Energy Efficiency Assessment

Texas State University

EDF Climate Corps 2016

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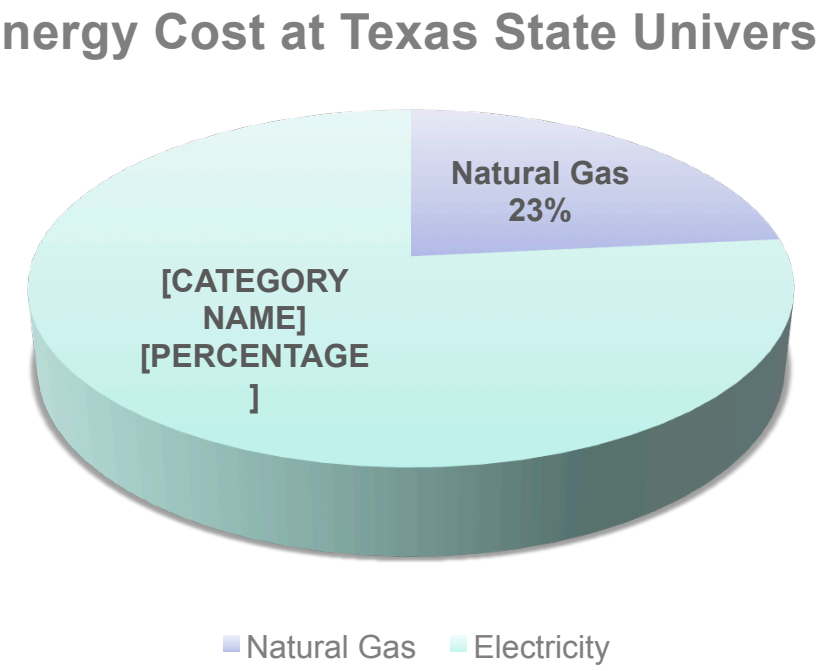
EDF ENVIRONMENTAL DEFENSE FUND | CLIMATE CORPS

EDF Climate Corps embeds trained graduate students in organizations to help meet their energy goals by accelerating clean energy projects in their facilities.

The following presentation is the result of an eight week Climate Corps fellowship at Texas State University, Central Plant

Texas State University

- 266 buildings:7.7 million gross square feet.
- 13 of these buildings consume more than 80 million kWh of electricity.
- This is equivalent of 7,334 single-family home (EIA).

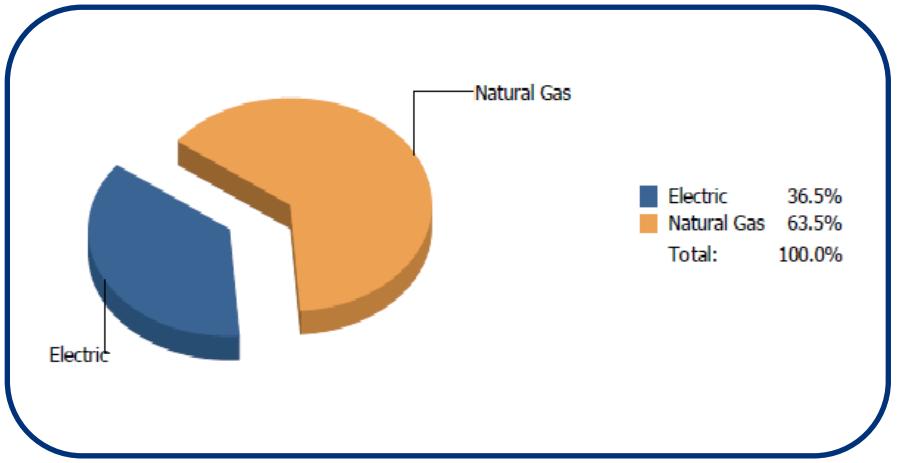


Source: EnergyCap application, readings for April 2015 to April 2016

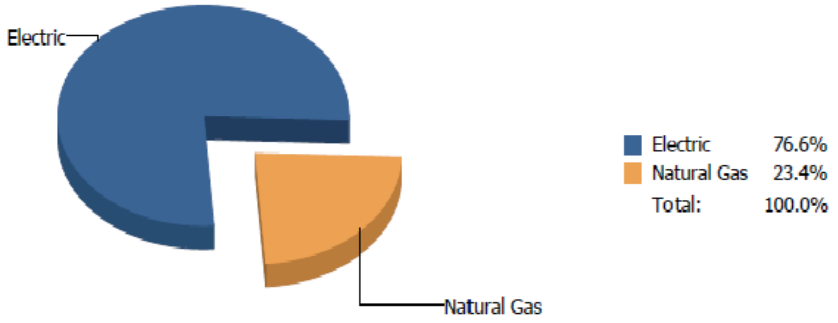
ɔpmost Place: [817] CoGeneration Power & Chiller Pla

Floor Area: 46,626 SqFt

Use Percentage



Cost Percentage



Billing Period between Apr 2015 and Apr 2016

Commodity	Common Unit		Energy Use		Energy Percentage	Cost	Cost Percentage
	Common Use	Cost/Unit	MMBtu	Cost/MMBtu			
Electric	62,269,842kWh	$0.0826 / kWh	212,527	$24.2156 / MMBtu	36%	$5,146,463.39	76.59%
Natural Gas	359,554MCF	$4.3749 / MCF	370,340	$4.2475 / MMBtu	64%	$1,573,014.78	23.41%
Grand Totals:			**582,867**			**$6,719,478.17**	

The Energy Challenge at Texas State University

- **Senate bill 898: mandates a goal to reduce electrical consumption throughout the university by at least 5% each year for 10 years, beginning September 1, 2011.**

- **Texas State Plan 2012-2017: goal 5.13: ensure regulatory compliance, environmentally responsible and sustainable practices and the efficient use of energy and water resources.**

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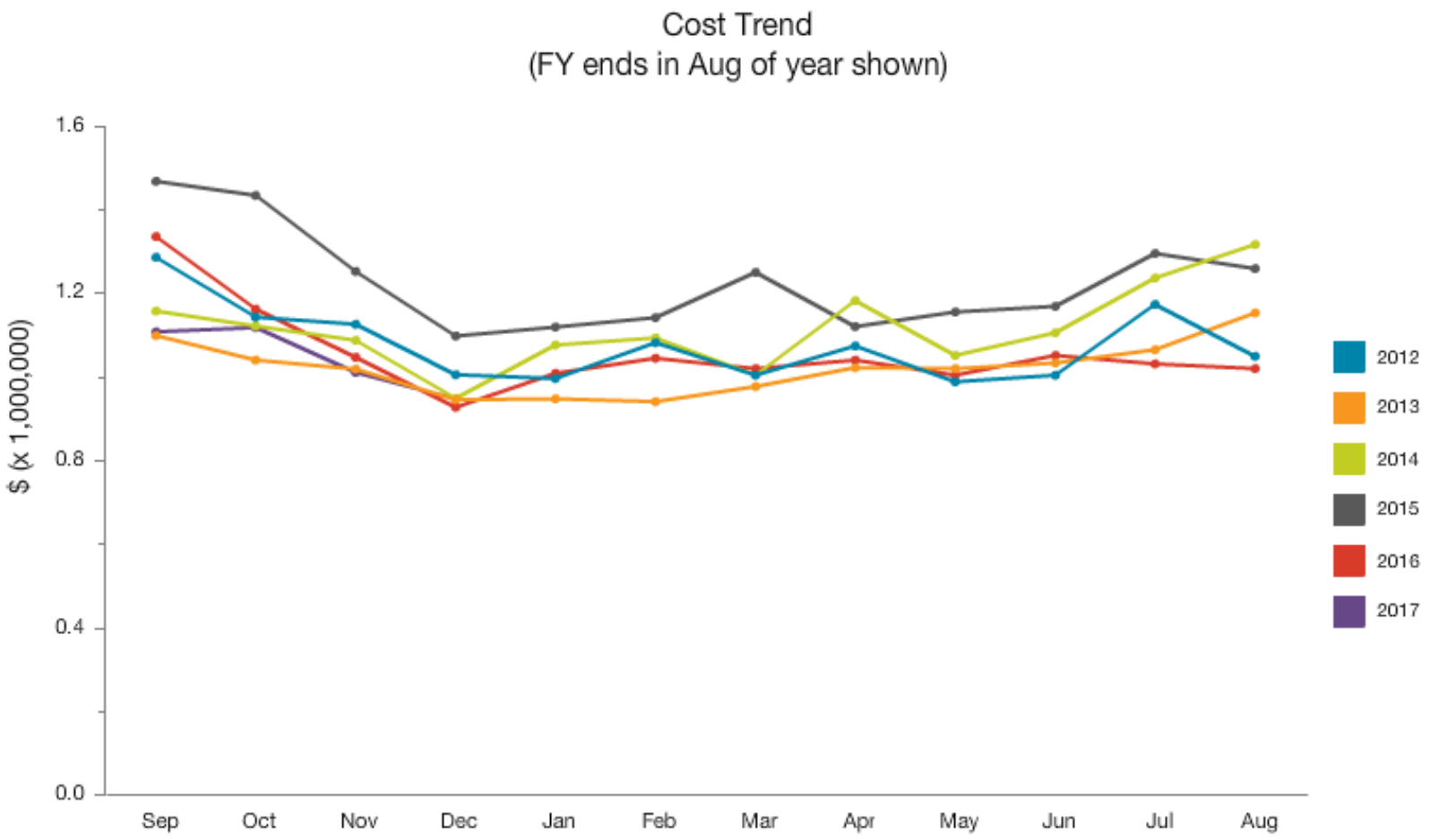
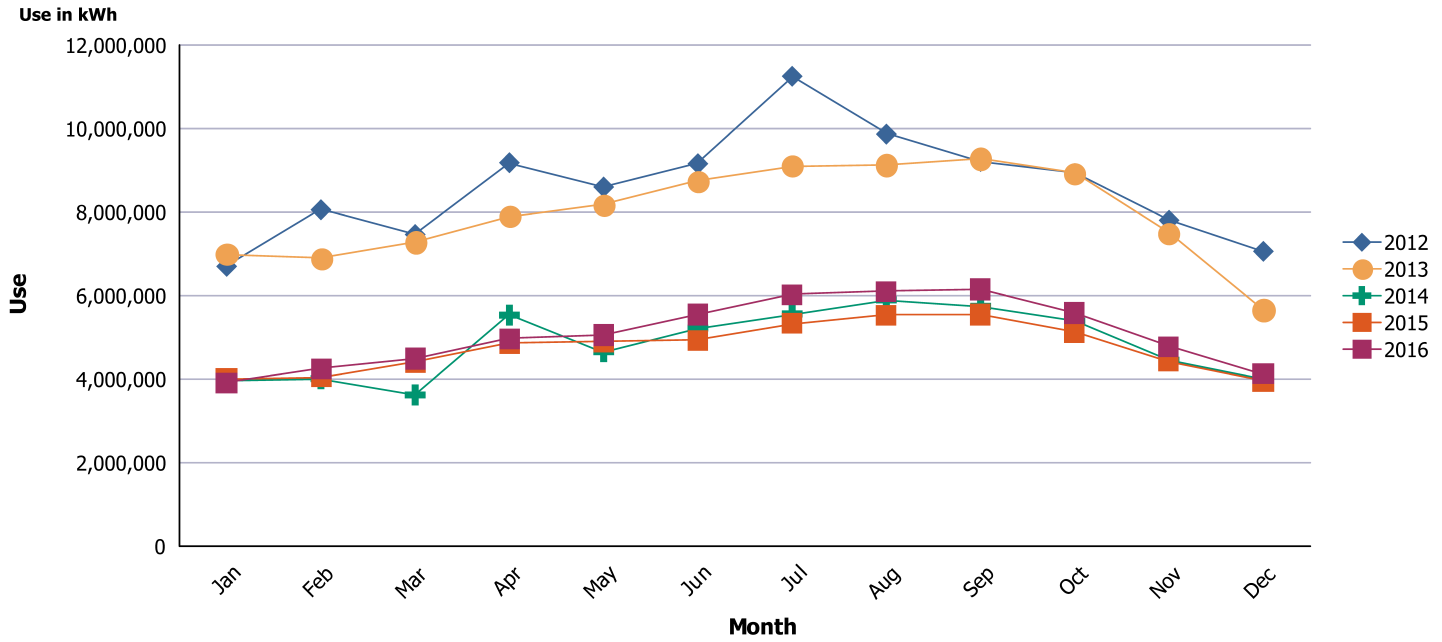


CoGeneration Center kWh consumption

Texas State University

Executive Energy Profile BL - 14



Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
2012	6,701,404	8,058,308	7,467,330	9,185,795	8,602,727	9,162,222	11,256,120	9,868,913	9,214,294	8,927,633	7,806,675	7,062,119	103,313,540
2013	6,987,488	6,895,869	7,287,094	7,901,913	8,178,075	8,742,618	9,106,397	9,134,432	9,280,644	8,936,697	7,493,469	5,658,150	95,602,846
2014	3,955,200	4,013,232	3,624,605	5,534,218	4,658,620	5,225,251	5,564,755	5,902,071	5,745,245	5,389,344	4,453,584	4,010,573	58,076,698
2015	4,017,955	4,056,547	4,416,691	4,862,564	4,887,830	4,936,330	5,336,140	5,532,365	5,548,636	5,136,460	4,432,992	3,953,808	57,118,318
2016	3,915,754	4,259,021	4,493,606	4,974,336	5,058,730	5,551,142	6,032,688	6,106,176	6,147,965	5,584,454	4,786,272	4,124,736	61,034,880
Totals	25,577,801	27,282,977	27,289,326	32,458,826	31,385,982	33,617,563	37,296,100	36,543,957	35,936,784	33,974,588	28,972,992	24,809,386	375,146,282

Electric Consumption Savings			
	Gross Square Feet (GSF)	Consumption (Kwh)	Consumption Per Sqft (kWh)
FY12	7,102,422	121,184,231	17.062
FY13	7,493,405	118,753,429	15.848
FY14	7,513,016	120,167,425	15.995
FY15	7,763,457	116,461,145	15.001
2016?	7,719,991	116,468,027	15.087

2012 – 2015: Increasing GSF and decreasing consumption

EUI= Energy utilization / Square Foot

https://goo.gl/QezY95

(Discounted) Cash Flow Model, Financial Metrics

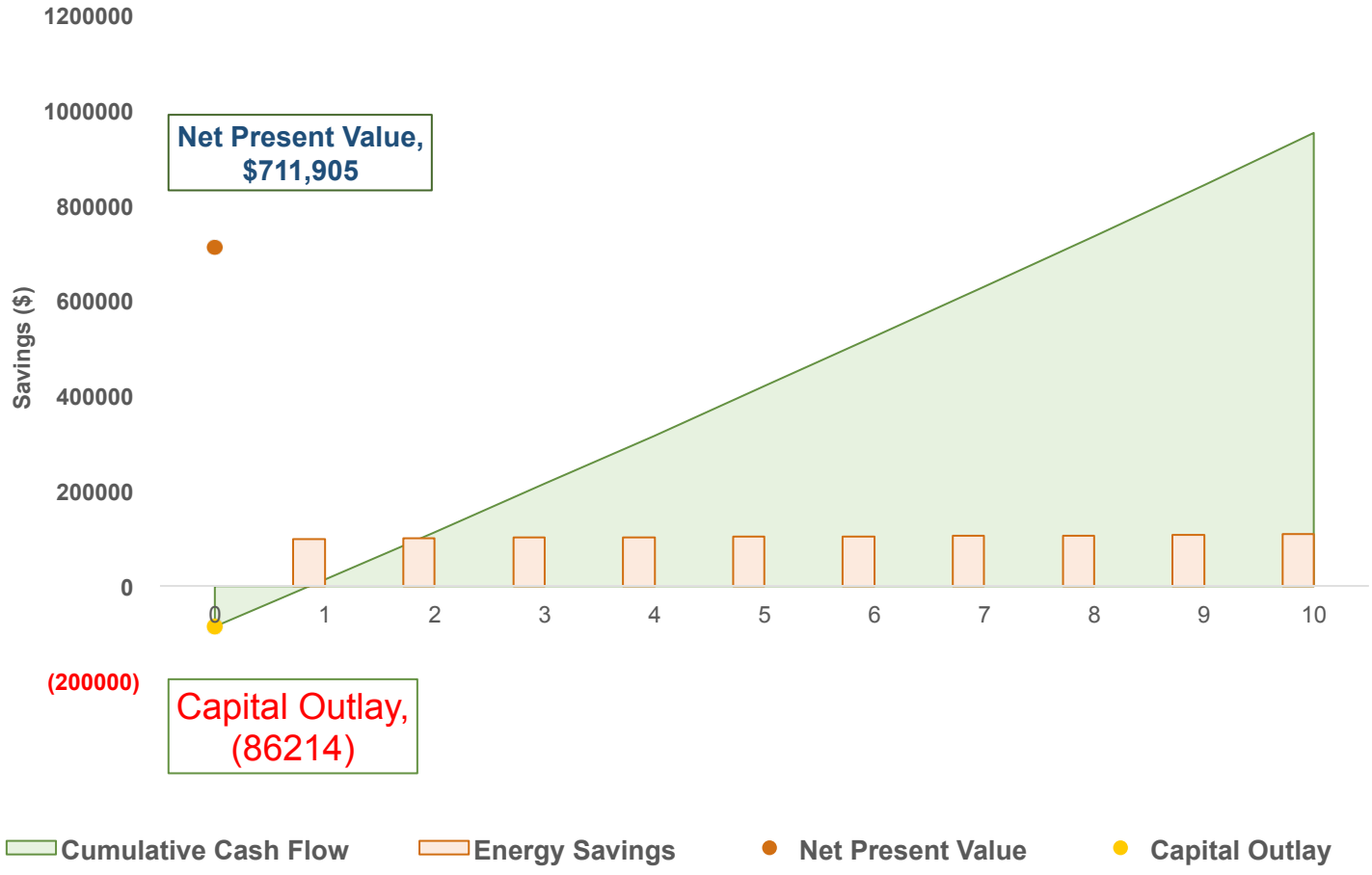
Investment-operating Cash flow

$$DCF = CF_1/(1+r)^1 + CF_2/(1+r)^2 + \ldots CF_n/(1+r)^n$$

Net Present Value (NPV):

- The value of all future cash flows
- Higher value = More profit, value 0 = No gain, no lose

$$NPV(i,N) = \sum_{t=0}^{n} Rt(CF)/(1+i(r))^t - \text{initial investment}$$


1200000
1000000
800000
600000
400000
200000
0
(200000)
Savings ($)
Net Present Value, $711,905
Capital Outlay, (86214)
0
1
2
3
4
5
6
7
8
9
10
Cumulative Cash Flow
Energy Savings
Net Present Value
Capital Outlay

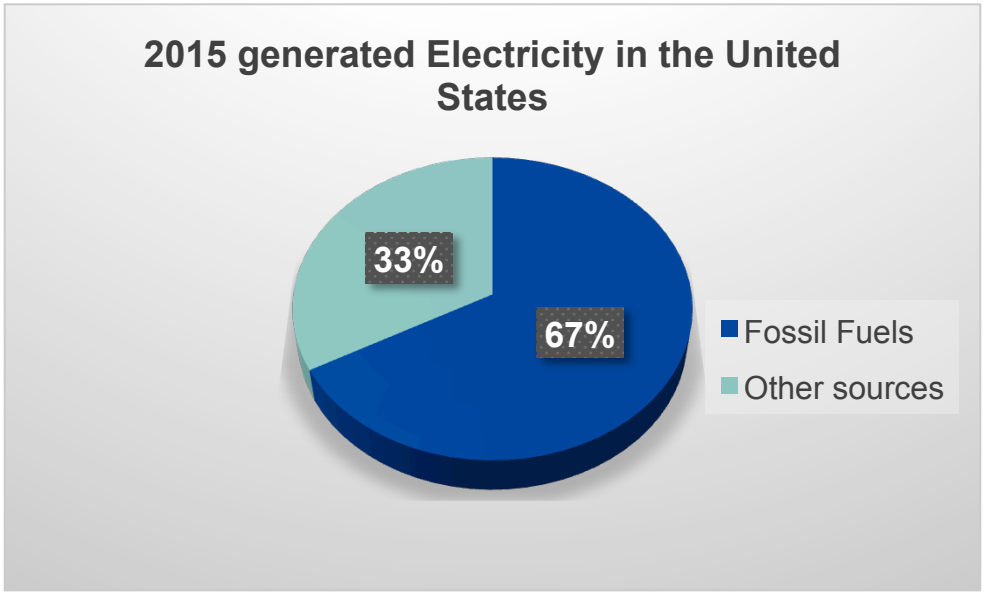
NPV alternatives:

- Payback period
- IRR→ Same formula as NPV→ Neutral NPV
- Annual cost savings
- CO2 calculation

How to calculate CO2?

In 2015, the United States **generated** about 4 trillion kilowatt-hours of **electricity**.

Source: EIA



- **Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat or steam.**

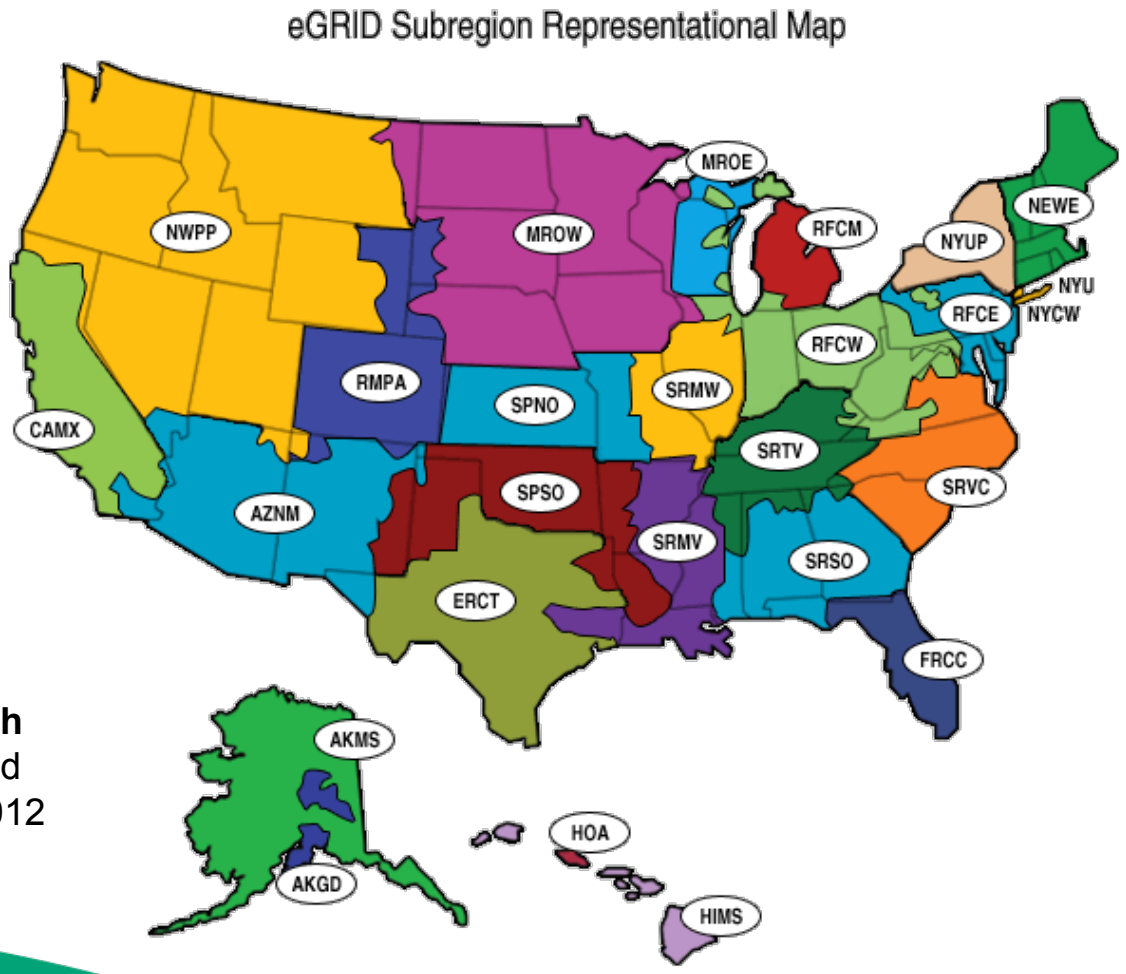
Two sets of emissions:

Market Based

Location Based

What is eGRID?

The Emissions & Generation Resource Integrated Database (eGRID) is a comprehensive inventory of environmental attributes of electric power systems.



Emission Factor
7.03 × 10^{-4} metric tons CO_2 / kWh
(eGRID, U.S. annual non-baseload CO_2 output emission rate, year 2012 data)

GREENHOUSE GAS PROTOCOL

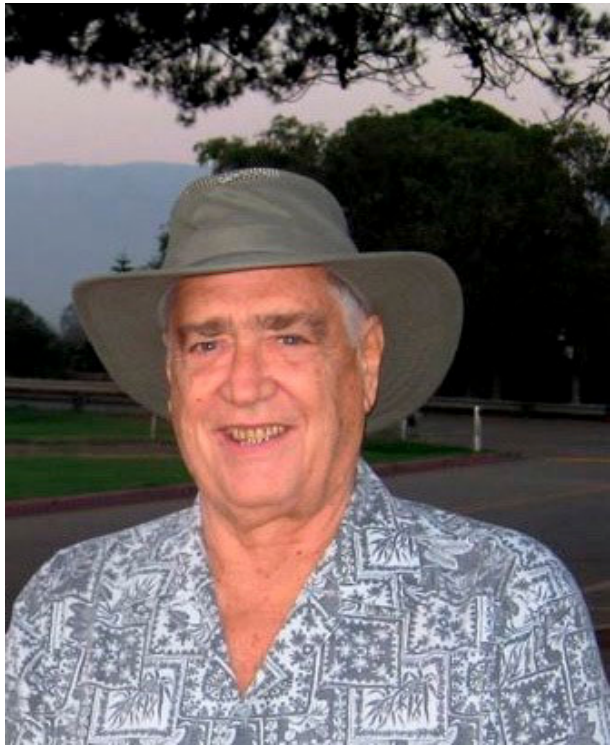
How do I calculate scope 2 emissions?

Scope 2 Emissions	=	Activity Data	x	Emission Factor
		MWh		mt CO2e/ MWh

Why Saving Energy?

Tobler's first law of geography: "**everything is related to everything else**, but near things are more **related** than distant things."

- Cost
- Carbon Footprint
- Unstable Fuel Price
- Spending in other Projects
- Climate Change
- Water Pollution
- Economy Improvement
- Quality of Life
- Security
- End of Fossil Fuel Era



Replacement of Lighting System

Linear fluorescent T8 bulb with 32 Watts of electricity consumption

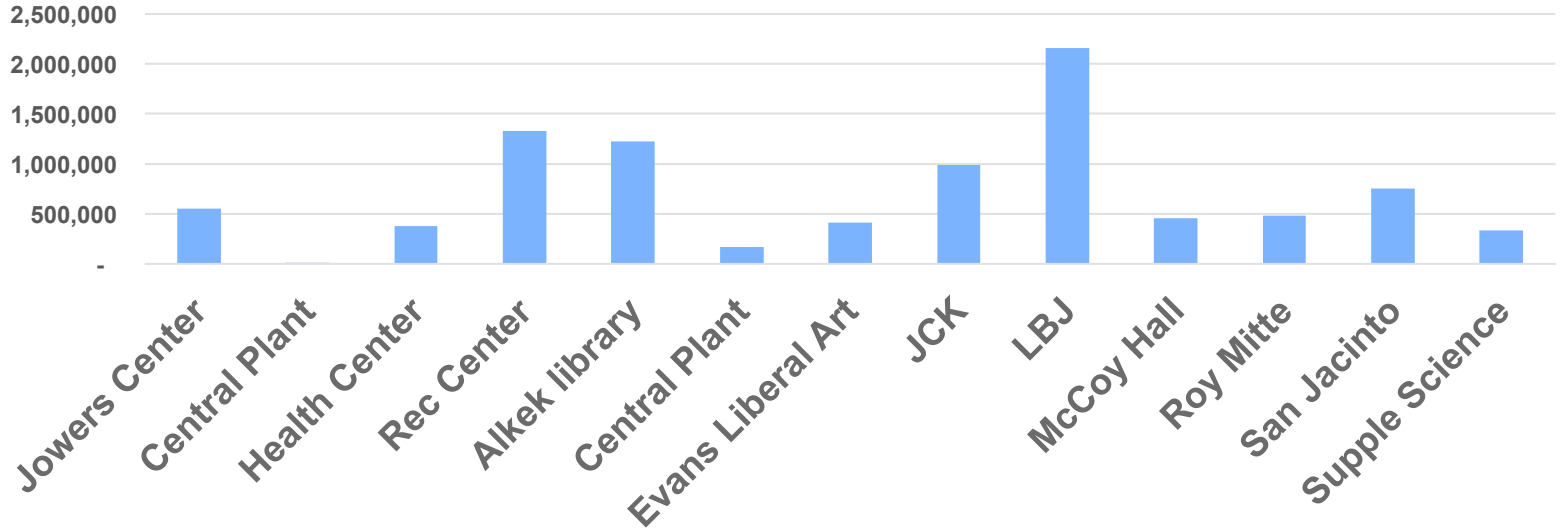
- Longer Life
- High lumens with low Watt
- Falling price in the past years: $2.50 now and $25 not long ago

Replacement of Lighting System

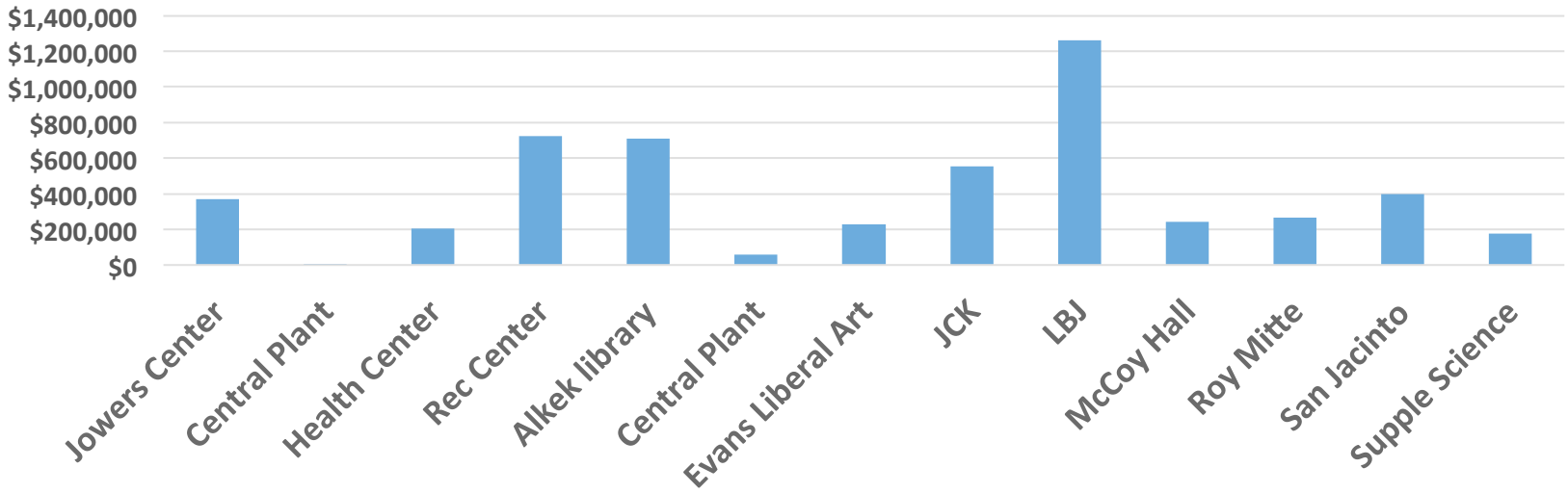
Project Details

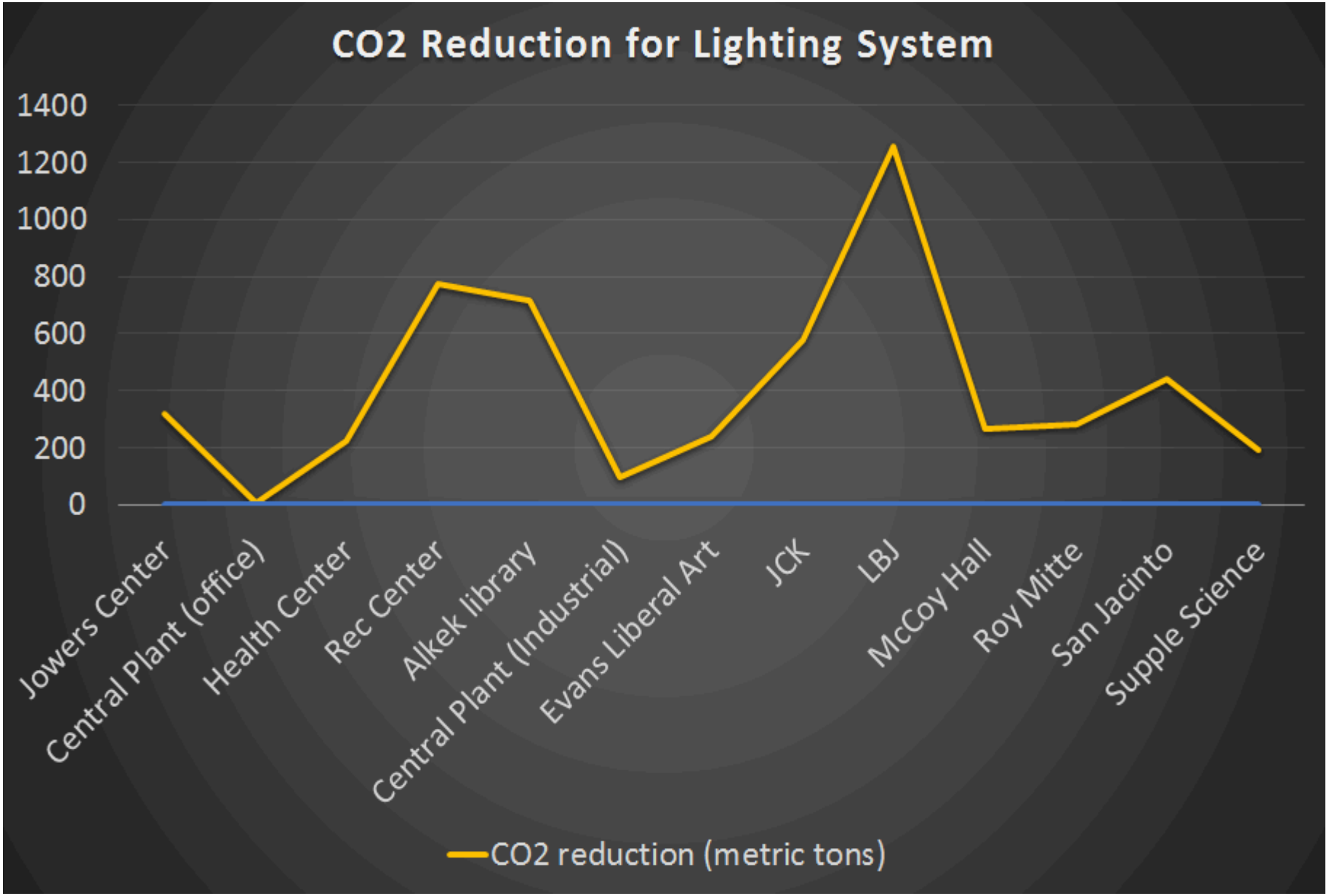
Project	NPV	Upfront Investment	Annual $ Savings	Annual kWh savings	Annual Metric Tons of CO2 reduced	Payback (yrs)
Lighting Replacement	$5,201,425	$1,916,199	$739,776	9,247,195	5,387	1.19

Lighting Replacement_Annual kWh saved



NPV_Lighting System



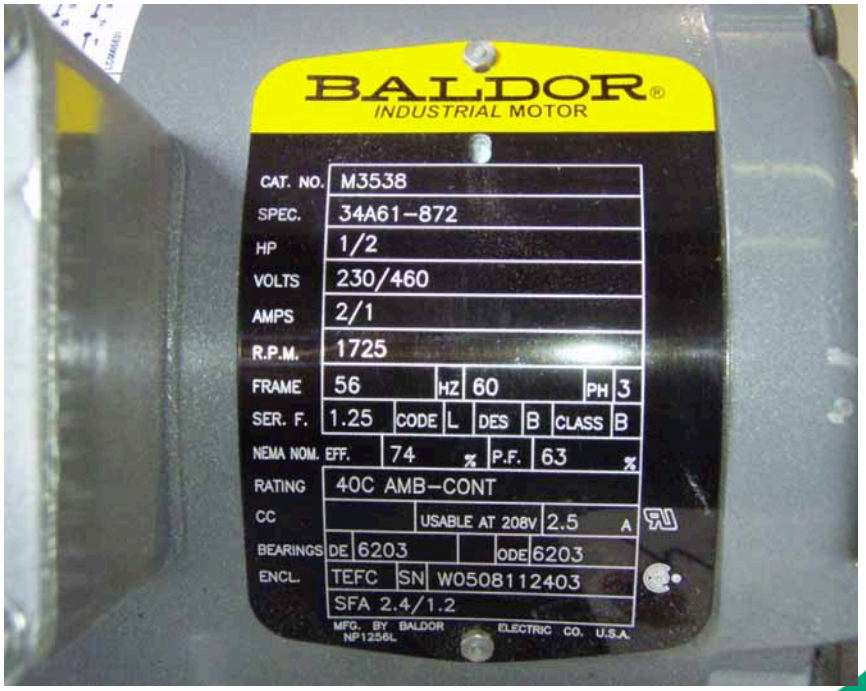

CO2 Reduction for Lighting System
1400
1200
1000
800
600
400
200
0
Jowers Center
Central Plant (office)
Health Center
Rec Center
Alkek library
Central Plant (Industrial)
Evans Liberal Art
JCK
LBJ
McCoy Hall
Roy Mitte
San Jacinto
Supple Science
CO2 reduction (metric tons)

Replacement of Motors

Basic Project Information

The majority of motors installed around the Texas State University campus exceed 90 percent of the National Electrical Manufacturers Association (NEMA) nominal efficiency at full-load capacity, which means a reasonably good performance.

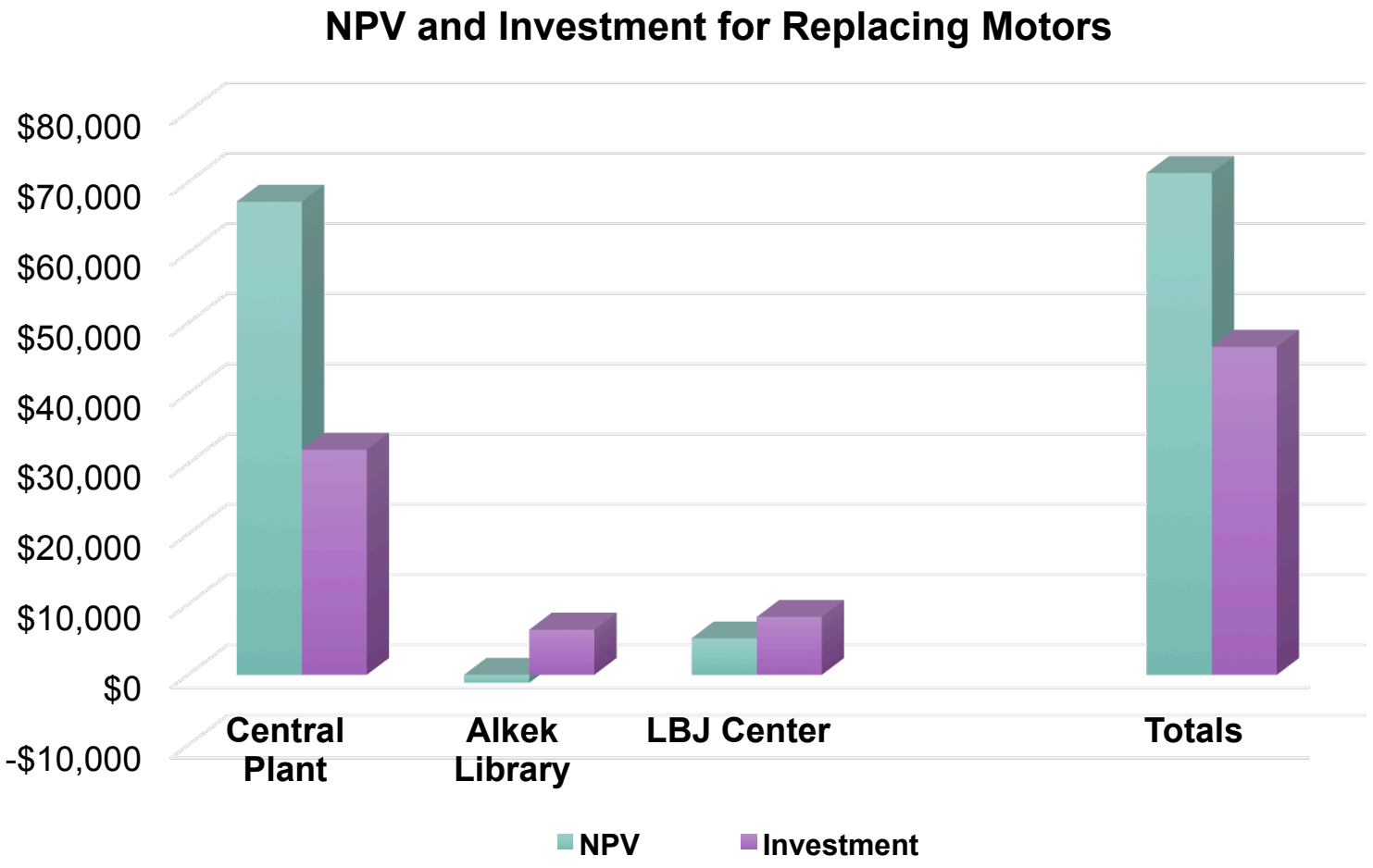
- 5.56 years of average payback
- Rewinding, repairing or replacing?
- Factors? lamination, stator…
- High duty cycle
- Possibility of a Motor Management Plan? Available history of each motor
- VFD



Replacement of Motors

Project Details

Project	NPV	Upfront Investment	Annual $ Savings	Annual kWh savings	Annual Metric Tons of CO2 reduced	Payback (yrs)
Replacement of Motors	$71,320	$46,616	$15,153	189,407	111	5.56


NPV and Investment for Replacing Motors
$80,000
$70,000
$60,000
$50,000
$40,000
$30,000
$20,000
$10,000
$0
-$10,000
Central Plant
Alkek Library
LBJ Center
Totals
NPV
Investment

Variable Frequency Drive Installation

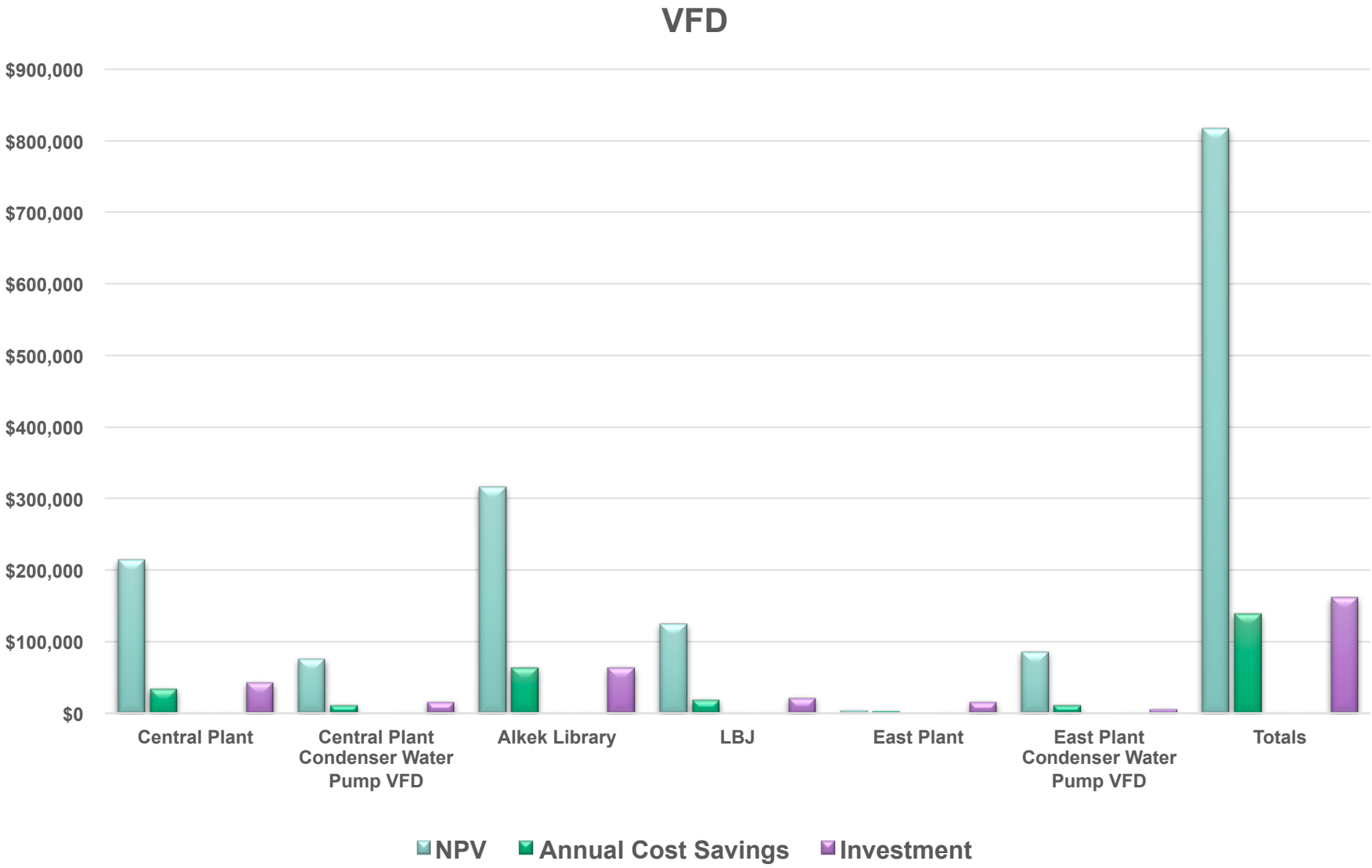
Basic Project Information

One of the best ways to meet energy efficiency measures is to apply variable frequency drives on the motors with constant speed induction. The output flow in case of fans and pumps changes in accordance with seasonal change and hours of operation of the buildings.

VFD Installation

Project Details

Project	NPV	Upfront Investment	Annual $ Savings	Annual kWh savings	Annual Metric Tons of CO2 reduced	Payback (yrs)
VFD Installation	$816,867	$161,750	$138,519	1,732,733	831	1.95


VFD
$900,000
$800,000
$700,000
$600,000
$500,000
$400,000
$300,000
$200,000
$100,000
$0
Central Plant
Central Plant Condenser Water Pump VFD
Alkek Library
LBJ
East Plant
East Plant Condenser Water Pump VFD
Totals
NPV
Annual Cost Savings
Investment

Pump Replacement

Basic Project Information

According to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), regardless of the fact that pumps have been under a scheduled maintenance plan, they are at the end of their lifespan of 15 to 20 years. Using more efficient pumps during the replacement process will be an important step in reducing energy consumption.

Pump Replacement

Project Details

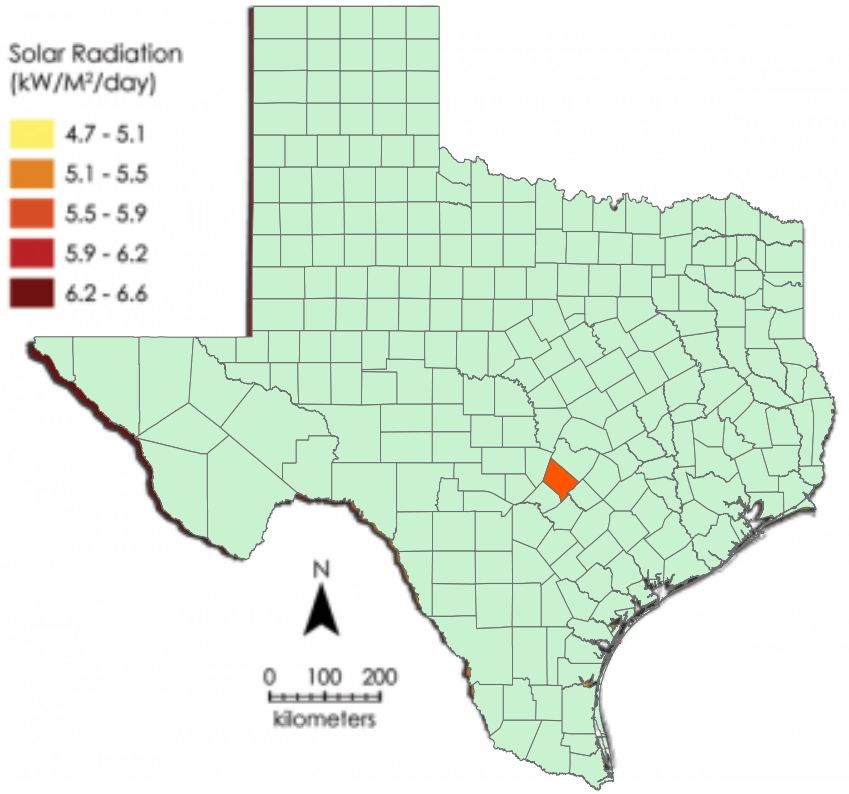
Project	NPV	Upfront Investment	Annual $ Savings	Annual kWh savings	Annual Metric Tons of CO2 reduced	Payback (yrs)
Pump Replacement	$2,529,808	$115,300	$337,655	4,220,693	2,459	0.99

Name of the Building	Annual kWh saved	NPV	Annual Cost Savings	CO2 reduction (metric tons)	Payback (year)	Investment
Central Plant	3,053,871	$1,808,995	$244,309.68	1779.00	0.32	$77,500
Alkek Library	1,020,055	$656,192	$81,604	594.00	0.08	$7,000
LBJ Center	146,767	$64,621	$11,741	86.00	2.58	$30,800
Totals	4,220,693	$2,529,808	$337,655	2459.00	2.98	$115,300

Solar Panels Installation

The average cost of electricity purchased from the local utility is **$0.08** per kWh.

- **How much it will cost in case of self production?**



- No rebate
- Municipal utility
- Long payback
- Largest investment
- Largest and most effective CO_2 reduction

Solar Panel Installation

Project Details

Project	NPV	Upfront Investment	Annual $ Savings	Annual kWh savings	Annual Metric Tons of CO2 reduced	Payback (yrs)
Solar Panel Installation	$1,495,143	$7,434,000	-	-	2,926	8.5

Results:Total Potential Impact for Texas State University

Total Energy Savings

Total Investment	**$12,173,865**
Annual kWh Savings	**15,391,436**
NPV	**$13,217,848**
CO2 emissions avoided:	**12,561 metric tons**

1,231,314 $

Significant Emission Reduction

12,561

This is equivalent to:

- 2,653 cars on the road each year
- 30,104,391 miles driven
- 1,413,413 gallons of gasoline consumed
- 100 acres of U.S forests preserved

Next Steps for Texas State University

Recommended Next Steps

Texas State University should consider projects that offer a quick payback, have a low initial investment, or high net present value. These projects are most likely to meet approval and implementation without disrupting existing budgetary considerations.

- Pumps
- Lighting
- Motors
- VFD

Recommended Next Steps

Action Plan & Timeline

Medium term (6 months-2 year) implementation

- Pump Replacement
- Lighting System Replacement
- Variable Frequency Drive
- Motor Replacement
- Condensate Recovery

Long term (3 – 5 years) implementation

- On-Site Solar Panels Installation

Thank you!

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https://drive.google.com/file/d/0B2hyHg1lMHN1dkJfLV9iVGxIV0k/view?usp=sharing

Project Overview