Turbine Inlet Cooling (TIC): An Energy Solution That’s Good for the Environment, Rate Payers and Plant Owners

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Commercial and Residential Air Conditioning Loads are Major Contributors to the Peak Power Demand

Source: Scot Duncan Presentation at ASHRAE June 2007
Contribution of Various Power Generation Technologies for Meeting Power Demand

Source: Scot Duncan Presentation at ASHRAE June 2007
Price of electric energy for the ratepayers goes up during the peak demand periods: as much as 4 times that during the off-peak periods.
Emissions of CO2 During Summer (California)

Source: Scot Duncan Presentation at ASHRAE June 2007
Combustion Turbine Power Plants
Fundamental Flaws

During hot weather, just when power demand peaks,

1. Power output decreases significantly
   - *Up to 35% below rated capacity*
   - *Depends on the CT characteristics*

2. Fuel consumption (heat rate) and emissions increase per kWh
Greatest Generation Capacity Loss Coincides with Peak Power Demand

- Peak Power Demand
- Lowest Generation Capacity

Daily Generation Profile

Ambient Temperature Scale = 77 to 122 F (25 to 50 C)

GT Output Scale = 75% to 100%
Turbine Inlet Cooling Economic Benefits

- Generates more MWh revenues during peak demand periods when electric energy price is high
- Reduces capital cost for the increased generation capacity compared to new power plants
- Reduces cost of electric energy generation compared to the low energy efficiency “peakers”
- Reduces cost for ratepayers by allowing lower capacity payments by the independent system operators (ISOs) for power producers
## TIC Helps Minimize Emissions

<table>
<thead>
<tr>
<th>System</th>
<th>Combined-Cycle CT</th>
<th>Simple-Cycle CT</th>
<th>Steam Turbine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel</td>
<td>Natural Gas</td>
<td>Natural Gas</td>
<td>No. 6 Fuel Oil</td>
</tr>
<tr>
<td>CO₂ Emissions, lb/MWh</td>
<td>814</td>
<td>1250</td>
<td>2236</td>
</tr>
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<td>NOₓ Emission, lb/MWh</td>
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<td>0.36</td>
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<tr>
<td>SO₂ Emission, lb/MWh</td>
<td>0</td>
<td>0</td>
<td>13.25</td>
</tr>
</tbody>
</table>

Source: Pasteris Energy, Inc.
Suggested Changes To Regulatory Structure

- **Realize full potential of existing CT plants**
  - Use TIC before allowing new plants to be built

- **Exempt TIC from environmental re-permitting**
  - Impact of TIC is similar to ambient temperature naturally going down

- **Calculate capacity payments for plant owners on the basis of systems incorporating TIC**
  - Consistent with the PJM affidavit made to the FERC in July 2006
Conclusions

- Turbine inlet cooling can provide significant increased generation
- Additional generation can be from efficient combined-cycle (CC) and simple-cycle (SC) power plants
- More MWh from CC and SC plant minimize/eliminate operation of higher-emission producing thermal power plants/steam-turbine systems
- Turbine inlet cooling of CC and SC power plants also reduces the cost of generation compared to the thermal power plants
- In summary, TIC is an energy solution that is good for the environment, ratepayers and plant owners
Combustion Turbine Power Plants
Fundamental Flaw # 1: Generation Capacity Decreases with Increase in Temperature

EFFECTS OF COMPRESSOR INLET AIR TEMPERATURE ON GAS TURBINE POWER OUTPUT

Up to 19% capacity loss at peak demand for this CT