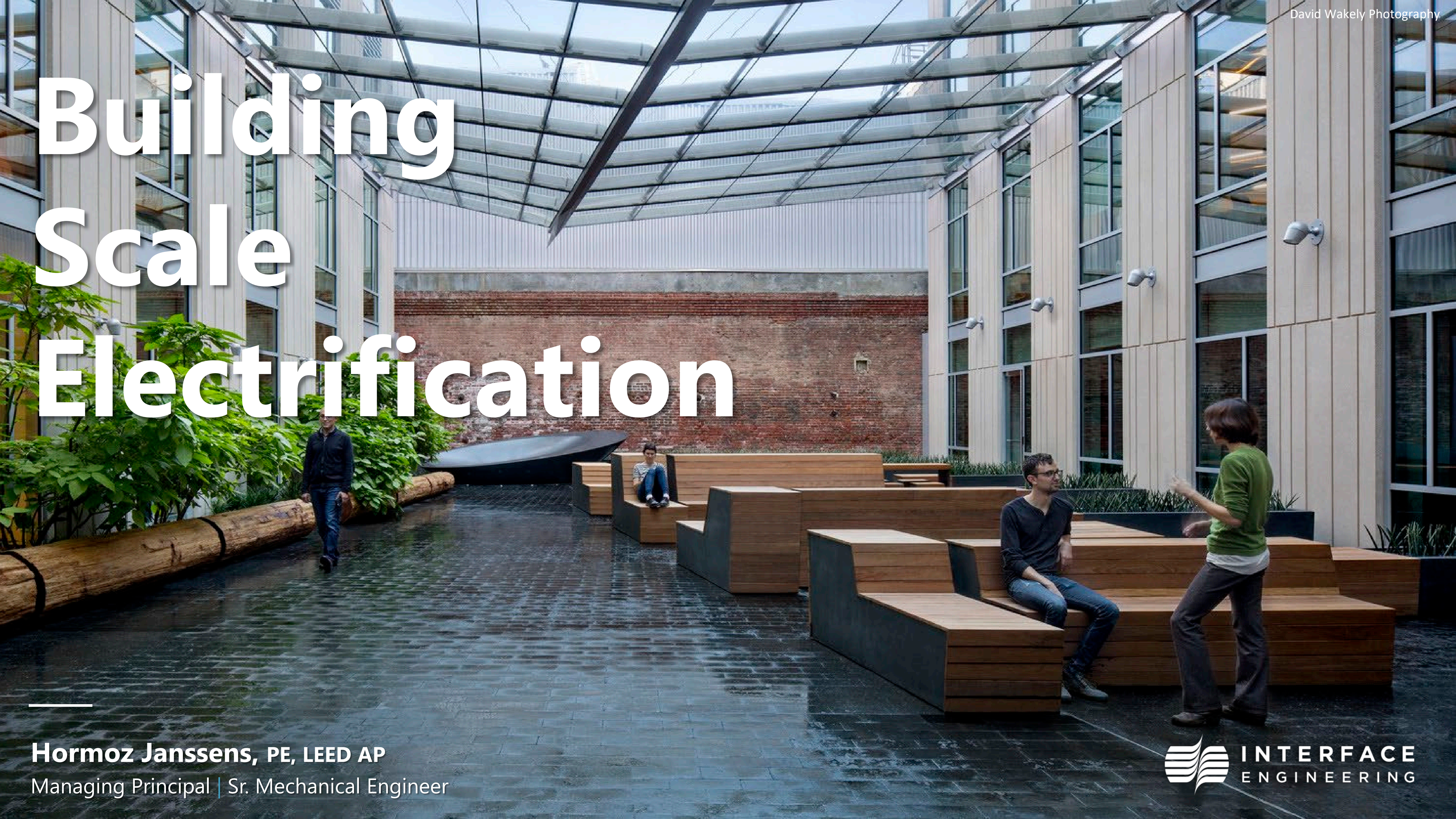


David Wakely Photography

Building Scale Electrification

Hormoz Janssens, PE, LEED AP
Managing Principal | Sr. Mechanical Engineer

INTERFACE ENGINEERING

Why electrification

University of Oregon John E. Jaqua
Academic Center for Student Athletes
ZGF Architects
Stephen Cridland

What's the Difference

- Electric solutions lower site energy
- Electric solutions allow for more sources of heat exchange
- Electric solutions allow for direct tie-into renewable sources
- Electric solutions eliminate on-site sources of combustion
- Electric solutions can eliminate heating plants
- Electric solutions can reduce or eliminate site natural gas piping and associated long term maintenance

The Falk School of Sustainability at Eden Hall Campus, Chatham University Design & Master Plan / LEED Platinum + Net Zero Energy Goals
Mithun
Bruce Damonte

In the classroom

University of Oregon John E. Jaqua
Academic Center for Student Athletes
ZGF Architects
Stephen Cridland

Example – Air Source Heat Pump

New Classroom Building

- Budget: Package Gas Rooftops
- Solution: Heat Pumps with Radiant Heated and Cooled Slabs and Natural Ventilation
- Result: 65% reduction in heating energy, 80-90% heating reduction during simultaneous heating and cooling
- More than doubled free area for installed photovoltaic generation

White Hill Middle School Masterplan and Design of Multi-Use and Classroom Buildings
WRNS Studio
Michael David Rose

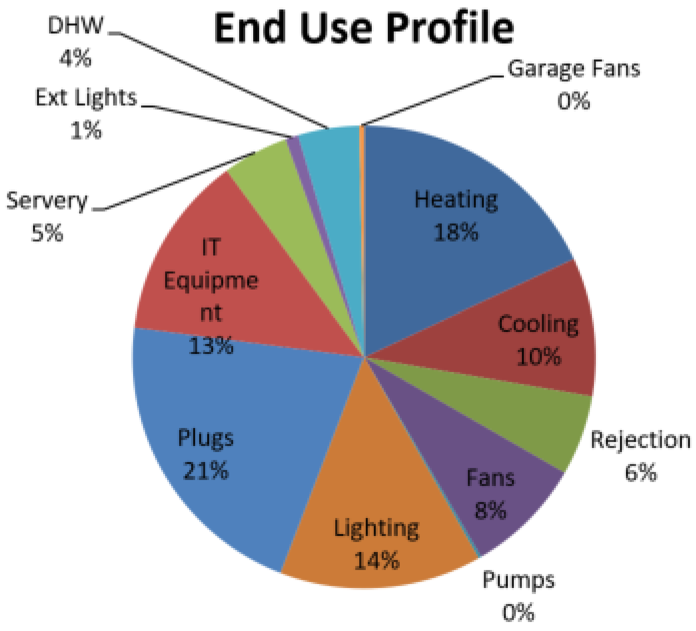
In the workplace

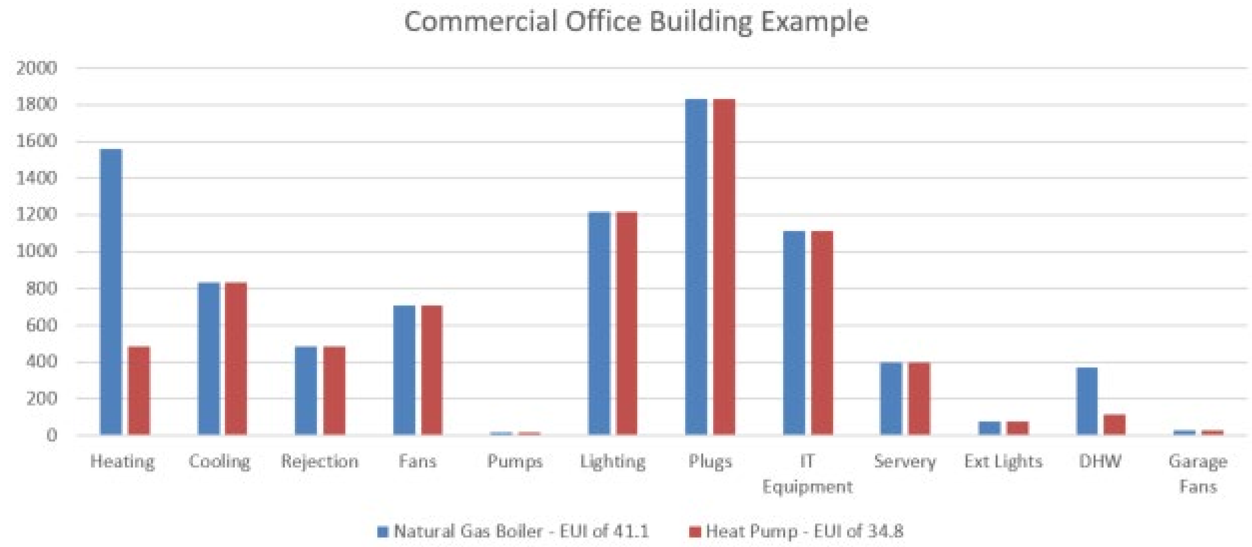
University of Oregon John E. Jaqua Academic Center for Student Athletes
ZGF Architects
Stephen Cridland

Example – Office Building

Energy Impact

- All electric heating / cooling
- Average High Tech Office
- Reduced Energy: 15%
- Reduced Heating: 62%
- Increases PV Area: 20%+

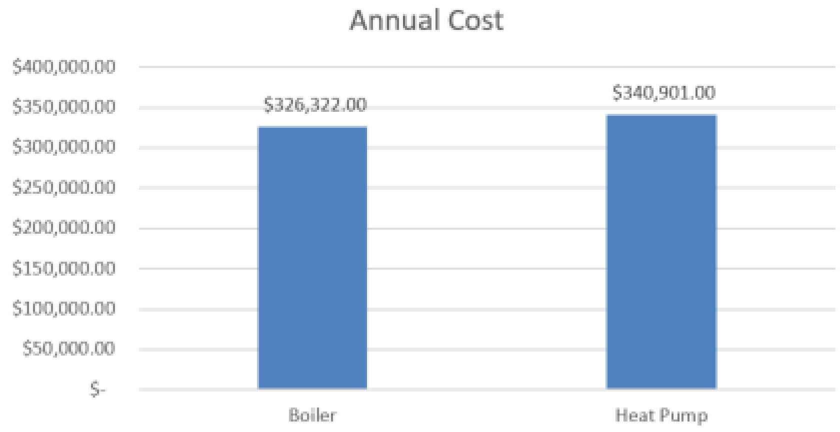




Example – Office Building

Financials - ZNE

- No First Cost Increase
- Energy Cost Slight Increase Prior to Renewables



- PV Required:
  - Assuming 1,250 kWh per installed kW
  - 816 kW vs. 963 kW
- PV Cost Savings = $514,500 (@$3.50/Watt)
- Add in Heat Recovery and ROI = 0 years

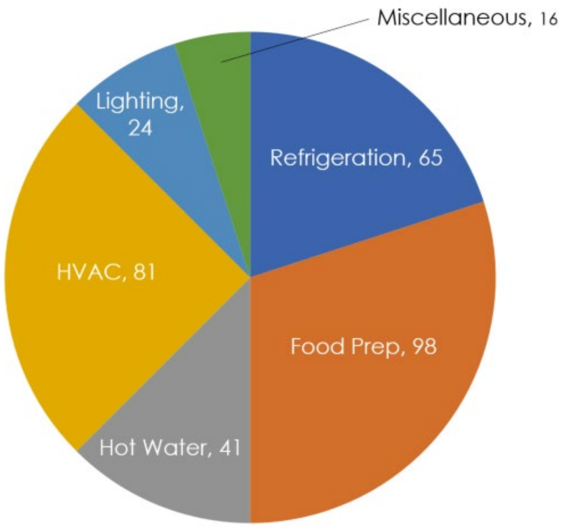
In the impossible

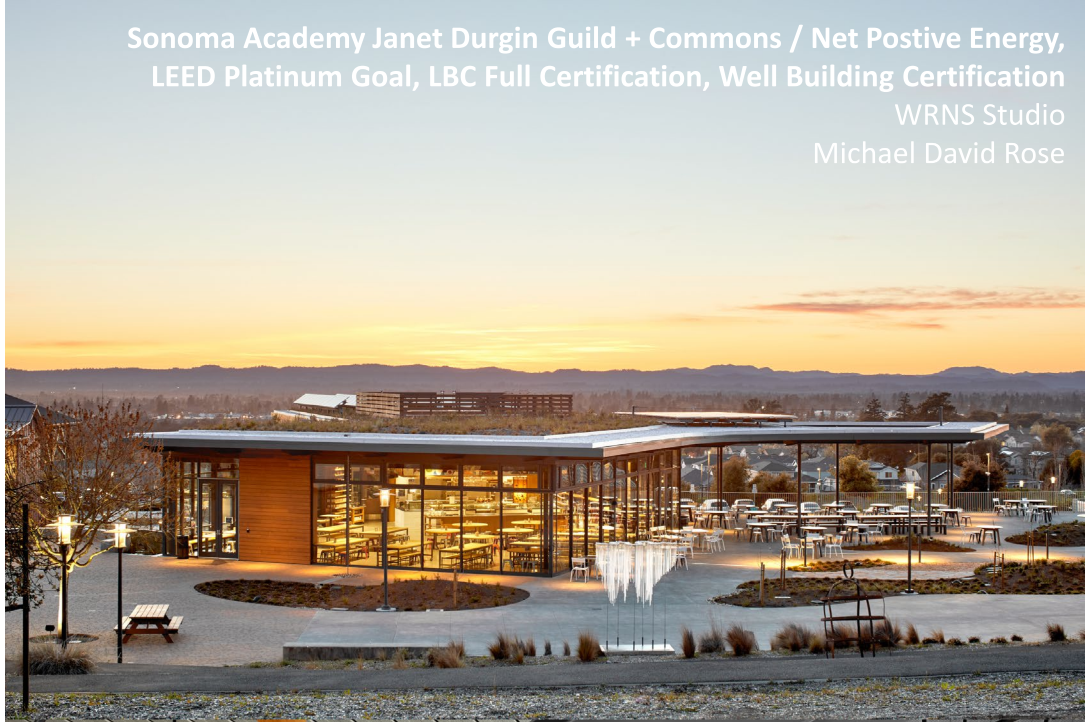
University of Oregon John E. Jaqua
Academic Center for Student Athletes
ZGF Architects
Stephen Cridland

Example – Food Service

Electrification of Cooking

- Starting Point:
  - Average Food Service Facilities EUI 250-400
- For a typical 20,000 ft^2 food service facility:
  - 1,900,000 kWh (averaged at EUI = 325)
  - 1,520 kW (@1,250 kWh per installed kW)

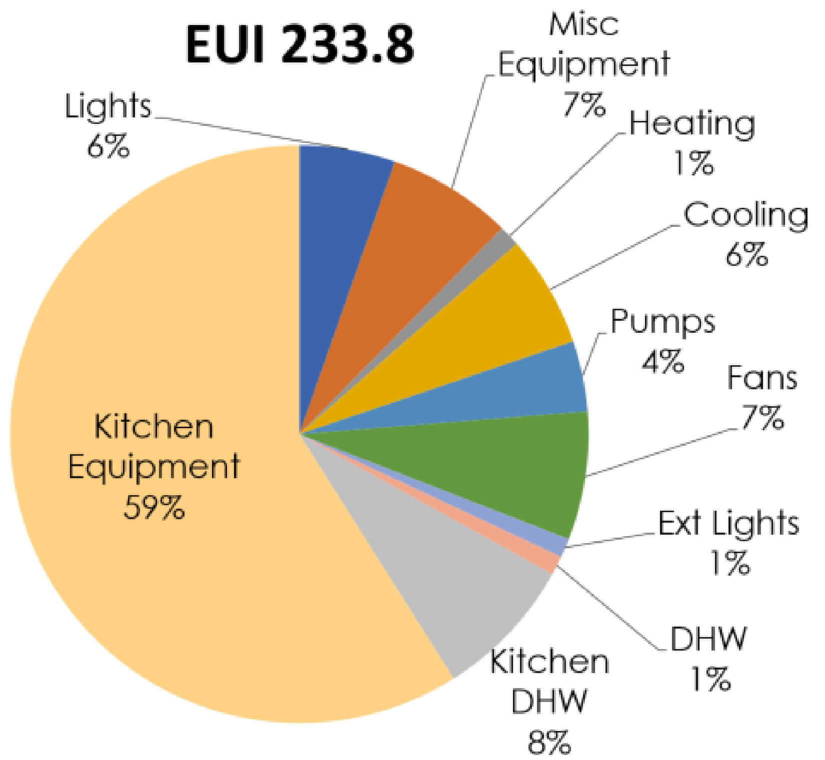




Example – Food Service

Electrification of Cooking

- Reduce from EUI = 325 to EUI = 233 through electrification and induction:
- For a typical 20,000 ft^2 food service facility:
  - 1,365 kWh (averaged at EUI = 233)
  - 1,092 kW (@1,250 kWh per installed kW)
  - 28% reduction in PV
  - $1,498,000 PV Cost Savings



Example – Food Service

Next Steps

- Information Gathering, ASHRAE Fundamentals Chapter 18
- Food Service Coordination

Table 5E Recommended Rates of Radiant and Convective Heat Gain from Warewashing Equipment During Idle (Standby) or Washing Conditions

Appliance	Energy Rate, Btu/h		Rate of Heat Gain, Btu/h: Unhooded				Rate of Heat Gain, Btu/h: Hooded		
	Rated	Standby/ Washing	Sensible Radiant	Sensible Convective	Latent	Total	Sensible Radiant	Usage Factor F_u	Radiation Factor F_r
Dishwasher (conveyor type, chemical sanitizing)	46,800	5700/43,600	0	4450	13490	17940	0	0.36	0
Dishwasher (conveyor type, hot-water sanitizing) standby	46,800	5700/N/A	0	4750	16970	21720	0	N/A	0
Dishwasher (door-type, chemical sanitizing) washing	18,400	1200/13,300	0	1980	2790	4770	0	0.26	0
Dishwasher (door-type, hot-water sanitizing) washing	18,400	1200/13,300	0	1980	2790	4770	0	0.26	0
Dishwasher* (under-counter type, chemical sanitizing) standby	26,600	1200/18,700	0	2280	4170	6450	0	0.35	0.00
Dishwasher* (under-counter type, hot-water sanitizing) standby	26,600	1700/19,700	800	1040	3010	4850	800	0.27	0.34
Booster heater*	130,000	0	500	0	0	0	500	0	N/A

Note: Heat load values are prorated for 30% washing and 70% standby. *Source*: Swierczyna et al. (2008, 2009).

Chatham Commons / LEED Platinum + Net Zero Energy Goals
Mithun
Phil Pavely

Table 5C Recommended Rates of Radiant Heat Gain from Hooded Gas Appliances During Idle (Ready-to-Cook) Conditions

Appliance	Energy Rate, Btu/h: Rated	Energy Rate, Btu/h: Standby	Rate of Heat Gain, Btu/h: Sensible Radiant	Usage Factor F_u	Radiation Factor F_r
Broiler: batch*	95,000	69,200	8,100	0.73	0.12
Broiler: chain (conveyor)	132,000	96,700	13,200	0.73	0.14
Broiler: overfired (upright)*	100,000	87,900	2,500	0.88	0.03
Broiler: underfired 3 ft	96,000	73,900	9,000	0.77	0.12
Fryer: doughnut	44,000	12,400	2,900	0.28	0.23
Fryer: open deep-fat, 1 vat	80,000	4,700	1,100	0.06	0.23
Fryer: pressure	80,000	9,000	800	0.11	0.09
Griddle: double sided 3 ft (clamshell down)*	108,200	8,000	1,800	0.07	0.23
Griddle: double sided 3 ft (clamshell up)*	108,200	14,700	4,900	0.14	0.33
Griddle: flat 3 ft	90,000	20,400	3,700	0.23	0.18
Oven: combi: combi-mode*	75,700	6,000	400	0.08	0.07
Oven: combi: convection mode	75,700	5,800	1,000	0.08	0.17
Oven: convection full-size	44,000	11,900	1,000	0.27	0.08
Oven: conveyor (pizza)	170,000	68,300	7,800	0.4	0.11
Oven: deck	105,000	20,500	3,500	0.2	0.17
Oven: rack mini-rotating*	56,300	4,500	1,100	0.08	0.24
Pasta cooker*	80,000	23,700	0	0.3	0
Range top: top off/oven on*	25,000	7,400	2,000	0.3	0.27
Range top: 3 burners on/oven off	120,000	60,100	7,100	0.5	0.12
Range top: 6 burners on/oven off	120,000	120,800	11,500	1.01	0.1
Range top: 6 burners on/oven on	145,000	122,900	13,600	0.85	0.11
Range: wok*	99,000	87,400	5,200	0.88	0.06
Rethermalizer*	90,000	23,300	11,500	0.26	0.49
Rice cooker*	35,000	500	300	0.01	0.6
Salamander*	35,000	33,300	5,300	0.95	0.16
Steam kettle: large (60 gal) simmer lid down*	145,000	5,400	0	0.04	0
Steam kettle: small (10 gal) simmer lid down*	52,000	3,300	300	0.06	0.09
Steam kettle: small (40 gal) simmer lid down	100,000	4,300	0	0.04	0
Steamer: compartment: atmospheric *	26,000	8,300	0	0.32	0
Tilting skillet/braising pan	104,000	10,400	400	0.1	0.04

Source: Swierczyna et al. (2008, 2009).

Table 5B Recommended Rates of Radiant Heat Gain from Hooded Electric Appliances During Idle (Ready-to-Cook) Conditions

Appliance	Energy Rate, Btu/h: Rated	Energy Rate, Btu/h: Standby	Rate of Heat Gain, Btu/h: Sensible Radiant	Usage Factor F_u	Radiation Factor F_r
Broiler: underfired 3 ft	36,900	30,900	10,800	0.84	0.35
Cheesemelter*	12,300	11,900	4,600	0.97	0.39
Fryer: kettle	99,000	1,800	500	0.02	0.28
Fryer: open deep-fat, 1-vat	47,800	2,800	1,000	0.06	0.36
Fryer: pressure	46,100	2,700	500	0.06	0.19
Griddle: double sided 3 ft (clamshell down)*	72,400	6,900	1,400	0.1	0.2
Griddle: double sided 3 ft (clamshell up)*	72,400	11,500	3,600	0.16	0.31
Griddle: flat 3 ft	58,400	11,500	4,500	0.2	0.39
Griddle-small 3 ft*	30,700	6,100	2,700	0.2	0.44
Induction cooktop*	71,700	0	0	0	0
Induction wok*	11,900	0	0	0	0
Oven: combi: combi-mode*	56,000	5,500	800	0.1	0.15
Oven: combi: convection mode	56,000	5,500	1,400	0.1	0.25
Oven: convection full-size	41,300	6,700	1,500	0.16	0.22
Oven: convection half-size*	18,800	3,700	500	0.2	0.14
Pasta cooker*	75,100	8,500	0	0.11	0
Range top: top off/oven on*	16,600	4,000	1,000	0.24	0.25
Range top: 3 elements on/oven off	51,200	15,400	6,300	0.3	0.41
Range top: 6 elements on/oven off	51,200	33,200	13,900	0.65	0.42
Range top: 6 elements on/oven on	67,800	36,400	14,500	0.54	0.4
Range: hot-top	54,000	51,300	11,800	0.95	0.23
Rotisserie*	37,900	13,800	4,500	0.36	0.33
Salamander*	23,900	23,300	7,000	0.97	0.3
Steam kettle: large (60 gal) simmer lid down*	110,600	2,600	100	0.02	0.04
Steam kettle: small (40 gal) simmer lid down*	73,700	1,800	300	0.02	0.17
Steamer: compartment: atmospheric*	33,400	15,300	200	0.46	0.01
Tilting skillet/braising pan	32,900	5,300	0	0.16	0

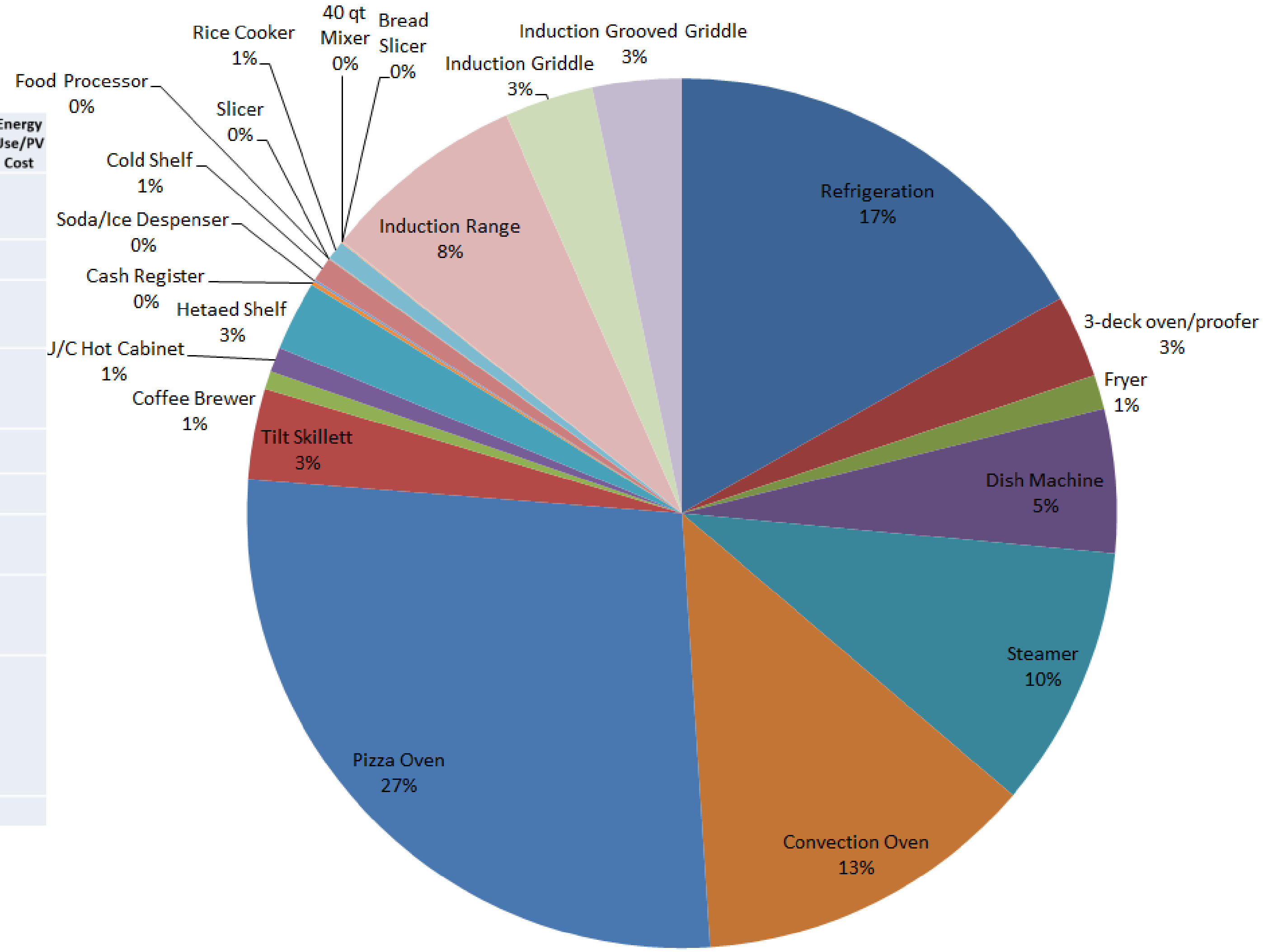
Source: Swierczyna et al. (2008, 2009).

Example – Food Service

Next Steps

- Modeling each specific end use by equipment
- Kitchen and Menu Charrette

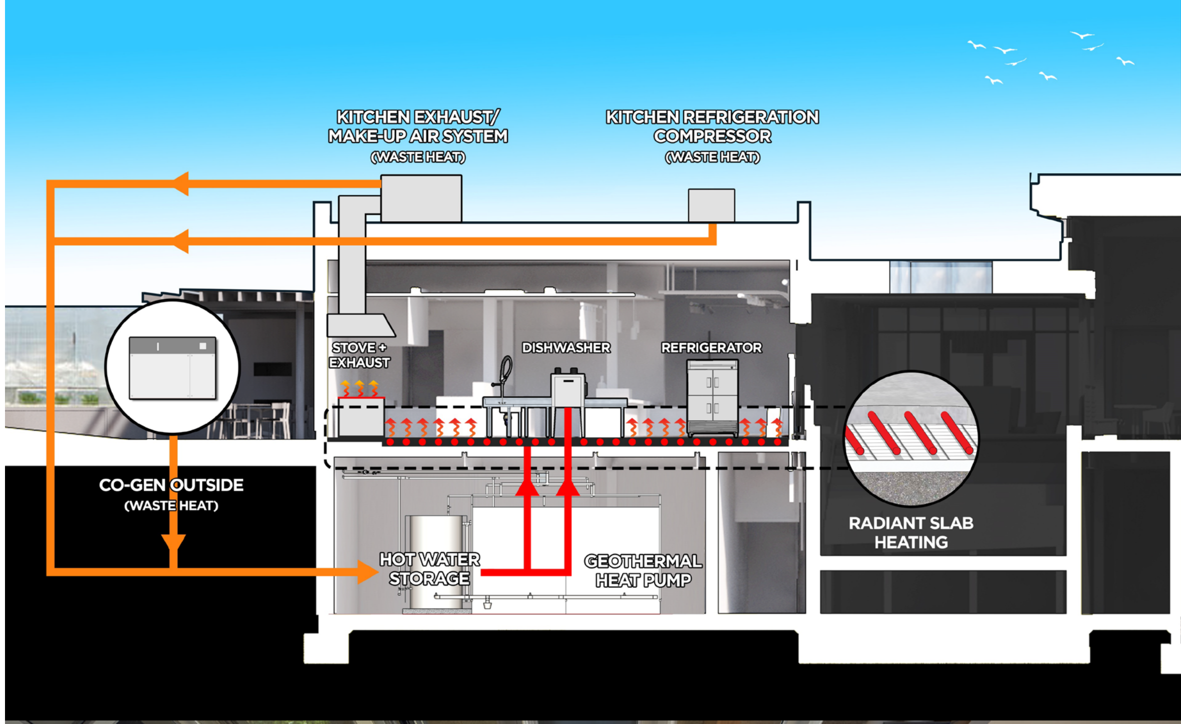
Item	Standard Practice	Energy Use/PV Cost	Efficient Practice	Energy Use/PV Cost	Radical Energy Reduction	Energy Use/PV Cost
Walk in cooler/freezer	Air-cooled compressor with heat rejection to atmosphere or indoors		Water-cooled compressors using geothermal loop		Water-cooled compressors using geothermal loop and air side economizer. Refrigeration heat recovery to domestic hot water system	
TMA	Typical design is outdoor air cooled		Current design is indoor water cooled remote refrigeration		Heat recovery can be added to refrigeration system	
U/C Refrigerator	Standard Energy Star Equipment		Super-insulated refrigerators		Can food service be done in such a manner to limit the need of U/C refrigerator	
TMA	Energy star will be provided		Super-Insulated does not provide any substantial savings due to the typical operation of the unit (Opening/Closing Door, etc.		Undercounter Refrigeration can be eliminated. This will require additional labor with trips to the main cold storage room.	
Dish Machine	Water conserving dishwasher		Super low water use dishwasher		Super low water use dishwasher with heat recovery	
TMA			Super low unit will be specified		Units in the size proposed for this project are not available with heat recovery.	
Display Oven			Can this equipment be utilized to provide warm meals only twice a day		Can this equipment be utilizied to only provide one hot meal a day? Is a display oven required for a super efficeint food service facility	
TMA			Owner/Operator decision on quantity of hot meals served per day - factor pre heat time/operational training		High speed convection microwave oven could be a replacement. Owner/Operator decision	
Soda/Ice Dispenser					Is ice dispensing really required or can beverages be kept cold in the basement or refrigerators and only brought out just in time for meals? Can there be other drinks provided that do not require a soda machine? Is soda what a healthy campus should be serving as schools are pulling soda machines out of their cafeterias?	
TMA	Energy Star rated unit				Eliminate, Owner/Operator decision	



Example – Food Service

Results

- EUI of approximately 98
- For a typical 20,000 ft^2 food service facility:
  - 570 kWh (averaged at EUI = 98)
  - 456 kW (@1,250 kWh per installed kW)
  - 70% reduction in PV
  - $3,724,000 PV Cost Savings
- ROI = Instant



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