Northwest **Power** and **Conservation** Council

10 March 2020

MEMORANDUM

TO: **Power Committee Members**

FROM: **Kevin Smit, Tina Jayaweera, Charlie Grist**

SUBJECT: **Draft Energy Efficiency Curves for 2021 Plan**

BACKGROUND:

Presenter: Charlie Grist, Tina Jayaweera, Kevin Smit

Summary: As part of development of the 2021 Plan, staff is developing energy efficiency (EE) supply curves that provide levelized cost (dollar per megawatt-hour) and savings (average megawatts) for each energy efficiency measure. These will be used as an input for the Regional Portfolio Model for doing scenario analysis. These supply curves will be finalized by March 31, 2020.

In developing the EE supply curves, staff has been working closely with the conservation resources advisory committee (CRAC) for advice regarding key underlying assumptions and direction regarding specific measures or categories of measures. Staff has also sought technical input from the Regional Technical Forum (RTF) as well as utilized the support of the RTF contract analysts. In addition, Bonneville has hired multiple consultants to conduct significant detailed review of each of our measure workbooks. The EE staff have also convened smaller groups of subject matter experts where additional technical expertise and advice are needed.

To date, the EE staff have developed over 90 individual measure workbooks containing thousands of individual energy efficiency measures.

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The presentation will show preliminary aggregated results. The presentation will summarize EE achievable potential by sector (Residential, Commercial, Industrial, Agriculture, and Distribution System) and will highlight new EE potential relative to the Seventh Power Plan. The supply curve details will continue to be revised through the end of March as the EE team addresses reviewer comments.

Relevance: Development of inputs for the 2021 Power Plan

Workplan: Power Division A.1: Develop the 2021 Power Plan: Conservation

More Info:

EE Supply Curve Workbooks Undergoing Public Review:
https://www.nwcouncil.org/energy/energy-advisory-committees/conservation-resources-advisory-committee

Summary of CRAC Decisions as of December 2019:
https://nwcouncil.box.com/s/rqr7defydc5684q1jkhonc3gvdc57xqq

Draft Conservation Supply Curves for the 2021 Power Plan

Power Committee Meeting

March 17-18, 2020

Charlie Grist, Tina Jayaweera, Kevin Smit

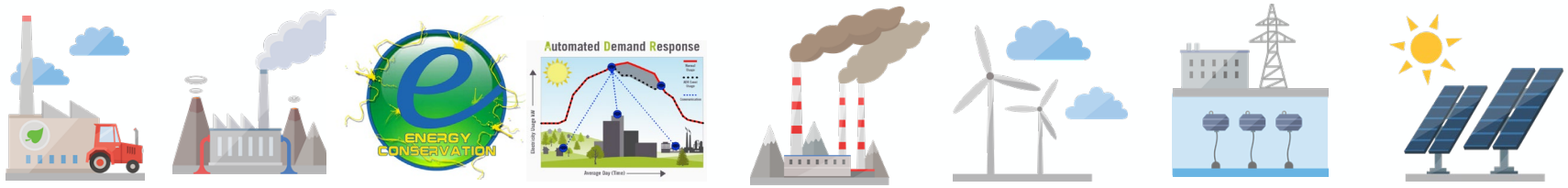
THE 2021
NORTHWEST
POWER PLAN
FOR A SECURE & AFFORDABLE
ENERGY FUTURE

Agenda

- Background
- Approach
- Process – Review and Collaboration
  - CRAC Meeting Key Issues summary
- Results by Sector
- Overall Supply Curve

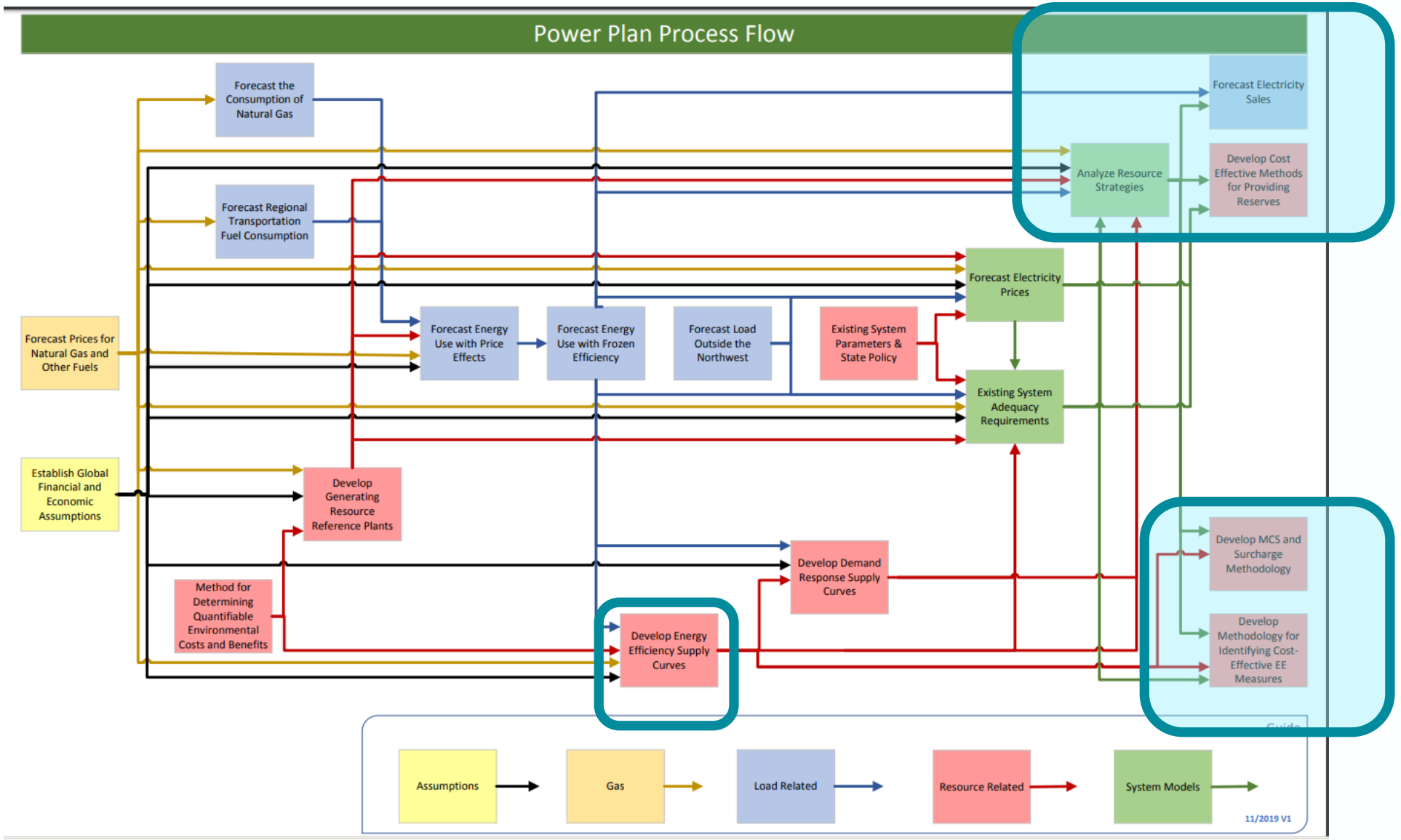
NOTE: All values presented are DRAFT. The review and revision process will continue through the end of March 2020.

Context:
Energy Efficiency as a Resource

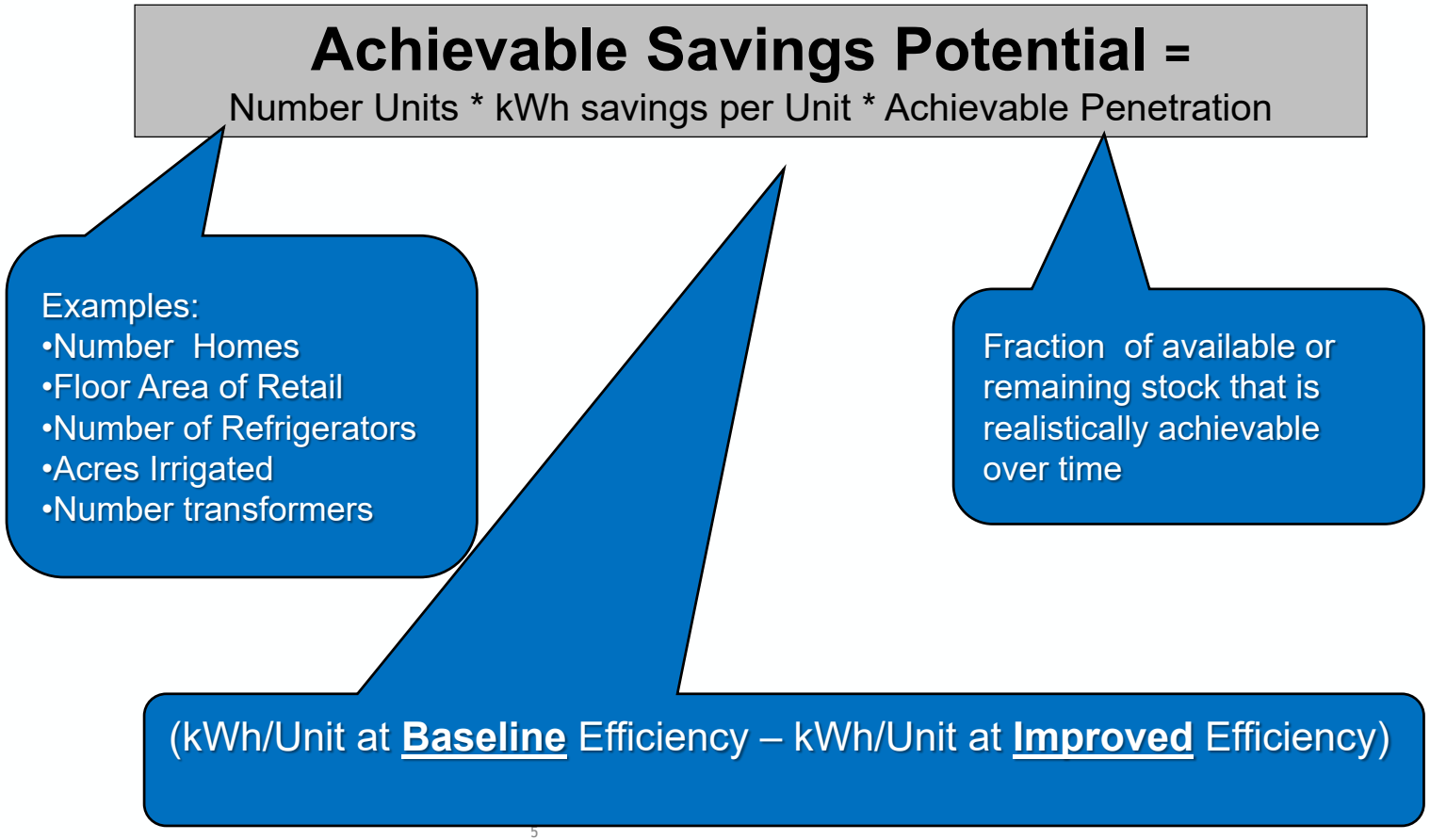


Need to Assess:

Amount Energy & Capacity, Cost, Pace

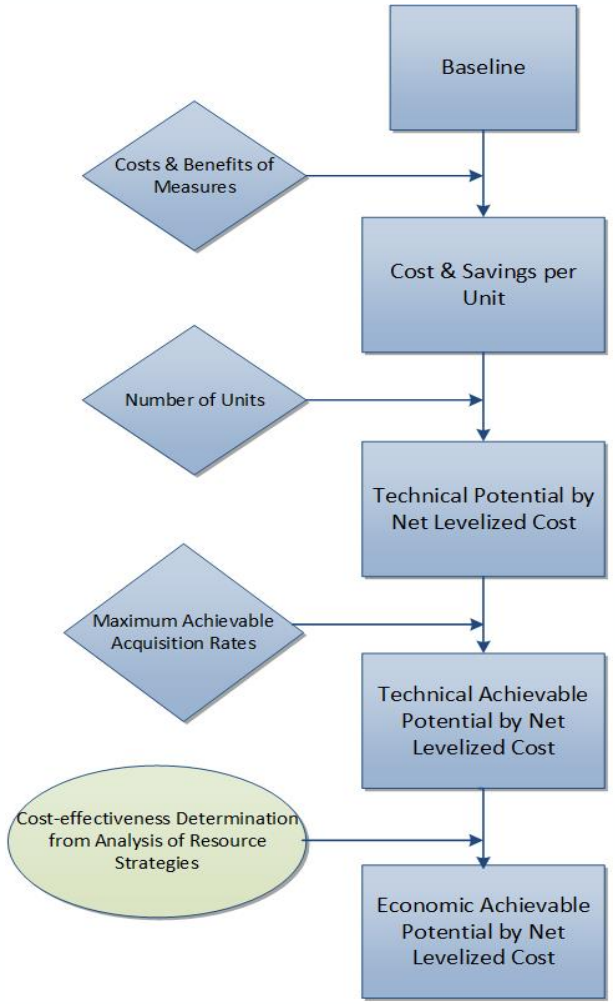

Power Plan Process Flow
Forecast the Consumption of Natural Gas
Forecast Regional Transportation Fuel Consumption
Forecast Prices for Natural Gas and Other Fuels
Establish Global Financial and Economic Assumptions
Method for Determining Quantifiable Environmental Costs and Benefits
Develop Generating Resource Reference Plants
Forecast Energy Use with Price Effects
Forecast Energy Use with Frozen Efficiency
Forecast Load Outside the Northwest
Existing System Parameters & State Policy
Develop Energy Efficiency Supply Curves
Develop Demand Response Supply Curves
Forecast Electricity Prices
Existing System Adequacy Requirements
Analyze Resource Strategies
Forecast Electricity Sales
Develop Cost Effective Methods for Providing Reserves
Develop MCS and Surcharge Methodology
Develop Methodology for Identifying Cost-Effective EE Measures
Assumptions
Gas
Load Related
Resource Related
System Models
11/2019 V1

The Basic Formula for Savings Potential



How do we develop energy efficiency supply curves?

1. Baseline
   - Identify measures that save electricity
   - Establish the measure's "baseline" consumption (i.e., what the measure is compared against)
2. Cost & Savings Per Unit
   - Estimate incremental electricity & capacity savings per unit
   - Estimate incremental costs & benefits per unit
   - Estimate measure life
3. Technical Potential
   - Calculate cost per kWh saved
   - Calculate number of units available
   - Multiply unit savings and cost by the number of units
4. Technical Achievable Potential
   - Apply achievability limits
   - Ramp rates



Identify Measures for Supply Curves

- Residential, Commercial, Industrial, Agriculture, Utility
- Nearly 100 Measure Workbooks
  - Buildings
  - Appliances & Equipment
  - Processes
  - Behavior
- Over 2400 measure permutations
  - By climate zone, vintage, heating system type
  - Items that change incremental cost or savings

Develop Cost & Savings per Unit

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

Capacity Benefits (kW)
- Deferred distribution and transmission line expansion cost ($/kW-yr) where coincident with system peak
- System peak impact

Measure Life
- Expected lifetime of the measure

Costs
- Capital & Financing
- Labor
- Program Administration
- Operations & Maintenance
- Reinstallation Cost

Non-Electric Impacts
- Water use changes
- Gas use changes
- Operations & maintenance
- Lamp replacements
- Quantifiable Environmental Impacts

Measure Interaction & Overlap
- Savings in one measure impact another
- No double counting

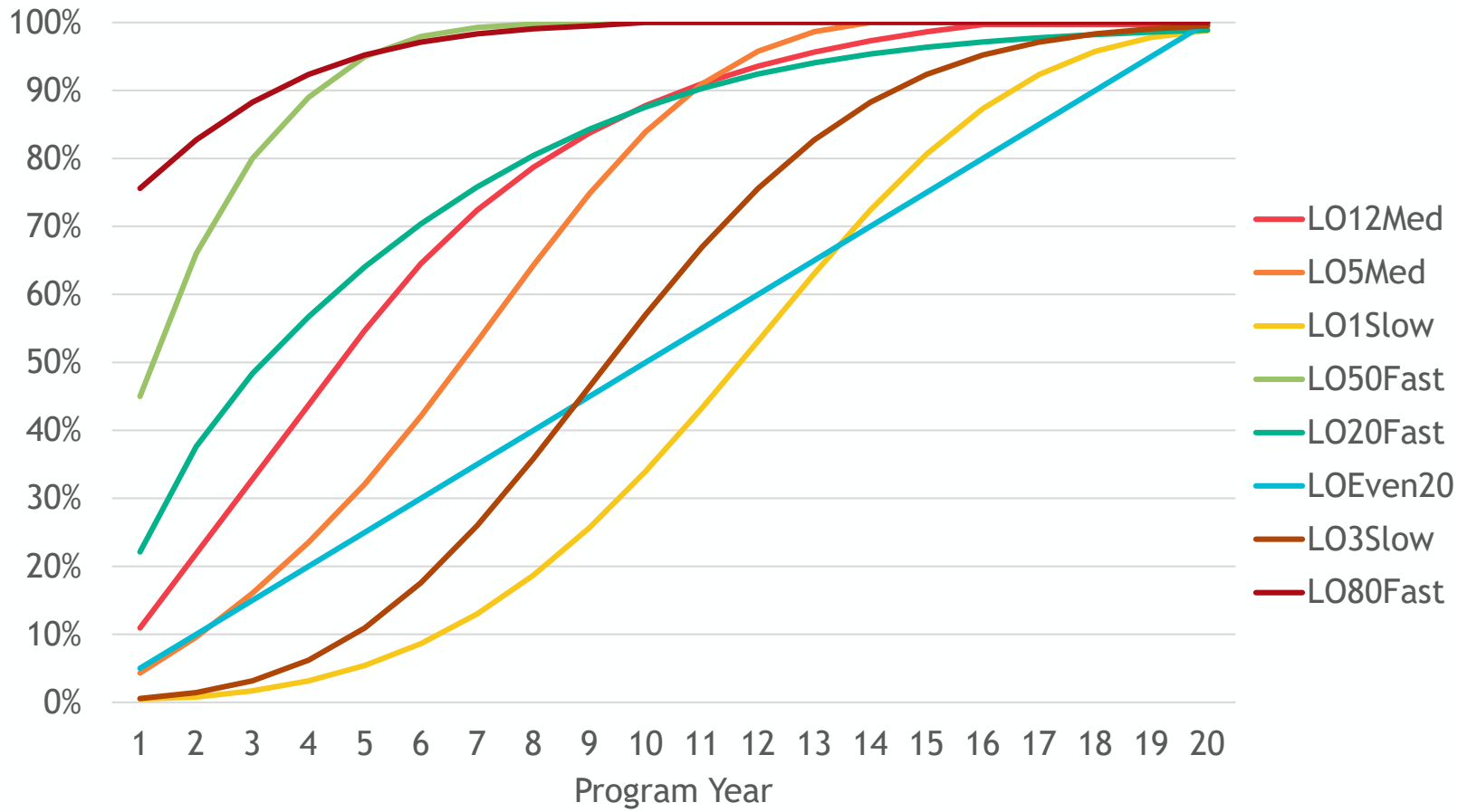
ProCost

Convert annual cash flow of costs & benefits to discounted constant cost per unit of savings (levelized cost in $/MWh)

And other metrics – winter & summer capacity (kW)

Estimate Annual Availability & Pace of Acquisition

Depends on Ramp Rates & Turnover



Data Sources

- Residential Building Stock Assessment
- Commercial Building Stock Assessment
- Industrial Segment Research
- Regional Organizations
  - Regional Technical Forum
  - Northwest Energy Efficiency Alliance
  - Bonneville Power Administration
  - Energy Trust of Oregon
  - Regional Utilities
  - US Department of Energy
  - US EPA (ENERGY STAR)
  - Pacific Northwest National Labs
  - State Energy Offices
- Contractors and Consultants
  - Consulting firms, trade allies, program delivery contractors

Decisions Reviewed with the CRAC

Subject	Summary Decision	Link
Resource Cost Framework	Living matrix of rationale and approach to incorporate quantifiable costs for 28 cost categories including NEIs	QRC Memo QRC Matrix
Environmental Methodology (Applies to new resources)	Use cost of regulatory compliance. Use qualitative approaches for residuals, unregulated impacts,& most benefits. (eg: water quantified—wood smoke not)	EM Memo
Climate Change	Incorporate impacts as baseline conditions—both direct (temperature & precipitation) and indirect (population & industry shift)	CC Memo CC & Load Pres
Discount Rate	Blended WACC of resource decision makers (3.75% real)	Disc Rate DR Workbook
T&D Deferral	Revised method & updated source data—Values significantly lower	T&D Deferral
Admin Cost Percentage	Retain previous—use single estimate for all measures set at 20% of measure incremental cost	Admin & Max
Maximum Achievable EE	Do on measure-by-measure basis. Can exceed 85% used previously.	Admin & Max

Specific Issues Reviewed with the CRAC

- Modeling Approaches
  - RPM modeling; Development logic, bundling, kW impact
  - Impact of state and federal legislation, codes, standards
  - Incrementalism
- Measure-specific (selected)
  - Commercial and Industrial Fans and Pumps
  - Strategic Energy Management
  - Conservation Voltage Reduction; CVR/DVR
  - Lighting Methodology & Approach
  - Behavioral Measures
  - Ductless Heat-Pump Controls Optimization

Development and Review Process

RTF

Start with all RTF measures

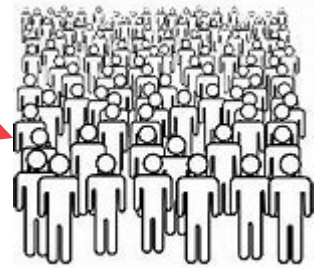
Jennifer and Annika help coordinate with RTF and RTF Analysts

Photo of Charlie, Tina, and Kevin circa summer 2019

EE Staff Develop Measures:

- savings, cost, life
- Units, applicability, turnover, achievability, ramp rates

LBL, PNNL,DOE, NEEA, ETO, BPA, EPA–ENERGY STAR, TRMs, Universities



Public Review of Workbooks

BPA & Consultants

Advisory Committees and Ad Hoc Expert Groups

Consultants

Highlights of EE Supply Curves for 2021 Plan

- *Following Charts are DRAFT results
- **Still developing workbooks
- ***Still getting outside review
- ****Some climate change incorporated

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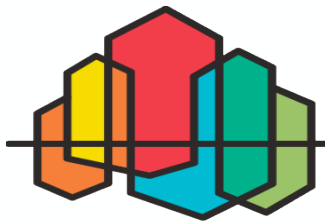
Summary Results

	20-Year Achievable Potential (aMW) (all cost bins)		Winter Peak MW	Summer Peak MW
Sector	7th Plan	2021 Plan PRELIMINARY	2021 Plan PRELIMINARY	2021 Plan PRELIMINARY
Residential	2,328	2,444		
Commercial	1,871	1,255		
Industrial	580	871		
Utility	218	232		
Agriculture	126	70		
Grand Total	5,123	**4,872**	**8,230**	**9,290**



Residential

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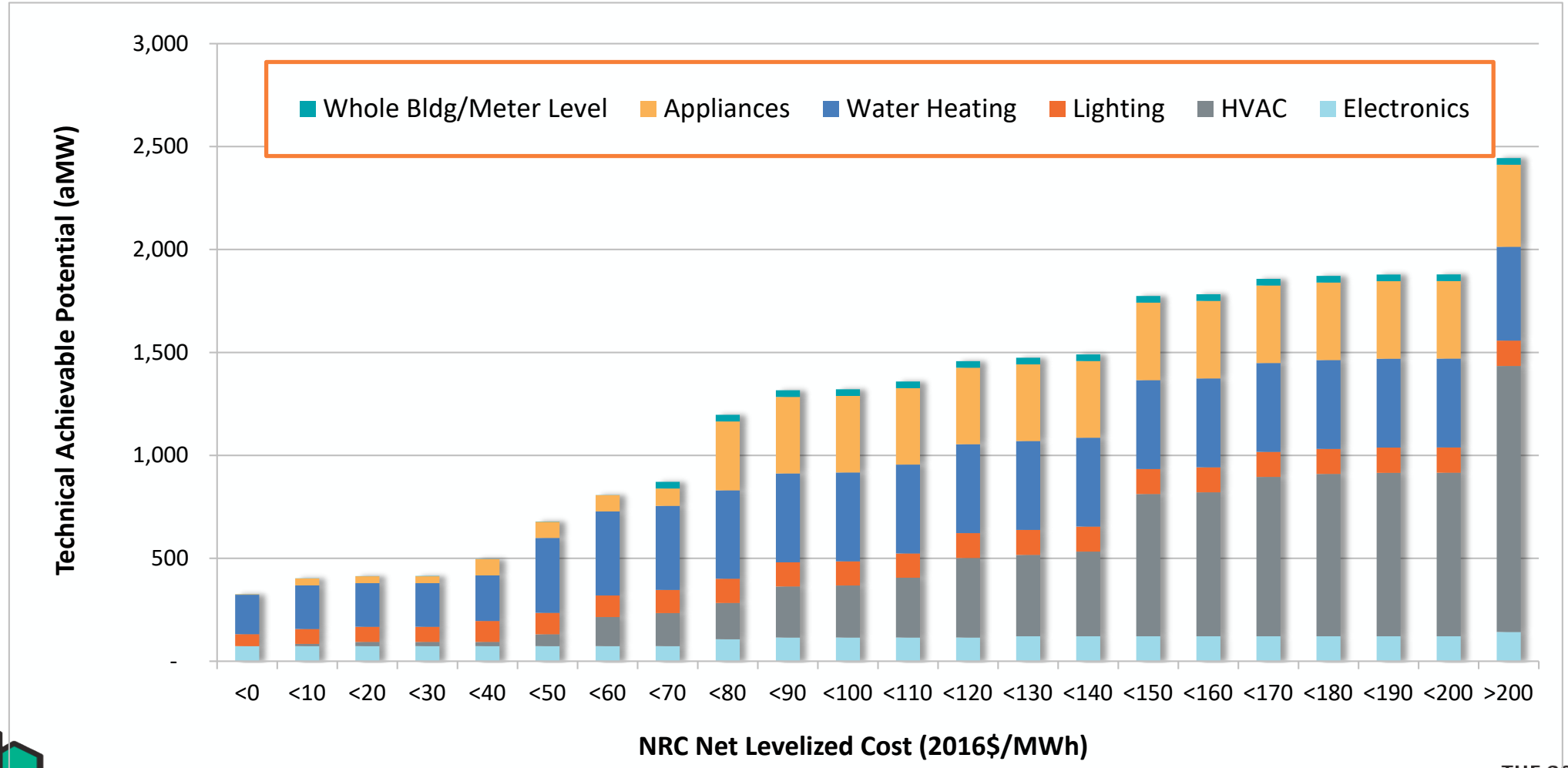
Residential Sector



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Key Findings - Res

End Use	Achievable Potential 2041 (aMW) All Cost Bins	Drivers of Changes
Lighting	123	LEDs market share, Washington standard, new fixture measures
HVAC (weatherization & equipment)	1292	Additional measures (e.g. central AC) and updated analysis. Many are high cost
Water Heating	455	Savings decrease across most measures, Washington standard for showerheads, aerators
Dryers	295	Lots more work on heat pump dryers (though slow ramp rate)
Electronics, Cooking, Behavior	278	Few new measures, updated savings
Total	2,444	New Residential Building Stock Assessment

Commercial

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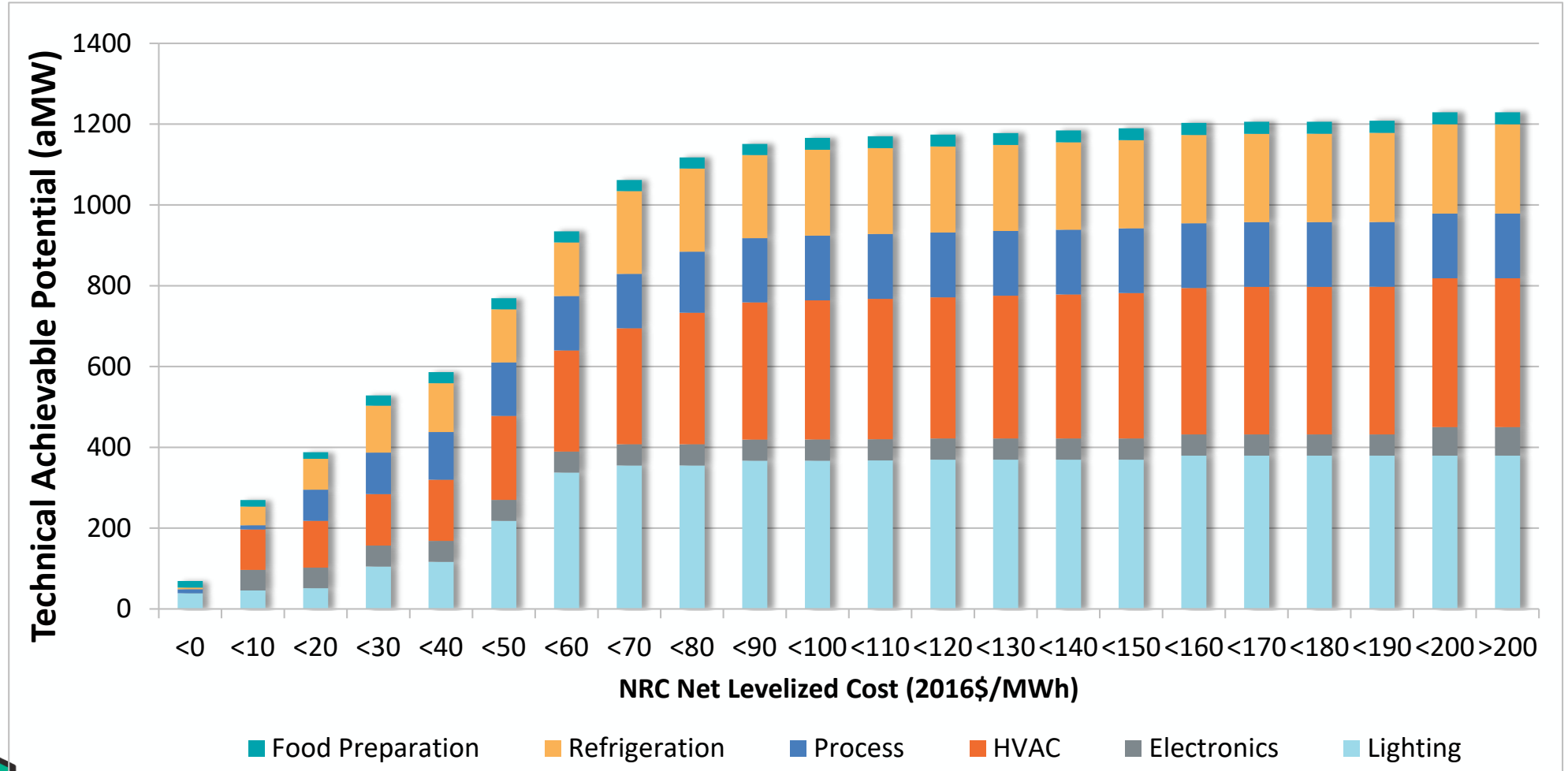
Commercial Sector Supply Curve



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Commercial Potential by Category

Commercial Measure Categories	Achievable Potential 2041 (aMW) - All Cost Bins	Notes
Lighting	389	LED lighting & controls for indoor, exterior, street & roadway applications
HVAC	378	Efficient Fans and Variable Speed Drives, VHE-DOAS (NEEA Research), Strategic Energy Management, Ductless Heat Pumps, and Variable Refrigerant Flow
Refrigeration	226	Grocery Refrigeration (BPA Emerging Tech Research), Water Cooers, Icemakers, Vending
Motors/Drives	100	Pumps (VS Drives, Optimization) – data from DOE standards rulemaking
Electronics	70	Embedded data centers, primarily Servers
Other	91	Engine Block Heater Controls, Circulation Pumps, Heat Pump Water Heaters
Total	**1255**	**Total**

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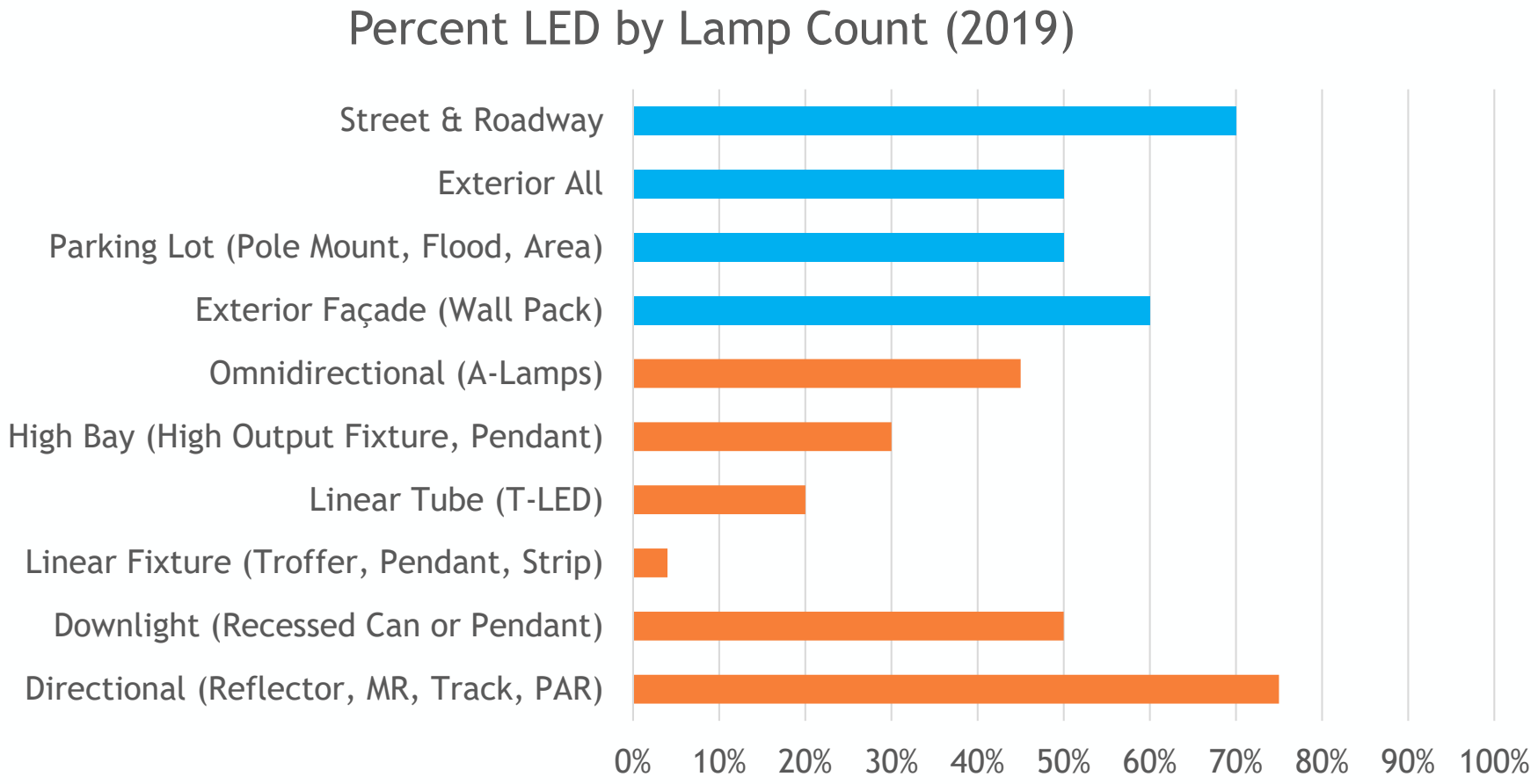
Commercial Lighting: Rapid LED Adoption



In 7P LED adoption was less than 5% - except for Street & Roadway

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Commercial: Embedded Data Centers

- Embedded Data Centers Only
  - Excludes Enterprise & Cloud DC where EE is in the forecast
- Large shift towards efficiency underway since 2014
  - Virtualization, consolidation, more efficient servers
- Complete re-vamp of conservation potential
  - Focus on efficient servers (New Energy Star™ specification 3.0)
  - Efficient servers cut server power by 18% – 25%
  - Added savings from lower HVAC requirements

49 aMW savings by 2041 at $7/MWh

Industrial

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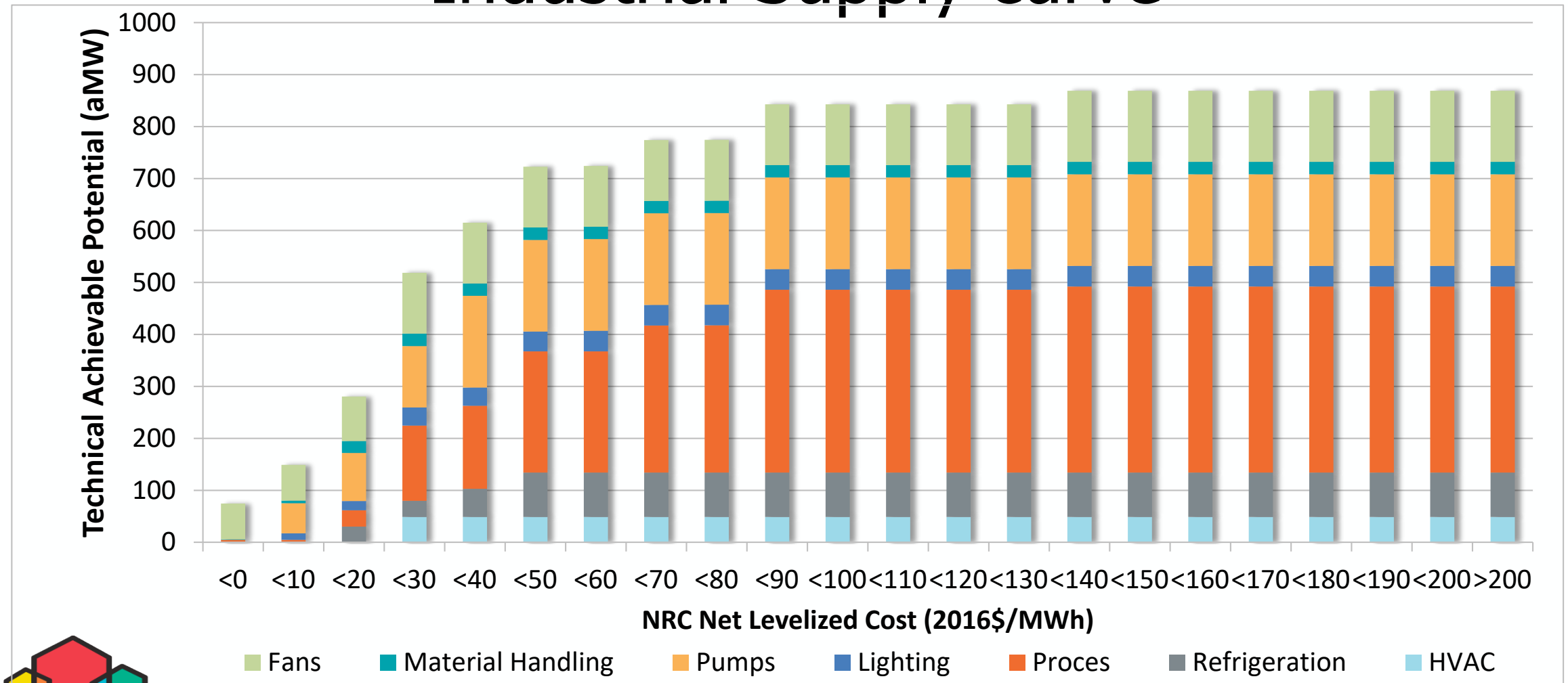
Industrial Supply curve



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Industrial Potential By Category

Industrial Measure Categories	Achievable Potential 2041 (aMW) All Cost Bins	Notes
Pumps	176	New pump research based on NEEA and DOE Standards data – Variable speed, trim, optimization
Strategic Energy Management	161	Based on regional program evaluations
Fans and Blowers	137	Significant new research – NEEA and DOE standards
Compressed Air	96	
Refrigeration	85	
Water/Wastewater	60	Significant revision based on project data
Other	156	

Other includes Material Processing and Handling, HVAC, Lighting*

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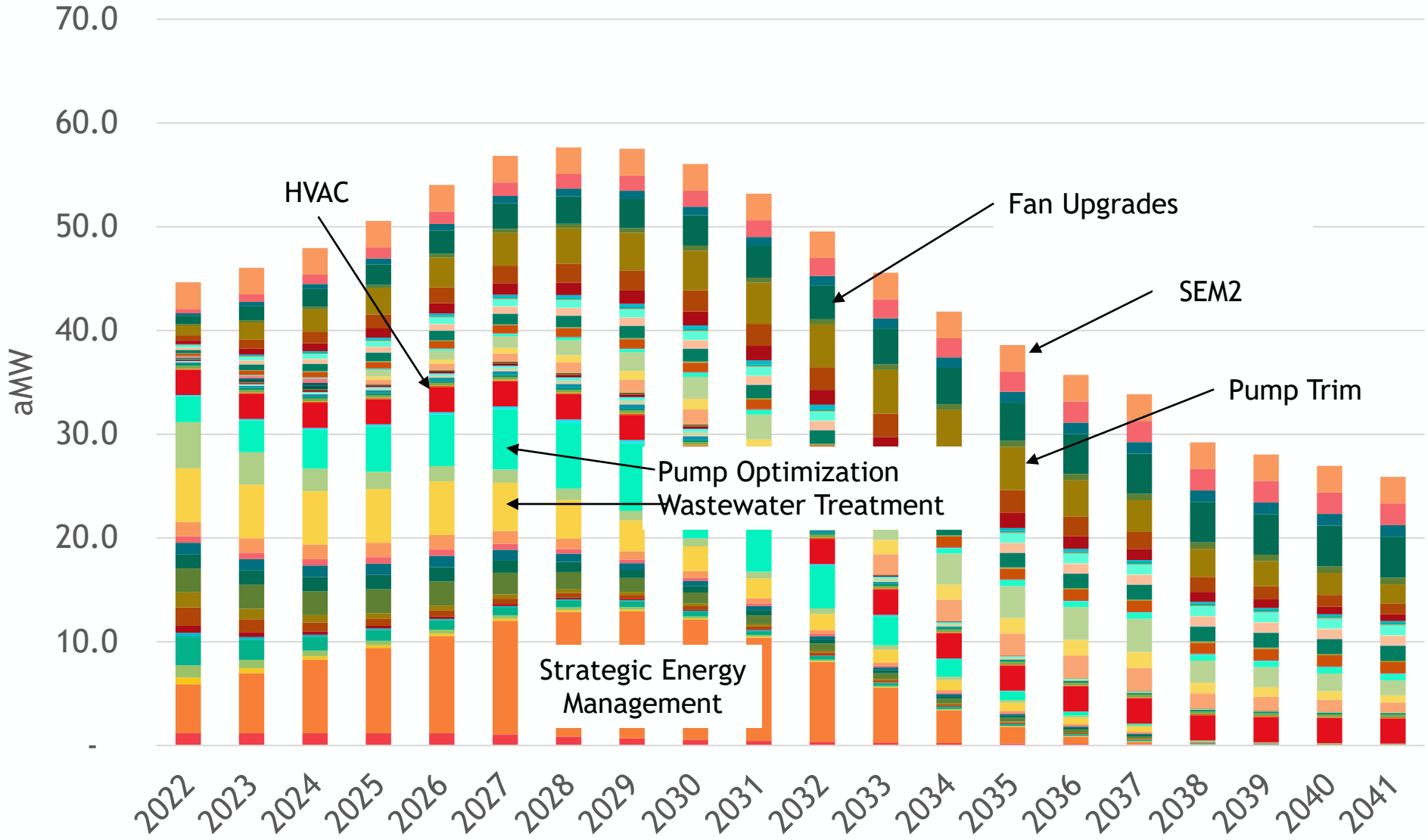
Industrial Annual Incremental Achievable Potential 2022-2041



Note: Average achievements 2010-2018 = 47 aMW per yr

Agricultural

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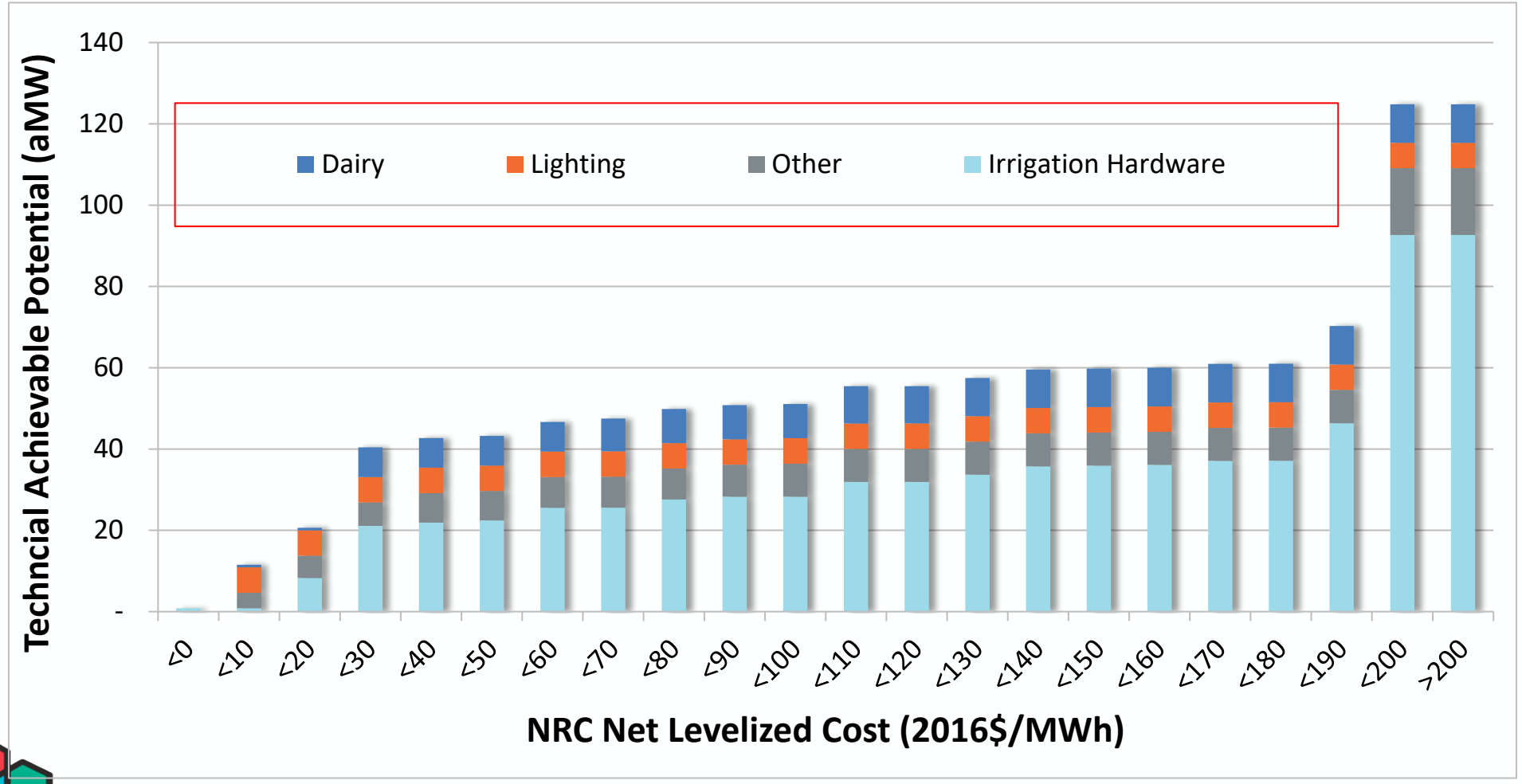
Agricultural Sector



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Key Findings - Ag

End Use	Achievable Potential 2041 (aMW) All Cost Bins	Drivers of changes
Irrigation Hardware/ Efficiency	46	Savings analysis, additional measures including Variable Rate Irrigation
Irrigation Water Management	0	Scientific Irrigation Scheduling no longer included – found to be standard practice
Lighting	6.3	Higher LED saturation
Dairy	9.5	More measures, including fans
Stock tanks, block heaters, motor	8.2	Additional measures
Total	70	New Census of Agriculture

Utility

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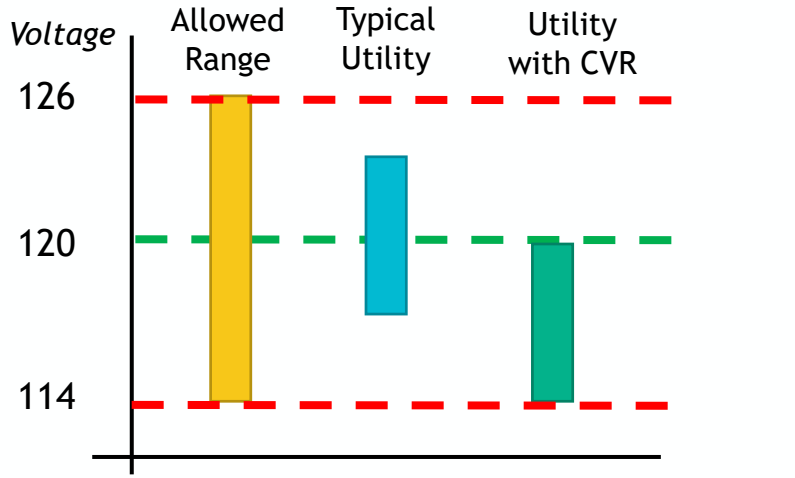
Distribution Efficiency: Conservation Voltage Reduction (CVR)

What is CVR?

- Distribution system equipment settings and/or upgrades can save energy by reducing line voltage and balancing line loading while still maintaining adequate power quality
- Energy savings come from reduced losses and lower consumption from some (but not all) devices



CVR: Conservation Voltage Reduction

Major Changes in 2021 Plan

1. Much better estimate of substation count
2. Bottom-up cost approach
   - Seventh Plan: Cost per substation, large and small, with costs from 15-year-old study
   - 2021 Plan: Cost per asset, estimate of assets on an urban vs. rural feeders, and resistive versus inductive load
3. Applies to small amount of industrial load
4. Generalized basis voltage drop (dV) & CVR factor (CVRf)

Substantial input from distribution system engineers at Bonneville and regional utilities

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Distribution Efficiency: Initial Outcomes

In simple terms, dividing total savings (MWh) by total costs ($) results in comparable findings (within ~10%) between the Seventh and 2021 Plans

Seventh Plan:
Region:
Savings: ~2M MWh
CapEx: ~$725M
O&M: ~$3.75M

2021 Plan:
Region:
Savings: ~1.6M MWh
CapEx: ~$630M
O&M: ~$31.5M

Savings Potential: ~230aMW by 2041 at cost of $23 to $60/MWh

Summary

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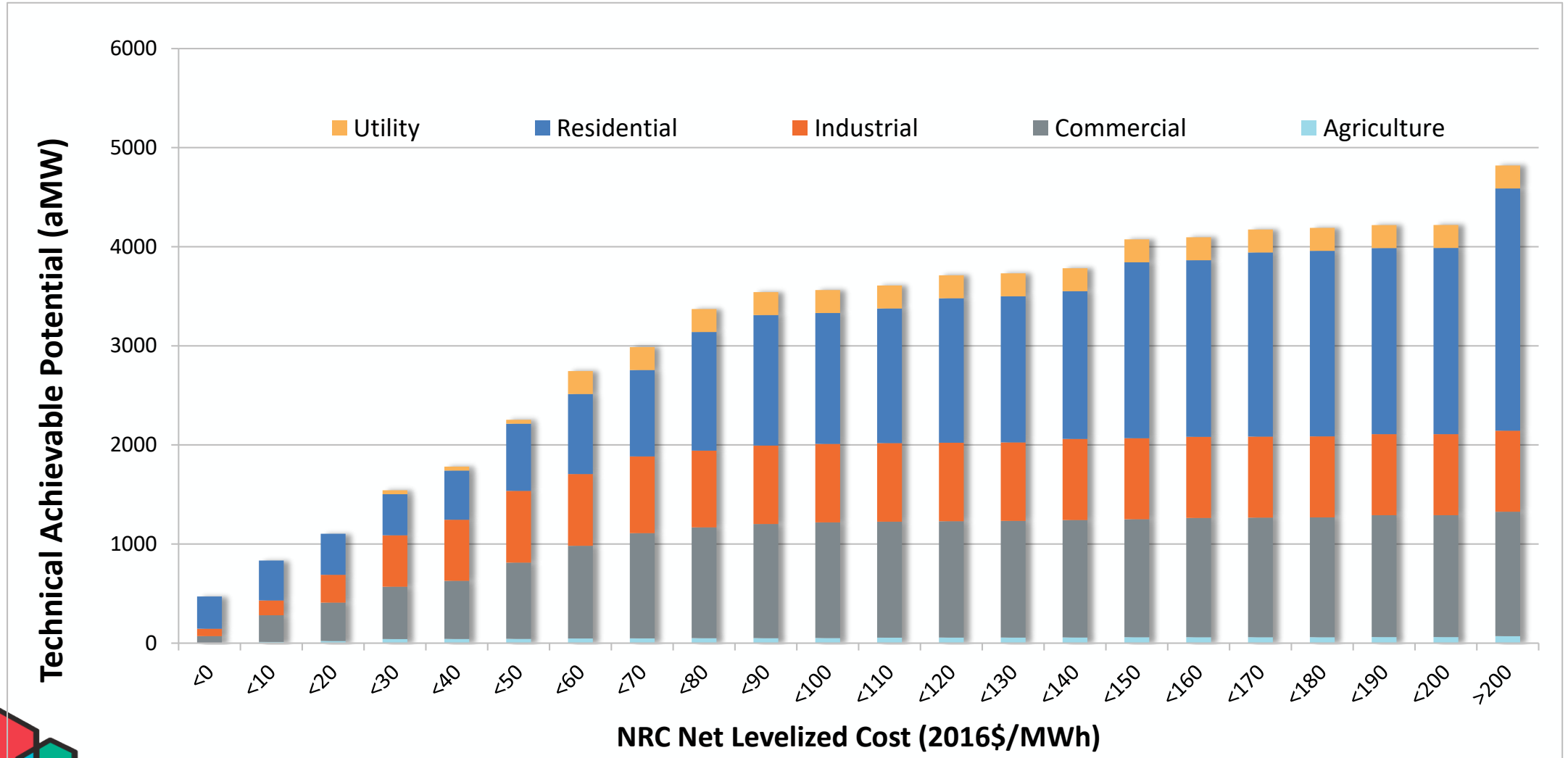
Aggregate Supply Curve



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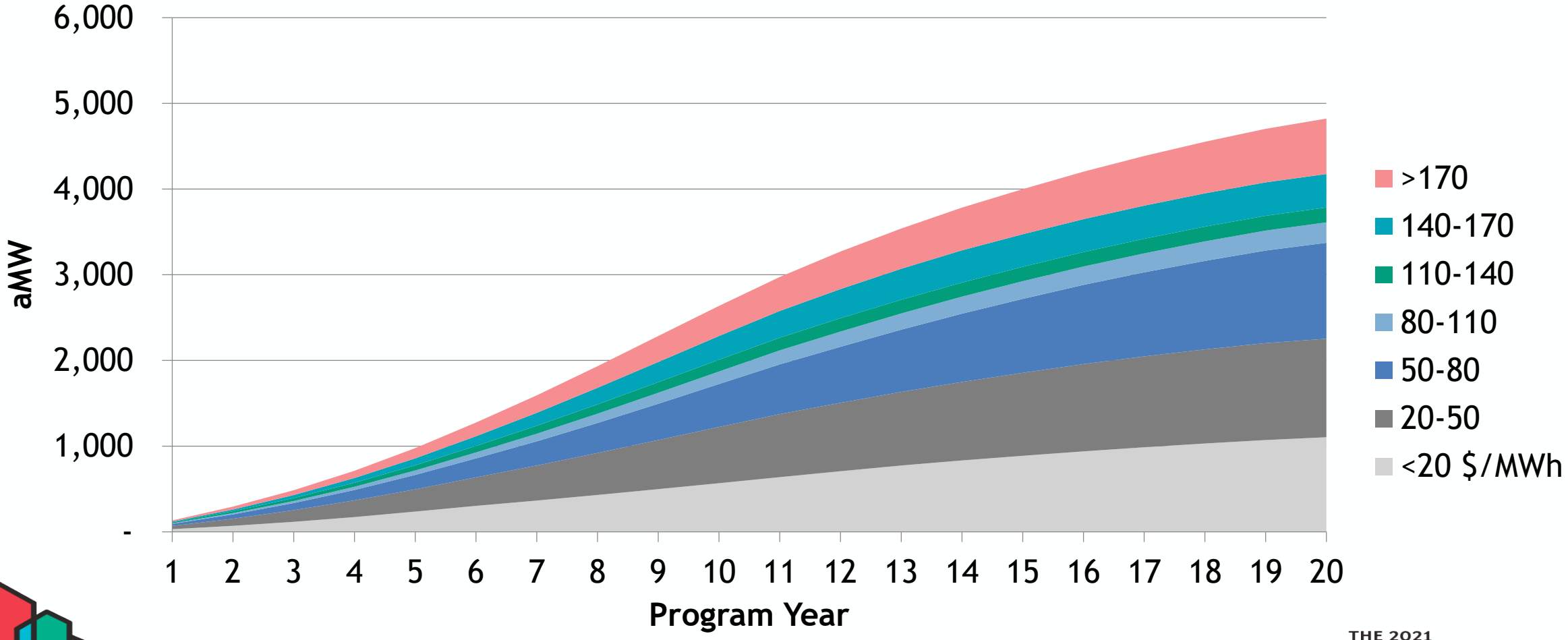
Potential Savings By Year and Cost Bin



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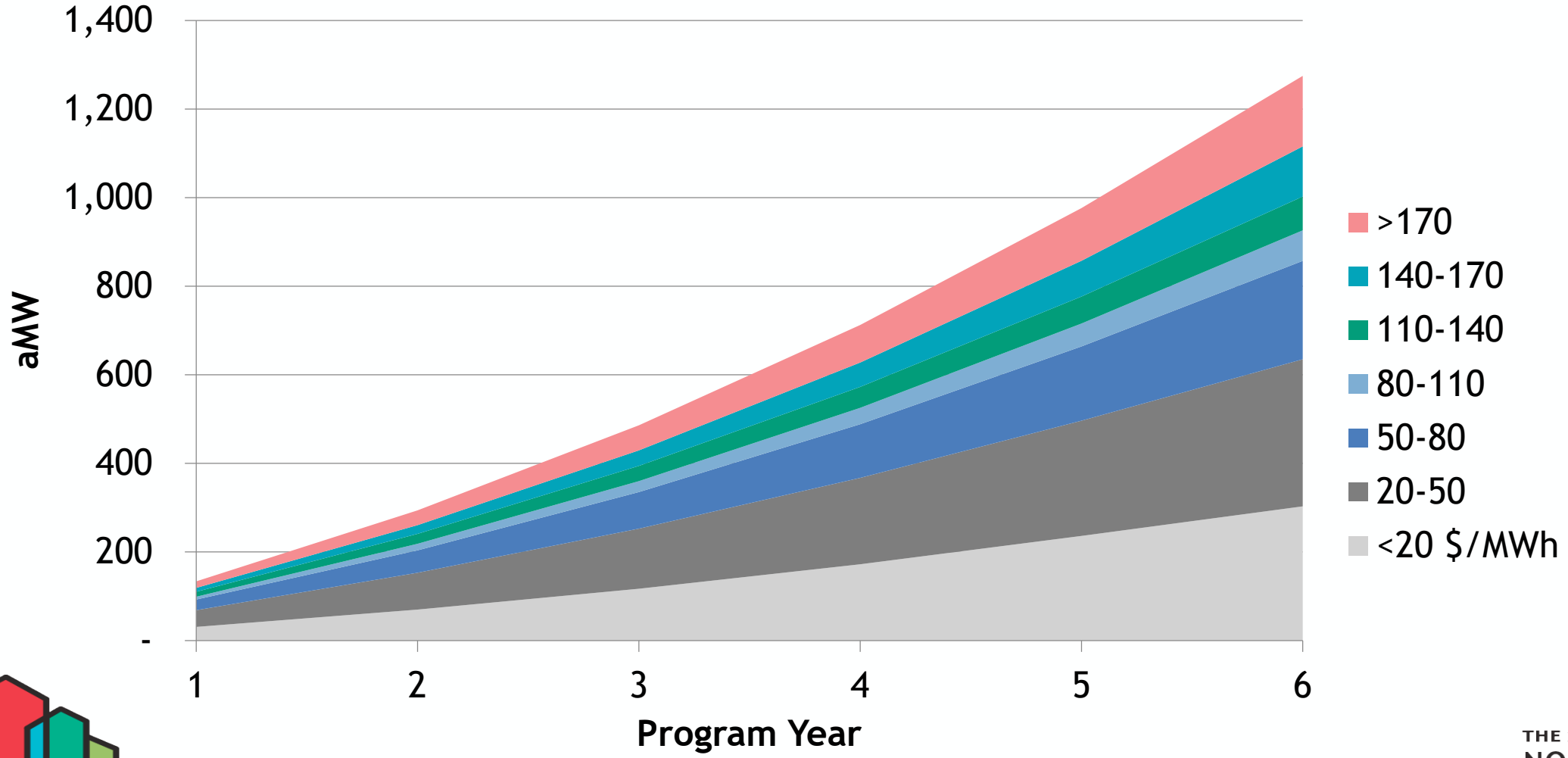
Cumulative Savings Potential First Six Years



Next Steps

- Several measure estimates still under development
- Finalize workbooks based on reviewer comments & data updates
- Re-run all measure workbooks with our final assumptions
- Bundle the supply curves into cost bins for the RPM