Subcommittee Process Technology Overview Commercial Refrigeration

AYAD AL-SHAIKH

JULY 2017

Information Sources

- Savings Data:
  - EEStats, 2016 CA IOU data (portfolio level data)
  - Claims, 2016 CA IOU data (deemed savings)
- Workpaper Information:
  - Posted at DropBox Library:
    - https://www.dropbox.com/sh/h25894esz33uvqt/AAASz5OBr72-D4klmRYOYDFia?dl=0
  - POU TRM (posted in DropBox library)
  - Ex Ante Table consolidation

Technology Overview Contents

- Savings Perspective
  - Slides 4 – 8
- “Technology Summary File” Explanation
  - Slides 10 – 18
- Cross Cutting Issues
  - Slides 19 – 20
- Framing of Savings Issues
  - Slides 21 – 68
  - Blue Text = POU differences
  - Red Text = Items needing subcommittee judgement

Commercial Refrigeration Savings Perspective

Category		Energy (kWh/yr)
Lighting	68%	616,618,770
HVAC / Motors	13%	
Agr / Pumps	5%	
Whole Building	4%	
Appl or Plug Load	3%	
Com Refrigeration	3%	
Pools	3%	
Food Service	0.4%	
Bldg Envelope	0.2%	
Water Heating	0.2%	
Total:		*911,794,869*

Category		Energy (therms/yr)
Lighting	-139%	
HVAC / Motors	31%	1,
Agr / Pumps	0%	
Whole Building	0%	
Appl or Plug Load	9%	
Com Refrigeration	8%	
Pools	10%	
Food Service	46%	2,2
Bldg Envelope	19%	
Water Heating	117%	5,900,737
Total:		*5,048,002*

Commercial Refrigeration Savings Perspective

CALIFORNIA TECHNICAL FORUM

Ref No	Name	Total No of Units	Energy (kWh/yr)
1.01	Anti-Sweat Heater (ASH) Controls	21,570	5,022,366
1.02	Anti-Sweat Heater Display Doors	2,424	1,539,951
1.03	Evaporator Fan Motors	1,397	524,845
1.04	Refrigerated Storage Auto Closer	1,760	3,731,458
1.05	Walk-in Cooler Evaporative Fan Cycling an	1,854	1,285,285
1.06	Refrigeration Head Pressure Controls	3,330	2,429,104
1.07	Refrigeration Night Covers	4,134	153,634
1.08	Bare Refrigeration Line Insulation	1,028	42,398
1.09	Add Doors to Walk-in Cooler	433	304,913
1.1	Compressor Retrofit: Multiplex	54	191,502
1.11	Display Case ECM Motor Retrofit	1,023	722,109
1.13	Efficient Condenser: Multiplex	350	197,666
1.14	Floating Head Pressure - Single Compresso	214	101,384
1.15	Low Temp Coffin to Reach-In	269	850,046
1.16	Medium Temp Open Case Retrofit	1,771	215,188
1.17	Display Cases with Doors	4,012	4,896,771
1.18	Add Med Temp Case Doors	5,433	2,575,884
			24,784,503

Category		Energy (kWh/yr)
Lighting	68%	616,618,770
HVAC / Motors	13%	
Agr / Pumps	5%	
Whole Building	4%	
Appl or Plug Load	3%	
Com Refrigeration	3%	
Pools	3%	
Food Service	0.4%	
Bldg Envelope	0.2%	
Water Heating	0.2%	
Total:		*911,794,869*

Category		Energy (therms/yr)
Lighting	-139%	
HVAC / Motors	31%	1
Agr / Pumps	0%	
Whole Building	0%	
Appl or Plug Load	9%	
Com Refrigeration	8%	
Pools	10%	
Food Service	46%	2,2
Bldg Envelope	19%	
Water Heating	117%	5,900,737
Total:		*5,048,002*

Commercial Refrigeration Measure Overview

Ref No	Name	Total No of Units	Energy (kWh/yr)
★ 1.01	Anti-Sweat Heater (ASH) Controls	21,570	5,022,366
★ 1.02	Anti-Sweat Heater Display Doors	2,424	1,539,951
★ 1.03	Evaporator Fan Motors	1,397	524,845
★ 1.04	Refrigerated Storage Auto Closer	1,760	3,731,458
★ 1.05	Walk-in Cooler Evap Fan Cycling and VFD Control	1,854	1,285,285
★ 1.06	Refrigeration Head Pressure Controls	3,330	2,429,104
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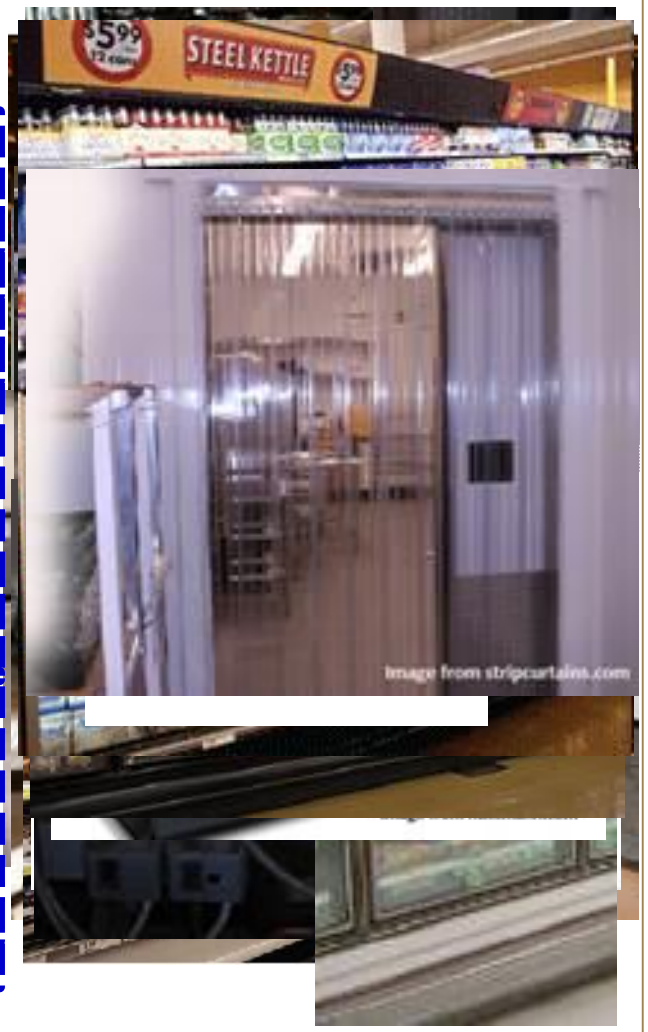
1.09	Add Doors to Walk-in Cooler	433	304,913
1.10	Compressor Retrofit: Multiplex	54	191,502
1.11	Display Case ECM Motor Retrofit	1,023	722,109
1.12	Efficient Condenser: Air Cooled to Evap		
1.13	Efficient Condenser: Multiplex	350	197,666
1.14	Floating Head Pressure - Single Compressors	214	101,384
1.15	Low Temp Coffin to Reach-In	189	723,509
1.16	Medium Temp Open Case Retrofit	1,310	191,522
★ 1.17	Display Cases with Doors	4,092	5,023,308
★ 1.18	Add Med Temp Case Doors	5,433	2,575,884
★ 1.19	Adaptive Refrigerator and Freezer Controls Comm		
1.20	Strip Curtain Infiltration Barrier for Refrig Space		
		50,596	**24,760,837**



Establishing Level of Effort

50% of Measures = 90% of Savings

CALIFORNIA TECHNICAL FORUM

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Ref No	Measure Name	Unit	No of Units	Energy (kWh/yr)
1.01	Anti-Sweat Heater (ASH) Controls	LEN-FT	21,570	5,022,366
1.02	Anti-Sweat Heater Display Doors	Each	2,424	1,539,951
1.03	Evaporator Fan Motors	Each	2,632	1,102,402
1.04	Refrigerated Storage Auto Closer	Each	1,760	3,731,458
1.05	Walk-in Cooler Evap Fan Cycling and VFD Control	Each	619	707,728
1.06	Refrigeration Head Pressure Controls	Cap-Tons	3,330	2,429,104
1.07	Refrigeration Night Covers	LEN-FT	4,382	156,654
1.08	Bare Refrigeration Line Insulation	LEN-FT	1,028	42,398
1.09	Add Doors to Walk-in Cooler	LEN-FT	433	304,913
1.10	Compressor Retrofit: Multiplex	Cap-Tons	54	191,502
1.11	Display Case ECM Motor Retrofit	Each	1,023	722,109
1.13	Efficient Condenser: Multiplex	Cap-Tons	350	197,666
1.14	Floating Head Pressure - Single Compressors	RATED-HP	214	101,384
1.15	Low Temp Coffin to Reach-In	LEN-FT	189	723,509
1.16	Medium Temp Open Case Retrofit	LEN-FT	1,522	212,169
1.17	Display Cases with Doors	LEN-FT	4,092	5,023,308
1.18	Add Med Temp Case Doors	LEN-FT	5,433	2,575,884
1.22	Commercial Reach-In Refrigerators and Freezers	Each	6,085	5,122,656
			57,141	**29,907,159**

ASH Controls

Auto-Door Closer
Walk-in Cycling Controls
Head Pressure Controls

Low Temp Coffin Upgrade

Display Case Doors
Reach-In Refrig/Freezers

Statewide Approach - New Opportunities

CALIFORNIA TECHNICAL FORUM

		PGE		SCE		SDGE		Total	
Ref No	Name	No of Units	Energy (kWh/yr)	No of Units	Energy (kWh/yr)	No of Units	Energy (kWh/yr)	No of Units	Energy (kWh/yr)
1.01	Anti-Sweat Heater (ASH) Controls	3,590	1,131,559	3,498	805,009	14,482	3,085,798	21,570	5,022,366
1.02	Anti-Sweat Heater Display Doors	281	176,237	2,143	1,363,714			2,424	1,539,951
1.03	Evaporator Fan Motors	2,320	1,063,168	312	39,233			2,632	1,102,402
1.04	Refrigerated Storage Auto Closer	698	1,718,494	759	1,975,281	303	37,683	1,760	3,731,458
1.05	Walk-in Cooler Evap Fan Cycling and VFD Control	609	704,988	10	2,741			619	707,728
1.06	Refrigeration Head Pressure Controls	2,323	1,699,343	1,007	729,761			3,330	2,429,104
1.07	Refrigeration Night Covers	2,380	38,615	1,754	115,019	249	3,019	4,382	156,654
1.08	Bare Refrigeration Line Insulation			800	41,608	228	791	1,028	42,398
1.09	Add Doors to Walk-in Cooler	433	304,913					433	304,913
1.1	Compressor Retrofit: Multiplex	54	191,502					54	191,502
1.11	Display Case ECM Motor Retrofit	1,023	722,109					1,023	722,109
1.13	Efficient Condenser: Multiplex	350	197,666					350	197,666
1.14	Floating Head Pressure - Single Compressors	214	101,384					214	101,384
1.15	Low Temp Coffin to Reach-In	189	723,509					189	723,509
1.16	Medium Temp Open Case Retrofit	1,310	191,522			212	20,647	1,522	212,169
1.17	Display Cases with Doors	2,347	2,795,121	1,665	2,101,651	80	126,537	4,092	5,023,308
1.18	Add Med Temp Case Doors	3,700	1,728,467	1,733	847,417			5,433	2,575,884
1.22	Commercial Reach-In Refrigerators and Freezers	5,876	4,933,367	128	119,378	81	69,911	6,085	5,122,656
			18,421,963		**8,140,810**		**3,344,386**		**29,907,159**

Increase outreach / consider different approach.

Create new offerings.

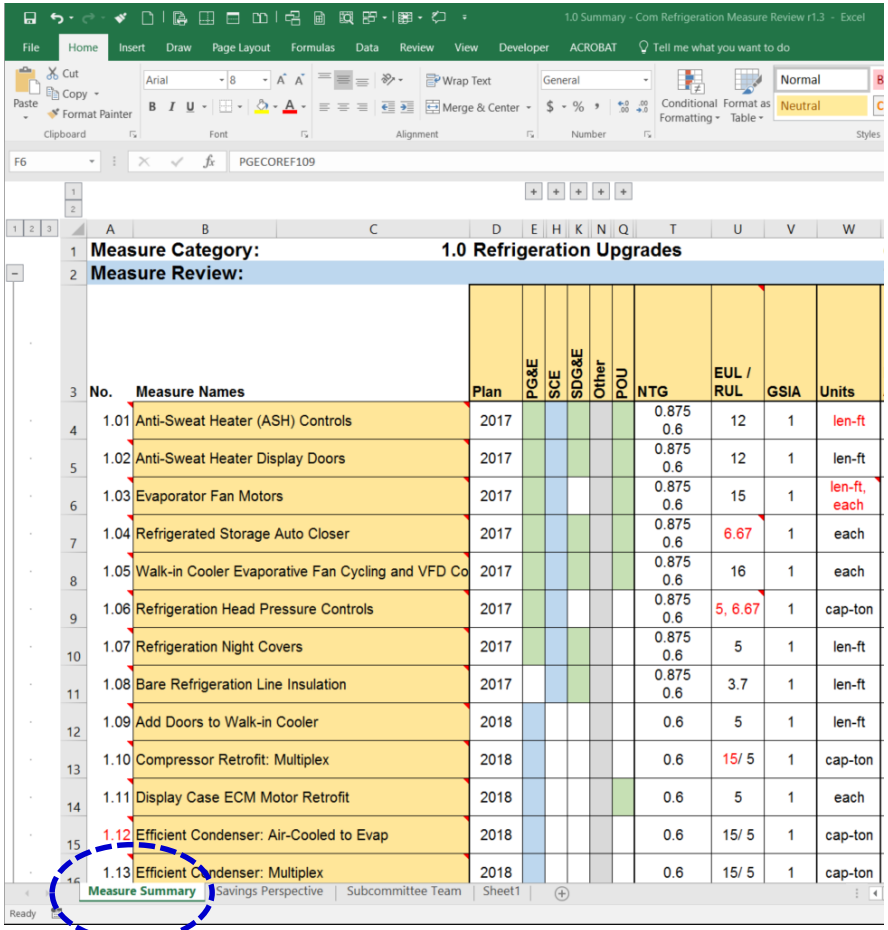
Intro to “Technology Summary” File

- Slides 10 to 18

Subcommittee Materials

- Category Summary File
  - Measure Review
  - Cross-Cutting Issues
  - Measure-Specific Issues
- Category Savings Perspective
- Subcommittee Team List
- Library of Workpapers
  - *Available on DropBox*
- Ex Ante Data Pivot Tables
  - *Used for data in Measure-Specific Issues section*

Category Summary File



Measure Category: 1.0 Refrigeration Upgrades

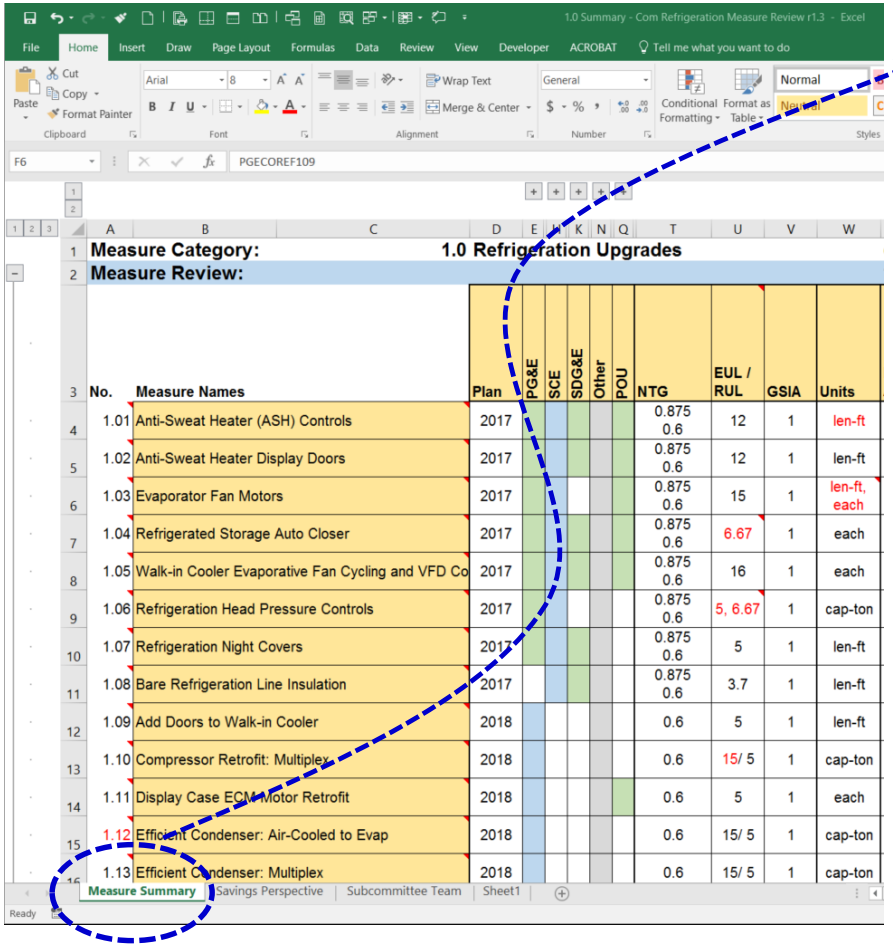
Measure Review:

No.	Measure Names	Plan	PG&E	SCE	SDG&E	Other	POU	NTG	EUL / RUL	GSIA	Units
1.01	Anti-Sweat Heater (ASH) Controls	2017						0.875 0.6	12	1	len-ft
1.02	Anti-Sweat Heater Display Doors	2017						0.875 0.6	12	1	len-ft
1.03	Evaporator Fan Motors	2017						0.875 0.6	15	1	len-ft, each
1.04	Refrigerated Storage Auto Closer	2017						0.875 0.6	6.67	1	each
1.05	Walk-in Cooler Evaporative Fan Cycling and VFD Co	2017						0.875 0.6	16	1	each
1.06	Refrigeration Head Pressure Controls	2017						0.875 0.6	5, 6.67	1	cap-ton
1.07	Refrigeration Night Covers	2017						0.875 0.6	5	1	len-ft
1.08	Bare Refrigeration Line Insulation	2017						0.875 0.6	3.7	1	len-ft
1.09	Add Doors to Walk-in Cooler	2018						0.6	5	1	len-ft
1.10	Compressor Retrofit: Multiplex	2018						0.6	15/ 5	1	cap-ton
1.11	Display Case ECM Motor Retrofit	2018						0.6	5	1	each
1.12	Efficient Condenser: Air-Cooled to Evap	2018						0.6	15/ 5	1	cap-ton
1.13	Efficient Condenser: Multiplex	2018						0.6	15/ 5	1	cap-ton

- Category Summary File
  - Measure Review
  - Cross-Cutting Issues
    - **Intent**: Higher level concern that effects multiple Measures
      - Policy Issues
      - Technical Issues
      - Technical Questions
      - Etc…
  - Measure-Specific Issues
    - **Intent**: Detailed issue that needs resolution before consolidation.

Note: Some Cross-Cutting issues are turning out to be Global Issues.

Category Summary File



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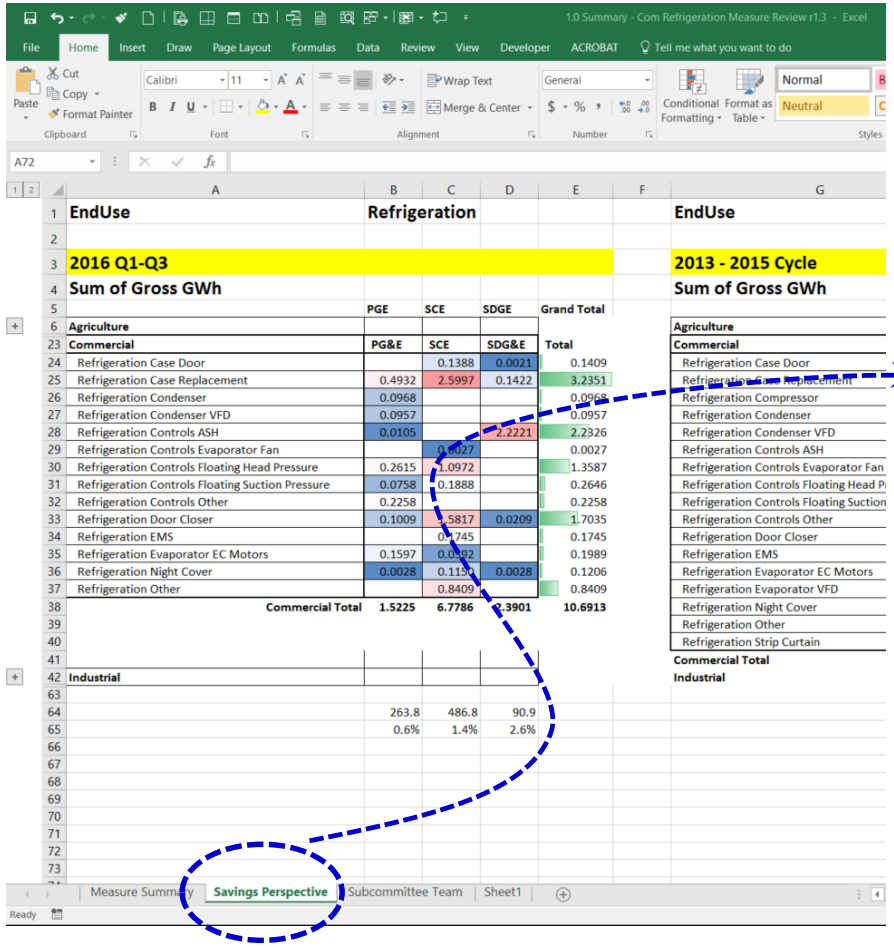
1.03	Evaporator Fan Motors	2017						0.875 0.6	15	1	len-ft, each
1.04	Refrigerated Storage Auto Closer	2017						0.875 0.6	6.67	1	each
1.05	Walk-in Cooler Evaporative Fan Cycling and VFD Co	2017						0.875 0.6	16	1	each
1.06	Refrigeration Head Pressure Controls	2017						0.875 0.6	5, 6.67	1	cap-ton
1.07	Refrigeration Night Covers	2017						0.875 0.6	5	1	len-ft
1.08	Bare Refrigeration Line Insulation	2017						0.875 0.6	3.7	1	len-ft
1.09	Add Doors to Walk-in Cooler	2018						0.6	5	1	len-ft
1.10	Compressor Retrofit: Multiplex	2018						0.6	15/ 5	1	cap-ton
1.11	Display Case ECM Motor Retrofit	2018						0.6	5	1	each
1.12	Efficient Condenser: Air-Cooled to Evap	2018						0.6	15/ 5	1	cap-ton
1.13	Efficient Condenser: Multiplex	2018						0.6	15/ 5	1	cap-ton

- Category Summary File
  - Measure Review
  - Cross-Cutting Issues
  - Measure-Specific Issues
- Category Savings Perspective
- Subcommittee Team List

Category Summary File



- Category Summary File
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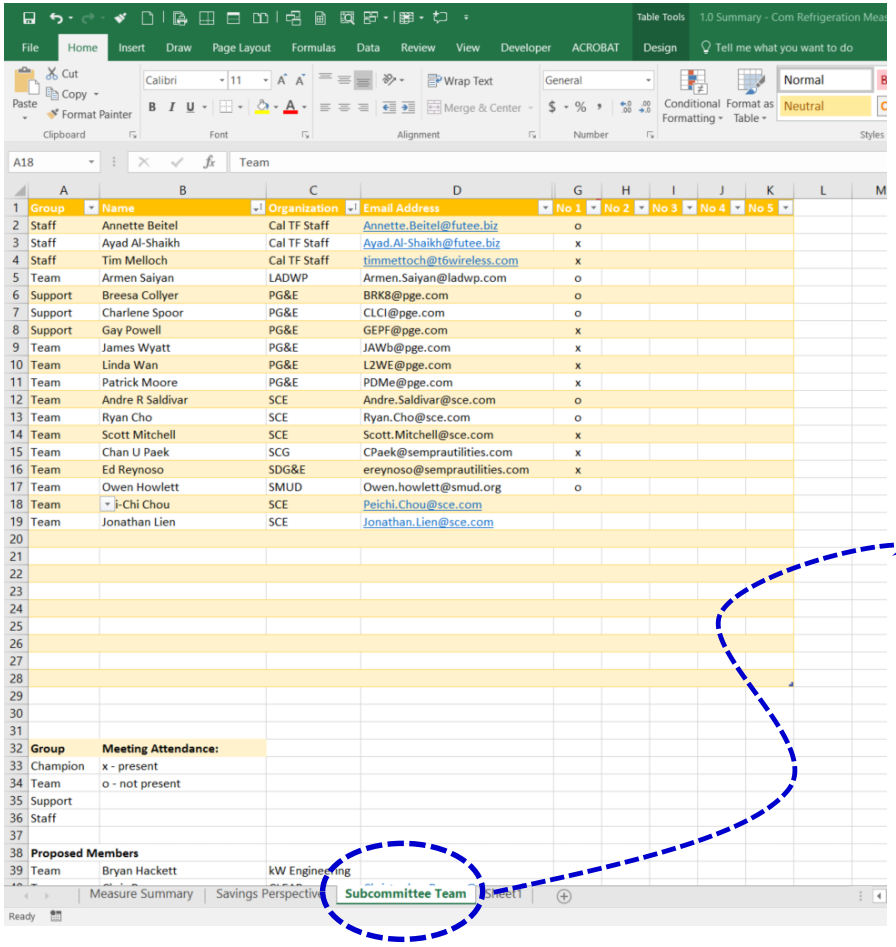
Category Summary File



Group	Name	Organization	Email Address	No 1	No 2	No 3	No 4	No 5
Staff	Annette Beitel	Cal TF Staff	Annette.Beitel@futee.biz	o				
Staff	Ayad Al-Shaikh	Cal TF Staff	Ayad.Al-Shaikh@futee.biz	x				
Staff	Tim Melloch	Cal TF Staff	timmettoch@t6wireless.com	x				
Team	Armen Saiyan	LADWP	Armen.Saiyan@ladwp.com	o				
Support	Breesa Collyer	PG&E	BRK8@pge.com	o				
Support	Charlene Spoor	PG&E	CLCI@pge.com	o				
Support	Gay Powell	PG&E	GEPF@pge.com	x				
Team	James Wyatt	PG&E	JAWb@pge.com	x				
Team	Linda Wan	PG&E	L2WE@pge.com	x				
Team	Patrick Moore	PG&E	PDMe@pge.com	x				
Team	Andre R Saldivar	SCE	Andre.Saldivar@sce.com	o				
Team	Ryan Cho	SCE	Ryan.Cho@sce.com	o				
Team	Scott Mitchell	SCE	Scott.Mitchell@sce.com	x				
Team	Chan U Paek	SCG	CPaek@semprautilities.com	x				
Team	Ed Reynoso	SDG&E	ereynoso@semprautilities.com	x				
Team	Owen Howlett	SMUD	Owen.howlett@smud.org	o				
Team	Ji-Chi Chou	SCE	Peichi.Chou@sce.com					
Team	Jonathan Lien	SCE	Jonathan.Lien@sce.com					

Group	Meeting Attendance:
Champion	x - present
Team	o - not present
Support	
Staff	

Proposed Members

Team	Bryan Hackett	kW Engineering

Measure Summary | Savings Perspective | Subcommittee Team | Sheet1

- Category Summary File
  - Measure Review
  - Cross-Cutting Issues
  - Measure-Specific Issues
- Category Savings Perspective
- Subcommittee Team List

Category Summary File

1.0 Summary - Com Refrigeration Measure Review r1.3 - Excel

F6 PGECOREF109

Measure Category: **1.0 Refrigeration Upgrades** Characterized as commercial refrigeration upgrades.

Measure Review:

No.	Measure Names	Plan	PG&E	SCE	SDG&E	Other	POU	NTG	EUL / RUL	GSIA	Units	Measure Application	Delivery	Calc	Number of: Measure App Ty	Delivery Types	Buildings	Vintage	Locations	Permutations	Offerings	Offering Description:	Baseline	Measure
1.01	Anti-Sweat Heater (ASH) Controls	2017						0.875 0.6	12	1	len-ft	REA	DirInstall PreRebDown	3	1	2	1	1	16	64	2	Low / Medium Temp	2	1
1.02	Anti-Sweat Heater Display Doors	2017						0.875 0.6	12	1	len-ft	ROB, ~~REF~~	DirInstall PreRebDown	3	1	2	1	1	16	64	2	Doors only / New case with doors	2	1
1.03	Evaporator Fan Motors	2017						0.875 0.6	15	1	len-ft, each	RET	DirInstall PreRebDown	3	1	2	1	1	16	192	6	Display case / Walk-ins (Shaded/PSC); Coolers / Freezers	6	1
1.04	Refrigerated Storage Auto Closer	2017						0.875 0.6	6.67	1	each	REA	DirInstall PreRebDown	3	1	2							2	1
1.05	Walk-in Cooler Evaporative Fan Cycling and VFD Co	2017						0.875 0.6	16	1	each	REA	DirInstall PreRebDown	3	1	2							1	2

Ayad Al-Shaikh:
This work paper focuses on ASH controls based on humidity to prevent condensation ("sweating") on the glass surface of refrigerated display cases. ASHs are electric resistance heaters installed at the following locations:

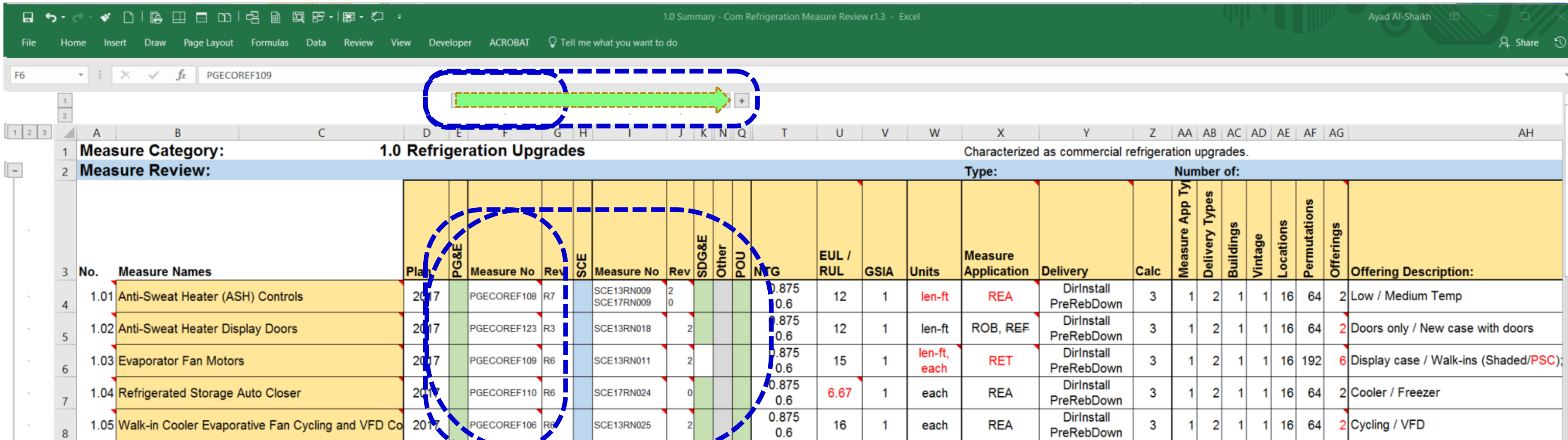
- Case mullion to prevent condensation on metal surfaces (Figure 1 ASH Locations Green)
- Door frame to prevent condensation on metal surfaces (Figure 1 ASH Locations Red)
- Glass edge to prevent condensation on the glass (Figure 1 ASH Locations Blue)

A grocery store's RH is closely related to the outdoor dew point (DP) temperature. Condensation occurs when the air temperature drops to the DP temperature. On warmer days when a customer opens the refrigerated display case glass door, warm moist air comes into contact with the cold glass surface which leads to condensation on the surface of the glass door. ASHs are used to evaporate this moisture from the glass surface, door frame and mullion of the cases.
In standard installations, the ASHs operate at full power 100% of the time. ASH controllers monitor the DP temperature of ambient air and adjust the duty cycle of the heaters accordingly. For example, when the air is dry and its dew point is low, the ASHs operate at a low duty cycle and surface is allowed to get cold since condensation will not form. On the other hand, when the air is humid and dew point is high, the ASHs operate at 100% duty cycle to keep the surface warm and above the dew point temperature. Between these extremes, the duty cycle is adjusted according to the measured DP.
Some of the heat generated by ASHs ends up as a load on the refrigeration system. Therefore, any reduction in ASH power not only will reduce the ASH electric demand, but also result in lower refrigeration loads. As a result, compressor run time and energy consumption are reduced. However, there will be a penalty incurred from the increased space heating energy use.

This measure applies to ASHs on both low temperature (freezer– below 32•F) and medium temperature (cooler – above 32•F) glass doors. Calculations for both coolers and freezers were carried out for all 16 California climate zones.

- Category Measure Number
  1. Commercial Refrigeration
  2. Food Service
  3. Agriculture / Pumping
  4. Water Heating
- Consolidation Plan Year (2017, 2018, n/a)
- Note: Comments available to give workpaper "Technical Description"

Category Summary File



No.	Measure Names	Pla	PG&E	Measure No	Rev	SCE	Measure No	Rev	SDG&E	Other	POU	NTG	EUL / RUL	GSIA	Units	Measure Application	Delivery	Calc	Measure App Ty	Delivery Types	Buildings	Vintage	Locations	Permutations	Offerings	Offering Description:
1.01	Anti-Sweat Heater (ASH) Controls	2017		PGECOREF108	R7		SCE13RN009 SCE17RN009	2 0				0.875 0.6	12	1	len-ft	REA	DirInstall PreRebDown	3	1	2	1	1	16	64	2	Low / Medium Temp
1.02	Anti-Sweat Heater Display Doors	2017		PGECOREF123	R3		SCE13RN018	2				0.875 0.6	12	1	len-ft	ROB, ~~REF~~	DirInstall PreRebDown	3	1	2	1	1	16	64	2	Doors only / New case with doors
1.03	Evaporator Fan Motors	2017		PGECOREF109	R6		SCE13RN011	2				0.875 0.6	15	1	len-ft, each	RET	DirInstall PreRebDown	3	1	2	1	1	16	192	6	Display case / Walk-ins (Shaded/PSC);
1.04	Refrigerated Storage Auto Closer	2017		PGECOREF110	R6		SCE17RN024	0				0.875 0.6	6.67	1	each	REA	DirInstall PreRebDown	3	1	2	1	1	16	64	2	Cooler / Freezer
1.05	Walk-in Cooler Evaporative Fan Cycling and VFD Co	2017		PGECOREF106	R6		SCE13RN025	2				0.875 0.6	16	1	each	REA	DirInstall PreRebDown	3	1	2	1	1	16	64	2	Cycling / VFD

Measure Category: 1.0 Refrigeration Upgrades — Characterized as commercial refrigeration upgrades.

- Workpaper Details
  - **Blue** Shading designates the lead workpaper that is referenced
  - **Green** Shading designates that a workpaper exists in the library
  - **Red** Shading designates that the workpaper exists, but we don't have a copy (yet)
  - Groups can be opened to show workpaper number and current revision
    - For POUs, this shows the reference within the CA TRM, if applicable.

Category Summary File

Measure Category: **1.0 Refrigeration Upgrades** Characterized as commercial refrigeration upgrades.

Measure Review:

No.	Measure Names	Plan	PG&E	SCE	SDG&E	Other	POU	NTG	EUL / RUL	GSIA	Units	Measure Application Type	Delivery Type	Calc	Number of: Measure App Ty	Delivery Types	Buildings	Vintage	Locations	Permutations	Offerings	Offering Description:	Baseline	Measure
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1.03	Evaporator Fan Motors	2017						0.875 0.6	15	1	len-ft, each	RET	DirInstall PreRebDown	3	1	2	1	1	16	192	6	Display case / Walk-ins (Shaded/PSC); Coolers / Freezers	6	1
1.04	Refrigerated Storage Auto Closer	2017						0.875 0.6	6.67	1	each	REA	DirInstall PreRebDown	3	1	2	1	1	16	64	2	Cooler / Freezer	2	1
1.05	Walk-in Cooler Evaporative Fan Cycling and VFD Co	2017						0.875 0.6	16	1	each	REA	DirInstall PreRebDown	3	1	2	1	1	16	64	2	Cycling / VFD	1	2

- Measure Characteristics Comparison
  - Net to Gross (NTG)
  - Effective Useful Life / Remaining Useful Life (EUL/RUL)
  - Gross Savings and Installation Adjustment (GSIA…similar to IR)
  - Units
  - Measure Application Type (ER, NC, RC, REA, RET, ROB, or ROBNC)
  - Delivery Type
  - Calculation Type (1=simple calculation; 2=complex calculation; 3=modeled result)
- Note: Red values indicate some type of discrepancy between workpapers

Category Summary File

1.0 Summary - Com Refrigeration Measure Review r1.3 - Excel

F6 | PGECOREF109

Measure Category: 1.0 Refrigeration Upgrades — Characterized as commercial refrigeration upgrades

Measure Review: — Type: — Number of:

No.	Measure Names	Plan	PG&E	SCE	SDG&E	Other	POU	NTG	EUL / RUL	GSIA	Units	Measure Application	Delivery	Calc	Measure App Types	Delivery Types	Buildings	Vintage	Locations	Permutations	Offerings	Offering Description:	Baseline	Measure
1.01	Anti-Sweat Heater (ASH) Controls	2017						0.875 0.6	12	1	len-ft	REA	DirInstall PreRebDown	3	1	2	1	1	16	64	2	Low / Medium Temp	2	1
1.02	Anti-Sweat Heater Display Doors	2017						0.875 0.6	12	1	len-ft	ROB, ~~REF~~	DirInstall PreRebDown	3	1	2	1	1	16	64	2	Doors only / New case with doors	2	1
1.03	Evaporator Fan Motors	2017						0.875 0.6	15	1	len-ft, each	RET	DirInstall PreRebDown	3	1	2	1	1	16	192	6	Display case / Walk-ins (Shaded/PSC); Coolers / Freezers	6	1
1.04	Refrigerated Storage Auto Closer	2017						0.875 0.6	6.67	1	each	REA	DirInstall PreRebDown	3	1	2	1	1	16	64	2	Cooler / Freezer	2	1
1.05	Walk-in Cooler Evaporative Fan Cycling and VFD Co	2017						0.875 0.6	16	1	each	REA	DirInstall PreRebDown	3	1	2	1	1	16	64	2	Cycling / VFD	1	2

- Permutations
  - Building Type (26 types, Res, Com, Any)
  - Vintage
  - Location (16 Climate Zones or IOU)
- Offerings

Supporting Material for Issues

Cross-Cutting Issues

- EUL – REA measure life
  - Cross-Cutting Committee -> When/how address policy changes
- Modeling measures in DOE2.2R vs Energy Plus
  - Review TPP 3 and Presentation; Timeline for recommendations
- SDG&E territories included
  - Goal of including all Climate Zones
- Cost documentation
  - What constitutes the Best Available Data
- Modeling documentation for Cooler / Freezer (*see 1.18*)
- Include water savings
- Address measure category concerns
  - Early Retirement, Repair Indefinitely
- Consider multiple building type models (*see 1.19*)
  - Recommend - No

REA Example
1.04 Auto Door Closer – EUL

Effective Useful Life (EUL) adjustments:

In their comments SDG&E requests that the Commission reject the Commission staff proposed adjustments measure EUL values in their claims.[72] Commission staff agrees with some of the SDG&E comments but disagrees with others. In general, Commission staff disagrees with SDG&E that there is a lack of clarity in the direction or timing relative to the EUL allowed to be claimed for REA measures. The guidance document covering REA measures was developed jointly by Commission staff and the IOUs and was first distributed in draft form to all IOUs in January of 2013 with the first final "living" document published for public distribution in July of 2014.[73] In that document the REA section provides that "The EUL of REA measures is capped at the RUL of the equipment being retrofitted. This means that REA measures utilize the RUL of the pre-existing equipment up to and not to exceed the EUL for the REA measure." From

1.04 Auto Door Closer – EUL

Savings Consensus

1.01 - Anti-Sweat Heater (ASH) Controls

- Overview:
  - PG&E, SCE, and SDG&E savings match. (*see spreadsheet*)
  - POU savings are based upon an earlier version of SCE workpaper (>20-70%); Does anyone know the history?
  - Savings vary by Offering and CZ.
  - Savings to not vary by Building Type.
    - Limited permutations do vary by BT (ie, Grocery for SDG&E).
  - Offerings:
    - Low Temp / Freezer
    - Medium Temp / Cooler

1.01 - Anti-Sweat Heater (ASH) Controls

- The baseline of the Freezer ASH Controls (D03-230) and Cooler ASH Controls (D03-231) measures considers the anti-sweat heaters operating at fixed full power all the time. The measure models consider ASH control based on humidity. The DEER 2014 prototypes were generated from MASControl version 3.00.20 with the weather files updated using DEER2014 CZ2010 weather data files. The built-in ASH control types based on the fixture temperature are included in table below.

Summary of Built-In ASH Control Types from DEER Prototypes

Component	Freezer	Cooler
ASH Control Type	Humidity-Ratio	Humidity-Ratio
Maximum Humidity	80%	n/a
Minimum Humidity	60%	n/a
Maximum Humidity Ratio	0.011	0.011
Minimum Humidity Ratio	0.005	0.005

- Models are available in workpaper.

1.02 - Anti-Sweat Heater Display Doors

- Overview:
  - PG&E and SCE savings match for Case Replacement
  - POU uses PG&E workpaper as the reference, but savings for low temp are about 2x greater.
  - Savings vary by Offering and CZ.
  - Savings to not vary by Building Type.
  - Offerings:
    - Low Temp, Anti-Sweat Heater (ASH) Door
    - Low Temperature High Efficiency Display Case with Special Door
      - Includes savings due to the higher efficiency LED lighting and ECM motors
    - POUs offer Low and Medium temp offerings
  - Note: SCE retired this workpaper in Dec 2016.

Measure Specific Example
Defining Offering - 1.02 ASH Display Doors

SCE – 583.95 kWh

Total Linear feet of Display Cases considered: 282 ft

		Base Case				Measure Case						
CZ	Vintage	Total Elec. Usage (kWh/yr)	Total Natural Gas Usage (kBtu/yr)	Total Natural Gas Usage (therms/yr)	Peak Demand (kW)	Total Elec. Usage (kWh/yr)	Total Natural Gas Usage (kBtu/yr)	Total Natural Gas Usage (therms/yr)	Peak Demand (kW)	Elec. Savings (kWh/ft-yr)	Peak Demand Reduction (kW/ft)	Natural Gas Savings (therm/ft-yr)
1	v14	1,369,185.25	3,171,792	31,717.92	199.95	1,211,802.00	3,307,038	33,070.38	171.64	558.10	0.10	(4.80)
2	v14	1,465,837.50	2,258,030	22,580.30	284.96	1,306,073.00	2,354,914	23,549.14	256.72	566.54	0.10	(3.44)
3	v14	1,420,911.63	2,193,456	21,934.56	234.82	1,254,527.38	2,314,410	23,144.10	207.79	590.02	0.10	(4.29)
4	v14	1,474,702.25	1,898,555	18,985.55	270.67	1,309,071.75	1,992,587	19,925.87	24[illegible]	[illegible]	[illegible]	[illegible]
5	v14	1,408,701.88	2,265,085	22,650.85	210.28	1,244,027.50	2,386,364	23,863.64	18[illegible]	583.95	0.09	(4.30)
6	v14	1,519,274.50	1,416,054	14,160.54	256.25	1,326,791.90	1,523,110	15,231.10	227.08	[illegible]	[illegible]	[illegible]
7	v14	1,500,034.10	1,303,640	13,036.40	242.89	1,306,081.80	1,419,039	14,190.39	210.94	687.77	0.11	(4.09)
8	v14	1,528,826.60	1,313,057	13,130.57	261.99	1,344,482.40	1,400,671	14,006.71	233.22	653.70	0.10	(3.11)
9	v14	1,556,778.60	1,435,531	14,355.31	314.67	1,377,149.50	1,516,323	15,163.23	280.06	636.98	0.12	(2.86)
10	v14	1,559,931.40	1,474,438	14,744.38	312.65	1,386,586.30	1,549,413	15,494.13	281.71	614.70	0.11	(2.66)
11	v14	1,558,721.60	1,967,045	19,670.45	310.63	1,403,370.10	2,035,222	20,352.22	288.89	550.89	0.08	(2.42)
12	v14	1,526,771.00	2,008,985	20,089.85	303.58	1,364,271.00	2,090,286	20,902.86	273.53	576.24	0.11	(2.88)
13	v14	1,574,349.50	1,846,203	18,462.03	308.70	1,412,034.38	1,913,786	19,137.86	277.77	575.59	0.11	(2.40)
14	v14	1,541,421.88	2,001,338	20,013.38	302.62	1,390,720.25	2,063,500	20,635.00	277.35	534.40	0.09	(2.20)
15	v14	1,623,312.50	901,918	9,019.18	297.33	1,463,351.00	939,934	9,399.34	272.17	567.24	0.09	(1.35)
16	v14	1,361,326.25	3,339,987	33,399.87	235.11	1,220,483.25	3,418,468	34,184.68	211.00	499.44	0.09	(2.78)

Measure Specific Example
Defining Offering - 1.02 ASH Display Doors

PG&E – 583.85 kWh

Measure Description	MeasAppType	BldgType	BldgVint	BldgLoc	NormUnit	KW Peak Electric Demand Reduction	KWh Electric Savings	THM Gas Savings	LIFE CYCLE (RUL if ER, RET, REA	Base Case Cost ($/unit)	MatlCost ($/unit)	LaborCost ($/unit)	Incremental/ Full Measure Cost ($/uni
Low Temperature High Efficiency Display Case with Special Door	ROB	Gro	Ex	CZ01	Len-ft	0.1	558	(5)	12	$579.21	$680	$85.24	$101
Low Temperature High Efficiency Display Case with Special Door	ROB	Gro	Ex	CZ02	Len-ft	0.1	567	(3)	12	$579.21	$680	$85.24	$101
Low Temperature High Efficiency Display Case with Special Door	ROB	Gro	Ex	CZ03	Len-ft	0.1	590	(4)	12	$579.21	$680	$85.24	$101
Low Temperature High Efficiency Display Case with Special Door	ROB	Gro	Ex	CZ04	Len-ft	0.1	587	(3)	12	$579.21	$680	$85.24	$101
Low Temperature High Efficiency Display Case with Special Door	ROB	Gro	Ex	CZ05	Len-ft	0.09	584	(4)	12	$579.21	$680	$85.24	$101
Low Temperature High Efficiency Display Case with Special Door	ROB	Gro	Ex	CZ11	Len-ft	0.08	551	(2)	12	$579.21	$680	$85.24	$101
Low Temperature High Efficiency Display Case with Special Door	ROB	Gro	Ex	CZ12	Len-ft	0.11	576	(3)	12	$579.21	$680	$85.24	$101
Low Temperature High Efficiency Display Case with Special Door	ROB	Gro	Ex	CZ13	Len-ft	0.11	576	(2)	12	$579.21	$680	$85.24	$101
Low Temperature High Efficiency Display Case with Special Door	ROB	Gro	Ex	CZ16	Len-ft	0.09	499	(3)	12	$579.21	$680	$85.24	$101

PG&E Values

BldgLoc	NormUnit	KW Peak Electric Demand Reduction	KWh Electric Savings	THM Gas Savings
CZ01	Len-ft	0.1	558	(5)
CZ02	Len-ft	0.1	567	(3)
CZ03	Len-ft	0.1	590	(4)
CZ04	Len-ft	0.1	587	(3)
CZ05	Len-ft	0.09	584	(4)
CZ11	Len-ft	0.08	551	(2)
CZ12	Len-ft	0.11	576	(3)
CZ13	Len-ft	0.11	576	(2)
CZ16	Len-ft	0.09	499	(3)

Measure Specific Example
Defining Offering - 1.02 ASH Display Doors

POUs provide additional offerings to differentiate between medium and low temperature display doors.

7.7.1 Energy Savings Table

The following table provides energy savings and demand reduction for medium and low temperature display cases with doors.

Climate Zone	Medium Temperature			Low Temperature		
	Demand Reduction (kW)	Energy Savings (kWh)	Therm Savings	Demand Reduction (kW)	Energy Savings (kWh)	Therm Savings
2	0.049	143	26	0.075	993	42
3	0.024	143	30	0.075	978	50
4	0.080	135	24	0.080	942	42
5	0.020	136	29	0.121	965	49
8	0.012	103	18	0.089	928	39
9	0.094	110	18	0.079	939	38
10	0.073	118	18	0.085	922	35
11	0.046	170	22	0.090	1,031	37
12	0.065	140	23	0.083	968	39
14	0.047	210	20	0.123	1,040	34
15	0.004	76	12	0.149	1,123	24
16	0.019	169	27	0.096	936	43

SCE – 583.95 kWh

PG&E – 583.85 kWh

1.02 - Anti-Sweat Heater Display Doors

- The DEER measure considers multiplex-compressor systems as the refrigeration type. The baseline of the Zero Heat Reach-in Glass Doors (ID D03-228) measure considers the anti-sweat heater (ASH) power of 214 Watt/door for the door and frame heaters with humidity control. The measure case of this measure considers the ASH power of 54 Watt/door for door frame heat only (eliminating door heaters). The energy savings methodologies of this DEER measure ID D03-228 is applied to the two solution codes of this work paper.
- Models are available in workpaper.
- Savings summary file shows parametric changes

1.03 Evaporator Fan Motors

- Overview:
  - PG&E and SCE savings match
    - PG&E (Each) / SCE (Len-ft) – conversion factor of 2.6
    - Recommend checking the conversion; whether it should be 2'6" (factor of 2.5)
  - POU savings vary by Evap (motor rated-hp) or Display Case
    - Note program implemented by 3P that uses IOU approach for LADWP
  - Savings vary by offering and CZ
  - Savings to not vary by Building Type, Vintage, or HVAC Type
  - Offerings:
    - **Display case** (Shaded Pole)
      - Coolers / Freezers
      - PG&E
      - POU (TRM109) – single values savings based upon a mix of field and modeled information (2x IOU savings)
    - **Walk-ins** (Shaded Pole/PSC);
      - Coolers / Freezers
      - PG&E and SCE
      - (not offered) SCE has two additional measure offering with a baseline of a PSC motor for walk-ins (cooler and freezer).

1.03 Evaporator Fan Motors

- The display cases and walk-ins are applicable to, but not limited to, grocery stores. ECM motors are more efficient than SHP and PSC motors. According to a commercial refrigeration study report by U.S. Department of Energy [128], typical SHP fan motor efficiencies range between about 15% to 38%, while typical PSC fan motor efficiencies range between about 40% to 70%, and typical ECM fan motor efficiencies range between about 71% to 83% for rated shaft output between 6-watt and 373-watt (1/2 hp). Therefore, replacing the evaporator fan SHP and PSC motors with ECM motors will reduce the evaporator fan energy consumption as well as the refrigeration cooling load for cooling the heat rejected by the motors, resulting in electrical energy savings.
- The measures of this work paper are weather sensitive. The building energy simulation tool eQuest was used to determine the annual impacts. The built-in DEER building prototypes, generated by MASControl v3.00.20 of grocery store, were used for simulations. The DEER building prototypes consider multiplex-compressor systems as the refrigeration type.
- Models are available in workpaper. Savings summary file shows parametric changes
- Note: Previous workpaper by DNVGL calculated savings based upon motor hp.
  - See PG&E document: “EC Motor WP Comparison”
- Question: Should Shade Pole Motors be the baseline condition for this measure?

1.11 Display Case ECM Motor Retrofit

- Overview:
  - This measure is very similar to 1.03
    - Can it be consolidated with 1.03 (special case of Display Case only)
  - Savings vary by Building Vintage and Climate Zone
  - Savings do not vary by Building Type, LT/MT, or Rated-hp
    - Only currently offered at Grocery Stores
  - PG&E only offers this measure.
  - Ensure that engineering assumptions in calculation are documented well and represent best available data.
  - Offerings:
    - ER only
    - Must be SHP->ECM, < 1hp, display case application

1.11 Display Case ECM Motor Retrofit

- Methodology
  - Direct/auxiliary energy savings:
    - Determine the direct energy savings of replacing a shaded pole motor with an ECM of equivalent size in a display case.
  - Total system energy savings:
    - Determine the savings that the refrigeration system will see due to the reduction on internal heat load from the more efficient ECM motors and add that to the direct/auxiliary savings for total system savings.
  - Motor size weighting:
    - Determine the frequency in which various motor sizes are installed in evaporator fans in display cases.
  - Display Case temperature weighting:
    - Determine the frequency that ECMs are installed in low temperature and medium temperature applications.
  - Calculate one kWh savings number for each California climate zone and vintage.

1.05 Walk-in Cooler Evaporative Fan Cycling and VFD Control

- Overview:
  - PG&E and SCE savings match (Each)
    - SDG&E savings are based on Cap-Tons (in Ex Ante tables; workpaper references are different – per “each”)
  - Savings vary by offering and CZ
  - Savings to not vary by Building Type, Vintage, or HVAC Type
  - Recommend considering other sensitive parameters for evaporators that are not in display cases.
  - Offerings:
    - Fan Cycling
    - VFD Control (not offered by PG&E)
    - POUs offer by rated-hp.

1.05 Walk-in Cooler Evaporative Fan Cycling and VFD Control

- The measures in this work paper are not in DEER 2014, so the energy savings were determined through building simulation in eQUEST 3.65 Refrigeration. Only the Grocery building type was simulated, and its savings were used for other building types because walk-in coolers and freezers generally have the same characteristics regardless of building type.

- Prototype generation
  - MASControl v3.00.20 was used to generate the DEER 2014 Grocery prototype files using the following parameters:
  - Building Type: Grocery
  - Climate Zones: 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16
  - Vintage: “14” (years 2014-2015)
  - HVAC Type: Blank (Default)
  - Thermostat Options: Blank (Default)
  - Case Options: CAv (Customer Average), C13 (Code 2013)
  - Tech ID: “D08-NE-HVAC-airAC-SpltPkg-135to239kBtuh-10p8eer”

- Models are available in workpaper.

1.05 Evap Controls
Defining Permutations

CALIFORNIA TECHNICAL FORUM

Small variation across climate zones

SCE

	Cycling			VFD			Change in savings:		
	kWh savings	kW Savings	therm savings	kWh savings	kW Savings	therm savings	kWh	kW	Therms
CZ1	268.40	0.03822	-0.021	320.96	0.04429	-0.020	20%	16%	-4%
CZ2	265.42	0.03637	-0.017	318.66	0.04216	-0.017	20%	16%	1%
CZ3	266.44	0.02327	-0.019	319.29	0.02931	-0.017	20%	26%	-7%
CZ4	267.05	0.04637	-0.016	320.89	0.05290	-0.015	20%	14%	9%
CZ5	266.05	0.03848	-0.021	319.03	0.04464	-0.020	20%	16%	-5%
CZ6	277.87	0.02875	0.010	331.93	0.03509	0.011	19%	22%	13%
CZ8	275.70	0.04304	-0.024	329.99	0.04979	-0.023	20%	16%	-3%
CZ9	273.40	0.04387	-0.004	327.83	0.04700	-0.002	20%	7%	-40%
CZ10	269.87	0.03652	-0.013	324.69	0.04321	-0.012	20%	18%	-6%
CZ11	273.77	0.03636	-0.014	329.19	0.04268	-0.012	20%	17%	-11%
CZ12	271.24	0.04603	-0.015	325.62	0.05280	-0.015	20%	15%	-4%
CZ13	274.37	0.04151	-0.013	328.72	0.04813	-0.011	20%	16%	-17%
CZ14	273.95	0.03236	-0.015	328.50	0.03922	-0.014	20%	21%	-3%
CZ15	266.31	0.03164	-0.009	322.40	0.03818	-0.008	21%	21%	-13%
CZ16	263.14	0.03458	-0.017	315.42	0.04096	-0.016	20%	18%	-9%

Savings variation b/w Cycling and VFD

PG&E

BldgLoc	NormUnit	KW Peak Electric Demand Reduction	KWh Electric Savings	THM Gas Savings
CZ01	Each	0.03822	268	-0.021
CZ02	Each	0.03637	265	-0.017
CZ03	Each	0.02327	266	-0.019
CZ04	Each	0.04637	267	-0.016
CZ05	Each	0.03848	266	-0.021
CZ11	Each	0.03636	274	-0.014
CZ12	Each	0.04603	271	-0.015
CZ13	Each	0.04151	274	-0.013
CZ16	Each	0.03458	263	-0.017

Savings for either Cycling or VFD control

1.05 Evap Fan Controls - POUs

7.5.1 Energy Savings Table

This table provides the energy savings for each motor size and the percent savings attributable to the fan controller.

Measure Description	Demand Reduction (kW)	Energy Savings – Early Retirement (kWh)	Energy Savings – Natural Replacement (kWh)
ECM for walk-in evaporator fan with controller – 16 W	0.071	620	212
ECM for walk-in evaporator fan with controller – 1/15 hp + 1/20 hp	0.157	1,379	333
ECM for walk-in evaporator fan with controller – 1/5 hp	0.266	2,329	920
ECM for walk-in evaporator fan with controller – 1/3 hp	0.402	3,518	1,524
ECM for walk-in evaporator fan with controller – 1/2 hp	0.553	4,841	2,283
ECM for walk-in evaporator fan with controller – 3/4 hp	0.711	6,226	3,444

Six motor rated-hp Options
No climate zone dependency

1.04 Auto-Door Closer

- Overview:
  - PG&E and SCE savings match
    - SDG&E savings (Len-Ft), but seem significantly lower (check)
    - SDG&E methodology is identical, so savings should be the same; confirm that this is correct.
  - POU savings vary by climate zone and offering, but savings smaller (2x)
  - Savings vary by offering and CZ
  - Savings to not vary by Building Type, Vintage, or HVAC Type
  - Offerings: (same for all IOUs)
    - Cooler
    - Freezer

1.04 Auto Door Closer – SCE vs TRM

SCE Values

Measure			Combination						
SolutionCode	MeasIndex	Unit	InstallType	BldgLoc	EUL	Life_1BL	kWh_1BL	kW_1BL	Therm_1BL
RF-16925	Main Cooler Door Auto Closer	Unit	REA	05	6.67	6.67	1725.22	0.31144	-0.104
RF-16925	Main Cooler Door Auto Closer	Unit	REA	12	6.67	6.67	2074.98	0.46256	-0.597
RF-32156	Main Freezer Door Auto Closer	Unit	REA	05	6.67	6.67	3524.46	0.20	-0.04
RF-32156	Main Freezer Door Auto Closer	Unit	REA	12	6.67	6.67	3912.41	0.81	-0.60

TRM Values
About 50%

7.8.1 Energy Savings Table

This table provides the energy savings and peak demand reduction for each climate zone.

Climate Zone	Cooler Door		Freezer Door	
	Demand Reduction	Energy Savings	Demand Reduction	Energy Savings
2	0.162	980	0.452	2,450
3	0.127	958	0.296	2,394
4	0.143	981	0.363	2,365
5	0.165	961	0.192	2,378
8	0.108	998	0.280	2,394
9	0.181	1,005	0.422	2,432
10	0.190	1,022	0.326	2,442
11	0.159	1,014	0.363	2,457
12	0.149	998	0.400	2,453
14	0.225	1,000	0.141	2,495
15	0.060	892	0.141	2,409
16	0.149	943	0.326	2,386
Average	**0.152**	**979**	**0.309**	**2,421**

1.04 Auto-Door Closer

- The measures in this work paper are not in DEER 2017, so the energy savings were determined through building simulation in eQUEST 3.65 Refrigeration. Only the Grocery building type was simulated, and its savings were used for other building types because walk-in coolers and freezers generally have the same characteristics regardless of building type.

- Prototype generation
  - MASControl v3.00.20 was used to generate the DEER 2014 Grocery prototype files using the following parameters:
  - •Building Type: Grocery
  - •Climate Zones: 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16
  - •Vintage: “14” (years 2014-2015)
  - •HVAC Type: Blank (Default)
  - •Thermostat Options: Blank (Default)
  - •Case Options: CAv (Customer Average), C13 (Code 2013)
  - •Tech ID: “D08-NE-HVAC-airAC-SpltPkg-135to239kBtuh-10p8eer”

- Models are available in workpaper.

1.06 Refrigeration Controls

- Overview:
  - PG&E and SCE savings do not match
    - PG&E – Refrig Case specific; DEER prototype models run with additional parameters
    - SCE – Averages with DEER values (over 3 baseline conditions, FHP)
  - Savings vary by offering, CZ, and Vintage (PG&E only)
  - Savings to not vary by Building Type or HVAC Type
    - Measure has only been implemented in Grocery stores (all IOUs)
  - POUs do not offer this deemed measure.
  - Offerings:
    - SCE has 5 offerings:
      - Floating Head (Com Air or Evap, Process Evap)
      - Floating Suction (Com Multiplex, Process Evap)
    - PG&E has 2 workpapers:
      - SCT Control - 4 offerings, 5 vintages (Com Air or Evap; VFD or no VFD)
      - SST Control - one offering, 5 vintages (Blend med/low temp, air/evap rejection)
  - Are offerings correctly established?

1.06 Refrigeration Controls

- SCE: The savings for each of the floating head pressure measures were direct averages of three DEER17 measures which address the same baseline. The remaining floating suction pressure measures were based on one DEER17 measure each. The table above shows the assignment of DEER17 measures to each of the core measure.

- PG&E: SCT Control - The original measures and energy models were created with DEER 2005. Measure information was updated in DEER 2008. The MAS Control tool that ran the batch simulations with the new 2014 T24 weather files appear to have pulled from the D08 version of the measure.
- PG&E: SST Control - The saving for this measure is from DEER 2008 and generated through MASControl V3.00.19. The nonresidential technology code selected was D08-NE-GrocRefg-FltSucPres-SSTReset.The grocery building type was selected for PG&E climate zones (1,2,3,4,5,11,12,13,16) and vintage codes 75, 85, 96, 03, and 07.

- Need a volunteer to compare approaches and savings.
  - Identify if we know why savings are varying and which approach represents the best available data.

1.07 Night Covers

- Overview:
  - PG&E and SCE savings do not match
    - Any understanding of why savings do not match?
  - Savings vary by offering and CZ
  - Savings to not vary by Building Type, Vintage or HVAC Type
    - Measure has only been implemented in Grocery stores (all IOUs)
  - POUs do not offer this deemed measure.
  - Offerings:
    - Low Temperature Open Horizontal Night Cover (34.1 kWh)
    - Low Temperature Open Vertical Night Cover (141.9 kWh)
    - Medium Temperature Open Vertical Night Cover (17.4 kWh)

1.07 Night Covers

- Measure ID D03-205 in the 2014 Database for Energy Efficient Resources (DEER) READi tool, which addresses installing night covers on medium-temperature open display cases. It does not address installing night covers on low-temperature open display cases (vertical or horizontal). The DEER 2014 savings are based on applying covers for a period of four hours and the database does not distinguish between vertical and horizontal cases. Also, the measure characteristics presents the savings due to installing infiltration barrier as 50%, this compares favorably with other studies on horizontal display cases and thus it is assumed that the database is referring to horizontal cases only. For medium-temperature display cases, existing DEER 2014 values are used.
- The building simulation models were generated for a Grocery Store with multiplex-compressor systems for the refrigeration display cases. Single-compressor systems are less efficient than multiplex-compressor systems. According to the DEER Report [26], single-compressor systems were typically designed prior to 1980. To be conservative, it is assumed that the generated energy savings of this work paper will also be applied to display cases with single-compressor systems.

- Models are available in workpaper.

1.08 Bare Refrig Line Insulation

- Overview:
  - SCE and SDG&E savings vary dramatically.
    - SCE savings vary by Climate Zone and Offering (Freezer / Cooler)
      - Savings do not vary by Building Type
    - SDG&E savings are averaged over all BT (Com) and all CZ (IOU)
      - Savings are also much smaller (1/10 to 1/100 of electric savings)
  - PG&E does not currently offer this measure.
  - POUs do not offer this deemed measure.
  - Ensure that engineering assumptions in calculation are documented well and represent best available data.
  - Offerings: (for SCE)
    - Freezer
    - Cooler
  - Offering: (for SDG&E)
    - For Walk-in Refrigeration Units; Baseline not completely bare.

1.08 Bare Refrig Line Insulation

- Methodology
  - SDG&E references an ASHRAE study, but adjusts the approach to meet SDG&E program implementation.
  - SCE uses an analytical calculation: (more detail on page 11)
    - Heat transfer analysis: Conduct a heat transfer analysis for both bare (baseline) and insulated (post-retrofit) suction lines of walk-ins to determine.
    - Refrigeration cycle analysis: Conduct refrigeration cycle analysis for both bare (baseline) and insulated (post-retrofit) suction lines.
    - Compressor power savings per unit of measure (ΔkW/linear-ft):
      - Determine demand savings by using bare and insulated suction line compressor power usage
      - Determine demand savings per linear-ft of exposed suction lines for both walk-in coolers and freezers
    - Equivalent-full-load-hours (EFLH) of operation:
      - EFLH is determined by using annual available operation hours (8,760) and overall duty cycle factor
      - Overall duty cycle factor is determined by taking into account compressor over-sizing factor, defrost periods and weather factor
    - Compressor energy savings per unit of measure (ΔkWh/sq-ft):
      - Determine energy savings by using demand savings and EFLH
      - Repeat energy savings calculation for all CTZs for both coolers and freezers and compile results
  - Discuss the best approach to take.

1.09 Add Doors to Walk-in Cooler

- Overview:
  - Savings vary by Offering (baseline fan)
  - Savings do not vary by Climate Zone, Bldg Type, etc.
  - PG&E only offers this measure.
  - POUs do not offer this deemed measure.
  - Ensure that engineering assumptions in calculation are documented well and represent best available data.
  - Offerings:
    - Standard fan baseline (more savings, about 2x)
    - Efficient fan baseline

1.09 Add Doors to Walk-in Cooler

- Methodology Assumptions:
  - The heat load absorbed by the case evaporator is transferred to the walk-in evaporator coils.
  - The refrigeration system that served the cases is identical to the refrigeration system that serves the Walk-in.
  - The evaporator fans for the walk-in run 8760 hours per year.
  - Installing the door removes the additional 800 Btu/h/ft load on the Walk-in that is required while the walk-in reach-in case is present.
  - The heat load presented by the Equipment Manufacturer is multiplied by the case length or number of doors to find the "case load" in the energy savings calculations
  - The case has standard fans, 1 row of standard canopy lighting, and an additional "optional" row of canopy lighting.
  - The HVAC system will need to increase its cooling load and the heating system will be able to reduce its heating load, both by the difference of the zone load (infiltration of heat and air from the sales area) between the base case and the energy efficient case.
  - Other:
    - FLH, Degradation Factor, HVAC Cooling EER

1.10 Compressor Retrofit: Multiplex

- Overview:
  - Savings vary by Measure Application Type (ER/ROB), Offering, Building Vintage, Climate Zone
  - Savings do not vary by Building Type or LT/MT
    - Only currently offered at Grocery Stores
  - PG&E only offers this measure.
  - POUs do not offer this deemed measure.
  - Ensure that engineering assumptions in calculation are documented well and represent best available data.
  - Offerings:
    - Air-Cooled to Air-Cooled / Air-Cooled to Water-Cooled
    - ER / ROB

1.10 Compressor Retrofit: Multiplex

- Methodology
  - The saving for this measure is from 2008 DEER data generated from MAS Control V3.00.19. The information can be identified in the database as measures D03-214 and D03-215.
  - ER - For early retirement claims: The existing compressor system must be in working order with no signs of replacement in the 12 months following the project application date. Pre-inspection of the existing equipment will be required. Preponderance of evidence must be supplied. Please see the template of information to be completed. Most projects will claim ROB. (ER savings 4-6x of ROB)
  - An additional rebate cannot be claimed for floating head pressure control
  - Models not available in workpaper; DEER savings.

1.12 Efficient Condenser Air to Evap-Cooled

- Note:
  - Measure being sunset due to cost effectiveness.
- Overview:
  - Savings vary by Building Vintage and Climate Zone
  - Savings do not vary by Building Type or LT/MT
    - Only currently offered at Grocery Stores
  - PG&E only offers this measure.
  - POUs do not offer this deemed measure.
  - Ensure that engineering assumptions in calculation are documented well and represent best available data.
  - Offerings:
    - ER / ROB

1.12 Efficient Condenser Air to Evap-Cooled

- Methodology
  - The data modeled using MASControl v3.00.19 includes: demand, electric, and interactive gas energy savings. DEER 2008 cost data includes: equipment unit costs, equipment incremental costs, and equipment useful life.
  - ER savings can be 2 – 10x of ROB savings.
  - Not clear why there is no later vintage (2003).
  - Water penalty not included; hybrid condenser not yet considered.
  - No models available in workpapers; DEER values.

1.13 Efficient Condenser: Multiplex

- Overview:
  - Savings vary by Building Vintage and Climate Zone
  - Savings do not vary by Building Type, Air/Evap-Cooled or LT/MT
    - Only currently offered at Grocery Stores
  - PG&E only offers this measure.
  - POUs do not offer this deemed measure.
  - Ensure that engineering assumptions in calculation are documented well and represent best available data.
  - Offerings:
    - ER / ROB

1.13 Efficient Condenser: Multiplex

- Methodology:
  - The savings for these measures are from DEER 2008 and generated through MASControl V3.00.19. The nonresidential technology codes selected was D08-NE-GrocRefg-Cndsr-AirCool-HiEff and D08-NE-GrocRefg-Cndsr-EvapCool-HiEff. The grocery building type was selected for PG&E climate zones (1,2,3,4,5,11,12,13,16) and vintage codes 75, 85, 96, 03, and 07.
  - No models available in workpapers; DEER values.

1.14 Floating Head Pressure Single Compressors

- Overview:
  - This measure is very similar to 1.06
  - Savings vary by Climate Zone
  - Savings do not vary by Building Type, Building Vintage, Air/Evap-Cooled or LT/MT
    - Only currently offered at Grocery Stores
  - PG&E only offers this measure.
  - POUs do not offer this deemed measure.
  - Ensure that engineering assumptions in calculation are documented well and represent best available data (see example).
  - Offerings:
    - Low Temperature / Medium Temperature Condensing Unit
    - Multi-Compressors – Single Condenser / Single-Compressor – Single Condenser

1.14 Floating Head Pressure Single Compressors

- Methodology
  - An energy savings forecast from the implementation of the Floating Head Pressure (FHP) on Single Compressor Systems-Air-Cooled Condenser measure was generated from the results of an eQUEST simulation model and engineering calculations.
  - Sensitivity analysis used to identify parameters to vary.
    - Result from tornado plots included in workpaper.

1.14 Floating Head Pressure Single Compressors

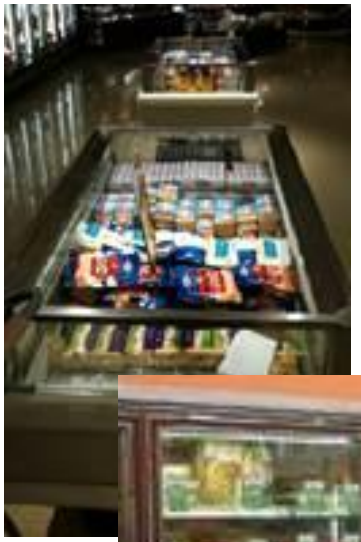
- Methodology

Base Case Variables						
Variable	**Units**	**Min**	**Typical**	**Max**	**MT**	**LT**
Compressor COP	unit less	N/A	2.7	3.1	2.49	1.45
Compressor Sizing Factor	%	110%	120%	130%	113%	117%
Condenser Sizing Factor	%	130%	170%	210%	150%	185%
Number of Condenser Fans	Number	4	5	6	4	4
Condenser Set Point	Degree F	85	90	95	94	94
Suction Temperature	Degree F	-30	15	40	15	-20
Measure Case Variables						
Variable	**Units**	**Min**	**Typical**	**Max**	**MT**	**LT**
EE Condenser Minimum Set Point	Degree F	60	70	N/A	70	70

Base Case Variables						
Variable	**Units**	**Min**	**Max**	**Typical**	**MT**	**LT**
Compressor COP	unit less	0.9	2.9	2.7	weighted	weighted
Compressor Sizing Factor	%	110%	130%	120%	121%	121%
Condenser Minimum Set Point (SCT)	Degree F	92.5	96.1	94.3	94	94
Suction Temperature	Degree F				15	-20

1.15 Low Temp Coffin to Reach-In

- Overview:
  - Savings vary by Offering
  - Savings do not vary by Climate Zone, Building Type, Building Vintage, Air/Evap-Cooled or LT/MT
    - Only currently offered at Grocery Stores
  - PG&E only offers this measure.
  - POUs do not offer this deemed measure.
  - Ensure that engineering assumptions in calculation are documented well and represent best available data.
  - Offerings:
    - Wide Coffin -> Reach In Case (1/4 of length)
    - Narrow Coffin -> Reach In Case (1/3 of length)



1.15 Low Temp Coffin to Reach-In

- Methodology
  - Rebate/claim is limited to 1/3 length of original wide coffin or ¼ length of original narrow coffin.
  - The base case and proposed case scenarios are compared to in equivalent display case *volumes, as opposed to length.*
  - Multistep, one-line calculations used to estimate savings.

1.16 Medium Temp Open Case Retrofit

- Overview:
  - Only one permutation
  - Savings do not vary by Climate Zone, Building Type, Building Vintage, Air/Evap-Cooled or LT/MT
    - Only currently offered at Grocery Stores
  - PG&E only offers this measure.
  - POUs do not offer this deemed measure.
  - Ensure that engineering assumptions in calculation are documented well and represent best available data
  - Offerings:
    - Medium Temperature Standard Efficiency to High Efficiency
      - From: Open vertical refrigerated display case
      - To: Open vertical refrigerated display case with a high efficiency evaporator coil

1.16 Medium Temp Open Case Retrofit

- Methodology
  - One line engineering calculation used.
  - Full Load Hour equivalent is derived from an eQUEST analysis.
  - Standard EER values are referenced from ASHRAE.
  - Savings estimates are referenced through a study by Cascade Energy Engineering / NEEA.

1.17 Display Cases with Doors

- Overview:
  - 2016 Savings vary by Offering, Climate Zone
    - Gas – SCG savings are lower for CZ, but potentially just based upon an older revision workpaper.
  - 2016 Savings do not vary by IOU (PG&E, SCE, SDG&E), Building Type or Vintage
  - 2017 Savings for SCE seem to vary by:
    - Equipment class (see example, slide 65), volume and measure application type (RET/ROB)
    - Does team agree that this is the right approach?
  - POUs do not offer this deemed measure.
  - 2016 Offerings:
    - Low Temperature
    - Medium Temperature

1.17 Display Cases with Doors

- Methodology
  - 2016 approach matched for IOUs for electric savings
    - The building simulation models were generated from the DEER measure analysis tool within eQUEST 3-61R. The DEER model simulates a grocery store with a multiplex-compressor system for the refrigerated display cases. Since single-compressor systems are generally slightly less efficient than multiplex-compressor systems, only multiplex systems have been analyzed as a conservative estimate of savings. To be conservative, it is assumed that the generated energy savings of this work paper will also be applied to display cases with single-compressor systems.
    - This work paper applies to display cases located within a space with heating, cooling, and humidity controls. The unit energy savings are represented per linear-foot of the display case. The building simulation models were generated for a grocery store. Since the heat gain to a display case mainly depends on the temperature maintained for the display case and the surrounding space temperature, it is assumed that the building types would not have significant impact on the energy savings. Thus, the resulting savings of the grocery store model is applied to all other building types considered in this work paper.
  - 2017 approach for SCE varies by equipment class

1.17 Display Cases w/ Doors (SCE approach)

Equipment Family	Equipment Family Designation	Sample Equipment Family Image	Operating Mode Designation	Temperature Designation	Operating Temp.	Equipment Class Designation
Vertical Open	VOP		Remote Condensing (RC)	M (38 °F)	?32 °F	VOP.RC.M
Semi vertical Open	SVO			M (38 °F)	?32 °F	SVO.RC.M
Horizontal Open	HZO			L (0 °F)	<32 °F	HZO.RC.L
Vertical Closed Transparent	VCT			M (38 °F)	?32 °F	VCT.RC.M
				L (0 °F)	<32 °F	VCT.RC.L
Horizontal Closed Transparent	HCT		Self-Contained (SC)	L (0 °F)	<32 °F	HCT.SC.L
				I (-15 °F)	?-5 °F	HCT.SC.I
Horizontal Closed Solid	HCS			M (38 °F)	?32 °F	HCS.SC.M
Pull-Down	PD			M (38 °F)	?32 °F	PD.SC.M

Source: DOE rule making [A], Table 3.2.5 Commercial Refrigeration Equipment Classes

1.17 Display Cases w/ Doors SCE approach

Condensing Unit Configuration	Equipment Class Designation	Maximum Daily Energy Consumption (kWh/day)	Data Source:	No. of tot. units:	No. of Units eff > DOE2017	% of Units eff > DOE2017	Overall % eff > DOE2017
Remote (RC)	VOP.RC.M	0.64 x TDA + 4.07	DOE	682	238	35%	17%
	SVO.RC.M	0.66 x TDA + 3.18	DOE	2624	1443	55%	23%
	HZO.RC.L	0.55 x TDA + 6.88	DOE	132	125	95%	15%
	VCT.RC.M	0.15 x TDA + 1.95	DOE	9056	6827	75%	24%
	VCT.RC.L	0.49 x TDA + 2.61	DOE	7204	5270	73%	10%
Self-Contained (SC)	HCT.SC.L	0.08 x V + 1.23	Energy Star v4	3	3	100%	43%
	HCS.SC.M	0.05 x V + 0.91	Energy Star v4	21	13	62%	30%
Self-Contained (SC)	PD.SC.M	0.11 x V + 0.81	DOE	33	7	21%	8%
Self-Contained (SC)	HCT.SC.I	0.56 x TDA + 0.43	DOE	14	14	100%	13%

1.18 Add Medium Temp Case Doors

- Overview:
  - Savings vary by Offering, Climate Zone
  - Savings do not vary by IOU, Building Type or Vintage
  - POUs do not offer this deemed measure.
  - 2016 Offerings:
    - Baseline with Night Covers
    - Baseline without Night Covers

1.18 Add Medium Temp Case Doors

- Methodology
  - Good example of model's equipment description (App B).
  - The energy savings for this measure were determined by using detailed computer simulations based on the eQUEST Refrigeration Version 3.61/DOE-2.2R energy analysis program. The program calculates hour-by-hour building and refrigeration system energy consumption over an entire year (8760 hours) using CEC's Title 24 weather data for a representative city in each CEC-defined climate zone. Model outputs and the associated calculations are available in Appendix A.
  - The display cases impacted by the measure are modeled with remote compressors and air-cooled condensers, with the exception of Climate Zones 15 and 16 where an evaporative-cooled condenser was used in the model. There was no modeling of integral units, i.e. display cases with compressor and condenser contained within case. The majority of the open vertical cases are on a suction group connected to a multiplex compressor system, with the minority served by a stand-alone compressor in a condensing unit, i.e. a packaged compressor and condenser. PECI industry experience indicates multiplexes make up a majority of the targeted market for this measure therefore multiplexes were used for the measure modeled refrigeration systems. A survey of EnergySmart Grocer auditors and grocery store design engineers found that 90% of stand-alone refrigeration compressors are in condensing units and 10% are with remote compressors. The stand alone systems modeled for this work paper used only compressors in condensing units with 1 fan. Additional details of the refrigeration system are outlined in Appendix B.

1.18 Add Medium Temp Case Doors

Variable	Min Value	Typical Value	Max Value	Source
Supply Air Temp (deg F) (base/post)	28/24	32/28	37/33	Display case Manufacturer Specifications/SCE report [446]
Night covers (base only)	Reduce infiltration to 0.6 for 6 hrs/night	No reduction	_	SCE report [455]
Case light density (W/ft) (base/post)	8/16 16/11	16/16	48/48 16/29.8	Display case Manufacturer Specifications/LED specs
Case fan demand (W/ft) (base=post)	5	10	15	Display case Manufacturer Specifications
Increase Suction temperature (deg F) (post only)	4	0	_	SCE report [446], display case with doors manufacturer specs
Anti-Sweat heaters (W/ft) (post only)	_	0	16.8	door manufacturer specifications, frame heat
Coil Capacity (BTU/hr-ft) Infiltration (BTU/hr-ft) Conduction/Radiation (BTU/hr-ft) (base/post)	1100 896/195 143/46.2	1600 1331/324 208/67.2	2000 1679/427 260/84.0	Display case Manufacturer Specifications, SCE [455] and ASHRAE RP-1402 report [450]

1.18 Add Medium Temp Case Doors

Variable	Electric Savings (kWh/ft-yr)	Change from typical (%)	Gas Savings (therm/ft-year)	Total Energy Savings (kBTU/ft-yr)	Change from typical (%)
Typical	476		56.3	7,257	
min case supply temp (28 F)	500	-5%	57.9	7,496	-3%
max case supply temp (37 F)	441	7%	54.0	6,905	5%
min lights, base (1 row T8)	416	13%	57.6	7,174	1%
max lights, base (6 rows T8)	732	-54%	53.6	7,859	-8%
LED vertical lights, post	515	-8%	55.9	7,351	-1%
T8 vertical lights, post	367	23%	57.5	7,002	4%
min fan (5 watts/ft)	477	0%	56.6	7,287	0%
max fan (15 watts/ft)	476	0%	56.2	7,243	0%
night covers, base	432	9%	50.9	6,560	10%
increase SST, post (+4 F)	504	-6%	58.9	7,611	-5%
add ASH to frame, post	304	36%	58.8	6,917	5%
max lights base = max light post	480	-1%	56.3	7,268	0%
min lights base=min lights post	479	-1%	56.9	7,323	-1%
min coil capacity (1100 BTU/hr-ft)	499	-5%	58.7	7,570	-4%
max coil capacity (2000 BTU/hr-ft)	473	1%	56.1	7,225	0%

1.19 Adaptive Refrigerator and Freezer Controls

- Overview:
  - Savings vary by Offering, Climate Zone, Building Type
  - Savings do not vary by IOU or Vintage
  - Unit of Measure is “cap-tons”; other evap system control are “each”
  - Offered by PG&E only
  - POUs do not offer this deemed measure.
  - 2016 Offerings:
    - Refrigerator/Cooler
    - Freezer (includes therm savings)

1.19 Adaptive Refrigerator and Freezer Controls

- Methodology
  - The building simulation models were generated for a Grocery Store with multiplex-compressor systems for the refrigeration walk-in coolers and freezers. Single-compressor systems are less efficient than multiplex-compressor systems. According to the DEER Report [3], single-compressor systems were typically designed prior to 1980. To be conservative, it is assumed that the generated energy savings for this work paper will also be applied to walk-in cooler and freezer with single-compressor systems.
  - A set of sensitivity analyses for two additional building types (Fast Food Restaurant and Small Retail) at two extreme weather conditions for one Building Vintage are performed. Refer to the end of this section for discussion.
    - As a result, the study shows that the savings estimated by the Fast Food Restaurant and Small Retail models are within 3% discrepancy compared to savings estimated by the Grocery models for the same building vintage. (Att C)
  - Models available in folder.

1.20 Strip Curtains

- Overview:
  - POUs offer this deemed measure.

Measure On Hold

1.21 Ultra Low Temperature Freezer

- Overview:
  - Workpaper not yet available form PG&E.
  - POUs are currently offering this deemed Measure.

Measure On Hold

1.22 Commercial Reach-In Refrigerators and Freezers

- Overview:
  - Savings vary by Offering, IOU (SDG&E savings are different, but methodology identical; references SCE13CCC001, Rev 2 – down rev)
    - Confirm that SDG&E savings should match other IOUs.
  - Savings do not vary by Climate Zone, Building Type, Vintage
  - POUs have the same offerings
  - Some offerings only by some IOUs (see chart on next slide)
    - Confirm the correct set of offerings
  - Discuss the purpose of the CDF factor for this Measure.
  - 2016 Offerings:
    - Refrig / Freezer
    - Solid / Glass Door
    - Size: <15 (under-counter), 15-29 (single door), 30-49 (double door), >50 (triple door) cubic feet

1.22 Commercial Reach-In Refrigerators and Freezers

- Offerings (savings kWh/unit)

Offering	PGE	SCE	SDGE
50 cubic feet Solid-Door Reach-In Freezer	4,552	4,552	5,108
50 cubic feet Solid-Door Reach-In Refrigerator	1,279	1,279	1,415
< 15 cubic feet Glass-Door Reach-In Refrigerator	723	723	
< 15 cubic feet Solid-Door Reach-In Freezer	595	595	679
< 15 cubic feet Solid-Door Reach-In Refrigerator	270	270	305
>50 cubic feet Glass-Door Reach-In Refrigerator	934	934	1,044
15 - 29 cubic feet Glass-Door Reach-In Refrigerator	661	661	738
15 - 29 cubic feet Solid-Door Reach-In Freezer	869	869	987
15 - 29 cubic feet Solid-Door Reach-In Refrigerator	493	493	554
30 - 49 cubic feet Glass-Door Reach-In Freezer		4,599	
30 - 49 cubic feet Glass-Door Reach-In Refrigerator	775	775	
30 - 49 cubic feet Solid-Door Reach-In Freezer	2,074	2,074	2,328
30 - 49 cubic feet Solid-Door Reach-In Refrigerator	854	854	924

- POU savings match
  - IOUs do not incent many glass door freezer options.

1.22 Commercial Reach-In Refrigerators and Freezers

- POU/TRM Offerings (savings kWh/unit)

		Unit Volume (Cu ft)			
	Door Type	< 15	15–29	29–49	>49
Refrigerator savings (kWh/yr)	Solid door	270	493	854	1,279
	Glass door	723	661	773	934
Freezer savings (kWh/yr)	Solid door	595	869	2,074	4,552
	Glass door	1,693	2,010	4,599	8,103

		Unit Volume (Cu ft)			
	Door Type	< 15	15–29	29–49	>49
Refrigerator incremental cost ($)	Solid door	$961	$1,241	$1,732	$2,396
	Glass door	$91	$760	$947	$1,363
Freezer incremental cost ($)	Solid door	$227	$1,200	$1,370	$1,732
	Glass door	$22	$109	$189	$791

1.22 Commercial Reach-In Refrigerators and Freezers

- Methodology
  - Baseline of Federal Requirement

Equipment Description (cubic feet)	Daily Energy Usage (kWh/day)
Solid-Door Reach-In Refrigerator	≤ 0.100V+2.04*
Solid-Door Reach-In Freezer	≤ 0.400V+1.38
Glass-Door Reach-In Refrigerator	≤ 0.120V+3.34
Glass-Door Reach-In Freezer	≤ 0.750V+4.10

  - Measure case of EnergyStar 2.0 Requirement

Equipment Description (cubic feet)	Daily Energy Usage (kWh/day)
Solid-Door Reach-In Refrigerator	
0 < V < 15	≤ 0.089V + 1.411*
15 ≤ V < 30	≤ 0.037V + 2.200
30 ≤ V < 50	≤ 0.056V + 1.635
50 ≤ V	≤ 0.060V + 1.416
Solid-Door Reach-In Freezer	
0 < V < 15	≤ 0.250V + 1.250
15 ≤ V < 30	≤ 0.400V – 1.000
30 ≤ V < 50	≤ 0.163V + 6.125
50 ≤ V	≤ 0.158V + 6.333

Glass-Door Reach-In Refrigerator	
0 < V < 15	≤ 0.118V + 1.382
15 ≤ V < 30	≤ 0.140V + 1.050
30 ≤ V < 50	≤ 0.088V + 2.625
50 ≤ V	≤ 0.110V + 1.500
Glass-Door Reach-In Freezer	
0 < V < 15	≤ 0.607V + 0.893
15 ≤ V < 30	≤ 0.733V - 1.000
30 ≤ V < 50	≤ 0.250V + 13.500
50 ≤ V	≤ 0.450V + 3.500

Additional Consolidation

- 1.03 Evaporator Fan Motors
- 1.11 Display Case ECM Motor Retrofit
  - 1.11 represents a specific offering from 1.03

- 1.06 Refrigeration Head Pressure Controls
- 1.14 Floating Head Pressure - Single Compressors
  - Measures include several varieties of controls

- 1.02 Anti-Sweat Heater Display Doors
- 1.17 Display Cases with Doors
- 1.18 Add Med Temp Case Doors
  - Variety of measures to Add/Replace Doors or Replace Cases

Understanding the Baseline Model

Measure Number	Measure Name	DOE2.2r Modeled Measure
1.01	Anti-Sweat Heater (ASH) Controls	Yes
1.02	Anti-Sweat Heater Display Doors	Yes
1.03	Evaporator Fan Motors	Yes
1.11	Display Case ECM Motor Retrofit	Partial
1.05	Walk-in Cooler Evaporative Fan Cycling and VFD Control	Yes
1.04	Refrigerated Storage Auto Closer	Yes
1.06	Refrigeration Head Pressure Controls	Yes - DEER only
1.07	Refrigeration Night Covers	Yes
1.08	Bare Refrigeration Line Insulation	No
1.09	Add Doors to Walk-in Cooler	Partial
1.10	Compressor Retrofit: Multiplex	Yes - DEER only
1.12	Efficient Condenser: Air-Cooled to Evap	Yes - DEER only
1.13	Efficient Condenser: Multiplex	Yes - DEER only
1.14	Floating Head Pressure - Single Compressors	Yes
1.15	Low Temp Coffin to Reach-In	No
1.16	Medium Temp Open Case Retrofit	Partial
1.17	Display Cases with Doors	Yes
1.18	Add Med Temp Case Doors	Yes
1.19	Adaptive Refrigerator and Freezer Controls Comm	Yes
1.20	Strip curtain infiltration barrier for refrigerated space	n/a
1.21	Ultra Low Temperature Freezer	n/a
1.22	Commercial Reach-In Refrigerators and Freezers	No

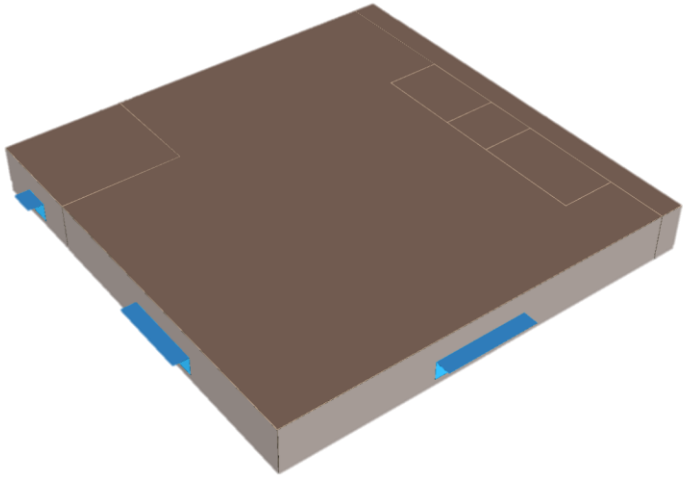
Partial = Engineering calculation that relies on Full Load Hours that is calculated through DOE2.2r

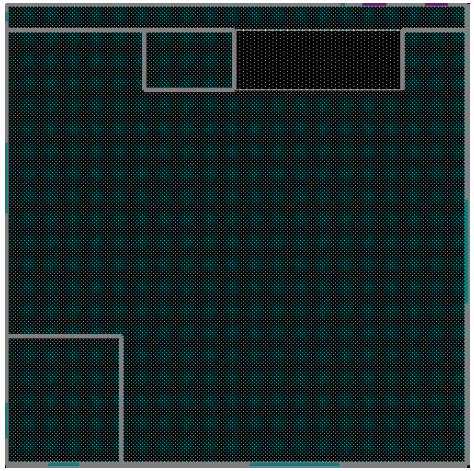
Yes – DEER only = Results in DEER come from modeling in DOE2.2r, but models are not available to review for direct comparison

No = Pure Excel-based engineering calculation is used

n/a = Measure not planned for consolidation

Understanding the Baseline Model





System & Zone Name	System Type Principal Zone Activity	Ret Zn	Area sqft
EL1 Sys1 (PVVT) (G.SW2)	Pkgd Var Vol Var Temp	D	3,500
··· EL1 SW Perim Zn (G.SW2)	(unknown)	C	3,500

System & Zone Name	System Type Principal Zone Activity	Type* Ret Zn	D Area sqft
EL1 Sys1 (PVVT) (G.N3)	Pkgd Var Vol Var Temp	D	2,851
··· EL1 North Perim Zn (G.N3)	(unknown)	C	2,851

System & Zone Name	System Type Principal Zone Activity	Type* Ret Zn	D Area sqft
EL1 Sys2 (PVVT) (G.SSE1)	Pkgd Var Vol Var Temp	D	40,007
··· EL1 SSE Perim Zn (G.SSE1)	(unknown)	C	40,007

System & Zone Name	System Type Principal Zone Activity	Type* Ret Zn	D Area sqft
Freezer_System	Pkgd Var Vol Var Temp	d	812
··· Freezer_Zone	(unknown)	S	812

System & Zone Name	System Type Principal Zone Activity	Ret Zn	Area sqft
Cooler_System	Pkgd Var Vol Var Temp	d	1,560
··· Cooler_Zone	(unknown)	S	1,560

System & Zone Name	System Type Principal Zone Activity	Type* Ret Zn	D Area sqft
PrepRoom_System	Pkgd Var Vol Var Temp	d	1,267
··· PrepRoom_Zone	(unknown)	S	1,267

Project Totals		Type*	D
System & Zone Name	System Type Principal Zone Activity	Ret Zn	Area sqft
Sum of SYSTEMs	··	··	49,997

Understanding the Baseline Model

Item	DEER Model - 1.02
Refrigerant	R507
System Type	
Compressor Type and Suction Groups	LT Semi-Hermetic: 3db3-0750-R507A 3ds3-100e-R507A (x3) 4dl3-150e-R507A 4dt3-2200-R507A (x4) MT Semi-Hermetic: 2da3-075e-R507A 3db3-100e-R507A (x2) 3db3-100e-R507A 3ds-150e-R507A (x5)
Means of compressor control	Fixed setpoint electronic sequencing control with on/off cycling
Subcooling	yes
Condenser Type	LT air-cooled remote condenser 4, cycling fans MT air-cooled remote condenser 4, cycling fans
Condenser Selection Design TD	10°F TD for LT air-cooled condensers 15°F TD for MT air-cooled condensers
Condenser Fans: Motor Power	Air-cooled LT: 4-1 HP fans Air-cooled MT: 4- 1 Hp fans

Item	DEER Model - 1.02
Means of Condenser Control	Fixed setpoint strategy Air cooled: fan cycling (based on pressure)
Condensing Temperature Setpoint	80F SCT (LT & MT) 78F backflood control
Heat Recovery (domestic hot water heating)	None
Display Cases and walk-ins served by LT System	LT_Frozen Food, Reach-in - 1 LT_Frozen Food, Reach-in - 2 LT_IC, Reach-in LT_Dual Temp - 1 LT_Dual Temp - 2
Display Case served by MT System	MT_Meat - 1 MT_Fish MT_MelonBakery MT_DeliPasta MT_ServDeli MT_Meat - 2 MT_Meat - 3 MT_Dairy1 MT_Dairy2 MT_Produce

Understanding the Baseline Model

Measure Number	Measure Name	DOE2.2r Modeled Measure
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1.19	Adaptive Refrigerator and Freezer Controls Comm	Yes
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1.21	Ultra Low Temperature Freezer	n/a
1.22	Commercial Reach-In Refrigerators and Freezers	No

Compared to 1.02 model:

- No refrig assignment changes
- Many refrig fixture changes
- No HVAC perf. changes

- Refrig fixture:
  Fan kW/door changes
- Added LT-VOP fixture

- No refrig assignment changes
- Minor refrig fixture changes
- Many HVAC performance changes

- Some refrig system changes
- DHW changes
- Many HVAC changes
- Many Refrig fixture changes

Concerns for the Baseline Model

- Taken from “Assessment of DEER Grocery Model”
  - Prepared by PECI, February 2011
  - Based upon audit data
    - 4,368 stores (convenient, grocery, supermarket)
- Now we will discuss issue that existed in 2011:
  - Refrigeration System Design
  - Refrigeration Load
  - Scheduling
  - HVAC
- *Goal: Can we identify issues that still exist?*

Concerns for the Baseline Model

- Taken from "Assessment of DEER Grocery Model"
  - Prepared by PECI, February 2011
  - Based upon audit data
    - 4,368 stores (convenient, grocery, supermarket)
- Refrigeration System Design
  - Compressor System Type
    - *Multiplex* assumption improves efficiency vs *Single Compressor* efficiency
    - Good for supermarket; 55% for grocery store; 2% for convenient store (increases savings)
  - Mechanical Sub-cooling
    - *Sub-cooling* assumption improves efficiency
    - Pre-2002 does not have; only 26% of sales ('99 – '09) included sub-cooling (increases savings)
  - Compressor Groups
    - More Compressor Groups improves efficiency
    - Most supermarkets have 2 LT groups and 3 MT groups (decreases savings)
  - Compressor Sizing
    - Increasing the sizing factor (up to 1.6) decreases system efficiency
    - Designs typically use a sizing factor of 1.2 (times the evaporator load) (increases or decreases savings)
  - Condenser Capacity
    - Condenser size is varied by vintage and capacities used in air- and evap-cooled condensers
    - Designs typically vary by climate zone (increases or decreases savings)

Concerns for the Baseline Model

- Refrigeration Load
  - Display Cases
    - Modeled as Refrig System Load rather than Plug-and-Process Load
    - Convenient store data (353 stores) shows 28% have self-contained compressors
    - Measures that do not distinguish LT/MT should account more accurately to the mix of LT/MT (DEER – 51%/49%; data – 35%/65%)
  - Display Case Evaporator Motors
    - Motor population assumptions effect loads and savings

	DEER 2005	PECI Supermarkets
7-12 watts (represented by 9W)	70%	10%
16-23 watts (represented by 19.5W)	27%	50%
1/20 HP (37W)	3%	40%

    - ECM efficiency assumption (DEER – 58%; data – 65-80%)
  - Refrigeration Load of Walk-in Coolers and Freezers
    - Modeling of Walk-in Cooler/Freezer design differs

Concerns for the Baseline Model

- Refrigeration Load
  - Refrigeration Load of Walk-in Coolers and Freezers
    - Modeling of Walk-in Cooler/Freezer design differs

	DEER 2005	PECI supermarkets	Affect on refrig. load
Number of walk-ins	3	8	PECI higher
Size of walk-ins	Range of 813 ft^2 to 1560 ft^2	437 ft^2 (avg)	DEER higher
Number of walk-in reach-ins	0	1	PECI higher
Size of walk-in reach ins	n/a	657 ft^2 (avg)	PECI higher
Height of walk-ins	25 ft	8-12 ft	DEER higher
Percent of LT Walk-ins	33%	25%	--
Percent of MT Walk-ins	66%	75%	--
Lowest Suction Temp	-9 °F	-20 °F	PECI higher
Walls adjacent to	Outside/sales floor	Unconditioned storage/sales floor	DEER higher

Concerns for the Baseline Model

- Scheduling
  - Assumption on occupancy data uses 16 hrs/day for all stores
  - Data shows 18 hrs/day for supermarkets (485 stores) and 14 hrs/day for convenient stores (497 stores)
  - Sensitive variable for some measures, like Night Covers (savings increases) and Reach-In Case Lights (savings decreases)
- HVAC
  - Requirement for OA volume driven by occupancy

	Occupancy Density (people/1000ft^2)
DEER 2005	22
NREL[8]	8
ASHRAE[9]	8

  - Assumption of operable economizers after 1978

Concerns for the Baseline Model

MEASURE	DEER 2005 ID	UNIT	DEER 2005 kWh Savings / Unit	PECI SMKT kWh Savings / Unit	Difference
Efficient condenser for evaporatively cooled multiplex	D03-213	TONS	1,917	1,719	-10%
Evaporator coil motors—for refrigerated display case—shaded pole to electronically commutated motor	D03-203	LINEAR FT	116	312	169%
Floating head pressure control (FHPC) for evaporatively cooled-condenser	D03-224	TONS	1,765	1,972	12%
FHPC for evaporatively cooled condensers with variable frequency drives	D03-226	TONS	1,800	1,991	11%
Night covers—vertical	D03-205	LINEAR FT	16	73	344%

Future Meetings Info

- Sensitivity Discussion