Wind Integration Studies

Preliminary Results

BIC & OC Meetings
8/12/09 & 8/13/09

First Draft 8/5/09 1520

For Discussion Purposes Only

Wind Plant Integration Issues

- **Transmission**
  - ***Local area limitations will affect wind plant output***
  - ***Transmission limitations are a major barrier to increasing wind plant penetration in some areas***
  - ***Earlier study finding has led to the introduction of wind energy management and associated market rules***
- **System Flexibility**
  - ***Intermittent nature of wind plant output will result in increased system variability for certain hours, depending on the level of wind penetration.***
  - ***Operator awareness and practices***
- **Wind Plant Performance & Standards**
  - ***Wind plant dynamic models and LVRT capability***

Study Tasks and Status

1. Develop study assumptions ***- Complete***
2. Develop and implement performance monitoring for operating wind generators ***- Complete***
3. Update other regions' experience with wind generators ***- Complete***
4. Study the impacts on higher penetrations of wind on system variability and operations ***- Simulations complete with analysis of the data still in progress***
5. Evaluate the impact of the higher penetration of wind generation on transmission infrastructure and system performance ***- Power flow work completed and key contingencies identified; system stability screen underway***

Study Tasks and Status

6. Evaluate the impact of the higher penetration of wind generation on energy production and production costs for NY system ***– Simulations in progress***
7. Additional Task – Generate a transmission upgrade list based on #6, refine the list by TOs, and feed back to #6 to assess effectiveness of these upgrades ***– Underway and being coordinated with the TOs "STARS" study***

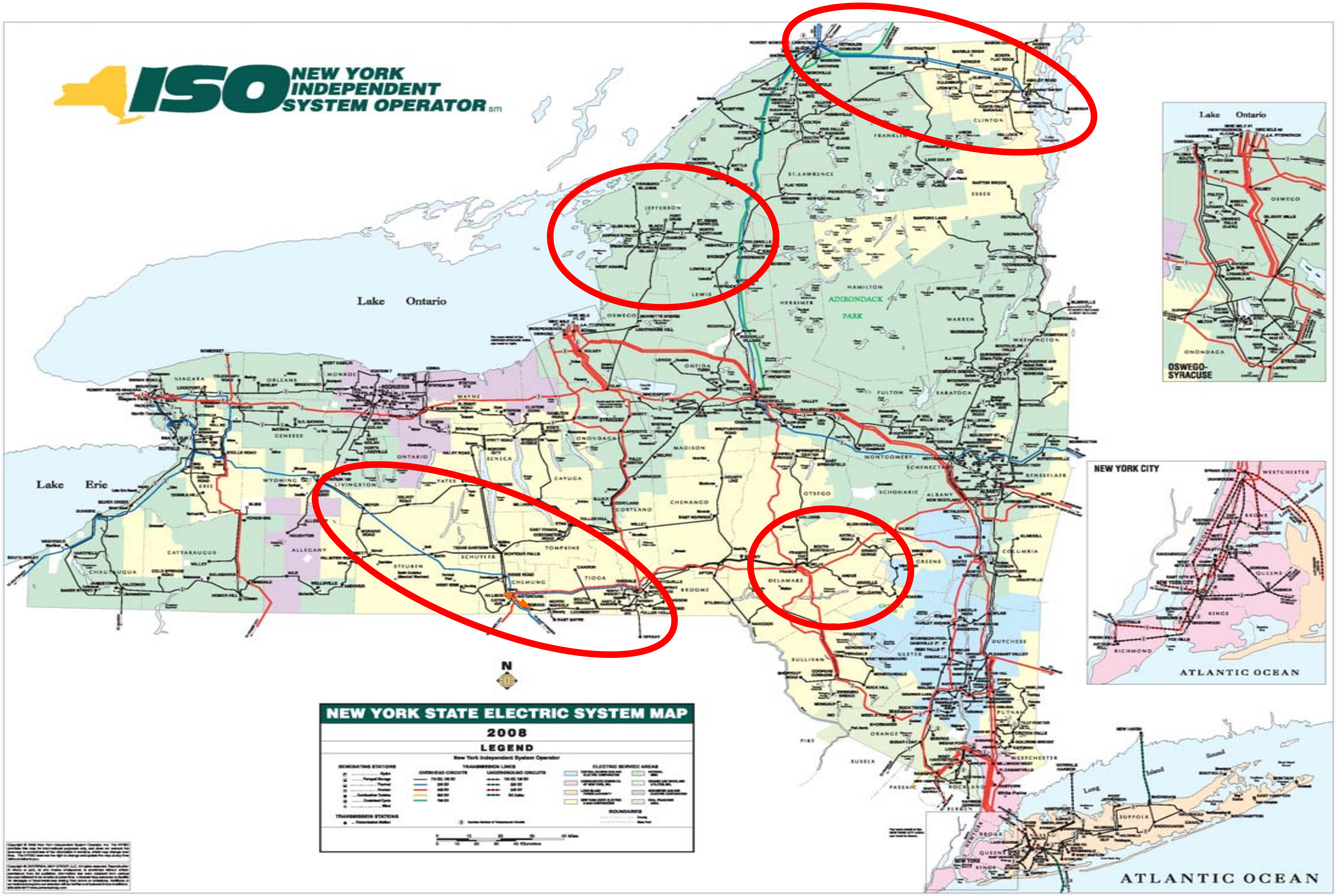
The completion of the final report is expected the fourth quarter of 2009.

Task 5 - Methodology

- Evaluate peak load (35 GW) and light load (13 GW)
- Evaluate 4,250 MW, 6,000 MW and 8,000 MW wind penetration
  - ***Wind modeled according to NYISO Interconnection Queue***
- Assess export capability of wind-rich zones using thermal transfer analysis
  - ***Generation transfers increased from west and north to downstate***
  - ***Monitor limitations of 100 kV and above system***
- Identify limiting elements and contingencies which potentially cause wind bottling
  - ***Evaluate wind and traditional generation to determine wind impact***
- Screen results using voltage and stability analysis

Task 5 - Observations

- West-Central wind is constrained locally by the underlying 115 kV system centered around Hillside
- Northern wind is constrained locally in two pockets
  - ***Willis-Plattsburgh area wind limited primarily by the tower contingency***
  - ***Thousand Islands area wind limited by radial 115 kV system***
- Leeds-PV shows as a constraint that limits bulk power transfers toward downstate

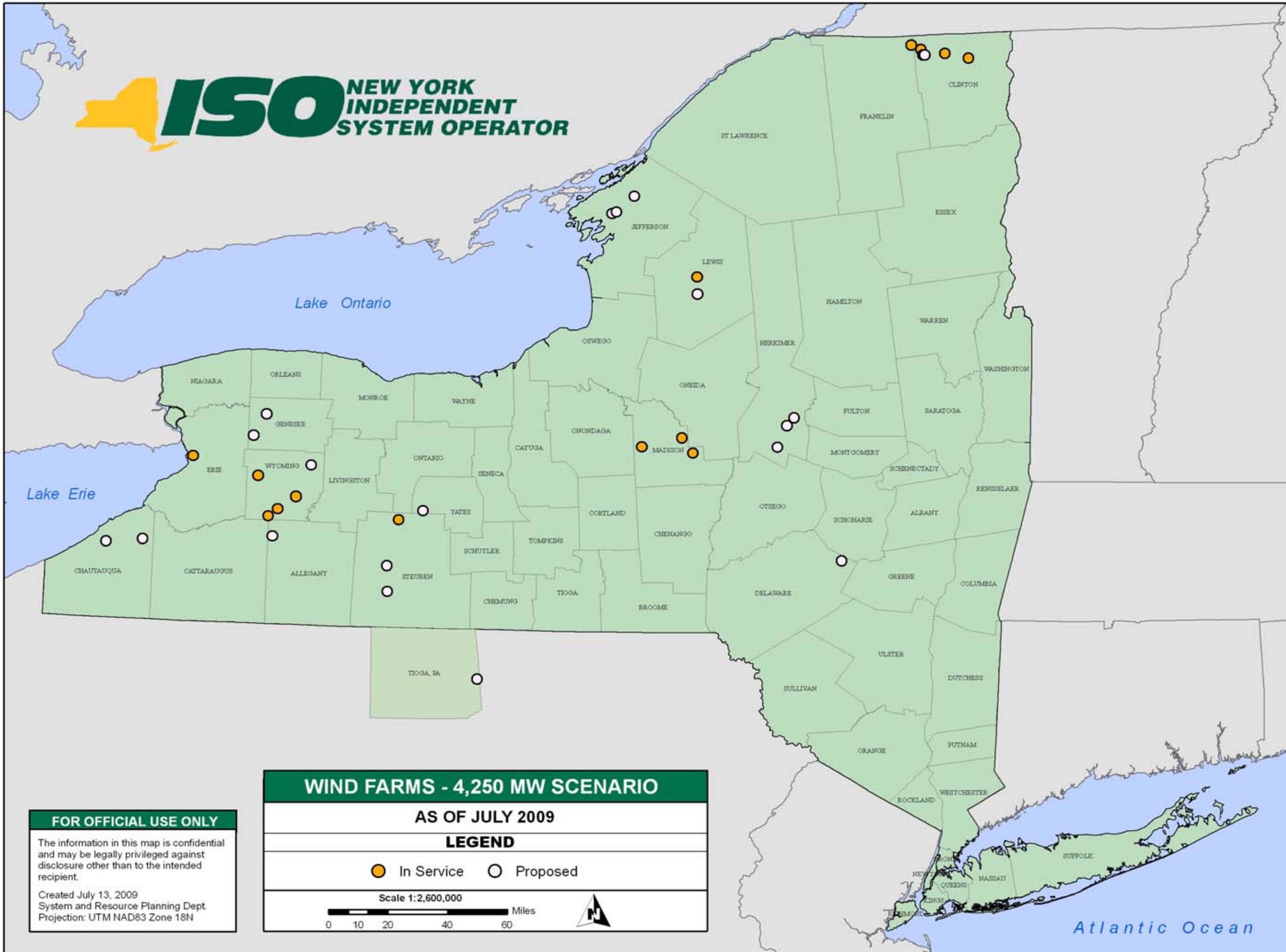

NEW YORK INDEPENDENT SYSTEM OPERATOR
Lake Ontario
Lake Erie
ADIRONDACK PARK
NEW YORK CITY
ATLANTIC OCEAN
OSWEGO-SYRACUSE
NEW YORK STATE ELECTRIC SYSTEM MAP
2008
LEGEND
ATLANTIC OCEAN

Task 6 - Methodology

- **Market Simulations using ABB's GridView**
  - ***SCUC/SCED model based on the marginal cost of individual units in the NY system***
- **Wind Scenarios**
  - ***Perfect Wind Forecast***
  - ***Wind plant generation profiles based on AWS simulations for selected locations in NY***
  - ***Four levels of Injection: Base (1275 MW), 4,250 MW, 6,000 MW and 8,000 MW***

Task 6 - Methodology

- **Neighboring Systems**
  - ***Used CARIS data to model systems external to NY. HQ is based on 2007 actual***
- **Report on Wind plant performance in terms of**
  - ***Energy Production/Capacity Factor***
  - ***Fuel Displacement***
  - ***Transmission Constraints***


NEW YORK INDEPENDENT SYSTEM OPERATOR
ISO
WIND FARMS - 4,250 MW SCENARIO
AS OF JULY 2009
LEGEND
In Service
Proposed
Scale 1:2,600,000
0 10 20 40 60
Miles
FOR OFFICIAL USE ONLY
The information in this map is confidential and may be legally privileged against disclosure other than to the intended recipient.
Created July 13, 2009
System and Resource Planning Dept.
Projection: UTM NAD83 Zone 18N
Lake Ontario
Lake Erie
Atlantic Ocean
CLINTON
FRANKLIN
ST LAWRENCE
ESSEX
JEFFERSON
LEWIS
HAMILTON
WARREN
OSWEGO
HERKIMER
WASHINGTON
NIAGARA
ORLEANS
MONROE
WAYNE
ONEIDA
FULTON
SARATOGA
GENESEE
ONONDAGA
CAYUGA
MADISON
MONTGOMERY
SCHENECTADY
ERIE
WYOMING
ONTARIO
SENECA
LIVINGSTON
RENSSELAER
YATES
CORTLAND
OTSEGO
ALBANY
CHENANGO
SCHOHARIE
TOMPKINS
SCHUYLER
CHAUTAUQUA
CATTARAUGUS
ALLEGANY
STEUBEN
GREENE
COLUMBIA
DELAWARE
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CHEMUNG
BROOME
TIOGA, PA
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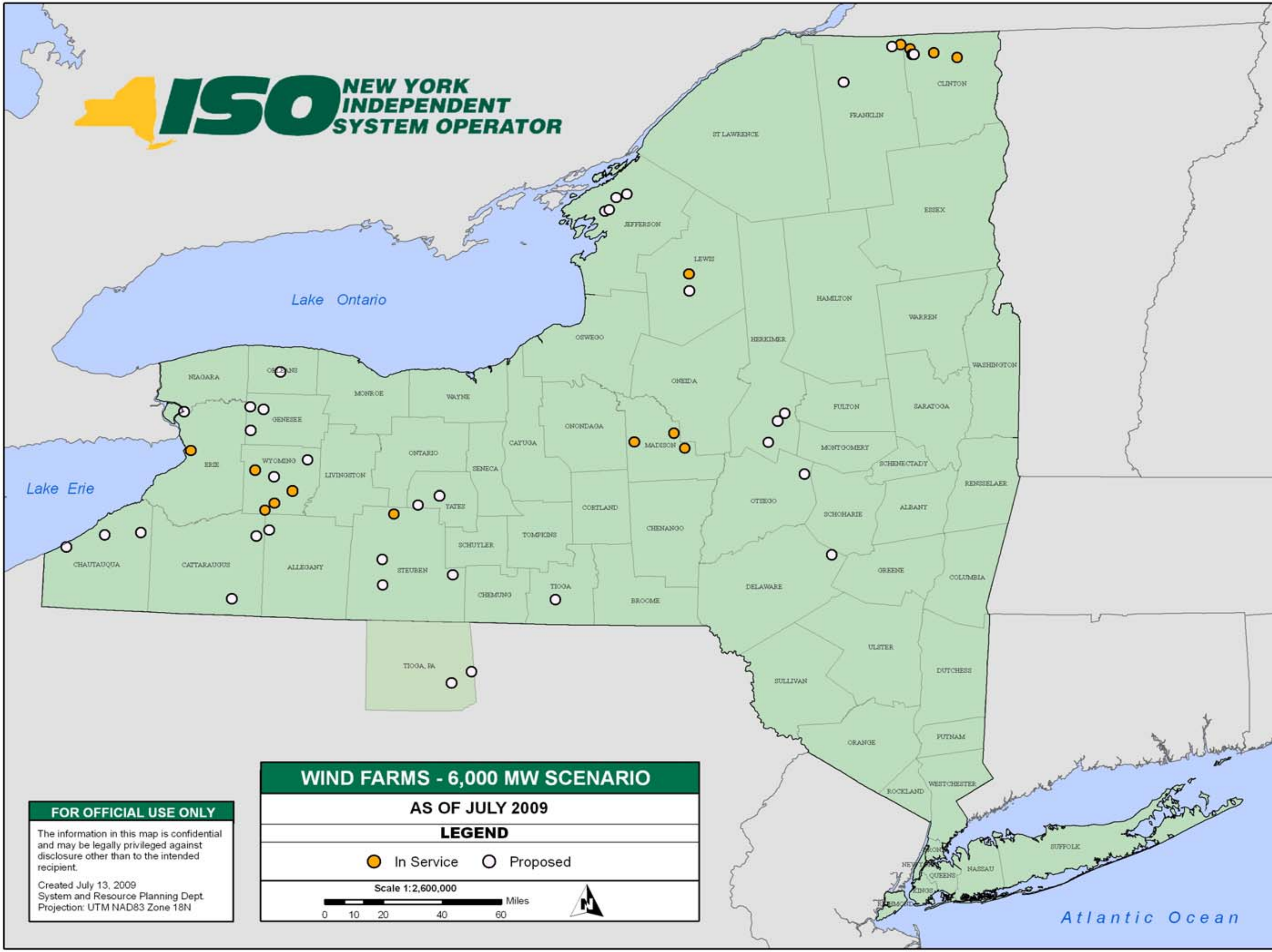
DUTCHESS
SULLIVAN
ORANGE
PUTNAM
WESTCHESTER
ROCKLAND
SUFFOLK
NASSAU
QUEENS
KINGS



NEW YORK
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SYSTEM OPERATOR
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CATTARAUGUS
ALLEGANY
STEUBEN
TIOGA, PA
WIND FARMS - 6,000 MW SCENARIO
AS OF JULY 2009
LEGEND
In Service
Proposed
Scale 1:2,600,000
0 10 20 40 60
Miles
N
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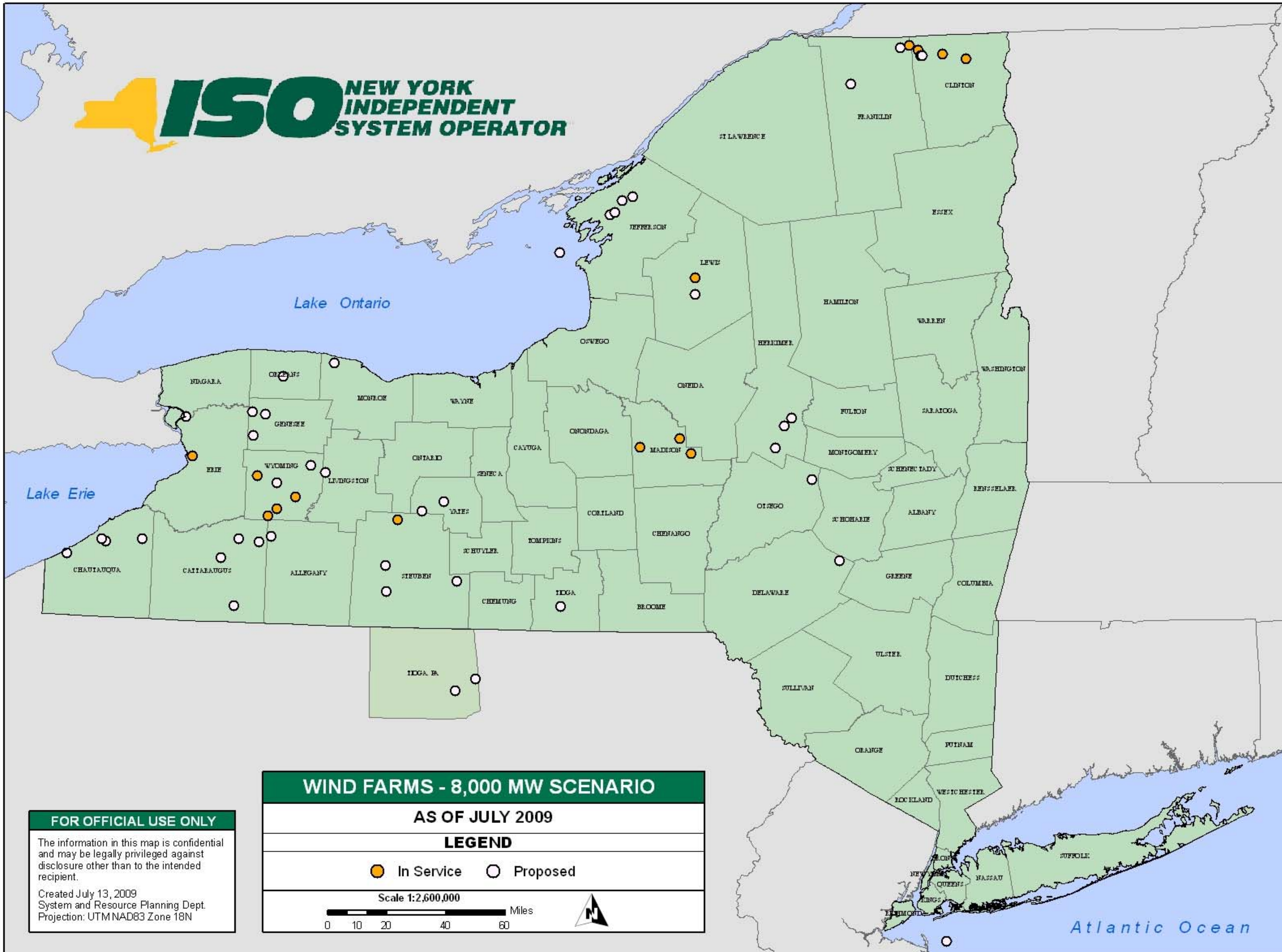
NEW YORK INDEPENDENT SYSTEM OPERATOR
WIND FARMS - 8,000 MW SCENARIO
AS OF JULY 2009
LEGEND
In Service
Proposed
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Miles
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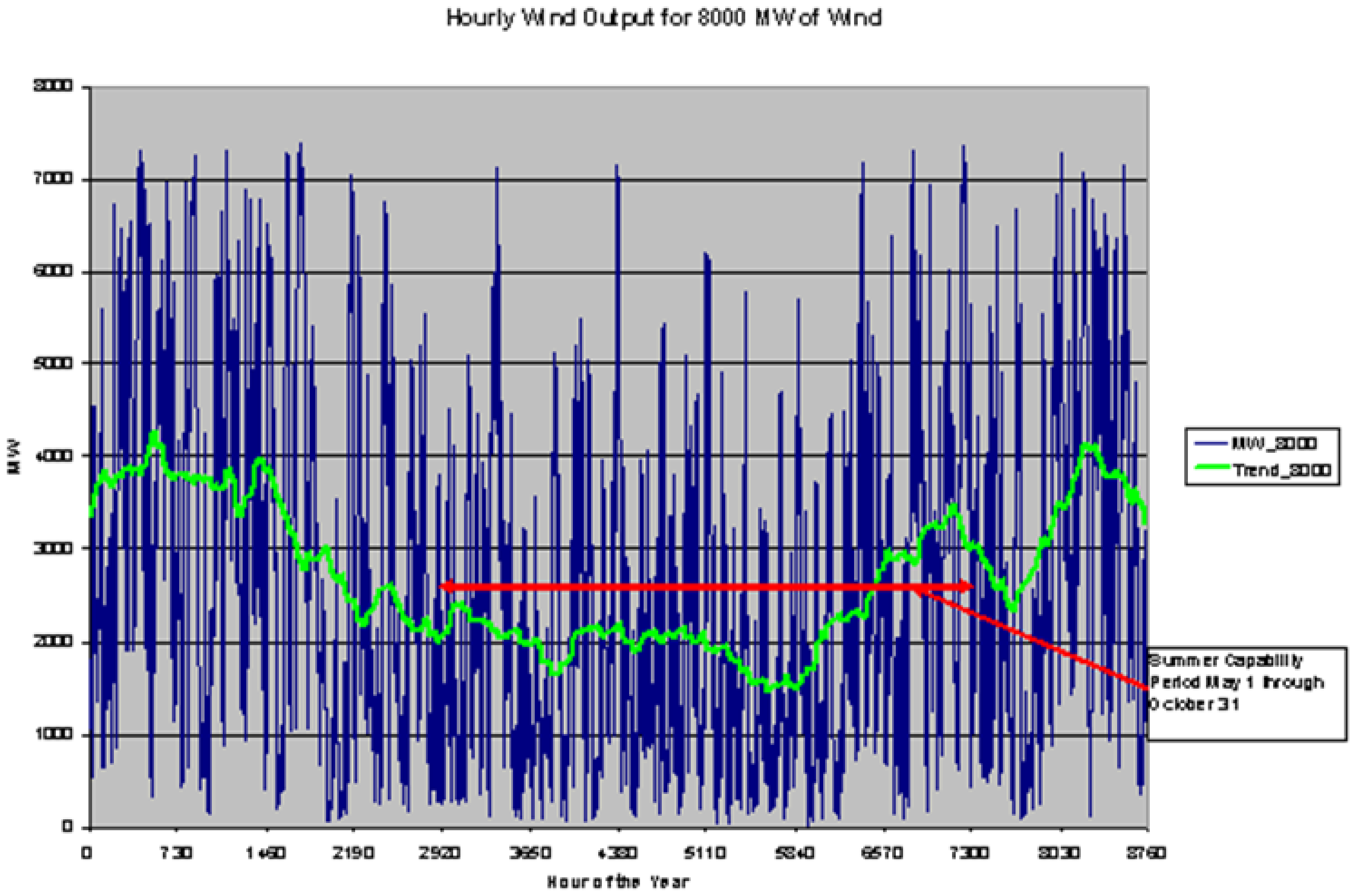
RICHMOND

Simulation -- 8,000 MW of Wind



Task 6 – Results: Impact of Transmission Constraints on Wind Plant Energy Output

- Transmission constraints result in “bottling” of wind plant output.
  - ***1274 MW of wind resulted in 1.2% of energy bottled***
  - ***4250 MW of wind resulted in 6.2% of energy bottled***
  - ***6000 MW of wind resulted in 7.7% of energy bottled***
  - ***8000 MW of wind resulted in 7.1% of energy bottled***
- The primary zones impacted were E, D and C
  - ***The % of wind bottled in these zones increased in all scenarios***

Task 6 – 8 GW Scenario Results: Fuel Type Displaced by Wind Plus Exports

- The primary fuel type displaced by wind generation was gas.
  - ***It accounted for over 80% of the reduction in NY generation***
- The next highest displaced fuel type was oil followed by a small amount of coal
- NY exports increased
  - ***Approximately 30% of the wind production resulted in increased exports.***

Task 6 - Key Observations

- Interconnection point of wind plant plays major role in the amount of wind plant MWs that can be integrated before significant transmission limitations are encountered:
  - ***Thousand Islands, Willis-Plattsburgh and Corning area locations exhibit the most potential for wind production to be constrained by transmission limitations.***
  - ***Wind resource management will be critical to integrating significant amounts of wind while maintaining system reliability.***
- Transmission limitations will need to be addressed to increase wind plant capacity factors

Need for System Flexibility

- Analysis of the wind simulations indicate that wind generation will result in increased system variability for certain time intervals as measured by net load (load minus wind) for time frames ranging from seconds to hours.
- The impact appears to increase linearly with increased wind penetration.
- Wind amplifies the morning ramp up period and evening ramp down period.
- Net minimum loads will be less than the minimum loads that are experienced currently. This could result in over generation conditions at night.
- Variation in wind conditions from year-to-year can result in significant changes in total available wind energy.

Further Work Is Needed

- Consider the identification of potential transmission upgrades.
- Need to continue the analysis of how the increased requirements in ramping and load following that will result from increased wind plant penetration will impact system performance.
- Need to investigate the ability of the system to deal with net minimum loads less than those that are experienced today – approximately 11,000 MW today vs. 8,000 MW in 2018 with 8 GW of wind.
- Need to evaluate the year-to-year fluctuations in wind plant output and their implications for planning purposes.

Further Work Is Needed – The Good News

- The NYISO well positioned to meet the challenges of the growth in wind generation.
- This is the result of the NYISO competitive markets, current system operating practices and the action taken and underway to integrate intermittent generation.
- To achieve wind plant penetrations that significantly exceed 3300 MW will take several years.
- Much will be learned and adjustments made over time as more experience is gained.

The New York Independent System Operator (NYISO) is a not-for-profit corporation that began operations in 1999. The NYISO operates New York's bulk electricity grid, administers the state's wholesale electricity markets, and provides comprehensive reliability planning for the state's bulk electricity system.

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