IESO Local Achievable Potential Studies

Technical Approach Memo
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Prepared by ICF

Overview

ICF's proprietary modeling platform DER Insight will be used to conduct the local achievable potential studies for IESO, specifically for the Toronto and Ottawa planning regions. The high-level process flow of the technical approach is shown in Figure 1.

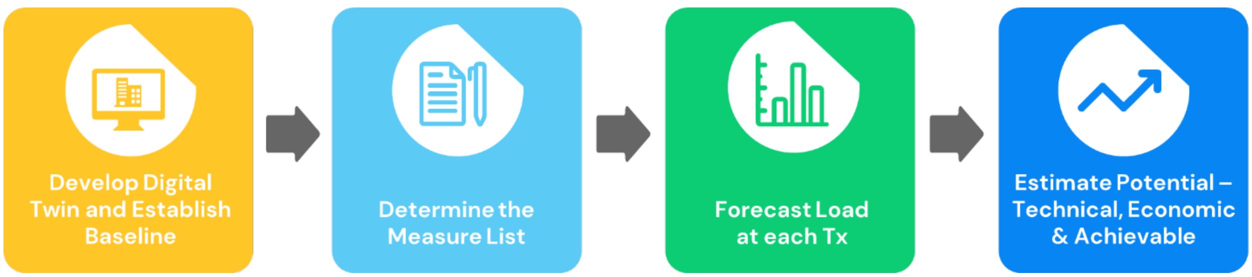

Figure 1: Technical Approach Process Flow

At the core of the modeling is the creation of digital twins or analytic representations of the premises to simulate the baseline load and energy savings, followed by the utilization of the potential modeling modules in DER Insight to arrive at the transformer station (TS) level achievable potential forecast.

Technical Approach

√ The **first step** of the study is to **develop digital twins** which in turn involves a four-sub-step process – (1) prepare the building stock using prototypical building types from NREL, (2) process and integrate input information including MPAC[1] data, (3) run ResStock[2] and

[1] MPAC (Municipal Property Assessment Corporation) data includes detailed property information in Ontario, Canada, such as type, size, location, age, and assessed value. (https://www.mpac.ca/en)

[2] ResStock is a modeling tool developed by NREL to analyze the U.S. residential building stock. It uses detailed data on housing characteristics, energy use, and regional variations to assess energy efficiency opportunities, retrofit impacts, and policy scenarios at scale. (https://resstock.nrel.gov/)

ComStock[3] building energy models to simulate the baseline load after customizing them to the climate zones of Toronto and Ottawa, (4) calibrate and refine the models and validate them against the real world data. The sources involved in obtaining the data for modeling the digital twins are shown in Table 1. With the digital twins in place, the **baseline load** at the TS level is obtained by aggregating the building loads that are connected to the specific TS.

Table 1 Data Sources for Step 1 - Digital Twin Modeling

Data Information / Type	Sources
Building Prototypes	National Renewable Energy Laboratory's (NREL) ResStock (2023) and ComStock (2024) prototypes
	Pacific Northwest National Laboratory's Residential Prototype Buildings
Input Data for Digital Twins	MPAC Data
	National Renewable Energy Laboratory's (NREL) ResStock (2023) and ComStock (2024) prototypes
	Dun and Bradstreet data
	IESO Residential End-Use Survey Results
	US EIA Manufacturing Energy Consumption Survey (MECS, 2018)
	US EIA Residential Energy Consumption Survey (RECS, 2020)
	US EIA Commercial Buildings Energy Consumption Survey (CBECS, 2018)
Baseload Measure List	IESO Measures and Assumptions List
	2022 IESO Achievable Potential Study
	2019 Integrated Ontario Electricity and Natural Gas Achievable Potential Study
Calibration and Validation Data	Load Distribution Company (LDC) Load

√ The **second step** in the process is to **determine the applicable conservation demand measures (CDMs) and the behind-the-meter (BTM) distributed energy resources (DERs)** applicable to the study and within the scope of modeling and estimate their savings. The measure types included in the study are shown in Table 2.

[3] ComStock is a tool developed by NREL to model the energy performance of commercial buildings in the U.S. It uses data on building characteristics, energy use, and regional differences to assess energy efficiency, retrofit opportunities, and the impact of policy changes. (https://comstock.nrel.gov/)

Table 2 Measures Included in the Study

Sector	Type of Measure	End-Uses/Examples
Residential	Energy Efficiency	Appliances
		Water Heating
		HVAC and HVAC Control
		Lighting
		Weatherization
		Cooking
		Plug Load
	Demand Response and Distributed Energy Resources	Electric Vehicles
		Water Heating Control
		Smart Thermostat
		Solar PV
		Battery Storage
Commercial and Industrial	Energy Efficiency	Appliances
		Water Heating
		HVAC
		Lighting
		Cooking
		Plug Load
		Refrigeration
		Envelope
		Data Centers
		Compressed Air
		Industrial Machine
		Industrial Process – Cooling, Heating
		Motors
	Demand Response and Distributed Energy Resources	Water Heating Control
		Smart Thermostat
		Solar PV
		Battery Storage
		Thermal Storage
		Interruptible Load

The calculation of energy savings for these selected measures takes one of two options based on the availability of data – (1) NREL or PNNL model simulation, for measures that exist in these models and can be simulated after customizing them to the specific territories and their standards and requirements[4] or (2) savings loadshape based impact estimation, aided by Technical Resource Manuals (TRMs) from similar territories.

Sources for information needed for this phase are listed in Table 3.

Table 3 Data Sources for Step 2 - Measure Development

Data Information / Type	Source
Upgrade Measure List (Energy Efficiency, Demand Response and DERs)	IESO Measures and Assumptions List
	2022 IESO Achievable Potential Study
	2019 Integrated Ontario Electricity and Natural Gas Achievable Potential Study
	ICF Potential Study Database
8760 Hourly Savings Loadshape /End Use Profiles	IESO 8760 Hourly Loadshape Profiles
	2025 Illinois Statewide TRM (version 13) - Volume 1 & Volume 2
Building Energy Models for Savings	NREL ResStock (2023) and ComStock (2024)
	PNNL Building Energy Prototypes – Residential: IECC 2021 Code and Commercial: ASHRAE 90.1.2019 Standard

√ The **third step** is to utilize the outputs of the first two steps and **develop a load forecast** for two scenarios – base case and high-electrification scenarios, for each of the TSs. This process utilizes the zonal forecasts from IESO and footprint level forecasts from the LDCs for calibration and validation of the TS forecasts by ICF. Data and sources used for this load forecasting exercise are shown in Table 4. While the base case utilizes the baseline load outputs from the digital twins as the starting point, the high-electrification scenario's annual energy usage forecast is guided by Canada's Energy Future 2023 Canada Net-Zero Scenario[5]

[4] Ontario 2024 Building Code Volume 1-2, SB-12 Prescriptive Compliance Package (Vol 1 and 2) (https://www.ontario.ca/page/2024-ontario-building-code); Energy Star New Homes (https://natural-resources.canada.ca/energy/efficiency/housing/new-homes/energy-starr-new-homes-standard/14286); Toronto Green Standard (https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/toronto-green-standard/toronto-green-standard-version-4/)

[5] Canada's Energy Future 2023 (https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/index.html)

and calibrated to the LDC high-electrification scenario load forecasts. A stock turnover module within DER Insight is used to build the high-electrification scenario.

Table 4 Data Sources for Step 3 - Load Forecast

Data Information / Type	Source
Common Data for All Scenarios	MPAC Data
	IESO Zonal Load Forecast and Split by End-Use
	LDC Load Forecast
	Ontario 2024 Building Code
	Toronto Green Standard
	US Energy Information Administration (EIA) Annual Energy Outlook's (AEO) Building Survival Rates
High-Electrification Scenario	Canada's Energy Future 2023

√ The **fourth and final step** is the step that addresses the goal of the project - calculating the local savings potential in a stepwise process **starting with the technical potential, then estimating the economic potential and ultimately arriving at the achievable potential savings** forecasts and associated costs. Simulated energy savings achieved by applying the finalized measures to each digital twin or its equivalent that is constructed using the load shapes, provides the estimate of how much energy is saved annually. Additional data sources for Step 4 are listed in Table 5.

1. **Technical Potential**: This phase identifies the maximum possible energy savings if all technically feasible measures are implemented with no consideration for constraints such as costs or participation levels. The digital twin simulations are used to evaluate this potential across various building types by implementing measures that are technically feasible on different buildings, providing an upper bound on what can ideally be achieved. This potential is only capped by the network hosting capacity for the distributed energy resources.

2. **Economic Potential**: The next step evaluates the cost-effectiveness of implementing the identified measures. The economic potential is determined by filtering the technically feasible measures for those that provide a positive cost-benefit ratio, considering factors such as installation costs, operational savings, the lifespan of each measure and electricity system costs such as avoided generation, capacity, transmission and distribution costs. Exceptions are allowed for considerations such as programs for low-income customers.

3. **Achievable Potential**: Finally, the achievable potential is assessed by applying participation curves to the economic potential, taking into account implementation and regulatory barriers such as lack of awareness, customer preference and program ramp-up rates. This phase provides a realistic estimate of the energy savings that can be expected to be achieved based on current technology adoption trends, incentive programs, and customer willingness to implement the recommended measures.

Table 5 Data Sources for Step 4 - Potential Estimation

Data Information / Type	Source
Measure and Program Costs	NREL Annual Technology Baseline (ATB) 2024
	ICF Potential Study Database
All LDC/Utility Inputs such as Avoided Costs and Network Hosting Capacity	IESO and the LDCs
Diffusion and Adoption Curves	ICF Potential Study Database
	IESO Historic Program Data
Cost Effectiveness Tests	Cost Effectiveness Guide for Energy Efficiency, IESO (2022)
	National Standard Practice Manual (2020)[6]

References

[1] AI: Digital Twins Help Utilities Manage Demand Growth | ICF

[2] The Value of Proactive Customer Targeting for Meeting Utility Goals

[3] How Utilities Can Evaluate the Cost-Effectiveness of DERs | ICF

[6] The National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources is a publication of the National Energy Screening Project (NESP). http://www.nationalenergyscreeningproject.org/national-standard-practice-manual/