Carbon Tax Issues in the Transportation Sector –
Focus on International Aviation and Marine Emissions

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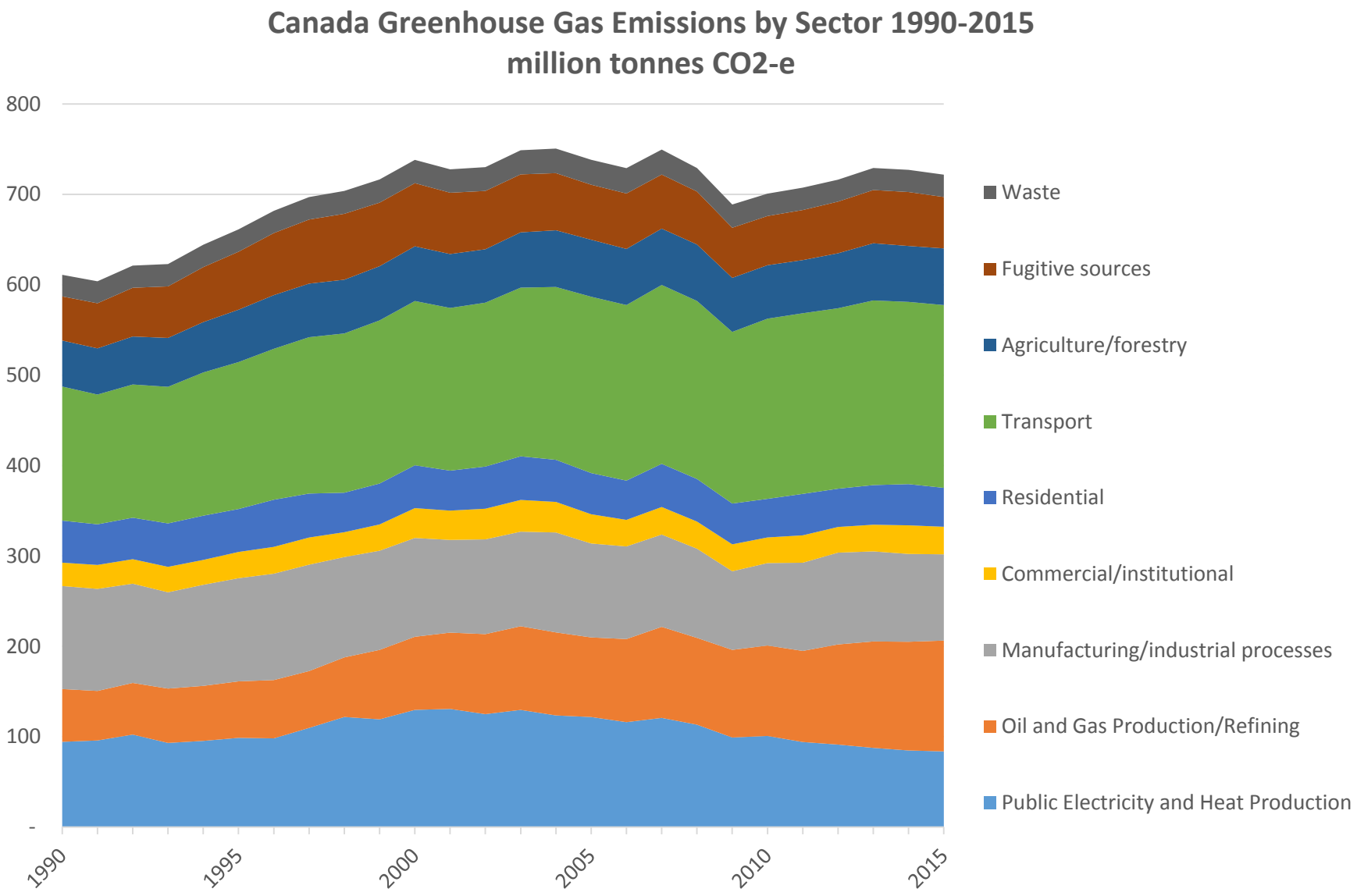
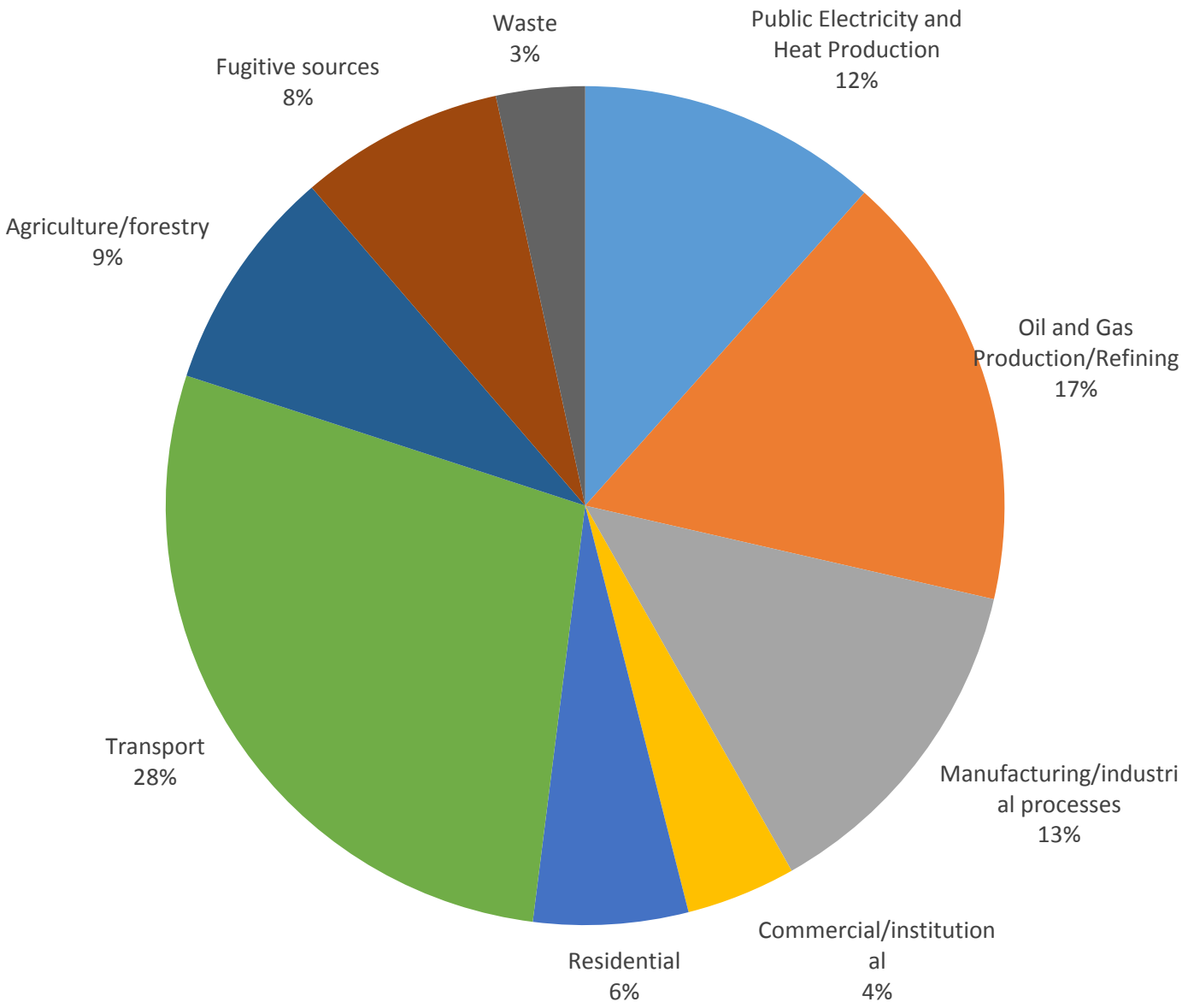
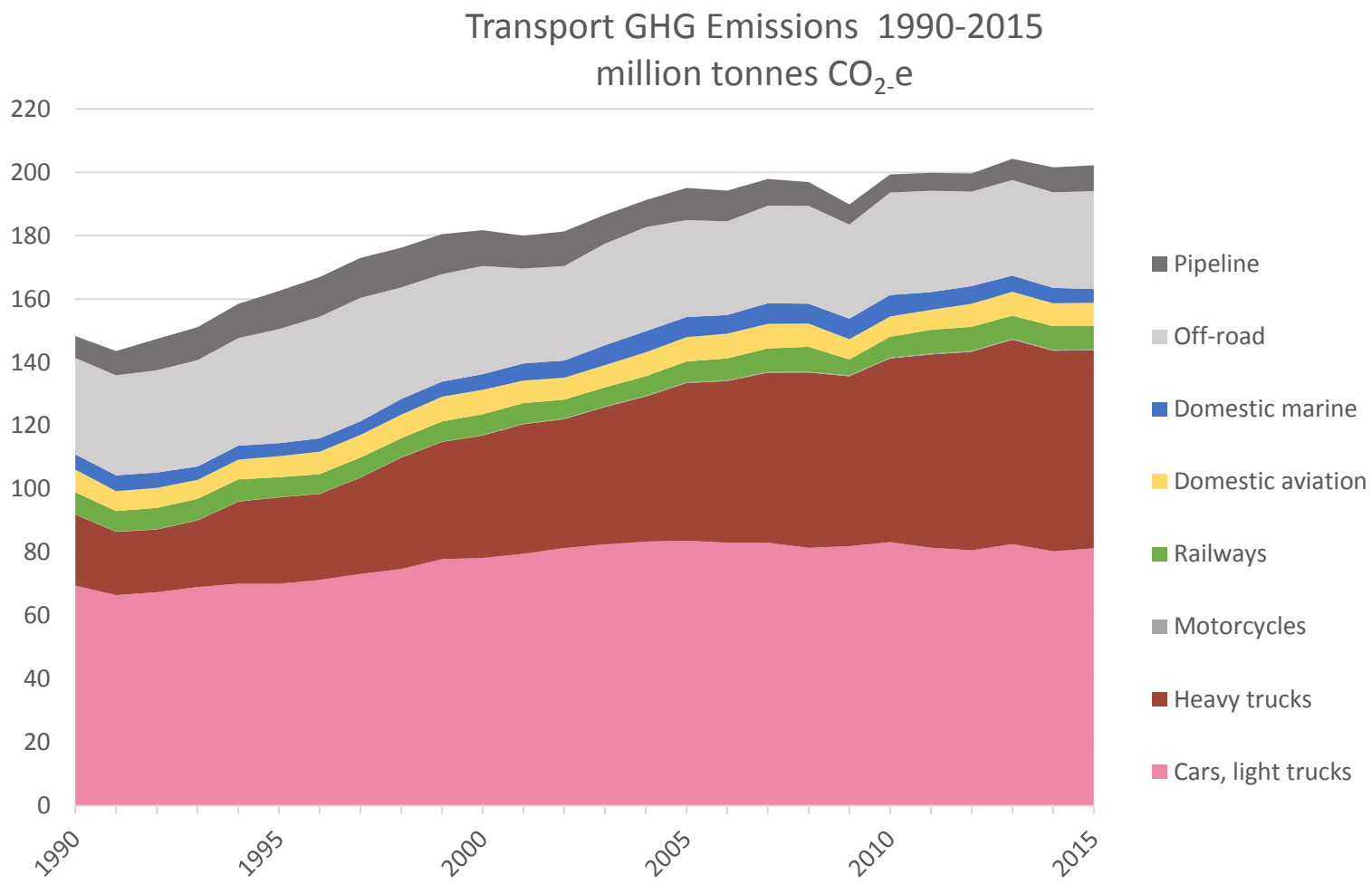


Source: Environment Canada: *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada*, 2017

Canada Greenhouse Gas Emissions by Sector 2015
Total 722 Mt CO_2-e



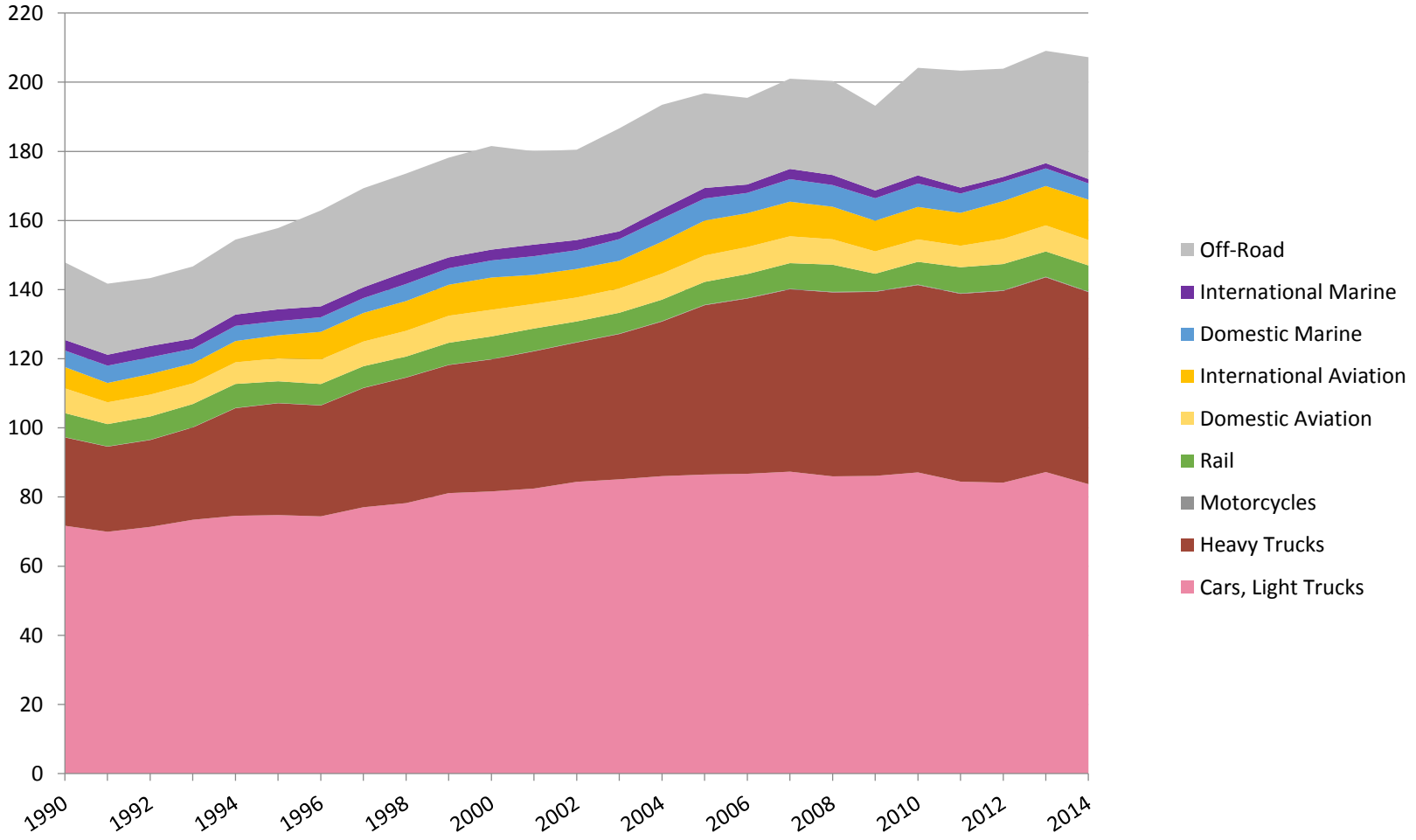
Source: Environment Canada: *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada*, 2017



These are the official transport sector categories required to be reported according to IPCC guidelines. They include pipeline, but exclude international aviation and marine emissions.

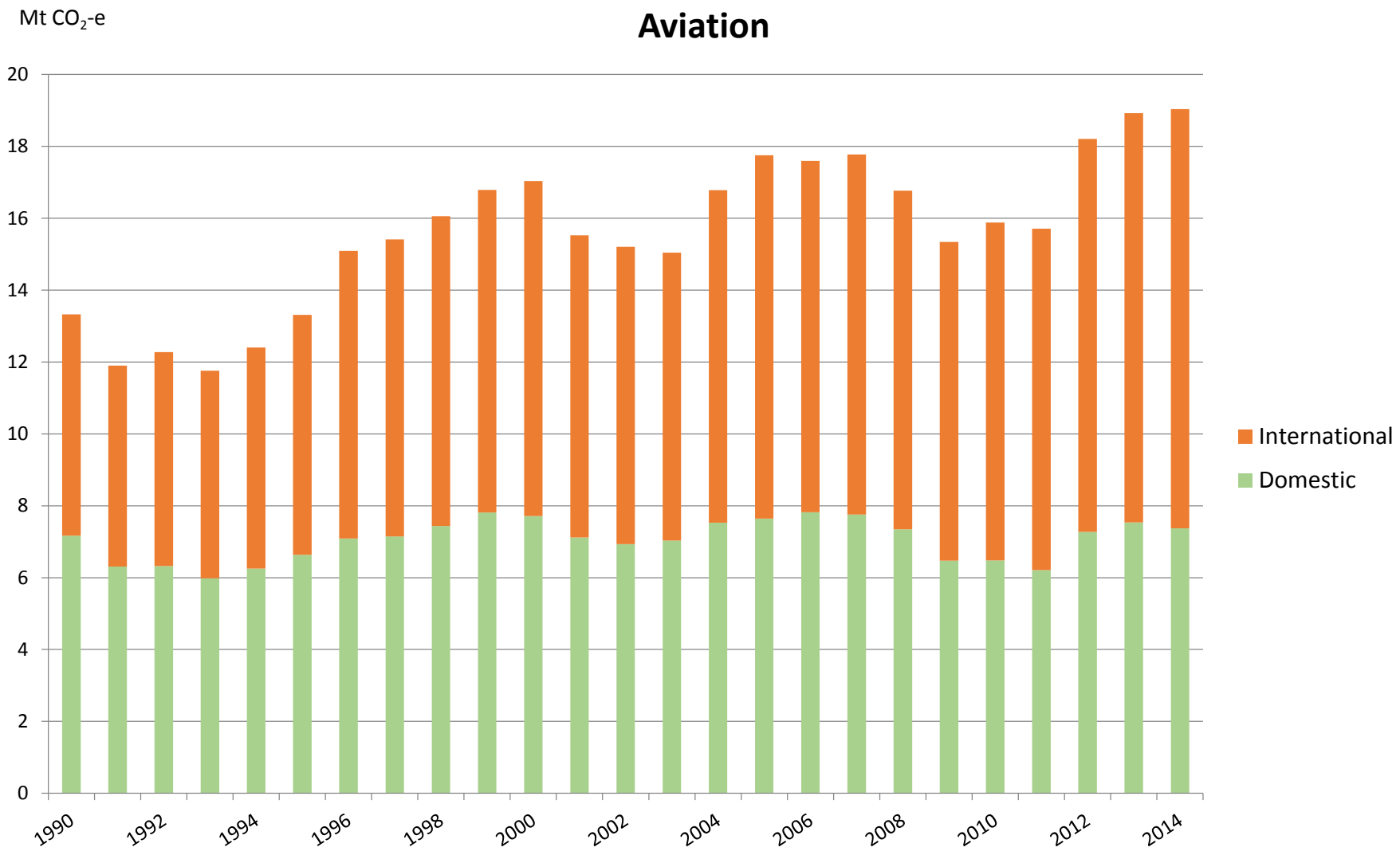
Source: Environment Canada: *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada*, 2017

Transport GHG Emissions Canada 1990-2014 (Mt CO_2-e)



These are transport sector categories included in Environment Canada's inventory model (MGEM). They exclude pipeline, but include international aviation and marine emissions (available at the detailed level only to 2014).

Source: Environment Canada Mobile GHG Emissions Model (MGEM) provided privately to the author, 2017.



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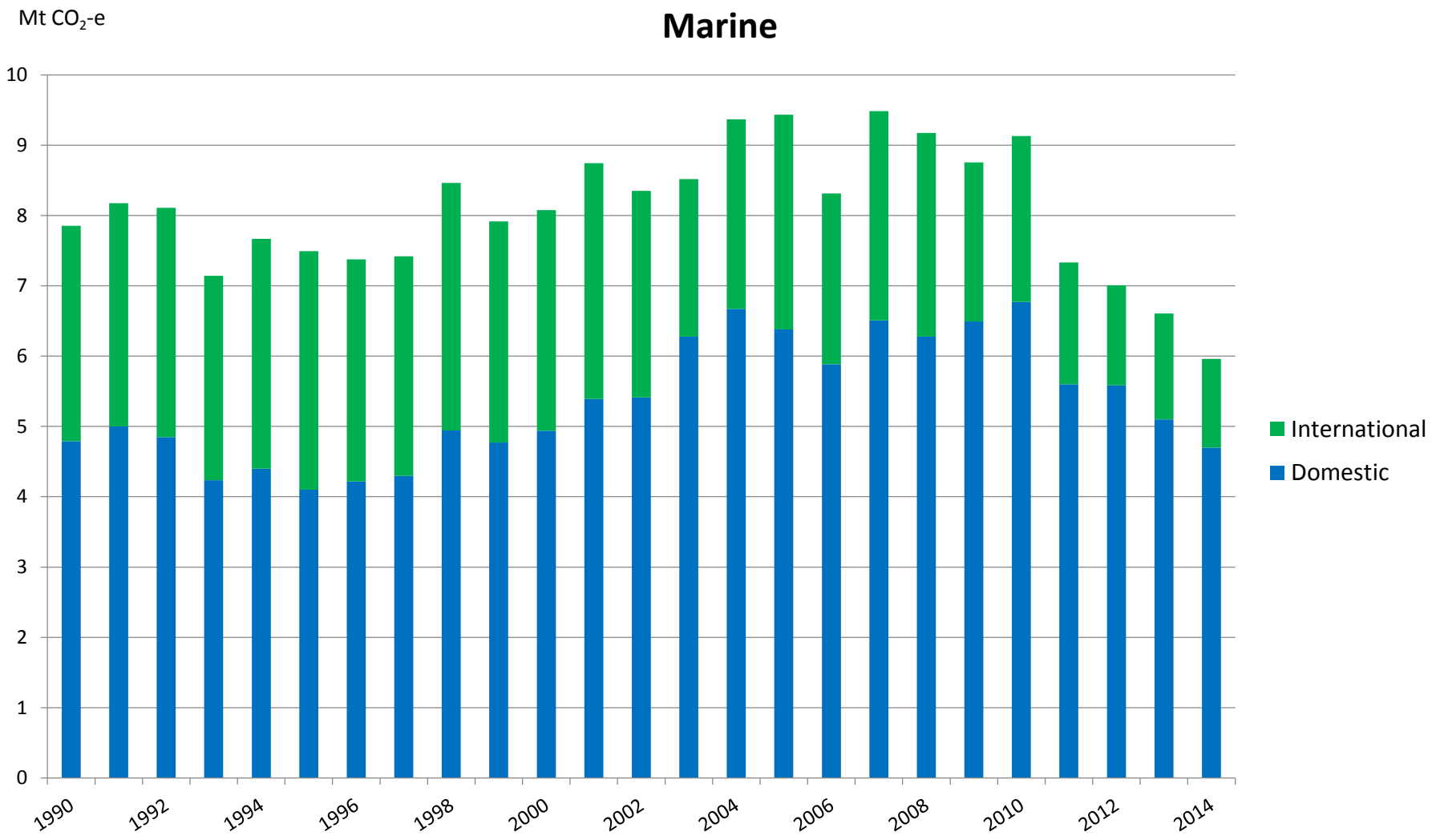

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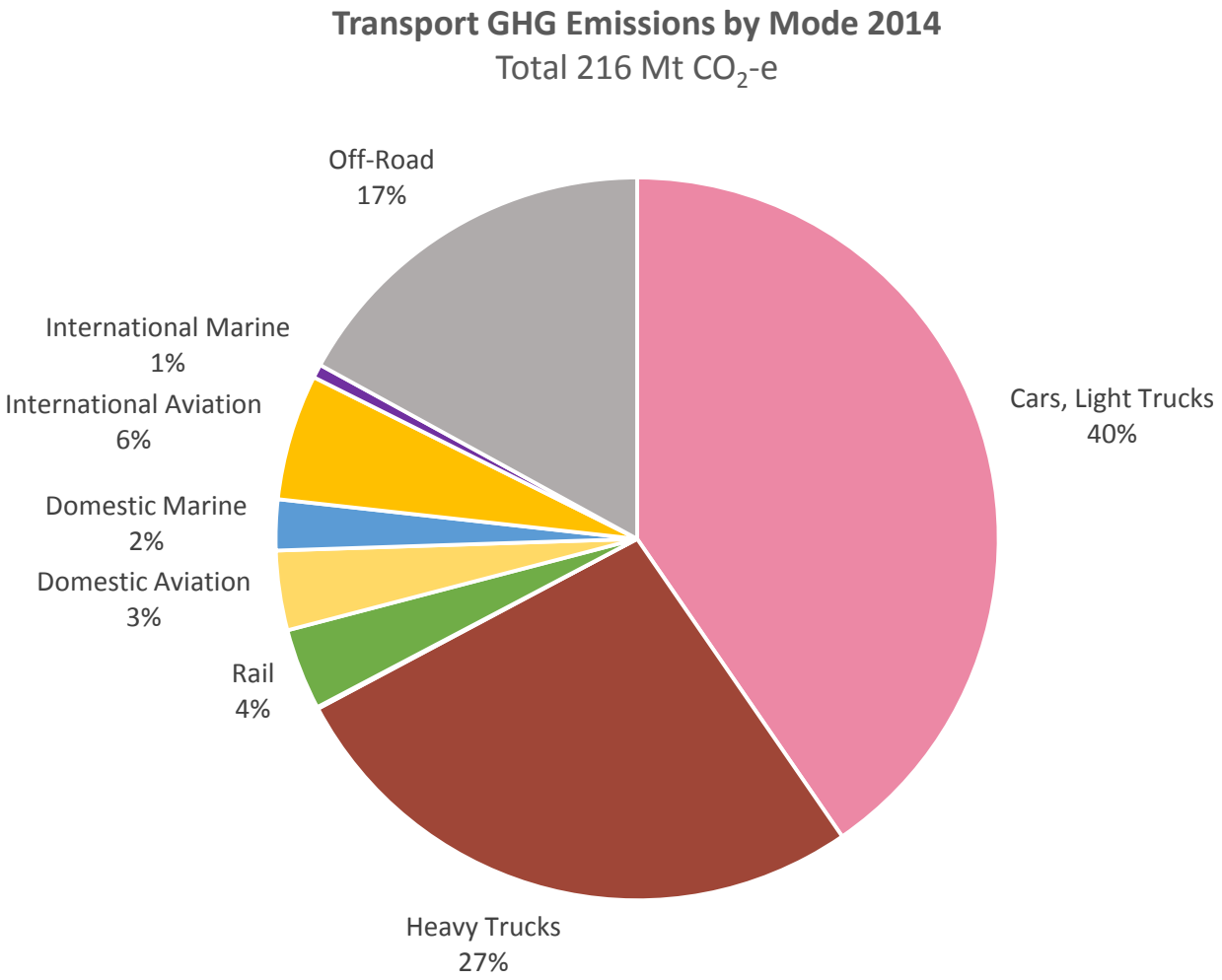
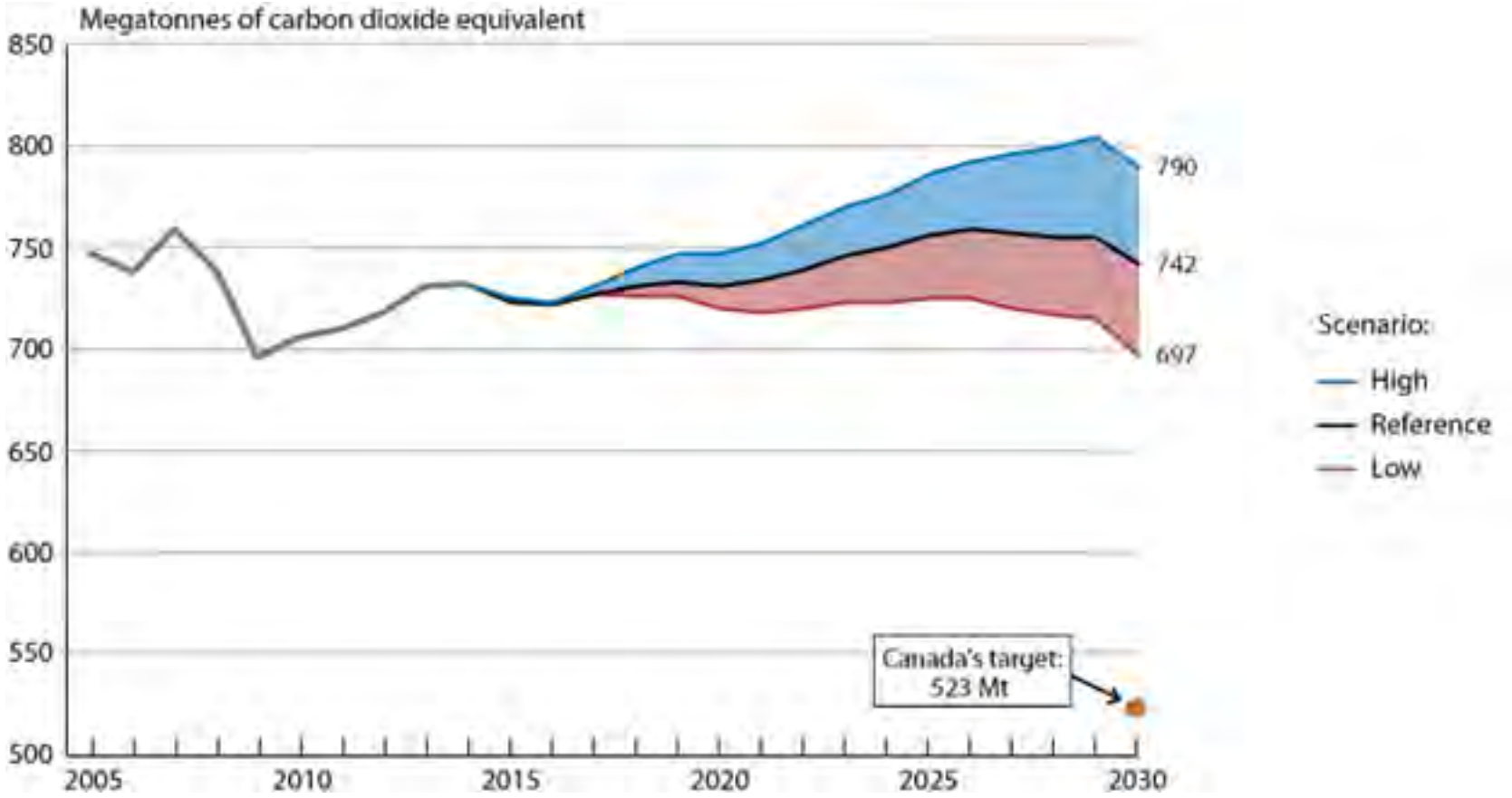


Source: Environment Canada Mobile GHG Emissions Model (MGEM) provided privately to the author, 2017.

Federal emission forecasts and target



Source: Environment Canada: "Progress Towards Canada's Greenhouse Gas Emissions Reduction Target," February 2017,
http://www.ec.gc.ca/indicateurs-indicators/CCED3397-174A-4F0E-8258-91DCFE295B34/ProgressTowardsCanadaGHGEmissionsTarget_EN.pdf

Federal Carbon Pricing proposal

Emission charges

- Charge per tonne CO_2e of $10/tonne in 2018 rising by $10 per year to $50/tonne in 2022.
- Pricing by Provs/Terrs through carbon taxes or cap-and-trade systems with same effective prices.
- "Backstop" of Federal carbon taxes if Provs/Terrs fail to act.
- Applies essentially to fossil fuels purchased for use in Canada.

Additional "Output-Based Pricing System":

- To be applied to all industrial facilities with annual emissions of at least 50kt
- Emissions targets per unit of output to be determined from sectoral best quartile practice.
- Credits to be allowed for emissions below target.
- Purchased credits to be submitted or payments at carbon tax rates made for emissions above target.
- System to operate from 2019, administered by Environment Canada.

Source: Environment Canada: "Technical Paper on the Federal Carbon Pricing Backstop," 2017.
https://www.canada.ca/content/dam/eccc/documents/pdf/20170518-2-en.pdf

Federal proposal for transportation fuels

Inter-Jurisdictional Commercial Transportation Requirements

Road and Rail

- Levy will apply to all fuel used domestically, including
  - movements with both domestic O & D, or
  - for international movements, the fuel used in the domestic portion.
- Applies equally to fuel used domestically if purchased outside Canada.

Marine and Aviation

- Levy will apply only to fuel used for domestic movements
- No levy on fuel used for international movements
- Applies to fuel purchased outside Canada and used for domestic movements.

Source: Environment Canada: "Technical Paper on the Federal Carbon Pricing Backstop," 2017.
https://www.canada.ca/content/dam/eccc/documents/pdf/20170518-2-en.pdf

Provincial actions on transportation fuels

BC carbon tax:
- Currently $30/tonne CO_2e, rising to $50/tonne in 2021
- Aviation and marine fuels for inter-jurisdictional or international movements exempt
- Fuel for intra-BC movements not exempt.

AB carbon levy:
- Currently $20/tonne CO_2e, rising to $30/tonne in 2018
- Aviation fuel for inter-jurisdictional or international movements exempt
- Fuel for intra-AB movements not exempt.

ON carbon cap-and-trade program:
- Aviation and marine fuels excluded.

QC carbon cap-and-trade program:
- Aviation and marine fuels excluded.

Source: Environment Canada: "Technical Paper on the Federal Carbon Pricing Backstop," 2017.
https://www.canada.ca/content/dam/eccc/documents/pdf/20170518-2-en.pdf

GHG emission factors

Fuel	Grams per litre			
	CO_2	CH_4	N_2O	CO_2-equivalent
Road gasoline	2,165	0.174	0.126	2,208
Road diesel	2,643	0.109	0.151	2,692
Rail diesel	2,643	0.151	1.041	2,969
Marine diesel	2,632	0.255	0.073	2,660
Aviation gasoline	2,365	2.190	0.230	2,482
Aviation turbo	2,560	0.063	0.071	2,583

Source: Emission Factors from Environment Canada Mobile GHG Emissions Model (MGEM) provided privately to the author, 2017.

Carbon tax examples

$/tonne CO_2e	¢/litre gasoline	¢/litre diesel	¢/litre residual fuel oil	¢/litre aviation turbo
10	2.21	2.80	3.19	2.58
20	4.42	5.60	6.37	5.17
30	6.63	8.40	9.56	7.75
40	8.84	11.21	12.75	10.33
50	11.05	14.01	15.93	12.92
100	22.11	28.02	31.87	25.83
200	44.21	56.03	63.74	51.67

Why are international aviation fuels tax-exempt?

Major concern in forging international agreements on reciprocal access for aviation and marine carriers that they not be subjected to discriminatory fees, double-taxation or tax grabs.

- 1944 UN Convention on International Aviation (Chicago Convention):
  - Established ICAO
  - Article 15 prohibited discriminatory charges on foreign carriers for airports or navigation services.
  - Article 24: fuel brought into a country and retained on board when leaving shall be exempt from customs duty or other local charges.
- Contracting States accepted in Bilateral Agreements to refrain from taxes or duties on aircraft engaged in international aviation or on fuel and oil on-board the aircraft.

- ICAO Resolution 8632 adopted in 1966 explicitly exempted fuel for international aviation from local taxes:

  "When an aircraft registered in one State … departs from an international airport of another State ... the f*uel, lubricants and other consumable technical supplies taken on board for consumption during the flight shall be furnished exempt from all customs and other duties… The expression "customs and other duties" shall include import, export, excise, sales, consumption and internal duties and taxes of all kinds levied upon the fuel, lubricants and other consumable technical supplies."*

Aviation (contd):
WORLDWIDE AIR TRANSPORT CONFERENCE (ATCONF)
SIXTH MEETING Montréal, March 2013 *
Taxation of and other levies on international air transport

- "Air carriers have encountered situations where taxes on the sale or use of international air transport are in contradiction to the ICAO policies on taxation as contained in Doc 8632."

- " … proliferation of taxes during the last ten years, some examples are … taxes levied on air passengers, but not levied on other modes of international transport, … introduced under various names, such as "air passenger duty", "air transportation tax", "air travel tax", etc…. Other taxes, for purposes outside aviation, such as "Solidarity" taxes established to combat different types of diseases … clearly discriminate against air transport, as they should not be levied on a particular sector. …Other States impose value added tax (VAT) and various sales taxes on fuel and other items purchased within their borders although used in international air transportation…"

- "ICAO makes a clear distinction between user charges and taxes. As defined by the ICAO Council, a charge is a levy that is designed and applied specifically to recover the costs of providing facilities and services for civil aviation, and a tax is a levy that is designed to raise national or local government revenues, which are generally not applied to civil aviation in their entirety or on a cost-specific basis."

- **Among the conclusions: "**ICAO has clear policies on taxation and user charges, which remain valid. States should be urged to apply these policies in their regulatory practices, in accordance with Assembly Resolutions…"

*https://www.icao.int/Meetings/atconf6/Documents/WorkingPapers/ATConf6-wp010_en.pdf

Why are international marine fuels tax-exempt?

- Similar concern in forging international agreements on reciprocal access for marine and aviation carriers that they not be subjected to discriminatory fees or tax grabs:

    - 1948 UN Convention on the International Maritime Organisation:
      "… To encourage the removal of discriminatory action and unnecessary restrictions by Governments affecting shipping engaged in international trade so as to promote the availability of shipping services to the commerce of the world without discrimination…"

- No IMO prohibition of taxes and fees.

- Serious concern about carriers' ability to buy fuel in lower-priced jurisdictions.

- Consequently no taxes on fuels for international movements.

Why are international aviation and marine GHG emissions excluded from national targets?

- The simple answer is that there was no agreement on how international emissions should be allocated among countries, in assigning responsibility for their mitigation.

- The United Nations Framework Convention on Climate Change (UNFCCC) of 1994 assigned responsibility for guidance on identifying and reporting national emissions to the Intergovernmental Panel on Climate Change (IPCC).

- Various alternative methods of assigning international aviation and marine emissions were assessed, but rejected, and the guidance on preparation of National Inventories was that emissions from fuel sold to any air or marine vessel engaged in international transport should be excluded from the national inventory and reported separately.

- Under the Kyoto Protocol, it was agreed that "the Parties shall pursue limitation or reduction of emissions of greenhouse gases … from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Marine Organization, respectively." The emissions did not, therefore, form part of the national targets outlined in the Protocol.

- In subsequent Copenhagen and Paris Accords the emissions remain outside national targets.

- ICAO and IMO remain responsible for mitigation of international emissions.

ICAO actions on international aviation emissions

- Following Kyoto Accord, ICAO recommended member States establish voluntary agreements with industry on emission limitation, and designed an agreement template.

- ICAO Board and ICAO General Meeting in 2009: adopted goal of improving fuel efficiency by an average of 1.5% per year from 2009 to 2020 (calculated on the basis of volume of fuel used per revenue tonne kilometre performed).

37th ICAO Assembly in 2010:

- amended the global aspirational goals for the international aviation sector of improving fuel efficiency by 2% per year, and stabilizing emissions from 2020 with carbon-neutral growth;
- resolved to undertake work to develop a framework for market-based measures (MBMs) in international aviation – i.e. fees or tradeable permits.

39th ICAO Assembly in 2016:

- adopted annual average fuel efficiency improvement of 2% p.a. also from 2021 to 2050.
- *Decided* to implement a Global MBM scheme in the form of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to address any annual increase in total CO2 emissions from international civil aviation above the 2020 levels.

- March 2017: ICAO adopted has adopted a new aircraft CO_2 emissions standard, applying to new aircraft type designs from 2020, and to aircraft type designs already in-production as of 2023. In-production aircraft which by 2028 do not meet the standard will no longer be able to be produced unless their designs are sufficiently modified.

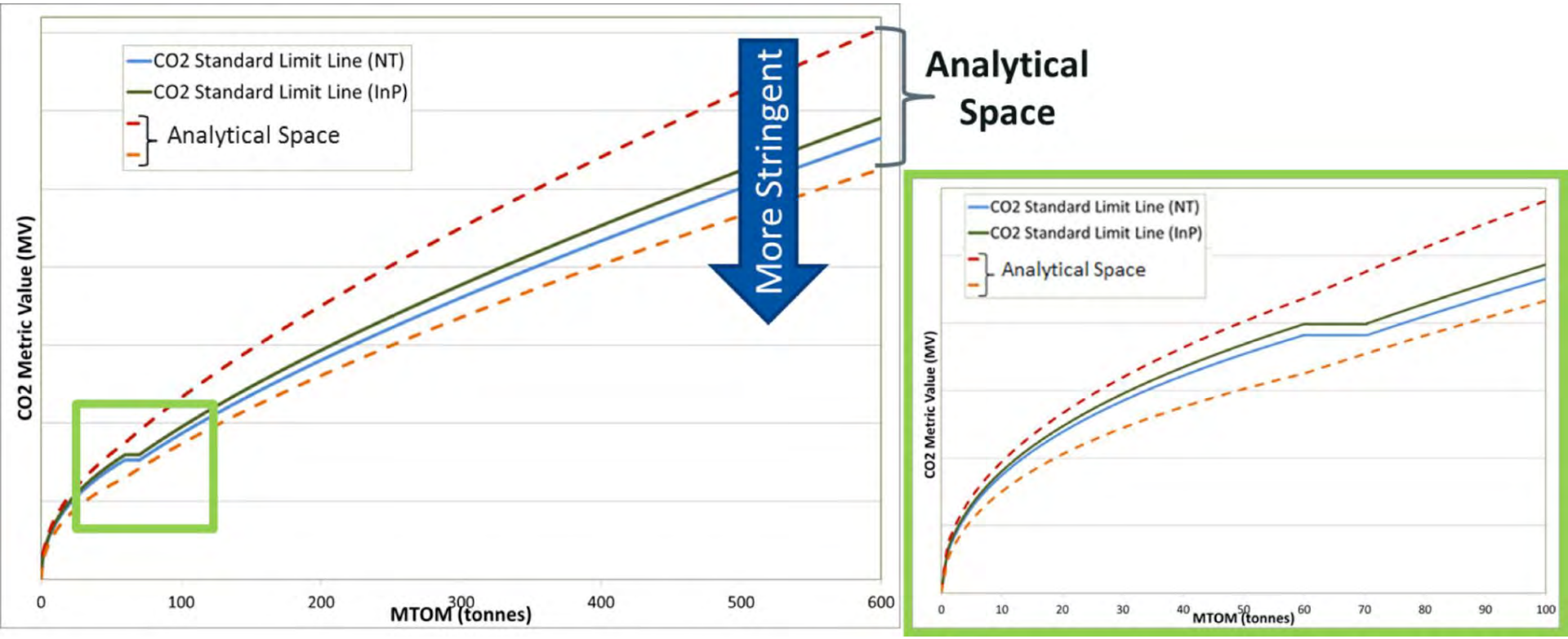
Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

- Pilot phase applies from 2021 through 2023 to States that have volunteered to participate in the scheme.
- First phase applies from 2024 through 2026 to States that voluntarily participate in the pilot phase, as well as any other States that volunteer to participate in this phase.
- Second phase applies from 2027 through 2035 "to all States that have an individual share of international aviation activities in RTKs in year 2018 above 0.5 per cent of total RTKs … except Least Developed Countries (LDCs), Small Island Developing States (SIDS) and Landlocked Developing Countries (LLDCs)."

- *A*mount of CO2 emissions required to be offset by a carrier in a given year from 2021 is calculated every year from the carrier's emissions multiplied by a weighted combination of the aviation sectoral growth and the carrier's own growth in that year. Aimed therefore to offset global growth in aviation emissions beyond 2020.
- ICAO to develop guidance on "Emissions Unit Criteria" consistent with UNFCC and Paris Accord decisions.
- ICAO to establish central registry of offsets; individual States to establish national registries.

- New entrant carrier exempted from CORSIA for three years or until the year in which its annual emissions exceed 0.1 per cent of total emissions in 2020

Aircraft CO_2 standard



[CO_2 Metric Value is cruise point fuel burn performance]

Source: ICAO 2016 Environmental Report
https://www.icao.int/environmental-protection/Documents/ICAO%20Environmental%20Report%202016.pdf

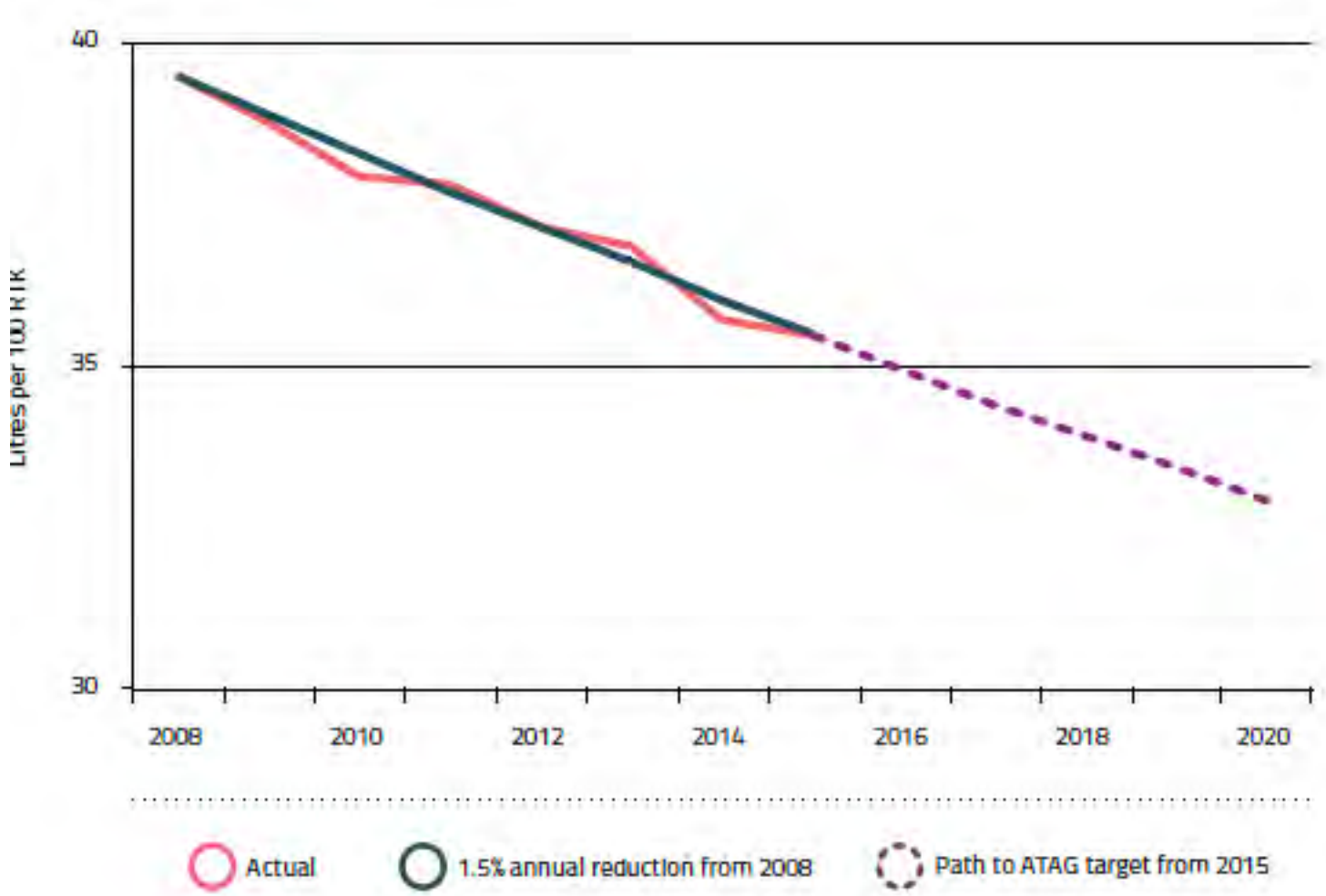
Canada's actions on aviation emissions

- 2005: Canada became the first country in the world to develop a Voluntary Agreement with the aviation industry following ICAO's template. By an MOU, the aviation industry through its Association (ATAC) agreed to a goal of 1.1% p.a. reduction in fuel use per RTK from the Kyoto base year of 1990, to reach a cumulative reduction of 24% in 2012.
- Transport Canada and ATAC published an annual report on performance under the MOU.
- Fuel efficiency actually improved by 32.9% between 1990 and 2012, an annual rate of 1.8%.

- 2012: the Government of Canada and the Canadian aviation industry released *Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation.* The Plan included a target of an average annual improvement in aviation fuel efficiency of at least 2% p.a. to 2020 from a 2005 baseline of 40.43 litres of fuel per 100 RTK.
- 2015: the target was modified to that of the international Air Transport Action Group, of 1.5% p.a. to 2020 from a 2008 baseline of 39.47 litres.
- Annual reports are published by Transport Canada and the aviation industry, the latest being for 2015 [report for 2016 in final processing].
- Fuel efficiency improved by 10.1% between 2008 and 2015, an annual rate of 1.52%.

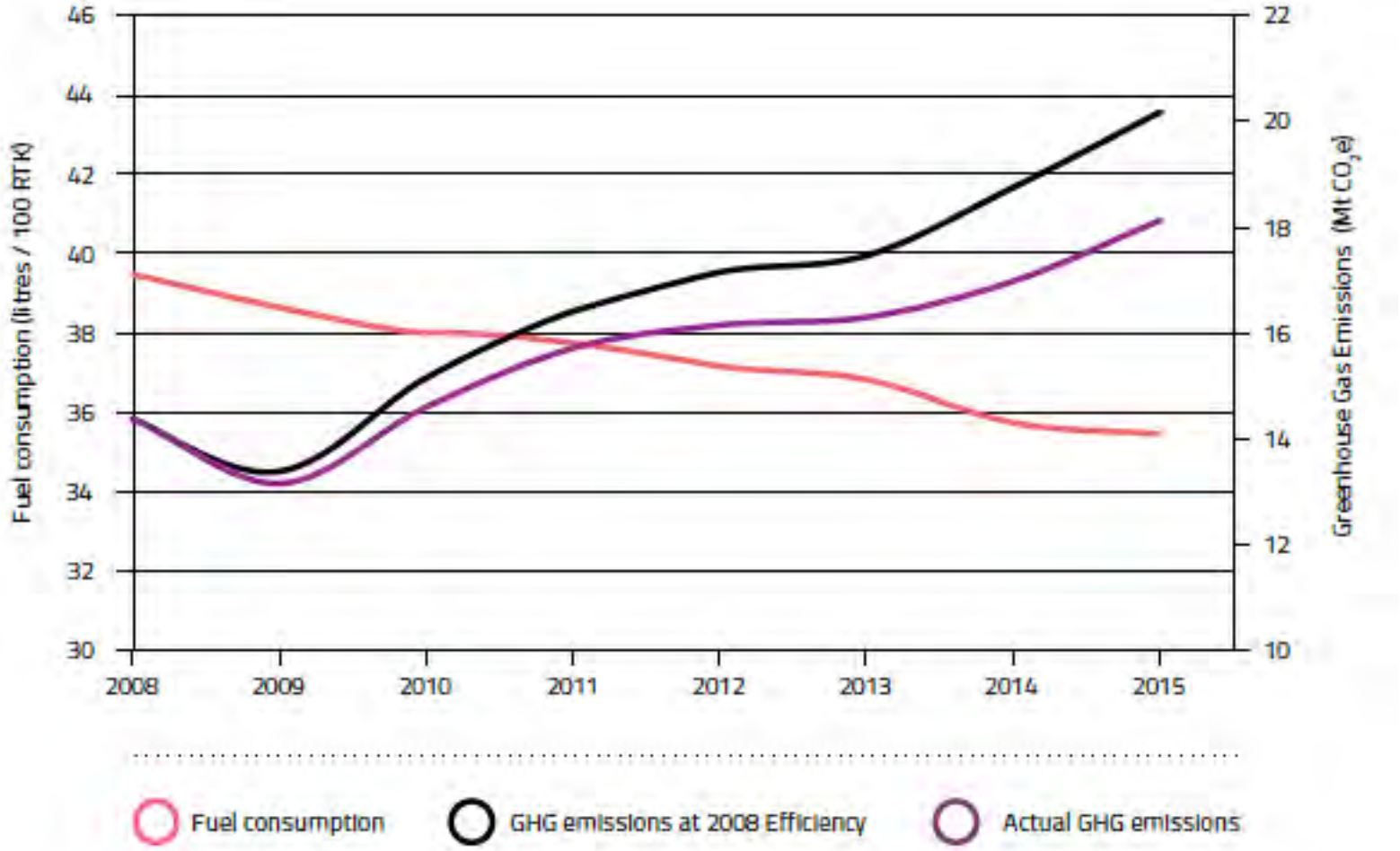
- Industry has reported annually on technological and operational measures taken to reduce the emission rate.

Progress towards ATAG Target, 2008 – 2020



Source: Transport Canada: "Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation, 2015 Annual Report, 2016 http://www.tc.gc.ca/eng/policy/aviation-emissions-3005.htm

Impact of Fuel Consumption Improvements since 2008 on Greenhouse Gas Emissions



Source: Transport Canada: "Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation, 2015 Annual Report, 2016 http://www.tc.gc.ca/eng/policy/aviation-emissions-3005.htm

IMO actions on international marine emissions

- 2003: IMO Resolution A.963(23) “IMO Policies and Practices Related to the Reduction of Greenhouse Gas Emissions from Ships”

- IMOs work to address GHG emissions considered: Technical, Operational and Market-based Measures (MBM)

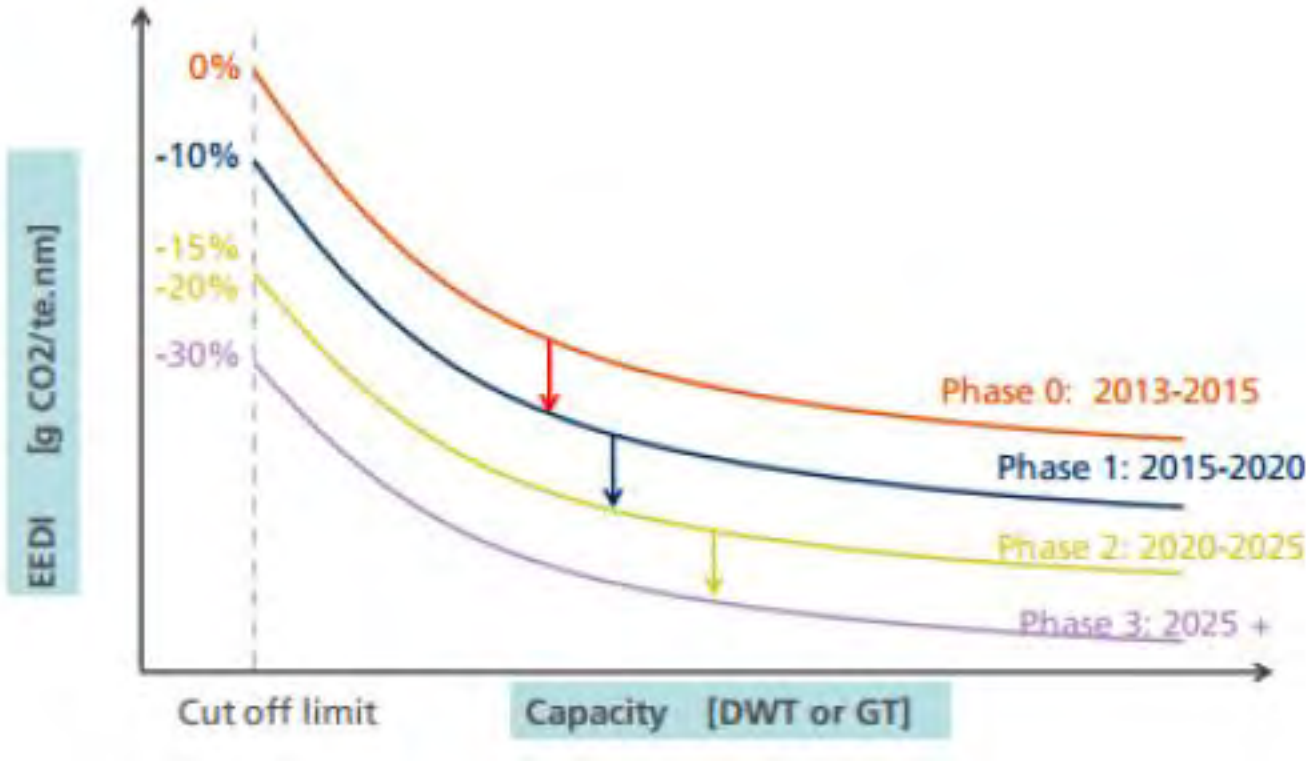
- 2011: New Chapter 4 of MARPOL Annex VI introduced two mandatory mechanisms as energy efficiency standard for ships to reduce international shipping’s GHG emissions via improved ship design and operations. These regulatory mechanisms are:
  - Energy Efficiency Design Index (EEDI), for new ships
  - Ship Energy Efficiency Management Plan (SEEMP), for all ships in operation.

- Energy Efficiency Design Index (EEDI): applicable to all new or substantially redesigned ships of 400 gross tonnage and above. Specifies GHG emissions rate to be achieved in g/tonne-nmile by ship capacity, becoming more stringent in future years

- 2013: Regulations of EEDI and SEEMP entered into force.

- Market-based measures remain under consideration by IMO’s Marine Environment Protection Committee (last met July 2017), including tradeable permit systems.

IMO design of EEDI regulation



Source: IMO: Train the Trainer (TTT) Course on Energy Efficient Ship Operation, Module 2 – Ship Energy Efficiency Regulations and Related Guidelines, Jan 2016
http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Air%20pollution/M2%20EE%20regulations%20and%20guidelines%20final.pdf

Technologies for EEDI reduction

No.	EEDI reduction measure	Remark
1	Optimised hull dimensions and form	Ship design for efficiency via choice of main dimensions (port and canal restrictions) and hull forms.
2	Light weight construction	New lightweight ship construction material.
3	Hull coating	Use of advanced hull coatings/paints.
4	Hull air lubrication system	Air cavity via injection of air under/around the hull to reduce wet surface and thereby ship resistance.
5	Optimisation of propeller-hull interface and flow devices	Propeller-hull-rudder design optimisation plus relevant changes to ship's aft body.
6	Contra-rotating propeller	Two propellers in series; rotating at different direction.
7	Engine efficiency improvement	De-rating, long-stroke, electronic injection, variable geometry turbo charging, etc.
8	Waste heat recovery	Main and auxiliary engines' exhaust gas waste heat recovery and conversion to electric power.
9	Gas fuelled (LNG)	Natural gas fuel and dual fuel engines.
10	Hybrid electric power and propulsion concepts	For some ships, the use of electric or hybrid would be more efficient.
11	Reducing on-board power demand(auxiliary system	Maximum heat recovery and minimizing required electrical loads flexible power solutions and power management.
12	Variable speed drive for pumps, fans etc.	Use of variable speed electric motors for control of rotating flow machinery leads to significant reduction in their energy use.
13	Wind power (sail, wind engine, etc.)	Sails, fletnner rotor, kites, etc. These are considered as emerging technologies.
14	Solar power	Solar photovoltaic cells.
15	Design speed reduction (newbuilds)	Reducing design speed via choice of lower power or de-rated engines.

Source: A Short Note on Ship's Energy Efficiency: EEDI, SEEMP & EEOI
http://marinestudy.net/a-short-note-on-ships-energy-efficiency-eedi-seemp-eeoi/

Potential carbon tax effects

Table 1: Estimated Quantities of Emissions Reduced Under Provincial Carbon Pricing Policies

	British Columbia	Alberta	Ontario	Quebec
Emissions reductions in 2020 (%) relative to no-policy case	5-15%[a]	7%[b]	11%[c]	15%[d]

[a] Estimates based on Murray and Rivers (2015).
[b] Estimates based on Leach et al., (2015) and Government of Canada (2016).
[c] Estimates based on Sawyer et al., (2016).
[d] Estimates based on Ouyed (2015) and Government of Canada (2016).

Table 2: Marginal Carbon Prices Under Provincial Carbon Pricing Policies

	British Columbia	Alberta	Ontario	Quebec
Marginal price of carbon	2016: $30 2020: $30	2016: $20 2020: $30	2016: n/a 2020: $19.40[a]	2016: $16.40 2020: $19.40[a]

[a] Projections of Western Climate Initiative (WCI) permit price are drawn from modelling analysis for Ontario (Sawyer et al., 2016).

Source: Ecofiscal commission: “Comparing Stringency of Carbon Pricing Policies,” July 2016
https://ecofiscal.ca/

Potential carbon tax effects – author's 2012 estimates

Assumed elasticities	Road Gas	Road Diesel	Rail Diesel	Aviation turbo	Av Gas	Marine diesel	Marine HFO
Transportation Table elasticities							
short-run	-0.15	-0.10	-0.10	-0.10	-0.15	-0.05	-0.05
long-run	-0.60	-0.40	-0.40	-0.30	-0.30	-0.30	-0.30
Estimated GHG savings in 2020							
Assumed lower elasticities							
short-run	-0.05	-0.05	-0.10	-0.10	-0.15	-0.05	-0.05
long-run	-0.20	-0.20	-0.40	-0.30	-0.30	-0.30	-0.30

GHG reductions in 2020 from $100 carbon tax

Elasticity assumptions	Road Gas	Road Diesel	Other fuels	Total
Transportation Table elasticities	-6.05	-3.62	-2.08	-11.8
Assumed lower elasticities	-2.07	-1.84	-2.08	-6.0

Source: Lawson J: "The Contribution of the Transport Sector to an Efficient Greenhouse Gas Strategy, Proceeding of the Annual Meeting of the Canadian Transportation Research Forum," 2012.
http://ctrf.ca/wp-content/uploads/2014/07/13LawsonTHECONTRIBUTION.pdf

THANKS FOR YOUR ATTENTION

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