Primer on Conservation Potential Assessment Methodology

October, 2014

Agenda

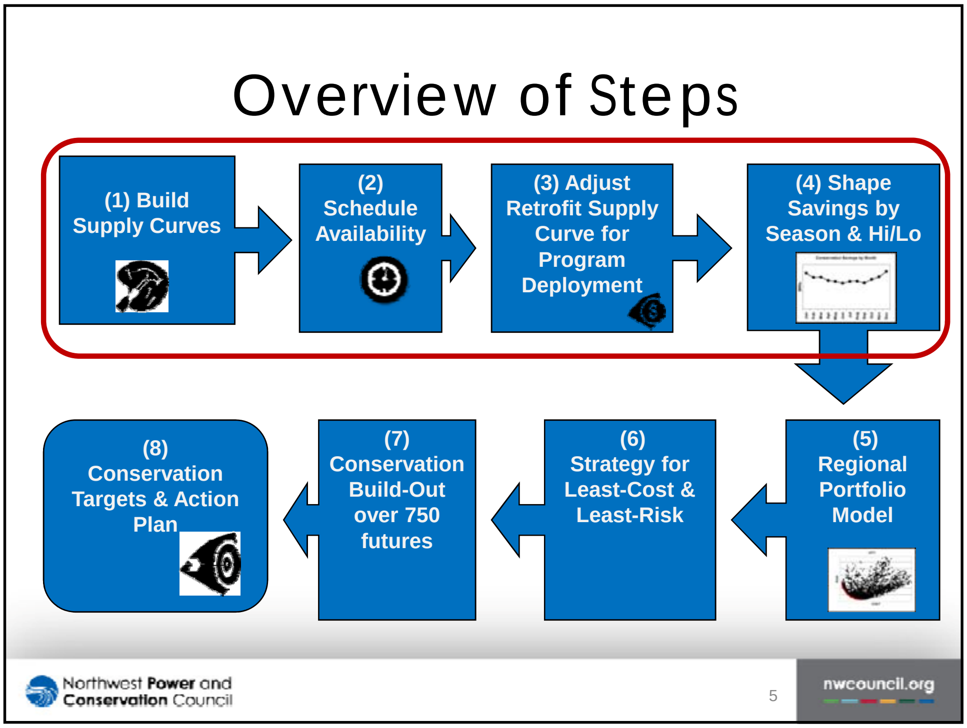
- Some Terms We Use
- Methodology Overview
- Step Through Methodology
- Identify Issues

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)


Overview of Steps
(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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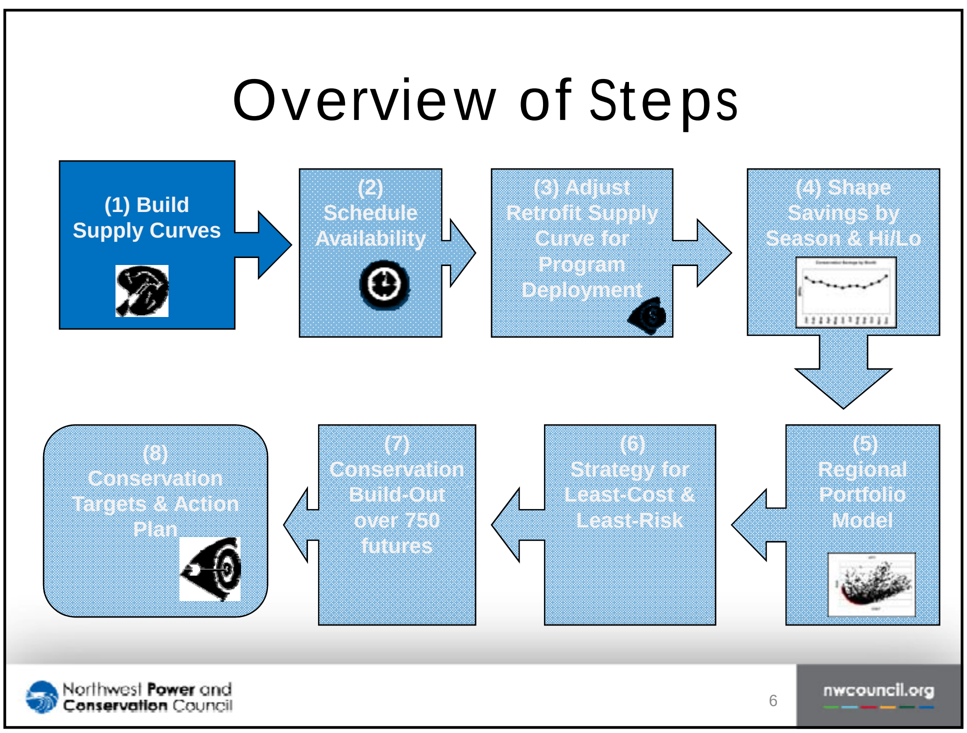
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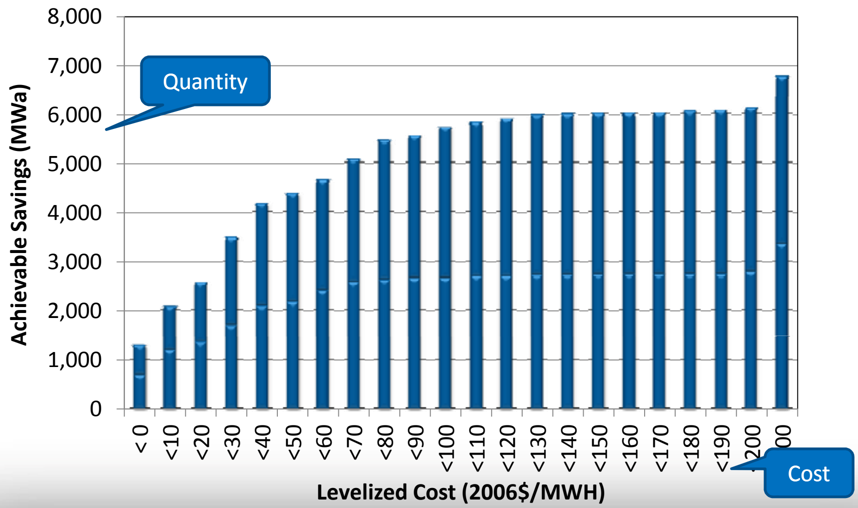
Supply Curves Show How Much Savings Are Available At What Cost



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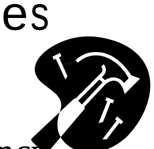
Steps in Building Supply Curves



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

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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

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

Measure Life Issues:
- Persistence of behavioral measures

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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)

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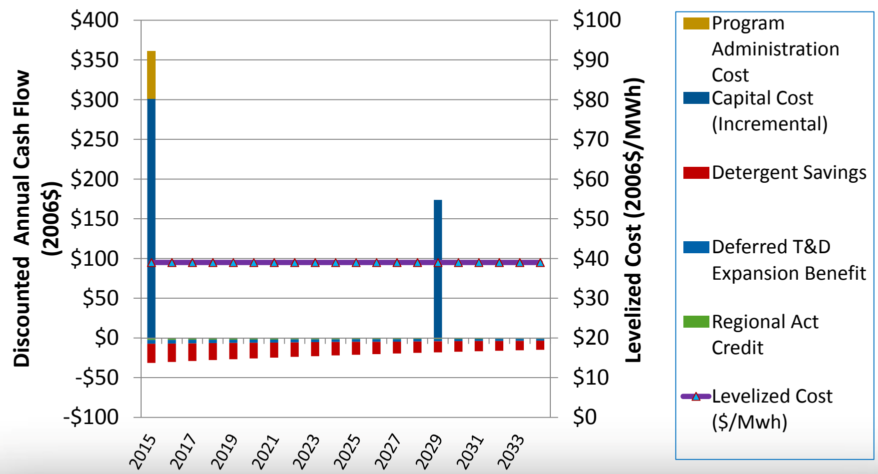
Discounted Costs & Benefits Over 20 Years
Energy Efficient Clothes Washer



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

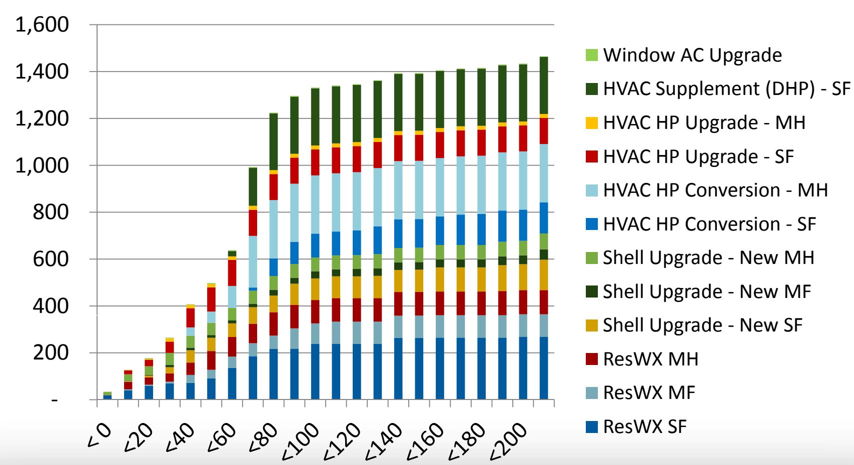
Examples of Units

- 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)

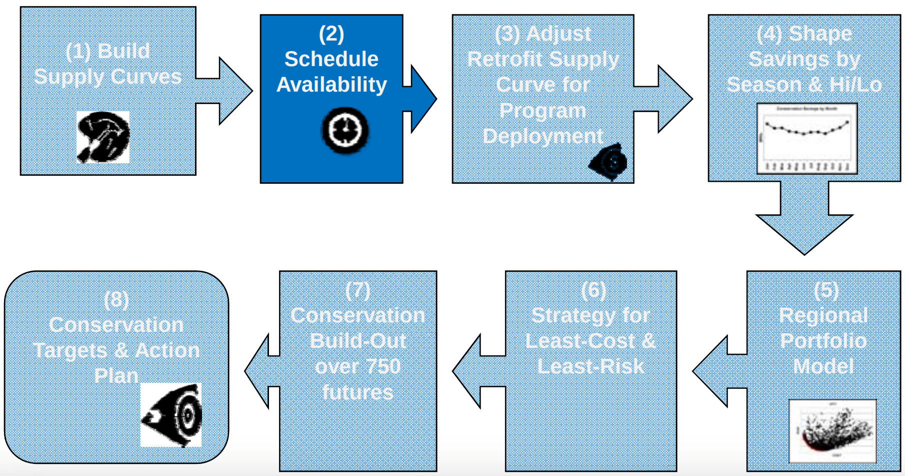
Data Sources:
- Council forecast models
- DOE Rule makings
- Manufacturers data
- Stock assessments (RBSA, CBSA, IFSA)

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

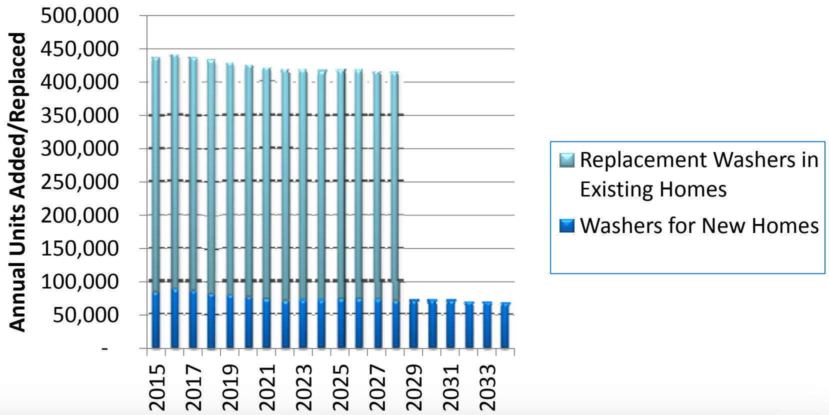
Natural Replacement
- Burn-out
- Remodel
- Market shifts

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



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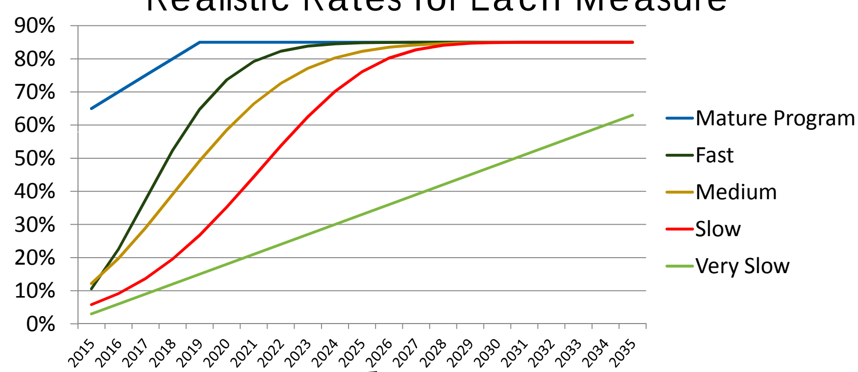
Maximum Program Ramp Rates
Realistic Rates for Each Measure



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

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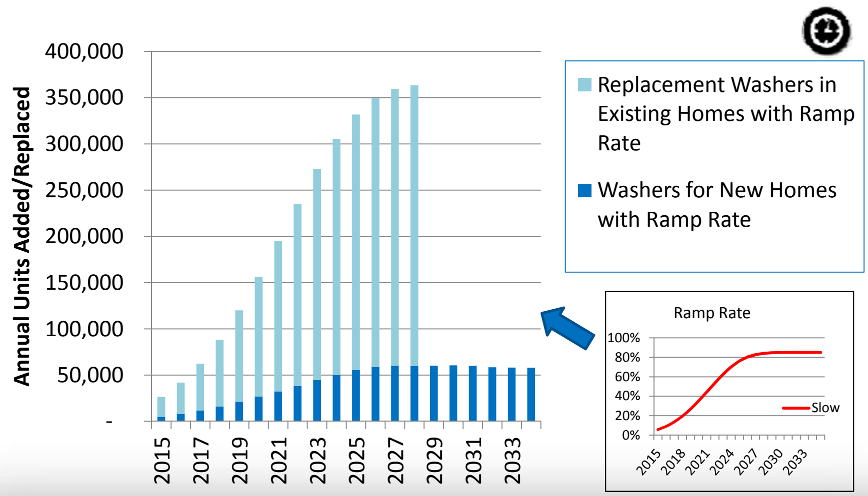
Available Stock COMBINED with Ramp Rates Determines Maximum Availability Schedule



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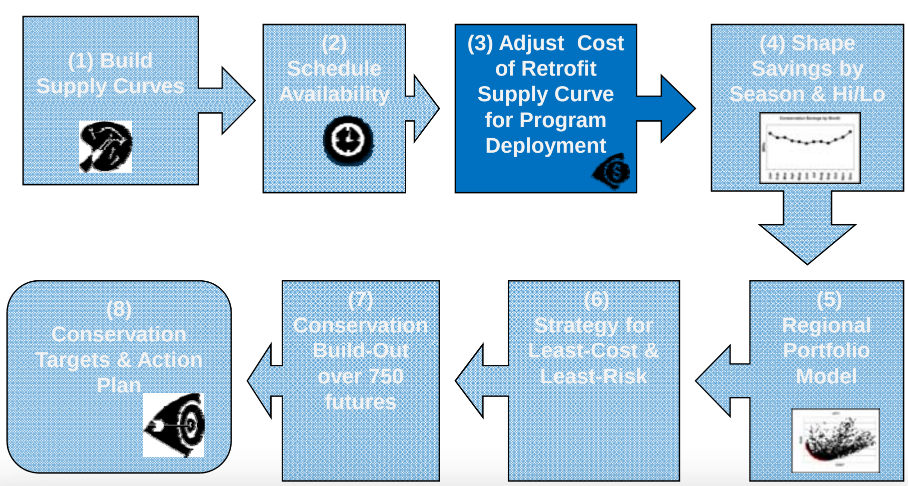
Overview of Steps



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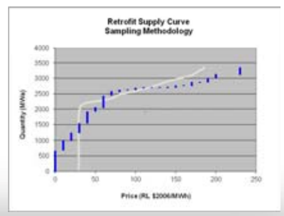
Adjustments to Cost of Retrofit Curve to Reflect Program Deployment

- Try to represent realistic program acquisition costs
- Portfolio Model acquires lowest-cost resources first
- But, real world programs don't acquire only 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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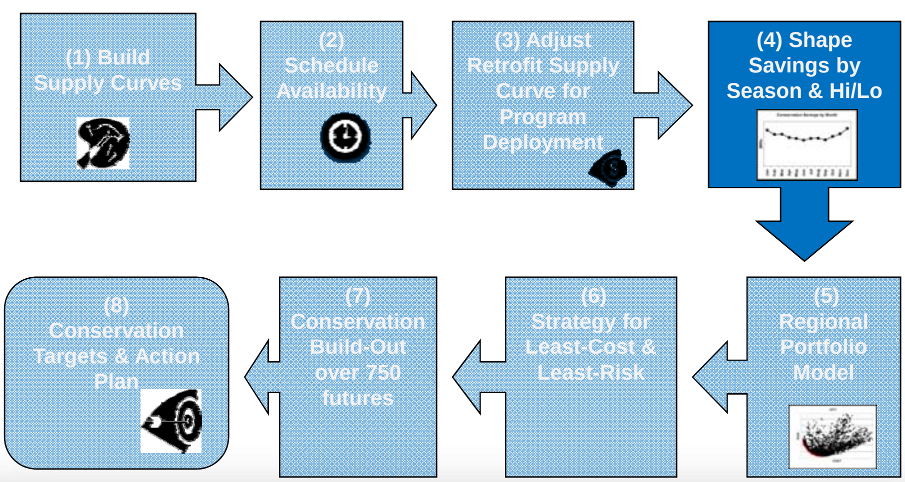
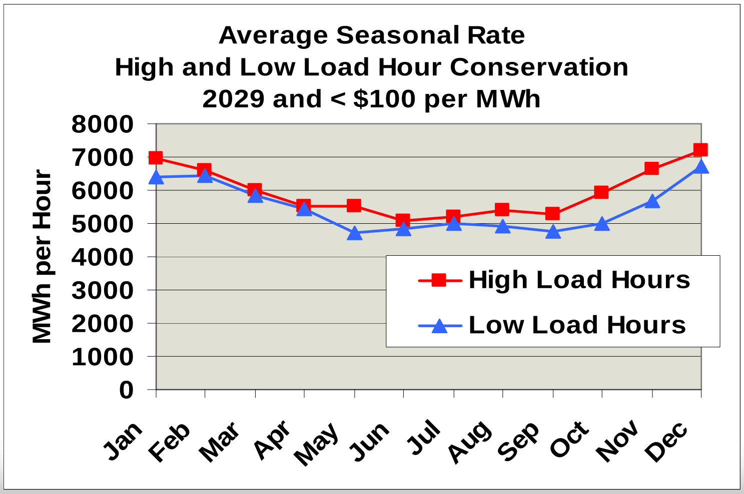
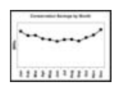


Shape the Savings
by Season & High/Low Load Hours



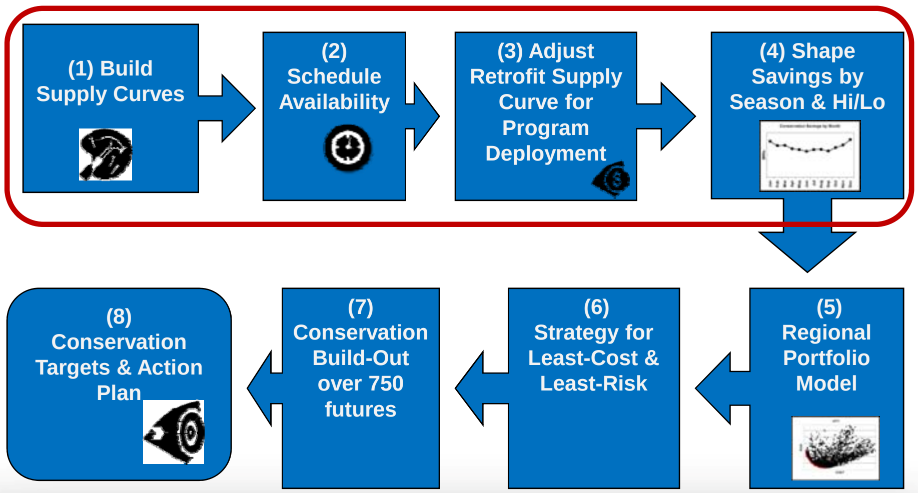
Reflect Time of Savings for Energy and Capacity



- 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)

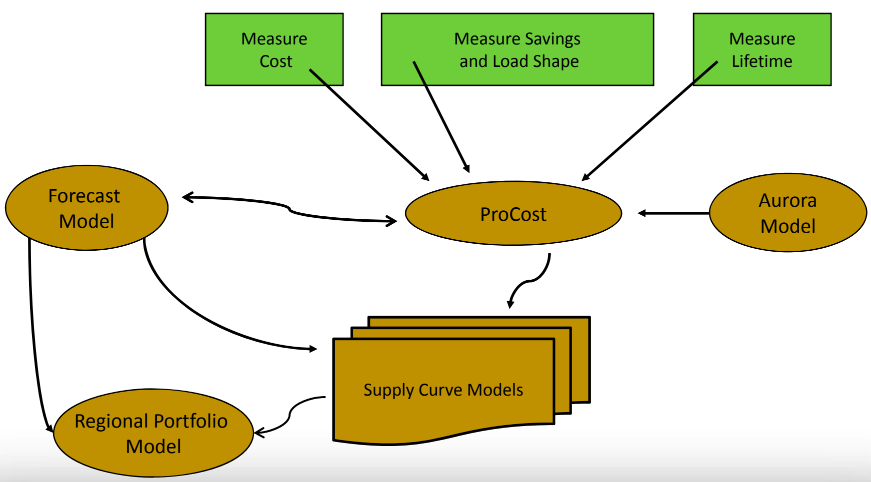
Cost Issues

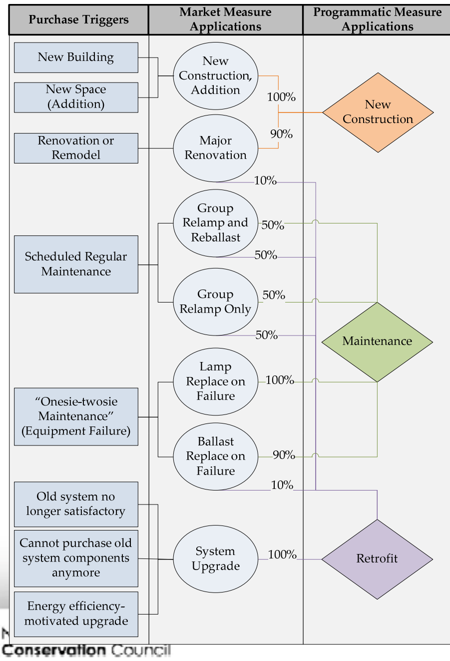
- Are "All Costs" captured?
- Treatment of tax credits for efficiency
- What non-electric benefits to include
  - YES: Direct & Quantifiable (water savings)
  - NO: Comfort, Noise reduction, Reduced absentee
  - MAYBE: Health benefit?
- Forecast cost increases or decreases?
  - Generally not
  - YES,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

Ramp Rate Issues

- Uncertainty predicting program uptake
- Staff & Advisory Committee input

Models Used for Estimating Conservation Resource Potential

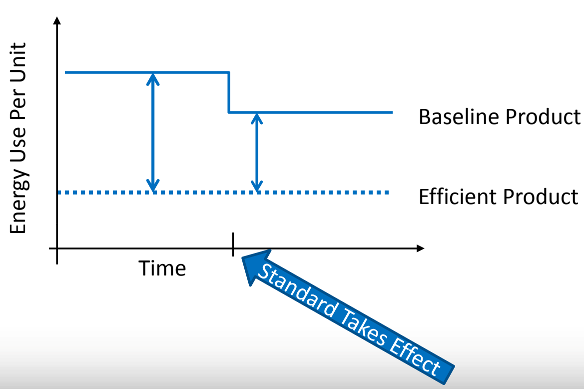




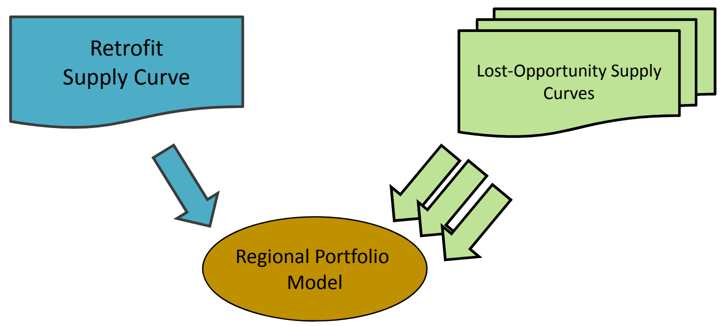
Setting Baseline Can Be Complex: Lighting Market

- 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