CONTRIBUTION OF TIMES-CANADA MODEL TO ENERGY POLICY SEA

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Outline

1. Introduction to TIMES models and TIMES-Canada
2. Model database: Reference energy systems and energy resources
3. Demand projections and final energy calibration
4. Examples of analysis and results
   a) Focus on the oil sector up to 2030
   b) GHG emission reduction scenarios up to 2050

1. INTRODUCTION TO TIMES MODELS AND PRECISIONS ON TIMES-CANADA

The Integrated MARKAL-EFOM System (TIMES) model

- Combine advanced versions of MARKAL models (ETSAP, IEA)
- Linear programming bottom-up energy models
- Integrated modeling of the entire energy system
- Prospective analysis on a long term horizon (50-100 yrs)
  - Demand driven (exogenous) in physical units
  - Price-elasticities for end-use demands
- Partial and dynamic equilibrium (perfect market)
- Optimal technology selection
- Objective-function: Maximizes net social surplus
- Environmental constraints (GHG emission limits)
- Energy and emission permits trading

In summary

Economic

- End-use demands
- Demand elasticities
- Crude oil price
- Reserve supply curves
- Other parameters
  - Discount rate
  - Time period
  - Time slices

Technology database

- Techno-economic attributes

Environmental

- Bounds
- Taxes, subsidies
- Sectors' measures

TIMES

Equilibrium

- Technology investments and annual activities
- Emission trajectories
- Adjusted demands for energy services
- Marginal prices of energy forms
- Imports/exports of energy and emission permits
- Total discounted system cost

TIMES-Canada

Regions: 13 provinces and territories

Base year: 2007
Horizon: 2050 (energy)
Horizon: 2100 (climate)

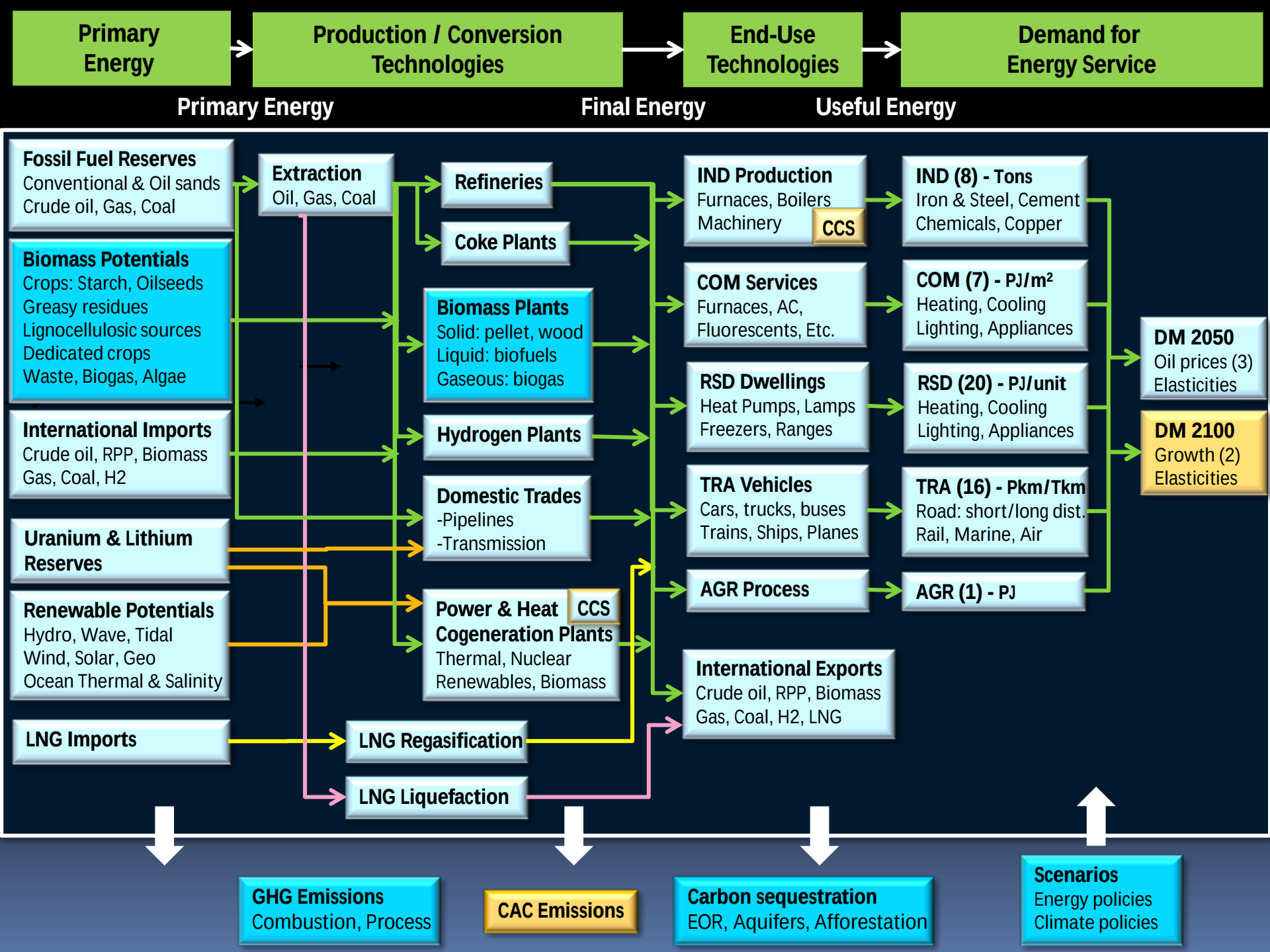
	Start	Mid	End	Length
1	2007	2007	2007	1
2	2008	2008	2009	2
3	2010	2010	2011	2
4	2012	2012	2013	2
5	2014	2015	2017	4
6	2018	2020	2022	5
7	2023	2025	2027	5
8	2028	2030	2032	5
9	2033	2040	2047	15
10	2048	2050	2052	5

Time slices
- 4 seasons: Spring, Summer, Fall, Winter
- 3 day periods: Day, Night, Peak

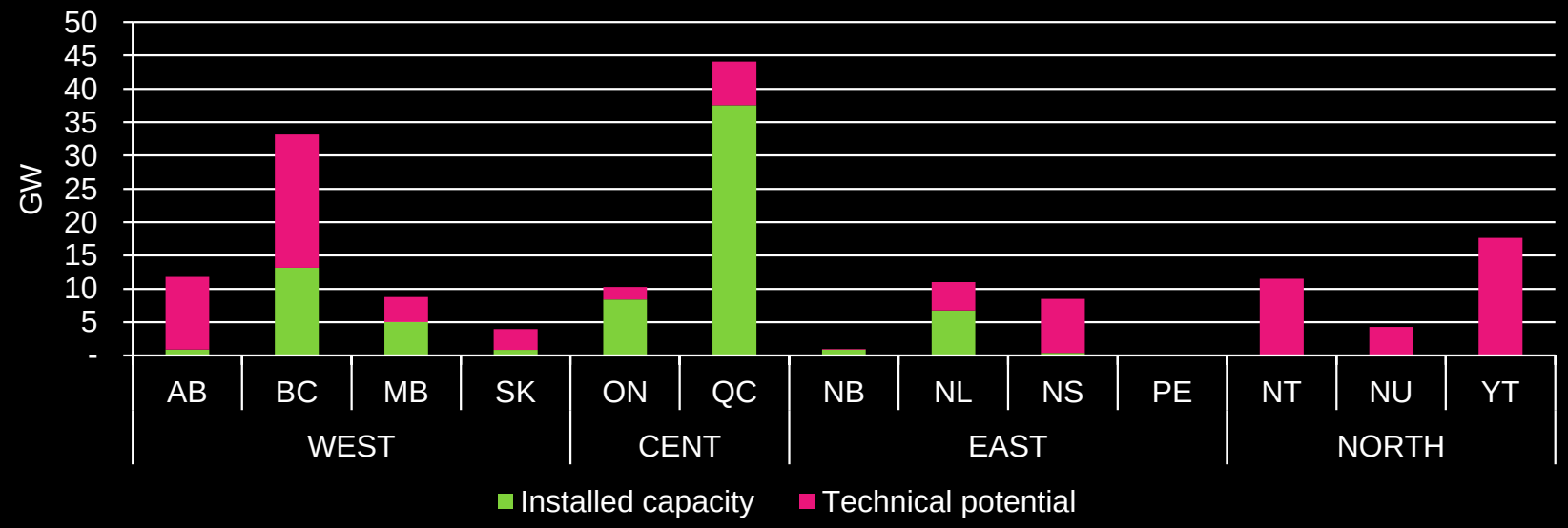
Context

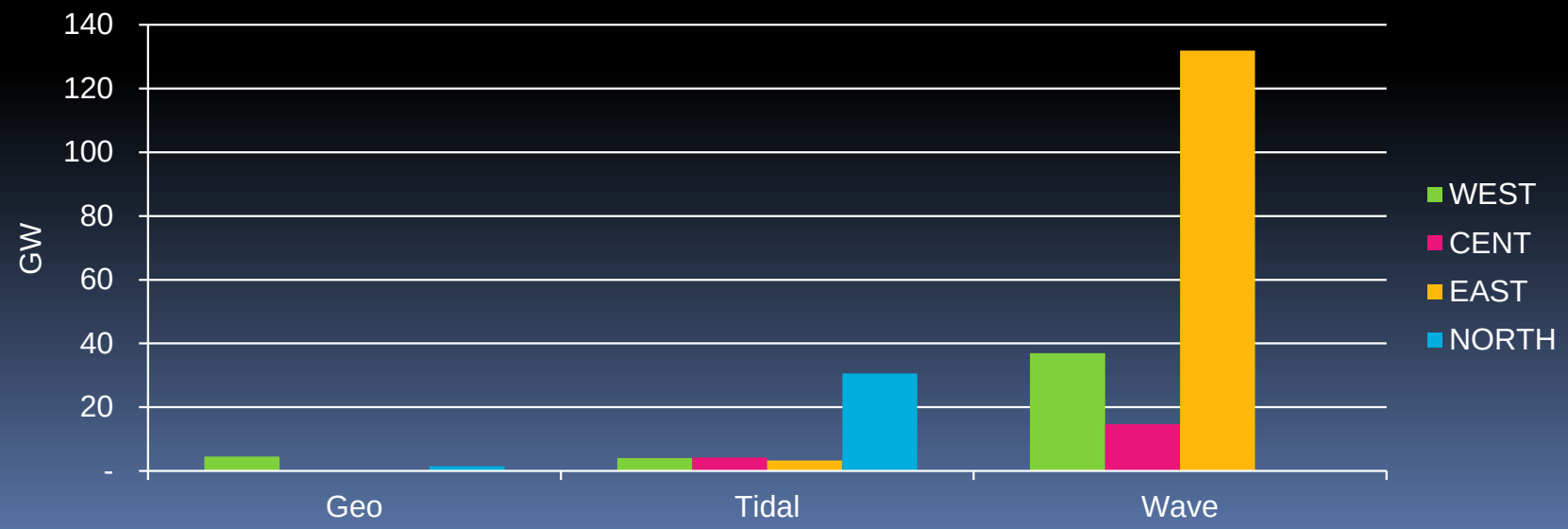
- Canada is an important player on the world scene
  - The largest supplier of natural uranium (1/3 of the global demand) (SK)
  - An important coal heritage (BC, AB, SK, Atlantic)
  - A leader in hydroelectricity production and important exporters (BC, QC)
  - An important producer of oil and gas (AB, MB, Atlantic)
- New opportunities for producing provinces to generate additional revenues from exports (fossil fuels or renewable electricity)
- Energy security issues for non-producing provinces that depends on crude oil imports (for transportation)
- Interests to develop renewable energy sources in all provinces
- Take into account GHG emission reduction issues
- Lack of a national energy strategy to optimize the management of energy systems and the conception of climate policies.

2. MODEL DATABASE: REFERENCE ENERGY SYSTEMS AND ENERGY RESOURCES

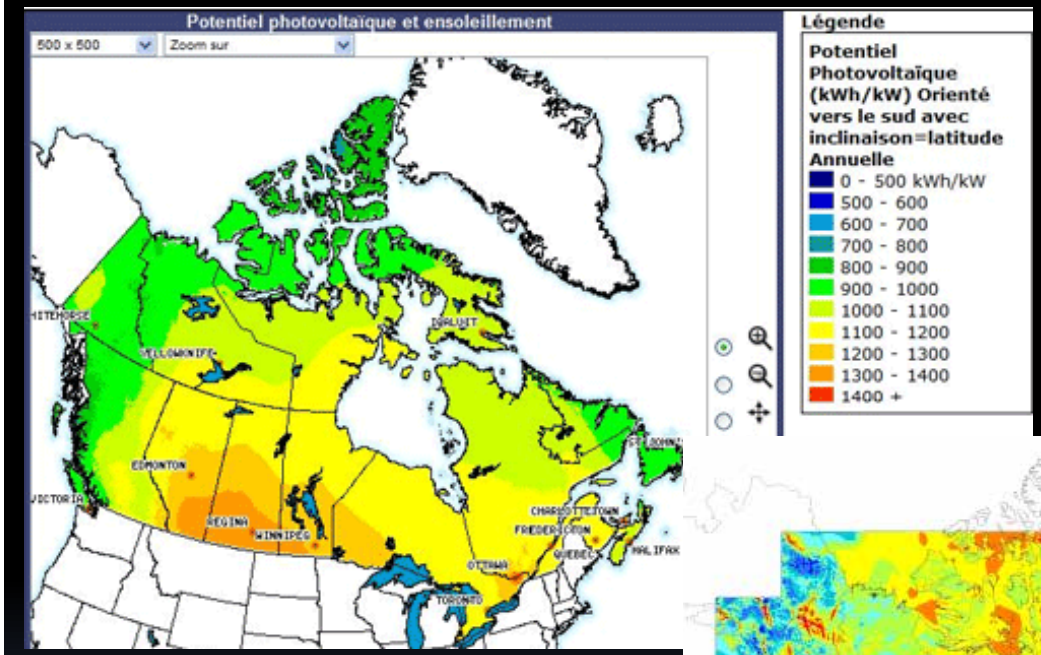

Primary Energy
Production / Conversion Technologies
End-Use Technologies
Demand for Energy Service
Primary Energy
Final Energy
Useful Energy
Fossil Fuel Reserves
Conventional & Oil sands
Crude oil, Gas, Coal
Biomass Potentials
Crops: Starch, Oilseeds
Greasy residues
Lignocellulosic sources
Dedicated crops
Waste, Biogas, Algae
International Imports
Crude oil, RPP, Biomass
Gas, Coal, H2
Uranium & Lithium Reserves
Renewable Potentials
Hydro, Wave, Tidal
Wind, Solar, Geo
Ocean Thermal & Salinity
LNG Imports
Extraction
Oil, Gas, Coal
Refineries
Coke Plants
Biomass Plants
Solid: pellet, wood
Liquid: biofuels
Gaseous: biogas
Hydrogen Plants
Domestic Trades
-Pipelines
-Transmission
Power & Heat Cogeneration Plants
CCS
Thermal, Nuclear
Renewables, Biomass
LNG Regasification
LNG Liquefaction
IND Production
Furnaces, Boilers
Machinery
CCS
COM Services
Furnaces, AC,
Fluorescents, Etc.
RSD Dwellings
Heat Pumps, Lamps
Freezers, Ranges
TRA Vehicles
Cars, trucks, buses
Trains, Ships, Planes
AGR Process
International Exports
Crude oil, RPP, Biomass
Gas, Coal, H2, LNG
IND (8) - Tons
Iron & Steel, Cement
Chemicals, Copper
COM (7) - PJ/m²
Heating, Cooling
Lighting, Appliances
RSD (20) - PJ/unit
Heating, Cooling
Lighting, Appliances
TRA (16) - Pkm/Tkm
Road: short/long dist.
Rail, Marine, Air
AGR (1) - PJ
DM 2050
Oil prices (3)
Elasticities
DM 2100
Growth (2)
Elasticities
GHG Emissions
Combustion, Process
CAC Emissions
Carbon sequestration
EOR, Aquifers, Afforestation
Scenarios
Energy policies
Climate policies

Renewable potential – Cumulative (GW)
Hydro, Geo, Tidal, Wave



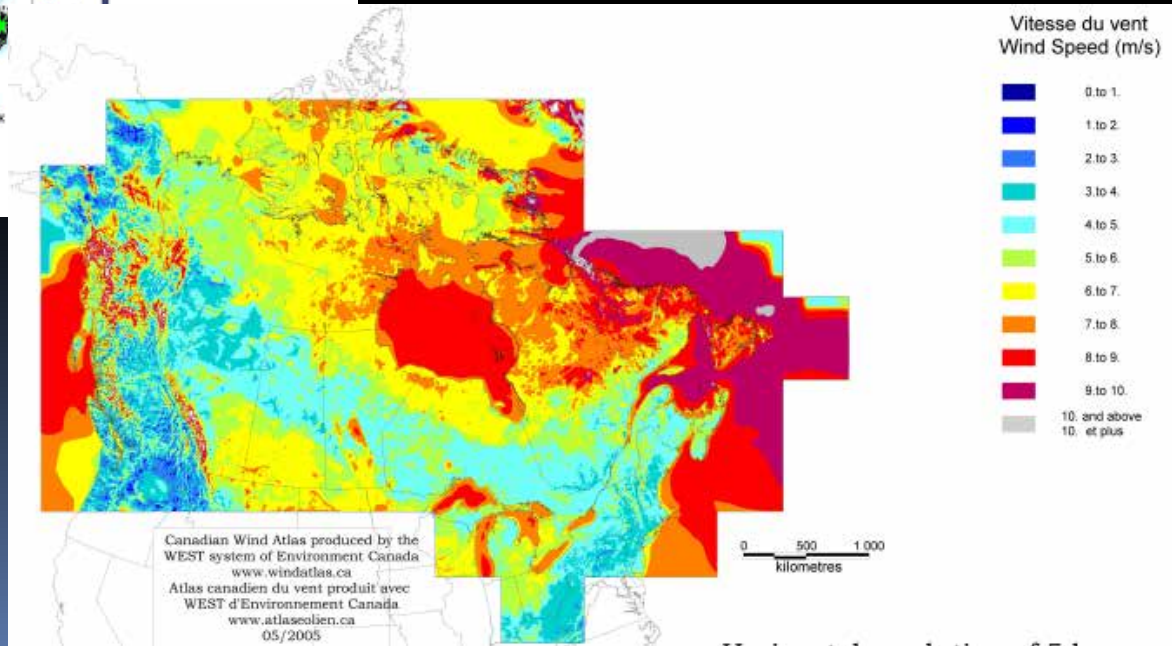


Renewable potential – Annual (kWh) Photovoltaic and Wind



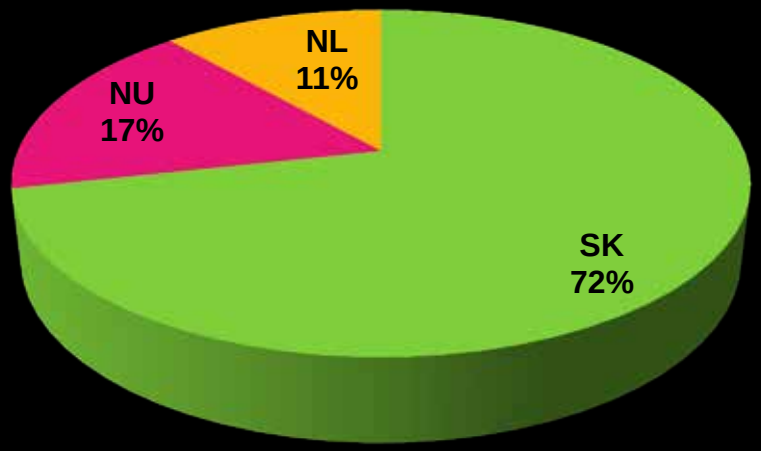
Natural Resources Canada, 2010.

Environment Canada, 2010. Wind Energy Atlas

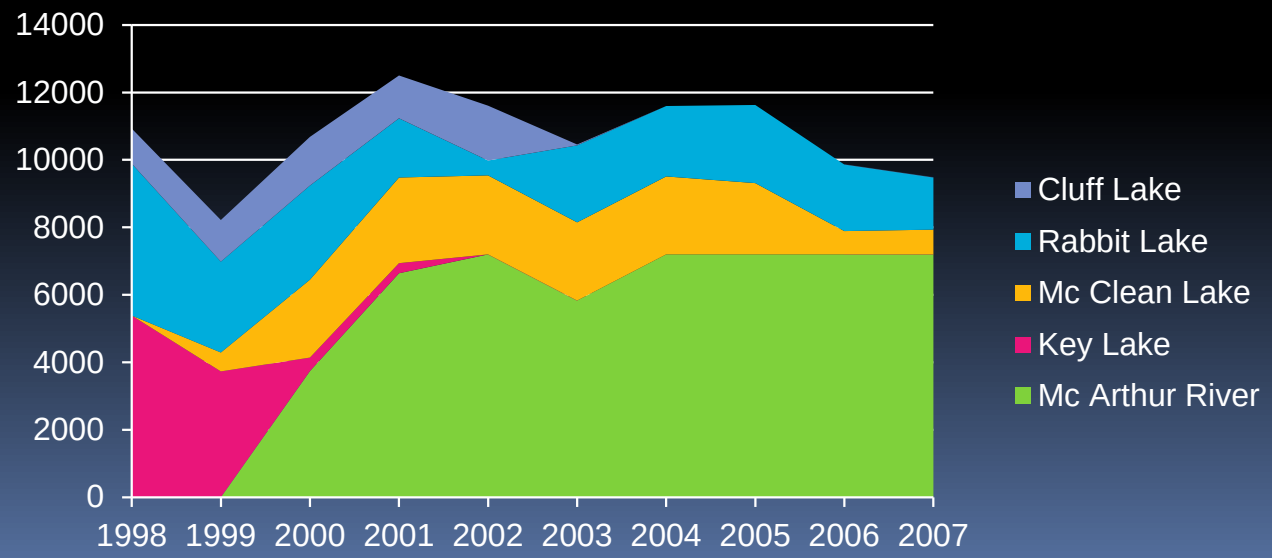


Uranium reserves and production, 1998-2007

Total reserves: 544 kt (365 EJ)

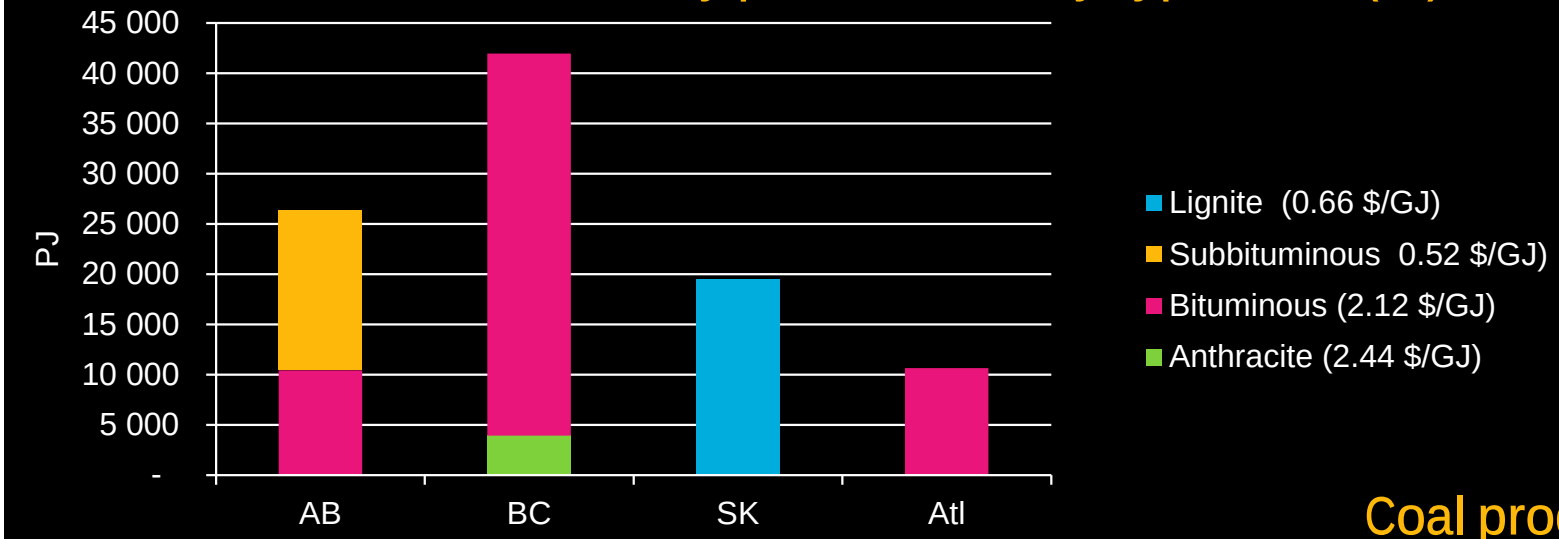


Uranium production in Saskatchewan (t)

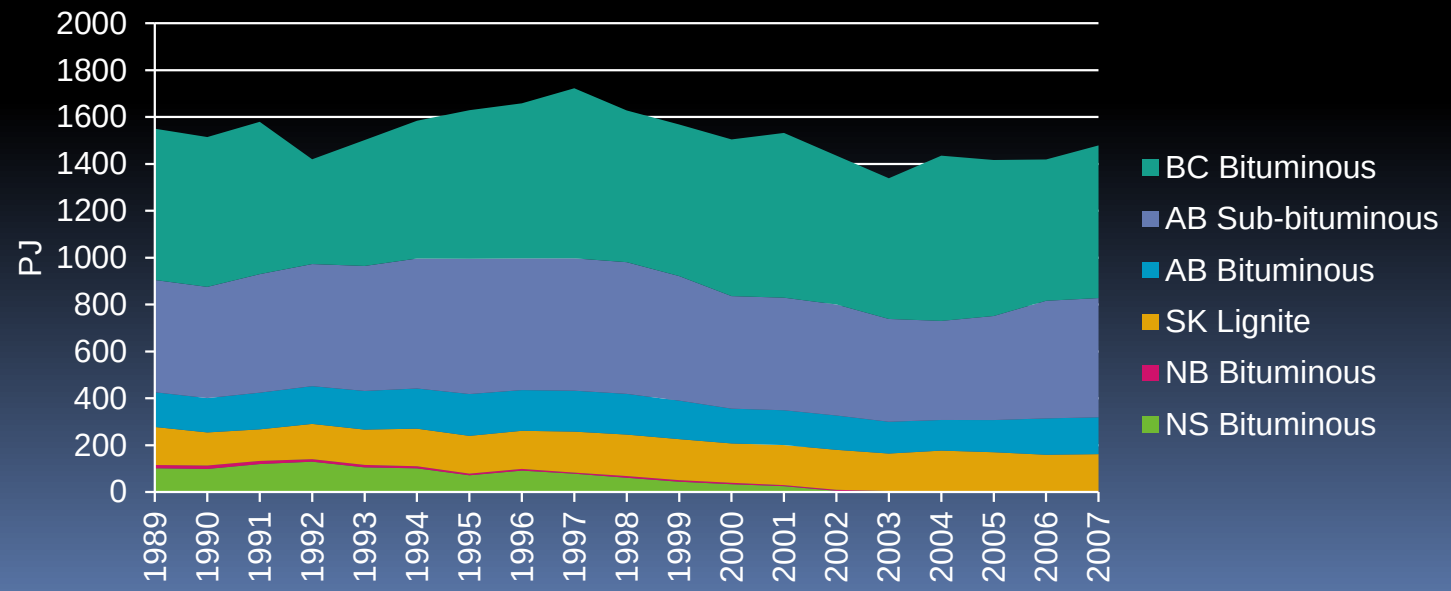


Coal reserves and production, 1989-2007

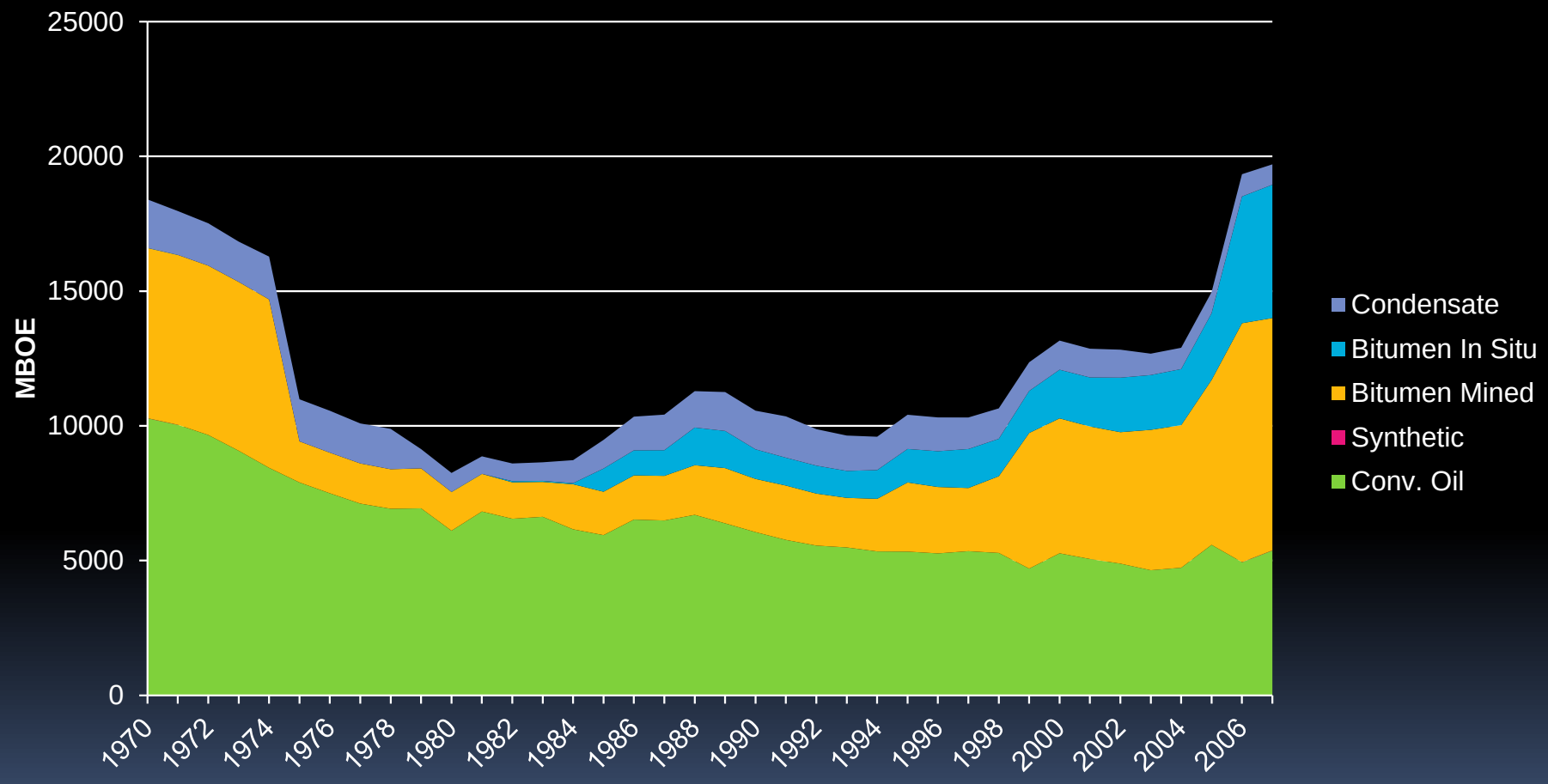
Coal recoverable reserves by province and by type, 2007 (PJ)



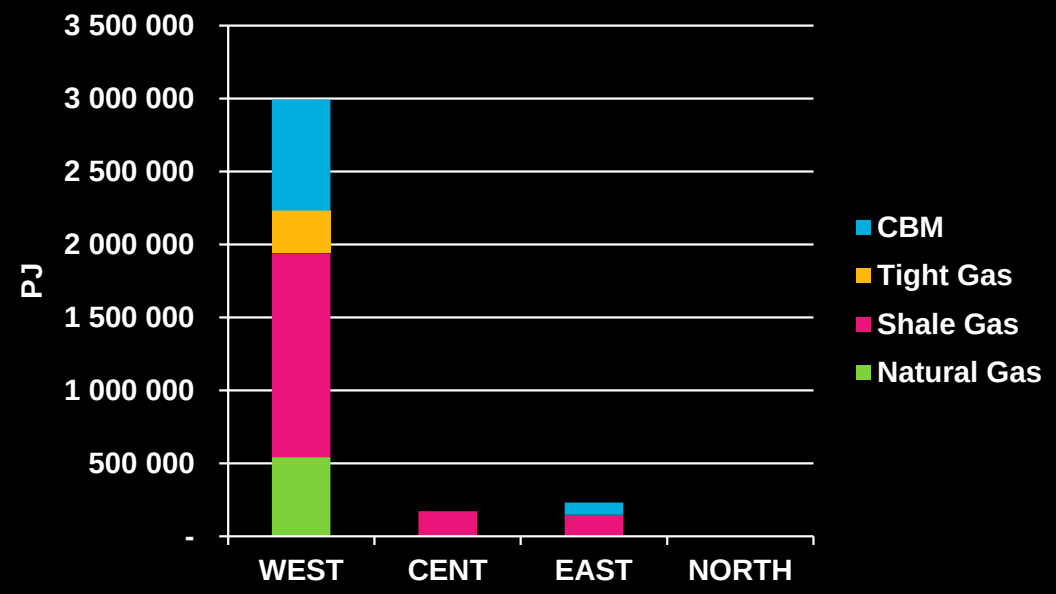
Coal production (PJ)

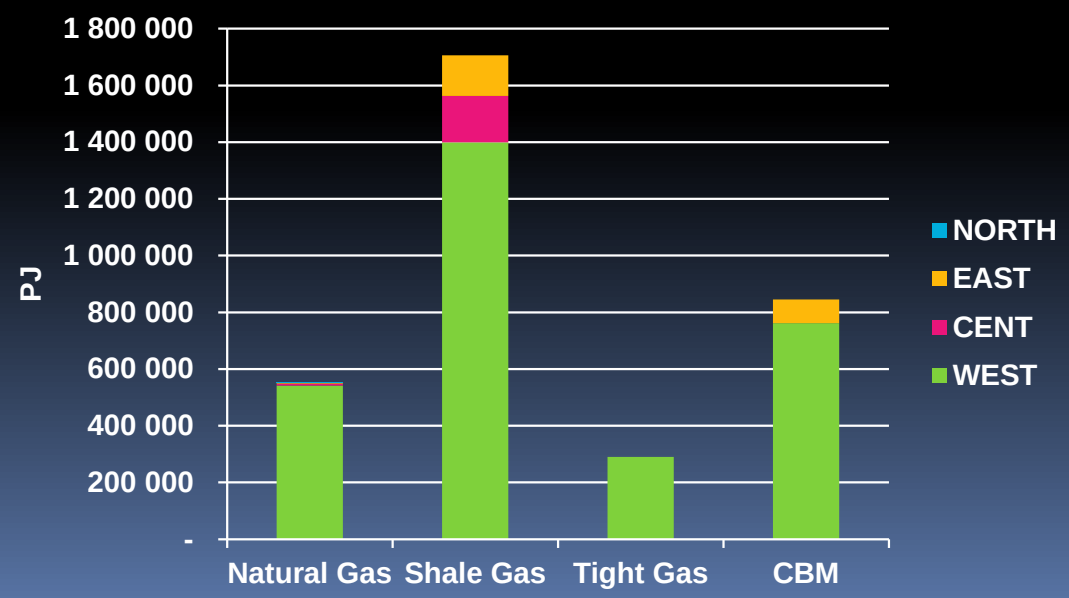


Oil reserves, 1970-2007

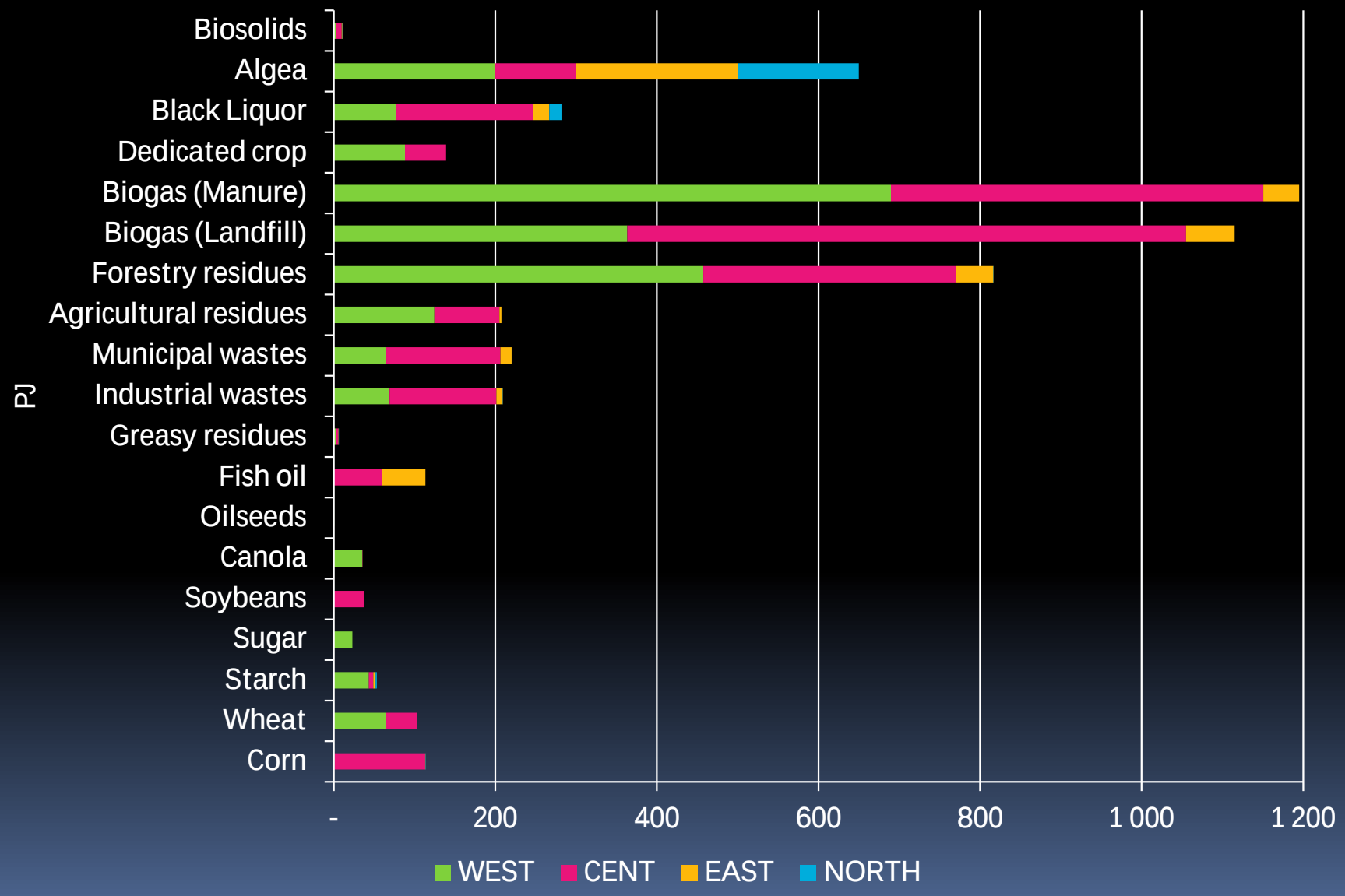


Gas reserves



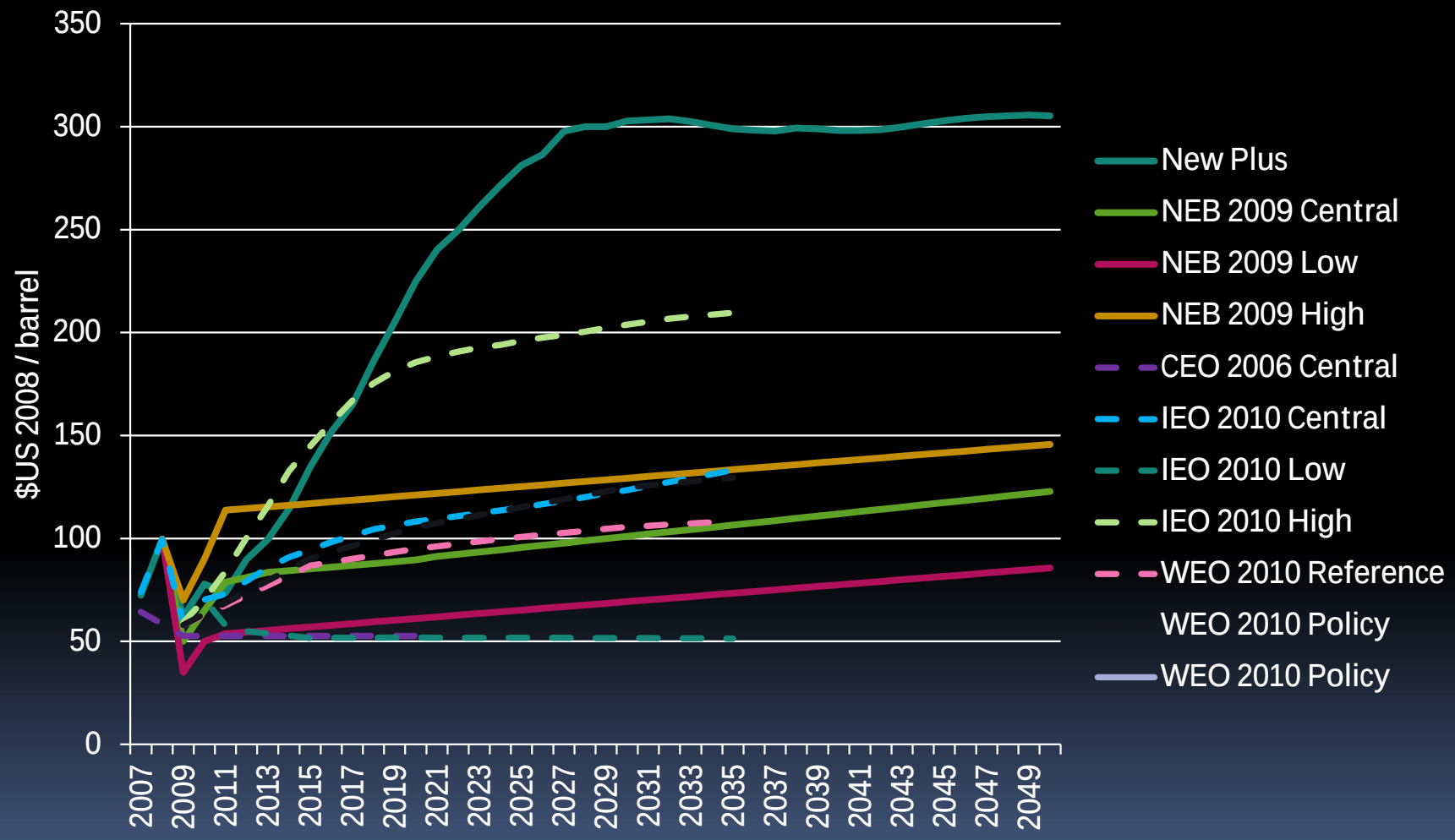


Biomass potential

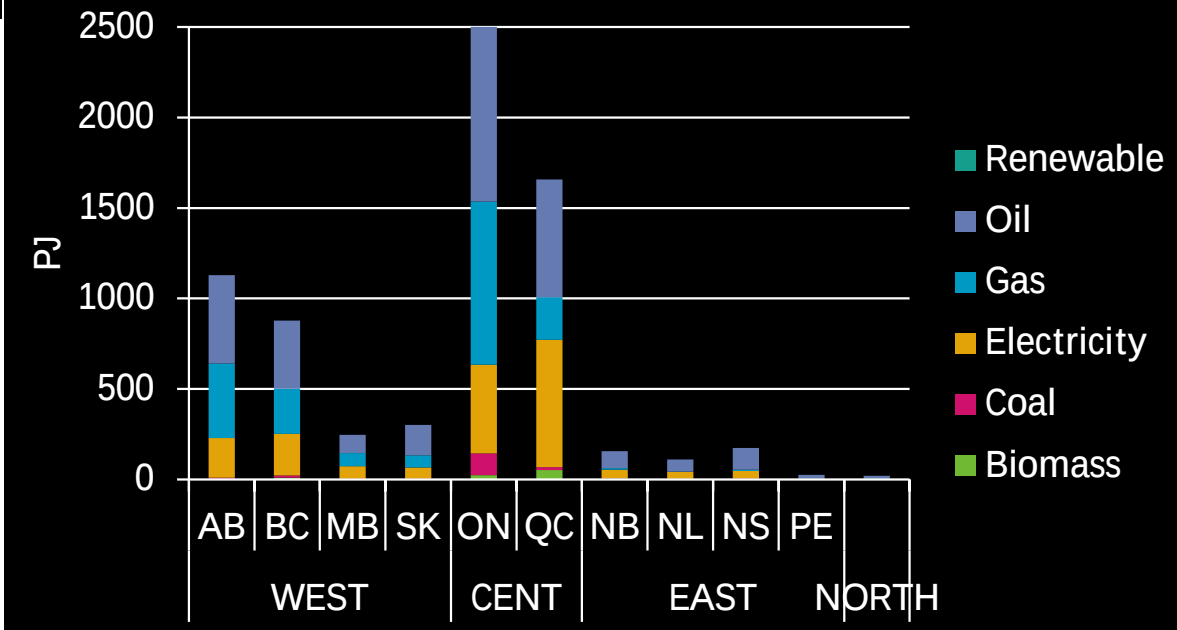


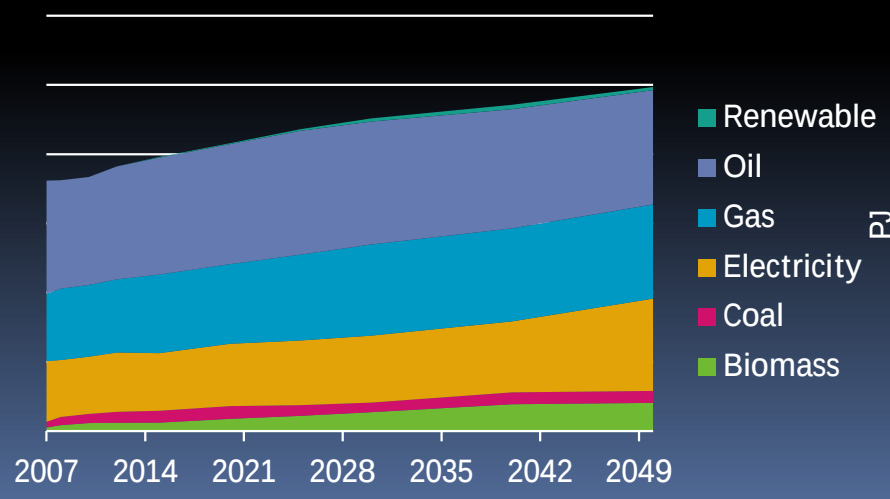
3. DEMAND PROJECTIONS AND FINAL ENERGY CALIBRATION

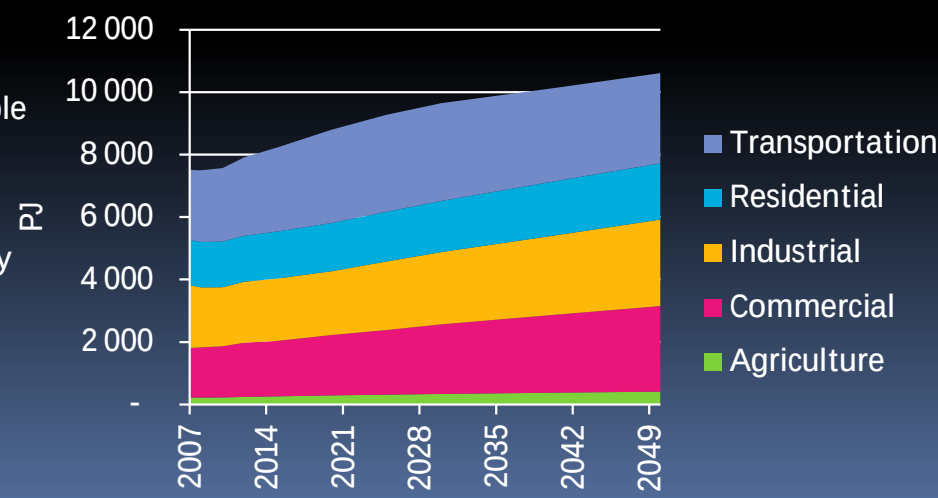
Driver growth projections, 2007-2030



Final energy consumption, 2007-2050 (PJ)

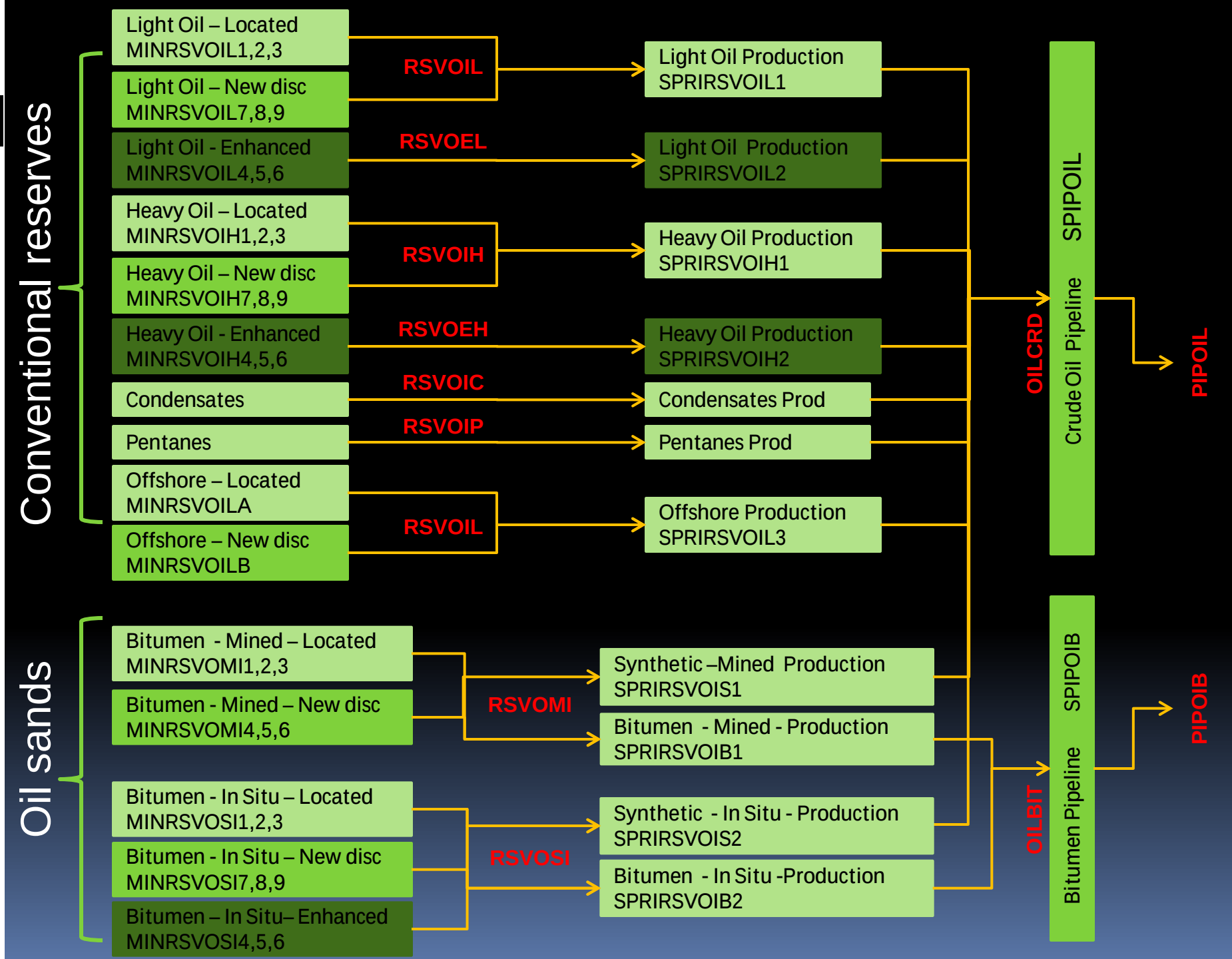




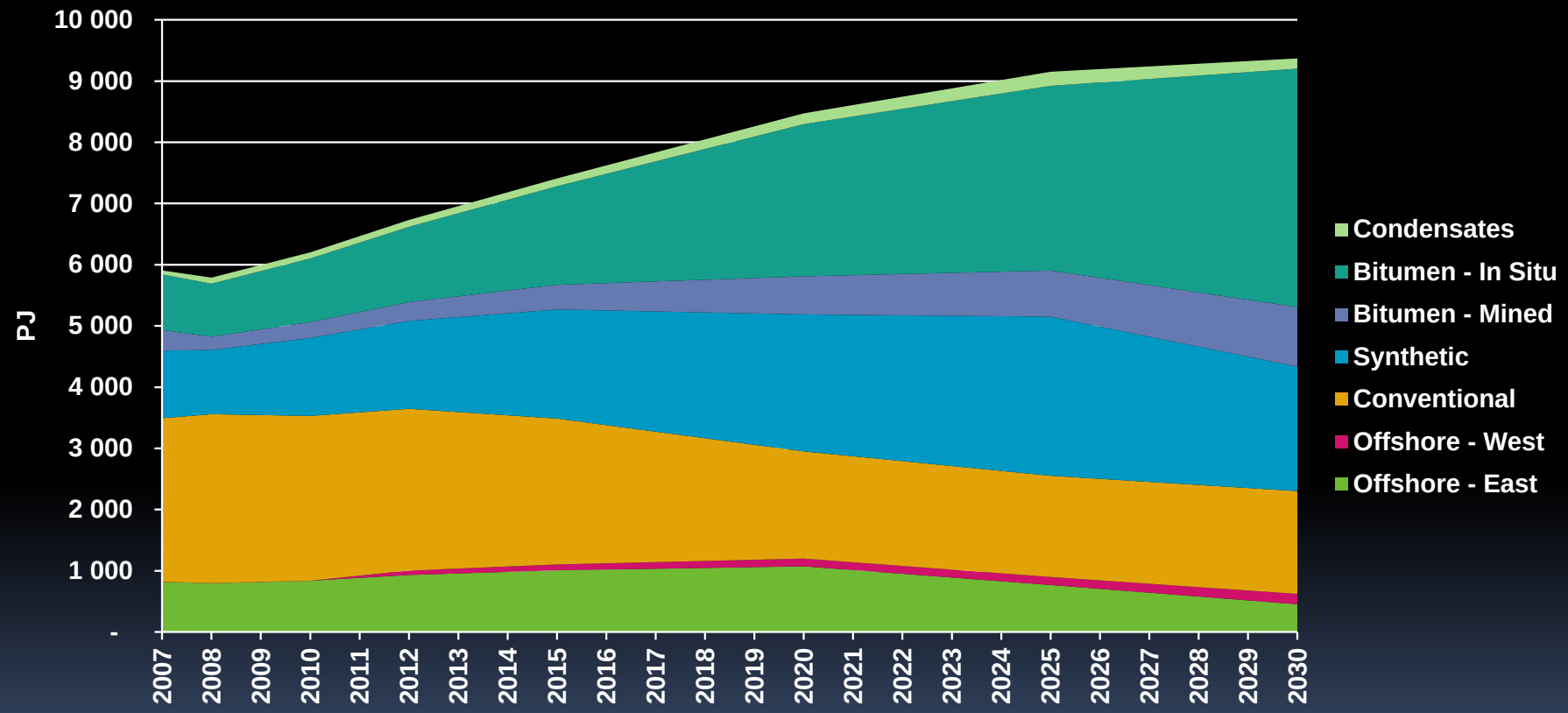


4. EXAMPLES OF ANALYSIS AND RESULTS

A. FOCUS ON THE OIL SECTOR UP TO 2030

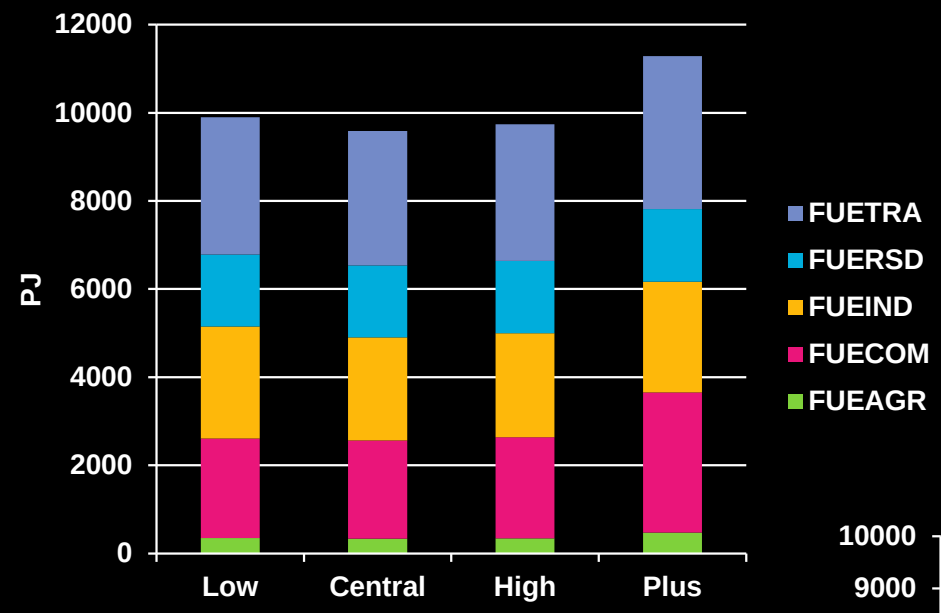

Conventional reserves
Light Oil – Located MINRSVOIL1,2,3
Light Oil – New disc MINRSVOIL7,8,9
Light Oil - Enhanced MINRSVOIL4,5,6
Heavy Oil – Located MINRSVOIH1,2,3
Heavy Oil – New disc MINRSVOIH7,8,9
Heavy Oil - Enhanced MINRSVOIH4,5,6
Condensates
Pentanes
Offshore – Located MINRSVOILA
Offshore – New disc MINRSVOILB
RSVOIL
RSVOEL
RSVOIH
RSVOEH
RSVOIC
RSVOIP
RSVOIL
Light Oil Production SPRIRSVOIL1
Light Oil Production SPRIRSVOIL2
Heavy Oil Production SPRIRSVOIH1
Heavy Oil Production SPRIRSVOIH2
Condensates Prod
Pentanes Prod
Offshore Production SPRIRSVOIL3
OILCRD
Crude Oil Pipeline SPIPOIL
PIPOIL
Oil sands
Bitumen - Mined – Located MINRSVOMI1,2,3
Bitumen - Mined – New disc MINRSVOMI4,5,6
Bitumen - In Situ – Located MINRSVOSI1,2,3
Bitumen - In Situ – New disc MINRSVOSI7,8,9
Bitumen – In Situ– Enhanced MINRSVOSI4,5,6
RSVOMI
RSVOSI
Synthetic –Mined Production SPRIRSVOIS1
Bitumen - Mined - Production SPRIRSVOIB1
Synthetic - In Situ - Production SPRIRSVOIS2
Bitumen - In Situ -Production SPRIRSVOIB2
OILBIT
Bitumen Pipeline SPIPOIB
PIPOIB

New oil production in Canada, 2007-2030 TIMES

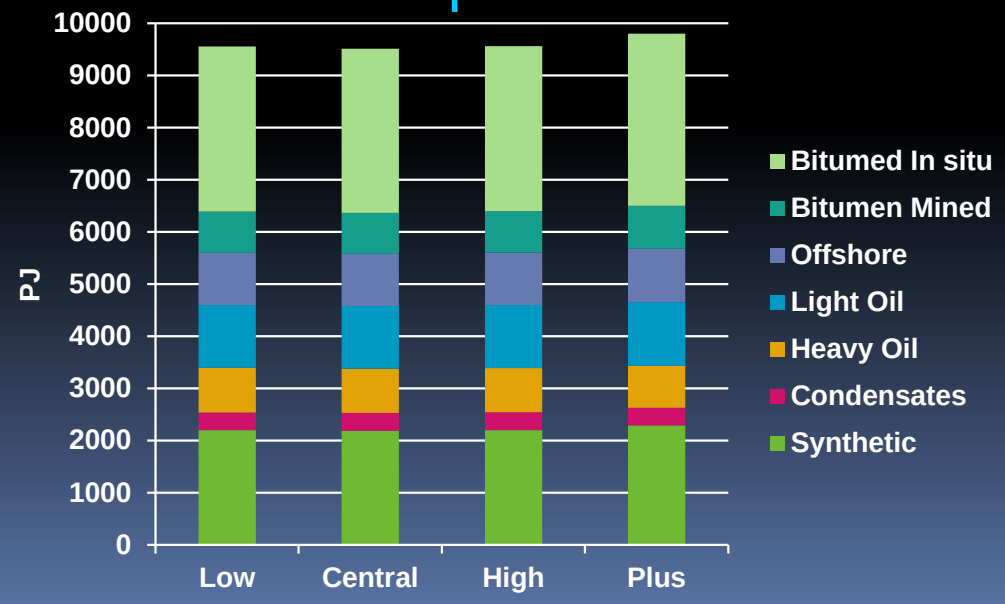


Four base cases: energy figures in 2030

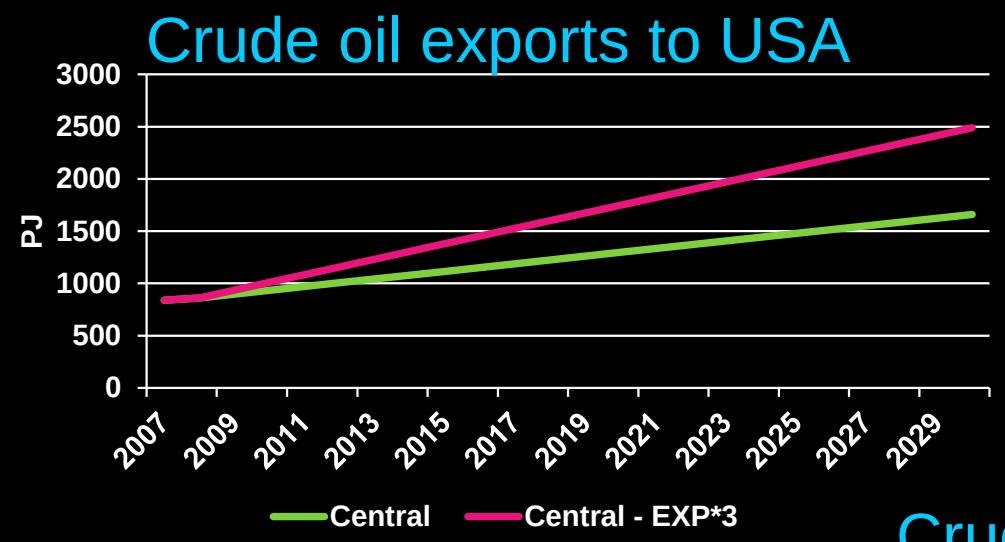
Final consumption

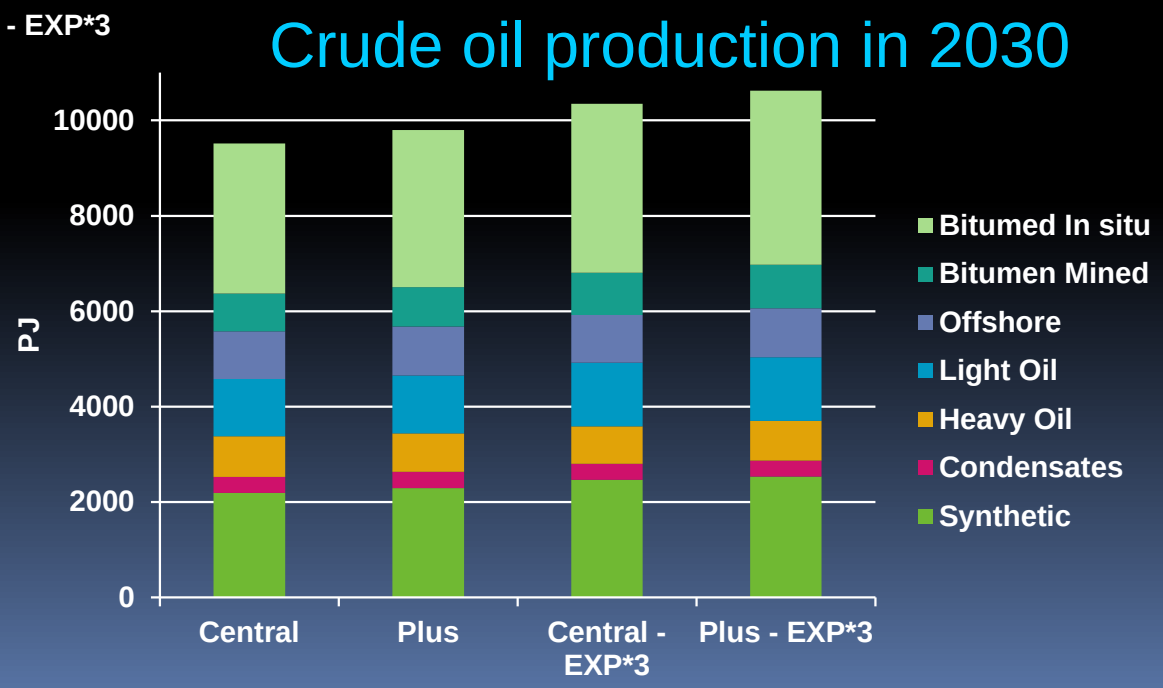


Crude Oil production in 2030



Oil exports to USA: 3x increase over 2007





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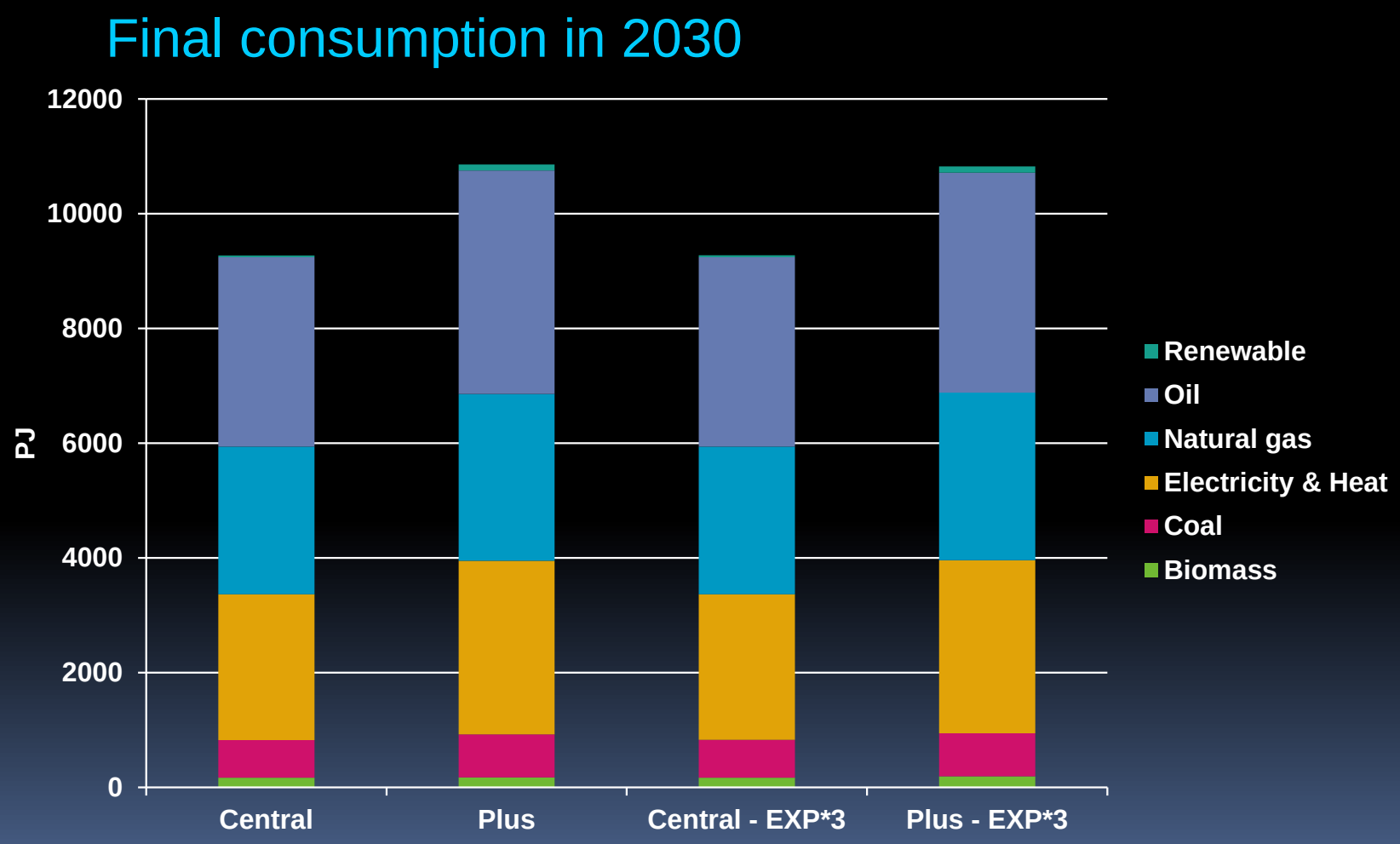


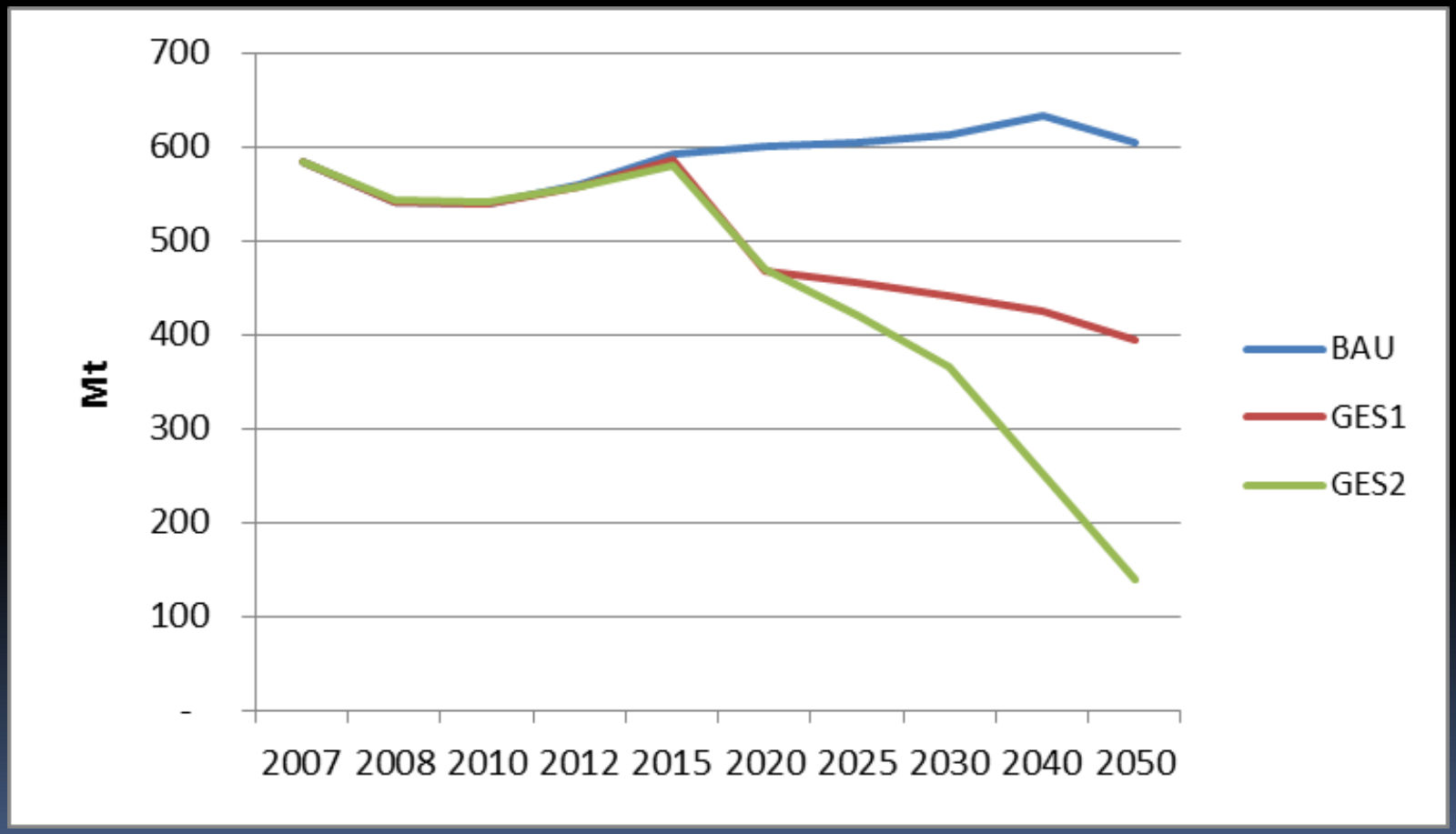
4.EXAMPLES OF ANALYSIS AND RESULTS

B. GHG EMISSION REDUCTION SCENARIOS UP TO 2050

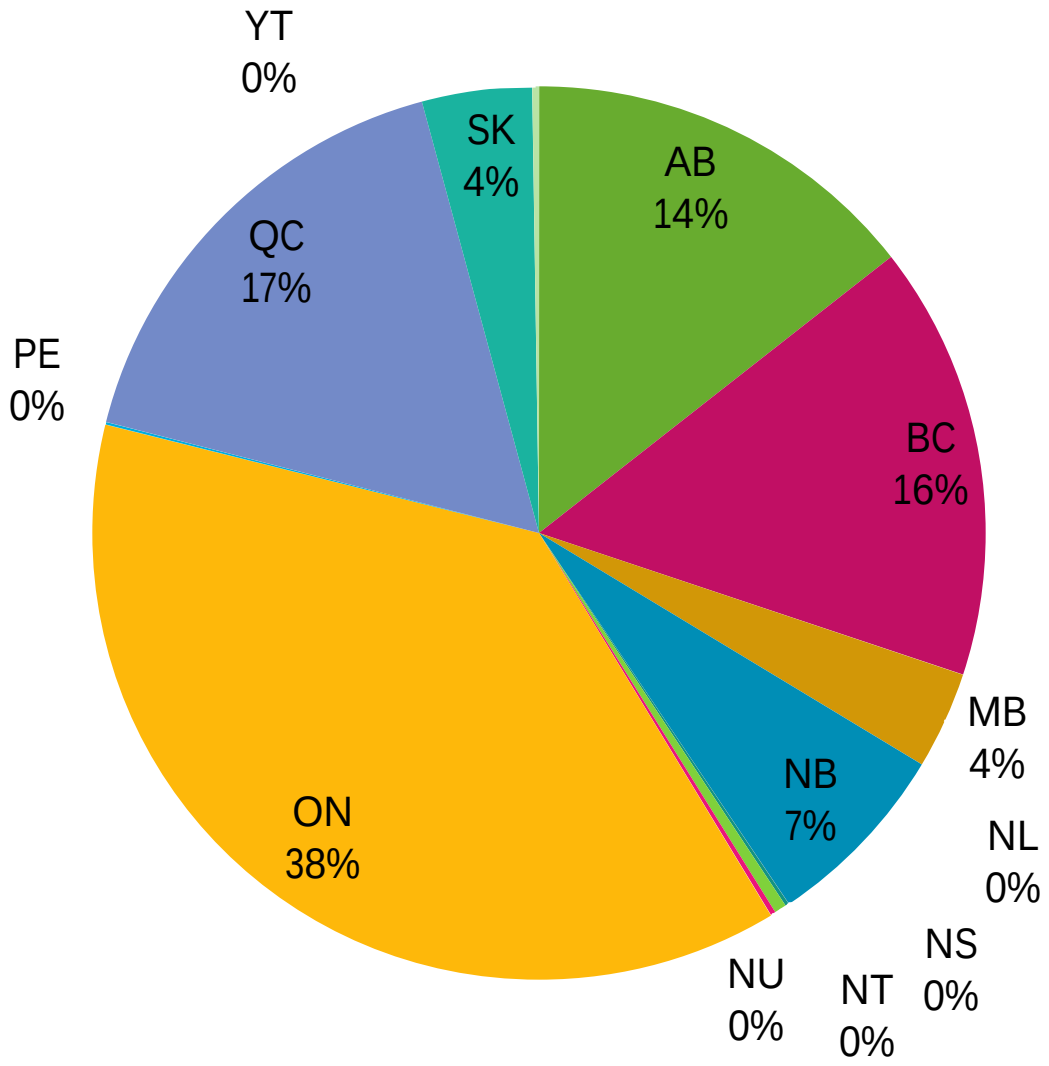
GHG EMISSION REDUCTION SCENARIOS UP TO 2050 (GHG1)

Province	Reference year	2020 Objective	2050 Objective
AB	2005	5%	14%
BC	2007	33%	50%
MB	2005	15%	45%
NB	1990	10%	20%
NL	1990	10%	20%
NS	1990	10%	20%
NT	2005	17%	50%
NU	2005	17%	50%
ON	1990	15%	30%
PE	1990	10%	20%
QC	1990	20%	40%
SK	2006	20%	40%
YT	2005	17%	50%

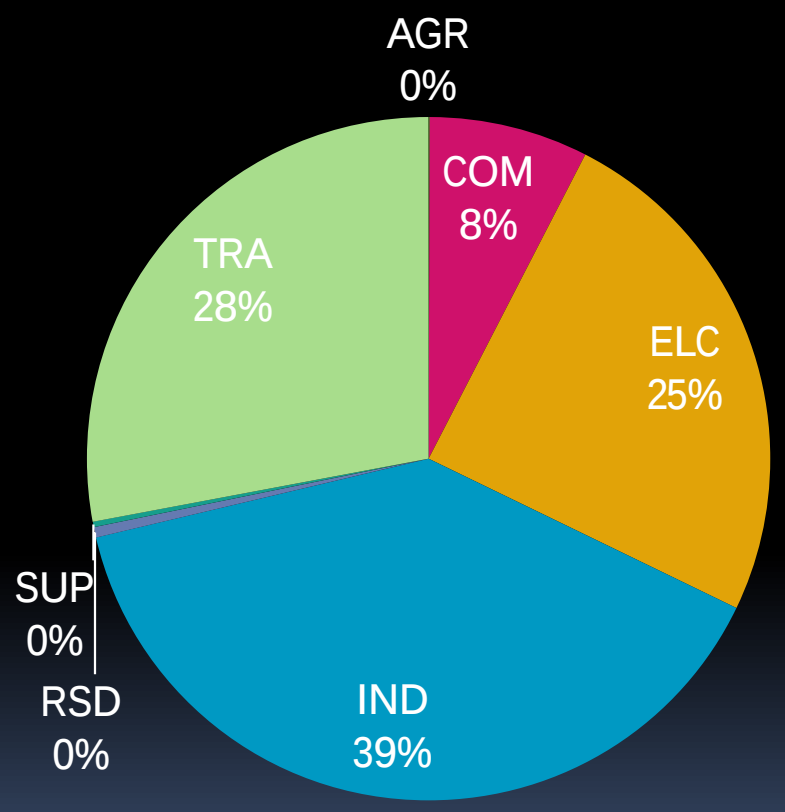
Canadian GHG emissions in three scenarios, 2007-2050

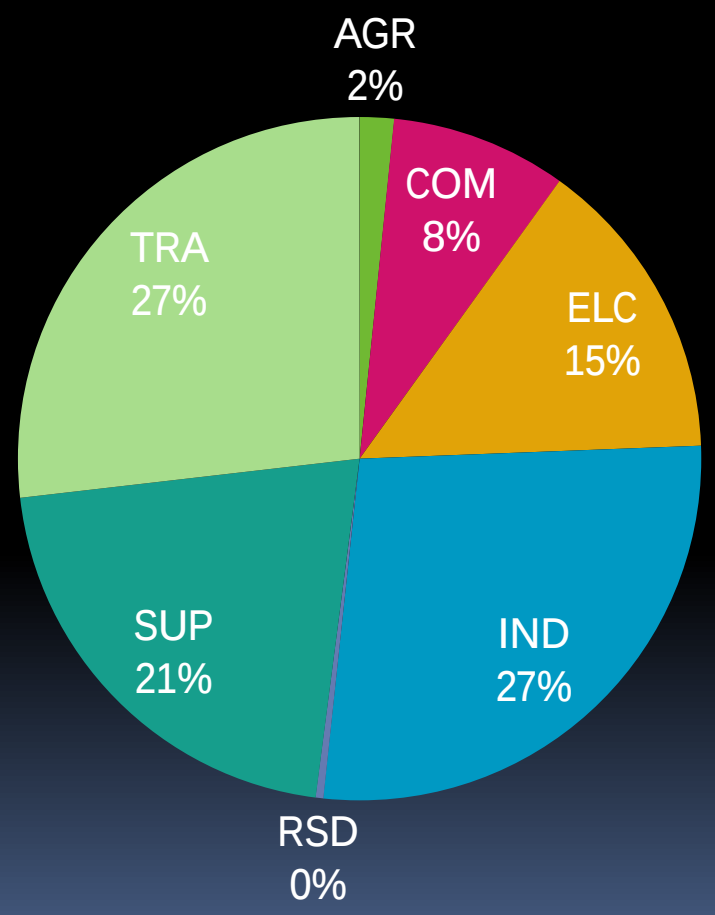


GHG reductions by province in the GHG1scenario, 2050

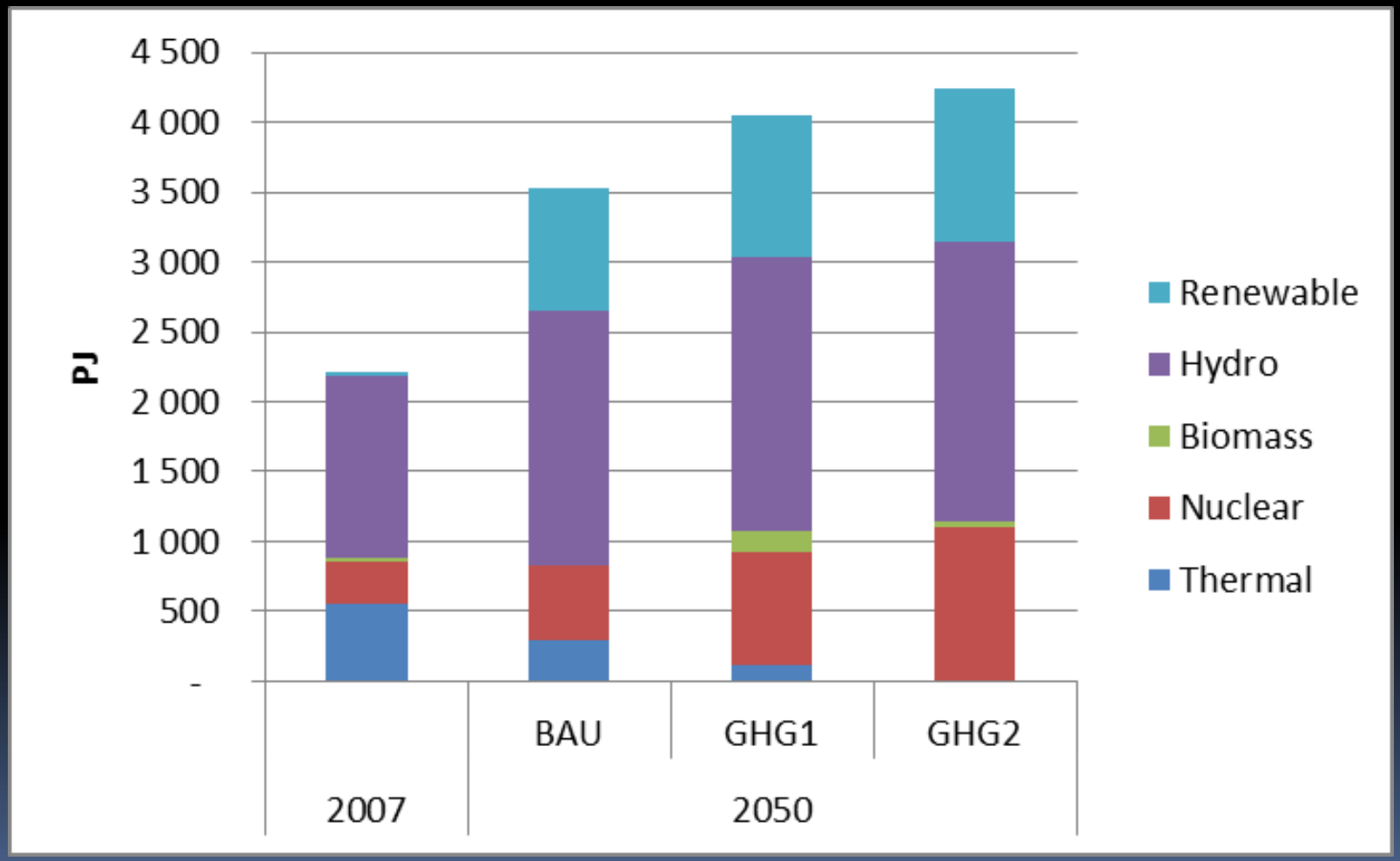


GHG reductions by sector in the GHG1 and GHG2 scenarios, 2050





Electricity production in 2050



Thank you from the E2G team

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