

Design and Performance of a Net Zero Energy Home

Presentation at the Black Hills Energy Expo

January 19, 2017

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Agenda

- 1. Background**
- 2. Design Features**
- 3. Modeling**
- 4. Actual Performance**

1. Background

- We decided a couple of years ago to move to Rapid City to be near our daughter, son-in-law, and grandchildren.
- We knew we wanted to build the most energy efficient home that we could afford.
- In addition, we knew that we wanted it to be located in an area that was easily accessible all the urban amenities.
- We were fortunate to find property located on Clark Street.
- However, it also presented challenges because of topography and the fact that it was located in the “environs” of the local West Boulevard Historic District.

1. Background (cont'd)

- Initial design by Joe Ferut, architect from Kent State (OH)
 - Plan “A” concept was 3-story design, but it was later abandoned as being too expensive
- Changes/refinements by local designer, Patricia Scarborough
 - Plan “B” reduced to 2-story design with smaller footprint
- Building by Todd Erskin of Erskin Construction (Hot Springs)
 - Only local builder we found with sufficient experience building Structural Insulated Panels (SIPs) homes

2. Design Features

A. Universal Design for Future Living in Place (1st consideration in sustainable design)

- 5' diameter turnaround in kitchen & master bath
- Roll-in shower in master bath
- 36" wide doorways used throughout
- Minimize step-ups/step-downs + hard, smooth flooring
- 42" wide stairway for ability to add future stair lift
- Plans for entrance ramps (front door & garage) if needed in future

2. Design Features (cont'd)

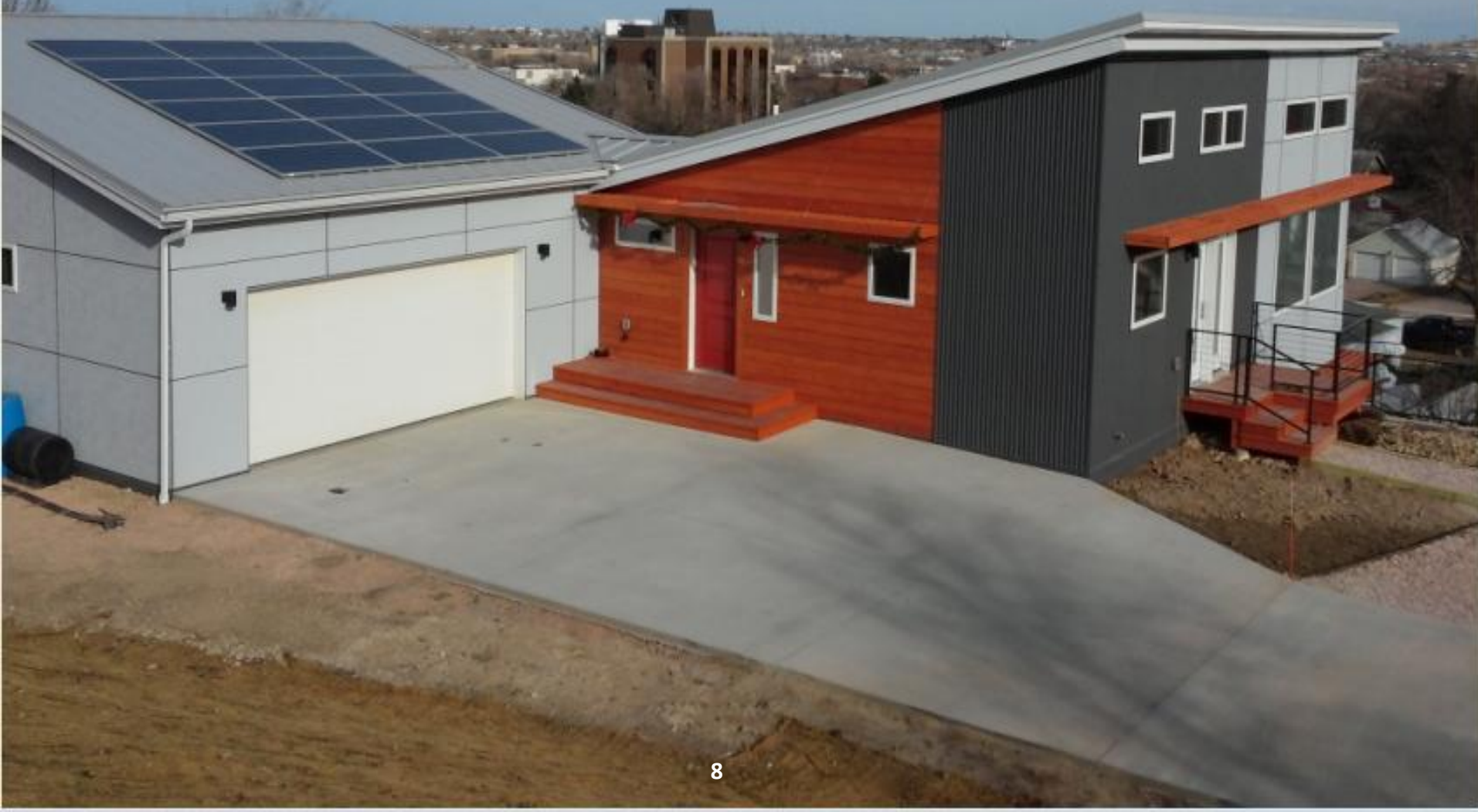
B. Good Passive House Design, including:

- **Site orientation with unobstructed southern exposure**
- **Appropriately sized south-facing glazing with high solar heat-gain coefficient (SHGC)**
- **Southern awnings/overhangs to minimize summer heat gains and maximize heat gain in winter**
- **Minimal amount of windows on N, E and W with low-E coating**
- **Efficient use of space for 3-bedroom home in relatively small size (2,240 sq ft)**

View of 1206 Clark Street, Rapid City, SD, looking North



View of 1206 Clark Street, Rapid City, SD, looking NE



2. Design Features (cont'd)

C. Building Envelope

- 6" foam below foundation slab in lower level
- 8" SIPs in lower level (R-34), 6" SIPs in upper walls (R-26), and 12" ceilings (R-52)
- Doors and windows are Alpen triple pane, argon gas filled
- House wrap and careful sealing done
- Result is tight home <0.2 ACH (1/3 of the Passivhaus std)



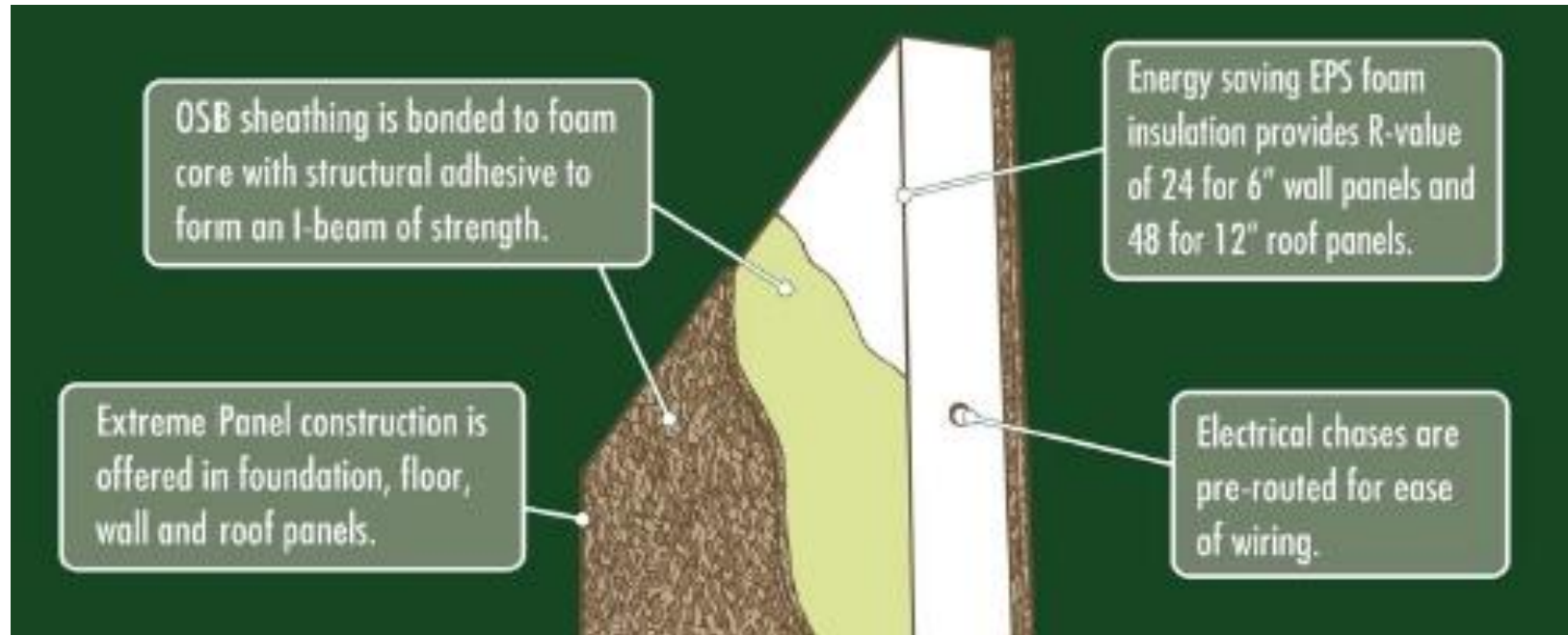
SIPs Done Right!

Extreme Panel Technologies, Inc.
475 East 4th St. North
P.O. Box 435
Cottonwood, MN 56229

800-977-2635
Fax: 507-423-5531
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Additional SIPs Info & Construction Pictures



2. Design Features (cont'd)

D. Appliances and Lighting

- Energy-star rated appliances, including refrigerator, dishwasher, electric induction stove, etc.
- Low-energy LED lighting used throughout

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WITH NEW MICRO SLIM DESIGN

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Down Lighting provides up to 1000 lumens at 12
watts



2. Design Features

E. Heating, Ventilating, Air Conditioning (HVAC)

- Heat Recovery Ventilation (HRV) system by Zehnder that includes Geothermal ground loop for pre-heating and pre-cooling
- “Mini-splits” by Senville (air-to-air heat pumps) for primary heating & cooling
- In-floor electric heating in two bathrooms



2. Design Features (cont'd)

F. Photovoltaic (PV) System

- (18)-310 watt Trina solar panels (5.6 kW total)
- SMA “Sunny-Boy” string inverter with extra 2,000 watt outlet
- Excess power goes back to the grid



2. Design Features (cont'd)

G. Back-up Systems

- Natural gas fireplace in lower level
- Battery storage? Future plans to add electric vehicle (EV) for energy storage/use (Note: 30A-240v circuit already in garage)



3. Modeling

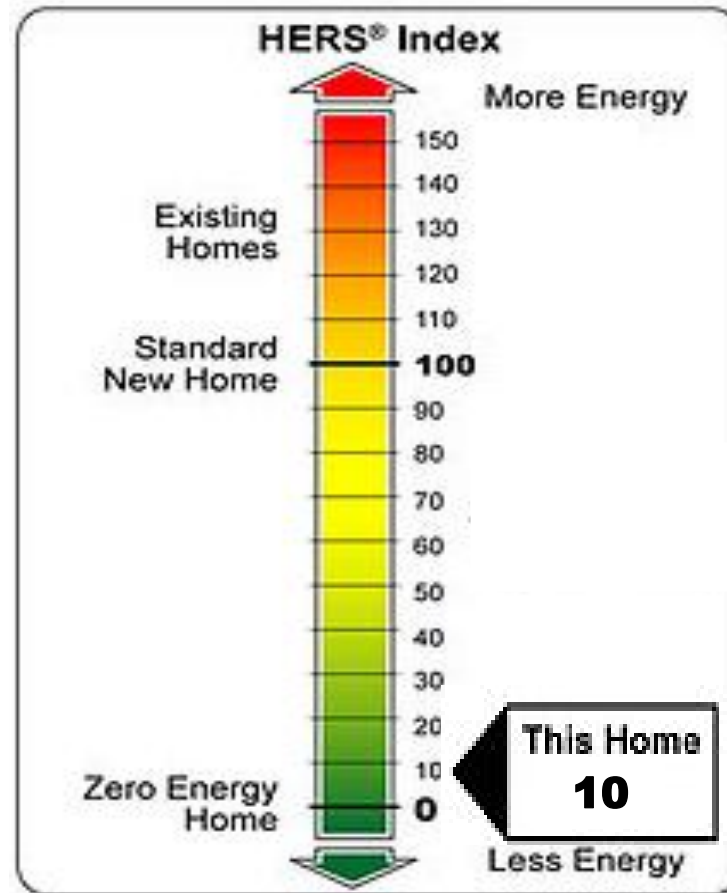
A. Modeling software used

- ResNet's REM/Rate v14.5.1 (HERS Score)
- BEopt v2.7.0.0
- HEED v4.0
- PV Watts

B. Residential modeling software is limited

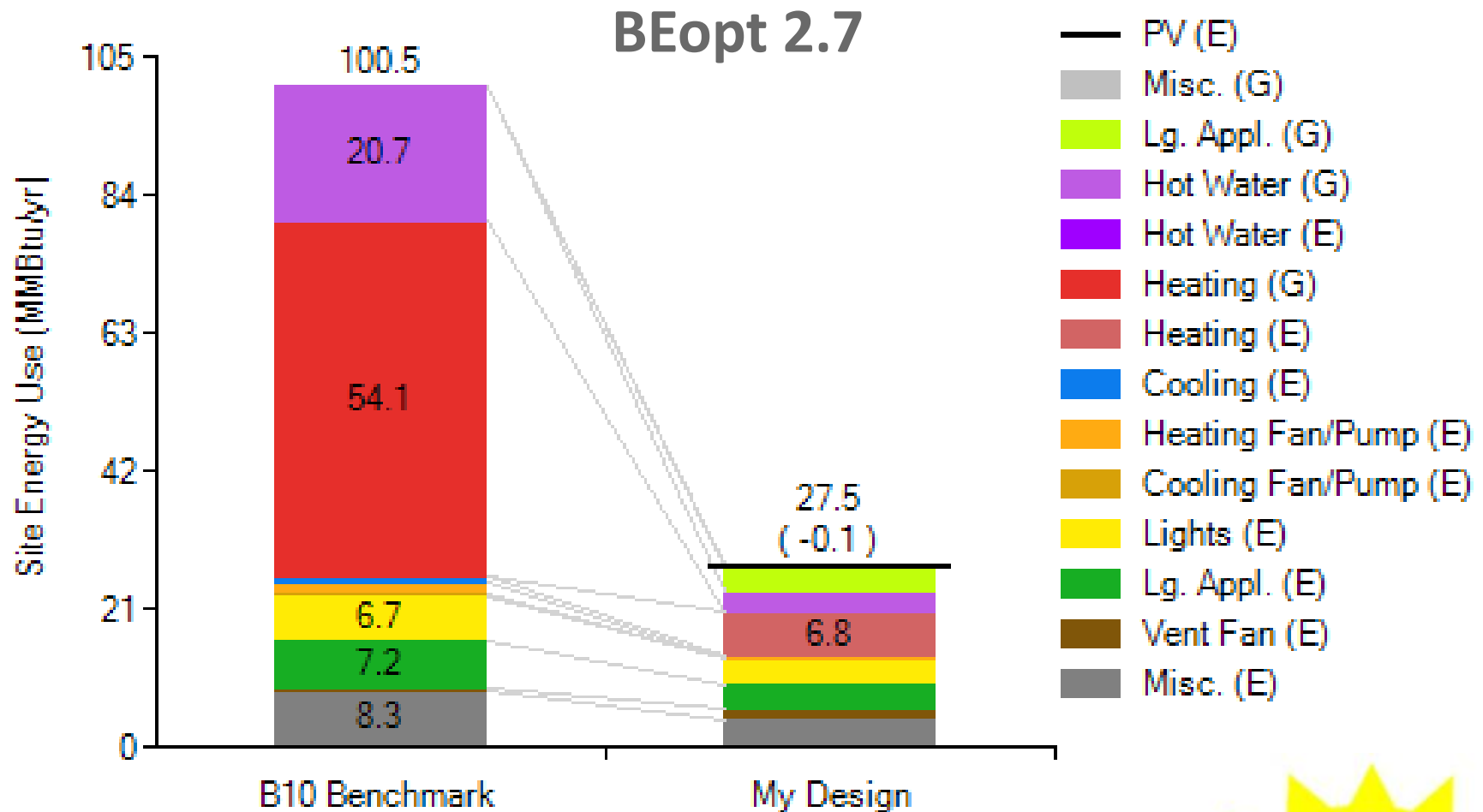
- None can handle our exact design (# of stories, roofs, windows, HVAC, etc.)
- Requires the use of multiple reiterations & best judgment

3. Modeling (cont'd)



RESNET HERS Index

3. Modeling (cont'd)

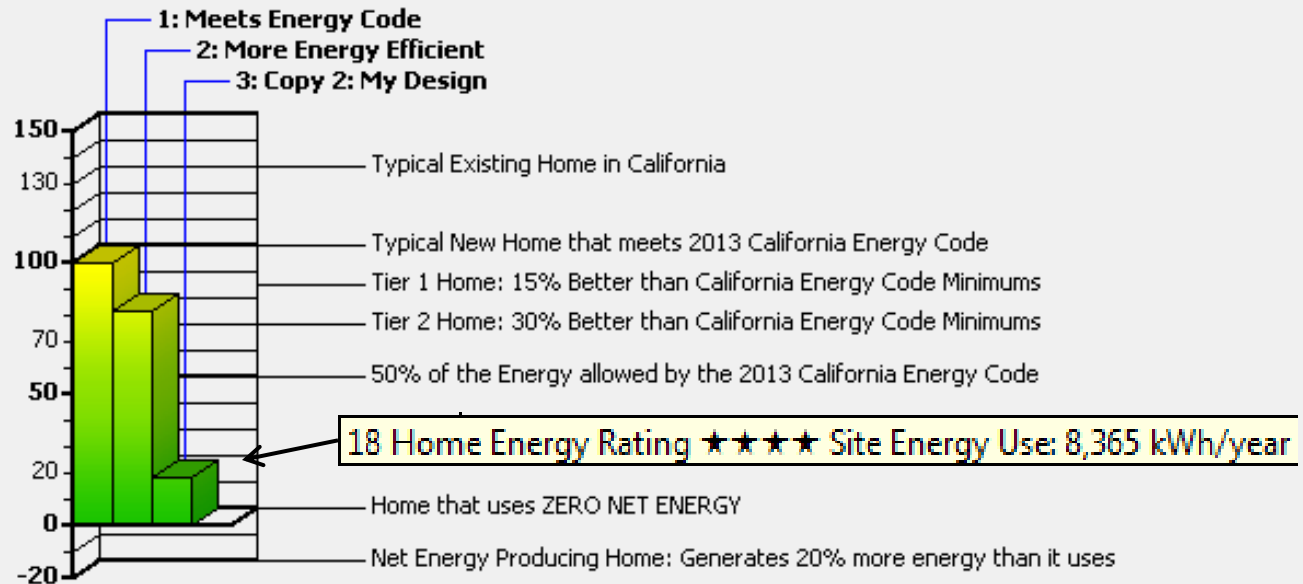


3. Modeling (cont'd)

Home Energy Rating
Scheme 3 : Copy 2: My Design

HEED 4.0

Project : 1206 Clark St.
Building Type: SINGLE FAMILY RESIDENCE
City Location: RAPID_CITY,SD,USA,TMY2-2



Energy Ratings are based on
Net Site Energy Consumption.

This is a "miles per gallon" rating of each design scheme, compared
to a home that meets the current California Energy Code minimum.

3. Modeling (cont'd)

Solar Prediction
(PV Watts)

8,065 kWh per Year *

Month	Solar Radiation (kWh / m ² / day)	AC Energy (kWh)	Energy Value (\$)
January	2.66	409	61
February	3.59	495	74
March	4.64	697	104
April	5.49	770	116
May	6.23	890	134
June	6.96	932	140
July	7.00	944	142
August	6.45	863	130
September	5.24	702	105
October	4.20	599	90
November	2.87	415	62
December	2.36	350	52
Annual	4.81	8,066	\$ 1,210

4. Actual Performance

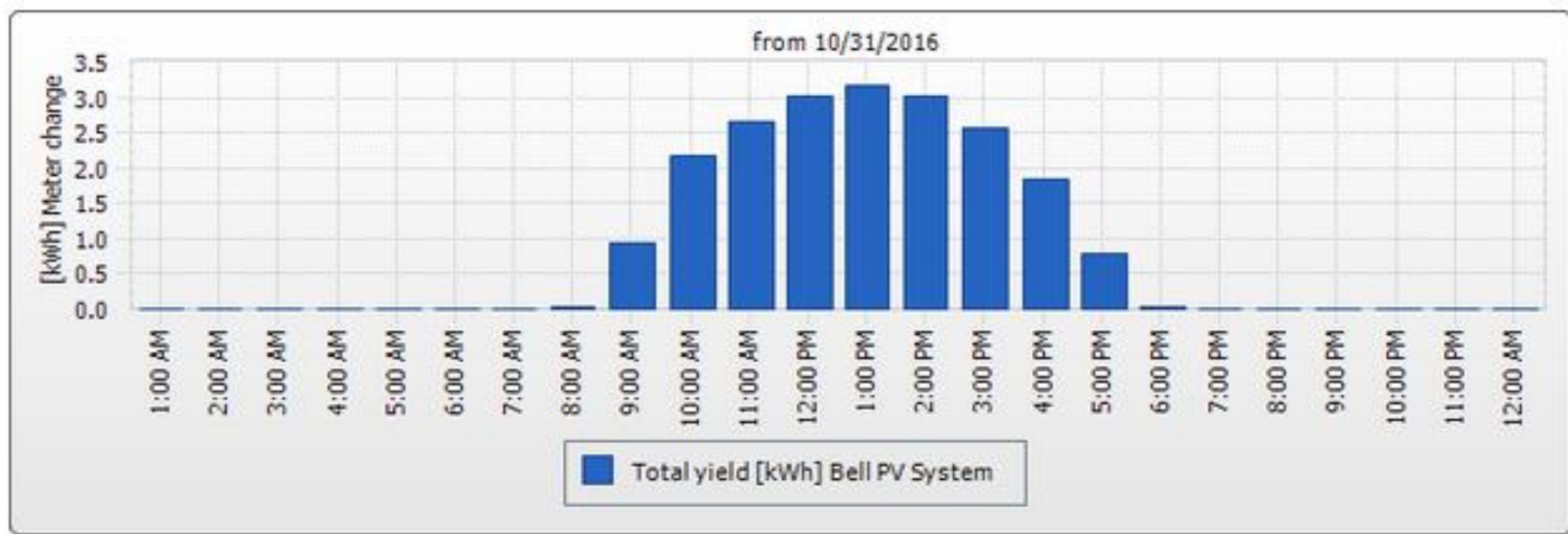
Measuring Actual Energy Performance (including both gas & electric)

- PV Generation per SMA inverter reporting (kWh)
- Input data from BH Energy bills (\$costs, electricity usage, & credit)
- Input data from MDU gas bills (converted to kWh)

4. Actual Performance (cont'd)

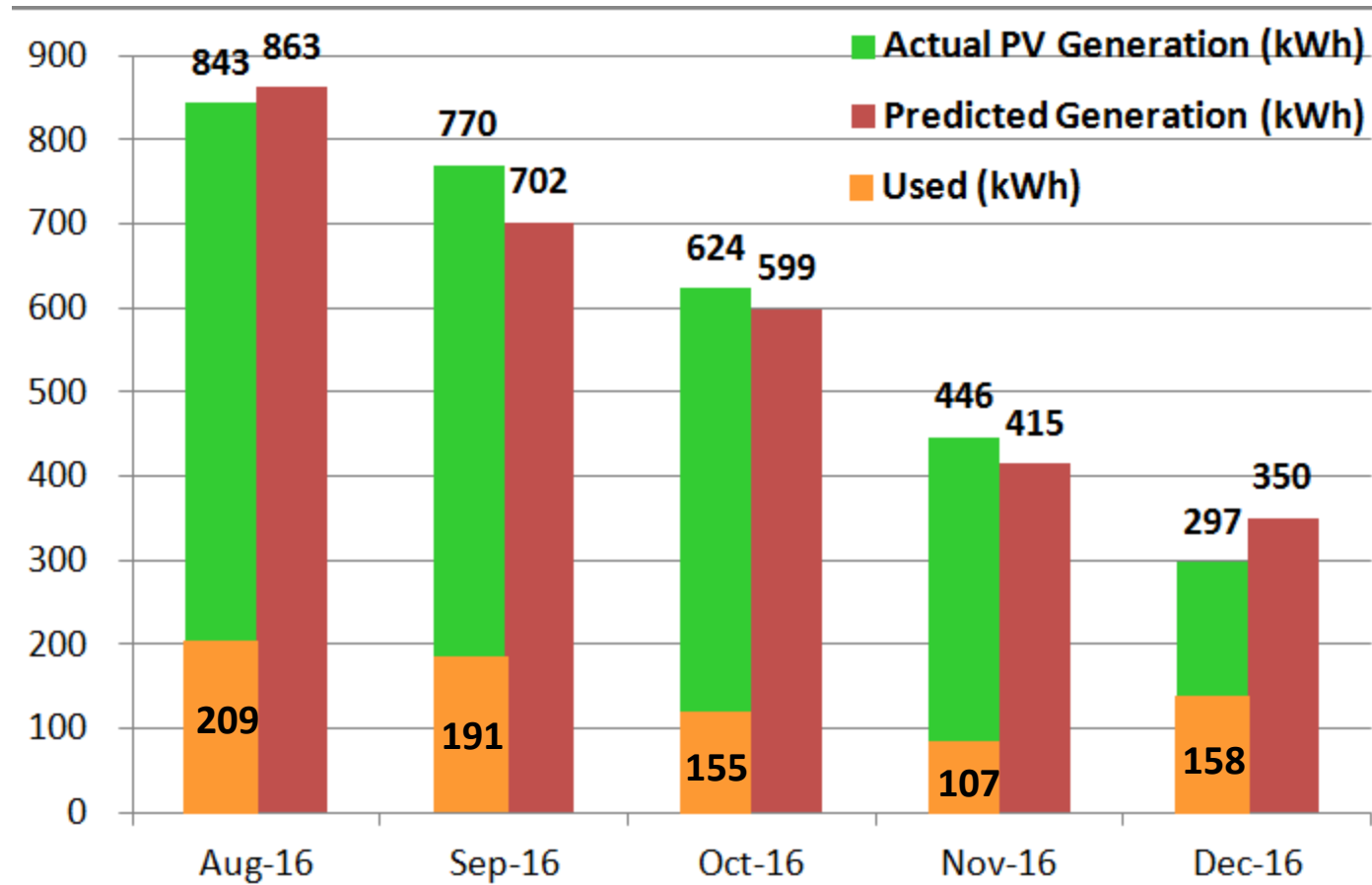
Bell PV System Daily report

Devices/PV system	Total yield Meter Change [kWh] 10/31/2016	Total yield Meter Change [kWh] October 2016	Total yield Meter Change [kWh] 2016
Bell PV System	20.25	93.29	93.29
	20.25 [Total]	93.29 [Total]	93.29 [Total]

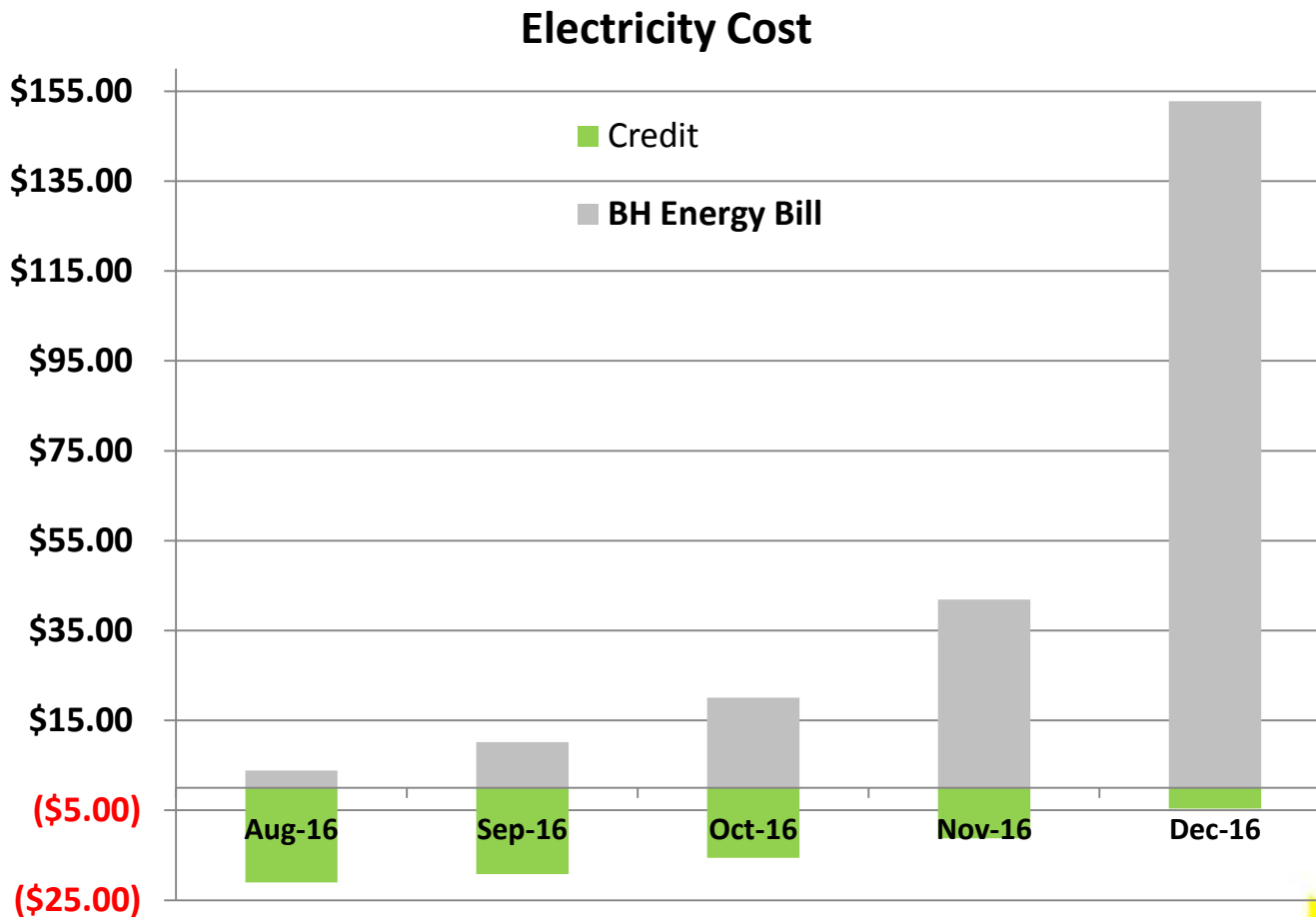


4. Actual Performance (cont'd)

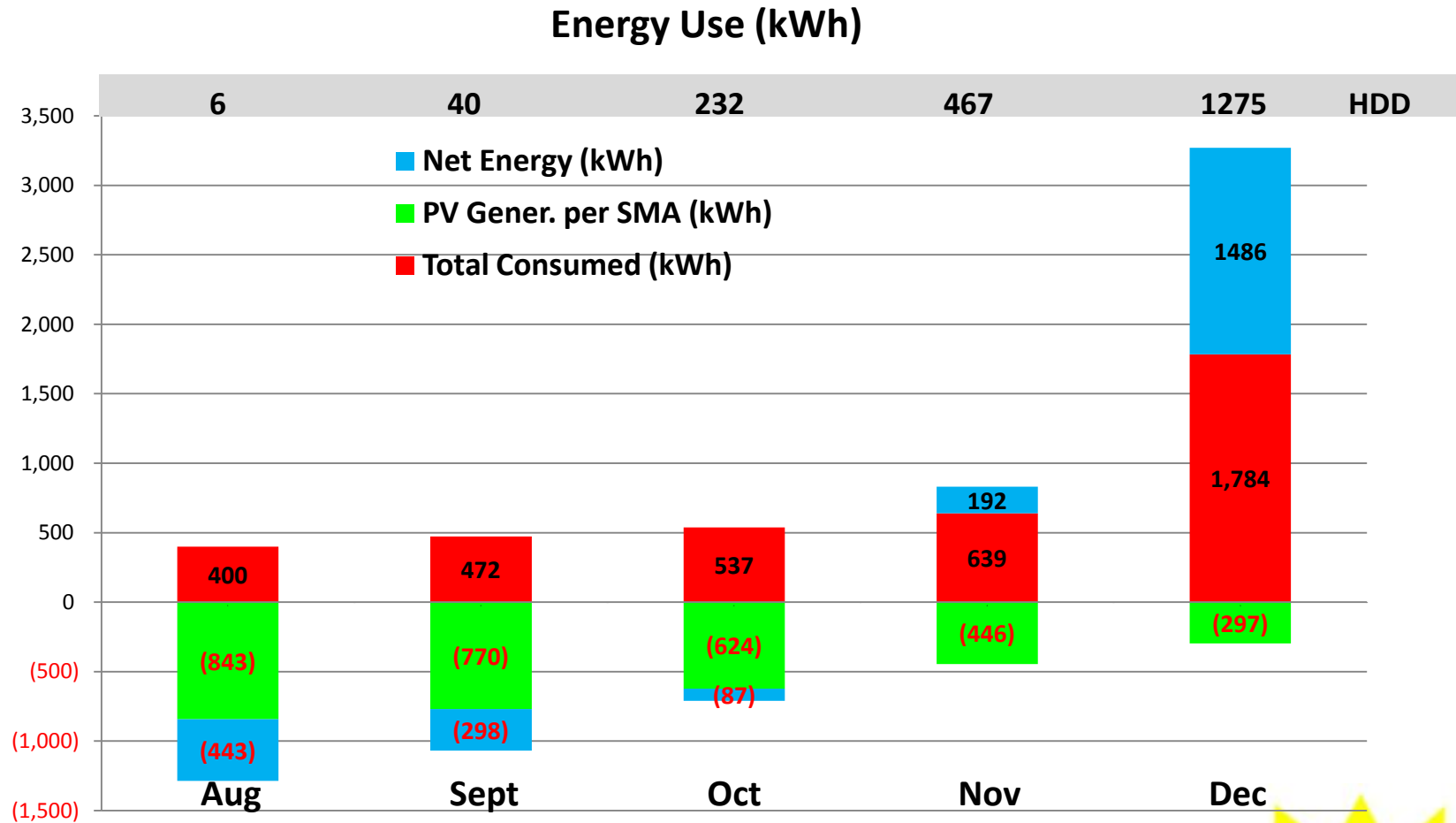
Solar PV Performance



4. Actual Performance (cont'd)



4. Actual Performance (cont'd)



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Questions?

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For more information:



Company specializing in energy audits, consulting, and coming soon to SD: Property Assessed Clean Energy (PACE)