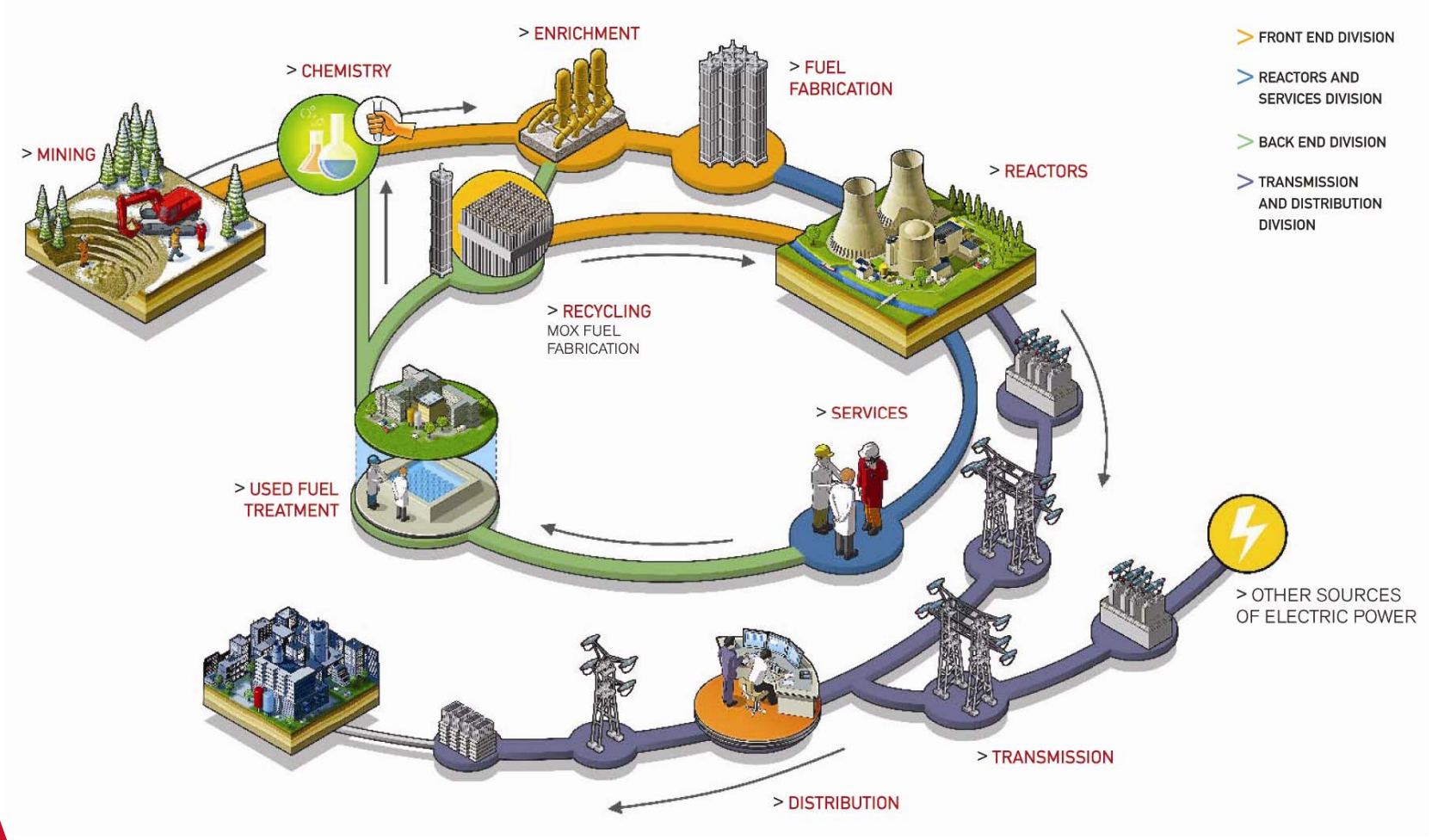

AREVA

Energy, AREVA's core business

2004: Sales: €11,110M - Employees: 70,000



AREVA

25th USAEE/IAEE North American conference
Fueling the Future:
Prices, Productivity, Policies and Prophecies

Potential synergies between nuclear and oil sands: A new target for future commercial reactor?

Christophe Bonnery

Denver – 09/21/2005

Agenda

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2. Bitumen Recovery Technologies
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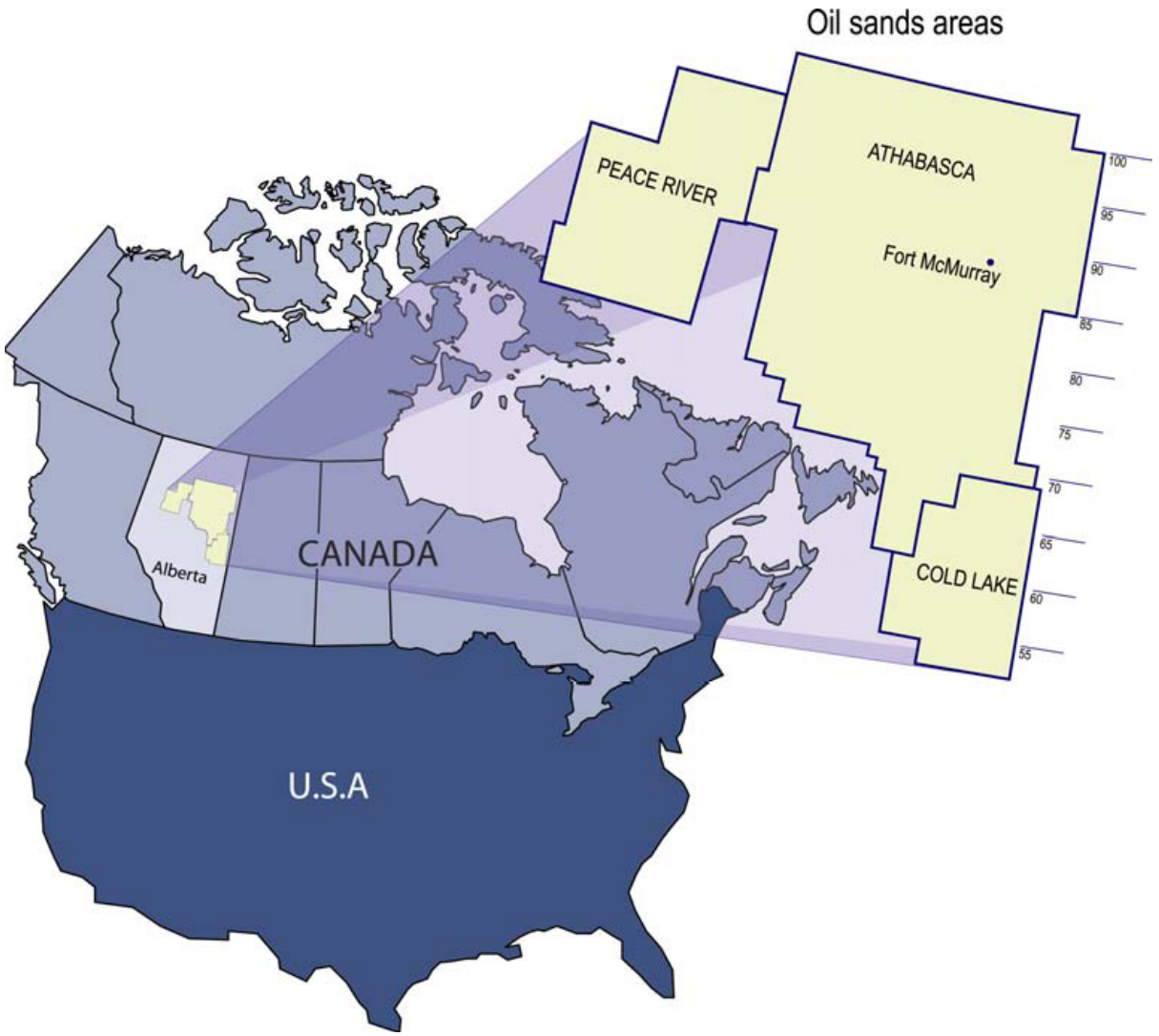
Oil Sands Resources and Reserves



Bitumen Recovery Technologies
Mining & Extraction (1/2)

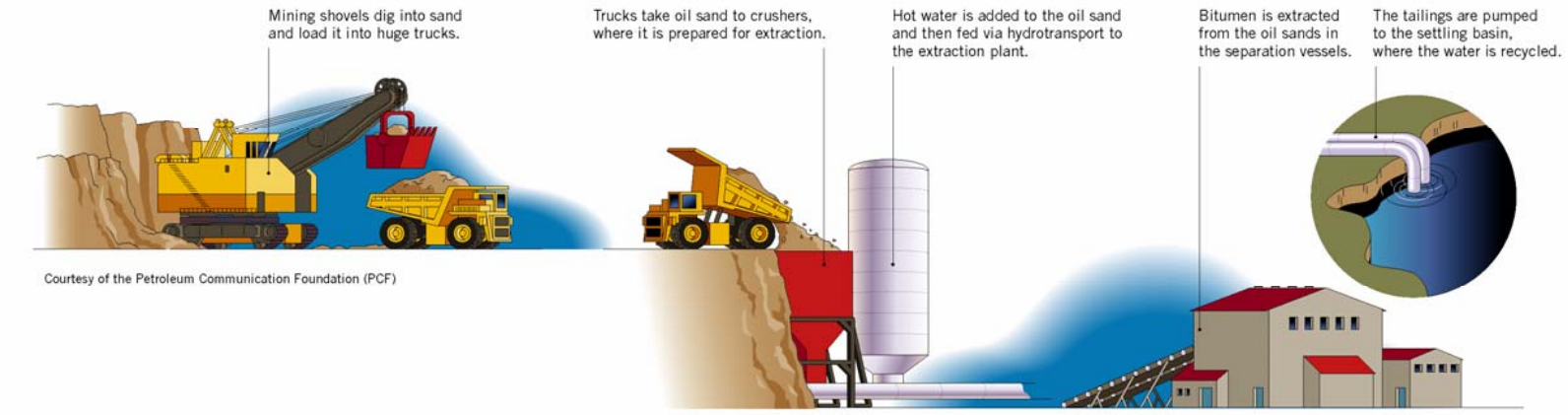
Mineable Resources/Reserves

- *< 75m depth to top of oil sands formation*

Surface Mining

Oil Sands Transport

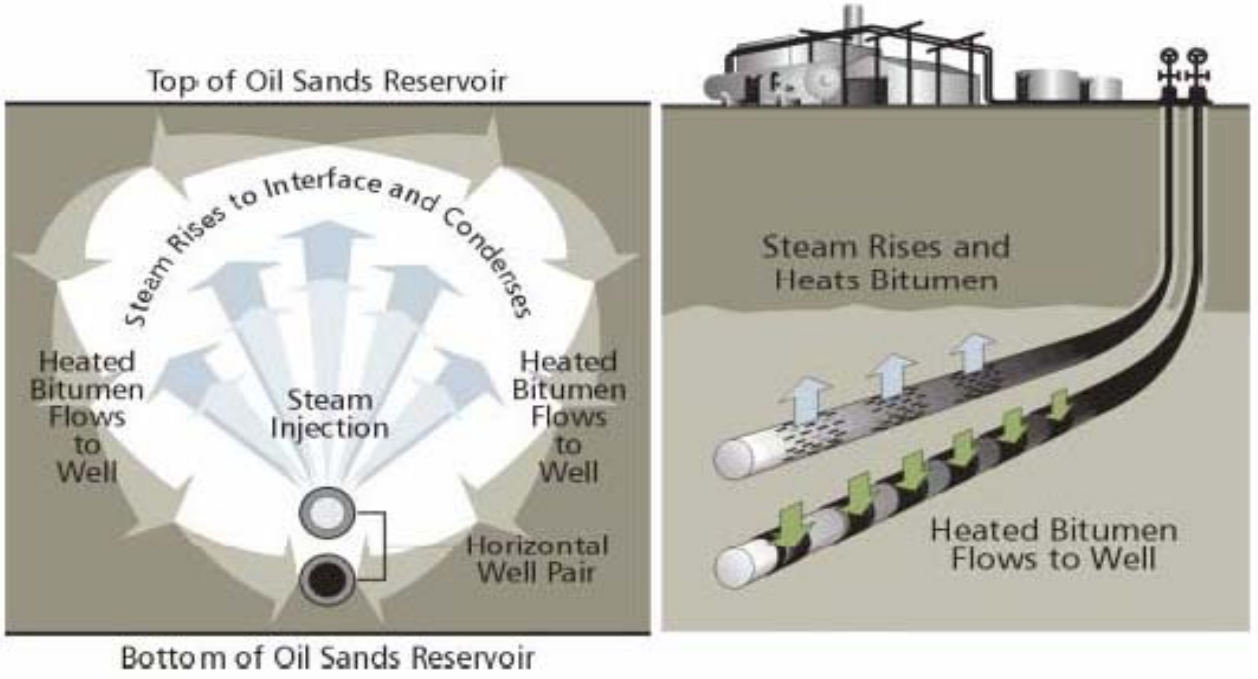
Bitumen Extraction



Bitumen Recovery Technologies
SAGD Process (2/2)

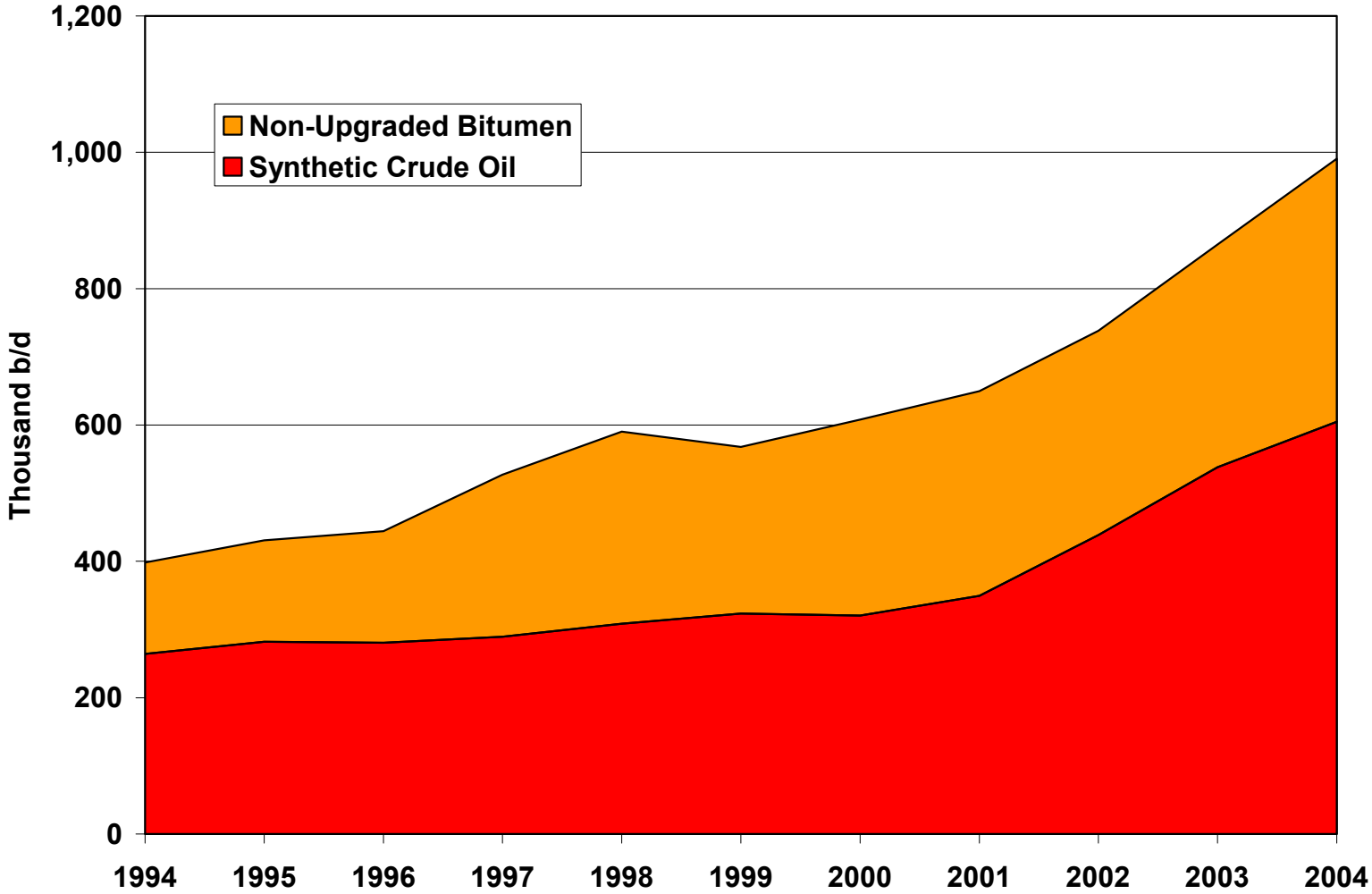
In Situ Resources/Reserves

- *> 75m depth to top of oil sands formation*



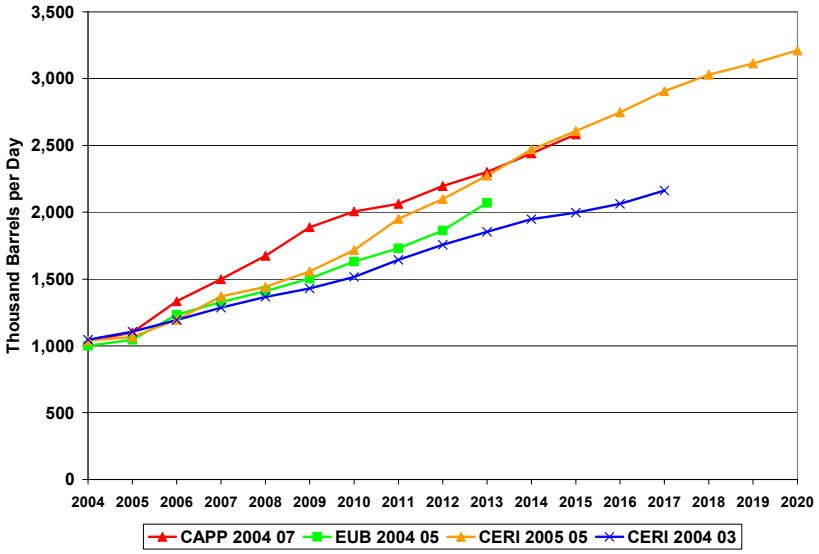
- *Upgrading process for most bitumen:*
  - *bitumen converted from a viscous oil to a high quality "synthetic" or "upgraded" crude oil similar to conventional light sweet crude oil*

Historical Bitumen Production



Source : EUB statistical reports

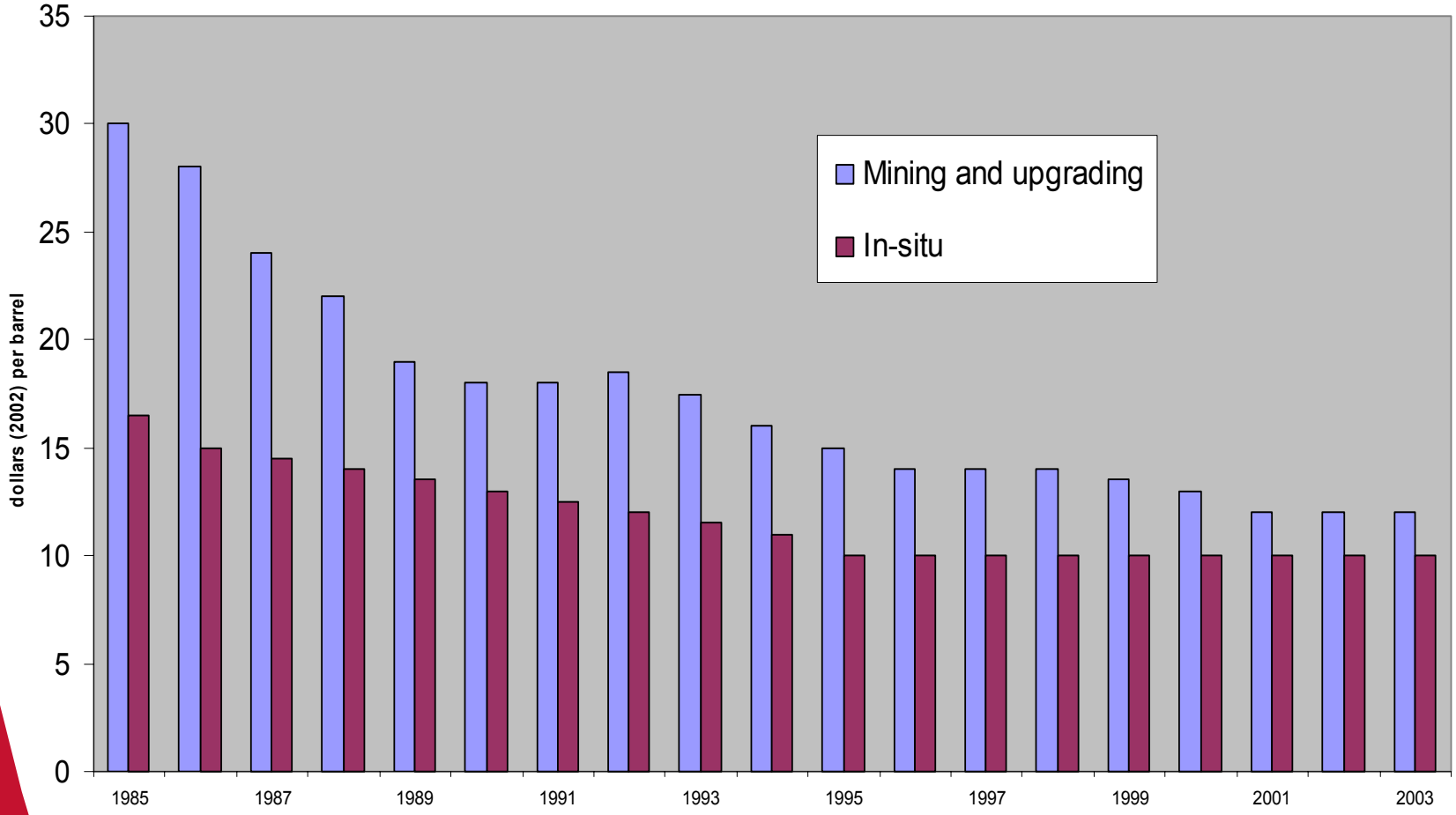
Medium-Term Industry and AREVA Long-Term Bitumen Production Outlooks



Medium-term bitumen production outlooks to 2020

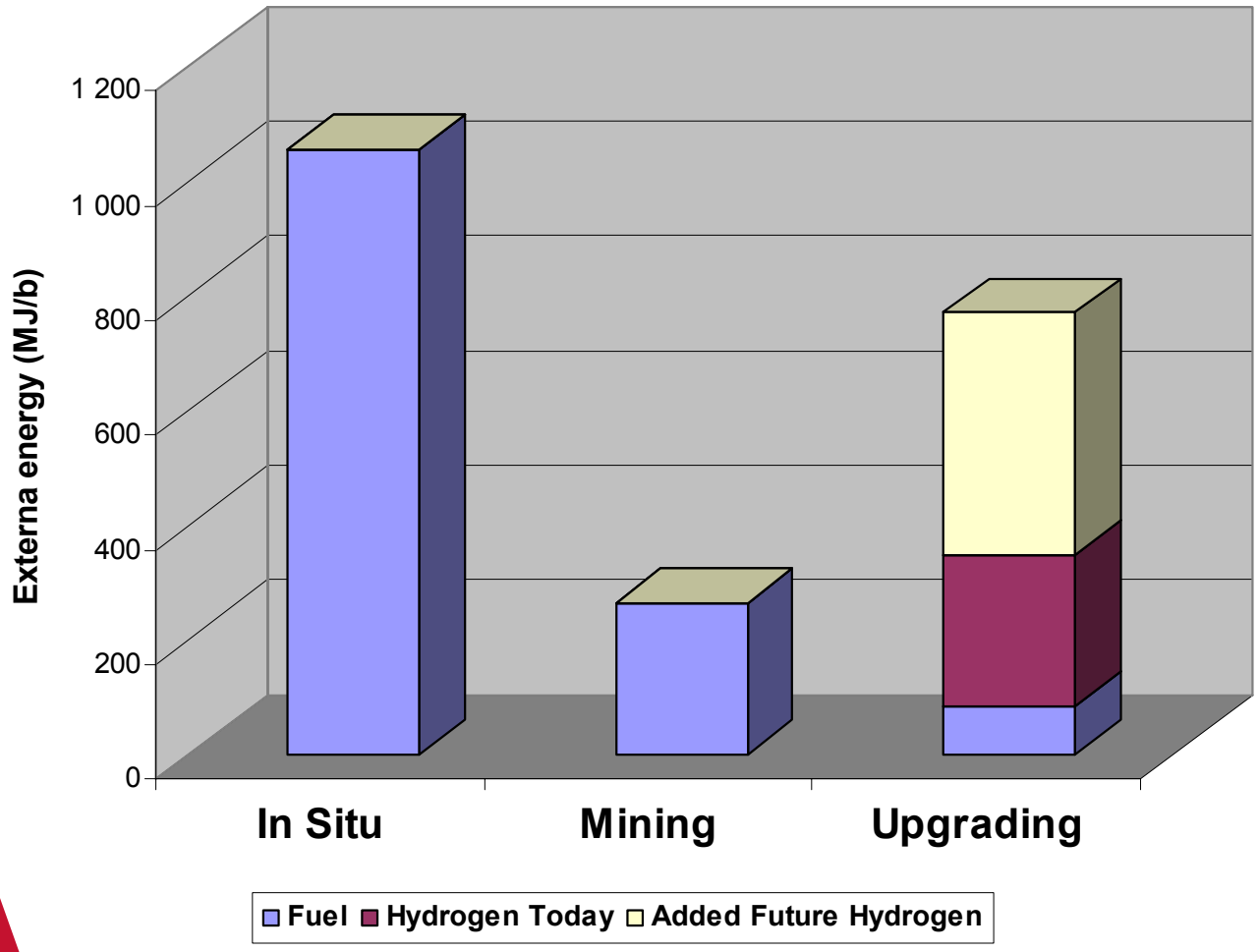
- AREVA long-term production outlook of the oil sands industry with a model using a database of all existing and proposed oil sands projects in the province.
- "Unadjusted and Adjusted" oil sands supply outlook approach: probabilities and adjusting the timing of individual projects.
- Detailed map for energy requirements and scheduling.
- Goal: possibility for AREVA to anticipate the demand and to design a nuclear reactor as much as possible suiting bitumen industry's energy requirements.
- 4 main drivers:
  - The bitumen economic driver
  - The energy requirement driver
  - The emissions driver
  - The nuclear competitiveness

Bitumen production economic driver: bitumen production costs

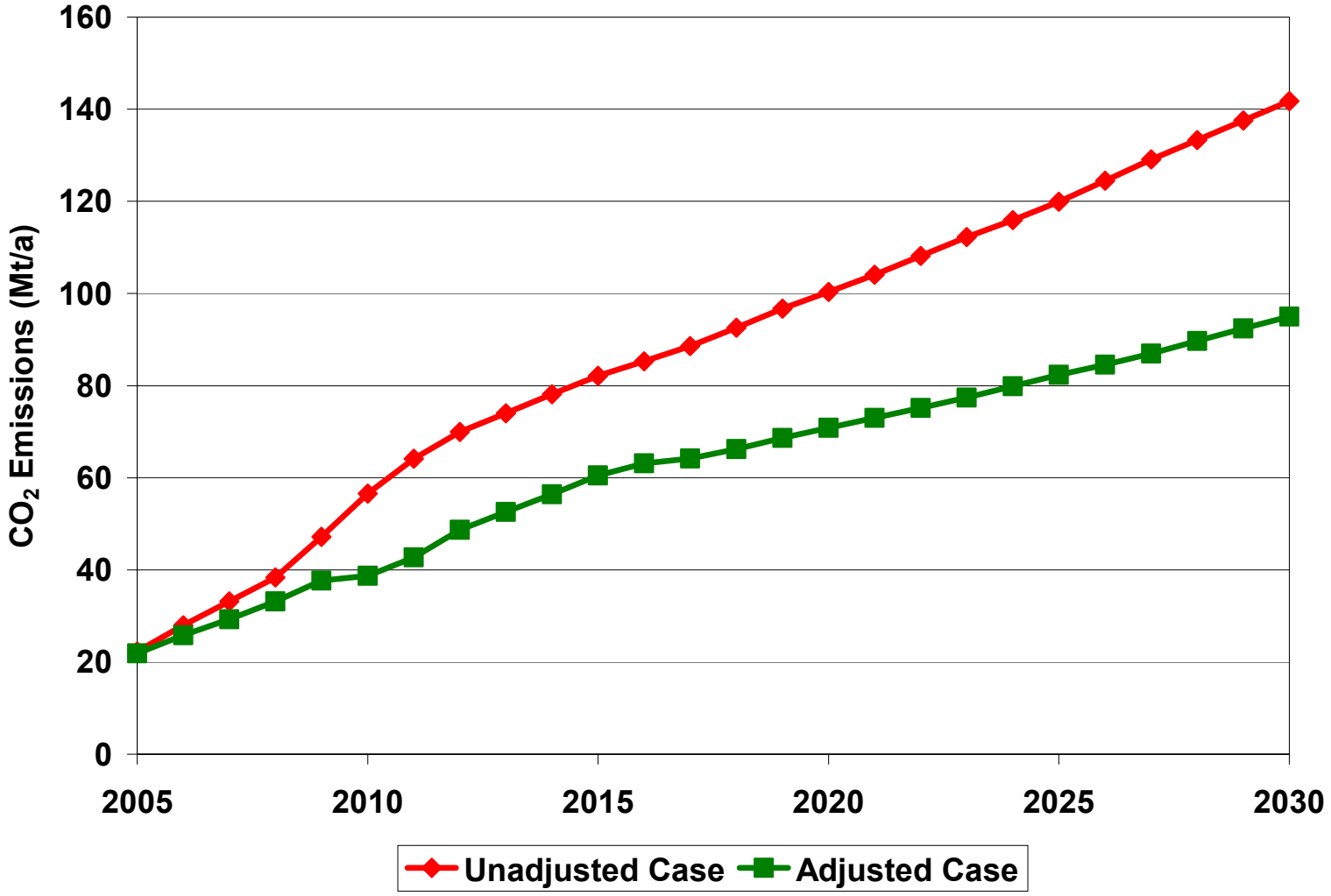


- ***Today operators are producing in economic conditions the bitumen extracted from Alberta***

Energy requirements driver: Oil Sands Industry Energy Requirements



Emissions driver: Business as usual scenarii (AREVA model)



The nuclear alternative

Technical adequacy

- ***Today, nuclear is almost exclusively used to produce electricity from its thermal power.***
- ***There are some experiences of large heat supply for industrial process or district heating.***
- ***There are no technological impediments to extracting heat/steam from a nuclear plant.***
- ***Heat is produced predominantly from fossil fuels, with which nuclear energy will have to compete.***
- ***However, all existing and prospective reactor types can be used,***
- ***Cogeneration can also be used widely in order to provide electricity for local needs.***

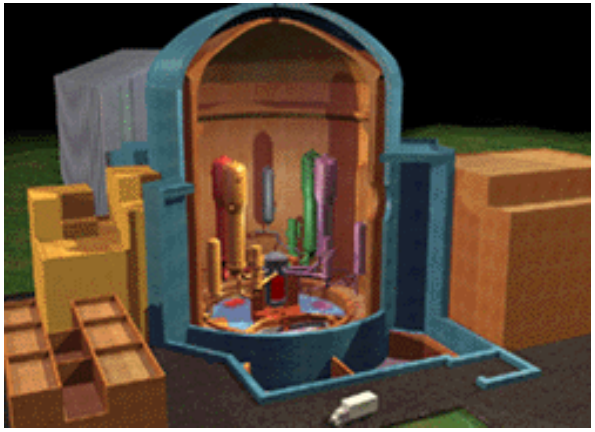
Different types of reactors in the world (end of 2003)

Type	Number of units
PWR (Pressurized Water Reactor)	213
BWR (Boiling Water Reactor)	92
VVER (Russian PWR)	50
Sub-total LWR	**355 (near 80% share)**
PHWR (Pressurized Heavy Water Reactors)	38
GCR (Gas Cooled Reactor)	12
RBMK (Water Graphite Reactors)	17
AGR (Advanced Gas cooled Reactor)	14
FBR (Fast Breeder Reactor)	3
Total	**439**

- ***World cumulative nuclear generation at the end of 2003: 43 795TWh.***
  - ***PWR : 26 029***
  - ***BWR : 10 776***
  - ***VVER : 2 417***
  - ***PHWR : 1 952***

Some AREVA reactors

- ***One example of PWR : the EPR***

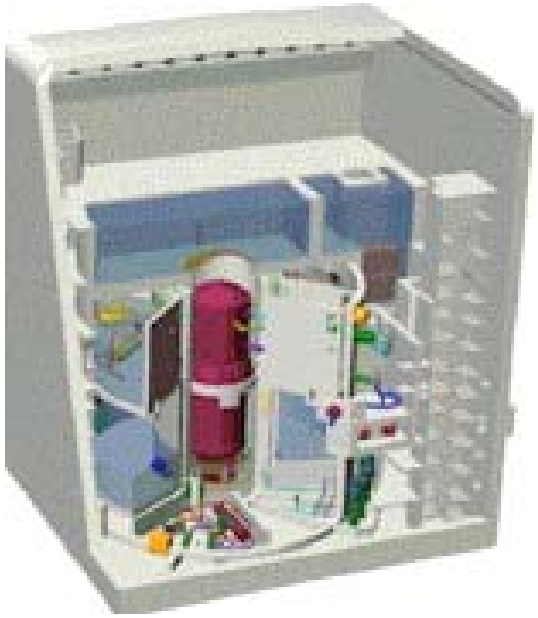


- ***In 2003, the EPR was selected by TVO company in Finland for commissioning in 2009***
- ***In 2004, EDF decided to build one EPR for comm.in 2012***

Main characteristics of the EPR		
Thermal power	MW	4250/4500
Electrical power	MW	in the 1,600 range
Efficiency	%	36
No. of primary loops		4
No. of fuel assemblies		241
Burnup	GWd/t	> 60
Secondary pressure	Bar	78
Seismic level	g	0.25
Service life	years	60

Some AREVA reactors

- ***One example of BWR : the SWR 1000***



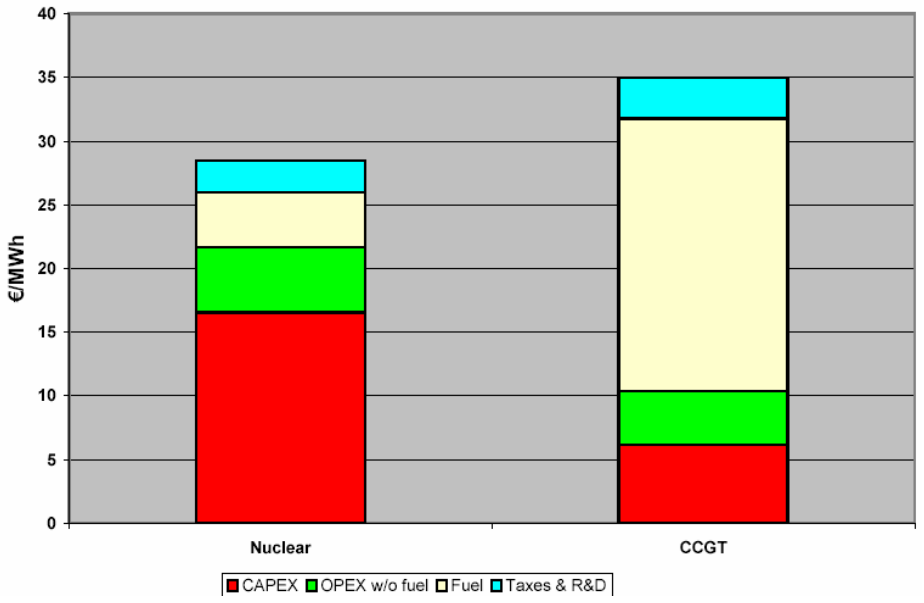
Thermal power	3 370 MW
Net power out put	1 254 MWe
Reactor pressure	75 bar
Type of fuel assemblies	Atrium 12
Number of fuel assemblies	664
Number of control rods	157
Length of active core	3.00 m
Design pressure of containment 3.5 bar	

- ***Active R&D program for an AREVA High Temperature Reactor (600 MWth)***

Economic adequacy: Competitiveness of nuclear well established

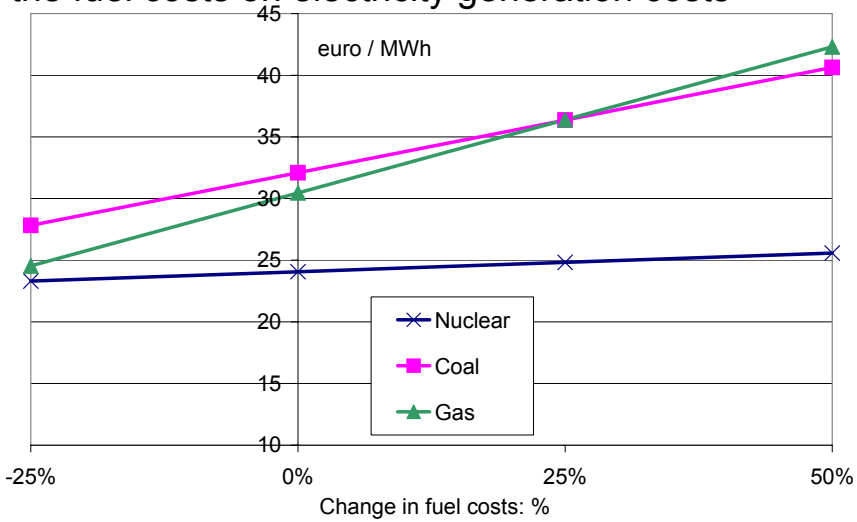
- ***OECD 2005 Study on Projected Costs of nuclear generated electricity:***
  - ***With a 10% discount rate, depending on the country, the cost of electricity ranges from 40 to 63 USD/MWh for combined cycle plants and from 30 to 50 USD/MWh for nuclear generation.***
- ***Production costs for new power generation facilities in France***

(discount rate 8%, gas price 3.3 $/MBtu)



Economic adequacy: Competitiveness of nuclear well established

- ***The economics of the EPR in Finland for the paper industry***
  - Impact of the fuel costs on electricity generation costs



- ***Although these comparisons concern electricity generation, there is no reason that nuclear competitiveness could be affected by the fact that nuclear is used to generate heat instead of electricity, since electricity is made from heat.***

Conclusion

- *In the next decades, due to the global increasing demand of energy, all primary sources will be necessary. Each of them will be used to its most effective application. Gas may be used for higher added value final uses.*
- *It is yet too early for AREVA to guarantee that nuclear will be the best solution to produce Alberta bitumen in good technical and economic conditions.*
- *However, this paper has demonstrated its interest.*
- *AREVA group, as supplier of nuclear reactors, fuel manufacturing and services, is ready to work as partner of other primary energy industries like the heavy oil extraction and upgrading.*
- *AREVA is ready to go further in any partnership with the industry or interested experts to a nuclear/fossil venture benefiting to the global energy offer, the economics and the environment.*

Possible technical ways to go further

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