

*Alaska – BC Intertie Feasibility Study
Meeting of Work Group and Technical Group*

**Development of
Regional Resource Planning Model**

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Craig, Alaska

HATCH ACRES

Hatch Acres Team

Bob Griesbach

Nan Nalder

Anibal Carias

Dick Griffith

Clark Smith

Bin Lian

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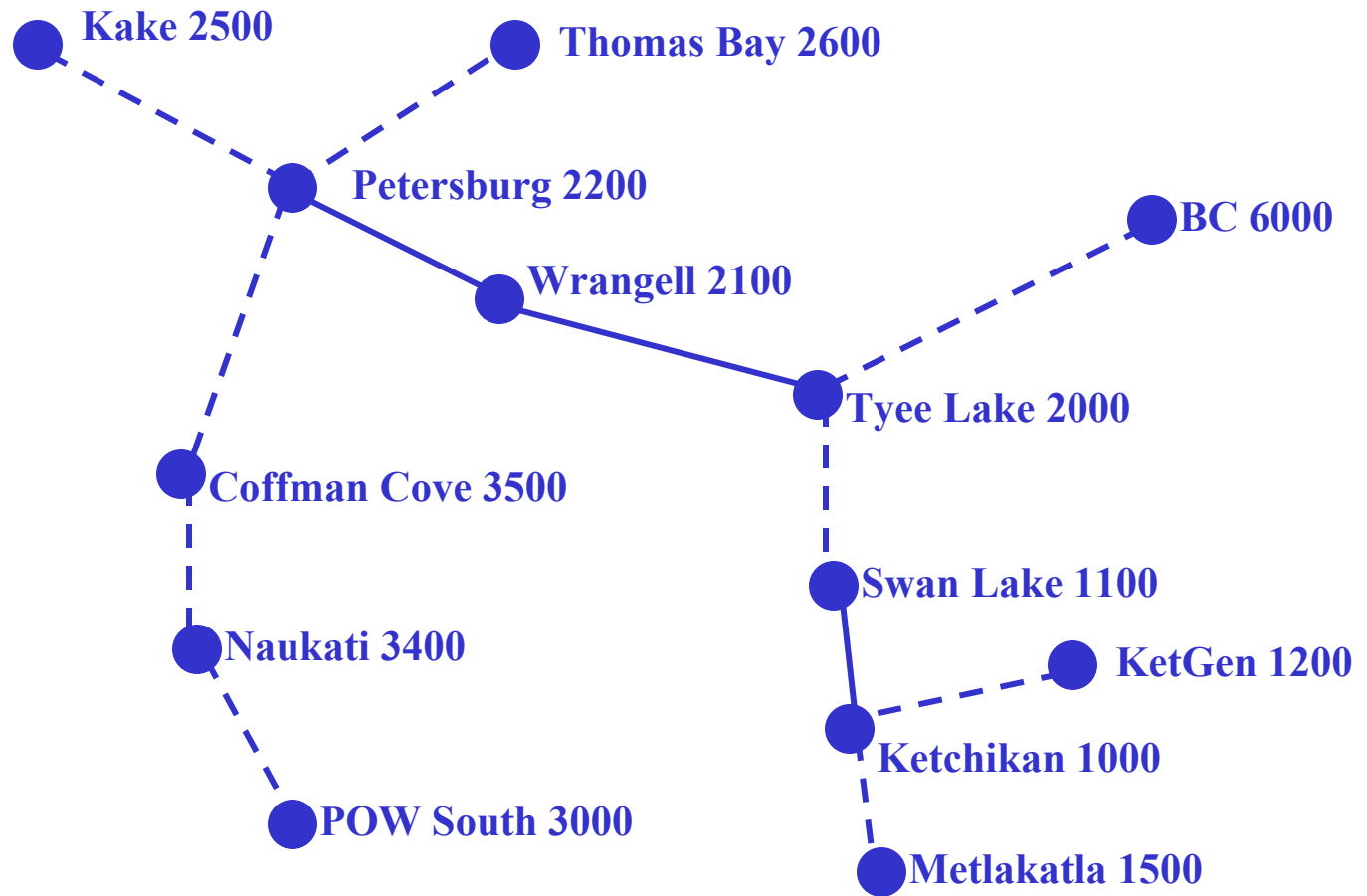
Introduction



- **Main Load Centers (Monthly and Annual Peaks and Energy Requirements)**
- **Existing and Future Renewable Generation Projects (Hydroelectric, Wind, etc.) at Various Locations**
- **Existing and Future Diesel Generation Units at Various Locations**
- **Transmission Lines (Within Isolated Systems and to Interconnect Systems)**

Development of Regional Resource Planning Model

- Monthly Peak and Energy Requirements for Each Load Center
- Monthly Available Capacity and Energy Generation from Each Renewable Generating Station
- Monthly Available Capacity for Each Diesel Unit and Transmission Line
- Maintenance Outage of Renewable Generating Stations, Diesel Units and Transmission Lines (In week(s))
- Capacity and Energy Reserve of Each Load Center
- Capacity and Energy Supply to Each Load Center
- Generation Dispatch Procedure
- Energy Generation and Costs of Each Plant/Unit
- Energy Export and Revenue



- **Reserve Calculation**

Capacity and Energy

Local Generation Only

- **Dispatch of Generation Resources**

- a) **Isolated Load Center (Either no Interconnection or Maintenance Outage of Lines)**

Local Generation Only

- i) **Hydro Resources**
- ii) **Diesel Resources**

- b) Interconnected Load Center**
 - i) Local Hydro Resources**
 - ii) Hydro Resources on the Priority List**
 - iii) One-Line Away Hydro Resources**
 - iv) Two-Line Away Hydro Resources**
- Etc.**

Repeat the Procedures above for Diesel Resources

Consideration of Study Duration

- **Up to 35 Years of Planning Horizon**
- **For Each Year (21 Periods)**
 - Monthly Base for Months from January to May and from September to December (9 Periods)**
 - Quarter (About One Week) Month Base for Months from June to August (12 Periods) to Allow for Flexibility to Model Planned Maintenance of Hydro Generating Units, Diesel Generation Sets or Transmission Lines**

Input Sheets

- **Scenario (Common Assumptions, Input Summary and Option Selection)**
- **Load**
- **Renewable**
- **Diesel**
- **Transmission**

Scenario Options

- **Common Assumptions**

Reference Year for Cost Estimate	2007
Reference Discount Year	2007
Prices of Export Energy at Delivery Point (\$/MWh)	0.0
Bus Number for Point of Export	6000
Export Losses From Export Bus (%)	2.00%
Cost of Expected Unsupplied Energy (\$/MWh)	1000.0
Discount Rate	6.0%
Escalation Rate for Hydro Capital Costs (%)	2.5%
Escalation Rate for Hydro Fixed Costs (%)	2.5%
Escalation Rate for Hydro Variable Costs (%)	0.0%
Escalation Rate for Diesel Capital Costs (%)	2.5%
Escalation Rate for Diesel Fixed Costs (%)	2.5%
Escalation Rate for Diesel Variable Costs (%)	2.5%
Escalation Rate for Diesel Fuel (%)	2.5%
Escalation Rate for Transmission Line Capital Costs (%)	2.5%
Escalation Rate for Transmission Line O&M Costs (%)	2.5%
Escalation Rate for Prices of Export Energy (%)	2.5%
Maximum Monthly Diesel Plant Capacity Factor	80.0%
Number of Years to be Included for End Effect	15

- **Load Centers**

Load Center							
No.	Name	Bus ID	Reserve		Supply Priority		
			(%)	(MW)	1st	2nd	3rd
1	Wrangell	2100	0.0%	0.10	2000	2600	
2	Petersburg	2200	0.0%	0.10	2000	2600	
3	Kake	2500	0.0%	0.10	2000	2600	
4	Ketchikan	1000	0.0%	0.10	1100	2000	1200
5	Metlakatla	1500	0.0%	0.10	1200	2000	
0	POW South	3000	0.0%	0.10			
0	Coffman Cove	3500	0.0%	0.10			
0	Naukati	3400	0.0%	0.10			
6	Unknown	0	0.0%	0.10			
7	New	0	0.0%	0.01			

- **Renewable Resources**

Renewable Generation Resources				
No.	Name	Bus ID	Earliest On-Line	Proposed On-Line
1	BlackBear+S.Fork	3000	2000	2050
2	Triangle Lake	1500	2026	2026
3	Purple + Chester	1500	2000	2000
4	Takatz	2700	2050	2051
5	Ketchikan	1000	2000	2000
6	Silvis	1000	2000	2000
7	BeaverFalls	1000	2000	2000
8	Swan Lake	1100	2000	2000
9	Tyee Lake	2000	2000	2000
10	BlindSlough	2200	2000	2000
11	SceneryCreek-TB	2600	2050	2051
12	Cascade (Swan-TB)	2600	2050	2051
13	Delta (RuthLake-TB)	2600	2050	2051
14	MahoneyLake	1200	2014	2014
15	WhitmanLake	1200	2010	2010
16	Connell Lake	1200	2018	2018
17	Carlana Lake	1200	2050	2050
18	SunriseLake	2100	2050	2051

- Diesel Generation

Diesel Generation					
No.	Name	Bus ID	Unit ID	Earliest On-Line	Proposed On-Line
1	Ketchikan	1000	1	2000	2000
			2	2040	2050
			3	2000	2000
			4	2000	2000
			5	2007	2007
			6	2007	2007
			7	2040	2050
			8	2040	2050
			9	2040	2050
			10	2040	2050
2	Wrangell	2100	1	2001	2001
			2	2000	2000
			3	2000	2000
			4	1981	2000
			5	2050	2051
			6	2050	2051
			7	2050	2051
			8	2050	2051
			9	2050	2051
			10	0	0
3	Petersburg	2200	1	1972	2000
			2	1979	2000

- **Transmission Lines**

Transmission Link				
No.	Name	Circuit ID	Earliest On-line	Proposed On-line
1	Ketchikan-Metlakatla	1	2013	2013
2	Ketchikan-SwanLake	1	2000	2000
3	Swan-Tyee	1	2010	2010
4	Tyee-Wrangell	1	2000	2000
5	Wrangell-Petersburg	1	2000	2000
6	Petersburg-Kake	1	2011	2011
7	Petersburg-Thomas	1	2050	2051
8	Coffman- Naukati	1	2050	2051
9	Coffman-Wrangell	1	2050	2051
10	Naukati - POW South	1	2050	2051
11	Tyee-BC	1	2000	2000
12	Tyee-Wrangell	2	2050	2051
13	Wrangell-Petersburg	2	2050	2051
14	Takatz - Kake	1	2050	2050
15	Ketgen-Ketchikan	1	2010	2010
16	Unknown	1	0	0
17	New	1	0	0

Input of Load Demand

Load Center			Demand										
No.	Name	Bus #	Type	Year	Jan	Feb	Mar	Apr	May	Jun			
					1	2	3	4	5	6	7	8	9
1	Wrangell	2100	Peak (MW)	2007	4.1	4.4	3.7	3.9	3.4	3.5	3.5	3.5	3.5
				2008	4.8	5.2	4.3	4.5	3.9	4.1	4.1	4.1	4.1
				2009	4.9	5.3	4.4	4.6	4.0	4.1	4.1	4.1	4.1
				2041									
			Energy(MWh)	2007	2040.2	1992.8	1831.4	1855.3	1673.5	423.7	423.7	423.7	423.7
				2008	2351.7	2298.0	2122.1	2151.1	1934.6	490.4	490.4	490.4	490.4
				2009	2415.8	2353.1	2173.8	2194.6	1969.7	497.3	497.3	497.3	497.3
				2041									
2	Petersburg	2200	Peak (MW)	2007	7.0	7.0	6.2	6.7	5.6	5.8	5.8	5.8	5.8
				2008	7.3	7.2	6.4	6.9	5.8	6.0	6.0	6.0	6.0
				2009	7.5	7.4	6.6	7.1	5.9	6.1	6.1	6.1	6.1
				2041									
			Energy(MWh)	2007	3786.1	3400.6	3352.3	3501.9	3034.8	759.2	759.2	759.2	759.2
				2008	3882.5	3481.0	3431.2	3570.5	3090.4	770.7	770.7	770.7	770.7
				2009	3977.0	3559.8	3508.7	3638.0	3145.2	782.1	782.1	782.1	782.1
				2041									

Input of Renewable Generation Resources

No.	Station		Location	On-Line Year	Capital (M\$)	Life (Year)	Year	Variable (\$/MWh)	Fixed (k\$/Year)	Capacity	Jan	Feb	Mar	Apr							
	Name	Bus ID									1	2	3	4							
2	Triangle Lake	1500	Metlakatla	2026	15.613	50	2007		211	Capacity (MW)	3.5	3.5	3.5	3.5							
							2008		211		3.5	3.5	3.5	3.5							
							2009		211		3.5	3.5	3.5	3.5							
							2041		211		3.5	3.5	3.5	3.5							
							2007			Energy (MWh)	807.3	632.4	566.8	757.7							
							2008				807.3	632.4	566.8	757.7							
							2009				807.3	632.4	566.8	757.7							
							2041				807.3	632.4	566.8	757.7							
							5	Ketchikan	1000	Ketchikan	2000			2007		250	Capacity (MW)	4.2	4.2	4.2	4.2
														2008		250		4.2	4.2	4.2	4.2
2009		250		4.2	4.2	4.2								4.2							
2041		250		4.2	4.2	4.2								4.2							
2007			Energy (MWh)	1895.0	1576.6	1645.6								1361.5							
2008				1895.0	1576.6	1645.6								1361.5							
2009				1895.0	1576.6	1645.6								1361.5							
2041				1895.0	1576.6	1645.6								1361.5							
6	Silvis	1000	Ketchikan	2000										2007		133	Capacity (MW)	2.1	2.1	2.1	2.1
														2008		133		2.1	2.1	2.1	2.1
							2009		133		2.1	2.1	2.1	2.1							
											2.1	2.1	2.1	2.1							

Input of Diesel Generation Resources

No.	Station		Unit ID	On-Line Year	Retiring Year	Capital (M\$)	Life (Year)	Heat Rate (Gal/MWh)	Fuel Costs (\$/Gal)	Variable (\$/MWh)	Fixed (k\$/Yr)	Jan	Feb	Mar	Apr
	Name	Bus ID										1	2	3	4
1	Ketchikan	1000	1	2000	9999	0	0	67.57	2.0905	20	140	3.5	3.5	3.5	3.5
			2	2040	9999	10	20	61.81	2.0905	20	400	10	10	10	10
			3	2000	9999	0	0	70.42	2.0905	20	220	5.5	5.5	5.5	5.5
			4	2000	9999	0	0	66.67	2.0905	20	420	10.5	10.5	10.5	10.5
			5	2007	9999	0	0	70.42	2.0905	20	108	1.6	1.6	1.6	1.6
			6	2007	9999	0	0	70.42	2.0905	20	108	1.6	1.6	1.6	1.6
			7	2040	9999	10	20	61.81	2.0905	20	400	10	10	10	10
			8	2040	9999	10	20	61.81	2.0905	20	400	10	10	10	10
			9	2040	2050	10	20	61.81	2.0905	20	400	10	10	10	10
			10	2040	2050	10	20	61.81	2.0905	20	400	10	10	10	10
2	Wrangell	2100	1	2001	9999			78.94	2.5705	25	80	2	2	2	2
			2	2000	9999			78.94	2.5705	25	80	2	2	2	2
			3	2000	9999			78.94	2.5705	25	80	2	2	2	2
			4	1981	9999			78.94	2.5705	25	100	2.5	2.5	2.5	2.5
			5	2050	9999	2.6	20	65.78	2.5705	20	80	2	2	2	2
			6	2050	9999	2.6	20	65.78	2.5705	20	80	2	2	2	2
			7	2050	9999	2.6	20	65.78	2.5705	20	80	2	2	2	2
			8	2050	9999	2.6	20	65.78	2.5705	20	80	2	2	2	2
			9	2050	9999	2.6	20	65.78	2.5705	20	80	2	2	2	2
			10	0	9999										
3	Petersburg	2200	1	1972	9999			77.03	2.2415	20	76	1.9	1.9	1.9	1.9
			2	1979	9999			69	2.2415	20	52	1.3	1.3	1.3	1.3
			3	1965	9999			68.71	2.2415	20	40	1	1	1	1
			4	1993	9999			76.84	2.2415	20	92	2.3	2.3	2.3	2.3
			5	2001	9999			71.76	2.2415	20	92	2.3	2.3	2.3	2.3
			6	2017	9999	2.6	20	65.78	2.2415	20	80	2	2	2	2
			7	0	9999										

Input of Transmission Lines

Transmission Link		Bus ID		Circuit ID	On-Line Year	Capital (M\$)	Life (Year)	Fixed Costs (k\$/Yr)	Losses (%)	Jan	Feb	Mar	Apr
No.	Name	Start	End							1	2	3	4
1	Ketchikan-Metlakatla	1000	1500	1	2013		30	125	2.00%	50	50	50	50
2	Ketchikan-SwanLake	1000	1100	1	2000			0	2.00%	75	75	75	75
3	Swan-Tyee	1100	2000	1	2010		30	500	2.00%	100	100	100	100
4	Tyee-Wrangell	2000	2100	1	2000			0	2.00%	100	100	100	100
5	Wrangell-Petersburg	2100	2200	1	2000			0	2.00%	100	100	100	100
6	Petersburg-Kake	2200	2500	1	2011		30	210	2.00%	100	100	100	100
7	Petersburg-Thomas	2200	2600	1	2050		30	810	2.00%	150	150	150	150
8	Coffman-Naukati	3500	3400	1	2050	0	30	40	2.00%	30	30	30	30
9	Coffman-Wrangell	3500	2100	1	2050	0	30	1300	2.00%	30	30	30	30
10	Naukati - POW South	3400	3000	1	2050	0	30	0	1.00%	30	30	30	30
11	Tyee-BC	2000	6000	1	2000		30	0	2.00%	100	100	100	100
12	Tyee-Wrangell	2000	2100	2	2050		30	360	2.00%	100	100	100	100
13	Wrangell-Petersburg	2100	2200	2	2050		30	360	2.00%	100	100	100	100
14	Takatz - Kake	2700	2500	1	2050		30	1200	2.00%	50	50	50	50
15	Ketgen-Ketchikan	1200	1000	1	2010		30	0	0.00%	30	30	30	30
16	Unknown	0	0	1	0			0	2.00%	10	10	10	10
17	New	0	0	1	0			0	2.00%	10	10	10	10
18	New	0	0	1	0			0	2.00%	10	10	10	10

Model Output

- **Minimum (Under DRY Hydrologic Condition)**
- **Average (Under AVERAGE Hydrologic Condition)**
- **Maximum (Under WET Hydrologic Condition)**

System Weighted Value

$$\begin{aligned} &= x\%*(\text{DRY_Value}) \\ &+y\%*(\text{AVERAGE_Value}) \\ &+z\%*(\text{WET_Value}) \end{aligned}$$

• Load Summary

Load Center		2007	2008	2009	2010
KETCHIKAN	Peak Demand (MW)	32.7	33.8	34.4	35.5
	Energy Demand (MWh)	164,195	169,479	172,659	178,038
	Capacity Reserve (MW)	2.2	1.1	0.5	-0.6
	Energy Reserve(MWh)	0	0	0	0
	Unsupplied Capacity (MW)	0.0	0.0	0.0	0.0
	Unsupplied Energy (MWh)	0	0	0	0
	Cost of Unsupplied Energy (\$M)	0.000	0.000	0.000	0.000
METLAKATLA	Peak Demand (MW)	3.1	3.1	3.2	3.3
	Energy Demand (MWh)	15,434	15,731	16,023	16,311
	Capacity Reserve (MW)	5.0	5.0	4.9	4.8
	Energy Reserve(MWh)	0	0	0	0
	Unsupplied Capacity (MW)	0.0	0.0	0.0	0.0
	Unsupplied Energy (MWh)	0	0	0	0
	Cost of Unsupplied Energy (\$M)	0.000	0.000	0.000	0.000
Load Summary	Costs (M\$)	0.000	0.000	0.000	0.000
	Cumulative Costs (M\$)	0.000	0.000	0.000	0.000
	Costs in PV (M\$)	0.000	0.000	0.000	0.000
	Cumulative Costs in PV (M\$)	0.000	0.000	0.000	0.000

• Renewable Summary

Renewable		2007	2008	2009	2010
KETCHIKAN	Available Capacity (MW)	4.2	4.2	4.2	4.2
	Available Energy (MWh)	19,758	19,758	19,758	19,758
	Capacity Used (MW)	4.2	4.2	4.2	4.2
	Energy Used (MWh)	19,758	19,758	19,758	19,758
	Capacity Losses (MW)	0.0	0.0	0.0	0.0
	Energy Losses (MWh)	0.0	0.0	0.0	0.0
	Capital Charges (M\$)	0.000	0.000	0.000	0.000
	Fixed Costs (M\$)	0.250	0.256	0.263	0.269
	Variable Costs (M\$)	0.000	0.000	0.000	0.000
	Subtotal Costs (M\$)	0.250	0.256	0.263	0.269
WHITMAN LAKE	Available Capacity (MW)	0.0	0.0	0.0	4.6
	Available Energy (MWh)	0	0	0	19,614
	Capacity Used (MW)	0.0	0.0	0.0	4.6
	Energy Used (MWh)	0	0	0	1,360
	Capacity Losses (MW)	0.0	0.0	0.0	0.0
	Energy Losses (MWh)	0.0	0.0	0.0	0.0
	Capital Charges (M\$)	0.000	0.000	0.000	0.646
	Fixed Costs (M\$)	0.000	0.000	0.000	0.294
	Variable Costs (M\$)	0.000	0.000	0.000	0.000
	Subtotal Costs (M\$)	0.000	0.000	0.000	0.940
Renewable Summary	Capital Charges (M\$)	0.000	0.000	0.000	0.646
	Fixed Costs (M\$)	1.165	1.194	1.224	1.549
	Variable Costs (M\$)	7.828	8.105	8.182	8.996
	Total Costs (M\$)	8.993	9.299	9.406	11.191
	Cumulative Costs (M\$)	8.993	18.292	27.698	38.889
	Costs in PV (M\$)	8.734	8.521	8.131	9.126
	Cumulative Costs in PV (M\$)	8.734	17.256	25.386	34.513

• Diesel Summary

Diesel		2007	2008	2009	2010
KETCHIKAN	Available Capacity (MW)	22.7	22.7	22.7	22.7
	Capacity Used (MW)	12.0	12.6	13.0	9.7
	Energy Used (MWh)	25,481	30,438	33,618	1,603
	Capacity Losses (MW)	0.0	0.0	0.0	0.0
	Energy Losses (MWh)	0.0	0.0	0.0	0.0
	Capital Charges (M\$)	0.000	0.000	0.000	0.000
	Fixed Costs (M\$)	0.996	1.021	1.046	1.073
	Variable Costs (M\$)	0.510	0.624	0.706	0.035
	Fuel Costs (M\$)	3.552	4.349	4.923	0.241
	Subtotal Costs (M\$)	5.057	5.994	6.676	1.348
PETERSBURG	Available Capacity (MW)	8.8	8.8	8.8	8.8
	Capacity Used (MW)	5.6	5.6	5.7	5.8
	Energy Used (MWh)	1,327	1,351	1,374	1,397
	Capacity Losses (MW)	0.0	0.0	0.0	0.0
	Energy Losses (MWh)	0.0	0.0	0.0	0.0
	Capital Charges (M\$)	0.000	0.000	0.000	0.000
	Fixed Costs (M\$)	0.352	0.361	0.370	0.379
	Variable Costs (M\$)	0.027	0.028	0.029	0.030
	Fuel Costs (M\$)	0.211	0.220	0.230	0.240
	Subtotal Costs (M\$)	0.589	0.608	0.628	0.649
Diesel Summary	Capital Charges (M\$)	0.000	0.000	0.000	0.000
	Production Costs (M\$)	2.601	2.771	2.911	2.300
	Fuel Costs (M\$)	4.427	5.275	5.916	1.318
	Subtotal Costs (M\$)	7.028	8.047	8.827	3.618
	Cumulative Costs (M\$)	7.028	15.074	23.902	27.520
	Costs in PV (M\$)	6.826	7.373	7.631	2.950
	Cumulative Costs in PV (M\$)	6.826	14.199	21.830	24.780

• Transmission Summary

Transmission Lines		2007	2008	2009	2010
SWAN-TYEE	Capital Charges (M\$)	0.000	0.000	0.000	0.000
	Fixed Costs (M\$)	0.000	0.000	0.000	0.538
	Subtotal Costs (M\$)	0.000	0.000	0.000	0.538
PETERSBURG-KAKE	Capital Charges (M\$)	0.000	0.000	0.000	0.000
	Fixed Costs (M\$)	0.000	0.000	0.000	0.000
	Subtotal Costs (M\$)	0.000	0.000	0.000	0.000
TYEE-BC	Capital Charges (M\$)	0.000	0.000	0.000	0.000
	Fixed Costs (M\$)	0.000	0.000	0.000	0.000
	Subtotal Costs (M\$)	0.000	0.000	0.000	0.000
Transmission Summary	Capital Charges (M\$)	0.000	0.000	0.000	0.000
	Fixed Costs (M\$)	0.000	0.000	0.000	0.538
	Total Costs (M\$)	0.000	0.000	0.000	0.538
	Cumulative Costs (M\$)	0.000	0.000	0.000	0.538
	Costs in PV (M\$)	0.000	0.000	0.000	0.439
	Cumulative Costs in PV (M\$)	0.000	0.000	0.000	0.439

• System Summary

		2007	2008	2009	2030	2031
System Summary	Grand Total Costs (M\$)	16.020	17.346	18.233	32.913	34.131
	Cumulative Costs (M\$)	16.020	33.366	51.600	546.542	580.674
	Grand Total Costs in PV(M\$)	15.560	15.894	15.762	8.369	8.188
	Cumulative Costs in PV(M\$)	15.560	31.454	47.216	268.655	276.843
Revenue Summary		2007	2008	2009	2030	2031
	Export Energy (MWh)	72,155	68,050	66,797	24,295	22,669
	Export Revenue (M\$)	0.000	0.000	0.000	0.000	0.000
	Cumulative Revenue (M\$)	0.000	0.000	0.000	0.000	0.000
	Export Revenue in PV(M\$)	0.000	0.000	0.000	0.000	0.000
	Cumulative Revenue in PV(M\$)	0.000	0.000	0.000	0.000	0.000
Net Costs Summary		2007	2008	2009	2030	2031
	Net Costs (M\$)	16.020	17.346	18.233	32.913	34.131
	Cumulative Net Costs (M\$)	16.020	33.366	51.600	546.542	580.674
	Net Costs in PV(M\$)	15.560	15.894	15.762	8.369	8.188
	Cumulative Net Costs in PV(M\$)	15.560	31.454	47.216	268.655	276.843
	With End Effect					
	Total Cost in PV (M\$)	356.364				
	Total Revenue in PV (M\$)	0.000				
	Total Net Cost in PV (M\$)	356.364				

Questions and Comments?

Thank You Very Much!

HATCH ACRES