Everything you wanted to know about natural gas but were afraid to ask.

Canadian Gas Association
CAMPUT Regulatory Course
JUNE 2017
The Resource Base
The Resource Base
The Resource Base
The Resource Base

Drilling Activity: natural gas - Canada
(wells drilled, metres drilled)

Source: CAODC
The Resource Base

- Natural gas resource base estimated at 1,278.1 tcf.
- Over 200 years of supply.
- Marketable production from that resource base totaled 5.57 trillion cubic feet (tcf) in 2016.

### Canadian Natural Gas Resources & Reserves *

<table>
<thead>
<tr>
<th>Resource estimates</th>
<th>tcf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional (excl tight gas)</td>
<td>68.1</td>
</tr>
<tr>
<td>Tight Gas</td>
<td>511.6</td>
</tr>
<tr>
<td>CBM</td>
<td>47.8</td>
</tr>
<tr>
<td>Shale Gas</td>
<td>370.5</td>
</tr>
<tr>
<td>Frontier</td>
<td>222.7</td>
</tr>
<tr>
<td>Other / Associated</td>
<td>9.0</td>
</tr>
<tr>
<td>Proven reserves included above</td>
<td></td>
</tr>
<tr>
<td>RNG Resources</td>
<td>48.4</td>
</tr>
<tr>
<td>Total Resources &amp; Reserves</td>
<td>1278.1</td>
</tr>
</tbody>
</table>

* Source: NEB Energy Futures Report, Reference case, October 2016
Natural Gas Composition

- Fossil natural gas is located underground in porous rock formations sandwiched or trapped between more solid rock formations.

- Natural gas is 95 - 98% methane (CH₄), its non-toxic, colorless, and odourless.

- Odour is added to processed natural gas as a safety feature to make it easily detectable in small very quantities.

- RNG, CNG, LNG all are forms of natural gas.

- Biomethane and biogas are raw gas that may not be up to pipeline quality.
Pipeline Quality Gas

**TRANSCANADA GAS ANALYSIS**
Sample Analyzed at: Victoria Square Stn. No. 50139

The analysis given below is representative of the gas being presently supplied by TransCanada, for the month of **OCTOBER 2010**.

<table>
<thead>
<tr>
<th>CONSTITUENT</th>
<th>VOLUME PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane (CH₄)</td>
<td>96.57%</td>
</tr>
<tr>
<td>Ethane (C₂H₆)</td>
<td>1.59%</td>
</tr>
<tr>
<td>Propane (C₃H₈)</td>
<td>0.10%</td>
</tr>
<tr>
<td>Normal Butane (C₄H₁₀)</td>
<td>0.01%</td>
</tr>
<tr>
<td>Iso-Butane (C₄H₁₀)</td>
<td>0.01%</td>
</tr>
<tr>
<td>Normal Pentane (C₅H₁₂)</td>
<td>0.00%</td>
</tr>
<tr>
<td>Iso-Pentane (C₅H₁₂)</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hexanes Plus (C₆H₁₄+)</td>
<td>0.00%</td>
</tr>
<tr>
<td>Nitrogen (N₂)</td>
<td>0.56%</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>0.74%</td>
</tr>
<tr>
<td>Oxygen (O₂)</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hydrogen (H₂)</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

**TOTAL SULPHUR:** \(0.17\) gms/Ccf *
\[3.84\] mg/m³

**HEATING VALUE:** \(1010.7\) BTU/cf (30° Hg, 60°F, Dry)
\[37.6\] MJ/m³ (101.325 kPa, 15°C, Dry)

**RELATIVE DENSITY** (Air = 1.0): 0.574

*0.14 gms/Ccf (3.2 mg/m³) added by Enbridge Gas Distribution as odourant.

Signed by Manager of Engineering Materials Evaluation Centre: [Signature]

---

*CGA - CANADIAN GAS ASSOCIATION*
Renewable Natural Gas

- RNG at $10-25 per gigajoule (GJ), is equivalent to between 4-9 cents per kilowatt hour (kWh).

- Renewable electricity contracts for utility scale solar in Ontario have been signed for approximately $19 and $44/GJ or 7-16 cents/kWh.

Sources: Statistics Canada, Table 128-0016. Alberta Innovates, 2010
The Production Base

Marketable natural gas production - Canada (billions of cubic feet)

Source: National Energy Board
Elements of the Natural Gas System

- Natural gas utilities serve more than 20 million Canadians.
- Natural gas meets over 36% of Canadian energy needs.
- Canada has over 450,000 km of natural gas distribution lines.
Elements of the Natural Gas System

Natural gas distribution systems - Canada 2015 (kilometres)

- Service lines: 138,370 (30%)
- Distribution mains: 248,274 (55%)
- Transmission mains: 67,612 (15%)

Total Kilometres of Pipeline: 454,256

Source: Canadian Gas Association
Elements of the Natural Gas System

- Once extracted from the ground collection and gathering lines bring the raw gas to plants where it is cleaned up and made suitable for end use.

- After clean up high pressure, large diameter pipelines deliver gas from production basins to the distribution utility’s system at a “City gate” station.

- Natural gas delivery systems consist of smaller, lower pressure pipelines, pressure controls, storage facilities and equipment and gas measurement equipment.
Elements of the Natural Gas System
Elements of the Natural Gas System
Elements of the Natural Gas System
Major activities/parts of a gas utility
Major parts of a gas utility system

• The City Gate – Where gas enters the distribution system from high pressure, large diameter natural gas transmission lines.
  – A metering/measurement and custody transfer point
  – Pressure reduction point to get pressure down to distribution system level pressures
  – Odourization point where that “rotten eggs” smell is added to allow for even small leaks to be easily detected
  – Reheating point because pressure reduction cools off the gas requiring reheating for it to flow properly.

• Distribution mains – larger backbone pipelines in a distribution system that carry gas to point where it is then “split off” to the various points of end use.

• District stations – a point inside the distribution system where further pressure reduction/modulation can take place. Point where “branching” off to specific community/customer locations is made.

• Service lines – smaller, low pressure lines that take gas off a distribution main line up to the customer location. Carry gas to the gas pressure regulator and gas meter at the point of end use.

• System is a “closed loop”, pressure based system that constantly measures and modulates pressure to track proper operation and safety.
Natural gas use

Energy final demand - 2015 - Canada - by type (%)

- Refined Petroleum Products: 39.1%
- Natural gas: 36.2%
- Electricity (hydro, nuclear): 22.3%
- All others*: 2.4%

Source: StatCan 128-0016

*Coal, NGLs, coke, coke oven gas, steam

Natural gas - demand by sector 2015 (TJ, %)

- Industrial: 1,508,070 (34.5%)
- Power gen.: 655,881 (15.0%)
- Residential: 689,772 (15.8%)
- Road Transport: 3,918 (0.1%)
- Public Admin./Commercial: 489,636 (11.2%)
- Agriculture: 39,125 (0.9%)
- Pipelines: 163,248 (3.7%)

Source: Statcan 128-0016  *transformed to RPP or steam, producer use, non-energy use
Natural gas use

Temperature & Natural Gas Demand - Canada

% annual growth rate


Source: Environment Canada, NOAA, CGA
Natural gas use
Residential natural gas use

Space & Water Heating - Canada
- Natural gas: 56%
- Heating oil: 8%
- Wood: 9%
- Propane & Coal: 2%
- Electricity: 25%

Residential Natural Gas Use
- Space heating: 70%
- Water heating: 30%

Source: NRCan End Use Database
• Statistics Canada reports that total household spending on natural gas decreased from $7.4 billion in 2014 to $6.5 billion in 2015, driven by ever lower prices.

• Meanwhile, StatsCan reports that electricity spending has increased by over $10 billion since 2000 to $20.3 billion in 2015.

• A cost-comparison of natural gas, to electricity, heating oil, and propane and heat pump/electric shows it’s the lowest cost residential energy option.

• In 2015, the average household spent between $1,240 to $3,640 to heat their home - and could save $2,400 by choosing natural gas.

Source: StatsCan, Kent Marketing, CGA
Industrial natural gas use

Natural Gas Use by Industry – by process

Source: CIEEDAC Report Jan 2016
Power generation natural gas use

Power Generation - Canada - 2015 - (GW.h)

- Natural gas 65,477 (10.3%)
- Coal 65,717 (10.3%)
- Nuclear steam turbine 95,682 (15.0%)
- Other types of electricity generation 5,222 (0.8%)
- Solar 344 (0.1%)
- Wind power turbine 17,112 (2.7%)
- Tidal power turbine 13 (0.0%)

Power Gen. GHG Emissions - Canada - 2015 - (%)

- Heavy fuel oil 1.948 (0.3%)
- Wood and spent pulping liquor 10,212 (1.6%)
- Diesel and light fuel oil 2,561 (0.4%)
- Other fossil fuels 268 (0.0%)
- Hydraulic turbine 373,845 (58.3%)
- Coal 63.5%
- Natural gas 33.9%

Source: Statistics Canada 128-0014, 127-0007, NRCan End Use Database, CGA
On Road:
• Commercial Canadian heavy engine technologies:
  • Reduce lifecycle carbon emissions by 20-25% and 85-90% using renewable natural gas (RNG)
  • Lower cost fuel for trucking, refuse, transit, vocational trucks.

For Marine:
• Opportunities on Great Lakes.
• Ferry applications.

For Rail:
• Strategic re-fuelling hubs can create a cleaner, safer, more economic North American rail re-fuelling network.

For Off-Road
• LNG in Canadian mining and other vehicle operations to improve competitiveness, attract investment and lower cost and emissions.

Heavy duty, medium, and freight light duty: 35% of Canadian Transportation Energy Use

Marine: 4% of Canadian Transportation Energy Use

Freight rail: 3% of Canadian Transportation Energy Use

Off road: 4% of Canadian Transportation Energy Use
Utility Regulation, Rates and Returns

- Why are utilities regulated?
- How are utilities regulated?
- What are the major features & principles of economic regulation?
- How do utilities set their rates?
- How do rate regulated utilities earn profits/return?
Competitive Markets

• The “invisible hand” of the market.

• Characteristics:
  – products or services are offered by many competing firms
  – customers purchase on the basis of price and quality
  – firms compete by offering low cost / high quality products or services

• Examples:
  • Coffee shops, clothing stores, supermarkets, haircuts
Natural Monopolies

- Characteristics
  - economies of scale
    - one large firm is more economic than many small ones
  - barriers to entry
    - large investment is needed and/or physical or regulatory restrictions.
  - can limit supply, price discriminate
  - have less/little incentive to innovate

- Natural monopoly exists when only one supplier is needed to meet all demand at the lowest cost way within a geographic area.
  - i.e., two or more utilities would have duplication of facilities resulting in higher rates.
Natural Gas Distribution Utilities

• Are natural monopolies
  – Only one distributor of natural gas in a geographic (franchise) area.
  – Economies of scale – can easily add customers and extend gas system.
  – Barriers to entry – the costs and physical obstacles to building a competing gas distribution system are prohibitive.

• Are an essential service
  – Population in franchise area relies on distribution system for heat, industrial processes, generation.

• Serve the public interest
  – Public interest requires that essential services be provided at “just and reasonable” rates.
  – Regulation seeks to retain the benefits of natural monopoly while protecting against the disadvantages of monopoly.
Public utility characteristics

• Principle obligations:
  – obligation to serve the public ("affected" with public interest)
  – provide safe and adequate service
  – charge fair and reasonable rates

• Major powers:
  – given opportunity to earn a fair return upon the value of the utility's property
  – given service franchise or certificate rights in the utility's area, i.e. monopoly
  – right of eminent domain and use of public ways, i.e. right to install its distribution system
Key regulatory decisions

Key decisions affecting regulation of public utilities in North America.

- Smyth versus Ames, United States Supreme Court, 1898

- Bluefield Water Works & Improvement Company versus Public Service Commission of the State of West Virginia, United States Supreme Court, 1923

- Northwestern Utilities Ltd. versus the City of Edmonton, Supreme Court of Canada, 1929

- Federal Power Commission versus Hope Natural Gas Co., United States Supreme Court, 1944

- National Energy Board, 2004
“The Board is of the view that the fair return standard can be articulated by having reference to three particular requirements. Specifically, a fair or reasonable return on capital should:

• **Be comparable** to the return available from the application of invested capital to other enterprises of like risk (the comparable investment standard)

• **Enable the financial integrity** of the regulated enterprise to be maintained (the financial integrity standard); and

• **Permit incremental capital to be attracted** to the enterprise on reasonable terms and conditions (the capital attraction standard)

“In the Board’s view, the determination of a fair return in accordance with these enunciated standards will, when combined with other aspects for ... revenue requirement, result in tolls that are just and reasonable.”
Rate Setting Methods for a Regulated Utility

• Cost of Service Rates (Rate of Return) method
  – Rates based on the utility’s cost of providing service to customers.
  – Annual arrangements

• Performance Based Rates (Incentive Regulation) method
  – Rates are based on a formula linked to utility’s performance and not on the utility’s cost of providing service to customers.
  – Often multi-year arrangements
The Rate Application

- Must explain reasons for the request for approval to change rates
  - changes in revenues
  - Changes in costs or incentive-based rate setting formula inputs

- Must demonstrate that proposed rates will be just and reasonable
  - fair to ratepayers and shareholders & fair to each ratepayer class.

- Utility forecasts its revenues for the year at existing rates - “revenue forecast”.

- Utility forecasts all of its costs for the year including the return on equity invested - “revenue requirement”.

- If the revenue forecast is less than revenue requirement, then the utility applies for a rate increase

- If the revenue forecast is greater than the revenue requirement, then the utility applies for a rate decrease.
The Revenue Requirement

RR = r(RB) + D + OM + T + Y

- RR = revenue requirement = cost of providing service/year
- RB = rate base
- r = rate of return allowed on rate base
- D = depreciation expense on assets in rate base
- OM = operating and maintenance costs
- T = taxes (income, capital, municipal, etc.)
- Y = cost of gas sold to customers
### Utility Capital Structure

<table>
<thead>
<tr>
<th></th>
<th>Allowed share</th>
<th>Allowed rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>L &amp; M Term Debt</td>
<td>60.17%</td>
<td>5.80%</td>
</tr>
<tr>
<td>Short Term Debt</td>
<td>13.9%</td>
<td>2.00%</td>
</tr>
<tr>
<td>Preference Shares</td>
<td>2.44%</td>
<td>3.20%</td>
</tr>
<tr>
<td>Common Equity</td>
<td>36.00%</td>
<td>8.93%</td>
</tr>
</tbody>
</table>

### Depreciation

<table>
<thead>
<tr>
<th></th>
<th>Rate Base</th>
<th>Revenue Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave. Depreciation Rate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Income Taxes

<table>
<thead>
<tr>
<th></th>
<th>Rate Base</th>
<th>Revenue Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Tax Rate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Project A: Base Year

<table>
<thead>
<tr>
<th></th>
<th>Capital Expenditure</th>
<th>Revenue Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate Base</td>
<td>$ 100,000,000</td>
<td>$ 100,000,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Allowed rate</th>
<th>Revenue Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>L &amp; M Term Debt</td>
<td>$ 60,170,000</td>
<td>$ 3,489,860</td>
</tr>
<tr>
<td>Short Term Debt</td>
<td>$ 1,390,000</td>
<td>$ 27,800</td>
</tr>
<tr>
<td>Preference Shares</td>
<td>$ 2,440,000</td>
<td>$ 78,080</td>
</tr>
<tr>
<td>Common Equity</td>
<td>$ 36,000,000</td>
<td>$ 3,214,800</td>
</tr>
<tr>
<td>Total</td>
<td>$ 100,000,000</td>
<td>$ 6,810,540</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Allowed rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depreciation</td>
<td>$ 4,300,000</td>
</tr>
<tr>
<td>Income Tax</td>
<td>$ 851,922</td>
</tr>
</tbody>
</table>

| Project A Base Year Revenue Requirement | $ 11,962,462 |
| Project A Base Year Revenues            | $ 11,962,462 |
Rate Case Process under Cost of Service

Public hearings are often held to determine/argue
– how much will it cost the utility to provide service to customers in one year – the “revenue requirement”. 
– and how much will each customer group be charged of that requirement - cost allocation and rate design.

Evidence provided by the LDC includes
– Test Year – budget forecast for future year
– Bridge Year – budget estimate for current year
– Historical Year – financial results for the last completed year
Where is the profit for the regulated utility?

- There is no markup or profit on:
  - Gas costs
  - Operation and maintenance costs
  - Depreciation expense
  - Taxes

- The profit is in the return on investment in rate base:
  - If 35% common shareholders’ equity is allowed by regulator,
  - Profit is the return on equity (ROE) approved by the regulator
  - If the ROE is 8.5%
  - On a $100M capital expenditure, common shareholders’ investment is $35M
    with the rest is financed by debt and preferred stock (or deemed to be so);
  - So the shareholders’ return is $35Mx0.085 = $2.98M.
Regulator's Rate Decision

• Are the Company’s forecasts reasonable?
  – Capital expenditures and rate base additions
  – customer additions
  – average uses and volume forecasts
  – gas costs
  – cost of debt capital

• Compare past forecasts to actual results
• Adjust forecasts
• Approve recovery in rates
How do we get to customer rates?

Cost allocation involves the assignment of the costs incurred by a company (revenue requirement) to each customer or customer class.

Cost of providing service
(Revenue Requirement)

Cost Allocation

Residential Customer Class

Commercial Customer Class

Industrial Firm Customer Class

Industrial Interruptible Customer Class
Elements of a Customer’s Natural Gas Bill

- **Customer Charge**
  - A fixed charge for services to administer your natural gas account.
  - You will be charged this cost even if you don’t consume any natural gas during a billing period. The charge covers expenses to administer natural gas accounts including meter reading, customer services, equipment maintenance, and emergency response services. Usually set annually.

- **Delivery**
  - Comprised of the costs to transport, store and distribute natural gas:
  - Transportation: the cost to transport natural gas from a supply basin to your franchise area. The National Energy Board approves the Transportation tolls and charge.
  - Delivery: The cost to deliver natural gas through the utility’s distribution system to customers. This charge includes all operating and maintenance costs and a regulated rate of return. This charge is approved by the Board.
  - Storage: the cost to store natural gas.
  - Transportation, storage and delivery charges depend upon the amount of natural gas consumed.
  - Transportation, delivery, and storage charges may be itemized separately on your bill.
  - The Board approves these charges annually, however occasional adjustments occur when certain accounts are cleared.

- **Gas Supply Charge**
  - This is the cost of the natural gas itself, charged based on the amount you use. The Board does not allow utilities to profit from the price at which they sell natural gas to their customers. Utilities charge customers the price they pay to obtain natural gas on their customer’s behalf. The price utilities pay for natural gas is determined in a competitive market.
  - The Board approves the price utilities charge for natural gas usually monthly or quarterly.

- **Gas Cost Adjustment**
  - The Gas Cost Adjustment may be itemized separately on your bill. The adjustment is the difference between the actual and forecast price of natural gas. The Gas Supply Charge combined with the Gas Cost Adjustment equals the effective rate charged for the molecules of natural gas.
Key Statistics on Natural Gas

Energy commodity prices - Canada
($/mmBtu)

Source: StatsCan 326-0009, Kent Group, CGA
Key Statistics on Natural Gas

Global Natural Gas Prices

Source: US Federal Reserve, World Bank, CGA
Key Statistics on Natural Gas

Natural Gas Price/Prix du gaz naturel - Alberta Market Price

Source: NGX, CGA
Key Statistics on Natural Gas

Natural Gas Storage - Canada
(billions of cubic feet)

Source: GMP First Energy, CGA
Key Statistics on Natural Gas

Natural gas customers - Canada - 2015

Industrial
22,478
0.3%

Commercial
582,558
8.7%

Residential Customers
6,116,012
91.0%

Source: StatCan 129-0003
Key Statistics on Natural Gas

Natural gas customers - by province - 2015

Que: 221,320 (3.3%)
NS: 4,786 (0.1%)
NB: 12,157 (0.2%)
BC: 1,009,473 (15.0%)
Alta: 1,259,717 (18.7%)
Sask: 380,923 (5.7%)
Man: 261,486 (3.9%)
Ont: 3,569,937 (53.1%)

Source: StatCan 129-0003
Key Statistics on Natural Gas

GDP - Natural gas Sector 2016 ($C 2007 millions)

- Natural gas distribution: $4,562
- Pipeline transmission: $2,941
- Support for extraction: $1,586
- Natural gas extraction: $32,202

Source: StatCan 379-0031, CGA
Key Statistics on Natural Gas

Exports & Imports of Natural Gas - Canada
(billions of cubic feet)

Source: StatsCan 131-0004, 129-0003
Key Statistics on Natural Gas

Direct Employment - Natural Gas Sector
(full time equivalent)

Source: StatCan 281-0024, CGA
Key Statistics on Natural Gas

Capital Investment - Natural Gas Sector
($C millions)

Source: StatCan 031-0002, CGA
Key Statistics on Natural Gas

Energy spending - Canada - 2016
($millions/%)

Motor fuels and lubricants
$39,582
57%

Electricity
$21,463
31%

Natural gas
$5,804
8%

Other fuels
$2,540
4%

Source: StatCan 380-0085
Environmental profile of Natural Gas

Natural Gas Emissions - (tonnes CO$_2$eq)

Source: NIR 2015, CEPEI
Environmental profile of Natural Gas

Natural Gas - full cycle GHG emissions (t CO₂eq)

Source: NRCan End Use Database, Environment Canada NIR, CEPEI
Environmental profile of Natural Gas

Source: CEPEI
Environmental profile of Natural Gas

GHG Emissions - Canada -2015
tonnes CO$_2$eq

Source: ECCC NIR report 2015, CEPEI
Environmental profile of Natural Gas

2015 Natural Gas System GHG Emissions by type (CO₂eq)

- CO₂: 7,636,121, 78%
- CH₄: 2,328,864, 23%
- N₂O: 62,403, 1%

Source: CEPEI
Environmental profile of Natural Gas

Air Pollutants - Natural Gas System

% share of national total

Source: Environment and Climate Change Canada, CEPEI
\[ \text{CH}_4 + 2\text{O}_2 = \text{CO}_2 + 2\text{H}_2\text{O} + \text{Heat} \quad (\text{perfect combustion}) \]

\[ \text{CH}_4 + \text{O}_2 = \text{CO} + 2\text{H}_2\text{O} + \text{Less Heat} \quad (\text{incomplete}) \]
For more information visit
www.cga.ca