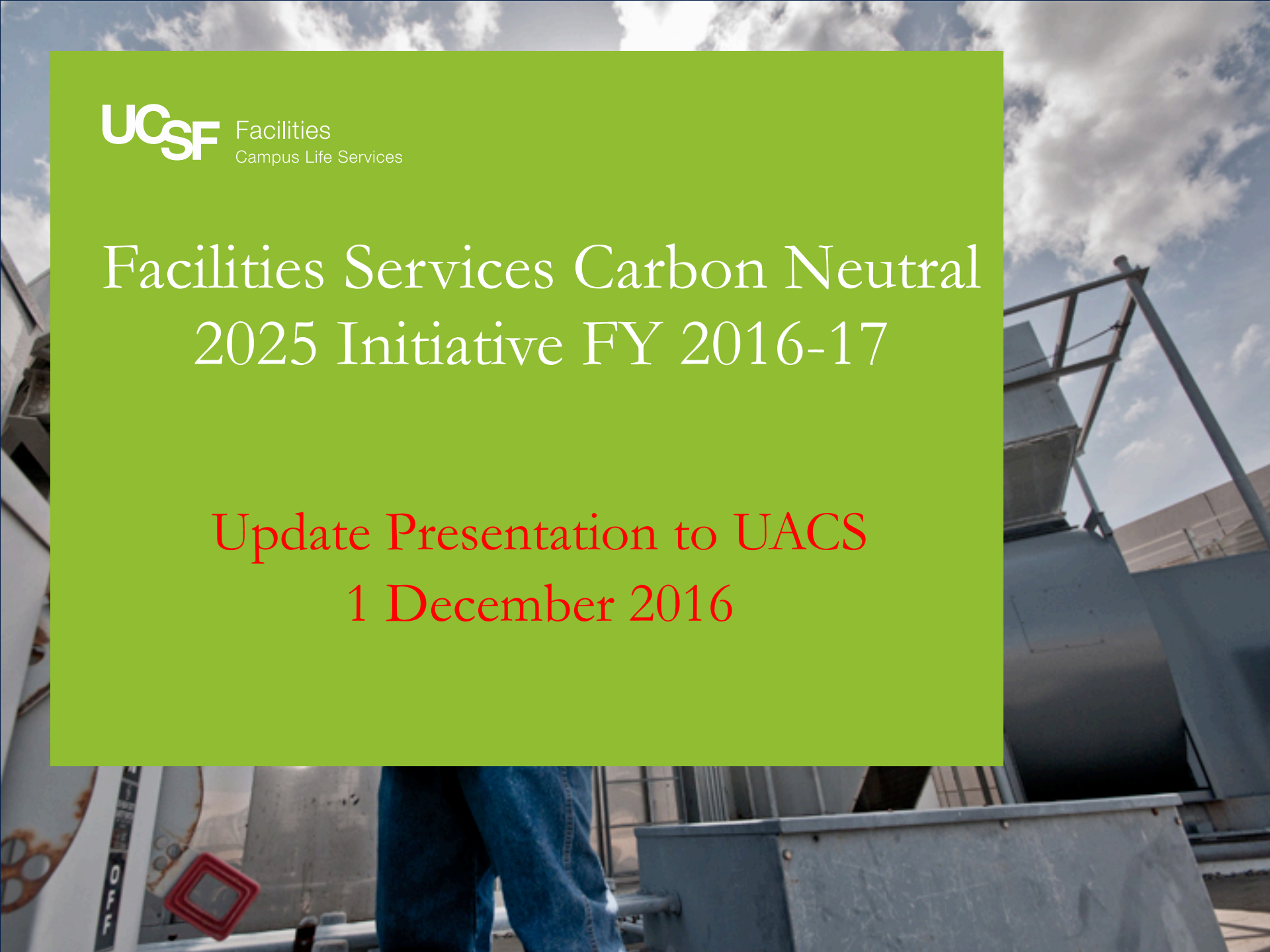
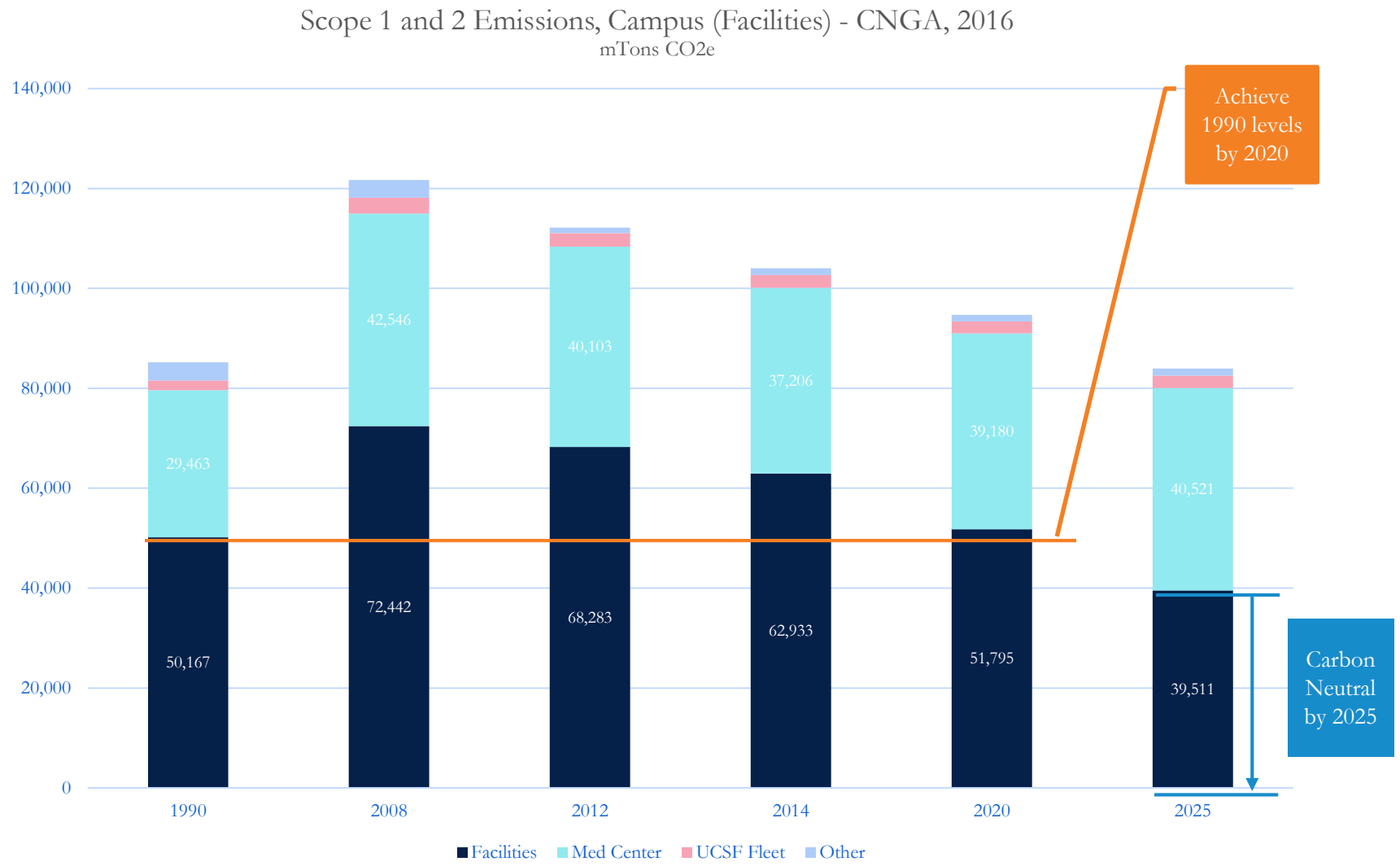


UCSF Facilities
Campus Life Services

Facilities Services Carbon Neutral 2025 Initiative FY 2016-17

Update Presentation to UACS
1 December 2016

PERFORMANCE AGAINST GOALS – CAMPUS PERSPECTIVE



UCSF Facilities
Campus Life Services

Facilities Services Carbon Neutral 2025 Initiative FY 16-17

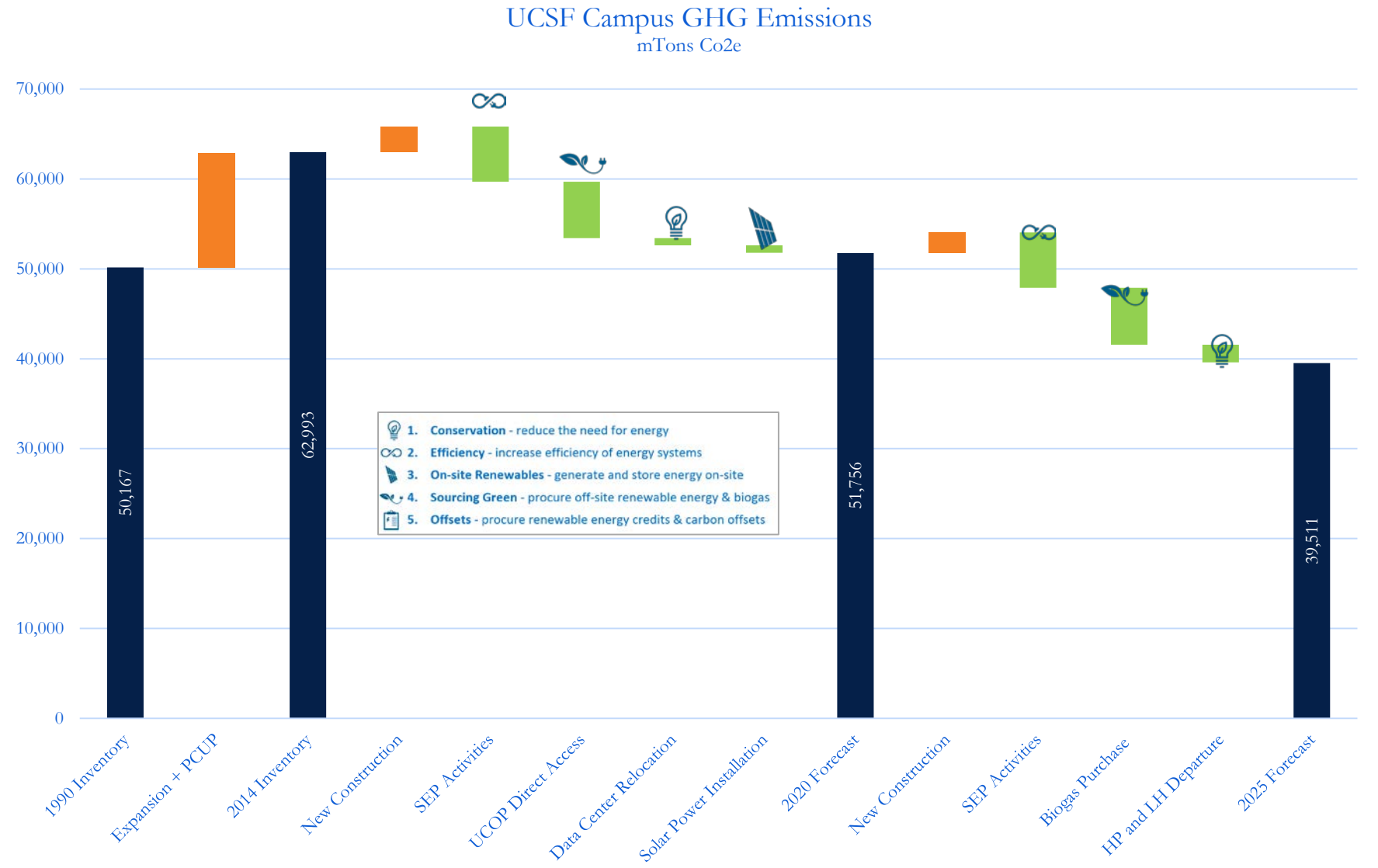
Quarter 1	Quarter 2	Quarter 3	Quarter 4

- Identify and list all potential carbon reduction strategies based on charrette results
- Conduct preliminary feasibility analysis

- Provide input to CCP*
- Document findings in Carbon Neutrality Roadmap

* 10-Year Comprehensive Capital Plan

PLANNED UCSF CAMPUS CARBON REDUCTION STRATEGIES – 2014 to 2025



Scenario comparison
Average costs and emissions reductions for Parnassus - Gensler 2016

	Scenario 1			Scenario 2			Scenario 3		
	CapEx ($M)	OpEx* ($K / year)	Reductions* ($MtCO_2e$ / year)	CapEx ($M)	OpEx* ($K / year)	Reductions* ($MtCO_2e$ / year)	CapEx ($M)	OpEx* ($K / year)	Reductions* ($MtCO_2e$ / year)
Operations Shift planned activity shift to Mission Bay	-	-	2,202	-	-	2,202	-	-	2,202
Occupant Engagement education, incentives and monitoring	$1-2M	$5-10K	1,704	$1-2M	$5-10K	1,589	$1-2M	$5-10K	1,386
Energy Efficiency HVAC, lighting and envelope retrofits	$16-66M	-	4,606	$25-50M	-	6,909	$35-75M	-	11,515
New buildings energy codes and standards	-	-	1,750	3-5% per sf	-	2,297	5-10% per sf	-	2,188
Central Energy / Cogeneration upgrades to district energy system	$10-20M	-	3,039	$50-100M	-	8,754	$100-200M	-	12,303
On-site Solar install solar photovoltaic capacity	$9-11M	$45-55K	210	$18-22M	$90-110K	419	$18-22M	$90-110K	419
Total cost of carbon reduction initiatives	$35-100M	$50-65K /yr	13,511	$95-175M	$95-120K /yr	22,170	$155-300M	$95-120K /yr	30,012
UC Direct Access procure off-site carbon-free electricity	-	$2,200K	2,130	-	$2,200K	2,130	-	$2,200K	2,130
Biogas procure wastewater or landfill biogas	-	-	0	-	-	3,146	-	-	0
Credits / offsets purchase RECs first, then carbon offsets	-	$750K	31,119	-	$280K	19,315	-	$720K	14,618
Utilities cost of natural gas & grid electricity	-	$10,300K	-	-	$6,000K	-	-	$9,600K	-
Estimated cost of utilities, credits and offsets	-	$13,300K /yr	33,249	-	$8,500K /yr	24,590	-	$12,500K /yr	16,748

***Averages over a 35 year period**

Strategies Analysis for Facilities Services

Area	1st Cost	CO2 Savings (Mtonnes/ year)	1st Cost $ per Mtonne Reduction	10-Year Operating Costs (savings)	Total 1st Costs + 10-Year Operating Costs	Net Costs $ per Mtonne Reduction
Energy Efficiency	$16-$75M	4,600 – 11,500	$3,500 - $6,500	($14-$55M)	$2-$20M	$500-$1200
Central Energy/ Cogeneration	$10 - $200M	3,000 – 12,300	$3,300 - $16,300	unk	unk	unk
On-Site Solar*	$9 - $22M	210 - 420	$42,900 - $52,500	neutral	neutral	$0
Energy and Offset Procurement Options		15,000 – 31,000		$25 - $30M	$25 - $30M	$960 - $1,300

* Decision to pursue 3rd party owned and operated solar projects

Facilities Services Strategies

1 – Implement aggressive energy efficiency

2 – Flesh out further Central Plant Options to understand investment per mtonne of carbon reduction.

3 – Seek opportunities for low or now cost 3rd Party solar PV projects

4 – Seek low cost offsets and renewable energy credits

Energy Efficiency Strategies

Lab Improvements:

- Air change reductions where possible
- Exhaust velocity based on actual wind conditions
- Lab equipment change outs

Deep HVAC Improvements

- Better controls
- Change out of Mechanical Systems

Deep Lighting Improvements

- LED lighting retrofits
- Occupancy sensors and other controls
- Bi-level Lighting for corridors

Parnassus Central Plant Technical Options

- **Option 1 - Shut Down Cogen Plant:** Utilize existing standby boilers to provide steam, continue steam turbine in service to reduce pressure and provide some level of electrical generation.
- **Option 2 – Shut down 1 Turbine:** Remove 1 GTG/HRSG from service. Utilize standby boiler to provide steam when required and steam turbine to step steam pressure down.
- **Option 3 – Convert Steam Distribution System to HHW**: Generate HHW at PCUP and distribute to Parnassus buildings. Remove steam distribution system and install local steam generators at buildings requiring steam service (MSB, HSIR, SOD, Koret, Moffit/Long, ACC, PSSRB)
- Option 3a – Fuel Cell with natural gas fired HHW boiler
- Option 3b – Heat Recovery Chiller generator with natural gas fired HHW boiler
- Option 3c – Electric HHW Boiler
- **Option 4 – Convert building HHW to local electric boilers:** Keep steam distribution system for process steam, generate HHW at buildings using electric boilers.
- **Option 5 – Hybrid:** Retain 1 GTG, provide makeup steam/HHW with electric/waste heat recovery system.

Pros and Cons of Parnassus Central Plant Options

Option	Pros	Cons
1. Shut Down PCUP	• Significantly reduce carbon emissions	• Significantly reduced reliability • Significantly reduced efficiency (no longer use waste heat)
2. Shut down 1 Turbine at PCUP	• Cut carbon emissions by almost 1/2	• Reduced reliability • Reduced efficiency
3. Convert Steam to Heating Hot Water	• Eliminate steam losses • Maximize use of new technologies	• High first cost • Difficulty in running new HHW piping throughout Parnassus
4. Electric Boilers	• Can use 100% renewable electricity	• Extremely high first costs and op costs • Need 3x electric capacity from PG&E as current

Mission Bay Options

- **Business as Usual:** PUP equipment remains in place and continues to serve existing load. New buildings are hooked into steam and CHW system, but have local HHW boilers fueled with Natural Gas.
- **Option 1 – Install central plant with cogeneration:** design central heating/cooling/steam plant with gas fired technologies to produce electricity for the campus.
- Option 1a – utilize fuel cells to produce electricity
- **Option 2 – Local Electric HHW generators:** Continue to utilize PUP/Rock Hall for steam generation. Install electric boilers in each building for HHW generation
- **Option 3 – Heat Recovery Chillers:** Install Heat Recovery chillers at PUP/CUP for portion of HHW load
- Option 3a – utilize gas fired boilers for makeup HHW load not provided by heat recovery chillers
- Option 3b – utilize electric boilers for makeup HHW load not provided by heat recovery chillers
- Option 3c – install thermal energy storage for both HHW and CHW

Pros and Cons of Mission Bay Central Plant Options

Option	Pros	Cons
1. Install central plant with cogeneration	• Improve campus reliability and efficiency	• Significantly increase carbon emissions
2. Local Electric HHW generators	• Can use 100% renewable electricity	• Extremely high first costs and op costs • Need 3x electric capacity from PG&E as current
3. Heat Recovery Chillers	• Use waste heat from chillers – highly efficient	• Unclear whether there is enough heating and cooling loads at same time

NEXT STEPS

- Flesh out Central Plant Options
- Present to Capital Programs Steering Committee as informational item
- Request placeholder on 10-year Capital Plan