Appendix 5.20
Updates to Yukon Electricity Conservation and Demand Management Potential Review
(ICF 2016)

MEMORANDUM

To: Stephanie Whitehead and Marc-Andre Lavigne, Yukon Energy Corporation

From: ICF International

Date: October 25, 2016

Re: Updates to Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011)

Table of Contents

1 Introduction

This objective of this report is to update the assumptions and results of 2011 Conservation Potential Review (CPR) for the Yukon Energy Corporation (YEC). YEC updates their 20-year resource plan every five years, with the next update planned for 2016. In preparation for YEC's upcoming Resource Plan, YEC is seeking to update some of the CPR model input assumptions to better reflect the current state of the modeled technologies and more accurately project the conservation potential. Following the 2011 study and subsequent program design work, YEC was able to obtain more accurate information on the penetration of certain technologies and the participation rate of certain program implementations. The scope of this update is summarized below:

- **Base year:** Updated base year with 2014 energy sales data
- **Reference case:** Updated reference case with new load forecast
- **Measure-level assumptions:** Updated avoided cost, discount rate and measure-level assumptions such as cost, energy savings, measure life, current penetration and applicability
- **Participation rates:** Updated participation for certain measures, including showerheads, pipe and tank insulation

The scope of the updates to the assumptions were limited to the hydro grid-connected region. The large diesel, small diesel, and Old Crow regional models were omitted. Dwelling types, commercial building types, and energy end uses definitions remained unchanged from the 2011 study. Further information on these definitions can be found in the 2011 report.

The overall analysis approach and methodology for this study remains unchanged from the original 2011 study. For further information on the major analytical steps and modelling approach please refer back to the 2011 report. The following sections of this report are organized as follows:

- **Section 2** presents the revised assumptions for the update of the 2011 study. This includes changes to measure level assumptions, applicability and participation assumptions.
- **Section 3** presents the revised energy savings results for the residential and commercial sectors.

2 Assumptions

2.1 General Assumptions

This section presents the details of all changes that were made to the study assumptions. The following changes were made across both sectors:

- **Base year:** 2014 sales data provided by YEC was used to update the base year and the base year was changed from 2010 to 2014
- **Reference case:** YEC provided load forecast insights to inform a revised reference case and the reference case was extended to 2035 (i.e. the last milestone year for the 2011 study was 2030)
- **Avoided cost and discount rate:** The avoided costs were changed to $0.2871/kWh and the real discount rate was changed to 3.38%.

2.2 Residential Assumptions

2.2.1 Residential Measure-Level Assumptions

The following list of measure-level assumption changes were made in the residential sector measures:

- **Cold Climate Air Source Heat Pumps:** Costs updated to $12,000 based on Zuba model pricing provided from client consultation with HVAC specialists.
- **Programmable Thermostats (Central Heating):** Updated to Smart Learning Thermostats
  - Savings: Savings percentage was increased to 8%
  - Costs: Upgrade costs set to $300.00 based on cost of average nest/ecobee cost.
- **CFLs – Indoor:** Measure was deleted (superseded by LED measure)
- **CFLs – Outdoor:** Replaced measure with LED Lamps – Outdoor
  - Upgrade: Changed to 15 W PAR38 LED lamp
  - Savings: Measure savings percentage increased to 83.3% due to lower wattage of outdoor LED lamps
  - Costs: Set to $51.75 based on a retail scan of outdoor LED Lamps
  - Lifetime: Set to 25,000 hours (14.4 years based on 4.75 hours of use per day)
- **PAR CFLs:** Replaced measure with Dimmable PAR LED Lamps
  - Upgrade: Changed to 8 W dimmable PAR LED lamp
  - Savings: Measure savings percentage increased to 87%
  - Cost: Set upgrade costs to $15.00 based on a retail scan of PAR LED lamps.
  - Lifetime: Measure lifetime set to 25 years
- **Dimmable CFLs:** Measure was deleted (superseded by LED measure)
- **LED Lamps:**
  - Baseline: Changed baseline to a blended baseline of incandescent and CFL lamps
  - Savings: Savings assumptions were decreased from 80% to 76% relative to the new blended baseline of CFLs and incandescent lamps.
  - Costs: Reduced cost per lamp to $11.00 based upon retail scan of globe-type, screw-in 8 W LED lamps
- **High Performance New Homes:**
  - Baseline: Changed baseline from EGH rating of 80 to EGH rating of 82
  - Cost: Updated to $6,570 with 33% cost factor

  - Savings: Savings assumptions were updated to 15% based on change in baseline scenario

2.2.2 Changes to Residential Penetration & Participation Rates

The following changes were made to penetration and participation rates in the residential sector measures:

- **LED Lamps:**
  - Reference penetration: Estimated at 50% by the end of the study period
- **LED Lamps – Outdoor:**
  - Reference penetration: Estimated at 50% by the end of the study period
  - Participation rates: Updated to match LED Lamps
- **PAR LED Lamps:**
  - Reference penetration: Estimated at 35% by the end of the study period
  - Participation rates: Updated to match LED Lamps
- **Smart Learning Thermostats:**
  - Reference penetration: Estimated at 10% by the end of the study period based on decrease in natural adoption compared to programmable thermostats

2.3 Commercial Assumptions

2.3.1 Commercial Measure-Level Assumptions

The following measure-level assumption changes were made to the commercial sector measures:

- **T8 Lighting:** Switched to LED Fluorescent Fixtures measure
  - Baseline: Standard 2-lamp F32T8 fixture consuming 58 W
  - Upgrade: Upgrade is a 2-lamp LED Fluorescent Fixture consuming 18 W
  - Cost: Upgrade cost set to $120 per fixture based upon client data
- **CFL Lamps (Indoor):** Measure was deleted (superseded by LED measure)
- **White LED Lamps:**
  - Cost: Upgrade costs set to $23.00 based on ICF's database of average LED lighting costs for previous lighting program implementations
- **Pulse-Start Metal Halide Lamps:** Changed measure to LED High Bay Fixtures
  - Upgrade: Changed to 125 W LED High Bay Fixture
  - Costs: Upgrade cost adjusted to $300 per fixture and baseline material cost adjusted to $200/fixture based upon costing data provided by the client
  - Lifetime: Adjusted to 50,000 hours based upon the average life expectancy of LED fixtures
- **T5HO High Bay:** Measure was deleted (superseded by LED measure)
- **CFL Lamps (Outdoor):** Changed this measure to LED Lamps (Outdoor)
  - Upgrade: 10 W LED Lamp
  - Costs: Updated cost to $28.45 per lamp based on ICF's database of average LED lighting costs for previous lighting program implementations
  - Lifetime: Updated to 20,000 hours
- **Induction (Outdoor):** Measure was deleted (superseded by LED measure)
- **Pulse Start Metal Halide Lamps (Outdoor):** Changed to LED Wallpack Outdoor Fixtures
  - Baseline: Standard 230 W metal halide wallpack
  - Upgrade: 50 W LED wallpack

    - Costs: Upgrade costs updated to $460/fixture, baseline cost of $345/fixture
    - Lifetime: Upgraded to 50,000 hours for LED fixture
- **Digital HID Street Lighting:** Measure was deleted (superseded by LED measure)
- **LED Street lighting:**
    - Cost: Costs were updated with a $185/fixture cost for LED Streetlight and a cost of $250/fixture for the baseline HPS streetlight
- **HP Glazing:**
    - Cost: Updated costs based on pricing list provided by Northerm. Unit window costs provided were used to derive incremental cost of approximately $5.03/ft^2
- **Super HP Glazing:**
    - Cost: Updated costs based on pricing list provided by Northerm. Unit window costs provided were used to derive incremental cost of approximately $13.32/ft^2
- **Programmable Thermostat:** Changed to Adaptive Thermostat measure
    - Savings: Upgraded savings to 15% based on average adaptive thermostat savings from case studies
    - Costs: Updated costs to $700/thermostat per 2000 ft^2 plus location factor

2.3.2 Changes to Commercial Penetration & Participation Rates

The following changes were made to penetration and participation rates in the commercial sector measures:

- **LED fluorescent fixtures:**
    - Reference penetration: Estimated at 15% by the end of the study period
    - Participation rate: The participation rate was decreased up to a maximum participation of 46%
- **LED High Bay Fixtures:**
    - Reference penetration: Estimated at 15% by the end of the study period
- **LED Lamps (Outdoor):**
    - Reference penetration: Estimated at 8% by the end of the study period
    - Participation rate: Updated to match white LED Lamps measure
- **LED Wallpack Outdoor Fixtures:**
    - Reference penetration: Estimated at 19% by the end of the study period
- **LED Streetlighting:**
    - Reference penetration: Estimated at 30% by the end of the study period
- **Adaptive Thermostats:**
    - Reference penetration: Estimated at 10% by the end of the study period

3 Results

The following section provides the updated results for the residential and commercial sector. Note that all results presented in this section represent the electrical consumption and savings only in the hydro grid connected region of Yukon. Below is a summary of the exhibit updates with the corresponding exhibit numbers from the 2011 Yukon Residential and Commercial sector reports:

- Residential (R) Exhibit Updates:
    - Exhibit 7R: Base Year Consumption by Dwelling Type & End Use
    - Exhibit 25R: Technology Screening
    - Exhibits 35R and 36R: Energy Efficiency Supply Curves
    - Exhibits 54R and 58R: Achievable Potential Energy Savings
    - Exhibits 62R, 62-2R, 65R, 65-2R: Achievable Electric Peak Load Reductions
    - Exhibits 41R and 42R: Electric Peak Load Reductions from Capacity Measures
    - Exhibits 42-2R and 42-3R: Lower Achievable Electric Peak Load Reductions from Capacity Measures
- Commercial (C) Exhibit Updates:
    - Exhibit 10C: Base Year Consumption by Sub Sector & End Use
    - Exhibit 25C: Technology Screening
    - Exhibits 35C and 36C: Energy Efficiency Supply Curve
    - Exhibits 54C and 58C: Achievable Potential Energy Savings (commercial sector equivalent to residential)
    - Exhibits 62C, 62-2C, 65C, 65-2C: Achievable Electric Peak Load Reductions (commercial sector equivalent to residential)
    - Exhibits 40C and 41C: Electric Peak Load Reductions from Capacity Measures
    - Exhibits 41-2C and 41-3C: Lower Achievable Electric Peak Load Reductions from Capacity Measures

3.1 Residential Results

Base Year

This section presents the results of the analysis of electricity consumption for the Base Year 2014. Electricity consumption is measured at the customer's point-of-use and does not include line losses.

Exhibit 7R presents total residential sector hydro grid electricity consumption by dwelling type and end use.

Base Year Electricity Use by Dwelling Type

Single detached dwellings account for the majority of residential electricity use in Yukon, with approximately 73% of residential hydro grid electricity consumed. Apartment buildings, including both the suites and common areas, account for the next largest share, using 11% of residential hydro grid electricity. Attached houses (duplexes, row houses, and townhouses) and mobile homes each account for 7% of residential hydro grid electricity.

Seasonal houses (using less than 3,000 kWh/yr. each) account for 2% of total residential hydro grid electricity consumption. Residential garages and sentinel lighting each consume less than 0.5% of residential hydro grid electricity.

Base Year Electricity Use by End Use

HVAC accounts for 33% of consumption, with 29% of that being electric space heating and the remainder being fans and pumps, including furnace fans, boiler circulation pumps, HRV fans, and bathroom and kitchen exhaust.

Domestic appliances (white goods) consume approximately 17% of total residential hydro grid electricity. Of this, clothes dryers account for 6% and refrigerators for 4%. Cooking appliances consume 4% and freezers each consume approximately 3%. Dishwashers and clothes washers consume less than 1% each, but this does not include the associated DHW consumption if DHW is heated electrically.

Domestic water heating accounts for approximately 15% of residential hydro grid electricity consumption.

Household electronics consume approximately 15% of residential hydro grid electricity, including 9% by computers and their peripherals, 3% by televisions, 1% by the various set-top boxes associated with televisions, and 3% by other home entertainment electronics.

Indoor, outdoor, and holiday lighting together account for 6% of residential hydro grid electricity consumption; 5% of this is indoor lighting and 1% is outdoor lighting. Holiday lighting is well under 1%.

Other end uses account for 13% of residential electricity consumption. Of this, 6% is consumed by spa heaters and pumps and 2% is consumed by block heaters and car warmers.

Exhibit 7R Base Year Annual Residential Electricity Consumption by Dwelling Type and End Use (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	19,773	11,737	46,057	14,306	3,801	282	11,115	15,631	10,505	1,671
Pre-1980 non-electrically heated single detached homes	23,104	9,875	38,467	11,969	3,181	237	9,281	11,890	7,988	1,272
1980 & newer electrically heated single detached homes	136,425	862	24,409	5,566	1,443	91	5,203	6,234	4,269	656
Pre-1980 electrically heated single detached homes	51,511	260	7,783	1,926	512	38	1,641	1,752	1,177	187
1980 & newer non-electrically heated attached/row housing	1,675	1,198	4,815	1,238	308	19	982	1,557	1,046	136
Pre-1980 non-electrically heated attached/row housing	1,911	1,006	4,013	1,034	258	16	818	1,178	791	103
1980 & newer electrically heated attached/row housing	8,960	103	2,322	438	105	6	418	569	389	49
Pre-1980 electrically heated attached/row housing	4,222	35	826	169	42	3	147	178	119	16
Non-electrically heated apartment units	4,159	2,891	8,244	2,677	248	24	2,303	3,179	2,126	237
Non-electrically heated apartment common areas	1,117	3,895	-	3,606	335	32	-	-	-	-
Electrically heated apartment units	26,791	177	4,298	999	85	8	1,045	1,307	892	96
Electrically heated apartment common areas	7,153	237	-	1,341	114	10	-	-	-	-
Non-electrically heated mobile/other	4,067	2,274	9,031	2,413	622	36	2,630	2,369	1,390	160
Electrically heated mobile/other	18,053	150	3,396	682	173	9	878	782	426	47
Seasonal housing	873	374	3,862	2,306	613	-	900	928	623	99
Residential garages	1,059	583	-	700	186	-	-	-	-	-
Sentinel Lighting	-	-	-	-	3,006	-	-	-	-	-
Grand Total	310,852	35,655	157,524	51,372	15,032	810	37,362	47,553	31,741	4,729

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
1980 & newer non-electrically heated single detached homes	1,107	20,933	22,626	27,472	9,467	4,202	7,613	5,506	1,386	13,435	248,624	23%
Pre-1980 non-electrically heated single detached homes	844	15,918	17,273	20,857	7,193	3,198	6,314	4,187	1,054	11,142	205,242	19%
1980 & newer electrically heated single detached homes	401	8,640	8,532	11,735	3,925	1,633	4,186	2,213	557	7,387	234,369	22%
Pre-1980 electrically heated single detached homes	123	2,399	2,852	3,045	1,051	467	1,008	612	154	1,778	80,276	8%
1980 & newer non-electrically heated attached/row housing	93	1,759	2,852	3,464	1,193	530	684	694	175	1,208	25,626	2%
Pre-1980 non-electrically heated attached/row housing	69	1,296	2,110	2,548	879	391	566	511	129	999	20,625	2%
1980 & newer electrically heated attached/row housing	31	658	1,001	1,328	446	187	330	253	64	582	18,238	2%
Pre-1980 electrically heated attached/row housing	10	199	354	379	131	58	92	76	19	162	7,238	1%
Non-electrically heated apartment units	85	1,594	-	8,408	2,898	1,287	1,815	-	-	3,204	45,380	4%
Non-electrically heated apartment common areas	94	1,717	1,534	-	-	-	-	2,271	572	-	15,172	1%
Electrically heated apartment units	33	704	-	3,906	1,308	544	983	-	-	1,736	44,910	4%
Electrically heated apartment common areas	35	732	625	-	-	-	-	987	249	-	11,482	1%
Non-electrically heated mobile/other	107	1,983	2,127	5,045	1,739	773	1,278	1,012	255	2,256	41,566	4%
Electrically heated mobile/other	30	613	635	1,634	551	233	465	313	79	821	29,969	3%
Seasonal housing	65	1,239	4,079	1,615	557	248	1,221	-	-	2,155	21,756	2%
Residential garages	-	-	-	-	-	-	-	372	94	1,741	4,734	0.4%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	3,006	0.3%
Grand Total	3,127	60,382	66,600	91,433	31,339	13,750	26,556	19,007	4,785	48,603	1,058,214	100%

Technology Screening

A summary of the technology screening results is provided in Exhibit 25R. For each of the measures, the exhibit shows:

- The name of the measure
- The cost basis[1] for the CCE (cost of conserved energy) that is shown, e.g., full versus incremental
- The measure's average CCE when applied to all sub sectors.

Measures analyzed on the basis of full cost have been placed towards the top of the exhibit below because they are qualitatively different from the measures that pass only on an incremental basis. A measure that passes on a full-cost basis can be applied immediately, even if the piece of equipment it replaces or improves is currently working properly. That means the rate at which the measure can be implemented as a utility DSM measure is limited by market and program constraints. A measure that passes only on an incremental basis, on the other hand, is limited by the rate of natural replacement (due to failure or obsolescence) or purchase of the piece of equipment it replaces.

Exhibit 25R Residential Sector Energy-efficiency Technology Measures, Screening Results[2]

Measure Name	Basis (Full/ Incremental)	Average CCE (¢/kWh)	
		Existing Homes	New Homes
DHW Pipe Insulation	Full	0.20	0.25
Ultra Low-Flow Showerheads	Full	0.71	1.01
Hot Tub Pump Timers	Full	0.82	0.87
Insulating Hot Tub Covers	Full	1.29	1.36
LED Lamps	Full	1.44	1.44
PAR LED Lamps	Full	1.72	1.72
LED Lamps - Outdoor	Full	1.79	1.79
Timers for Electric Car Warmers	Full	2.21	2.22
Smart Learning Thermostats	Full	2.81	3.25
Solar Spa Pre-heat	Full	3.05	3.21
Programmable Thermostats (Baseboard Heating)	Full	3.13	3.52
Heat Pump Spa Heaters	Full	3.72	3.90
Motion Detectors for Outdoor Lighting	Full	4.38	4.38
Motion Detectors for Indoor Lighting	Full	4.61	4.61
Timer/Thermostat for Block Heaters	Full	5.05	5.00
Attic Insulation	Full	5.48	-
Outdoor Temperature Reset	Full	5.59	6.47
DHW Tank Insulation	Full	6.10	8.00
Basement (Foundation) Insulation	Full	6.27	-
LED Holiday Lighting (Outdoor)	Full	7.39	6.31
LEED Certified Apartment Buildings	Full		6.90
Spot/Task Lighting	Full	7.55	7.55
Air Leakage Sealing and Insulation (Old Homes)	Full	7.55	-

[1] See Step 3 in Section 7.2 of the 2011 Yukon Residential Report for a complete description.
[2] Average CCE does not include program costs.

Measure Name	Basis (Full/ Incremental)	Average CCE (¢/kWh)	
		Existing Homes	New Homes
Smart Power Bars (Computers and Peripherals)	Full	7.59	7.72
Ductless Mini-Split Systems	Full	8.62	8.77
Air Sealing/Weather Stripping/Caulking	Full	8.88	-
Zone Heating	Full	9.38	10.85
Cold Climate Air Source Heat Pumps	Full	9.42	10.54
DHW Recirculation Systems (e.g. Metlund D'MAND)	Full	10.79	14.56
Wastewater Heat Recovery Systems	Full	11.25	14.51
Smart Power Bars (Televisions and Home Entertainment)	Full	13.35	12.96
Wall Insulation	Full	13.27	-
Crawlspace Insulation	Full	14.87	-
SuperGreen Homes (EGH rating of 85)	Full		16.05
DHW Piping Optimization	Full	18.37	16.19
Slab Insulation (Unfinished Basements)	Full	16.53	-
Solar Pre-heated Make-Up Air Systems (e.g., SolarWall®)	Full	18.60	20.80
High-efficiency Spa Pumps	Full	19.33	20.38
Timers for Electric Battery Blankets	Full	24.39	24.13
Near-zero/Net-zero Energy Homes	Full		26.09
LED Holiday Lighting (Indoor)	Full	27.58	27.58
Timers for Outdoor Lighting	Full	59.01	59.01
High-Efficiency Furnace Blower Motors (ECPM)	Full/Incr.	18.52	13.63
High-Efficiency (ENERGY STAR) Clothes Washers	Full/Incr.	15.44	15.67
Ground Source Heat Pumps (Closed Loop)	Full/Incr.	24.45	26.96
High-Efficiency (ENERGY STAR) Refrigerators	Incr.	5.60	5.80
Triple-glazed Windows	Incr.	14.65	6.78
Future Improvements to Electronics	Incr.	10.60	10.55
High-Efficiency (ENERGY STAR) Dishwashers	Incr.	11.23	14.88
High-Efficiency (ENERGY STAR) Freezers	Incr.	11.29	11.71
Quadruple-glazed Windows	Incr.	21.29	12.74
Efficient Fluorescent Fixtures (Replace T12s with T8s)	Incr.	12.80	12.80
Energy Efficient (ENERGY STAR) Printers and Faxes	Incr.	14.84	15.10
Optimizing of Glazing for Passive Solar Heating	Incr.	18.29	55.34
High-efficiency Heat Recovery Ventilators (HRVs)	Incr.	18.86	21.31
Energy Efficient (ENERGY STAR) Televisions	Incr.	21.83	21.83
Convection Ovens - Electric	Incr.	41.25	52.52
ENERGY STAR Ceiling Fans	Incr.	162.54	162.54
High-Efficiency Cooktops (Induction)	Incr.	421.30	536.44

Energy-efficiency Supply Curves

A supply curve was constructed based on the approximate Economic Potential savings associated with the above measures. The following approach was followed:

- Measures are introduced in sequence to show incremental impact and cost
- Sequence was determined by listing first the items that reduce the electrical load, then those that meet residual load with the most efficient technology
- Items appear in order, beginning with those that have the lowest average CCE

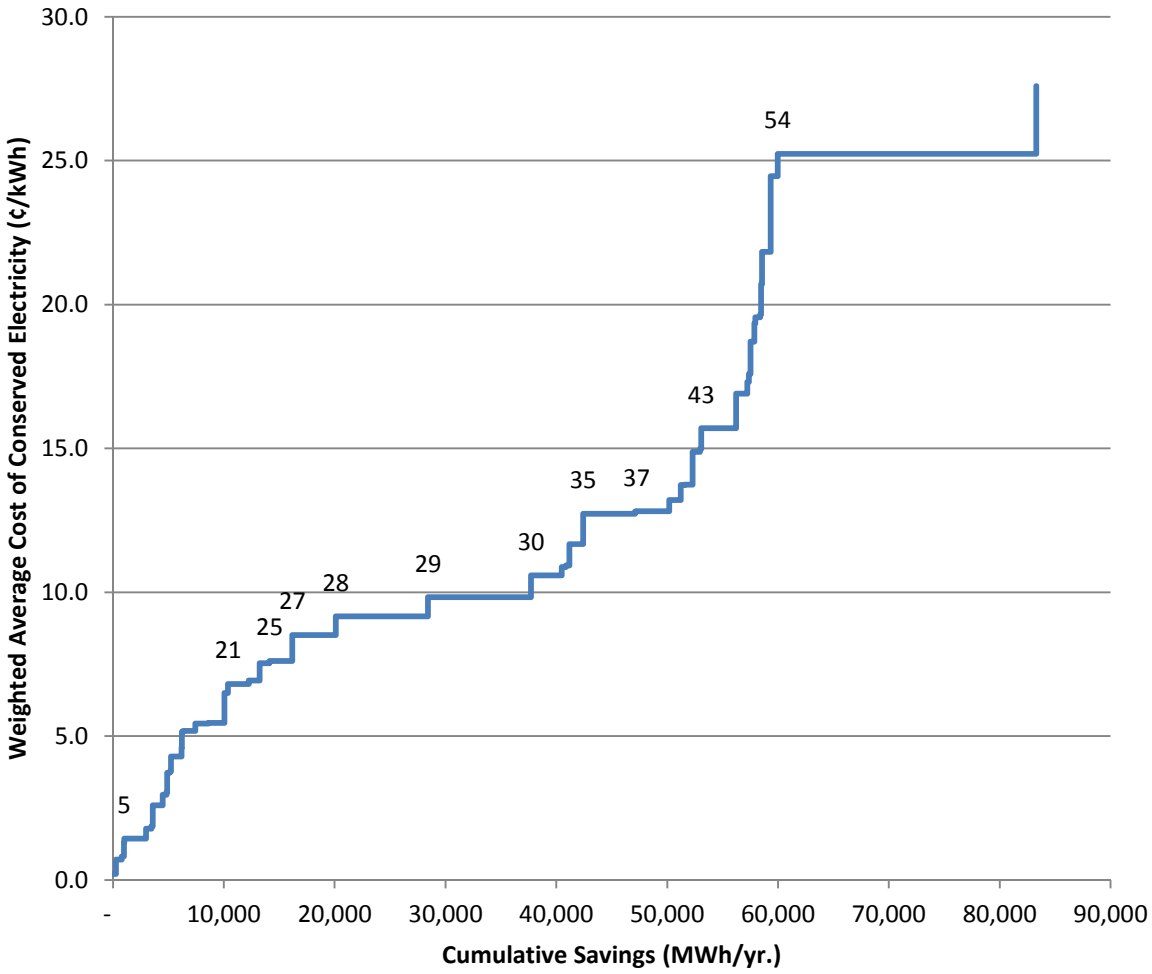
Exhibit 35R shows the measures included in the supply curve and Exhibit 36R shows the supply curve for Yukon as a whole in the 2030 milestone year. Since the 2035 results are based off of an extrapolation of 2030 results without any further achievable workshop consultations, the penetration and participation values for all measures were held constant over this period. Therefore, the 2030 supply curve results are presented below as this milestone year has the most reliable data.

Exhibit 35R Summary of Residential Sector Energy-Efficiency Measures, 2030

Ref #	Measure	Economic Potential Savings (MWh/yr.)	Accumulated CCE ($)	Weighted Average CCE (¢/kWh)
1	DHW Pipe Insulation	258	546	0.2
2	Showerheads	544	3,845	0.7
3	Hot Tub Pump Timers	194	1,596	0.8
4	Hot Tub Covers	16	213	1.3
5	LED Lamps	1,957	28,278	1.4
6	LED Lamps - Outdoor	497	8,876	1.8
7	Car Warmer Timers	119	2,221	1.9
8	Smart Learning Thermostats	904	23,453	2.6
9	Prog. Thermostats	347	10,267	3.0
10	Solar Spa Pre-heat	63	1,933	3.0
11	Heat Pump Spa Heaters	222	8,268	3.7
12	Pulse start metal halide sentinel lights	101	3,819	3.8
13	Block Heater Timers	952	40,858	4.3
14	Motion Detectors - Outdoor	11	476	4.4
15	Motion Detectors - Indoor	29	1,321	4.6
16	Basement Insulation	110	5,668	5.2
17	Attic Insulation	1,094	56,691	5.2
18	ENERGY STAR Refrigerators	1,190	64,763	5.4
19	Outdoor Temp Reset	1,435	78,438	5.5
20	DHW Tank Insulation	328	21,304	6.5
21	LEED Apartments	1,869	127,306	6.8
22	Sealing & Insul. - Old Homes	995	68,997	6.9
23	Air Sealing	854	64,362	7.5
24	Spot or Task Lighting	34	2,600	7.5

Ref #	Measure	Economic Potential Savings (MWh/yr.)	Accumulated CCE ($)	Weighted Average CCE (¢/kWh)
25	Power Bars (PCs)	2,060	156,805	7.6
26	LED Holiday - Outdoor	4	341	7.8
27	Ductless Mini-Splits	3,911	332,892	8.5
28	Zone Heating	8,318	762,693	9.2
29	Cold Temp Heat Pumps	9,301	914,389	9.8
30	Future Elec Improvement	2,759	292,148	10.6
31	ENERGY STAR Dishwashers	385	41,916	10.9
32	ENERGY STAR Freezers	301	32,934	10.9
33	DHW Recirculation	1,248	145,605	11.7
34	Crawl Space Insulation	9	1,158	12.5
35	ENERGY STAR Clothes Washers	4,672	594,515	12.7
36	T8 Fixtures	147	18,783	12.8
37	Wall Insulation	2,952	378,288	12.8
38	Power Bars (TVs)	1,028	135,755	13.2
39	Triple-glazed Windows	365	50,077	13.7
40	Wastewater Heat Recovery	697	95,692	13.7
41	ENERGY STAR Printers and Fax	687	102,189	14.9
42	Slab Insulation	117	17,456	15.0
43	High-Perf. New Homes	3,143	493,576	15.7
44	DHW Piping Optimization	992	167,618	16.9
45	Optimizing Glazing for Passive	165	28,656	17.3
46	HRVs	133	23,358	17.6
47	Furnace Motors	338	63,302	18.7
48	Spa Pumps	94	18,161	19.3
49	Solar Pre-heat Makeup Air	419	81,948	19.6
50	Quadruple-glazed Windows	101	19,915	19.6
51	Battery Blanket Timers	91	18,866	20.7
52	ENERGY STAR TVs	784	171,064	21.8
53	Ground Heat Pumps - Closed	617	151,056	24.5
54	Net Zero Homes	23,336	5,890,246	25.2
55	LED Holiday - Indoor	3	831	27.6
	Grand Total	83,300	11,828,327	14.2

Exhibit 36R Energy-efficiency Supply Curve, Residential Sector, 2030



Summary of Potential Electric Energy Savings

Exhibit 54R and Exhibit 58R present the residential achievable potential results for the total hydro grid connected Yukon service territory by technology and milestone year.

The Achievable Potential is defined as the proportion of the savings identified in the Economic Potential that could realistically be achieved within the study period. The achievable potential recognizes that it is difficult to induce customers to purchase and install all the electrical efficiency technologies that are economically feasible. The results are presented as a range, defined as lower and upper. The rate at which customers accept and purchase energy-efficiency products will be influenced by the level of financial incentives, information and other measures put in place by YEC.

The most significant savings in the Achievable Potential come from the following measures:

- Cold temperature heat pumps, which account for 24% of the upper Achievable Potential savings in 2035 and 20% of the lower Achievable Potential savings in 2035
- Zone heating systems, which account for 13% of the upper Achievable Potential savings in 2035 and 10% of the lower Achievable Potential savings in 2035
- ENERGY STAR clothes washers, which account for 9% of the upper Achievable Potential savings in 2035 and 13% of the lower Achievable Potential savings in 2035
- High-performance new homes, which account for 7% of the upper Achievable Potential savings in 2035 and 14% of the lower Achievable Potential savings in 2035
- Ductless mini-split systems, which account for 7% of the upper Achievable Potential savings in 2035 and 6% of the lower Achievable Potential savings in 2035
- LEED certified apartment buildings, which account for 4% of the upper Achievable Potential savings in 2035 and 4% of the lower Achievable Potential savings in 2035
- LED Lamps, which account for 3% of the upper Achievable Potential savings in 2035 and 4% of the lower Achievable Potential savings in 2035

There are numerous other smaller measures that contribute to the overall Achievable Potential results.

Exhibit 54R Upper Achievable Residential Electricity Savings by Technology and Milestone Year (MWh/yr.)

End Use	Measure	2015	2020	2025	2030	2035	Adoption Curve	Weighted Average CCE (¢/kWh)
Space heating	Cold Temp Heat Pumps	403	2,035	5,402	9,807	9,653	B	9.8
Space heating	Zone Heating	185	986	2,761	5,292	5,196	B	9.0
Clothes dryer	ESTAR Clothes Washers	1,286	2,324	3,225	3,671	3,592	C	12.8
Space heating	High-Perf. New Homes	220	1,392	2,457	2,993	2,978	D-2017	15.7
Space heating	Ductless Mini-Splits	113	581	1,556	2,836	2,792	B	8.5
Indoor lighting	LED Lamps	299	938	1,573	1,664	1,088	B	1.4
Space heating	LEED Apartments	10	199	813	1,782	1,773	B	6.8
Space heating	Smart Learning Thermostats	357	673	946	1,175	1,135	A	2.5
Computer and peripherals	Power Bars (PCs)	119	310	563	824	882	A/B	7.6
Computer and peripherals	Future Elec Improvement	-	-	278	1,004	1,286	B	10.6
Space heating	Outdoor Temp Reset	31	165	465	899	883	B	5.4
Refrigerator	ESTAR Refrigerators	21	217	506	734	752	C	5.4
Television	ESTAR TVs	22	268	622	662	597	C	21.8
Computer and peripherals	ESTAR Printers and Fax	33	396	527	577	621	C	14.9
Block heaters & car warmers	Block Heater Timers	86	221	412	649	646	A/B	4.4
Domestic hot water (DHW)	Showerheads	209	337	433	475	439	A	0.7
Ventilation & circulation	Furnace Motors	270	431	463	333	332	A	18.7
Space heating	Wall Insulation	34	131	282	476	464	B	12.7
Television	Power Bars (TVs)	49	136	262	411	479	A/B	13.2
Space heating	Prog. Thermostats	92	180	262	338	327	A	2.9
Domestic hot water (DHW)	DHW Recirculation	19	83	213	393	373	B	11.5
Domestic hot water (DHW)	ESTAR Dishwashers	14	127	283	308	309	C	10.8
Domestic hot water (DHW)	DHW Tank Insulation	74	141	217	287	265	A	6.5
Space heating	Ground Heat Pumps - Closed	17	84	204	319	314	B	24.2
Domestic hot water (DHW)	DHW Piping Optimization	17	72	184	334	317	B	16.6
Indoor lighting	PAR LEDs	290	410	88	-	-	F	1.7
Space heating	Attic Insulation	20	75	159	265	258	B	5.2
Domestic hot water (DHW)	DHW Pipe Insulation	58	111	171	226	209	A	0.2
Freezer	ESTAR Freezers	5	55	129	215	300	C	10.9
Space heating	Solar Pre-heat Makeup Air	7	40	110	201	198	B	19.3
Spa heaters and pumps	Heat Pump Spa Heaters	66	109	105	132	129	A/B	3.7
Spa heaters and pumps	Hot Tub Pump Timers	50	90	96	135	132	A/B	0.8
Space heating	Sealing & Insul. - Old Homes	11	44	96	165	160	B	6.9
Space heating	Air Sealing	10	37	80	138	137	B	7.4
Outdoor lighting	LEDs - Outdoor	90	155	50	-	-	F	1.8
Outdoor lighting	Pulse start metal halide sentinel lights	6	25	57	101	101	A	3.8
Domestic hot water (DHW)	Wastewater Heat Recovery	3	18	53	104	100	B	13.8
Block heaters & car warmers	Car Warmer Timers	11	28	51	81	81	A/B	1.9
Spa heaters and pumps	Spa Pumps	25	44	47	66	65	A/B	19.4
Block heaters & car warmers	Battery Blanket Timers	8	21	39	62	62	A/B	21.2
Space heating	HRVs	0	8	26	55	71	B	16.5
Indoor lighting	T8 Fixtures	1	15	37	52	52	B	12.8
Space heating	Triple-glazed Windows	0	7	22	49	78	B	13.5
Space heating	Basement Insulation	9	26	37	27	27	B	5.1
Space heating	Slab Insulation	3	9	18	28	28	B	14.6
Spa heaters and pumps	Solar Spa Pre-heat	8	15	16	22	22	A/B	3.1
Holiday lighting	LED Holiday - Outdoor	18	25	19	4	4	A	7.8
Indoor lighting	Spot or Task Lighting	9	15	17	15	10	A/B	7.5
Holiday lighting	LED Holiday - Indoor	13	17	14	3	3	A	27.6
Indoor lighting	Motion Detectors - Indoor	5	9	12	12	10	A/B	4.6
Spa heaters and pumps	Hot Tub Covers	4	8	8	11	11	A/B	1.3
Space heating	Optimizing Glazing for Passive	0	2	6	14	21	B	16.3
Outdoor lighting	Motion Detectors - Outdoor	2	5	6	7	4	A/B	4.4
Space heating	Quadruple-glazed Windows	0	1	2	5	7	B	16.1
Space heating	Crawl Space Insulation	0	1	1	2	1	B	12.3
Grand Total		4,715	13,852	26,482	40,441	39,773		9.7

Exhibit 58R Lower Achievable Residential Electricity Savings by Technology and Milestone Year (MWh/yr.)

End Use	Measure	2015	2020	2025	2030	2035	Adoption Curve	Weighted Average CCE (¢/kWh)
Domestic hot water (DHW)	DHW Pipe Insulation	45	86	132	174	161	A	0.2
Domestic hot water (DHW)	Showerheads	162	260	334	367	339	A	0.7
Spa heaters and pumps	Hot Tub Pump Timers	14	43	58	96	94	B	0.8
Spa heaters and pumps	Hot Tub Covers	1	4	5	8	8	B	1.3
Indoor lighting	LED Lamps	248	779	1,298	1,370	896	B	1.4
Indoor lighting	PAR LEDs	232	328	71	-	-	F	1.7
Outdoor lighting	LEDs - Outdoor	72	124	40	-	-	F	1.8
Block heaters & car warmers	Car Warmer Timers	3	13	31	57	57	B	1.9
Space heating	Smart Learning Thermostats	134	255	363	458	444	A	2.5
Space heating	Prog. Thermostats	31	61	90	117	114	A	2.9
Spa heaters and pumps	Solar Spa Pre-heat	2	7	10	16	16	B	3.1
Spa heaters and pumps	Heat Pump Spa Heaters	18	48	60	88	86	B	3.7
Outdoor lighting	Pulse start metal halide sentinel lights	6	25	57	101	101	A	3.8
Outdoor lighting	Motion Detectors - Outdoor	1	2	3	3	2	A/B	4.4
Block heaters & car warmers	Block Heater Timers	24	104	250	459	457	B	4.4
Indoor lighting	Motion Detectors - Indoor	3	5	6	7	5	A/B	4.6
	Subtotal (CCE up to 5 ¢/kWh)	**996**	**2,144**	**2,808**	**3,322**	**2,780**		**2.0**
Space heating	Basement Insulation	2	5	6	5	5	B	5.1
Space heating	Attic Insulation	4	13	28	47	46	B	5.2
Refrigerator	ESTAR Refrigerators	3	60	209	390	404	B	5.4
Space heating	Outdoor Temp Reset	11	63	187	373	367	B	5.5
Domestic hot water (DHW)	DHW Tank Insulation	57	109	167	221	204	A	6.5
Space heating	LEED Apartments	5	100	408	894	889	B	6.8
Space heating	Sealing & Insul. - Old Homes	2	8	17	29	28	B	6.9
Space heating	Air Sealing	2	7	14	24	24	B	7.4
Indoor lighting	Spot or Task Lighting	4	8	9	8	5	A/B	7.5
Computer and peripherals	Power Bars (PCs)	60	155	282	412	441	A/B	7.6
Holiday lighting	LED Holiday - Outdoor	18	25	19	4	4	A	7.8
Space heating	Ductless Mini-Splits	40	227	650	1,266	1,249	B	8.5
Space heating	Zone Heating	65	380	1,118	2,222	2,187	B	9.2
Space heating	Cold Temp Heat Pumps	140	768	2,162	4,179	4,120	B	9.8
	Subtotal (CCE between 5 -10 ¢/kWh)	**412**	**1,926**	**5,276**	**10,074**	**9,974**		**8.7**
Computer and peripherals	Future Elec Improvement	-	-	145	531	686	B	10.6
Freezer	ESTAR Freezers	1	16	55	125	195	B	10.9
Domestic hot water (DHW)	ESTAR Dishwashers	2	33	111	132	133	B	11.0
Domestic hot water (DHW)	DHW Recirculation	3	14	37	68	64	B	11.6
Space heating	Crawl Space Insulation	0	0	0	0	0	B	12.3
Space heating	Wall Insulation	6	23	50	84	82	B	12.7
Indoor lighting	T8 Fixtures	1	12	31	43	43	B	12.8
Television	Power Bars (TVs)	25	68	131	206	240	A/B	13.2
Clothes dryer	ESTAR Clothes Washers	149	627	1,525	2,746	2,682	B	13.4
Space heating	Triple-glazed Windows	0	1	4	9	14	B	13.5
Domestic hot water (DHW)	Wastewater Heat Recovery	1	3	9	18	17	B	13.8
Space heating	Slab Insulation	0	2	3	5	5	B	14.6
Computer and peripherals	ESTAR Printers and Fax	4	102	160	210	265	B	14.9
	Subtotal (CCE between 10 -15 ¢/kWh)	**191**	**901**	**2,261**	**4,177**	**4,427**		**12.9**
Space heating	High-Perf. New Homes	128	1,164	2,468	3,007	2,992	D-2022	15.7
Space heating	Quadruple-glazed Windows	0	0	0	1	1	B	16.1
Space heating	Optimizing Glazing for Passive	0	0	1	2	4	B	16.3
Space heating	HRVs	0	3	9	20	25	B	16.5
Domestic hot water (DHW)	DHW Piping Optimization	3	12	32	59	56	B	16.6
Ventilation & circulation	Furnace Motors	101	162	174	127	126	A	18.7
Spa heaters and pumps	Spa Pumps	7	21	29	47	46	B	19.4
Space heating	Solar Pre-heat Makeup Air	3	16	50	98	97	B	19.4
	Subtotal (CCE between 15 -20 ¢/kWh)	**242**	**1,379**	**2,764**	**3,361**	**3,348**		**16.0**
Block heaters & car warmers	Battery Blanket Timers	2	10	24	44	44	B	21.4
Television	ESTAR TVs	3	69	238	288	317	B	21.8
Space heating	Ground Heat Pumps - Closed	6	36	100	185	183	B	24.3
Holiday lighting	LED Holiday - Indoor	10	13	10	2	2	A	27.6
	Subtotal (CCE greater than 20	**21**	**128**	**372**	**519**	**545**		**22.7**
	Grand Total	**1,862**	**6,477**	**13,481**	**21,454**	**21,073**		**10.0**

Summary of Electric Peak Load Reductions: Electric Energy Measures

Exhibits 62R and 65R show the demand reductions associated with each residential sector electric energy savings measure in 2030. The 2030 results are presented in Exhibits 62R and 65R place of the 2035 results as they are more reliable results. With the absence of new achievable potential workshops, the results from 2035 were extrapolated from 2030 results with penetration and participation rates held constant. The results by milestone year are presented for the upper and lower achievable peak period 1 reductions in exhibits 62-2R and 65-2R respectively.

Most measures contribute to the peak demand reductions approximately in proportion to their electric energy savings. There are some notable exceptions. Block heaters are used at times that coincide closely with the utility peak, so their demand reduction would be disproportionate to their share of the electricity consumption savings. The potential reduction from block heater timers is even more significant than this would suggest, however, because the timer measure changes the load shape by moving the consumption almost entirely off the utility peak. Block heater timers offer the second largest potential for reducing peak demand in the Residential sector.

In contrast, the central heat pump and ductless mini-split systems, which both offer considerable electric energy savings potential, provide no reduction in peak electrical demand. This is because the utility peak occurs during the coldest period of the heating season, when these systems cease to operate as heat pumps and make use of their electric resistance backup heating elements.

Exhibit 62R Electric Peak Load Reductions Upper Achievable Energy Savings Measures, 2030 (MW)

Measure	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Zone Heating	1.89	1.85	1.25
Block Heater Timers	1.18	1.48	0.00
High-Perf. New Homes	0.96	0.94	0.72
ESTAR Clothes Washers	0.80	0.68	0.36
LEED Apartments	0.58	0.58	0.38
Smart Learning Thermostats	0.42	0.41	0.28
LED Lamps	0.40	0.45	0.18
Outdoor Temp Reset	0.32	0.31	0.21
Wall Insulation	0.17	0.17	0.11
Future Elec Improvement	0.15	0.15	0.11
Power Bars (PCs)	0.12	0.12	0.09
Prog. Thermostats	0.12	0.12	0.08
Ground Heat Pumps - Closed	0.11	0.11	0.08
ESTAR TVs	0.10	0.10	0.08
Attic Insulation	0.09	0.09	0.06
ESTAR Refrigerators	0.09	0.09	0.07
ESTAR Printers and Fax	0.09	0.09	0.06
Solar Pre-heat Makeup Air	0.07	0.07	0.05
Power Bars (TVs)	0.06	0.06	0.05
Sealing & Insul. - Old Homes	0.06	0.06	0.04
Car Warmer Timers	0.05	0.07	0.00
Furnace Motors	0.05	0.05	0.05
Air Sealing	0.05	0.05	0.03
Showerheads	0.04	0.05	0.12
Battery Blanket Timers	0.04	0.05	0.00
DHW Recirculation	0.03	0.04	0.10
ESTAR Dishwashers	0.03	0.04	0.07
DHW Piping Optimization	0.03	0.03	0.08
ESTAR Freezers	0.03	0.03	0.02
DHW Tank Insulation	0.03	0.03	0.07
Pulse start metal halide sentinel lights	0.02	0.02	0.02
Hot Tub Pump Timers	0.02	0.02	0.02
Heat Pump Spa Heaters	0.02	0.02	0.02
DHW Pipe Insulation	0.02	0.02	0.06
HRVs	0.02	0.02	0.01
Triple-glazed Windows	0.02	0.02	0.01
LED Holiday - Outdoor	0.02	0.02	0.00
T8 Fixtures	0.01	0.01	0.01
LED Holiday - Indoor	0.01	0.01	0.00
Slab Insulation	0.01	0.01	0.01
Spa Pumps	0.01	0.01	0.01
Basement Insulation	0.01	0.01	0.01
Wastewater Heat Recovery	0.01	0.01	0.03
Optimizing Glazing for Passive	0.00	0.00	0.00
Spot or Task Lighting	0.00	0.00	0.00
Solar Spa Pre-heat	0.00	0.00	0.00
Motion Detectors - Indoor	0.00	0.00	0.00
Hot Tub Covers	0.00	0.00	0.00
Quadruple-glazed Windows	0.00	0.00	0.00
Motion Detectors - Outdoor	0.00	0.00	0.00
Crawl Space Insulation	0.00	0.00	0.00
Grand Total	8.41	8.58	5.02

Exhibit 62-2R Upper Achievable Electric Peak Load Reductions (Peak Period 1 - Annual Peak Hour) (MW)

Measure	2015	2020	2025	2030	2035
Zone Heating	0.07	0.35	0.99	1.89	1.85
Block Heater Timers	0.18	0.44	0.77	1.18	1.18
High-Perf. New Homes	0.07	0.44	0.78	0.96	0.95
ESTAR Clothes Washers	0.27	0.50	0.70	0.80	0.79
LEED Apartments	0.00	0.06	0.26	0.58	0.58
Smart Learning Thermostats	0.13	0.24	0.34	0.42	0.41
Outdoor Temp Reset	0.01	0.06	0.17	0.32	0.32
LED Lamps	0.07	0.23	0.38	0.40	0.26
Future Elec Improvement	0.00	0.00	0.04	0.15	0.20
Wall Insulation	0.01	0.05	0.10	0.17	0.17
Power Bars (PCs)	0.02	0.05	0.08	0.12	0.13
Prog. Thermostats	0.03	0.06	0.09	0.12	0.12
Ground Heat Pumps - Closed	0.01	0.03	0.07	0.11	0.11
ESTAR Refrigerators	0.00	0.03	0.06	0.09	0.09
ESTAR TVs	0.00	0.04	0.10	0.10	0.09
Attic Insulation	0.01	0.03	0.06	0.09	0.09
ESTAR Printers and Fax	0.00	0.06	0.08	0.09	0.09
Power Bars (TVs)	0.01	0.02	0.04	0.06	0.07
Solar Pre-heat Makeup Air	0.00	0.01	0.04	0.07	0.07
Sealing & Insul. - Old Homes	0.00	0.02	0.03	0.06	0.06
Car Warmer Timers	0.01	0.02	0.03	0.05	0.05
Furnace Motors	0.04	0.07	0.07	0.05	0.05
Air Sealing	0.00	0.01	0.03	0.05	0.05
Battery Blanket Timers	0.01	0.01	0.03	0.04	0.04
Showerheads	0.02	0.03	0.04	0.04	0.04
ESTAR Freezers	0.00	0.01	0.02	0.03	0.04
DHW Recirculation	0.00	0.01	0.02	0.03	0.03
ESTAR Dishwashers	0.00	0.01	0.03	0.03	0.03
DHW Piping Optimization	0.00	0.01	0.02	0.03	0.03
Triple-glazed Windows	0.00	0.00	0.01	0.02	0.03
HRVs	0.00	0.00	0.01	0.02	0.03
Pulse start metal halide sentinel lights	0.00	0.01	0.01	0.02	0.02
DHW Tank Insulation	0.01	0.01	0.02	0.03	0.02
Hot Tub Pump Timers	0.01	0.01	0.01	0.02	0.02
Heat Pump Spa Heaters	0.01	0.02	0.02	0.02	0.02
DHW Pipe Insulation	0.01	0.01	0.02	0.02	0.02
LED Holiday - Outdoor	0.07	0.09	0.07	0.02	0.02
T8 Fixtures	0.00	0.00	0.01	0.01	0.01
LED Holiday - Indoor	0.05	0.06	0.05	0.01	0.01
Slab Insulation	0.00	0.00	0.01	0.01	0.01
Spa Pumps	0.00	0.01	0.01	0.01	0.01
Basement Insulation	0.00	0.01	0.01	0.01	0.01
Wastewater Heat Recovery	0.00	0.00	0.00	0.01	0.01
Optimizing Glazing for Passive	0.00	0.00	0.00	0.00	0.01
Solar Spa Pre-heat	0.00	0.00	0.00	0.00	0.00
Quadruple-glazed Windows	0.00	0.00	0.00	0.00	0.00
Spot or Task Lighting	0.00	0.00	0.00	0.00	0.00
Motion Detectors - Indoor	0.00	0.00	0.00	0.00	0.00
Hot Tub Covers	0.00	0.00	0.00	0.00	0.00
Motion Detectors - Outdoor	0.00	0.00	0.00	0.00	0.00
Crawl Space Insulation	0.00	0.00	0.00	0.00	0.00
LEDs - Outdoor	0.02	0.04	0.01	-	-
PAR LEDs	0.07	0.10	0.02	-	-
Grand Total	1.24	3.28	5.78	8.41	8.25

Exhibit 65R Electric Peak Load Reductions Lower Achievable Energy Savings Measures, 2030 (MW)

Measure	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
High-Perf. New Homes	0.96	0.94	0.73
Block Heater Timers	0.84	1.05	0.00
Zone Heating	0.79	0.78	0.52
ESTAR Clothes Washers	0.60	0.51	0.27
LED Lamps	0.33	0.37	0.15
LEED Apartments	0.29	0.29	0.19
Smart Learning Thermostats	0.16	0.16	0.11
Outdoor Temp Reset	0.13	0.13	0.09
Future Elec Improvement	0.08	0.08	0.06
Ground Heat Pumps - Closed	0.07	0.06	0.04
Power Bars (PCs)	0.06	0.06	0.05
ESTAR Refrigerators	0.05	0.05	0.04
ESTAR TVs	0.05	0.04	0.03
Prog. Thermostats	0.04	0.04	0.03
Car Warmer Timers	0.04	0.05	0.00
Solar Pre-heat Makeup Air	0.03	0.03	0.02
Showerheads	0.03	0.04	0.09
Power Bars (TVs)	0.03	0.03	0.02
ESTAR Printers and Fax	0.03	0.03	0.02
Wall Insulation	0.03	0.03	0.02
Battery Blanket Timers	0.03	0.04	0.00
Pulse start metal halide sentinel lights	0.02	0.02	0.02
Furnace Motors	0.02	0.02	0.02
DHW Tank Insulation	0.02	0.02	0.06
Attic Insulation	0.02	0.02	0.01
LED Holiday - Outdoor	0.02	0.02	0.00
ESTAR Freezers	0.02	0.01	0.01
DHW Pipe Insulation	0.02	0.02	0.04
Hot Tub Pump Timers	0.01	0.01	0.01
ESTAR Dishwashers	0.01	0.02	0.03
Heat Pump Spa Heaters	0.01	0.01	0.01
T8 Fixtures	0.01	0.01	0.00
Sealing & Insul. - Old Homes	0.01	0.01	0.01
Air Sealing	0.01	0.01	0.01
LED Holiday - Indoor	0.01	0.01	0.00
Spa Pumps	0.01	0.01	0.01
HRVs	0.01	0.01	0.00
DHW Recirculation	0.01	0.01	0.02
DHW Piping Optimization	0.01	0.01	0.01
Triple-glazed Windows	0.00	0.00	0.00
Solar Spa Pre-heat	0.00	0.00	0.00
Spot or Task Lighting	0.00	0.00	0.00
Slab Insulation	0.00	0.00	0.00
Basement Insulation	0.00	0.00	0.00
Motion Detectors - Indoor	0.00	0.00	0.00
Wastewater Heat Recovery	0.00	0.00	0.00
Hot Tub Covers	0.00	0.00	0.00
Optimizing Glazing for Passive	0.00	0.00	0.00
Motion Detectors - Outdoor	0.00	0.00	0.00
Quadruple-glazed Windows	0.00	0.00	0.00
Crawl Space Insulation	0.00	0.00	0.00
Grand Total	4.92	5.06	2.78

Exhibit 65-2R Lower Achievable Electric Peak Load Reductions (Peak Period 1 - Annual Peak Hour) (MW)

Measure	2015	2020	2025	2030	2035
High-Perf. New Homes	0.04	0.37	0.78	0.96	0.95
Block Heater Timers	0.05	0.21	0.47	0.84	0.83
Zone Heating	0.02	0.14	0.40	0.79	0.78
ESTAR Clothes Washers	0.03	0.13	0.33	0.60	0.59
LEED Apartments	0.00	0.03	0.13	0.29	0.29
LED Lamps	0.06	0.19	0.31	0.33	0.22
Smart Learning Thermostats	0.05	0.09	0.13	0.16	0.16
Outdoor Temp Reset	0.00	0.02	0.07	0.13	0.13
Future Elec Improvement	0.00	0.00	0.02	0.08	0.10
Ground Heat Pumps - Closed	0.00	0.01	0.04	0.07	0.07
Power Bars (PCs)	0.01	0.02	0.04	0.06	0.07
ESTAR Refrigerators	0.00	0.01	0.03	0.05	0.05
ESTAR TVs	0.00	0.01	0.04	0.05	0.05
Prog. Thermostats	0.01	0.02	0.03	0.04	0.04
ESTAR Printers and Fax	0.00	0.02	0.02	0.03	0.04
Car Warmer Timers	0.00	0.01	0.02	0.04	0.04
Power Bars (TVs)	0.00	0.01	0.02	0.03	0.04
Solar Pre-heat Makeup Air	0.00	0.01	0.02	0.03	0.03
Showerheads	0.01	0.02	0.03	0.03	0.03
Battery Blanket Timers	0.00	0.01	0.02	0.03	0.03
Wall Insulation	0.00	0.01	0.02	0.03	0.03
ESTAR Freezers	0.00	0.00	0.01	0.02	0.02
Pulse start metal halide sentinel lights	0.00	0.01	0.01	0.02	0.02
Furnace Motors	0.02	0.03	0.03	0.02	0.02
DHW Tank Insulation	0.01	0.01	0.01	0.02	0.02
Attic Insulation	0.00	0.00	0.01	0.02	0.02
LED Holiday - Outdoor	0.07	0.09	0.07	0.02	0.02
Hot Tub Pump Timers	0.00	0.01	0.01	0.01	0.01
DHW Pipe Insulation	0.00	0.01	0.01	0.02	0.01
ESTAR Dishwashers	0.00	0.00	0.01	0.01	0.01
Heat Pump Spa Heaters	0.00	0.01	0.01	0.01	0.01
T8 Fixtures	0.00	0.00	0.01	0.01	0.01
Sealing & Insul. - Old Homes	0.00	0.00	0.01	0.01	0.01
HRVs	0.00	0.00	0.00	0.01	0.01
Air Sealing	0.00	0.00	0.00	0.01	0.01
LED Holiday - Indoor	0.04	0.05	0.04	0.01	0.01
Spa Pumps	0.00	0.00	0.00	0.01	0.01
DHW Recirculation	0.00	0.00	0.00	0.01	0.01
DHW Piping Optimization	0.00	0.00	0.00	0.01	0.00
Triple-glazed Windows	0.00	0.00	0.00	0.00	0.00
Solar Spa Pre-heat	0.00	0.00	0.00	0.00	0.00
Slab Insulation	0.00	0.00	0.00	0.00	0.00
Basement Insulation	0.00	0.00	0.00	0.00	0.00
Wastewater Heat Recovery	0.00	0.00	0.00	0.00	0.00
Optimizing Glazing for Passive	0.00	0.00	0.00	0.00	0.00
Spot or Task Lighting	0.00	0.00	0.00	0.00	0.00
Motion Detectors - Indoor	0.00	0.00	0.00	0.00	0.00
Hot Tub Covers	0.00	0.00	0.00	0.00	0.00
Motion Detectors - Outdoor	0.00	0.00	0.00	0.00	0.00
Quadruple-glazed Windows	0.00	0.00	0.00	0.00	0.00
Crawl Space Insulation	0.00	0.00	0.00	0.00	0.00
LEDs - Outdoor	0.02	0.03	0.01	-	-
PAR LEDs	0.06	0.08	0.02	-	-
Grand Total	0.52	1.68	3.26	4.92	4.82

Summary of Electric Peak Load Reductions: Capacity Measures

Exhibits 41R and 42R show the economic demand reductions associated with each residential sector peak load reduction measure in 2015. Exhibit 41R shows the name of the measure, the cost basis for the CEPR that the shown (full versus incremental) and the measure's average CEPR. The following approach was taken in updating these exhibits from the 2011 study:

- The discount rate was updated to 3.38% from 7.5%, thus impacting the CEPR values.
- The applicable dwellings count was updated from the 2010 base year to the new 2015 milestone year data, thus impacting the dwelling saturation and MW reduction for each capacity measure.
- Costing assumptions for each measure were left unchanged from the 2011 CPR study.

Measures analyzed on the basis of full cost have been placed towards the top of Exhibit 41R as they are qualitatively different from the measures that pass only on an incremental basis. A measure that passes on a full-cost basis can be applied immediately, while incremental measures presume the adoption of other technologies as a condition of their cost effectiveness (e.g., facility network gateways).

Exhibit 42R shows a list of the capacity electric peak load reduction measures grouped by applicable end use category. This exhibit shows the measure name, dwelling saturation, applicable count in 2015, average demand reduction and average CEPR. Note that since there was no threshold established for maximum cost effective CEPR, all measures are listed and there are no exclusions based on cost effectiveness.

Exhibit 41R Residential Sector Electric Peak Load Reduction Measures, Screening Results

Measure Name	Basis (Full/Incremental)	CEPR Ranges ($/kW)
One-way switch for engine block heater	Full	$55 - $68
Electric central thermal storage	Full	$109 - $111
One-way switch for pools and spas	Full	$77 - $82
One-way switch for water heating control	Full	$105 - $117
Electric room thermal storage for supplemental heat	Full	$96 - $99
One-way switch for plug loads	Full	$172 - $234
One-way switch for lighting control	Full	$270 - $300
One-way switch for engine block heater	Incremental	$48 - $60
One-way switch for pools and spas	Incremental	$37 - $39
One-way switch for plug loads	Incremental	$51 - $69
One-way switch for lighting control	Incremental	$80 - $89
One-way switch for water heating control	Incremental	$77 - $86

Exhibit 42R Total Applicable Dwelling Types and MW Impact by Measure

Electric Peak Reduction Measures	Dwelling Saturation	Applicable Count 2015	Avg MW	Avg CEPR $/kW/yr.
Space Heating				
One-way switch for engine block heater - utility load control – stand-alone	52%	7,897	1.5	$55 - $68
One-way switch for engine block heater - utility load control - incremental	52%	7,897	1.5	$48 - $60
Electric thermal storage (central)	13%	1,982	6.8	$109 - $111
Electric thermal storage (room/supplemental)	9.3%	1,418	1.7	$96 - $99
Electric Water Heating				
One-way switch-based utility load control – stand-alone	68%	10,267	2.7	$105 - $117
One-way switch-based utility load control - incremental	68%	10,267	2.7	$77 - $86
Lighting				
One-way switch-based utility load control - stand-alone	95%	14,379	1.2	$270 - $300
One-way switch-based utility load control - incremental	95%	14,379	1.2	$80 - $89
Plug Loads				
One-way switch-based utility load control - stand-alone	95%	14,379	1.0	$172 - $234
One-way switch-based utility load control – incremental	95%	14,379	1.0	$51 - $69
Electric Pools and Spas				
One-way switch-based utility load control - stand-alone	6.3%	949	0.6	$77 - $82
One-way switch-based utility load control – incremental	6.3%	949	0.6	$37 - $39

Summary of Lower Achievable Electric Peak Load Reductions: Capacity Measures

Exhibit 42-2R below shows the residential lower achievable demand reduction for peak period 1 and the average full cost CEPR value by end use category for each milestone year until 2035. The demand curve showing the lower achievable demand with EE measures only versus the lower achievable demand with both EE and capacity measures is shown in Exhibit 42-3R. The following approach was taken in developing these exhibits:

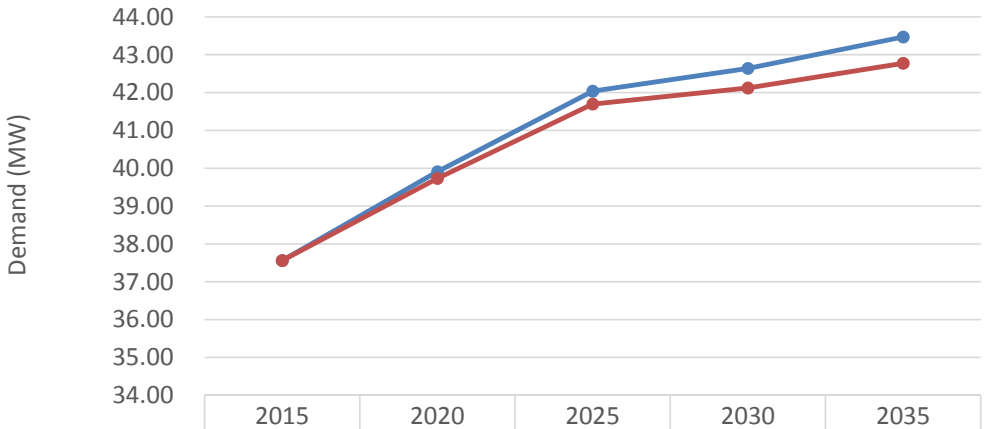
- The demand for each end use category after EE measures are applied was used as the baseline demand from which peak reductions occur due to capacity measures
- A lower achievable potential of 5% was assumed for all capacity measures, and was linearly extrapolated to all milestone years from a starting uptake of 0% in 2015 (due to lack of utility programs) up to a maximum of 5% in the year 2035.

Note that results of the achievable reduction due to capacity measures presented below are based upon the *lower* achievable potential and are subject to variation as they are highly jurisdiction-specific and dependent upon the structure of the utility programs. It is recommended that additional research be conducted in order to account for these limitations.

Exhibit 42-2R Lower Achievable Potential Peak Load Reductions by End Use (MW) – Capacity Measures

	2020	2025	2030	2035	Average CEPR ($/kW/yr.)
Space Heating	0.10	0.21	0.31	0.41	$100
Electric Water Heating	0.03	0.07	0.10	0.14	$111
Lighting	0.02	0.03	0.04	0.06	$285
Plug Loads	0.01	0.03	0.04	0.05	$203
Electric Pools and Spas	0.01	0.01	0.02	0.03	$80
TOTAL	**0.17**	**0.35**	**0.52**	**0.69**	

Exhibit 42-3R Lower Achievable Potential Demand (MW) – EE Measures only vs. EE & Capacity Measures



	2015	2020	2025	2030	2035
Demand with Lower Achievable EE Measures Applied (MW)	37.56	39.90	42.04	42.64	43.47
Lower Achievable Potential Demand (MW)	37.56	39.73	41.69	42.12	42.78

3.2 Commercial Results

Base Year

This section presents the results of the analysis of electricity consumption for the Base Year 2014. Electricity consumption is measured at the customer's point-of-use and does not include line losses.

Exhibit 10C presents total commercial sector hydro grid electricity consumption by sub sector and end use.

Base Year Electricity Use by Sub Sector

Other General Service Buildings account for the largest share of electricity use within the building sub sectors (19%), followed by Office (15%), and Education, Warehouse/Wholesale and Non-food Retail at 9% each.

Non-buildings account for 12% of Base Year Commercial sector hydro grid electricity use.

Base Year Electricity Use by End Use

Lighting is the largest Commercial sector end use, accounting for approximately 37% of total Commercial sector hydro grid electricity use. Indoor lighting, which consists of general, architectural and high-bay lighting, accounts for approximately 34%, while outdoor lighting accounts for the remaining 3%.

Space heating is the second largest end use, accounting for 14% of Commercial sector hydro grid electricity use, followed by refrigeration (9%), HVAC fans & pumps (8%), and computer equipment (6%). Cooking equipment, domestic water heating and a number of smaller end uses account for the remaining Commercial sector hydro grid electricity use.

Non-building loads are treated as both an end use and sub sector in this analysis. These loads account for 12% of Commercial sector end use hydro grid electricity consumption. Energy consumption for street lighting and block heaters is broken out separately as well.

Exhibit 10C Base Year Annual Commercial Electricity Consumption by Sub Sector and End Use (MWh/yr.)

Sub Sector	General Lighting	Architectural Lighting	High Bay Lighting	Outdoor Lighting	Space Heating	Space Cooling	HVAC Fans and Pumps	Water Heating	Computer Equipment	Other Plug Loads	Food Service Equipment	Refrigeration	Elevators	Miscellaneous	Non Buildings	Street Lighting	Block Heater	Grand Total
Office	6,421	2,127	-	642	6,135	621	2,882	478	4,091	1,055	144	151	146	756	-	-	-	25,650
Food Retail	628	620	1,064	275	604	41	510	110	185	177	130	6,498	-	54	-	-	-	10,896
Non-food Retail	4,959	2,642	996	865	2,150	167	1,377	148	530	635	253	379	-	253	-	-	-	15,354
Hotel / Motel	860	1,543	-	291	2,225	148	980	721	365	330	214	514	66	174	-	-	-	8,430
Healthcare	1,246	458	-	196	723	46	1,315	81	251	392	116	87	45	58	-	-	-	5,013
Education	3,820	1,504	585	410	3,313	52	1,650	1,069	1,158	942	483	479	-	241	-	-	-	15,707
Recreation Centres	511	273	1,921	587	190	3	350	145	27	224	312	2,570	-	138	-	-	-	7,252
Restaurant	461	1,660	-	593	1,239	67	669	379	103	135	877	1,888	-	54	-	-	-	8,124
Warehouse / Wholesale	885	728	6,425	677	1,221	6	919	126	712	646	160	2,793	-	399	-	-	-	15,696
Other General Service Buildings	9,038	3,970	973	1,264	5,958	535	3,227	442	3,190	1,309	337	469	96	741	-	-	-	31,550
Non-Buildings	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20,562	-	-	20,562
Street lighting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,714	-	3,714
Parking Lot Plug	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	360	360
Grand Total	28,830	15,524	11,962	5,799	23,757	1,687	13,878	3,700	10,613	5,846	3,024	15,828	353	2,869	20,562	3,714	360	168,308

Technology Screening

A summary of the technology screening results is provided in Exhibit 25C. For each of the measures, the exhibit shows:

- The name of the measure
- The cost basis[3] for the CCE that is shown, e.g., full versus incremental
- The measure's average CCE when applied to all sub sectors.

Measures analyzed on the basis of full cost have been placed towards the top of the exhibit below because they are qualitatively different from the measures that pass only on an incremental basis. A measure that passes on a full-cost basis can be applied immediately, even if the piece of equipment it replaces or improves is currently working properly. That means the rate at which the measure can be implemented as a utility DSM measure is limited by market and program constraints. A measure that passes only on an incremental basis, on the other hand, is limited by the rate of natural replacement (due to failure or obsolescence) or purchase of the piece of equipment it replaces.

Exhibit 25C Commercial Sector Energy-efficiency Technology Measures, Screening Results[4] - Hydro Region

Measure Name	Basis (Full/[5] Incremental)	Average CCE (¢/kWh)
Low Flow Faucets	Full	0.22
Lighting Controls (Outdoor)	Full	0.39
Low Flow Showerheads	Full	0.48
Demand-Controlled Kitchen Ventilation	Full	0.64
Domestic Hot Water Tank Insulation	Full	1.72
Brine Pump Control	Full	1.84
Infrared Electric Radiant Heaters	Full	1.90
LED High Bay Fixtures	Full	2.15
Air Sealing	Full	2.26
Adjustable Speed Drive (Fan Application)	Full	2.32
Demand-Controlled Ventilation	Full	2.33
High-Volume Low-Speed Destratification Fans	Full	2.39
Building Recommissioning	Full	2.80
High Performance T8 (T12 Retrofit)	Full	2.92
LED Lamps (Outdoor)	Full	3.18
LED Street Lighting	Full	3.46
Block Heater Controls	Full	3.58
Air-to-Air Heat Recovery	Full	3.70
White LED Lamps	Full	4.40
Occupancy Controls	Full	4.74
Drainwater Heat Recovery	Full	4.85
LED Fluorescent Fixtures	Full	5.77
Ceramic Metal Halide Lamps	Full	6.04

[3] See Step 3 in Section 7.2 for a complete description.
[4] Average CCE does not include program costs.
[5] Due to the high avoided cost of new supply in Yukon many measures pass at full cost. The CCEs for energy-efficient equipment upgrades at time of failure (incremental) are typically significantly lower.

Measure Name	Basis (Full/[5] Incremental)	Average CCE (¢/kWh)
High Performance T8 (Redesign)	Full	6.61
Low Flow Pre-Rinse Spray Valves	Full	6.81
LED Wallpack Outdoor Fixtures	Full	7.18
Ground-Source Heat Pump	Full	7.68
Refrigeration Plant Controls	Full	8.61
High Performance T8 (T8 Retrofit)	Full	9.62
Adaptive Thermostats	Full	9.70
High Efficiency Refrigeration Equipment - Full Cost Measures	Full	10.79
Refrigeration Plant Heat Recovery	Full	16.15
Premium Efficiency Motors	Full	17.42
Dimming Controls (Daylighting)	Full	18.21
T5 High Output Arena Lighting	Full	24.31
Low Emissivity Ceiling	Full	34.36
New Building Construction - 25% Better than Current Practice	Incr.	1.95
New Building Construction - 40% Better than Current Practice	Incr.	3.66
ENERGY STAR Computers	Incr.	4.56
High Performance Glazing	Incr.	5.23
ENERGY STAR Servers	Incr.	6.34
ENERGY STAR Refrigerators and Freezers	Incr.	6.84
Halogen IR Lamps	Incr.	7.26
ENERGY STAR Office Equipment	Incr.	7.78
New Building Construction - 60% Better than Current Practice	Incr.	8.13
Wall Insulation Upgrade	Incr.	9.60
High-Efficiency Cooking Equipment	Incr.	10.49
Super High Performance Glazing	Incr.	10.65
Roof Insulation Upgrade	Incr.	11.86
High Efficiency Refrigeration Equipment - Incremental Cost Measures	Incr.	12.84
High Efficiency Chillers	Incr.	53.64
High Efficiency Packed Direct-Expansion (DX) Cooling	Incr.	94.29
Low Flow Faucets	Full	0.22
Lighting Controls (Outdoor)	Full	0.39
Low Flow Showerheads	Full	0.48
Demand-Controlled Kitchen Ventilation	Full	0.64
Domestic Hot Water Tank Insulation	Full	1.72
Brine Pump Control	Full	1.84

Energy-efficiency Supply Curves

A supply curve was constructed based on the approximate Economic Potential savings associated with the above measures. The following approach was followed:

- Measures are introduced in sequence to show incremental impact and cost
- Sequence was determined by listing first the items that reduce the electrical load, then those that meet residual load with the most efficient technology
- Items appear in order, beginning with those that have the lowest average CCE

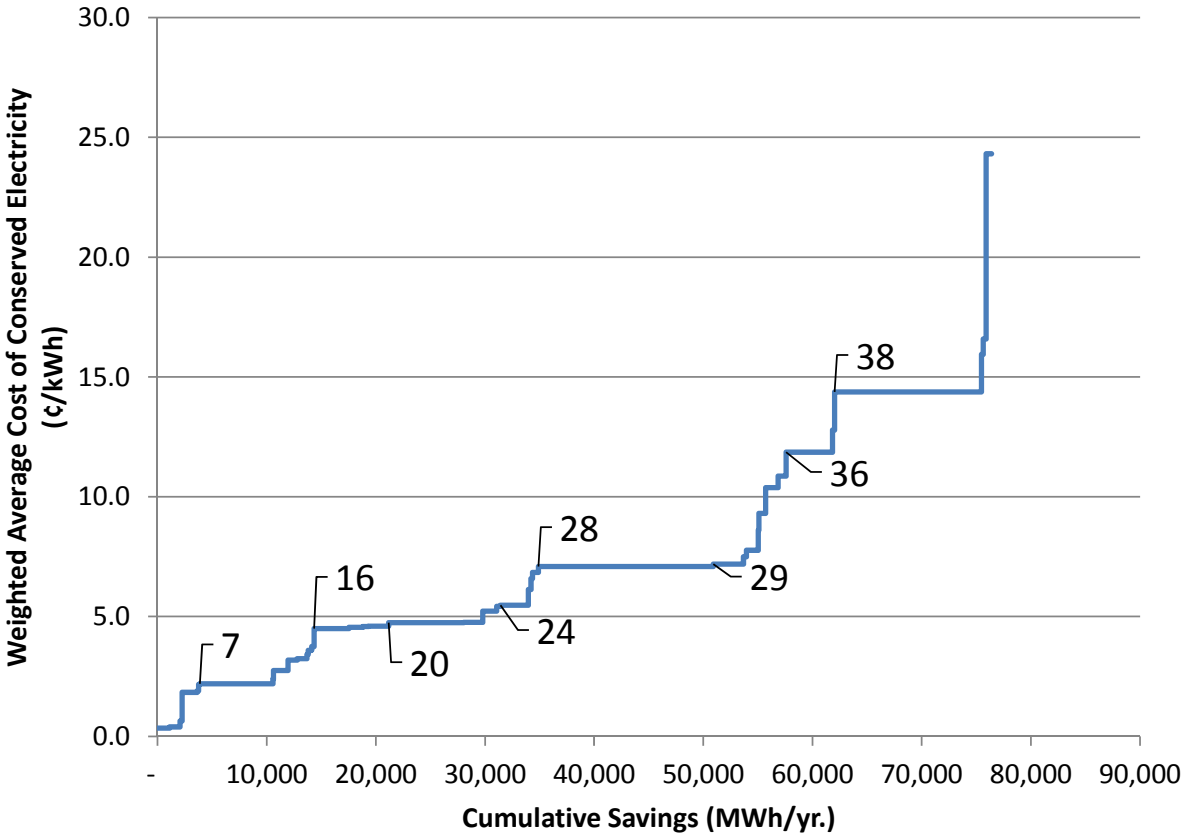
Exhibit 35C shows the measures included in the supply curve and Exhibit 36C shows the supply curve for Yukon as a whole in the 2030 milestone year. Since the 2035 results are based off of an extrapolation of 2030 results without any further achievable workshop consultations, the penetration and participation values for all measures were held constant over this period. Therefore, the 2030 supply curve results are presented below as this milestone year has the most reliable data.

Exhibit 35C Summary of Commercial Sector Energy-efficiency Measures, 2030

Ref #	Measure	Economic Potential Savings (MWh/yr.)	Cost of Savings ($)	Weighted Average CCE (¢/kWh)
1	Low Flow Faucets	1,095	3,758	0.3
2	Lighting Controls (Outdoor)	965	3,788	0.4
3	Demand Controlled Kitchen Ventilation	188	1,198	0.6
4	Brine Pump Control	1,374	25,246	1.8
5	Infrared Electric Radiant Heaters	131	2,490	1.9
6	Low Flow Pre Rinse Spray Valves	114	2,478	2.2
7	LED High Bay Fixtures	6,710	147,050	2.2
8	High-Volume Low-Speed Destratification Fans	50	1,190	2.4
9	Adjustable Speed Drive (Fan Application)	1,324	36,390	2.7
10	LED Lamps (Outdoor)	850	27,021	3.2
11	Air Sealing	898	29,169	3.2
12	Tank Insulation	98	3,346	3.4
13	Block Heater Controls	234	8,390	3.6
14	Drainwater Heat Recovery	93	3,351	3.6
15	Adaptive Thermostats	213	7,975	3.7
16	ENERGY STAR Computers	3,207	144,419	4.5
17	HP to redesign increment	1256	57208	4.6
18	DC Ventilation	523	24,026	4.6
19	High Efficiency Refrigeration - Full Cost	1,840	84,617	4.6
20	Building Recommissioning	6,889	326,795	4.7
21	Air to Air HR	1,744	82,959	4.8

Ref #	Measure	Economic Potential Savings (MWh/yr.)	Cost of Savings ($)	Weighted Average CCE (¢/kWh)
22	HP Glazing	1,270	66,443	5.2
23	HP to SHP Glazing increment	359	19,480	5.4
24	HE Refrigeration - Incr. Cost	2,545	139,235	5.5
25	Low Flow Showerheads	233	14,279	6.1
26	Occupancy Controls	139	9,141	6.6
27	ENERGY STAR Fridges, Freezers	544	37223	6.8
28	LED Fluorescent Fixtures	16,040	1,137,413	7.1
29	LED Wallpack Outdoor Fixtures	2,762	198,398	7.2
30	ENERGY STAR Office Equipment	261	19,608	7.5
31	Ground-Source Heat Pumps	1,075	83,489	7.8
32	Refrigeration Plant Controls	58	5,003	8.6
33	ENERGY STAR Servers	632	58,851	9.3
34	Wall Insulation	1,124	116,721	10.4
35	Roof Insulation	754	81,917	10.9
36	High Performance T8 (T8 Retrofit)	4,260	505,173	11.9
37	PE Motors	176	22,446	12.8
38	Whole Building - 60% More Efficient than Current	13449	1933922	14.4
39	High Efficiency Cooking Equipment	171	27,252	15.9
40	Dimming Controls (Daylighting)	258	42,702	16.6
41	T5HO Arena Lighting	488	118,717	24.3
	Total	76,395	5,660,277	7.4

Exhibit 36C Energy-efficiency Supply Curve, Commercial Sector, 2030



Summary of Potential Electric Energy Savings

Exhibits 54C and 58C present the achievable potential results for the total hydro grid connected Yukon service territory by technology and milestone year.[6] The most significant savings in the Achievable Potential come from the following measures:

- Building recommissioning, which accounts for 16% of the upper Achievable Potential savings in 2035 and 15% of the lower Achievable Potential savings in 2035
- LED fluorescent fixtures, which account for 14% of the upper Achievable Potential savings in 2035 and 12% of the lower Achievable Potential savings in 2035
- LED high bay fixtures, which account for 11% of the upper Achievable Potential savings in 2035 and 9% of the lower Achievable Potential savings in 2035
- High performance new buildings (whole building – 60% more efficient than current), which account for 9% of the upper Achievable Potential savings in 2035 and 11% of the lower Achievable Potential savings in 2035
- High efficiency refrigeration measures (both full and incremental cost), which account for 8% of the upper Achievable Potential savings in 2035 and 15% of the lower Achievable Potential savings in 2035
- ENERGY STAR computers, which account for 5% of the upper Achievable Potential savings in 2035 and 7% of the lower Achievable Potential savings in 2035
- LED wallpack outdoor fixtures, which account for 4% of the upper Achievable Potential savings in 2035 and 4% of the lower Achievable Potential savings in 2035

There are numerous other smaller measures that contribute to the overall Achievable Potential results.

[6] Note that these exhibits were not present in the original commercial sector report. However, they are equivalent to Exhibits 54 and 58 in the original residential sector report.

Exhibit 54C Upper Achievable Electricity Savings by Technology and Milestone Year (MWh/yr.)

End Use	Measure	2015	2020	2025	2030	2035	Adoption Curve	Weighted Average CCE (¢/kWh)
General Lighting	LED Fluorescent Fixtures	1,279	2,813	4,561	6,481	6,350	A/B	3.7
General Lighting	Building Recommissioning	558	2,107	4,398	7,128	7,059	B	2.7
High Bay Lighting	LED High Bay Fixtures	799	1,890	3,257	4,881	4,881	A/B	1.2
Space Heating	Whole Building - 60% More Efficient than Current	30	523	2,076	4,518	3,981	B	11.2
Refrigeration	High Efficiency Refrigeration - Full Cost	1,805	1,805	1,805	1,805	1,805	D	4.5
Computer Equipment	Energy Star ® Computers	256	1,594	1,948	2,294	2,331	B	3.6
Outdoor Lighting	LED Wallpack Outdoor Fixtures	346	802	1,349	1,965	1,965	A/B	3.8
General Lighting	High Performance T8 (T8 Retrofit)	321	718	1,186	1,720	1,685	A/B	6.2
Refrigeration	HE Refrigeration - Incr. Cost	39	468	1,126	1,843	1,843	A/B	6.3
Space Heating	Air to Air HR	115	446	946	1,546	1,521	B	2.6
Outdoor Lighting	Lighting Controls (Outdoor)	274	577	846	1,016	1,016	A/B	0.3
HVAC Fans and Pumps	Adjustable Speed Drive (Fan Application)	64	255	573	1,019	1,019	B	1.4
Water Heating	Low Flow Faucets	207	415	622	829	829	A/B	0.2
General Lighting	Dimming Controls (Daylighting)	103	309	528	685	671	A/B	10.7
Space Heating	Air Sealing	51	203	448	772	759	B	1.7
Outdoor Lighting	LED Lamps (Outdoor)	134	297	475	653	653	B	2.0
Space Heating	Ground-Source Heat Pumps	163	306	414	473	465	A	2.7
Computer Equipment	Energy Star ® Servers	165	310	380	449	456	B	7.3
Refrigeration	Brine Pump Control	120	241	361	481	481	A	0.5
Space Heating	HP Glazing	7	85	234	453	595	A	1.5
Space Heating	DC Ventilation	35	134	284	464	456	B	2.5
General Lighting	Occupancy Controls	86	185	285	370	362	A/B	3.8
High Bay Lighting	T5HO Arena Lighting	64	151	261	391	391	A/B	13.4
Space Heating	Wall Insulation	7	81	220	420	521	A	3.0
Space Heating	Roof Insulation	5	57	155	294	362	A	3.2
General Lighting	HP to redesign increment	47	106	175	254	248	A/B	2.4
Computer Equipment	Energy Star ® Office Equipment	22	136	164	192	195	B	6.1
Space Heating	Adaptive Thermostats	57	110	154	190	187	A/B	2.0
Water Heating	Low Flow Showerheads	47	93	140	186	186	A/B	2.9
Refrigeration	Energy Star ® Fridges, Freezers	5	57	150	204	201	A/B	3.4
Space Heating	Demand Controlled Kitchen Ventilation	14	53	112	183	179	B	0.4
Other Plug Loads	Block Heater Controls	23	58	107	171	174	A/B	1.9
Space Heating	HP to SHP Glazing increment	2	25	69	133	174	A	1.6
HVAC Fans and Pumps	PE Motors	7	30	74	139	139	B	6.7
Water Heating	Low Flow Pre Rinse Spray Valves	23	46	68	91	91	A/B	1.1
Water Heating	Tank Insulation	21	40	59	77	77	A/B	1.7
Space Heating	Infrared Electric Radiant Heaters	17	32	46	56	55	A	0.6
Food Service Equipment	High Efficiency Cooking Equipment	1	17	45	61	60	A	4.6
Refrigeration	Refrigeration Plant Controls	11	20	29	36	36	A	2.9
Water Heating	Drainwater Heat Recovery	10	19	27	34	34	A	1.2
Space Heating	High-Volume Low-Speed Destratification Fans	8	14	20	24	24	A	0.8
Grand Total		7,345	17,628	30,178	44,983	44,518		4.0

Exhibit 58C Lower Achievable Electricity Savings by Technology and Milestone Year (MWh/yr.)

End Use	Measure	2015	2020	2025	2030	2035	Adoption Curve	Weighted Average CCE (¢/kWh)
Water Heating	Low Flow Faucets	104	207	311	415	415	A/B	0.3
Outdoor Lighting	Lighting Controls (Outdoor)	152	341	547	748	748	A/B	0.4
Space Heating	Demand Controlled Kitchen Ventilation	7	28	61	105	105	B	0.6
Refrigeration	Brine Pump Control	34	69	103	137	137	A	1.8
Space Heating	Infrared Electric Radiant Heaters	5	10	14	18	18	A	1.9
Water Heating	Low Flow Pre Rinse Spray Valves	11	23	34	46	46	A/B	2.2
High Bay Lighting	LED High Bay Fixtures	420	995	1,714	2,569	2,569	A/B	2.2
Space Heating	High-Volume Low-Speed Destratification Fans	2	4	6	8	8	A	2.4
HVAC Fans and Pumps	Adjustable Speed Drive (Fan Application)	32	127	287	509	509	B	2.7
Outdoor Lighting	LED Lamps (Outdoor)	33	124	254	408	408	B	3.2
Space Heating	Air Sealing	26	102	229	403	401	B	3.2
Water Heating	Tank Insulation	10	21	30	40	40	A/B	3.3
Other Plug Loads	Block Heater Controls	12	30	56	90	92	A/B	3.6
Water Heating	Drainwater Heat Recovery	3	6	8	11	11	A	3.6
Space Heating	Adaptive Thermostats	29	56	80	101	101	A/B	3.7
Space Heating	DC Ventilation	17	68	150	258	257	B	4.5
Refrigeration	High Efficiency Refrigeration - Full Cost	903	1,805	1,805	1,805	1,805	D	4.5
Computer Equipment	Energy Star ® Computers	224	1,297	1,544	1,837	1,867	B	4.5
General Lighting	HP to redesign increment	25	56	92	133	131	A/B	4.5
Space Heating	Air to Air HR	58	228	501	859	855	B	4.6
General Lighting	Building Recommissioning	284	1,099	2,376	4,030	3,999	B	4.8
	Subtotal (CCE up to 5 ¢/kWh)	**2,391**	**6,696**	**10,205**	**14,532**	**14,522**		**3.6**
Space Heating	HP Glazing	2	24	67	129	170	A	5.2
Refrigeration	HE Refrigeration - Incr. Cost	78	702	1,430	2,184	2,184	A/B	5.3
Space Heating	HP to SHP Glazing increment	1	7	20	39	51	A	5.4
Water Heating	Low Flow Showerheads	23	47	70	93	93	A/B	5.8
General Lighting	Occupancy Controls	46	105	171	239	234	A/B	5.9
Refrigeration	Energy Star ® Fridges, Freezers	1	14	56	102	101	A/B	6.8
General Lighting	LED Fluorescent Fixtures	673	1,480	2,400	3,411	3,342	A/B	7.1
Outdoor Lighting	LED Wallpack Outdoor Fixtures	182	422	710	1,034	1,034	A/B	7.2
Computer Equipment	Energy Star ® Office Equipment	20	113	133	157	159	B	7.4
Space Heating	Ground-Source Heat Pumps	47	91	131	163	162	A	7.8
Refrigeration	Refrigeration Plant Controls	3	6	9	12	12	A	8.6
Computer Equipment	Energy Star ® Servers	142	251	299	357	363	B	9.2
	Subtotal (CCE between 5 -10 ¢/kWh)	**1,218**	**3,263**	**5,496**	**7,921**	**7,906**		**6.6**
Space Heating	Wall Insulation	2	23	63	122	153	A	10.4
Space Heating	Roof Insulation	1	17	45	87	108	A	10.8
General Lighting	High Performance T8 (T8 Retrofit)	169	378	624	905	887	A/B	11.8
HVAC Fans and Pumps	PE Motors	3	15	38	72	72	B	12.9
Space Heating	Whole Building - 60% More Efficient than Current	24	408	1,619	3,523	3,104	B	14.4
	Subtotal (CCE between 10 -15 ¢/kWh)	**199**	**841**	**2,390**	**4,710**	**4,324**		**13.6**
Food Service Equipment	High Efficiency Cooking Equipment	0	5	13	17	17	A	16.1
General Lighting	Dimming Controls (Daylighting)	56	175	316	443	434	A/B	16.6
High Bay Lighting	T5HO Arena Lighting	34	81	142	215	215	A/B	24.3
	Subtotal (CCE greater than 15 ¢/kWh)	**90**	**261**	**470**	**675**	**666**		**19.1**
	Grand Total	**3,899**	**11,060**	**18,561**	**27,838**	**27,417**		**6.4**

Summary of Electric Peak Load Reductions: Electric Energy Measures

Exhibits 62C and 65C show the demand reductions associated with each electric energy savings measure in 2030. The 2030 results are presented in place of the 2035 results as they are more reliable results. With the absence of new achievable potential workshops, the results from 2035 were extrapolated from 2030 results with penetration and participation rates held constant. Most measures contribute to the peak demand reductions approximately in proportion to their electric energy savings. The results by milestone year are presented for the upper and lower achievable peak period 1 reductions in exhibits 62-2C and 65-2C respectively.

Exhibit 62C Electric Peak Load Reductions from Upper Achievable Energy Savings Measures, 2030 (MW)

Measure	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Building Recommissioning	1.26	1.17	0.94
LED Fluorescent Fixtures	1.04	0.99	0.70
Whole Building - 60% More Efficient than Current	0.99	0.89	0.71
LED High Bay Fixtures	0.86	0.75	0.57
LED Wallpack Outdoor Fixtures	0.53	0.55	0.53
Air to Air HR	0.48	0.41	0.33
Energy Star ® Computers	0.32	0.31	0.16
High Performance T8 (T8 Retrofit)	0.28	0.26	0.19
Lighting Controls (Outdoor)	0.28	0.28	0.28
Air Sealing	0.24	0.20	0.16
HE Refrigeration - Incr. Cost	0.21	0.21	0.20
High Efficiency Refrigeration - Full Cost	0.21	0.21	0.20
LED Lamps (Outdoor)	0.18	0.18	0.18
Adjustable Speed Drive (Fan Application)	0.16	0.15	0.11
DC Ventilation	0.14	0.12	0.10
Ground-Source Heat Pumps	0.14	0.12	0.10
HP Glazing	0.14	0.12	0.10
Wall Insulation	0.13	0.11	0.09
Dimming Controls (Daylighting)	0.11	0.10	0.07
Roof Insulation	0.09	0.08	0.06
Low Flow Faucets	0.08	0.08	0.07
T5HO Arena Lighting	0.07	0.06	0.04
Brine Pump Control	0.07	0.07	0.06
Energy Star ® Servers	0.06	0.06	0.03
Occupancy Controls	0.06	0.06	0.04
Demand Controlled Kitchen Ventilation	0.06	0.05	0.04
Adaptive Thermostats	0.05	0.04	0.03
HP to SHP Glazing increment	0.04	0.04	0.03
HP to redesign increment	0.04	0.04	0.03
Low Flow Showerheads	0.03	0.03	0.02
Energy Star ® Office Equipment	0.03	0.03	0.01
Energy Star ® Fridges, Freezers	0.02	0.02	0.02
PE Motors	0.02	0.02	0.02
Block Heater Controls	0.02	0.02	0.02
Infrared Electric Radiant Heaters	0.02	0.02	0.01
Low Flow Pre Rinse Spray Valves	0.02	0.02	0.01
Tank Insulation	0.01	0.01	0.01
High-Volume Low-Speed Destratification Fans	0.01	0.01	0.00
High Efficiency Cooking Equipment	0.01	0.01	0.01
Drainwater Heat Recovery	0.01	0.01	0.00
Refrigeration Plant Controls	0.00	0.01	0.00
Grand Total	8.53	7.90	6.28

Exhibit 62-2C Upper Achievable Electric Peak Load Reductions (Peak Period 1 - Annual Peak Hour) (MW)

Measure	2015	2020	2025	2030	2035
Building Recommissioning	0.10	0.37	0.78	1.26	1.25
LED Fluorescent Fixtures	0.21	0.45	0.73	1.04	1.02
LED High Bay Fixtures	0.14	0.33	0.57	0.86	0.86
Whole Building - 60% More Efficient than Current	0.01	0.11	0.45	0.99	0.87
LED Wallpack Outdoor Fixtures	0.09	0.22	0.37	0.53	0.53
Air to Air HR	0.04	0.14	0.29	0.48	0.47
Energy Star ® Computers	0.04	0.22	0.27	0.32	0.33
High Efficiency Refrigeration - Full Cost	0.21	0.21	0.21	0.21	0.21
Lighting Controls (Outdoor)	0.07	0.16	0.23	0.28	0.28
High Performance T8 (T8 Retrofit)	0.05	0.12	0.19	0.28	0.27
Air Sealing	0.02	0.06	0.14	0.24	0.24
HE Refrigeration - Incr. Cost	0.00	0.05	0.13	0.21	0.21
LED Lamps (Outdoor)	0.04	0.08	0.13	0.18	0.18
Ground-Source Heat Pumps	0.05	0.09	0.12	0.14	0.14
Adjustable Speed Drive (Fan Application)	0.01	0.04	0.09	0.16	0.16
HP Glazing	0.00	0.03	0.07	0.14	0.18
DC Ventilation	0.01	0.04	0.09	0.14	0.14
Wall Insulation	0.00	0.03	0.07	0.13	0.17
Dimming Controls (Daylighting)	0.02	0.05	0.08	0.11	0.11
Low Flow Faucets	0.02	0.04	0.06	0.08	0.08
Roof Insulation	0.00	0.02	0.05	0.09	0.12
Energy Star ® Servers	0.02	0.04	0.05	0.06	0.06
Brine Pump Control	0.02	0.03	0.05	0.07	0.07
T5HO Arena Lighting	0.01	0.03	0.04	0.07	0.07
Occupancy Controls	0.01	0.03	0.05	0.06	0.06
Adaptive Thermostats	0.01	0.03	0.04	0.05	0.05
Demand Controlled Kitchen Ventilation	0.00	0.02	0.04	0.06	0.06
HP to redesign increment	0.01	0.02	0.03	0.04	0.04
HP to SHP Glazing increment	0.00	0.01	0.02	0.04	0.05
Low Flow Showerheads	0.01	0.02	0.02	0.03	0.03
Energy Star ® Office Equipment	0.00	0.02	0.02	0.03	0.03
Energy Star ® Fridges, Freezers	0.00	0.01	0.02	0.02	0.02
Infrared Electric Radiant Heaters	0.01	0.01	0.01	0.02	0.02
PE Motors	0.00	0.00	0.01	0.02	0.02
Block Heater Controls	0.00	0.01	0.01	0.02	0.02
Low Flow Pre Rinse Spray Valves	0.00	0.01	0.01	0.02	0.02
Tank Insulation	0.00	0.00	0.01	0.01	0.01
High-Volume Low-Speed Destratification Fans	0.00	0.00	0.01	0.01	0.01
Drainwater Heat Recovery	0.00	0.00	0.00	0.01	0.01
High Efficiency Cooking Equipment	0.00	0.00	0.01	0.01	0.01
Refrigeration Plant Controls	0.00	0.00	0.00	0.00	0.00
Grand Total	1.25	3.16	5.61	8.53	8.46

Exhibit 65C Electric Peak Load Reductions from Lower Achievable Energy Savings Measures, 2030 (MW)

Measure	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Whole Building - 60% More Efficient than Current	0.77	0.69	0.56
Building Recommissioning	0.72	0.66	0.53
LED Fluorescent Fixtures	0.55	0.52	0.37
LED High Bay Fixtures	0.45	0.39	0.30
LED Wallpack Outdoor Fixtures	0.28	0.29	0.28
Air to Air HR	0.27	0.23	0.18
Energy Star ® Computers	0.26	0.25	0.13
HE Refrigeration - Incr. Cost	0.25	0.25	0.24
High Efficiency Refrigeration - Full Cost	0.21	0.21	0.20
Lighting Controls (Outdoor)	0.20	0.21	0.20
High Performance T8 (T8 Retrofit)	0.15	0.14	0.10
Air Sealing	0.13	0.11	0.08
LED Lamps (Outdoor)	0.11	0.11	0.11
Adjustable Speed Drive (Fan Application)	0.08	0.08	0.06
DC Ventilation	0.08	0.07	0.05
Dimming Controls (Daylighting)	0.07	0.07	0.05
Energy Star ® Servers	0.05	0.05	0.02
Ground-Source Heat Pumps	0.05	0.04	0.03
Low Flow Faucets	0.04	0.04	0.04
HP Glazing	0.04	0.03	0.03
Wall Insulation	0.04	0.03	0.03
Occupancy Controls	0.04	0.04	0.03
T5HO Arena Lighting	0.04	0.03	0.02
Demand Controlled Kitchen Ventilation	0.03	0.03	0.02
Roof Insulation	0.03	0.02	0.02
Adaptive Thermostats	0.03	0.02	0.02
Energy Star ® Office Equipment	0.02	0.02	0.01
HP to redesign increment	0.02	0.02	0.01
Brine Pump Control	0.02	0.02	0.02
Low Flow Showerheads	0.02	0.01	0.01
Energy Star ® Fridges, Freezers	0.01	0.01	0.01
HP to SHP Glazing increment	0.01	0.01	0.01
PE Motors	0.01	0.01	0.01
Block Heater Controls	0.01	0.01	0.01
Low Flow Pre Rinse Spray Valves	0.01	0.01	0.01
Infrared Electric Radiant Heaters	0.01	0.01	0.00
Tank Insulation	0.00	0.00	0.00
High-Volume Low-Speed Destratification Fans	0.00	0.00	0.00
High Efficiency Cooking Equipment	0.00	0.00	0.00
Drainwater Heat Recovery	0.00	0.00	0.00
Refrigeration Plant Controls	0.00	0.00	0.00
Grand Total	5.11	4.76	3.80

Exhibit 65-2C Lower Achievable Electric Peak Load Reductions (Peak Period 1 - Annual Peak Hour) (MW)

Measure	2015	2020	2025	2030	2035
Building Recommissioning	0.05	0.20	0.42	0.72	0.71
Whole Building - 60% More Efficient than Current	0.01	0.09	0.35	0.77	0.68
LED Fluorescent Fixtures	0.11	0.24	0.39	0.55	0.54
LED High Bay Fixtures	0.07	0.18	0.30	0.45	0.45
Energy Star ® Computers	0.03	0.18	0.22	0.26	0.26
High Efficiency Refrigeration - Full Cost	0.10	0.21	0.21	0.21	0.21
LED Wallpack Outdoor Fixtures	0.05	0.11	0.19	0.28	0.28
Air to Air HR	0.02	0.07	0.16	0.27	0.27
HE Refrigeration - Incr. Cost	0.01	0.08	0.17	0.25	0.25
Lighting Controls (Outdoor)	0.04	0.09	0.15	0.20	0.20
High Performance T8 (T8 Retrofit)	0.03	0.06	0.10	0.15	0.14
Air Sealing	0.01	0.03	0.07	0.13	0.13
LED Lamps (Outdoor)	0.01	0.03	0.07	0.11	0.11
Adjustable Speed Drive (Fan Application)	0.01	0.02	0.05	0.08	0.08
DC Ventilation	0.01	0.02	0.05	0.08	0.08
Dimming Controls (Daylighting)	0.01	0.03	0.05	0.07	0.07
Energy Star ® Servers	0.02	0.04	0.04	0.05	0.05
Ground-Source Heat Pumps	0.01	0.03	0.04	0.05	0.05
Low Flow Faucets	0.01	0.02	0.03	0.04	0.04
Occupancy Controls	0.01	0.02	0.03	0.04	0.04
HP Glazing	0.00	0.01	0.02	0.04	0.05
T5HO Arena Lighting	0.01	0.01	0.02	0.04	0.04
Wall Insulation	0.00	0.01	0.02	0.04	0.05
Demand Controlled Kitchen Ventilation	0.00	0.01	0.02	0.03	0.03
Adaptive Thermostats	0.01	0.01	0.02	0.03	0.03
Roof Insulation	0.00	0.01	0.01	0.03	0.03
Energy Star ® Office Equipment	0.00	0.02	0.02	0.02	0.02
HP to redesign increment	0.00	0.01	0.01	0.02	0.02
Brine Pump Control	0.00	0.01	0.01	0.02	0.02
Low Flow Showerheads	0.00	0.01	0.01	0.02	0.02
HP to SHP Glazing increment	0.00	0.00	0.01	0.01	0.02
Energy Star ® Fridges, Freezers	0.00	0.00	0.01	0.01	0.01
PE Motors	0.00	0.00	0.01	0.01	0.01
Block Heater Controls	0.00	0.00	0.01	0.01	0.01
Low Flow Pre Rinse Spray Valves	0.00	0.00	0.01	0.01	0.01
Infrared Electric Radiant Heaters	0.00	0.00	0.00	0.01	0.01
Tank Insulation	0.00	0.00	0.00	0.00	0.00
High-Volume Low-Speed Destratification Fans	0.00	0.00	0.00	0.00	0.00
Drainwater Heat Recovery	0.00	0.00	0.00	0.00	0.00
High Efficiency Cooking Equipment	0.00	0.00	0.00	0.00	0.00
Refrigeration Plant Controls	0.00	0.00	0.00	0.00	0.00
Grand Total	0.65	1.87	3.30	5.11	5.03

Summary of Electric Peak Load Reductions: Capacity Measures

Exhibits 40C and 41C show the economic demand reductions associated with each commercial sector peak load reduction measure in 2015. Exhibit 40C shows the name of the measure, the cost basis for the CEPR that the shown (full versus incremental) and the measure's average CEPR. The following approach was taken in updating these exhibits from the 2011 study:

- The discount rate was updated to 3.38% from 7.5%, thus impacting the CEPR values.
- The applicable count was updated from the 2010 base year to the new 2015 milestone year data, thus impacting the MW reduction for each capacity measure.
- Costing assumptions for each measure were left unchanged from the 2011 CPR study.

Measures analyzed on the basis of full cost have been placed towards the top of Exhibit 40C as they are qualitatively different from the measures that pass only on an incremental basis. A measure that passes on a full-cost basis can be applied immediately, while incremental measures presume the adoption of other technologies as a condition of their cost effectiveness (e.g., facility network gateways).

Exhibit 41C shows a list of the capacity electric peak load reduction measures grouped by applicable end use category. This exhibit shows the measure name, applicable count in 2015, average demand reduction and average CEPR. Note that since there was no threshold established for maximum cost effective CEPR, all measures are listed and there are no exclusions based on cost effectiveness.

Exhibit 40C Commercial Sector Capacity Reduction Measures, Screening Results

Measure Name	Basis (Full/Incremental)	CEPR Ranges ($/kW)
Engine block heater switch-timer	Full	$36 - $45
Lighting switch load control	Full	$19 - $21
Multiple whole facility elevator/HVAC switches	Full	$41
Electric heat switch control for Hotels	Full	$60 - $68
Electric water heater control switches	Full	$49 - $55
Multiple whole facility refrigeration switches	Full	$56
Multiple whole facility plug load switches	Full	$31 - $42
Electric thermal storage room units	Full	$142 - $159
Multiple whole facility elevator/HVAC switches	Incremental	$34
Electric heat switch control for Hotels	Incremental	$46 - $52
Multiple whole facility refrigeration switches	Incremental	$42
Electric water heater control switches	Incremental	$36 - $41
Multiple whole facility plug load switches	Incremental	$18 - $25

Exhibit 41C Economic Potential Electric Capacity measures and MW Impact

Electric Peak Reduction Measures	Applicable Count 2015	Avg. kW/unit	Avg kW	Avg CEPR $/kW/yr.
Space Heating				
One-way switch for engine block heater - utility load control – stand-alone (assumes 10,000 units)	1,395	0.17 - 0.22	271	$36 - $45
Electric thermal storage (10% of Hotel/Health Offices)	792	0.73 - 0.82	617	$142 - $159
One-way switch for control (Hotels) – stand alone	74	5.15 - 5.77	404	$60 - $68
One-way switch for control (Hotels) - incremental	74	5.15 - 5.77	404	$46 - $52
Electric Water Heating				
One-way switch-based utility load control – stand alone	925	0.52 - 0.59	514	$49 - $55
One-way switch-based utility load control – incremental	925	0.52 - 0.59	514	$36 - $41
Lighting				
One-way switch-based utility load control – stand alone	1,344	1.6 - 1.77	2,267	$19 - $21
One-way switch-based utility load control - incremental	1,344	1.6 - 1.77	2,267	$19 - $21
Plug Loads				
One-way switch-based utility load control – stand alone	823	0.72 - 0.97	694	$31 - $42
One-way switch-based utility load control – incremental	823	0.72 - 0.97	694	$18 - $25
Other Loads				
One-way switch-based Refrigeration – stand alone	75	1.75	131	$56
One-way switch-based Refrigeration – incremental	75	1.75	131	$42
One-way switch-based Elevators & HVAC Fans – stand alone	60	5.25	315	$41
One-way switch-based Elevators & HVAC Fans – incremental	60	5.25	315	$34

Summary of Lower Achievable Electric Peak Load Reductions: Capacity Measures

Exhibit 41-2C below shows the lower achievable demand reduction for peak period 1 and the average full cost CEPR value by end use category for each milestone year until 2035. The demand curve showing the lower achievable demand with EE measures only versus the lower achievable demand with both EE & capacity measures is show in Exhibit 41-3C. The following approach was taken in developing these exhibits:

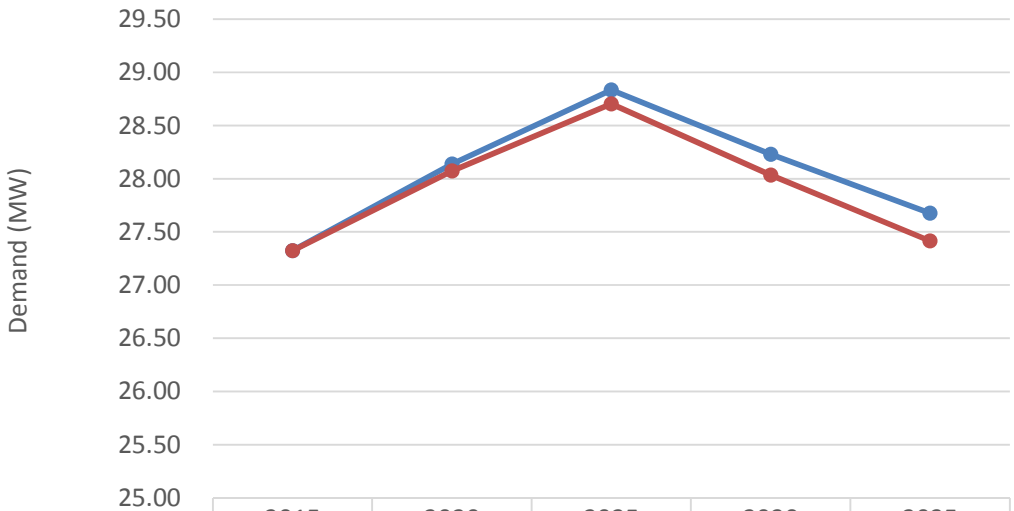
- The demand for each end use category after EE measures are applied was used as the baseline demand from which peak reductions occur due to capacity measures
- A lower achievable potential of 5% was assumed for all capacity measures, and was linearly extrapolated to all milestone years from a starting uptake of 0% in 2015 (due to lack of utility support) up to a maximum of 5% in the year 2035.

Note that results of the achievable reduction due to capacity measures presented below are based upon the *lower* achievable potential and are subject to variation as they are highly jurisdiction-specific and dependent upon the structure of the utility programs. It is recommended that additional research be conducted in order to account for these limitations.

Exhibit 41-2C Lower Achievable Potential Peak Load Reductions by End Use (MW) – Capacity Measures

	2020	2025	2030	2035	Average CEPR ($/kW/yr.)
Space Heating	0.02	0.03	0.05	0.06	$100
Electric Water Heating	0.01	0.01	0.02	0.03	$52
Lighting	0.03	0.06	0.09	0.11	$20
Plug Loads	0.01	0.02	0.03	0.03	$37
Refrigeration	0.00	0.00	0.00	0.01	$56
Elevators & HVAC Fans	0.00	0.01	0.01	0.02	$41
TOTAL	**0.07**	**0.13**	**0.20**	**0.26**	

Exhibit 41-3C Lower Achievable Potential Demand (MW) – EE Measures only vs. EE & Capacity Measures



	2015	2020	2025	2030	2035
Demand with Lower Achievable EE Measures Applied (MW)	27.32	28.14	28.84	28.23	27.68
Lower Achievable Potential Demand (MW)	27.32	28.07	28.70	28.03	27.42

3.3 Discussion

Cost of Conserved Energy (CCE)

The CCE values in this study do not account for program costs. In addition, parameters that affect the NTG (net-to-gross) ratio (e.g. free-ridership, spillover, etc.) are highly dependent on the design of programs and other jurisdiction-specific features. Since the CCE values for the study do not assume a NTG ratio (i.e. distortion effects, such as free ridership, are ignored since they are program constructs), the CCE values are closer to being gross values.

However, the reference case assumes natural efficiency. This means that the reference case incorporates assumptions for changes to the penetration of energy efficiency measures in absence of utility support over the timeframe of the study. As such, the measure savings values are closer to being net of free ridership.

ICF expects that the CCE can be used as a proxy of utility program costs for YEC, since only a portion of the measure costs are covered by the utility. A recent study by the Lawrence Berkeley National Lab (LBNL) assessed the total cost of electric energy efficiency programs and the relative investments by program administrators versus program participants. Investments by program participants were net of incentives and/or rebates by utilities. The study found that the cost per unit savings varied significantly by jurisdiction and program type, as did the relative investment by program administrators versus participants. However, the study found that, on average, “program administrators and participants split the cost of saving electricity almost

exactly in half".[7] Since the CCE includes all measure costs and the average utility incentive for many energy efficiency programs is no more than 30% of measure costs, the CCE is a reasonable proxy of overall utility program costs for implementing energy efficiency; especially in a jurisdiction with a relatively small number of customers.

An ACEEE study, which focuses on utility costs (program spending) per unit savings and includes only electric DSM programs, is a useful point of reference as well.[8] This study profiled 14 leading EE program administrators in the US and a total of 107 program years. The study found that the levelized cost of saved energy (LCSE) ranged between 1 and 8 cents/kWh and the median was $0.035/kWh for their sample (i.e. all values in $USD). YEC would be expected to be on the higher end of this range based on the size of your jurisdiction and the fact that DSM programs are fairly new.

Achievable Potential

As noted earlier in this memo, the achievable potential results are presented as a range, defined as lower and upper. This is because any estimate of Achievable Potential over a long-term period is necessarily subject to uncertainty.

The lower Achievable Potential assumes Yukon market conditions that are similar to those contained in the Reference Case. That is, the customers' awareness of energy-efficiency options and their motivation levels remain similar to those in the recent past, technology improvements continue at historical levels, and new energy performance standards continue as per current known schedules. It also assumes that the ability of the Yukon utilities and government to influence customers' decisions towards increased investments in energy-efficiency options remains roughly in line with previous company DSM experience.

The upper Achievable Potential assumes Yukon market conditions that aggressively support investment in energy efficiency. For example, this scenario assumes that real energy prices increase over the study period. It also assumes that federal and territorial government actions to mitigate climate change result in increased levels of complementary energy-efficiency initiatives. The upper Achievable Potential typically does not reach Economic Potential levels; this recognizes that some portion of the market is typically constrained by barriers that cannot realistically be affected by DSM programs within the study period.

It should also be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific program targets or with program design. While both are closely linked to the discussion of Achievable Potential, they involve more detailed analysis that is beyond the scope of this study. Nonetheless, ICF is aware that achievable potential results are often used to guide targets in some jurisdictions. The lower Achievable Potential often represents a "business-as-usual" scenario in many jurisdictions, while it may represent a more aggressive target in jurisdictions with less DSM experience, such as Yukon.

[7] "The Total Cost of Saving Electricity through Utility Customer-Funded Energy Efficiency Programs: Estimates at the National, State, Sector and Program Level". Lawrence Berkeley National Lab, 2015.
[8] "Big Savers: Experiences and Recent History of Program Administrators Achieving High Levels of Electric Savings". ACEEE, Report Number U1601, April 2016.