

Econ 366 – Energy Economics

Fall 2012

Topic 1: Introduction (including some
Canadian energy data)

Main Goal

- Learn how to apply economic principles to the study of the production and use of energy
 - Microeconomics: actions of consumers and producers and how they respond to prices, regulations, etc.
 - Macroeconomics: role of energy resources in economic development

What is energy?

- Ability to produce heat
 - Measured, for example, in calories
 - 1 calorie = amt of heat required to increase the temperature of 1 gram of water by 1° Celsius (from 14.5 ° to 15.5 ° Celsius) (p.22)
- Ability to do work
 - Measured, for example, in Joules
 - 1 joule = “energy expended (or work done) in applying a force of one newton* through a distance of one meter”
(<http://en.wikipedia.org/wiki/Joule>)
- unit converter <http://www.iea.org/stats/unit.asp>

**“amount of net force required to accelerate a mass of one kilogram at a rate of one meter per second squared” ([http://en.wikipedia.org/wiki/Newton_\(unit\)](http://en.wikipedia.org/wiki/Newton_(unit)))*

Energy Sources

- Possible categorizations (usefulness depends on issue of interest)
 - Fossil / non-fossil
 - Renewable / non-renewable
 - Primary / secondary
 - Commercial / non-commercial
 - Conventional / non-conventional
 - Imported / exported

Classification examples (p.12)

	Renewable	Non-renewable
Commercial	Large scale hydro Geothermal Nuclear	Products derived from fossil fuels (coal, oil, natural gas)
Traditional/non-commercial	Animal residues Crop residues Windmills and watermills Sustainable fuelwood	Unsustainable fuelwood
New and novel	Solar Tidal Ocean thermal	Non-conventional oil

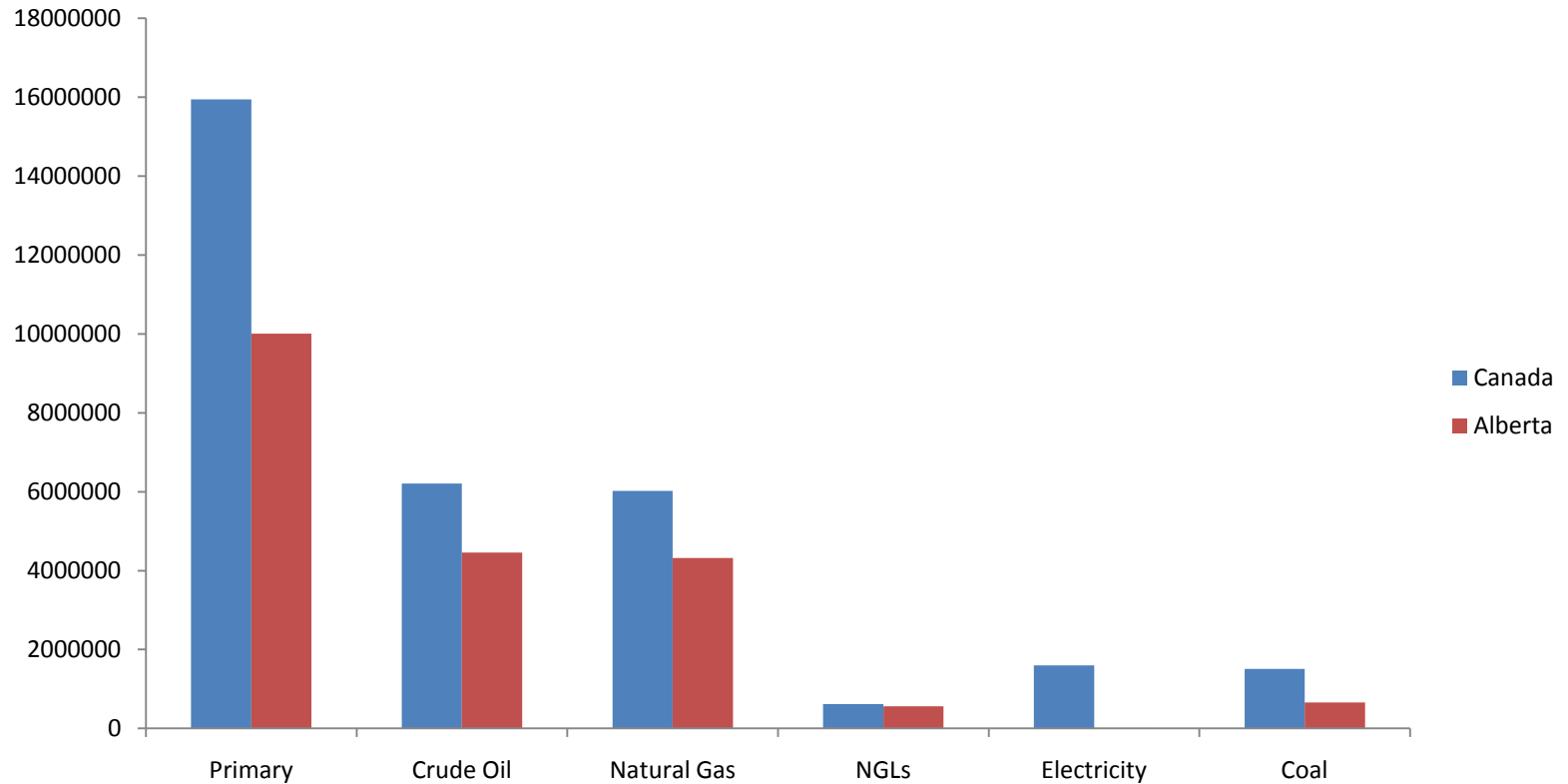
Which are primary / secondary sources?

How much do Canadians produce?

1TJ = 10^{12} Joules

PRIMARY ENERGY 2010 (Terajoules)

CANSIM TABLE 128-0016

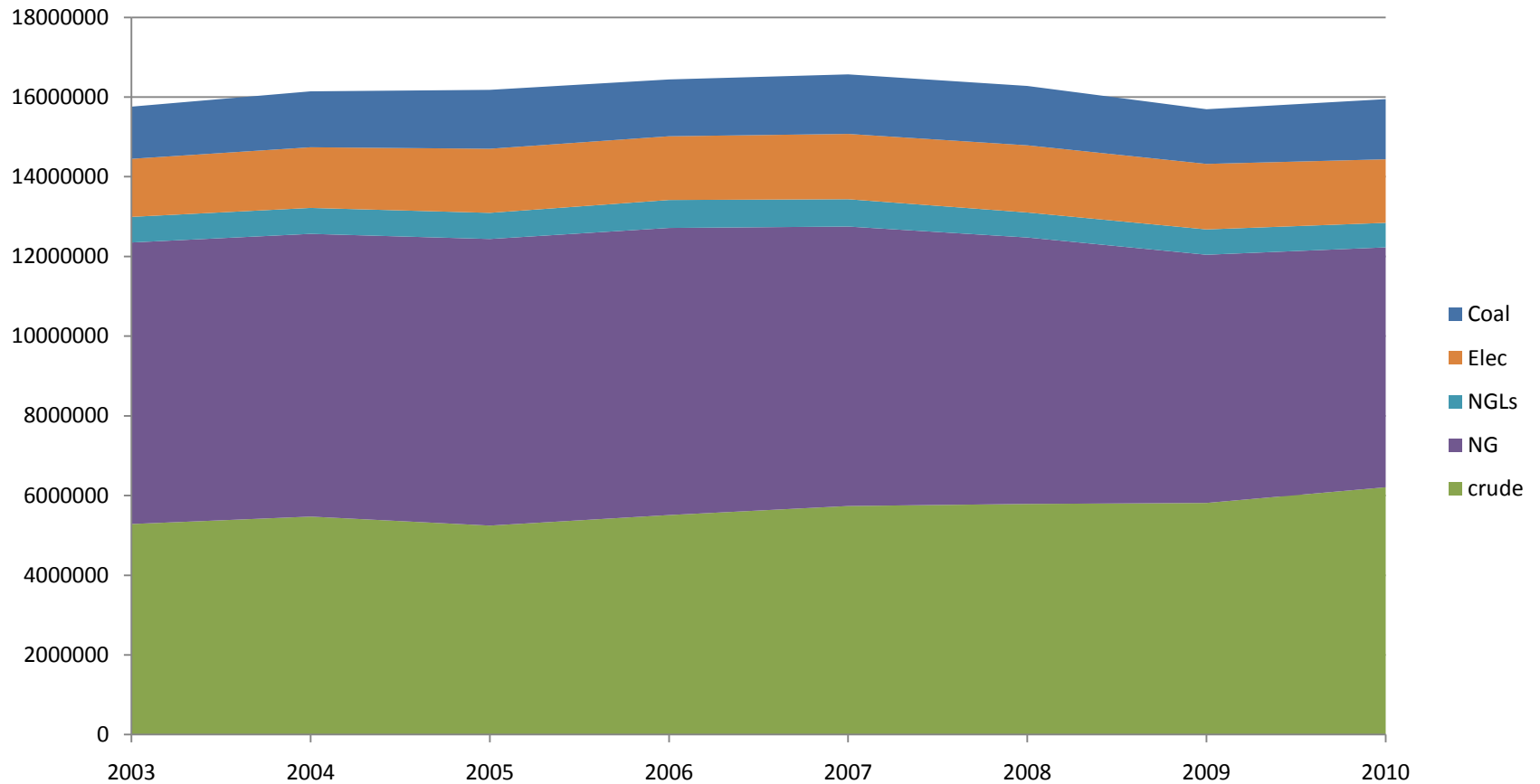


How much do Canadians produce?

Cansim Table 128-0016

1TJ = 10^{12} Joules

Primary Production – Canada (TJ)

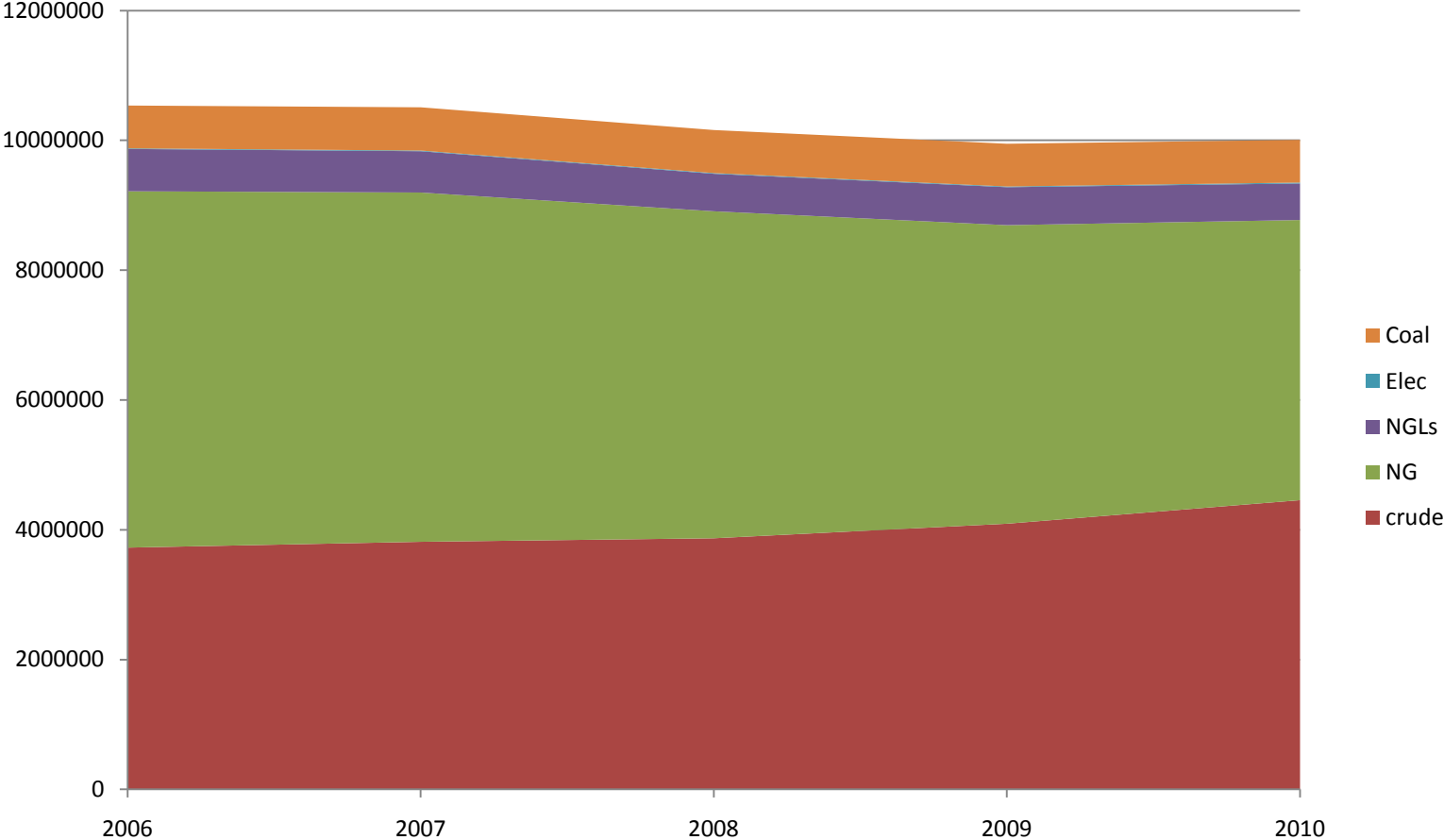


How much does Alberta produce?

Cansim Table 128-0016

1TJ = 10^{12} Joules

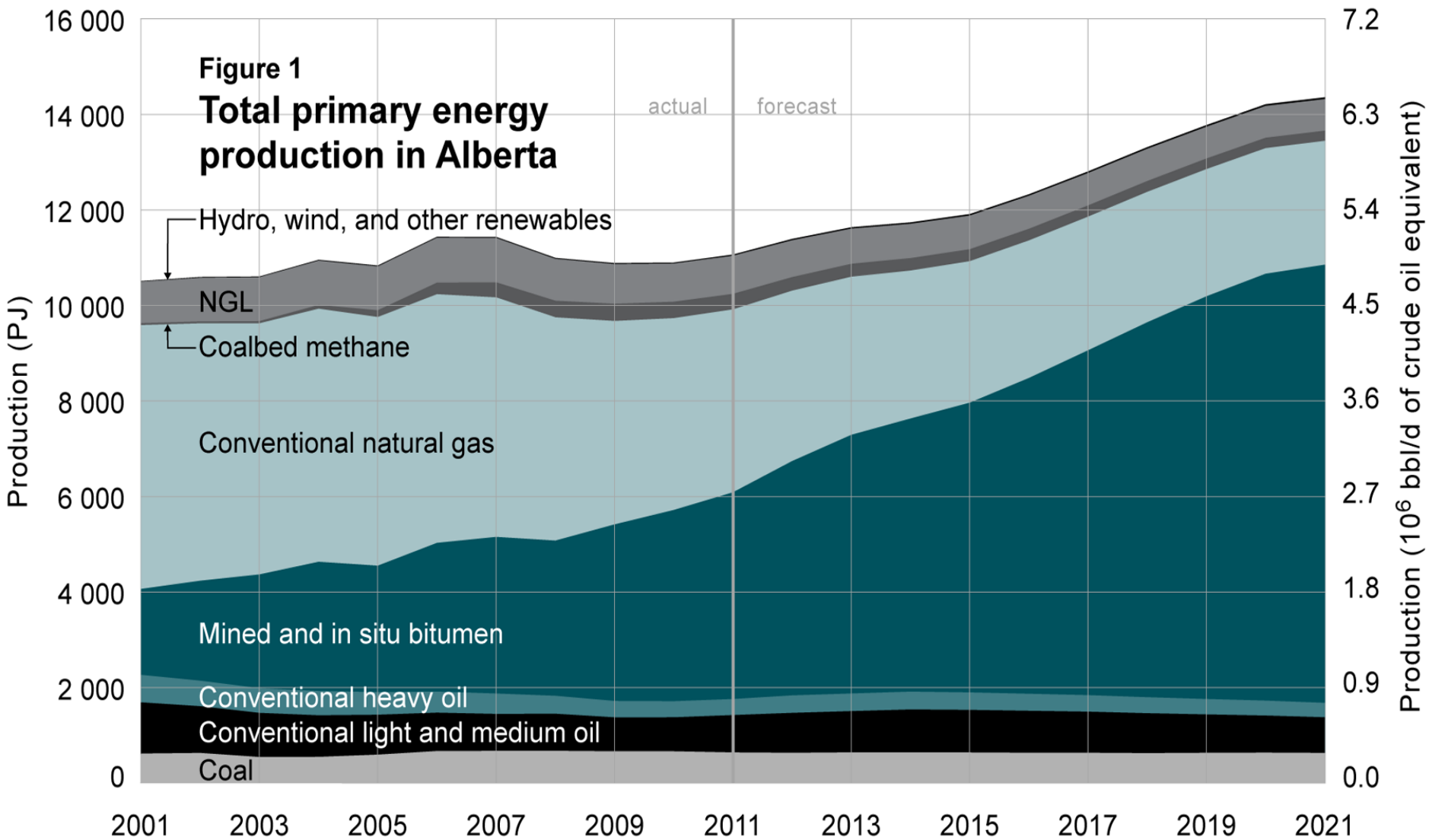
Primary Production – Alberta (TJ)



Detailed Alberta Primary Energy Production

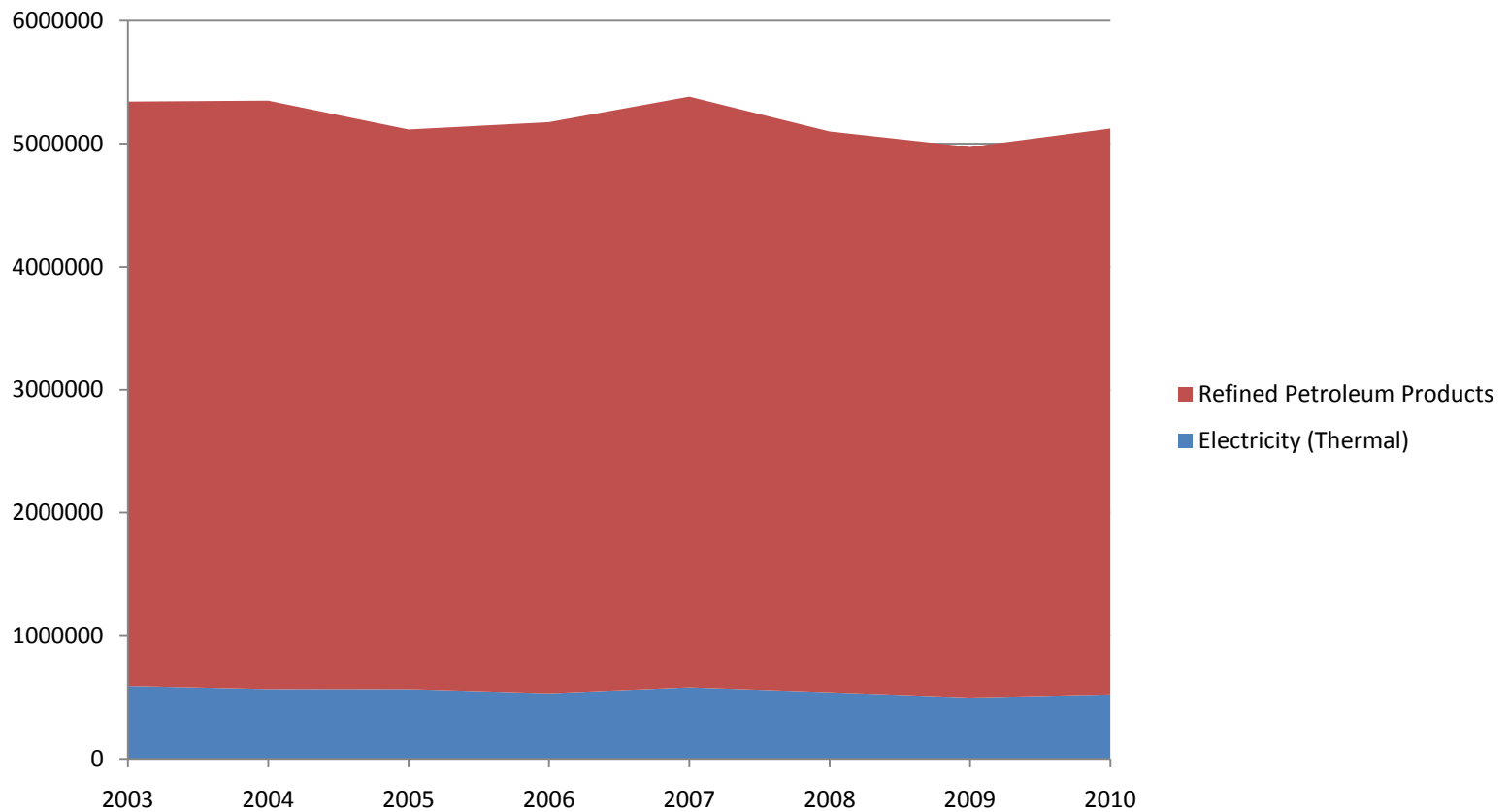
Source: ERCB st98-2012-overview

1PJ=10¹⁵Joules



Secondary Energy Production in Canada

Secondary Energy Production (TJ)

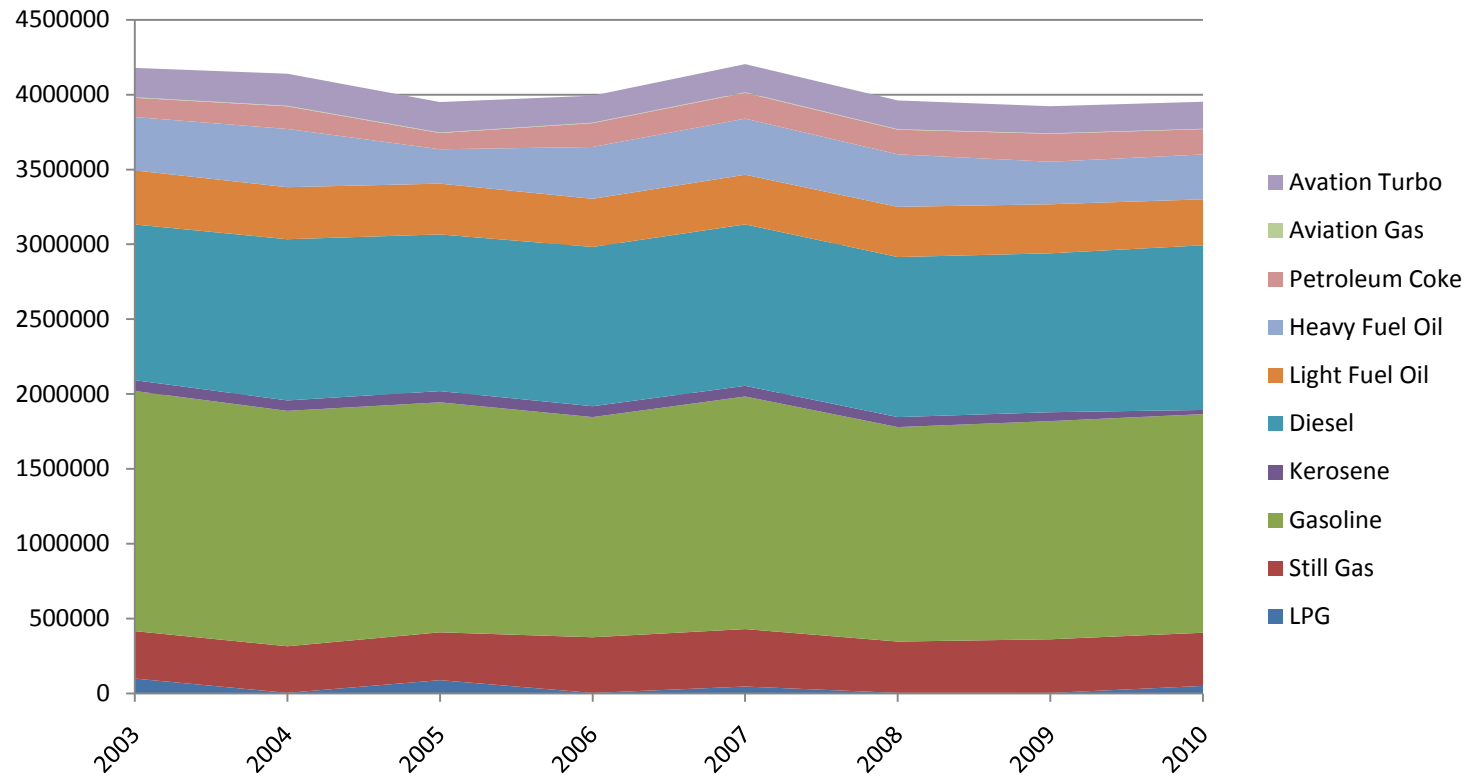


Secondary Energy: Refined Petroleum Products

Cansim Table 128-0016

1TJ = 10^{12} Joules

Refined Petroleum Products (TJ) (excluding non-energy products)



Link between sources and end-users:

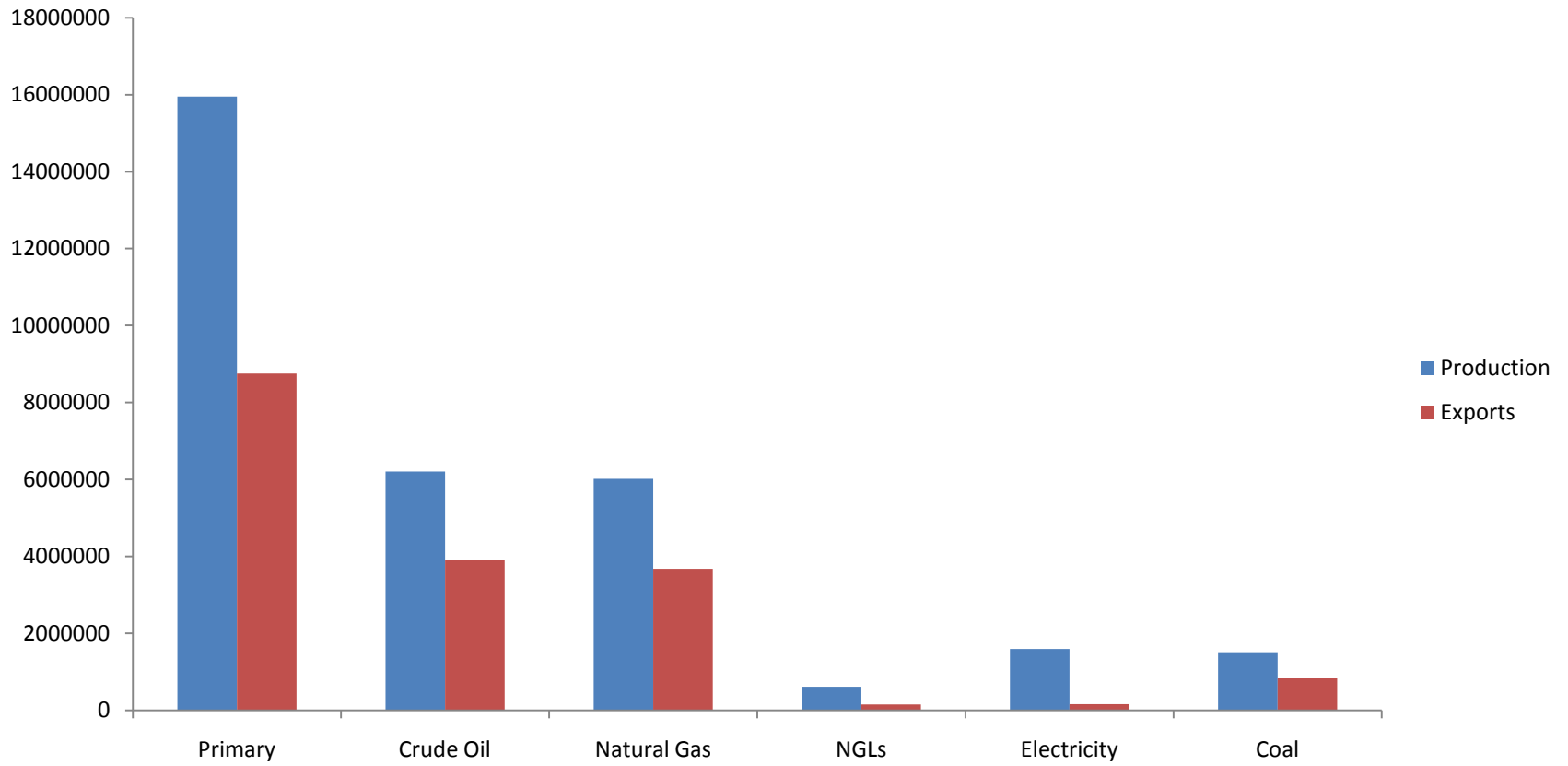
- Supply sector: exploration, development, production
- Transportation
- Transformation (refining, generation; non-energy products)
- Transportation
- End-users (derived demands for work and heat; demand for non-energy products)

Canadian Energy Products

- Some are used within the country
- Some are exported to other countries
- Both primary and secondary energy products are exported
- Both primary and secondary energy products are imported

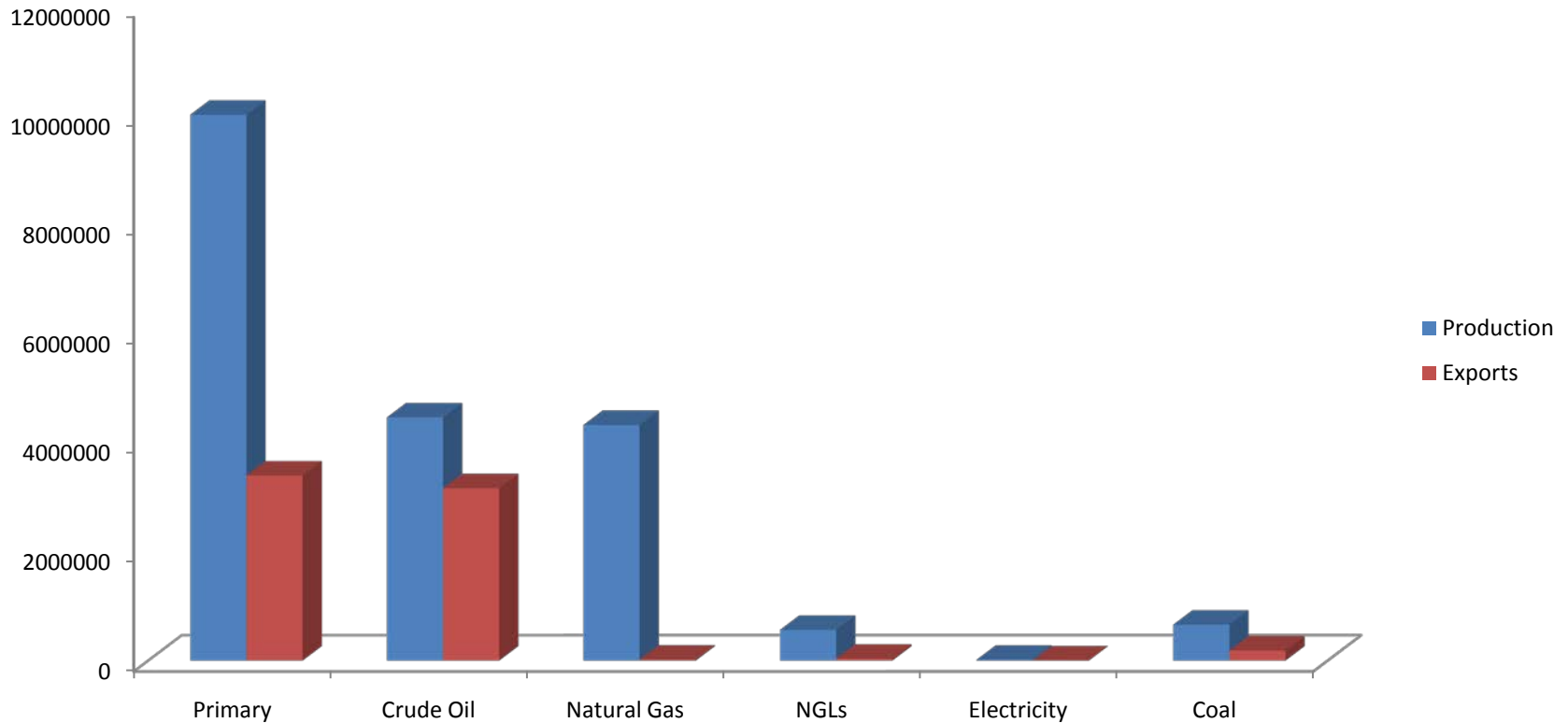
How Much Energy is Exported from Canada?

Production and Exports of Primary Energy: (TJ) 2010



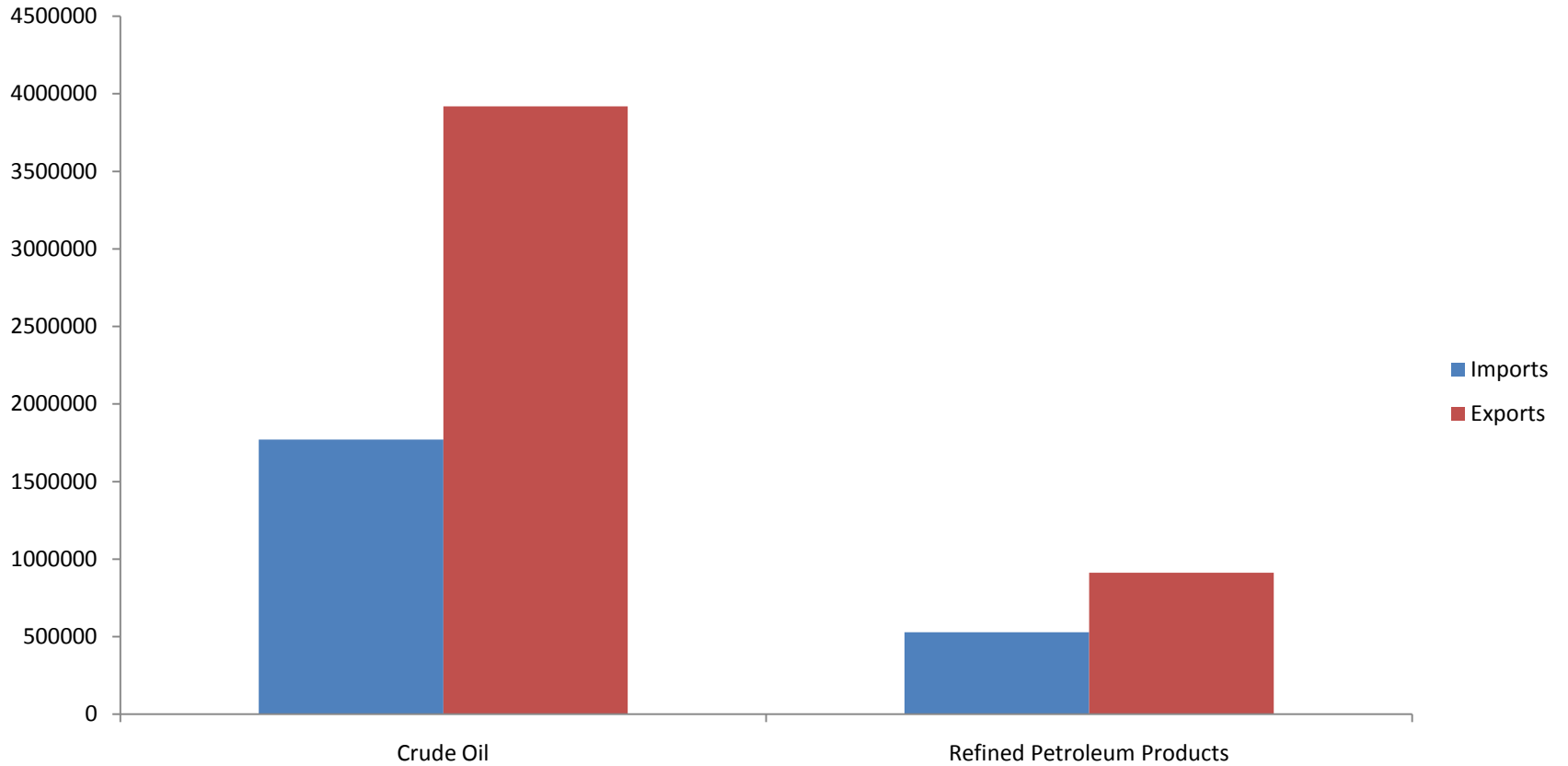
How Much Energy is Exported from Alberta?

Production and Exports of Primary Energy (TJ) : 2010



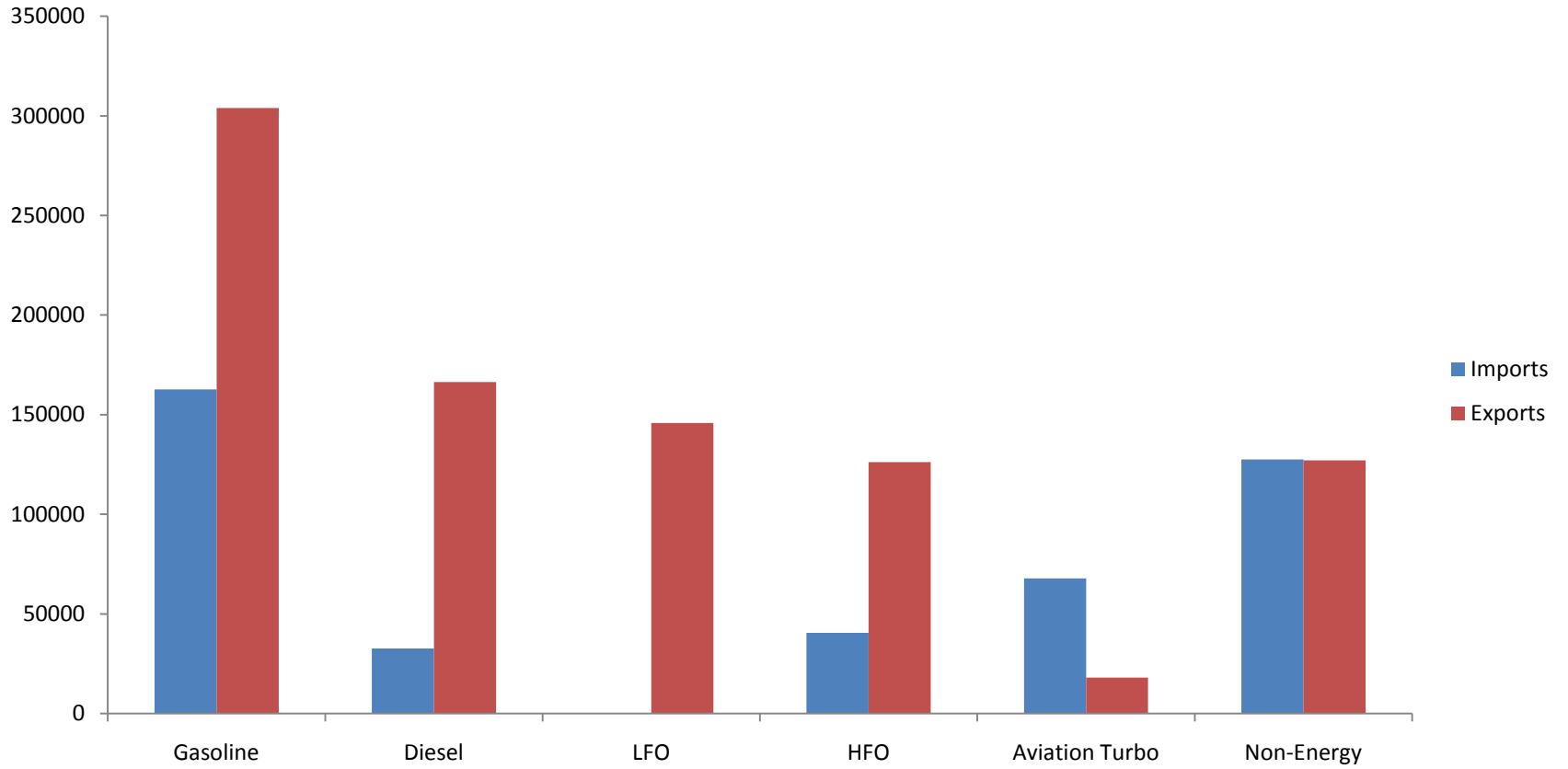
Canadian Exports and Imports

Crude and Refined Oil Products(TJ)



Canadian Exports and Imports

Selected Refined Petroleum Products (TJ)



Domestic Use

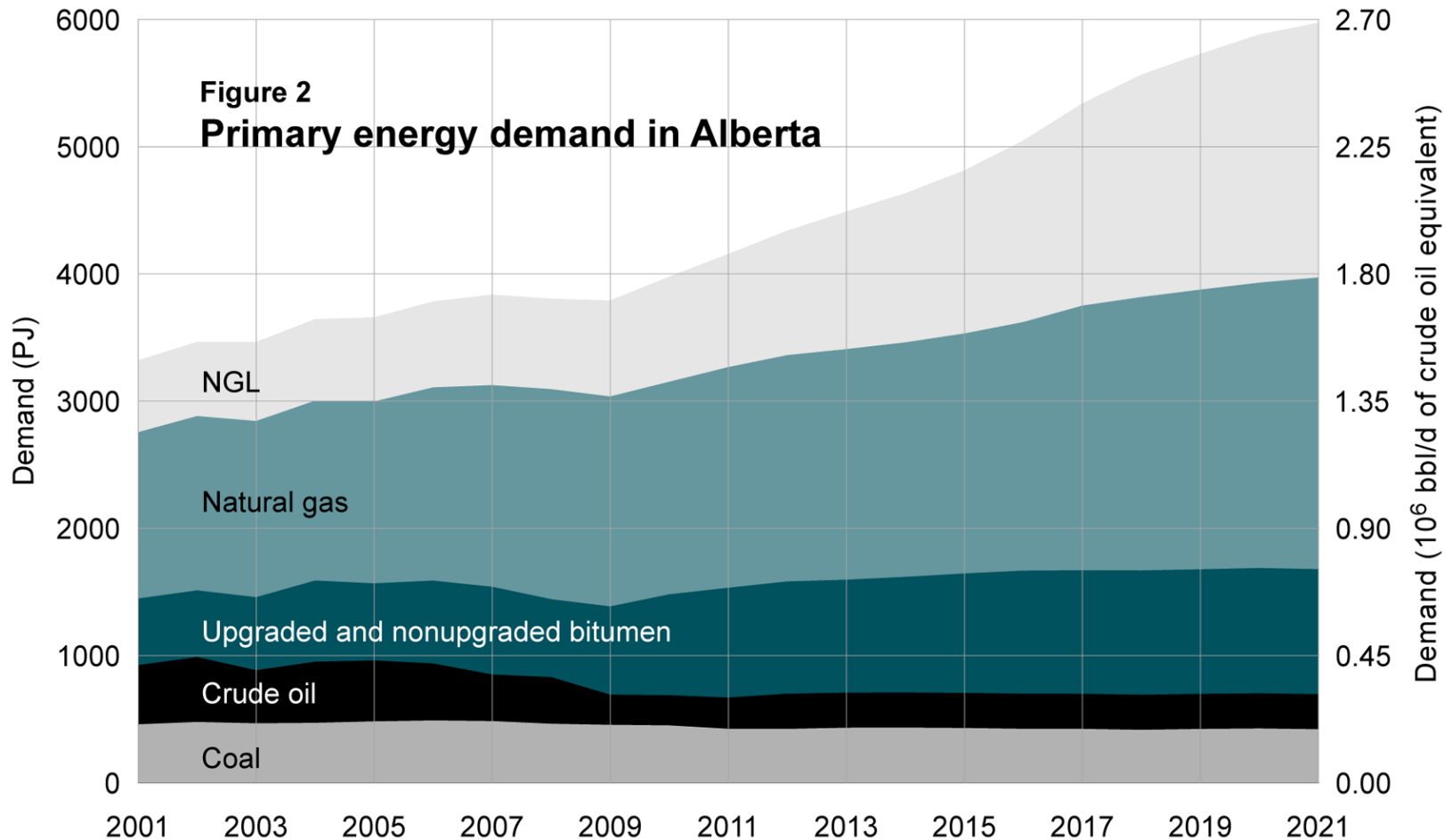
Major End-Use Sectors

- Industrial
- Transportation
- Residential
- Commercial / Institutional
- Agricultural

Detailed Alberta Primary Energy Demand

All sectors by primary fuel type

Source: ERCB st98-2012-overview



How much do Canadians use?

<http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/home.cfm>

Industrial Energy Use (in PJs: 1 PJ = 10^{15} Joules)

Year	2005	2006	2007	2008	2009
Quantity	3244.2	3155.5	3415.9	3201.6	3168.4

Composition of Industrial Energy Use (in %)

Year	2005	2006	2007	2008	2009
Electricity	26.5	26.5	23.5	23.0	21.1
Natural Gas	28.5	30.2	32.5	32.4	36.8
Fuel Oil	9.8	8.4	8.1	7.9	6.9
Still Gas / Petr. Coke	12.4	13.9	14.8	13.8	15.0
Wood Waste	14.4	12.2	12.8	14.2	13.2

some categories omitted... see website

How much do Canadians use?

<http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/home.cfm>

Transportation (Passenger/Freight/Off-road) Energy Use (in PJ)

Year	2005	2006	2007	2008	2009
Quantity	2501.3	2492.2	2594.0	2595.4	2576.6

Composition of Transportation Energy Use (in %)

Year	2005	2006	2007	2008	2009
Electricity	0.1	0.1	0.1	0.1	0.1
Natural Gas	0.1	0.1	0.1	0.1	0.1
Gasoline	54.8	55.1	53.9	53.2	54.4
Diesel	31.3	31.4	31.6	32.5	31.9
Ethanol	0.3	0.3	1.2	1.3	1.4
Aviation Turbo Fuel	10.2	10.1	9.9	9.7	9.3
some categories omitted					

How much do Canadians use?

<http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/home.cfm>

Residential Energy Use (in PJ's)

Year	2005	2006	2007	2008	2009
Quantity	1395.3	1334.4	1438.9	1460.6	1422.3

Composition of Residential Energy Use (in %)

Year	2005	2006	2007	2008	2009
Electricity	39.0	39.7	38.2	39.3	40.6
Natural Gas	46.3	46.3	47.4	47.2	46.4
Heating Oil	6.6	6.2	6.1	5.2	4.5
Wood	7.1	6.8	7.1	7.1	7.5
Other*	1.0	1.1	1.1	1.2	1.1
*coal, propane, etc.					

How much do Canadians use?

<http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/home.cfm>

Commercial/Institutional Energy Use (in PJ)

Year	2005	2006	2007	2008	2009
Quantity	1162.2	1090.0	1158.4	1193.4	1186.0

Composition of Commercial/Institutional Energy Use (in %)

Year	2005	2006	2007	2008	2009
Electricity	41.8	43.5	44.6	45.5	43.8
Natural Gas	43.4	42.9	41.4	41.3	42.9
Fuel Oil / Kerosene	12.0	10.8	10.9	10.1	10.6
Steam	0.2	0.2	0.3	0.3	0.2
Other*	2.6	2.5	2.7	2.8	2.5

*coal, propane, etc.

How much do Canadians use?

Online data no longer available

Agricultural Energy Use (in PJ)

Year	2005	2006	2007	2008	2009
Amt	208.5	211.4	215.6	217.2	188

Composition of Agricultural Energy Use (in %)

Year	2005	2006	2007	2008	2009
Electricity	17.7	16.8	15.4	16.0	Not available
Natural Gas	9.5	9.7	10.3	10.4	Not available
Gasoline	24.8	24.8	22.2	22.1	Not available
Diesel	41.7	42.9	44.8	44.8	Not available
Fuel Oil /Kerosene	3.0	2.5	3.6	2.9	Not available
Propane	3.4	3.3	3.7	3.7	Not available

UK Energy Accounting Framework (for total energy and energy sub-categories)

- Domestic Primary Supply = Production + Imports – Exports – Bunkers* + Δ inventory
- Secondary Supply = Transformation inputs - energy sector own use – transmission/distribution losses
- Final consumption = sum of end-use energy and non-energy uses in all (non-energy) sectors
- Primary Demand = Transformation inputs + energy sector own use (+ losses) + Final consumption
- *Bunkers = fuel used by ships for international voyages; measured primary demand and primary supply rarely coincide → statistical difference

Table 2.3 from Textbook

Table 2.3 Abridged Overall Energy Balance for the U.K. for 2008 (unit: ktOE)

	Coal and products	Oil and products	Natural gas	Renewable and waste	Electricity and heat	Total
Supply						
Indigenous production	11362	78580	69672	4361	12965	176939
Imports	28918	91683	35000	948	1057	157606
Exports	-599	-84325	-10548	0	-109	-95581
Marine bunkers	0	-2733	0	0	0	-2733
Stock change	-1996	268	-265	0	0	-1993
Primary supply	37684	83473	93859	5309	13913	234238
Statistical difference	-171	-195	75	0	91	-200
Primary demand	37855	83668	93784	5309	13822	234438
	0	0	0	0	0	0
Transfers	-126	6	-6	0	0	-125
Transformation	-33882	-1530	-34157	-3537	21468	-51638
Electricity generation	-30769	-989	-32165	-3537	20187	-47274
Heat generation	-336	-60	-1992	0	1281	-1107
Petroleum refineries	0	-264	0	0	0	-264
Coke manufacture	-218	0	0	0	0	-218
Blast furnaces	-2570	-217	0	0	0	-2787
Patent fuel manufacture	12	0	0	0	0	12
Energy industry use	853	4777	5950	0	2354	13934
Losses	236	0	1172	0	2358	3766
Final consumption	2758	77367	52499	1772	30578	164974
Industry	1990	6360	11393	336	10537	30616
Transport	0	57268	0	821	725	58814
Other	768	4454	40308	615	19316	65461
Non energy use	0	9284	797	0	0	10081

Source Digest of UK Energy Statistics, 2009

Energy Accounting Example (Table 2.3)

- Domestic (Primary) Supply = Production + Imports – Exports – Bunkers + Δ inventory
 $234238^* = 176939 + 157606 - 95581 - 2733 + (-1993)$
- Secondary Supply = Transformation inputs (+ transfers) - energy sector use – transmission/distribution losses
 $34063 = 51638 (+125) - 13934 - 3766$
- Final consumption = industrial energy use + transportation energy use + other sector energy use + total non-energy uses
 $164974^{**} = 30616 + 58814 + 65461 + 10081$
- Primary Demand
 $234438^{**} = 51638 (+125) + 13934 + 3766 + 164974$
Statistical error = -200
- *units of measurement: ktoe; ** minor discrepancy due to rounding errors