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Energy Efficiency Potential Studies:

What Are They?
Why Do They Them?
How Are They Done?
What To Watch Out For?

Presented to the Illinois Stakeholders Advisory Group

February 17, 2009

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Overview

- What Are They?
  - Definitions
  - Types of potential studies
- Why Do Them?
  - What are the purposes of potential studies?
  - How does the purpose influence the methods, data and level of analysis, and cost?
  - What can studies do and not do to support different purposes?
- How Are They Done?
  - What are the basic methods to estimate potential and different levels of effort?
  - When do you need a full-scale study with primary data collection?
- What To Watch Out For?
  - Comprehensiveness of scope
  - Will the available data and budget really provide what you want?
  - Methodological concerns

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What Are Potential Studies?

- An estimate of the amount of EE that could be captured over a specific time period for a given base load forecast
  - Typically also estimates costs, cost-effectiveness, and sometimes emissions reductions, job impacts
  - Typically disaggregates sources of EE — customer class, building type, end-use, industry sector, measure
- Can focus on:
  - Theoretical technical potential
  - Theoretical economic potential based on specific cost-effectiveness criteria
  - Maximum achievable potential — of economic or technical
  - "Program" potential, budget constrained, specific market, etc.
  - From specific policies, codes and standards, etc.

Definitions

- **Technical Potential:**
  - The theoretical EE opportunities from all measures assuming 100% adoption, without regard for economics and other market barriers.
- **Economic Potential:**
  - Subset of Technical that is cost-effective. Typically based on Total Resource Cost (TRC) test, but could be a different test.
- **Achievable or Market Potential:**
  - Typically the "maximum" achievable EE recognizing barriers to adoption, assuming well designed and implemented, fully funded programs or strategies.
  - Often assumes 100% incentives (% of measure costs)
- **Program or Budget Constrained Potential:**
  - Similar to achievable, but specifically constrained to consider only specific programs, funding levels, etc.
  - Most useful to support EE plans based on already determined constraints.
  - Often presented as "achievable" — creates confusion.

Market Assessments vs. Potential Studies

- Market assessments typically focus on a specific market and attempt to understand its status and how it works.
  - Market could be technology, industry sector, new construction, end-use services, etc.
  - Quantify overall market size and current baseline and saturation of efficient products or practices
  - Qualitative understanding of:
    - Market supply channels
    - Who the major actors are
    - How decision processes work and who has what influence
    - Attitudes and expectations of major actors
    - Barriers to greater efficiency
    - Testing of EE program strategies
- Market assessments more directly support program design and establish baselines from which to track market transformation progress over time.

Why?

Figure out why you need a study before planning or doing one:

- Do you really need one?
- If so, what for?
- How detailed does it need to be?
- Who are the stakeholders?
- How will it be used?

Why Do A Potential Study?

- Making the case for efficiency
- Establishing energy efficiency portfolio funding levels and goals
- Allocating resources to different policy or program areas (*e.g.*, codes, standards, DSM, DR, CHP, etc.)
- Assessing reliability alternatives to traditional supply-side resources
- Program design support and analysis

How?

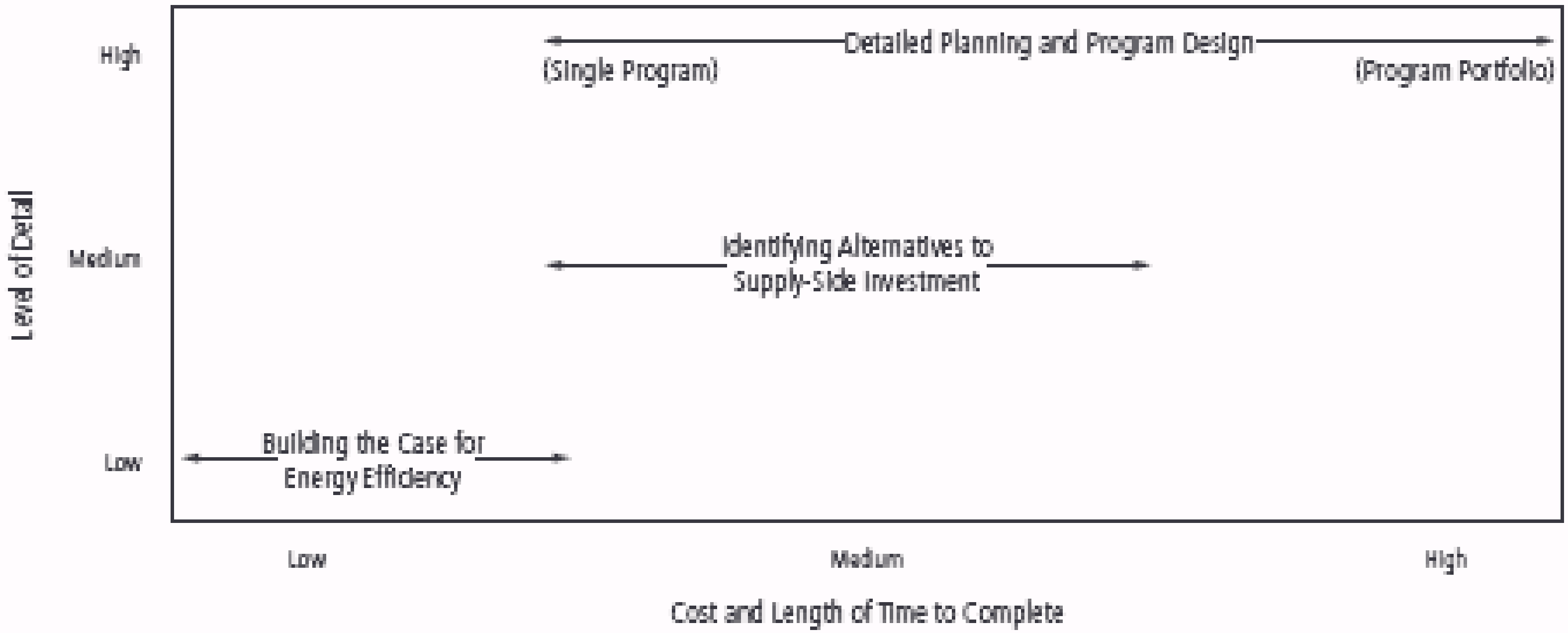
Purpose should drive methods

- Making the case for efficiency — Focus on overall opportunities and economics, don't sweat the details
- Funding levels and goals — Will they realistically push the envelope of maximum achievable potential?
- Alternatives to supply — Need for greater detail, disaggregation and precision if driving time-critical resource planning decisions
- Supporting program design or policy allocations — Focus on those markets that matter, don't worry about theoretical opportunities you won't consider
  - Consider market assessments as alternatives

How?

- Are different territories that different?
  - Yes, but…
  - Do you have data to support the differences?
    - Baseline studies
    - Industrial sector, building type and end-use breakdowns
    - End use Load shapes
  - Do you need the level of precision that requires a great deal or primary data or can you draw off of other regional efforts?
    - NEEP New England Study
    - Western Governors' Study

Figure ES-1. Considerations for Conducting Potential Studies



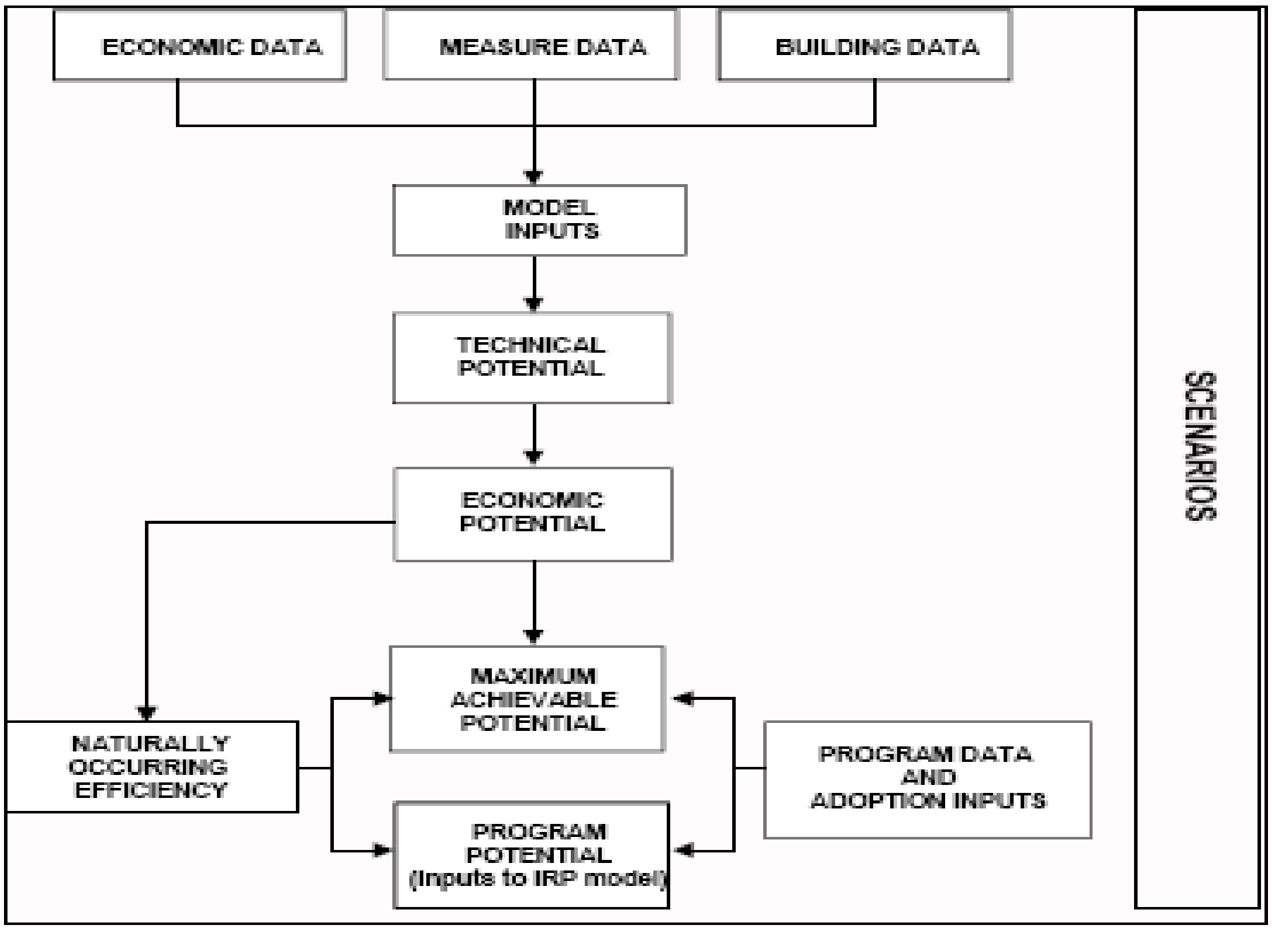
Typical Costs Can Vary

- "High" Level — $20,000 - $50,000
  - Draw off of other studies
  - Apply secondary results to territory loads by sector, end-use
  - Won't provide level of detail by building type, sub-regions, measure, etc.
- Medium Level — $75,000 - $200,000
  - More detailed, bottom-up data and analysis
  - Typically high reliance on secondary data — hopefully from territory or nearby
  - More detailed measure-level data and results
- Detailed Level — $250,000 - $750,000
  - Reliance on significant primary data collection
  - Greatest accuracy and determination of differences from other areas

What Outcomes Do You Need?

- What will influence decisions? — Purpose and stakeholders drive presentation of results
  - GWh
  - Peak MW
  - % of forecast
  - Detailed disaggregated results (measure, industry, building type)
  - Hourly reliability effects
  - Funding needs
  - Societal economics
  - Carbon reductions
  - Jobs

Figure 2-3: Simplified Conceptual Overview of Modeling Process



Methods

- Specific methods can vary, and will be driven at least in part by available data.
- Fundamental approach involves:
  - –Establish basecase forecast (and understand what it represents)
  - –Disaggregate forecast — building type, end use, etc.
  - –Identify technologies and practices
  - –Characterize technologies (costs, savings, lives, load shapes)
  - –Identify eligible populations by market
  - –Establish basecase measure penetrations
  - –Screen measures for cost-effectiveness
  - –Identify programs and budgets
  - –Establish achievable penetrations (and "in-program" penetrations)
  - –Adjust for changing stocks, interactions, mutual exclusivity

Typical Residential Methods — Bottom-Up

- Calibrate and disaggregate billing data to equipment level
- Collect census or other data — # households, SF vs. MF, fuel shares, heating system types, appliance saturations, etc.
- Collect product data — baselines, #s sold annually, etc.
- Apply per measure data
- Project number of widgets (basecase and potential)

Typical C&I Methods — Top-down

Central Equation:

Annual Measure Scenario Potential	=	New or Existing Building End Use KWh Sales Per Year	X	Applicability Factor	X	Feasibility Factor	X	Turnover Factor (Existing Market-Driven only)	X	Savings Factor	X	Annual Net Penetration (Achievable - Base Case)

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Example of Top-Down Approach

Annual Measure Achievable Potential

(High Efficiency HVAC Replacement on Burnout)

Building End Use Sales Per Year (Office Cooling)	100,000 MWh		
× Applicability Factor (Unitary Tons / Total Tons)	50%	=	80,000 MWh
× Feasibility Factor	100%	=	80,000 MWh
× Turnover Factor (1 / Measure Life)	6.7%	=	3,350 MWh
× Savings Factor	20%	=	670 MWh
× Annual Net (Achievable Base Case) Penetration	3%	=	20.1 MWh

Top-Down Approach — Sample Segmentation

84 C & I Technologies –
2,430 Measures

4 markets:

- New construction
- Existing (Renovation; Remodel / Replacement; Retrofit)

11 Building Types – Agriculture, Education, Grocery, Health, Industrial, Lodging, Office, Restaurant, Retail, Warehouse, Other

9 End Uses – Cooling, Exterior Lighting, Interior Lighting, Office Equipment, Refrigeration, Space Heating, Water Heating, Whole Building, Miscellaneous

Establishing Baselines

- **What's in the forecast?**
  - **Simple econometric trend analysis or detailed end-use forecast?**
  - **Codes & standards?**
  - **Past or expected EE programs?**
  - **Naturally occurring efficiency?**
- **Forecast must reflect underlying baseline assumptions**
- **Equipment and system baseline data**
  - **Available studies**
  - **Regional or neighboring data**
  - **Surveys and on-site data collection**

Interactions and Mutual Exclusivity

- Total potential is less than the sum of the parts
- Interactions:
  - Some measures will effect savings of other measures
  - Example: High efficiency AC will reduce cooling savings from optimizing distribution system
  - Need to correctly account for interactions, and determine ranking of measures.
  - Individual measure cost-effectiveness is different than cost-effectiveness as part of a group — costs don't change but savings do.
  - Requires judgment when dealing with achievable and program potential

Interactions and Mutual Exclusivity, cont.

- Some measures are mutually exclusive
- Example: T8, HPT8 and T5 fluorescents replacing same T12 fixtures
- Can arbitrarily assign shares
- For technical and economic, 100% should go to best measure
- For achievable and program potential better approach is to adjust penetrations based on program experience, program design and judgment

Keep Track of Building and Equipment Stocks

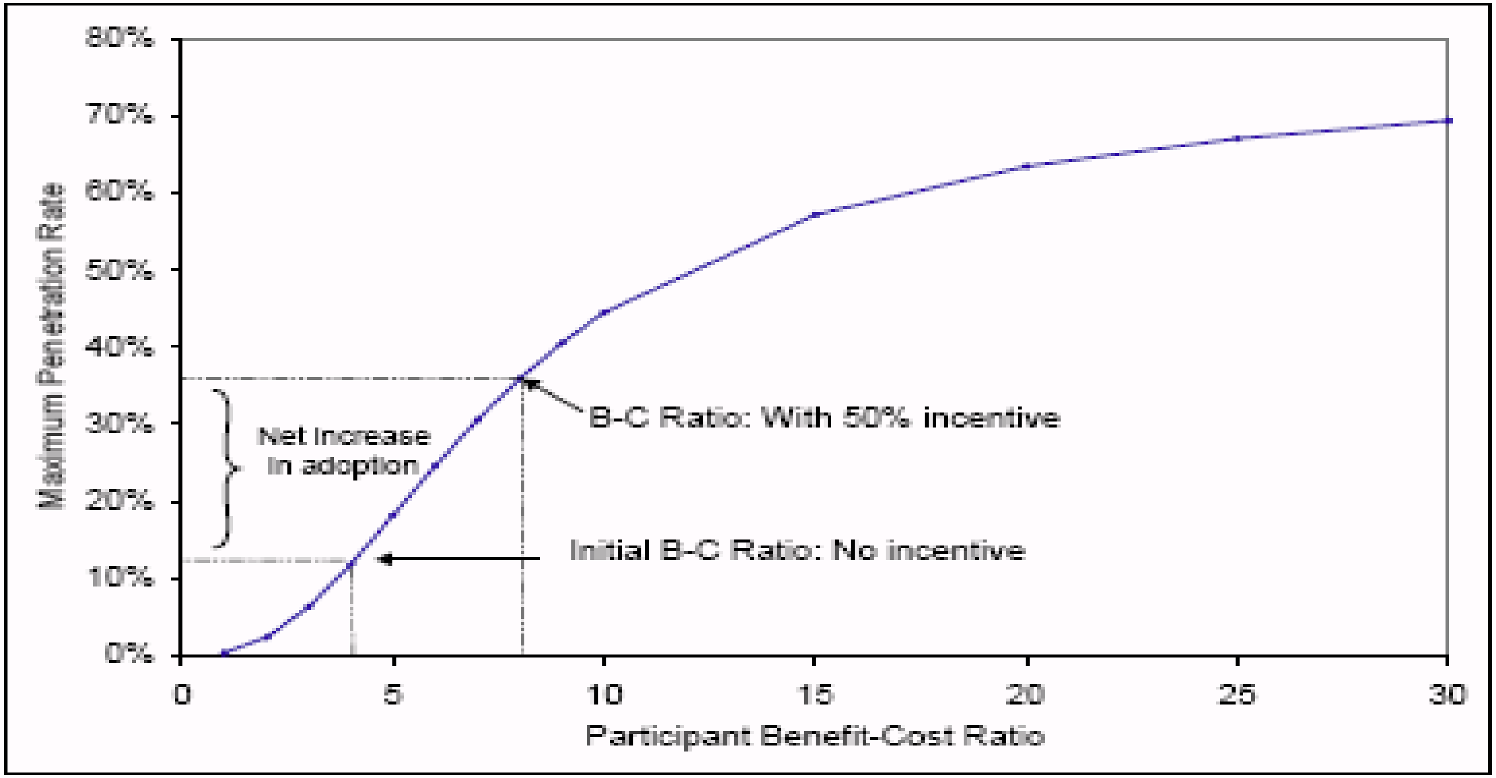
- Segment by market
  - New construction
  - Major renovation
  - Remodeling
  - Replacement on burn-out
  - Early Retirement
- If get deep retrofit (early retirement), then less available for other existing construction markets
  - Year-by-year adjustments necessary
  - Need to explicitly adjust eligible markets each year for prior activity

Modeling Penetration

- Most qualitative part of analysis
- Perhaps biggest area of uncertainty and dispute
- Major impact for achievable and program analyses
- Formulaic approaches not recommended
- Should explicitly model:
  - Basecase penetrations
  - Potential penetrations (for technical and economic = 100%)
  - “In-program” penetrations
- Don’t recommend simple free rider/spillover factor approach

Common Formulaic Approach

Figure 2-6: Illustration of Effect of Incentives on Adoption Level as Characterized in Implementation Curves



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Why is Formulaic Approach Bad?

- Assumes all customer decisions are purely economic ones
  - Ignores the many barriers to efficiency adoption
  - Ignores reason for EE programs, and program strategies
  - Ignores the substantial differences between measures and customers
- Falls apart for true maximum achievable potential
- Ignores all past program experience and knowledge of markets
- Example:
  - Retrocommissioning — short payback, low penetration
  - High efficiency chillers — long payback, high penetration

Better Penetration Approach

- Explicitly estimate basecase, achievable and “in-program”
- **Basecase:** What is current penetration, and how do you expect it to change overtime
  - Current sales practices
  - Expected or known codes and standards
- **Achievable:** What penetrations in the total market do you expect, based on specific measure and program designs
  - Pace of ramp up
  - Marketing Strategy
  - Upstream efforts
  - Incentives
- **Net savings = achievable - basecase**

Better Penetration Approach

- “In-Program”: What is the expected formal program “participation”
  - Customers collecting incentives are not equal to the achievable or the net penetrations
  - Drives incentive budgets
  - Establishes net-to-gross ratios
- Model post-program market effects

Better Penetration Approach

- "In-Program": What is the expected formal program "participation"
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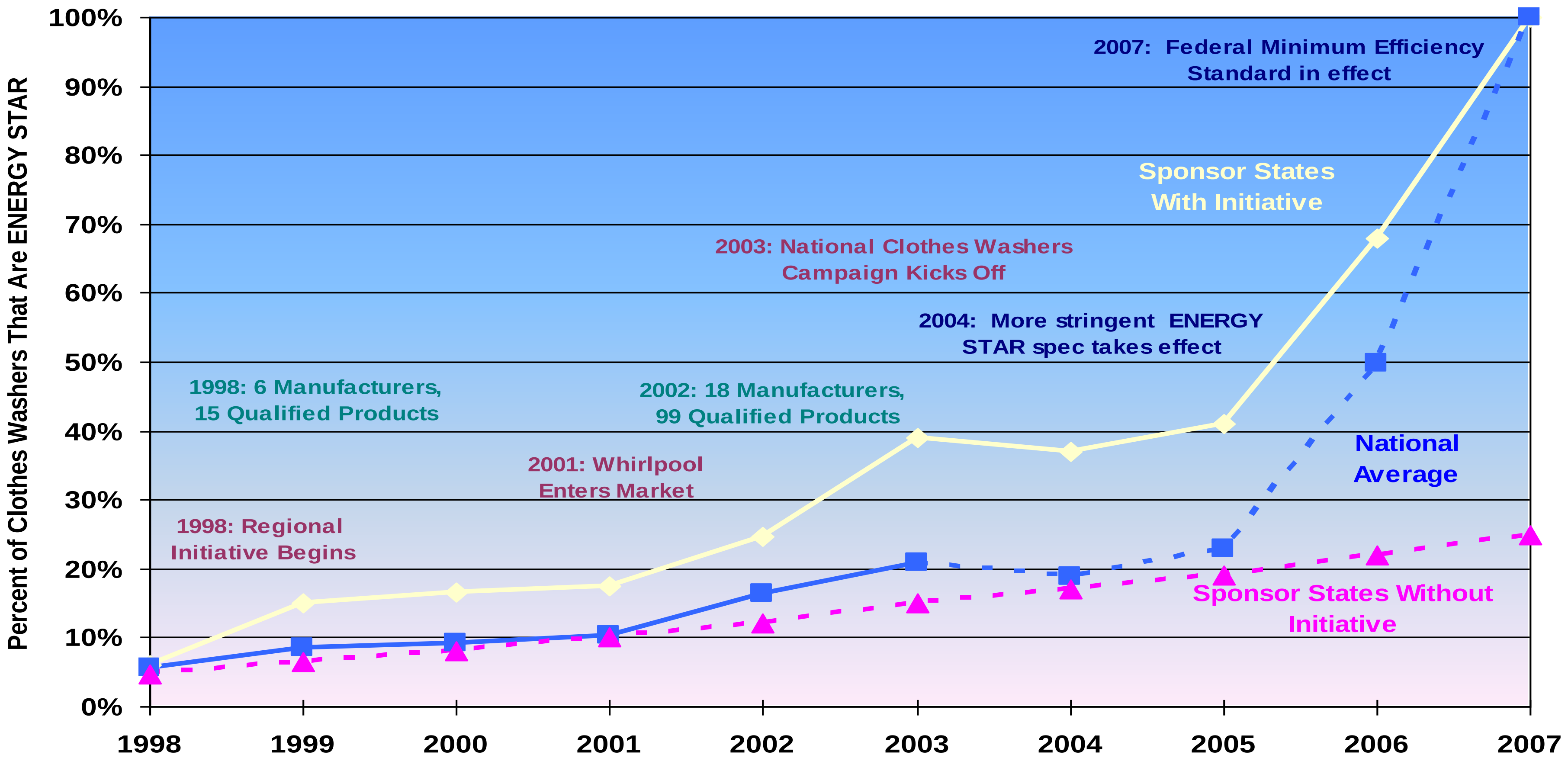
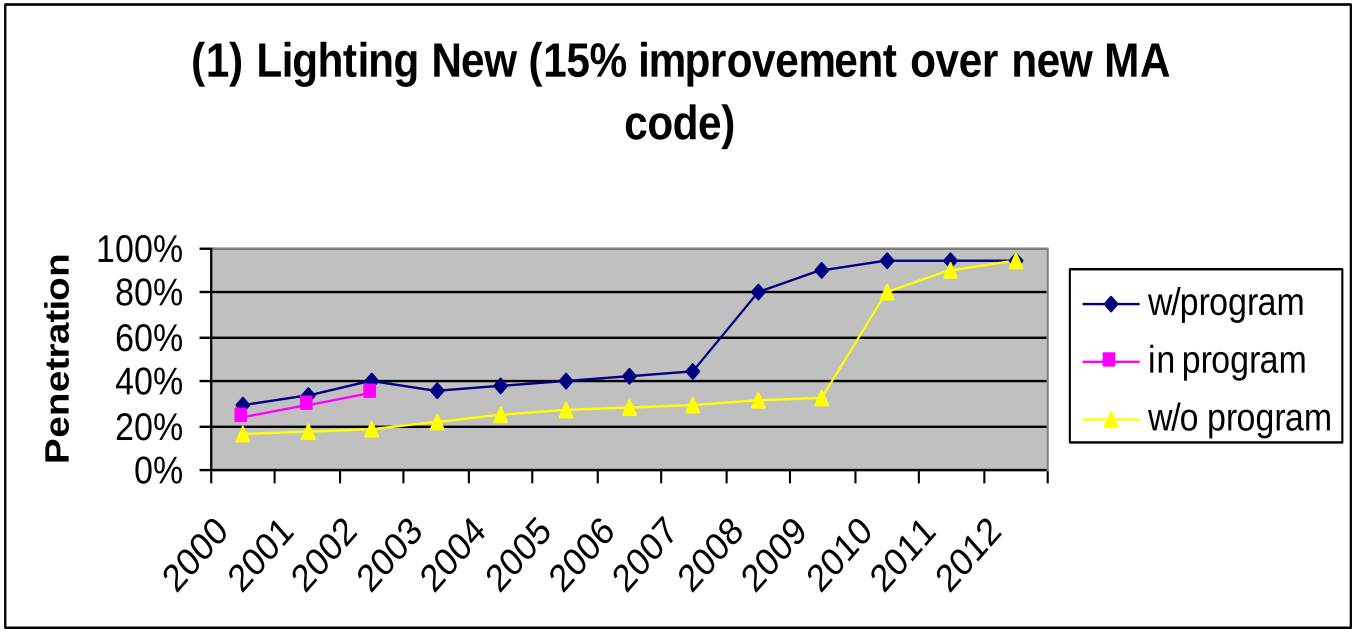
High Efficiency Clothes Washers Transformation In New England



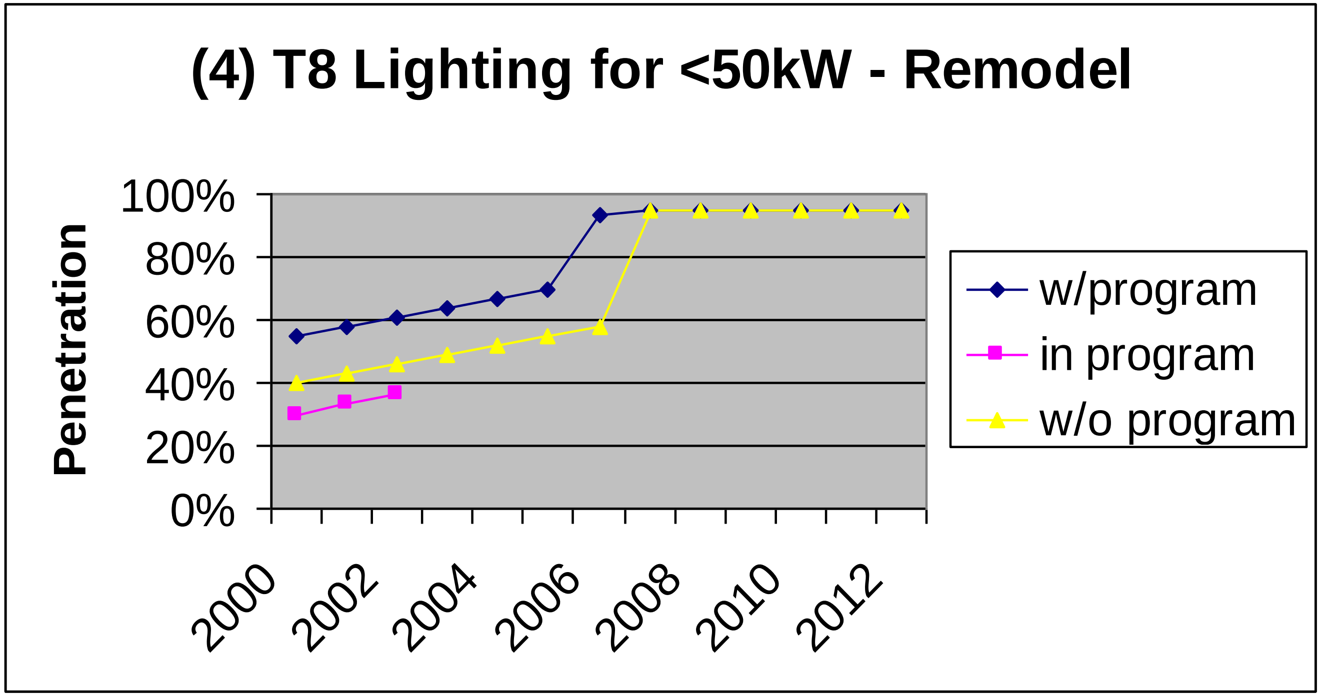
Better Penetration Approach — Example



Notes:

Assumes w/ program has slight drop in 2003 because of termination of program and removal of incentives. Then gradually climbs back up.
Assumes MA code updated in 2008 to adopt lighting criteria 15% better than current w/ program. W/o program assumes this would not occur until 2010.
Assumes only 80% of new construction and major renovation comply with updated code in first year, gradually growing to 95% compliance.

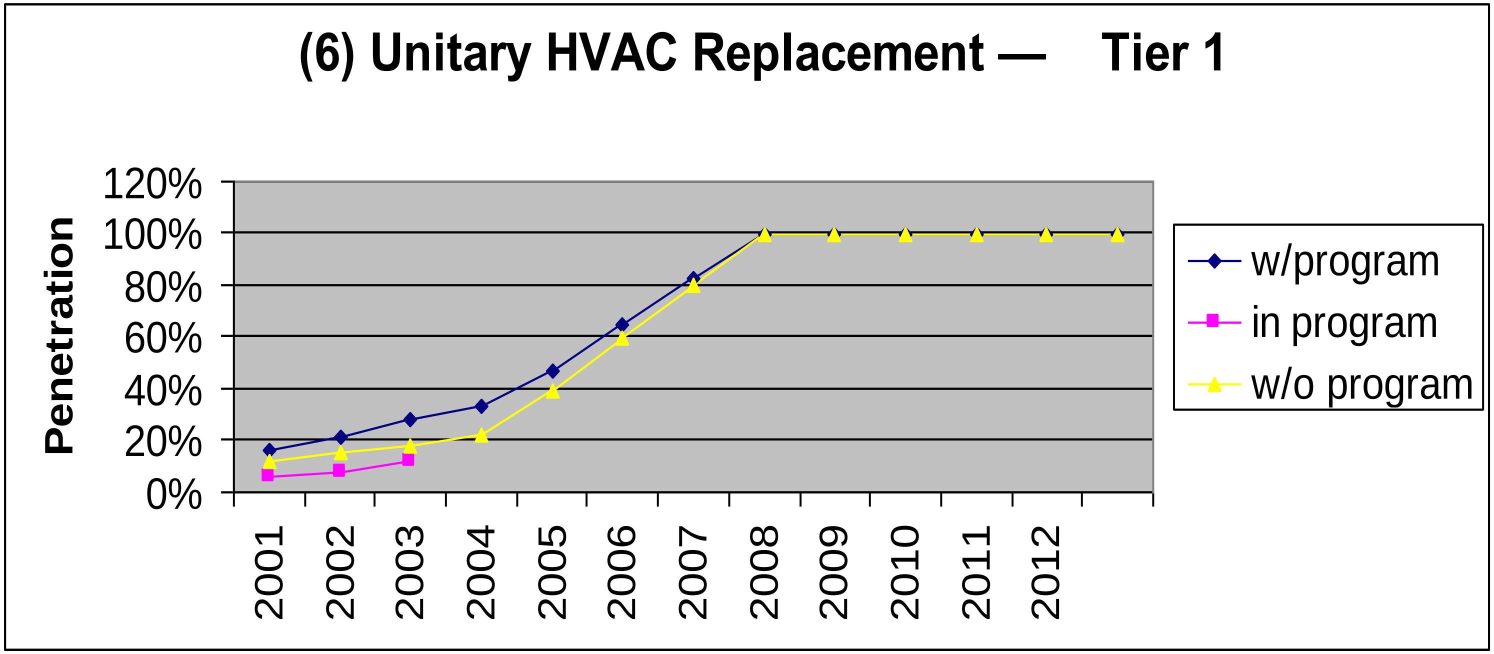
Better Penetration Approach — Example



Notes:

Assumes federal ballast standard (EPACT) mandates T8s and goes into effect in 2006 with or without the program.
Assumes 5% of fluorescent ballasts are used in specialized applications exempt from new EPACT standard.

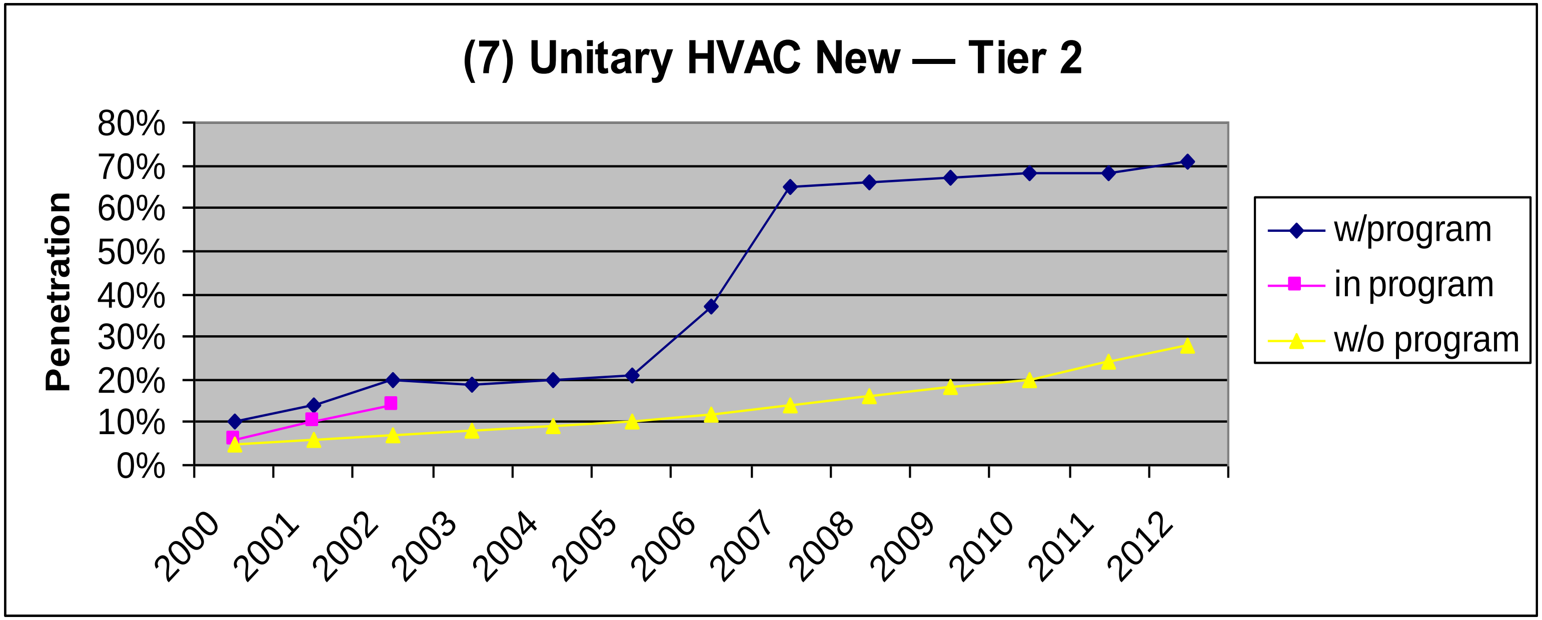
Better Penetration Approach — Example



Notes:

Tier one penetrations include all units meeting or exceeding Tier 1 efficiency (e.g., including those meeting or exceeding Tier 2).
Assumes Federal standard (EPACT) covering large units requires Tier 1 starting in 2004. (MA Code in 2002 only captures new construction and renovation, not replacement).
Assumes Federal standard (EPACT) goes into effect in 2006 for small units. Because of existing inventory, penetration doesn't reach 100% until 2007.

Better Penetration Approach — Example

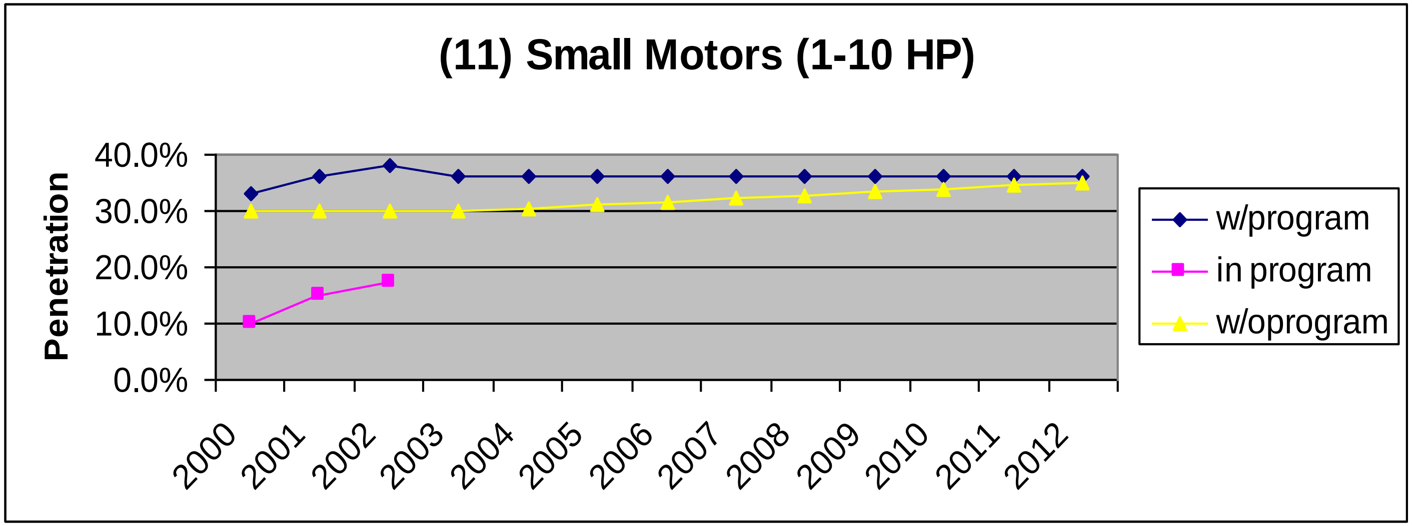


Notes:

Assumes w/ program has slight drop in 2003 because of termination of program and removal of incentives. Then gradually climbs back up.

Assumes Federal standard (EPACT) requiring Tier 2 efficiency for large units only will be achieved w/ program in 2007. W/o program, stanrdard will be Tier 1.

Better Penetration Approach — Example



Notes:

Penetrations represent all "premium" motors, not just CEE-qualifying eligible for a rebate. It is estimated that approximately 80% of premium are also CEE-qualifying.

Assumes w/ program has slight drop in 2003 because of termination of program and removal of incentives. Then penetration remains flat.

Assumes market w/o program will gradually catch up to almost the same penetration by 2012 as w/ program.

Baseline w/o program penetration based on Easton Motors Market Assessment, August 1999.

Net effect between w/ program and w/o program based on the net effects estimated from BECO Delphi study conducted by GDS and Feldman, July 1999. Assumes "aggressive" scenario for first three years, "moderate" scenario for 2003 and beyond.

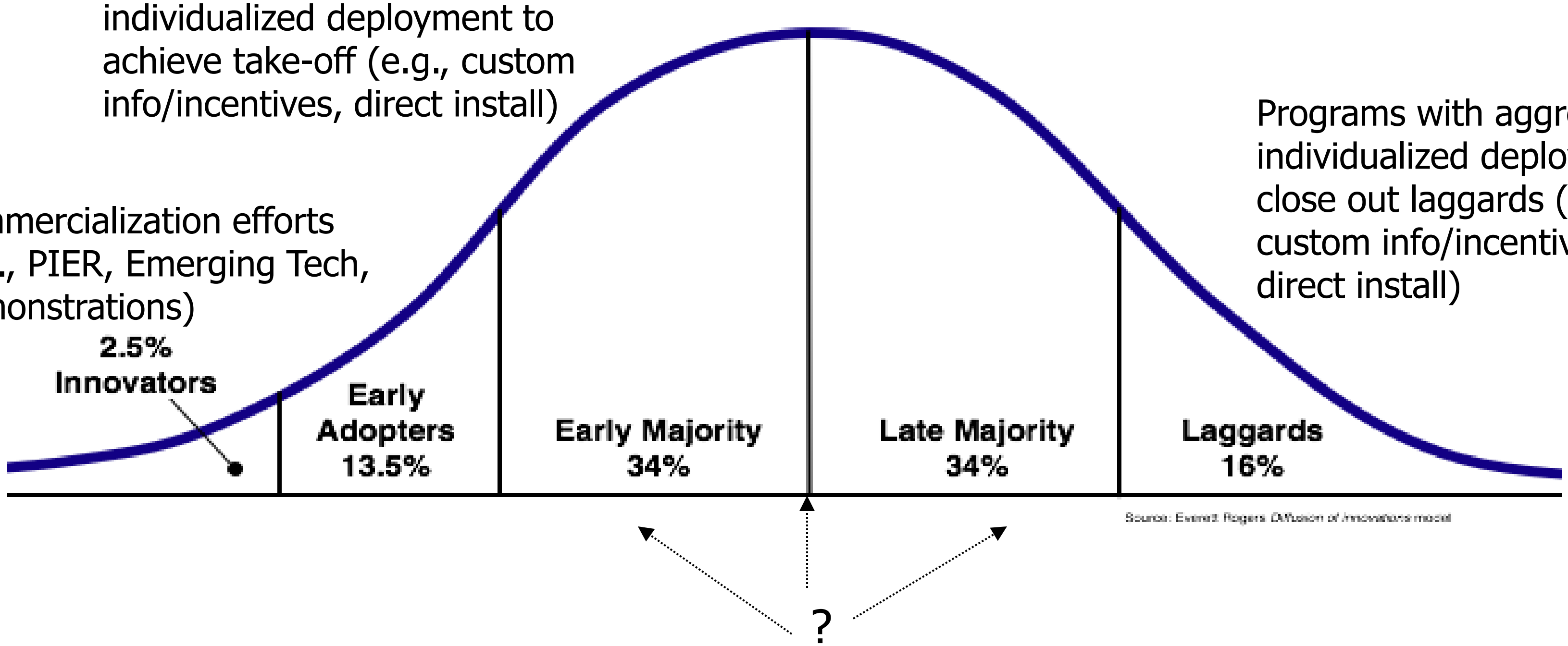
Technology Diffusion & Program Life-Cycle

Programs focused on high-volume deployment and leveraging market momentum (e.g., mass information, prescriptive rebates)

Programs with aggressive, individualized deployment to achieve take-off (e.g., custom info/incentives, direct install)

Programs with aggressive individualized deployment to close out laggards (e.g., custom info/incentives, direct install)

Commercialization efforts (e.g., PIER, Emerging Tech, Demonstrations)

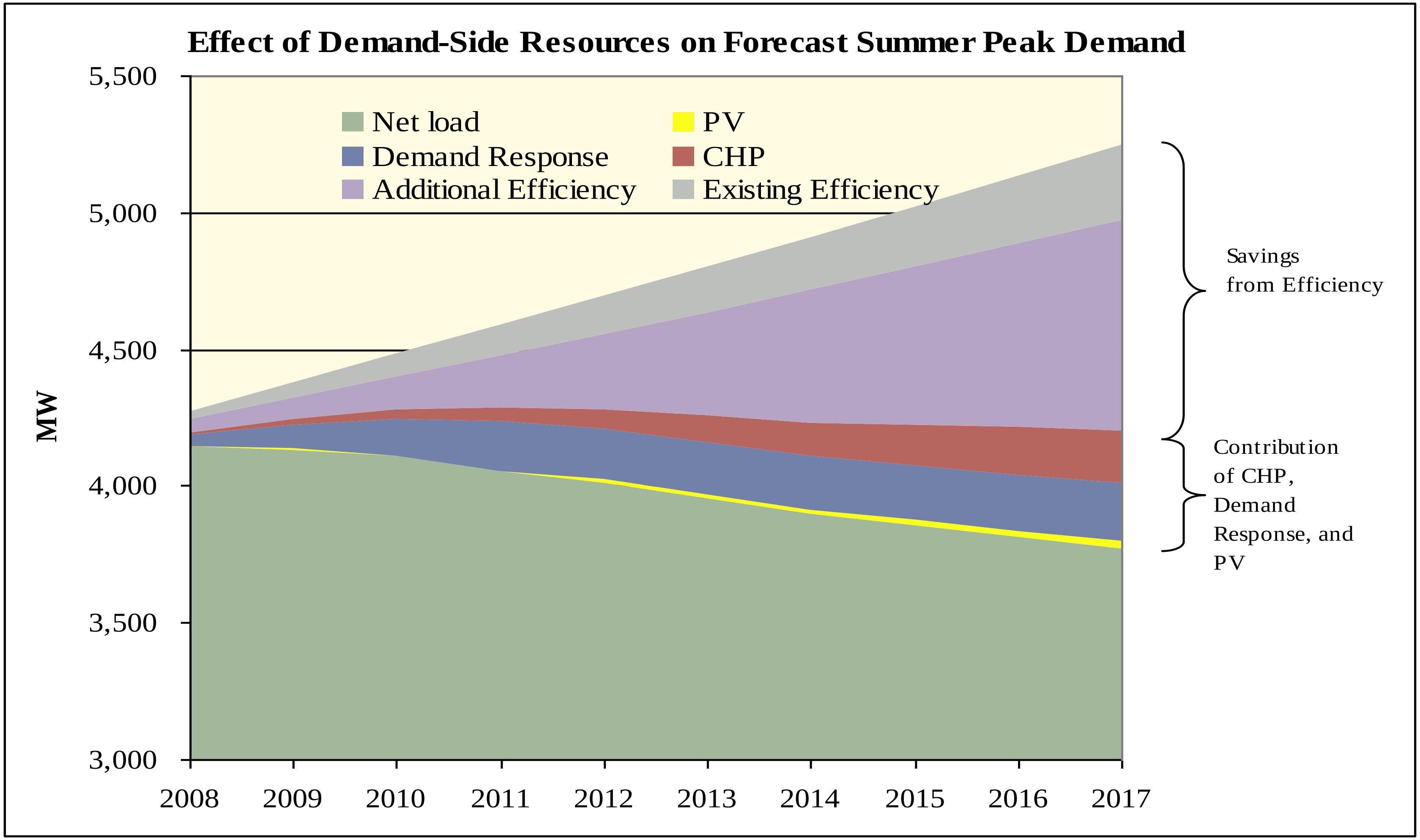


Codes and Standards

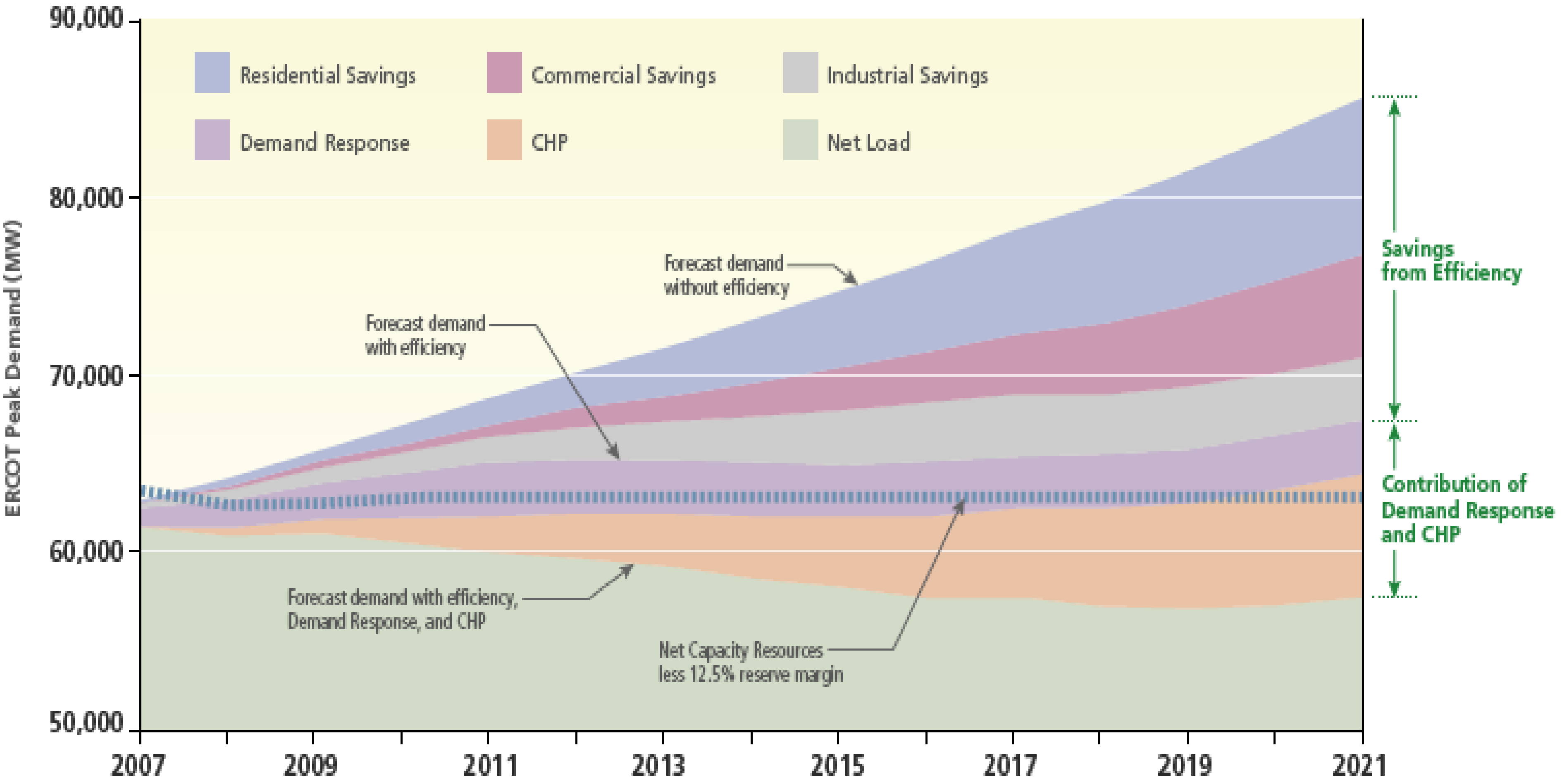
Results — What to Expect

- Think through the results you want and need
  - Level of detail and disaggregation
- Avoid false precision
  - Do you really know differences between offices and schools?
  - Is the measure level data important?
- Presentation matters
  - How will stakeholders interpret results?
  - What are you trying to learn and communicate?

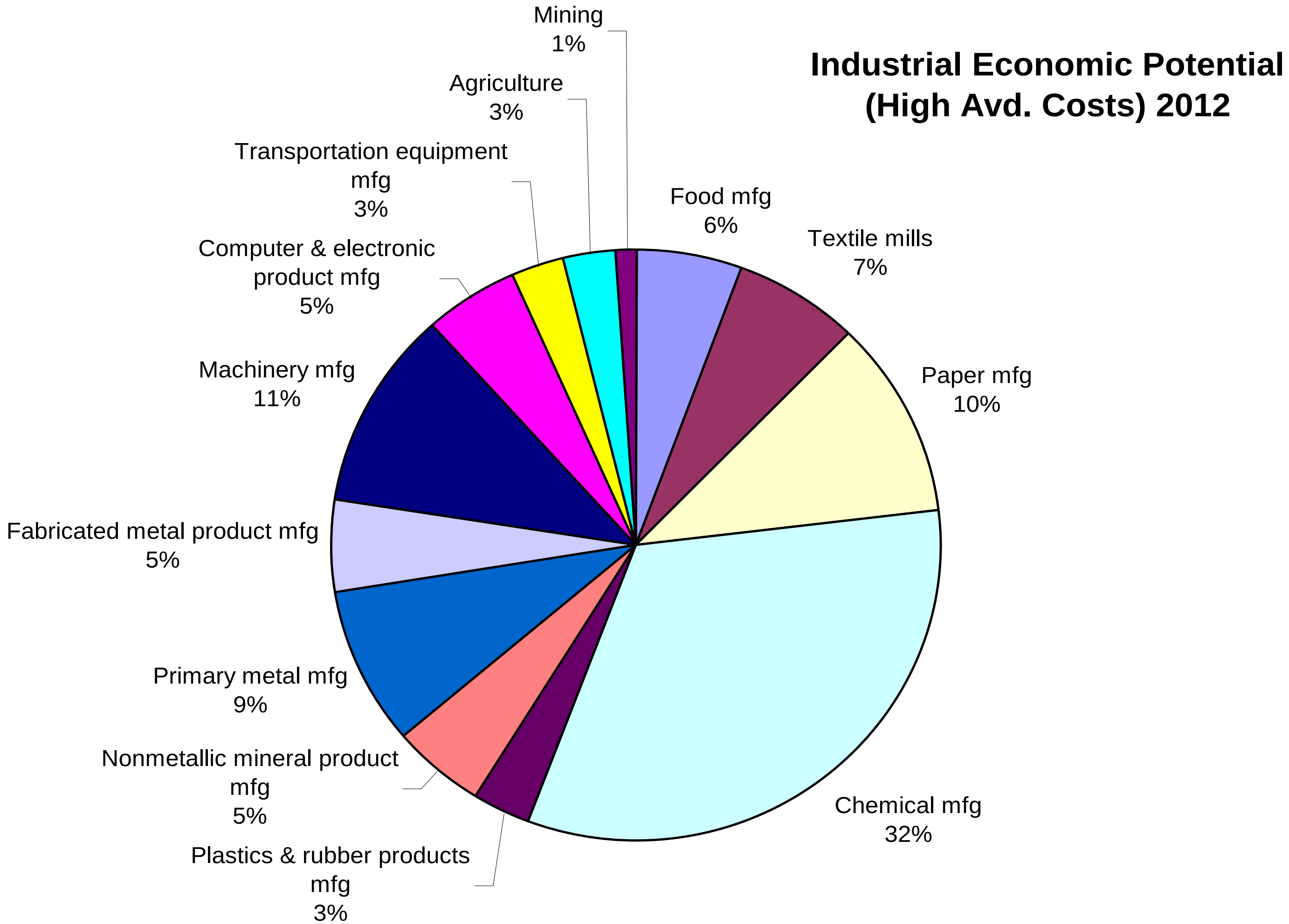
New England Utility — Getting to Zero



Texas Electric Peak Demand Efficiency Achievable Potential — Policy Focus



New York Industrial Potential by Technology Sector — Program Segmentation Strategy



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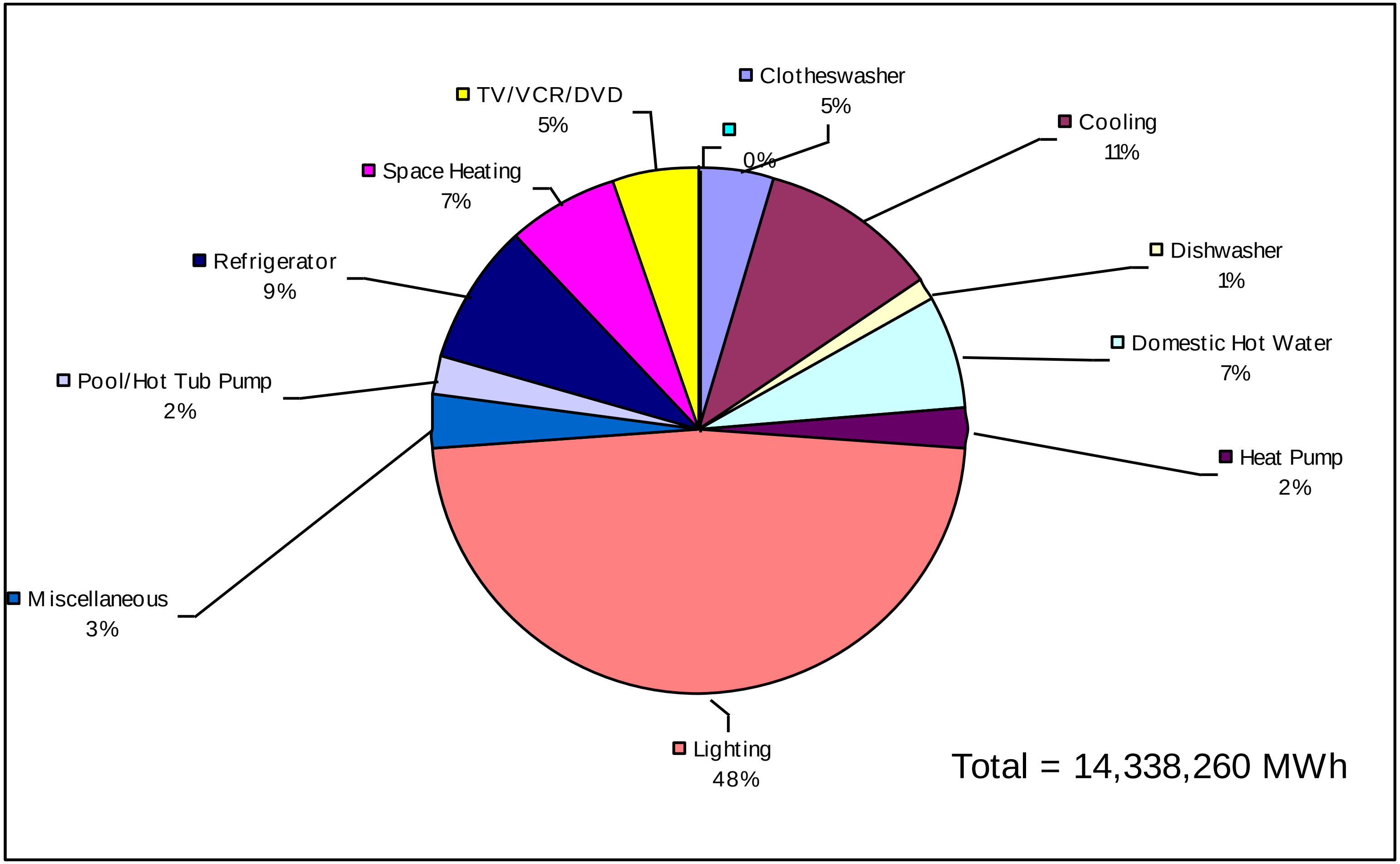
Residential Potential by Measure Category



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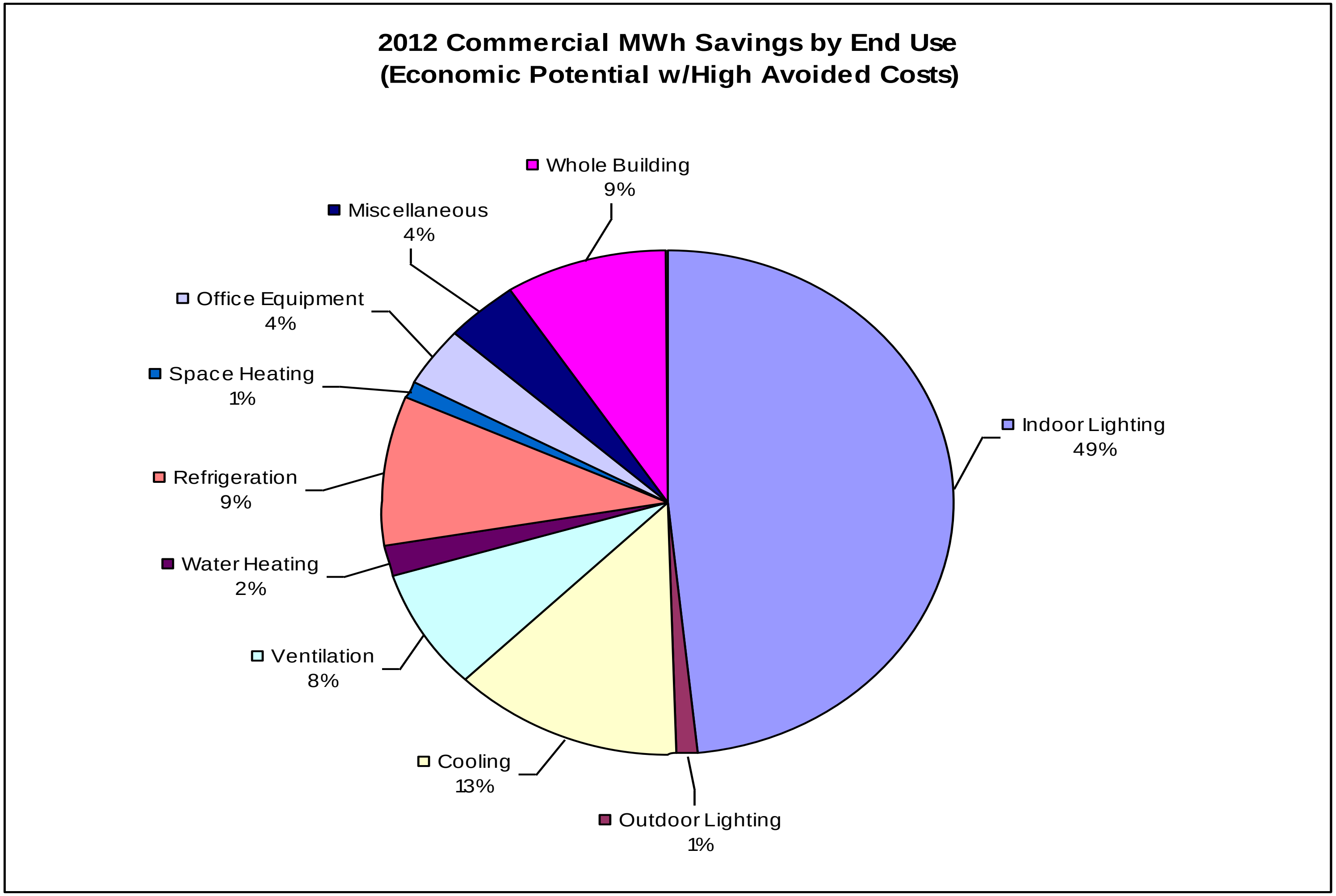
Commercial Potential by End-Use



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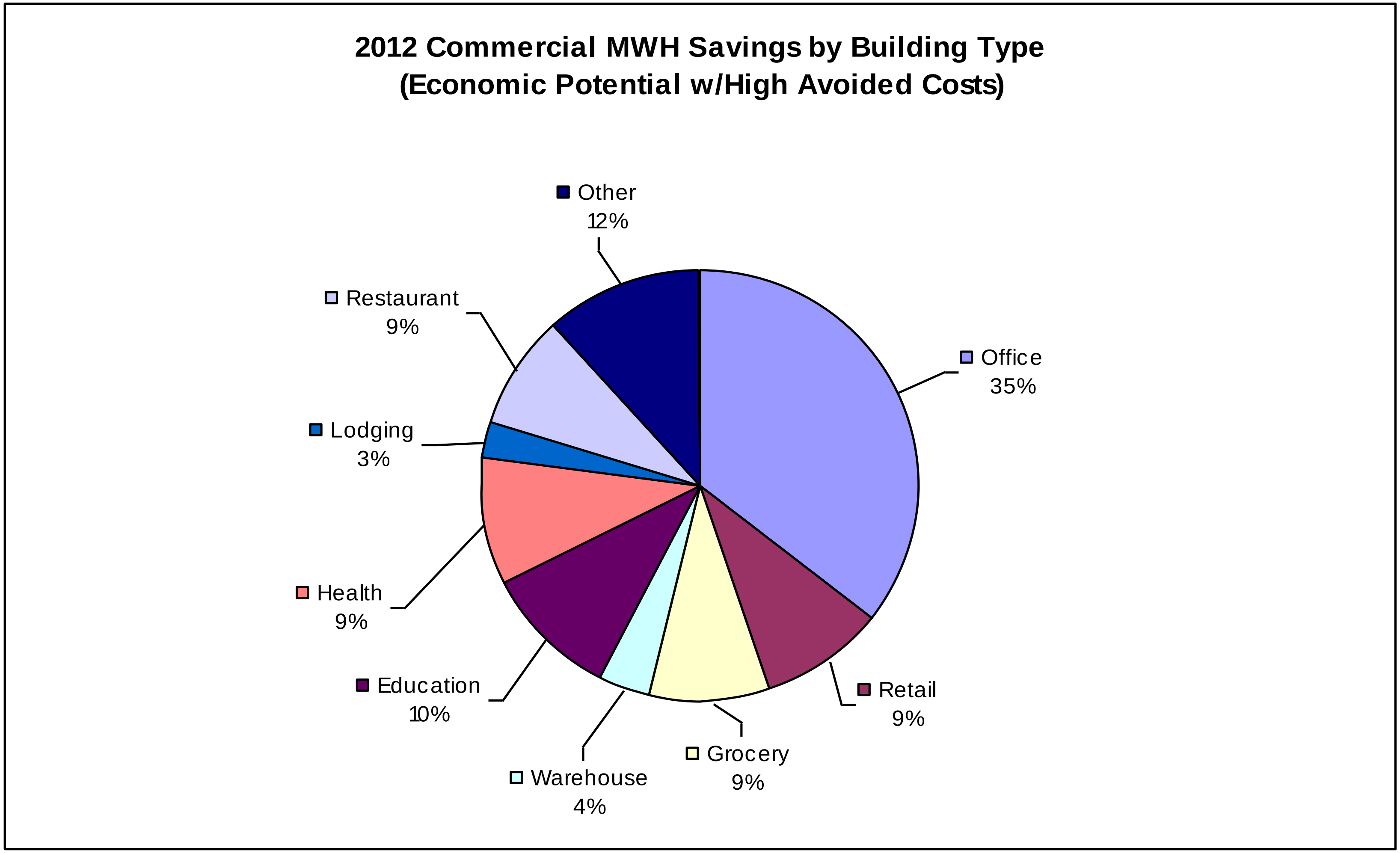
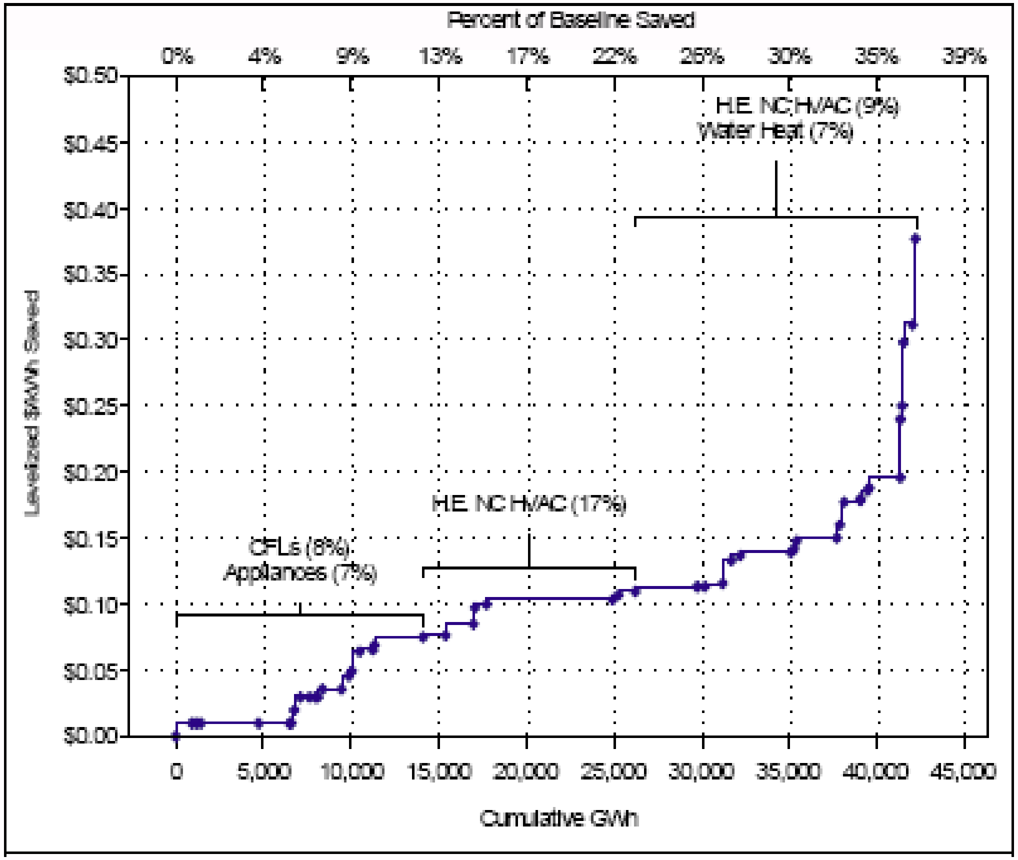
Commercial Potential by Building Type



Supply Curves — How are They Used?

Figure 6-8: Residential Energy Supply Curve for All Measures



If avoided costs = 7 cents, then only CFLs and appliances cost-effective?

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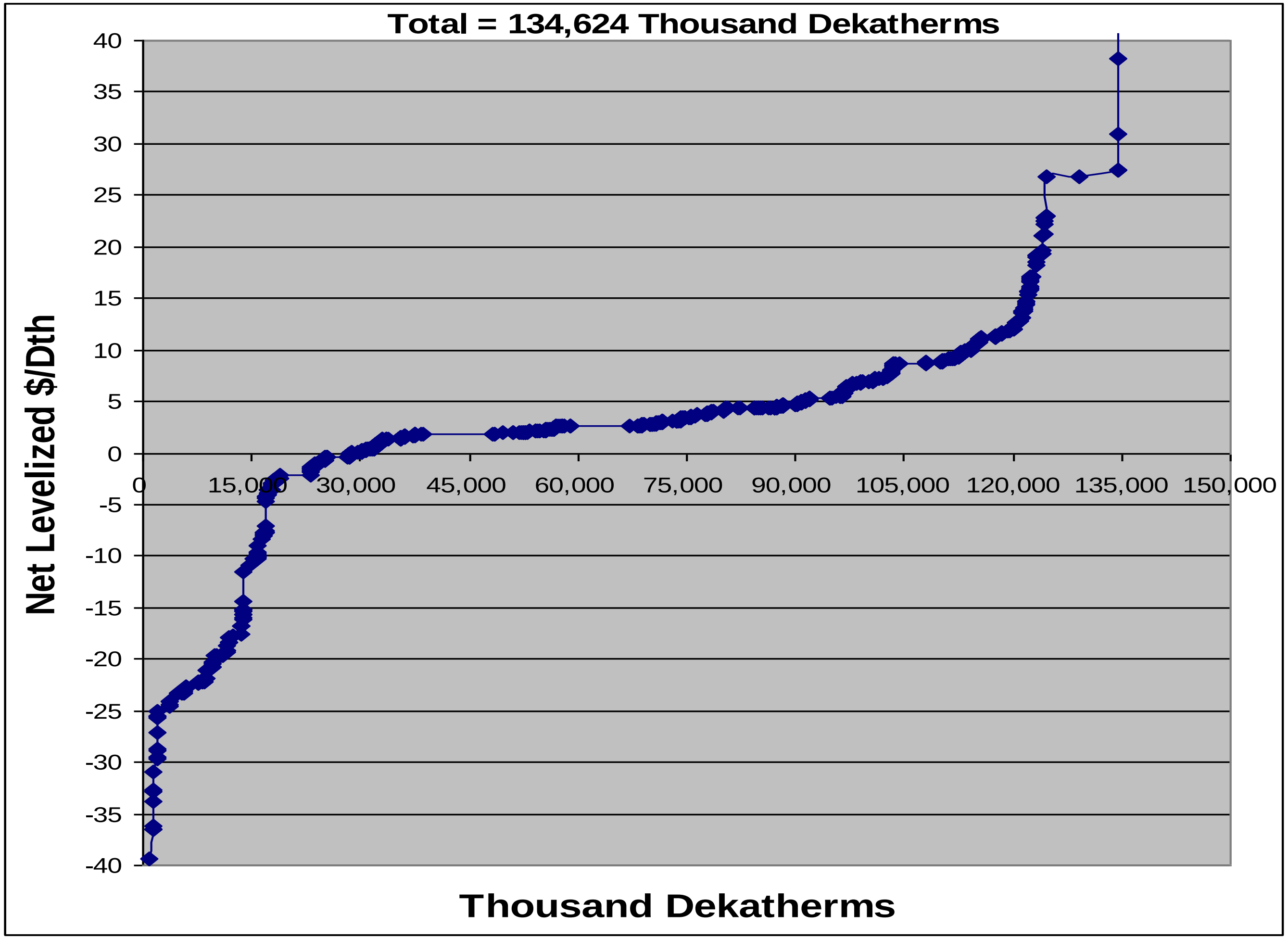
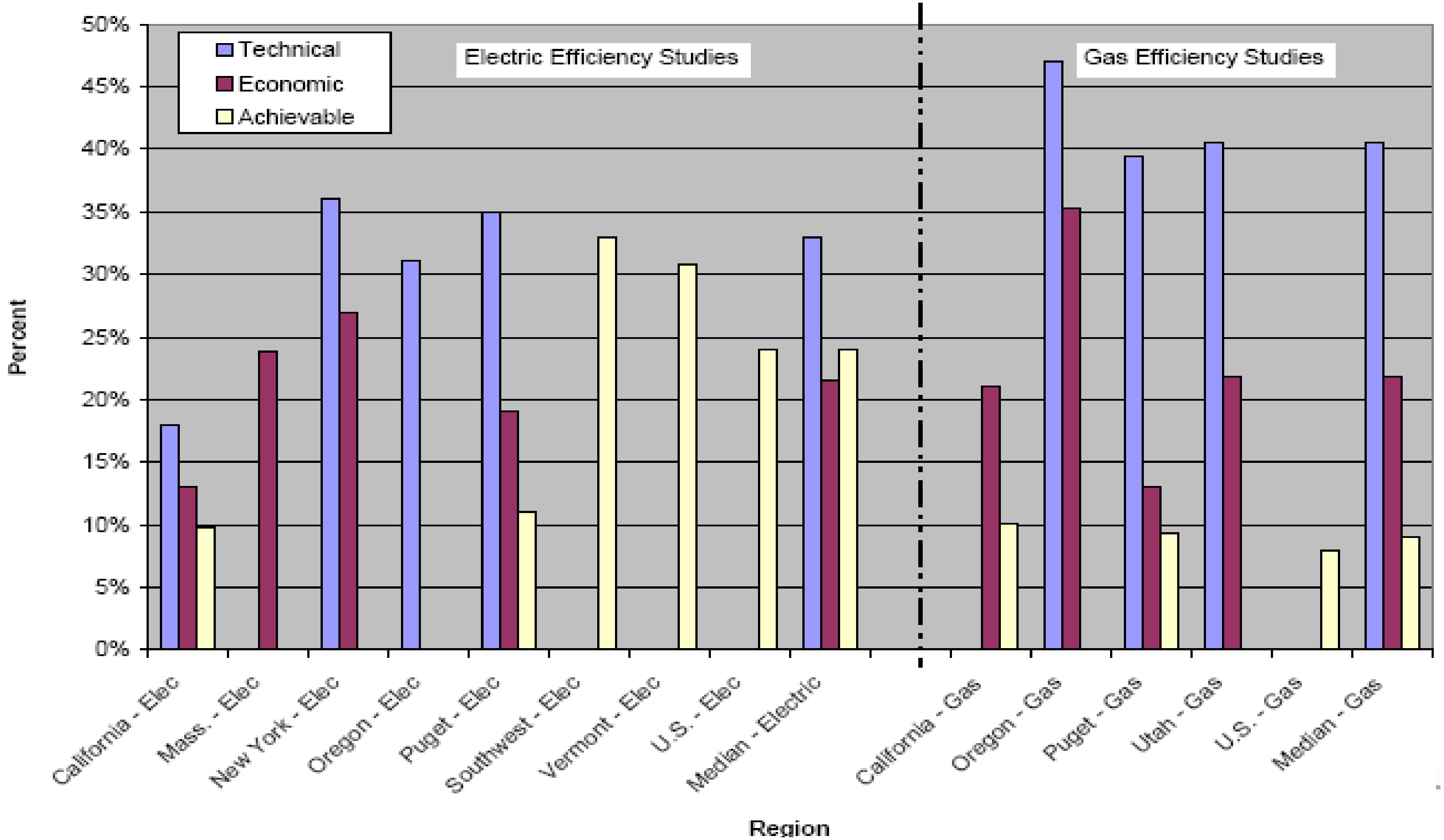
Supply Curves — How are they used?



A better approach is *net* levelized costs

Allows direct comparison with avoided costs

How big is the Energy Efficiency Potential in the Buildings Sector?



Why do Achievable Potentials Vary so Dramatically?

- Scope and definition of assignment is biggest variable
  - Excluding certain markets (e.g., new construction)
  - Constraining program designs or budgets
  - Limiting measure list
- Methodology is also important
  - How are baselines established and used?
  - Are stock adjustments, interactions, mutual exclusivity properly modeled?
  - Low and/or formulaic penetrations
- Who does and how matter more than the region — if you don't have (or pay to collect) good local data, may want to simply consider other studies.

Most if Not All Studies Biased Low

- Virtually all discretionary decisions lead to underestimates (Goldstein)
- Measures never cover everything
  - Miscellaneous loads (and plug loads) often ignored.
  - Bundling packages of technologies can help (e.g., integrated new building design)
- Any scope decisions are generally to limit comprehensiveness of study
- Cost-effectiveness screens out many measures on average, while many customers could still do cost-effectively
- Often ignores technology advancements
- Political interests may have major effect

EPRI Study

- Estimates basecase load growth of 1%/yr.
- Estimates EE can reduce to 0.8%/yr.
- **Net achievable potential = 0.2%/yr.**

- BUT:
  - VT currently capturing 2%/yr (4.5% with no ramp up for geotargetted areas)
  - CA, MA, CT, RI, NY all approaching 2%/yr, in some cases planning for 2+%/yr
  - Many jurisdictions have maintained 1%/yr levels for decades with no sign of diminishing returns
  - NY economic potential in 1989 = 2003 (despite programs since 1989)

EPRI Study, cont.

- Ignores all early retirement
  - Policy decision that things should be improved only at time of natural market investment
  - Assumption that retrofit opportunities generally not cost-effective or achievable
- BUT:
  - Many program portfolios capture majority of savings from retrofit opportunities.
  - Retrofit typically accounts for about 60-75% of economic potential

EPRI Study, cont.

- Other recent studies have also been very low estimates
- May be result driven
- Can something be judged not achievable when it is already being achieved?
- Raises question of purpose and need for studies
  - If planning to design programs to capture 1%/yr savings, do you need a study to show that achievable is more than double?
  - Are you looking to stretch to the limit?

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Conclusions

- Demand-side resources can and will be part of future energy solutions.
- Potential studies are critical to modeling DSM as a resource.
  - How large are the opportunities?
  - What are they worth?
  - How quickly can we get them?
  - What will it cost, and what non-dollar resources are needed?
- Need to fully understand purpose and use of information before developing work plan.
- Methods should be driven by purpose and data.
  - May need to collect primary data
  - May be fine to do high level study, borrowing from existing knowledge base — How will always depend on Why and So What

- "Prediction is very difficult, especially about the future."
  - – Niels Bohr