Task 7

Congestion Analysis
and
Transmission System Upgrades

Task 7 – Methodology

- **Evaluation of Transmission Limitations**
  - ***Review projects' actual capacity factor vs. perfect production to determine level of bottling***
  - ***Identify specific transmission constraints (limiting element/contingency) for each project (or group of projects)***
    - ***Consistent with TOs local Planning Criteria, Rules, Standards and Operating Procedures***
  - ***Identify possible upgrades on limiting elements/transmission facilities***

Transmission Upgrades

- Considerations
  - ***Scope of upgrades***
    - **Single project**
    - **Small group of projects**
    - **General system (wide-area) projects**
  - ***Types of upgrade***
    - **Terminal limitations**
    - **Conductor limitations**
    - **Complete rebuild**
    - **Reconfiguration**
- Upgrades included in project facility studies are assumed available

Transmission Constraints

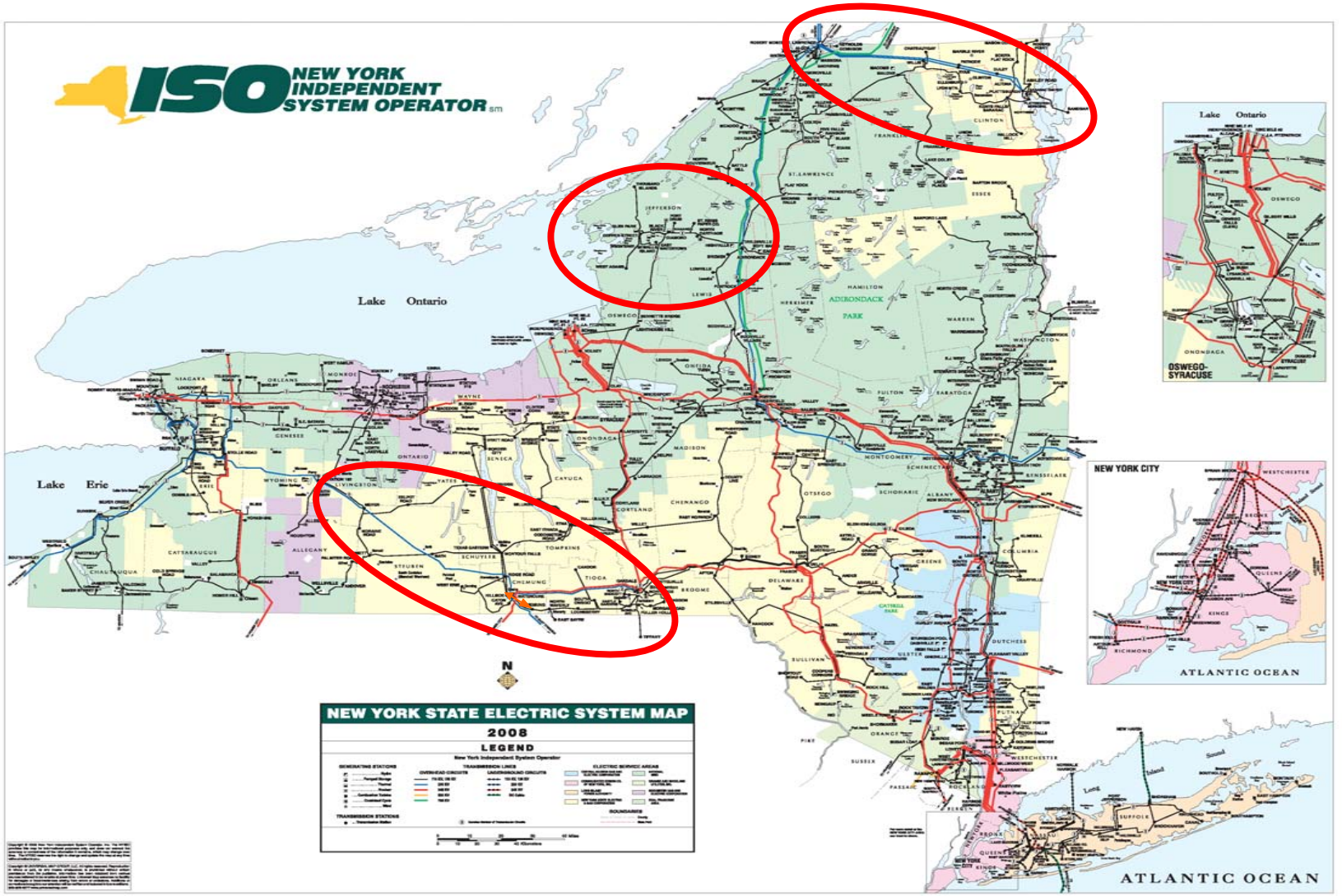
- Major transmission constraints identified in three local areas:
  - **Corning/Elmira**
  - **Willis/Plattsburgh**
  - **Watertown/Thousand Islands**
- ***Limiting elements are primarily local 115kV***
- ***Limiting contingencies include***
  - **EHV contingencies (d/c tower, stuck breaker)**
  - **Parallel path EHV**
  - **115kV double circuit (d/c) tower**
  - **Parallel path 115kV**

Summary of Energy Bottling

- Wind Resource Energy bottling is based on a project's actual capacity factor vs. "perfect production" capacity factor
  - ***Identify transmission constraint(s) causing the capacity factor reduction***
  - ***Identify project(s) constrained by limitation***
- Modify simulation model with upgrade(s) and repeat simulation to measure benefit

Upgrade Scenario Results

Zone	Wind Capacity	Base	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
A	1309	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
B	281	0.1%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
C	1591	6.1%	4.5%	3.9%	1.2%	0.2%	0.0%	0.0%	0.0%
D	1068	15.0%	12.0%	2.5%	1.7%	1.7%	1.7%	1.7%	1.7%
E	1648	15.8%	15.1%	14.0%	11.1%	10.4%	11.0%	8.0%	3.3%
F	70	0.1%	0.1%	0.1%	0.1%	0.2%	0.1%	0.1%	0.2%
Total	5967	8.8%	7.7%	5.4%	3.7%	3.2%	3.4%	2.5%	1.2%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Lake Ontario
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LEGEND
ATLANTIC OCEAN

System Limitations

- EHV constraints identified in the simulations
  - ***These are (historical) constraints that are not unique to the addition of wind generation***
    - ***Leeds – Pleasant Valley 345kV***
    - ***Rock Tavern – Ramapo 345kV***
  - ***Existing contingencies – New constraints***
    - ***Oakdale 345kV (exit) tower, stuck breaker***
    - ***Hillside 230kV (exit) tower***

Evaluation of Upgrades

- Identify specific transmission line(s) and needed capacity (rating)
  - ***Review upgrades with Transmission Owner(s)***
    - **Identify line terminal upgrades that will allow operation up to conductor ampacity**
    - **Determine feasibility of reconductoring as remediation option vs. rebuilding**
  - ***Identify projects' benefit***
- Other considerations
  - ***Timing of wind projects***
  - ***TO plans for facility upgrade/renewal***

Simulation of Upgrades

- Develop a sequence of upgrades to address the identified wind resource bottling
  - *Up to 7 simulation scenarios were developed to quantify the upgrades to reduce bottled energy <2% within any Zone*
  - *Used production cost simulations to identify the limiting contingency(ies) and elements and "needed relief" to size the upgrade (and quantify benefit)*

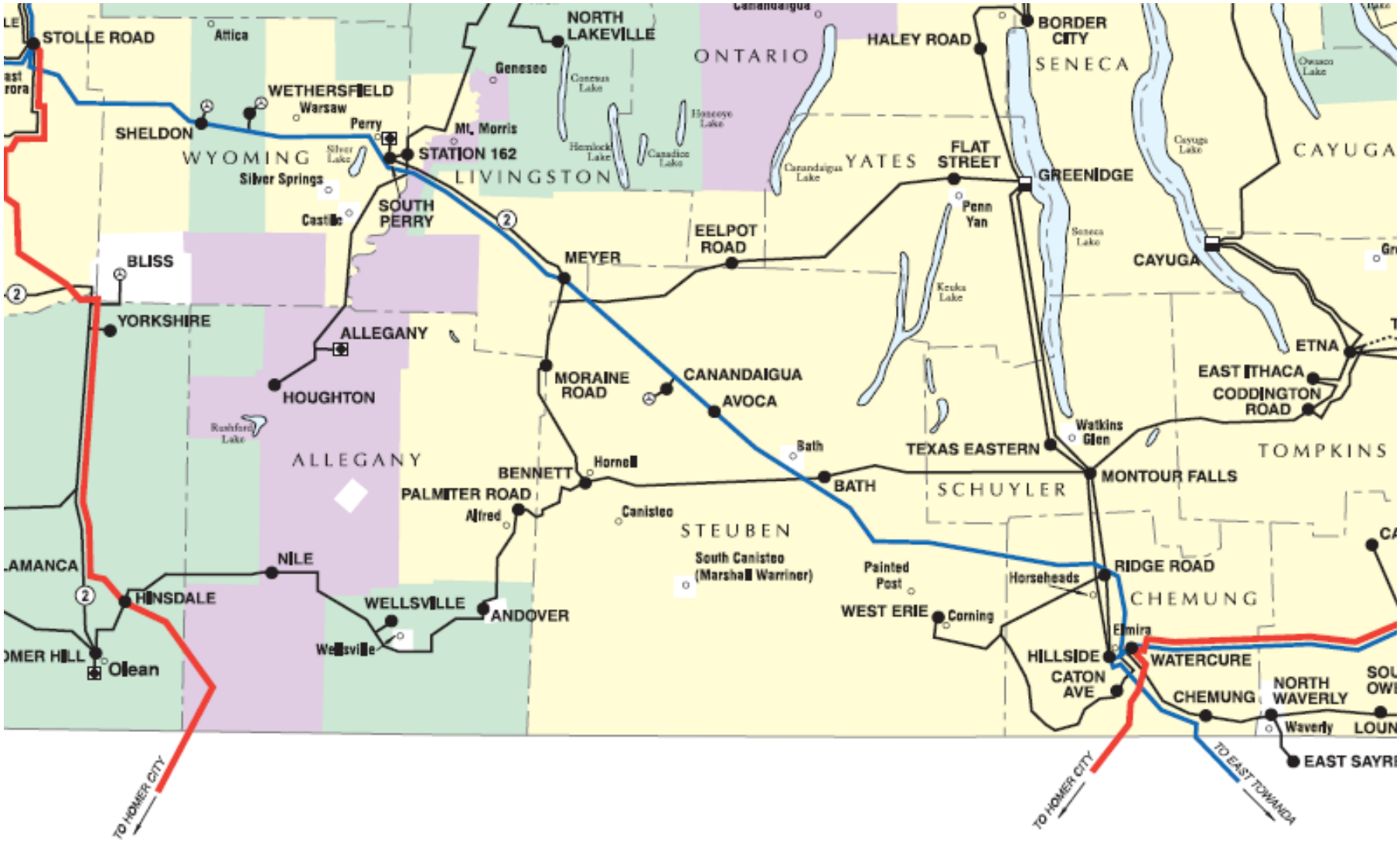
Southern Tier

- *NYSEG portion of Zone C*
- Existing capacity 364MW
- Proposed additional capacity 586MW
- Identified constraints in several locations
  - ***Locations potentially limited by local 115kV (pre-contingency loading)***
    - ***Bennett – Bath 115kV***
    - ***Meyer – Greenidge 115kV***
  - ***Pre-contingency loading limitations may be resolved by line terminal upgrades and/or reconductoring***

Zone C Constraints

- Pre-contingency loading
  - **Bennett – Bath – Montour Falls 115kV**
  - **Bennett – Moraine Rd – Meyer 115kV**
  - **Eel Pot Rd – Flat St – Greenidge 115kV**
- Contingency overloads
  - **Avoca – Hillside 230kV**
  - **Montour Falls – Ridge Rd 115kV**
  - **Eel Pot Rd – Flat St – Greenidge 115kV**
  - **Hillside – No. Waverly 115kV**
- Mitigations
  - **Upgrade 230kV to design conductor rating**
  - **Reconductor 115kV**

Southern Tier Constraints (west)



Southern Tier (2)

- **Larger group of projects limited by 115kV line for EHV contingencies**
  - ***(preceding group + additional 490MW)***
    - ***Hillside 230kV tower***
    - ***Oakdale 345kV transmission***
      - ***Oakdale 345kV tower***
      - ***Oakdale 345kV stuck breaker***
  - ***EHV station exit reconfiguration to mitigate tower contingencies at Hillside, Oakdale***
  - ***Reconductor/rebuild limiting elements:***
    - ***Montour Falls – Ridge Road 115kV (2 circuits)***
    - ***Hillside – No. Waverly 115kV***

Southern Tier (3)

- **Zone E Constraint impacts all projects in So. Tier (Zone C) and project in Zone E:**
  - ***Generally limits west-to-east transfers***
  - ***Delhi – Fraser Tap 115kV limiting for Contingencies:***
    - ***Oakdale – Fraser 345kV***
    - ***Oakdale 345kV stuck breakers***
  - ***Upgrade to conductor design rating:***
    - ***Delhi – Fraser Tap section of Delhi – Colliers 115kV***

Southern Tier Constraints (east)

Zone C Upgrade Projects

Step	Zone	Upgrade Project	Cost k$
1	C	Reconfigure Hillside 230kV exit	2000
1	C	Reconfigure Oakdale 345kV exit	3000
2	C	Reconductor (2) Montour Falls-Hillside 115kV	20900
2	C	Reconductor Hillside-N.Waverly 115kV	17500
2	C	Upgrade Hillside line#68 terminal	1000
2	E	Upgrade protections Delhi-Colliers	750
3	C	Upgrade terminals Bennett-Howard-Bath 115kV	1000
3	C	Upgrade terminals Bath Montour Falls 115kV	2000
3	C	Upgrade terminals Bennett-Moraine Rd-Meyer 115kV	2000
4	C	Upgrade terminals Meyer-Greenidge 115kV	250
5	C	Reconductor Eel Pot Rd-Greenidge 115kV	15400
		Total	65800

Zone D Constraints

- **Pre-contingency loading**
  - **(none)**

- **Contingency overloads**
  - **Moses – Willis 230kV**
  - **Duley/Ryan – Plattsburgh 230kV**
  - **Plattsburgh 230/115kV**
  - **Willis – Colton 115kV**

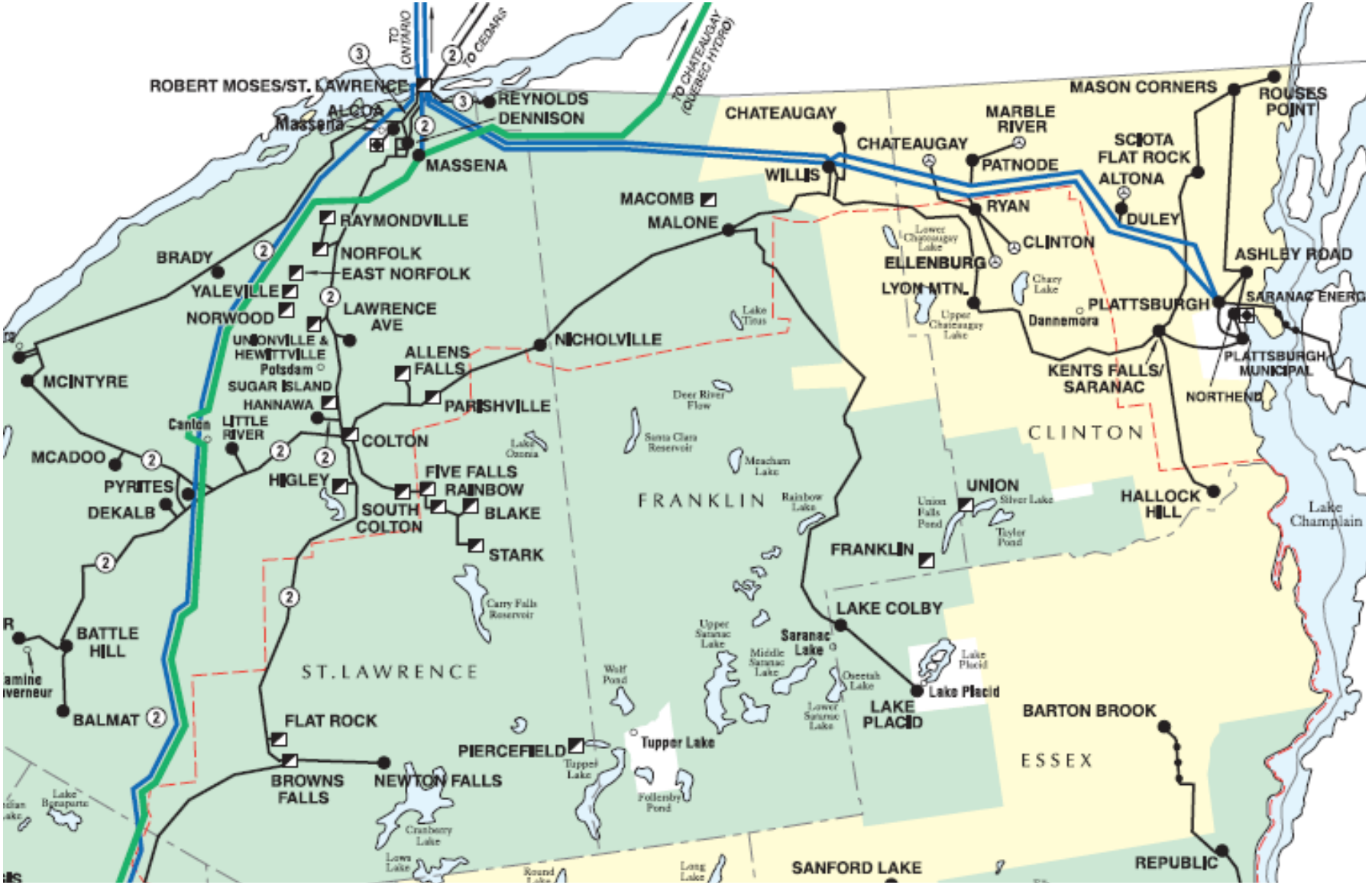
Zone D Constraints (continued)

- **Mitigations**
  - **Reconfigure Moses 230kV exit tower**
    - ***115kV no longer limiting***
  - **Upgrade 230kV to design conductor rating**
    - ***Upgrade terminal equipment***

Willis/Plattsburgh Area

- **Existing wind capacity 387 MW**
- **Proposed additional capacity 681 MW**
- **1st constraint – 115kV Willis-Malone-Colton for loss of d/c 230kV St. Lawrence-Willis (tower)**
  - ***Assume reconfiguration of the Moses/St. Lawrence exit to mitigate the d/c tower contingency***
  - ***Next transmission constraints:***
    - **Plattsburgh 230/115 transformers**
    - **Moses-Willis-Plattsburgh 230kV terminal equipment**

Northern NY Constraints



Zone D Upgrade Projects

Step	Zone	Upgrade Project	Cost k$
1	D	Reconfigure Moses 230kV exit	2000
2	D	Plattsburgh 230kV terminal upgrades	
3	D	Upgrade terminals Moses-Willis 230kV	2000
4	D	Plattsburgh 230kV ring bus	16000
		Total	20000

Zone E Constraints

- **Pre-contingency loading**
  - **Rockledge – Coffeen St 115kV**
  - **Coffeen St – Black River 115kV**
  - **Lighthouse Hill – Mallory 115kV**

- **Contingency overloads**
  - **Coffeen St – Black River 115kV**
  - **Black River – Taylorville 115kV**
  - **Taylorville – Boonville 115kV**
  - **Black River – Lighthouse Hill – Mallory 115kV**
  - **Indian River – Black River 115kV**

Zone E Constraints (continued)

- Mitigations
  - **Reconductoring Watertown area facilities may not be feasible due to required conductor size and tower design and age**
  - **Alternative EHV overbuild may be indicated specifically for the Watertown pocket**

Watertown "Pocket"

- **Proposed capacity 716 MW**
- **Identified constraints**
  - ***Local 115kV radial from projects to Watertown***
    - **Lyme Tap – Coffeen St 115kV (pre-ctg loading)**
    - **Coffeen St – Black River 115kV**
  - ***115kV tower contingencies (east, south) cause severe overload of remaining circuits***
    - **Black River – Taylorville 115kV**
    - **Black River – Lighthouse Hill 115kV**

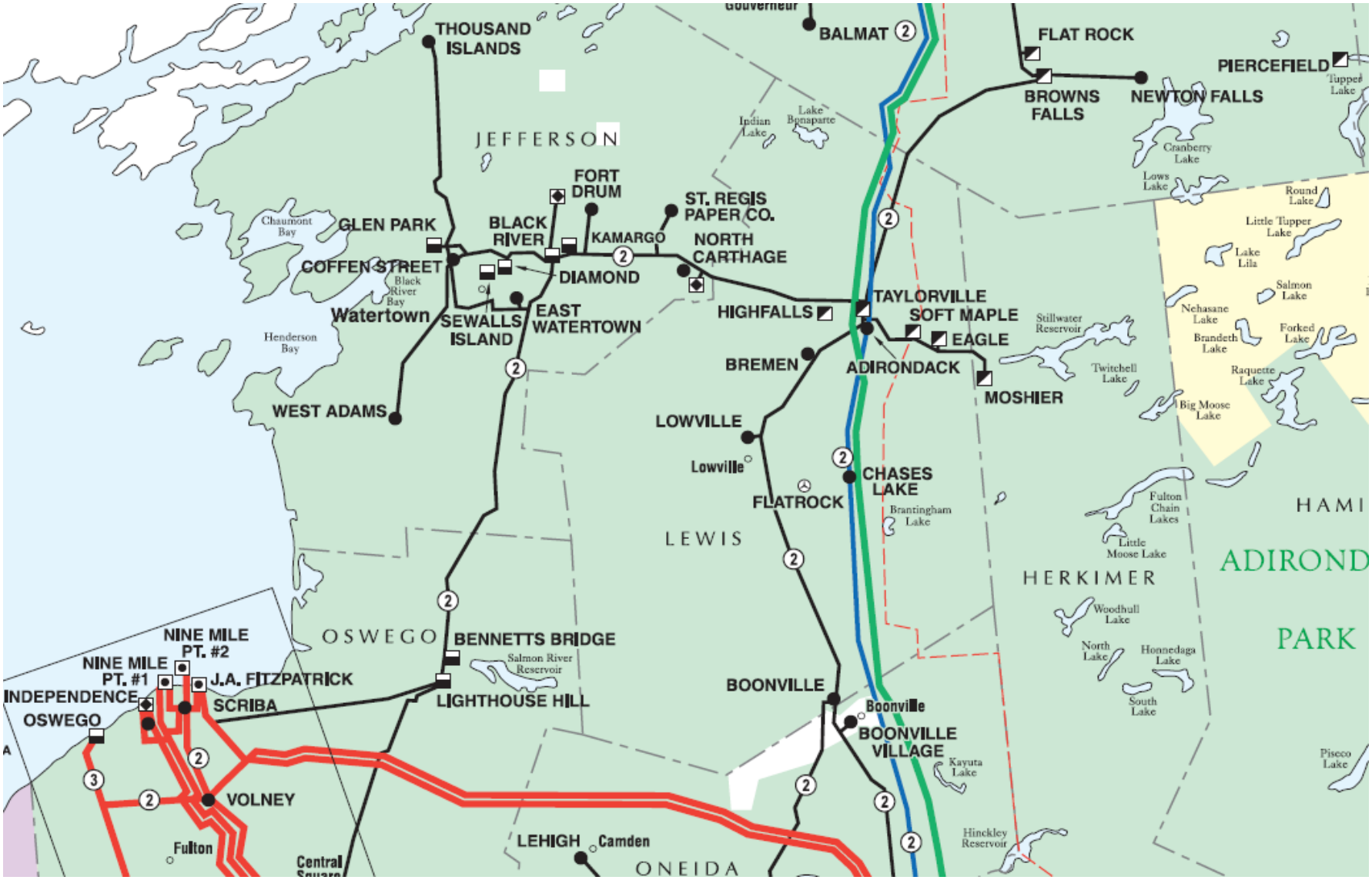
Watertown "Pocket" (continued)

- **Proposed capacity 716 MW**
- **Identified constraints continued**
  - ***Reconductor/rebuild transmission paths***
    - **Black River – Taylorville 115kV**
    - **Lighthouse Hill – Mallory 115kV**
    - **Coffeen St – Black River 115kV**
    - **Taylorville – Boonville 115kV**

Zone E Upgrade Projects (1)

Step	Zone	Upgrade Project	Cost k$
2	E	Upgrade protections Delhi-Colliers	750
3	E	Rebuild Lighthouse Hill-Mallory 115kV	41855
3	E	Rebuild Lyme Tap-Coffeen St 115kV #4	9588
3	E	Upgrade Lyme-Lyme Tap 115kV #4	250
7	E	Rebuild Coffeen St-Black River #3	9160
7	E	Upgrade terminals Indian River-Black River 115kV #9	500
7	E	Build 2nd Rockledge-Coffeen St 115kV	24545
		Total	86648

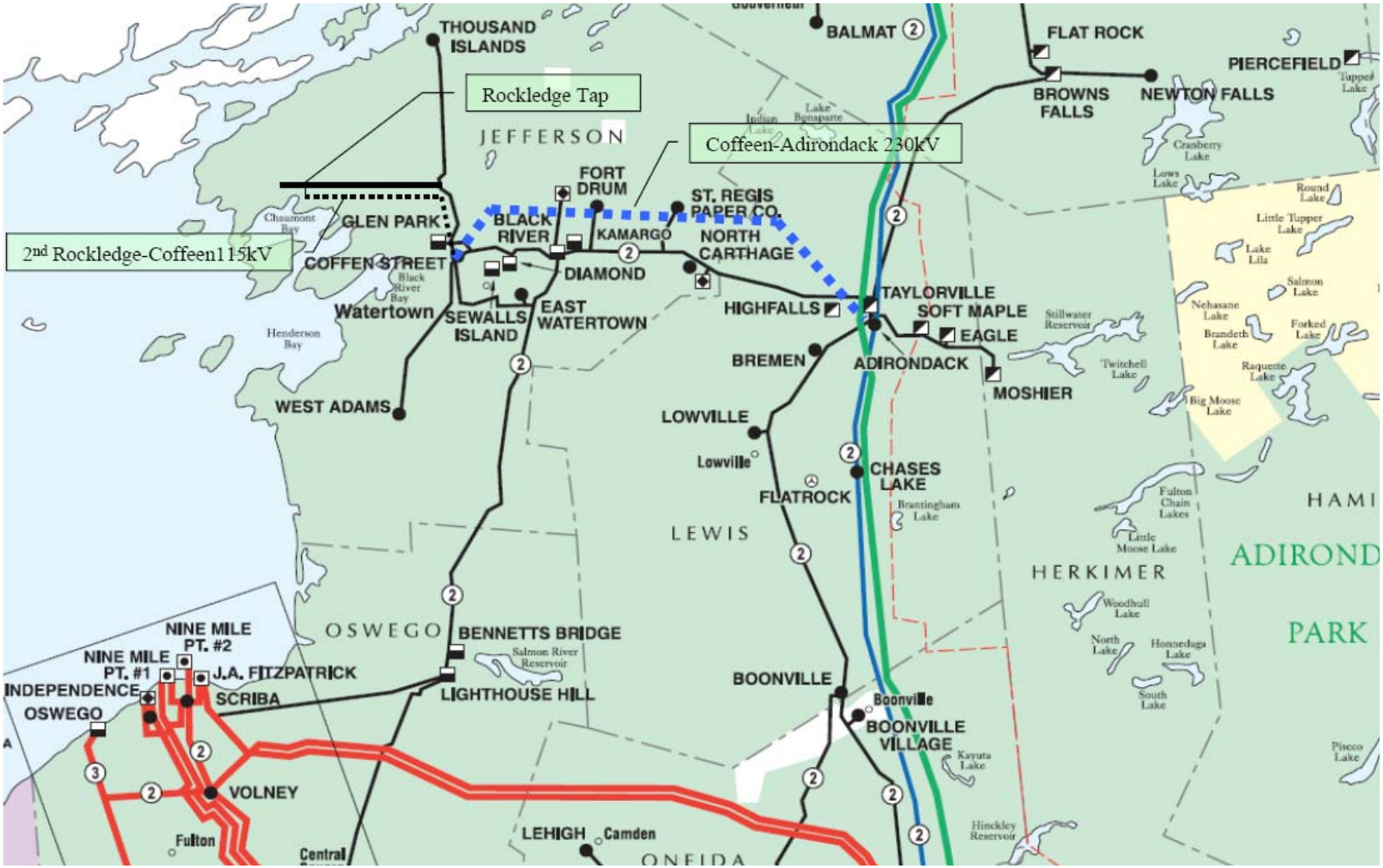
Watertown Area Constraints



Watertown 115kV Upgrade

Step	Zone	Upgrade Project	Cost k$
5	E	Rebuild Black River-Lighthouse Hill #5 & 6, and Taylorville-Boonville #5 & 6	119868
6	E	Rebuild Black River-Taylorville #1, 2 & 8	38693
		Total	158561

Watertown 230kV Alternate



Watertown 230kV Upgrade

Step	Zone	Upgrade Project	Cost k$
2	E	Upgrade terminal connections Black River - Taylorville 115kV #1, 2, & 8	600
3	E	Upgrade terminals Coffeen St-Black River 115kV #3	500
4	E	Upgrade terminals Taylorville-Boonville 115kV #5 & 6	1000
8	E	Build new 230kV Coffeen St-Adirondack 230kV	132000
		Total	134100

Summary Results for 6000MW Case

6000 Base Case - Comparison of Watertown Reinforcements					
Zone	Wind Capacity	Base Case	System Upgrades	Watertown 115kV Alt.	Watertown 230kV Alt.
A	1309	0.1%	0.0%	0.0%	0.0%
B	281	0.1%	0.0%	0.0%	0.0%
C	1591	6.2%	0.4%	0.3%	0.5%
D	1068	11.3%	1.7%	1.7%	1.7%
E	**1648**	**13.7%**	**8.2%**	**3.2%**	**3.6%**
F	70	0.1%	0.1%	0.1%	0.1%
Total	**5967**	**7.6%**	**2.7%**	**1.3%**	**1.4%**

Summary of Upgrades

- **Existing EHV transmission adequate**
  - *No indication of major EHV capacity needs*
- **EHV Transmission upgrades**
  - ***Limited mitigations necessary to relieve constraints***
    - **Double-circuit tower contingencies**
    - **Line terminal upgrades**
- **Similar results for 8000MW buildout case**

Summary Results for 8000MW Case

8000 Base Case - Comparison of Watertown Reinforcements					
Zone	Wind Capacity	Base Case	System Upgrades	Watertown 115kV Alt.	Watertown 230kV Alt.
A	1510	0.1%	0.1%	0.1%	0.1%
B	418	0.1%	0.0%	0.0%	0.0%
C	1860	6.2%	0.5%	0.5%	0.6%
D	1068	11.6%	1.7%	1.7%	1.7%
E	1648	13.5%	7.7%	3.0%	2.9%
F	70	0.2%	0.4%	0.4%	0.4%
J	700	0.0%	0.0%	0.0%	0.0%
K	700	0.0%	0.0%	0.0%	0.0%
Total	**7974**	**5.8%**	**1.9%**	**1.0%**	**1.0%**

Summary of Upgrades (2)

- Local 115kV Transmission Upgrades
  - ***Impact groups of projects***
  - ***Certain projects necessary only if all projects in a constrained group are realized***
- Watertown most significantly constrained
  - ***5 proposed projects impacted by very limited capacity double circuit transmission network***
  - ***Tower design and age and conductor size precludes re-conductoring***
    - **Will require complete rebuilding to accommodate the projected wind resources proposed**
    - **Alternative 230kV upgrade could be economically attractive and benefit local reliability**

Summary of "Bottled Energy"

6000 Base Case - Bottled Energy (MWHr)					
Zone	Wind Capacity	Base Case	System Upgrades	Watertown 115kV Alt.	Watertown 230kV Alt.
A	1309	1,965	1,720	1,708	1,684
B	281	682	310	226	398
C	1591	286,368	16,380	16,093	21,438
D	1068	365,160	53,504	53,459	53,278
E	1648	647,623	390,202	153,768	171,055
F	70	217	247	244	295
Total	**5967**	**1,302,014**	**462,363**	**225,498**	**248,149**

Summary of Upgrades (3)

- **Bottom line – estimated cost of upgrades and net energy production from wind:**
  - ***Zone C*** ***$ 65.8 M***
    - ***Net wind energy production increase: 259.4 GWHr***
  - ***Zone D*** ***$ 20.0 M***
    - ***Net wind energy production increase: 311.6 GWHr***

Summary of Upgrades (continued)

- **Bottom line – estimated cost of upgrades and net energy production from wind:**
  - ***Zone E*** ***$ 220.748 – 245.209 M***
    - **System** **$ 86.648M**
      - ***Net wind energy production increase: 257.4 GWHr***
    - **Watertown Alternates**
      - **Watertown 115kV** **$158.561M**
        - ***Net wind energy production increase:*** ***246.4 GWHr***
      - **Watertown 230kV** **$134.1 M**
        - ***Net wind energy production increase:*** ***219.1 GWHr***

Task 7

Stability Analysis Update

Off-Peak / High Wind Case

- **Central East level 3399 MW based on Oswego Complex commitment (3/5, 4/6 Sithe)**
  - ***Total Wind generation dispatch 6572 MW***
  - ***NYCA load+losses 17202 MW***
  - ***Total NYCA generation (net) 14796 MW***
    - ***Total pump/gen -1555 MW***

Off-Peak / High Wind Case (continued)

- **Interface flows**
  - ***Dysinger East*** ***1602 MW***
  - ***West Central*** ***887 MW***
  - ***Moses-South*** ***1587 MW***
  - ***Total East*** ***7494 MW***
  - ***UPNY-SENY*** ***4789 MW***
  - ***UPNY-ConEd*** ***2264 MW***

Peak Load / High Wind Case

- **Central East level 3390 MW based on Oswego Complex commitment (5/5, 6/6 Sithe)**
  - ***Total Wind generation dispatch 3400 MW***
  - ***NYCA load+losses 33559 MW***
  - ***Total NYCA generation (net) 33510 MW***

Peak Load / High Wind Case (continued)

- **Interface flows**
  - ***Dysinger East*** ***2048 MW***
  - ***West Central*** ***943 MW***
  - ***Moses-South*** ***1689 MW***
  - ***Total East*** ***7671 MW***
  - ***UPNY-SENY*** ***6872 MW***
  - ***UPNY-ConEd*** ***4145 MW***

Contingency Tests

- **Central East contingencies**
  - ***CE01 – 3ph NC Edic-N.Scotland #14***
  - ***CE02 – 3ph NC Marcy-N.Scotland #18***
  - ***CE07 – LLG NC Edic/Marcy EF40/UCC41***
  - ***CE08 – LLG NC Coopers Corners #33/UCC41***
  - ***CE15 – SLG-stk Marcy #19/UE1-7***
  - ***CE18 – LLG NC Rock Tavern CCRT34/CCRT42***
- ***Responses of key indicators compared in each of the tested cases***

Stability Analysis

- **Summary of base case set-up**
  - ***Import data from GV simulation***
    - **Generation commitment and dispatch**
    - **NYCA load**
    - **External schedules**
  - ***Primary testing: Central East interface***
  - ***Increase available generation in western NY to margin transfer test level ~ 3400 MW***
- **Detailed analyses of results discussed at previous Workshops**

Stability Results

- **System exhibits stable response at tested transfer levels**
  - ***No indication of adverse impact on unit or system stability***
  - ***No potential transfer limitations***
- **Wind projects' performance acceptable**
  - *No indication of over/under voltage tripping*
  - *No indication of over/under frequency tripping*
- **System response is stable and well damped**