Client Meeting Agenda

Topic: ME 476C Team Client Meeting

Friday March 15th, 2024
~7:30am-8:30am

Meeting called by: Dr. Tom Acker

Attendees: Janelle, Courtney, Aaron, Steven, Maciej and Dr. Tom Acker

7:30am-7:40am	Presentation of Roles and Schedule • Report 1 Topics • Website Check	Room
7:40am-8:15am	Website Discussion (Courtney and Steven) • Should we include link to SRP? Report 1 Topics Discussion • Customer Requirements • Engineering Requirements • Concept Selection	
8:15am-8:20am	• Additional Questions	
8:20am-8:30am	Next week • Analysis Memos coming up • Prototype testing plan	

Meeting Notes:
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NPV

1) Compare 2 alternatives, do nothing but pay the electric bill, can do it on an annual basis, PHX is probably in the $1000's.
2) The material product is the initial investment, maitence how many times a year does the CM need to be replaced
3) If it comes out positive it is a good product, where if it is less than it is a poor product
4) Put it in a spreadsheet, and create a NPV table
5) Compare with each design will drive what our decision for the final design will be
6) Has to save a LOT of money

7) We need to pick a lifetime for the life expectancy of the device. Not based on electricity bill because that is forever
8) I is the discount rate
9) What rate of return, what is the intrest rate on that money, the morgae rate becomes the cost of money
1) What people expect as a rate of return on the device, Find papers on discount rates
2) 8% is about what SRP's 4% is more normal
3) The NPV and internal rate of return are what we want. We need a strong internal rate of return value,
4) Discount rate is huge and important to understand in this project. We NEED to understand that

BUILT THIS FORM TO MATCH CHICO'S LCOE CALCULATOR

Green Shading = INPUT number
Yellow Shading = OUTPUT number
Orange Shading = Research
Blue Shading = Results Summary

Present Value factor = 1/(1+i)^n
Degredation factor = 1/(1+i)^(n-1)
($12,240)

Fraction avoided = 100%
SRP buyback rate Years 1-10 = $0.04 per kWh
SRP buyback rate Years 11-25 = $0.050 per kWh (assumes inflation rate of electricity for 10 years)

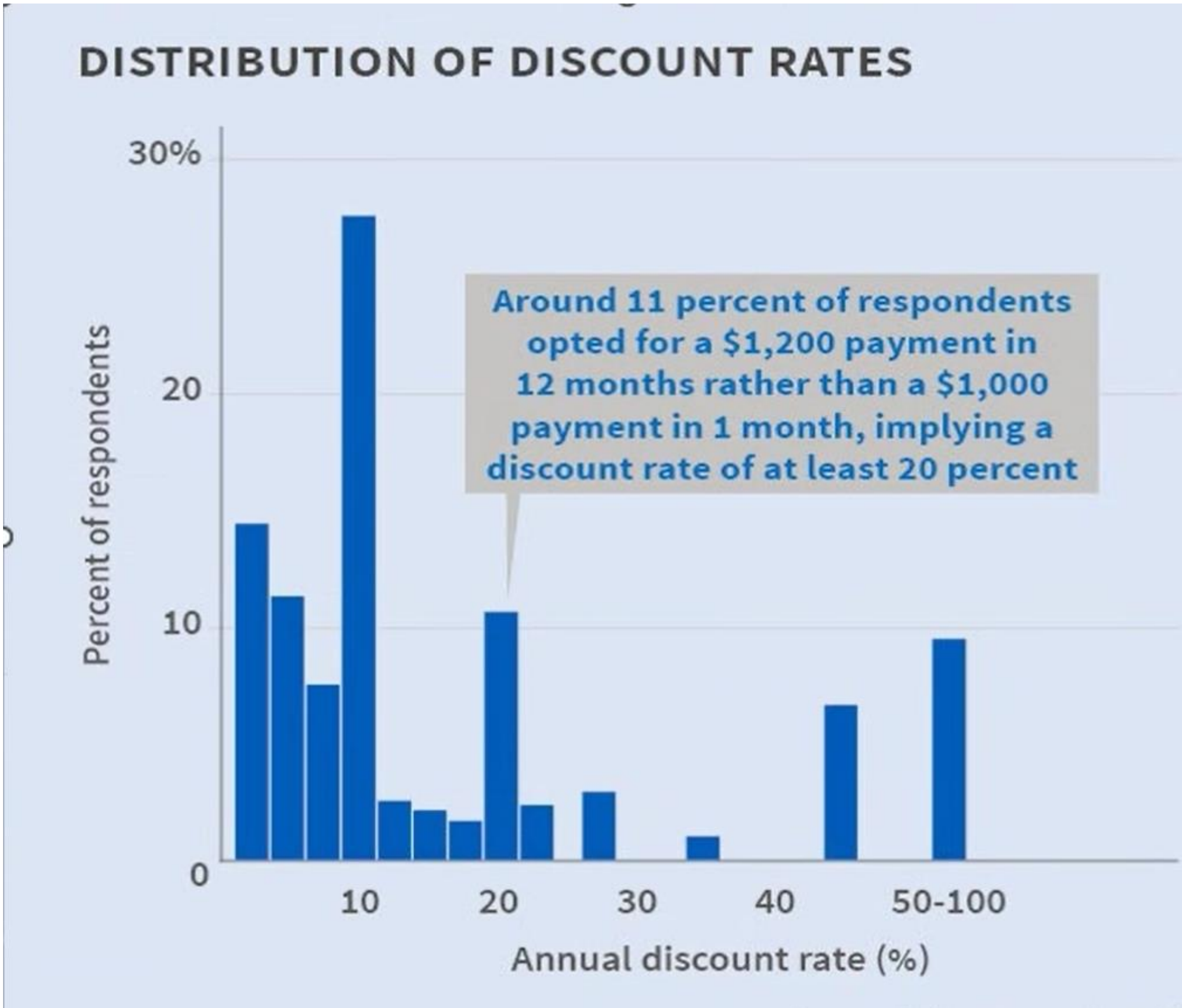
Project life =	25	yrs
Discount Rate = i =	7.52%	
Overnight Capital =	($37,800)	
ITC =	30%	
Cash value of ITC =	$11,340	
State rebate =	$1,000	
Net Investment =	($25,460)	
AC system size =	7	kW-AC
DC:AC ratio =	1.24	
DC system size =	8.7	kW DC
Installed system cost =	$5,400	/kW-AC
AC Capacity Factor =	24.0%	
DC Capacity Factor =	19.4%	
Annual energy per kW-AC =	2,102	kWh/kW-AC
Est.Ann. Energy Prod.=	14,717	kWh
Total cost =	($37,800)	
Cost after ITC & state rebate =	($25,460)	
Project life =	25	years
Discount rate =	7.52%	
LCOE =	0.165	$/kWh
Ann. Elec. Consumption =	10,000	kWh
Ave cost of electricity (elec. + tax + fees) =	$0.11	per kWh
inflation rate of electricity =	2.21%	2.21%
Degredation rate =	0.75%	per year
Total Degredation factor =	0.916	
Degredated Lifetime Energy Prod. =	336,855	
Lifetime Energy Prod. No degred.=	367,920	

Year	Present Value factor	Degredation factor	kWh Energy Prod.	kWh Discounted Energy Prod.	$/kWh Ave SRP Cost of Energy	kWh SRP avoided Energy Purchase	$ Savings on Electric Bill	kWh Energy sold to SRP	$ Revenue from SRP	kWh Energy purch. from SRP	$ Paym to S
0	1.00										
1	0.93	1.00	14,717	13,688	$0.110	10,000	$1,100	4,717	$189	0	
2	0.87	0.993	14,607	12,635	$0.112	10,000	$1,124	4,607	$184	0	
3	0.80	0.985	14,499	11,664	$0.115	10,000	$1,149	4,499	$180	0	
4	0.75	0.978	14,391	10,768	$0.117	10,000	$1,175	4,391	$176	0	
5	0.70	0.971	14,283	9,940	$0.120	10,000	$1,201	4,283	$171	0	
6	0.65	0.963	14,177	9,176	$0.123	10,000	$1,227	4,177	$167	0	
7	0.60	0.956	14,072	8,471	$0.125	10,000	$1,254	4,072	$163	0	
8	0.56	0.949	13,967	7,820	$0.128	10,000	$1,282	3,967	$159	0	
9	0.52	0.942	13,863	7,219	$0.131	10,000	$1,310	3,863	$155	0	
10	0.48	0.935	13,760	6,664	$0.134	10,000	$1,339	3,760	$150	0	
11	0.45	0.928	13,657	6,151	$0.137	10,000	$1,369	3,657	$182	0	
12	0.42	0.921	13,556	5,679	$0.140	10,000	$1,399	3,556	$177	0	
13	0.39	0.914	13,455	5,242	$0.143	10,000	$1,430	3,455	$172	0	
14	0.36	0.907	13,355	4,839	$0.146	10,000	$1,462	3,355	$167	0	
15	0.34	0.901	13,255	4,467	$0.149	10,000	$1,494	3,255	$162	0	
16	0.31	0.894	13,156	4,124	$0.153	10,000	$1,527	3,156	$157	0	
17	0.29	0.887	13,058	3,807	$0.156	10,000	$1,561	3,058	$152	0	
18	0.27	0.881	12,961	3,514	$0.160	10,000	$1,595	2,961	$147	0	
19	0.25	0.874	12,865	3,244	$0.163	10,000	$1,630	2,865	$143	0	
20	0.23	0.868	12,769	2,995	$0.167	10,000	$1,666	2,769	$138	0	
21	0.22	0.861	12,674	2,765	$0.170	10,000	$1,703	2,674	$133	0	
22	0.20	0.855	12,580	2,552	$0.174	10,000	$1,741	2,580	$128	0	
23	0.19	0.848	12,486	2,356	$0.178	10,000	$1,779	2,486	$124	0	
24	0.18	0.842	12,393	2,175	$0.182	10,000	$1,819	2,393	$119	0	
25	0.16	0.836	12,301	2,008	$0.186	10,000	$1,859	2,301	$115	0	

LCOE = Investment / (discounted energy production)
LCOE = 0.165 $/kWh
Discount Rate = i = 7.52%

Ann. Produciton with degredation = 336,855 | 153,962 = discounted energy production
Ann. Production no degredation = 367,920 | 142,106 = discounted energy over 20 YEARS ONLY
Total Degredation factor = 0.916 | 124,422 = discounted energy over 15 YEARS ONLY

ethod of selecting discount rate -->	Climate	15-yr Mort	Energy Star	Hi 30-yr Mort	Chico	S&P 500
	Acker 0%	**Acker 4%**	**Acker 5%**	**Acker 7%**	**Acker 8%**	**Acker 11%**
Installed system cost ($/kW-AC)=	$4,282	$4,282	$4,282	$4,282	$4,282	$4,282
Capacity factor =	19.1%	19.1%	19.1%	19.1%	19.1%	19.1%
energy per kW-AC (kWh/kW-AC) =	1,673	1,673	1,673	1,673	1,674	1,673
System size (kW-AC)=	10.75	10.75	10.75	10.75	10.75	10.75
Est.Ann. Energy Prod.=	17,986	17,986	17,986	17,986	18,000	17,986
Total cost =	($46,032)	($46,032)	($46,032)	($46,032)	($46,027)	($46,032)
Cost after ITC & state rebate =	($31,222)	($31,222)	($31,222)	($31,222)	($31,219)	($31,222)
LCOE ($/kWh) =	**0.074**	**0.117**	**0.129**	**0.155**	**0.169**	**0.213**
Discount Rate =	0%	4%	5%	7%	8%	11%
NPV =	$55,672	$21,189	$15,667	$6,934	$4,676	($4,411)
IRR =	**9.2%**	**9.2%**	**9.2%**	**9.2%**	**10.1%**	**9.2%**
Project life (years) =	25	25	25	25	25	25


DISTRIBUTION OF DISCOUNT RATES
30%
20
10
0
Percent of respondents
Around 11 percent of respondents opted for a $1,200 payment in 12 months rather than a $1,000 payment in 1 month, implying a discount rate of at least 20 percent
10
20
30
40
50-100
Annual discount rate (%)


NPV @ i = ($8,747)
IRR = 3.5%
Project life = 25 years
(20 year LCOE =) 0.179 $/kWh
(15 year LCOE =) 0.205 $/kWh
S&P 500 Average Annual Return past 30 years
Period (start-of-year to end-of-2023) Average annual S&P 500 return
5 years (2019-2023) 15.36%
10 years (2014-2023) 11.02%
15 years (2009-2023) 12.63%
20 years (2004-2023) 9.00%
25 years (1999-2023) 7.18%
30 years (1994-2023) 9.67%
https://www.nerdwallet.com/article/investing/average-stock-market-return
Choose ~11%
Average 15-year Mortgage Rates (Fed. Reserve)
Week ending 2/8/2024
5-year average = 3.84
10-year average = 3.58
15-year average = 3.61
20-year average = 4.12
25-year average = 4.59
30-year average = 5.04
https://fred.stlouisfed.org/series/MORTGAGE15US
Choose ~4%
Average 30-year Mortgage Rates (Fed. Reserve)
Week ending 2/8/2024 6.64
5-year average = 4.47
10-year average = 4.26
15-year average = 4.29
Discount rate for Energy Efficiency purchases
11% https://www.nber.org/digest/jun15/individual-discount-rates-and-energy-efficient-purchasing
https://www.nber.org/papers/w20969
Half below and half above this threshold (11%), depending on many factors (e.g., higher education, lower rate) -->
5% Typical in government regulatory analysis
https://www.nber.org/system/files/working_papers/w20969/w20969.pdf
FRED — 15-Year Fixed Rate Mortgage Average in the United States
Percent
2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
Shaded areas indicate U.S. recessions.
Source: Freddie Mac
fred.stlouisfed.org

Website

Add a page and link to SRP's public landing page

Decision Matrix
Internal rate of return are key factors in anything
Ideas that have a negative NVP they are not going to be considered. PERIOD
Comfort level- will it keep the house cool and help with the load
Ease of Maintenace and operating cost
Load and power saving are the same thing
Split the new build and existing- and do what calculations we need for the product, which market are we planning on doing. He wants us to pick based on the ideas we have. He wants us to go with based on what we are enthusiastic about. Based on the NVP for each

Reject number- If it rates below a number, we just don't do it

Final Design
We need to do the thermal analysis if we are taking out the refrigerant, if not we just need to find the heat being dissipated from the line
We are taking the
2 choices take the cold air the other take the refrigerant
Think of a freezer

Micro PCM panel

If we put the PCM directly into a device like courtneys, if we could use the PCM
Steven's overall is a simplified model of everything
How are we storing it? How do we cool the air down?
Compressor only compresses gases not liquid
We can buy a cheap AC device and take it apart for parts
Vent refrigerant and then how to load it back into the system
There is an HVAC person on campus who can do it for us, we need an HVAC professional to do that for us
If we cut into the lines we need an HVAC person
If we make our own we need someone to help us

Material Analysis
This is a great start

The 12 kw AC find out what the typical AC load is i a house
It is basically saying how much ice can it freeze in an hour
Everyone needs to calculate the efficiency for each part of the design
What is the efficiency of this unit
We can do a CFD model on this, but we can do first law and heat transfer calculations
Compare basic battery storage with our device

2 analysis
Financial NVP analysis on each device
We each have a device and we need to run a heat transfer analysis on each portion. When we are releasing the heat and when we are recharging the device. Each needs a thermal analysis, using the first law of thermodynamics, and heat exchanger
Refrigerant cycle analysis