Electric System Losses Technical Conference

July 17, 2008

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Our Vision

…"We are committed to being an **innovative leader in energy management** and to **safeguarding our global environment** for future generations."

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NYS 15x15 & EEPS

- National Grid supports New York State's 15x15 goal[1] and sees the value of aggressive deployment of energy efficiency, including utility, state, and third party programs, as well as building codes and appliance standards.
- The Electric System Losses Proceeding is one component of the overall Energy Efficiency Portfolio Standard ("EEPS").

(1) NYS's goal of reducing forecasted electricity usage by 15% statewide by 2015

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NYS 15x15 & EEPS

- National Grid Stands ready to lead, working with you in developing and implementing innovative policies to help deliver this vision of an economic and environmentally sustainable energy future for our citizens and customers

- National Grid Filed a suite of integrated electric and gas energy efficiency programs with the Commission on April 30, 2008.

- National Grid plans to revise and re-submit this filing to satisfy the requirements of the Commission's June 23rd Order in the EEPS proceeding.

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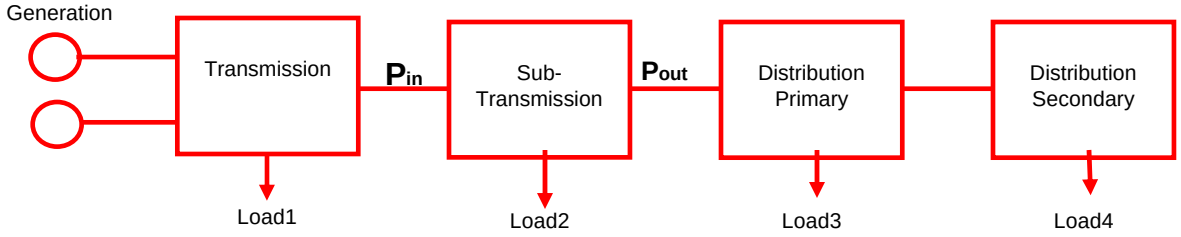
System Losses

- **Line losses are inherent in all devices that electric current passes through**
- **In the T&D System consider the following model**



$$EF = \left(\frac{P_{in}}{P_{out}} \right)$$

$$EF = \left(\frac{P_{in}}{P_{out}} \right) = \left(\frac{P_{out} + P_{Loss}}{P_{out}} \right) = 1 + \frac{P_{Loss}}{P_{out}}$$

- **EF = Energy Expansion Factor**
- **Losses can be reduced but not eliminated**
  - Each component of losses in the system may have the potential for a marginal reduction. (i.e. Expansion Factor for Transmission Level could be expected to go from 2.7% to 2.6%)
  - The distributed nature of losses would require widespread electric system changes to realize measurable improvements.

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System Losses

- **Level of System** — **Energy Expansion Factor** [3]
  - Transmission — 1.027
  - Sub-Transmission — 1.026
  - Distribution Primary — 1.042
  - Distribution Secondary — 1.063

- **Level of System** — **Cumulative Energy Expansion Factors**
  - Trans. — 1.027
  - Trans + Sub Trans. — 1.053
  - Trans + Sub-Trans.+ Dist.Pri — 1.069
  - Trans + Sub-Trans.+ Dist.Pri + Dist.Sec — 1.092

- **Unaccounted For Energy** (i.e. Company Use, Actual Losses incurred in month, theft, billing cycle timing differences, etc.)
  - True-up via Energy Costs for $P_{out} = P_{in}$ through LSEs

- **All cost of losses are included within the energy portion of the bill**

(3) Values listed above in NIAGARA MOHAWK POWER CORPORATION P.S.C. NO. 207 ELECTRICITY Tariff, Rule 39.18.1.1

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National Grid Methodology for Development of Expansion Factors(2)

- **Transmission Level**
  - Load Flow models with EMS verification
  - Snapshots at several different load levels on- & off-peak
  - Wheeling and sales transactions were removed from cases
  - Developed a system average

- **Sub-Transmission**
  - Obtained 1 hour avg. EMS samples for eight (8) sub-transmission areas (P_{in}) for an entire year
  - Established a Load vs. Loss characteristic using Load Flow Varied load within sub-transmission pocket.
  - Fit a curve and literally developed loss estimates for every hour.
  - Obtained a fairly accurate efficiency factor

- **Distribution**
  - More dependent on load it is serving
  - Used six (6) typical feeders as a representative of entire distribution system
    - Conductor losses
    - Distribution transformer losses were included
      - Transformer losses for 115/15kV class banks included in distribution primary loss number
    - Modeled distribution secondary via two methods - a secondary crib (i.e. single distribution transformer with multiple customers off of same secondary), and a single distribution transformer feeding a large customer
  - Used these models to develop factors

- **Performed studies periodically since 1993. Current factors in tariffs since 1999.**

(2) Models described here are geared for loss allocation in the rate making process.

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Putting things in perspective

- **Line losses are inherent in all devices that electric current passes through**
- **Note that a 1% decrease on NYS system of 33,400 MW translates to 334MW.**
- **Questions:**
  - Is it reasonable to expect overall system losses to go from range of approximately 7-10% to 6.3-9% (i.e. a 10% reduction in losses)*?
  - How can we get there, and how economic are the options?
    - PF improvements
    - Transformer design - load and no-load loss minimization
    - Reconductoring with larger wire
    - re-shaping the load curve
    - Upgrading voltage classes (345kV to 500kV, 4.16kV to 13.8kV etc.)
    - More Transmission Lines for Cross State Transfer (reducing the “I”)
    - Etc.
  - Are time-of-use rates or demand response needed to help re-shape our load curves?
  - Where should the priority be?

* On the 33400MW system for Pin, and keeping Pout constant, this would be a reduction in range of 200MW to 275MW

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Thoughts on Reactive Compensation and incentives for customer PF correction

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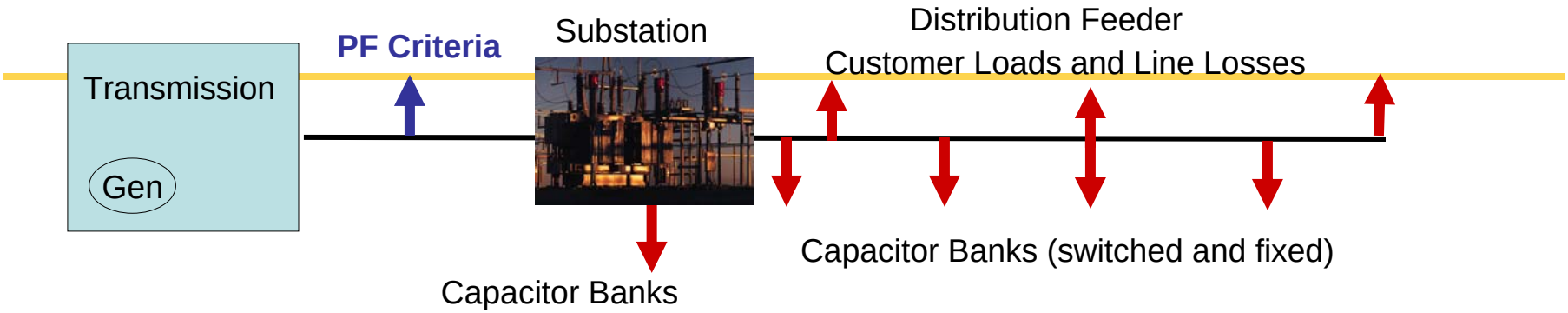
Vision of Future for Reactive Support



Vision for all of National Grid's service territory

- **Customer incentives to meet higher PF requirements at their site**
- **Distribution capacitors (Establish PF criteria at transmission interconnection point)**
- **Capacitors or electronic controlled VAR support (such as a SVC) at transmission substations (economic planning, regional needs, and reliability needs)**
- **Establish generator reactive reserve requirements. Rotating MVAR capability will principally be used for dynamic stability.**

Issues in Niagara Mohawk service territory

- **Existing tariff: customer incentive for VAR support**
- **Rate cap (T&D)**
- **Cost Sharing of VAR Compensation**
- **Incremental O&M expense for inspections and maintenance of reactive sources**
- **Lead time for external policy change implementation**
- **VAR meters needed at some locations**

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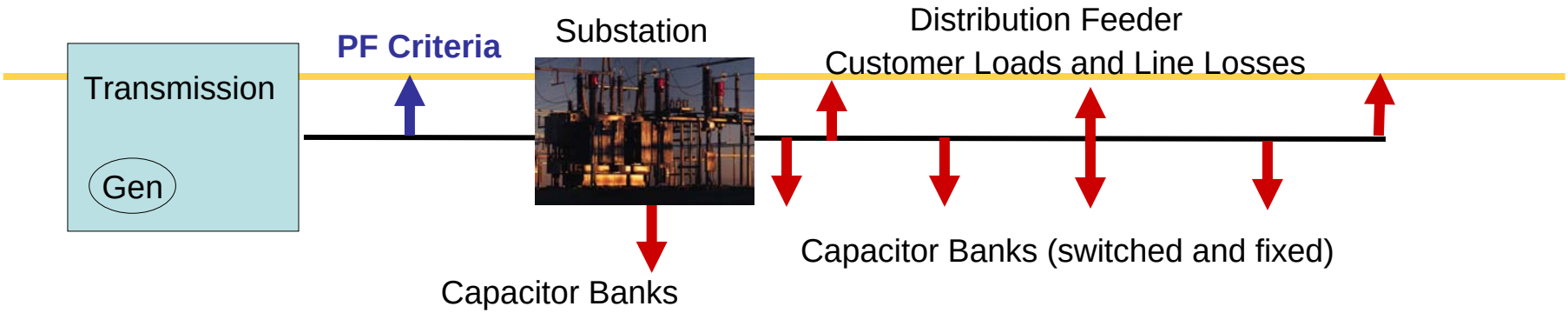
Vision of Future for Reactive Support, cont.



How to transition to this Vision for Niagara Mohawk Service Territory

- **Develop a NY policy based on this vision with stakeholder input**
- **Start identifying all needs (local first, regional next)**
- **Develop the cost and implementation time-line**
- **Work on appropriate tariff changes with PSC (customer PF obligation)**
- **Include PF correction and Power Quality Service Program (as proposed by National Grid in April 2008 EE Program Filing)**
- **Address cost recovery to implement this new policy and its implementation with NYPSC**
- **Address cost allocation with NYISO stakeholders (specific to transmission VAR support)**
- **Gain agreement that all entities are subject to the same policy**
- **Propose significant completion within 10 years after tariff changes,**
  - **Driven by practicality of engineering, design, implementation, and material availability**
  - **Cost allocation issues**
  - **Quantity of locations across the system that need to be addressed**

In the meantime

1. **Ensure that voltage needs are met for all new feeders from the perspective of local voltage profiles and reactive management needs are offsetting/deferring thermal upgrade requirements**
2. **Include capacitors in new distribution stations served from the 115kV**
3. **Add capacitors where area is identified with significantly low PF**

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Where we are today:

- **Identifying local area shunt compensation needs**
  - **Local Distribution Area Studies will identify feeder compensation to**:
    1. Meet on-peak distribution feeder voltage requirements
    2. Reduce MVA loading (postpone capital expenditures)
    3. Reduce station transformer VAR losses
  - **Local Area Transmission Studies will identify compensation required to meet transmission voltage requirements by either:**
    1. Further correcting distribution load power factor
    2. Adding transmission station capacitor banks
- **Company (Niagara Mohawk) Load Modeled on Summer Peak**
  - 6700 MW, 2509 MVARS (0.936 PF*)

* Load PF represents metered feeder / customer load plus transformer losses based on info in our Load Flow cases

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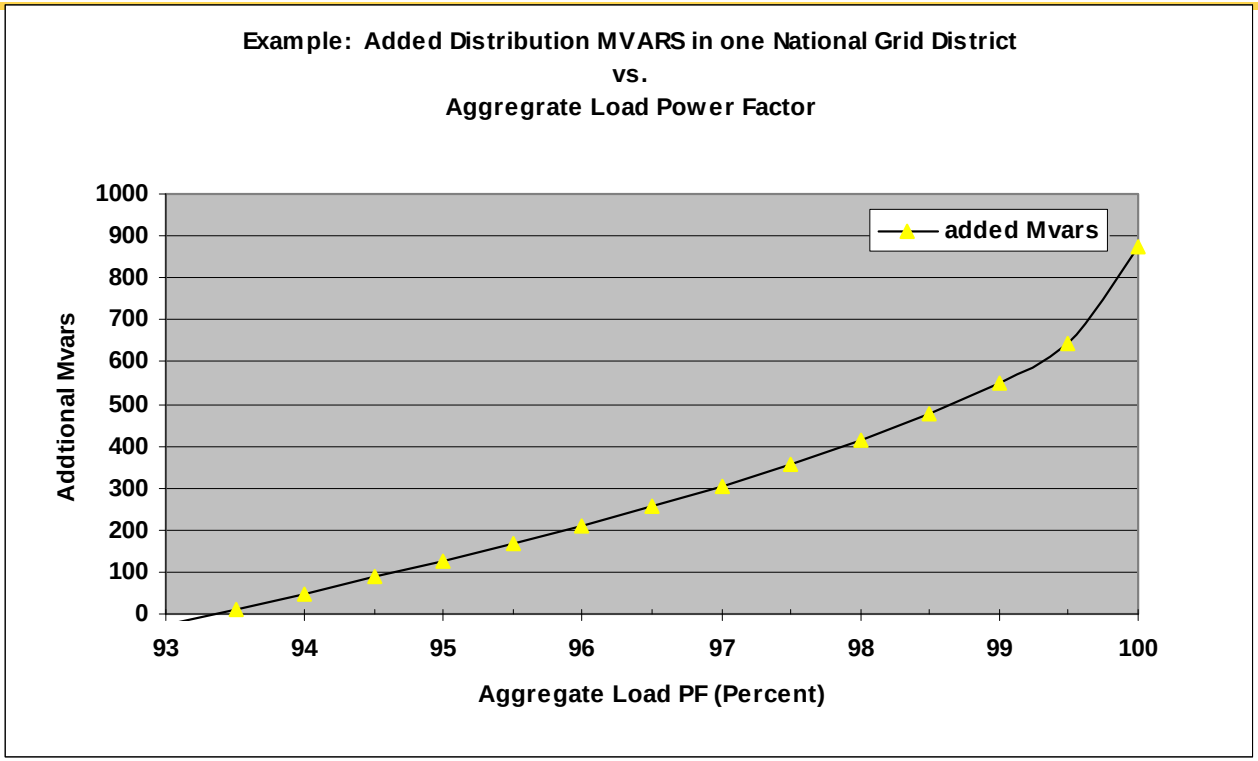
Transition to Higher Power Factor Levels (non-linear relationship)



Estimates for Incremental improvements in PF:

~150MVAr additions required to move from 0.94 to 0.96

~450 MVAr addition required to move from 0.98 to 1.0

Relationship is not Linear throughout range

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Considerations for transitioning to higher compensation levels beyond capacity deferral

- **As Distribution level PF requirements are increased, a point is reached at which a mix of switched and fixed Distribution Caps at many stations will be needed. Additional Costs would be required to optimize capacitor controls.**

- **Conceptual Example**
  - If were to add 300-400 MVARS to distribution network in <u>one</u> local district
  - 600 KVAR, (average Cap Bank Size on Dist. Feeder)
  - This would be ~ 500 to 650 distribution capacitor banks to add
  - Using a conceptual cost of $20/Kvar = between $6 and $8 million.
  - Prices again would rise the closer you approach unity

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More Considerations

- **Time to study and obtain better cost estimates**

- **Appropriate transition periods**
  - Large regional distribution shunt compensation additions require significant time to design, procure and install
  - It is assumed that following approval of tariff changes that such an effort may take on the order of 3 years to realize minor improvement, 7 years to realize measurable improvement, and 10 years to realize substantial improvement.

- **Additional inspection and maintenance efforts with associated O&M expenses need to be implemented in association with additional asset development.**

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Customer Charges for VARs in NY

- **Current Billing for PF using RkVA**
  - **Reactive Demand is based upon the highest RkVA of lagging reactive demand measured over a 15-minute interval during the month, minus one-third of the highest kW demand measured during the month.**
  - **Charge for RkVA occurs when a customer's demand (kW) exceeds 500 kW for 3 consecutive months.**
- **Charge**
  - **<u>Service Class No. 3 (>100 kW for 12 consecutive mos.):</u>**

    $0.85 for each RkVA of lagging reactive demand

  - **<u>S.C. No. 3-A (>2,000 kW in any 6 cons. mos of the prev 12 mos):</u>**

    $1.02 for each RkVA of lagging reactive demand

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Power Factor Costs - NY

- **Effect on the bill – example**
  - Metered RkVA – (Metered kW / 3) = Billed RkVA
    1128 – 1356 / 3 = 676

DETAIL OF CURRENT CHARGES

Delivery Services

	Energy	Demand	Reactive
Metered Usage	264141 kWh	1356.0 kW	1128.0 RkVA
Billed Usage	**269761 kWh**	**1371.7 kW**	**676.0 RkVA**

METER NUMBER 05005989 NEXT SCHEDULED READ DATE Oct 17

SERVICE PERIOD Aug 18 - Sep 18 NUMBER OF DAYS IN PERIOD 32

RATE Electric SC3 T&D VOLTAGE DELIVERY LEVEL 2.2 - 15 kv

Customer				480.47
First 450 Hours			269761 kWh	2,703.01
Demand	16.5	x	1371.7 kW	22,633.05
Reactive Billed	0.85	x	676 RkVA	574.60
SBC/RPS	0.002118	x	269761 kWh	571.35
Transmission Rev Adj	0.00074	x	269761 kWh	199.62
Customer Service Credit	-0.002	x	269761 kWh	-539.52
			Total Delivery Services	**$ 26,622.58**

  - 676 RkVA x $0.85 = $575 per month or $6,895 per year
  - We estimate it would cost this customer $85,000 to install capacitors on site to avoid this charge.

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More Considerations on PF

- NYISO RPWG will need to develop Load/Zonal PF testing methodology acceptable to NYISO Market Participants
- What business forum to take lead on effort? Market based (RNA) or Reliability Mandate (NYSRC) ?
- Cost Recovery
- Customer Incentives
- Agreements with Municipals or other wholesale customers related to PF. This may impact NYISO Tariffs

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Next Steps

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Next Steps for System Loss Evaluation

- **Participate in Development of Study Scope(s)**
- **Identify realistic goals for achieving benefits and prioritize initiatives**
- **Define what the economic model is for loss savings & PF Correction:**
  - Who are the benefactors?
  - How will costs and savings be aligned?
  - How will these loss improvements / reactive compensation cost recovery be addressed?
  - How will it ensure that all the benefits, including reductions in overall delivered energy, is sufficiently factored in?
- **Identify ways to provide proper incentives for customers to encourage a desired PF outcome**

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National Grid's Next Steps

- Initiate efforts to improve power factor at the worst performing sites to improve voltage and release capacity to defer more significant construction projects
- Incorporate loss analysis of alternative plans within ongoing transmission planning reliability related studies
- Work with DPS Staff to proper incentives are in place for customers with respect to PF correction.
- On a regional basis, work with the NYISO and other TOs to evaluate the means of introducing added VAR compensation to increase transfer limits where needed.
- Work with DPS Staff to develop cost recovery mechanisms for VAR compensation identified within the NYISO / NYSRC processes

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