

Appendix H

Avoided Cost

Draft 2023 WA IRP

## **Appendix H – Introduction**

The purpose of this document is to present the inputs into Cascade’s avoided cost calculation, as well as the sources for these inputs. The data itself is sourced from a number of processes integral to the 2023 IRP, specifically the resource integration and distribution system planning sections. Once calculated, these figures are sent to Cascade’s energy efficiency team, where they are used to generate Cascade’s Conservation Potential Assessment (CPA). Beginning on Page 21, Cascade has provided an explanation regarding the upstream emissions calculation, which is used in the avoided cost calculation. Resource Planning appreciates its partnership with the energy efficiency team, as the CPA is a vital element to forecasting energy efficiency savings over the 28-year planning horizon.

# Avoided Cost Workbook

## Summary of tabs

Name	Description
FINAL CALCULATION	Aggregator of data from all other tabs. Currently costs past 20 years = 20th year cost
INCRM FIXED TRANSPORT	Fixed cost of contracts that will be used to solve pre-DSM identified shortfalls
VARIABLE TRANSPORT	Variable cost of Contracts. Once a shortfall is identified this should only use new contract costs
FUEL	Average fuel loss across all of Cascade's Contracts
INCRM FIXED STORAGE	Fixed cost of storage contracts that are selected as cost effective pre-DSM
VARIABLE STORAGE	Variable cost of storage contracts. Once a shortfall is identified this should only use new contract costs
COMMODITY COST	Price of gas based on CNGC price forecast. Can be modified for either Peak AC or annual. Need to input weights for each zone, which should be calculated by SENDOUT supply take by zone
CARBON TAX	Adder to the commodity cost based on the desired carbon scenario
ENVIRONMENTAL ADDER	Should stay 10% as per NWPCC recommendation unless scenario analysis
DISTRIBUTION SYSTEM	Weighted average authorized margin, currently for Washington core cust.
RISK PREMIUM	Theoretical Cost to fully hedge natural gas portfolio
INFLATION	Estimated rate of inflation, modeled off the CPI.

Nominal Avoided Cost (By Zone) - \$/Therm							
	Zone 1	Zone 2	Zone 3	Zone 4	Oregon	Washington	System
2023	\$ 1.218	\$ 1.471	\$ 1.355	\$ 1.387	\$ 1.387	\$ 1.315	\$ 1.358
2024	\$ 0.921	\$ 1.264	\$ 1.159	\$ 1.665	\$ 1.665	\$ 1.250	\$ 1.460
2025	\$ 2.393	\$ 1.220	\$ 1.063	\$ 1.068	\$ 1.068	\$ 1.079	\$ 1.078
2026	\$ 1.507	\$ 1.022	\$ 0.952	\$ 1.126	\$ 1.126	\$ 0.953	\$ 1.042
2027	\$ 2.442	\$ 1.149	\$ 1.001	\$ 1.047	\$ 1.047	\$ 1.030	\$ 1.040
2028	\$ 2.385	\$ 1.100	\$ 0.986	\$ 1.012	\$ 1.012	\$ 1.013	\$ 1.014
2029	\$ 2.607	\$ 1.250	\$ 1.051	\$ 1.022	\$ 1.022	\$ 1.085	\$ 1.056
2030	\$ 0.895	\$ 3.708	\$ 1.954	\$ 1.066	\$ 1.066	\$ 2.690	\$ 1.887
2031	\$ 2.672	\$ 1.239	\$ 1.074	\$ 1.133	\$ 1.133	\$ 1.107	\$ 1.121
2032	\$ 1.717	\$ 1.109	\$ 1.031	\$ 1.148	\$ 1.148	\$ 1.039	\$ 1.094
2033	\$ 2.811	\$ 1.415	\$ 1.160	\$ 1.096	\$ 1.096	\$ 1.197	\$ 1.148
2034	\$ 3.073	\$ 1.327	\$ 1.114	\$ 1.063	\$ 1.063	\$ 1.161	\$ 1.113
2035	\$ 2.902	\$ 1.322	\$ 1.141	\$ 1.073	\$ 1.073	\$ 1.179	\$ 1.127
2036	\$ 0.993	\$ 1.931	\$ 1.340	\$ 1.118	\$ 1.118	\$ 1.577	\$ 1.350
2037	\$ 1.859	\$ 1.230	\$ 1.126	\$ 1.168	\$ 1.168	\$ 1.130	\$ 1.149
2038	\$ 3.343	\$ 1.413	\$ 1.208	\$ 1.121	\$ 1.121	\$ 1.253	\$ 1.187
2039	\$ 3.304	\$ 1.413	\$ 1.212	\$ 1.138	\$ 1.138	\$ 1.257	\$ 1.198
2040	\$ 3.662	\$ 1.386	\$ 1.214	\$ 1.126	\$ 1.126	\$ 1.262	\$ 1.195
2041	\$ 1.064	\$ 1.072	\$ 5.998	\$ 1.163	\$ 1.163	\$ 11.790	\$ 6.527
2042	\$ 4.016	\$ 1.529	\$ 1.291	\$ 1.223	\$ 1.223	\$ 1.352	\$ 1.289
2043	\$ 4.117	\$ 1.567	\$ 1.323	\$ 1.253	\$ 1.253	\$ 1.386	\$ 1.321
2044	\$ 4.226	\$ 1.608	\$ 1.358	\$ 1.287	\$ 1.287	\$ 1.422	\$ 1.356
2045	\$ 4.344	\$ 1.653	\$ 1.396	\$ 1.323	\$ 1.323	\$ 1.462	\$ 1.394
2046	\$ 4.472	\$ 1.702	\$ 1.437	\$ 1.362	\$ 1.362	\$ 1.505	\$ 1.435
2047	\$ 4.608	\$ 1.754	\$ 1.481	\$ 1.403	\$ 1.403	\$ 1.551	\$ 1.479
2048	\$ 4.752	\$ 1.809	\$ 1.528	\$ 1.447	\$ 1.447	\$ 1.599	\$ 1.525
2049	\$ 4.905	\$ 1.867	\$ 1.577	\$ 1.494	\$ 1.494	\$ 1.651	\$ 1.574
2050	\$ 5.065	\$ 1.928	\$ 1.628	\$ 1.542	\$ 1.542	\$ 1.705	\$ 1.625
2051	\$ 5.233	\$ 1.992	\$ 1.682	\$ 1.593	\$ 1.593	\$ 1.761	\$ 1.679
2052	\$ 5.407	\$ 2.058	\$ 1.738	\$ 1.646	\$ 1.646	\$ 1.820	\$ 1.735
2053	\$ 5.588	\$ 2.127	\$ 1.796	\$ 1.701	\$ 1.701	\$ 1.881	\$ 1.793
2054	\$ 5.775	\$ 2.198	\$ 1.856	\$ 1.759	\$ 1.759	\$ 1.944	\$ 1.853
2055	\$ 5.970	\$ 2.272	\$ 1.919	\$ 1.818	\$ 1.818	\$ 2.009	\$ 1.916
2056	\$ 6.172	\$ 2.349	\$ 1.984	\$ 1.879	\$ 1.879	\$ 2.077	\$ 1.980
2057	\$ 6.381	\$ 2.429	\$ 2.051	\$ 1.943	\$ 1.943	\$ 2.148	\$ 2.048
2058	\$ 6.598	\$ 2.511	\$ 2.121	\$ 2.009	\$ 2.009	\$ 2.221	\$ 2.117
2059	\$ 6.823	\$ 2.597	\$ 2.193	\$ 2.077	\$ 2.077	\$ 2.296	\$ 2.189
2060	\$ 7.055	\$ 2.685	\$ 2.268	\$ 2.148	\$ 2.148	\$ 2.375	\$ 2.264
2061	\$ 7.296	\$ 2.777	\$ 2.345	\$ 2.222	\$ 2.222	\$ 2.456	\$ 2.341
2062	\$ 7.545	\$ 2.872	\$ 2.425	\$ 2.297	\$ 2.297	\$ 2.539	\$ 2.421
2063	\$ 7.803	\$ 2.970	\$ 2.508	\$ 2.376	\$ 2.376	\$ 2.626	\$ 2.504
2064	\$ 8.070	\$ 3.072	\$ 2.594	\$ 2.457	\$ 2.457	\$ 2.716	\$ 2.590
2065	\$ 8.346	\$ 3.177	\$ 2.683	\$ 2.541	\$ 2.541	\$ 2.809	\$ 2.678
2066	\$ 8.632	\$ 3.286	\$ 2.775	\$ 2.628	\$ 2.628	\$ 2.905	\$ 2.770
2067	\$ 8.928	\$ 3.398	\$ 2.870	\$ 2.718	\$ 2.718	\$ 3.005	\$ 2.865
2068	\$ 9.234	\$ 3.514	\$ 2.968	\$ 2.812	\$ 2.812	\$ 3.108	\$ 2.963

Real 2021\$ Avoided Cost (By Zone)							
	Zone 1	Zone 2	Zone 3	Zone 4	Oregon	Washington	System
2023	\$ 1.218	\$ 1.471	\$ 1.355	\$ 1.387	\$ 1.387	\$ 1.315	\$ 1.358
2024	\$ 0.877	\$ 1.203	\$ 1.103	\$ 1.585	\$ 1.585	\$ 1.190	\$ 1.390
2025	\$ 2.168	\$ 1.105	\$ 0.963	\$ 0.968	\$ 0.968	\$ 0.978	\$ 0.976
2026	\$ 1.300	\$ 0.882	\$ 0.821	\$ 0.971	\$ 0.971	\$ 0.822	\$ 0.898
2027	\$ 2.004	\$ 0.943	\$ 0.822	\$ 0.859	\$ 0.859	\$ 0.845	\$ 0.854
2028	\$ 1.863	\$ 0.860	\$ 0.771	\$ 0.791	\$ 0.791	\$ 0.791	\$ 0.793
2029	\$ 1.939	\$ 0.929	\$ 0.782	\$ 0.760	\$ 0.760	\$ 0.807	\$ 0.785
2030	\$ 0.633	\$ 2.625	\$ 1.383	\$ 0.754	\$ 0.754	\$ 1.904	\$ 1.336
2031	\$ 1.801	\$ 0.835	\$ 0.724	\$ 0.763	\$ 0.763	\$ 0.746	\$ 0.755
2032	\$ 1.101	\$ 0.711	\$ 0.661	\$ 0.736	\$ 0.736	\$ 0.666	\$ 0.702
2033	\$ 1.716	\$ 0.864	\$ 0.708	\$ 0.669	\$ 0.669	\$ 0.731	\$ 0.701
2034	\$ 1.785	\$ 0.771	\$ 0.647	\$ 0.618	\$ 0.618	\$ 0.674	\$ 0.647
2035	\$ 1.605	\$ 0.731	\$ 0.631	\$ 0.593	\$ 0.593	\$ 0.652	\$ 0.623
2036	\$ 0.523	\$ 1.016	\$ 0.705	\$ 0.589	\$ 0.589	\$ 0.830	\$ 0.711
2037	\$ 0.932	\$ 0.616	\$ 0.564	\$ 0.585	\$ 0.585	\$ 0.566	\$ 0.576
2038	\$ 1.594	\$ 0.674	\$ 0.576	\$ 0.535	\$ 0.535	\$ 0.598	\$ 0.566
2039	\$ 1.500	\$ 0.642	\$ 0.550	\$ 0.516	\$ 0.516	\$ 0.571	\$ 0.544
2040	\$ 1.582	\$ 0.599	\$ 0.525	\$ 0.486	\$ 0.486	\$ 0.545	\$ 0.516
2041	\$ 0.438	\$ 0.441	\$ 2.467	\$ 0.478	\$ 0.478	\$ 4.849	\$ 2.684
2042	\$ 1.572	\$ 0.598	\$ 0.505	\$ 0.479	\$ 0.479	\$ 0.529	\$ 0.504
2043	\$ 1.534	\$ 0.584	\$ 0.493	\$ 0.467	\$ 0.467	\$ 0.516	\$ 0.492
2044	\$ 1.499	\$ 0.570	\$ 0.482	\$ 0.456	\$ 0.456	\$ 0.504	\$ 0.481
2045	\$ 1.466	\$ 0.558	\$ 0.471	\$ 0.447	\$ 0.447	\$ 0.494	\$ 0.471
2046	\$ 1.437	\$ 0.547	\$ 0.462	\$ 0.437	\$ 0.437	\$ 0.484	\$ 0.461
2047	\$ 1.409	\$ 0.536	\$ 0.453	\$ 0.429	\$ 0.429	\$ 0.474	\$ 0.452
2048	\$ 1.383	\$ 0.527	\$ 0.445	\$ 0.421	\$ 0.421	\$ 0.466	\$ 0.444
2049	\$ 1.359	\$ 0.517	\$ 0.437	\$ 0.414	\$ 0.414	\$ 0.457	\$ 0.436
2050	\$ 1.336	\$ 0.508	\$ 0.429	\$ 0.407	\$ 0.407	\$ 0.450	\$ 0.429
2051	\$ 1.314	\$ 0.500	\$ 0.422	\$ 0.400	\$ 0.400	\$ 0.442	\$ 0.422
2052	\$ 1.292	\$ 0.492	\$ 0.415	\$ 0.393	\$ 0.393	\$ 0.435	\$ 0.415
2053	\$ 1.271	\$ 0.484	\$ 0.408	\$ 0.387	\$ 0.387	\$ 0.428	\$ 0.408
2054	\$ 1.250	\$ 0.476	\$ 0.402	\$ 0.381	\$ 0.381	\$ 0.421	\$ 0.401
2055	\$ 1.230	\$ 0.468	\$ 0.395	\$ 0.375	\$ 0.375	\$ 0.414	\$ 0.395
2056	\$ 1.211	\$ 0.461	\$ 0.389	\$ 0.369	\$ 0.369	\$ 0.407	\$ 0.388
2057	\$ 1.191	\$ 0.453	\$ 0.383	\$ 0.363	\$ 0.363	\$ 0.401	\$ 0.382
2058	\$ 1.173	\$ 0.446	\$ 0.377	\$ 0.357	\$ 0.357	\$ 0.395	\$ 0.376
2059	\$ 1.154	\$ 0.439	\$ 0.371	\$ 0.351	\$ 0.351	\$ 0.388	\$ 0.370
2060	\$ 1.136	\$ 0.432	\$ 0.365	\$ 0.346	\$ 0.346	\$ 0.382	\$ 0.364
2061	\$ 1.118	\$ 0.426	\$ 0.359	\$ 0.340	\$ 0.340	\$ 0.376	\$ 0.359
2062	\$ 1.101	\$ 0.419	\$ 0.354	\$ 0.335	\$ 0.335	\$ 0.370	\$ 0.353
2063	\$ 1.083	\$ 0.412	\$ 0.348	\$ 0.330	\$ 0.330	\$ 0.365	\$ 0.348
2064	\$ 1.066	\$ 0.406	\$ 0.343	\$ 0.325	\$ 0.325	\$ 0.359	\$ 0.342
2065	\$ 1.050	\$ 0.400	\$ 0.337	\$ 0.320	\$ 0.320	\$ 0.353	\$ 0.337
2066	\$ 1.034	\$ 0.393	\$ 0.332	\$ 0.315	\$ 0.315	\$ 0.348	\$ 0.332
2067	\$ 1.017	\$ 0.387	\$ 0.327	\$ 0.310	\$ 0.310	\$ 0.342	\$ 0.326
2068	\$ 1.002	\$ 0.381	\$ 0.322	\$ 0.305	\$ 0.305	\$ 0.337	\$ 0.321

<h2>Discount Rate</h2> <p>5.06%</p> <p>Source: <a href="https://www.zillow.com/mortgage-rates/30-year-fixed/">https://www.zillow.com/mortgage-rates/30-year-fixed/</a></p> <p>As of - 6/8/2022</p>
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### Incremental Fixed Transportation

Total Cost - \$/dth	
2023	0
2024	0
2025	0
2026	0
2027	0
2028	0
2029	0
2030	0
2031	0
2032	0
2033	0
2034	0
2035	0
2036	0
2037	0
2038	0
2039	0
2040	0
2041	0
2042	0

Allocated Cost		
	I-5 Exp	GTN
2021	0	0
2022	0	0
2023	0	0
2024	0	0
2025	0	0
2026	0	0
2027	0	0
2028	0	0
2029	0	0
2030	0	0
2031	0	0
2032	0	0
2033	0	0
2034	0	0
2035	0	0
2036	0	0
2037	0	0
2038	0	0
2039	0	0
2040	0	0

**Variable Transportation**

Total Cost \$/dth	
2023	0.008729844
2024	0.008729844
2025	0.008729844
2026	0.008729844
2027	0.008729844
2028	0.008729844
2029	0.008729844
2030	0.008729844
2031	0.008729844
2032	0.008729844
2033	0.008729844
2034	0.008729844
2035	0.008729844
2036	0.008729844
2037	0.008729844
2038	0.008729844
2039	0.008729844
2040	0.008729844
2041	0.008729844
2042	0.008729844

Shortfalls Begin:		0
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New Allocated Cost		
	I-5 Exp	GTN
2023	0	0
2024	0	0
2025	0	0
2026	0	0
2027	0	0
2028	0	0
2029	0	0
2030	0	0
2031	0	0
2032	0	0
2033	0	0
2034	0	0
2035	0	0
2036	0	0
2037	0	0
2038	0	0
2039	0	0
2040	0	0
2041	0	0
2042	0	0

Contracts	
Contract	Cost
GTN13687	0.004001515
GTN13688	0.00531888
GTN17019W	0.00173264
GTN17021	0.00434656
GTN17022	0.00452416
GTN17023	0.00656256
GTN17025	0.0068304
GTN17026	0.0070128
GTN17028	0.00727216
GTN17031	0.00750704
GTN17033	0.0077424
GTN17034	0.00801552
GTN17036	0.00831104
GTN17037	0.00979936
NWP100002N	0.03
NWP100064Z20	0.03
NWP100134N11	0.03
NWP100149S	0.03
NWP100150N	0.03
NWP132329Z3W	0.03
NWP135558SS	0.03
NWP139090Z26	0.03
NWP139382	0.03
NWP139383	0.03
NWP139384	0.03
NWP139630MEO	0.03
NWP139637Z3W	0.03
NWP140047DC	0.03
NWP140748Z26	0.03
RUBY6103600B	0.01
GTN18507	0.00979936
<b>Average</b>	<b>0.02748746</b>

**Fuel**

Total Cost - dth	
2023	0.012807692
2024	0.012807692
2025	0.012807692
2026	0.012807692
2027	0.012807692
2028	0.012807692
2029	0.012807692
2030	0.012807692
2031	0.012807692
2032	0.012807692
2033	0.012807692
2034	0.012807692
2035	0.012807692
2036	0.012807692
2037	0.012807692
2038	0.012807692
2039	0.012807692
2040	0.012807692
2041	0.012807692
2042	0.012807692

Existing Contracts		
Contract	Cost	
GTN13687	0.005	
GTN13688	0.005	
GTN17019W	0.005	
GTN17021	0.005	
GTN17022	0.005	
GTN17023	0.005	
GTN17025	0.005	
GTN17026	0.005	
GTN17028	0.005	
GTN17031	0.005	
GTN17033	0.005	
GTN17034	0.005	
GTN17036	0.005	
GTN17037	0.005	
JPWD-100302	1.61	
JPWD-100401	0.17	
JPWD-135365	0.17	
JPWD-139622	0.17	
JPWD-139624	1.61	
JPWD-139626	0.17	
JPWD-139627	1.61	
NWP100002S	1.61	
NWP100064MEO	1.61	
NWP100134S3S	1.61	
NWP100149N	1.61	
NWP100150S	1.61	
NWP132329MEO	1.61	
NWP135558P3W	1.61	
NWP139090Z26	1.61	
NWP139382	1.61	
NWP139383	1.61	
NWP139384	1.61	
NWP139630MEO	1.61	
NWP139637Z3W	1.61	
NWP140047DC	1.61	
NWP140748Z26	1.61	
PLWD-100304	1.61	
PLWD-100601	0.53	
PLWD-140857	0.53	
PLWD-141193	1.61	
GTN18057	0.005	
<b>Average</b>	<b>1.195806452</b>	



### Fixed Storage

Total Cost \$/dth	
2021	0
2022	0
2023	0
2024	0
2025	0
2026	0
2027	0
2028	0
2029	0
2030	0
2031	0
2032	0
2033	0
2034	0
2035	0
2036	0
2037	0
2038	0
2039	0
2040	0

Allocated Cost	
2021	0
2022	0
2023	0
2024	0
2025	0
2026	0
2027	0
2028	0
2029	0
2030	0
2031	0
2032	0
2033	0
2034	0
2035	0
2036	0
2037	0
2038	0
2039	0
2040	0

### Variable Storage

Total Cost \$/dth	
2019	0
2020	0
2021	0
2022	0
2023	0
2024	0
2025	0
2026	0
2027	0
2028	0
2029	0
2030	0
2031	0
2032	0
2033	0
2034	0
2035	0
2036	0
2037	0
2038	0

New Allocated Cost	
2019	0
2020	0
2021	0
2022	0
2023	0
2024	0
2025	0
2026	0
2027	0
2028	0
2029	0
2030	0
2031	0
2032	0
2033	0
2034	0
2035	0
2036	0
2037	0
2038	0

**Commodity Cost - Calculated From Price Forecast**

\$/dth	Zone 1	Zone 2	Zone 3	Zone 4	Oregon	Washington	System
2023	5.607068	5.774859	5.744817	6.015492	6.015492	5.61970042	5.879073
2024	3.727867	3.842855	3.822267	4.004557	4.004557	3.7365245	3.911539
2025	3.142412	3.236361	3.21954	3.37345	3.37345	3.14948543	3.296722
2026	2.92139	2.999242	2.985303	3.102232	3.102232	2.92725144	3.040205
2027	2.775327	2.838771	2.827411	2.91552	2.91552	2.78010402	2.866025
2028	2.789262	2.849546	2.838752	2.920447	2.920447	2.79380065	2.873714
2029	2.838937	2.902002	2.89071	2.976336	2.976336	2.8436851	2.927423
2030	2.906857	2.970625	2.959207	3.034188	3.034188	2.9116582	2.98643
2031	2.905455	2.968463	2.957182	3.023335	3.023335	2.91019847	2.977308
2032	2.985695	3.047905	3.036767	3.103184	3.103184	2.99037866	3.057578
2033	3.079513	3.140227	3.129357	3.196457	3.196457	3.08408444	3.151614
2034	3.077847	3.138871	3.127945	3.190452	3.190452	3.08244145	3.146104
2035	3.168583	3.233091	3.221542	3.27716	3.27716	3.17344	3.231812
2036	3.198183	3.267598	3.255169	3.302897	3.302897	3.203409	3.255876
2037	3.151787	3.22734	3.213813	3.249175	3.249175	3.15747531	3.200427
2038	3.222101	3.299196	3.285392	3.320865	3.320865	3.22790561	3.271212
2039	3.28396	3.359113	3.345657	3.384805	3.384805	3.28961797	3.335733
2040	3.309947	3.38208	3.369165	3.410615	3.410615	3.31537791	3.362948
2041	3.383176	3.454407	3.441653	3.486448	3.486448	3.38853853	3.43881
2042	3.514565	3.577993	3.566637	3.622865	3.622865	3.51934016	3.578051

**Basin Weights (From SENDOUT)**

	Aeco	Rockies	Sumas
Zone 1	0	0.409083	0.590917
Zone 2	0	0.502903	0.497097
Zone 3	0	0.486105	0.513895
Zone 4	0.222371	0.394663	0.382966
Oregon	0.222371	0.394663	0.382966
Washington	0	0.416146	0.583854
System	0.189784	0.353965	0.456252
Forecast Type?	Annual		

Commodity Cost			
Price Forecast (Annual)			
	Aeco	Rockies	Sumas
2023	6.828098	6.663888	4.875447
2024	4.550234	4.452107	3.226487
2025	3.836675	3.734141	2.732767
2026	3.448984	3.411737	2.581931
2027	3.17299	3.174919	2.498696
2028	3.15801	3.168955	2.526406
2029	3.225425	3.236147	2.563955
2030	3.245493	3.308491	2.628812
2031	3.204372	3.302311	2.630717
2032	3.285782	3.377523	2.714438
2033	3.38264	3.461915	2.814783
2034	3.360327	3.4622	2.811765
2035	3.420161	3.574884	2.887308
2036	3.414388	3.635386	2.895514
2037	3.312523	3.627655	2.822351
2038	3.38337	3.707675	2.885946
2039	3.461714	3.757306	2.956269
2040	3.497987	3.764269	2.995427
2041	3.586236	3.83182	3.072586
2042	3.768865	3.914063	3.237998

Carbon Compliance Cost			
Scenario?	SCC 2.5%	SCC 2.5%	
\$/dth	Washington	Oregon	System
2023	4.57905159	4.579052	4.579052
2024	4.64949854	4.649499	4.649499
2025	4.79039243	4.790392	4.790392
2026	4.86083938	4.860839	4.860839
2027	4.93128633	4.931286	4.931286
2028	5.00173328	5.001733	5.001733
2029	5.07218022	5.07218	5.07218
2030	5.14262717	5.142627	5.142627
2031	5.21307412	5.213074	5.213074
2032	5.28352107	5.283521	5.283521
2033	5.35396801	5.353968	5.353968
2034	5.42441496	5.424415	5.424415
2035	5.49486191	5.494862	5.494862
2036	5.56530886	5.565309	5.565309
2037	5.70620275	5.706203	5.706203
2038	5.7766497	5.77665	5.77665
2039	5.84709665	5.847097	5.847097
2040	5.91754359	5.917544	5.917544
2041	5.98799054	5.987991	5.987991
2042	6.05843749	6.058437	6.058437

EPA 40 CFR Part 98 Subpart NN default higher heating value is 1.026 mmbtu/Mscf

EPA 40 CFR Part 98 Subpart NN Methodology 2 default CO2 emissions factor - 0.0544 metric tons CO2/Mscf

CNGC WA heating values - from EPA Subpart NN reporting

2012	1.032	mmbtu/Mscf
2013	1.035	mmbtu/Mscf
2014	1.043	mmbtu/Mscf
2015	1.062	mmbtu/Mscf
2016	1.073	mmbtu/Mscf
2017	1.075	mmbtu/Mscf
average	1.05333333	mmbtu/Mscf

Carbon Forecast		
Year	\$/ton	\$/dth
		SCC 2.5%
2023	83.12575	4.579052
2024	84.40461	4.649499
2025	86.96232	4.790392
2026	88.24118	4.860839
2027	89.52004	4.931286
2028	90.79889	5.001733
2029	92.07775	5.07218
2030	93.35661	5.142627
2031	94.63547	5.213074
2032	95.91433	5.283521
2033	97.19318	5.353968
2034	98.47204	5.424415
2035	99.7509	5.494862
2036	101.0298	5.565309
2037	103.5875	5.706203
2038	104.8663	5.77665
2039	106.1452	5.847097
2040	107.424	5.917544
2041	108.7029	5.987991
2042	109.9818	6.058437

EPA 40 CFR Part 98 Subpart NN default higher heating value is 1.026 mmbtu/Mscf  
 EPA 40 CFR Part 98 Subpart NN Methodology 2 default CO2 emissions factor - 0.0544 metric tons CO2/Mscf  
 CNGC WA heating values - from EPA Subpart NN reporting

2012	1.032 mmbtu/Mscf
2013	1.035 mmbtu/Mscf
2014	1.043 mmbtu/Mscf
2015	1.062 mmbtu/Mscf
2016	1.073 mmbtu/Mscf
2017	1.075 mmbtu/Mscf

average 1.053333  
 CO2 to Therm Conversion 0.005509

**Upstream Emissions Calculation**

CNGC Emission Factor for Upstream Natural Gas System (assumed % of GHG emitted upstream of natural gas delivered)	1.01%	0.00852248 Upstream Emission Rate, CH4 g/mmbtu	Upstream Emission Rate, CO2e g/mmbtu 167 4,680	End Use Emission Rate, CO2e g/mmbtu (based on Table NN-2 of 40 CFR Part 98 Subpart NN and company heating value) 50,405	Total Emission Rate CO2e Metric Tons/therm 0.005509 55,086
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Upstream Natural Gas System GHG Emission Rates (assumed % of GHG lost upstream of natural gas delivered)	0.77%	1.43%	28 Source: 2007 IPCC Report	10
GHGenius - from Puget Sound Clean Air Agency LCA Worksheet for PSE Tacoma LNG Facility (Canada supply)				
2020 EPA Annual GHG Inventory of US GHG Emissions and Sinks (1990-2018) (US Rockies supply)				
GWP of Methane - 100 yr				
therns per mmbtu - conversion				

CNGC Gas Supply %	52.4%	11.8%	35.8%
Sumas (BC Canada)			
AECC (AB Canada)			
US Rockies			

1)	unit of delivered natural gas - 1 mmbtu & mcf equivalent	<b>mmbtu</b>	<b>mcf</b>
		1	0.927
		<b>% CH<sub>4</sub></b>	<b>mcf of CH<sub>4</sub></b>
2)	Assumption on the % of the delivered gas that is methane	93.4	0.865
3)	Calculation of the amount of methane in a delivered unit of natural gas	<b>lb/mmbtu</b>	<b>g/mmbtu</b>
		36.632	16,616
		<b>lb/mcf</b>	<b>g/mcf</b>
		39.535	17,933

EIA	Mcf NatGas	mmbtu NatGas - 2021 EPA eGRT Cascade WA Subpart NN Report Value	Metric Ton CH <sub>4</sub> in 1 Mcf of CH <sub>4</sub>
<a href="https://www.wa.eia.gov/epa/efgpt/eg_uhp?id=45&amp;t=8">https://www.wa.eia.gov/epa/efgpt/eg_uhp?id=45&amp;t=8</a>	1	1.07925	0.0192

← From 40 CFR Part 98 Subpart W Equation W-36  $\rho$  = Density of GHG. Use 0.0526 kg/ft<sup>3</sup> for CO<sub>2</sub> and N<sub>2</sub>O, and 0.0192 kg/ft<sup>3</sup> for CH<sub>4</sub> at 60 °F and 14.7 psia.

Metric Ton MT	Grams g	Ton	lbs
1	1,000,000	1.10231	2204.62



### Environmental Adder

	System	Adder	10%
2023	110%		
2024	110%		
2025	110%		
2026	110%		
2027	110%		
2028	110%		
2029	110%		
2030	110%		
2031	110%		
2032	110%		
2033	110%		
2034	110%		
2035	110%		
2036	110%		
2037	110%		
2038	110%		
2039	110%		
2040	110%		
2041	110%		
2042	110%		

<b>Distribution System Costs in Real \$2021/dth</b>							
<b>\$/dth</b>	<b>Zone 1</b>	<b>Zone 2</b>	<b>Zone 3</b>	<b>Zone 4</b>	<b>Oregon</b>	<b>Washington</b>	<b>System</b>
2023	0.8850	3.0245	1.9945	2.0168	2.0168	1.7564	1.8853
2024	0.0000	2.8539	1.9685	6.1764	6.1764	2.8367	4.4908
2025	12.5296	2.7822	1.5062	1.4092	1.4092	1.7028	1.5574
2026	5.1078	1.2405	0.7009	1.9659	1.9659	0.7563	1.3554
2027	11.8887	2.1909	1.0950	1.3630	1.3630	1.3451	1.3540
2028	10.8343	1.6646	0.8622	0.9842	0.9842	1.0844	1.0348
2029	11.7034	2.4786	1.1431	0.8813	0.8813	1.4076	1.1469
2030	0.0000	18.0598	6.7790	1.0089	1.0089	11.5481	6.3282
2031	10.7754	1.9518	0.9497	1.2661	1.2661	1.1848	1.2251
2032	4.5505	0.9649	0.5156	1.1550	1.1550	0.5938	0.8718
2033	10.3192	2.5366	1.1301	0.7344	0.7344	1.3608	1.0505
2034	11.2020	1.9447	0.8258	0.5200	0.5200	1.0987	0.8121
2035	9.7257	1.7473	0.8441	0.4677	0.4677	1.0581	0.7657
2036	0.0000	4.4517	1.6285	0.5446	0.5446	2.7896	1.6777
2037	3.9094	1.0024	0.5374	0.7106	0.7106	0.5858	0.6476
2038	10.1174	1.7139	0.8317	0.4383	0.4383	1.0537	0.7489
2039	9.3844	1.5474	0.7209	0.3982	0.3982	0.9340	0.6686
2040	10.2784	1.3077	0.6393	0.2744	0.2744	0.8520	0.5659
2041	0.0000	0.0000	18.4209	0.3252	0.3252	40.1007	20.4007
2042	10.4257	1.5483	0.7070	0.4428	0.4428	0.9418	0.6947

**Risk Premium**

Year	System Risk Premium
2023	-0.010347855
2024	-0.011026907
2025	-0.017865489
2026	-0.013067388
2027	0.000761389
2028	0.013589426
2029	0.046481654
2030	0.077069484
2031	0.174579265
2032	0.238960111
2033	0.203911128
2034	0.145713439
2035	0.125487339
2036	0.255842411
2037	0.23509581
2038	0.167905463
2039	0.224764224
2040	0.26312279
2041	0.29575784
2042	0.29575784

### Inflation

Year	System Inflation Factor
2023	2.50%
2024	2.65%
2025	2.80%
2026	2.93%
2027	3.05%
2028	3.13%
2029	3.21%
2030	3.27%
2031	3.30%
2032	3.33%
2033	3.35%
2034	3.36%
2035	3.37%
2036	3.38%
2037	3.40%
2038	3.40%
2039	3.40%
2040	3.41%
2041	3.42%
2042	3.41%
2043	3.42%
2044	3.42%
2045	3.42%
2046	3.43%
2047	3.42%
2048	3.42%
2049	3.43%
2050	3.42%
2051	3.42%
2052	3.42%
2053	3.42%
2054	3.42%
2055	3.42%
2056	3.42%
2057	3.42%
2058	3.42%
2059	3.42%
2060	3.42%
2061	3.42%
2062	3.42%
2063	3.42%
2064	3.42%
2065	3.42%
2066	3.42%
2067	3.42%
2068	3.42%

## Upstream Gas Emissions Calculation Methodology & Assumptions

### Introduction

This section describes the decision points and approach used in updating the upstream natural gas emissions factor used by Cascade Natural Gas Corporation (Cascade) for the 2023 Integrated Resource Plan (IRP) planning cycle. The discussion below lays out the steps taken by Cascade to address the concerns raised by the Commission staff and the findings resulting from the described upstream natural gas emissions research.

Cascade developed an upstream methane emissions factor for the state of Washington that was used in the 2020 Integrated Resource Plan for calculating avoided cost and this has been updated for the 2023 IRP through input of UTC directly and the technical advisory group made up of interested parties, the public, and Commission Staff.

### Cascade's 2020 Upstream Emissions Factor Calculation Methodology

In this section, Cascade details the 2020 Integrated Resource Plan upstream emissions calculation. The equations and inputs for calculating upstream emissions rate and the total emissions rate (ERT) used in the avoided cost calculation are shown and explained below:

$$ER_T = \frac{1 \text{ dekatherm}}{10 \text{ therm}} * \frac{1 \text{ mmbtu}}{1 \text{ dekatherm}} * (UER_{CO_2e} + CER_{CO_2e})$$

$$UER_{CO_2e} = UER_{CH_4} * GWP_{Methane}$$

$$CER_{CO_2e} = \frac{EF_{EPA \text{ Subpart NN}}}{\text{Heating Value}}$$

$$UER_{CH_4} = \rho_{\text{methane}} * \frac{\% \text{ methane in natural gas}}{\text{Heating Value}} * ULF_{\text{Weighted \%}}$$

$$ULF_{\text{Weighted \%}} = (ULF_{US \text{ Rockies \%}} * \% \text{ Cascade U.S. Rockies Supply}) + (ULF_{\text{Canada \%}} * \% \text{ Cascade Canada Supply})$$

Where:

- $ER_T$  = Total emissions rate in CO<sub>2e</sub> - metric tons per therm of natural gas delivered, the sum of the upstream emissions rate and the customer end-use emissions rate.
- $UER_{CO_2e}$  = Upstream Emissions Rate (emissions estimated to occur upstream of customer receipt) in CO<sub>2e</sub> metric tons per MMBtu of natural gas delivered.
- $UER_{CH_4}$  = Upstream Emissions Rate (emissions estimated to occur upstream of customer receipt) in CH<sub>4</sub> metric tons per MMBtu of methane delivered.

- $CER_{CO_2e}$  = the customer emissions rate, from customer end-use combustion of natural gas delivered, in CO<sub>2e</sub> metric tons per MMBtu.
- $GWP_{Methane} = 25$ , The global warming potential (GWP) of methane at 100 years. This GWP value is from Chapter 2, Table 2.14, of IPCC 4th Assessment Report AR4 Climate Change 2007: The Physical Science Basis).
- $EF_{EPA\ Subpart\ NN} = 0.0544$  metric tons of CO<sub>2</sub> emitted per the combustion of 1 Mcf of natural gas, an EPA emissions factor from 40 CFR Part 98 Subpart NN.<sup>1</sup>
- **Heating Value = 1.07904**, This is the 2019 average of the heating value of gas supplied to Cascade's distribution system in Washington. This is taken from Cascade's annual GHG emissions report to EPA.
- $\rho_{methane} = 0.0192$  metric tons of methane per 1 Mcf of methane, the density of methane as provided in 40 CFR Part 98 Subpart W.<sup>2</sup>
- **% methane in natural gas = 93.4%**. This value represents an average percentage of methane in natural gas from EPA GHG inventory data and is discussed on page 14 of AGA's June 2020 Energy Analysis Report.<sup>3</sup> Cascade reviewed data from September and October 2020 on Williams' (Northwest Pipeline) website<sup>4</sup>, analyses posted for public review, and confirmed that locations where Cascade receives natural gas were in the range of 93.4%.
- $ULF_{Weighted\ \%}$  = the upstream loss factor expressed in percent methane emitted upstream per total methane delivered and is a weighted average of the different methane emissions loss factors representing the estimated natural gas that is supplied to Cascade from the U.S. Rockies or Canada.
- $ULF_{US\ Rockies\ \%} = 1.0\%$ , This upstream loss factor represents an estimate of the percent of methane lost from infrastructure supplying natural gas from the U.S. Rockies.
- $ULF_{Canada\ \%} = 0.77\%$ , This upstream loss factor represents an estimate of the percent methane lost from infrastructure supplying natural gas from Canada.
- **% Cascade U.S. Rockies Supply = 35.8%**, Percent for Cascade's Washington customers, estimated using Cascade gas supply data.
- **% Cascade Canada Supply = 64.2%**, Percent for Cascade's Washington customers, estimated using Cascade gas supply data.

Further background on this calculation and spreadsheet used to detail this calculation was discussed in a supplemental TAG meeting on October 15, 2020.

<sup>1</sup> [e-CFR 40 CFR Part 98 Mandatory Greenhouse Gas Reporting, Subpart NN - Suppliers of Natural Gas and Natural Gas Liquids](#)

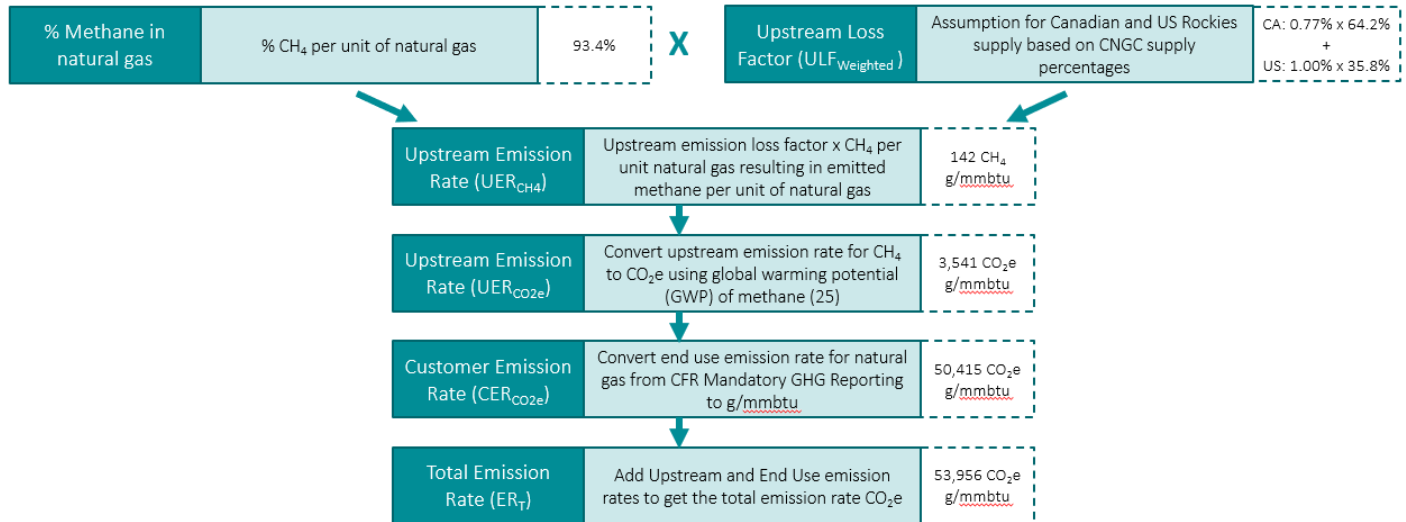
<sup>2</sup> [e-CFR 40 CFR Part 98 Mandatory Greenhouse Gas Reporting, Subpart W - Petroleum and Natural Gas Systems](#)

<sup>3</sup> Ibid 6-18

<sup>4</sup> [Williams Northwest Pipeline Daily Gas Quality Values Website](#)

Below is a flow chart representing the 2020 IRP Upstream Emissions Factor Calculation Methodology including the 2020 IRP assumptions:

**Figure H-1: 2020 IRP Upstream Emissions Factor Calculation Methodology**



### Approach Used in Updating the Calculations

The Washington Utilities and Transportation Commission Staff provided feedback on the findings and forecasts for the new resource acquisitions in Cascade’s 2020 IRP. In the feedback, the staff commented on the methodology assumptions applied in the upstream emissions factor calculation, requesting clarity on certain aspects and additional rigor on others.

In response to the feedback and as part of the in-progress 2023 IRP planning cycle, Cascade reviewed this calculation and associated assumptions against industry standards to determine changes to the assumptions to better align it with current best practices.

The first step of the review process was to identify alternative examples of upstream gas emissions calculation—particularly those within a similar geographic region—as these entities source their natural gas from similar gas suppliers. Cascade identified the following regional and national sources to compare upstream gas emissions calculation methodologies:

- **Peer/Regional Sources**
  - Puget Sound Energy 2020 GHG Inventory<sup>5</sup>
  - Avista 2021 Natural Gas IRP<sup>6</sup>

<sup>5</sup> [Puget Sound Energy 2020 GHG Inventory](#)

<sup>6</sup> [Avista 2021 Natural Gas IRP](#)

- NW Power and Conservation Council – Upstream Methane Emissions Workbook<sup>7</sup>
- **National Sources**
  - Natural Gas Sustainability Initiative – Methane Emissions Intensity Protocol<sup>8</sup>
  - IPIECA Estimating Petroleum Industry Value Chain (Scope 3) Greenhouse Gas Emissions<sup>9</sup>
  - American Petroleum Institute – Compendium of Greenhouse Gas Emissions Methodologies for the Natural Gas and Oil Industries 2021<sup>10</sup>

The Commission Staff feedback to the 2020 IRP specifically identified the upstream emissions loss rate for the Rocky Mountain Region and the GWP of methane as the main assumptions to reevaluate in the 2020 Cascade calculation methodology. Commission staff was concerned that the original 1.0% upstream emissions loss rate assumption—based on analysis from the American Gas Association—was too low. The Commission recommended an update to 2.47%, a figure calculated by the Environmental Defense Fund. Commission staff also flagged the GWP value of 25 from the 2014 IPCC AR4 as too low and recommended an update to the AR5 value, ranging from 28 to 34. Based on this feedback, Cascade identified the following independent variable assumptions for comparison while reviewing the alternative calculation methodologies and associated assumptions: Upstream Emissions Loss Rate for both US and Canadian supply, the GWP of methane, and the percent of methane in delivered natural gas.

## Findings

The review resulted in a comparison of assumptions—provided in Figures H-2 and H-3 below—for updates to the 2020 IRP calculation.

Figure H-2: Peer Assumptions

Assumption	Cascade	Puget Sound	Avista	NW Council Workbook
<b>Upstream Loss Factor (ULF) - Canadian Supply</b>	0.77%	0.77%	0.77%	0.77%

<sup>7</sup> [NW Power and Conservation Council - Upstream Methane Emission Workbook](#)

<sup>8</sup> [Natural Gas Sustainability Initiative – Methane Emissions Intensity Protocol](#)

<sup>9</sup> [IPIECA Estimating Petroleum Industry Value Chain \(Scope 3\) Greenhouse Gas Emissions 2016](#)

<sup>10</sup> [American Petroleum Institute – Compendium of Greenhouse Gas Emissions Methodologies for the Natural Gas and Oil Industries 2021](#)



<b>Upstream Loss Factor (ULF) – US Supply</b>	1.00%	NA	1.00%	2.47%
<b>Upstream Loss Factor (ULF Weighted %)</b>	0.85%	1.25%	0.79%	1.37%
<b>GWP Methane – 100 Years</b>	25	25	34	34
<b>% Methane in natural gas</b>	93.4%	NA	NA	97%

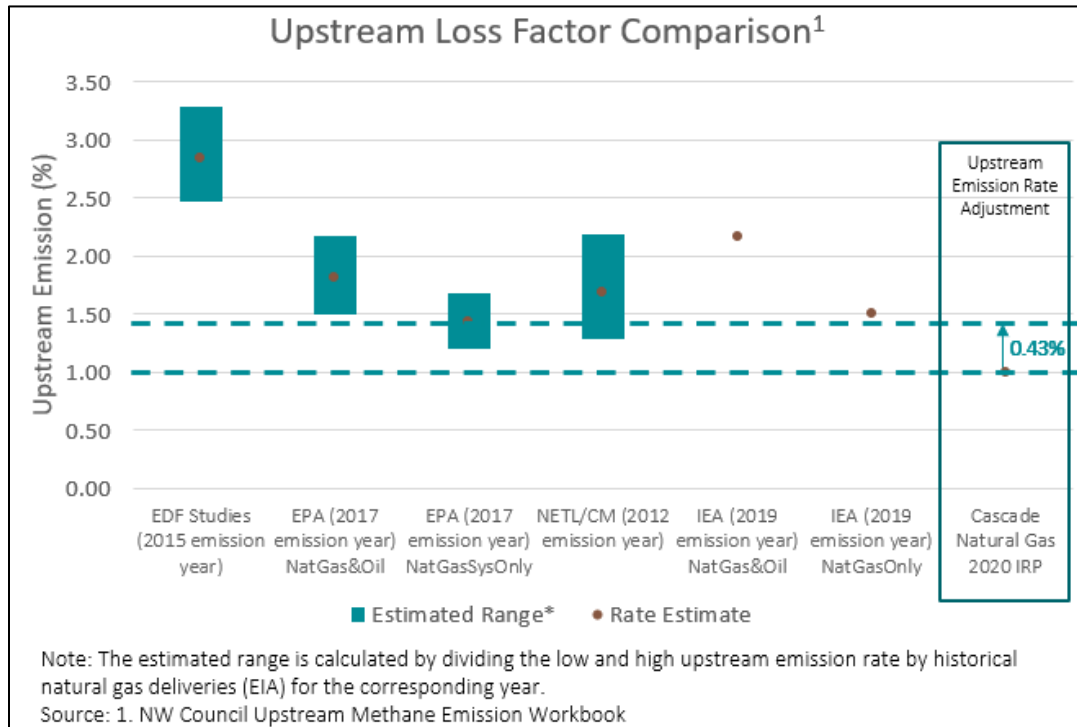
Figure H-3: National Assumptions

Variable	Cascade	Alternative Values & Sources
<b>Upstream Loss Factor - Canadian Supply</b>	0.77%	NA
<b>Upstream Loss Factor – US Supply</b>	1.00%	<ul style="list-style-type: none"> <li>• 2.84% (Range: 2.47-3.29%) - Environmental Defense Fund Coordinated Studies 2018</li> <li>• 1.82% (Range: 1.49-2.18%) - EPA Natural Gas and Oil 2017 Emission Year</li> <li>• 1.43% (Range: 1.20-1.68%) - EPA Natural Gas System Only 2017 Emission Year</li> <li>• 1.51% - IEA Natural Gas Only 2019 Emission Year</li> </ul>
<b>GWP Methane – 100 Years</b>	25	<ul style="list-style-type: none"> <li>• 25 – IPCC Fourth Assessment Report 2007</li> <li>• 28 – IPCC Fifth Assessment Report 2014</li> <li>• 28-34 – United Nations Economic Commission for Europe</li> </ul>
<b>% Methane in natural gas</b>	93.4%	<ul style="list-style-type: none"> <li>• 95-98% - EPA Pipeline Quality Estimate</li> <li>• 94.9% – NAESB Natural Gas Spec Sheet (2002)</li> <li>• 70-90% - Yale Climate Change Communication (2020)</li> <li>• 85-90% - Britannica Composition and Properties of Natural Gas</li> </ul>

While a review of peer and National sources did provide examples that matched Cascade's 2020 assumptions, Cascade also recognizes upward pressure on upstream loss factors as new evaluation methods arise. Therefore, Cascade will be updating the

Upstream Loss Factor for US gas supply to 1.43% based on the EPA 2017 Emission Year, provided in the NW Power and Conservation Council – Upstream Methane Emission Workbook. The 2020 assumption of 1.00% upstream loss factor is lower than EDF, IEA, NETL, and EPA GHG Inventory 2017 Emission Year estimates according to methodology applied by the NW Power & Conservation Council. The 1.43% upstream loss factor is within the range of the NETL Life Cycle Model Study and 0.08% below the IEA 2019 Natural Gas System Only Rate estimate as laid out in Figure H-4.

Figure H-4: Upstream Loss Factor Emission Comparison – US Supply



The Commission-recommended emissions rate of 2.47% determined by the EDF highlights new approaches and challenges to tracking methane emissions in the natural gas supply chain. In addition to Cascade has updating its upstream U.S. Rockies emissions rate to 1.43%, Cascade is utilizing the 2.47% rate as a *high* emissions scenario for the avoided cost calculation.

Cascade will also update the GWP of methane to 28 from 25. While international reporting standards under the United Nations Framework Convention on Climate Change currently require the use of the GWP values from IPCC’s AR4 (25), the GWP estimates presented by the most recent IPCC scientific assessment reflect the current state of science. In the IPCC AR5 Synthesis Report, this value is 28.

Regarding the methane composition of commercial natural gas, Cascade believes that the 93.4% methane in natural gas—based on the GTN & Williams Northwest Pipeline<sup>11</sup>

<sup>11</sup> [Williams Northwest Pipeline Daily Gas Quality Values Website](#) – Kemmerer Compression Station

methane percent data for US Rockies' city gates—is a reliable representation of average methane in the gas system. This value within 2% of the EPA estimates of 95-98% and therefore should be maintained. By comparison, there are several sources listing the methane composition of commercial natural gas: Yale Climate Communication<sup>12</sup> lists the range as 70-90%, Britannica<sup>13</sup> lists it at 85-90%, and the EPA Pipeline Quality Estimate<sup>14</sup> lists 95-98%. Cascade will continue to review this value in future IRPs considering the most recent gas supply methane percent data available; if the value trends differently in future years, Cascade can adjust accordingly.

## Result - Cascade 2023 Upstream Emissions Factor Calculation Methodology

In this section, Cascade details the 2023 Integrated Resource Plan upstream emissions calculation and assumptions. The equations in the 2023 calculation are maintained from the equation structure in the 2020 IRP calculation methodology. The equations and inputs for calculating upstream emissions rate and the total emissions rate (ERT) used in the avoided cost calculation are shown and explained below:

$$ER_T = \frac{1 \text{ dekatherm}}{10 \text{ therm}} * \frac{1 \text{ mmbtu}}{1 \text{ dekatherm}} * (UER_{CO_2e} + CER_{CO_2e})$$

$$UER_{CO_2e} = UER_{CH_4} * GWP_{Methane}$$

$$CER_{CO_2e} = \frac{EF_{EPA \text{ Subpart NN}}}{\text{Heating Value}}$$

$$UER_{CH_4} = \rho_{\text{methane}} * \frac{\% \text{ methane in natural gas}}{\text{Heating Value}} * ULF_{\text{Weighted \%}}$$

$$ULF_{\text{Weighted \%}} = (ULF_{US \text{ Rockies \%}} * \% \text{ Cascade U.S. Rockies Supply}) + (ULF_{\text{Canada \%}} * \% \text{ Cascade Canada Supply})$$

Where:

- $ER_T$  = Total emissions rate in CO<sub>2e</sub> - metric tons per therm of natural gas delivered, the sum of the upstream emissions rate and the customer end-use emissions rate.
- $UER_{CO_2e}$  = Upstream Emissions Rate (emissions estimated to occur upstream of customer receipt) in CO<sub>2e</sub> metric tons per MMBtu of natural gas delivered.
- $UER_{CH_4}$  = Upstream Emissions Rate (emissions estimated to occur upstream of customer receipt) in CH<sub>4</sub> metric tons per MMBtu of methane delivered.

<sup>12</sup> [Yale Climate Communication - Should it be called natural gas or methane](#)

<sup>13</sup> [Composition and Properties of Natural Gas](#)

<sup>14</sup> [EPA - Overview Oil and Natural Gas Industry](#)

- $CER_{CO_2e}$  = the customer emissions rate, from customer end-use combustion of natural gas delivered, in CO<sub>2e</sub> metric tons per MMBtu.
- $GWP_{Methane} = 28$ , The global warming potential (GWP) of methane at 100 years.
- $EF_{EPA\ Subpart\ NN} = 0.0544$  metric tons of CO<sub>2</sub> emitted per the combustion of 1 Mcf of natural gas, an EPA emissions factor from 40 CFR Part 98 Subpart NN.<sup>15</sup>
- **Heating Value = 1.07925**, This is the 2021 average of the heating value of gas supplied to Cascade's distribution system in Washington. This is taken from Cascade's annual NN GHG emissions report to EPA.
- $\rho_{methane} = 0.0192$  metric tons of methane per 1 Mcf of methane, the density of methane as provided in 40 CFR Part 98 Subpart W.<sup>16</sup>
- **% methane in natural gas = 93.4%**. This value represents an average percentage of methane in natural gas from EPA GHG inventory data and is discussed on page 14 of AGA's June 2020 Energy Analysis Report.<sup>17</sup> Cascade reviewed 2022 data on Williams' (Northwest Pipeline) website<sup>18</sup>, analyses posted for public review, and confirmed that locations where Cascade receives natural gas were in the range of 93.4% (the average of methane % data received from GTN for July- September 2022).
- $ULF_{Weighted\ \%}$  = the upstream loss factor expressed in percent methane emitted upstream per total methane delivered and is a weighted average of the different methane emissions loss factors representing the estimated natural gas that is supplied to Cascade from the U.S. Rockies or Canada.
- $ULF_{US\ Rockies\ \%} = 1.43\%$ , This upstream loss factor represents an estimate of the percent of methane lost from infrastructure supplying natural gas from the U.S. Rockies.
- $ULF_{Canada\ \%} = 0.77\%$ , This upstream loss factor represents an estimate of the percent methane lost from infrastructure supplying natural gas from Canada.
- **% Cascade U.S. Rockies Supply = 35.8%**, Percent for Cascade's Washington customers, estimated using Cascade gas supply data.
- **% Cascade Canada Supply = 64.2%**, Percent for Cascade's Washington customers, estimated using Cascade gas supply data.

<sup>15</sup> [e-CFR 40 CFR Part 98 Mandatory Greenhouse Gas Reporting, Subpart NN - Suppliers of Natural Gas and Natural Gas Liquids](#)

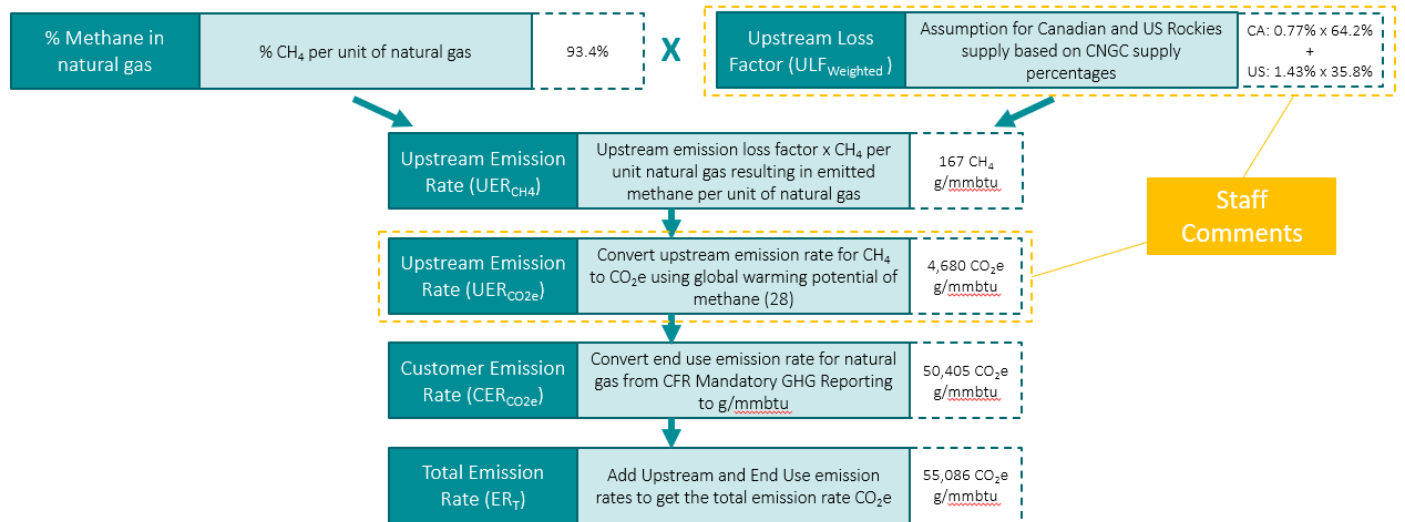
<sup>16</sup> [e-CFR 40 CFR Part 98 Mandatory Greenhouse Gas Reporting, Subpart W - Petroleum and Natural Gas Systems](#)

<sup>17</sup> Ibid 6-18

<sup>18</sup> [Williams Northwest Pipeline Daily Gas Quality Values Website](#)

A flow chart displaying the 2023 calculation methodology, updated assumptions, and resulting emissions rate impact is displayed in Figure H-5.

**Figure H-5: 2023 calculation methodology**



With the updated assumptions, the upstream emissions rate increases to a value of 4,680 CO<sub>2e</sub> g/MMbtu from a value of 3,541 CO<sub>2e</sub> g/MMbtu in the 2020 IRP, or a 32% increase. Cascade will continue to evaluate upstream emissions rate assumptions and new methane emissions tracking methodology as it is released to support methodology development in future IRP processes.