# *Progress Report*
# *Study Approach and Assumptions*

Presentation to NYISO Installed Capacity Working Group

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# *Topics*

- Technology screening results
- Responses to comments on Approach and Assumptions presentation at December 3, 2012, ICAP Working Group meeting

Note: Abbreviations Summary provided on last slide

# *Revised Criteria for Screening Technologies*

- Can meet environmental requirements
- Commercially available
- Plant scale
- Available to most developers
  - *Excludes resources that have limited availability, e.g., hydro, MSW, LFG*
- COD no later than Capability Year beginning May 1, 2016
- Dispatchable; has peaking or cycling characteristics
  - *Capable of cycling off during off-peak hours on a daily basis*
    - *In NYC, tax abatement available if unit qualifies as a peaking unit (annual average of less than 18 hours per start)*
  - *Starts and achieves minimum load within an hour*
- Reflecting the above factors, the plant would have 100-400 MW, depending on technology
  - *Need MWs of at least two generators (CT, ST or RICE driven) to cover common costs*

# *Application of Technology Screening Criteria*

- These technologies will not be reviewed in more detail:
  - *Intermittent power resources (wind, solar) because they are not dispatchable and have low Unforced Capacity Percentage in summer (for wind) and winter (for solar).*
  - *Dispatchable renewable technologies (hydropower, biomass, MSW, LFG) because they have limited fuel availability and are not available to most developers*
  - *Fuel cells and storage technologies because they are not economically viable or available to most developers (e.g., CAES)*
  - *Nuclear technologies because of long lead times and dispatchability*
  - *Coal technologies because of long lead times, emissions requirements, and commercial status of carbon sequestration and storage technologies*
- Several natural gas technologies have industry proven designs and have been reviewed in more detail:
  - *Simple cycle combustion turbines*
  - *Combined cycle*
  - *Reciprocating internal combustion engines*

# Gas Technologies Reviewed in More Detail (to date)

| # Units | Technologies | Notes | Plant Rating at Full Load (Net) Heat Rate (Btu/kWh) HHV | Plant Rating at Full Load (Net) Capacity (MW) |
|---|---|---|---|---|
| 1 | Siemens SGT6-PAC5000F(5) - Simple Cycle | No Emission Controls | 10,641 | 222.5 |
| 1 | Siemens SGT6-PAC5000F(5) - Simple Cycle | SCR/CO Catalyst w/tempering air | 10,641 | 222.5 |
| 1 | Siemens SGT6-PAC5000F(5) - 1x1x1 CC w/TC2F STG | SCR/CO Catalyst; wet cooling, no duct firing | 6,909 | 339.0 |
| 2 | General Electric LMS100-PA | No Emission Controls; wet cooling | 9,062 | 206.3 |
| 2 | General Electric LMS100-PA | SCR/CO Catalyst; wet cooling | 9,082 | 205.8 |
| 12 | Wartsila 18V50SG | Catalyst | 8,370 | 220.2 |

- Evaluated for Albany and NYC at ISO conditions
  - *59 °F dry bulb; 51.5 °F wet bulb; 60% relative humidity*
  - *Altitude of 275 ft for Albany and 20 feet for NYC*
- Technologies chosen for evaluation are representative of frame and aeroderivative combustion turbines and Reciprocating Internal Combustion Engines (RICE) used in recent US projects
  - *Frame: Siemens SGT6-5000F(5) in Simple or Combined Cycle*
  - *Aeroderivative: GE LMS100 PA*
  - *RICE: Wartsila 18V50SG*
- Capacity and heat rate values shown above are for Albany
  - *NYC values are similar*

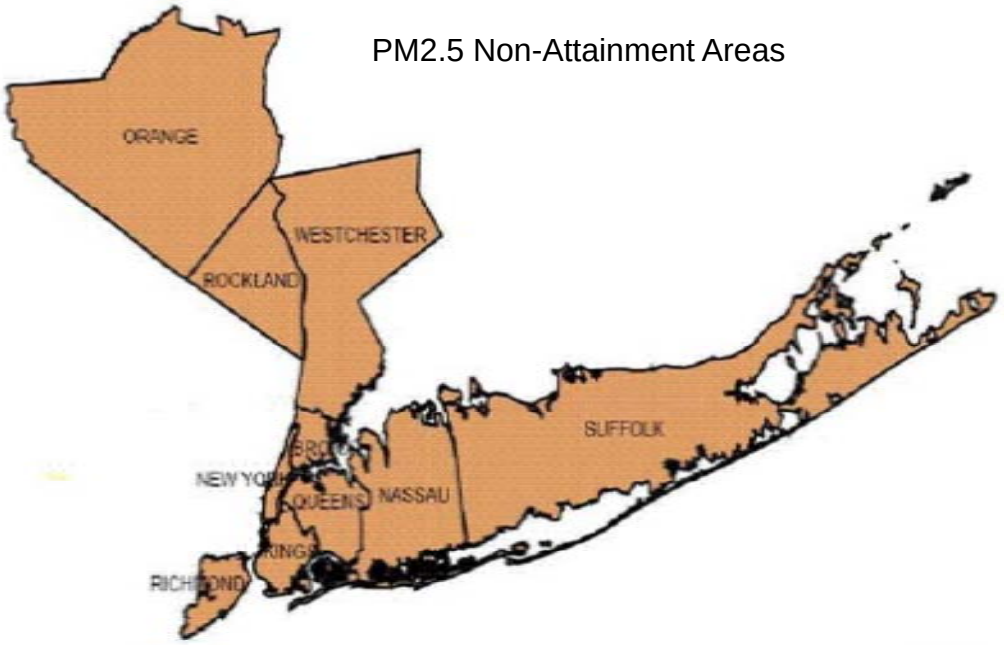
# *Emissions Rates of Reviewed Gas Technologies*

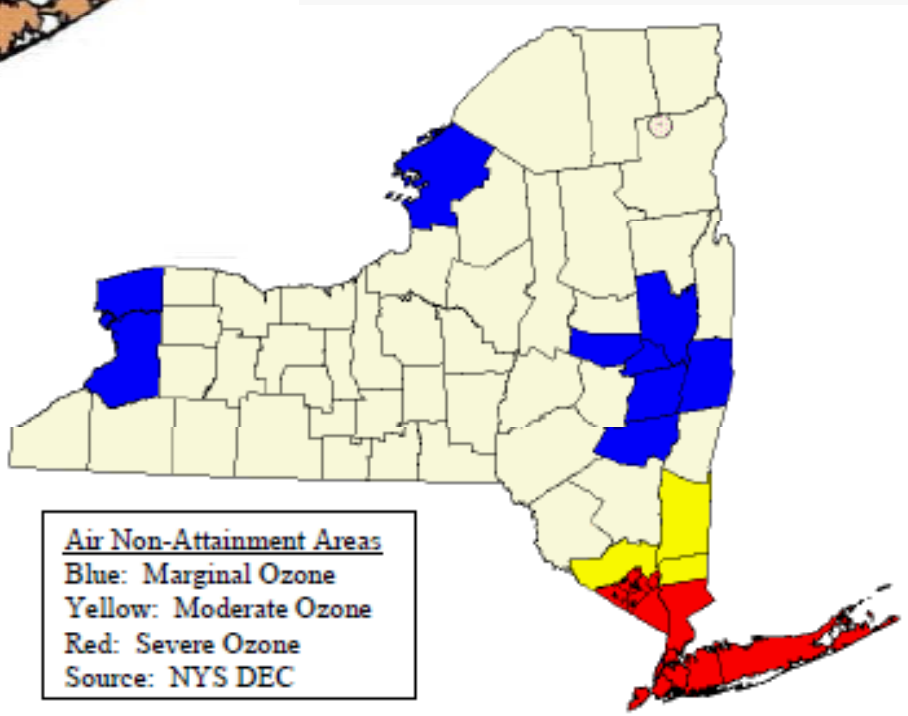
| # Units | Technologies | Notes | Plant full load emissions rate (lb/hr) | | | | |
|---|---|---|---|---|---|---|---|
| | | | NOx | VOC | CO | PM | CO2e |
| 1 | Siemens SGT6-PAC5000F(5) - Simple Cycle | No Emission Controls | 75.5 | 5.8 | 45.9 | 10.6 | 271,778 |
| 1 | Siemens SGT6-PAC5000F(5) - Simple Cycle | SCR/CO Catalyst w/tempering air | 21.3 | 4.5 | 10.4 | 16.1 | 271,780 |
| 1 | Siemens SGT6-PAC5000F(5) - 1x1x1 CC w/TC2F STG | SCR/CO Catalyst; wet cooling, no duct firing | 17.1 | 4.5 | 10.4 | 11.9 | 271,627 |
| 2 | General Electric LMS100-PA | No Emission Controls; wet cooling | 107.3 | 9.5 | 497.8 | 12.4 | 223,949 |
| 2 | General Electric LMS100-PA | SCR/CO Catalyst; wet cooling | 17.0 | 4.8 | 24.9 | 16.8 | 224,758 |
| 12 | Wartsila 18V50SG | Catalyst | 31.8 | 57.6 | 58.1 | 65.8 | 209,511 |

- Emissions based on 100% load and 100% natural gas for Albany, and excludes start-up and shut-down emissions
  - *NYC emissions rates are similar*
- PM emission rates include both filterable and condensable particulate matter. All PM emitted is assumed to be PM2.5
- CO2e (CO2 equivalents) emissions includes total greenhouse gases taking into account each greenhouse gas's global warming potential
  - *To exceed the Major Source threshold for CO2e emissions, only 736 – 955 hours of full load annual operation is required in Albany, depending on technology*
    - *Equivalent to a capacity factor of 8% – 11%*
  - *We have assumed that all technologies will qualify as Major Sources, requiring an evaluation of whether the emissions will exceed LAER and PSD thresholds for Non-Attainment and PSD Pollutants*

# *New York Air Non Attainment Areas*

PM2.5 Non-Attainment Areas

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# *LAER and PSD Operating Hour Thresholds for Non-Attainment and PSD Pollutants Albany*

| # Units | Technologies | Notes | Non-Attainment Pollutants | | | | PSD Pollutants | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | NOx | | VOC | | CO | PM | CO2e |
| | | Major Source Threshold (tpy): | LAER 100 | PSD 40 | LAER 50 | PSD 40 | PSD 100 | PSD 10 | PSD 100,000 |
| 1 | Siemens SGT6-PAC5000F(5) - Simple Cycle | No Emission Controls | 2,651 | 1,060 | 8,760 | 8,760 | 4,353 | 1,895 | 736 |
| 1 | Siemens SGT6-PAC5000F(5) - Simple Cycle | SCR/CO Catalyst w/tempering air | 8,760 | 3,760 | 8,760 | 8,760 | 8,760 | 1,244 | 736 |
| 1 | Siemens SGT6-PAC5000F(5) - 1x1x1 CC w/TC2F STG | SCR/CO Catalyst; wet cooling, no duct firing | 8,760 | 4,687 | 8,760 | 8,760 | 8,760 | 1,679 | 736 |
| 2 | General Electric LMS100-PA | No Emission Controls; wet cooling | 1,174 | 470 | 8,760 | 8,417 | 402 | 1,608 | 893 |
| 2 | General Electric LMS100-PA | SCR/CO Catalyst; wet cooling | 8,760 | 4,696 | 8,760 | 8,760 | 8,035 | 1,109 | 890 |
| 12 | Wartsila 18V50SG | Catalyst | 6,293 | 2,517 | 1,735 | 1,388 | 3,445 | 304 | 955 |

| | |
|---|---|
| | Exceeding threshold triggers Non-Attainment Area requirements for pollutant: LAER, emissions offsets, and an analysis of alternative sites, sizes, environmental control techniques and technologies. |
| | Exceeding threshold triggers PSD requirements for pollutant: BACT, air quality impact analysis, and additional impact analysis. |
| | Does not exceed Non-Attainment Area or PSD thresholds. |

- The annual hours of operation for Simple Cycle turbines with No Emissions Controls will likely exceed the threshold triggering LAER for NOx
- The annual hours of operation for RICE will likely exceed the threshold triggering LAER for VOCs
- The annual operating hours for all alternatives will likely exceed the thresholds triggering BACT for NOx, PM, and CO2e

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# *LAER and PSD Operating Hour Thresholds for Non-Attainment and PSD Pollutants New York City*

| | | | Non-Attainment Pollutants | | | | | | PSD Pollutants | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | NOx | | VOC | | PM | | CO | CO2e |
| | | Major Source Threshold (tpy): | LAER 100 | PSD 40 | LAER 50 | PSD 40 | LAER 100 | PSD 10 | PSD 100 | PSD 100,000 |
| # Units | Technologies | Notes | | | | | | | | |
| 1 | Siemens SGT6-PAC5000F(5) - Simple Cycle | No Emission Controls | - | - | - | - | - | - | - | - |
| 1 | Siemens SGT6-PAC5000F(5) - Simple Cycle | SCR/CO Catalyst w/tempering air | - | - | - | - | - | - | - | - |
| 1 | Siemens SGT6-PAC5000F(5) - 1x1x1 CC w/TC2F STG | SCR/CO Catalyst; dry cooling, no duct firing | 2,903 | 290 | 8,760 | 1,110 | 8,760 | 1,676 | 8,760 | 730 |
| 2 | General Electric LMS100-PA | No Emission Controls; dry cooling | 295 | 29 | 5,285 | 529 | 8,760 | 1,608 | 404 | 897 |
| 2 | General Electric LMS100-PA | SCR/CO Catalyst; dry cooling | 2,949 | 295 | 8,760 | 1,057 | 8,760 | 1,192 | 8,073 | 894 |
| 12 | Wartsila 18V50DF | Catalyst | 1,447 | 145 | 1,245 | 124 | 2,945 | 294 | 3,803 | 1,049 |

| | |
|---|---|
| | Exceeding threshold triggers Non-Attainment Area requirements for pollutant: LAER, emissions offsets, and an analysis of alternative sites, sizes, environmental control techniques and technologies. |
| | Exceeding threshold triggers PSD requirements for pollutant: BACT, air quality impact analysis, and additional impact analysis. |
| | Does not exceed Non-Attainment Area nor PSD thresholds. |

- Simple cycle frame technology was not evaluated for New York City
- The annual hours of operation for the simple cycle aeroderivative with no emissions controls will likely exceed the threshold triggering LAER for NOx and VOC
- The annual hours of operation for RICE will likely exceed the threshold triggering LAER for NOx, VOC, and PM
- The annual operating hours for all alternatives will likely exceed the thresholds triggering BACT for CO2e

# *Technologies Eliminated from Further Evaluation*

- The permitting process for LAER and BACT will likely eliminate:
  - *Simple cycle turbines with No Emission Controls*
    - *Analysis of alternative environmental control technologies would likely conclude that controls could be added*
- The permitting process for BACT will likely eliminate:
  - *Simple cycle frame turbines with Emission Controls*
    - *Analysis of BACT would likely conclude that Combined Cycle frame turbines can reduce CO2e emissions per MWh*

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# *Technologies Proposed for Evaluation*

- Technologies proposed for evaluation in the DCR study:
  - *General Electric LMS100 PA*
    - *Simple Cycle aeroderivative combustion turbine*
    - *2 unit configuration*
  - *Siemens SGT6-PAC5000F(5)*
    - *Combined Cycle based on frame combustion turbine*
    - *1x1x1 configuration*
  - *Both technologies must have SCR and CO catalyst*
    - *Purchase of NOx ERCs required in NYC*
- RICE technology can be included for evaluation in the DCR study recognizing that obtaining an emissions permit will be more challenging than for Combined Cycle and aeroderivative technologies
  - *Under New York LAER regulations, an analysis of alternative "environmental control techniques and technologies" is required for proposed major sources of NOx and/or VOC emissions*
    - *This analysis may conclude that aeroderivative turbines could provide the same duty with less emissions, excluding RICE from consideration*
  - *RICE will be required to have NOx and CO catalyst and to purchase ERCs (VOC, NOx and possibly PM in NYC; VOC and possibly NOx in Albany)*

# *Responses to Comments on December 3 Presentation on Approach and Assumptions*

- As with previous DCRs, any stakeholder wishing to provide actual cost or other data for consideration can do so.
- We previously evaluated 4 vs. 2 vs. single unit plants (for 2007 DCR) and determined that capital cost per kW was not significantly reduced by adding units to a 2-unit facility
- Comments on technology screening criteria were addressed in previous slides
  - *Operations more than 16 hours per day - revised*
  - *Scalable, generic, and readily available technology - agreed*
  - *Efficiency of reciprocating internal combustion engines - provided*
- Incremental capital cost of dual fuel capability will be provided
- Cost of new entry in both attainment and non-attainment areas in Zone G will be provided for consideration
  - *Labor rates, emissions control requirements, and transmission lines available for interconnection vary by county within Zone G, and will impact costs*

# *Abbreviation Summary*

- AF – Attachment Facility
- A&G – Administrative & General
- BACT – Best Available Control Technology
- CAES – Compressed Air Energy Storage
- CC – Combined Cycle
- CO – Carbon Monoxide
- CO2 – Carbon Dioxide
- CO2e – Carbon Dioxide Equivalents
- COD – Commercial Operation Date
- CT – Combustion Turbine
- CTG – Combustion Turbine Generator
- CTO – Connecting Transmission Owner
- CY – Class Year
- DCR – Demand Curve Reset
- ERC – Emissions Reduction Credit
- GE – General Electric
- GIS – Gas Insulated Substation
- GHG – Green House Gas
- HHV – High Heating Value
- ISO – International Organization for Standardization
- kV - Kilovolt
- kW – Kilowatt
- LAER – Lowest Achievable Emissions Rate
- LFG – Landfill Gas
- LIPA – Long Island Power Authority
- MSW – Municipal Solid Waste
- MW – Megawatt
- NOx – Nitrogen Oxides
- NYC – New York City
- PM – Particulate Matter
- POI – Point of Interconnection
- PSD - Prevention of Significant Deterioration
- RICE- Reciprocating Internal Combustion Engine
- SA – Stand Alone
- SCR – Selective Catalytic Reduction
- SUF – System Upgrade Facilities
- SDU – System Deliverability Upgrades
- STG – Steam Turbine Generator
- TC2F – Tandem Compound Dual Flow
- tpy – Tons per year
- VOC – Volatile Organic Compounds