The Northwest Power and Conservation Council's Methodology for Determining Achievable Conservation Potential - Outline of Major Elements

1) Resource Definitions

    i) Technical Potential

    ii) Economic Potential

    iii) Achievable Potential

        (1) Non-lost opportunity resources ("schedulable")

        (2) Lost opportunity resources

2) Technical Resource Potential Assessment

    a) Review wide array of energy efficiency technologies and practices across all sectors and major end uses

    b) Methodology

        i) Technically feasibility savings = Number of applicable units * incremental savings/applicable unit

        ii) "Applicable" Units accounts for

            (a) Fuel saturations (e.g. electric vs. gas DHW)

            (b) Building characteristics (single family vs. mobile homes, basement/non-basement, etc.)

            (c) System saturations, (e.g., heat pump vs. zonal, central AC vs. window AC)

            (d) Current measure saturations

            (e) New and existing units

            (f) Measure life (stock turnover cycle)

            (g) Measure substitutions (e.g., duct sealing of homes with forced-air resistance furnaces vs. conversion of homes to heat pumps with sealed ducts)

iii) "Incremental" Savings/applicable unit accounts for

(a) Expected kW and kWh savings shaped by time-of-day, day of week and month of year

(b) Savings over baseline efficiency

(i) Baseline set by codes/standards or current practices

(ii) Not always equivalent to savings over "current use" (e.g., new refrigerator savings are measured as "increment above current federal standards, not the refrigerator being replaced)

(c) Climate - heating, cooling degree days and solar availability

(d) Measure interactions (e.g. lighting and HVAC, duct sealing and heat pump performance, heat pump conversion and weatherization savings)

3) Economic Potential - Ranking Based on Resource Valuation

a) Total Resource Cost (TRC) is the criterion for economic screening - TRC includes all cost and benefits of measure, regardless of who pays for or receives them.

i) TRC B/C Ratio $\geq$ = 1.0

ii) Levelized cost of conserved energy (CCE) $\leq$ levelized avoided cost for the load shape of the savings may substitute for TRC if "CCE" is adjusted to account for "non-kWh" benefits, including deferred T&D, non-energy benefits, environmental benefits and Act's 10% conservation credit

b) Methodology

i) Energy and capacity value (i.e., benefit) of savings based on avoided cost of future wholesale market purchases (forward price curves)

ii) Energy and capacity value accounts for shape of savings (i.e., uses time and seasonally differentiated avoided costs and measure savings)

iii) Uncertainties in future market prices are accounted for by performing valuation under wide range of future market price scenario during Integrated Resource Planning process (See 4.1)

c) Costs Inputs (Resource Cost Elements)

   i) Full incremental measure costs (material and labor)

   ii) Applicable on-going O&M expenses (plus or minus)

   iii) Applicable periodic O&M expenses (plus or minus)

   iv) Utility administrative costs (program planning, marketing, delivery, on-going administration, evaluation)

d) Benefit Inputs (Resource Value Elements)

   i) Direct energy savings

   ii) Direct capacity savings

   iii) Avoided T&D losses

   iv) Deferral value of transmission and distribution system expansion (if applicable)

   v) Non-energy benefits (e.g. water savings)

   vi) Environmental externalities

e) Discounted Presented Value Inputs

   i) Rate = After-tax average cost of capital weighted for project participants (real or nominal)

   ii) Term = Project life, generally equivalent to life of resources added during planning period

   iii) Money is discounted, not energy savings

4) Achievable Potential

   a) Annual acquisition targets established through Integrated Resource Acquisition Planning (IRP) process (i.e., portfolio modeling)

   b) Conservation competes against all other resource options in portfolio analysis

      i) Conservation resource supply curves separated into

         (1) Discretionary (non-lost opportunity)

         (2) Lost-opportunity

(3) Annual achievable potential constrained by historic “ramp rates” for discretionary and lost-opportunity resources

(a) Maximum ramp up/ramp down rate for discretionary is 3x prior year for discretionary, with upper limit of 85% over 20 year planning period

(b) Ramp rate for lost-opportunity is 15% in first year, growing to 85% in twelfth year

(c) Achievable potentials may vary by type of measure, customer sector, and program design (e.g., measures subject to federal standards can have 100% “achievable” potential)

c) Revise Technical, Economic and Achievable Potential based on changes in market conditions (e.g., revised codes or standards), program accomplishments, evaluations and experience

i) All programs should incorporate Measurement and Verification (M&V) plans that at a minimum track administrative and measure costs and savings.

ii) Use International Performance Measurement and Verification Protocols (IPMVP) as a guide

Council Conservation Resource Potential Assessment and Cost-Effectiveness Methodology

Tom Eckman
Manager, Conservation Resources

Washington Utilities and Transportation Commission I-937 Workshop
September 3, 2009

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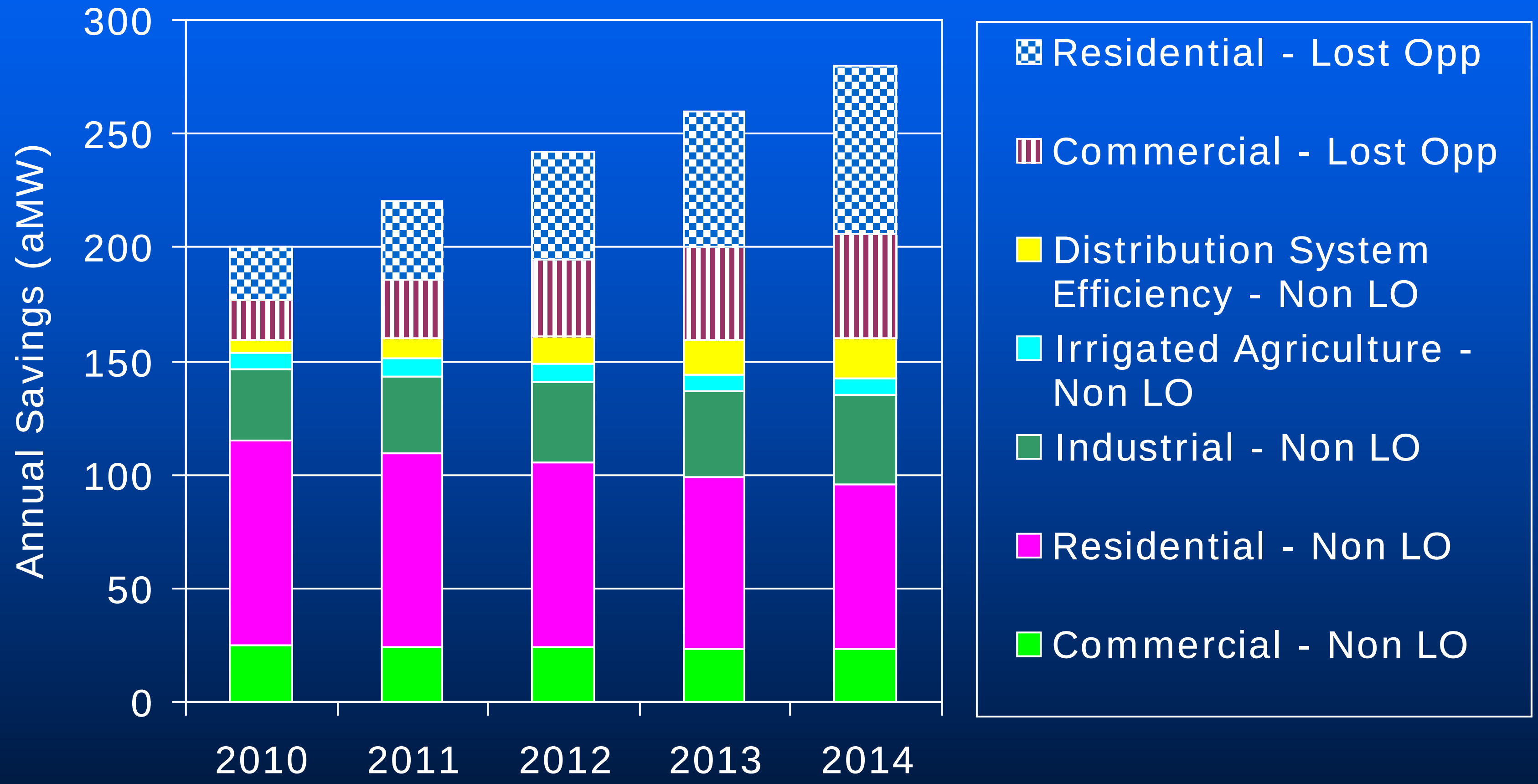
6th Plan Conservation Targets by Sector and Resource Type



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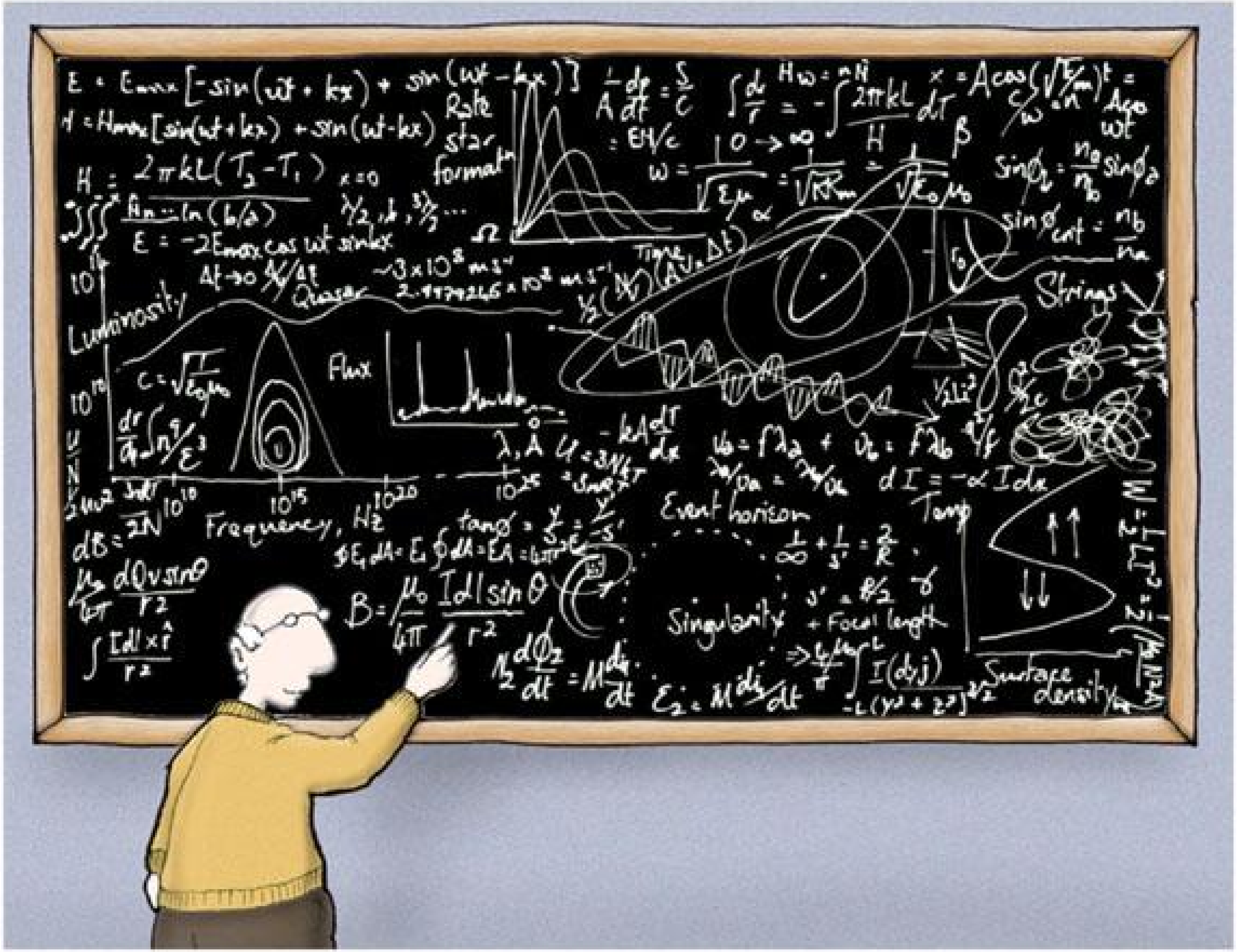

How Do We Know How Much is Left To Do?

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Web Images Groups Directory News

PNW Efficiency Potential

I'm Feeling Lucky Google Search

- Advanced Search
- Preferences
- Language Tools

It's *Only* a Six Step Process

- Step 1 - Estimate ***Technical Potential*** *on a* ***per application*** *basis*
- Step 2 – Estimate ***Economic Potential*** *on a* ***per application*** *basis*
- Step 3 - Estimate number of ***applicable units***
- Step 4 – Estimate ***Technical Potential*** *for* ***all*** *applicable units*
- Step 5 – *Estimate* ***Realizable Potential*** *for* ***all realistically achievable*** *units*
- Step 6 - Estimate ***Economic Potential*** *for* ***all*** *applicable units*

Before You Start – Decide On A Cost-Effectiveness Metric

- Participant Cost Test (PTC)
  - Costs and benefits to the program participant
- Total Resource Cost (TRC)
  - All Quantifiable costs & benefits regardless of who accrues them. Includes participant and others' costs
- Utility Cost Test (UTC)
  - Quantifiable costs & benefits that accrue only to the utility system. Specifically excludes participant costs
- Rate Impact Measure (RIM)
  - Net change in electricity utility revenue requirements.
    - » Attempts to measure rate impact on all utility customers especially those that do not directly participate in the conservation program
    - » Treats "lost revenues" (lower participant bills) as a cost

Overview of Methodology

- Resource Potentials Assessment
  - Determines technical availability, achievable potential & cost
- IRP Analysis
  - Determines cost-effectiveness level and "targets"
  - Compares all resources
  - Develops low-cost resources first
  - Results in resource acquisition plans
    - Targets & budgets & programs for conservation

Source for Methodology

- Regional Act
  - and Council interpretation of the Act
- Bottom line
  - Develop cost-effective resources first
- Defines cost-effective conservation
  - "…estimated incremental system cost no greater than that of the least-cost <u>similarly reliable and available</u> alternative measure or resource…"

The Basic Formula

Achievable Potential **=**

Number Units * Cost-Effective kWh per Unit * Market Penetration

Number Homes,
Floor Area of Retail,
Number of TVs,
Acres Irrigated,
Pounds Steel

(kWh/Unit at Current Efficiency – kWh/Unit at Cost-Effectiveness Limit of Efficiency)

Current Efficiency is adjusted for adopted codes & standards and stock turnover (Frozen Efficiency)

Cost-Effective Limit of Efficiency is estimated from Portfolio Model Results. It is based on the cost of the next lowest cost resource available to meet load.

Fraction realistically achievable over time

Generic Methodology for Estimating Conservation Resource Potential & Targets

Measure Cost

- Program Data
- Contractor Bids
- Retail Price Surveys

Measure Savings and Load Shape

- End Use Load Research
- Engineering Models
- Billing History Analysis
- Independent Testing Labs

Measure Lifetime

- Evaluations
- Census Data
- Manufacturers Data
- Engineering Estimates

Supply Curves

- Number of eligible units* savings per unit = aMW
- Lost-opportunity resources
- Non-lost opportunity resources

PROCOST Model

Determines measure and program level "cost-effectiveness" using:

- Measure costs, savings & load shape
- Aurora Market prices
- T&D savings (losses & deferred $)
- 10% Act Credit
- Council Financial Assumptions (e.g. Discount Rate, Administrative costs, etc.)
- Risk Premium adjusted to match Resource Portfolio Model acquisitions

Market Price Model

Provides Forecast of Hourly Avoided Capacity & Energy Costs Under Average Water Conditions

Resource Portfolio Model

Determines NPV of Portfolios with Alternative Levels of Conservation vs Other Resources & Cost-Effectiveness Limit for Conservation

Plan's Targets

Inputs to Resource Potentials Assessment Methodology

- Availability
  - Scope of measures
    - » Technologies
    - » Practices
  - Applicability territory
    - » Number of units
    - » Units savings
  - Achievable over time
    - » Retrofit
    - » Lost-Opportunity

- Costs
  - Materials & labor
  - Annual O&M
  - Periodic Replacement
  - Program Admin
  - Financing costs
  - Externalities
  - Other non-electric

Results of Resource Potential Assessment Methodology

- Summarize availability & cost
  - – Supply Curves
  - – TRC levelized costs
    - » All Costs (net of benefits) per kWh
  - – Lost-Opportunity Supply Curve
  - – Retrofit Supply Curve (Non-Lost-Op)
  - – Availability timeline
- Apples to apples comparison

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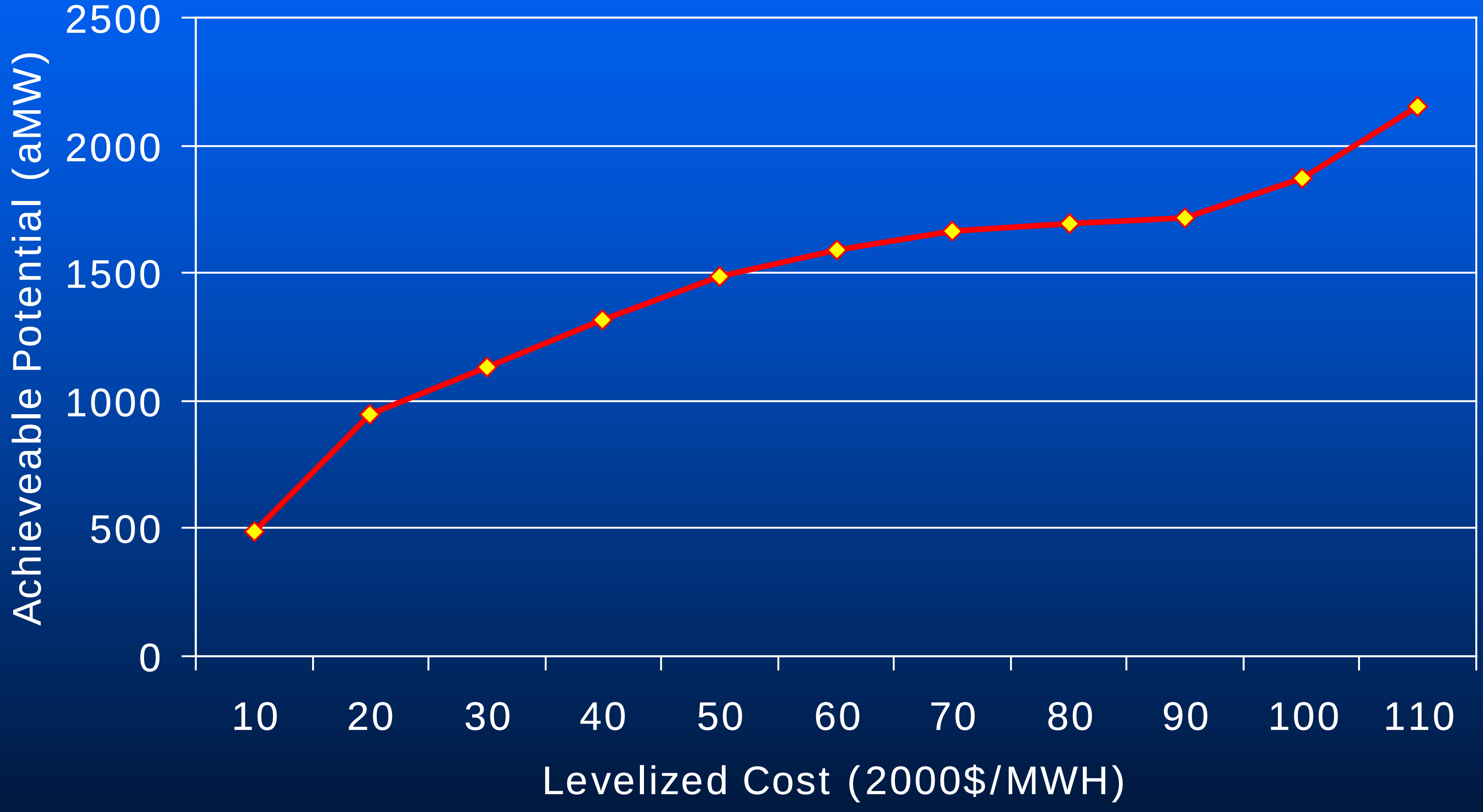
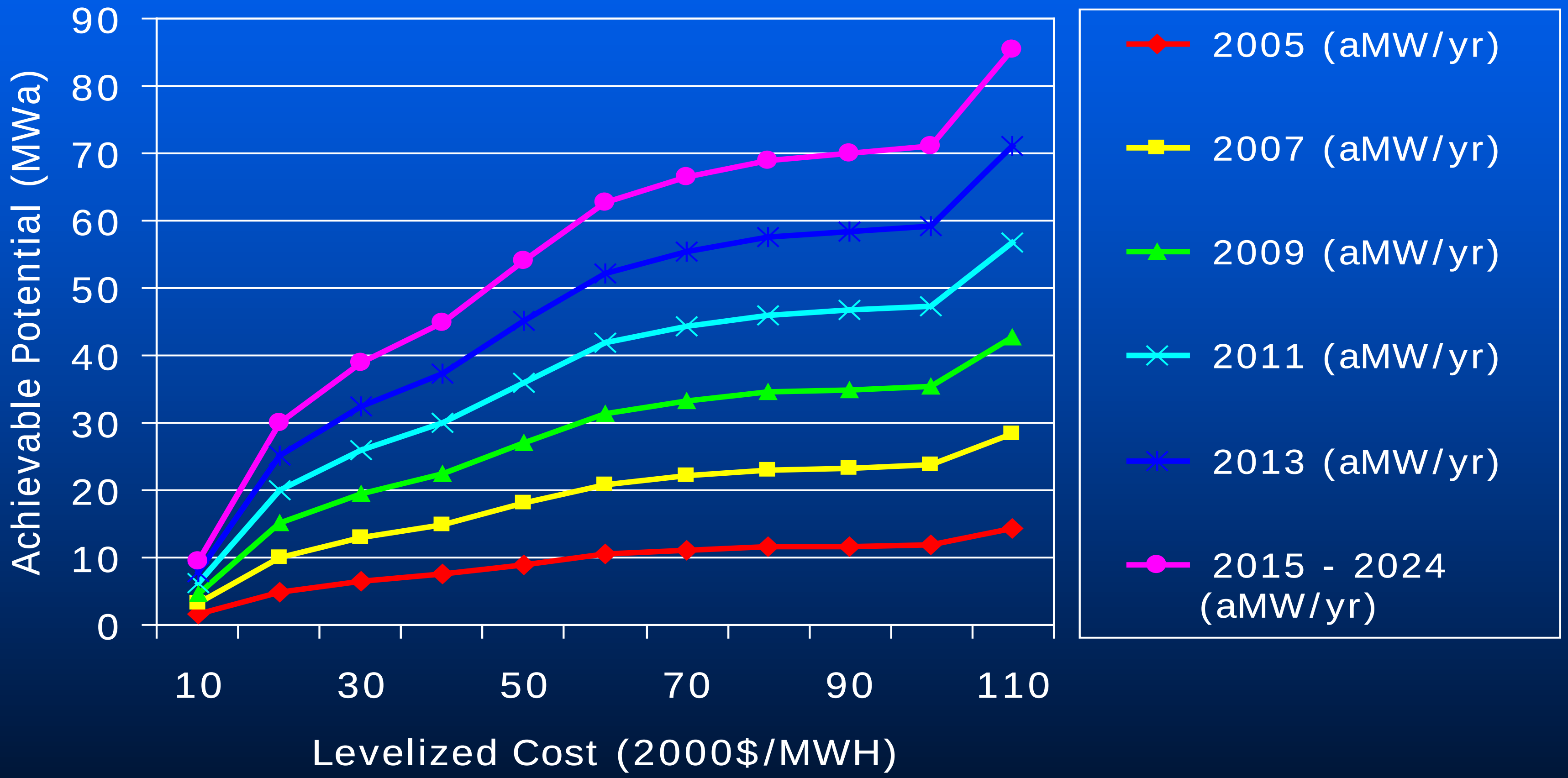
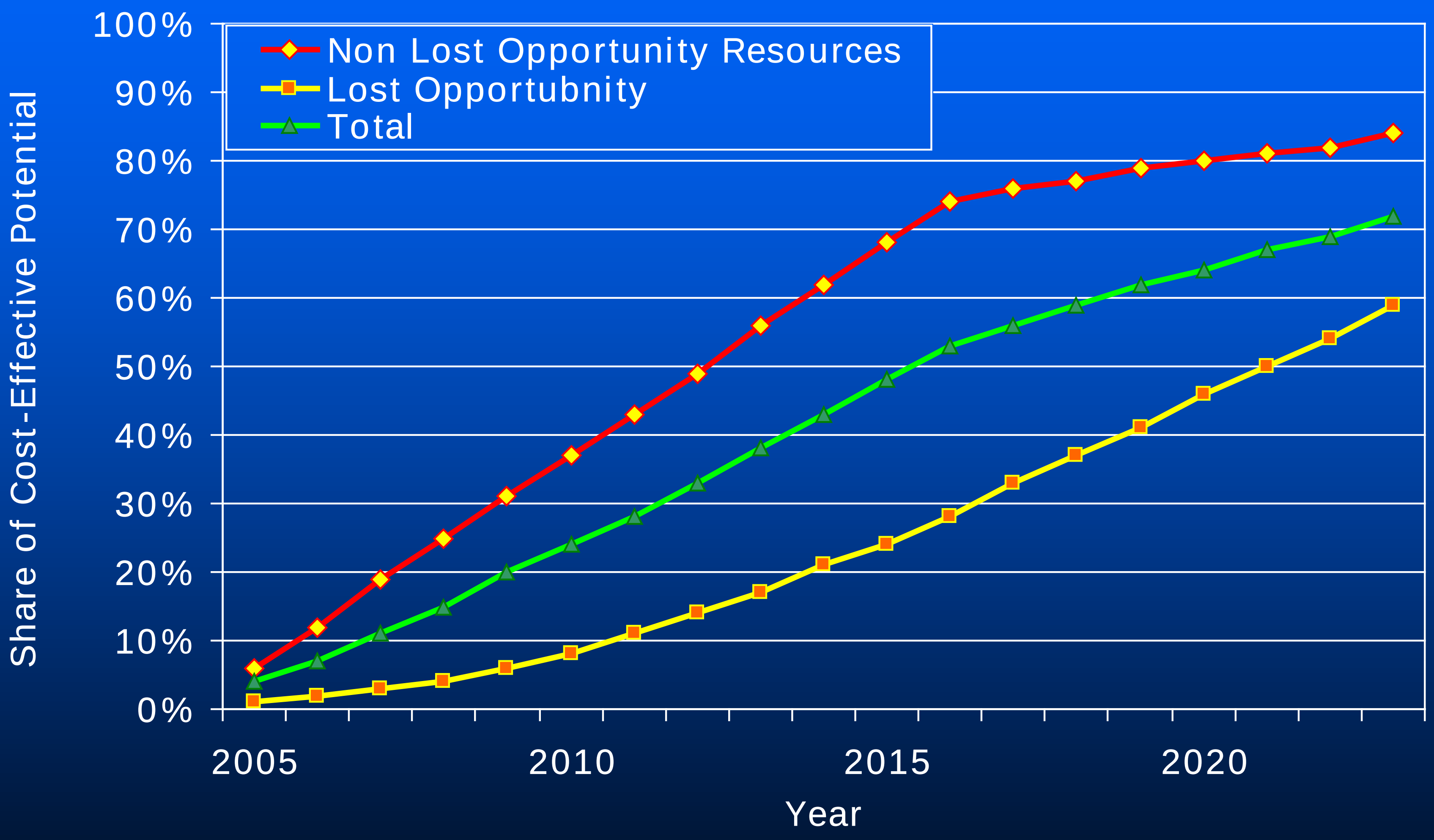
5^{th} Plan's Non Lost-Opportunity Supply Curve



5th Plan's Lost-Opportunity Supply Curves



5th Plan's Achievable Potential



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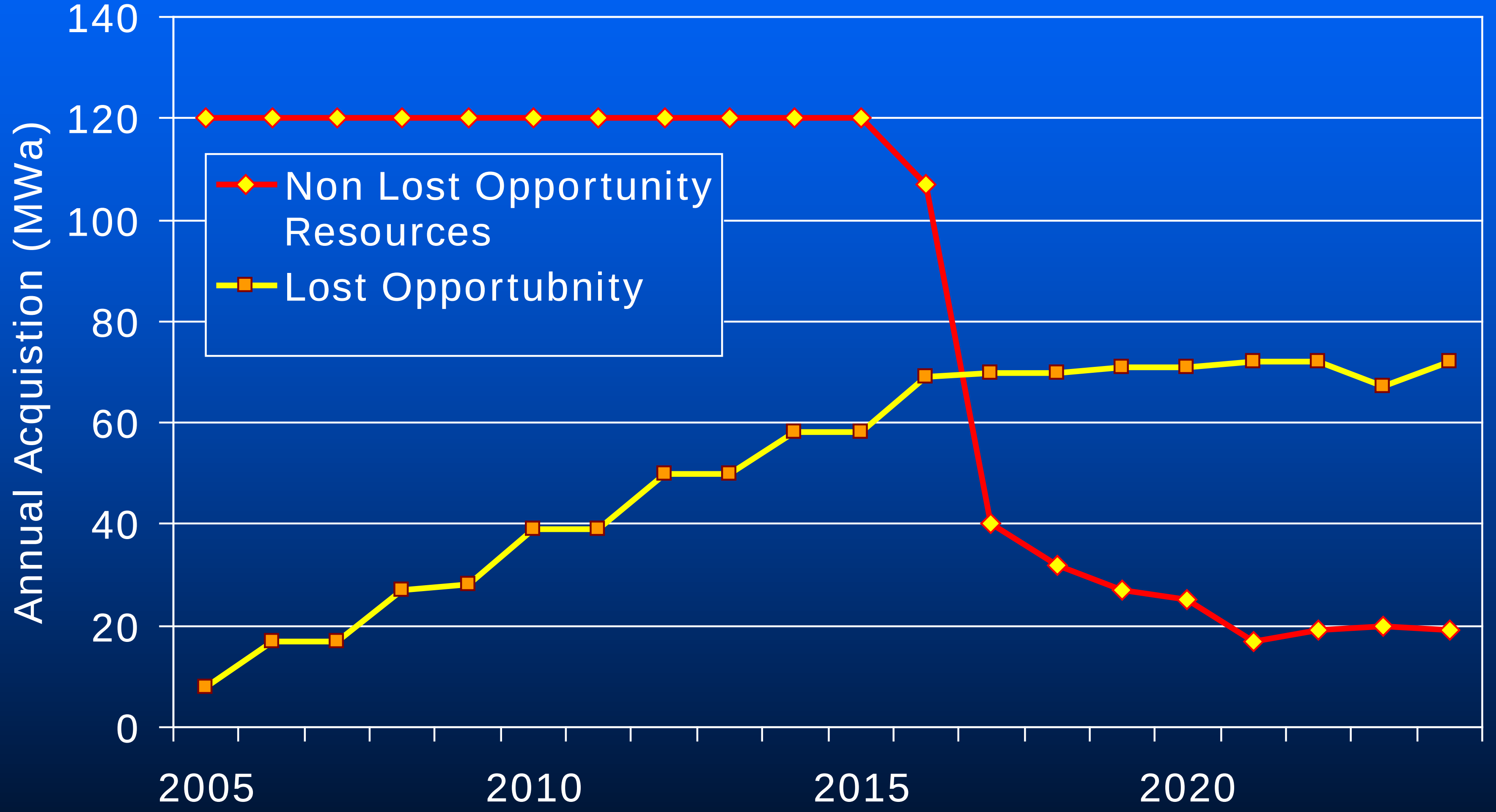
Annual Conservation Acquisitions in 5th Plan



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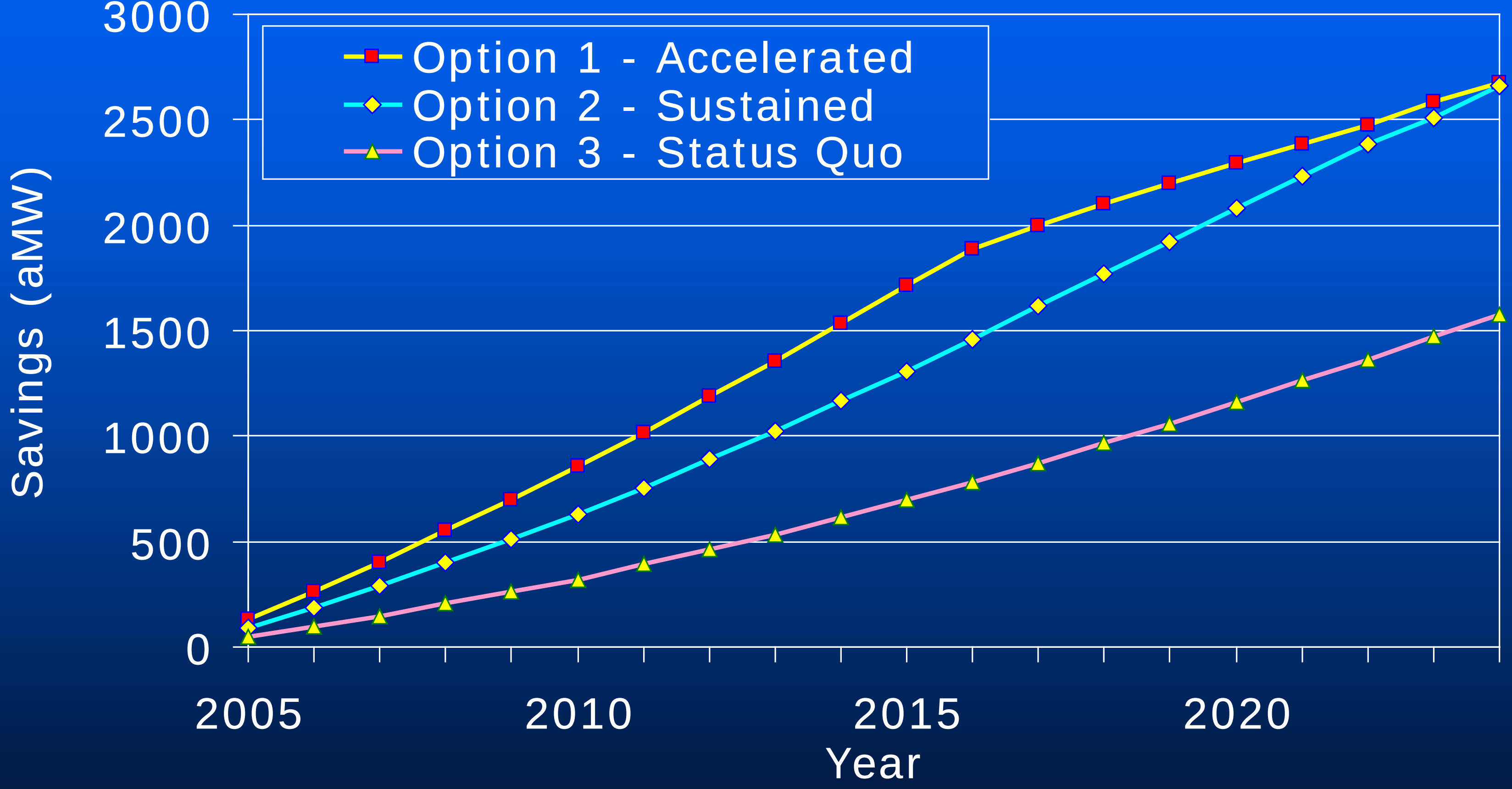
Pace of Conservation Deployment Matters



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Developing 6th Plan Achievable Penetration Rates

Two Approaches

- Historic Perspective
  - Recent Regional Performance
- Forward-Looking
  - Build from Bottom Up
  - Measure-by-Measure Penetration Rates

Near-Term Achievability

Historic Perspective

- Program Performance
- Pace of Codes & Standards
- Periodic Survey of Current Stock

Forward Looking

- Considers Character of Measures
- Implementation Strategies
- Size & Cost
- Physical Availability of Equipment
- Training & Education Requirements

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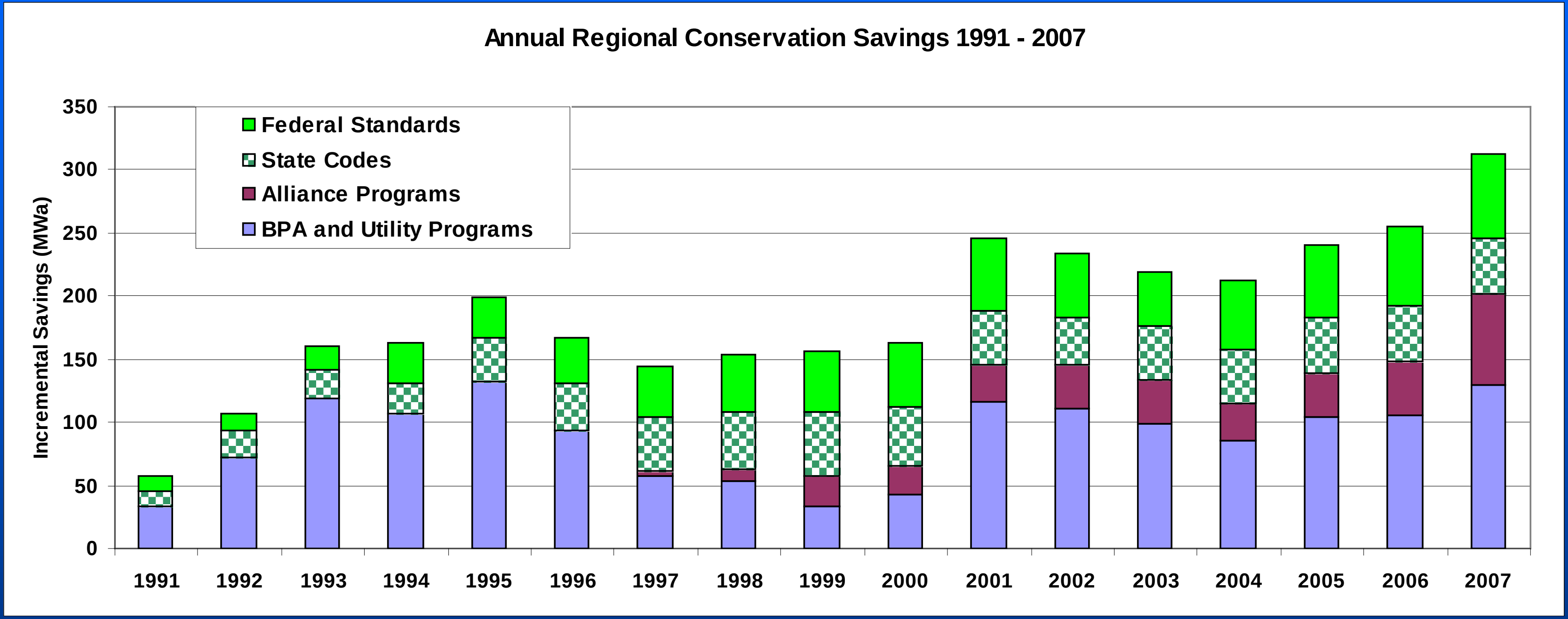
Historic Perspective



BPA, Utility & NEEA Programs

- Averaged 150 MWa per year since 2001
- Over 200 MWa in 2007
- Probably >200 MWa in 2008
- At $40-50 /MWh Avoided Costs

Codes & Standards

- One third of Savings since 1991
- Large Long-Term Potential
- Near-Term Impact Limited by New Stock Additions & Turnover Rates

Forward-Looking

Use a Bottom-Up Approach to Estimate Penetration Rates

- Estimate Annual Penetration Rates by Measure Bundle
- Distinguish Features that Impact Penetration Rate
  - Complexity of Measures
  - Delivery Mechanisms & Decision Makers
  - Current Market Saturation
  - Equipment & Infrastructure Availability
  - Subject to Code or Standard
  - Size & Cost
- (Annual Penetration Rate) x (Annual Units) x (Unit Savings)

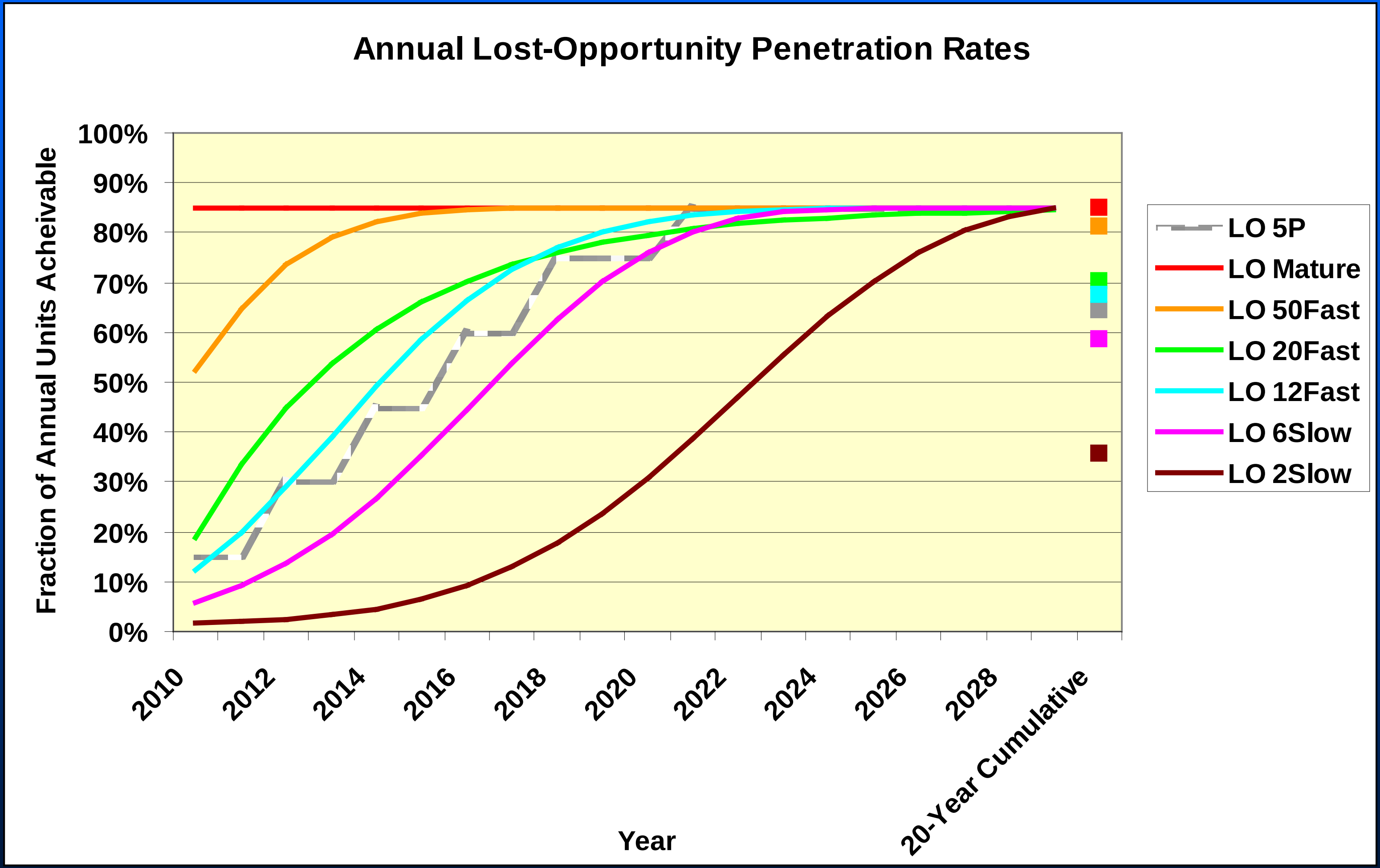
- Then Sum of All Measure-Level Supply Curves by Year & Levelized Cost bin

Penetration Rate "Families"

- Lost-Opportunity
  - Emerging Technology
  - LO Slow
  - LO Medium
  - LO Fast

- Retrofit
  - New Measure
  - In 20 Years
  - In 10 Years
  - In 5 Years

Family of Lost-Opportunity Penetration Rates



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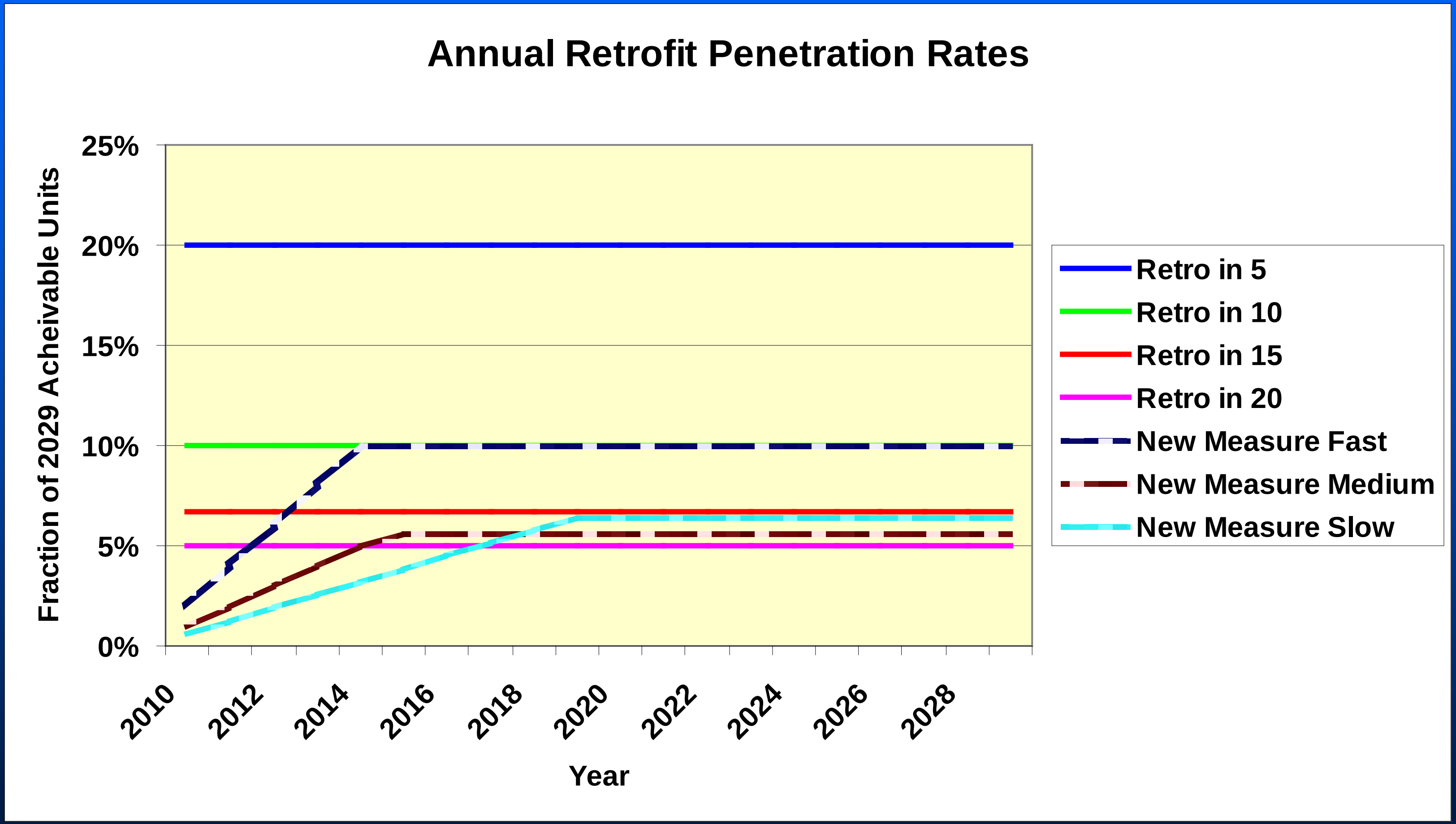
Family of Retrofit Penetration Rates



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Residential Lost-Opportunity
Achievable Penetration Rate Themes

LO Slow

- Refrigerators
- Freezers
- Cooking
- Heat Pump Upgrades
- Elec Furnace to HP Conversions

About 540 MWa by 2029

LO Medium

- Clothes Washer
- Dishwasher
- Clothes Dryer
- Shell & Window Measures
- Window AC Units

About 340 MWa by 2029

LO Emerging Technology

- Heat Pump Water Heater
- Gravity Film Heat Exchanger

About 600 MWa by 2029

Residential Retrofit
Achievable Penetration Rate Themes

Retro in 5 Years
- Showerheads
- Lighting

About 240 MWa by 2029

Retro in 15 Years
- Weatherization
- HVAC Conversions

About 750 MWa by 2029

New Measure Ramp-Up
- Solar DHW
- Solar PV

About 610 MWa by 2029

Commercial Lost-Opportunity
Achievable Penetration Rate Themes

LO Fast
- Lighting Power Density
- Lighting Controls
- Premium HVAC Equipment
- Variable-Speed Chillers
- Glass – New & Replacement
- Simple HVAC Measures – New
- Package Refrigeration Equip
- Exterior Building Lighting
- Street & Roadway Lighting - New

About 740 MWa by 2029

LO Medium
- Integrated Building Design
- Daylighting
- Complex HVAC Measures
- Street & Roadway Lighting - Repl
- Parking Lighting
- Signage

About 180 MWa by 2029

Commercial Retrofit

Achievable Penetration Rate Themes

Retro in 10 Years

- Lighting Power Density
- Lighting Controls
- Glass – Retrofit
- Simple HVAC Measures
- Insulation
- DCV Restaurant Hoods
- Computer Servers & IT

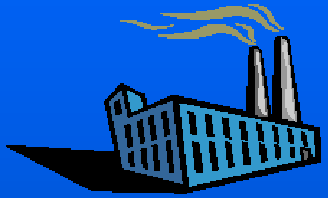
Retro in 20 Years

- Controls Commissioning Complex
- Complex HVAC Measures
- Grocery Refrigeration
- Network PC Controls
- Sewage Treatment
- Water Supply

About 180 MWa by 2029

About 350 MWa by 2029

Industrial Lost-Opportunity
Achievable Penetration Rate Themes



LO Fast

- Lighting Power Density
- Lighting Controls

About 70 MWa by 2029

LO Medium

- Material Handling
- Motor Rewind

About 60 MWa by 2029

Industrial Retrofit
Achievable Penetration Rate Themes

Retro in 10 Years

- Compressed Air Measures
- Centrifugal Fans
- Belts
- Transformers
- Refrigeration & Food Storage
- Chip Fab Measures

About 250 MWa by 2029

Retro in 20 Years

- Fan & Pump Optimization
- Premium Fan & Pump Equip
- Pulp & Paper Equipment

About 170 MWa by 2029

New Measure Ramp-Up (?)

- Plant Energy Management
- Energy Project Management
- Integrated Plant Energy Management

About 250 MWa by 2029

Agriculture Retrofit
Achievable Penetration Rate

Retro in 10 Years

- Scientific Irrigation Systems
- Irrigation Hardware
- Dairy

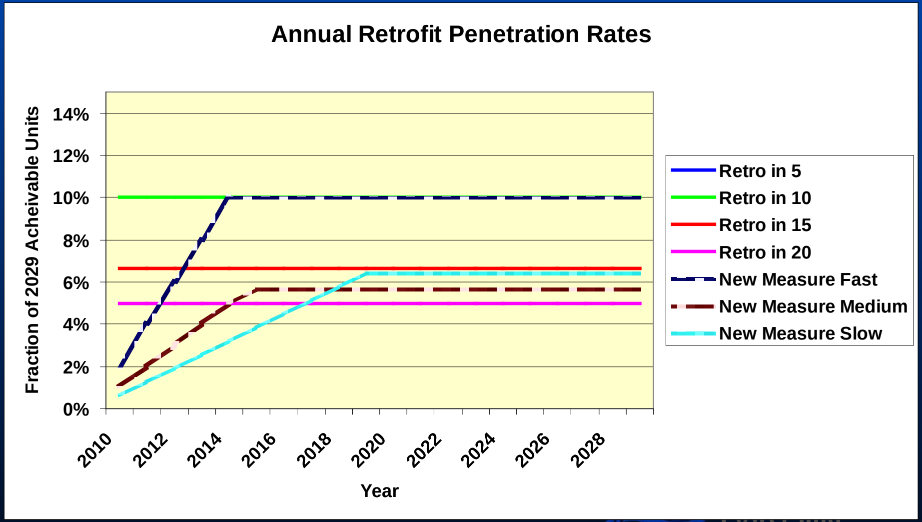
About 110 MWa

Distribution System Retrofit
Achievable Penetration Rate

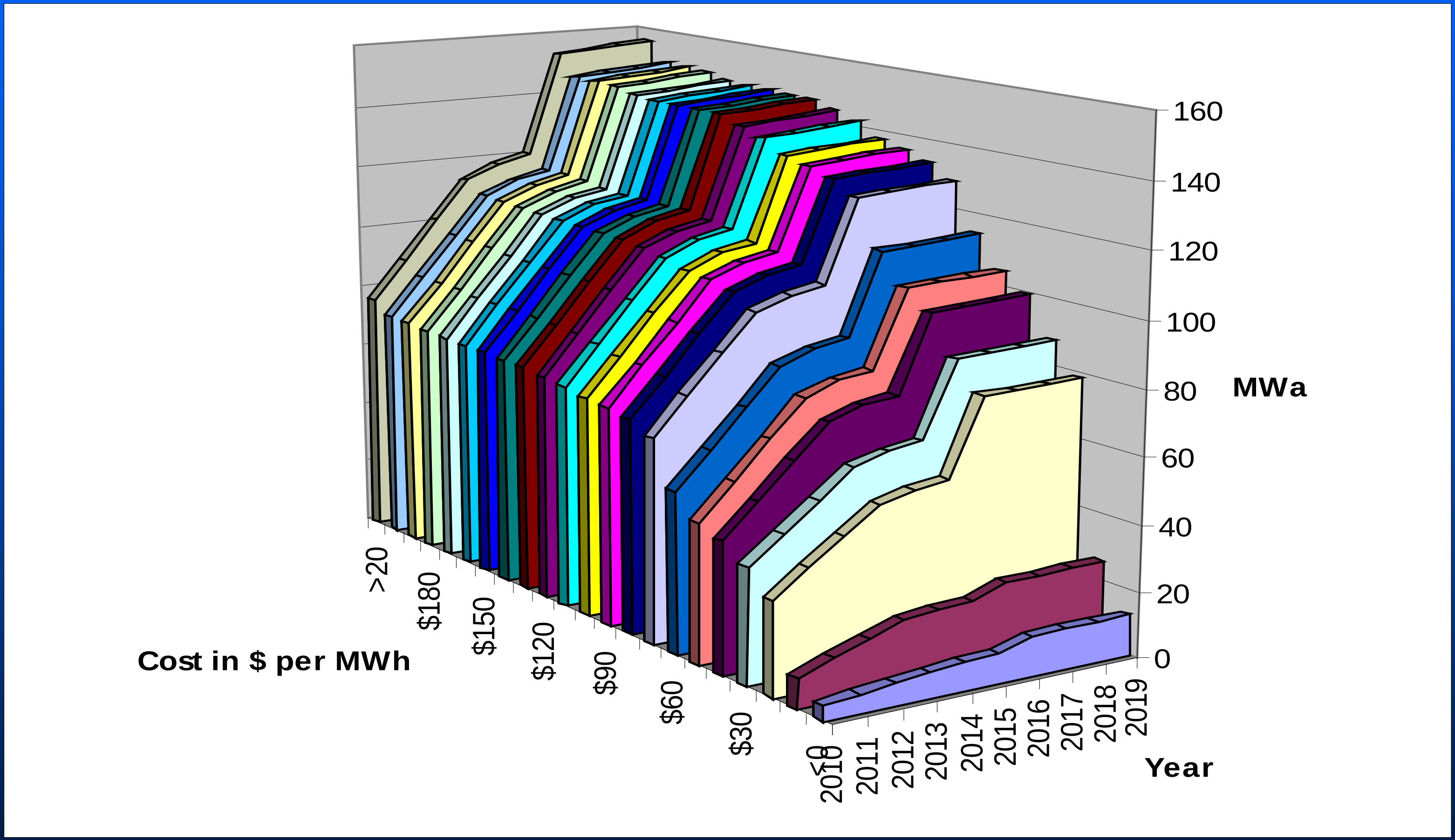
<u>New Measure Ramp-Up Medium</u>

- Line Drop Compensation
- VAR Management. Phase Load Balancing, & Feeder Load Balancing
- Substation Voltage Regulators & Select Re-Conductoring
- End-of Line Voltage Control Regulators

About 420 MWa by 2029



Initial Results
Bottom Up Lost-Opportunity Supply Curve 2010-2019



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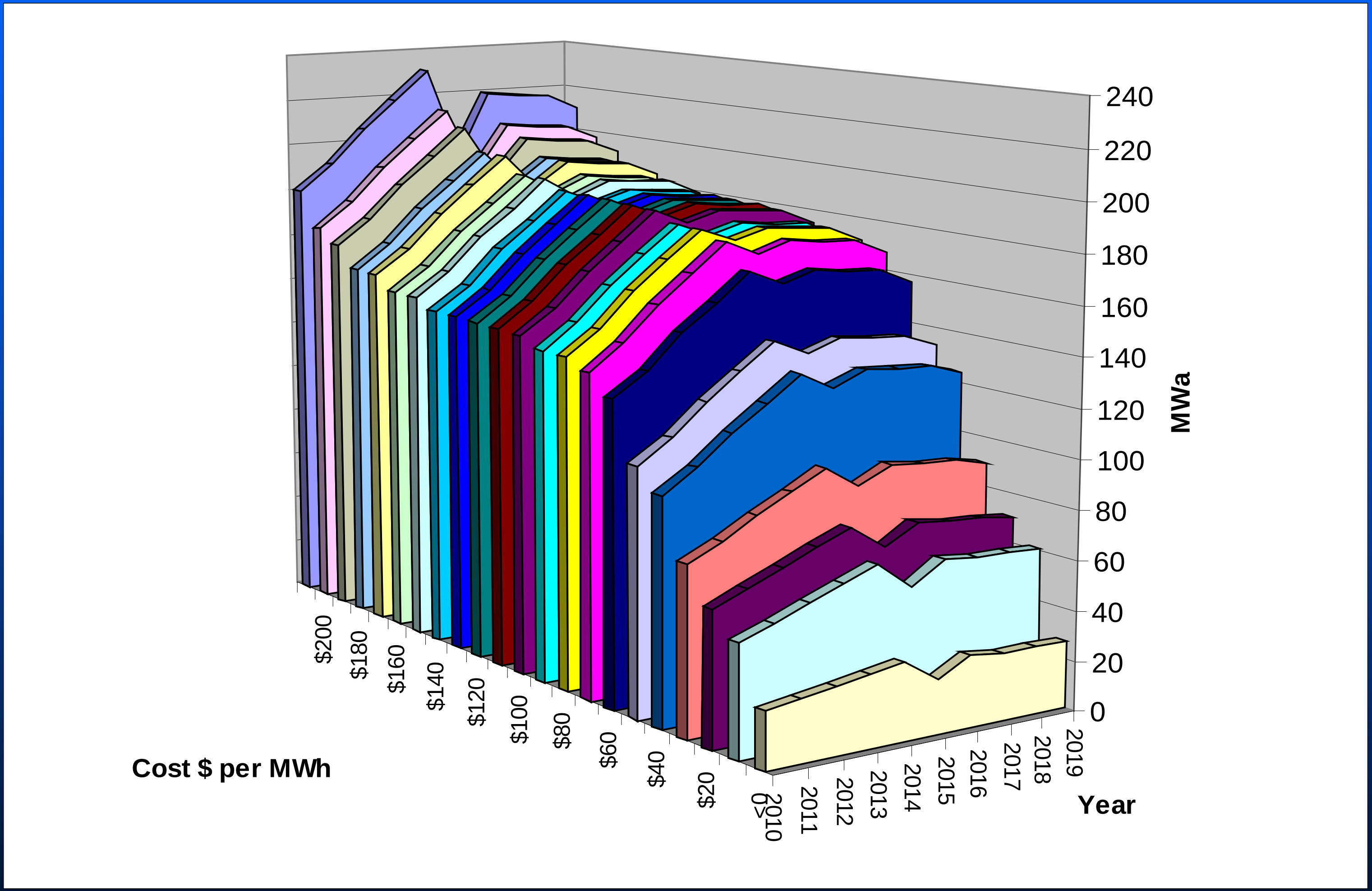
Initial Results: Bottom Up Retrofit Supply Curve 2010-2019



IRP Methodology

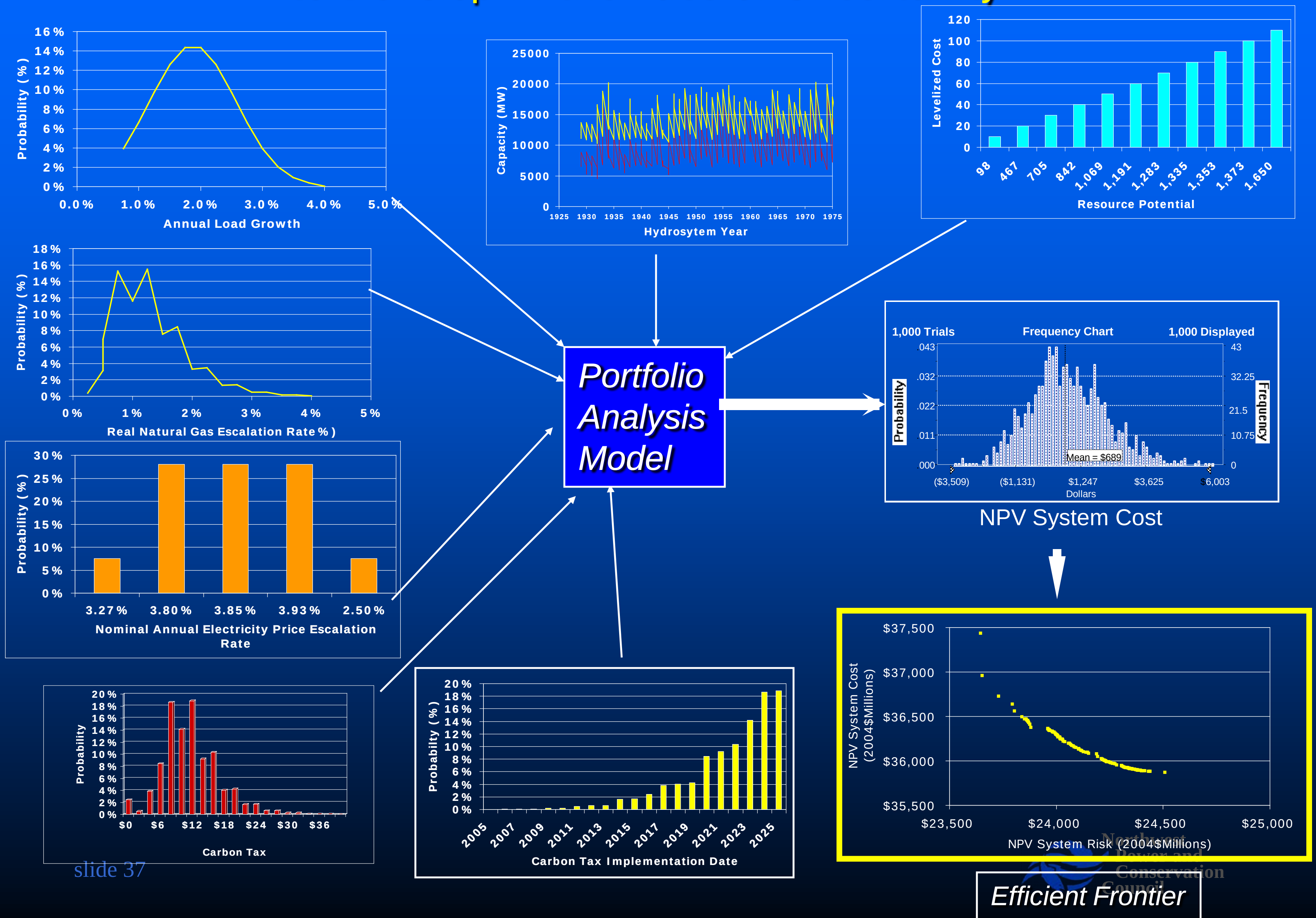
- Supply Curves delivered to Portfolio Model
- Portfolio Model finds least cost & risk Plans
  - Plan is resource acquisition & option schedule
  - Includes both conservation & generation
  - Amounts & timing of acquisitions & options
- For conservation this includes
    - » Lost-Opportunity schedule
    - » Non-Lost-Opportunity schedule
    - » A Cost-effectiveness threshold

Conservation Program Implementation

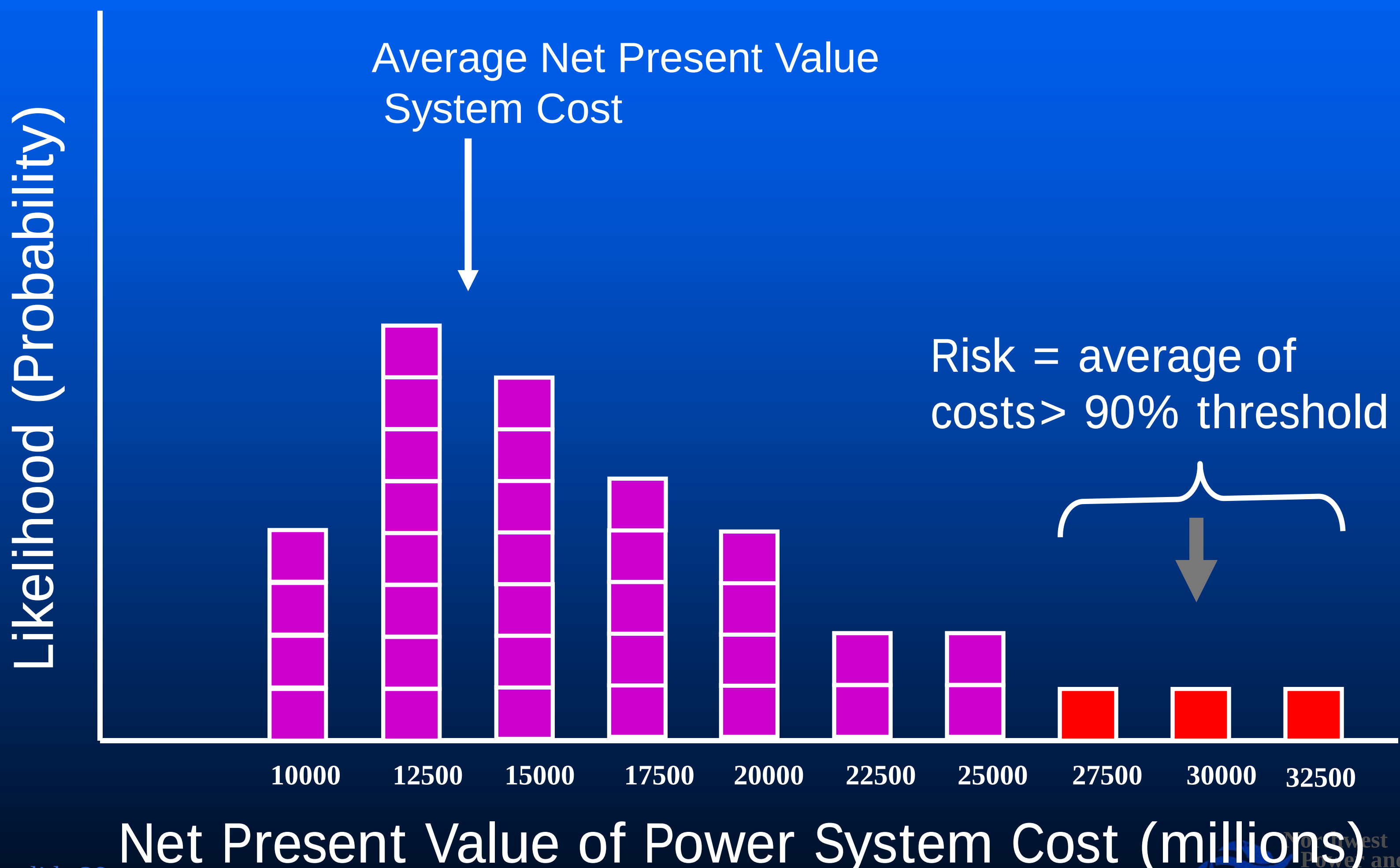
IRP Methodology

- Test thousands of potential "planned portfolios"
- Against 750 futures
- Found Plans with low cost & risk
- Tested Alternative Conservation Deployment Schedules
- Regional Conservation Targets
  - Derived from Plans on low-cost low-risk front

Portfolio Analysis Determines How Much Energy Efficiency to Develop in the Face of Uncertainty



Portfolio Model Calculates Risk and Expected Cost Associated With Each Plan Across 750 "Futures"



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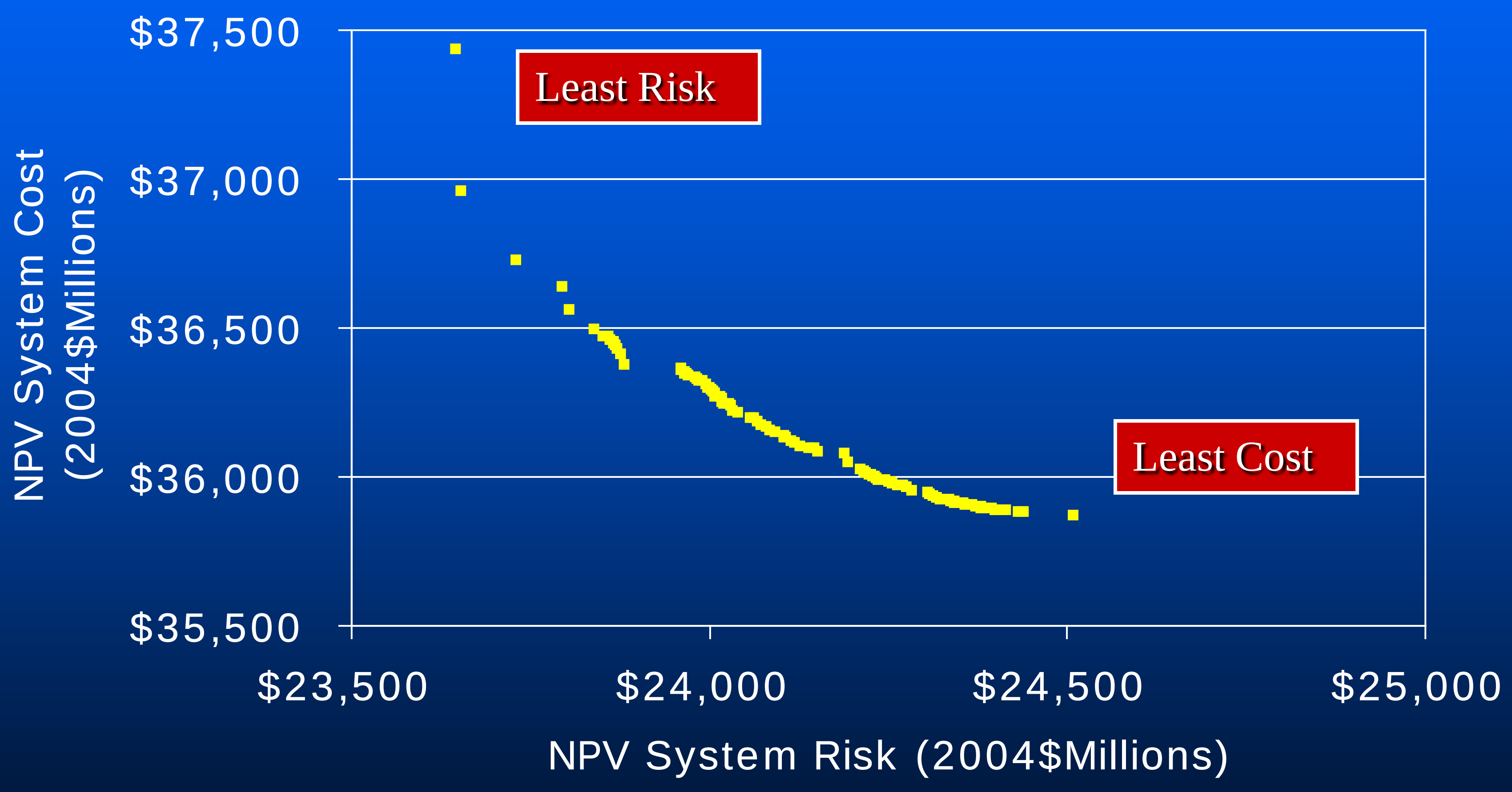
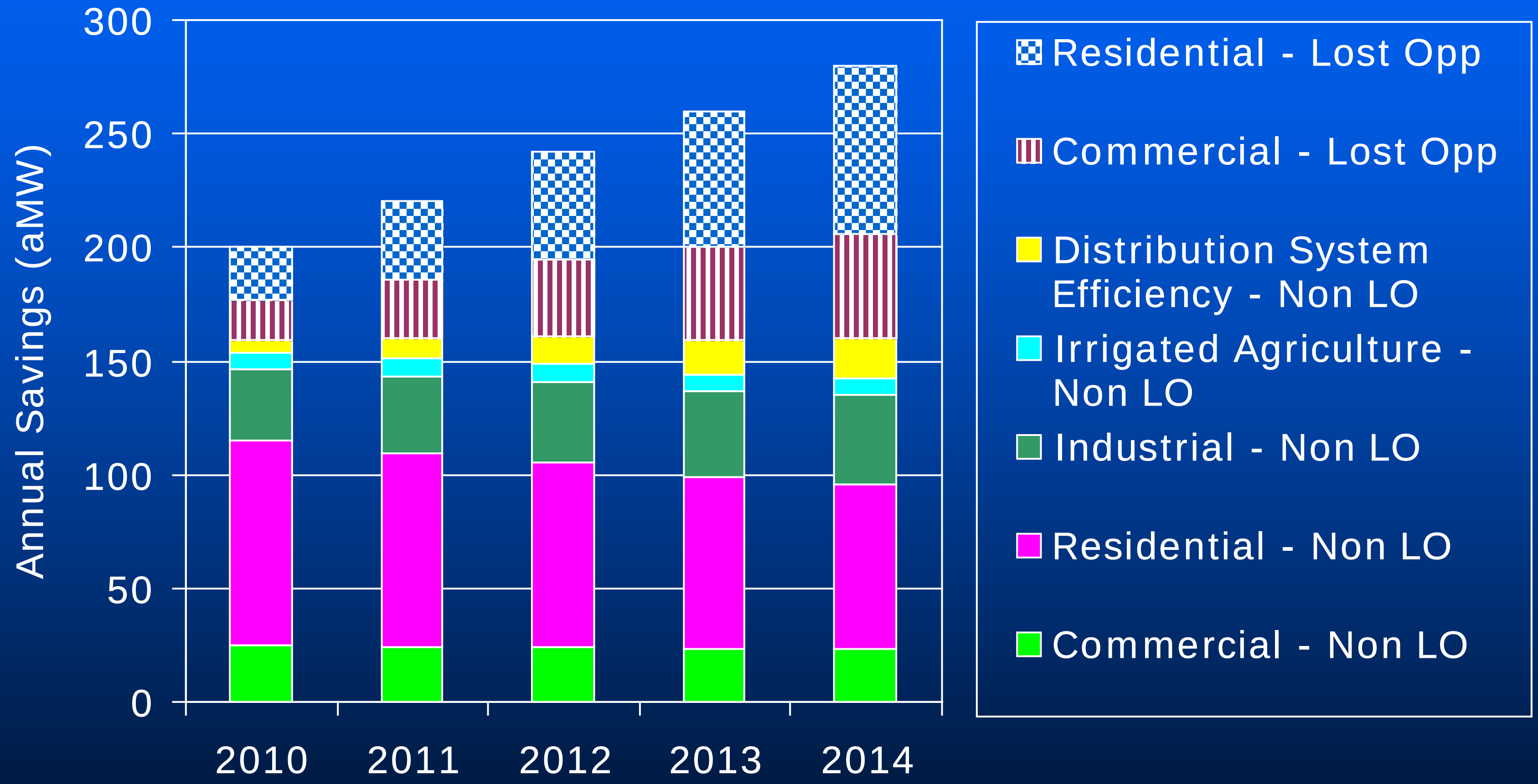
Plans Along the Efficient Frontier Permit Trade-Offs of Costs Against Risk



6th Plan Conservation Targets by Sector and Resource Type



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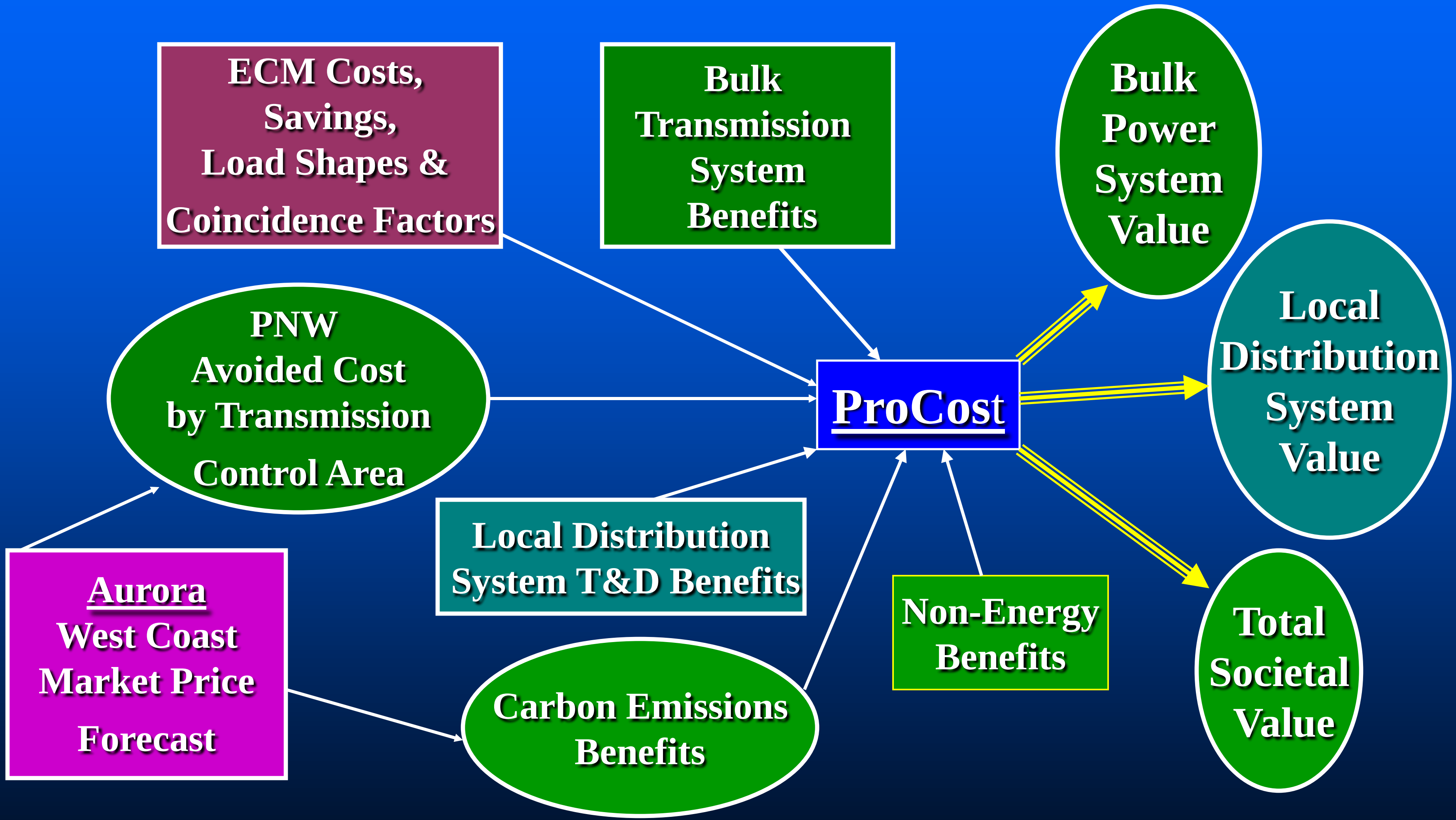
Or . . .
Utilities Can Just Use the Utility Target Calculator

..\Action Plan\UtilityTargetCalc_v1_8_6thPlan.xls

Background Slides

Regional Act Cost-Effectiveness

Conservation Measure Cost-Effectiveness "Inputs and Outputs"



What’s A kWh Saved Worth?

- Value of a kWh of savings depends
  - Cost of power in the wholesale market during the time of day, day of week, month of the year and the year it is saved
  - How many years it lasts

Plus …
Other Values of Conservation

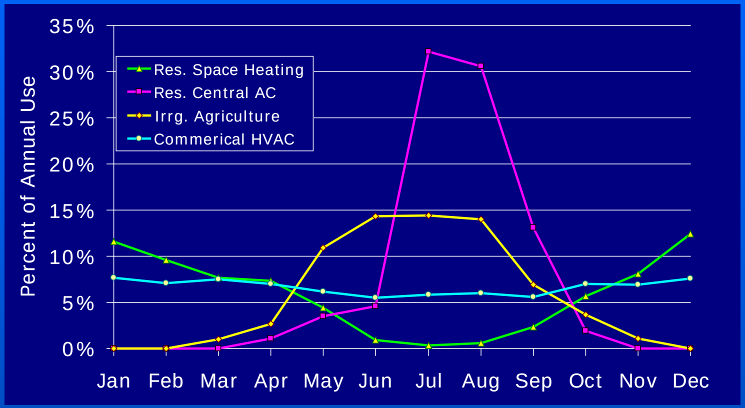
- Quantifiable Non-Energy Benefits
  - Water savings, maintenance labor
- Distribution system expansion deferral
  - Poles, wires, transformers, substations
- Transmission system expansion deferral
  - Bigger poles & wires
- Externalities: Like CO_2 production
- Regional Act Credit of 10% to conservation

Why Value Conservation at Wholesale Market Prices?

- Price paid to buy <u>or sell</u> the marginal kWh, or "run" the marginal resource
- At any given time, the marginal resource may or may not be a new power plant
- Conservation often displaces older generation out of the region
- Conservation defers new coal, wind, solar and gas generation

Timing-Based Value

Shape of Savings



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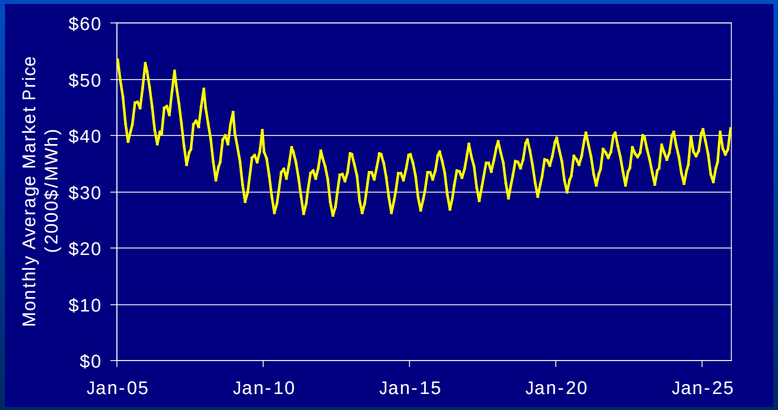
Value of Wholesale Power



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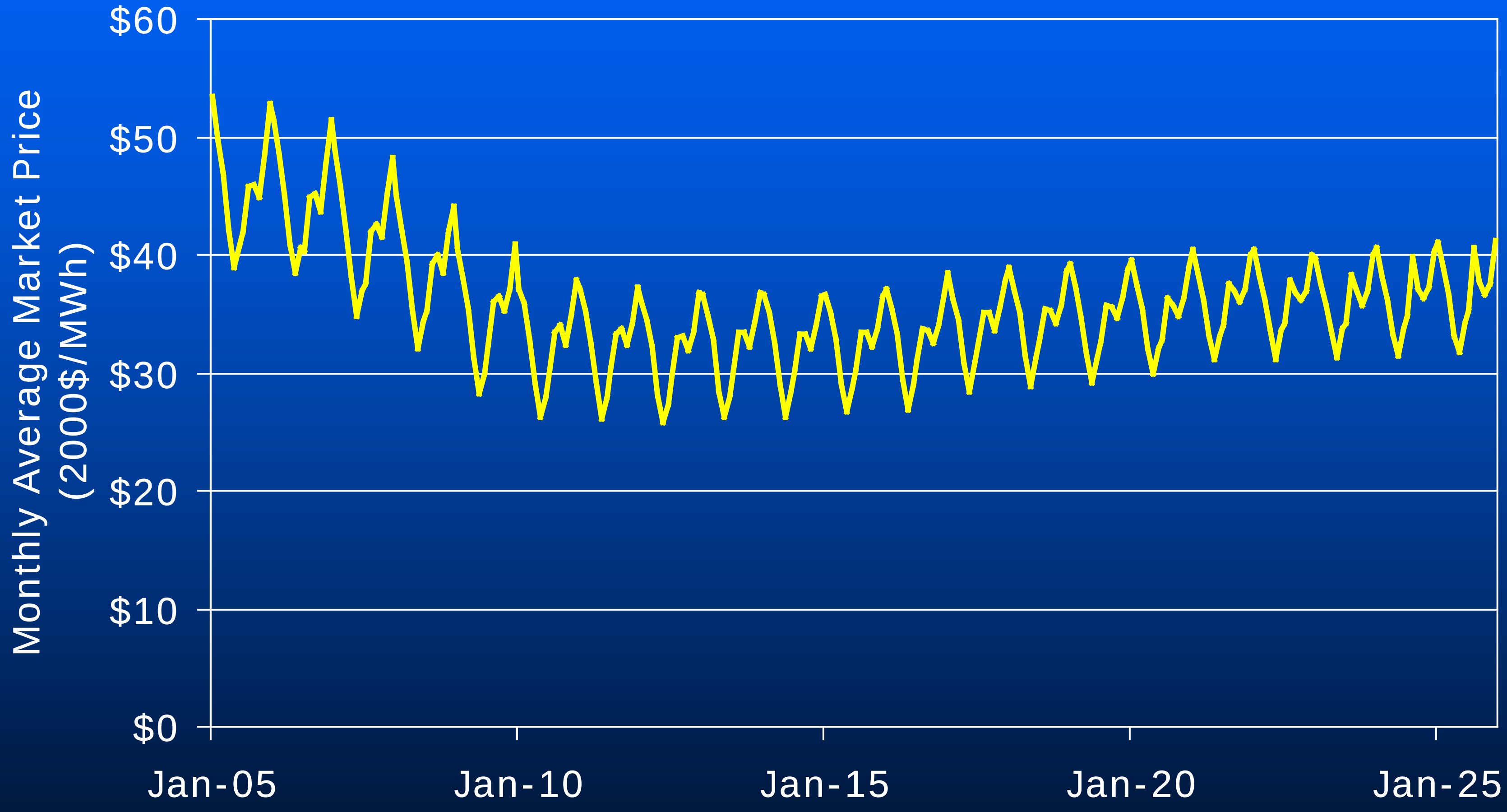
Value of kWh Saved

$

Council 5th Plan Forecast of Future Average Monthly Market Prices
(Mid C-Trading Hub)



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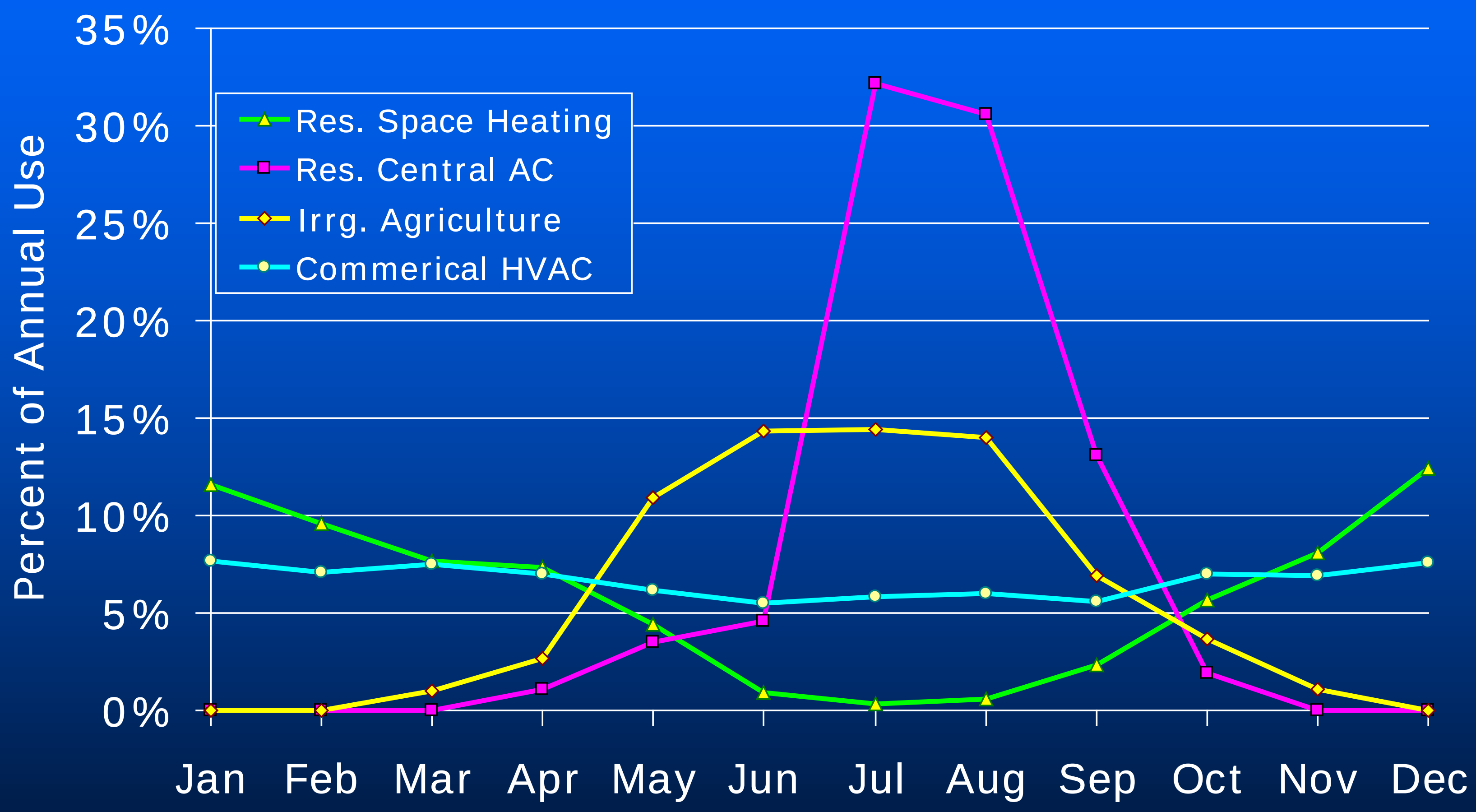
Typical "On-Peak" Load Profiles



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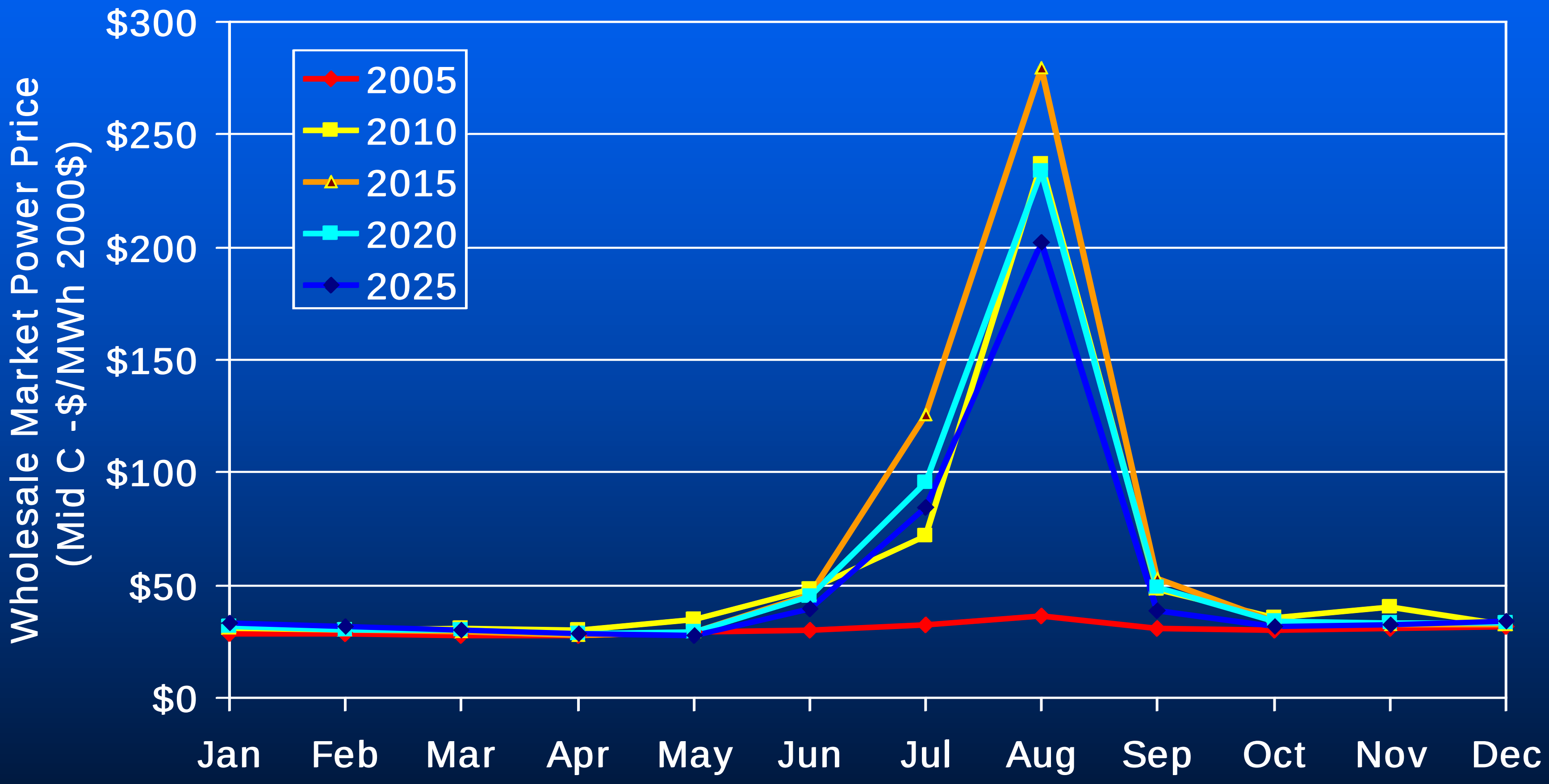
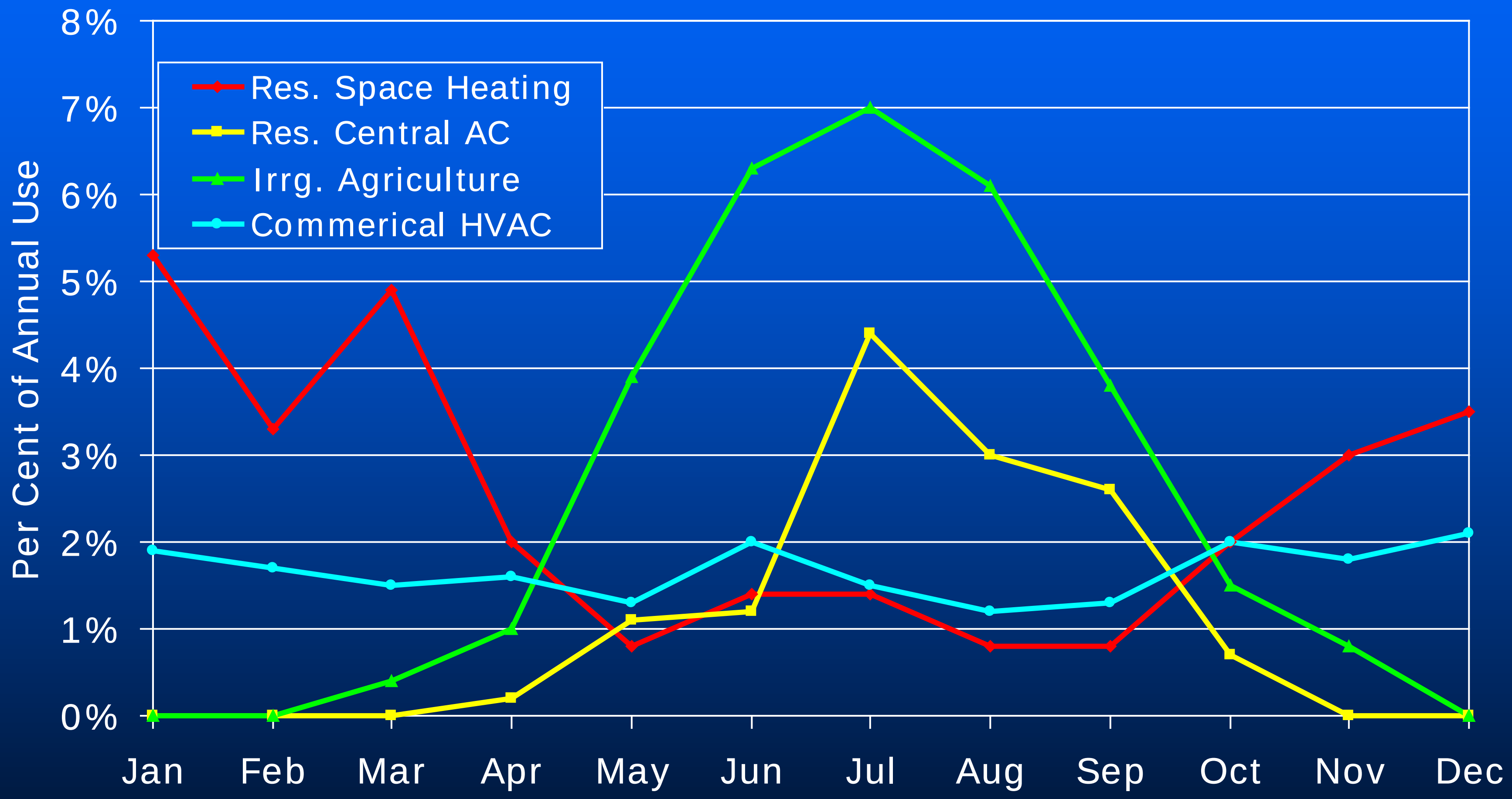
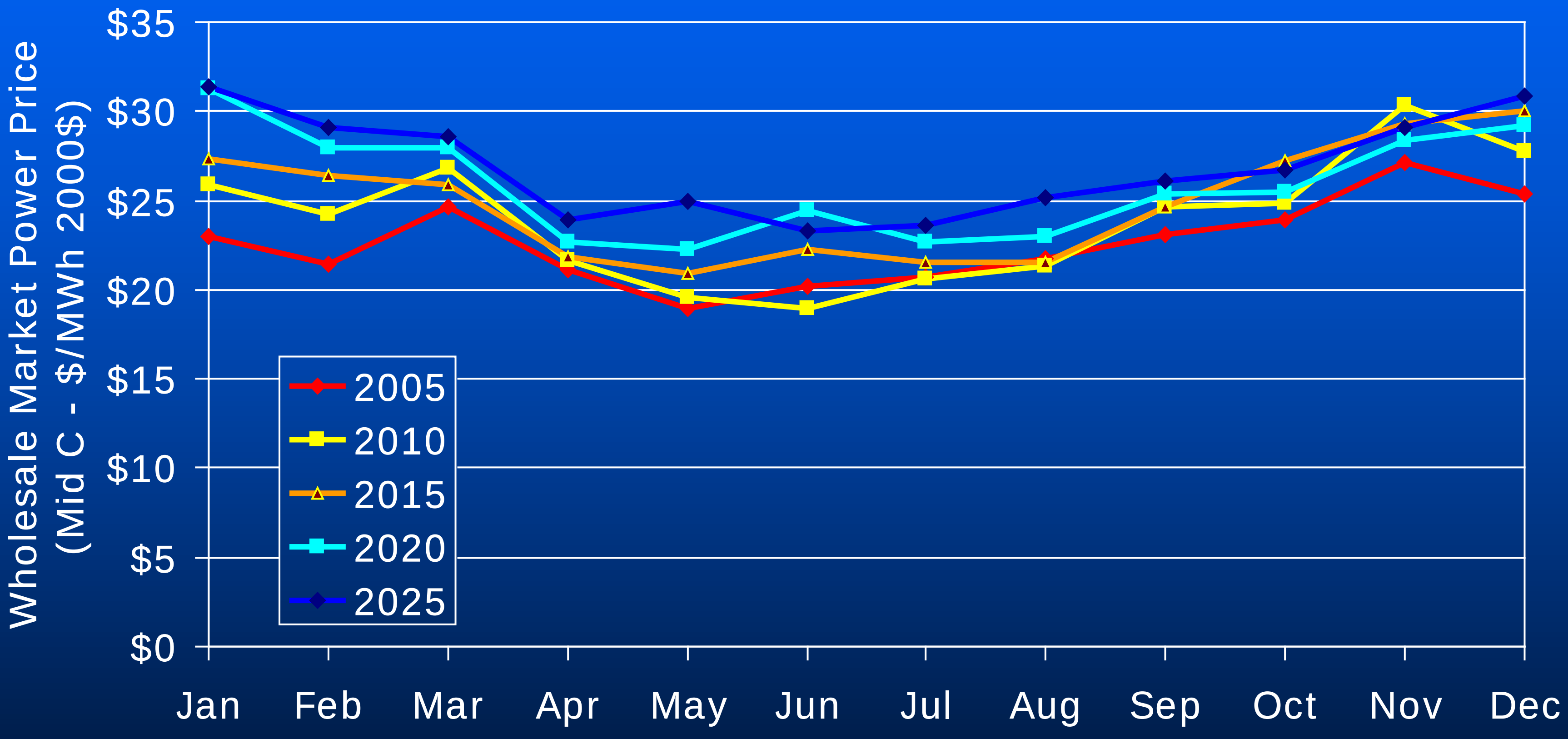
Forecast On-Peak Market Power Prices by Month and Year



Typical Off-Peak Load Profiles



Forecast Off-Peak Market Power Prices by Month and Year

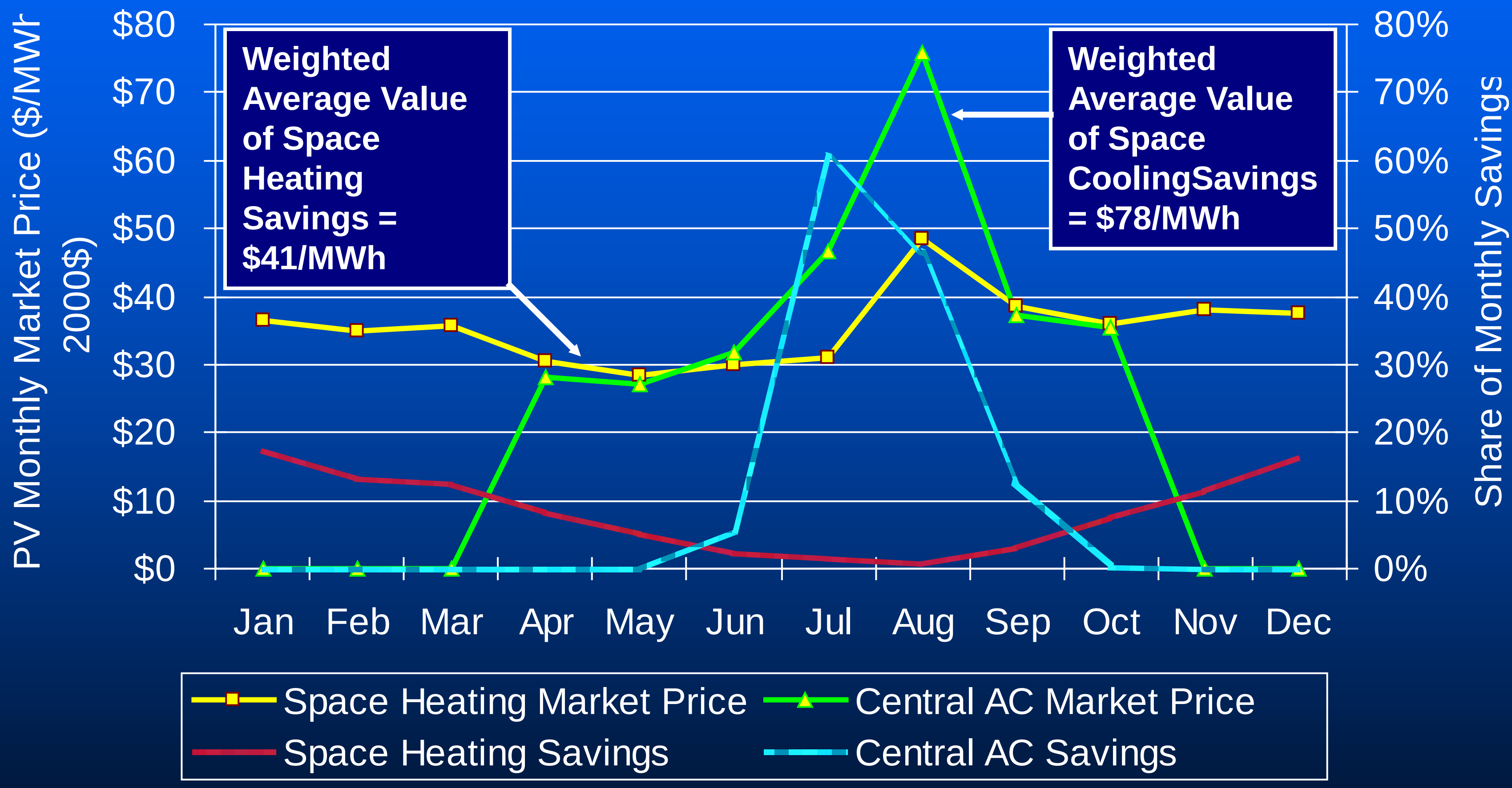


The Council's Conservation's Cost-Effectiveness Analysis Compares Savings with Forecast Market Prices <u>*at the time the savings occur*</u>

- *Four "Load Segments" are used to compute the value of savings:*
  - *Weekday "Peak" Load Hours*
  - *Weekday "Ramp Up/Ramp Down" hours and "Weekend Peak" Load Hours*
  - *Weekday and "Weekend Off-Peak" hours*
  - *Weekend and Holiday "Very-Low"*

Definition of Load Segment Hours								
Hour	Monday	Tuesday	Wednesda	Thursday	Friday	Saturday	Sunday	Holiday
1	3	3	3	3	3	4	4	4
2	3	3	3	3	3	4	4	4
3	3	3	3	3	3	4	4	4
4	3	3	3	3	3	4	4	4
5	2	2	2	2	2	2	2	4
6	2	2	2	2	2	2	2	3
7	2	2	2	2	2	2	2	3
8	2	2	2	2	2	2	2	3
9	1	1	1	1	1	2	2	2
10	1	1	1	1	1	2	2	2
11	1	1	1	1	1	2	2	2
12	1	1	1	1	1	2	2	2
13	1	1	1	1	1	2	2	2
14	1	1	1	1	1	2	2	2
15	1	1	1	1	1	2	2	2
16	1	1	1	1	1	2	2	2
17	1	1	1	1	1	2	2	2
18	1	1	1	1	1	2	2	2
19	2	2	2	2	2	2	2	3
20	2	2	2	2	2	2	2	3
21	2	2	2	2	2	2	2	3
22	2	2	2	2	2	2	2	4
23	3	3	3	3	3	4	4	4
24	3	3	3	3	3	4	4	4

Each Conservation Measure Has a Different "Cost-Effectiveness" Limit Based on When It's Savings Occur



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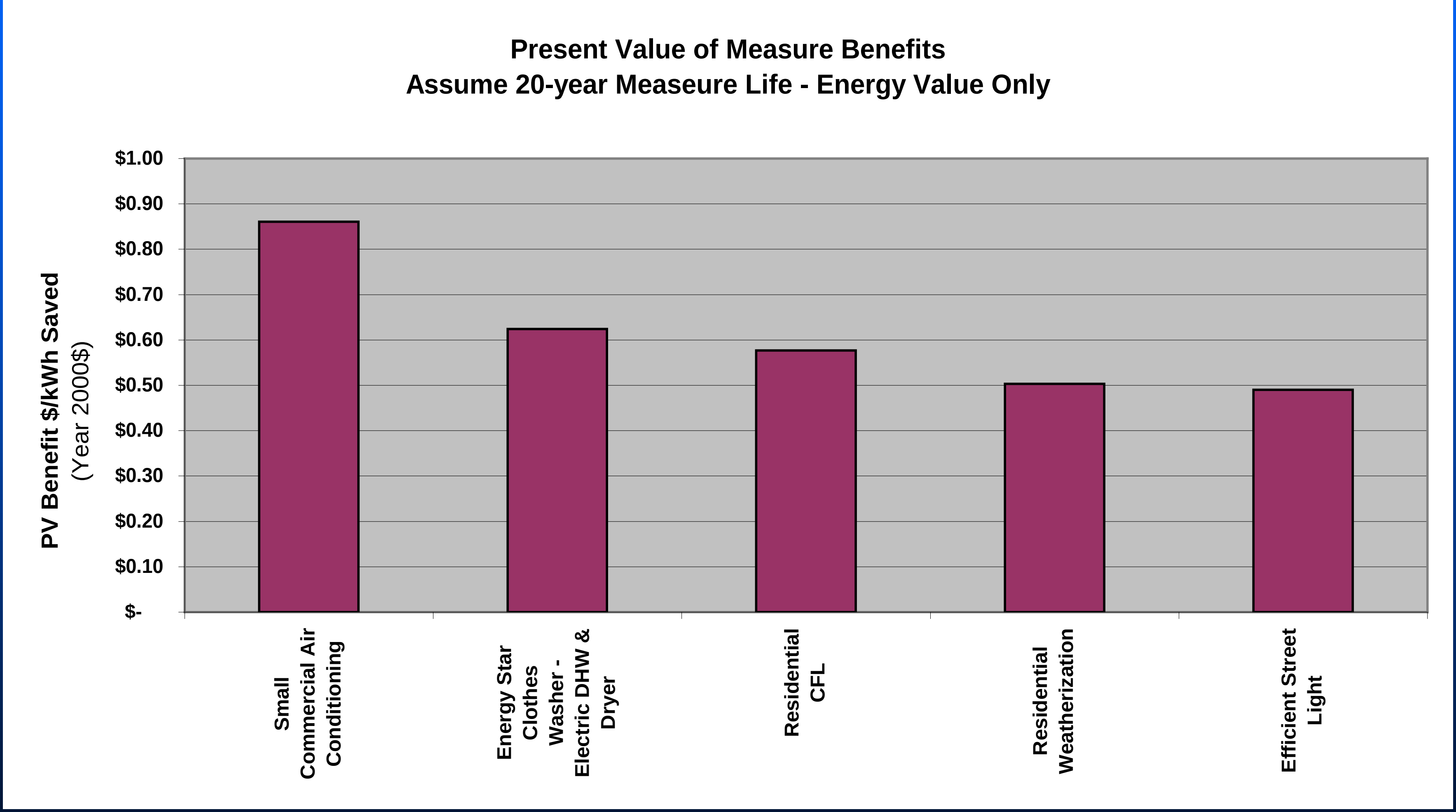
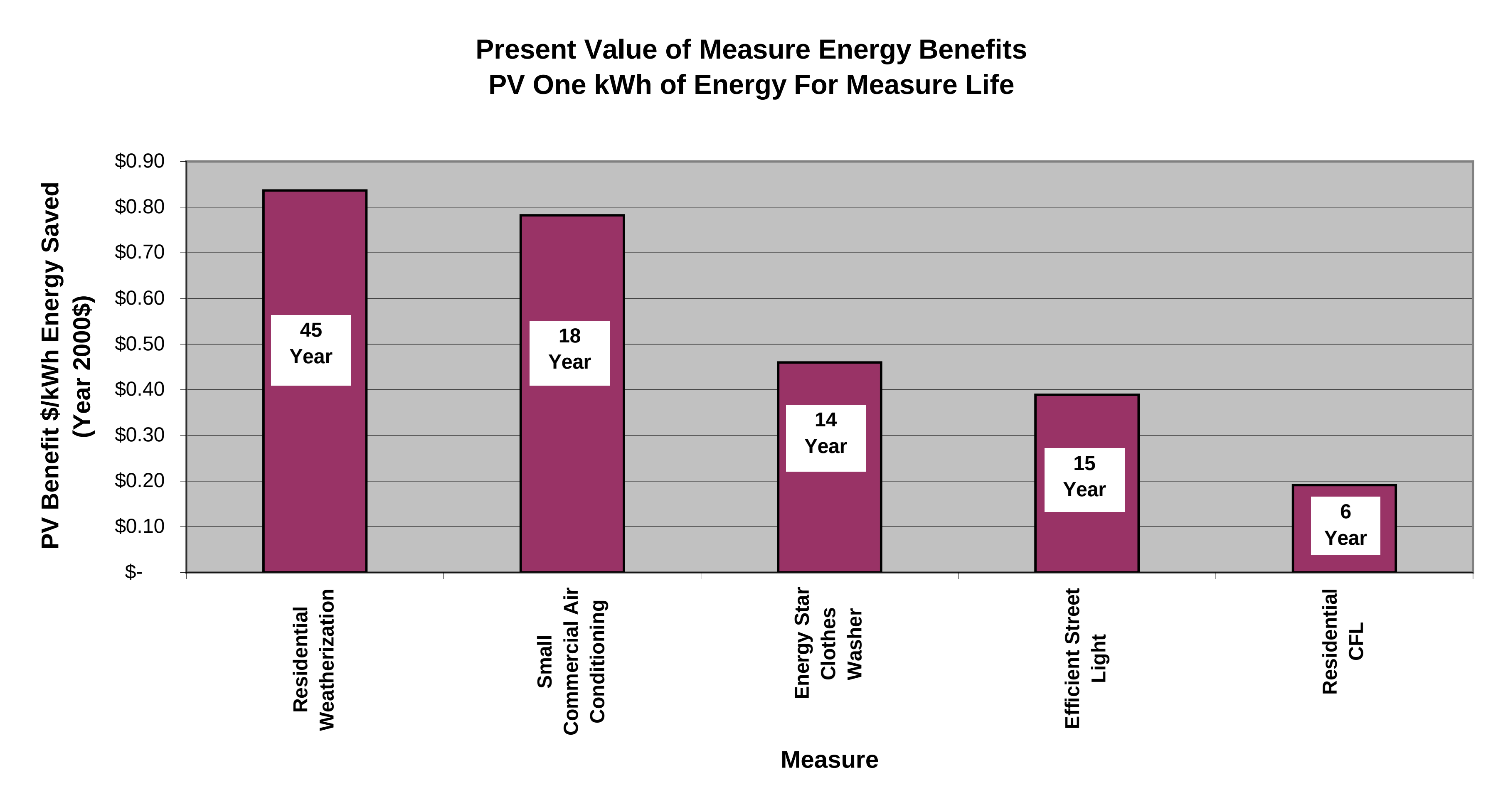
Value Depends on Shape of Savings
Present Value of One kWh Energy Saved
Assuming a 20-Year Measure Life



But …
Longer-Lived Measures Have More Value
Present Value of One kWh Saved
For Life of Measure - Energy Value Only



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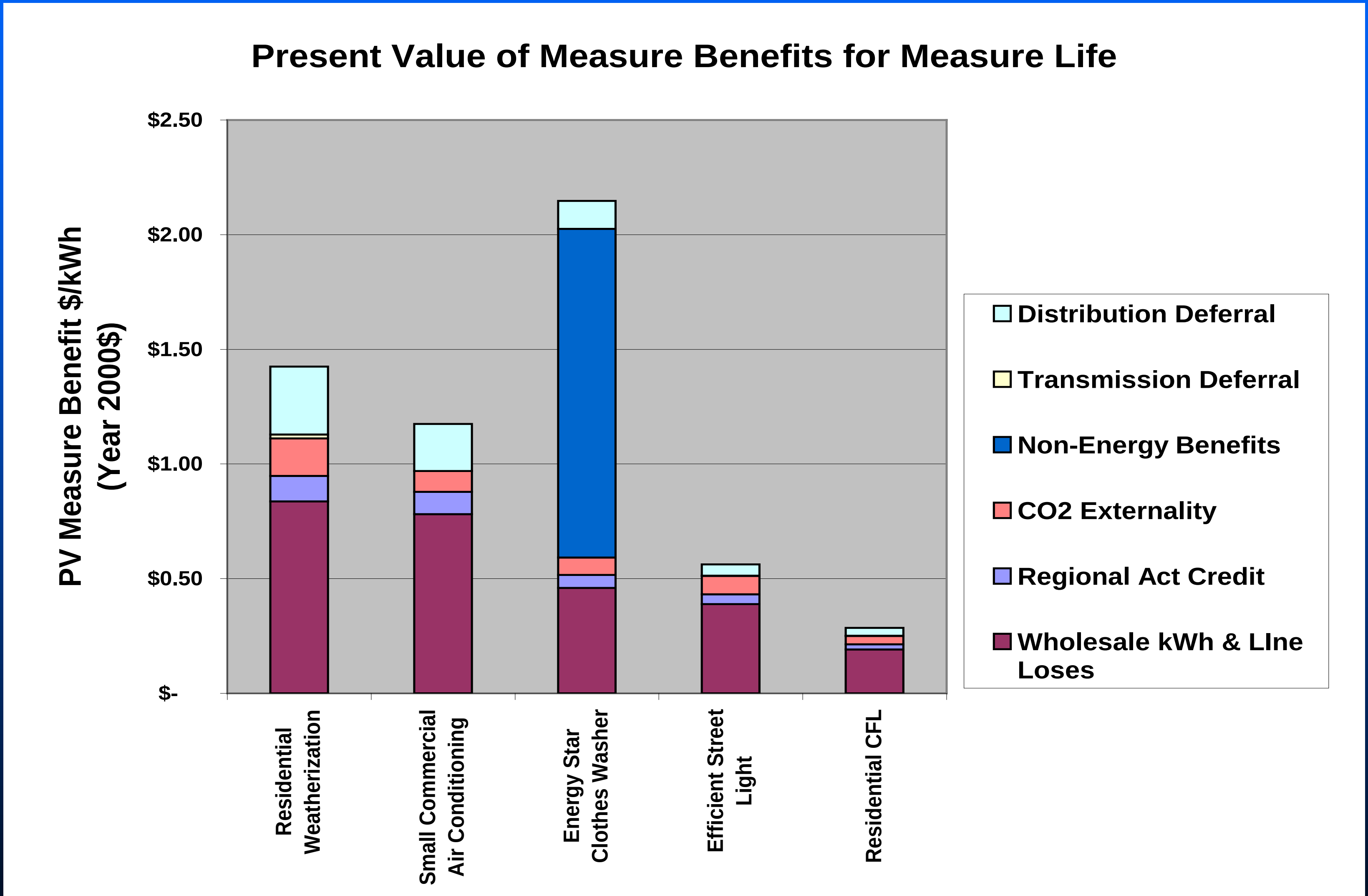
Present Value of One KWh Saved Considering All Benefits



Benefit/Cost Ratio

$$\textbf{B/C Ratio} = \frac{\textbf{Present Value All Benefits}}{\textbf{Present Value All Costs}}$$

- Incorporates all benefits
  - Shape of saved kWh, life of savings, transmission & distribution deferrals, non-energy benefits, quantifiable externalities
- Incorporates all costs
  - Capital & labor, O&M, periodic replacement, pogram admin & non-energy costs
  - Regardless of who pays
- Incorporates time value of money for both
- Good when greater than 1.0

Why We Use Benefit/Cost Ratio to Measure Conservation Cost-Effectiveness

- B/C ratio because timing of savings matters
- There is no single cost against which resources are measured**
- All resources must now "compete" for development against the West Coast wholesale market price
- That price varies dramatically by time of day and season of the year

■**Levelized cost was useful when we estimated the avoided cost as a single generating plant

Why Cost-Effectiveness?

- Conservation reduces system costs when it is less expensive than alternative supplies
  - The bigger the difference the greater the value
  - No economic benefit to conservation that costs the same as alternative supplies
- Conservation reduces risk relative to some alternatives
  - It carries no risk of fuel or climate change cost
  - Reduces variability of loads
  - Has value even when market prices are low

The Act defines regional cost-effectiveness as follows:

- "Cost-effective", when applied to any measure or resource referred to in this chapter, means that such measure or resource must be forecast to be reliable and available within the time it is needed, and to meet or reduce the electric power demand, as determined by the Council or the Administrator, as appropriate, of the consumers of the customers <u>at an estimated incremental system cost no greater than that of the least-cost similarly reliable and available alternative measure or resource</u>, or any combination thereof." (Emphasis added).

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Under the Act the term "system cost" means:

- “An estimate of all direct costs of a measure or resource over its effective life, including, if applicable, the cost of distribution and transmission to the consumer, waste disposal costs, end-of-cycle costs, and fuel costs (including projected increases), and such quantifiable environmental costs and benefits as are directly attributable to such measure or resource”

Act Interpretation

- The Council has interpreted the Act's provisions to mean that in order for a conservation measure to be cost-effective the discounted present value of all of the measure's benefits should be compared to the discounted present value of all of its costs.
- This interpretation was adopted in the Council's 1983 Plan and *has not been modified*

Why Limit Utility Investments to Cost-effective Measures?

- ***It's Immoral*** – Unless payments are limited by Rate Impact Measure/Test non-participant's rates go up to subsidize others for savings that aren't cost-effective
- ***It's Uneconomic*** – Both the utility system and society could serve the same needs at a lower cost and money spent on non-cost effective measure reduces the amount available to secure these energy services from lower cost options
- ***It's Illegal*** – Bonneville is restricted by the Act and both BPA and the region's utilities are constrained by the Council's model conservation standards for BPA and utility programs

Comparing Costs of Conservation & Alternatives

- Levelized Cost
  - Compare alternatives with different lifetimes & cash flow streams
- Benefit/Cost Ratio
  - Compare stream of benefits & costs
  - Use NPV to capture time value of costs & benefits
- Perspectives
  - Total Resource Cost Perspective (TRC)
  - Utility Perspective (UPC)
  - Bonneville Perspective
  - Customer Perspective

Resource Assessment Methods (Availability & Cost)

- Scope of measures
  - Review known measures & practices
  - Over 130 measures & practices 5th Plan
  - New measures (technology)
  - Old measures die (codes supplant some)
- Technical potential is
  - Number of applicable units * Incremental savings per unit

Determine Measure Applicability
Account for territory-specific factors

- Fuel saturations (electric vs gas water heat)
- Building characteristics (size, vintage, insulation)
- Building use (retail, office, school … single-family, multi-family, mobile home)
- System saturations (heat pump, zonal or gas heat)
- Equipment saturations (36 lamps per house)
- Current measure saturations (4 cfls/house)
- Measure life (stock turnover cycle)
- Measure substitution or overlap (either seal ducts on FAF ***OR*** convert FAF to HP and seal ducts)

Determine "Incremental" Savings per Applicable Unit

- Estimated kW & kWh savings
  - By time-of-day, day of week & month of year
- Savings over baseline efficiency
  - Baseline set by codes/standards or current practices
- Climate-sensitive
  - Heating & cooling degree days & solar
- Measure interactions estimated
  - Lighting & HVAC
  - Order of measures applied

Developing Costs

- Costs
  - Materials & labor
  - Financing costs
  - Annual O&M
  - Periodic Replacement
  - Program Admin
  - Externalities
  - Other non-electric

From programs, bids, published sources

If financed use sponsor's cost

Lamp & ballast replacement costs

Marketing, staff,

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The Basic Formula

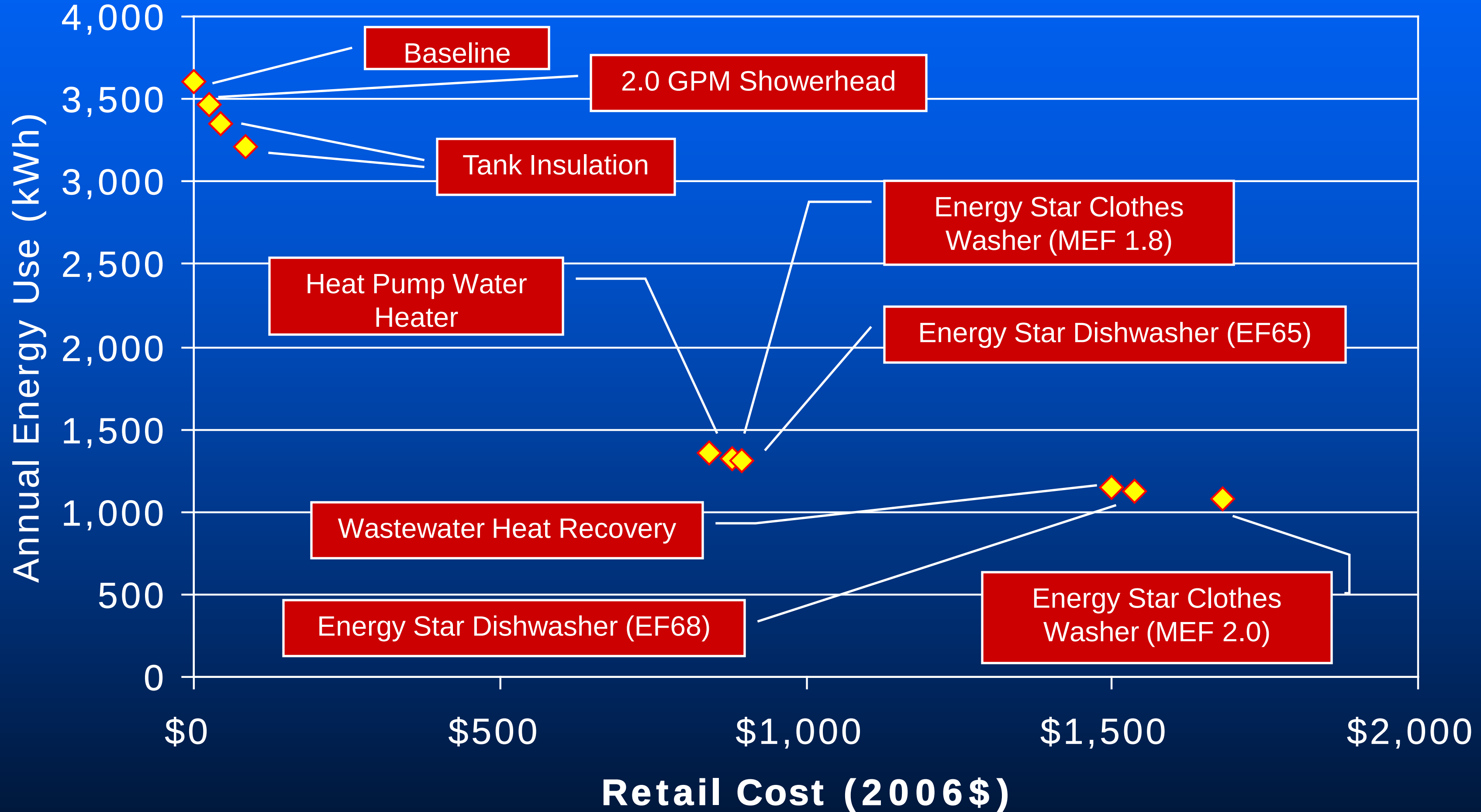
Achievable Potential = Number of Applicable Units X (Energy Use @ Frozen Efficiency - Energy Use @ Cost Effectiveness Limit) X Expected Market Penetration

Where :

Frozen Efficiency Use = Current efficiency adjusted for stock turnover and adopted changes in codes and standards.

Cost Effectiveness Limit = Cost of next similarly available and reliable resource (represented by future wholesale market prices) adjusted for T&D cost deferrals, environmental costs & risks (fuel price, carbon control, etc.) – *Estimated from Portfolio Model Results*

Retail Cost and Efficiency Trade-off Curve
Electric Water Heating



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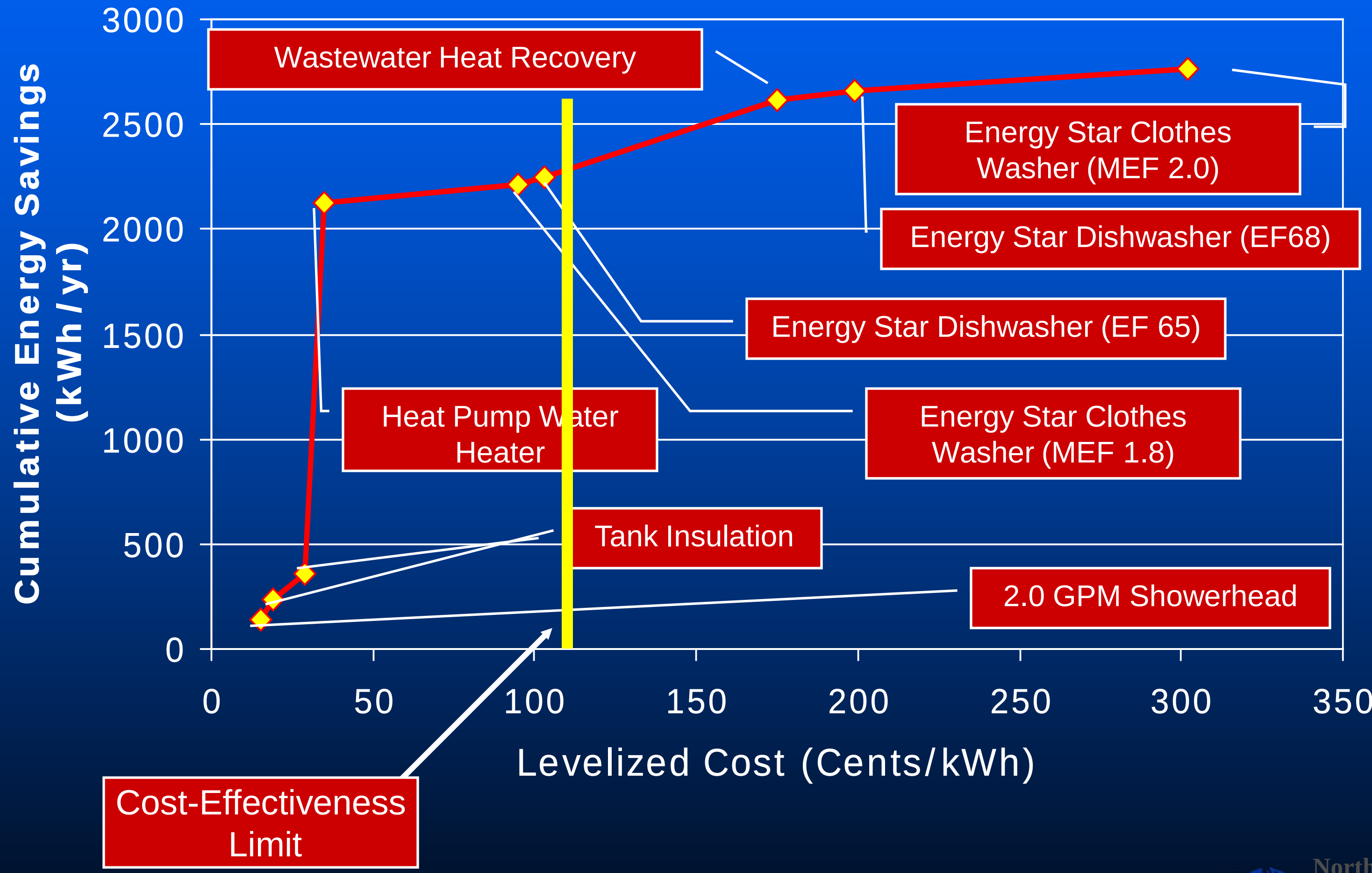
Residential Hot Water Heating Dwelling Unit Supply Curve



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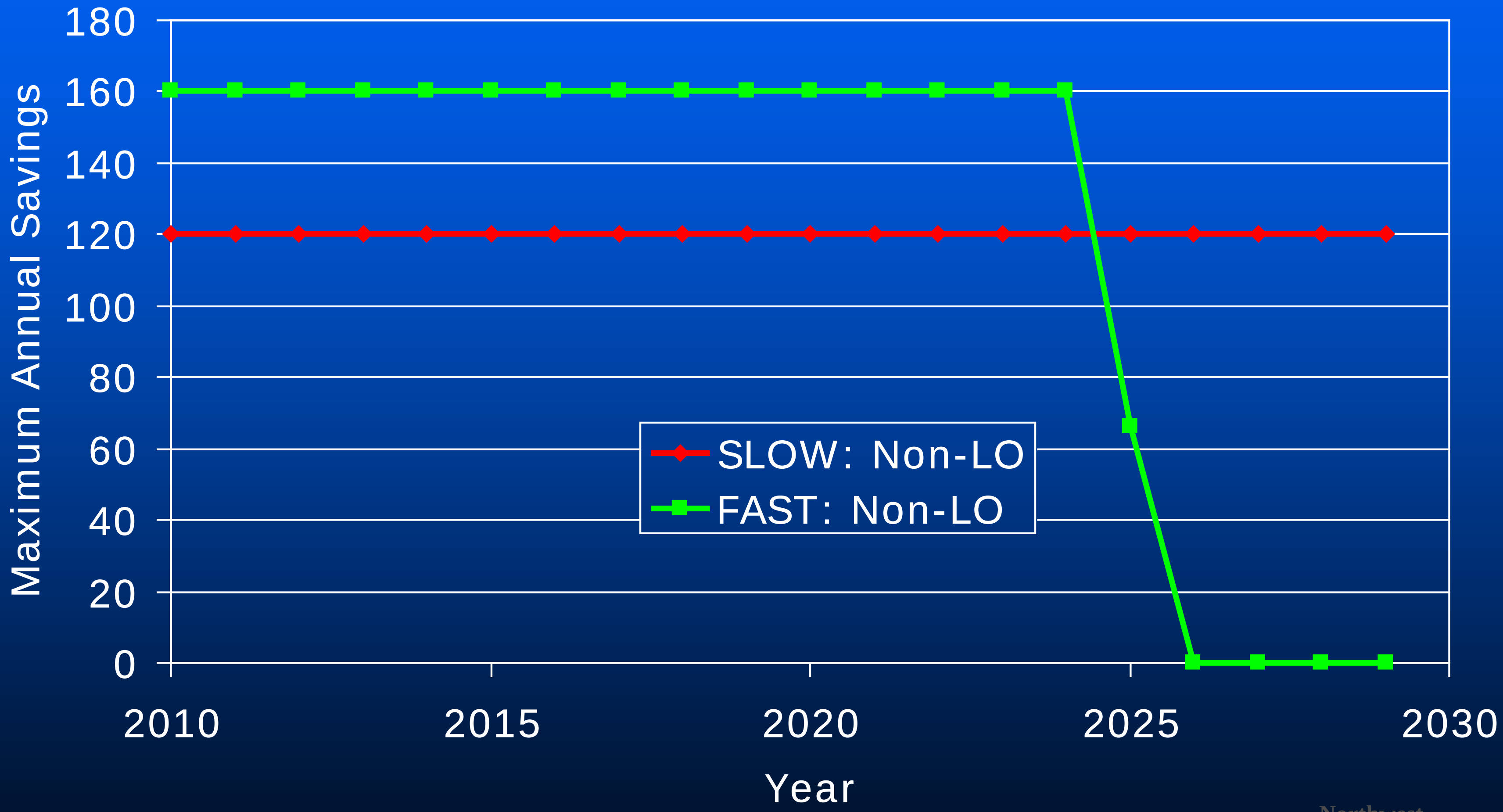
Annual Deployment Rates for Non-Lost Opportunity Resources



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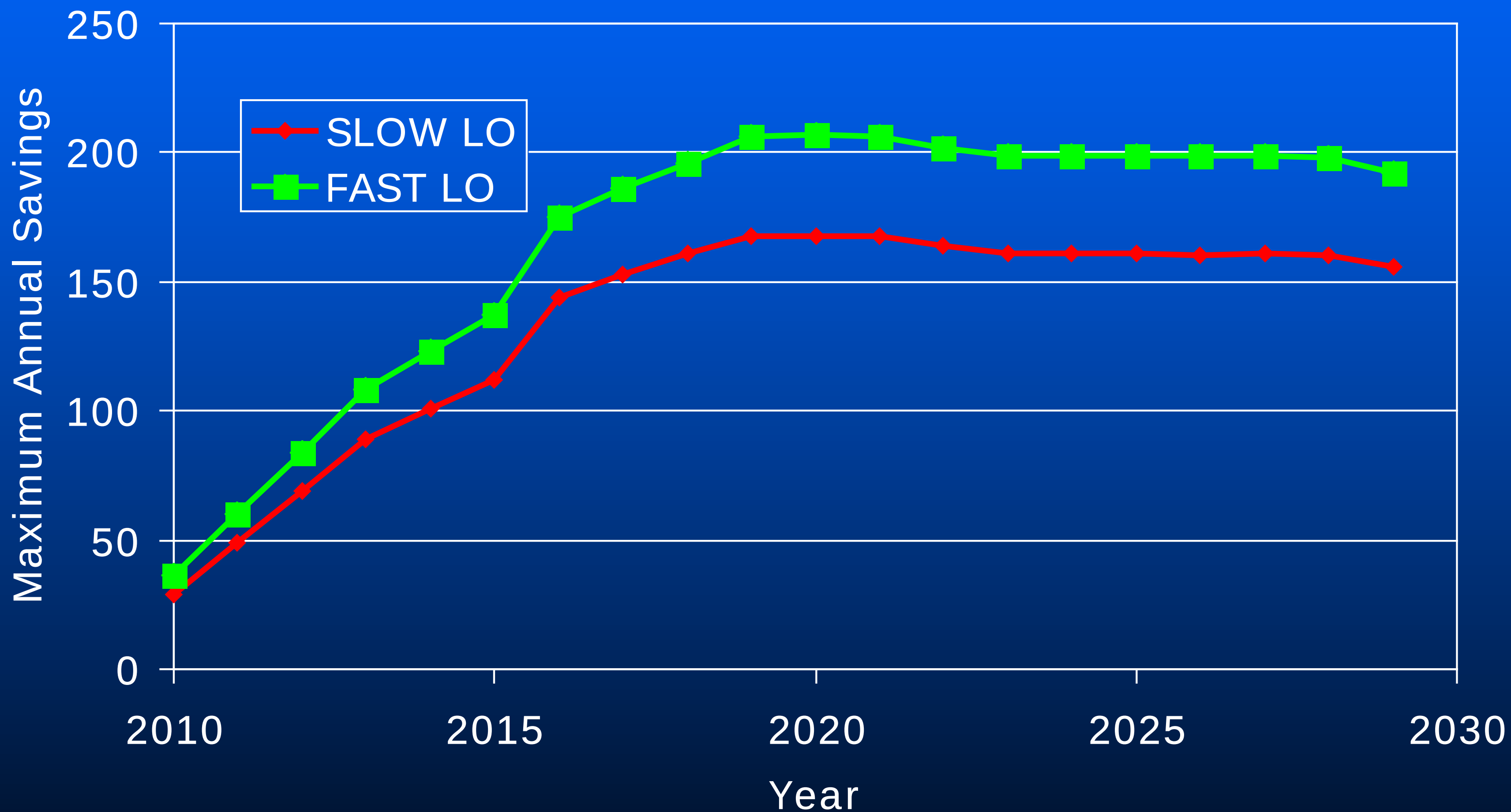
Annual Deployment Rate for Lost Opportunity Resources



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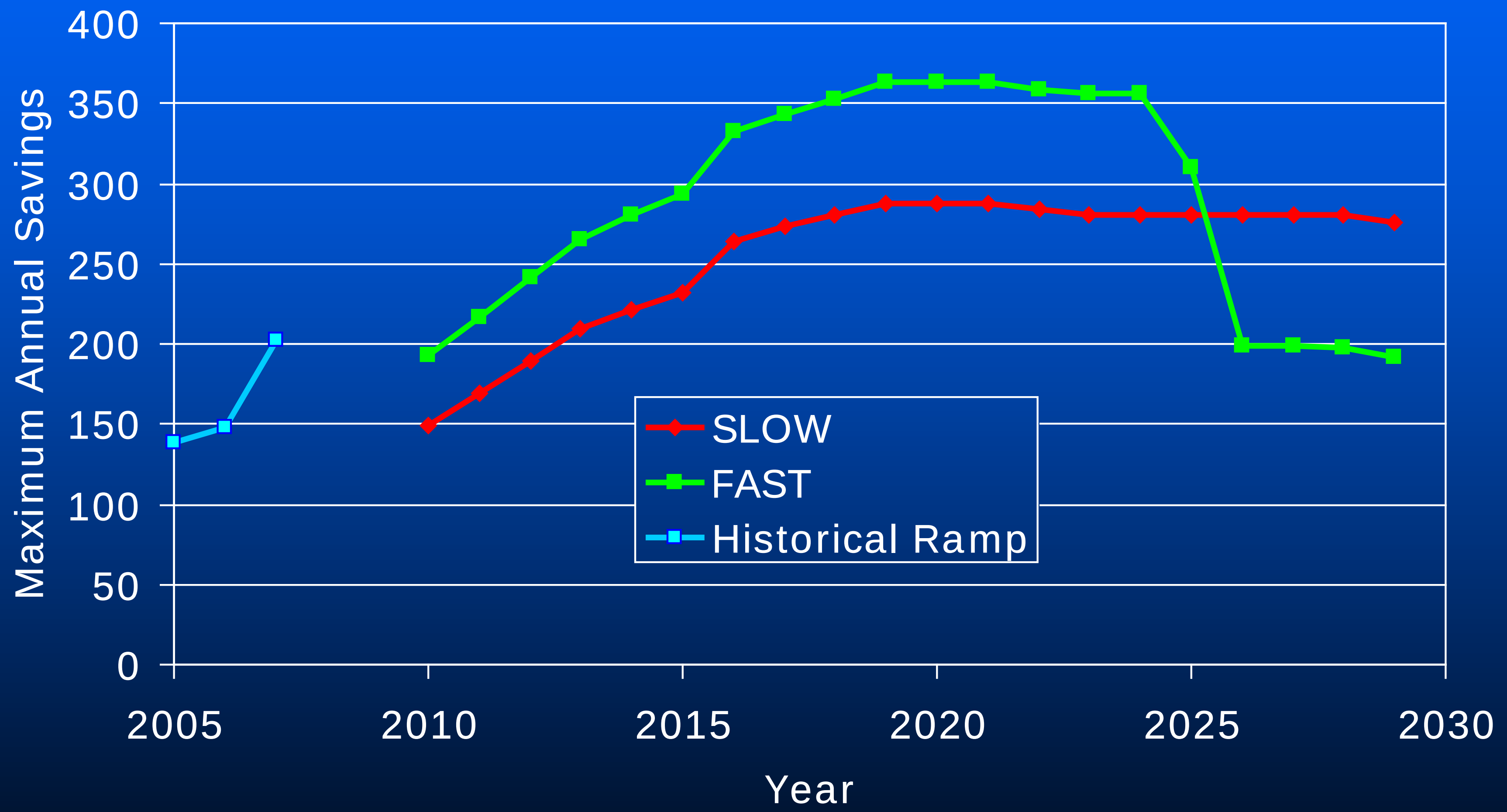
Annual Deployment Rates for All Conservation Resources



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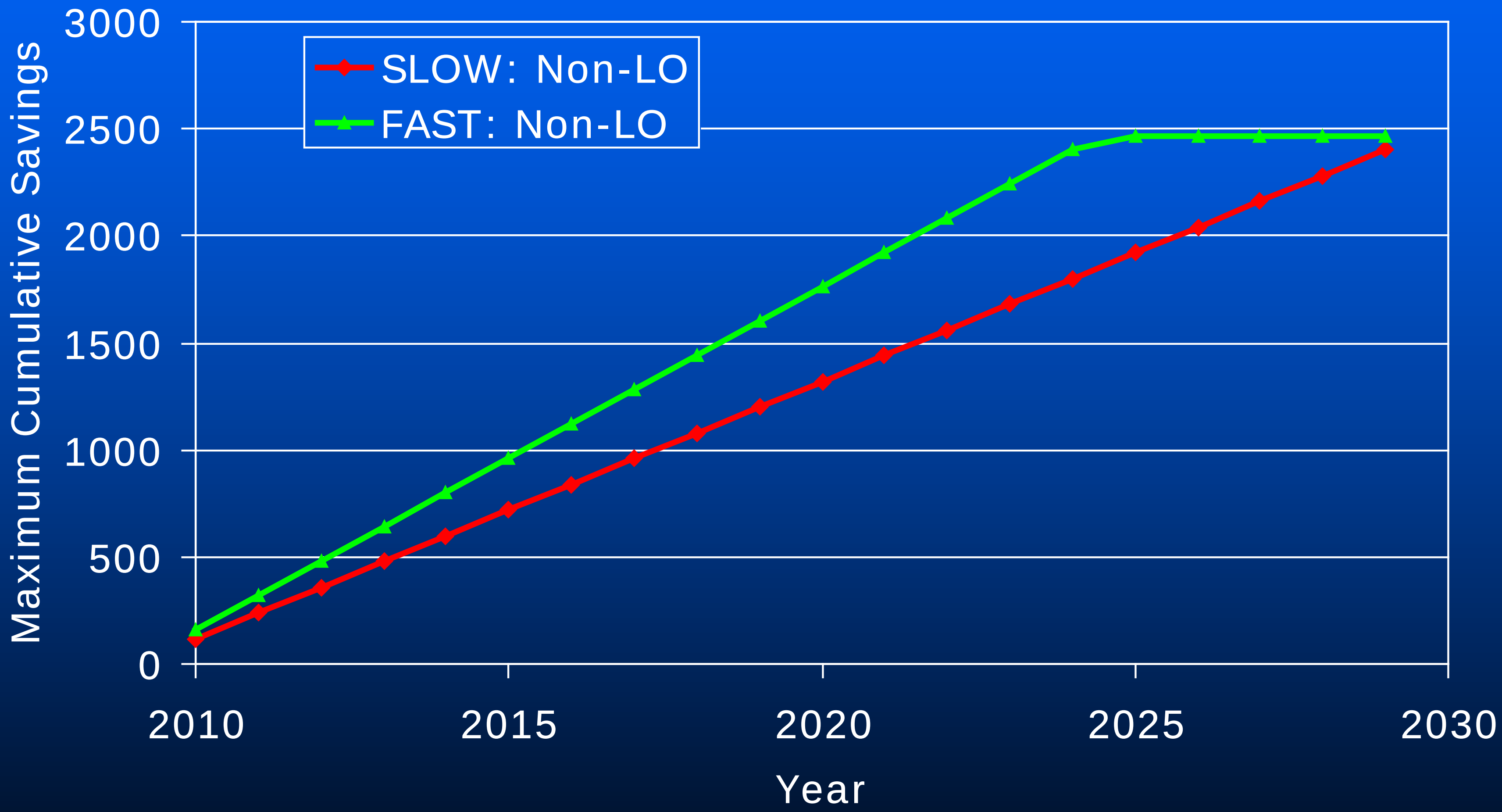
Cumulative Deployment Rate for Non-Lost Opportunity Resources



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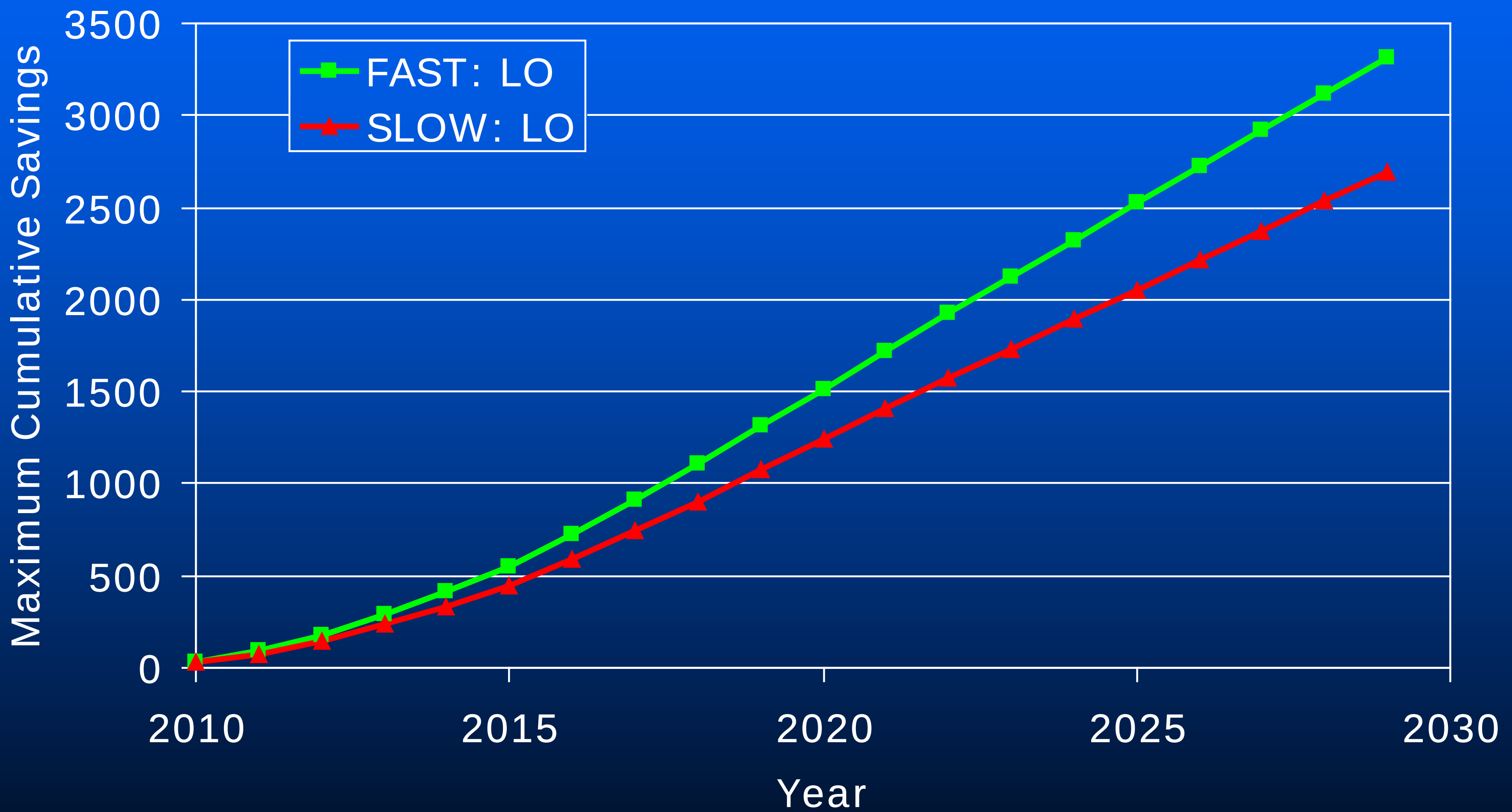
Cumulative Deployment Rate for Lost Opportunity Resources



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Cumulative Deployment Rate for All Resources