

# COMBINED HEAT & POWER

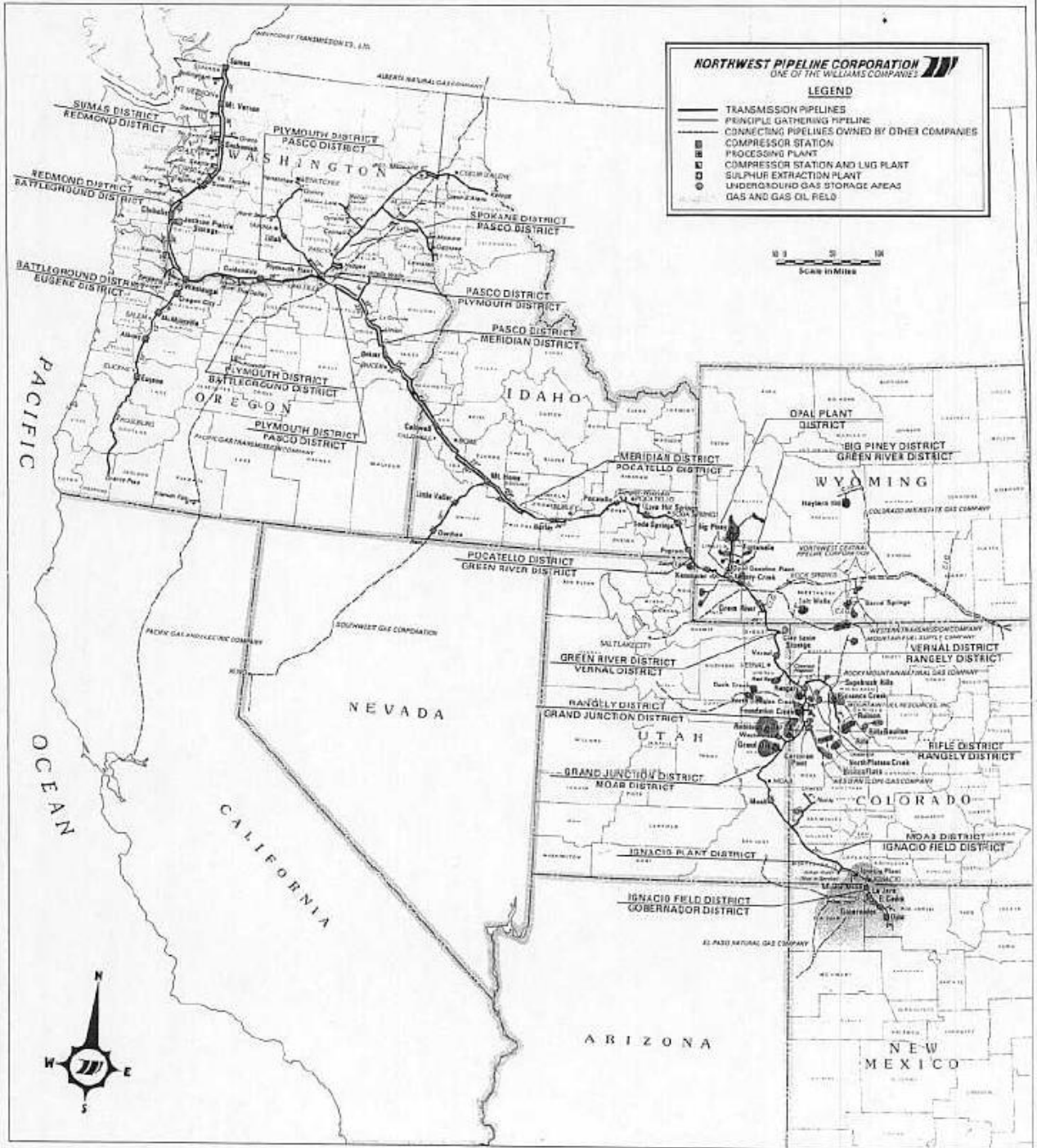
J.R. Simplot

Mountain Home, Idaho

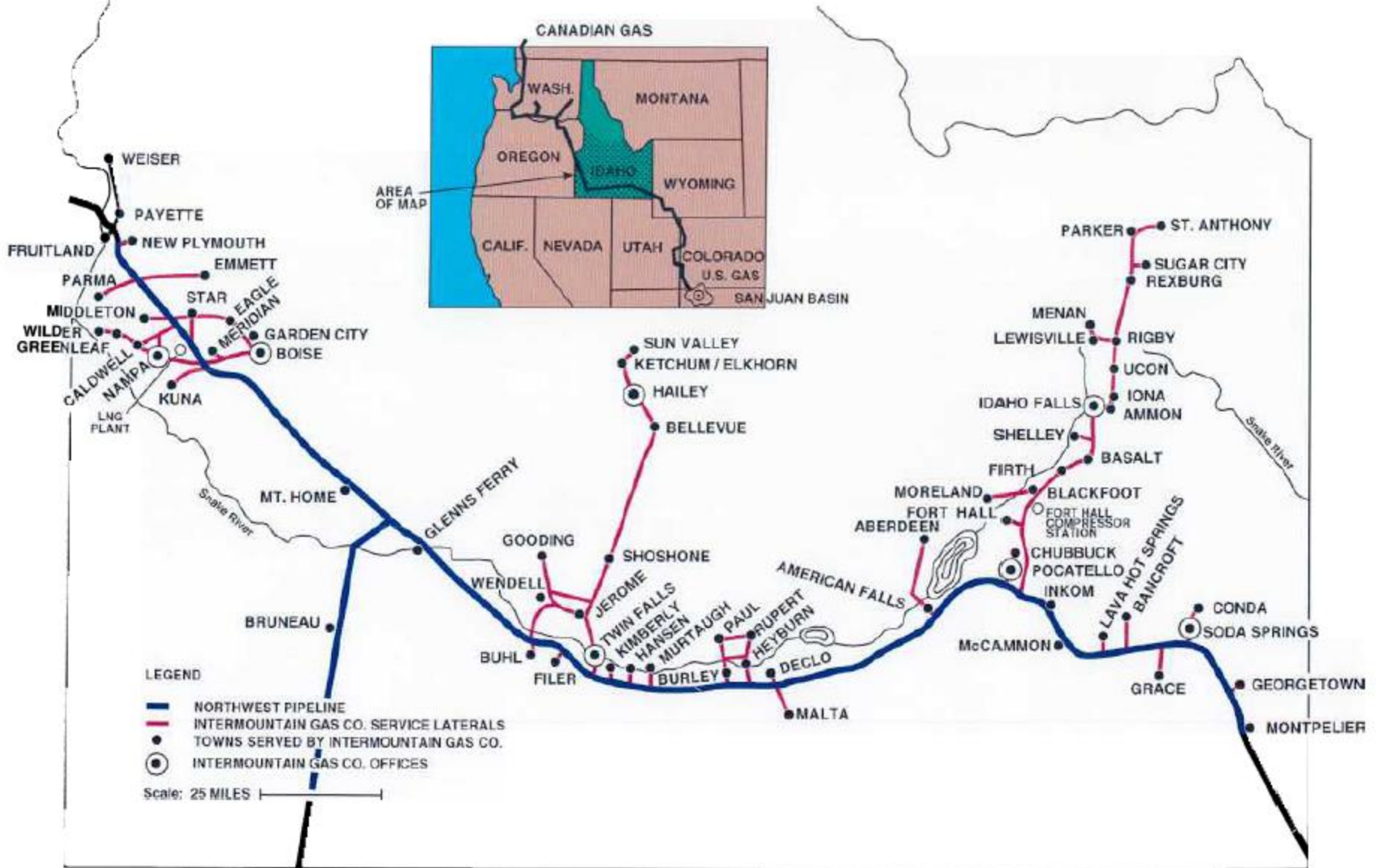
**NORTHWEST PIPELINE CORPORATION**  
 ONE OF THE WILLIAMS COMPANIES

**LEGEND**

- TRANSMISSION PIPELINES
- PRINCIPLE GATHERING PIPELINE
- CONNECTING PIPELINES OWNED BY OTHER COMPANIES
- COMPRESSOR STATION
- PROCESSING PLANT
- COMPRESSOR STATION AND LUG PLANT
- SULPHUR EXTRACTION PLANT
- UNDERGROUND GAS STORAGE AREAS
- GAS AND GAS OIL FELD



# NATURAL GAS SYSTEM INTERMOUNTAIN GAS COMPANY



# Why Co-Generate

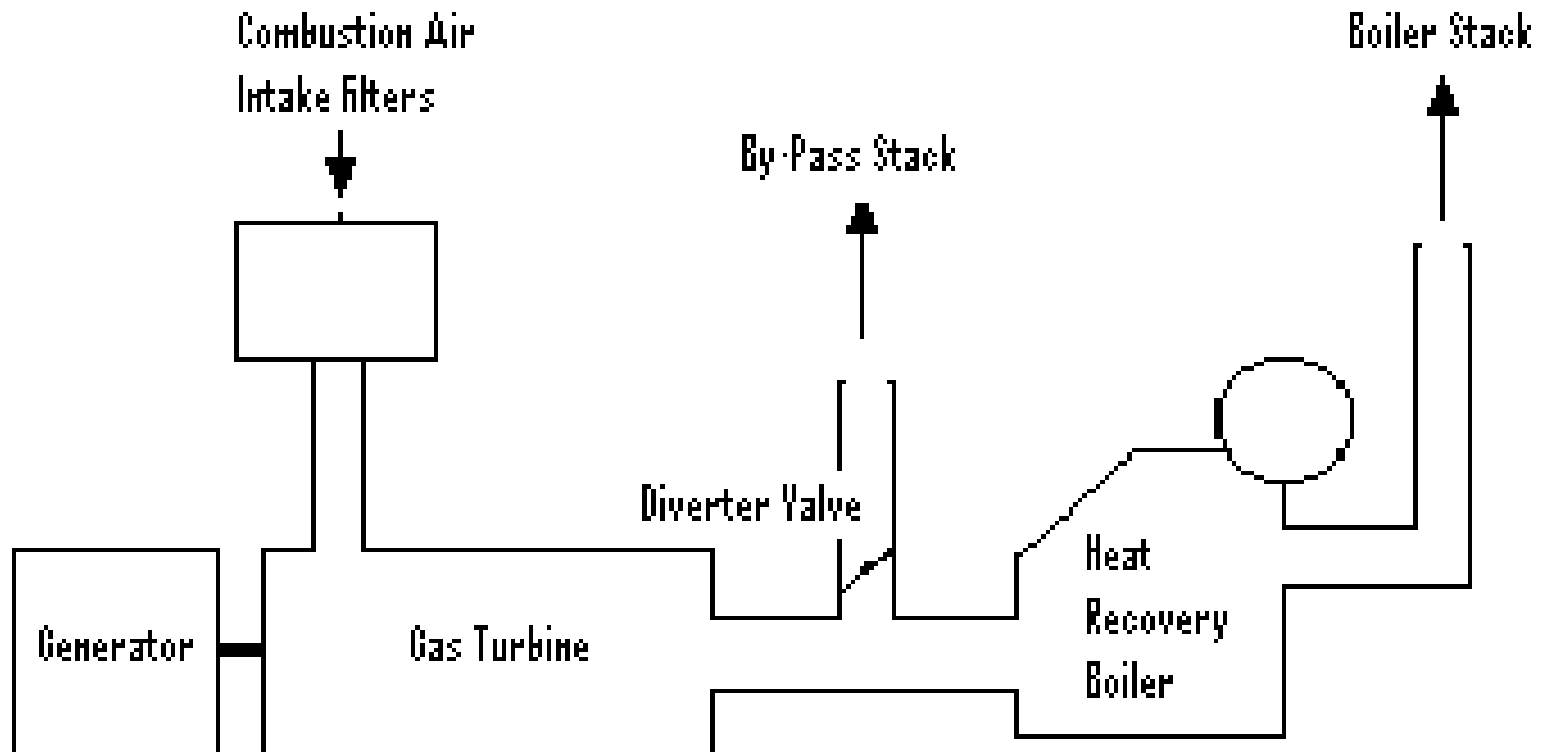
Electricity is most often generated in one of three ways

1. From steam systems at an efficiency of 26%
2. From simple gas turbines at an efficiency of 35%
3. From combined cycles, gas turbine and use exhaust for steam turbine at an efficiency of 46%

# COMMON POWER CYCLE THERMAL EFFICIENCIES

- Simple Steam Cycle 25% - 35%
  - Generate steam at high pressure exhaust steam from steam turbine to condenser.
- Simple Gas Turbine 30% - 35%
  - Gas Turbine driven generator with exhaust to atmosphere.
- Combined Cycle 50% - 60%
  - Gas Turbine driven generator with exhaust used to make high pressure steam, and high pressure steam used to generate additional electricity in steam turbine.
- Gas Turbine-Process Steam 75% - 85%
  - Gas Turbine driven generator with exhaust used to make low pressure steam for process.

# COMBINED GAS TURBINE PROCESS STEAM SYSTEM



# ECONOMIC ANALYSES

- Simple boiler system requires 500 therms/hr
- Co-generation system requires 1300 therms/hr
- Co-generation also will provide 63 million kw-hr/year of electricity for sale or internal use.

# ESTIMATED PLANT REQUIREMENTS for 3000 tons/day FINISHED PRODUCT

- Peak steam 51,000 lbs/hr
- Average steam 38,000 lbs/hr
- Connected Horse Power 2000
- Average electricity demand 1500 kw.
- Water requirements 275 gpm.



# POSSIBLE CO-GENERATION ALTERNATIVE

- Match free steam from gas turbine to average facility process steam load, and then duct fire waste heat recovery boiler to meet peak steam loads.

# ENERGY REQUIREMENTS FOR SIMPLOT ROLLING MILL

(without combined heat & power)

- 475 Therms of natural gas per hour to generate 38,000 lbs of process steam.
  - Natural Gas budget of \$1,995,000.00 per year
- 1500 kw to operate the rolling mill equipment.
  - Electric budget including demand of \$693,000.00 per year.
- Total utility budget of \$2,688,000.00 per year.
- **CAN A COMBINED HEAT AND POWER PLANT REDUCE THE UTILITY BUDGET?**



Pictured are twin GE-5 Gas Turbines. The photographer has his back to the Heat Recovery Boiler, although the steam line can be seen at the top center of the picture. We are looking towards the generator, and the gas line can be viewed at the bottom center yellow pipe.

# A FEW GAS TURBINE ALTERNATIVES

Turbine	Electricity kw	Free Steam Lbs/hr
GE 5	5,500	30,000
GE 10	11,000	58,000
LM 1600	13,700	60,000
LM 2000	17,600	76,000
LM 2500	24,000	96,000

## INCREMENTAL COST FOR ELECTRICITY

	Process System	CHP 5.5 MW GT
Steam from process boilers	38,000 lbs/hr	7,000 lbs/hr
Steam from waste heat recovery boiler	0 lbs/hr	31,000 lbs/hr
Total Process Steam	38,000 lbs/hr	38,000 lbs/hr
Electricity Generated on site	0 kw	5,500 kw
Natural Gas for Process boilers	463 therms/hr	85 therms/hr
Natural Gas to Gas Turbine	0 therms/hr	536 therms/hr
Total Natural Gas Requirements	463 therms/hr	621 therms/hr
Additional Gas for Heat and Power Cycle	0 therms/hr	158 therms/hr
Cost of Natural Gas	\$0.50/therm	\$0.50/therm
Incremental Fuel Cost for electricity	\$0.0/kwh	\$0.0144/kwh
Maintenance cost for electricity	\$0.0	\$0.0045/kwh
<b>Operating Cost for electricity (no capital reduction)</b>	<b>\$0.0</b>	<b>\$0.0189/kwh</b>
Capital Budget for the system	\$0.00	\$6,320,000

# Summary of Technology

- Characteristics
  - The source is designed to be base loaded but because we have process boilers it is fully dispatchable.
  - The gas turbine will require overhalls but the life of the system is 40 years.
  - If base loaded a capacity factor of 90% to 95% is expected.
  - The capital cost are estimated at \$1,150/kw
  - Incremental operating costs \$18.90/MWh
  - Lead time of 2 years to permit, develop and construct.
  - The technology exists, it is proven, and reliable.

# Environmental Impact and Alternative

- The alternative to the combined heat and power system is to burn 463 therms/hr for the process and 341 therms/hr for the power, a total of 804 therms/hr.
- The combined heat and power cycle only requires 621 therms/hr for the same result.
  - 23% less fuel is burned
  - 23% fewer emissions are generated.
- Combined heat and power is good for the country.

**IDAHO POWER COMPANY**  
**AVOIDED COST RATES FOR FUELED PROJECTS**  
**SMALLER THAN TEN MEGAWATTS**  
 September 26, 2002  
 mills/kWh

LEVELIZED							NON-LEVELIZED	
CONTRACT LENGTH (YEARS)	ON-LINE YEAR						CONTRACT YEAR	NON-LEVELIZED RATES
	2002	2003	2004	2005	2006	2007		
1	13.19	13.49	13.80	14.12	14.44	14.78	2002	13.18
2	13.33	13.64	13.95	14.27	14.60	14.94	2003	13.49
3	13.48	13.79	14.10	14.43	14.76	15.10	2004	13.80
4	13.62	13.93	14.25	14.58	14.91	15.26	2005	14.11
5	13.75	14.07	14.39	14.73	15.06	15.41	2006	14.44
6	13.89	14.21	14.54	14.87	15.21	15.56	2007	14.77
7	14.02	14.34	14.67	15.01	15.36	15.71	2008	15.11
8	14.16	14.48	14.81	15.15	15.50	15.86	2009	15.46
9	14.28	14.61	14.94	15.29	15.64	16.00	2010	15.82
10	14.40	14.73	15.07	15.42	15.78	16.14	2011	16.18
11	14.52	14.86	15.20	15.55	15.91	16.28	2012	16.55
12	14.64	14.98	15.33	15.68	16.04	16.41	2013	16.94
13	14.76	15.10	15.45	15.80	16.17	16.54	2014	17.33
14	14.87	15.21	15.56	15.92	16.29	16.67	2015	17.73
15	14.98	15.33	15.68	16.04	16.41	16.79	2016	18.14
16	15.09	15.43	15.79	16.15	16.53	16.91	2017	18.55
17	15.19	15.54	15.90	16.27	16.64	17.02	2018	18.98
18	15.29	15.64	16.00	16.37	16.75	17.14	2019	19.42
19	15.39	15.74	16.11	16.48	16.86	17.25	2020	19.87
20	15.48	15.84	16.21	16.58	16.96	17.35	2021	20.33
							2022	20.80
							2023	21.28
							2024	21.77
							2025	22.28
							2026	22.80
							2027	23.32



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 September 26, 2002  
 mills/kWh

LEVELIZED							NON-LEVELIZED	
CONTRACT LENGTH (YEARS)	ON-LINE YEAR						CONTRACT YEAR	NON-LEVELIZED RATES
	2002	2003	2004	2005	2006	2007		
1	39.81	40.81	41.83	42.88	43.95	45.05	2002	39.81
2	40.29	41.30	42.33	43.39	44.47	45.59	2003	40.81
3	40.76	41.78	42.82	43.89	44.99	46.12	2004	41.83
4	41.22	42.25	43.31	44.39	45.50	46.64	2005	42.88
5	41.67	42.72	43.78	44.88	46.00	47.15	2006	43.95
6	42.12	43.17	44.25	45.36	46.50	47.66	2007	45.05
7	42.56	43.62	44.71	45.83	46.98	48.16	2008	46.17
8	42.99	44.06	45.17	46.30	47.45	48.64	2009	47.33
9	43.41	44.49	45.61	46.75	47.92	49.12	2010	48.51
10	43.82	44.92	46.04	47.19	48.37	49.59	2011	49.73
11	44.22	45.33	46.46	47.63	48.82	50.04	2012	50.97
12	44.62	45.73	46.88	48.05	49.25	50.49	2013	52.25
13	45.00	46.13	47.28	48.47	49.68	50.92	2014	53.56
14	45.38	46.51	47.68	48.87	50.09	51.35	2015	54.90
15	45.74	46.89	48.06	49.26	50.50	51.76	2016	56.28
16	46.10	47.25	48.44	49.65	50.89	52.17	2017	57.69
17	46.44	47.61	48.80	50.02	51.27	52.56	2018	59.13
18	46.78	47.95	49.15	50.38	51.65	52.94	2019	60.62
19	47.11	48.29	49.50	50.74	52.01	53.31	2020	62.14
20	47.43	48.61	49.83	51.08	52.36	53.67	2021	63.70
							2022	65.29
							2023	66.93
							2024	68.61
							2025	70.33
							2026	72.10
							2027	73.91

# EXTERNALITIES ASSOCIATED with CHP PROJECTS

- Added Positive Economic Viability to the Host Facility
  - Dual Use of an Energy Source
  - Added Employment
  - Added Property Tax Rate Base
  - Added Income Tax Revenue Stream
  - Internal Electrical consumption may free resources and help to relieve Transmission Constraints
  - Added resource to the Regional Generation Pool
  - Net addition of NOx and CO2 may be less
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- Initial Generation Pricing may exceed Local Utility WACOE but is set by State PUC and is therefore, Just and Reasonable and is based upon the Avoided Cost as set in Open Hearings.
  - Return on Capital Invested and Payout may not meet Host Company Guidelines especially during constrained economic times.

# FINANCING and OWNERSHIP OPTIONS

- PURPA Qualified Facility
- Host Facility
- Third Party with Steam Contract to Host
  - Partnership with Local Electric Utility (They can own up to fifty percent of a QF.)
  - Adds effectively to their Rate Base



# Where is the Market Headed?



## Short Term Outlook ???

