

Building Performance Standards

A Policy Primer for Municipalities
in the Greater Toronto & Hamilton Area

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Foreword

Buildings are the largest source of greenhouse gas emissions in most cities, representing 46% of emissions in the Greater Toronto and Hamilton Area.

Existing building performance standards are taking root in cities across North America as key policies to address these emissions as well as economic, health, and housing priorities. If policymakers in the GTHA design them well, our communities can look forward to healthier buildings that cost less to heat and cool, creating in-demand jobs for local economies and delivering better protection in the next storm, heatwave, or smoke alert.

Performance standards for existing buildings are a proven policy tool already in effect in 11 municipalities across the United States, with another 27 expected to adopt these standards over the next few years. Vancouver was the first Canadian city to introduce building performance standards, and Toronto is working hard to become the first in the GTHA.

By learning from established best practices and working closely with local stakeholders, GTHA officials can regulate the transition to net zero ready buildings using a predictable and phased approach. This gives building operators the opportunity to integrate decarbonization into their asset management plans and execute the required capital upgrades when it is most effective to do so.

With regulatory certainty and clear expectations of targets and timelines for retrofits, owners can improve resiliency and future-proof their buildings against the rising cost of power outages, severe storms, and air pollution.

Higher performance buildings mean that occupants get better ventilation and protection from extreme heat, which are increasingly being linked to cardiovascular and respiratory diseases, increased hospital visits, and premature mortality. The retrofit industry can count on a growing, long-term market for an essential service, enabling companies to invest in training, building capacity, and embracing best practices as they emerge.

At a time when climate and affordability crises are intersecting, we need to increasingly identify policy solutions that not only tackle emission reductions head-on, but also directly address other public priorities. As this research outlines, well-designed and coordinated performance standards for existing buildings in the GTHA have just that potential.



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What are Existing Building Performance Standards?

Building performance standards (BPS) are a key policy tool used to improve the performance of existing buildings.

They typically mandate environmental performance targets that become stricter over time, continuously driving improvement across the existing building stock¹.

Key components of BPS include:

- Building type(s) subject to compliance
- Performance targets
- Compliance timelines
- Compliance management

In addition to helping meet energy and emission reduction goals, BPS policies and programs can be designed to achieve co-benefits for building owners, occupants and broader communities. These include improving occupant health, addressing extreme heat and other thermal comfort related challenges, improving indoor and outdoor air quality, addressing long-term resilience and future proofing against increasing utility costs. BPS can also help encourage investment in renewable energy, energy storage, and electrification² as well as supporting local job creation and skills development.

In the United States, eleven jurisdictions have passed BPS policies or programs and another 27 are part of the National BPS Coalition committed to passing similar

1. ASHRAE. (2023). Building Performance Standards: A Technical Resource Guide. Technical Resources. <https://www.ashrae.org/about/tfbd-technical-resources>

2. United States Environmental Protection Agency. (2023). Benchmarking and Building Performance Standards Policy Toolkit. Energy Resources for State and Local Governments. <https://www.epa.gov/statelocalenergy/benchmarking-and-building-performance-standards-policy-toolkit>



policies³. In Canada, the City of Vancouver is the first jurisdiction to adopt BPS⁴. This primer highlights one national and four international jurisdictions that have implemented BPS, summarizing best practices.

Most jurisdictions target larger commercial and multifamily buildings (e.g., >25,000 ft²), except France which focuses on single-family homes. Best practice recommendations show that jurisdictions need to consider several elements when deciding on building type, including savings potential, potential to address longstanding equity concerns, and degree of outreach or support needed.

Differences exist around the types of performance targets, with jurisdictions using energy-based standards, emission-based standards, or a combination of the two. Performance targets are also expressed as intensity values (e.g., energy or carbon emissions per building floor area) or as an asset rating (e.g., European Union's A-G label). Compliance dates across the case studies vary from 2024 to 2030, with requirements typically being phased in the beginning with larger buildings. And lastly, jurisdictions can take on different approaches to reporting and compliance mechanisms⁵.

3. Institute for Market Transformation. (2023). Building Performance Standards. <https://www.imt.org/public-policy/building-performance-standards/>

4. Institute for Market Transformation. (2023). Vancouver Adopts First Building Performance Standards in Canada. <https://www.imt.org/news/vancouver-adopts-first-building-performance-standard-in-canada/>

5. United States Environmental Protection Agency. (2023). Benchmarking and Building Performance Standards Policy Toolkit. Energy Resources for State and Local Governments. <https://www.epa.gov/statelocalenergy/benchmarking-and-building-performance-standards-policy-toolkit>



About

Benefits of Adopting Building Performance Standards

City and Community Benefits

- Alignment with climate action goals and building resiliency strategies
- Reduced building emissions, which are one of the leading sources in large urban areas
- Addressing extreme heat in buildings
- Supporting local economies by generating employment opportunities and access to in-demand local jobs as well as training opportunities for local workers - the City of Toronto's Net Zero Existing Building Strategy estimates that if the proposed retrofit pathway is taken, 18,100 full-time jobs will be created in local construction, energy services and supportive work over a 30-year period⁶⁻⁷
- Opportunity to engage communities and address social equity challenges, specifically in frontline, marginalized communities

Benefits to Building Owners

- Setting medium and long-term mandatory targets helps to establish regulatory certainty and a level playing field. Clear expectations are set for building owners (based on building size and type), helping to reduce the risk of stranded assets.
- Improving building climate resiliency and future proofing against rising utility costs: investment in energy efficiency measures and renewables help building systems become less susceptible to power outages, extreme weather storms and other disruptions, as well as to air pollution and smoke impacts⁸.
- Opportunity to transform ageing building stock, increasing property values and becoming more attractive to tenants, investors, and buyers.

6. The City of Toronto. (2021). The City of Toronto's Net Zero Existing Buildings Strategy. <https://www.toronto.ca/legdocs/mmis/2021/ie/bgrd/backgroundfile-168403.pdf>

7. The City of Toronto. (2021). The City of Toronto's Net Zero Existing Buildings Strategy. Impact Modeling & Assessment Technical Appendix. <https://www.toronto.ca/wp-content/uploads/2021/10/907c-Net-Zero-Existing-Buildings-Strategy-2021.pdf>

8. San Francisco study found that after a 7.9 magnitude earthquake, gas service to buildings would take six months to restore, while electricity services could be restored within several weeks (<https://sfenvironment.org/zebtaskforce>)



- Reducing adverse health impacts on building occupants during periods of extreme heat or prolonged heat.
- Supporting programs and mechanisms alongside BPS can help address the technical and financial challenges experienced by some building owners, particularly in the affordable housing sector⁹. These programs can help building owners realize the full retrofit benefits and reduce instances of displacing tenants.

Benefits to Tenants

- Building retrofits can help reduce exposure to extreme heat and address instances of poor ventilation (which are increasingly being linked to exasperating cardiovascular diseases, acute respiratory diseases, asthma, allergies, sick building syndrome, and mental illnesses¹⁰).
- Reduced utility bills, in cases where tenants pay their own bills.
- Non-compliance fees can be used towards equitable emission investment funds to support marginalized communities, targeting affordable housing programs¹¹.
- Supporting programs and mechanisms alongside BPS can be designed to provide financial assistance to protect against significant rent increases in the affordable housing stock¹².

9. ASHRAE. (2023). Building Performance Standards: A Technical Resource Guide. Technical Resources. <https://www.ashrae.org/about/tfbd-technical-resources>

10. San Francisco Department of Public Health. (2023). Assessing the Health Co-benefits of San Francisco's Climate Action Plan. <https://sfclimatehealth.org/>

11. ACEEE. (2023) Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals. <https://www.aceee.org/research-report/b2303>

12. ACEEE. (2023) Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals. <https://www.aceee.org/research-report/b2303>



Case Studies

Building Performance Standards in Action

Five jurisdictional case studies are highlighted in this section:



Vancouver
Adopted 2022

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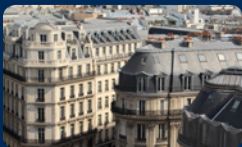
New York City
Adopted 2019

[PAGE 9](#)



Boston
Final ordinance adopted 2021

[PAGE 11](#)



France
Adopted 2015, and 2021

[PAGE 12](#)



Netherlands
Amended 2018

[PAGE 13](#)

Case Studies

Vancouver: Annual Greenhouse Gas and Energy Limits By-Law¹³

Key Outcomes

- Help reduce carbon emissions in buildings by 50% by 2030 and 100% by 2050
- Incentivize building electrification

Compliance Management

- Building owners report their total carbon emissions and energy consumption of the previous calendar year through an Annual Emissions Report
- Records inspections and on-site inspections can be performed at any time to verify information
- Alternative compliance is also possible through the purchase of eligible renewable energy credits.
- Building owners need to amend any incomplete or inaccurate reports within 30 days of discovering the inaccuracy or incompleteness.
- Non-compliance: \$350/tonne of CO₂ exceeding allowable limit, \$100/GJ exceeding heat energy limit

Additional Highlights

- Carbon limit is based on onsite fossil fuel consumption for space and water heating primarily from natural gas.
- Phased deadlines for equipment replacement starting in 2026 (heating units, make up air units, fireplaces and decorative gas appliances) and sub-metering.
- Regional Governing Authority looking to adopt similar standards to cover areas around Vancouver.

Performance Targets

by 2024

Commercial buildings >100,000 ft²

Annual energy and carbon reporting

by 2025

Commercial buildings >50,000 ft² AND multi-family >100,000 ft²

Annual energy and carbon reporting

by 2026

Commercial + multi-family buildings >50,000 ft²

Annual energy and carbon reporting

- GHG intensity limits for:
- 25 kgCO₂e/m² per year for office buildings
- 14 kgCO₂e/m² per year for retail buildings

(Note 2030 interim targets are expected to be published by 2026.)

by 2040

Commercial + multi-family buildings >50,000 ft²

0 kgCO₂e/m² per year
+ additional heat energy limits for commercial buildings

13. City of Vancouver. (2022). Annual Greenhouse Gas and Energy Limits By-law No. 13472. <https://bylaws.vancouver.ca/consolidated/13472.pdf>

Case Studies

New York City: LL97¹⁴

Key Outcomes

- Help reduce GHG emission by 40% by 2030 and 80% by 2050 (2005 baseline)
- Help meet City Government buildings targets of 40% by 2025, 50% by 2030 (2006 baseline year)
- New York City Housing Authority (NYCHA) buildings: make best efforts to reduce emissions by 40% by 2030 and 80% by 2050 (2005 baseline year)

Compliance Management

Building owners submit an annual Energy Efficiency Report (EER) by May of each year (first compliance report is due May 2025). Reports to include data on energy consumption, emissions, energy sources used, and actions taken to lower emissions

Building owners can either:

- 1) Meet carbon limits through energy efficiency (including renewables/storage);
- 2) Purchase eligible Renewable Energy Credits (RECs); and/or
- 3) Follow a list of prescriptive energy conservation measures

Non-compliance: \$268 USD for every metric ton of CO₂¹⁵ exceeding allowable limit, or requirement to buy carbon offsets or eligible RECs. There are also penalties for failure to file report or providing false statement

Persistent violations can result in additional fines and revocation of building permits or certificates of occupancy

Performance Targets

New and existing mid-rise and high-rise buildings >25,000 ft²

(including multifamily, commercial, and institutional)¹

2024-2029

Multi-family:
6.75 kgCO₂e/ft²
Office:
8.46 kgCO₂e/ft²

2030-2035

Multi-family:
2.69 kgCO₂e/ft²
Office:
3.35 kgCO₂e/ft²

2035-2040

Multi-family:
1.65 kgCO₂e/ft²
Office:
2.69 kgCO₂e/ft²

2040-2050

Multi-family:
0.58 kgCO₂e/ft²
Office:
2.05 kgCO₂e/ft²

14. City of New York. (2023). Local Law 97. Sustainable Buildings. <https://www.nyc.gov/site/sustainablebuildings/1197/local-law-97.page>

15. Equivalent to approximately \$326 CAD/tonne (based on \$1.34CAD=\$1USD exchange rate).

1. For a full list of emission limits for hotels, supermarkets, data centers, grocery stores see <https://www.urbangreencouncil.org/what-we-do/driving-innovative-policy/1197/>

Additional Highlights

- Approximately 11% of buildings will need to make changes to meet the 2024-2029 cap (compliance has been faster than expected), and over 75% will need to make changes to meet the 2030-2035 cap.
- Policy captures 50,000 buildings, 60% of NYC building floor area and 50% of the City's building emissions¹⁶.
- Affordable and income-restricted buildings have delayed or altered requirements.
- Policy allows for an annual carbon trading system so buildings that do not meet emissions can buy credits from buildings that are below limits (currently under study).
- The policy specifies carbon content for each fuel type. Electricity emission factors are expected to go down over time (e.g., 2030-2035 factor is 50% lower than the 2024-2029 factor). Deadline is set to develop factors beyond 2030¹⁷.
- To help address concerns that building owners should not be responsible for the emissions of the electrical grid, emissions are calculated by multiplying total energy consumption of each fuel type used on site by a specified carbon coefficient.

16. Urban Green Council. (2023). What is Local Law 97? <https://www.urbangreencouncil.org/what-we-do/driving-innovative-policy/1197/>

17. ACEEE. (2023) Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals. <https://www.aceee.org/research-report/b2303>

Case Studies

Boston: Building Energy Reporting and Disclosure Ordinance¹⁸⁻¹⁹

Key Outcomes

- Achieve net zero emissions across all buildings over 20,000 ft² or 15 units by 2050.
- Encourage adoption of energy efficiency measures, fuel switching, investment in renewable energy

Compliance Management

- Buildings need to report energy and water use annually as well as purchased RECs or Alternative Compliance Payments (ACPs). Third-party verification is required every five years.
- ACPs can be purchased at \$234 USD/tCO₂ (costs to be updated every five years) for emissions over targets.
- Failure to report: \$300 USD/day for large buildings over 35,000 ft² and \$150 USD/day for smaller buildings
- Non-compliance with emissions: \$1,000 USD/day for large buildings over 35,000 ft² and \$300 USD/day for smaller buildings

Additional Highlights

- ACPs are collected in an Equitable Emissions Investment Fund to support marginalized communities. An Emissions Review Board will oversee funds, with two-thirds of members from local community organizations.

Performance Targets

2025-2029

Commercial buildings
>35,000 ft² + residential
>35 units

Multi-family:
4.1 kgCO₂e/ft²,

Commercial:
5.3-19.2 kgCO₂e/ft²

2030-2034

Commercial buildings
>20,000 ft² + residential
>15 units

Multi-family:
2.4 kgCO₂e/ft²,

Commercial:
2.8-11.1 kgCO₂e/ft²

by 2050

Emission standards
continue to scale down
every five years

0 kgCO₂e/ft² for all sectors

18. ACEEE. (2023) Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals. <https://www.aceee.org/research-report/b2303>

19. City of Boston. (2021). Ordinance Amending City of Boston Code. Building Energy Reporting and Disclosure (BERDO). https://www.cityofboston.gov/images_documents/Signed%20Ordinance_tcm3-38217.pdf

1. Emission standards are based on commercial building type. The lowest are for storage facilities and office buildings, while the highest are for technology/science buildings. For a full list visit https://www.cityofboston.gov/images_documents/Signed%20Ordinance_tcm3-38217.pdf

Case Studies

France: Energy Transition Toward Green Growth Act + Climate and Resilience Law ²⁰⁻²¹⁻²²

Key Outcomes

- Reduce fossil fuel consumption by 40% by 2030 and help achieve carbon neutrality by 2050
- Target 500,000 home renovations per year (with half occupied by low-income households).
- A 15% reduction in fuel poverty by 2020.

Compliance Management

- After 2022, real estate transactions need to provide building audits specifying what measures need to be done to bring buildings into compliance.
- After 2025, Buildings cannot be sold if they are below performance requirements, and tenants or purchasers can take legal action against building owners for non-compliance (2021 law update)

Additional Highlights

- Other parts of the act call for reducing 60% of energy consumption in commercial buildings by 2050 (baseline 2010).
- The law includes measures to support installing renewables and specifically targeting heat loss.
- A two-tiered grants system (MaPrimeRénov) is available for homeowners, landlords, and condo properties. The first tier is for specific energy saving measures, while the second targets minimum 35% energy reductions. Other support programs include interest-free loans and one-stop shop renovation platforms.

20. European Union member countries, rather than individual cities, enact BPS under the European Union's Energy Performance and Buildings Directive (EPBD).

21. ACEEE. (2023) Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals. <https://www.aceee.org/research-report/b2303>

22. European Commission. (2021). Impact Assessment Report Accompany the Proposal for a Directive of the European Parliament and of the Council on the Energy Performance of Buildings. <https://data.consilium.europa.eu/doc/document/ST-15088-2021-ADD-4/en/pdf>

Performance Targets

By 2025

Renovate all private residential buildings with primary energy consumption >330 kWh/m²

Upgrade G-rated buildings to a minimum D-rated level

by 2028

F-rated buildings to a minimum D-rated level¹

by 2034

E-rated buildings to a minimum D-rated level.

1. F-and-G rated buildings represent approximately 15% of the housing stock.

Case Studies

The Netherlands: Building Decree²³⁻²⁴

Key Outcomes

- Target 62,000 out of the 96,000 office buildings in the Netherlands
- Increase investment in renovations within the commercial sector.

Compliance Management

Noncomplying buildings are no longer permitted to be used as office buildings. Buildings cannot be sold if they are below C-level requirements, and tenants or purchasers can take legal action against building owners for non-compliance.

Additional Highlights

- As of 2022, 50% meet the requirement, 11% need to undertake work to come into compliance, and 39% do not yet have a rating²⁵.
- The measures required to reach C-level need to have a payback period of 10 years. Owners and tenants do not need to install measures that result in a higher payback period, even if a C-level is not reached.
- The C-level rating is based on calculated energy use and an Energy Efficiency Index ranges from A+ (most efficient) to G (least efficient). It is equivalent to approximately 225 kWh/m².²⁶
- There are exemptions for historic buildings and buildings where less than 50% of the floor area is used for offices.
- The C-level rating is expected to be incrementally improved in the future (no specific regulations have been suggested).
- Buildings that lack a plan to achieve C-level rating will have increasing difficulty in securing bank financing.

Performance Targets

As of 2023

Office buildings need to have an equivalent C-level rating

(law was adopted in 2018 giving 5 years for compliance).

23. ACEEE. (2023) Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals. <https://www.aceee.org/research-report/b2303>

24. National Law Review. (2018). Energy Label C Obligation for All Office Buildings in the Netherlands in 2023 (With Few Exceptions). <https://www.natlawreview.com/article/energy-label-c-obligation-all-office-buildings-netherlands-2023-few-exceptions>

25. NL Times. (2021). Quarter of Dutch Offices Still Not Energy Efficient Enough. <https://nltimes.nl/2021/06/16/quarter-dutch-offices-still-energy-efficient-enough>

26. Business Government Netherlands. (2023). Building Regulations. <https://business.gov.nl/regulation/building-regulations/#::-:text=This%20decree%20contains%20the%20technical,energy%20efficiency%20and%20the%20environment>

Summary

Getting it Right

Getting BPS right is critical for municipalities to reach their climate targets.

Careful consideration must be given to ensure maximum public benefits for the community and no additional public harms are created. For example, policies must consider and protect affordability for tenants and fair timelines that reflect market readiness. Both will be important to ensure policies are fair and supported by the community.

TAF recommends that municipalities consult their local stakeholders on the following:

Policy Design

- ✓ Target setting, metrics, and timelines
- ✓ Compliance mechanisms
- ✓ Verification processes and data gathering
- ✓ Use of non-compliance fees

Affordability and Equity

- ✓ Protection of low-and-middle income renters
- ✓ Holistic cost-benefit analysis
- ✓ Future proofing against rising utility costs
- ✓ Climate resiliency

Industry Readiness

- ✓ Workforce size, training, and skills development
- ✓ Availability of products and building materials
- ✓ Access to capital
- ✓ Technical and financial support for building owners



Best Practices

Stakeholder consultation is important in understanding the building stock and ownership types as well as identifying concerns and gathering solutions.

Jurisdictions that have implemented BPS recommend starting stakeholder consultations early, gathering feedback from building owners, design community and trades, utilities, and community-based organizations²⁷.

Some jurisdictions have city staff lead this process, while others, like in Boston, contract a community organization to gather feedback from specific stakeholder groups.

Building benchmarking data is a helpful starting point when developing performance targets.

Most jurisdictions undergo a benchmarking analysis to better understand current building performance and inform the performance targets setting process.

Where such data was not readily available, like in the case of Vancouver, computer models and benchmarked data from a similar climate (Seattle) were used.

Including site energy and carbon intensity targets can help drive energy efficiency improvements and building decarbonization.

Jurisdictions have a few choices when selecting the metrics for BPS targets. Some specify carbon intensities (Vancouver, New York, Boston), which directly addresses the primary goal of reducing emissions.

However, this approach could result compliance through inefficient electrification (e.g., electric resistance instead of heat pumps). It may also create challenges in planning for compliance with long term targets given uncertainty around the future carbon intensity of the electricity grid.

Other jurisdictions use energy intensities (Denver, Maryland), placing greater emphasis on efficiency over fuel switching. However, energy intensity is poorly correlated with carbon emissions. The emerging best practice is to combine site-based carbon and energy targets, ensuring a focus on both efficiency and fuel switching to lower carbon energy sources. Uncertainty over the future carbon intensity of the grid is resolved by excluding electricity emissions from the carbon target.

27. ACEEE. (2023) Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals. <https://www.aceee.org/research-report/b2303>



Provide both interim and long-term targets: long-term targets enable regulatory certainty while interim targets help ensure continued progress.

Many North American jurisdictions use a combination of interim and long-term targets to give building owners and industry the flexibility to time and undertake retrofits that fit within building capital replacement cycles. Long-term targets provide a clear direction of where the building sector needs to go and are critical for asset planning.

Interim targets can be met with more limited investment by building owners, giving them the flexibility to time big expenditures in a way that fits with their planning, avoiding premature replacement of major systems.

Phase-in BPS requirements, either by building size and/or by building type.

Many jurisdictions use a combination, starting with the largest buildings (e.g., commercial, multi-family) before phasing in smaller buildings or other archetypes.

This helps prepare the retrofit market, allowing time for goods and services to ramp up in a particular jurisdiction.

This phased approach also allows cities to expand their own compliance management capabilities as well as address any training or capacity needs.

Integrate the priorities of marginalized communities when developing BPS goals.

BPS are an important way to address many of the concerns that marginalized communities face, including improving the quality and affordability of the existing building stock, maximizing health outcomes, and scaling local job creation.

Community representatives and equity experts need to be empowered to participate in the goal setting process and jurisdictions need to establish mechanisms in place for tracking and reporting progress against these goals²⁸.

Ensure there are financial incentives and mechanisms in place to support building owners and improve compliance.

Most jurisdictions with BPS have education and technical support programs in place for building owners, as well as incentives and other forms of financial support (e.g., tax incentives, utility incentives, early adopter incentives).

A two-tiered penalty system is also recommended for non-compliance, where more modest penalties are given to first-time buildings not meeting targets, and more substantial penalties are for multiple years of non-compliance²⁹.

28. Institute for Market Transformation. (2023). Short Building Performance Standard Model Law. <https://www.imt.org/resources/short-building-performance-standard-model-law/>

29. ACEEE. (2023) Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals. <https://www.aceee.org/research-report/b2303>



Additional Resources

Further Reading

For further information on building performance standards, please visit the following resources:

- Canadian Environmental Law Association || Commissioned by TAF: [Recommendations for Municipalities: Mandatory Building Performance Standards](#)
- American Council for an Energy Efficient Economy (ACEEE): [Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals](#)
- ASHRAE and DOE: [Building Performance Standards - A Technical Resource Guide](#)
- IMT: [Building Performance Standards Implementation Guide](#)
- US EPA: [Building Performance Standards Policy Toolkit](#)

Feedback & Engagement

On October 10, 2023, TAF convened municipal, community, and industry representatives for the *Dan Leckie Forum to advance building performance standards in the GTHA*.

- For a summary of key takeaways, read [Insights Uncovered from the 2023 Dan Leckie Forum](#)
- To submit feedback or participate in future engagements, contact us at policy@taf.ca





We're a regional climate agency that invests in low-carbon solutions for the Greater Toronto and Hamilton Area and helps scale them up for broad implementation.

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