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Flexible Generation for Renewable Integration

June 11, 2012

DOCKET
12-IEP-1D
DATE JUN 11 2012
RECD. JUN 12 2012

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

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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

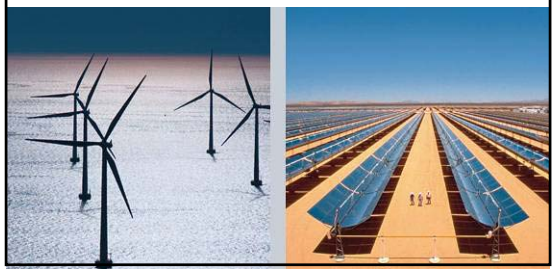
with the

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

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

In-Service Year = 2009 (Nominal 2009 $)	Size	Merchant			IOU			POU		
	MW	$/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	284.59	346.32	34.63	232.40	282.92	28.29	234.08	190.06	19.01
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

Source: Energy Commission

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

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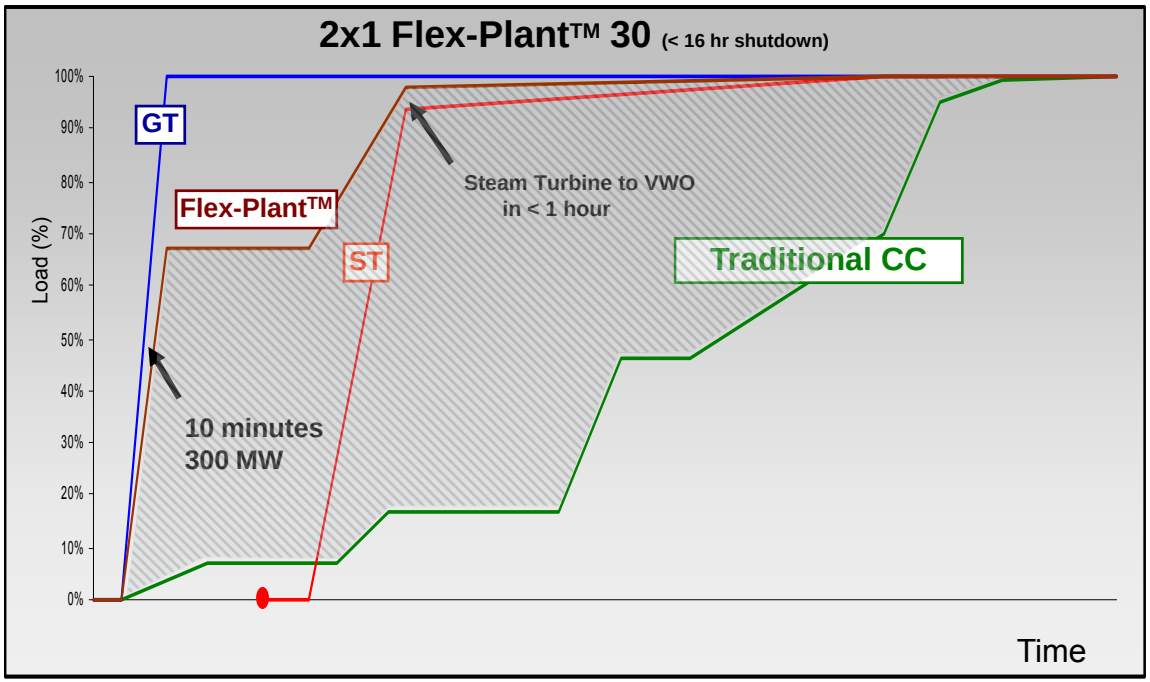
Traditional combined cycles were not designed to start up fast or ramp fast

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 –

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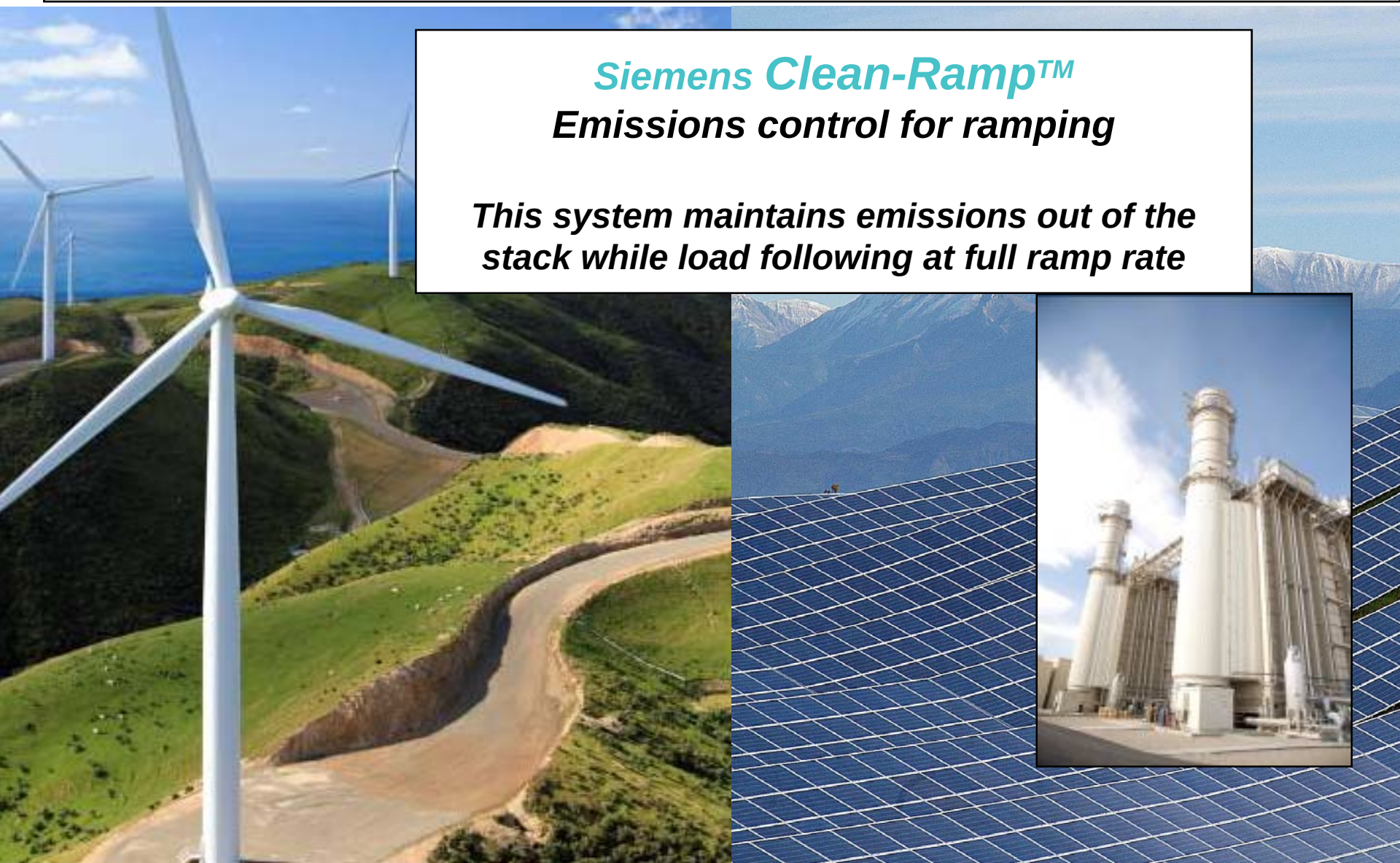
Siemens Clean-Ramp™

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™**

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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