Electric and Natural gas
Water Heating
4 Case Study Apartments

Denton Vandersteen, P. Eng., CEM
Customer Engineering Services Department
Industrial & Commercial Solutions Division

May 11, 2015
We’ll look at...

- Current commercial (general service) electricity and natural gas rates.
- Calculating the cost of demand rate electricity vs. natural gas for service water heating.
- Field energy monitoring results of 1 existing apartment buildings heating service water with Hi E gas and 3 with electricity.
## Electricity Rates

### Large Business Solutions

### Electricity Rate Schedule

<table>
<thead>
<tr>
<th>Service Size</th>
<th>Phase</th>
<th>Monthly Meter Charge (First 1000 kWh)</th>
<th>Energy Charge (1001 to 3000 kWh)</th>
<th>Demand Charge (3001 kWh+)</th>
<th>Total kWh Charge</th>
<th>kWh Increase Factor</th>
<th>Revenue Required by Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Service Small</td>
<td>Single Phase</td>
<td>$10.73</td>
<td>7.742</td>
<td>4,381</td>
<td>3,142</td>
<td>Net Charge</td>
<td>$9.39</td>
</tr>
<tr>
<td></td>
<td>Three Phase</td>
<td>$17.42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Service Medium</td>
<td>Single Phase</td>
<td>$24.48</td>
<td>7.742</td>
<td>6,389</td>
<td>3,142</td>
<td>Net Charge</td>
<td>$9.39</td>
</tr>
<tr>
<td></td>
<td>Three Phase</td>
<td>$41.48</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Service Large - 100 kW</td>
<td>Three Phase</td>
<td>$76.26</td>
<td>7.742</td>
<td>6,389</td>
<td>3,142</td>
<td>Net Charge</td>
<td>$9.39</td>
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<tr>
<td></td>
<td>Single Phase</td>
<td>$67.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>General Service Large - 200 kW</td>
<td>Three Phase</td>
<td>$111.64</td>
<td>7.742</td>
<td>6,389</td>
<td>3,142</td>
<td>Net Charge</td>
<td>$9.39</td>
</tr>
<tr>
<td></td>
<td>Single Phase</td>
<td>$102.82</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Service Large - 500 kW</td>
<td>Three Phase</td>
<td>$227.24</td>
<td>7.742</td>
<td>6,389</td>
<td>3,142</td>
<td>Net Charge</td>
<td>$9.39</td>
</tr>
<tr>
<td></td>
<td>Single Phase</td>
<td>$218.42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes
- Rates are as approved by the Public Utilities Board of Manitoba prior to June 1, 2019, and are subject to change.
- All Rates Schedules in this publication are applied on a MONTHLY basis except on rates.
- Accurate meter reading may be required or the meter may be read at the request of the utility.
- Monthly rates are designed to encourage efficient consumption.
- Primary service is full utility-owned transformers, unless otherwise stated.
- There is a one-time 1% reduction on recorded demand for transformer loads.
- Definitions of electricity terms can be found at www.hydro.mb.ca/energyinfo/termsandconditions.html

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Manitoba Hydro
Large Business Solutions
Telephone: 1.800.345.4134 Fax: 1.204.345.4134
Email: energyinfo@hydro.mb.ca
www.hydro.mb.ca/largebusiness

www.hydro.mb.ca
Electrical Billing Components

- **Basic Charge**
  - This includes the direct costs of metering, portions of the distribution system, as well as billing and customer service administration.

- **Energy Charge**
  - That portion of the charge for electric service based upon the electric energy (kWh) consumed.

- **Demand Charge**
  - That portion of the charge for electric service based upon the peak electric capacity (kVA) required each month.

- **Taxes (GST, PST, City)**
# Electricity Rate Schedule

Effective: May 1, 2014 / Replaces: May 1, 2013

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Basic Monthly Charge ($/month)</th>
<th>Monthly Energy Charge (¢/kWh)</th>
<th>Monthly Demand Charge ($/kVA)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>First 11 000 kWh</td>
<td>Next 8 500 kWh</td>
</tr>
<tr>
<td>General Service Small</td>
<td>Single Phase</td>
<td>$19.73</td>
<td>7.752</td>
</tr>
<tr>
<td></td>
<td>Three Phase</td>
<td>$27.82</td>
<td>7.752</td>
</tr>
<tr>
<td>General Service Medium</td>
<td></td>
<td>$29.36</td>
<td>7.752</td>
</tr>
<tr>
<td>General Service Large &lt; 30 kV</td>
<td>N/A</td>
<td></td>
<td>3.339</td>
</tr>
<tr>
<td>General Service Large 30–100 kV</td>
<td>N/A</td>
<td></td>
<td>3.105</td>
</tr>
<tr>
<td>General Service Large &gt; 100 kV</td>
<td>N/A</td>
<td></td>
<td>3.009</td>
</tr>
</tbody>
</table>
Demand & Energy Metering

kVA demand ~ km/h speed

kWh consumed ~ km’s travelled
Electrical Terminology

**Power (Demand)**
- Horsepower (hp)
- Watt (W) = J/sec
- Kilowatt (kW) (1000 W)
- Kilovolt Ampere (kVA)

**Measure of how fast**

**Energy (Consumption)**
- Kilowatt Hour (kWh)
- Joule (J)
- Giga Joule (GJ)

**Measure of how much**

Multiply POWER by TIME to get ENERGY
Demand Details

• Peak demand is the peak rate of demand for power in kilovolt-amps (kVA) recorded since the last meter reading.

• The billed demand is the highest actual demand recorded in a 15 minute floating time frame. Therefore, an electrical device has to operate for only 15 minutes to set the demand for the entire month.
Mechanical Thermal Meter

- Thermal meter consists of a scale and 2 needles:
  - **Red** needle is active and moves as the rate of demand changes. Controlled thru a thermal coil (element) which acts as a damper (shock absorber) to slow down its reaction time.
  - **Black** needle is pushed up the scale by a tab on the red needle and is the one that is read monthly.
Pulse Meter

- Demand register of an Electronic Pulse meter measures:
  - the average kVA demand recorded over a 15 minute period.
  - the maximum 15 min. average kVA recorded since the last meter reading
  - kW & kVAR peaks
  - Power Factor at kVA peak, etc....
# Natural Gas Rate Schedule

Effective: May 1, 2015 / Replaces: February 1, 2015

### Transportation & Delivery Related Charges

<table>
<thead>
<tr>
<th>Basic Monthly Charge</th>
<th>Demand Transportation Charge</th>
<th>Demand Distribution Charge</th>
<th>Transportation to Centra</th>
<th>Distribution to Customer</th>
<th>Distribution to Customer Refund</th>
<th>Primary Gas*</th>
<th>Supplemental Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>($/month)</td>
<td>($/m³)</td>
<td>($/m³)</td>
<td>($/m³)</td>
<td>($/m³)</td>
<td>($/m³)</td>
<td>($/m³)</td>
<td>($/m³)</td>
</tr>
<tr>
<td>Small General Service (SGS)</td>
<td>$14.00</td>
<td>N/A</td>
<td>N/A</td>
<td>$0.0395</td>
<td>$0.1185</td>
<td>N/A</td>
<td>$0.1183</td>
</tr>
<tr>
<td>Large General Service (LGS)</td>
<td>$77.00</td>
<td>N/A</td>
<td>N/A</td>
<td>$0.0384</td>
<td>$0.0657</td>
<td>N/A</td>
<td>$0.1183</td>
</tr>
<tr>
<td>High Volume Firm Service (HVF)</td>
<td>$1,221.42</td>
<td>$0.4182</td>
<td>$0.1671</td>
<td>$0.0049</td>
<td>$0.0337</td>
<td>N/A</td>
<td>$0.1183</td>
</tr>
<tr>
<td>Mainline Firm Service (MLF)</td>
<td>$1,247.13</td>
<td>$0.4237</td>
<td>$0.1816</td>
<td>$0.0068</td>
<td>$0.0291</td>
<td>N/A</td>
<td>$0.1183</td>
</tr>
<tr>
<td>Interruptible Service</td>
<td>$1,254.45</td>
<td>$0.1232</td>
<td>$0.0855</td>
<td>$0.0037</td>
<td>$0.0145</td>
<td>N/A</td>
<td>$0.1183</td>
</tr>
</tbody>
</table>

*If you are a Western Transportation customer, contact your broker for the Primary Gas rate applicable to you.
## Rebundled Natural Gas Rates

### Short Cut Method - Rebundled Sales Rates

<table>
<thead>
<tr>
<th>Rate Class</th>
<th>Basic monthly charge</th>
<th>Re-bundled Demand charge ($/m3)</th>
<th>Re-bundled unit charge ($/m3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small General Service (SGS)</td>
<td>$14.00</td>
<td>N/A</td>
<td>$0.2843</td>
</tr>
<tr>
<td>Large General Service (LGS)</td>
<td>$77.00</td>
<td>N/A</td>
<td>$0.2304</td>
</tr>
<tr>
<td>High Volume Firm Service (HVF)</td>
<td>$1,221.42</td>
<td>$0.5853</td>
<td>$0.1649</td>
</tr>
<tr>
<td>Mainline Firm Service (MLF)</td>
<td>$1,247.13</td>
<td>$0.6053</td>
<td>$0.1622</td>
</tr>
<tr>
<td>Interruptible Service</td>
<td>$1,254.45</td>
<td>$0.2087</td>
<td>$0.1455</td>
</tr>
</tbody>
</table>

### Billing Percentages

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Billing Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm Service</td>
<td>81% Primary Gas; 19% Supplemental Gas</td>
</tr>
<tr>
<td>Interruptible Service</td>
<td>83% Primary Gas; 17% Supplemental Gas</td>
</tr>
</tbody>
</table>

### Notes
- Rates are as approved by the Public Utilities Board of Manitoba (PUB), effective May 1, 2015, and are subject to change.
- Base Rates and T-Service Rates are available upon request.
- Minimum monthly bill is equal to the Basic Monthly Charge plus the Demand Charges as appropriate.
- Sales Service provided by Centra is subject to Centra's Schedule of Sales and Transportation Services and Rates as approved by the PUB. Copies of this document are available upon request.
- Definitions of natural gas terms can be found at www.hydro.mb.ca/regulatory_affairs/definitions.shtml.

### Unit Conversions
- 1 MCF = 28.32784 m³
- 1 CCF = 100 cubic feet
- 1 MCF = 1 000 cubic feet
Large General Service
Natural Gas Rate May 1/15

- **How to do a rate “re-bundling” calculation:**
  - Transportation Charge
    - $0.0384/cu.m. x 100% +
  - Distribution Charge
    - $0.0657/cu.m. x 100% +
  - Primary Gas
    - $0.1183/cu.m x 81% +
  - Supplemental Gas
    - $0.1605/cu.m. x 19% =
  - **Rebundled Effective Rate**
    - $0.2304/cu.m.
Example Comparison

**Natural Gas:**
Operation = 8 hrs/day * 5 days/wk * 52 wks/year
= 2080 hrs/year
Use = (100000 Btu/hr / 35310 Btu/m³ / 80%) * 2080 hrs/year
= 7363 m³/year
Cost = 7363 m³/year * $0.2304/m³ = $1,696/year

**Electricity:**
Demand = 100000 Btu/hr / 3413 Btu/kWh = 29.3 kW
= 29.3 kVA (using power factor = 1.0)
Energy = 29.3 kW * 2080 hrs/year = 60,943 kWh/yr
Cost = 29.3 kVA/mth*12 mth/yr*$9.09/kVA + 60,943 kWh/yr*$0.03552/kWh
= $5,543/year
Alternative Heating Fuel Costs

- Electric 24/7 Heat Load: 6.93
- G.S. Med. 40 hr/wk Load: 16.77
- Nat. Gas, LGS @60%Eff.: 3.71
- $0.2304cu.m. @80%Eff.: 2.78
- @95%Eff.: 2.34
- Nat. Gas, SGS @60%Eff.: 4.58
- $0.2843/cu.m. @80%Eff.: 3.44
- @95%Eff.: 2.89
- Propane @60%Eff.: 9.45
- $0.40/L @80%Eff.: 5.94
- @95%Eff.: 7.42
- Fuel Oil @60%Eff.: 14.03
- $0.90/L @75%Eff.: 11.22
- @85%Eff.: 9.90

May 1/2015 Rates
Typical Annual Water Heating Costs for a 40 Suite Apartment Block

### Natural Gas

- **Condensing Tank or Tankless Water Heater** (90% Seasonal Efficiency): $3,518
- **Mid-Efficient Tankless Water Heater or Boiler** (75% Seasonal Efficiency): $4,222
- **Natural Draft Tank Water Heater with Vent Damper** (65% Seasonal Efficiency): $4,871
- **Natural Draft Tank Water Heater** (55% Seasonal Efficiency): $5,757

### Electricity

- **4 x 120 US Gallon Tanks with 4x12= 48 kW of Heating Elements**: $5,236
- **2 x 120 US Gallon Tanks with 2x54= 108 kW of Heating Elements**: $5,104

### Energy Rates*

**Natural Gas:**
- Large General Service: $0.2304/cubic metre
- Demand: $9.09/kV.A

**Electricity:**
- General Service Medium Energy: $0.03552/kWh

*Rates in effect on May 1, 2015
Case Study #1 – 22 Suite Mixed Occupancy Apartment

- High efficiency gas tank type water heater
  - 100 USG, 199,900 Btu/h input, 95% thermal efficiency rating
- Tank fitted with monitoring equipment:
  - Water meter with pulse output on its cold water inlet pipe.
  - Gas meter with pulse output on gas supply pipe.
  - Energy meter on power venter fan motor.
  - RTD temperature sensors on water inlet and water outlet
  - Data logger collecting all temperature and pulse outputs at 5 minute intervals
- Monitored for 17 days
Case Study #1 – 22 Suite Mixed Occupancy Apartment

- 30 people = 1.36 people per suite
- Metered gas consumption of 6776 cu.ft. over a period of 408 hours (17 days)
- Annual gas use estimate of 4,120 cu.m = 42,642 ekWh
  - 1421 ekWh/yr/person = $32/yr/person
  - 1938 ekWh/yr/suite = $44/yr/suite
- Metered DHW usage of 36,787 L / 17 days / 30 people
  - 72 L/day/person
- Average water T out = 118F (48C), T in = 42F (5.4C)
- Overall water heater efficiency of 90.1%
- Steady State efficiency of 94.5%
Typical Daily Usage: Water vs Gas Consumption

Overall period (24 hrs) = 90.1% Efficiency

Steady state = 94.5% Efficiency
Case Study #2 – 42 Suite Mixed Occupancy Apartment

- Tank 1 - 120 USG, 54 kW of elements
- Tank 2 - 120 USG, 40 kW of elements
- 74 people = 1.74 people per suite
- Metered water tank consumption of 17,027 kWh over a period of 852 hours (35.5 days)
- Annual consumption estimate of 175,000 kWh
  - 2365 kWh/yr/person =$222/yr/person
  - 4166 kWh/yr/suite = $392/yr/suite
- 94 kW of monthly peak demand contribution
Annual Water Heating Costs of 42 Suite Apartment Block

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>$16,470</td>
</tr>
<tr>
<td>Electricity</td>
<td>$10,254</td>
</tr>
<tr>
<td>Demand Charges</td>
<td>$6,216</td>
</tr>
<tr>
<td>Energy Charges</td>
<td>$4,254</td>
</tr>
</tbody>
</table>

- Condensing Tank or Tankless Water Heater (90% Seasonal Efficiency): $4,331
- Mid-Efficient Tankless Water Heater or Boiler (75% Seasonal Efficiency): $5,197
- Natural Draft Tank Water Heater with Vent Damper (65% Seasonal Efficiency): $5,997
- Natural Draft Tank Water Heater (55% Seasonal Efficiency): $7,087
- 2 x 120 US Gallon Tanks with 94 kW of Heating Elements: $4,254

ENERGY RATES*
- Natural Gas: Large General Service: $0.2304/cubic metre
- Electricity: General Service Medium: Energy: $0.03552/kWh + Demand: $9.09/kV.A

*Rates in effect on May 1, 2015.
Graph 2: Modified HWT kW Demand vs. Building kW Demand

- **Total HWT kW (15 min avg)**
- **Main Bldg Load kW (15 min avg)**
Case Study #3 – 52 Suite Mixed Occupancy Apartment

- Tank 1 - 120 USG, 27 kW of elements
- Tank 2 - 120 USG, 27 kW of elements
- 87 people = 1.67 people per suite
- Metered water tank energy consumption of 10,221 kWh over a period of 410 hours (17.1 days)
- Annual consumption estimate of 218,200 kWh
  - 2508 kWh/yr/person = $157/yr/person
  - 4196 kWh/yr/suite = $262/yr/suite
- 54 kW of monthly peak demand contribution
Annual Water Heating Costs of 52 Suite Apartment Block

**ENERGY RATES**
- **Natural Gas:**
  - Large General Service: $0.2304/cubic metre
- **Electricity:**
  - General Service: $0.03552/kWh
  - Medium Energy: $0.03552/kWh
  - Demand: $9.09/kV.A

*Rates in effect on May*

<table>
<thead>
<tr>
<th>System</th>
<th>Efficiency</th>
<th>Annual Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensing Tank or Tankless Water Heater (90% SE)</td>
<td></td>
<td>$5,395</td>
</tr>
<tr>
<td>Mid-Efficient Tankless Water Heater or Boiler (75% SE)</td>
<td></td>
<td>$6,474</td>
</tr>
<tr>
<td>Natural Draft Tank Water Heater with Vent Damper (65% SE)</td>
<td></td>
<td>$7,470</td>
</tr>
<tr>
<td>Natural Draft Tank Water Heater (55% SE)</td>
<td></td>
<td>$8,828</td>
</tr>
<tr>
<td>2 x 120 US Gallon Tanks with 54 kW of Heating Elements</td>
<td></td>
<td>$13,634</td>
</tr>
</tbody>
</table>

**Electricity**
- Demand Charges: $5,890
- Energy Charges: $7,744

**Natural Gas**
- $5,395
- $6,474
- $7,470
- $8,828

**Total Costs:**
- Condensing Tank or Tankless Water Heater: $5,395
- Mid-Efficient Tankless Water Heater or Boiler: $6,474
- Natural Draft Tank Water Heater with Vent Damper: $7,470
- Natural Draft Tank Water Heater: $8,828
- 2 x 120 US Gallon Tanks with 54 kW of Heating Elements: $13,634
Case Study #4 – 31 Suite Seniors Apartment

- Tank 1 - 120 USG, 30 kW of elements
- Tank 2 - 120 USG, 27 kW of elements
- Tank 3 – 120 USG, 30 kW of elements
- 35 people = 1.12 people per suite
- Metered water tank consumption of 5,898 kWh over a period of one month (30 days)
- Annual consumption estimate of 71,759 kWh
  - 2050 kWh/yr/person = $156/yr/person
  - 2315 kWh/yr/suite = $176/yr/person
- 27 kW of monthly peak demand contribution because all flow short circuited thru the one middle tank. Two outer tanks never operated and contributed to peak.
Annual Water Heating Costs of 31 Suite Seniors Block

<table>
<thead>
<tr>
<th>Options</th>
<th>Natural Gas</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensing Tank or Tankless Water Heater (90% Seasonal Efficiency)</td>
<td>$1,752</td>
<td>$2,945</td>
</tr>
<tr>
<td>Mid-Efficient Tankless Water Heater or Boiler (75% Seasonal Efficiency)</td>
<td>$2,102</td>
<td>$2,514</td>
</tr>
<tr>
<td>Natural Draft Tank Water Heater with Vent Damper (65% Seasonal Efficiency)</td>
<td>$2,425</td>
<td></td>
</tr>
<tr>
<td>Natural Draft Tank Water Heater (55% Seasonal Efficiency)</td>
<td>$2,866</td>
<td></td>
</tr>
<tr>
<td>3 x 120 US Gallon Tanks with 27 kW of Heating Elements Operating</td>
<td></td>
<td>$5,459</td>
</tr>
</tbody>
</table>

ENERGY RATES*
Natural Gas: Large General Service
$0.2304/cubic metre

Electricity: General Service Medium
Energy: $0.03552/kWh + Demand: $9.09/kV.A

*Rates in effect on May 1, 2015
MORE INFO

Denton Vandersteen, P.Eng. CEM
Senior Commercial Systems Engineer
Customer Engineering Services Department
(204) 360-3803
dmtvandersteen@hydro.mb.ca

www.hydro.mb.ca