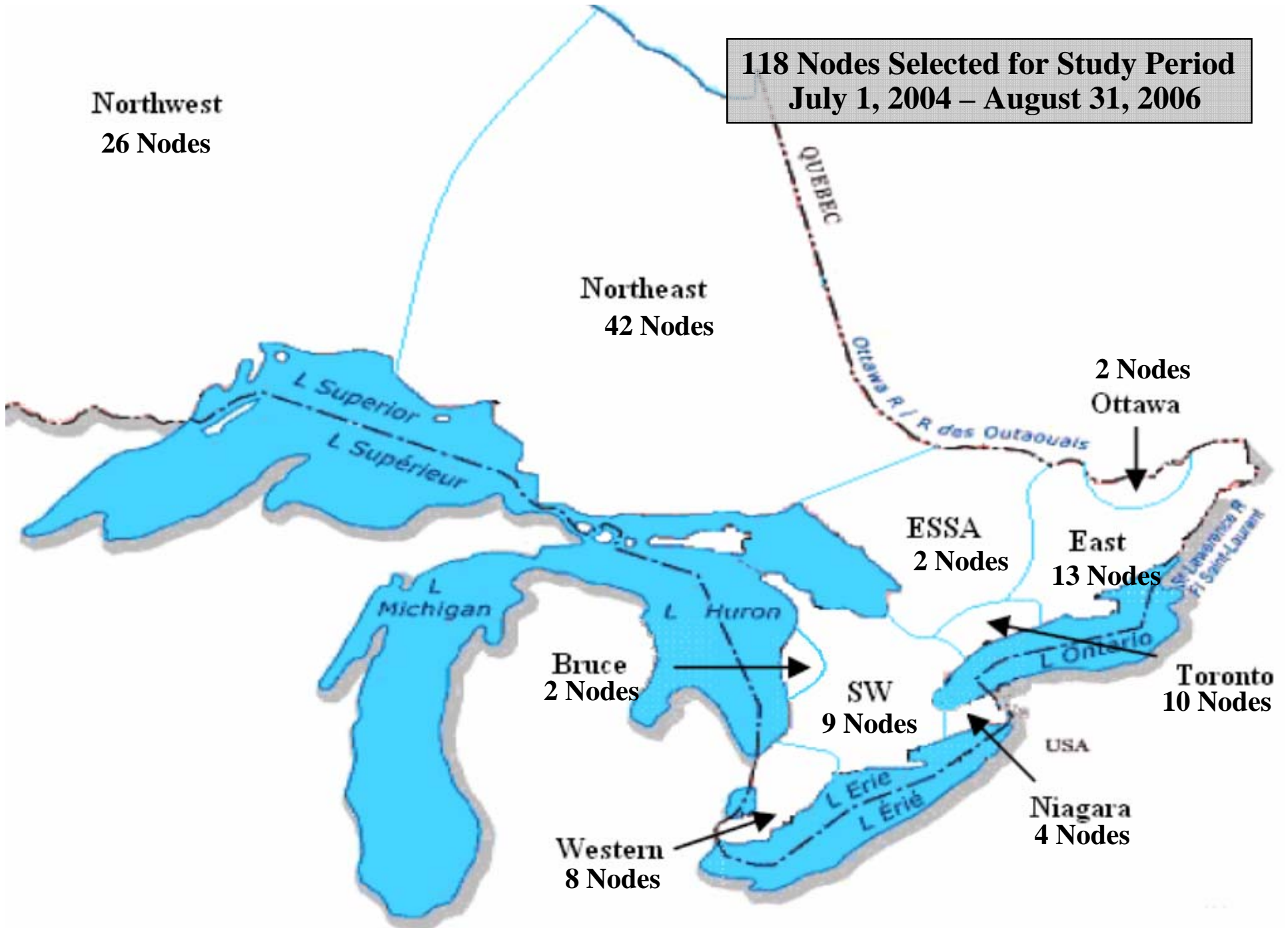


Review of Shadow Prices

MPWG October 6, 2006

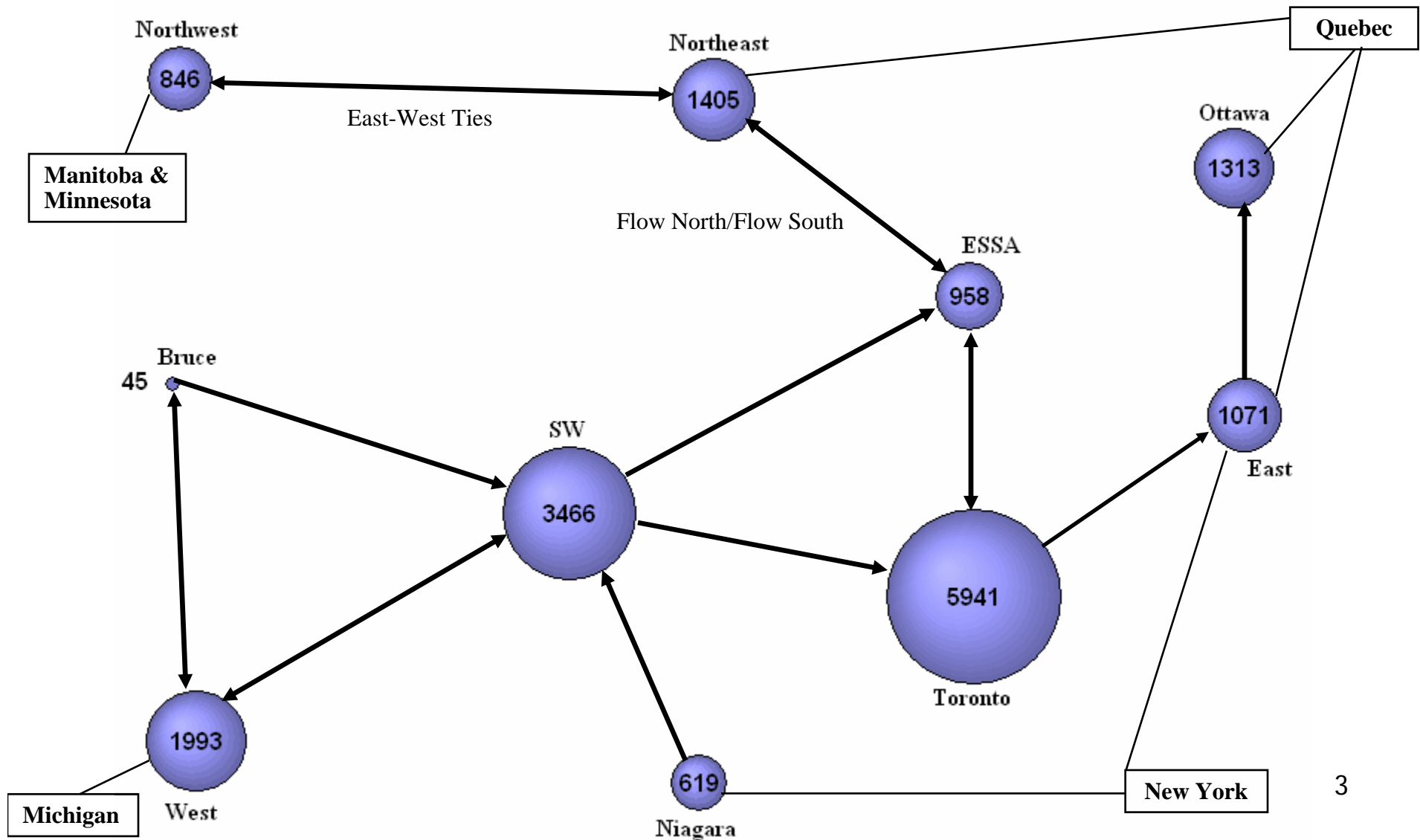


**118 Nodes Selected for Study Period
July 1, 2004 – August 31, 2006**



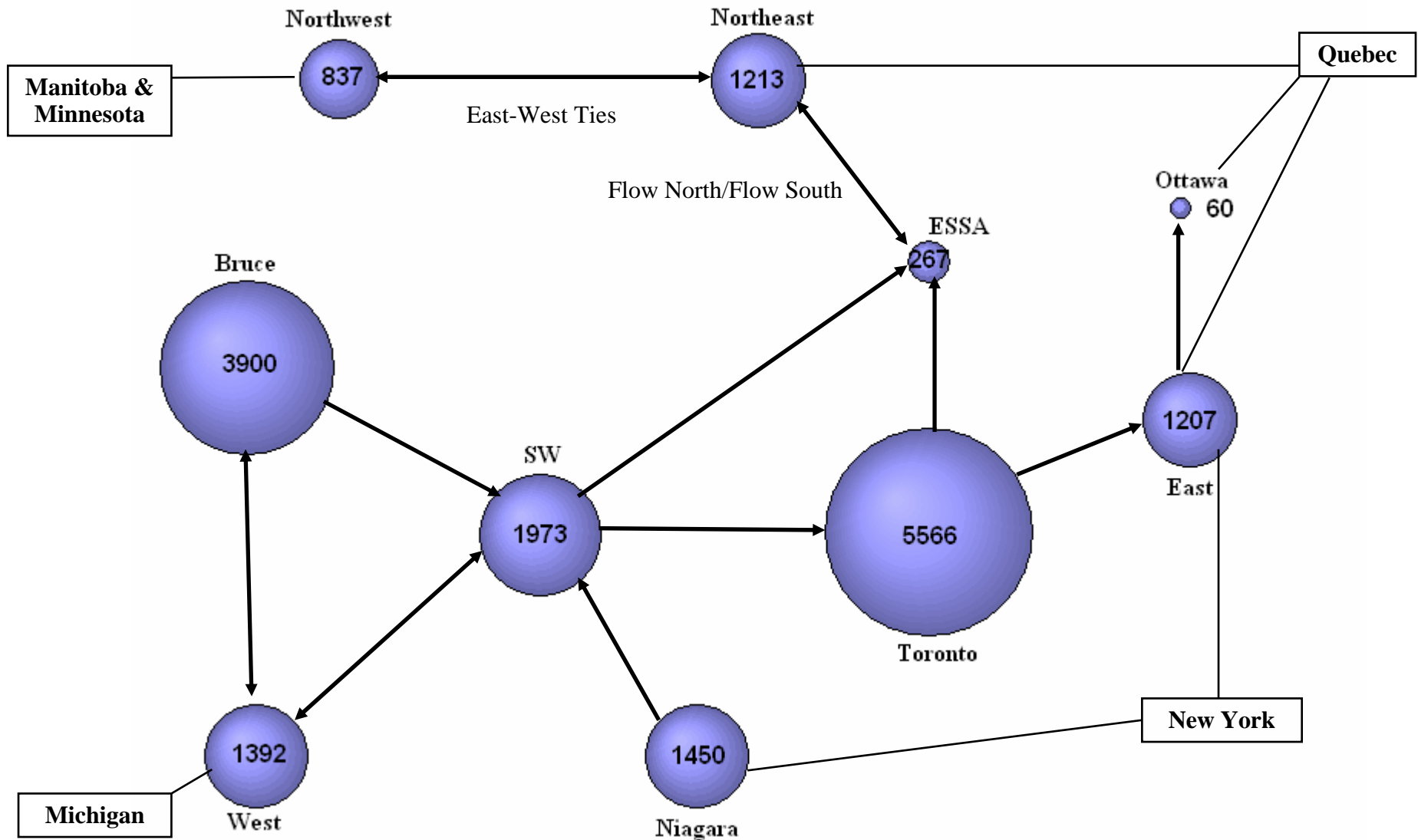
10 Historical Zones and Interfaces

With Average Hourly Demand (MW) for Study Period



10 Historical Zones and Interfaces

With Average Hourly Generation (MW) for Study Period



- Nodal Pricing requires greater precision than CMSC-based regime
 - Nodal prices can be very sensitive to any manual operator actions – could be IESO operator actions or MP operator actions (E.g. Bruce G/R outage example)
 - Non-compliance to dispatch instructions can significantly effect nodal prices – New York has specific process to deal with this – we don't want to lose any progress made on dispatch issues.
 - Loss factors can really influence the calculation of nodal prices:
 - Having used static loss factors to date has skewed the shadow prices – specifically of concern to Northeast prices, making them appear too low, due to there being mainly energy limited hydro in the Northeast.
 - Dispatchable loads currently make use of a loss factor of one (no losses) which results in shadow prices that do not necessarily reflect the actual cost of serving load at that node.
 - Under CMSC-based pricing, local market power only effects CMSC payments – permits an ex-post examination and potential claw-back process - but no adjustments to shadow prices are made.

- Participants will react differently with nodal prices
 - e.g. energy - limited hydro units currently offer very low at some times, confident that they will either receive HOEP or constrained-off payments. This results in some very low shadow prices in the Northwest and Northeast zones.
 - We believe that if their offer price was likely to define their payment, they would offer at their opportunity cost – resulting in a higher nodal price.
- Both constrained and unconstrained algorithms use the same price-calculation logic when an OR shortage exists
 - However, this logic is only used for a global OR shortage and not a local-area OR shortage
 - This will result in shadow prices >\$2000 for local area OR shortages,

- Shadow Prices calculated by the DSO are not capped. This table shows the frequency of extreme prices during the study period. The table is based on all 118 nodes selected.

	All Prices	> \$2000	≥ \$6000	≥ \$12,000	≥ \$30,000	≥ \$60,000	< -\$2000	< \$0
# of Prices	24,307,680	12,983	3191	2682	1433	40	1781	369,247
% of Prices	100%	0.0534%	0.0131%	0.0110%	0.0059%	0.0002%	0.0073%	1.52%

- Placing a cap of \$2000 on all instances of 5-minute prices > \$2000 resulted in lowering the average price by 11%.
- Replacing all instances of 5-minute prices > \$2000 with \$1000 resulted in lowering the average price by only another 1%.

How Homogeneous are Prices in the Zones?

- There are many different possible ways to answer this question.
- For each hour in the study, the standard deviation of shadow prices was computed for each zone.
- These standard deviations were then averaged to produce one number for each zone, based on the entire study period.

Zone	Average Hourly STDEV of Price
Bruce	\$ 0.30
Niagara	\$ 0.83
Toronto	\$ 1.07
Southwest	\$ 2.09
Ottawa	\$ 2.17
West	\$ 3.32
ESSA	\$ 3.65
East	\$ 4.25
Northeast	\$ 11.20
Northwest	\$ 15.48
Everything But NW and NE	\$ 3.97
All 118 Nodes	\$ 20.88

How Homogeneous are Prices in the Zones?

- Not much variability in most zones, except NE and NW.
- Review of these values indicates variability is mainly due to losses
 - Suggests that aggregating all 8 southern zones into single zone would not result in significant intra-zonal price differences
 - However, this is a large, complex zone in which congestion can occur at times in several sub-zones, which brings treating this as a single zone into question.
- NE and NW have significant variability
 - Suggests that significant congestion and loss effects exist within these zones and maybe they need to be divided differently than the current zone model.
 - Further review is required to isolate price differences

Average historical shadow prices are presented for information purposes only and in no way reflect either future pricing or pricing that would have existed if prices were based on nodal prices.

Average historical shadow prices are presented for information purposes only and in no way reflect either future pricing or pricing that would have existed if prices were based on nodal prices.

Northwest
\$32.49

Northeast
\$60.24

\$72.06
Ottawa

ESSA
\$69.48

East
\$69.69

Bruce
\$68.85

SW
\$71.39

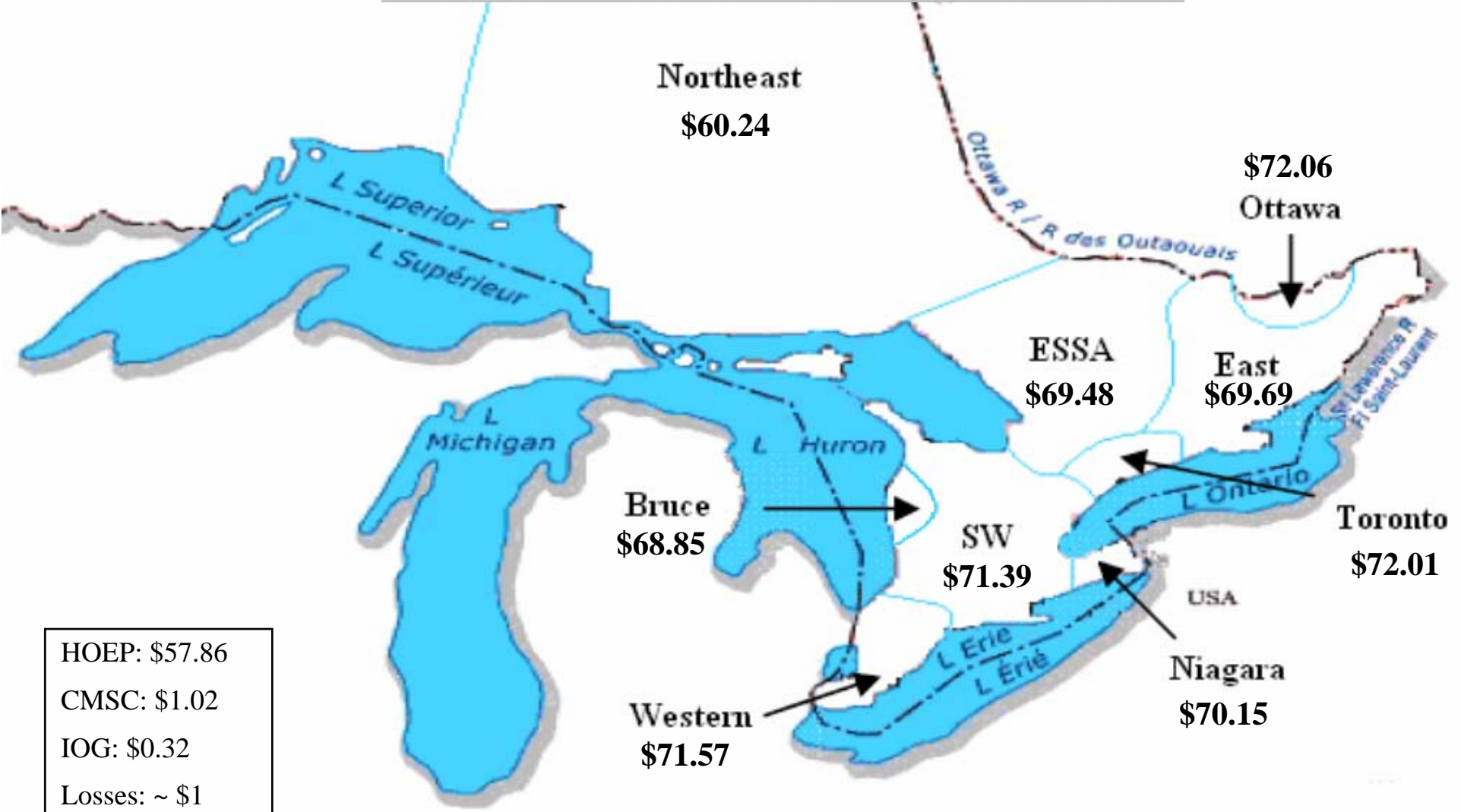
Toronto
\$72.01

USA

Niagara
\$70.15

Western
\$71.57

HOEP: \$57.86
CMSC: \$1.02
IOG: \$0.32
Losses: ~ \$1



Concerns with Existing Pricing Model

- Inefficiencies exhibited in export and import transactions, and in signals sent to embedded generation and D/R.
- Lacks pricing transparency
 - Does not reflect true cost of energy delivery under the system constraints – costs of congestion are currently very opaque
 - Uncertain uplift values can not be hedged
- Fails to provide the right economic signals in both the short and long terms
 - Short term benefits - demand response during peak periods
 - Long term benefits - understandable justification for citing of new transmission, power plants or industry.
- Requires complex set of “out of spot market” fixes through settlement formulas (CMSC etc.), rules and regulations.

Where Could We Go From Here?

- What other options are available:
 - Nodal
 - Nodal prices for all
 - Zonal
 - Using nodal and/or zonal combination
 - Average of nodal prices for zone price
 - Unconstrained pricing within each zone
- We believe zonal prices are simpler than nodal prices – do you agree?

- Is There a “Keep it Simple” Alternative?
 - For example, what if unconstrained pricing continues but calculated for more than one zone? i.e. three unconstrained zones connected by transmission links that at times are congested and therefore create price differences between the zones.
 - Permits continuation of ex-post pricing?
 - Permits continuation of ex-post local market power?
 - Requires continuation of CMSC?
 - Permits continuation of ramp-rate multiplier?
 - Seen as a transitional step – walk before running?

Possible outcomes using 3 unconstrained zones

HOEP: \$57.86

DRAFT

Early Thoughts



Rationale:

NW goes up due to arbitrage from MISO (Manitoba and Minnesota) and changes in bidding behaviour.

Northeast and South rise about \$4 - \$5 due to loss of northwest surplus (as per MSP evaluation of impact of elimination of constrained-off pmts) but that increase is mitigated by arbitrage with NY and Michigan.

Northeast is modestly lower than South due to infrequent congestion on Flow-South

Questions We Are Left With

- We expect that participant's will alter bid/offer strategies if locational pricing is implemented. Current bid/offer behaviour appears to be skewing some of the shadow prices – eg NW & NE where many offers are large and negative.
 - How much impact will this have on the final price outcomes?
 - We will investigate further and hypothesize.
- How do participant actions affect nodal prices and what corrections (if any) would be required? eg. reduce generator output to avoid frequent dispatch instructions when near a system limit.
- Manual dispatches by the ISO will still be required for reliability in some situations. How will these actions be reflected in the nodal prices?
- The use of loss factors that are static and have not been adjusted since market opening causes anomalies in the shadow prices. How would this be addressed?

Questions We Are Left With (cont.)

- We have capped all shadow prices at MMCP and $-MMCP$, assuming that our current price cap would not change. Other jurisdictions use bid/offer caps and no price cap. Which method is appropriate for a locational pricing scheme in Ontario?
- The DSO uses penalty functions when necessary to overcome system limitations such as OR or energy shortages, and transmission limit violations. Are these functions appropriately priced? Or does it matter if we have \$2,000/MWh MMCP?
- Under nodal pricing, local market power can skew nodal prices – this has led some jurisdictions to implement automatic mitigation processes. How would this be addressed in Ontario?
- If zones are to be implemented, what zonal construct is appropriate? Should NW and NE zones be further divided? Should southern zones be combined?

- Report to Stakeholder Advisory Committee on Nov 1 and IESO Board on Nov 17
 - SAC and Board to determine if further investigation of locational pricing is needed.