Assessment of IESO's Pathways to Decarbonization Study

From the Perspective of Municipal Climate Action Plans

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Glossary

Term	Definition
DSM	Demand side management
GHG	Greenhouse gases
IESO PDS	Pathways to Decarbonisation Study
IESO	Independent Electricity Systems Operator
LDC	Local distribution companies
MW	Megawatts, a measure of electricity capacity equivalent to 1,000 kilowatts
NREL	National Renewable Energy Laboratory
TWh	Terawatt hours, a measure of electricity consumption equivalent to 1 million MWh

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1 | Introduction

The paper provides an analysis of the Pathways to Decarbonization study[1] (referred to as "the IESO PDS" in this paper) of the Ontario Independent Electricity System Operator (IESO), with a focus on the alignment of that study with municipal climate action plans, the actions and policies required to support the implementation of those municipal climate action plans, and additional modelling and analyses required to inform future plans for an electricity grid in Ontario that would support community efforts to mount an effective emergency response to climate change.

The IESO PDS is an important first step in beginning the effort to conceptualise a decarbonised electricity system in Ontario. Developing this pathway is a difficult task as it involves multiple variables and complex decisions or judgements with respect to representing those variables in the future, which is intrinsically unknowable. The IESO PDS uses sophisticated modelling tools to assess a pathway, building on previous analysis and work by the IESO. An open, transparent and collaborative approach is essential to achieve the desired results for Ontario's energy consumers and related communities. Ontario has also recognized the importance of integrated municipal energy and emission plans which are essential to translate current energy siloes into real impacts for consumers across Ontario's municipalities.

The IESO PDS and municipal climate action plans both aim to reduce GHG emissions. While the IESO PDS focuses narrowly on the energy commodity system, and particularly on electricity supply, municipal climate action plans analyse the community as an energy system in which the electricity energy system is embedded. In both approaches, the challenge of decarbonization results in transformational strategies that include electrification of heat and mobility markets, but there are significant differences in the framing, method, and results. Municipal climate action plans identify steep pathways to decarbonise that yield economic returns, while the IESO PDS envisions massive centralized investment in new generation and transmission capabilities, many of which require expensive megaprojects and novel technologies.

These two futures envisioned by the IESO PDS and the municipal climate action plans respectively are not only incompatible but mutually destructive. The rate increases that would be required to support the buildout of nuclear and expensive and long lead time technologies in the IESO PDS would set back local government climate action plans by discouraging electrification and disadvantaging lower income households. At the same time, successful local decarbonization and electrification strategies will moderate the growth in electricity consumption on a scale that would strand assets in the IESO pathway. Many of the decarbonization opportunities and levers available to municipalities are "out of scope" in the IESO analysis, and this "blind spot" creates risks for all ratepayers and shareholders in Ontario's still mostly public power sector.

The table below summarises some of the differences between the assumptions and framing of municipal climate action plans and those reflected in the IESO PDS.

[1] IESO. (2022). Pathways to Decarbonisation.

Table 1. Characteristics of Municipal Climate Action Plans and IESO PDS

Aspect	Municipal Climate Action Plans	IESO PDS
Climate mitigation paradigm	Climate emergency aligned with science; mitigation as central focus. Comprehensive and integrated decarbonization of the system	Climate mitigation is not central to the IESO mandate; the policy target of decarbonisation by 2050 is treated as a system constraint.
Approach	Backcast and prevent emissions	Meet demand via a decarbonized, centralised electricity supply system
System boundary	Comprehensive, services, amenities, fuel, and electricity, community-based	Narrow, electricity commodity supply system, demand determined exogenously
Engagement	Broad community support, passed by Councils	Limited to technical stakeholders
Temporal resolution	Annual	Static with 2035 and 2050 snapshots
Scope	All energy sources	Electricity supply
Mitigation opportunities evaluated	Integrated energy efficiency, land-use, energy supply in transportation, buildings waste,	Existing and future technologies. Exogenous inputs from the 2019 APS, non-integrated
Financial impacts	Comprehensive analysis of energy-consumption stocks, calculating net present value for multiple scenarios	Overnight capital costs of supply and DSM costs, no benefits analysis; no comparison to status quo
Technologies	Proven technologies	Proven technologies and emerging technologies
Scope of mitigation actions	Comprehensive	Supply, efficiency of electricity using devices, focus on meeting demand over reducing demand
Projected annual consumption	Variable but in aggregate 1% per year	2-3% per year for the province
Co-benefits	Health benefits, new jobs, avoided damage from climate change	Not assessed
Household energy costs	Decrease	Not assessed, but indicates that electricity prices will increase

The IESO Pathways to Decarbonisation Report

The Independent Electricity Systems Operator (IESO) published a report titled Pathways to Decarbonisation ("IESO PDS"). in December 2022. The IESO PDS evaluates two futures for Ontario's electricity system, one that includes a moratorium on new natural gas generation (beyond that already committed), and one that leads to a decarbonized electric grid in a context in which heat and mobility end uses are mostly electrified by mid-century. This review focuses on the decarbonization pathway.

The 2022 Annual Energy Outlook is the point of departure for the Pathways Analysis, and the decarbonization scenario goes well beyond the electrification and forecast growth in the Outlook, resulting in much higher levels of electricity consumption – 265 TWh by 2043 as compared with 208 TWh in the Annual Outlook. Electricity consumption grows by a total of 150 TWh to reach 300 TWh by 2050, reflecting as much new consumption in the next 28 years as has occurred since the electric power system was established in Ontario over 120 years ago.

To provide this electricity, the IESO includes 19,600 MW of legacy capacity (mostly hydro and nuclear), 17,800 MW of new nuclear supply, 17,600 MW of new wind, 6,000 MW of solar, 2,000 MW of long duration storage, 15,000 MW of hydrogen, 6,000 MW of demand response, 650 MW of new hydroelectric and 3,800 MW of imports. This split between grid generation and local generation is not specified, but the massive 500 kV transmission and 230 kV transformer station build-out (150-280 new load supply stations at $30 million-plus each) reflect a system which would double down on the delivery of bulk power to local distribution companies, with minimal contributions from locally generated power.

The report identifies challenges such as the time lag between project initiation and generation (10-15 years for major projects), the need for a much larger workforce, the engagement of communities and First Nations, the fact that some technologies such as low-carbon fuels and small modular reactors (SMRs) are still in development, the latency of the regulatory system and the challenge of rising costs.

The IESO PDS indicates that no regret measures include accelerating efforts to acquire new non-emitting supply, beginning the planning process for new nuclear, long-duration storage, hydroelectric facilities, and transmission infrastructure, investing in emerging technologies, initiating collaboration amongst stakeholders and indigenous communities, ensuring that regulatory processes are able to manage future investments of this scale and establishing mechanisms to track progress.

The total investment required is between $375 billion and $425 billion, leading to an increase of unit rates of at least 20-30% (more if the forecast proves too high and the investments are underutilised). This does not include the capital costs of the electrification of the end uses assumed (e.g., heat pumps, electric vehicles), nor is there any explicit consideration of the capital cost implications to local distribution companies.

2 | Municipal Climate Action

Municipalities are on the frontline of climate change. The environmental, public health and economic costs of climate change are being borne by local communities, and Ontario municipalities have direct experience with the disruptive impacts of flooding, increased temperatures, and extreme weather. Climate change is an emergency and requires an emergency response.

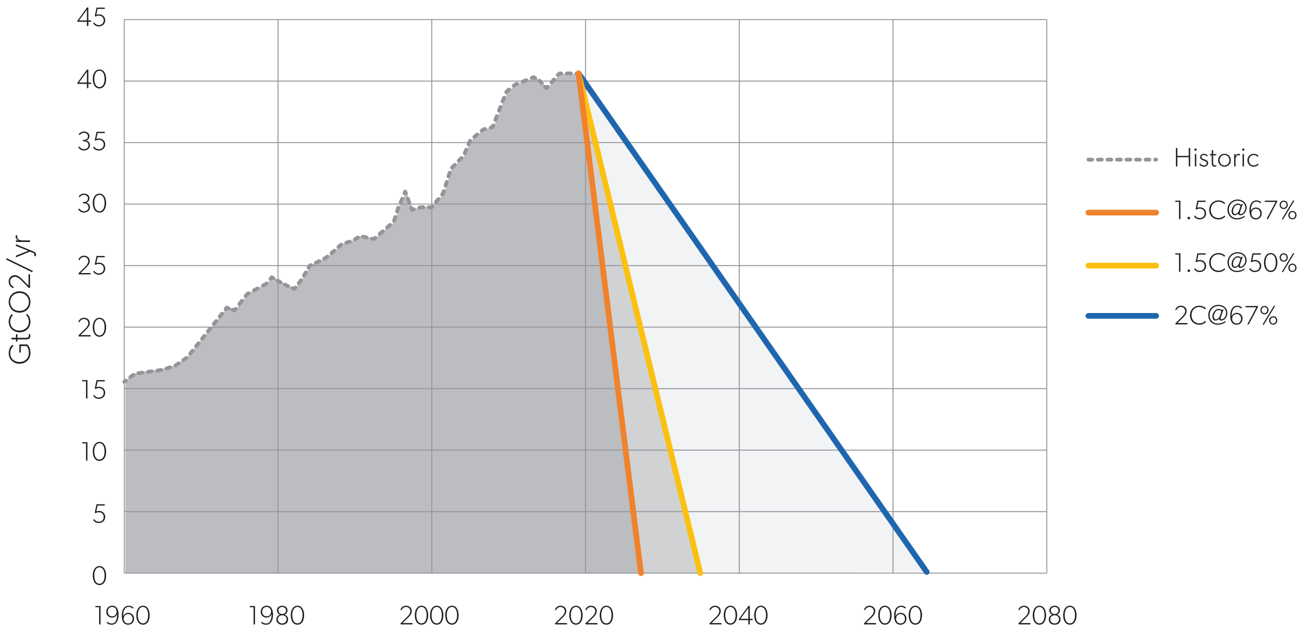

Figure 1. Global GHG emissions and decarbonisation pathways: the timeframe required to limit dangerous levels of warming is short[2]

As a result, Ontario municipalities are fully engaged in addressing climate change and are making commitments to GHG reductions through voluntary programs, including:

- 155 participate in the Federation of Canadian Municipalities' Partners for Climate Protection Program (155 municipalities),[3] which includes GHG inventories, target-setting, and plan development.
- 66 municipalities in Ontario have declared climate emergencies, representing approximately 10 million people. The climate emergency declarations have shaped municipal responses to climate action and climate action plans.
- Major cities participate in the UN's Race to Zero program which requires science-based targets.
- Select municipalities report annually to CDP and the Global Covenant of Mayors on their progress, which are global reporting platforms that track performance of cities.

[2] IRENA (2022), RE-organising power systems for the transition. (p.27) International Renewable Energy Agency, Abu Dhabi.
[3] FCM (2023). Partners for Climate Protection Membership. Retrieved from: https://www.pcp-ppc.ca/membership.

New approaches are increasing the rigour and sophistication of the implementation of climate action plans including:

- Businesses and municipalities are adopting science-based targets, which results in the requirement for deeper emissions reductions that are aligned with the latest science on climate change.[4]
- Municipalities are using carbon budgets to operationalise their GHG targets using policies and investments.

2.1 Municipal Climate Action Planning in Ontario

In Ontario, municipalities have been undertaking year-long projects to develop detailed climate action plans. This process involves technical analysis and modelling of urban systems, models which are calibrated against observed electricity and natural gas consumption, and development of future scenarios of the energy system. The future scenarios reflect population growth, new and existing policies, the impacts of climate change on heating demand and actions and policies identified by the community and municipal staff. In aggregate, these plans project growth in electricity consumption of 1% per year, including accounting for the electrification of heating and transportation by 2050, growth which is limited in large part due to demand side measures that IESO has not considered, such as deep building retrofits. Reduced electricity consumption translates into avoided generation, distribution and transmission investments, a relatively smaller energy infrastructure and, ultimately, units of electricity that need not be paid for by households and businesses.

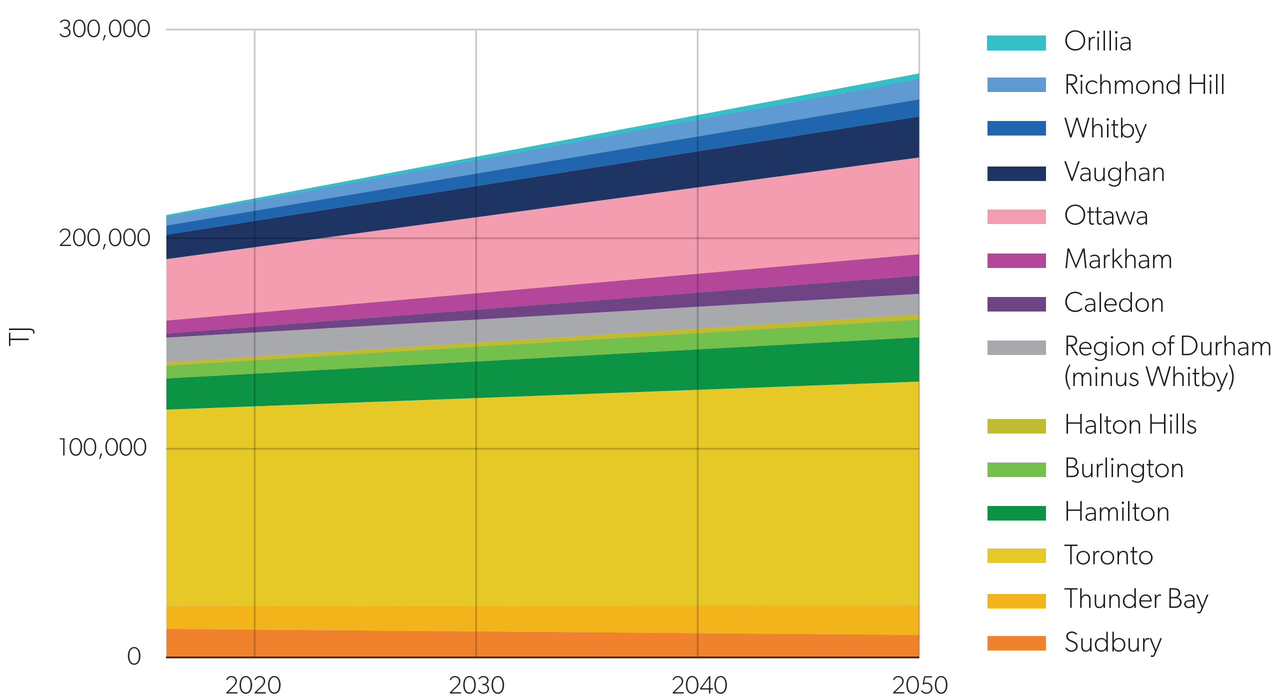

Figure 2. Projected annual electricity consumption from 2016 to 2050 in low carbon scenarios from climate action plans for a selection of Ontario municipalities.

[4] Science-based Targets Network (2023). Science-based climate targets: A guide for cities. Retrieved from: https://sciencebasedtargetsnetwork.org/wp-content/uploads/2020/11/SBTs-for-cities-guide-nov-2020.pdf.

Like the IESO, municipalities envision massive financial investments in decarbonising the energy system, but instead of directing those investments mostly to new generation, most of the funds flow to efficiency improvements in the energy system, which generate financial returns. Part of the increased electricity demand is addressed through solar PV generation on rooftops, and on parking lots.

The type of whole system, "bottom-up", integrated approach to decarbonization characterised by these municipal action plans leads to a very different outcome and value proposition from the one reflected in the IESO PDS. While electrification figures prominently, efficiency comes first, not just technological efficiency of electricity using devices, but also the efficiency with which services and amenities are provided. Expanding the boundaries to include the entire energy system in which the electricity system is embedded also expands the decarbonization solution set and the range of opportunities for citizen and company engagement.

In addition to resulting in lower growth rates for electricity consumption, this approach also identifies opportunities for local generation that are much larger than are normally reflected in central planning exercises like the IESO PDS. When combined with efficiency, digitization and the development of smart building and smart grid technologies, reliability can be bolstered at the local level while moderating the capital costs associated with hardening the distribution system to cope with greater reliance on central grid power. The bulk power grid remains critical but coevolution with modernised local distribution systems shifts the focus to the optimised provision of customer needs for reliable, affordable comfort, mobility, access, and information.

Figure 3 is a representative example of scenarios for a municipality in Ontario, in this case a Business as Planned scenario and a Net Zero scenario for the City of Toronto. The decline in total energy consumption coupled with the increase in local electricity generation in the Net Zero scenario illustrates the emphasis on reducing consumption and meeting electricity needs locally characteristic of most municipal climate action plans. Both objectives reduce pressure on the provincial electricity system for additional capacity and transmission, while achieving local objectives for economic development, GHG reductions and resilience.

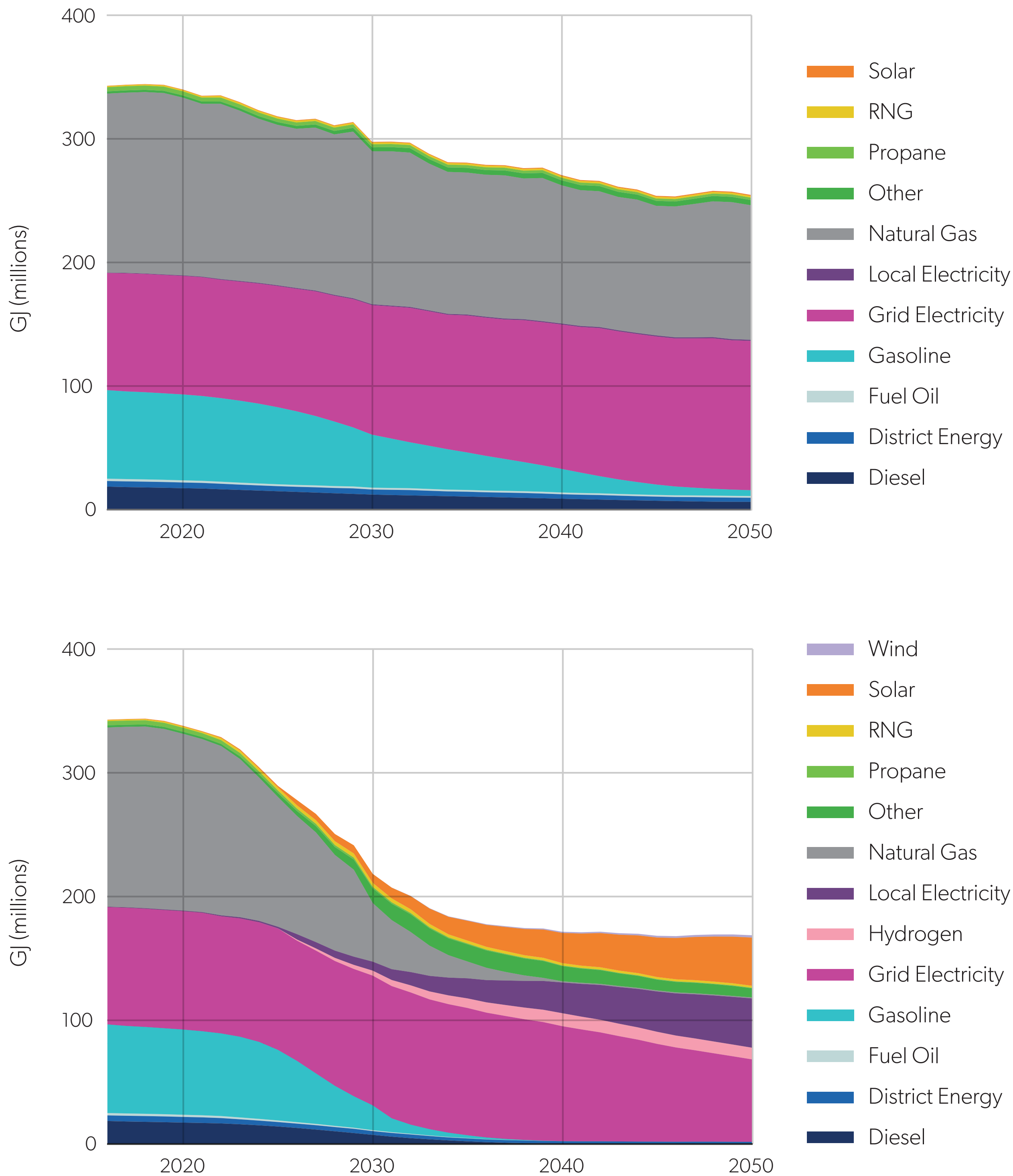

Figure 3. Example of total energy consumption by Toronto in a Business as Planned scenario (top) and a Net Zero scenario (bottom). The chart demonstrates the vision for decentralisation of projected electricity generation, where electricity consumption from the grid (fuchsia), is nearly matched by behind-the-meter generation (purple), and commercial scale installations of solar (orange) and wind (mauve).

While municipal climate action plans generally develop bottom-up annual projections of total energy consumption, including electricity (Figure 3), they do not assess peak demand, but there is a correlation. NREL found in an analysis of decarbonising the US electricity system by 2035 that a 1.3% decrease (in annual electricity consumption) translated into a 16-20% reduction in 2035 installed capacity.[5] A similar analysis of Ontario's electricity system found that reducing just 11% of expected consumption by 2035 (23 TWh) can eliminate the need for incremental build outs of wind, solar, and storage by almost half (12 GW instead of 22 GW).[6]

2.2 The Pathway Matters

Municipalities are increasingly focussed on aligning operational and investment decisions with GHG targets, an approach known as carbon budgeting. Central to carbon budgeting is the concept of a cumulative limit on emissions. GHG emission targets are typically structured for achieving a specified level of annual emissions by a target year in the future (e.g., 60% below 2015 levels by 2030), but it is the cumulative atmospheric emissions over a period of years or decades that determine the degree of global warming that will ensue. Reflecting this scientific reality, in the carbon-budget approach, it is the cumulative emissions between the present and the target year that are limited. This underscores the importance of defining viable pathways in which annual emissions are continually brought down over time to assure compliance with the cumulative limits.

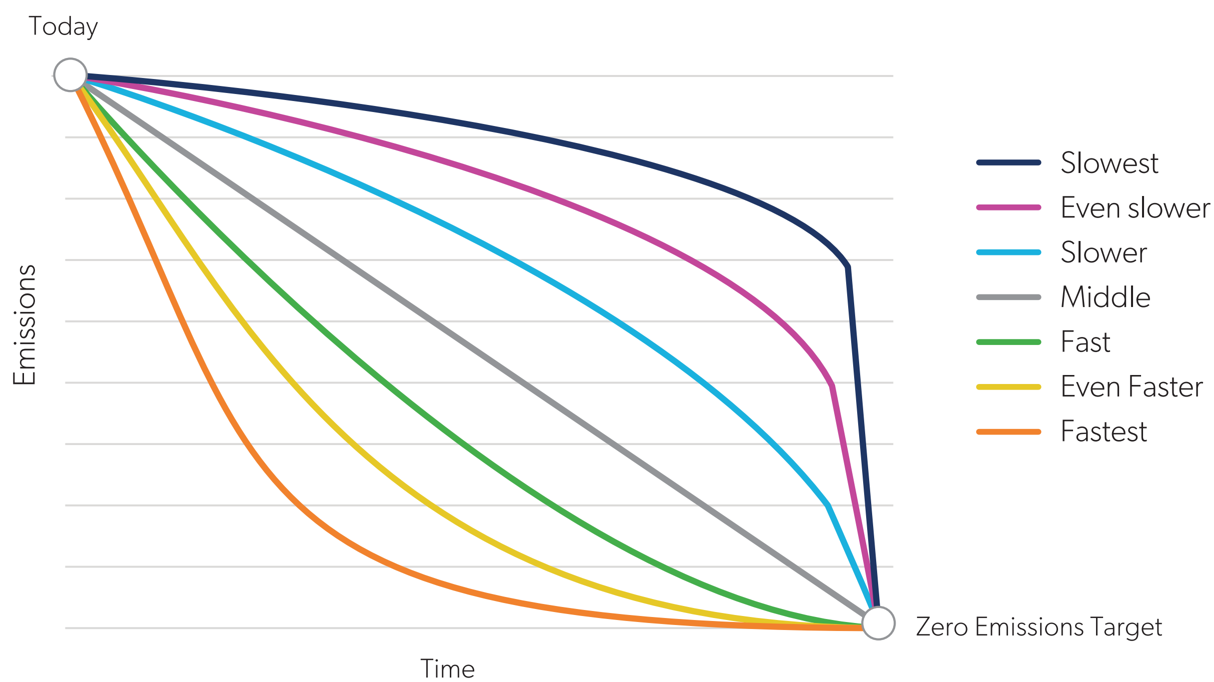

Figure 4. Delayed vs. immediate action in meeting a common cumulative carbon emissions budget.

[5] Denholm, P., Brown, P., Cole, W. et al. (2022). Examining Supply-Side Options to Achieve 100% Clean Electricity by 2035. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A40-81644. https://www.nrel.gov/docs/fy22osti/81644.pdf

[6] Power Advisory (2022). Scenarios for a Net-Zero Electricity System in Ontario. Retrieved from: Scenarios for a Net-Zero Electricity System in Ontario

For example, Figure 4 portrays emissions over a 30-year period for seven different pathways to net-zero emissions by 2050. The pathways result in very different cumulative emissions, represented by the area under the curve. The curves which result in more cumulative emissions are also steeper at the end of the time period. The steepness of individual curves is a proxy for the rapid action and degree of disruption required to meet the target. As a result, decarbonising the electricity system sooner reduces cumulative GHG emissions and decreases costs and disruption.

2.3 Municipalities and the energy transition

The technologies, regulations, and business models that have characterised the electricity sector for the past century are being challenged by a transition fuelled by innovations in technologies and techniques for storage, end use, measurement, analysis, control, marketing, and generation of electricity. Driven by these new technological possibilities, municipalities and consumers are expecting more choice and demanding more control over the cost and attributes of their electricity supply, illustrated in Figure 8.[7]

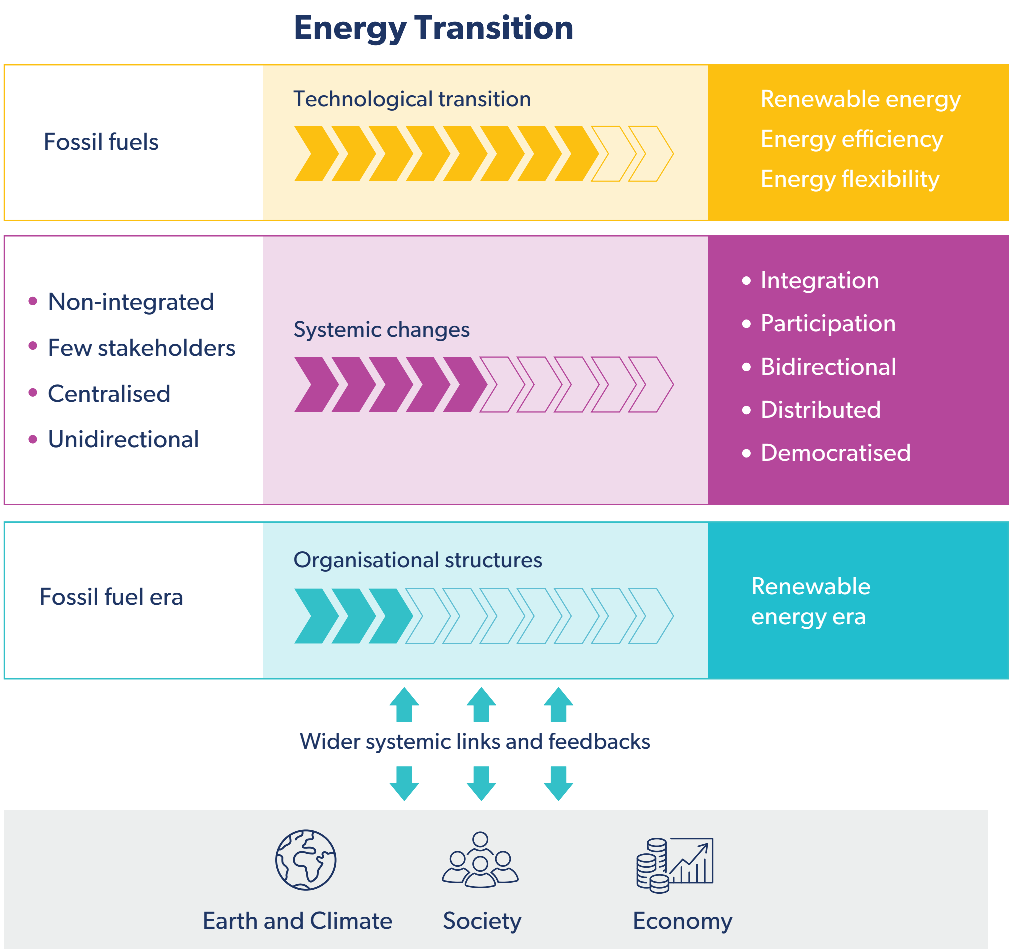

Figure 5. Dimensions of the Energy Transition

[7] IRENA (2022), RE-organising power systems for the transition, International Renewable Energy Agency, Abu Dhabi.

Municipalities in Ontario are actively engaged in this transition, and it is integral to their climate action plans with measures that include supporting the development of renewable energy cooperatives, deploying thermal energy storage, installing ambient district energy systems and decentralised renewable energy, and creating microgrids. And as a study for the IESO concluded, these strategies are a cost-effective strategy for addressing capacity increases required in Ontario's electricity system.[8]

The IESO PDS scenario retains the historical generate->one way transmission->customer demand paradigm, which is unable to assess the dynamic relationship between demand and supply that is intrinsic to advancing a cost effective decarbonization effort that reduces demand as much as economically possible and then meets demand as locally as possible to reduce expense on central generation and transmission.

A New Paradigm: From Demand Side Response (DSR) to Intelligent Demand

Octopus Energy is an innovative energy provider in the UK that is actively engaging in balancing demand with renewable generation. In a recent blog, they write "DSR is a neat solution to an old problem. It was originally designed to reduce peak electricity demand and keep coal fired and nuclear power stations running smoothly by shifting relatively predictable electricity consumption to times of relatively predictable low demand. However, the world has changed since then. The energy system is evolving significantly as we add more intermittent renewables to the grid and electrify heat and transport. As a concept, DSR is at an evolutionary dead-end. It isn't just DSR's age that's a problem - the ideas behind DSR are dated: they won't get us to net zero. Instead, we should be thinking about 'Intelligent Demand'.

Octopus Energy (2023). Moving from 'Demand Side Response' to 'Intelligent Demand'. Retrieved from: https://octopus.energy/blog/intelligent-demand/.

Increased use of electricity for heating and transportation end uses, large shifts in the relative costs of different generation technologies, growth of distributed generation and storage technologies, a shift from production-centred to consumer-centred business models (including the emergence of "prosumers" which both produce and consume), multi-directional flow of information and energy, and Internet of Things (IoT-enabled control and optimization are all contributing to a reinvention of the electricity system. It is fertile ground for the new technologies of distributed generation, energy management and energy storage.

Going forward, municipalities will be the locations where these changes play out. The nascent technological and business model pathways to increased electrification of space heating and personal transportation are complex and highly dependent on the future development of new building energy technology, urban land-use form, and personal mobility patterns. From autonomous electric vehicles to localised microgrids and district energy systems, it is clear the solutions will be inextricably linked to the future of both the grid and municipalities. Integrated electricity and community energy planning will ensure that the vision, objectives and investments are aligned, while lack of alignment implies cascading electricity system costs.

[8] Dunsky (2022). Ontario's Distributed Energy Resources (DER) Potential Study.

2.4 A Focus on Service and Amenity

Energy is used for services including mobility, warmth, coolth, lighting and others. Currently, electricity is used for a subset of these services, but in a decarbonized scenario, electricity will displace natural gas, gasoline, and diesel. To evaluate the financial impact of electrification, one needs to evaluate the energy costs for those services. For example, it is less likely to be an issue if the household cost of electricity doubled while the costs of natural gas and gasoline are zero (if these fuels are no longer used), then if electricity costs double on top of natural gas and gasoline costs.

An analysis of the broader energy system finds that electrifying heating and transportation reduces overall energy consumption (see Figure 2 for example), generating savings even if electricity prices increase on a per unit basis. As a result, household expenditures on energy decrease across the board, as illustrated in Figure 6, a finding that is also reinforced by a national analysis.[9]

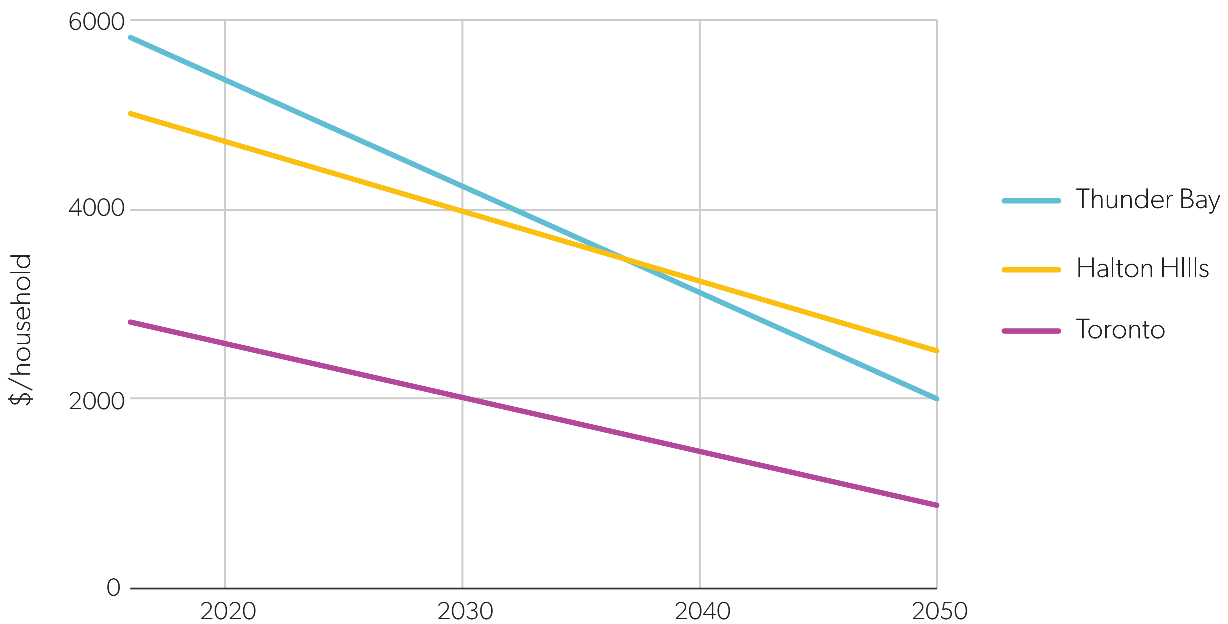

Figure 6. Total annual household energy costs (housing and transportation) modelled for the low carbon scenarios for four Ontario municipalities.

The efficiency in the energy system occurs because electric vehicles are 3-5 times more efficient than gasoline vehicles and heat pumps are 3 times more efficient than natural gas furnaces, so even if a household is paying more per unit of electricity, the household is using less energy overall. These efficiency gains are compounded with measures such as building retrofits and land-use policies which increase the share of trips by walking and cycling.

[9] Smith, R. and Harland, K. (2023). New analysis finds most Canadian households will save money in switch to electricity. Retrieved from: https://climateinstitute.ca/new-analysis-finds-most-canadian-households-will-save-money-in-switch-to-electricity/

3 | An Immovable Object Meets an Irresistible Force: The IESO PDS vs. Municipal Climate Action Planning

There are serious misalignments between the IESO PDS and municipal climate action planning in Ontario. These misalignments stem from differences in how the decarbonization challenge is framed and the electricity system is perceived, from the different mandates and objectives of the IESO and Ontario municipalities, and from differences in the information and data on which the analyses are based.

A fundamental aspect of scenario planning is that there are multiple scenarios to compare. IESO just provides one scenario, leaving us without a counterfactual, a reference or business as usual scenario against which we can assess the merits of this scenario, on cost, on reliability or any other factor, such as lower demand, or removing the constraints on distributed energy resources (such as solar and wind supply).

Electrification of buildings and vehicles is central to any effective climate change response strategy, and especially for municipalities where buildings and transportation typically account for most greenhouse gas emissions. The success of Ontario's climate change response and the future of the electric power system could not be more interdependent; municipal efforts to decarbonize will have significant impacts on the bulk power system, and the prospects for municipal decarbonization strategies to succeed depend largely on the investments and initiatives taken by the IESO.

Municipal Governments and the Ontario Public Power System

Municipal governments in Ontario played a central role in the development of the electric power system in the province from the earliest days when electricity was being first deployed for street lighting and municipal electric rail systems. Recognizing the electric power system as both a natural monopoly and as critical infrastructure for economic development, Ontario opted for public ownership in 1906 and vested the ownership of local distribution systems with municipal governments. Local utilities (owned by municipal governments) purchased power at cost from the provincially owned Hydro Electric Power Commission (later to become Ontario Hydro) and resold it with a markup sufficient to cover the costs of building and maintaining the local network of wires and transformers needed to deliver the bulk power to every business and household in their community.

Some municipalities built and operated generating facilities, but the primary function of the local utilities has been to manage the end use delivery of power that was generated centrally by the provincial utility. The electric power distribution infrastructure in Ontario was largely built by these municipal utilities and they became and continue to be vital institutions in Ontario communities. They were converted to share corporations in 1998 as part of a sweeping restructuring of the electric power industry and, while this led to consolidation and partial privatisation, many of the local distribution companies (LDC's) in Ontario are still wholly or partly owned by municipal governments. The electricity industry in Ontario is provincially regulated, and local distribution companies, even when wholly owned by municipal governments, have generally operated at arm's length from municipal governments.

3.1 Demand Side Disconnect

There is a significant "disconnect" between the IESO approach to thinking about the future level of electricity consumption and the approach reflected in municipal climate action plans. The IESO PDS concludes that broad electrification of the Ontario economy will result in aggregate electricity consumption growing at 2.7% per year, reaching 300 TWh by 2050, about double its current level. Municipal climate action plans envisage broad electrification occurring in the context of systemic changes in the demand chain for electricity that will keep growth to much lower levels, with aggregate consumption in the range of 200-230 TWh by 2050.

The IESO provides only a few of their assumptions that result in their forecast of 150 TWh of growth that would result from broad scale electrification of the Ontario economy, and they provide no sectoral breakdown of the growth.

The broad assumptions that the IESO do provide include the conversion all new and existing residential and commercial building space and water heating to heat pumps, conversion of 20% of industrial natural gas use to heat pumps and electrification of greenhouses, electrification of 100% of the light duty vehicle fleet (with a 5% adder for medium weight truck electrification), electrification of 20% of industrial natural gas consumption, development of the Ring of Fire in northern Ontario, and a number of other less significant items.

We attempted to reproduce the IESO 150 TWh result with the assumptions that are included in the IESO PDS report and concluded they would add 65-105 TWh to Ontario electricity. Further, the high end of our range assumes no thermal retrofits of existing buildings, no further improvements in the efficiency of new buildings, no reductions in HVAC energy intensity that result from the conversion to smart buildings with heat pumps, not continuing further improvements in the efficiency of new buildings, no improvements in electric vehicle efficiency, and no improvements in industrial energy efficiency as the result of electrification. In other words, the basis of the rationale for the growth in electricity consumption is not readily apparent, given the information provided.

The IESO PDS applied high levels of electrification but "did not undertake a cost-optimization exercise comparing different decarbonization options on the demand-side", deferring to ongoing analysis for the Ministry of Energy on the evolution of electricity demand in Ontario. Changes on the "demand side" have been the defining dynamic of Ontario's electricity system for the past 30 years and they go much deeper than the superficial impacts of electricity commodity efficiency gains (e.g., as encouraged by DSM programs). It is possible these moderating dynamics will be overshadowed by electrification (a thorough analysis required to know), but they will still be there, and they are not captured by the IESO methodology.

Electricity demand is derived from underlying service demands (heat, mobility, light information transfer) which are in turn derived from even more fundamental demands for amenity (comfort, security, knowledge, access). The electricity system includes all these components and their dynamics, and to optimise only on the supply of kilowatt-hours, even with an adjustment for the technological efficiency of electricity using devices, guarantees a suboptimal result at the system level. This limitation reverberates throughout the IESO PDS as the analysis is driven by the suboptimal projection of 300 TWh of electricity consumption in 2050 and the corresponding 2.7% growth rate.

This "demand side blindness" is a longstanding weakness of Ontario power system planning and permeates the IESO perspective, as illustrated for example in their assumption that firm imports of electricity from Quebec would be from new hydroelectric and new wind facilities, with no inclusion of the tens of TWh of existing electricity supply that will be freed up as by the conversion of resistance space heating to heat pump technology.

The methodology that underpins the IESO PDS starts with a long-range load forecast of electricity demand, thus defining a gap between the current capability of the system to provide electricity and the projected future demand. This is a demonstrably inappropriate method for long range planning and a primary source of many of the risks the IESO PDS presents. Even with the end use representation that has been added to the forecasting tools in recent years, forecasting by its very nature elevates "trend into destiny". There is no better illustration of this than the history of long-range electricity demand forecasting in Ontario (see box), the consequences of which led to investment overshoot, the virtual bankruptcy of the utility, and inflated electricity costs for Ontario communities.

Is it different this time? That argument has been made on the previous occasions when the Ontario Power Authority or before them Ontario Hydro has used a gap between their long-range forecast and the current capability of the system to justify increased borrowing for system expansion. And it seems obvious that the electrification of vehicles and space heating will increase electricity consumption, but by how much? That is the critical question. Given the demonstrated inadequacy of the long-range forecast methodology to see into the local dynamics of electricity demand and anticipate how it will change over time, and given the stakes, there is a need for much more thorough and integrated analysis of how Ontario can make the transition to a zero-carbon economy than that provided with the flawed methods and limited scope of the IESO PDS.

This Time It's Different?

In 1976, Ontario Hydro argued that by 1997 there would be a 38,000 MW gap between supply and demand in Ontario unless the province built and had in service an additional 24 nuclear reactors and 18 coal-fired generators, all to be online by the early 2000's, over and above the sixteen reactors that were in various stages of design and construction at the time. The expansion plan was based on a forecast system peak of 57,000 MW in 1997; low and high variations were examined that had the peak in 1997 at 36,000 MW and 67,000 MW, respectively, with the assertion that "it is unlikely the actual load will be outside the range of these scenarios". The actual peak demand in 1997 was 22,200 MW. None of the 42 additional nuclear and coal stations that were deemed necessary by 1997 were ever built, and the gap never materialised.

In 1989, Ontario Hydro produced a new long-range plan, driven by a long range forecast the defined a large gap between the system's current capacity and the projected future needs. The supply/demand gap in that plan was projected to open up in the mid-1990's, reaching 9,700 MW by 2005 and 21,300 MW by 2014, leading to Ontario Hydro's proposal for several additional nuclear and coal-fired generating facilities. Ontario Hydro asserted there was only a 10% probability the actual load would fall below a lower bound forecast that reached 28,700 MW by 2004 and 33,500 MW by 2014. Actual demand peaked at 25,000 MW in 2004, 10,000 MW below the median forecast and 3,700 MW below even the lower boundary the forecast bandwidth. The plan was eventually withdrawn by Ontario Hydro. None of the proposed facilities were built and the gap never materialised.

In the 2005-2007 period, plans for additional gas power plants were expedited because of a gap between the system's capacity and a forecast that demand would grow to 163 TW-hours by 2010, 169 TW-hours by 2015 and to 177 TW-hours by 2020. Once again, the gap did not materialise; in fact, while this expansion planning was going on, power demand had already begun a long term decline from its peak of 157 TW-hours in 2005 to 132 TW-hours in 2017, and remains well below 140 TW-hours today.

3.2 Municipalities Matter

Municipalities have a crucial role in the energy transition, as they directly or directly control or indirectly influence 60% of GHG emissions. They have a long history in energy systems, playing a pivotal role in the development of public power in Ontario, and still today own many local distribution companies.

Planning policy, the domain of municipalities, can shape electricity demand as heating and transportation electrify. For example, the orientation and shape of buildings can reduce energy consumption by 20-40% at zero incremental cost, the application of green development standards can require specific energy/emissions performance in new construction. Transportation policies which switch vehicular trips to walking, cycling and transit reduce electricity demand for charging. Smart charging infrastructure, required by planning policies, can reduce peak impacts of electric vehicle charging. Ambient temperature district energy systems can provide thermal energy storage and manage peak electricity demand on cold days.

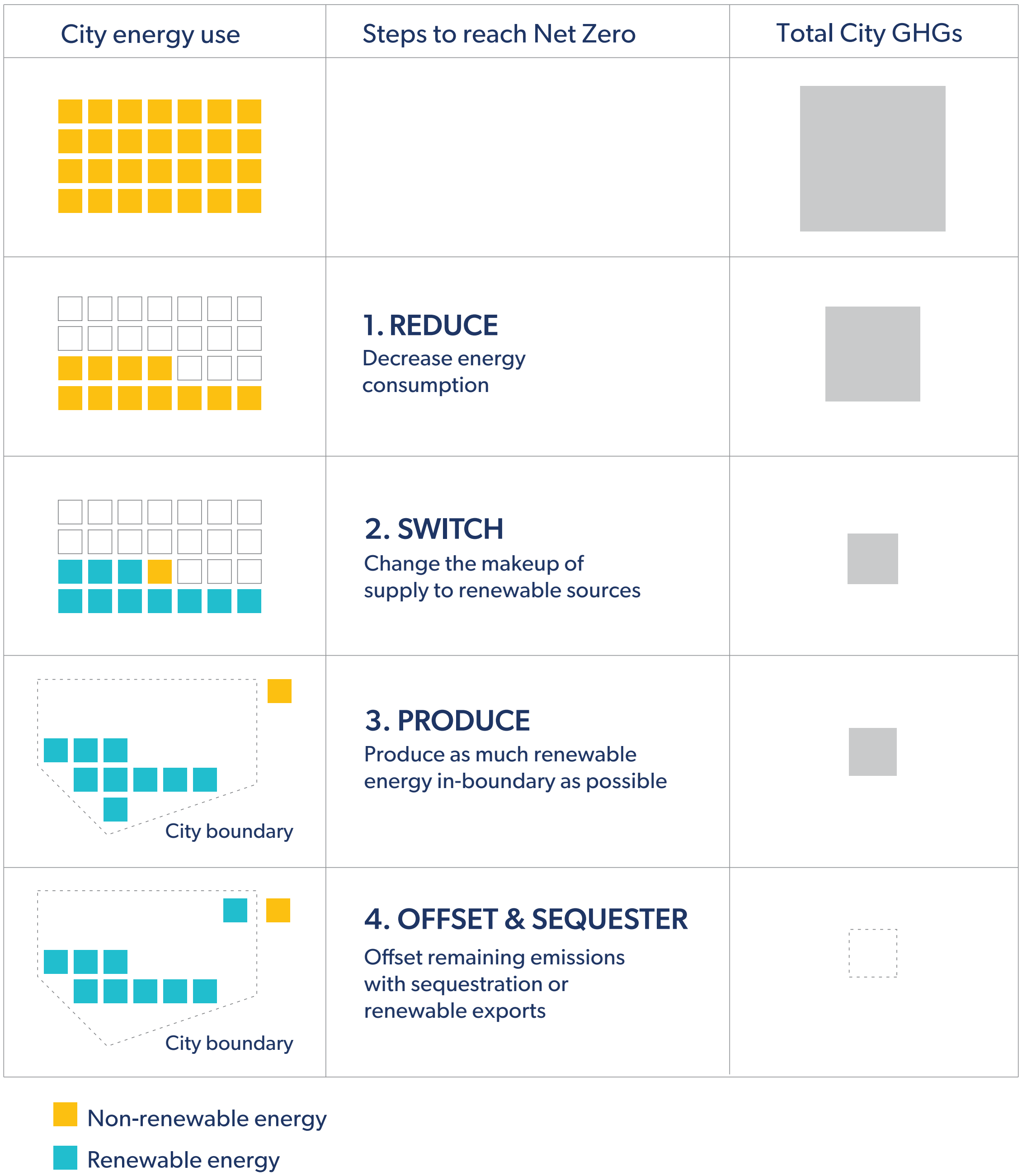

Figure 7. Schematic of the pathway to net zero emissions, emphasising efficiency first. [10]

In the past five years, municipalities have been building their capacity to implement climate action plans, developing policies and programs, and advocating to other levels of government. Relevant examples include:

- City of Toronto's Community Energy Planning Program
- Green Development Standards implemented or under development in Brampton, Toronto, Whitby, Mississauga, Caledon, Markham, Pickering, Ajax, Mississauga, Caledon, and Hamilton which result in increasingly high-performance new buildings.

[10] Graphic modified from a version created for the City of Markham's Net Zero Energy Plan.

- Retrofit programs implemented or under development in Toronto, Region of Durham, Kingston and Ottawa and under development in numerous Ontario municipalities.
- Electrification and renewable energy installations on municipal facilities
- Renewable energy projects on municipal facilities
- Renewable natural gas projects on landfills and through organic diversion
- Integration of GHG targets into official plans and secondary plans, influencing the shape and configuration of buildings
- Development of district energy projects
- Development of EV charging infrastructure
- Development of microgrids

These efforts demonstrate that municipalities are increasingly engaged in the energy transition, and not accounting for these efforts in the scenarios limits the opportunity to develop new and beneficial partnerships that can lower the risk of investment overshoot that has characterized central electricity planning in Ontario for the past several decades. It is crucial to engage communities as active change agents rather than considering them as passive consumers or stakeholders that must be sold on the IESO's plan.

3.2.1 Distribution systems move from the end of the line to the front line.

In addition, as noted above, municipalities are hosts to and very often shareholders of the local distribution companies in Ontario. These systems have a key role to play in delivering the demand side and renewable energy resources at the heart of grid decarbonization, but the IESO PDS deemed them out of scope:

Given our mandate, this assessment focuses only on the bulk power system – i.e., high-voltage transmission lines, generation, and interconnections with neighbouring jurisdictions – and does not consider the impact on local distribution systems." (p.7)

This is a key issue for municipalities and a major gap in the analysis, especially given the role of end use electrification (heat pumps, electric vehicles) in grid decarbonization. Not only will the distribution systems be profoundly affected by the way decarbonization is pursued at the bulk power system level, but the strategies and investments of the distribution companies can and will have profound impacts on the cost and feasibility of bulk system decarbonization. A bulk system decarbonization pathway analysis that does not include an integrated analysis of distribution system scenarios runs a high risk of failure. On the other hand, the inclusion of distribution systems will emphasise the requirement for regulatory change that empowers LDCs to optimise investments in order to reduce the burden on the bulk power system.

3.2.2 Embedded generation – a sleeping giant?

Both the absolute quantity and the relative contribution of local generation is larger in municipal climate action plans than what seems to be inferred in the IESO PDS. In a future in which electricity consumption is growing at 1% per year rather than 2.7% per year, the supply of locally available renewable electricity can make a larger contribution. All else being equal, a greater contribution to community electricity supply from embedded generation translates to reduced pressure on the bulk power system, saved capital investments in new transmission lines and transformer stations, and all the other benefits of a more even balance of supply and consumption at the local level.

3.3 Costs Matter

The IESO estimates their approach to decarbonizing the bulk power system will require capital investments of $375-$425 billion over the next 25 years, resulting in 20-30% increases in the system costs per unit of demand (emphasis added). Given the long history in Ontario of underestimating capital costs and overestimating demand growth, there is a high risk the rate impacts could be higher. In addition, many of the generation and transmission facilities in the IESO PDS have lead times that are long compared to how quickly technology and costs are evolving (dropping) at the distribution level, creating the risk, familiar to Ontario ratepayers and taxpayers, that the assets will be stranded before they are complete. The IESO PDS does not assess the risk of the stranded asset risk, for example, if the fossil fuel generating stations are closed prior to their end of life or carbon capture costs when the federal Clean Electricity Standard comes into effect in 2035 and requires all fossil fuel generated electricity to have carbon capture technology installed.

The rate increases that would be required to support the buildout of nuclear and expensive and long lead time technologies in the IESO PDS would set back local government climate action plans by discouraging electrification and disadvantaging lower income households.

3.4 Broader Economic Impacts

The capital investment for the strategy in the decarbonisation pathway – an average of $16 billion per year for the next 25 years – represents a large step increase over historical levels, on the order of a doubling or more of investment in the entire electric utility sector in Ontario. The abatement cost of these investments are not compared to the demand side and distributed generation investments that predominate in local climate action plans. To the extent decarbonizing the electricity supply costs more per tonne of GHG reduced than the investments in community climate action plans, the IESO PDS pathway would result in a misallocation of capital and lost opportunities. Further, investments in the bulk power system generate relatively fewer jobs that are concentrated near the megaprojects in the plan, in contrast to demand side and distributed generation actions which have higher job multipliers and result in employment that is more geographically distributed.

3.4.1 IESO has not evaluated the benefits of decarbonising the electricity system.

The National Renewable Energy Laboratory (NREL) has undertaken a study similar in its focus to the IESO PDS but considering pathways to decarbonize the US electricity system by 2035.[11] NREL quantifies both the health benefits and the value of avoided damage from climate change to calculate the net present value of each scenario. IESO did not consider either of these benefits in calculating the capital cost.

In each of the scenarios that NREL evaluated, health benefits[12] generally equal the system costs and the benefits of avoided climate damage significantly exceed the system costs so that the scenarios generate net benefits that exceed the value of the system costs. Avoided climate damages are represented by the social cost of carbon, which is standard in cost-benefit analysis of regulatory processes in Canada and the US. Municipalities are also interested in other benefits, such as job creation by sector (Figure 9), brand, and ability to attract businesses.

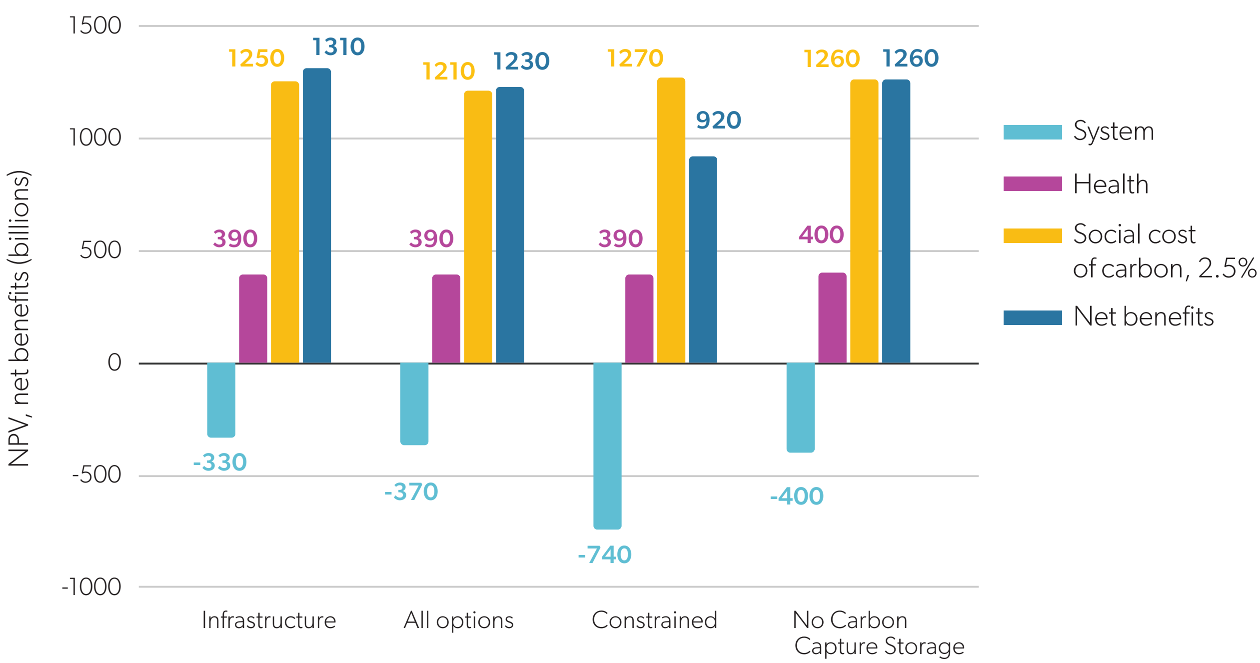

Figure 8. Net present value of decarbonising the US electricity system, including health, and avoided climate change impacts.[13] Negative values equal costs and positive values equal savings.

[11] Denholm, P., Brown, P., Cole, W. et al. (2022). Examining Supply-Side Options to Achieve 100% Clean Electricity by 2035. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A40-81644. https://www.nrel.gov/docs/fy22osti/81644.pdf

[12] The NREL quantified the benefit of reduced premature mortality as a result oflmproved air quality. Other benefits such as reduced morbidity, changes to hospitalizations, or ecosystem damage, could also be quantified.

[13] Ibid, p. xviii

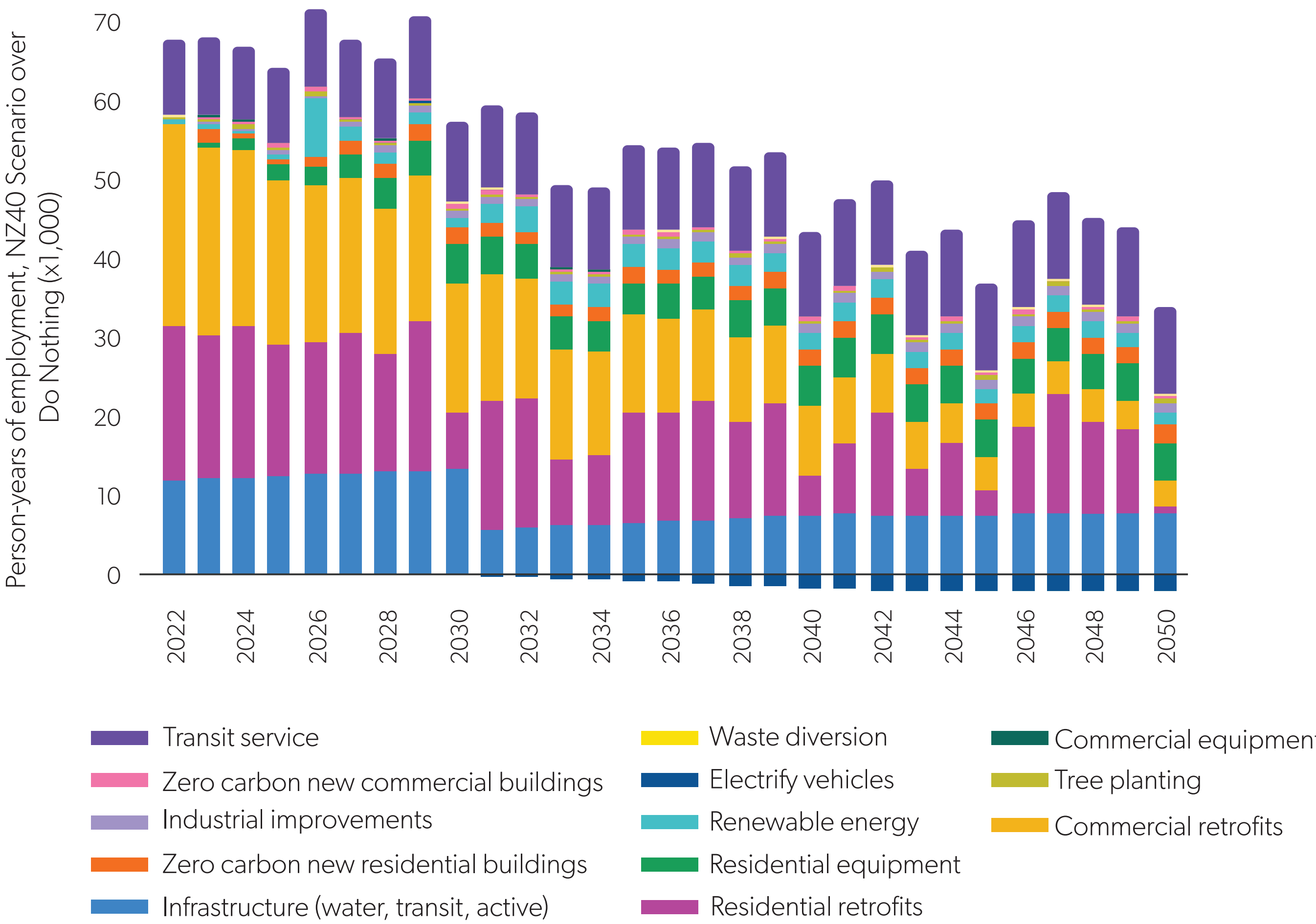

Figure 9. Annual person years of employment generated in Toronto's Net Zero Strategy. Municipalities are able to work with colleges and universities to design a workforce strategy that aligns with its decarbonisation strategies.

3.4.2 More risk: IESO is putting favouring wild cards over safe bets.

Setting aside the question of the rate of growth of demand, IESO's assumptions on opportunities for supply are not aligned with other jurisdictions. As is industry standard, IESO applies an optimisation model that seeks the least cost options given certain constraints. The constraints that IESO has set result in the model selecting expensive nuclear power, in an apparently arbitrarily cap onshore wind, and assign disproportionately high transmission costs to a portion of the wind capacity. The result is a lower reliance on wind and solar by 2050 than other major jurisdictions (US and UK) are identifying by 2035.

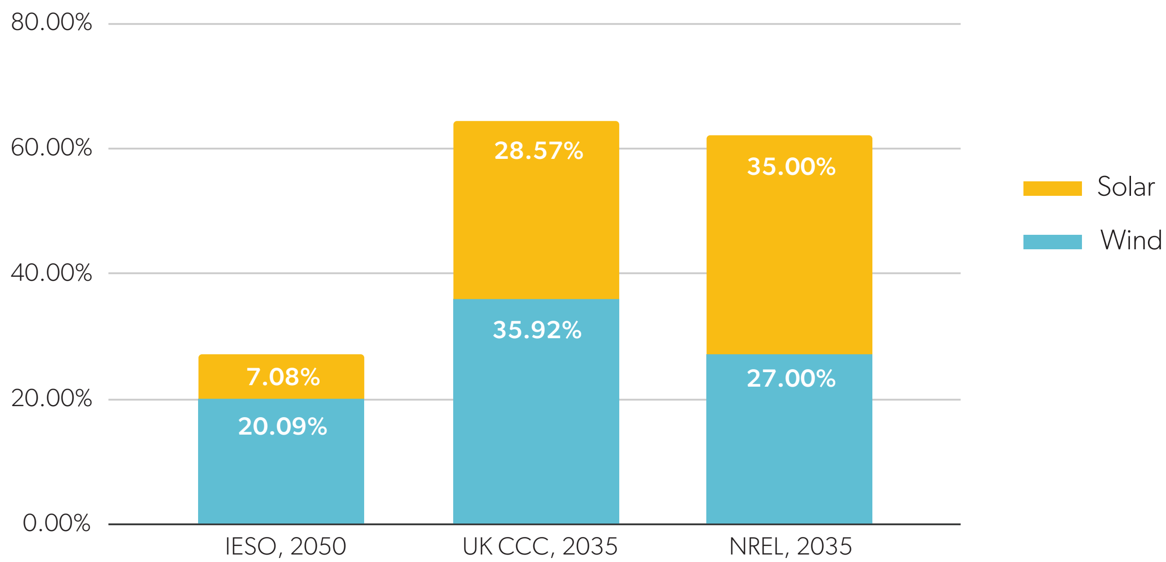

Figure 10. The share of wind and solar in the mix for decarbonisation scenarios for Ontario (2050),]UK (2035), and US (2035).

Scenarios which explore higher penetration of wind and solar earlier and the costs and benefits of that approach would help mitigate the risks associated with uncertain and expensive nuclear technologies and the risk of stranded fossil fuel investments, a specific risk resulting from pending federal Clean Electricity Regulations.[14]

[14] Government of Canada. (2022). Clean Electricity Regulations. Retrieved from: https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/clean-electricity-regulation.html

4 | Recommendations

Decarbonising the electricity system in Ontario is a priority for municipalities in Ontario. The IESO PDS is an important first, however, in order to meaningfully and substantively inform policy, additional analysis and detail is necessary. The following recommendations describe the analysis and processes that municipalities require in their roles of stewarding climate action plans, shaping energy demand through land-use planning, economic development and infrastructure deployment and owning and operating critical components of the energy system.

1. **Additional Scenarios:** Scenarios are only valuable when they represent distinct visions of the future which can be weighed against each other. In consultation with municipalities, the PDS needs to to develop and analyse additional scenarios that include:
    a. One or more reference or business as usual scenarios, which incorporate state of good repair;
    b. One or more scenarios with Increased deployment of wind, solar and storage and decreased deployment of nuclear and hydrogen;
    c. A scenario that aligns with the federal Clean Electric Regulations;
    d. A scenario that evaluates 24/7 Carbon-Free Electricity (CFE);[15]
    e. A scenario that evaluates flexibility, consumption and demand reduction actions, independent of the 2019 Achievable Potential Study; and
    f. A scenario that directly aligns with the community climate action pathways.
2. **An Integrated Energy System Analysis:** Because of the transformation of the energy system, decarbonisation scenarios need to be evaluated in a detailed, integrated and bottom-up representation of demand and supply. In the decarbonisation paradigm, the boundaries between demand and supply are dissipating and in this respect, the 2019 Achievable Potential Study is an inadequate foundation.
3. **Review of the IESO Mandate:** The regulatory framework that governs Ontario's electricity commodity market is not aligned with the policy objective of avoiding dangerous climate change. There is a need for a review and modernization of the regulatory framework, including the role and mandate of the IESO.
4. **Regional Disaggregation:** The challenges, impacts and opportunities vary across different regions in Ontario; understanding these dynamics is critical to municipal energy planning. Each scenario needs to address the regional impacts on jobs and household energy expenditures.

[15] The 24/7 Carbon-Free Energy Compact, an UN Energy Compact is supported by a group of energy buyers, energy suppliers, governments, system operators, solutions providers, investors, and other organisations on a mission to transform global electricity grids to "absolute zero" - or full decarbonisation. Municipalities are increasingly adopting the 24/7 target. For example, see: C40 (2022). C40 and Google launch 24/7 Carbon-Free Energy for Cities programme. https://www.c40.org/news/c40-and-google-launch-24-7-carbon-free-energy/

5. **Climate Change Impacts:** The impacts of climate change projections are transforming every aspect of society; these impacts need to be incorporated into projections of electricity demand and supply.
6. **Transparency:** The modelling assumptions used by IESO must be transparent and accessible with an appropriate rationale. For example, what is the basis for the constraints on wind generation and associated transmission costs?
7. **Comprehensive Economic Analysis:** The economic impacts on health outcomes and the social cost of carbon need to be reflected in the economic analysis of scenarios.
8. **Risks:** The risk of stranded assets as a result of the forthcoming Clean Electricity Regulations and technology learning curves needs to be assessed for each scenario, including its impacts on electricity rates for each scenario.
9. **Accounting Scenarios:** GHG reporting needs to align with the international accounting standard for municipalities, the GHG Protocol for Cities, in order that municipalities can assess the impacts of the scenarios on their climate action plans.
10. **Distribution Transformations:** The implications of local climate action plans on distribution systems needs to be reflected in the scenarios.
11. **Localised Energy Planning:** This analysis highlights the imperative to develop integrated localised energy systems planning jointly between municipalities, utilities and the IESO, which includes:
    - **a.** Developing a shared governance model for the planning process
    - **b.** Identifying common objectives
    - **c.** Incorporating community engagement
    - **d.** Ensuring a transparent, evidence-based approach
    - **e.** Developing municipal expertise and capacity on energy systems
    - **f.** Analysing of peak demand and demand management strategies at the community scale for different scenarios
    - **g.** Developing programs, incentives and funding mechanisms that advance municipal objectives

Assessment of IESO's Pathways to Decarbonization Study

From the Perspective of
Municipal Climate Action Plans

SSG