

IMM CONE CT Study Results

MIC Special Session:
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Monitoring Analytics

Objective of Study

- **Develop an independent determination of CONE CT revenue requirements for the four CONE Areas**
- **Participants**
 - **Pasteris Energy, Inc. – Overall coordination, soft cost development, proforma**
 - **Stantec – EPC cost estimate, project schedule, drawdown and escalation**
 - **David R. Alexander, Consulting – Emissions Reductions Credits, permits and costs**
 - **deGrouchy, Sifer and Company, CPA - Tax and accounting advisors**

CONE CT Technology Comparison

IMM CONE CT Plant Description

CONE Area	1 - EMAAC	2 - SWMAAC	3 - Rest of RTO	4 - WMAAC
State	NJ	MD	PA	PA
County	Gloucester	Charles	Cambria	Luzerne
CT OEM	GE	GE	GE	GE
CT Model	7HA.02	7HA.02	7HA.02	7HA.02
Number of CTs	2	2	2	2
NOx Selective Catalytic Reduction (SCR)	Yes	Yes	Yes	Yes
CO Oxidaton Catalyst	Yes	Yes	Yes	Yes
CT Inlet Air Chilling to 50 F	Yes	Yes	Yes	Yes
CT Inlet Air Evaporative Cooling	No	No	No	No
Dual Fuel	Yes	Yes	Yes	Yes
Firm Gas Contract	No	No	No	No
Black Start Capability	No	No	No	No
On Site Gas Compression	No	No	No	No
Net Capacity (MW) (ICAP)	755.760	746.726	734.712	742.611
Net Heat Rate (BTU/kWh) (ICAP)	9,147	9,122	9,212	9,208
Site Elevation (Ft)	0	180	800	520
Ambient Temperature (F)	94.1	93.2	82.4	90.3
Relative Humidity (%)	44.8%	49.4%	58.6%	47.9%

CONE CT Technology Comparison

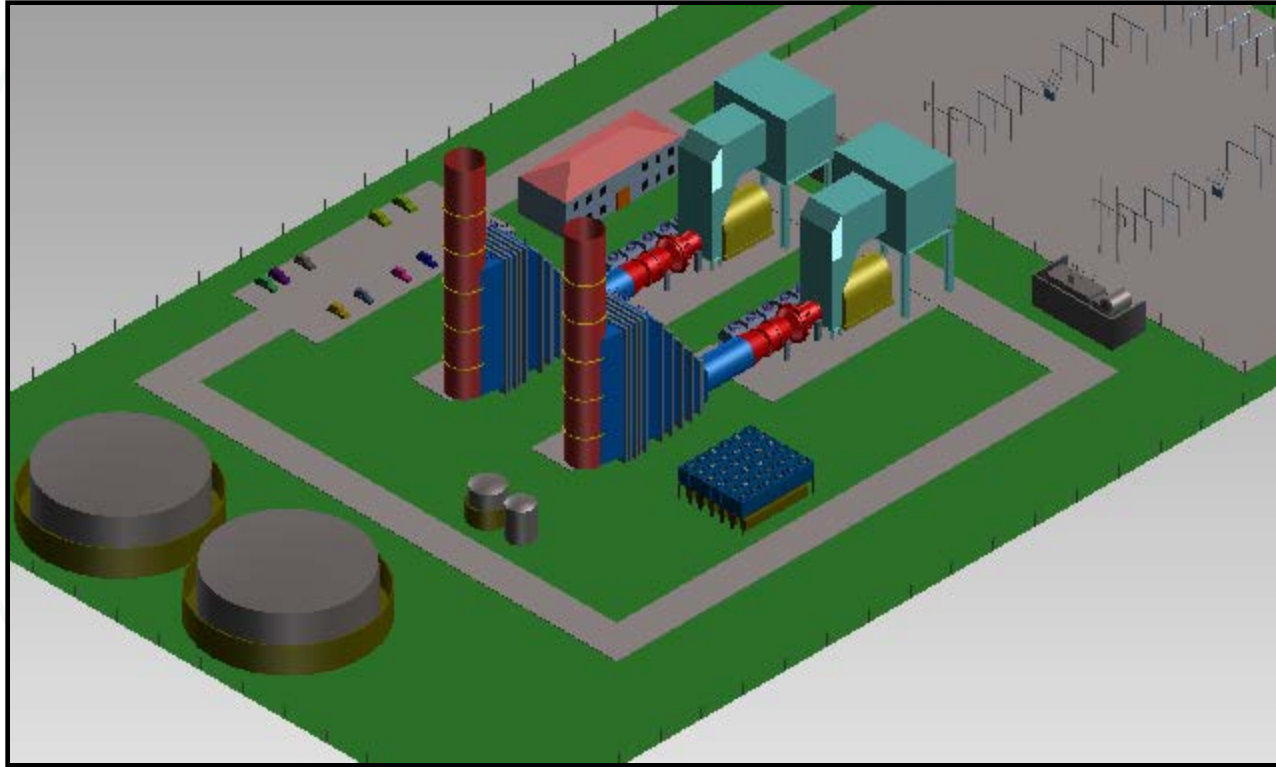
Brattle CONE CT Plant Description

CONE Area	1 - EMAAC	2 - SWMAAC	3 - Rest of RTO	4 - WMAAC
State	North-NJ	MD	PA-OH	PA
County	NA	Charles	NA	Luzerne
CT OEM	GE	GE	GE	GE
CT Model	7HA.02	7HA.02	7HA.02	7HA.02
Number of CTs	1	1	1	1
NOx Selective Catalytic Reduction (SCR)	Yes	Yes	No	Yes
CO Oxidation Catalyst	Yes	Yes	No	Yes
CT Inlet Air Chilling to 50 F	No	No	No	No
CT Inlet Air Evaporative Cooling	Yes	Yes	Yes	Yes
Dual Fuel	Yes	Yes	Yes	Yes
Firm Gas Contract	No	No	No	No
Black Start Capability	No	No	No	No
On Site Gas Compression	No	No	No	No
Net Capacity (MW) (ICAP)	352.000	355.000	321.000	344.000
Net Capacity (MW) (ICAP) (Two CTs)	704.000	710.000	642.000	688.000
Net Heat Rate (BTU/kWh) (ICAP)	9,274	9,270	9,221	9,263
Site Elevation (Ft)	330	150	990	1200
Ambient Temperature (F)	92	96	89.8	91.2
Relative Humidity (%)	55.5%	44.6%	49.7%	49.2%

CONE CT Technology Comparison

- **IMM ambient conditions are based on PJM Manual 21 procedures.**
 - **Uses mean ambient condition at time of PJM system summer peak over last 15 years.**
- **IMM CONE CT employs SCR and CO catalyst in Rest of RTO.**

Rendering of CONE CT Power Plant

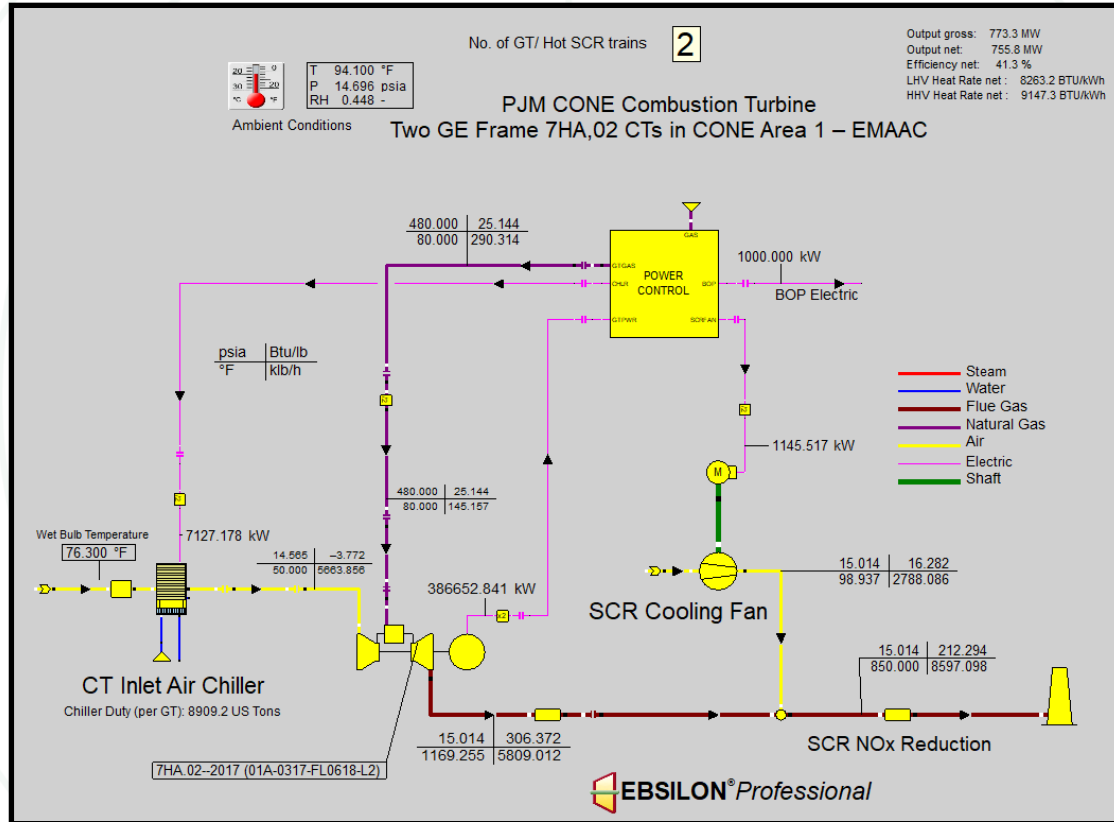


PJM Manual 21 ICAP Ambient Conditions

PJM System Peak Ambient Conditions 15 Year Average

PJM Historical System Peaks		EMAAC		SWMAAC		Rest of RTO		WMAAC	
PJM Peak Date	PJM Peak Hour EDT	DBT	WBT	DBT	WBT	DBT	WBT	DBT	WBT
8/22/2003	16	91.0	79.4	91.4	79.6	78.1	72.2	84.9	75.8
8/3/2004	17	82.0	75.7	80.6	75.5	79.0	67.3	84.0	71.2
7/27/2005	16	97.0	77.6	98.6	79.1	73.0	66.5	87.1	76.4
8/2/2006	17	96.1	77.4	95.0	79.3	84.0	74.1	91.9	76.3
8/8/2007	17	96.1	78.1	98.4	78.0	82.9	75.2	91.9	74.1
6/9/2008	17	96.1	74.7	93.0	75.7	84.9	69.2	91.9	72.4
8/10/2009	17	93.9	78.1	93.4	76.1	79.0	71.1	87.1	75.8
7/7/2010	17	100.9	72.1	97.5	76.2	87.1	69.3	93.9	71.9
7/21/2011	17	97.0	78.9	96.8	83.4	89.1	75.5	96.1	76.4
7/17/2012	17	97.0	72.8	98.4	73.5	87.1	72.2	96.1	73.1
7/18/2013	17	96.1	79.4	95.0	76.1	84.9	72.7	95.0	75.5
6/17/2014	18	91.9	71.3	90.9	76.4	82.0	68.9	84.9	72.2
7/28/2015	17	90.0	74.7	85.1	76.9	80.1	68.3	90.0	70.8
8/11/2016	16	93.9	78.8	92.1	77.7	82.0	74.3	91.0	78.6
7/19/2017	18	93.0	75.5	92.3	75.5	82.9	71.5	89.1	74.1
Mean		94.1	76.3	93.2	77.3	82.4	71.2	90.3	74.3

Power Plant EBSILON Model Flow Diagram



EBSILON Model Results

CONE CT - Plant Performance at PJM ICAP Ambient Conditions - EBSILON Model Results

CONE Area		1 - EMAAC	2 - SWMAAC	3 - Rest of RTO	4 - WMAAC
Inputs	Units				
Equivalent Elevation	ft.	0	180	800	520
Ambient Temperature	°F	94.1	93.2	82.4	90.3
Wet Bulb Temperature	°F	76.3	77.3	71.2	74.3
Ambient Relative Humidity	Percent	44.8%	49.4%	58.6%	47.9%
CT 1 Desired Inlet Air Temperature	°F	50.0	50.0	50.0	50.0
CT 1 Chiller System Input	kW/Ton	0.80	0.80	0.80	0.80
CT 2 Desired Inlet Air Temperature	°F	50.00	50.00	50.00	50.00
CT 2 Chiller System Input	kW/Ton	0.80	0.80	0.80	0.80
CT 1 SCR Cooling Air Desired Exit Pressure	PSIA	15.081	15.081	15.081	15.081
CT 1 SCR Cooling Air Fan Isentropic Efficiency	Percent	70.0%	70.0%	70.0%	70.0%
CT 2 SCR Cooling Air Desired Exit Pressure	PSIA	15.081	15.081	15.081	15.081
CT 2 SCR Cooling Air Fan Isentropic Efficiency	Percent	70.0%	70.0%	70.0%	70.0%
BOP Parasitic Load	kW	1,000	1,000	1,000	1,000
Results					
Actual Net Power	MW	755.760	746.726	734.712	742.611
CT 1 Net Power	MW	386.653	381.844	375.923	380.513
CT 2 Net Power	MW	386.653	381.844	375.923	380.513
Gross Power	MW	773.306	763.688	751.846	761.026
CT 1 Chiller Electric Load	kW	7,127.2	7,399.0	5,412.4	6,454.8
CT 2 Chiller Electric Load	kW	7,127.2	7,399.0	5,412.4	6,454.8
CT 1 SCR Cooling Air Fan Load	MW	1.1455	0.5823	2.6546	2.2528
CT 2 SCR Cooling Air Fan Load	MW	1.1455	0.5823	2.6546	2.2528
BOP Parasitic Load	kW	1,000	1,000	1,000	1,000
Net Power (ICAP)	MW	755.760	746.726	734.712	742.611
CT 1 Heat Consumption	BTU/Hr. (LHV)	3,122,486,722	3,076,627,055	3,057,101,433	3,088,638,270
CT 2 Heat Consumption	BTU/Hr. (LHV)	3,122,486,722	3,076,627,055	3,057,101,433	3,088,638,270
Total Fuel	MMBTU/Hr. (LHV)	6,245.0	6,153.3	6,114.2	6,177.3
Total Fuel	MMBTU/Hr. (HHV)	6,913.2	6,811.7	6,768.4	6,838.2
Net Plant Heat Rate	BTU/kWh (HHV)	9,147	9,122	9,212	9,208

IMM CONE CT E&AS Results

2017 CONE COMBUSTION TURBINE EAS RUNS					
CONE Area	Zone	\$/MW-Yr	\$/MW-Day	Run Hours	No. Starts
EMAAC	AECO	\$21,522	\$58.96	3,378	207
Rest of RTO	PENELEC	\$28,929	\$79.26	4,089	232
SWMAAC	Pepco	\$14,498	\$39.72	2,278	211
WMAAC	PPL	\$22,510	\$61.67	3,446	209

Capital Cost Comparison

IMM CONE CT Capital Cost (\$000)

CONE Area	1 - EMAAC	2 - SWMAAC	3 - Rest of RTO	4 - WMAAC
Net Capacity (MW) (ICAP)	755.760	746.726	734.712	742.611
Equipment and EPC	\$385,577	\$360,506	\$363,347	\$366,160
Non - EPC	\$79,043	\$74,328	\$72,685	\$74,154
Overnight Cost	\$464,620	\$434,834	\$436,032	\$440,314
IDC	\$12,480	\$11,680	\$11,712	\$11,827
Total Project Cost	\$477,100	\$446,514	\$447,744	\$452,141
Total Project Cost (\$/kW)	\$631.29	\$597.96	\$609.41	\$608.85

Brattle CONE CT Capital Cost (\$000)

CONE Area	1 - EMAAC	2 - SWMAAC	3 - Rest of RTO	4 - WMAAC
Net Capacity (MW) (ICAP)	352.000	355.000	321.000	344.000
Equipment and EPC	\$244,539	\$227,622	\$193,912	\$236,365
Non - EPC	\$71,432	\$69,153	\$62,625	\$68,299
Overnight Cost	\$315,971	\$296,775	\$256,537	\$304,664
IDC	\$14,086	\$13,365	\$11,440	\$13,587
Total Project Cost	\$330,057	\$310,140	\$267,977	\$318,251
Total Project Cost (\$/kW)	\$937.66	\$873.63	\$834.82	\$925.15
Total Project Cost (\$/kW) (Combined Cycle)	\$950.76	\$841.37	\$887.06	\$928.53

Capital Cost Comparison

- **IMM CONE CT total project cost (TPC) is 68.5 percent of Brattle TPC on a \$/kW basis.**
- **IMM lower cost is due to economies of scale with two CT configuration.**

Capital Cost Comparison

IMM CONE CT Capital Cost Detail

CONE Area	1 - EMAAC	2 - SWMAAC	3 - Rest of RTO	4 - WMAAC
Plant Proper EPC	\$385,577	\$360,506	\$363,347	\$366,160
State Sales Tax	\$465	\$465	\$465	\$465
Electric Interconnect	\$15,509	\$14,327	\$14,208	\$14,472
Gas Interconnect	\$19,670	\$18,172	\$18,020	\$18,355
Equipment Spares	\$6,294	\$6,294	\$6,294	\$6,294
Owner's Contingency	\$9,639	\$9,013	\$9,084	\$9,154
Mobilization and Startup	\$3,137	\$3,137	\$3,137	\$3,137
Land Purchase	\$3,236	\$2,178	\$1,846	\$1,600
Development Expenses	\$7,078	\$7,078	\$7,078	\$7,078
Legal Fees	\$2,199	\$2,199	\$2,199	\$2,199
Financing Fees	\$4,771	\$4,465	\$4,477	\$4,521
Interest During Construction	\$12,480	\$11,680	\$11,712	\$11,827
Permits	\$2,307	\$2,263	\$1,998	\$2,141
Emissions Reduction Credits	\$2,237	\$2,237	\$1,379	\$2,237
Initial Fuel Oil Inventory	\$2,500	\$2,500	\$2,500	\$2,500
Total Project Cost	\$477,100	\$446,514	\$447,744	\$452,141

Capital Cost Comparison

Brattle CONE CT Capital Cost Detail

	CONE Area			
	1	2	3	4
	EMAAC	SWMAAC	Rest of RTO	WMAAC
Capital Costs (in \$millions)	352 MW	355 MW	321 MW	344 MW
Owner Furnished Equipment				
Gas Turbines	\$74.4	\$74.4	\$74.4	\$74.4
HRSR / SCR	\$26.6	\$26.6	\$0.0	\$26.6
Sales Tax	\$6.7	\$6.1	\$4.7	\$6.4
Total Owner Furnished Equipment	\$107.7	\$107.1	\$79.1	\$107.4
EPC Costs				
Equipment				
Condenser	\$0.0	\$0.0	\$0.0	\$0.0
Steam Turbines	\$0.0	\$0.0	\$0.0	\$0.0
Other Equipment	\$25.7	\$25.6	\$28.5	\$25.7
Construction Labor	\$43.5	\$31.8	\$31.0	\$37.6
Other Labor	\$16.5	\$15.3	\$12.9	\$16.0
Materials	\$6.6	\$6.5	\$6.5	\$6.6
Sales Tax	\$2.1	\$1.9	\$2.2	\$2.0
EPC Contractor Fee	\$20.2	\$18.8	\$16.0	\$19.5
EPC Contingency	\$22.2	\$20.7	\$17.6	\$21.5
Total EPC Costs	\$136.8	\$120.5	\$114.8	\$128.9
Non-EPC Costs				
Project Development	\$12.2	\$11.4	\$9.7	\$11.8
Mobilization and Start-Up	\$2.4	\$2.3	\$1.9	\$2.4
Net Start-Up Fuel Costs	\$2.6	\$1.7	\$0.2	\$0.6
Electrical Interconnection	\$7.8	\$7.8	\$7.1	\$7.6
Gas Interconnection	\$29.1	\$29.1	\$29.1	\$29.1
Land	\$0.4	\$0.7	\$0.3	\$0.5
Fuel Inventories	\$3.0	\$3.0	\$2.7	\$2.9
Non-Fuel Inventories	\$1.2	\$1.1	\$1.0	\$1.2
Owner's Contingency	\$4.7	\$4.6	\$4.2	\$4.5
Emission Reduction Credit	\$0.0	\$0.0	\$0.0	\$0.0
Financing Fees	\$8.0	\$7.5	\$6.5	\$7.7
Total Non-EPC Costs	\$71.4	\$69.2	\$62.6	\$68.3
Total Capital Costs	\$316.0	\$296.8	\$256.5	\$304.7
Overnight Capital Costs (\$million)	\$316	\$297	\$257	\$305
Overnight Capital Costs (\$/kW)	\$898	\$836	\$799	\$886
Installed Cost (\$/kW)	\$938	\$874	\$835	\$925

First Year Fixed Expenses Comparison

IMM First Year Fixed Expenses (\$000)

CONE Area	1 - EMAAC	2 - SWMAAC	3 - Rest of RTO	4 - WMAAC
Site O&M Labor	\$1,527.3	\$1,428.0	\$1,439.2	\$1,450.4
O&M Contract Parts and Labor	\$672.7	\$629.0	\$633.9	\$638.8
Major Maintenance	\$5,063.0	\$3,414.3	\$6,128.6	\$5,164.9
Electric Purchases	\$274.0	\$274.0	\$274.0	\$274.0
Employee Training	\$99.3	\$99.3	\$99.3	\$99.3
O&M Management Fee	\$146.0	\$146.0	\$146.0	\$146.0
Insurance	\$2,137.6	\$1,998.8	\$2,011.7	\$2,028.7
General and Administrative Expenses	\$204.1	\$204.1	\$204.1	\$204.1
Property Taxes	\$1,176.5	\$1,039.1	\$277.7	\$554.3
Total Fixed O&M	\$11,300.4	\$9,232.5	\$11,214.4	\$10,560.4

First Year Fixed Expenses Comparison

Brattle First Year Fixed Expenses

	CONE Area			
	1	2	3	4
O&M Costs	EMAAC	SWMAAC	Rest of RTO	WMAAC
	352 MW	355 MW	321 MW	344 MW
Fixed O&M (2022\$ million)				
LTSA	\$0.270	\$0.270	\$0.270	\$0.270
Labor	\$1.079	\$1.176	\$0.820	\$0.869
Maintenance and Minor Repairs	\$0.518	\$0.534	\$0.473	\$0.482
Administrative and General	\$0.231	\$0.247	\$0.190	\$0.198
Asset Management	\$0.518	\$0.565	\$0.394	\$0.418
Property Taxes	\$0.256	\$4.070	\$1.843	\$0.251
Insurance	\$1.896	\$1.781	\$1.539	\$1.828
Firm Gas Contract	\$0.000	\$0.000	\$0.000	\$0.000
Working Capital	\$0.035	\$0.033	\$0.028	\$0.034
Total Fixed O&M (2022\$ million)	\$4.803	\$8.676	\$5.557	\$4.350

First Year Fixed Expenses Comparison

- **IMM CONE CT includes major maintenance in fixed O&M.**

Revenue Requirements Comparison

CONE CT Revenue Requirements 2022 Capacity Year (\$/MW-Year)

CONE Area	1 - EMAAC	2 - SWMAAC	3 - Rest of RTO	4 - WMAAC
Current	\$133,144	\$140,953	\$133,016	\$134,124
Brattle Study	\$106,400	\$108,400	\$98,200	\$103,800
IMM (No Parent Co. with NOL carryforwards)	\$95,058	\$91,151	\$96,175	\$94,371
IMM (Parent Co. no NOL carryforwards)	\$82,827	\$80,644	\$84,755	\$83,028

CONE CT Revenue Requirements 2022 Capacity Year (\$/MW-Day)

CONE Area	1 - EMAAC	2 - SWMAAC	3 - Rest of RTO	4 - WMAAC
Current	\$364.78	\$386.17	\$364.43	\$367.46
Brattle Study	\$291.51	\$296.99	\$269.04	\$284.38
IMM (No Parent Co. with NOL carryforwards)	\$260.43	\$249.73	\$263.49	\$258.55
EAS Revenues (2017)	\$58.96	\$39.72	\$79.26	\$61.67
Net CONE	\$201.47	\$210.01	\$184.24	\$196.88
IMM (Parent Co. no NOL carryforwards)	\$226.92	\$220.94	\$232.20	\$227.48
EAS Revenues (2017)	\$58.96	\$39.72	\$79.26	\$61.67
Net CONE	\$167.96	\$181.22	\$152.95	\$165.80

Revenue Requirements Comparison

- **Brattle model appears to represent a project with a large parent company to absorb 100 percent of bonus depreciation. (From new tax law.)**
- **IMM has calculated costs:**
 - **with a parent company**
 - **with a project only company with net operating loss carryforwards**

Economic Assumptions Comparison

IMM Economic Assumptions

CONE Area	1 - EMAAC	2 - SWMAAC	3 - Rest of RTO	4 - WMAAC
GDP Deflator (%)	2.50%	2.50%	2.50%	2.50%
EPC Escalation (%) (Materials, Equipment & Labor)	3.00%	3.00%	3.00%	3.00%
Property Tax Escalation (%)	2.50%	2.50%	2.50%	2.50%
ATWAAC (%)	8.52%	8.54%	8.49%	8.49%
Federal Tax Rate (%)	21.0%	21.0%	21.0%	21.0%
State Tax Rate (%)	9.00%	8.25%	9.99%	9.99%
Effective Income Tax Rate (%)	28.11%	27.52%	28.89%	28.89%

Brattle Economic Assumptions

CONE Area	1 - EMAAC	2 - SWMAAC	3 - Rest of RTO	4 - WMAAC
GDP Deflator (%)	2.20%	2.20%	2.20%	2.20%
EPC Escalation (%) (Equipment & Materials)	2.40%	2.40%	2.40%	2.40%
EPC Escalation (%) (Labor)	3.90%	3.90%	3.90%	3.90%
Property Tax Escalation (%)	2.20%	2.20%	2.20%	2.20%
ATWAAC (%)	7.44%	7.44%	7.40%	7.40%
Federal Tax Rate (%)	21.0%	21.0%	21.0%	21.0%
State Tax Rate (%)	9.00%	8.25%	9.99%	9.99%
Effective Income Tax Rate (%)	30.00%	29.25%	30.99%	30.99%

Economic Assumptions Comparison

- **IMM tax advisor concludes that state income tax remains deductible for federal income tax.**

Financial Assumptions Comparison

Financial Assumptions

Study	IMM	Brattle
Equity (%):	50%	35%
Debt (%):	50%	65%
Debt Interest Rate (%):	7.0%	6.5%
Target ATIRR (%)	12.00%	12.80%
ATWAAC (%)	8.5%	7.5%
Federal Tax Rate (%)	21.0%	21.0%
NOL Carryforward Limit	80.0%	Unclear
Cap on Interest Deductions (% of EBITDA)	30.0%	Unclear
Debt Term (Yrs.):	20	20
Construction Schedule (Months):	20	20

Financial Assumptions Comparison

- **For a stand alone corporation using 100 percent bonus expensing, NOL carryforwards should be used.**
- **There is a 30 percent of EBITDA limit on loan interest deductions.**
- **These lost deductions cannot be carried forward.**
- **Base on IMM analysis:**
 - **Limit is exceeded at 55 percent debt for a stand alone corporation.**
 - **Limit is exceeded in the first operating year at 50 percent debt for structure with a parent company.**

Areas for Discussion

- **One or two unit CT configuration**
- **State income tax deduction at federal level**
- **CONE CT financial structure as stand alone project or with parent company**
- **Brattle study questions**
 - **30 percent of EBITDA interest expense limit**
 - **NOL carryforwards for a stand alone project**
 - **Manual 21 for ICAP capacity determination**

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