New Passive House Standards

How PHIUS + 2015 Makes Passive House Viable in Very Cold Climates

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Background

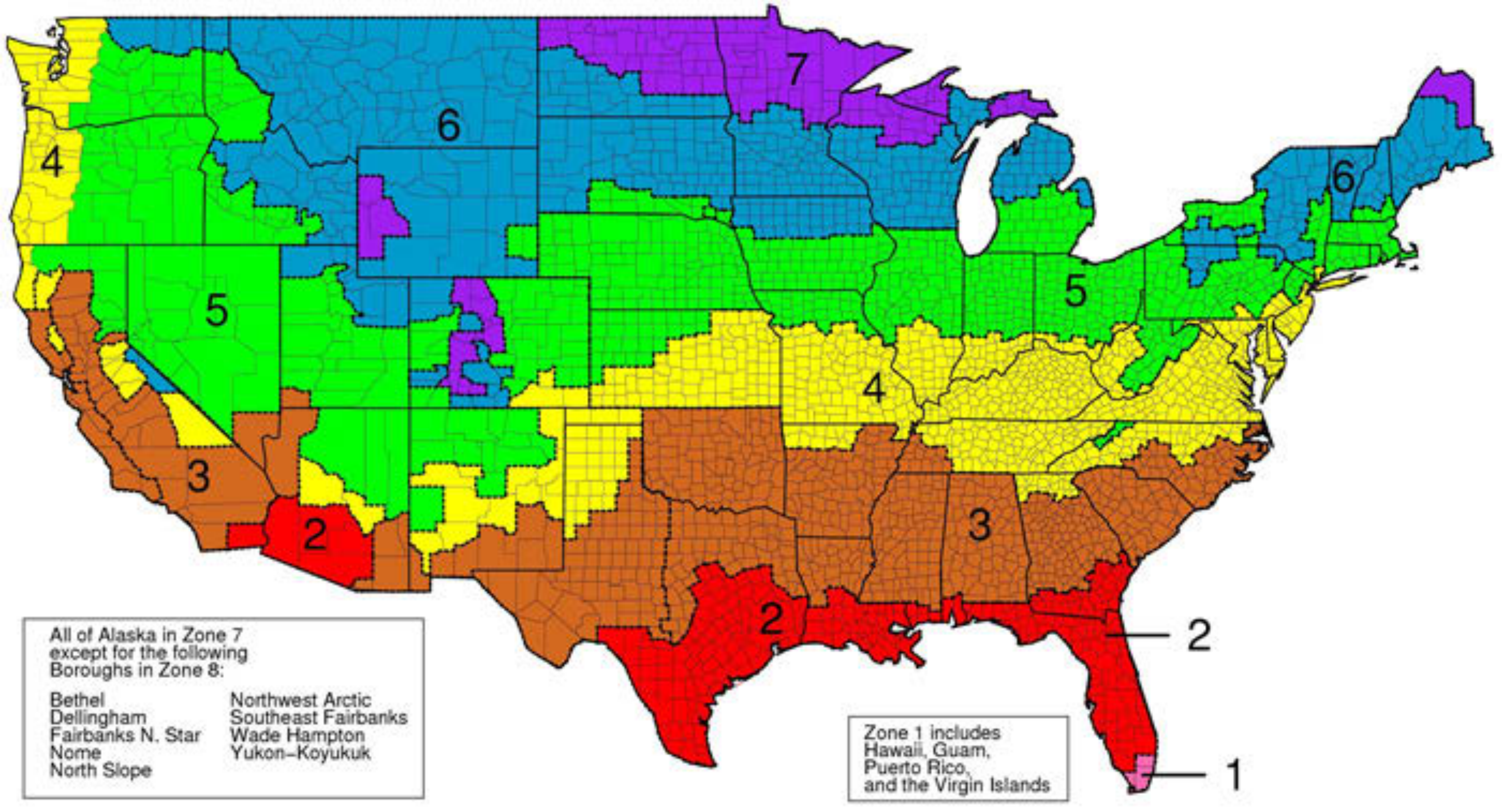
- Passive House concept developed in Germany
- First German PH built in 1990
- PH main focus is on energy performance of building shell and systems
- Modeled verification of heating, cooling and overall energy use.
- Measured air tightness verification

German PH Standards

- 15 kwh / m2 / year (4.75 btu / ft2) heating and cooling energy
- 120 kwh / m2 / year (38.04 btu / ft2) total primary energy
- .6 ACH50 minimum air tightness
- Same standard everywhere regardless of climate

Applying German PH Standards to US

- North America has a wide range of climate zones
- Hot humid climates and very cold climates are not handled well in original PH models and techniques
- German PH standards proved very difficult to meet cost effectively in extremely cold climates
- German standard uses Treated Floor Area for calcs – very different than US standards for measuring living spaces


7
6
4
6
5
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3
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2
1
All of Alaska in Zone 7
except for the following
Boroughs in Zone 8:
Bethel
Dellingham
Fairbanks N. Star
Nome
North Slope
Northwest Arctic
Southeast Fairbanks
Wade Hampton
Yukon–Koyukuk
Zone 1 includes
Hawaii, Guam,
Puerto Rico,
and the Virgin Islands


amvic


TYPAR

Evolution of PH in North America

- PHIUS + certification added third party verification using specially trained RESNET HERS raters.
  - Site inspections
    - Sub-slab insulation check
    - Preliminary blower door testing
    - Insulation quality check
    - Final blower door testing
    - Ventilation system balancing

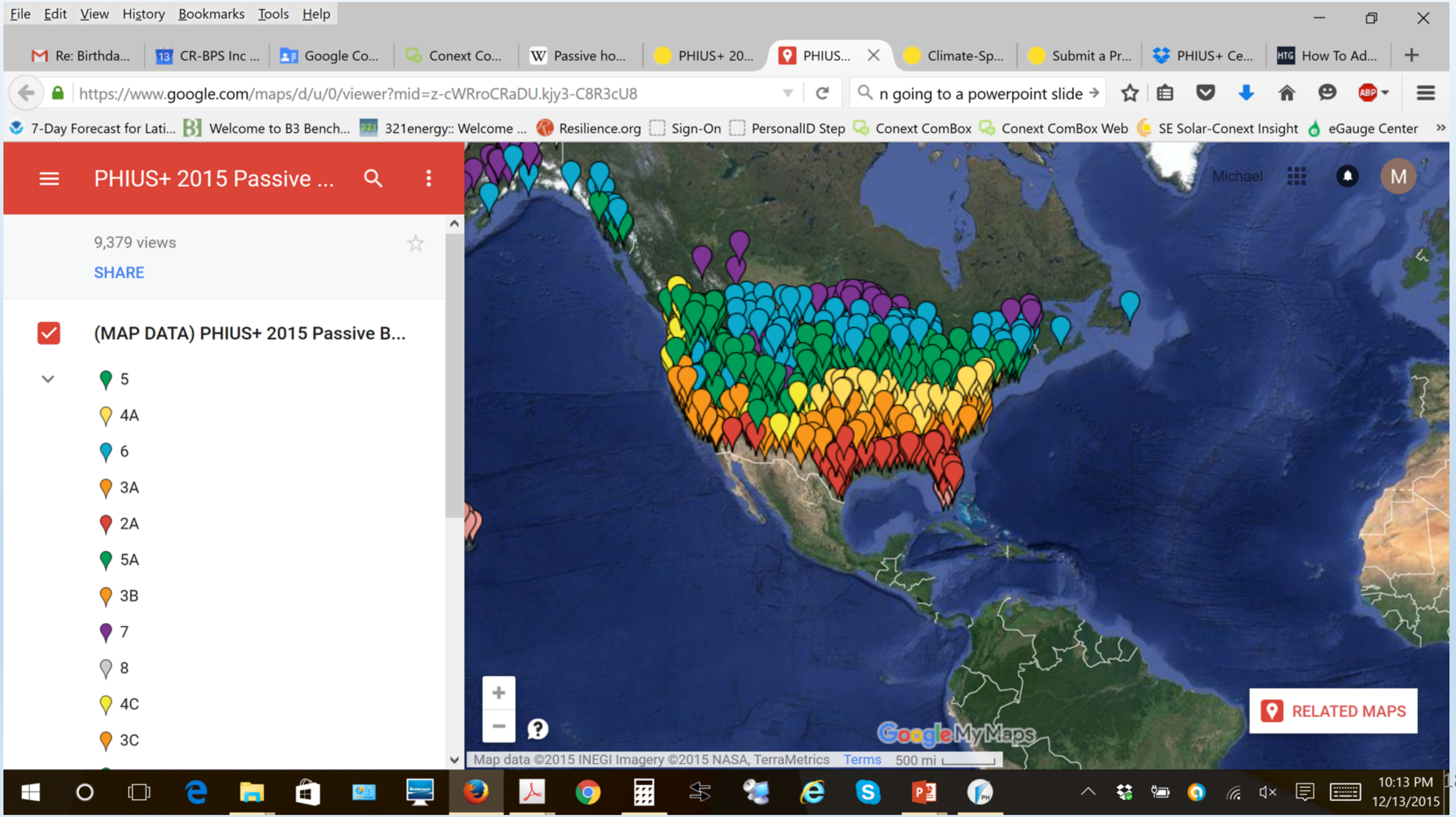
Evolution of PH in North America (cont)

- PHIUS + adds verification and certification for:
  - DOE Zero Energy Ready Home
  - DOE Challenge Home
  - Energy Star (Thermal enclosure, water management, HVAC)
  - EPA Indoor Air Plus

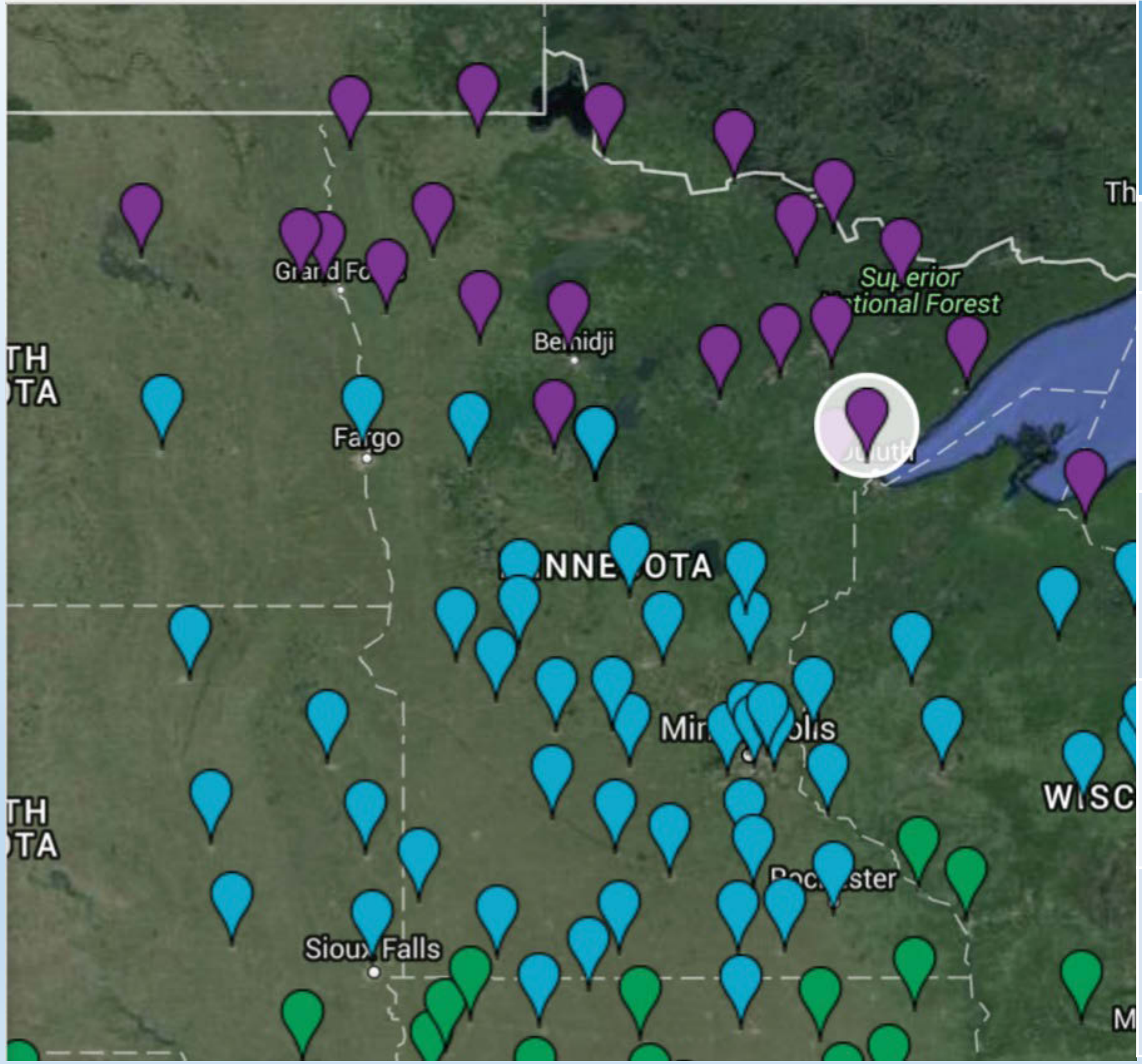
PHIUS + 2015

- In effect as of Sept. 15, 2015
- Developed over a three year process by PHIUS technical committee
- Developed with the assistance of Building Science Corporation with funding by a US DOE Building America grant.
- The main objective was to adapt PH goals to optimize cost effectiveness by fine tuning energy targets to specific climate zones.

Climate Specific Energy Allowances

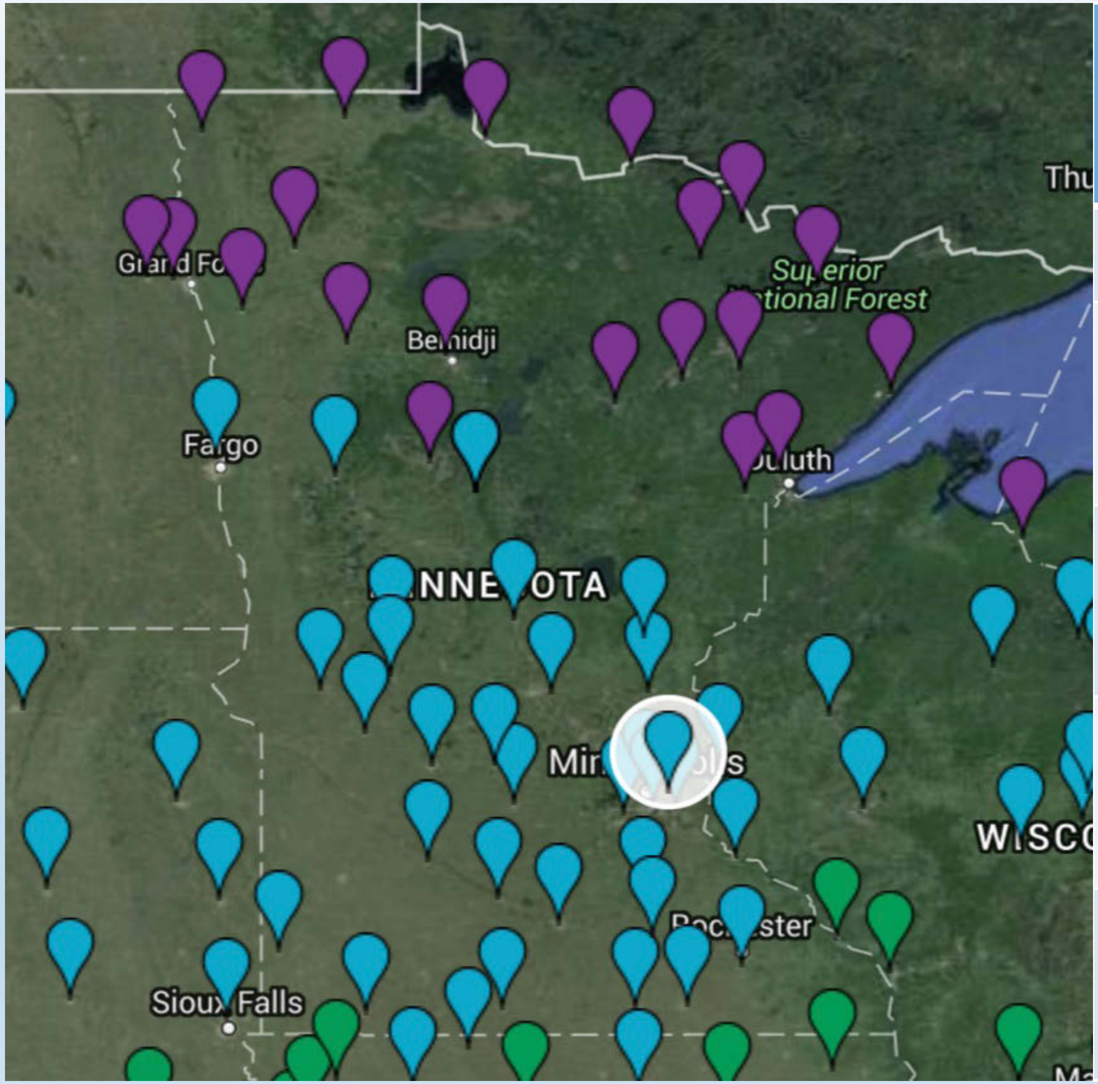


Climate Specific Energy Targets - Duluth



	German Standard	PHIUS+ 2015 (Duluth)
Climate Zone	All	7
Annual Heating Demand kBTU/ft2	4.75 (TFA)	8.4 (iCFA)
Annual Cooling Demand kBTU/ft2	4.75 (TFA)	1 (iCFA)
Peak Heating Load BTU/hr/ft2	NA	5.7 iCFA)
Peak Cooling Load BTU/hr/ft2	NA	3.6 (iCFA)

Climate Specific Energy Targets – St. Paul



	German Standard	PHIUS+ 2015 (St. Paul)
Climate Zone	All	6
Annual Heating Demand kBTU/ft2	4.75 (TFA)	7.2 (iCFA)
Annual Cooling Demand kBTU/ft2	4.75 (TFA)	2.9 (iCFA)
Peak Heating Load BTU/hr/ft2	NA	5.6 iCFA)
Peak Cooling Load BTU/hr/ft2	NA	4.2 (iCFA)

Climate Specific Energy Targets

	German Standard	PHIUS+ 2015 (Des Moines)	PHIUS+ 2015 (St. Paul)	PHIUS+ 2015 (Duluth)	PHIUS+ 2015 (Int. Falls)
Climate Zone	All	5	6	7	7
Annual Heating Demand kBTU/ft2	4.75	5.7	7.2	8.4	9.1
Annual Cooling Demand kBTU/ft2	4.75	4.5	2.9	1	1
Peak Heating Load BTU/hr/ft2	NA	5.3	5.6	5.7	6.2
Peak Cooling Load BTU/hr/ft2	NA	4.6	4.2	3.6	3.7

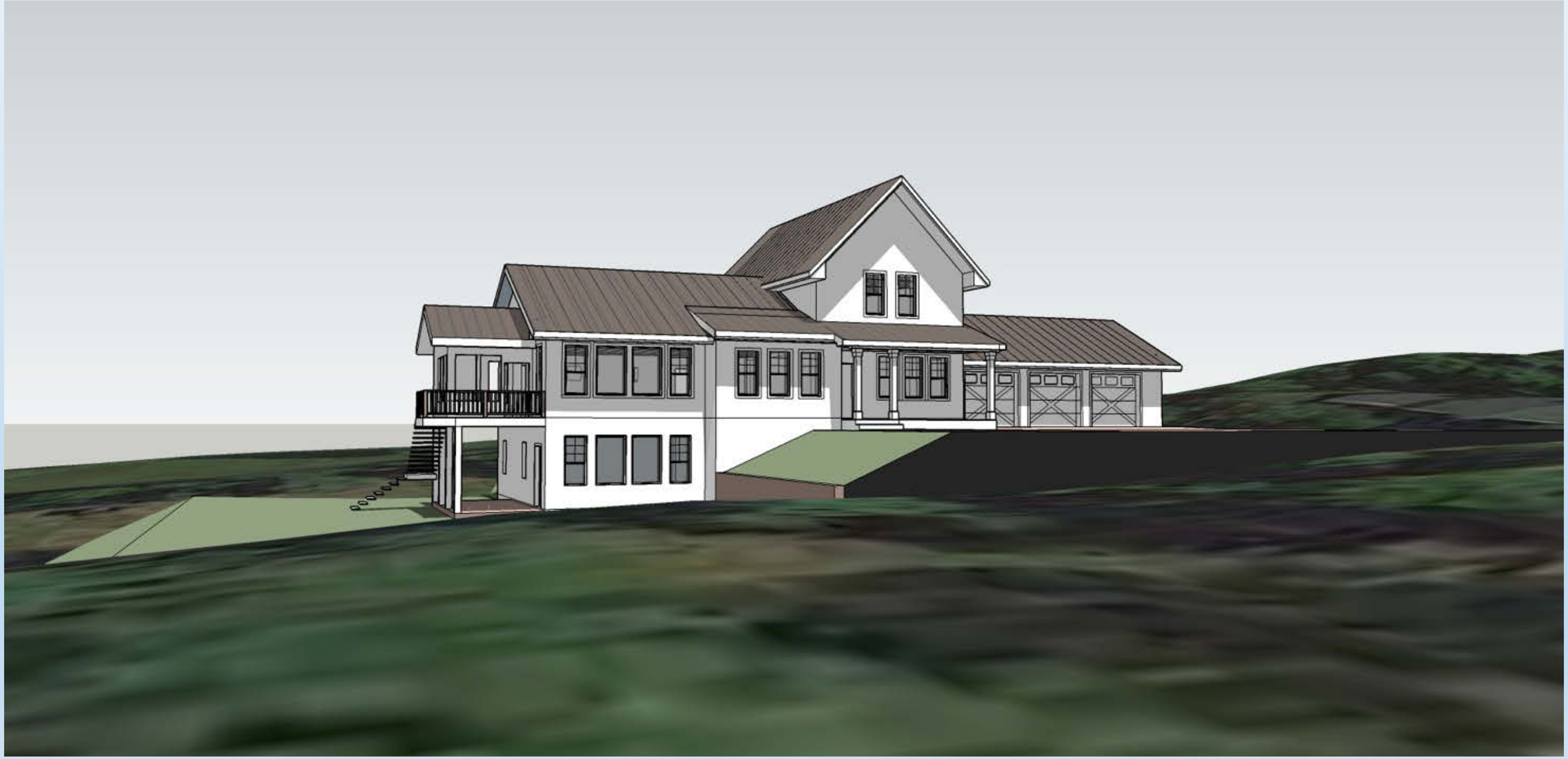
PHIUS + 2015 – Other Changes

- Replaced Treated Floor Area (TFA) with Interior Conditioned Floor Area (iCFA).
  - Simplified calculations and reconciled with US norms.

- Changed air tightness measurement from volume based .6 ACH50 to shell area based .05 CFM50 per ft2 of exterior skin area.
  - References components where leakage occurs, removes small house penalty.

- Changed Primary Energy allowance from floor area basis to occupancy basis (number of bedrooms plus one X 6,200 kWh/y)

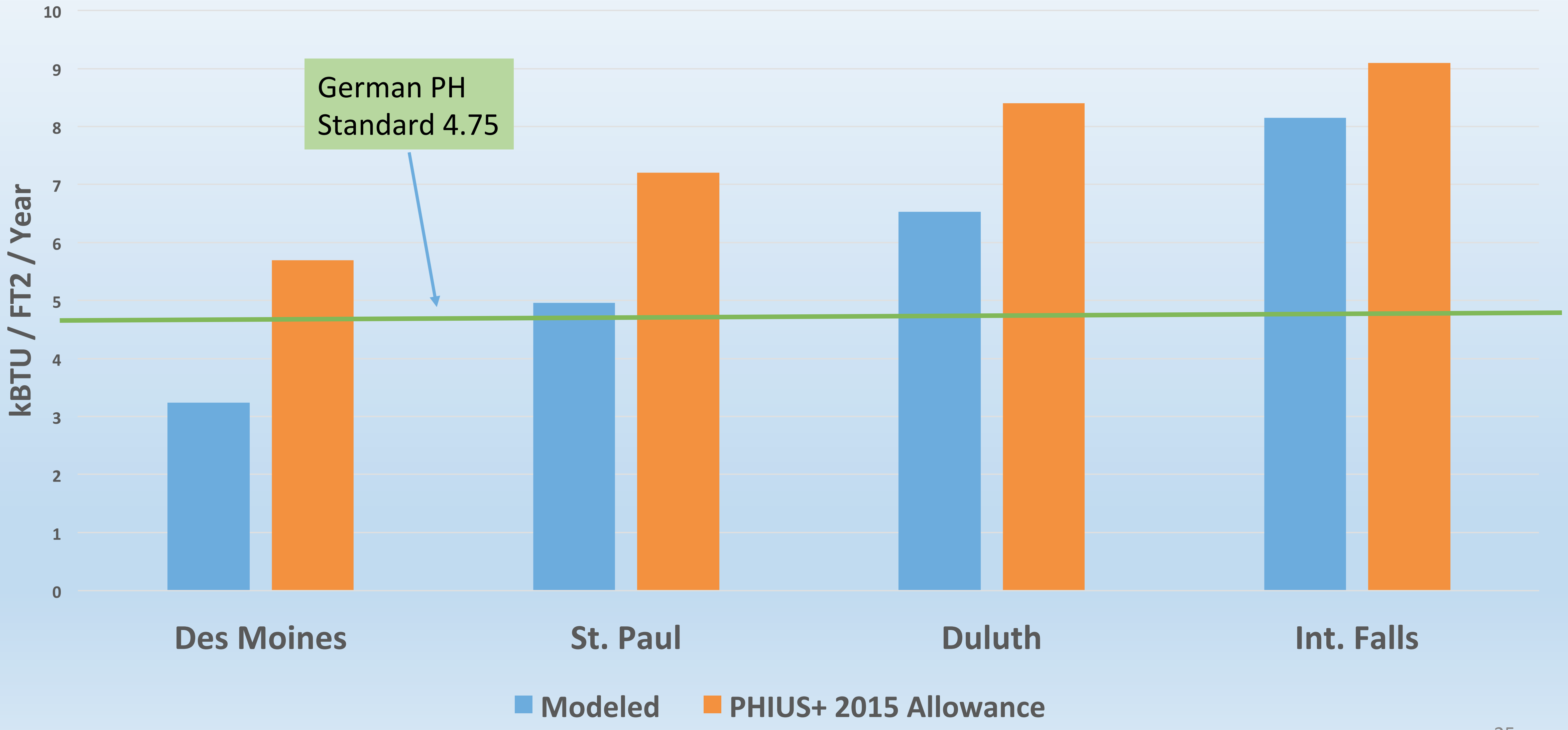
Example Project – Afton, MN
4027 ft2 iCFA



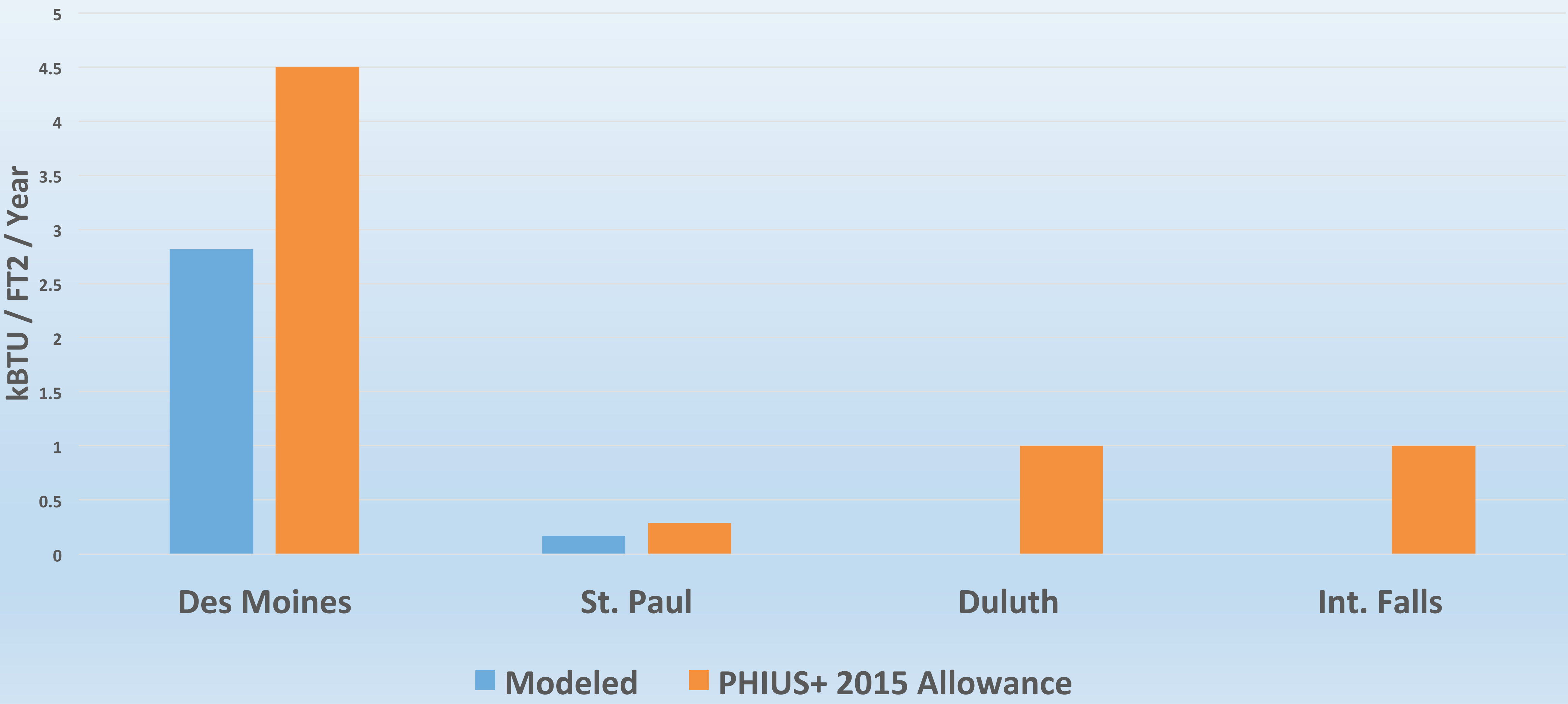
Example Project – Different locations

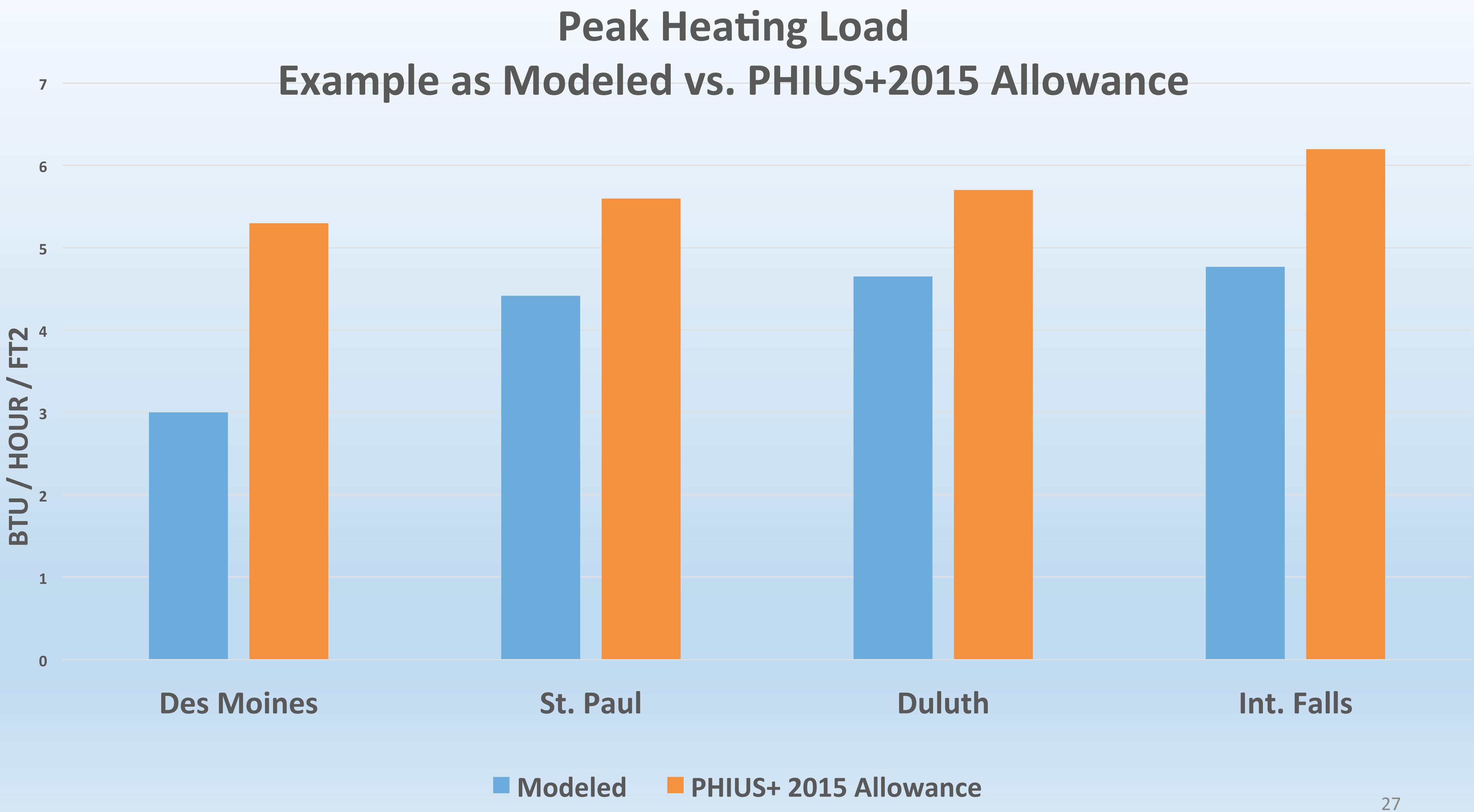
	Example Modeled Des Moines	PHIUS+ 2015 Des Moines	Example Modeled St. Paul	PHIUS+ 2015 St. Paul	Example Modeled Duluth	PHIUS+ 2015 Duluth	Example Modeled Int. Falls	PHIUS+ 2015 Int. Falls
Annual Heating Demand kBTU/ft2/y	3.24	5.7	4.96	7.2	6.53	8.4	8.15	9.1
Annual Cooling Demand kBTU/ft2/y	2.82	4.5	.17	2.9	0	1	0	1
Peak Heating Load BTU/hr/ft2	3.0	5.3	4.42	5.6	3.78	5.7	4.77	6.2
Peak Cooling Load BTU/hr/ft2	1.05	4.6	1.36	4.2	0	3.6	0	3.7
Primary Energy kWh/y	20,430	31,000	19,440	31,000	20,620	31,000	21,920	31,000

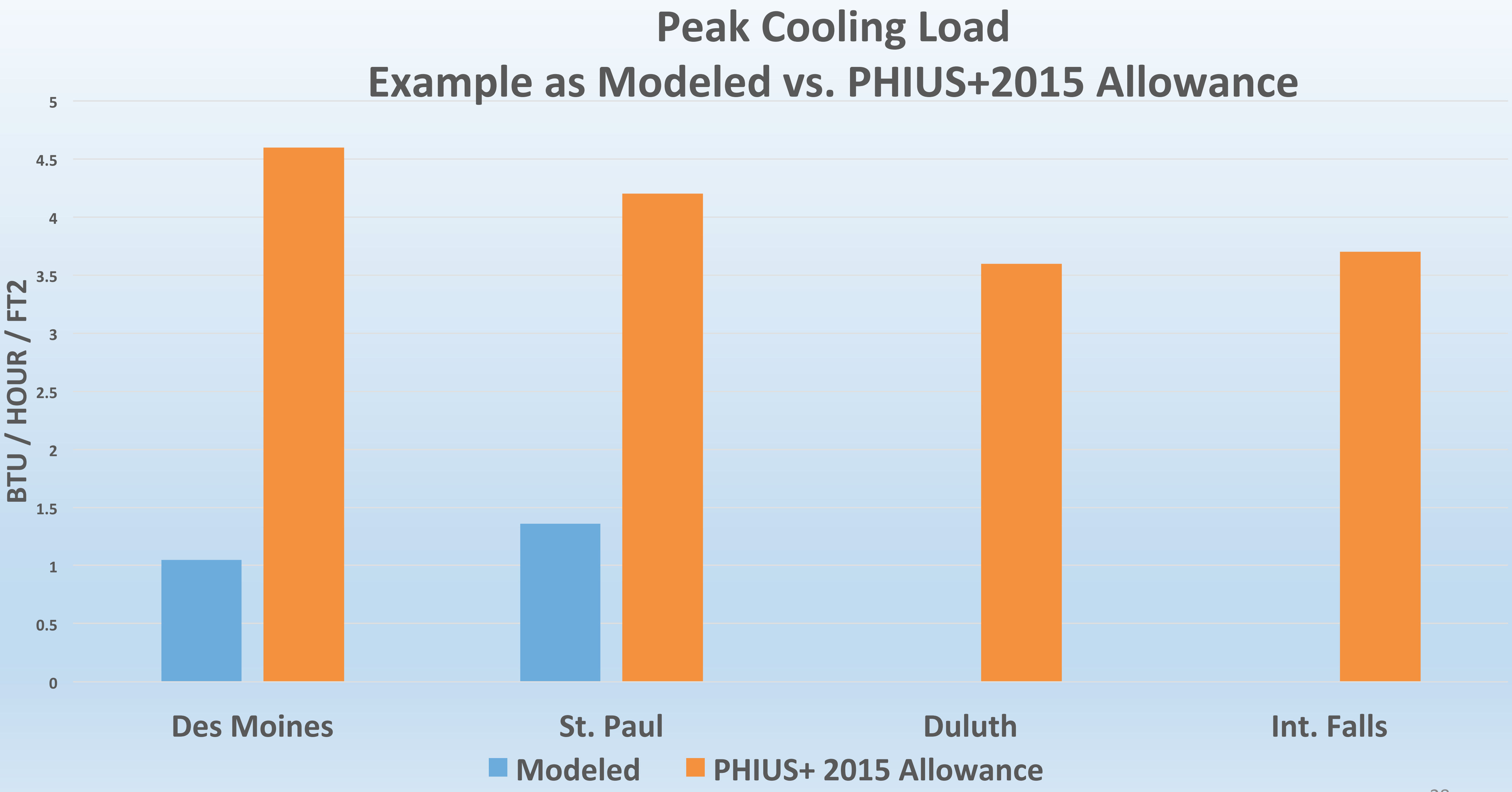
Annual Heating Demand
Example as Modeled vs. PHIUS+2015 Allowance



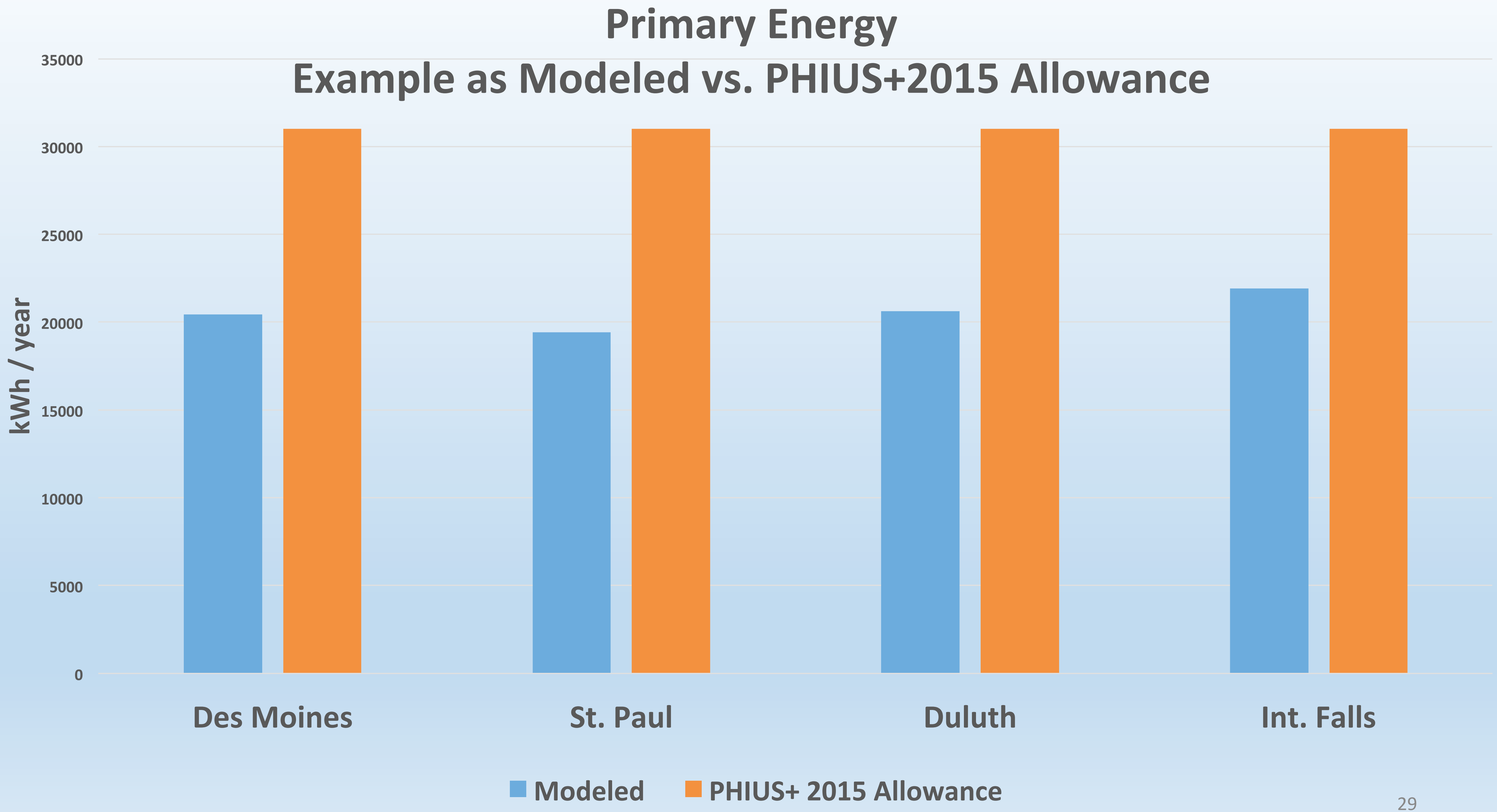
Annual Cooling Demand
Example as Modeled vs. PHIUS+2015 Allowance




Peak Heating Load
Example as Modeled vs. PHIUS+2015 Allowance
BTU / HOUR / FT2
0
1
2
3
4
5
6
7
Des Moines
St. Paul
Duluth
Int. Falls
Modeled
PHIUS+ 2015 Allowance

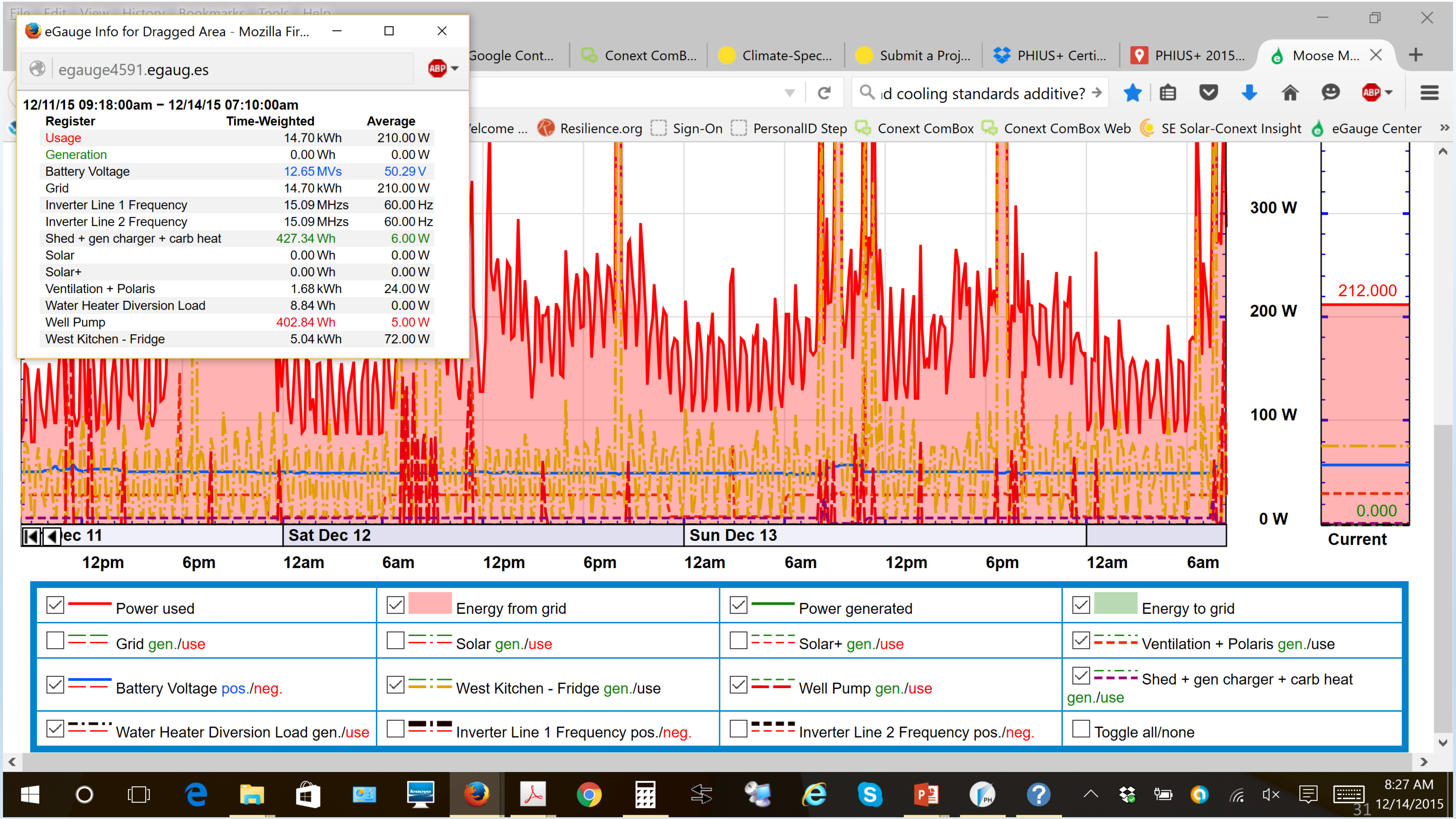


Peak Cooling Load
Example as Modeled vs. PHIUS+2015 Allowance
BTU / HOUR / FT2
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Des Moines
St. Paul
Duluth
Int. Falls
Modeled
PHIUS+ 2015 Allowance


Primary Energy
Example as Modeled vs. PHIUS+2015 Allowance
35000
30000
25000
20000
15000
10000
5000
0
kWh / year
Des Moines
St. Paul
Duluth
Int. Falls
Modeled
PHIUS+ 2015 Allowance

Electrical Monitoring to ID Problem Loads

- Growing plug and other electrical loads are big opportunity.
- Small loads that run a lot can add up.
- Larger loads that rarely run may use surprisingly little energy.
- The only way to know is to measure it.
- Guesses are cheap and worth every penny.



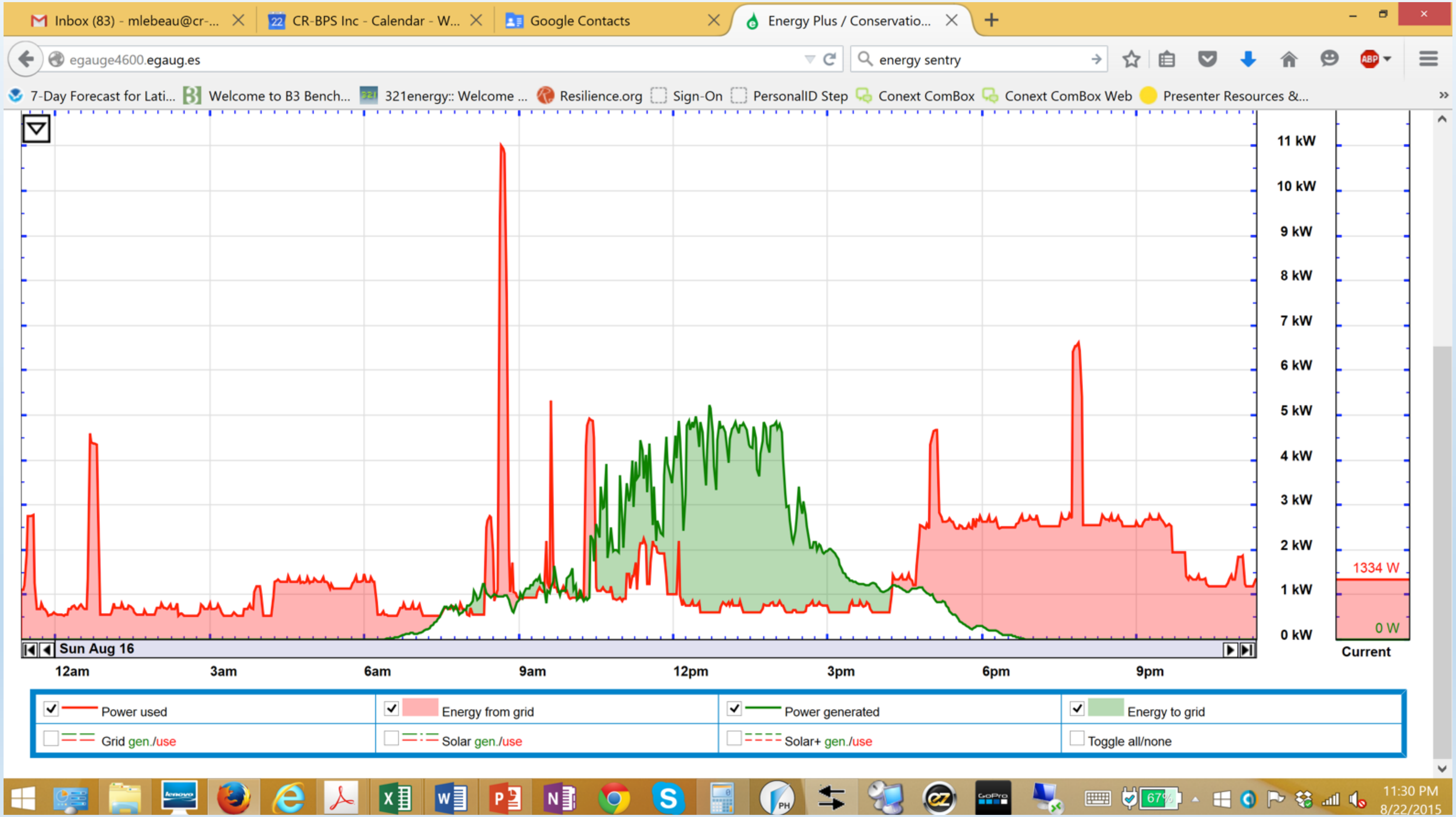
eGauge Info for Dragged Area - Mozilla Fir...

egauge4591.egaug.es

12/11/15 09:18:00am – 12/14/15 07:10:00am

Register	Time-Weighted	Average
Usage	14.70 kWh	210.00 W
Generation	0.00 Wh	0.00 W
Battery Voltage	12.65 MVs	50.29 V
Grid	14.70 kWh	210.00 W
Inverter Line 1 Frequency	15.09 MHzs	60.00 Hz
Inverter Line 2 Frequency	15.09 MHzs	60.00 Hz
Shed + gen charger + carb heat	427.34 Wh	6.00 W
Solar	0.00 Wh	0.00 W
Solar+	0.00 Wh	0.00 W
Ventilation + Polaris	1.68 kWh	24.00 W
Water Heater Diversion Load	8.84 Wh	0.00 W
Well Pump	402.84 Wh	5.00 W
West Kitchen - Fridge	5.04 kWh	72.00 W

Monitoring demand and production to help users track energy balance and control loads



Site Energy versus Source Energy

- What we measure at the meter, or sub-meter, is **Site Energy**.
- **Site Energy** represents the performance of the building and loads.
- **Source Energy** is the amount of energy that goes into production, transmission and distribution.
- Many programs, such as PH, requires the calculation of **Source Energy.**

Source-Site Ratios of Various Fuels (EPA 2013)

*(Electrical values vary regionally, and over time, as the generation fuel mix shifts)

Energy Type	U.S. Ratio *	Canadian Ratio
Electricity (Grid Purchase)*	3.16 *	2.05
Electricity (on-Site Solar or Wind Installation)	1	1
Natural Gas	1.05	1.02
Fuel Oil (1,2,4,5,6,Diesel, Kerosene)	1.01	1.01
Propane & Liquid Propane	1.01	1.03
Steam	1.2	1.2
Hot Water	1.2	1.2
Chilled Water	1	0.71
Wood	1	1
Coal/Coke	1	1
Other	1	1

Net Zero in Challenging Climates

(Far Northern MN - 4,000 ft2 example)

- PHIUS+2015 Heating Allowance = 9.1 kbtu/ft2/yr
  - (92% increase over previous standard of 4.75)
- 9000 x 4000=36,000 btu (**10,550 kwh) (site)** (4,000 ft2 house example)
- 10,550 / 1,200 = **8.8 kW PV to meet allowed annual heating load.**

Net Zero in Challenging Climates (cont.)

(Far Northern MN – 4,000 ft2 Example)

- Old Primary Energy Standard
  - 38 kbtu = 11kWh / ft2/yr X 4,000 = 44,000 kWh
  - 44,000 / 1,200 = **36.66 kW PV** (ignoring **Site /Source** factor)
- PHIUS+2015 Source Energy Standard
  - 6200 X 4 = 24,800 kWh / year
  - 24,800 / 1,200 = **21 kW PV** (ignoring **Site / Source** factor)

Isabella Experiment Station

eGauge

View | LAN Access | Tools | Settings | Help

8/8/2015 11:54pm – 8/15/2015 11:54pm

Summary for time-period shown in graph

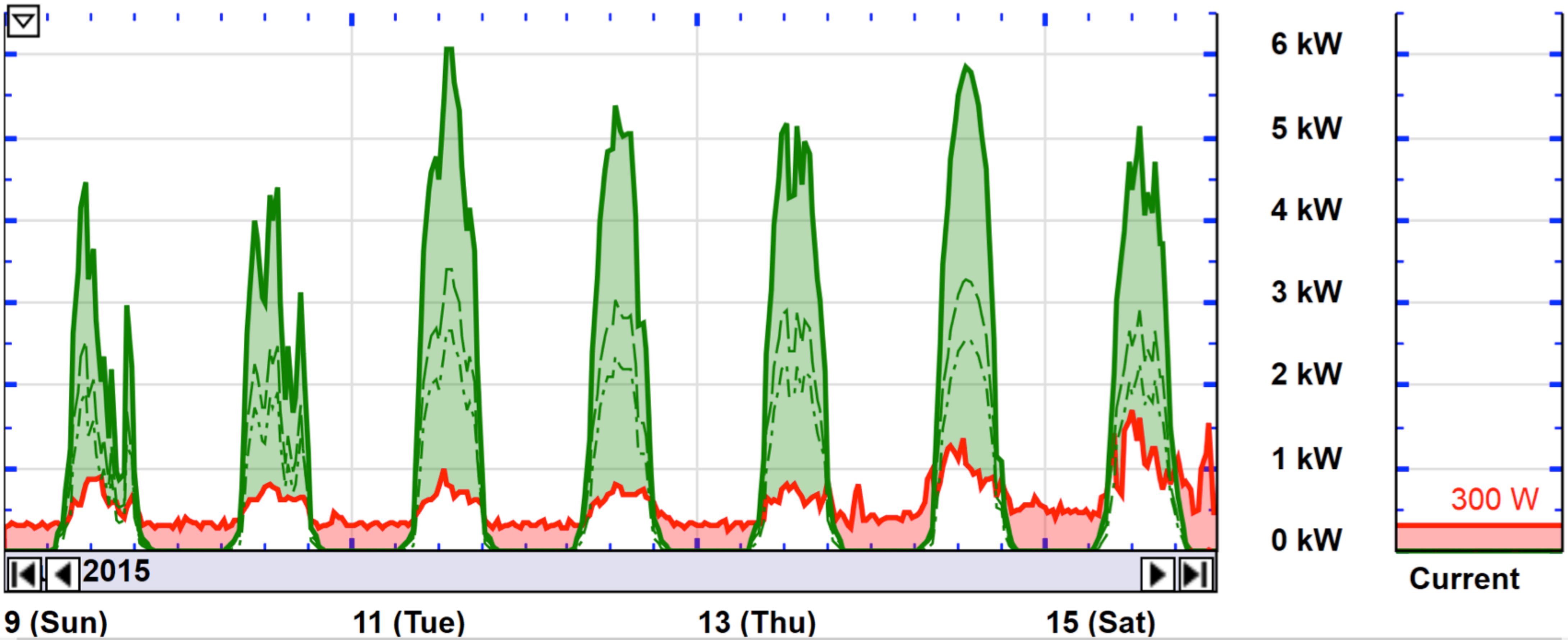
Energy Used	92.5 kWh	(approx. $12.02 used)
Energy Generated	236 kWh	(approx. $30.72 saved)
Net	144 kWh sold	(approx. $18.70 earned)

Summary over last 30 days

Energy Used	480 kWh	(approx. $62.45 used)
Energy Generated	812 kWh	(approx. $105.60 saved)
Net	332 kWh sold	(approx. $43.15 earned)

All | 1y | 6M | 3M | 1M | 3w | 1w | 3d | 1d | 12h | 6h | 3h | 1h | 10m

Auto | 500kW | 100kW | 50kW | 10kW | 5kW | 1kW | 500W | 100W | 50W



Thank You!

- Questions?