Toronto IRRP Forecasting Methodology

April 2024

Connecting Today.
Powering Tomorrow.

This methodology document was prepared by Toronto Hydro to support the Toronto IRRP demand forecasts, with input from the IESO.

Table of Contents

1. Methodology

1.1 IRRP High Electrification Forecast

The first step is to complete a system-wide econometric forecast. To do this, the sum of historical non-coincident bus peak loads [MVA] is taken ("non-coincident system peaks") for both summer and winter, and then temperature-normalized to a 17-year median[1]. The summer non-coincident system peaks are then linearly regressed against "Total Establishments" – the number of commercial and industrial buildings in the City of Toronto. The winter non-coincident system peaks are then linearly regressed against Toronto (CMA) GDP Annual Change (%). The resulting linear regression is used to forecast summer and winter non-coincident system peaks assuming normal temperature.

To avoid double-counting load growth with known customer connection requests, the linear trend is only applied starting years 6 and onwards of the forecast (2028 and onwards in this case). No linear trend is applied to the first 5 years of the forecast (2023-2027 in this case).

Forecasted non-coincident system peaks are then allocated to the bus level, based on historical ratios of non-coincident bus peak to non-coincident system peak.

Following this, additional load growth is added to each bus due to the following drivers, which are forecasted separately: electric vehicles, electrified heating, and data centres. The "High" Scenario forecasts of these drivers were used for the High Electrification Forecast. Please see the description of the IRRP Base Forecast for a description of the Scenarios.

Next, THESL's firm customer connection requests and planned permanent load transfer projects are added (or subtracted where applicable) to each bus. This results in the final forecast of non-coincident bus peaks in MVA assuming normal temperature.

Last, power factors and coincidence factors are used to convert into coincident bus peaks in MW.

1.2 IRRP Base Forecast

The IRRP Base Forecast follows a similar methodology to the IRRP High Electrification Forecast; however, it considers temperature, econometric variables, electric vehicle load, electrified heating load, and data centre load to be random variables, in order to model uncertainty for each of these inputs. A probability distribution for temperature was developed from 17-year historical data. Probability distributions for econometric variables were developed from a minimum of 10 years of historical actuals. Probability distributions for electric vehicle load, electrified heating load, and data centre load were developed by assigning a probability to each of four Scenarios, described in Table 1.

Given the distributions for each of electric vehicle load, electrified heating load, and data centre load, a Monte-Carlo simulation was used to develop a distribution of forecasted non-coincident bus peaks. The median of this distribution is taken to produce the final IRRP Base forecast of non-coincident bus peaks in MVA. Power factors and coincidence factors are used to convert into coincident bus peaks in MW.

In contrast, the IRRP High Electrification Forecast considers expected values for econometric variables, normal temperature, and only considers the "High" Scenario for electric vehicle, electrified

[1] THESL's historical peak history starts at 2006. Summer normal temperature = 30.0°C. Winter normal temperature = -17.0°C. Temperature is hourly temperature at time of peak.

heating, and data centre loads. The firm customer connection requests and planned permanent load transfer components remain the same in both IRRP Forecasts.

Table 1 | Toronto IRRP Demand Scenarios

Scenario	**Electric Vehicles (EV)**	**Electrified Heating**	**Data Centres**
High	Achieves TransformTO Strategy targets for EVs: 30% of registered vehicles are EVs in 2030, 100% of registered vehicles are EVs in 2040	Achieves TransformTO Net-Zero targets for buildings by 2040	Elevated growth until a saturation point in approx. 2038
Medium	TransformTO interim target (30%) delayed by 5 years, and final target (100%) delayed by 10 years	Achieves TransformTO Net-Zero targets for buildings by 2050	Steady growth until a saturation point in approx. 2038
Low	TransformTO interim target (30%) delayed by 10 years, and final target (100%) delayed by 20 years	Achieves TransformTO Net-Zero targets for buildings by 2060	Decelerating growth until a saturation point in approx. 2038
Business as Usual	Trending Historical EV Adoption	Models load growth based on Business as Planned targets in TransformTO	Low and steady growth until a saturation point in approx. 2038

1.3 Assumptions

GDP growth (in terms of annual percentage change) for the Toronto Census Metropolitan Area is technically used to forecast winter non-coincident system peaks; however, no GDP forecast is available beyond 5 years out. Therefore, GDP is forecasted to be constant for years 6 and onwards.

Firm customer connection requests and anticipated loads from City of Toronto Development plans have been added into the IRRP Forecasts. Loads from City of Toronto Development plans were added due to the high level of certainty that the projects will proceed. The timing and demand of these development loads have been estimated from high level discussions with the City of Toronto. This is in contrast to firm customer connection requests which provide timing and demand estimates for each individual connection (typically building or building complex) requested by a customer.

Historical CDM was not explicitly accounted for in the gross IRRP Forecasts provided by THESL. Historical actual peak loads, which includes the contribution of historical actual CDM, were used in the regression analysis involving non-coincident system peak load. Therefore, the forecasted non-coincident system peak load implicitly assumes the effect of historical CDM actuals.

2. Drivers of Load Growth and Reflection of Provincial/Municipal Growth Plans and Community Energy Plans

The following plans were referenced in order to define the Scenarios described in #1 above.

- "Secondary Plan Areas", City of Toronto
- "Official Plan", City of Toronto
- "Transform TO Net Zero Strategy", City of Toronto
- "Technical Report - Transform TO Net Zero Strategy", City of Toronto
- Green Bus Program, City of Toronto: Toronto Transit Commission
- "2030 Emissions Reduction Plan – Canada's Next Steps for Clean Air and a Strong Economy", Environment and Climate Change Canada
- "Electric Vehicle Strategy", Report for Action, City of Toronto

The forecasted impact of Municipal development plans is provided separately in the "City of Toronto Development Plans - Load Projections" spreadsheet. The electrical demand of City Development projects was provided either by third party consultants, or by the City of Toronto.

3. Detailed Load Type Breakdown

Per the methodology described above, electric vehicles, electrified heating, data centres, and changes in load due to economic factors were forecasted at the system level.

EV load was allocated to the bus level based on the geographical distribution of current vehicles. The assumption is that existing vehicles will be electrified, and the resulting new EV load would have the same geographical distribution.

Electrified heating load was allocated to the bus level based on the customer count on each bus; buses with more customers receive a proportionally higher allocation.

Data centre load was allocated to the bus level based on a mix of approaches. Known upcoming developments, for which a firm customer connection request had not been received, were allocated to the closest station. Half of forecasted new developments, for which there was no known upcoming development, were allocated to stations with existing data centre customers. The remaining half was randomly allocated across the service area, with a strong bias to the downtown area.

Changes in load due to economic factors were allocated to the bus level based on historical coincidence factors (between bus and system peaks), with a bias to areas targeted for development by the City of Toronto in its "Secondary Plan Areas" and "Official Plan".

For detailed connections per station, please see attached "Detailed Breakdown" and "City of Toronto Development Plans - Load Projections" spreadsheets.

3.1 EV Assumptions

The forecasted percentage of total registered vehicles in Toronto which are EVs, for each Scenario, is provided in the following table.

Table 2 | Registered EVs as a Percentage of all Registered Vehicles in Toronto

	Light-duty vehicles				Medium-duty vehicles				Heavy-duty vehicles			
Year	**High**	**Medium**	**Low**	**BAU**	**High**	**Medium**	**Low**	**BAU**	**High**	**Medium**	**Low**	**BAU**
2023	4%	3%	3%	3%	1%	1%	0%	0%	1%	1%	0%	0%
2024	6%	4%	4%	4%	2%	2%	1%	0%	3%	3%	2%	0%
2025	10%	5%	5%	5%	5%	3%	2%	0%	5%	6%	4%	0%
2026	14%	7%	6%	6%	8%	4%	3%	0%	8%	8%	6%	0%
2027	17%	9%	7%	7%	13%	5%	4%	0%	12%	10%	8%	0%
2028	21%	10%	9%	9%	18%	7%	5%	0%	17%	13%	10%	0%
2029	25%	12%	10%	10%	23%	10%	7%	0%	23%	15%	12%	0%
2030	30%	14%	12%	12%	30%	12%	8%	0%	30%	17%	14%	0%
2031	34%	16%	14%	13%	36%	15%	10%	0%	36%	18%	15%	0%
2032	39%	17%	16%	15%	44%	18%	12%	0%	43%	20%	17%	0%
2033	44%	20%	18%	17%	51%	21%	14%	0%	51%	22%	19%	0%
2034	50%	25%	20%	19%	59%	25%	16%	0%	58%	26%	21%	0%
2035	60%	30%	22%	21%	66%	30%	19%	0%	66%	30%	23%	0%
2036	69%	37%	24%	22%	73%	35%	21%	0%	73%	35%	25%	0%
2037	78%	44%	26%	24%	80%	41%	23%	0%	80%	41%	26%	0%
2038	87%	50%	27%	26%	87%	47%	25%	0%	87%	48%	28%	0%
2039	97%	57%	29%	28%	94%	54%	28%	0%	93%	56%	29%	0%
2040	100%	62%	30%	30%	100%	61%	30%	0%	100%	64%	30%	0%
2041	100%	68%	32%	32%	100%	65%	33%	0%	100%	68%	32%	0%
2042	100%	72%	34%	34%	100%	69%	35%	0%	100%	71%	34%	0%
2043	100%	77%	37%	36%	100%	73%	38%	0%	100%	75%	37%	0%
2044	100%	81%	40%	38%	100%	77%	40%	0%	100%	79%	39%	0%
2045	100%	85%	43%	40%	100%	81%	43%	0%	100%	82%	42%	0%
2046	100%	88%	47%	41%	100%	85%	45%	0%	100%	86%	46%	0%
2047	100%	92%	51%	43%	100%	89%	49%	0%	100%	90%	51%	0%

EV charging profiles assumed by THESL are provided in the table below, in kW/EV. System peak is assumed to occur between 6-7pm. Contributions to peak load are highlighted yellow.

Table 3 | EV Charging Profiles

Hour	Light-duty EV	Medium-duty EV	Heavy-duty EV
0	0.64	4.47	32.20
1		4.57	28.04
2	0.64	4.07	21.50
3		4.84	16.40
4	0.64	4.56	15.74
5		4.00	13.49
6	0.01	3.53	14.22
7		3.18	13.23
8	0.01	0.95	2.69
9		1.12	9.66
10	0.12	2.00	11.63
11		2.28	15.17
12	0.15	4.54	12.97
13		4.07	11.48
14	0.23	3.96	12.16
15		5.29	10.51
16	0.50	6.33	10.19
17		5.74	9.76
18	0.50	5.48	7.13
19		5.57	6.47
20	0.50	6.42	4.91
21		6.45	4.48
22	0.64	5.70	3.65
23		4.47	32.20

3.2 Electrified Heating Assumptions

Electrified heating was assumed at the following adoption rates, defined as the percentage of buildings in the City of Toronto using electrified heating.

Table 4 | Electrified Heating Adoption Rates

Year	Residential (Dwellings)				Commercial & Industrial (GFA)			
	High	**Medium**	**Low**	**BAU**	**High**	**Medium**	**Low**	**BAU**
2023	31%	29%	28%	27%	3%	2%	1%	2%
2024	36%	33%	31%	28%	6%	4%	3%	4%
2025	41%	36%	34%	30%	9%	6%	4%	5%
2026	46%	40%	37%	31%	12%	8%	6%	7%
2027	51%	43%	39%	32%	16%	10%	7%	9%
2028	55%	46%	42%	34%	19%	12%	8%	11%
2029	60%	49%	44%	35%	22%	13%	10%	12%
2030	64%	52%	46%	36%	25%	15%	11%	14%
2031	68%	55%	49%	37%	32%	17%	13%	15%
2032	72%	58%	51%	38%	40%	19%	14%	17%
2033	76%	60%	53%	39%	47%	21%	15%	19%
2034	79%	63%	55%	40%	55%	23%	17%	20%
2035	83%	66%	57%	41%	62%	25%	18%	22%
2036	86%	68%	59%	42%	70%	30%	19%	23%
2037	90%	71%	61%	42%	77%	35%	21%	25%
2038	93%	73%	63%	43%	85%	40%	22%	26%
2039	97%	76%	65%	44%	92%	45%	24%	28%
2040	100%	78%	67%	45%	100%	50%	25%	29%
2041	100%	80%	69%	46%	100%	55%	29%	31%
2042	100%	83%	71%	46%	100%	60%	33%	32%
2043	100%	85%	73%	47%	100%	65%	36%	33%
2044	100%	87%	74%	48%	100%	70%	40%	35%
2045	100%	89%	76%	49%	100%	75%	44%	36%
2046	100%	92%	78%	50%	100%	80%	47%	37%
2047	100%	94%	80%	50%	100%	85%	51%	39%

3.3 Data Centre Assumptions

Data centre load is forecasted to be a significant driver in the near-to-mid-term, as these loads come on to the system as sudden large demands. Data centre load is forecasted to "saturate" by approximately 2038. We are expecting that by this time there will no longer be sufficient land available in THESL's service territory for significant new data centres to be constructed.

Confirmed data centre firm customer connection requests include the following.

Table 5 | Data Centre Load Forecast Assumptions

Station	DESN	Bus	Total Requested Load (MVA)	Requested Energization Year	Year of Final Requested Load Buildup
Horner TS	T1/T2	EJ	50	2023	2026
Finch TS	T3/T4	JQ	48	2022	2026
Warden TS	T3/T4	JQ	28	2023	2029
Bermondsey TS	T1/T2	JQ	28	2025	2029
Scarborough TS	T21/T22	JQ	28	2025	2029
Agincourt TS	T5/T6	BY	28	2026	2030

3.4 Transit Assumptions

THESL has received firm customer connection requests from Metrolinx for the Ontario Line. These requests have been included in both IRRP Forecasts.

THESL has also received firm customer connection request for the following transit projects and has included them in both IRRP Forecasts: Finch West LRT, Scarborough Subway Extension, and the Eglinton Crosstown West Extension.

The IRRP forecasts assume that the Toronto Transit Commission (TTC) will electrify 190 buses a year until it has electrified 100% of its fleet in 2040, consistent with the TTC's Green Bus Program.

Space heating for public transit stations is modelled as 0.05 kW/m2 in heat demand. Heat demand is converted to electrical demand assuming a coefficient of performance (COP) of 2.5.

4. Co-ordination with the City of Toronto

Based on Toronto City Council's commitment to achieve net zero emissions community-wide by 2040 (NZ40 Strategy), Toronto Hydro must assume a substantial electrification effort will be underway over the next 15+ years. Due to technical, policy, and financial challenges, the pacing of this effort is uncertain; but the final outcome of this effort, electrification, is nearly certain.

For these reasons, Toronto Hydro has included electrification in most of its scenarios informing its base forecast, and has used a probabilistic approach to address the uncertainty of pacing.

Independent Electricity System Operator
1600-120 Adelaide Street West
Toronto, Ontario M5H 1T1

Phone: 905.403.6900
Toll-free: 1.888.448.7777
E-mail: customer.relations@ieso.ca

ieso.ca

@IESO_Tweets
linkedin.com/company/IESO

Connecting Today.
Powering Tomorrow.