Energy Saving Opportunity from Select PNNL Lighting Research
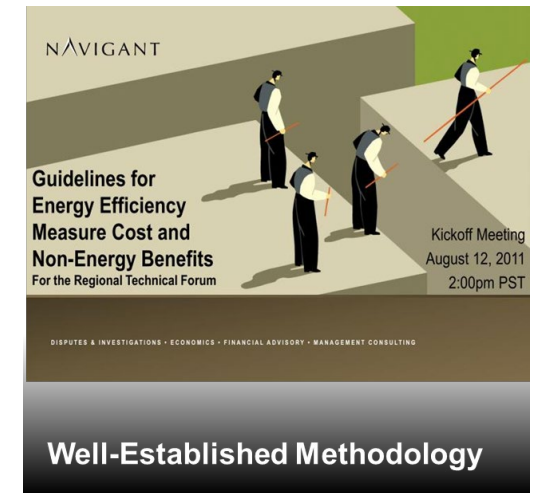
January 30, 2020

Marc Ledbetter, PNNL

Charge from DOE: Estimate Future Energy Saving Opportunity from Proposed PNNL Research

- PNNL SSL work plan for FY19-21 included some new research elements
- The new elements were collectively referred to as Emerging Lighting Science and Application Specific Lighting; they included research on:
  - Glare
  - Flicker
  - Color rendering
  - Non-visual effects
  - Outdoor environmental effects

Charge from DOE (Continued)

- PNNL began investigating alternate ways for estimating potential future energy savings, starting in early FY2019

- After rejecting a research-topic-by-research-topic effect approach (too complicated and expensive), PNNL embarked on a two-step approach:
  - First, estimate the value to potential buyers of advanced lamps and luminaires, using Non-Energy Benefits methodology in use for many years by electric utility industry.
  - Second, use those estimates of value as inputs to the lighting market model used by DOE to estimate future energy savings from advanced lamps and luminaires.

- PNNL received buy-in for this approach from DOE

- PNNL then subcontracted step one to a consultancy with the most experience in non-energy benefits methodology: Skumatz Economic Research Associates (SERA)

- PNNL then subcontracted step two to Navigant (now known as Guidehouse, Inc.), developer of the DOE lighting market model

SERA

Skumatz Economic Research Associates

NAVIGANT

Guidelines for Energy Efficiency Measure Cost and Non-Energy Benefits
For the Regional Technical Forum

Kickoff Meeting
August 12, 2011
2:00pm PST

DISPUTES & INVESTIGATIONS • ECONOMICS • FINANCIAL ADVISORY • MANAGEMENT CONSULTING

Well-Established Methodology

U.S. DEPARTMENT OF **ENERGY** | Energy Efficiency & Renewable Energy

Energy Savings Forecast of Solid-State Lighting in General Illumination Applications

Prepared for the U.S. Department of Energy
Solid-State Lighting Program

September 2016

Prepared by Navigant

Model used by DOE SSL for many years

Study Investigated Advanced Luminaires and Lamps: What are They

- For purposes of this study, they are the lamps and luminaires made possible by PNNL lighting research, containing a number of advanced features, including:
  - Reduced glare (with no price nor energy penalty by 2030)
  - Reduced flicker (with no price nor energy penalty by 2030)
  - Improved color rendering (with no price penalty, and a 20% increase in energy efficiency by 2030)
  - Improved non-visual effects (allows higher CCTs and intensity during the day, and lower CCTs and intensities at night; with no price penalty, and10% increase in energy efficiency by 2030)
  - For street/roadway luminaires, luminaires that minimize impacts on dark skies and wildlife while allowing improved human visibility (with no price penalty, and 10% increase in energy efficiency by 2030)

Step One: Estimating Buyer Value of Advanced Lamps and Luminaires Made Possible by PNNL Research

- Using descriptions of hypothetical future lamps and luminaires likely to result from PNNL research ("advanced lamps and luminaires", SERA queried potential buyers of luminaires, asking for their views on the value of these luminaires

Sector / Respondent Group	Source / Administration Method[1]	Population Mailed to (adjusted for bouncebacks)	Number of Responses	Calculated Response Rate
Commercial – Lighting Designers	Purchased email addresses in relevant NAICS business codes; SERA emailed link to web survey	9717	184	1.9%
Commercial – Business Owners	Purchased panel survey responses, statistically representative nationwide	n.a.	400	n.a.
Commercial – Business Owner Follow-up sample[2]	Purchased panel survey responses, statistically representative nationwide	n.a.	104	n.a.
Residential – Builders	Purchased email addresses in relevant NAICS business codes; SERA emailed link to web survey	8275	104	1.3%
Residential – Households	Purchased panel survey responses, statistically representative nationwide	n.a.	400	n.a.
Street/roadway – Public Works and Utilities (combined)	Purchased email addresses in relevant NAICS business codes; SERA emailed link to web survey	7161	79	1.1%

Step One: Estimating Buyer Value of Advanced Luminaires Made Possible by PNNL Research (Continued)

- Using techniques developed for estimating Non-Energy Benefits of utility energy efficiency programs, SERA analyzed the responses, and produced estimates of value (purchase price effect)

- Estimates of value from SERA were used as key inputs to the modeling work performed by Navigant

Key Assumption

- We assumed we could model the effect advanced features would have on the demand for advanced LED products by subtracting the SERA-estimated values from the prices used for the products, based on:
  - Microeconomic theory
  - Verification that the demand curves were linear
  - And various other simplifying assumptions

Key Assumption

Demand curve D' (for advanced LED products before adjusting for the extra values estimated by SERA) is unknown, but is assumed to be linear and parallel to the demand curve for advanced LED products derived from the Navigant lighting market model (D). If it lies a distance above the unadjusted demand curve equal to the value estimated by SERA, then the SERA estimates (v) can be subtracted from the Advanced LED prices used in D to model the results one would achieve if D' were known. In this case, the increase in demand from Qo to Q' is the same whether unadjusted prices (Po) were used with D', or adjusted prices (Po-v) were used with D.
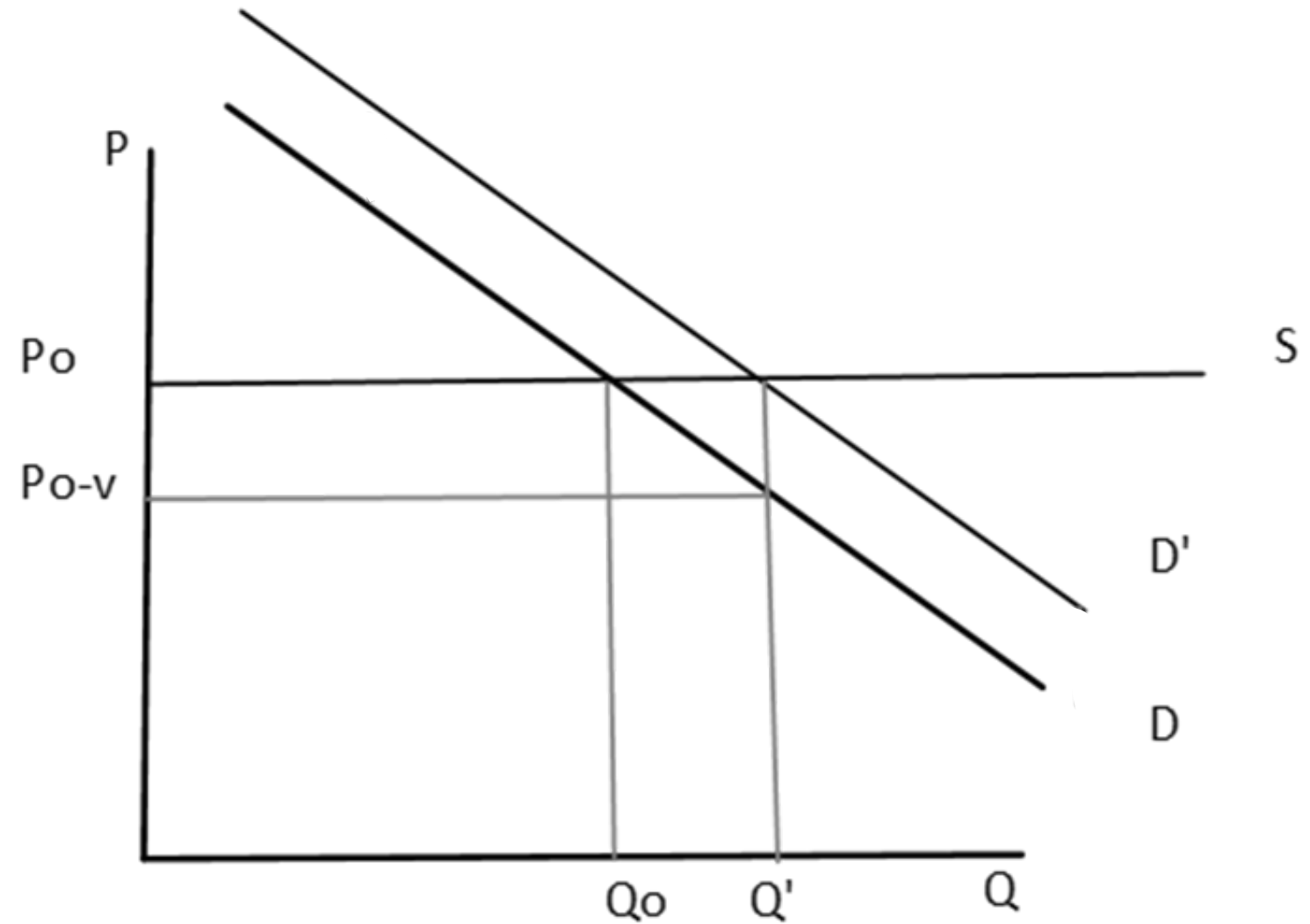
Step Two: Estimating Energy Saving Potential from Advanced Luminaires

- Navigant analysis focused on three representative product classes (sub-markets):
    - Commercial 4 ft linear luminaires
    - Residential general service lamps
    - Outdoor Street/Roadway luminaires
- Results from these analyses were scaled and then extended to all commercial, residential, and outdoor sub-markets
- This approach was used to make analysis possible within time frame and budget allowed

Steps One and Two of the Study

- I am now followed by two presenters, who will describe the work they did to complete steps one and two of this study:
  - **Lisa Skumatz, SERA,** will describe their use of non-energy benefits methodology to estimate the value potential buyers associate with the advanced features made possible by future PNNL research, and their results
  - **Valerie Nubbe, Navigant Consulting**, will describe their use of the model they developed for the DOE SSL program to estimate the energy saving opportunity made possible by the future PNNL research, and their results