Econ 366 – Energy Economics
Fall 2012

Measuring Energy / Energy Data

Energy Data Sources

- Alberta Data: Energy Resources Conservation Board
- Canadian Data: Statistics Canada (Cansim), Natural Resources Canada Office of Energy Efficiency, Canadian Association of Petroleum Producers (CAPP)
- International Data: US Department of Energy (USDOE), Energy Information Administration (EIA), International Energy Agency (IEA), British Petroleum (BP)
- Many other data sources; some (Platts for example) require registration and/or subscriptions

Measuring Energy

- Value
  - $20 worth of gas; $80 worth of electricity
- Natural units
  - 5 litres of gas; 30 cubic metres of n.g (at a standard pressure and temperature of 101.325 kPa and 15°C); a cord of wood; a ton of coal
- Calorific value
  - KwH; GJ / tonne; MJ / m^3
  - 4.184 Joules = 1 calorie
- Commercial units / Product Equivalence
  - Ktoe; tce (less 'precise' than calorific value since oil, coal not uniform)
- unit converter http://www.iea.org/stats/unit.asp

Scientific Notation

Term	Value	Scientific notation
kilo	thousand	10^3
mega	million	10^6
giga	billion	10^9
tera	thousand billion	10^{12}
peta	million billion	10^{15}
Exa	billion billion	10^{18}

Metric / Imperial Conversions (ERCB)

Metric		Imperial
1 kilojoule	=	0.948213 British thermal units
1 m^3 (oil)*	=	6.2929 Cdn barrels of oil
1 m^3 (ethane)	=	6.3301 Cdn barrels of ethane
1 m^3 (gas)	=	35.49373 cubic feet of gas
1 m^3 (propane)	=	6.3 Cdn barrels of propane
tonne	=	0.984206 long tons (2240 lbs) 1.102311 short tons (2000 lbs)

* See ERCB for temperatures / pressures of all volume measures

Primary Energy Content Factors (ERCB)

Fuel		GJ
Natural gas (thousand cubic metres)		37.4
Ethane (per cubic metre)		18.5
Propane (per cubic metre)		25.4
Butanes (per cubic metre)		28.2
Light and medium crude oil (per cubic metre)		38.5
Heavy crude oil (per cubic metre)		41.4
Bitumen (per cubic metre)		42.8
Synthetic crude oil (per cubic metre)		39.4
Pentanes plus (per cubic metre)		33.1
Subbituminous coal (per tonne)		18.5
Bituminous coal (per tonne)		25.0

Product definitions : http://www.eia.gov/dnav/pet/TblDefs/pet_cons_psup_tbldef2.asp

Secondary Energy Content Factors (ERCB)

Refined Products		**GJ**
Motor gasoline (per cubic metre)		34.7
Diesel (per cubic metre)		38.7
Aviation turbo fuel (per cubic metre)		35.9
Aviation gasoline (per cubic metre)		33.5
Kerosene (per cubic metre)		37.7
Light fuel oil (per cubic metre)		38.7
Heavy fuel oil (per cubic metre)		41.7
Generated Energy		**GJ**
Electricity (per megawatt-hour of output)		3.6

‘Product Equivalence’ conversions

Term		Equivalences
toe		tonne of oil equivalent = 41.868 GJ = 10 Gcal = 39683.2 kBTU = 0.01163 GWh = 1.4285714286 tce
tce		tonne of coal equivalent = 29.3076 GJ =7 Gcal = 0.7 toe = 27778.24 kBTU = 0.008141 GWh

- Many more conversion rates available in Tables 2.4 - 2.9 in textbook and at http://www.iea.org/stats/unit.asp

Making conversions: Example 1 from textbook

- Coal
  - Natural units:
    - 72Megatonnes = 72 x 1000000 x 1000 kg
  - Calorific value:
    - 6200 kcal / kg
  - Energy content:
    - 62 x 72 x 10^{11} x 1000 cal = 446.4 x 10^{15} cal = 446.4 Pcal
    - 446.4 Pcal = 4.1868 x 446.4 PJ = 1868.9875 PJ
    - 446.4Pcal = 100 x 446.4 ktoe = 44640 ktoe

Making conversions: Example 1 from textbook

- Crude Oil
  - Natural units:
    - 495 Million barrels = 495 X 1000000 x 158.987 litres
      = 78.699 billion litres
  - Calorific value:
    - 8000 kcal / litre
  - Energy content:
    - 8000 x 78.699 x 10^9 x 1000 cal = 629.6 x 10^{15} cal = 629.6 Pcal
    - 629.6 Pcal = 4.1868 x 629.6 PJ = 2636 PJ
    - 629.6 Pcal = 100 x 629.6 ktoe = 62959 ktoe

Making conversions: Example 1 from textbook

- Natural Gas
  - Natural units:
    - 2860 Billion cft
  - Calorific value:
    - 900 BTU / cft
  - Energy content:
    - 2860 x 900 x 10^9 BTU = 2574000 GBTU =
      = 0.000252 x 2574000 Pcal = 648.648 Pcal
    - 648.648 Pcal = 4.1868 x 648.648 PJ = 2716 PJ
    - 648.648 Pcal = 100 x 648.648 ktoe = 64865 ktoe

Making conversions: Example 1 from textbook

- Hydro Electricity
  - Natural units:
    - 11600 GWh
  - Calorific value
    - 860kcal / kWh (1GWh = 860 Gcal)
  - Energy content:
    - 11600 x 860 x 10^9 cal = 9.976 x 10^{15} cal = 9.976 Pcal
    - 9.976 Pcal = 4.1868 x 9.976 PJ = 41.77 PJ
    - 9.976 Pcal = 100 x 9.976 ktoe = 997.6 ktoe

Making conversions: Example 1 from textbook

- Geothermal
  - Natural units:
    - 2900 GWh
  - Calorific value
    - 860kcal / kWh → 1GWh = 860 Gcal
  - Energy content:
    - 2900 x 860 x 10^9 cal = 2.494 x 10^{15} cal = 2.494 Pcal
    - 2.494 Pcal = 4.1868 x 2.494 PJ = 10.44 PJ
    - 2.494 Pcal = 100 x 2.494 ktoe = 249.4 ktoe

Summary of Conversion Results Textbook Example 1

Source	Pcal	PJ	ktoe	% of Domestic Production
Coal	446.40	1868.99	44640.00	25.70
Crude Oil	629.59	2635.96	62958.85	36.24
Natural Gas	648.65	2715.76	64864.80	37.34
Hydro	9.98	41.77	997.60	0.57
Geothermal	2.49	10.44	249.40	0.14
Total	1737.11	7272.92	173710.65	100.00