainment and Recreation	Other Tracks
Fire Station	Other Tracks
Transportation Infrastructure (Tunnel, Roadway, Dock, etc.)	Other Tracks
Gym/Athletic Club	Other Tracks
Laundry/Dry Cleaner	Other Tracks
Residential	Other Tracks

Original Measure	Mapped Measure
Custom pump	Custom - Pump
Custom compressed air	Custom - Compressed Air
Custom refrigeration	Custom - Refrigeration
Custom aerator	Custom - Aerator
Custom Variable Frequency Drive	Custom - VFDs
Custom HVAC	Custom - Other
Custom fan	Custom - Other
Custom secondary process	Custom - Other
Custom primary process	Custom - Other
Custom controls	Custom - Other
Custom heat recovery	Custom - Other
Custom process	Custom - Other
Custom filter	Custom - Other
Custom chiller	Custom - Other
Custom insulation	Custom - Other
Custom piping	Custom - Other
Custom air abatement	Custom - Other
Custom humidifier	Custom - Other
Custom welder	Custom - Other
Custom other measure	Custom - Other
Custom ducts	Custom - Other
Custom battery charger	Custom - Other
Custom conveyor	Custom - Other
Custom hydraulics	Custom - Other
Custom containment vessel	Custom - Other
Custom fume collector	Custom - Other
Custom data center	Custom - Other
Custom scrubber	Custom - Other
Custom disinfection	Custom - Other
Custom transformer	Custom - Other

Original Measure	Mapped Measure
Ceiling insulation	Other
Wall insulation	Other
Welder	Welder
Battery Charger	Battery Charger
HVAC	HVAC
Lighting	Lighting (Indoor Ag)
Pipe insulation	Other
Greenhouse	Greenhouse
Cooling tower	HVAC
Vacuum pump	Other
Tanked water heater	Other
Generator Block Heater	Other

Appendix B. Interview Guide

Industrial Plant Closure Study Interview Guide

Site ID/Name: _____
Associated Project IDs: _____
Site Contact: _____
Site Contact Email: _____
Site Contact Phone: _____
Interviewer: _____
Interview Date: _____

Objective: To gather information regarding the project to inform the site closure study. Key areas of interest may include the following:

- Knowledge of project
- Operating conditions
- Installation

Interview Protocol

- Review the project files in preparation for the interview. When available, refer to the evaluation plan for project background and key data points for investigation.
- Establish that the customer representative is knowledgeable about the project and equipment.
- Ensure confidentiality.
- Ensure that the customer understands which project or projects you want to discuss.
- Conduct the interview in a conversational tone and avoid reaction (positive or negative) to responses. There are no 'right' or 'wrong' responses – we simply want answers that reflect what actually occurred and is occurring.
- Actively listen and give the respondent time to think. Some silence is a good thing. Do not try to fill the silence by suggesting answers.
- Probe or ask follow-up questions for more robust responses, as warranted.

Interview Guide

The formal introduction section is only used for cold calls (expected to be a minority of cases). For most projects, we will conduct the initial introduction by email.

Introduction

1. Hello, my name is [INSERT NAME], I'm calling from Cadmus on behalf of Energy Trust of Oregon, may I speak with [CONTACT NAME]?
    a. [If contact not at phone number, ask for contact info. Provide Energy350 contact info if they would like to speak to someone from Energy Trust; production@energytrust.org, 1.866.202.0576
    b. [If contact is not available, try to SCHEDULE CALLBACK.]
    c. [If person no longer works there, ask for the name and contact info for a person who is familiar with the

project and ask to speak with that person.]

2. [If you reach contact- Introduce yourself] Hello, my name is [INSERT NAME], I'm calling from Cadmus on behalf of Energy Trust of Oregon. We are conducting a study of energy efficiency measures installed through the Production Efficiency program.
3. Are you the person who is most familiar with the [DESCRIBE PROJECT] at your facility?
    a. [If NO, ask for the name and contact info for a person who is familiar with the project and ask to speak with that person.]
    b. [If YES] Is this a good time to have a discussion about your experience with the program? I expect it to take about 10-15 minutes.
    c. [If REFUSED]. Is there a better time for me to call you? [SCHEDULE CALLBACK]
    d. [If REFUSED AGAIN]. Thank you for your time. [End call. Record refusal in tracker.]
4. Before we get started, I'd like to note that your responses are confidential and will only be publicly reported in aggregate. Individual facility responses will not be identified in public documents but will be made available to Energy Trust of Oregon. [IF NEEDED: individual responses will be reported anonymously as part of a group. We will not publicly report any identifying information.]
5. For note taking purposes only, is it okay if I record this call?
    a. [If YES - RECORD RESPONSES]
    b. [If NO – DO NOT RECORD]

General Project Questions

6. [Verify facility staff are familiar with all measures associated with the site.]: Our project documentation shows your facility has complete [NUMBER OF PROJECTS] projects between 2010 and 2022. Are you familiar with some or all of these?
7. [Verify measure removals]: Were any of the measures mentioned removed since installation?
    a. [If YES] Which measures? When were they removed?
    b. [If NO] Continue to next.
8. [Verify operating hours for each measure]: For the measures that remained installed, per the project analysis documentation,
    a. After the project was completed/equipment was installed on [INSERT INSTALLED DATE] the operating hours were [INSERT DOCUMENTED SCHEDULES FOR EACH MEASURE]. Is that correct?
        i. [If YES to a]: Have the operating hours changed since the project was completed/equipment was installed?
    b. [If NO to a]: Please describe the operating hours immediately after the project was completed/equipment was installed.
        i. Have the operating hours changed since the project was

completed/equipment was installed?

9. [If YES to {OPERATING HOURS CHANGED? (8ai/bi)}]: Please describe the hours changes and approximately when the changes occurred (including both the start and end dates, if applicable).
   a. Why were the operating hours/schedules changed?
   b. Do you anticipate that these changes are temporary or permanent?
   c. [If project was the cause of (or allowed) the change or if unclear]: Did the project have any role in this change?
      i. [If YES]: What was its role?
10. [Verify shift schedules]: For the same measures,
    a. After the project was completed/equipment was installed on [INSERT INSTALLED DATE] the shift schedules were [INSERT DOCUMENTED SCHEDULES]. Is that correct?
       i. [If YES]: Have the shift schedules changed since the project was completed/equipment was installed?
    b. [If NO to 10a]: Please describe the shift schedules immediately after the project was completed/equipment was installed.
       i. Have the operating shift schedules changed since the project was completed/equipment was installed?
11. [If YES to {OPERATING HOURS CHANGED? (10ai/bi)}]: Please describe the shift schedules changes and approximately when the changes occurred (including both the start and end dates, if applicable).
    a. Why were the shift schedules changed?
    b. Do you anticipate that these changes are temporary or permanent?
    c. [If project was the cause of (or allowed) the change or if unclear]: Did the project have any role in this change?
       i. [If YES]: What was its role?
12. [Project performance]:
    a. How is the implemented change/equipment working?
    b. Have there been any issues with the performance of the implemented change/equipment since the installation?
    c. Have you changed any operating parameters, such as setpoints, since the project was completed/equipment was installed?
       i. [If YES: Please specify what has changed and when the changes were made.]
13. Are you planning any operating changes in the next year?
    a. [If YES]: Please specify what will change and when the changes are planned to take effect.

14. [Other changes. Note: This question is open ended and intended to uncover other unanticipated changes that have occurred at the facility. It might reveal something like the replacement of a load/unload air compressor with a VFD compressor for a compressed air leak repair measure, which would significantly change compressor efficiency and resulting savings.]
    a. Have there been any other facility changes since the project was completed/equipment was installed that impacted the project/installed equipment or the facility as a whole?
        i. [If YES]: Please describe the changes and their approximate timeline.
15. Is there anything else you would like to tell me about the project?

Thank you very much for your time and participation with Energy Trust and for your support of this important study.