Smart Grid Strategies for Maximizing Savings from Customer PV Installations

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Outline

- Background
- AMI capabilities relating to PV
  - Maximize energy savings
  - Improve customer payback period

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Background

- Multiple Factors impact the actual energy savings from PV systems
  - Weather
  - Appliance fuel-switching
  - Behavior
- Two recent studies suggest customers increase energy usage after installing a PV system

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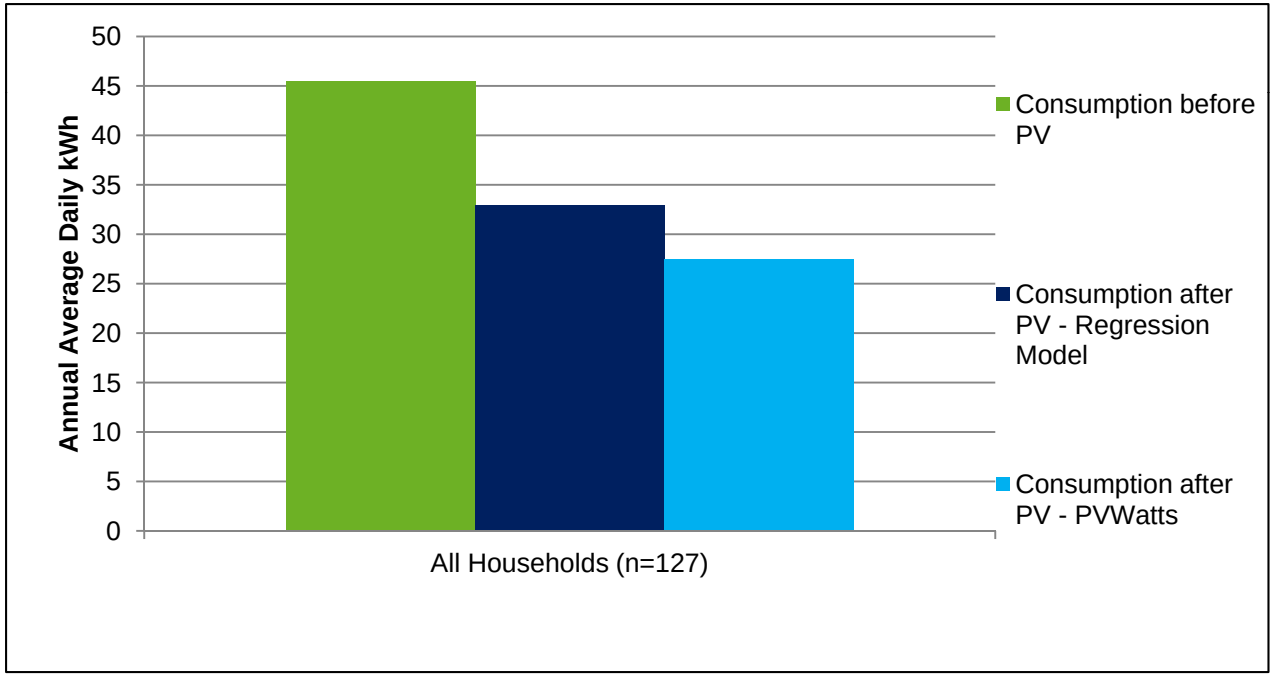
Study in PA

- Compared billing analysis results to PVWatts, controlling for weather



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Implications

- Utilities with PV rebate programs may want to better understand factors that may result in less-than-expected savings, particularly during peak demand hours
- Utilities may also want to consider other strategies for reducing peak demand

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How Can Utilities Encourage Energy Savings?

- AMI capabilities can be leveraged to optimize energy savings

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Advantages of AMI

- More certainty in peak demand impacts of PV and other distributed generation systems
- Encourages customers to switch to a TOU rate
- DLC functionality for customers
- PBI programs
- Improved cost-effectiveness for the PV customer

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Peak Demand Impacts

- For some utilities, reducing peak demand is their key goal
- Take-back effect creates uncertainty in peak demand impacts of energy efficiency or DG
- Hourly net consumption data reduces the uncertainty around peak impacts

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Time of Use (TOU) Rates

- Utilities support TOU schedules as a means to reduce peak loads
- The peak hours, where higher rates occur, are often hours during which the PV system is generating electricity

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Direct Load Control (DLC)

- Another means for utilities to reduce peak loads
- DLC often controls water heaters and space heating/cooling systems
- Utilities could provide incentives to PV customers with batteries in return for a control switch that discharges batteries during peak events

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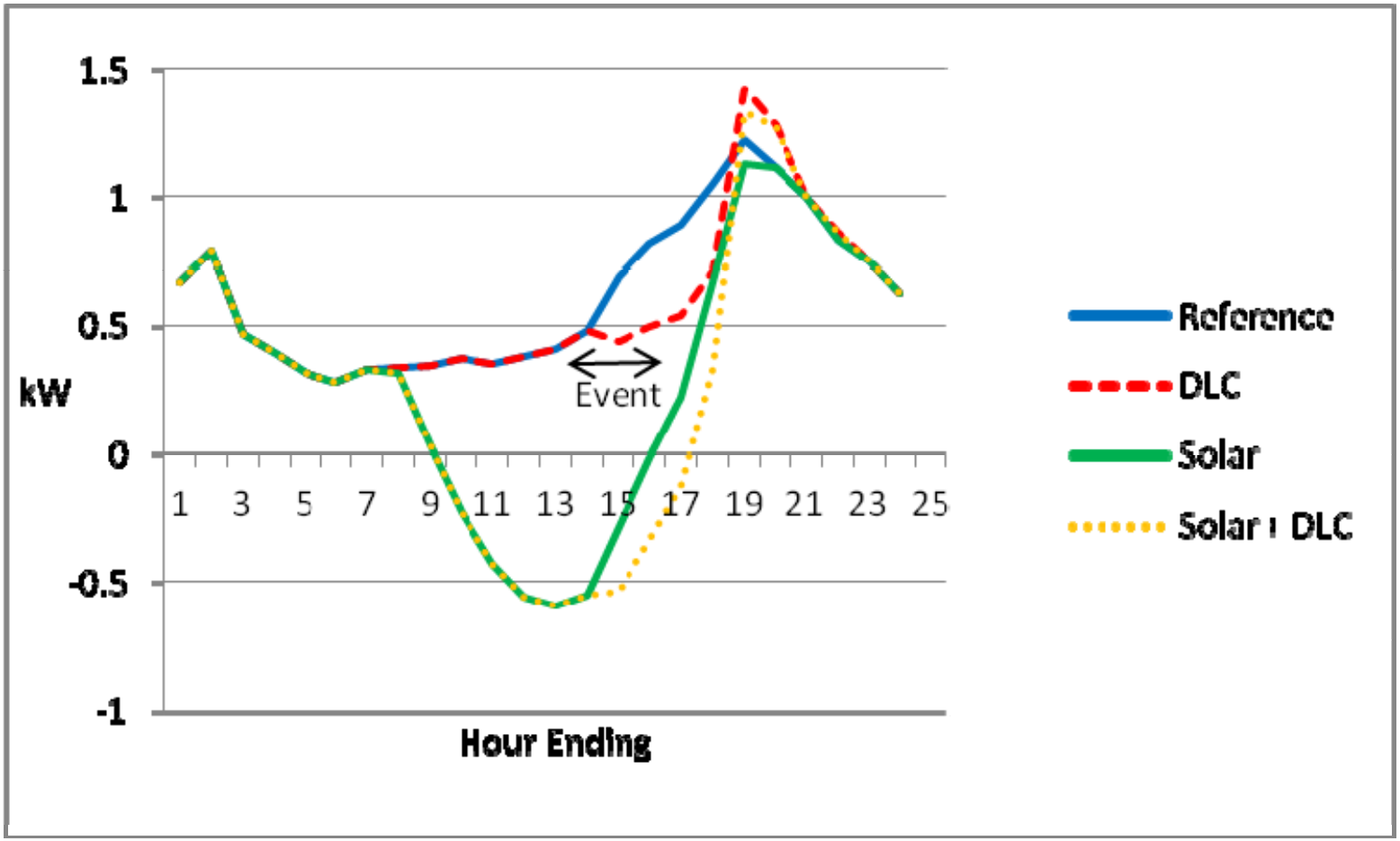
DLC Example During Peak Summer Event



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Performance Based Incentives

- Smart meters sometimes have more than one portal, allowing a second portal to be used to record PV system generation
- Protect utilities from the risk of large upfront incentives in the event that a system that underperforms
- Creates a scenario where optimal PV operation is in the customer's best interest

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PV System Cost-Effectiveness

- TOU rates, DLC incentives, and PBI programs all reduce the payback period for a PV customer
- Utilities could also set up e-mail alerts when systems do not produce as much energy as expected so that customers can repair systems sooner

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Conclusions

- Utilities are currently investing in smart grid technology
  - Enables utilities to run more programs aimed at reducing peak demand
- Utility programs aimed at reducing peak demand are simultaneously advantageous to PV system owners

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Save the Date

May 15-17, 2012	AESP's Spring Conference Baltimore, MD
Oct. 15-17, 2012	AESP's Fall Conference Long Beach, CA
Jan. 28-31, 2013	AESP's 23rd National Conference Orlando, FL

www.aesp.org

Example: PPL Electric Utilities Renewable Energy Program

- PPL installed smart meters in 2002-2004
- Provided incentives for PV systems in 2009 – 2010
- AMI data before and after PV system installation was used to create a regression model to estimate energy consumption

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Energy Consumption Regression Model

- Dependent Variable:
  - Daily Consumption (AMI data, summed daily)
- Independent Continuous Variables:
  - HDD
  - CDD
  - Irradiance*PV System capacity
- Independent Binary Variables:
  - PV System Installation
  - Weekday
  - Site
  - Month-year

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Regression Model Results

Variable	Estimate	Standard Error	Significance Level
Irradiance* capacity	-0.0003	0.000008	0.1%
Install_flag	-5.300	0.367	0.1%
CDD	0.035	0.004	0.1%
HDD	-0.001	0.001	Not significant
CDD*CDD	0.00005	0.00001	0.1%
HDD*HDD	0.00002	0.000001	0.1%
Weekday_flag	-0.677	0.162	0.1%

$R^2 = 0.61$

$$Daily\ Change\ in\ Consumption = a_1(Irradiance)(Capacity) + a_2(Install_{flag})$$

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Annual Change in Consumption After Installing a PV System

$$Daily\ Change\ in\ Consumption = a_1(Irradiance)(Capacity) + a_2(Install_{Flag})$$

Sample Size n = 127 homes
Avg daily irradiance in 2010 = 4,374 Wh/m^2-day
Capacity = 6.2 kW

Variable	Values	Result
a_1*Irradiance*Capacity	-0.0003*4,374*6.2	-8.136
a_2*Install_flag	-5.300*1	-5.300
	Daily Change in Consumption	-13.436 kWh
	Annual Change in Consumption	**-4,904 kWh**
	PVWatts Prediction*	**-6,583 kWh**

*TMY2 avg daily irradiance was 12% less than the avg daily irradiance in 2010. Using the TMY2 avg daily irradiance results in -4,578 kWh change in energy consumption

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Reviewing and Incorporating Survey Data

- Survey data was available for 44 customers
  - Any changes in electricity use?
    - Fuel switching? No one
    - New appliances? Yes, but all EE
  - Has system been operational since installed? 43 said yes
  - Electric heating? 24 said yes
  - Air conditioning? 38 said yes

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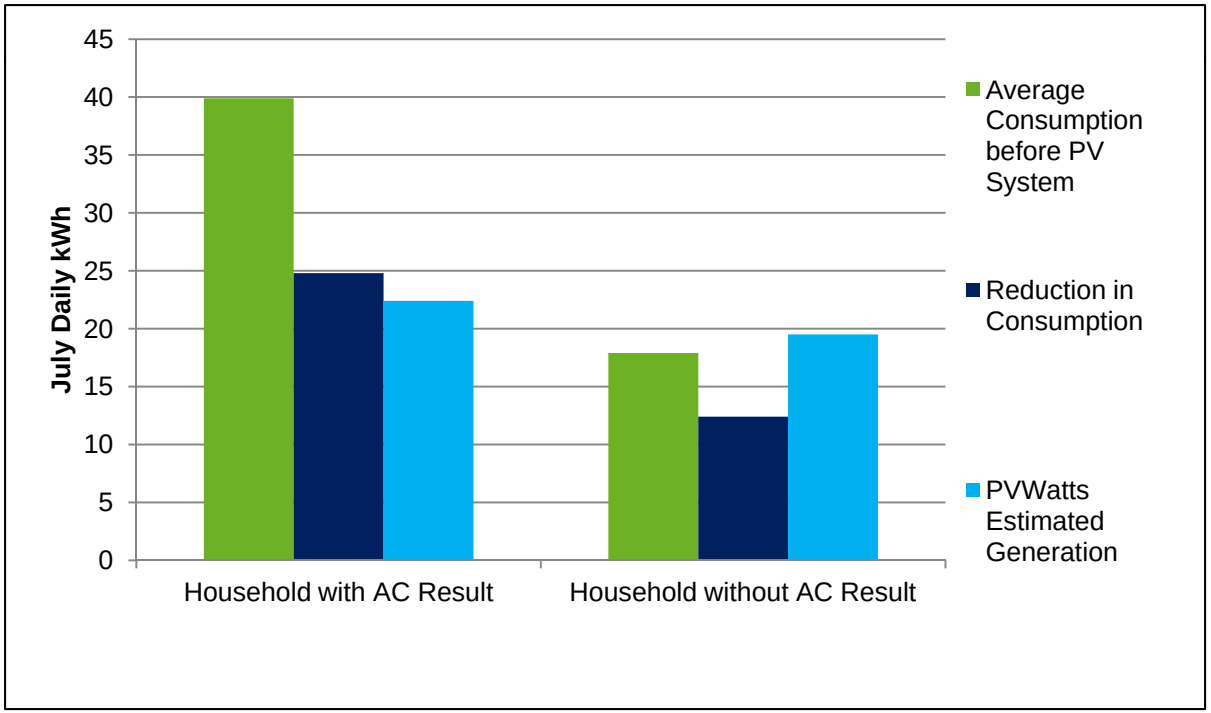
Summer Impacts - July

$$\textit{Daily Change in Consumption} = a_1(Irradiance)(Capacity) + a_2(Install_{flag}) + a_3(HDD)(Install_{flag})(Heat_{flag}) + a_4(CDD)(Install_{flag})(Cool_{flag})$$



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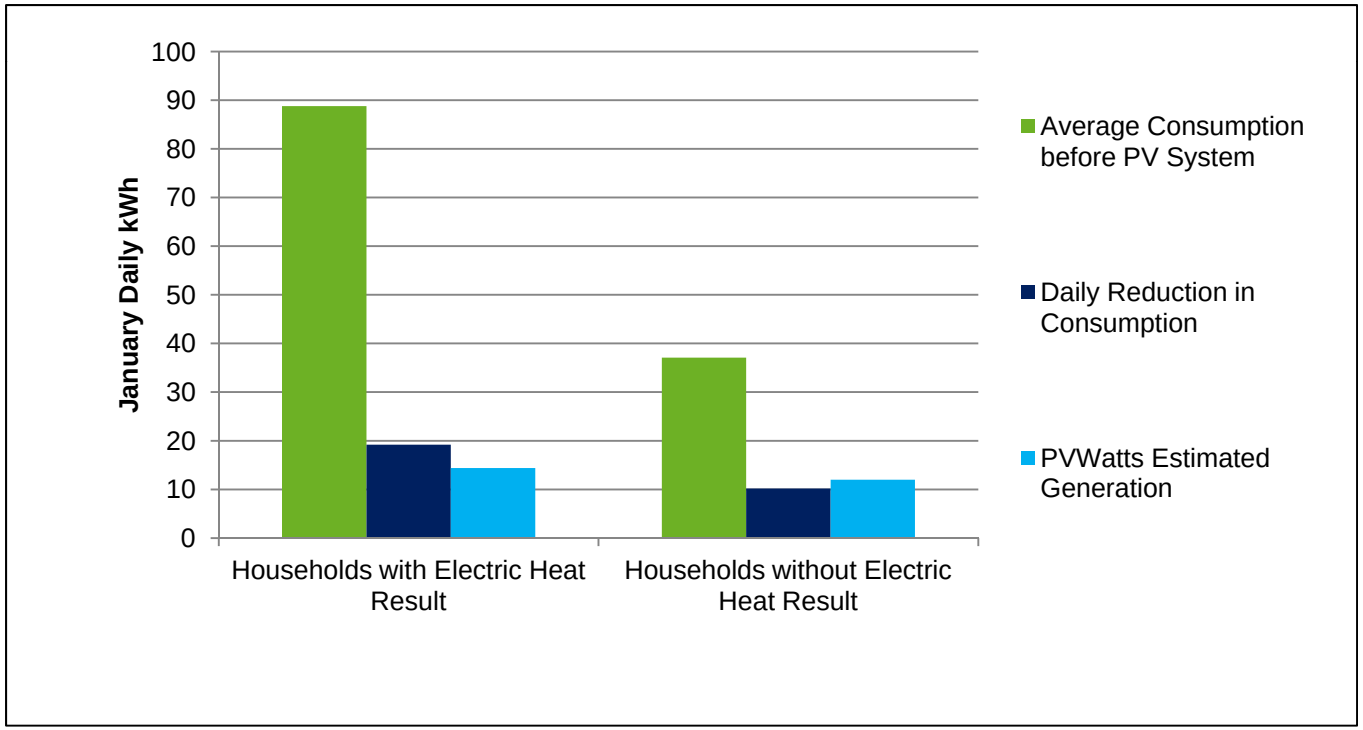
Winter Impacts - January

$$\textit{Daily Change in Consumption} = a_1(Irradiance)(Capacity) + a_2(Install_{flag}) + a_3(HDD)(Install_{flag})(Heat_{flag}) + a_4(CDD)(Install_{flag})(Cool_{flag})$$



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Conclusions from PPL Program

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- AMI capabilities can be leveraged to optimize energy savings

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