Renewable natural gas (RNG) Decarbonize long-haul trucking today

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1. What is RNG and how it can help decarbonize heavy-duty trucks?
2. Refueling infrastructure
3. Truck availability and performance
4. SWOT
5. Recommendations
RNG, a recognized source of renewable energy

RNG is recognized as a source of GHG reduction by:
- MELCCFP* and MERN**
- Treasury Board of Canada

RNG is part of:
- The government’s effort to lead by example
- The Plan for a Green Economy (PGE) and the budget allocated for RNG production
- Canada’s plan to reach net-zero emissions

The Québec government has set a target of RNG injection of 10% of volumes by 2030

Renewable natural gas is injected into our network and interchangeable with conventional natural gas

- Inputs
- Production
- Distribution
- Uses

* Ministère de l’Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs
** Québec’s Ministère de l’Énergie et des Ressources naturelles
Renewable natural gas (RNG) in a nutshell

RNG production converts the biogenic GHG emissions already generated by the normal activities of the sectors where organic materials originate, into value-added inputs for the biomethanation process.

For example, RNG production makes it possible to:

• capture and convert biogas, containing CH$_4$ produced by landfills.
• avoid producing CO$_2$-emitting chemical fertilizers by substituting them for digestate, a by-product of the biomethanation process.
• avoid some methane emissions from manure and wastewater management.

Gas that is interchangeable with conventional natural gas since they both share the same pipes, equipment, benefits, and applications.

Derived from the biomethanation of organic matter and therefore 100% renewable. Does not contribute to additional GHG emissions.

Energy that gives a second life to organic matter, contributes to the circular economy and can be produced locally.

* Compared to traditional natural gas.
Existing and future RNG production sites

RNG Facilities
Operational: 281
Under Construction: 180
Planned: 296
Total: 757

Source: RNG Facilities in North America (Canada & U.S.) as of March 20, 2023 / rngcoalition.com
Compressed natural gas (CNG) is a natural gas composed primarily of methane. It is compressed to a pressure of 3,600 psi for storage in vehicle tanks.

At 3,600 psi, natural gas takes up 300 times less space than 1 m$^3$ of natural gas at ambient temperature and pressure.

Although there are two ways of storing gas for transportation use, CNG has been heavily adopted by the fleet for convenience and supply reasons.
Schematics of CNG station and real-life installations

Compression equipment (station)

Quick fill dispenser: 5 to 10 minutes per truck
CNG stations between Quebec and Windsor (Detroit)

There are 642 public access CNG stations in the US and Canada
- 25 are located in Canada
- 13 are located along the Quebec-Windsor corridor

Maximum distance between stations: **250 km**
Average truck autonomy: **900 km**
Optimal solution for displacing diesel

The cleanest combustion engines currently offered on the market, with important environmental benefits:

<table>
<thead>
<tr>
<th>Cummins engine emissions under ftp cycle from l’EPA¹</th>
<th>Carbon monoxide</th>
<th>Nitrogen oxide</th>
<th>Particulate matter</th>
<th>Carbon dioxide</th>
<th>Nitrous oxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollutants and Green House Gases</td>
<td>CO</td>
<td>NOₓ</td>
<td>PM</td>
<td>CO₂</td>
<td>N₂O</td>
</tr>
<tr>
<td>Diffrence vs EPA standards</td>
<td>-90%</td>
<td>-95%</td>
<td>-90%</td>
<td>-16%</td>
<td>-80%</td>
</tr>
</tbody>
</table>

¹ Données tirées du certificat de conformité telles que compilées par la California Air Resources Board (CARB), moteur JCEXH0540LBN, année-modèle 2018.
² Technologie Near Zero est appliquée à tous les moteur Cummins 8,9L et 11,9L à gaz naturel depuis l’année-modèle 2018.

- Certified EPA et CARB
- Meets EPA standards for CO₂ and NOₓ for the year 2027
- Less noisy than diesel: -10dB
- 3-way catalyzer for treatment of exhaust gases
  - No more urea
  - No more particulate filter
  - Reduction of 20% of sensors
- Spark ignition
- 80% parts = diesel engine
- Maintenance costs = diesel engine
- Cold weather performance demonstrated

+ 85,000 engines manufactured
+ 30 years of experience

320 HP 1,000 lb-ft
240 HP 560 lb-ft
400 HP 1,450 lb-ft

No more diesel particulate filters (DPF)!
New natural gas high-power engine coming to market in 2024

Engine 15L 100% NG (X15N)

- Start of production 2023; deliveries 2024
- Announced introduction in chassis by PACCAR (Peterbilt and KW)
- Weight reduction of 300 lbs compared to X15 diesel
- Compatible with transmission: Endurant HD (Eaton-Cummins) and eventually from other manufacturers
- 500 HP of maximum power
- Efficiency improved by 10% compared to the ISX12N
- Reduction of GHG by 10% compared to the ISX12N
- Will meet emissions standards of the EPA and CARB of 2024 and 2027
- No diesel particulate filter (DPF)

Power nodes
400 to 500 HP
1,450 to 1,850 lb-ft
CNG Trucks

Average incremental cost: $90,000 but varies depending on the tanks’ size selected.

Autonomy averaging 900 km and up to 1,600 km, according to the configuration of the tanks.

Class 8 – North American Freight
Quebec – Windsor case study: DIESEL vs R-CNG

DIESEL vs R-CNG
Assuming average distance travelled per year is 150,000 Km

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DIESEL engine</th>
<th>Parameters</th>
<th>R-CNG Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual consumption (L/year)</td>
<td>52 500</td>
<td>$0</td>
<td>60 000</td>
</tr>
<tr>
<td>Efficiency</td>
<td>35 L / 100 km</td>
<td>40 DLE / 100 km</td>
<td>$90 000</td>
</tr>
<tr>
<td>Incremental cost of CNG vs. diesel</td>
<td>$0</td>
<td>Grant Écocamionnage (MTQ)</td>
<td>($27 000)</td>
</tr>
</tbody>
</table>

Fuel cost for trip
- **DIESEL**: $678.60
- **R-CNG**: $491.40

Price per litre
- **DIESEL**: $1.65 / L
- **R-CNG**: $1.06 / DLE

Price per Km
- **DIESEL**: $0.58 / km
- **R-CNG**: $0.42 / km

**QUICK FACTS**
- 2.6 year ROI
- To recoup net incremental cost
- 145 tCO₂e (-99.4%) Annual GHG reduction

Quebec City — 1,170 km — Windsor
# Strength, Weaknesses, Opportunities & Threats (SWOT)

## Strength
- Public infrastructure to deliver R-CNG to HD trucks deployed and growing
- Refueling easy and fast (5-10 minutes)
- RNG is available now and its production across North America is expanding
- Major trucks OEM offer Cummins NG engines today and their integration is done directly on the manufacturing line
- Provincial support (Ecocamionnage) to reduce upfront capital costs for trucking companies when purchasing CNG truck
- Interesting ROI to buy a CNG truck and run it using R-CNG
- Minimal impact on total payload carried compared to other ALT-fuels
- Existing CSA codes for installing CNG stations, maintenance infrastructure, CNG tanks, etc.

## Weaknesses
- Incremental cost of CNG truck compared to diesel equivalent (capital allocation)
- Albeit the growing number of maintenance facilities, more are required to provide smooth operation for carriers along different routes
- Rental companies are moving slowly to incorporate ALT-fuel offerings to customers
- Variability in maintenance costs is very dependent on trucking maintenance culture and processes
- Cost of maintenance shop upgrade to repair and maintain CNG trucks
- Small number of technicians trained to maintain CNG trucks
- OEMs all have their powertrain solution for diesel, offering NG engines impacts profitability

## Opportunities
- Introduction of 15L (X15N) engine in 2024
- Clean Fuel Regulation (CFR) offers credit generation opportunities for RNG
- Companies with ESG targets requesting their carriers reduce emissions

## Threats
- Price of diesel
- ZEV focus not encompassing a lifecycle approach
- A long decisional process that can be subject to market fluctuations
- The driver shortages in the industry impact the ability of freight carriers to focus on the introduction of alt-fuels
- Freight carrier pricing model with fuel surcharge for diesel
- Economic uncertainties slowing down investments
- Truck supply chain is still sluggish even post Covid (impacting diesel trucks as well)
Recommendations

- ZEV conceptually focuses only on tailpipe emissions. A full lifecycle approach should be considered to include technologies such as RNG.

- Increase the financial incentives for fleets at the purchase of a CNG truck when using RNG.

- Continue to support the deployment of public CNG stations (using RNG) to open new trucking corridors which will encourage adoption.

- Support the transformation of maintenance infrastructures (repair shops) to increase and improve the service offering.

We are ready now to deliver a net-zero carbon long-haul transport solution!
Thanks for your attention!

For any questions, please reach out

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