Northwest **Power** and
Conservation Council

September 30, 2014

MEMORANDUM

TO: Power Committee

FROM: Charlie Grist

SUBJECT: Primer on Energy Efficiency Assessment Methodology

Presenter: Charlie Grist

Summary: Staff will present an overview of the Council methods used to develop estimates of energy conservation potential for the Seventh Power Plan. The presentation will summarize the key steps used to estimate the amount, cost and availability of energy efficiency resource potential. The presentation will cover the process up to the point where efficiency resources are passed to the Regional Portfolio Model for evaluation compared to generation and demand response resources.

Staff will highlight analytical methods, data sources and issues related to developing an assessment of energy conservation potential. Most of the assessment is data driven. The Council primarily uses a bottom-up approach which evaluates hundreds of measures with respect to cost, savings and availability across all sectors of the economy. It relies on data from a wide range of data sources. There are a few policy choices which will need to be made over the course of Power Plan development. These will be identified for future Council discussions.

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The presentation will also touch on the review process used for the conservation potential assessment. Both the Regional Technical Forum (RTF) and the Conservation Resources Advisory Committee (CRAC) are used to vet the analysis and make suggestions on improvements.

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Relevance: The assessment of regional conservation potential is one of the principle components of the Council's plan development process. This primer will provide Council members with an understanding of analytical steps used to conduct this assessment as well as the public review process used by staff.

Workplan: 1.D. Update conservation resource assessment

Background: The staff has presented previously on the calculation of the levelized cost of energy at both GRAC meetings and Council meetings.

More Info: For a primer on the LCOE calculation, see the April 2013 presentation http://www.nwcouncil.org/media/6838753/4.pdf

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Primer on Conservation Potential Assessment Methodology

October, 2014

Agenda

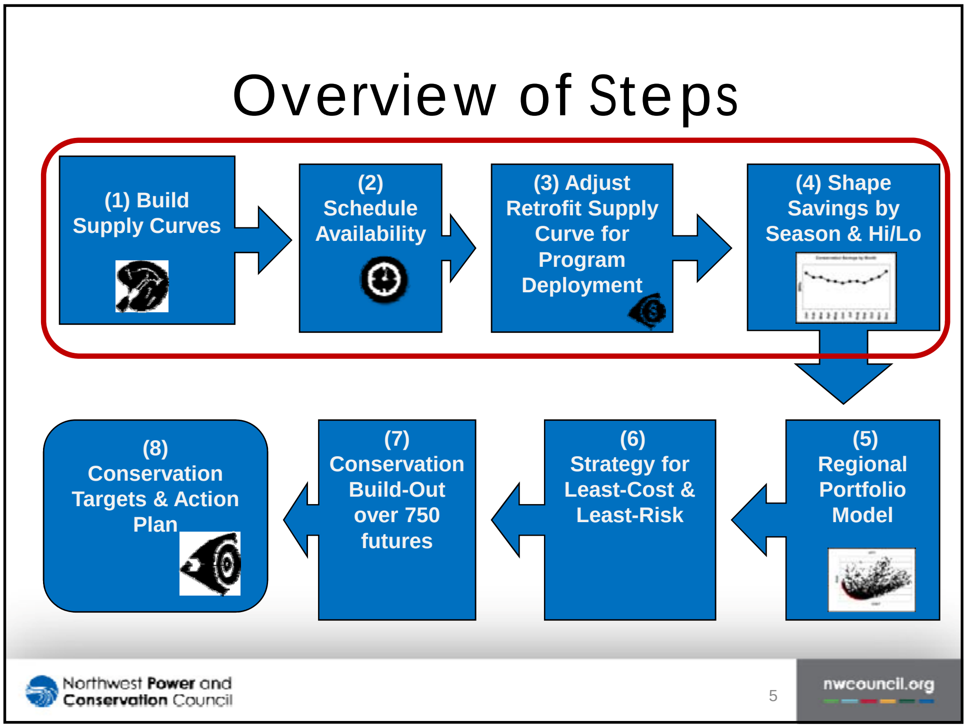
- Some Terms We Use
- Methodology Overview
- Step Through Methodology
- Identify Issues

Terms You'll Hear Today

- Conservation Supply Curves
- Lost-Opportunity Conservation
- Retrofit Conservation
- Baseline
- Current Practice
- Incremental Cost or Savings
- Program Administration Cost
- Deferred Distribution Expansion
- Regional Act 10% Credit
- Non-Energy Benefit
- Total Resource Cost
- Discount Rate
- Cost of Saved Energy
- Levelized Cost
- Conservation Measure or Practice
- Conservation Program
- Federal Energy Standards
- State Building Codes
- New, Natural Replacement, Retrofit
- Maximum Annual Availability
- Building Stock
- Equipment Stock
- Product Turnover
- Technical Potential
- Achievable Potential
- Ramp Rate

Some Terms for Today

- Mid-C Price, Market Price
- High Load Hour, Low Load Hour
- Energy
- Kilowatt-hour (kWh)
- Megawatt-hour (MWh)
- Average megawatt (aMW)
- Capacity
- Peak Demand
- Kilowatt (kW)
- Megawatt (MW)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(1) Build Supply Curves
(2) Schedule Availability
(3) Adjust Retrofit Supply Curve for Program Deployment
(4) Shape Savings by Season & Hi/Lo
(5) Regional Portfolio Model
(6) Strategy for Least-Cost & Least-Risk
(7) Conservation Build-Out over 750 futures
(8) Conservation Targets & Action Plan
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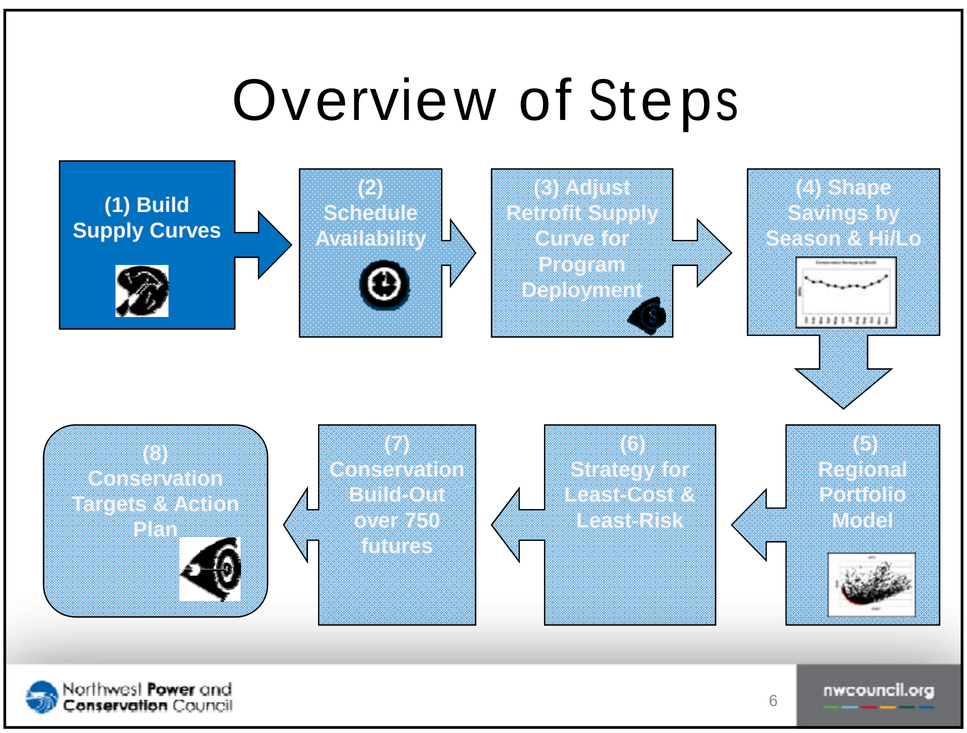
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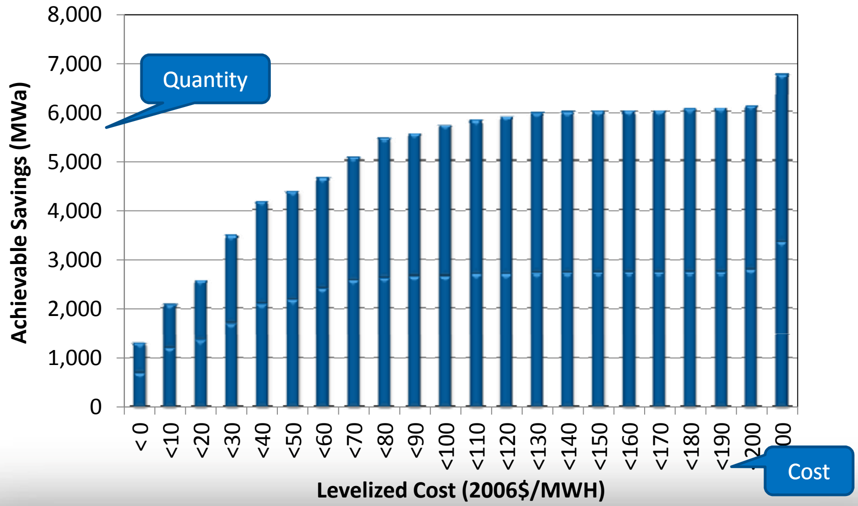
Supply Curves Show How Much Savings Are Available At What Cost



Steps in Building Supply Curves

1. Identify Measures that Save Electricity
2. Establish the Measure's "Baseline" Efficiency
3. Estimate Electricity & Capacity Savings per Unit
4. Estimate Costs & Benefits per Unit
5. Estimate Measure Life
6. Calculate Cost per kWh Saved
7. Calculate Number of Units Available
8. Multiply Unit Savings and Cost * Number of Units

Step 1: Identify Measures for Supply Curves

- Example - Nearly 400 measures bundles in Sixth Power Plan
  - Buildings
  - Appliances
  - Processes
  - Utility distribution system (poles, wires and transformers)
  - Across residential, commercial, industrial, agriculture, utility
- Over 1400 measure permutations
  - By climate zone, vintage, heating system type
  - Items that change incremental cost or savings

Step 2: Establish Baseline
Depends on Decision Timing

New
- New homes
- New buildings
- New equipment
- New additions

Decision when new item is built or purchased.

Baseline is best of minimum code requirement, federal standard, or common practice

Natural Replacement
- Burn-out
- Remodel
- Market shifts

Decision when burnout or obsolescence.

Baseline is best of minimum code requirement, federal standard, or common practice

Retrofit
- Remove & Replace (windows)
- Add-on (insulate attic of older home)

Decision timing is discretionary.

Baseline is as-found condition, unless subject to code or standard

$\underbrace{\text{New} \quad \text{Natural Replacement}}_{\text{Lost-Opportunity Resources}}$

Set Baseline (Examples)

	New	Natural Replacement	Retrofit
Attic Insulation	State Code sets minimum May vary by state: WA, OR, ID, MT R-49 (15 inches)	N/A. Attic insulation does not wear out	As-found condition in stock. Data from Residential Building Stock Assessment 6% less than 3 inches 20% 3 to 10 inches 25% 10 to 15 inches 49% Greater than 15 inches
High Efficiency Clothes Washer	Federal Standards for Energy Factor & Water Factor Four types of machines with different standards Effective dates 2011 - 2015 – 2018 –	Same Federal Standards Applies to turnover. Washer life 14 years. All stock replaced in 20 year forecast period	N/A

Sync Baseline with Electricity Load Forecast

- Forecasts of electricity demand AND conservation potential must both use same baseline efficiency
- Council Approach: Freeze the efficiency level of New and Natural Replacement purchase events
  - New and replacement products enter the stock at the market efficiency of new-products or minimum code/standard, which ever is greater
  - As a result of product turnover, the average efficiency of the stock of appliances and equipment increases over time

Step 3:
Estimate Electricity & Capacity Savings

Energy Savings (kWh)
- kWh per unit at the site
- Line losses from source to site
- Seasonal & daily shape of savings
- Measure interactions
- Measure "Take Back"

Capacity Benefits (kW)
- IF coincident with peak:
- Deferred distribution and transmission line expansion cost
- Quantified In $/KW-yr

Data Sources:
- Program evaluation data
- Billing history analysis
- Sub-metered data
- Engineering estimates
- DOE Rule makings
- Building simulation models
- Independent testing labs
- End use load research

The Basic Formula for Savings

Achievable Savings Potential =
Number Units * kWh savings per Unit * Achievable Penetration

Examples:
- Number Homes
- Floor Area of Retail
- Number of Refrigerators
- Acres Irrigated
- Number transformers

Fraction of available or remaining stock that is realistically achievable over time

(kWh/Unit at **Baseline** Efficiency – kWh/Unit at **Improved** Efficiency)

Step 4:
Estimate All Costs & Benefits Above Baseline

Costs
- Capital & Financing
- Labor
- Program Administration
- Operations & maintenance
- Reinstallation Cost
- Quantifiable Environmental Costs

Non-Electric Benefits
- Water savings
- Gas savings
- Materials savings
- Operations & maintenance
- Lamp replacements
- Quantifiable Environmental Benefits

Data Sources:
- Program Data
- Contractor Bids
- Retail Price Surveys
- World Wide Web
- Engineering estimates
- DOE Rule makings
- Manufacturers
- Secondary Research

The Basic Formula for Cost

All Costs & Benefits Per Unit

Capital, Financing, Labor, Program Admin, O&M, Reinstallation Cost, Deferred Transmission & Distribution Line Expansion, Other Non-Electric (Gas & Water)

In the year they occur

ProCost

Cost of Saved Energy

Result: $ per MWh saved comparable to market purchase or generation cost

Step 5: Estimate Measure Life

Measure Lifetime (Years)

Res. Halogen light bulb	2
Res. CFL bulb	8
Res. LED bulb	12
Insulation	40
Irrigation scheduling	1

- 20-Year Analysis
- Short-life measures are "re-installed"
- Reflects total cost over 20 years

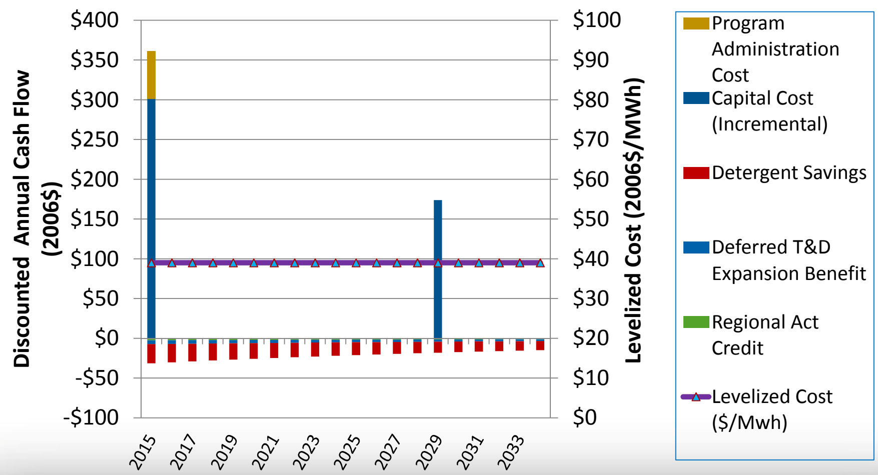
Data Sources:
- Program evaluation data
- Engineering estimates
- DOE Rule makings
- Manufacturers data
- Census data

<u>Measure Life Issues:</u>
- Persistence of behavioral measures

Step 6: Calculate Cost per kWh Saved

- Problem:
  - Measures have different lifetimes
  - Costs & benefits occur at different times over the 20-year period
  - Need to compare to costs of power purchase or cost of generation
- Solution: Convert annual cash flow to constant annual cost per unit of savings (e.g., cents/kWh, $/MWh)

Discounted Costs & Benefits Over 20 Years Energy Efficient Clothes Washer



Step 7: Estimate Number of Units Where Measure is Applicable

New

- New homes
- New buildings
- New equipment
- New additions

Number of units driven by population or economic growth

Natural Replacement

- Burn-out
- Remodel
- Market shifts

Number of units driven by equipment life, turnover rates, consumer preference & obsolescence

Retrofit

- Remove & Replace
- Add-on

Number of units driven by remaining stock not adopting measure

Estimate Number of Units

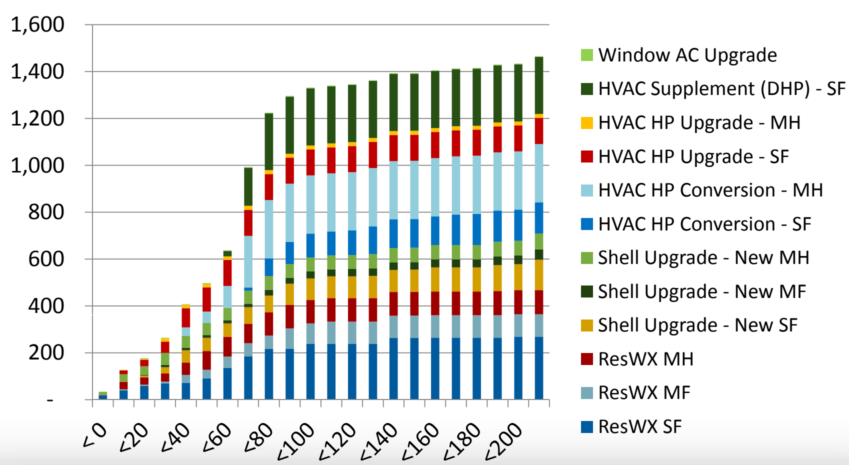
Examples of Units

- Number of replacement clothes washers per year (330,000)
- Number of new single family homes per year (84,000)
- Floor area of Mini Mart groceries (45,000,000)
- Sq.Ft. of attics with no insulation in older homes (540,000,000)

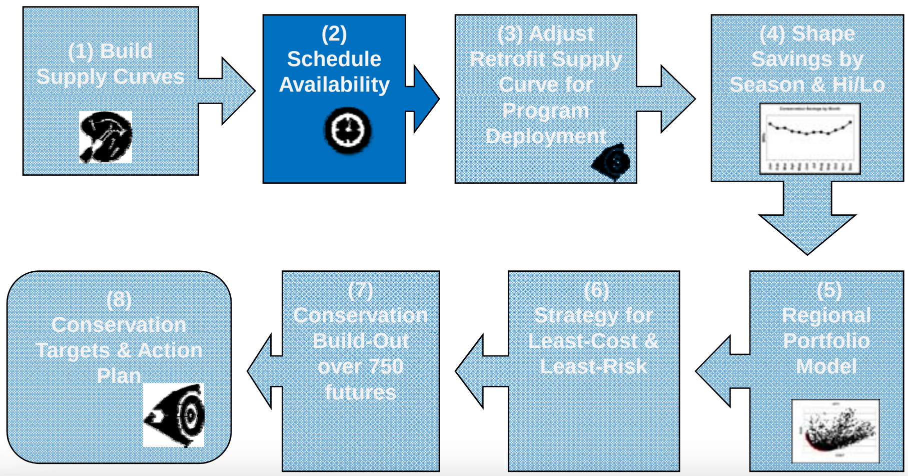
Data Sources:
- Council forecast models
- DOE Rule makings
- Manufacturers data
- Stock assessments (RBSA, CBSA, IFSA)

Annual Estimates
- Year-by-year for 20-year forecast period
- Existing stock minus demolition & conversion
- New stock added
- New appliances added
- Appliance & equipment turnover

Step 8: Add Up Each Measure Cost & Savings



Overview of Steps



Why Schedule Availability of EE?

- Need EE construction schedule for comparability to generation resources
- Not all energy efficiency can be acquired immediately
- Three key considerations
  - Maximum *achievable* over planning period (i.e., 20 years)
  - Maximum *annual* availability (i.e., MWa/year)
  - Maximum *rate of change in* availability (i.e., ramping/acceleration rate)

Maximum Achievable

- Achievability Assumes:
  - Utility system can pay all cost (if measure is cost-effective based on power system benefits)
  - Many efficiency requirements can be embedded in codes/standards
  - 20-year time frame
- Less than 100% adoption generally assumed
  - Assumes not all customers will accept the efficient unit, even if offered "free-of-charge"
- *Achievable Potential* is Always Less Than *Technical Potential*

Maximum Annual Availability
Depends on Timing of Decisions

New
- New homes
- New buildings
- New equipment
- New additions

Driven by population or economic growth

Natural Replacement
- Burn-out
- Remodel
- Market shifts

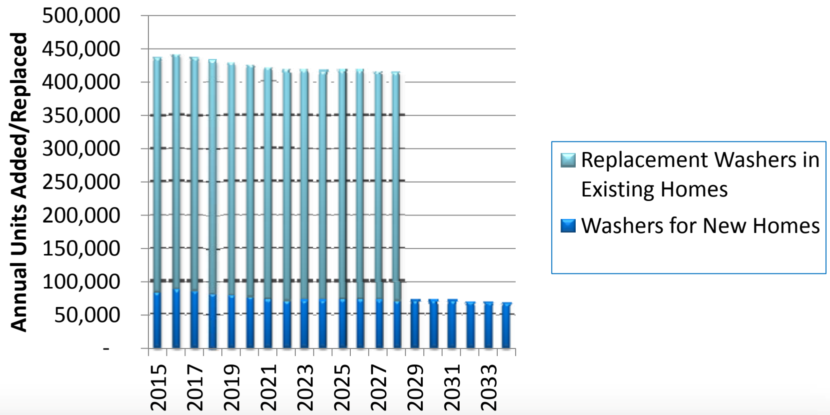
Driven by equipment life, turnover rates, consumer preference & obsolescence

Retrofit
- Remove & Replace
- Add-on

Existing stock has useful remaining life but could be replaced or upgraded

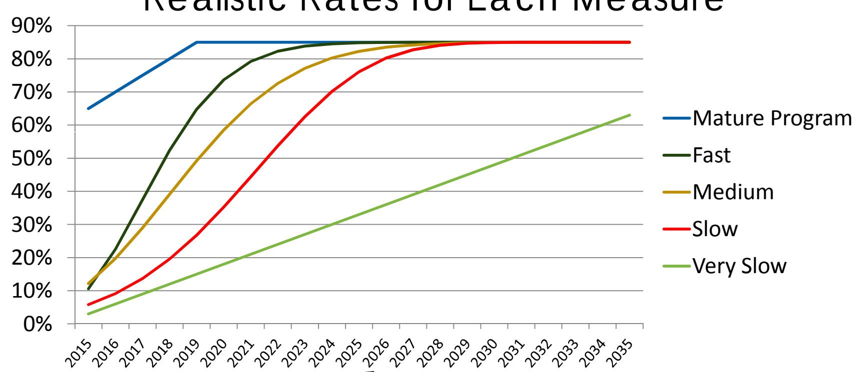
Applicable Stock Estimate

Clothes Washer Example



Maximum Program Ramp Rates

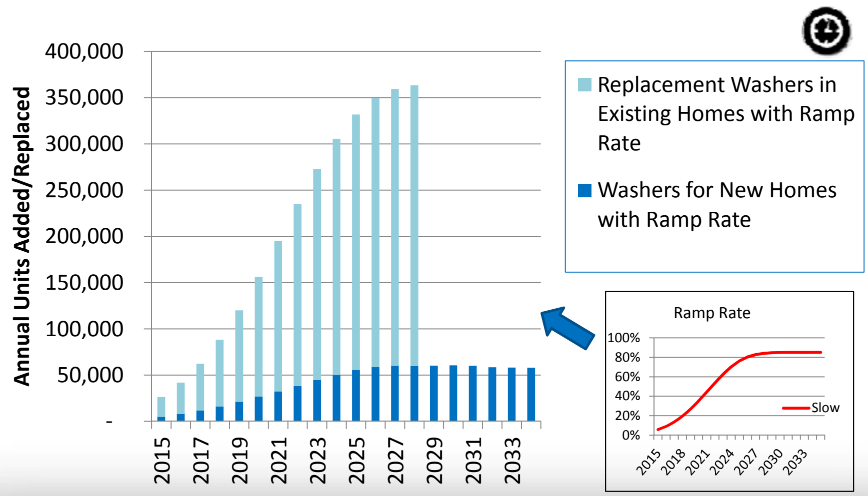
Realistic Rates for Each Measure



Data Sources that inform Ramp Rate:

- Past program performance
- Timing of new standards
- Cost of measure
- Consumer acceptance
- Non-energy benefits
- Physical availability of equipment
- Training & education requirements

Available Stock COMBINED with Ramp Rates Determines Maximum Availability Schedule



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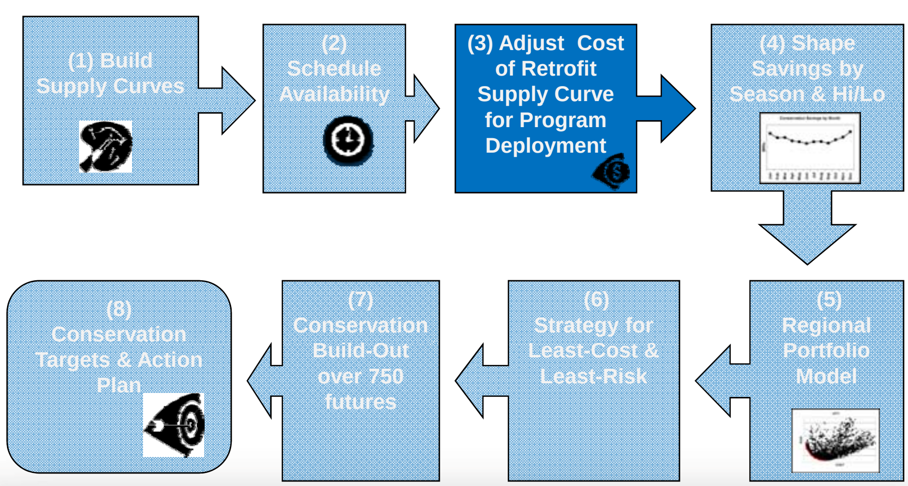
Overview of Steps



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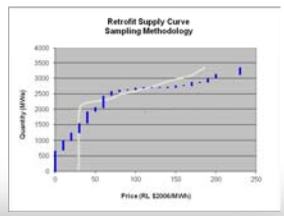
Adjustments to Cost of Retrofit Curve to Reflect Program Deployment

- Try to represent realistic program acquisition costs
- Portfolio Model acquires lowest-cost resources first
- But, real world programs don't acquire <u>only</u> the lowest cost conservation first
- Programs buy "up to" a cost effectiveness limit
- So adjust conservation supply curve to meld in some higher cost measures with the low-cost



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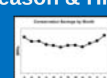

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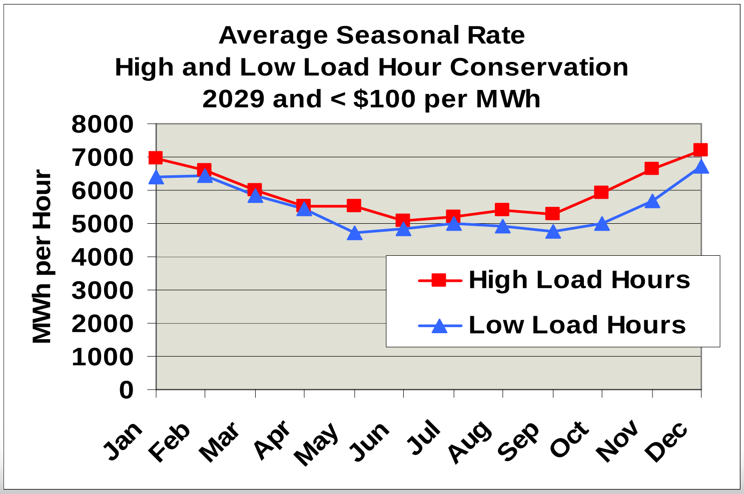
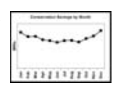
Shape the Savings
by Season & High/Low Load Hours



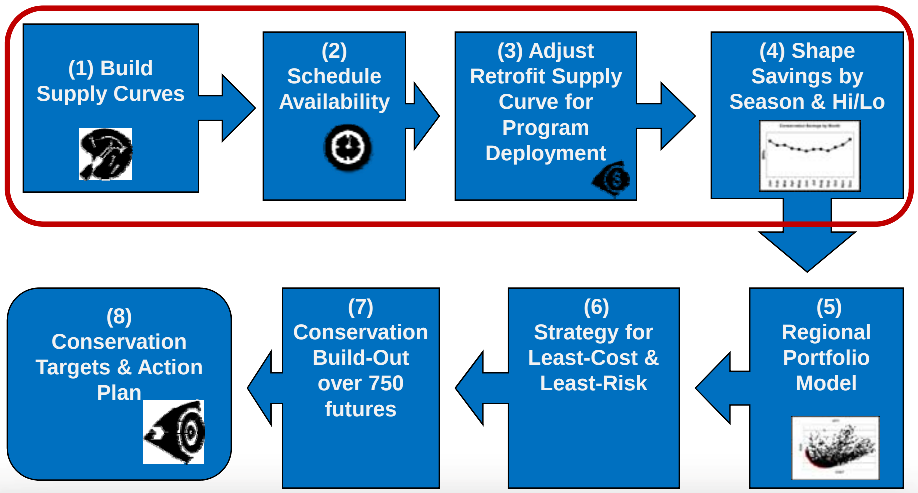
Reflect Time of Savings for Energy and Capacity



- Value of savings depends on when savings occur
  - Based on time-dependent market price of energy
  - Winter energy more valuable than summer
  - Daytime energy more valuable than nighttime

- Capacity value of savings depends on timing too
  - More valuable if coincident with peak system needs
  - Peak coincident savings defer need for generating capacity
  - Peak coincident savings defer need for expanding transmission and distribution systems

Review of Steps



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Backup Slides

Preparing Supply Curves for the Regional Portfolio Model

- Four major steps
- Data-driven analysis
  - Costs, savings, availability
- A few areas require some judgment
  - Maximum achievable
  - Ramp rates
- Issues & analysis reviewed by advisory committees
  - Regional Technical Forum (RTF)
  - Conservation Resources Advisory Committee CRAC)

Measure Identification Issues

- Is the technology/measure "similarly available and reliable"
- Which measures to remove?
  - What's been done by programs?
  - What will codes and standards capture?
  - Is there remaining potential?
- Which to add?
  - What new technology is available?
  - Is the technology being adopted?

Baseline Issues

- Is *Common/Standard Practice* better than the applicable minimum code/standard?
  - Need reliable market data
- Is the Measure a *Natural Replacement* or *Early Retirement*?
  - Products or systems replaced before failure may have short remaining useful lives (i.e., their savings do not persist)

Savings Issues

- How to account for rapid changes in technology
- Persistence of savings for behavioral measures
- Interactions between measures over time
- Do productivity increases count as savings?
- Data on market baseline can be scarce
- Data on shape of savings is old and/or must be estimated for some measures (e.g. lighting controls)

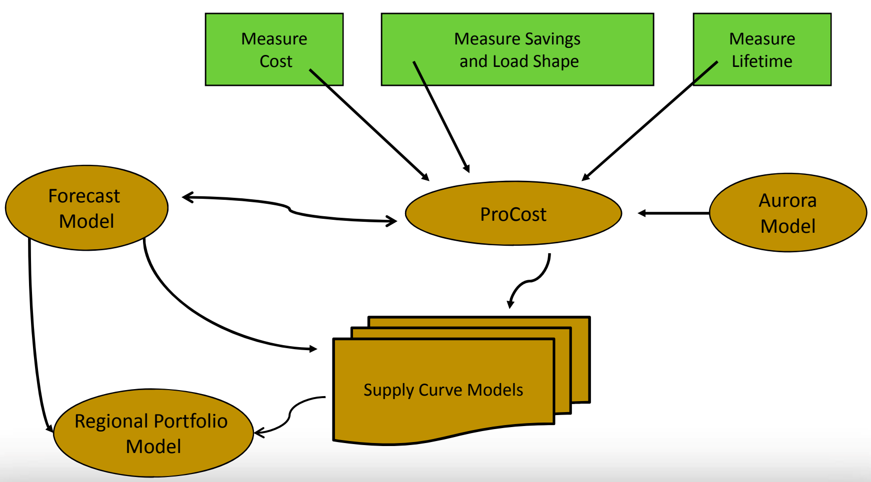
Cost Issues

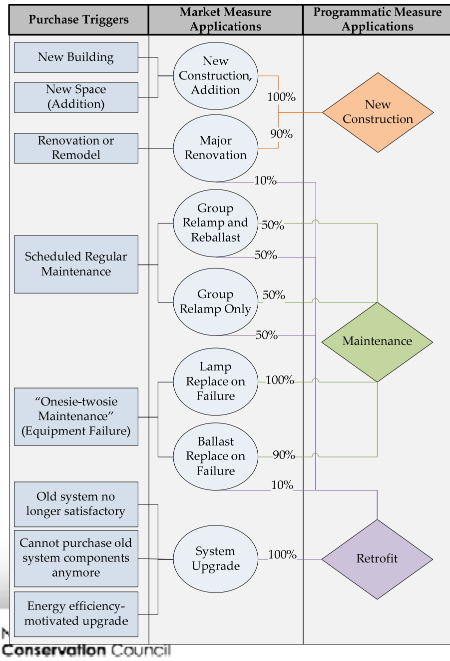
- Are "All Costs" captured?
- Treatment of tax credits for efficiency
- What non-electric benefits to include
  - YES: Direct & Quantifiable (water savings)
  - NO: Comfort, Noise reduction, Reduced absentee
  - MAYBE: Health benefit?
- Forecast cost increases or decreases?
  - Generally not
  - YES, if changing fast (Solid State Lighting)

Ramp Rate Issues

- Uncertainty predicting program uptake
- Staff & Advisory Committee input

Models Used for Estimating Conservation Resource Potential

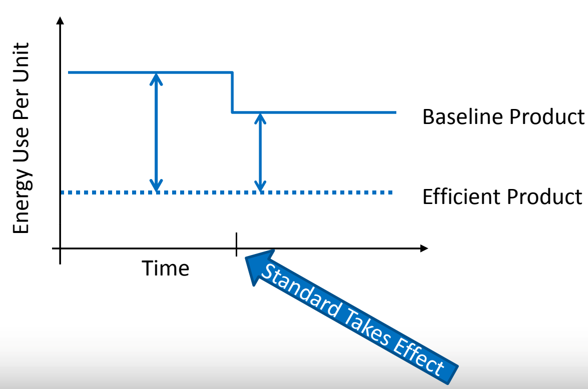




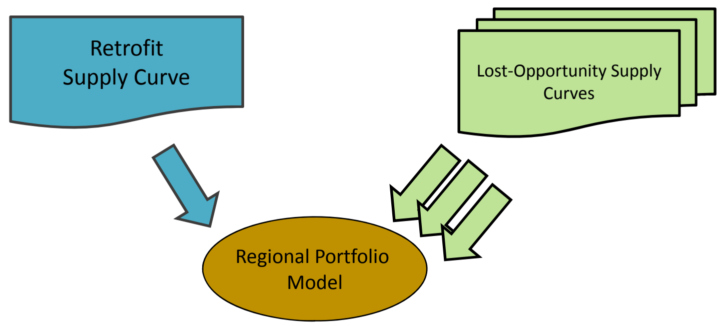
Setting Baseline Can Be Complex: Lighting Market

- Multiple sub markets
- Multiple purchase events in each market
- Separate baselines each segment
- **Need to track both efficiency and unit count for each market segment**

Both Electricity Demand & Savings Potential Decrease As A Result of Normal "Stock Turnover"



Separate Curves Are Created for Lost-Opportunity & Retrofit Measures Due to Differences in Limits to Deployment



Mid-C Historical Power Prices

2013 Monthly Prices