

# SIEMENS

## Flexible Generation for Renewable Integration

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**Flex-Plant™ combined cycles are designed to enable all your resources to operate in concert**

**SIEMENS**

**Marsh Landing**

*Commercial operation 2013*



**El Segundo**

*Commercial operation 2013*



**Lodi Energy Center**

*Commercial operation 2012*



*Flexible Efficient Clean*

The newest versions of **Siemens Flex-Plant™** combined cycles are even more flexible combining the **Low cost, clean power generation of a combined cycle** with the **Flexible fast load following capability of a gas turbine**

## Optimizing the energy mix

### Green energy but mostly intermittent supply

Renewable energy such as...

- Wind energy
- Solar energy



### Siemens Flex-Plant™ combined cycles

**Gas Fired Flex-Plants™ can Start Fast**  
150 MW in 10 min

**Load Follow Up AND Down**  
>75 MW/min in a 2x1 F

**High Efficiency  
Low Water Usage  
and Low Emissions – even while ramping with**

**Siemens Clean-Ramp™**

### Low flexibility base load

- Coal fired plants
- Nuclear power plants
- Hydro power plants



Siemens has been leading the way in flexible combined cycles for over a decade

# Combined Cycles

## An advantage in efficiency



Table 1: Summary of Average Levelized Costs – In-Service in 2009

In-Service Year = 2009 (Nominal 2009 \$)	Size MW	Merchant			IOU			POU		
		\$/kW.Yr	\$/MWh	¢/kWh	\$/kW.Yr	\$/MWh	¢/kWh	\$/kW.Yr	\$/MWh	¢/kWh
Small Simple Cycle	49.9	353.65	860.71	86.07	274.07	667.28	66.73	255.88	311.63	31.16
Conventional Simple Cycle	100	333.25	811.07	81.11	257.29	626.43	62.64	242.00	294.73	29.47
Advanced Simple Cycle	200	284.50	346.32	34.63	232.40	282.92	28.29	234.08	100.06	10.01
Conventional Combined Cycle (CC)	500	773.91	126.12	12.61	712.74	116.32	11.63	662.70	108.35	10.83
Conventional CC - Duct Fired	550	743.48	129.82	12.98	682.37	119.32	11.93	632.03	110.71	11.07
Advanced Combined Cycle	800	716.27	116.73	11.67	661.04	107.88	10.79	615.74	100.67	10.07
Coal - IGCC	300	747.38	116.83	11.68	628.75	98.32	9.83	629.53	98.49	9.85
Biomass IGCC	30	656.89	109.99	11.00	666.72	111.65	11.16	701.86	117.58	11.76
Biomass Combustion - Fluidized Bed Boiler	28	683.49	104.02	10.40	661.87	100.75	10.08	698.48	106.42	10.64
Biomass Combustion - Stoker Boiler	38	726.41	108.25	10.83	710.28	105.87	10.59	740.14	110.42	11.04
Geothermal - Binary	15	427.95	83.11	8.31	475.41	93.52	9.35	505.80	106.91	10.69
Geothermal - Flash	30	422.60	78.91	7.89	467.95	88.51	8.85	494.92	100.59	10.06
Hydro - Small Scale & Developed Sites	15	165.65	86.47	8.65	181.77	95.54	9.55	189.61	103.50	10.35
Hydro - Capacity Upgrade of Existing Site	80	135.40	66.96	6.70	131.31	65.39	6.54	99.17	51.29	5.13
Solar - Parabolic Trough	250	376.70	224.70	22.47	399.04	238.27	23.83	452.71	271.52	27.15
Solar - Photovoltaic (Single Axis)	25	439.58	262.21	26.22	466.76	278.71	27.87	533.55	320.00	32.00
Onshore Wind - Class 3/4	50	203.33	72.41	7.24	217.56	77.75	7.78	220.99	80.52	8.05
Onshore Wind - Class 5	100	208.69	65.47	6.55	222.94	70.19	7.02	225.69	72.44	7.24

Simple cycles

19¢/kWh- 87¢/kWh

Combined cycles

10¢/kWh- 13¢/kWh

Per CEC Draft Staff Report  
 “Comparative Cost for California  
 Central Station Electricity Generation”  
 August 2009

CEC-200-2009-017-SD

*Combined Cycles generate lower cost Megawatt-hours and lower green house gas generation per MW*

*Siemens Flex-Plants™ offer this cost of generation with the flexibility and speed of a simple cycle*

# Flex-Plant™ Technology - a Combined Cycle Peaker

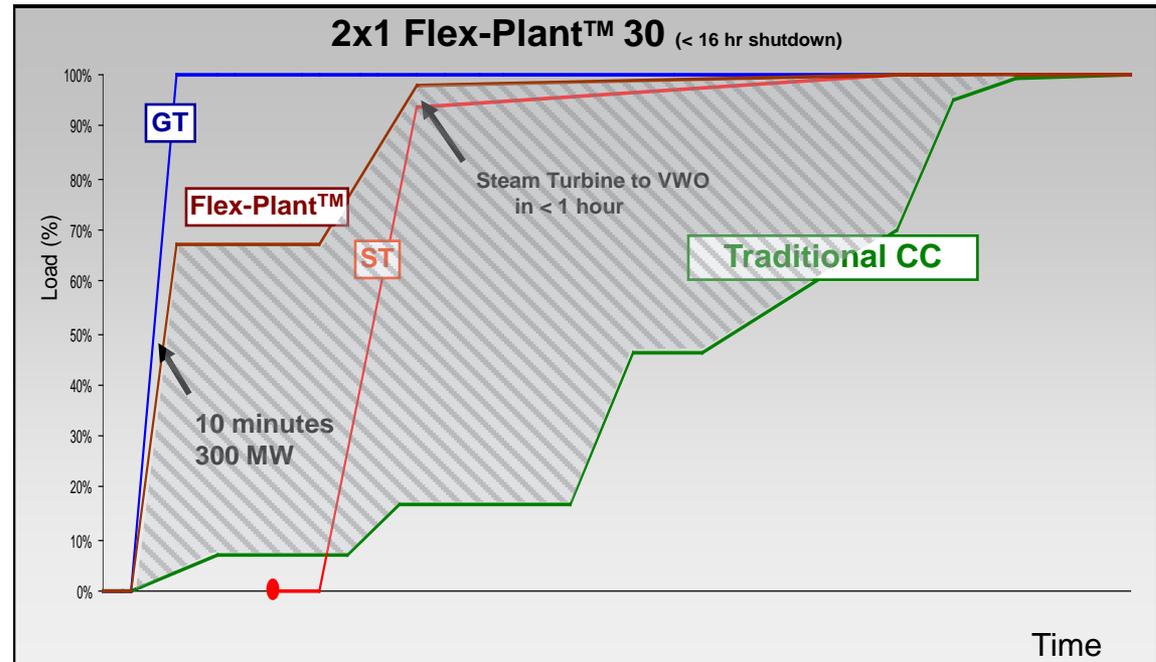
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Traditional combined cycles were not designed to start up fast or ramp fast

Flex-Plants™ are the result of an evolutionary process to create fast, reliable, combined cycles that fully leverage the flexibility of the gas turbine - they start fast, change load fast, and shut down and restart dependably

That means that in 20 minutes, this Flex-Plant™ can supply all of your GT power, and more than 65% of your total plant power

Instead of < 10% of plant power for a conventional combined cycle



All with much less water than an aeroderivative based simple cycle and the ability to use conventional SCR technology for low emissions

Siemens Improved Flexible Operation with  
Transient Emission Control – Clean-Ramp™

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***Siemens Clean-Ramp™***  
***Emissions control for ramping***

***This system maintains emissions out of the  
stack while load following at full ramp rate***



# Flex-Plants™

a partner for renewables

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Flex-Plants™ - combining a high value combined cycle and a high efficiency peaker

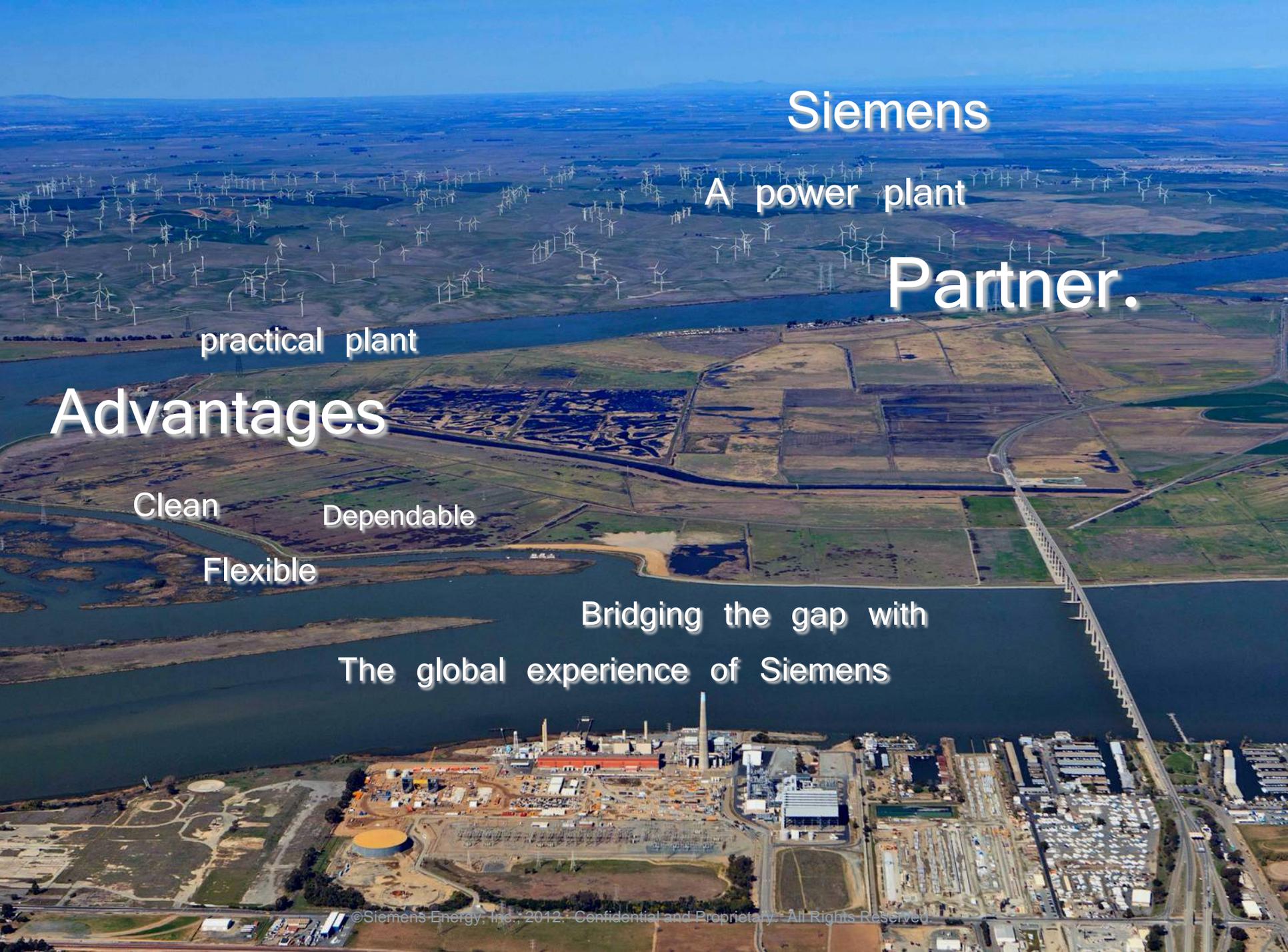
- Huge operating window from low engine load to full combined cycle power
- High efficiency from the low load to maximum power
- Low cost of generation and less greenhouse gas
- Low emissions at low load, max power and while ramping with **Clean-Ramp™**

## Challenges for California



### *Flex-Plants™ are Being Built in California ...but challenges remain*

1. There's little payoff for flexibility and traditional evaluation methods don't typically value the ability to move fast
  - flexibility options have to buy their way in or they aren't selected
2. Licensing, permitting and RFP process take a very long time
  - this keeps implementation years behind in technology and
  - inserts a cost/price risk due to long bid validities which increase facility costs



Siemens

A power plant

Partner.

practical plant

Advantages

Clean

Dependable

Flexible

Bridging the gap with

The global experience of Siemens