City of Columbia Council Work Session

Integrated Electric Resource

and

Master Plan

city of Columbia

Integrated Electric Resource and Master Plan

Tonight's Work Session:

- Provide an update / overview of IERMP
- Gather comments and informational needs from Council

IERMP Task Force

Current Task Force make-up

- Philip Fracica
- Tom O'Connor, Vice Chair
- Alexander Antal
- Dick Parker (also serves as liaison with Climate and Environment Commission)
- Detelina Marinova
- (Vacated Seat)
- Robin Wenneker (Water and Light Advisory Board)
- Kim Fallis (Water and Light Advisory Board)
- David Switzer (Water and Light Advisory Board)
- Jay Hasheider (Water and Light Advisory Board). Chair
- Thomas Jensen (Water and Light Advisory Board)
- Tom Rose (Ad-hoc non-voting representative of the Community Development Commission)
- Gregg Coffin (Ad-hoc non-voting representative of the University of Missouri)

Task Force Assignments

- Assist Staff in:
  - developing an IERMP plan including project costs
  - determine costs of expansion
  - identifying ways to recover costs
  - and right-of-way needs;
- Ensure Public Participation;
- Review Capital Requirements;
- Review costs to expand
- Report with its findings and recommendations related to the Integrated Electric Resource and Master Plan. The Task Force shall be dissolved upon submission of its final report.

Composition of the IERMP study

Three Components

Integrated Electric Resource Plan

Master Plan

Cost of Service

Tonight's Agenda

Integrated Electric Resource Plan

- Load Forecast and Scenarios

Master Plan

- Distribution System Assessment
- Transmission Options
- Non-Wires Alternative
- Value of Solar
- Advanced Metering Infrastructure (AMI)

IRP

- Load Forecast
- Scenarios

Load Forecast

Reference Case Load Forecast

- Identifies energy and peak loads
  - Uses:

    Customer Counts
    Weather

    Economic Parameter

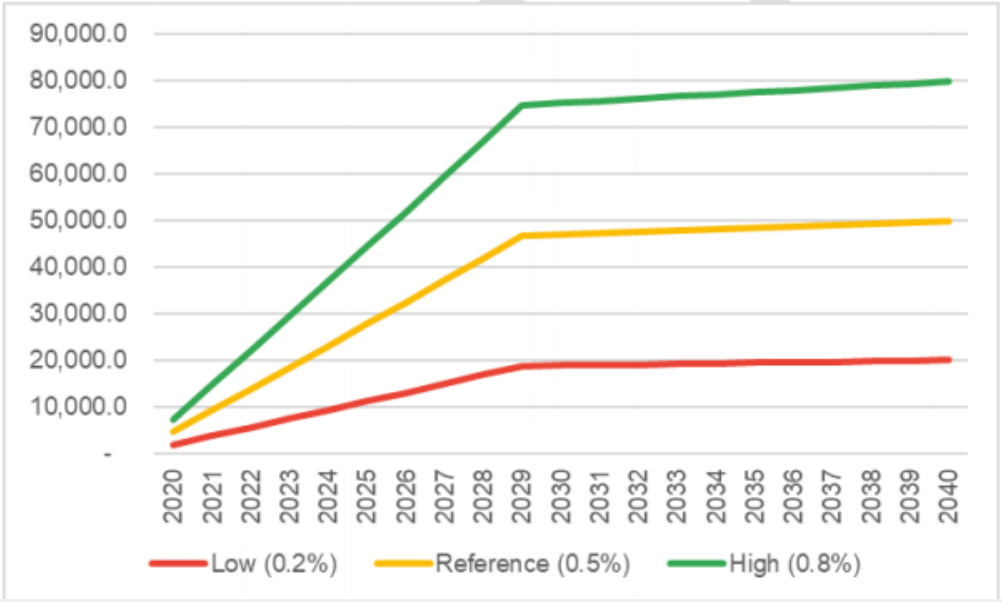
    Distributed Generation (Customer owned solar)
    Electric Vehicles

    Energy Efficiency

Base Load Forecast

Energy Efficiency Forecast

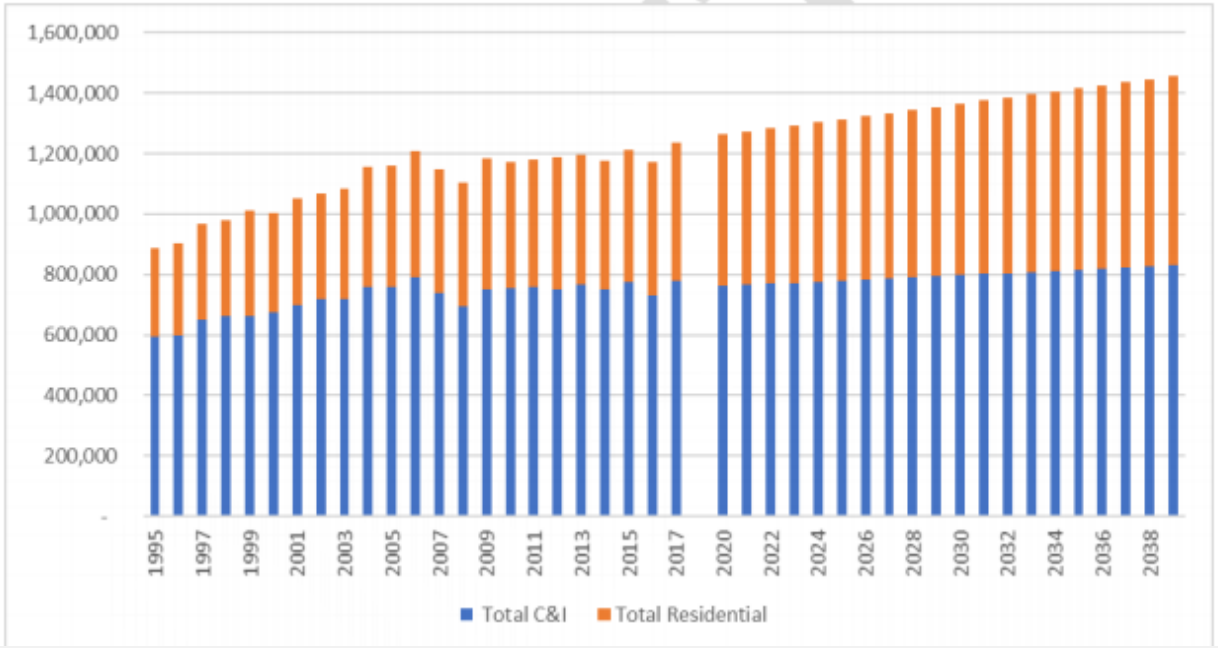
Figure 4: Projected Energy Savings (MWh) for High, Low, and Reference Cases



Base Load Forecast

Energy Growth: 0.8% declining to 0.7%

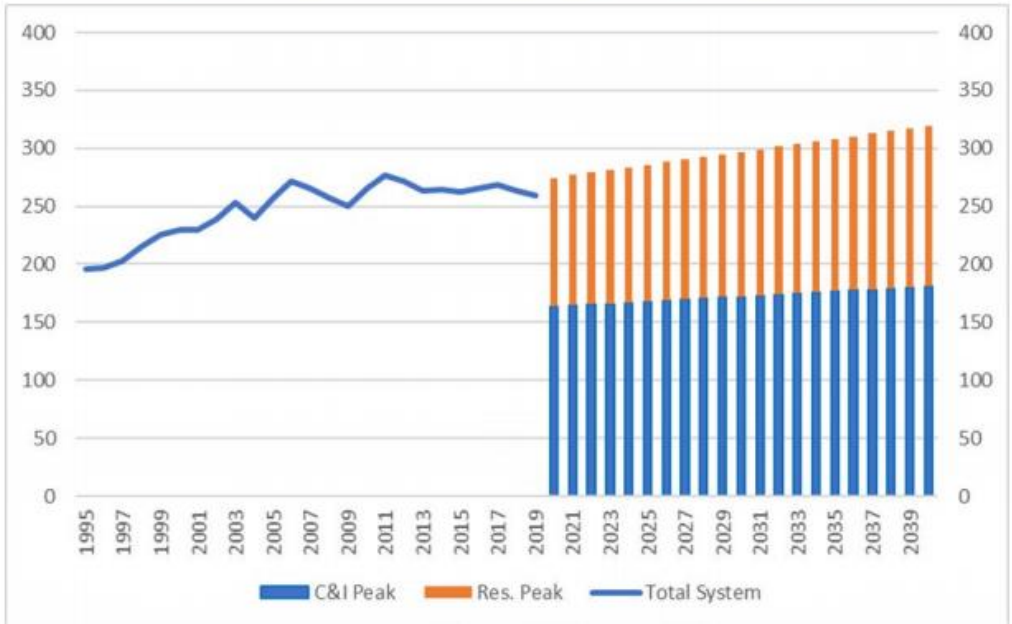
Figure 1: Historical and Forecast (MWh) Energy Consumption (1995-2040)



Base Load Forecast

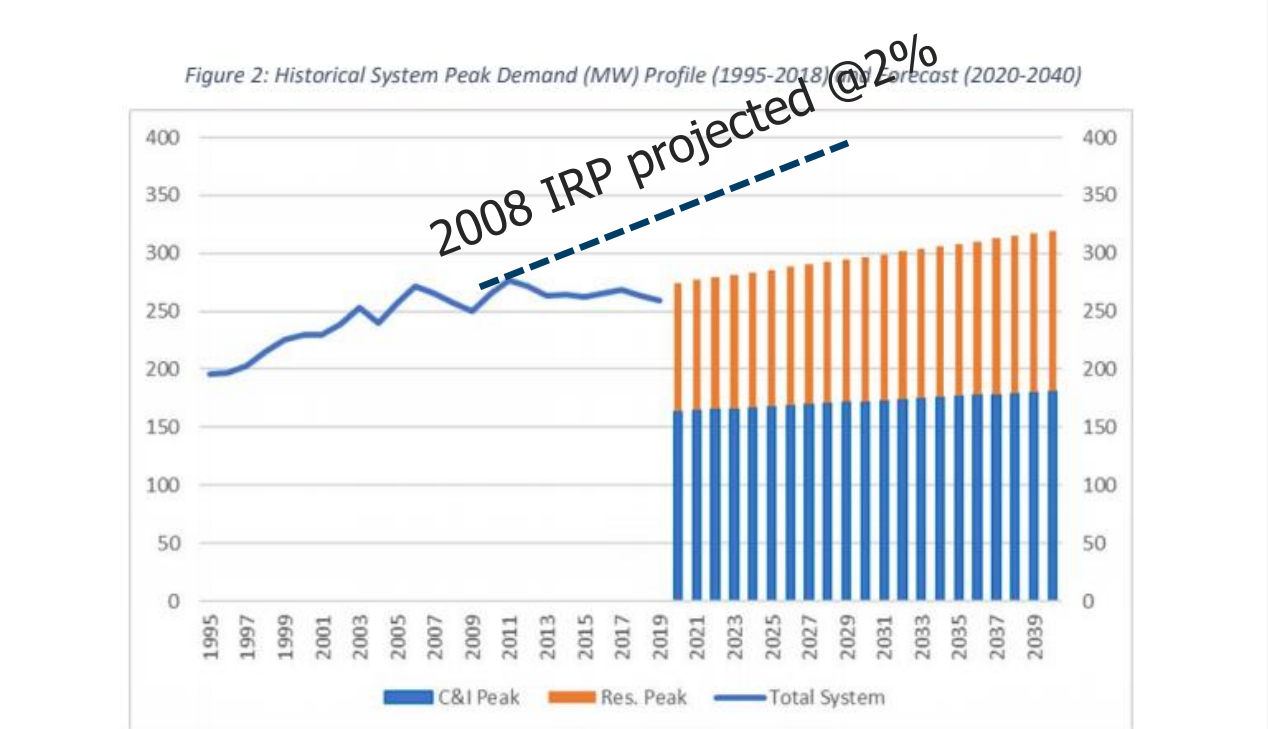
Peak Load Growth : 0.8% declining to 0.7%

Figure 2: Historical System Peak Demand (MW) Profile (1995-2018) and Forecast (2020-2040)

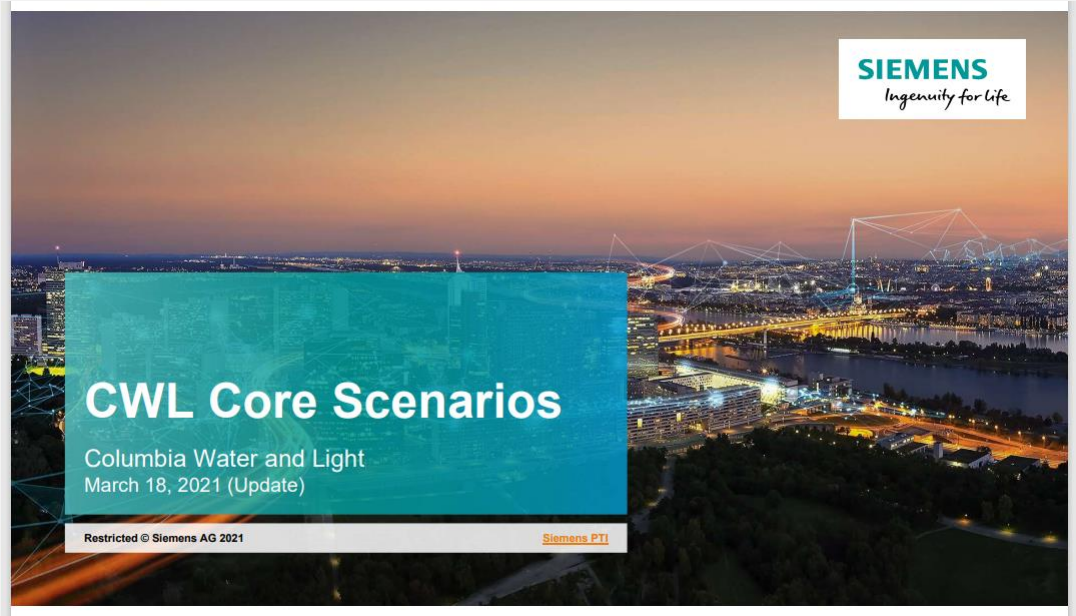


Historical Load Forecast

2008 forecast (at 2%) with actual and Siemens forecast



Scenarios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Ingenuity for life
CWL Core Scenarios
Columbia Water and Light
March 18, 2021 (Update)
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Scenario Presentations

IRP Scenarios

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Scenario Element	Reference Case	High Technology case	High Regulatory case	Mid Term Utility Renewable with High CO2	Early Utility Renewable with High CO2 Price	Early Utility Renewable (regardless of what the rest of country does, probably not a climate crisis scenario)	High Seasonal Load (hotter summers, and increased loads from electrification and colder winters) ***	Recession Economy (what happens if we enter long recession that slows investment in new EV and furnaces, etc.)
City Goal of 80% Carbon Reduction **	2050	2050	2050	Prior to 2040	Prior to 2030	Prior to 2030	2050	2050
City Goal of 100% Carbon Reduction **	2060	2060	2060	2040	2030	2030	2060	2060
Electric Utility at 100% Renewable	2050	2050	2050	2040	2030	2030	2050	2050
Economic Growth	Base	High	Low	Base	Base	Base	Base	Low
Regional load	Base	Base	Low	Base	Base	Base	High	Low
Transmission Permitting hurdle	Base	Base	Base	Base	Base	Base	Base	Base
Thermal Capital costs	Base	Base	Base	Base	Base	Base	Base	Base
Renewables and Battery Storage Capital costs	Base	Low	Base	Base	Base	Base	Base	Base
DSM, EE, DR Penetration	Base	High	Low	High	High	High	Base	Base
Delivered coal prices	Base	Base	High	Base	Base	Base	Base	Low
Delivered natural gas prices	Base	Low	High	Base	Base	Base	Base	Low
CO2 Emission Prices *	Base	Low	High	High	High	Base	Base	Low
Electric Vehicle Penetration	Base	High	Base	High	High	High	High	Low
Electrification for Heating	Base	High	Base	High	High	High	High	Low
DER (Solar, CHP)	Base	High	High	High	High	High	Base	Base
Fracking and Methane regulations	Status Quo	Status Quo	Stringent	Status Quo	Status Quo	Status Quo	Status Quo	Status Quo
Coal Emissions and Waste Regulations	Status Quo	Status Quo	Stringent	Status Quo	Status Quo	Status Quo	Status Quo	Status Quo

* Base assumes Siemens Reference Case Carbon pricing starting in the mid 2020s. Low stands for near zero pricing.

** Assumes a Net Zero Carbon Goal

*** CWL have experienced milder summers since their last peak (277 MW) in 2011 with peak loads in the 267 MW regularly. Customers growth at 1.3% per year, and 8% more transformers since 2016. This all points out to the possibility of a higher peak demand when the next hot spell happens.

Selected Scenarios

1. Reference Case
2. Early Renewable Scenario
3. High Seasonal Load Scenario
4. Recession Economy
5. Early Renewable Scenario with High CO2 Prices
6. Mid Renewable Scenario with High CO2
7. Mid Renewable Scenario with Gas Peaker/ and Batteries
8. High Technology Scenario
9. High Regulatory Case

Elements in scenarios

IRP Scenarios

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Scenario Element	Reference Case	High Technology case	High Regulatory case	Mid Term Utility Renewable with High CO2	Early Utility Renewable with High CO2 Price	Early Utility Renewable (regardless of what the rest of country does, probably not a climate crisis scenario)	High Seasonal Load (hotter summers, and increased loads from electrification and colder winters) ***	Recession Economy (what happens if we enter long recession that slows investment in new EV and furnaces, etc.)
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IRP Scenarios

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Key Elements

Mid Utility with High CO2 (prices)

- **Mid Utility Renewable with High CO2 (2040 Environmental Targets)**
- **100% Renewable by 2040**
- **Net Zero Carbon by 2040**
- **High penetration of Solar DG ~ Equivalent to 20% of gross electricity demand by 2040 vs. 7.3% in the Reference Case**
- **High EE penetration (0.7% annual EE savings first 10 years) with ~6.8% cumulative savings through 2040 (11% peak savings)**
- **High Electric Vehicle demand (8% of gross load vs. 1.7% in Reference Case)**
- **Resulting load is 10.7% lower compared to Reference Case by 2040**
- **Energy from Coal PPAs are mostly sold back to market by 2040 to comply with net zero carbon target**

Scenario Based Load Forecast

Net Load Forecast Across Scenarios

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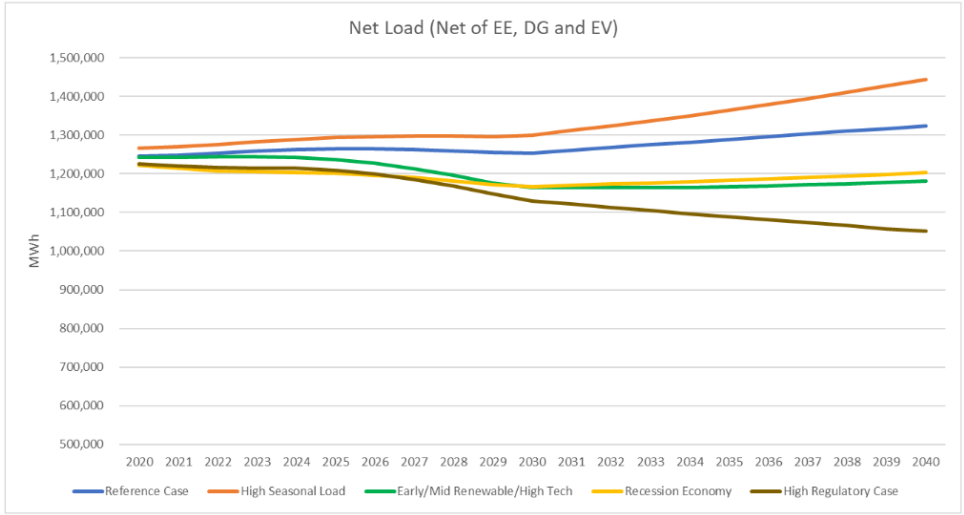

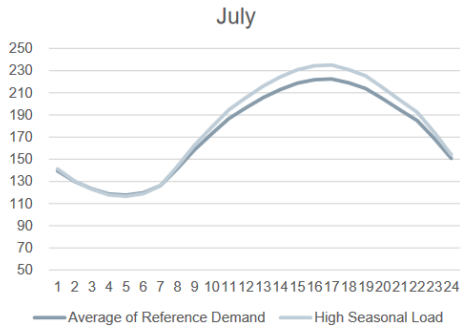

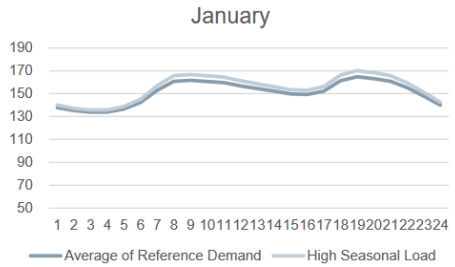

Scenario Based Load Forecast

Comparison Expansion Plans Across Scenarios

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Comparison Expansion Plans

Technology	Reference Case	Early Renewable 2030	High Seasonal Load	Recession Scenario	Early Renewable 2030 w/ High CO2	Mid Renewable 2040 w/ CO2 (1st Plan)	Mid Renewable 2040 w/ CO2 (2nd Plan)	High Tech Case	High Regulation Case
LFG	0	0	0	0	0	0	0	0	0
Wind	0	68	20	22	38	84	90	54	8
Solar	154	175	159	81	213	129	94	0	46
Gas Peaker	0	0	18	0	0	0	18	54	18
Battery Storage	4	2	1	0	0	1	10	0	0
Max. Capacity Purchased Single Year	45	5	48	20	0	15	5	50	20
Biomass	0	0	0	0	0	0	0	0	0
Total Installed Capacity Excluding Capacity Market Purchases (MW)	**159**	**246**	**198**	**102**	**251**	**214**	**212**	**108**	**71**
Total Renewable + Storage	**159**	**246**	**180**	**102**	**251**	**214**	**194**	**54**	**53**

Comparative costs between scenarios

NPV of Costs Across Scenarios

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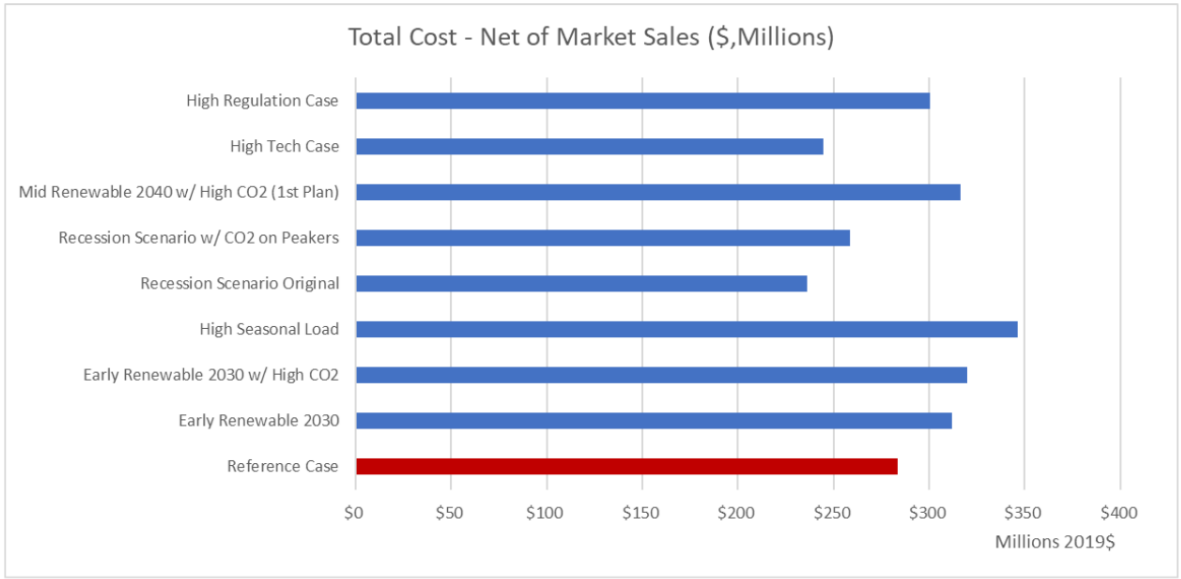

Scenario Decisions

- **Scenarios combine projected loads with different options of generation mixes**
- **Staff should be given guidance as to which scenario (direction) to take**
- **IERMP Task Force can assist council with information and provide TF recommendations in our report**

Electric Distribution Overview

Distribution System Evaluation

- Spatial Load Forecast (Current, 2025, 2030, 2040)
- Modeling System at Peak (both N and N-1)
- Overloads and Capacity Concerns by Substation
- Solutions (circuits, transformers, capacitor banks)
- Budgetary Capital Estimates
- Key Findings

Spatial Load Forecast

- A spatial load forecast was developed for the entire distribution system
- A system model was updated and used to evaluate the system
- The model was used to determine overload and capacity needs in the system and at each of the City's eight substations
- Corrective solutions were developed to handle current and future overload concerns

Spatial Load Forecast

- The tables below shows the substation loading at the time of system peak and the individual substation peak load. Both considering the current coverage area
- We note that most substation peak close to the time of the system peak (both peaks are similar) with the exception of Bolstad and Grindstone that have significant differences followed by Power Plant. This is due to load shapes and timing differences as shown in the next slid.
- Substation capacity is check against the projected individual substation peak load and possible actions, for each substation are proposed to meet the requirements as shown later in this presentation.

Substation load at System Peak (MW)

Substation	Peak 2020	2025 Load	2030 load	2040 Load
Blue Ridge	24	24	25	28
Bolstad	14	16	19	25
Grind Stone	35	37	38	41
Harmony Branch	40	40	40	41
Hinckson Creek	45	44	45	47
Perche Creek	35	35	34	35
Power Plant	48	47	48	51
Rebel Hill	32	33	33	36
Total	**273**	**276**	**281**	**305**

Substation Individual Peak Load MW

Substation	Peak 2020	2025 Load	2030 load	2040 Load
Blue Ridge	24	24	25	28
Bolstad	24	27	32	43
Grind Stone	42	44	45	49
Harmony Branch	40	40	40	41
Hinckson Creek	45	44	45	47
Perche Creek	36	36	35	36
Power Plant	51	51	51	55
Rebel Hill	32	33	33	36

Spatial Load Forecast

Columbia Spatial Load Forecast and Substation Assessment
Spatial Load Forecast; overall load growth

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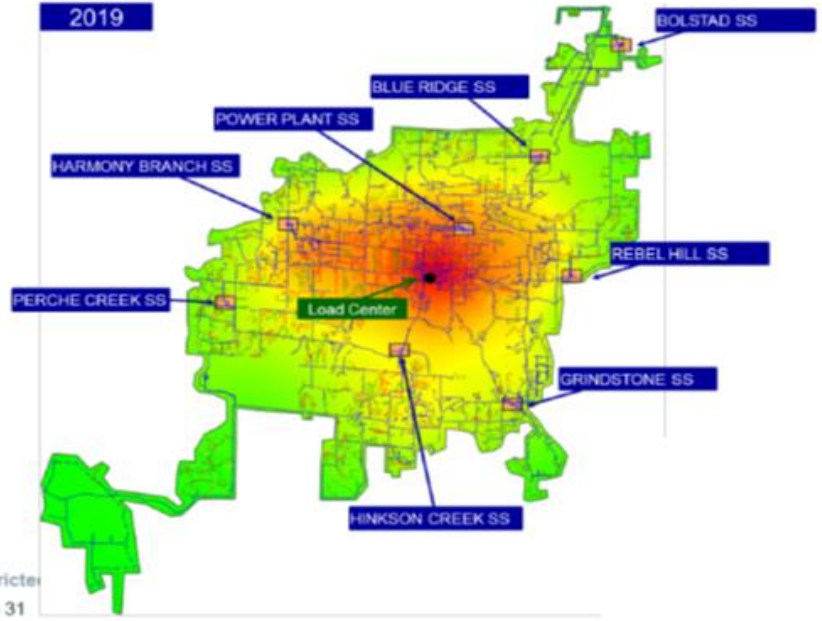
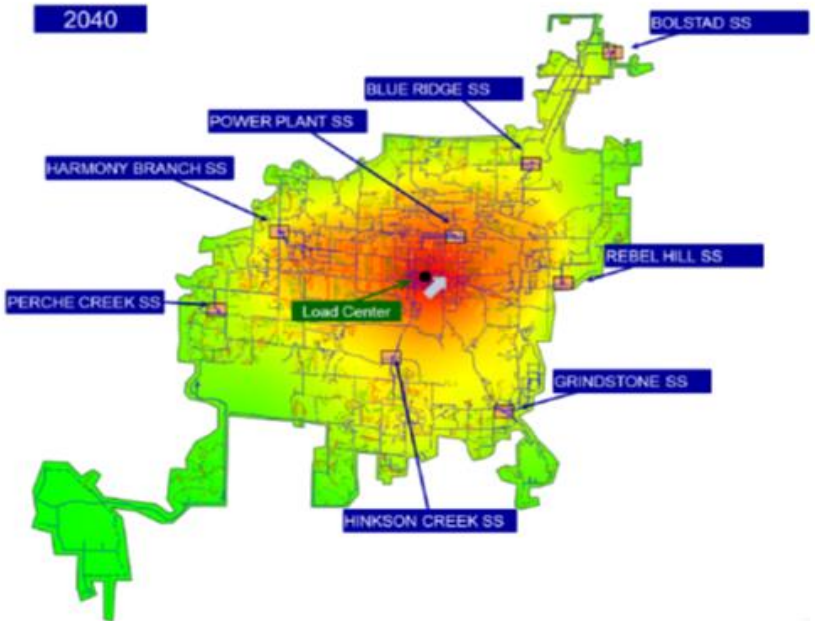
- The figures below provide another view of the results of the spatial load forecast. These figures show a "heat map" where shifts from green to red reflects increases in the load density. Note that from 2019 to 2040 there an slight but noticeable increase in the load density northeast of the City towards Bolstad Substation and the load centers shift in that direction.





Overload and Capacity Concerns

System Intact Conditions
Existing Network 2030 Feeder Peak Load Conditions

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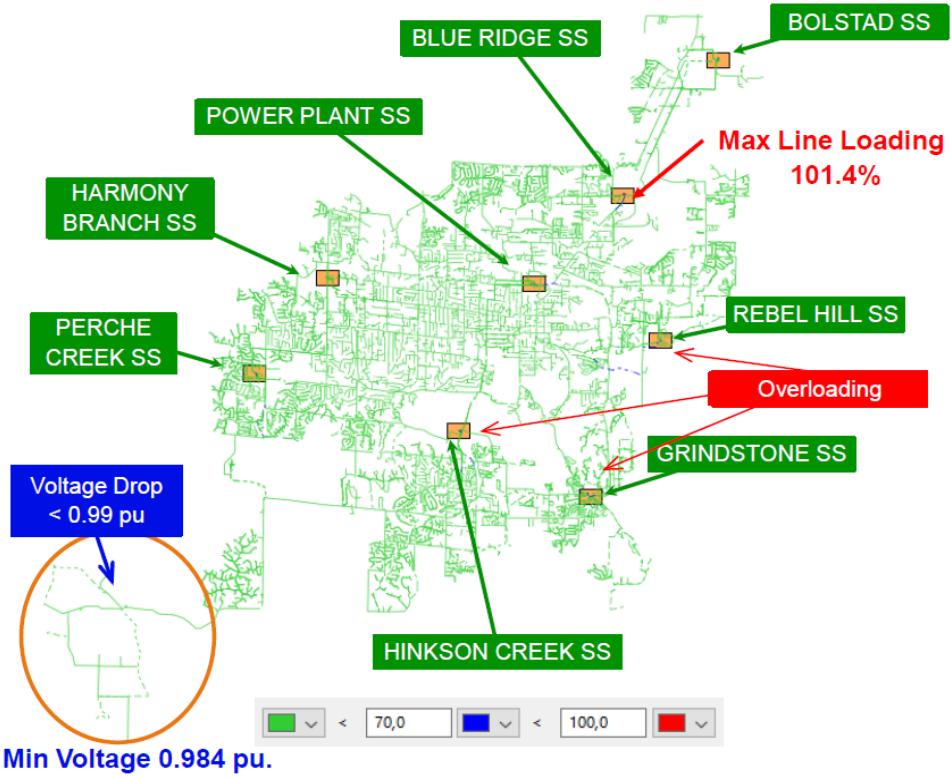
- By 2030 the voltage situation remains about the same the lowest voltage again was found in PC-221 (98.4%) and the entire end of this feeder was below the target 99% nominal.
- With respect of loading by 2030 we start seeing overloads under normal conditions (no outages). These need to be addressed together with the emergency condition operations.
- The figure shows the loading throughout the network and green indicates loading under 70%, blue shows loading above 70% but below overload and points to possible issues during contingencies and red is an overload.
- All issues of concern are in small sections are located on the substations exit.



Distribution Solutions and Upgrades

- Re-balance loads with new conductors and re-conductoring of existing lines
- Addition of breakers as needed
- Addition of transformers as needed
- Added capacity banks were needed for voltage/power factor control

New Underground Feeders

Investments
New Feeders and New Sections

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The procedure just presented resulted in the following investments

- Five new feeders out of Rebel Hill, Perche Creek and Bolstad are proposed by 2025 and this is adequate for the long term.
- These three substations were also identified as needing additional transformers by 2025 which further supports the addition of new feeders. The total length of new feeder underground sections is 9.56 miles, being the longest at Perche Creek for which we assessed a Non-Wires Alternative.

New Sections			
Substation	Feeder Name	Type	Length [mi]
BOLSTAD	BD231_ST	500 CU	1.14
PERCHE CREEK	PC231_ST	500 CU	0.08
PERCHE CREEK	PC232_ST	500 CU	4.80
REBEL HILL	RH231_ST	500 CU	1.35
REBEL HILL	RH232_ST	500 CU	2.19
			9.56

- In addition to the above about 1.26 miles of new sections along existing feeders will need to be added to create new connections or transfer load.

New Sections			
Substation	Feeder Name	Type	Length [mi]
BOLSTAD	BD213	500 CU	0.002
BOLSTAD	BD223	500 CU	0.227
GRINDSTONE	GS211	500 CU	0.391
GRINDSTONE	GS232	500 CU	0.007
REBEL HILL	RH221	500 CU	0.06
REBEL HILL	RH223	500 CU	0.799
			1.26

Upgrading Existing Lines

Investments
Reconductoring

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The procedure just presented resulted in the following investments

- Approximately 1.13 miles of feeder with a 4/0 conductor will have to be relaced with a 500 Cu conductor.
- New capacitor banks proposed to improve power factor located at various locations; 23.1 MVAr in 2025, 3 MVAr in 2030 and 8.4 MVAr in 2040. Size and number of capacitor banks for each term is listed below.

Reconductoring			
Substation	Feeder Name	Type	Length [mi]
BLUE RIDGE	BR212	500 CU	0.213
GRINDSTONE	GS231	500 CU	0.065
HARMONY BRANCH	HB233	500 CU	0.005
HINKSON CREEK	HC231	500 CU	0.314
POWER PLANT	PP212	500 CU	0.296
POWER PLANT	PP221	500 CU	0.003
POWER PLANT	PP223	500 CU	0.197
REBEL HILL	RH231_ST	500 CU	0.04
		Total	1.133

	2025				2030				2040			
Substation List	300 kVAr	600 kVAr	900 kVAr	1200 kVAr	300 kVAr	600 kVAr	900 kVAr	1200 kVAr	300 kVAr	600 kVAr	900 kVAr	1200 kVAr
BLUE RIDGE	0	0	0	1	0	0	0	0	1	0	0	0
BOLSTAD	1	2	2	1	1	2	0	0	2	4	2	0
GRINDSTONE	0	3	2	1	0	0	1	0	0	0	0	1
HARMONY BRANCH	0	1	0	0	0	0	0	0	0	0	0	0
HINKSON CREEK	2	0	1	0	0	0	0	0	0	0	0	0
PERCHE CREEK	1	0	0	0	0	0	0	0	0	0	0	0
POWER PLANT	1	2	3	0	1	0	0	0	1	0	1	0
REBEL HILL	3	3	1	2	1	0	0	0	3	0	0	0
Total	8	11	9	5	3	2	1	0	7	4	3	1

New Transformers and Capacity Banks

- An estimated 59, about 101.8 MVA, distribution transformers are needed through 2040 for load growth
- An estimated 39.4 Mvar of distribution capacitor banks are needed through 2040
- Three Transmission level transformers are estimated for growth and load transfer, specifically
    - 22.4 MVA 69/13.8 kV at Bolstad
    - 28.0 MVA 161/13.8 kV at Rebel Hill
    - 22.4 MVA 69/13.8 kV at Perche Creek

Distribution Capital Needs

CWL - Capital Expenditure

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- The table below shows CWL capital expenditure budget for distribution and transmission/distribution substations. Distribution level budget are based on comprehensive analysis and includes cost of underground cable, switching equipment, distribution transformer and capacitor banks.
- Transmission level budget includes the power transformer and one HV and MV breaker costs.
- The investments with priority are shown in the next slide.

CWL Investments		Cost [$] 2025	2030	2040	Total
Distribution Level		**$36.869.668**	**$2.933.495**	**$6.555.517**	**$46.358.680**
	Underground Cable	$18.580.462	-	-	$18.580.462
	Breaker&Switch	$3.473.932	-	$80.250	$3.554.182
	Distribution Transformer	$14.456.835	$2.892.763	$6.340.852	$23.690.450
	Capacitor Bank	$358.440	$40.732	$134.415	$533.587
Transmission Level		**$4.610.134**	**$0**	**$0**	**$4.610.134**
	Power Transformer	$2.143.063	-	-	$2.143.063
	Breaker	$2.467.071	-	-	$2.467.071
	Total	**$41.479.802**	**$2.933.495**	**$6.555.517**	**$50.968.814**

Distribution System – Key Findings

- Proposed solutions and upgrades correct overload conditions and serve growth over the study period
- Load forecasting and modeling are dynamic – Water and Light staff will need to continue routine analysis and planning
- Top priority distribution projects should complete by 2025 to avoid risk
- Substation re-balance and upgrades avoid need for Millcreek Sub

Update- Transmission Assessment

Summary of Modeling Results

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1. City of Columbia is NERC compliant.

1. In **112 years** or more, there is a very small likelihood (less than **0.002%**) of 2 simultaneous events that could cause CWL to shed load.

Load Shed Frequency

The table below shows the probability of having an event that leads to load shed, either event E1 or E2. **Each individual event, E1 or E2, is expected to happen every 200 or more years.**

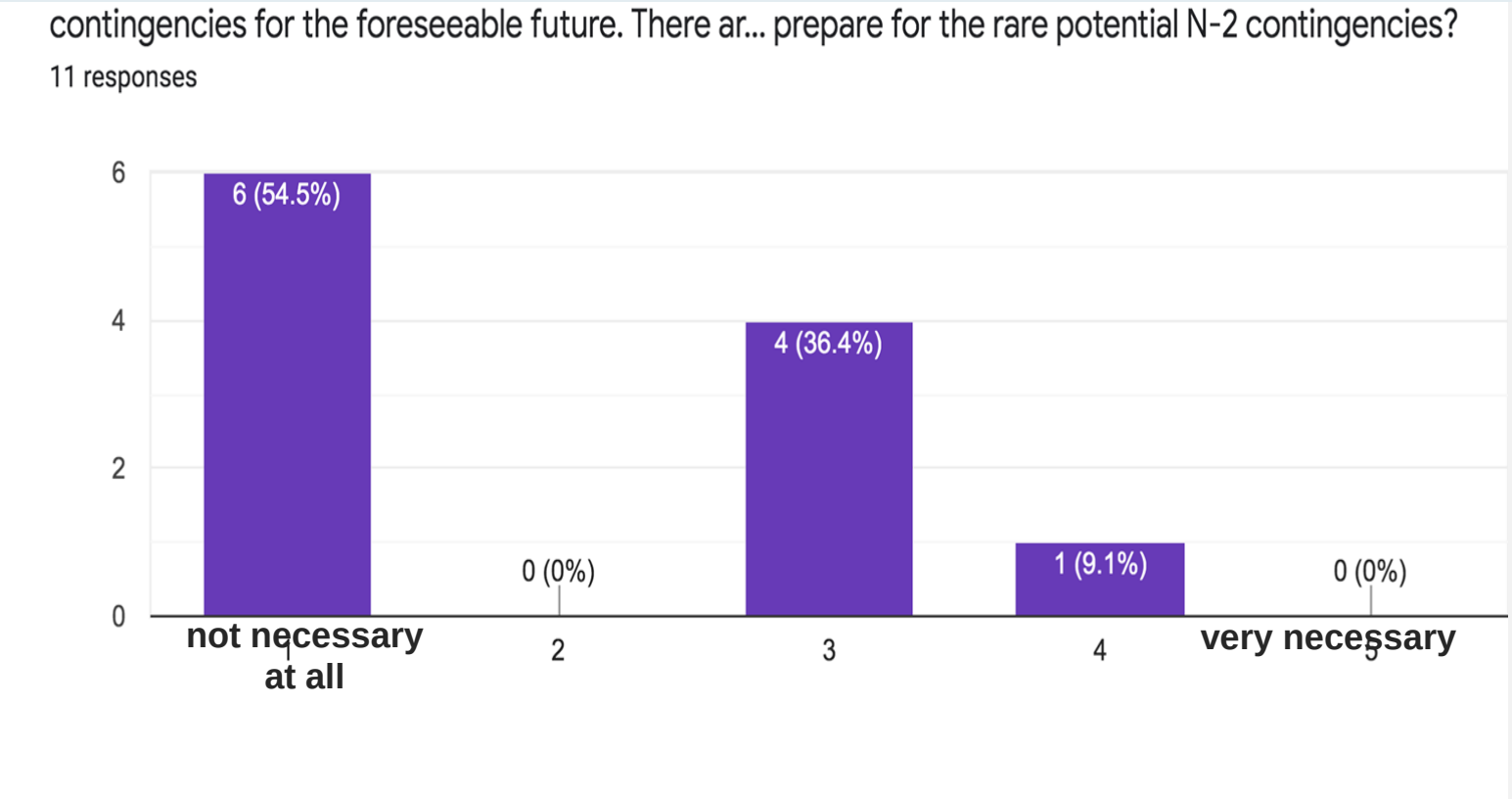
	Probability	Duration (H)	1/ Frequency (Years)
Event 1	0.0019%	32.6	198
Event 2	0.0014%	32.6	260

Finally, the probability of a load shed, that is either E1 **OR** E2 happening, is expected every 112 years.

E1	E2	Probability
1	0	0.00188%
0	1	0.00143%
1	1	0.00000%
0	0	99.99668%
Total		100.00000%

Probability	0.00332%
Duration	32.60
1/ Frequency (Years)	112

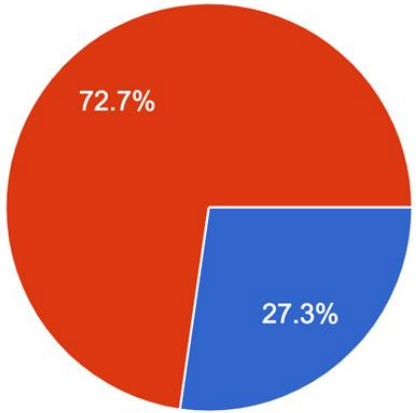
Survey Q5: According to the consultants, our transmission system should be able to meet all N-1 contingencies for the foreseeable future. There are two possible N-2 contingencies that the consultants identified. It is estimated those could happen every 100-200 years. How necessary do you feel it is to build new transmission lines/routes to prepare for the rare potential N-2 contingencies?



Summary from Task Force Survey

Survey Q1: According to the consultants, the City's existing electric infrastructure meets all regulatory requirements for potential contingencies. What solution to our transmission system do you feel is most appropriate for the immediate future?

11 responses



- Comfortable maintaining existing transmission infrastructure, as long as an appropriate load shedding plan is in place
- Comfortable maintaining existing infrastructure without any additional transmission project, but bolstering the system with the use of renewables and DSM.
- Not comfortable with the current transmission infrastructure, and would like the City to continue work towards a more traditional transmission approach.

Transmission Discussion Matrix

	maintaining existing transmission and adding combination of renewable, battery, AMI meters demand side incentive	Perche-Hinkson-Grindstone (upgrading Hinkson substation or relocating outside of floodway)	do nothing with transmission expansion at this time, ensure appropriate load shedding plan in place	Option E - north of town connecting	tapping into Ameren 345KV line north of Columbia	Option B-2	Option A
Task Force survey of preliminary support for various options	10 out of 11	9 out of 11	7 out of 11	7 out of 11	4 out of 11	4 out of 11	1 out of 11
meets NERC requirements	yes	yes	yes	yes	yes	yes	yes
adds transmission capacity	potentially reduces load	yes	no	yes	yes	yes	yes
adds resiliency to system	yes	potentially	no	yes	yes	yes	yes
adds renewable to utility portfolio	yes	allows import	no	allows import	allows import	allows import	allows import
generates additional new energy	yes	no	no	no	no	no	no
does it meet potential University of Missouri needs	potentially	potentially	no	potentially	potentially	potentially	potentially
# of properties/parcels abutting route	N/A	305	N/A	194	N/A	269	374

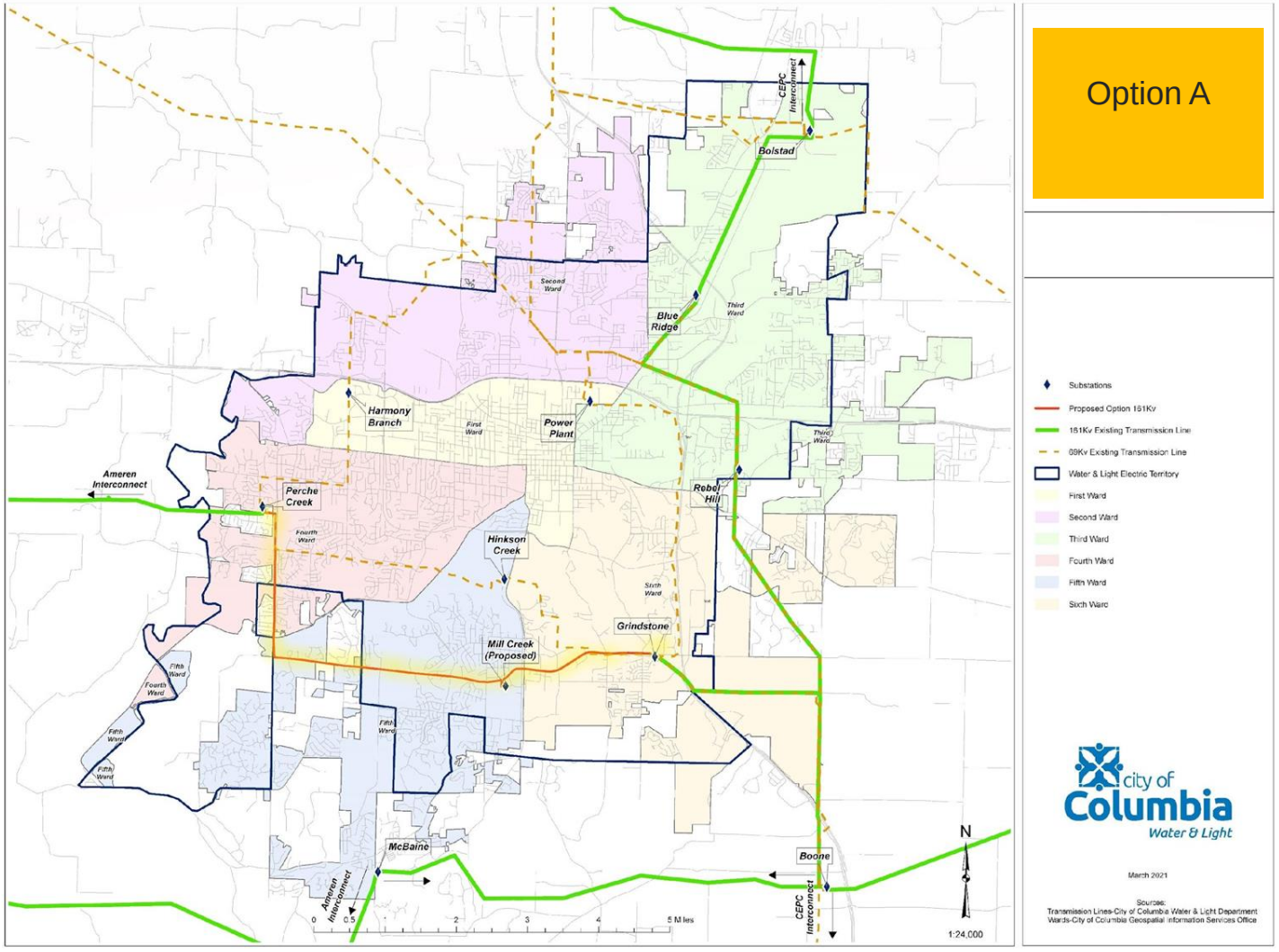
Summary

1. City of Columbia is NERC compliant.

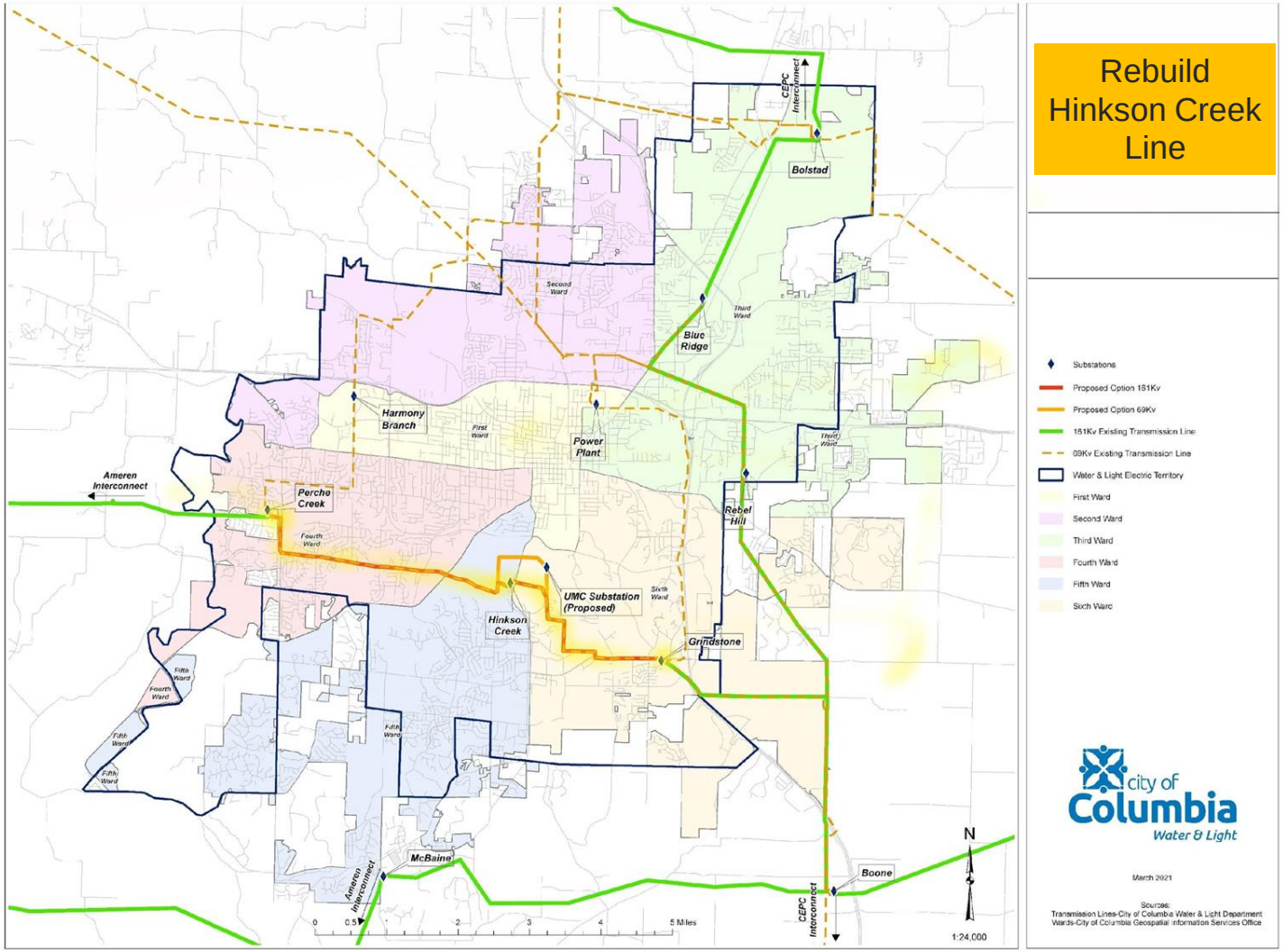
3. Task force survey shows comfort with existing infrastructure

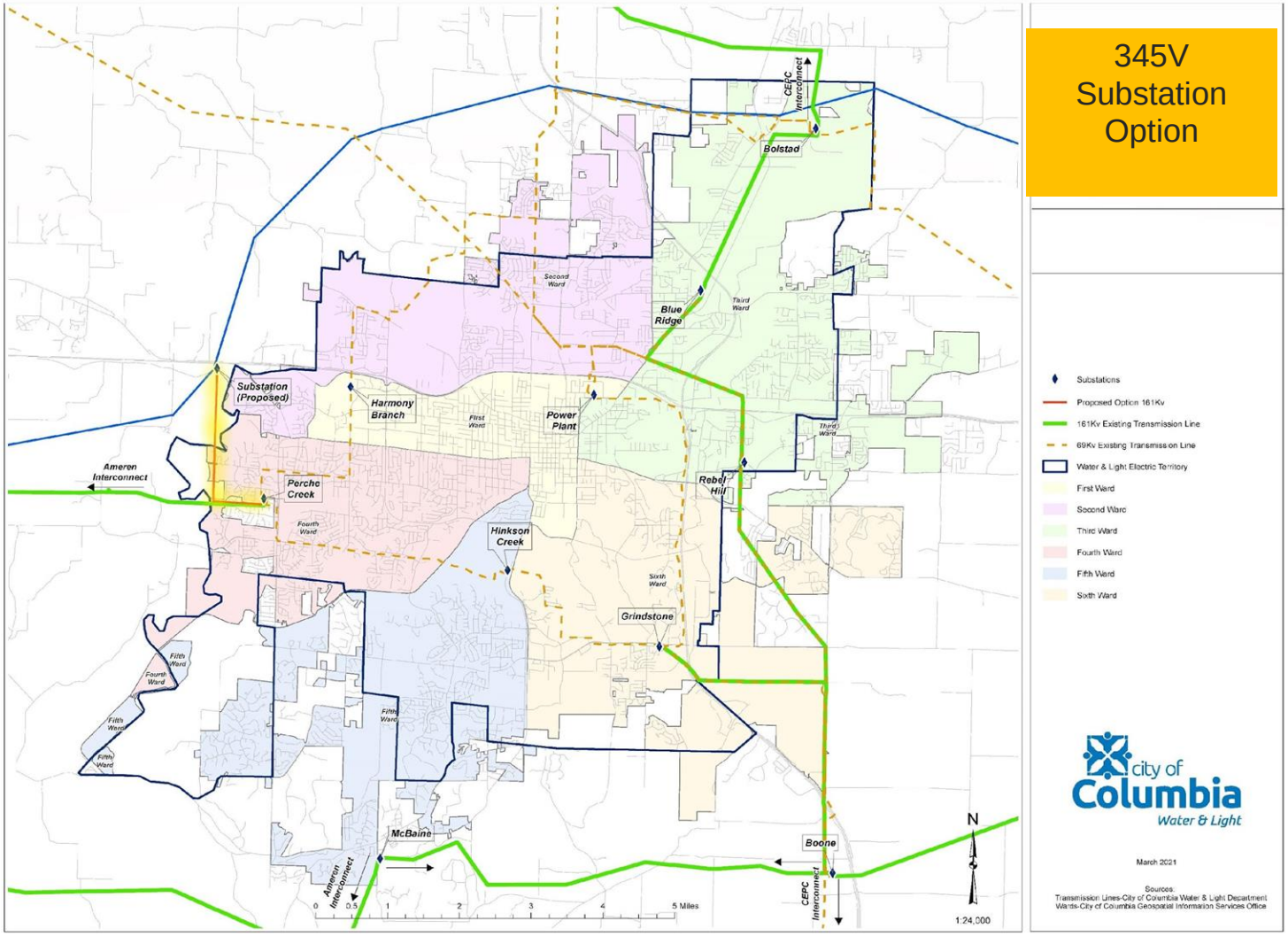
- 3/11 recommend do nothing

- 8/11 bolster with renewables, batteries and/or DSM


Option A
CEPC Interconnect
Bolstad
Blue Ridge
Second Ward
Third Ward
Harmony Branch
First Ward
Power Plant
Ameren Interconnect
Perche Creek
Fourth Ward
Rebel Hill
Hinkson Creek
Sixth Ward
Grindstone
Mill Creek (Proposed)
Fifth Ward
McBaine
Boone
Substations
Proposed Option 161Kv
161Kv Existing Transmission Line
69Kv Existing Transmission Line
Water & Light Electric Territory
First Ward
Second Ward
Third Ward
Fourth Ward
Fifth Ward
Sixth Ward
city of Columbia
Water & Light
March 2021
Sources:
Transmission Lines-City of Columbia Water & Light Department
Wards-City of Columbia Geospatial Information Services Office
0
0.5
2
3
4
5 Miles
1:24,000
N

Rebuild Hinkson Creek Line




345V Substation Option
CEPC Interconnect
Bolstad
Second Ward
Third Ward
Blue Ridge
Substation (Proposed)
Harmony Branch
First Ward
Power Plant
Ameren Interconnect
Perche Creek
Fourth Ward
Rebel Hill
Hinkson Creek
Sixth Ward
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Water & Light
March 2021
Sources:
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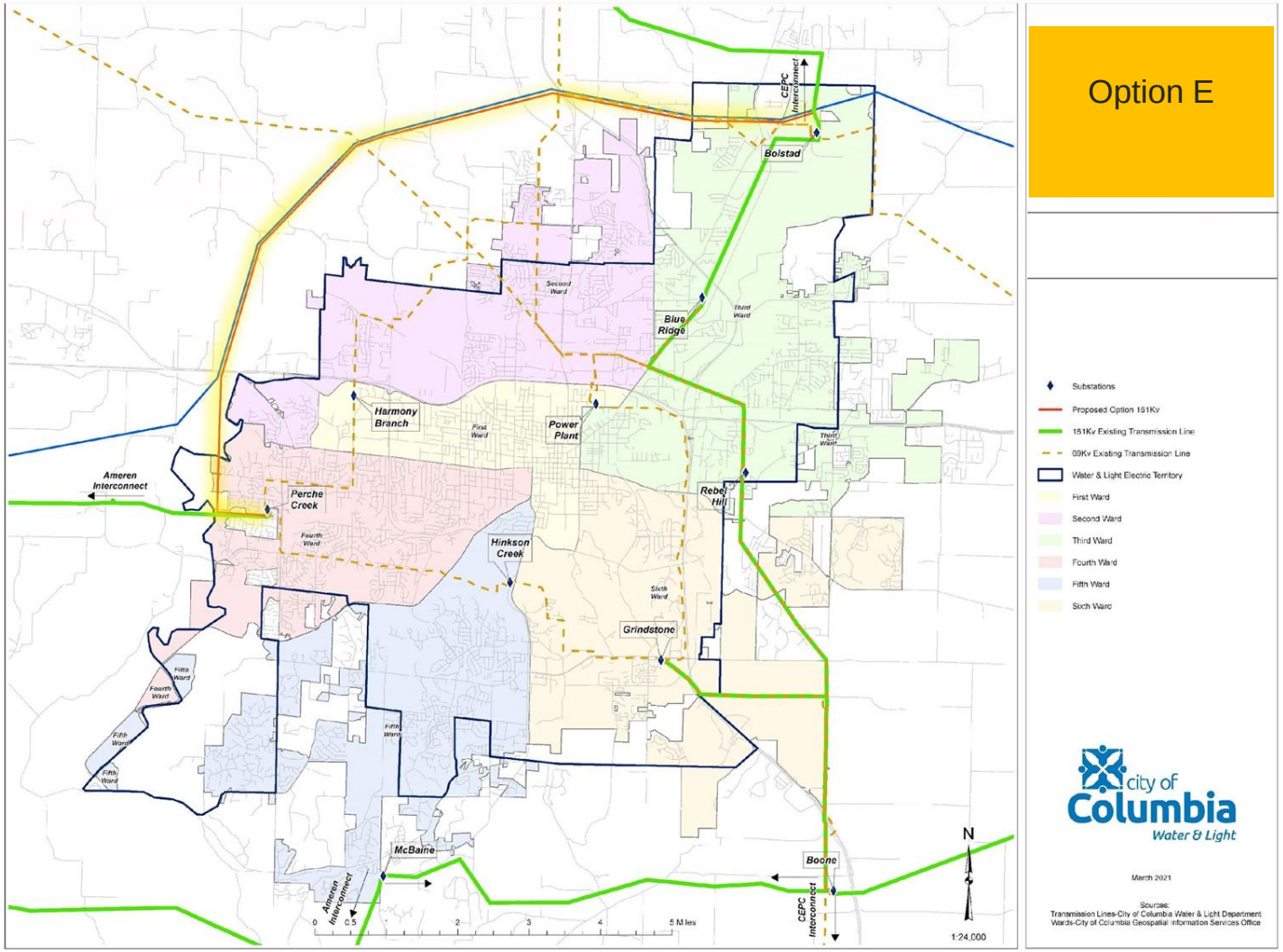
Wards-City of Columbia Geospatial Information Services Office
0 0.5 1 2 3 4 5 Miles
1:24,000
N


Option E
CEPC Interconnect
Bolstad
Blue Ridge
Second Ward
Third Ward
Harmony Branch
First Ward
Power Plant
Ameren Interconnect
Perche Creek
Fourth Ward
Rebel Hill
Hinkson Creek
Sixth Ward
Grindstone
Fifth Ward
McBaine
Boone
Ameren Interconnect
CEPC Interconnect
0 0.5 2 3 4 5 Miles
1:24,000
N
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Sources:
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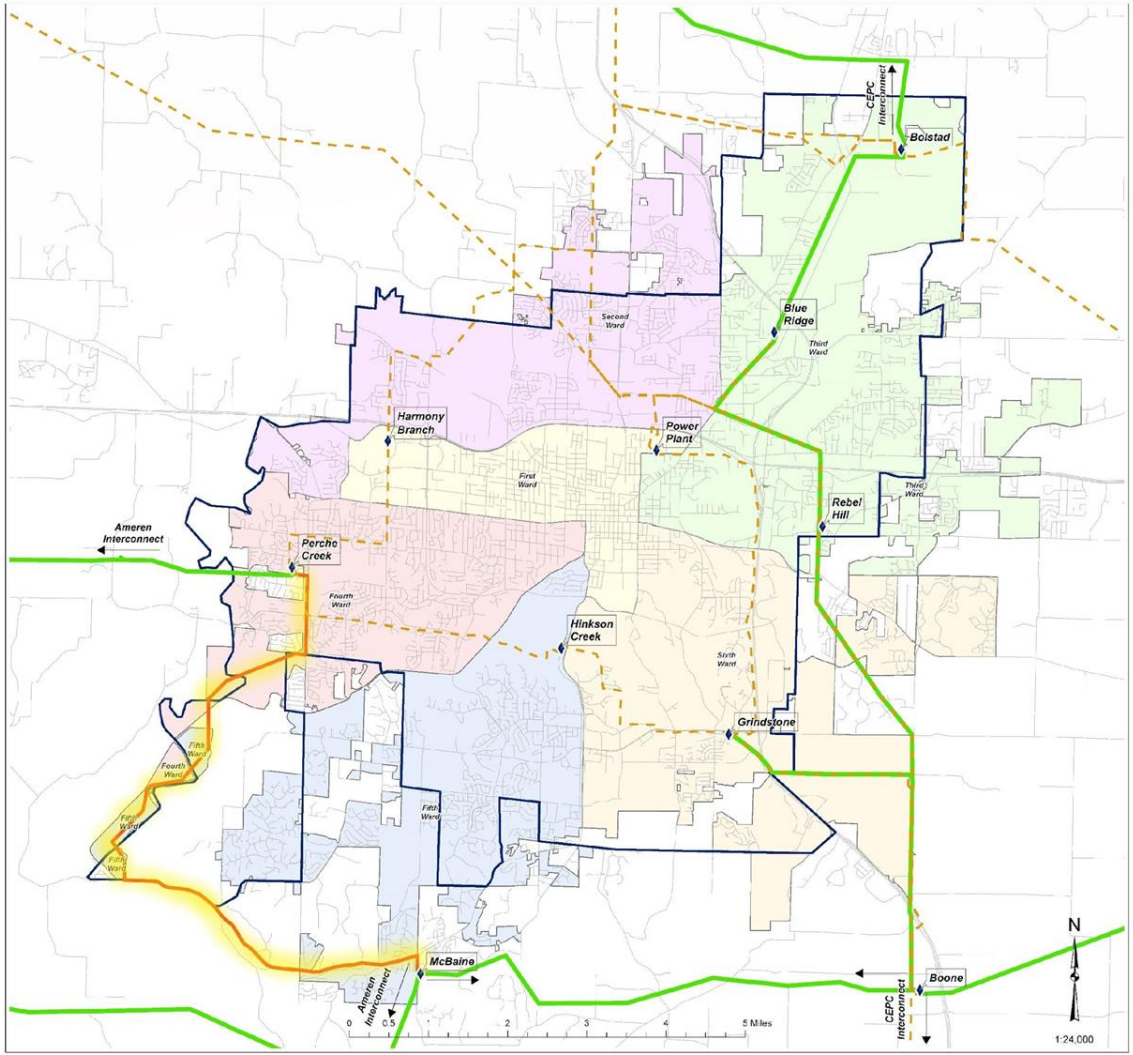
Option B2



Substations
Proposed Option 161Kv
161Kv Existing Transmission Line
69Kv Existing Transmission Line
Water & Light Electric Territory
First Ward
Second Ward
Third Ward
Fourth Ward
Fifth Ward
Sixth Ward

city of Columbia
Water & Light

March 2021

Sources:
Transmission Lines-City of Columbia Water & Light Department
Wards-City of Columbia Geospatial Information Services Office

Non Wires Alternative

Otherwise known as:

- Non-Transmission Alternatives
- Non-Wires Options
- Non-Wires Solutions

Acronyms:

NWA NTA NWO NWS

US Department of Energy 2009

ENERGY.GOV
Office of Electricity Delivery & Energy Reliability

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Home » Updating the Electric Grid: An Introduction to Non-Transmission Alternatives for Policymakers

UPDATING THE ELECTRIC GRID: AN INTRODUCTION TO NON-TRANSMISSION ALTERNATIVES FOR POLICYMAKERS

Throughout the United States a consensus has emerged that an improved transmission system is in the interest of the country as a whole.1 However, decisions to implement new transmission lines may face significant cost, environmental, and public acceptance barriers which delay implementation of needed transmission improvements. As State decision makers consider transmission investments, it may be important to account for Non-Transmission Alternatives (NTA). NTAs are programs and technologies that complement and improve operation of existing transmission systems that individually or in combination defer or eliminate the need for upgrades to the transmission system.

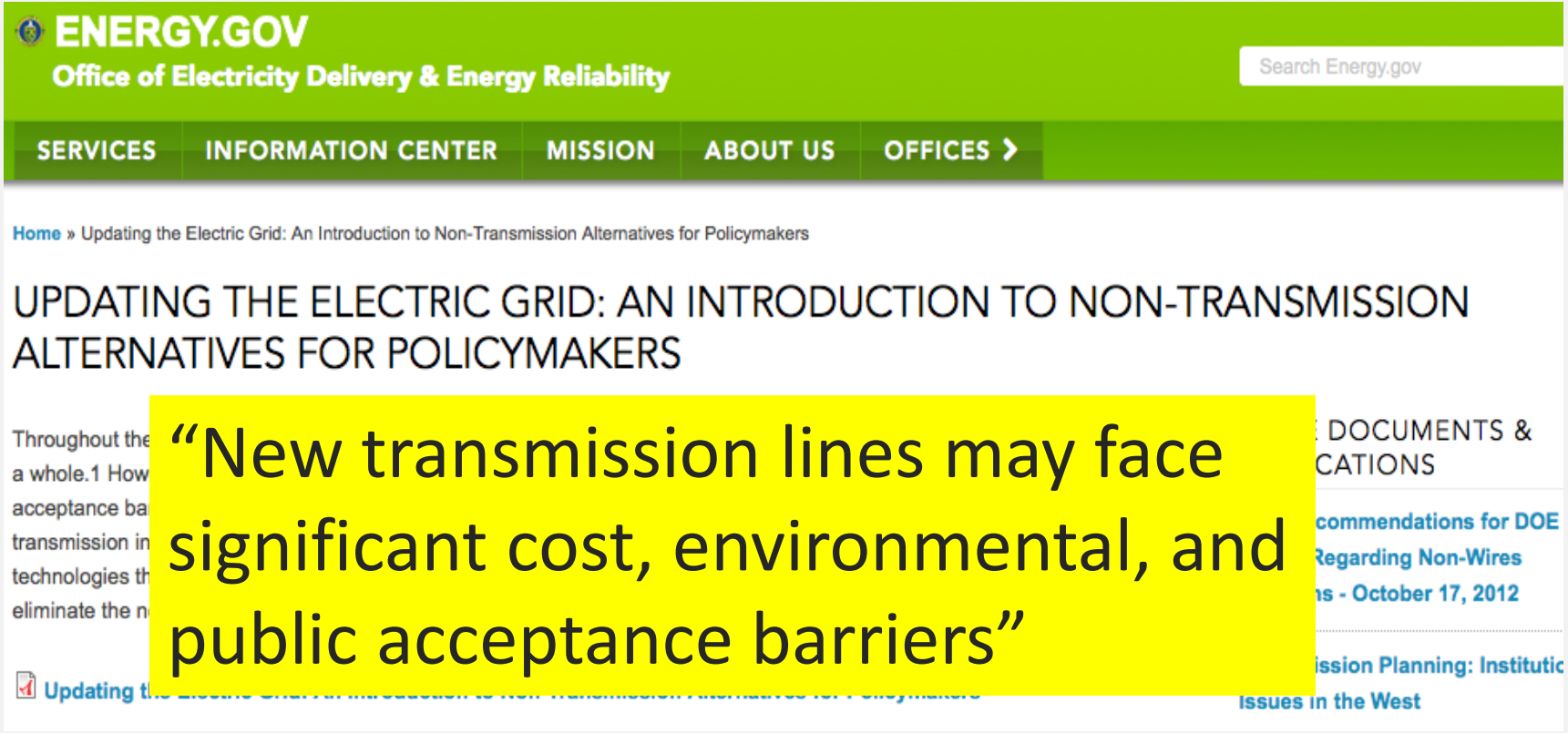
Updating the Electric Grid: An Introduction to Non-Transmission Alternatives for Policymakers

MORE DOCUMENTS & PUBLICATIONS

EAC Recommendations for DOE Action Regarding Non-Wires Solutions - October 17, 2012

Transmission Planning: Institutic Issues in the West

US Department of Energy 2009



Non Wires Alternative

NWAs are programs, policies, and technologies **that complement and improve operation of existing transmission and distribution systems that individually or in combination defer or eliminate the need for upgrades to the transmission and distribution systems.**

Non Wires Alternative

When a NWA requires funding, it can be funded by a customer, the utility, a third party (e.g., Power Purchase Agreement), or a combination thereof.

NWA Technologies

- Combined Heat and Power Systems
- Demand Side Management
- Demand Response (e.g. time-based rates)
- Smart Grid Technologies
- Incentivized Efficiency & Conservation (Rates)
- Energy Storage (batteries, thermal, EV-to-grid)
- Load Shifting / Shedding
- All forms of Distributed Energy Production (solar and other renewables)
- Energy Efficient Building Codes

Benefits from NWA

- Variety of options and funding mechanisms
- Scalable, flexible, region specific (targeted)
- Smarter grid
- Increases resilience and self-reliance
- Cost effective
- Keeps rates low
- Keeps money local
- Can defer, or eliminate need for upgrades to the transmission system

Non Wires Alternative

Columbia is already benefiting from Non Wire Programs

Residential CWL Programming

Home Performance Program

Home Performance with Energy Star Program – This is a national program designed to bring your home up to Energy Star standards. An assessment of your entire home by a certified contractor will show you ways to save on your energy costs.

Home Performance Rebates and Loans – Customers who participate in the Home Performance with Energy Star program can finance the suggested energy efficiency improvements through our rebates and loans program.

Home Performance Energy Efficiency Scores – The efficiency score is a free service for participants of the Home Performance with Energy Star Program.

Residential Audit, Rebates, Discounts, and Loans

Free Residential Energy Audit – Audits are available for all customers. Our evaluation of your home or business will provide energy and water efficiency tips specific for your location. Sign up using our online audit sign-up form.

Attic Plus Rebates – Rebates for insulation improvements are available to residential electric customers who may not be eligible for Home Performance rebates.

Commercial CWL Programming

Rebates and Loans

Lighting Incentive Program – Get paid to increase your lighting efficiency! Upgrade old lighting fixtures to LED. Commercial customers can receive $300 for each kilowatt of electricity saved by a new lighting system.

Air Conditioner and Heat Pump Rebates – Install new efficient HVAC units of 1-20 tons and receive rebates from $50 to $3,770, depending on the size and efficiency of the unit. Ground source heat pump rebates are also available starting at $300/ton.

Motors and Drives Rebate – Get paid to increase your motor efficiency! The Motors and Drives Incentive Program provides an alternative to the purchase of wholesale electric power by purchasing efficiency from our customers. Columbia Water & Light is willing to “buy” motor and drive efficiency by paying customers a rebate.

Custom Rebate Program – Columbia Water & Light’s custom incentive program looks at the overall load reduction of a total project and requires a minimum 30 percent increase in total energy efficiency. Projects must have a minimum reduction of 1 kW and rebates will be offered up to a maximum of 75 kilowatts of load reduction, for a maximum rebate of $22,500.

Energy Efficiency Loans – Why not make an energy efficiency upgrade now and start saving on your utility bills? We can help by financing the upgrades. Low-interest loans, up to $30,000 are available for eligible customers.

Solar CWL Programming

Learn How to Go Solar and Save

Getting Started with Solar – Read these frequently asked questions to learn whether solar may work for your home or business.

Solar Rebates – Learn how to receive a solar rebate and estimate your rebate amount. Rebates are based on the overall capacity of a solar system as well as its energy production during “peak” times. Download rebate application now.

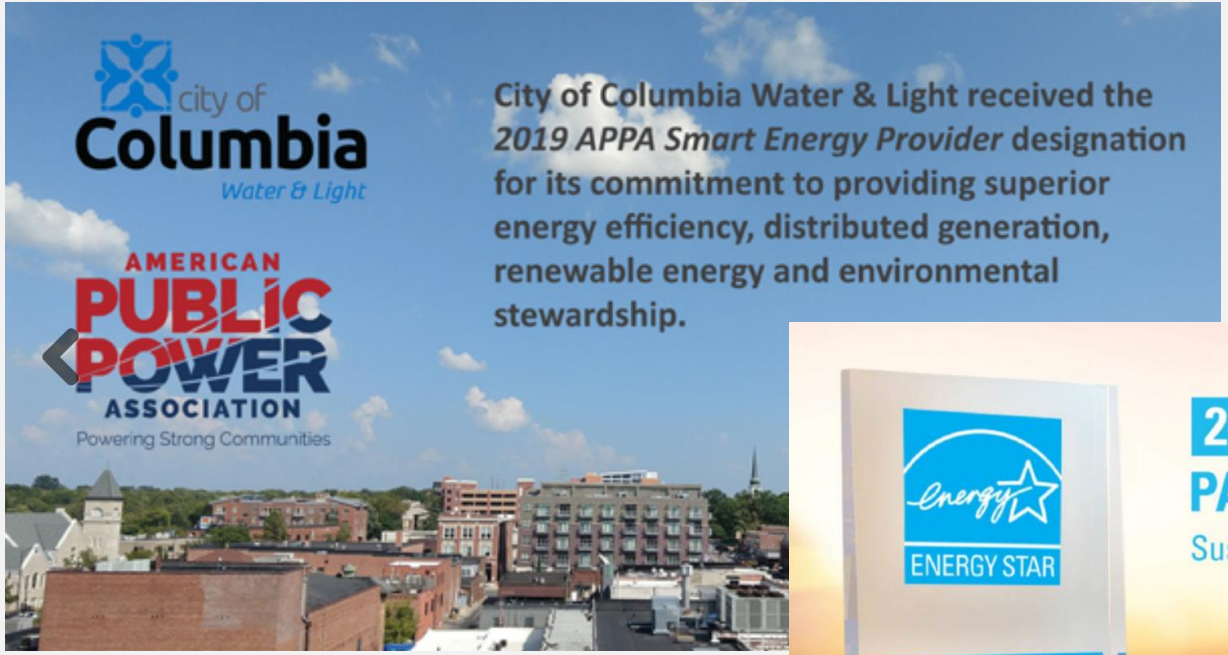
Solar Loans – Columbia Water & Light offers electric customers low-interest loans for photovoltaic systems and solar water heaters. Download residential loan application or commercial loan application now.

Net Metering – A net meter can measure electricity flowing to the utility from a customer’s renewable energy system on sunny days when a customer is producing more energy than they are using. It can also reverse its direction to measure the amount of electricity used by the customer that is supplied by the utility. At the end of the month, the customer is billed for the difference or the “net” amount of electricity used during a month.

Solar Water Heaters – Learn how you can begin cutting your water heating costs (up to 50 to 80 percent) by installing a solar water heater.

Solar Water Heater Rebates – Apply for solar water heater rebates from $400 to $800. Download rebate application now.

Awards for CWL NWA programs



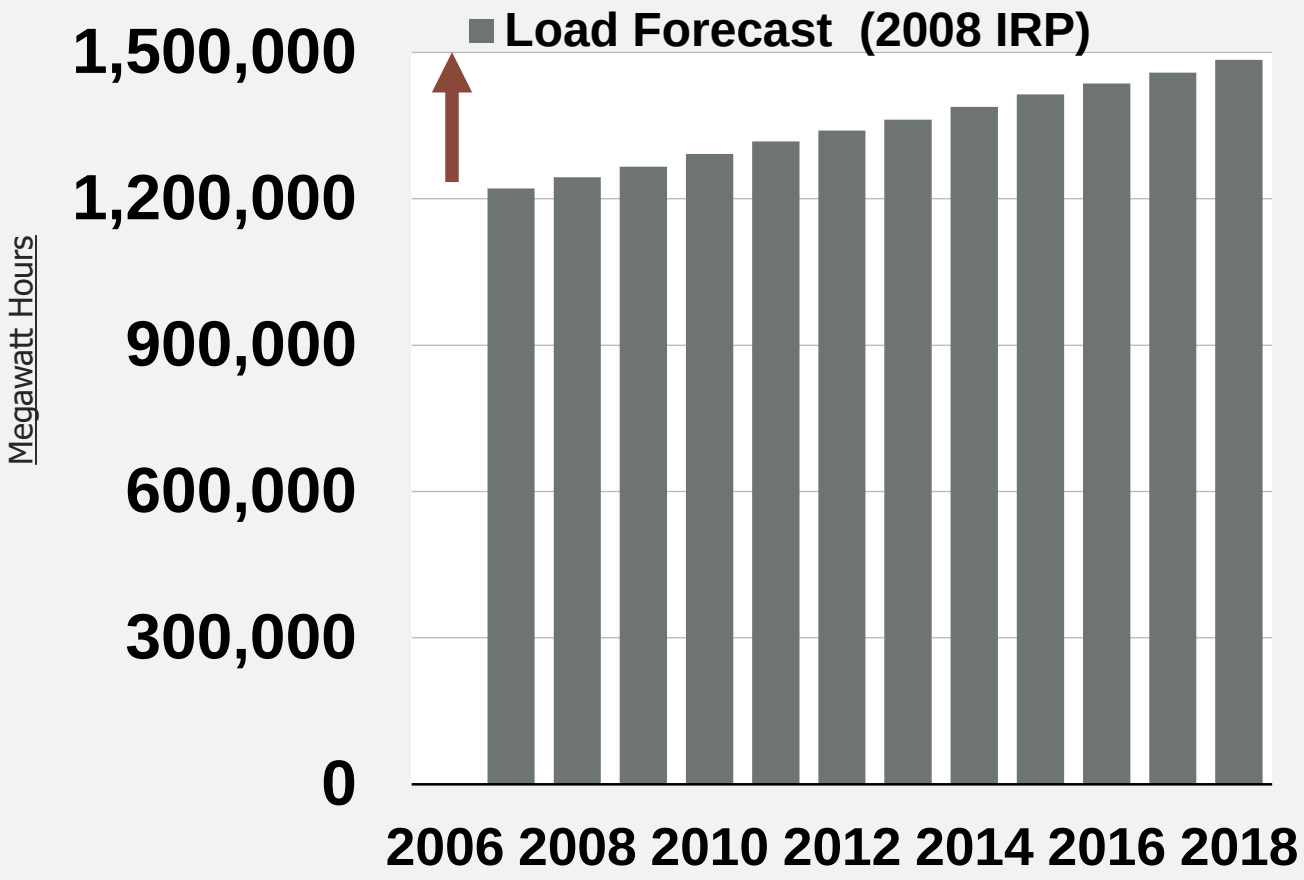
"Water & Light honored for sustained excellence"

Benefits of NWA

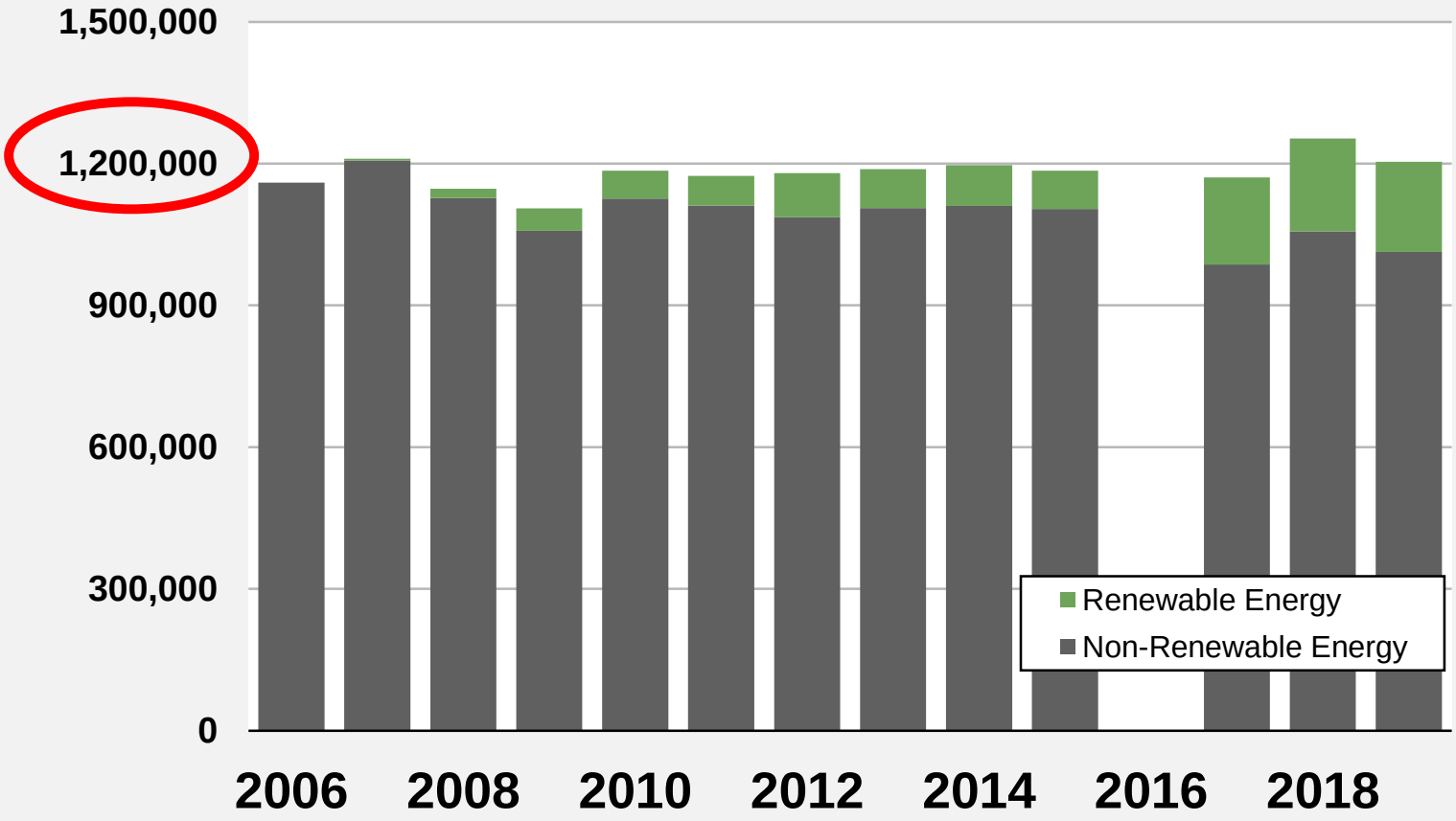
Beyond awards, our NWA programs have:

- **Flattened usage for the past 15 yrs**
- **Saved money**
- **Deferred the need for more wires**

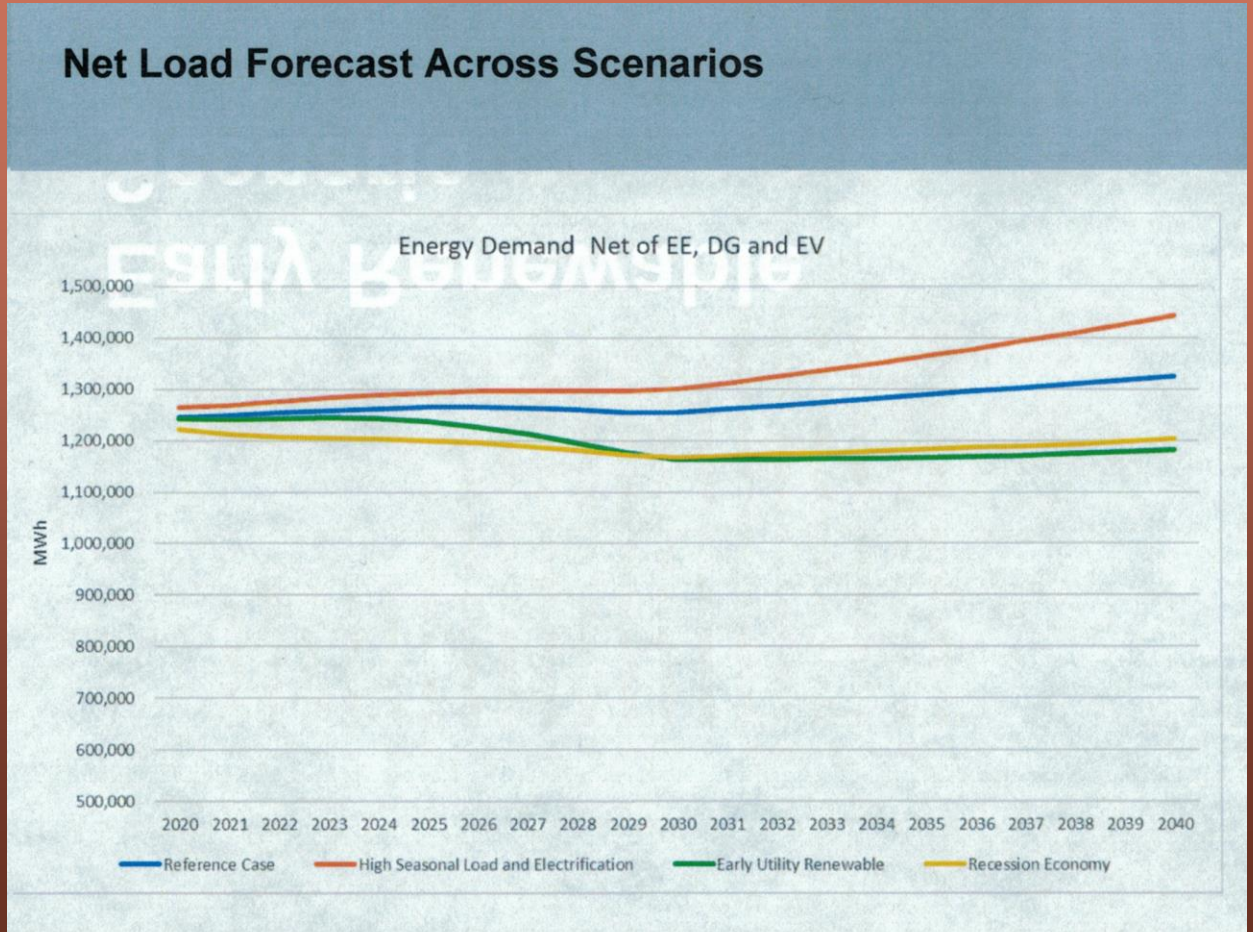
2008 IRP Load Forecast, 2007 - 2018



Actual usage data

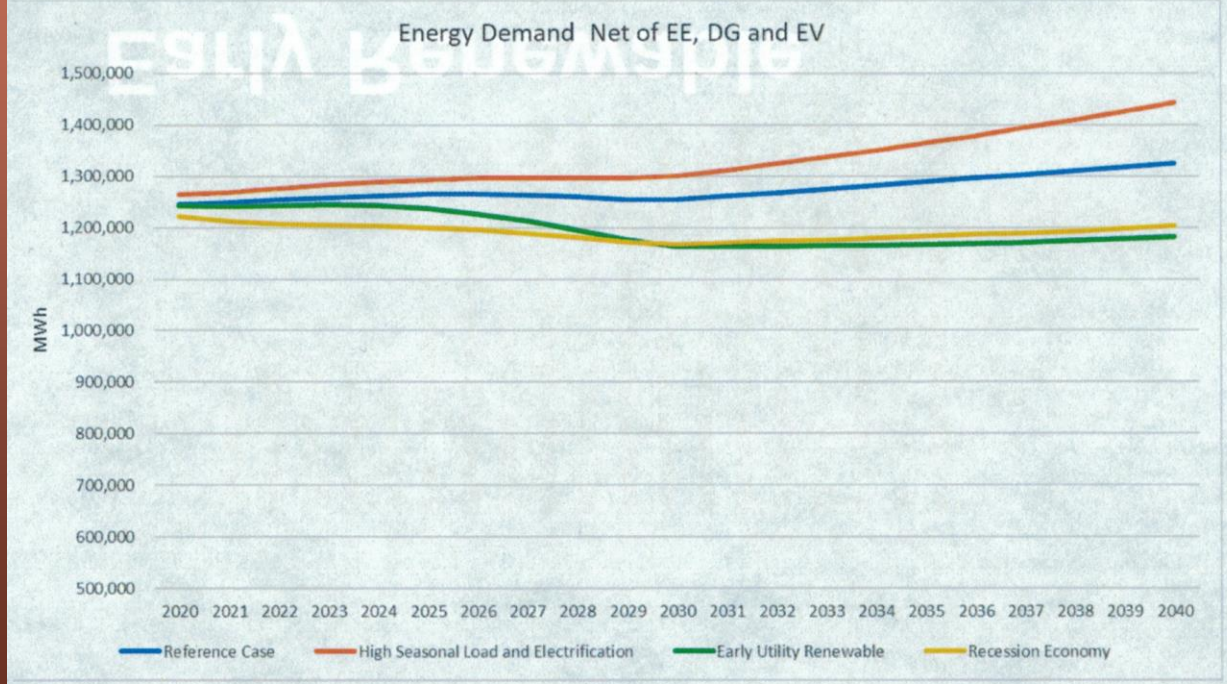


Siemens Load Forecast is Basically Flat



Siemens report will likely focus on wires alternatives

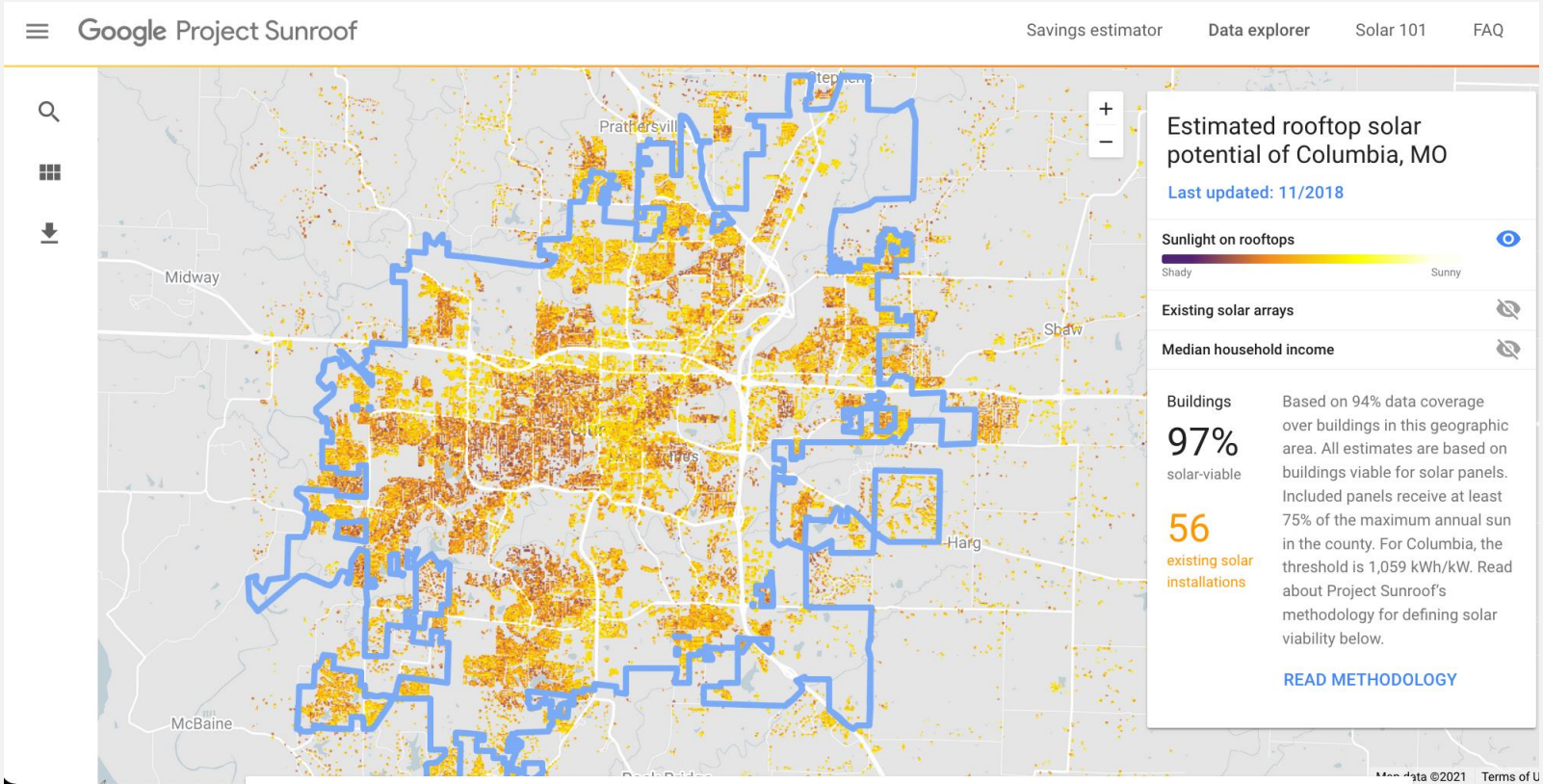
Net Load Forecast Across Scenarios



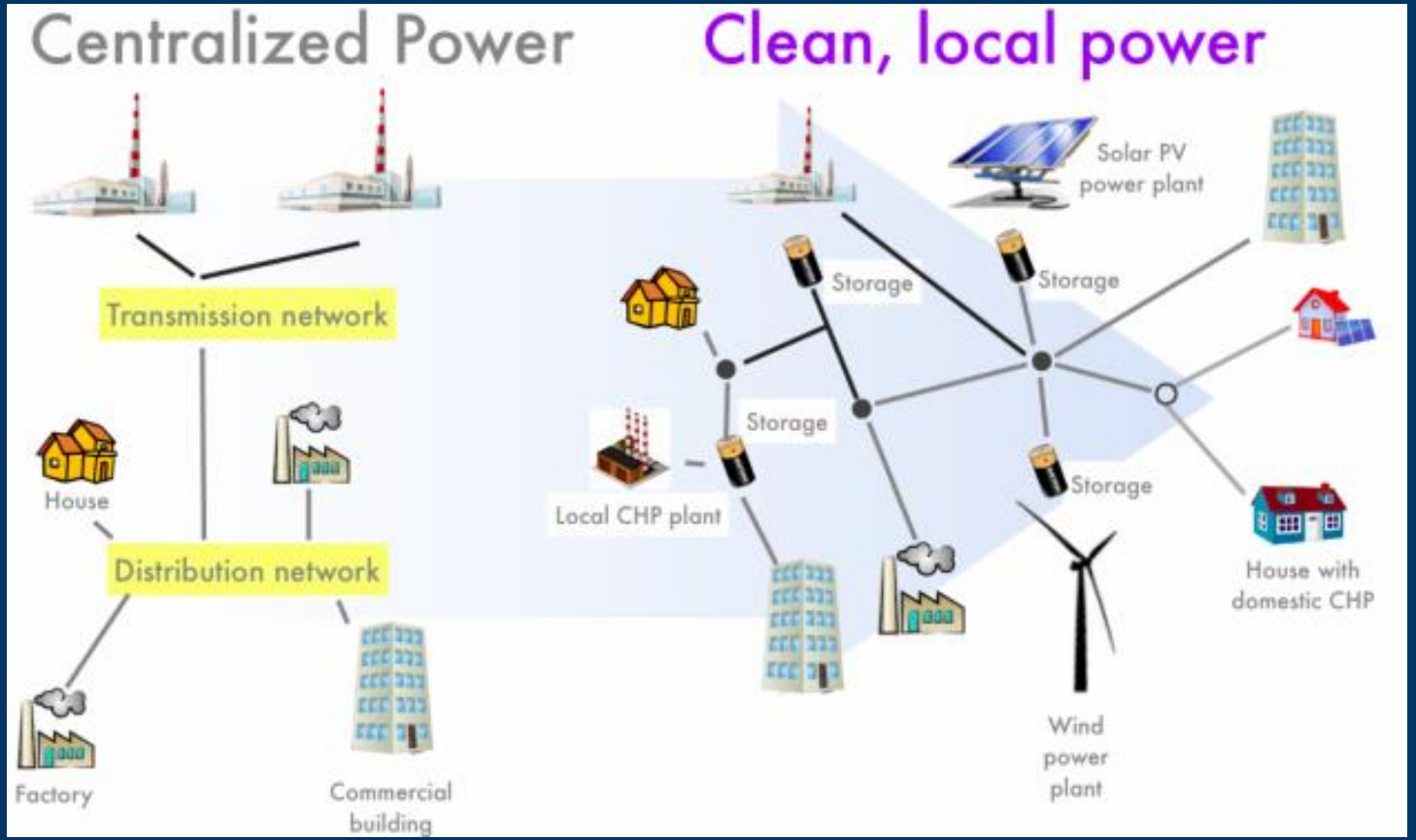
New NWA technologies are coming

- Improving technologies
- Decreasing costs
- Smarter grids
- New program development
    - Aggregate net metering
    - Utility investment tools (Pay As You Save (PAYS)

Rooftop Solar Potential in Columbia



Different Visions of Our Energy Future



Value of Solar

Components in a Value of Solar

- Energy Value
- Capacity Value
- Transmission Value
- Distribution Value
- Value Components Not Included

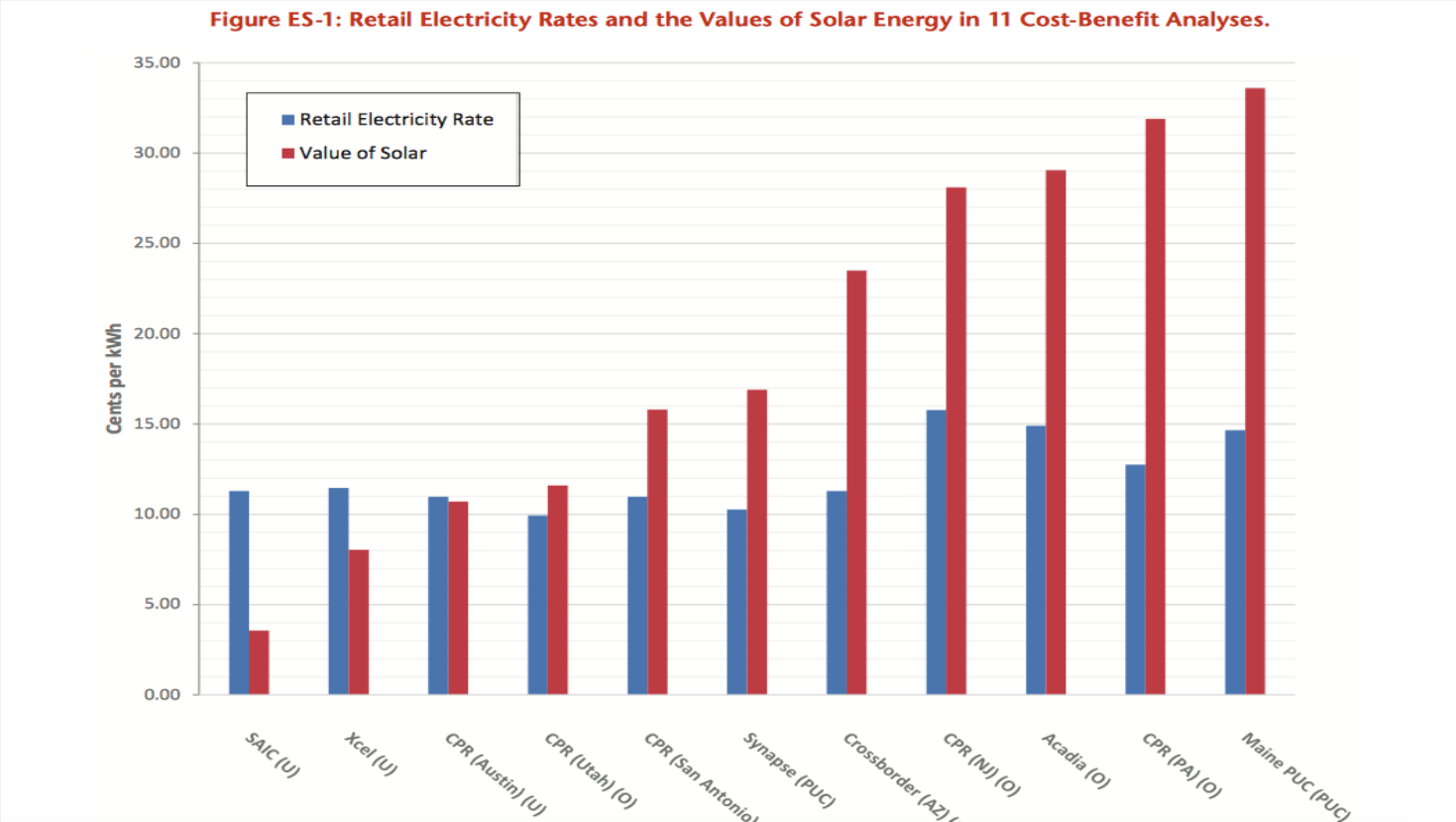
Component value from consultant

Energy Value (CWLD hourly node pricing for 2020)
Capacity (1 NCP x 6 year average annual auction)
Transmission - Delivery (12 NCP peak based variable transmission)
Transmission - Delivery (26-A volumetric kWh based variable transmission)
Distribution System Loss Savings

Solar PVWATTS Fixed Roof Mount 7.95 KW DC			
With Loss Savings (behind customer meter)			
Annual		per kWh	
$	265.20	$	0.02422
$	0.83	$	0.00008
$	3.00	$	0.00027
$	19.43	$	0.00178
$	288.47	$	0.02635

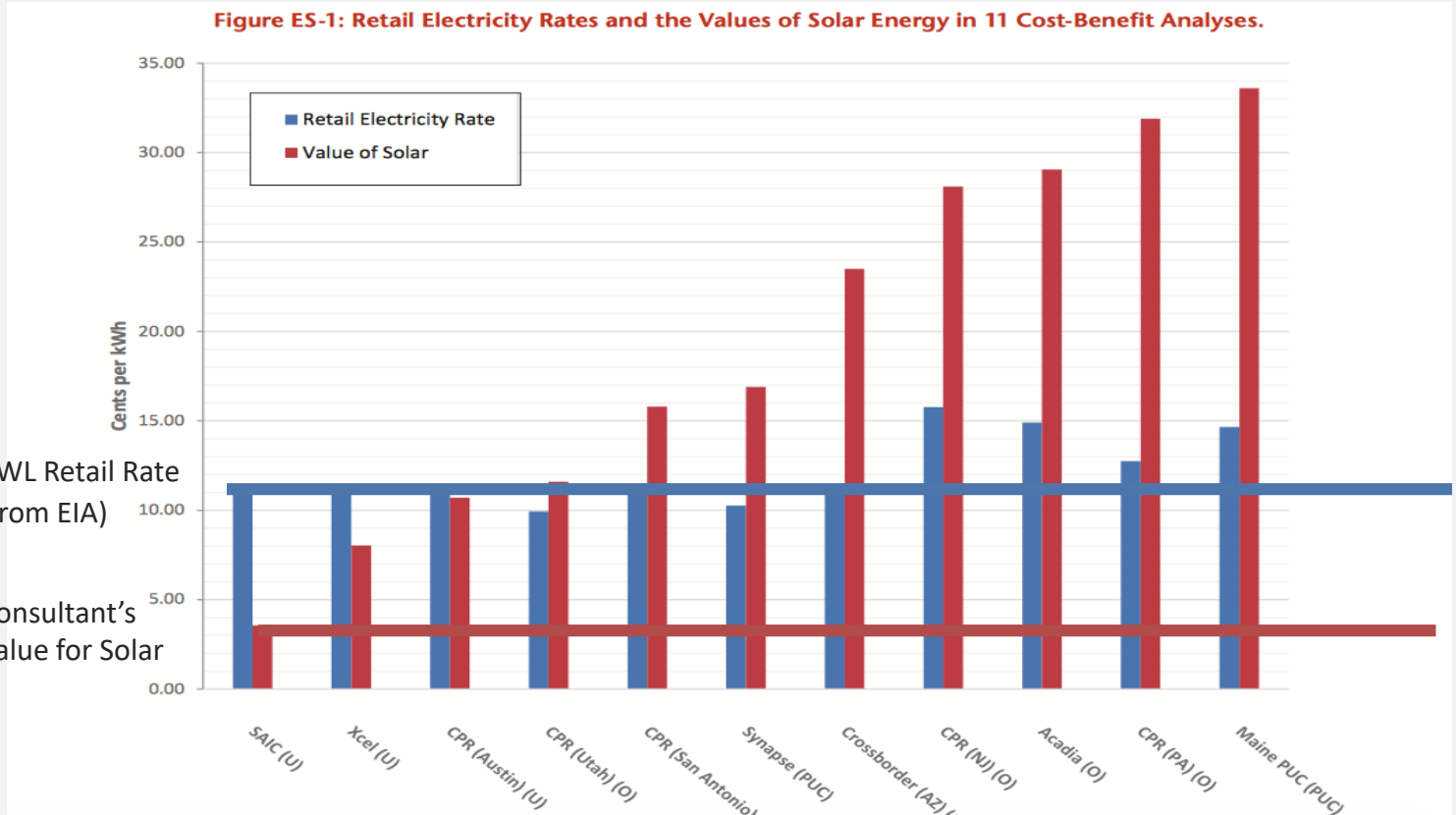
UFS
Utility Financial Solutions, LLC

11 Studies completed across the US



CW&L

Report targets $0.026 for VoS in Columbia

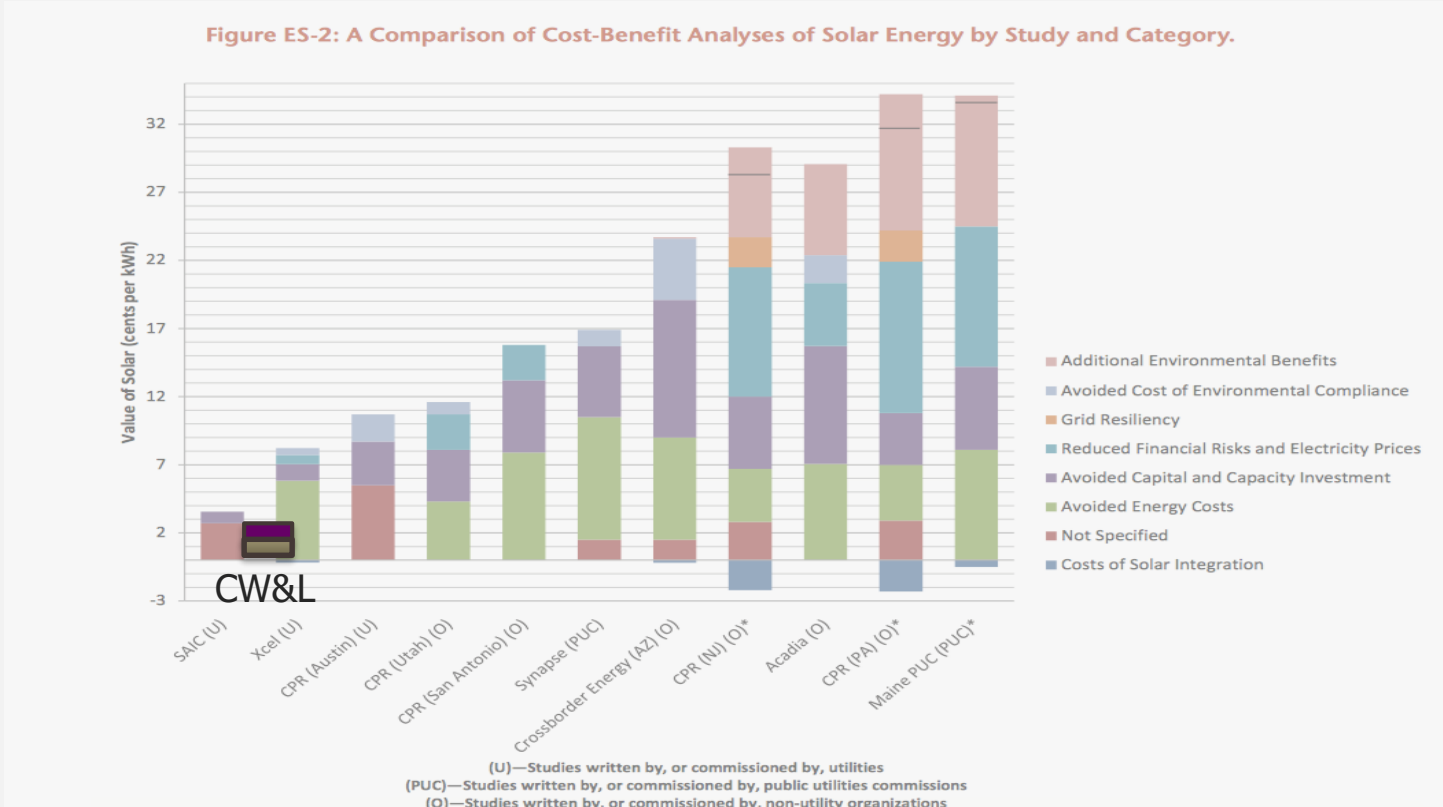


CWL Retail Rate (from EIA)

Consultant's Value for Solar

CW&L

CWL component value (UFS)



Value components that were **not** included

- Avoided base load plant, O&M & grid infrastructure savings
- Some early studies allocated a portion of traditional base load plant, variable O&M and a projected grid savings to the VOS
  - It has been generally found that base load plants have not been able to be taken offline nor realize variable operational benefit from customer installed solar.
  - Utilities with high solar penetration are experiencing increased infrastructure costs to support the variability of renewables.

UFS
Utility Financial Solutions, LLC

Value components that are widely recognized

COMPONENT	DESCRIPTION	SUPPORTING STUDIES CITED
Avoided Energy Costs	Avoidance of energy produced by other sources	• RW Beck 2009 • RMI 2013 • NREL 2015 • Swisher 2015
Avoided capital and capacity investment in generation infrastructure	Deferment of upgrades to or construction of generation resources	• Farrell 2014 • Swisher 2015 • NREL 2015
Avoided capital and capacity investment in T&D infrastructure	Deferment of upgrades of transmission and distribution (T&D) lines	• RW Beck 2009 • NREL 2015 • Swisher 2015
Avoided O&M costs	Savings of operations and maintenance costs for generation, transmission, and distribution assets	• RW Beck 2009 • Farrell 2014 • NREL 2015

VoS components less widely used

COMPONENT	DESCRIPTION	SUPPORTING STUDIES CITED
Increased grid resiliency and reliability	Alleviation of pressure and increased resiliency and reliability on the local grid	• Frontier 2016
Avoided losses and other locational benefits	Avoidance of electrical losses associated with delivery from centralized plants	• RMI 2013 • EPRI 2016c
Environmental benefits	Avoidance of greenhouse gas emissions, reduction in air pollution, and avoidance of environmental compliance costs	• RW Beck 2009 • Frontier 2015 • EEI 2014
Job Creation	Benefits from local economic development and job security	• Swisher 2015

VoS components excluded from this analysis

- Societal / environmental benefits
  - Not current and actual quantifiable costs to CWL
  - If self directed benefit, will need to be paid by other rate payers
- SREC, REC – Note some states have renewable energy credit programs in place that increase the realized financial benefit of installing solar.
  - Missouri not currently participating
  - Typical adds 1.5 to 4 cents per kWh to VOS.

UFS Utility Financial Solutions, LLC

Importance of an accurate Value of Solar

- Allows equitable comparison with other sources of energy
- Provides a basis for incentives without subsidies
- May see enhanced benefits from local energy production (i.e. economic development, job creation) that were not included in components
- Provides a rational basis to adjust VoS in future

Possible options for Task Force

The Task Force has discussed integrating additional components into the study with consultant and received a response that all obligations with current contract have been met and any further work will require additional funding.
Task Force may ultimately disagree with the VoS assessment, if so possible options:

- Renegotiate a change order (with additional time and costs)
- Note any disagreement in the Task Force Report
- Ask Council / Staff to conduct a new follow-up study to capture all desired Vo components

Advance Metering Infrastructure

Advance Metering Infrastructure

The U.S. Department of Energy calls AMI an:

> Integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers.

Components of AMI

AMI systems are comprised of several key components

- Communications network
- Electric meters
- Water meters
- AMI head-end system
- Data management
- Billing Integration
- Customer portals

CWL's Current AMI Status

Highlights from AMI Report ….

- Using *Itron* AMR meters (no 2-way communications)
- High seasonal turn-ons/offs due to customers attending college
- Some customer interval data is available but not currently used
- Rate design options are limited due to metering
- CWL's electric operations are highly regarded and meet the public power's industry highest RP3 rating

Potential Benefits from AMI in Columbia

Customer Benefits

- Service problem notification
- On demand meter readings
- Customer usage portal
- New rate options
- Pre-paid meter payments
- Home energy management solutions
- Demand Response participation potential

Potential Benefits from AMI in Columbia

Electric Utility Operations Benefits

- Service restoration
- High/Low voltage notification
- Improved system monitoring
- Reduced utility revenue loss
- Reduced system demand and energy losses

Potential Benefits from AMI in Columbia

Water Utility Operations Benefits

- Eliminates required visual readings for 70%+ meters
- Eliminates ad hoc replacement of failed batteries
- On-demand water readings
- Improved system monitoring
- Reduced utility revenue loss
- Allows controlled matching between production and storage to meet supply
- Better pressure management throughout water system

Potential Benefits from AMI in Columbia

Other Benefit Areas

- Positive contribution to Climate Action and Adaptation Plan
- Leveraged AMI communications and shared hourly usage with wastewater system improves pumping and scheduling for WW system

- Siemens proposes that CWL issue a request for proposal for an AMI project
- The likely savings to CWL could approach $6 – $8 million dollars

Summary of AMI Capital Investment

Electric Infrastructure	$ 22,804,870
Water Infrastructure	$ 7,711,635
Communications Infrastructure	$ 335,000
AMI Software	$ 1,181,000
Total	$ 32,112,505

Further Task Force Work

- Request being sent to Council for additional work by Siemens
- Continue with Cost of Service
- Time to completion may take from 1 to 3 months

city of

Columbia