How Long Do These Things Last: Estimating CFL Measure Life

Lisa Wilson-Wright, Nexus Market Research
Angela Li, National Grid
Jeff Zynda, RLW Analytics
Ralph Prahl, Prahl & Associates
Paul Gray, The United Illuminating Company

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Presentation Overview

- Review existing studies
- Sample development and classification
- Analyses to estimate measure life
- Conclusions

How Long Do These Things Last:

REVIEW EXISTING STUDIES

Three Studies, Four Reports

- Readily available on the internet
- California investor-owned utility programs
- CFLs and fixtures distributed in mid-1990s
- Different types of programs
- Divergent ways of identifying sample of products to include
- Non-linear approaches to estimation

Comparison of California Studies

Information	Athens 1999	Xenergy 2001	SDG&E 2001	SDG&E 2003
Program Type	Markdown	Common area direct install	Markdown	Markdown
Years Obtained	1994-1995	1994-1995	1996-1997	1996-1997
Age at Study	4-5 years	3 & 6 years	4-5 years	6-7 years
Sample Development	Multiple studies	Database	Postcards	Postcards
Determination of Status	Self-report in one of the studies	On-site verification	Self-report, annual survey	Self-report, annual survey
Estimation method	Generalized Gamma	Weibull	Maximum Likelihood	Maximum Likelihood
CFL Measure Life in Years	5.8	78.5 (16)	6.0	7.5

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SAMPLE DEVELOPMENT AND CLASSIFICATION

On-site Methodology

- Technicians searched for specific products obtained through energy efficiency programs
- Visually confirmed:
  - Installation
  - Continued operation
  - Storage
- Customer self-report of disposition for products not visually confirmed
  - Estimated year removed and why
  - Where other products now located

Information Needed for On-Site

- Occupant / current owner phone number
- Product model number
- Number of each product obtained
- Year product obtained

- Limited programs from which sample pulled
  - Direct install (home energy assessment, ENERGY STAR homes)
  - Retail instant coupon

Sampled Products by Year Acquired

Year Acquired	Retail CFLs	Direct Install CFLs	Exterior Fixtures	Interior Fixtures
2002	24%	19%	20%	18%
2003	14%	20%	21%	12%
2004	15%	21%	20%	17%
2005	23%	21%	20%	22%
2006	24%	20%	20%	31%
Total	**695**	**441**	**215**	**397**

Product Classification

Product Status	Coupon CFLs	Direct Install CFLs	Exterior Fixtures	Interior Fixtures
Survived	48%	56%	37%	55%
Failed	20%	14%	17%	6%
Excluded	32%	31%	46%	39%
Total	**695**	**441**	**215**	**397**

- Survived visually confirmed as installed and working
- Failed visually confirmed, customer reported as burned out, broken, or permanently removed from service
- Excluded products stored, installed outside of service territory, or unknown disposition (not found, customer unable to recall)

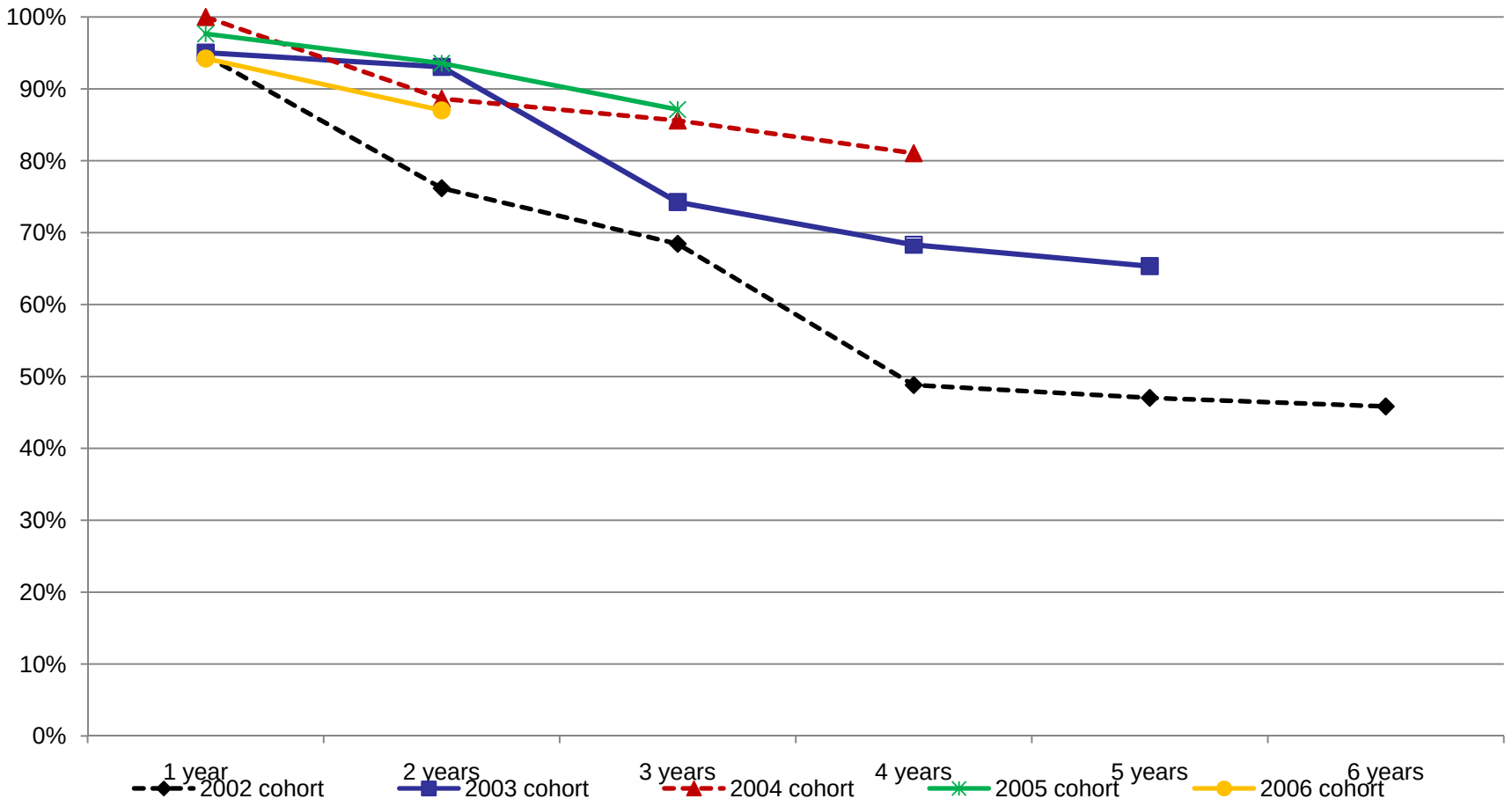
Sources of Potential Bias

- Limited number of programs included
  - No low-income or markdown
  - Minimal direct install
- Households with large numbers of fixtures targeted
  - Committed CFL users
  - Higher number of contractors, electricians
- Inaccurate customer recall
  - Small and inexpensive product
  - Length of time between purchase and survey
- Only households with same phone number
  - Fewer young respondents
  - Fewer low-income

How Long Do These Things Last:

ESTIMATING MEASURE LIFE

Improvement in CFL Quality?



Survival Analysis

- Examines the time to an event
  - 'Event' when lighting product stops working or removed from service
  - 'Measure life' is when 50% of the products can be expected to have failed
- Survival functions not linear
  - Cannot use ordinary least squares regression
  - Turn to non-linear estimation methods
- Three different approaches used
  - Life tables
  - Logit regression analyses
  - Parametric regression analyses

Parametric Regression Models

- Fit the data to a non-linear model
- Use established equations, transformations
- ‘Iterate’ data until cannot improve ‘fit’
- Tested five different models
- Find the best model based on:
  - Shape
  - Standard error
  - Akaike Information Criteria (AIC)
    - Log likelihood
    - Number of parameters in model

Example: Coupon CFLs

Total Products=474, Failed=140

Model	Measure Life	Std. Error	AIC
Exponential	7.6	0.6	720
Gamma	6.6	0.8	634
Log Logistic	**5.5**	**0.3**	**659**
Log Normal	5.7	0.4	645
Weibull	5.6	0.3	672

- Low standard error, moderate AIC
- Wanted same model type for each product
  - Log normal probably ‘best’ choice in five above, but…
  - Other log logistic better for other CFL types (direct install, markdown)

Final Estimates

Product	Model	Measure Life
Coupon CFLs	Log logistic	5.5
Direct install CFLs	Log logistic	6.7
Markdown CFLs	Log logistic	6.8
Exterior fixtures	Weibull	5.5
Markdown exterior fixtures	Weibull	5.9
Interior fixtures	Not recommended – too early to tell	

- Markdown CFLs computed from coupon and direct install products also offered in markdown programs. Not observed directly.
- Markdown estimate in between previous studies'

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CONCLUSIONS

Strengths and Weaknesses of Current Study

- Three major strengths
  - Random selection of respondents vs. self selection via post-card return
  - On-site verification supplemented by respondent recall vs. recall only
  - Estimate for the current generation of products
- One major weakness
  - Conducted up to six years after obtained, so increased potential for recall related error

Alternative Study Design?

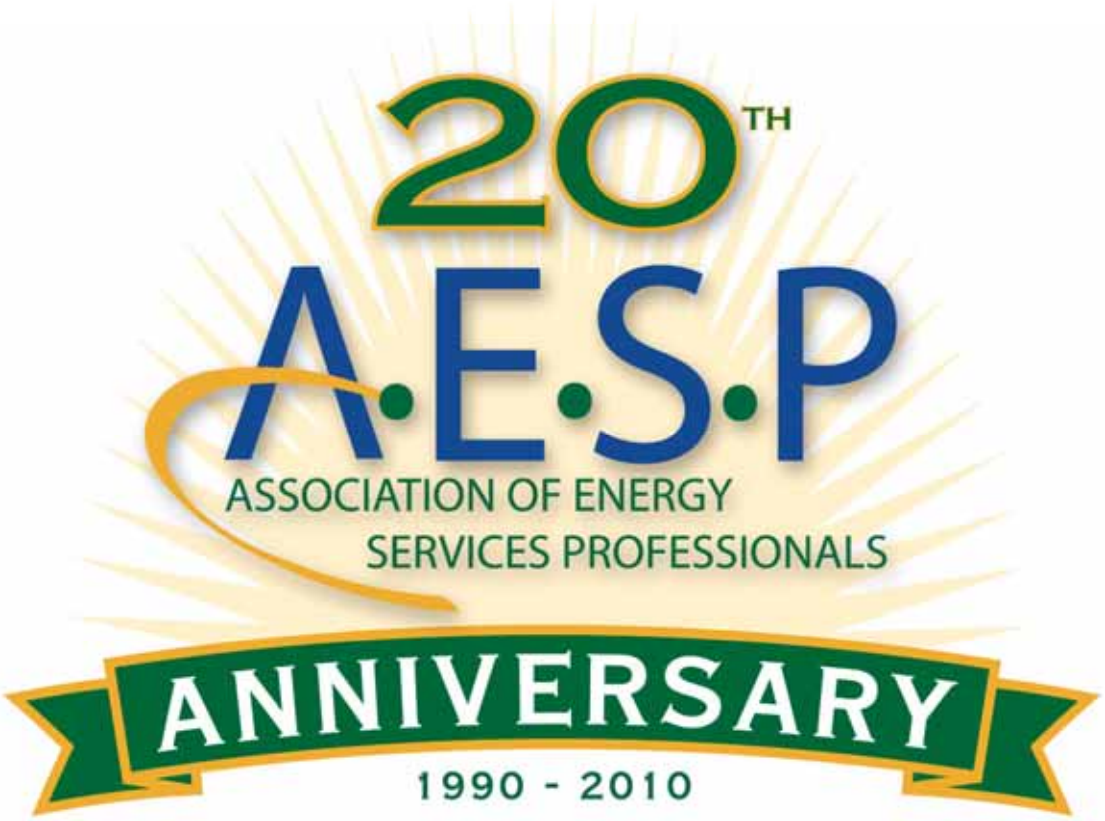
- Follow panel of several hundred CFL and energy-saving fixture users
- Six plus years to make sure enough products ‘fail’ – more for interior fixtures
- Identify panel through random digit dial or other means not involving self-selection
- Go to homes and mark products to be tracked
- Train household members on tracking products
- Track disposition via phone multiple times a year
- Provide interim reports to sponsors

Strengths and Weaknesses of Alternative Design

- Strengths:
  - Random selection
  - Reduces respondent recall error
  - Easily track specific products over time
- Weaknesses:
  - Time: 6+ years to get reliable results, but program offerings and delivery will change
  - Money: Expensive study
  - New sources of potential bias

Acknowledgements

- Energy efficiency program sponsors in
  - Connecticut
  - Maine
  - Massachusetts
  - New Hampshire
  - Rhode Island
  - Vermont



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