

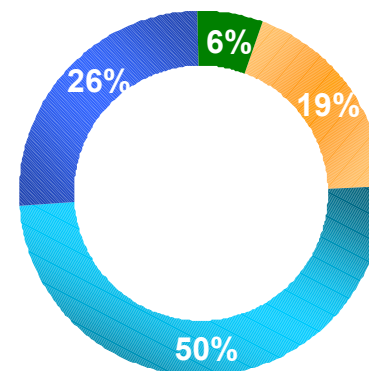
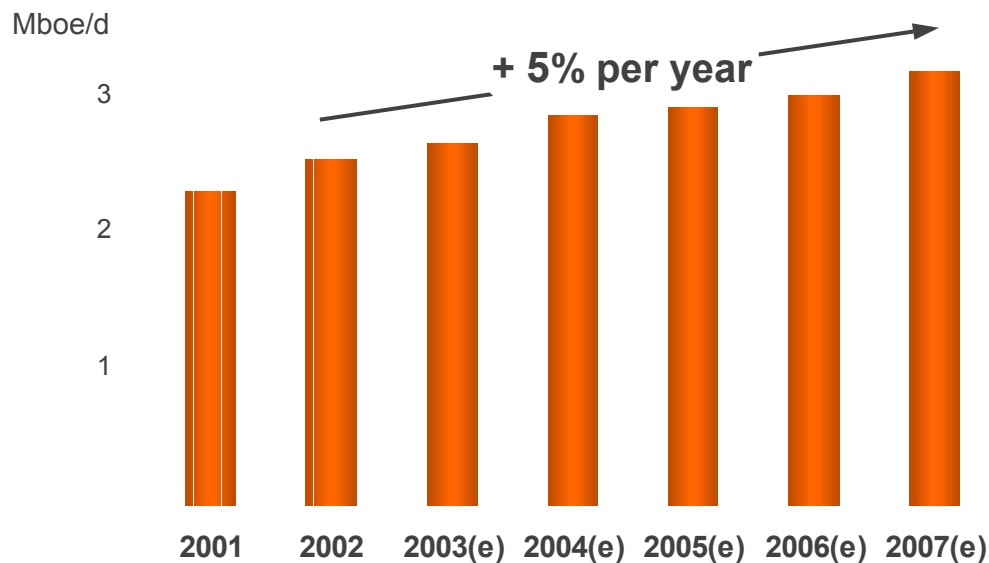


Sharing experiences in Canada and Venezuela

Venezuela Field Trip - September 2003

Total: strongest production growth among the majors

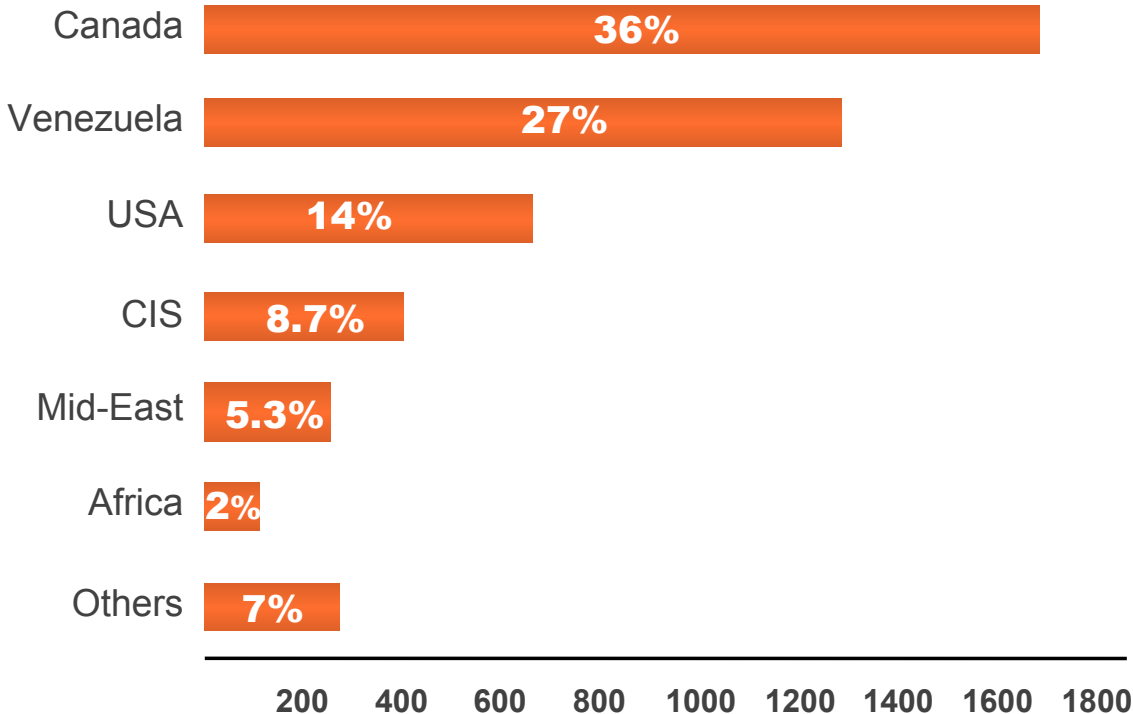
Total's production growth 2001-2007



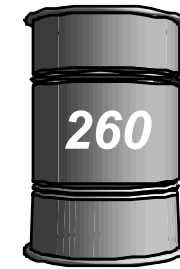
- Onshore
- Offshore
- Deep Offshore
- Heavy Oil

Heavy Oil: oil in place and reserves worldwide

Oil in Place
≈ 4,600 Bb



Light oil reserves (Bb)



Saudi Arabia

Heavy oil reserves (Bb)
(resources)



Venezuela
(Orinoco)



Canada
(Athabasca)

Less than 1% produced or under active development



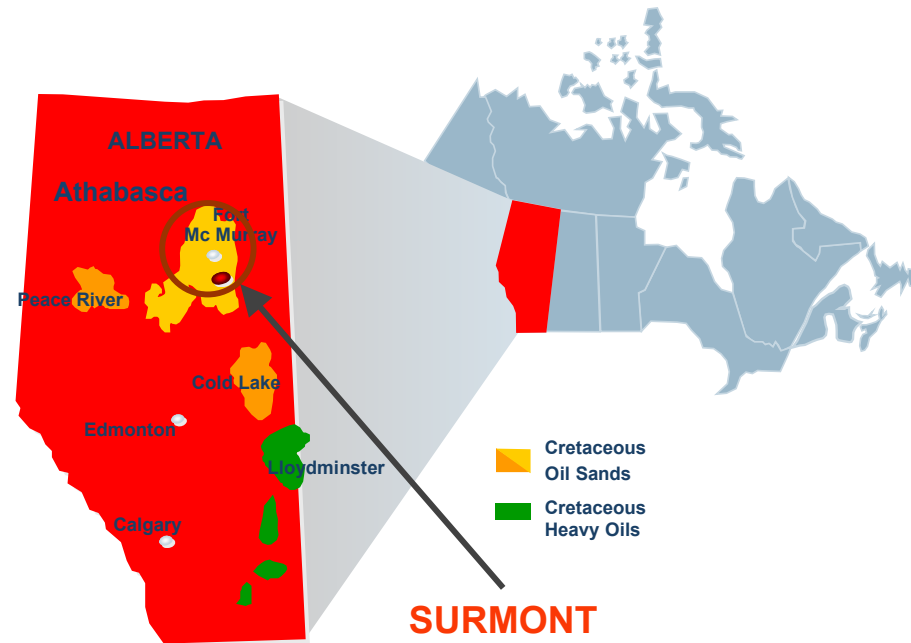
Huge untapped resources in Orinoco and Athabasca

Orinoco: 54,000 km²



SINCOR OPCO

Athabasca: 45,000 km²



**SURMONT
SAGD Pilot**

● **Extra Heavy Oils:** $\mu < 10,000$ cPo

Oil in place: 1,200 Bb

(PDVSA estimates)

Developped 8 to 10 Bb

7 $<^{\circ}$ API < 20

● **Tar Sands & Bitumen:** $\mu > 10,000$ cPo

Oil in place: 1,300 Bb

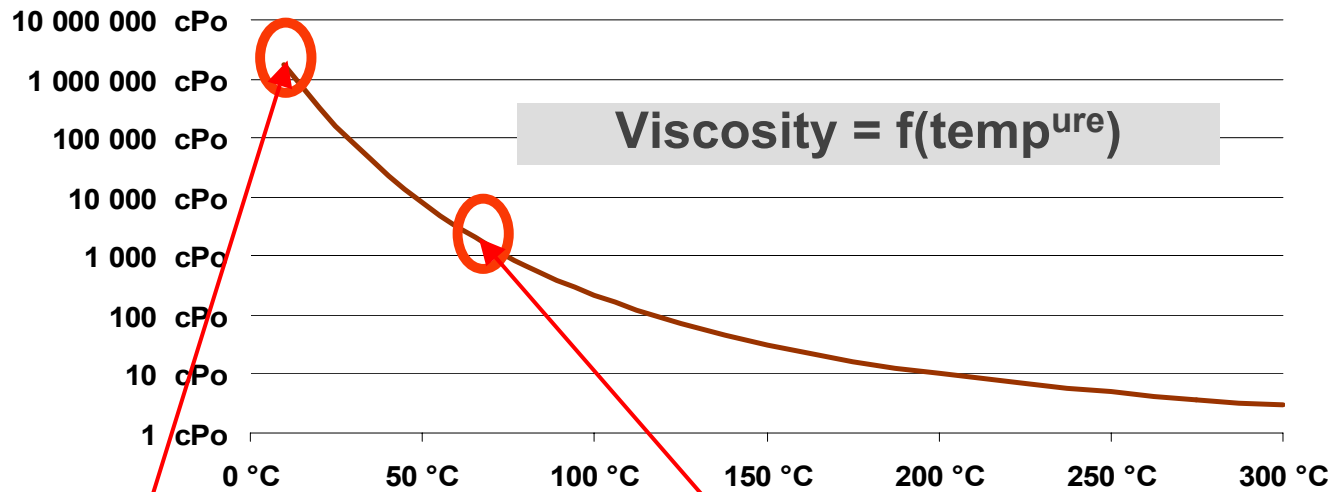
(AEUB estimates)

Developped per mining extraction 10 to 12 Bb

7 $<^{\circ}$ API < 12



A decisive difference: the geothermal gradient



Athabasca

T reservoir # 11°C

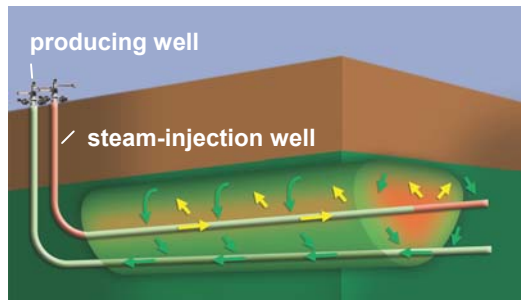
μ # 1,000, 000 cPo

Orinoco

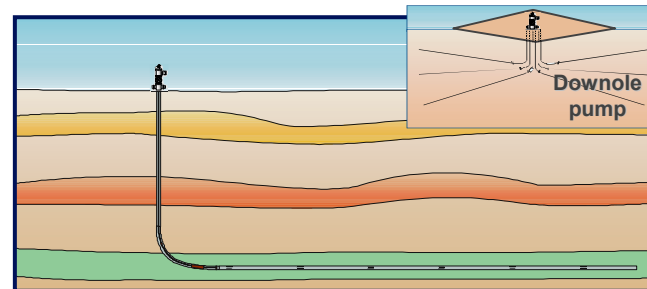
T reservoir # 53°C

μ # 1,500 to 3,000 cPo

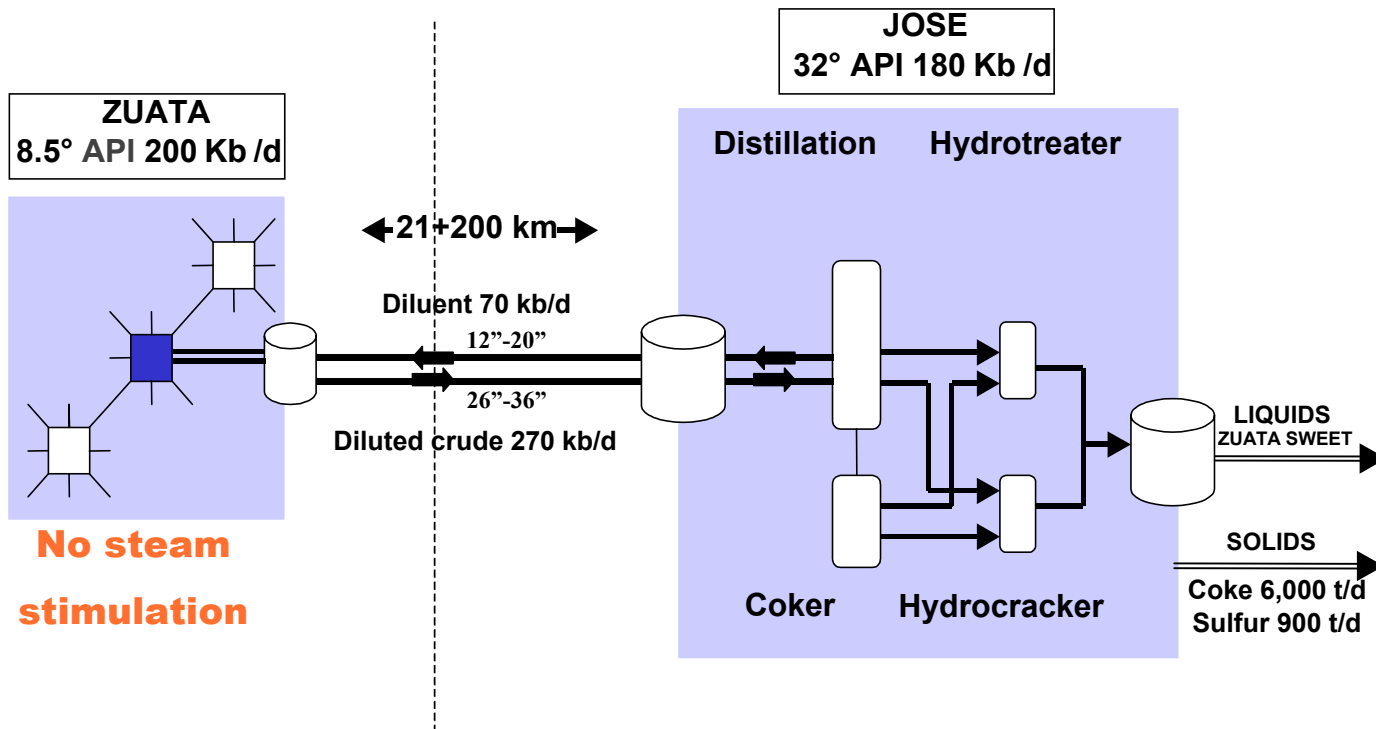
► Thermal Production Compulsory



► Cold Production Possible



Sincor: leading edge technology



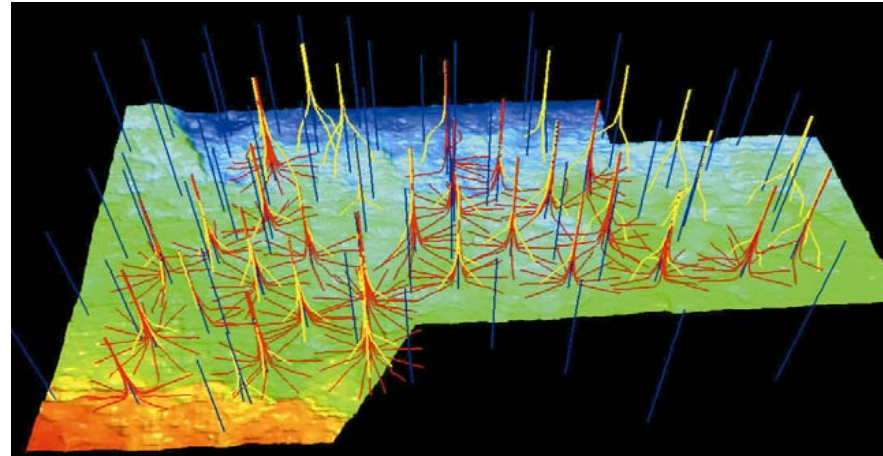
- Oil gravity : 8.5° ⇔ 32° API
- Plateau production : 200 kb/d of crude oil
180 kb/d of Zuata Sweet
- Contract duration : 35 years

- Investment : US\$ 4.2 billion
- Technical costs : < 7 US\$ / b

Sincor: leading edge technology

80 Clusters ▶

1,200-1,500 Wells ▶



■ Geosciences

- Widespread use of seismic inversion and geo-modelling

■ Drilling

- Development using horizontal wells (1,400-m drains)
- Real-time transmission of drill-bit position vs seismic line

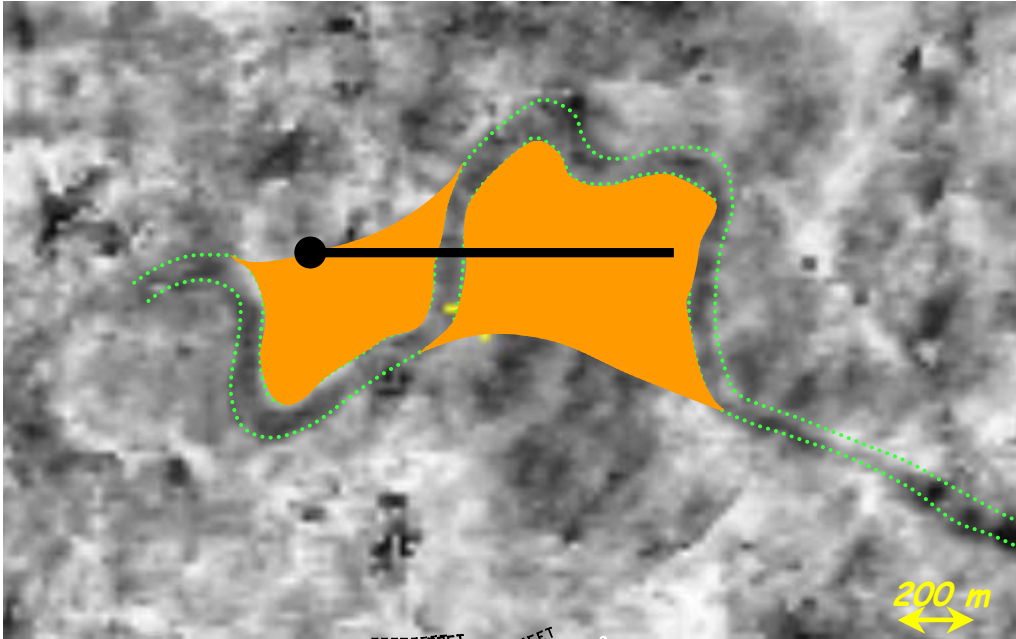
■ Completion

- High-capacity PCP pumps
- Down-hole injection of diluent
- Cold production 1,000 to 4,000 b/d

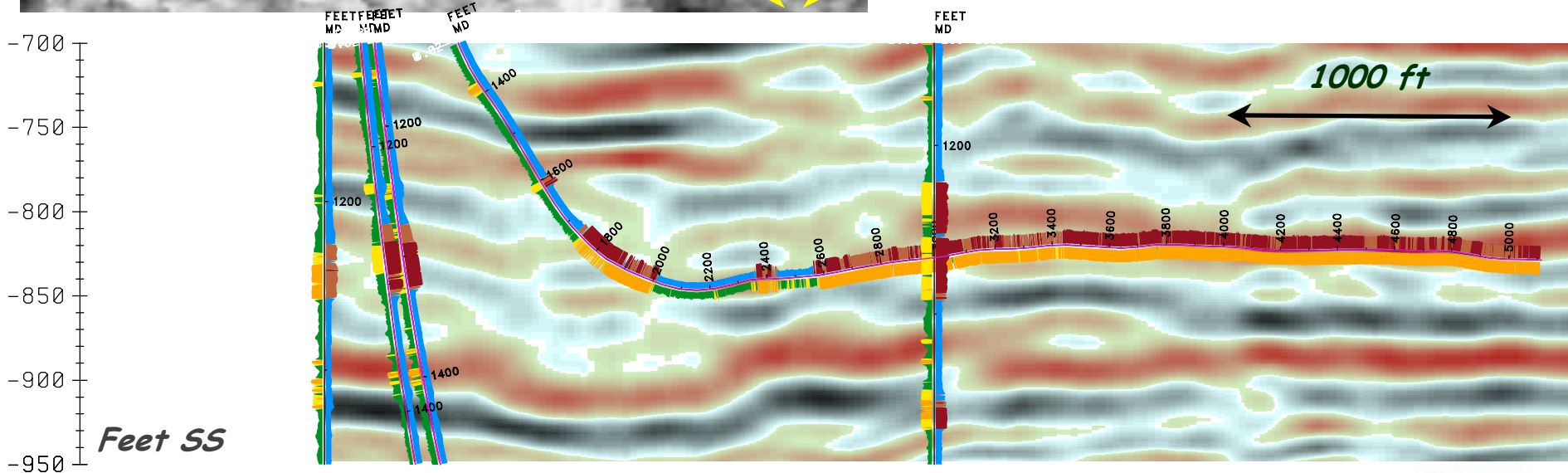
■ Production

- Multi-phase pumping and metering
- Real-time data transmission

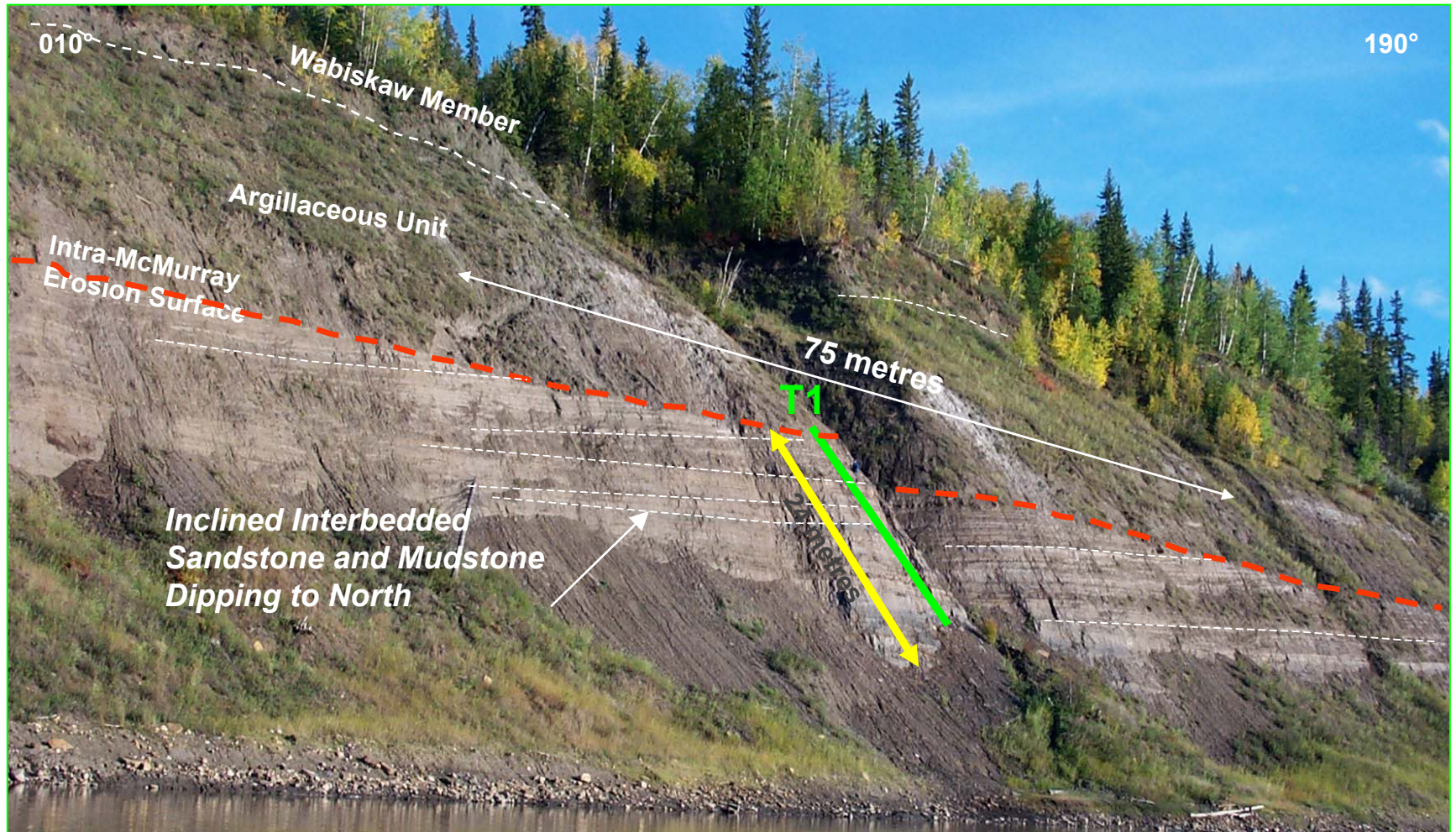
Sincor: leading edge technology



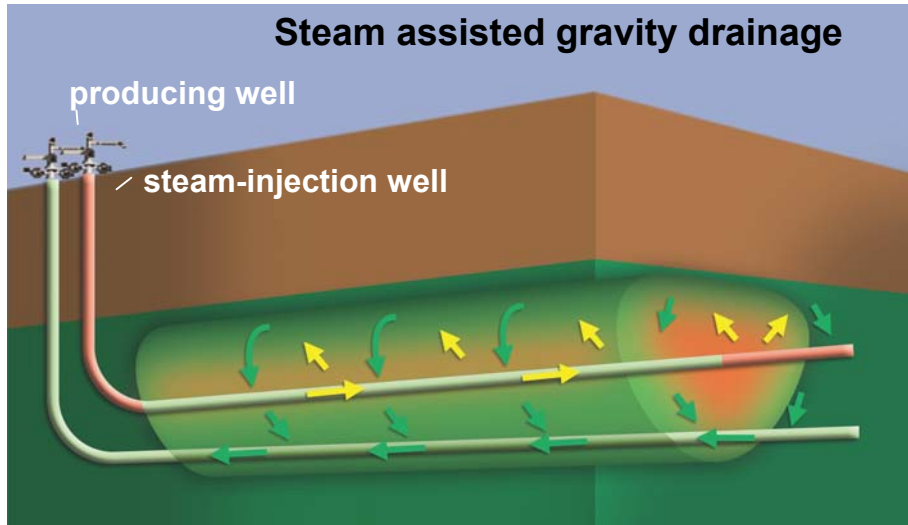
- **Challenge:** Reservoir characterization to pilot wells through best sand reservoir inside the meander system



Athabasca oil sands outcrops



SAGD: an emerging technology in Canada



- High recovery factor
- Several pilot projects since 1980's in Alberta and elsewhere
- Mature enough for medium-scale pre-industrial phases

BUT:

- Huge need of energy
- Size of facilities and energy consumption directly related to steam oil ratio (has to be < 3 vol./vol.)
- Large GHG emissions
- Requires techniques adapted to high temperatures (artificial lift, metering, surface pumping, ...)



TOTAL

SAGD: from pilot to pre-industrial phase



Phase 1 of Foster Creek
(EnCana)



Phase 1 of Christina Lake
(EnCana)



Phase 1 of Mac Kay River
(PetroCanada)



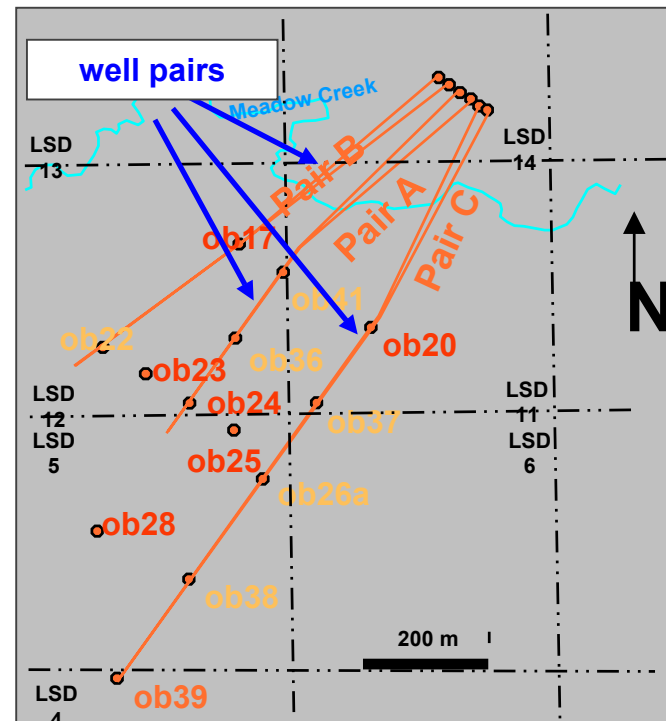
Surmont Pilot (Conoco-Phillips / **Total** / Devon)

Surmont: SAGD project - on going pilot



Objectives:

- Confirm commercial oil-rates & Steam/Oil ratio
- Test high temperature (# 200°C) artificial lift
- Phase 1 (25 kb/d) preparation before FFD decision with upgrader (100 kb/d)

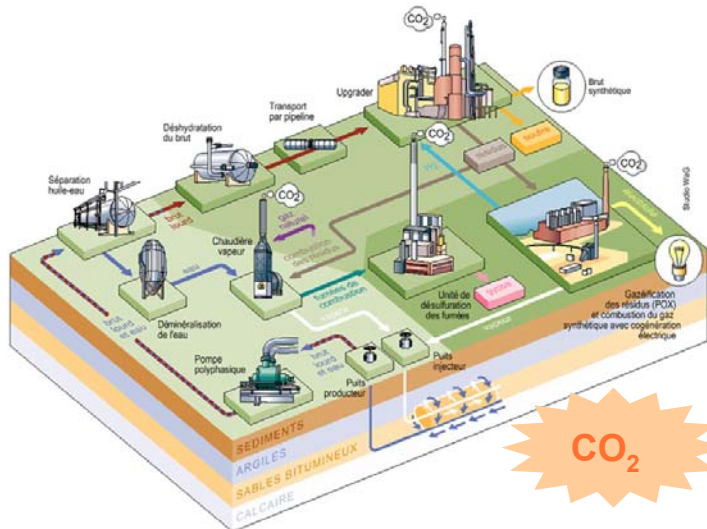
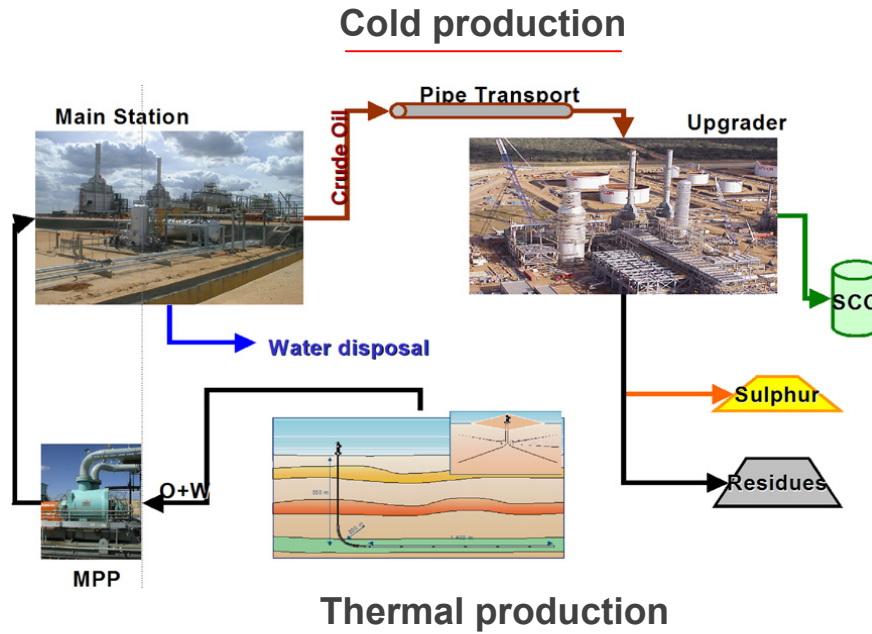


Key drivers for extra heavy oil investments

- **Technical** ▶ size, scope, complexity
- **Commercial** ▶ infrastructure, products, markets
- **Economical & financial** ▶ profitability, access to financing, visibility
- **Sustainable development** ▶ business opportunities, neighboring communities, environmental management, CO₂ emission



Technology: an essential ingredient



Challenges

Artificial Lift & flow modeling

Efficiency of CHOPS

% Recovery in Compaction Drive

% Recovery in Solution Gas Drive (foamy oil)

Heavy Crudes Transportation

Emerging Upgrading Processes

Fluid Characterization (RMN)

Reservoir Characterization

Artificial Lift & flow modeling @ HT

Steam Monitoring

Emerging EOR methods (SAGD, VAPEX, ISC)

Alternative Fuels :
Combustion & Gasification of Residues

Boiler Feed Water Treatment

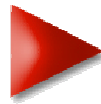
Multiphase Metering & Pumping @ HT



Heavy Oil Challenges: how to improve the recovery factor

Orinoco

**Present Situation:
Expected Recovery Factor
6 - 10 %**

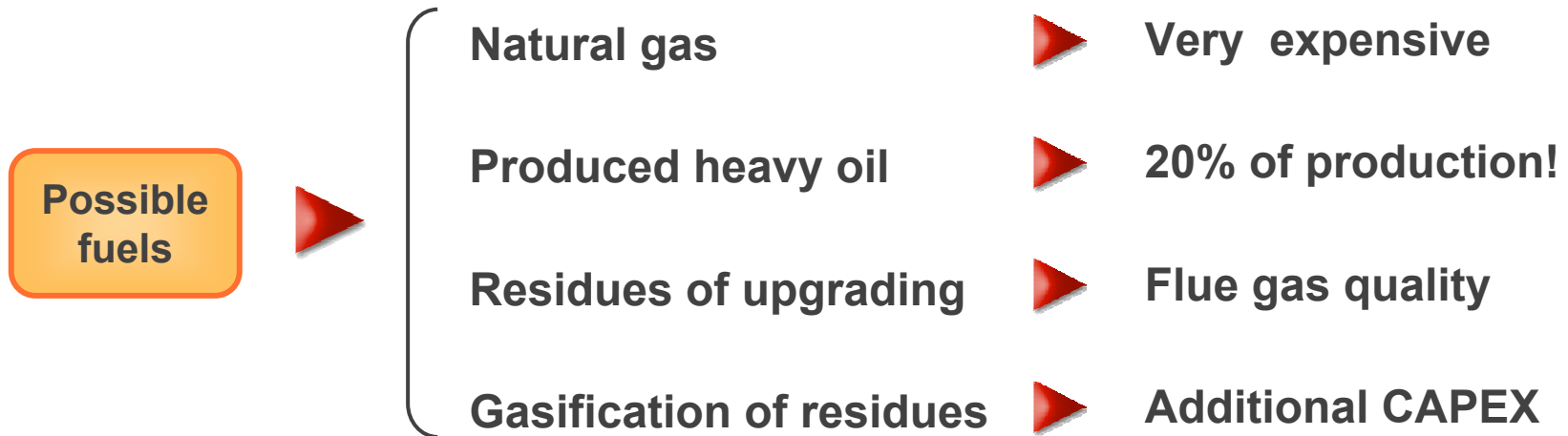


- **Additional recovery thanks to sand compaction**
- **Foamy oil effect**
- **Artificial lift**
- **Impact of thermal techniques**

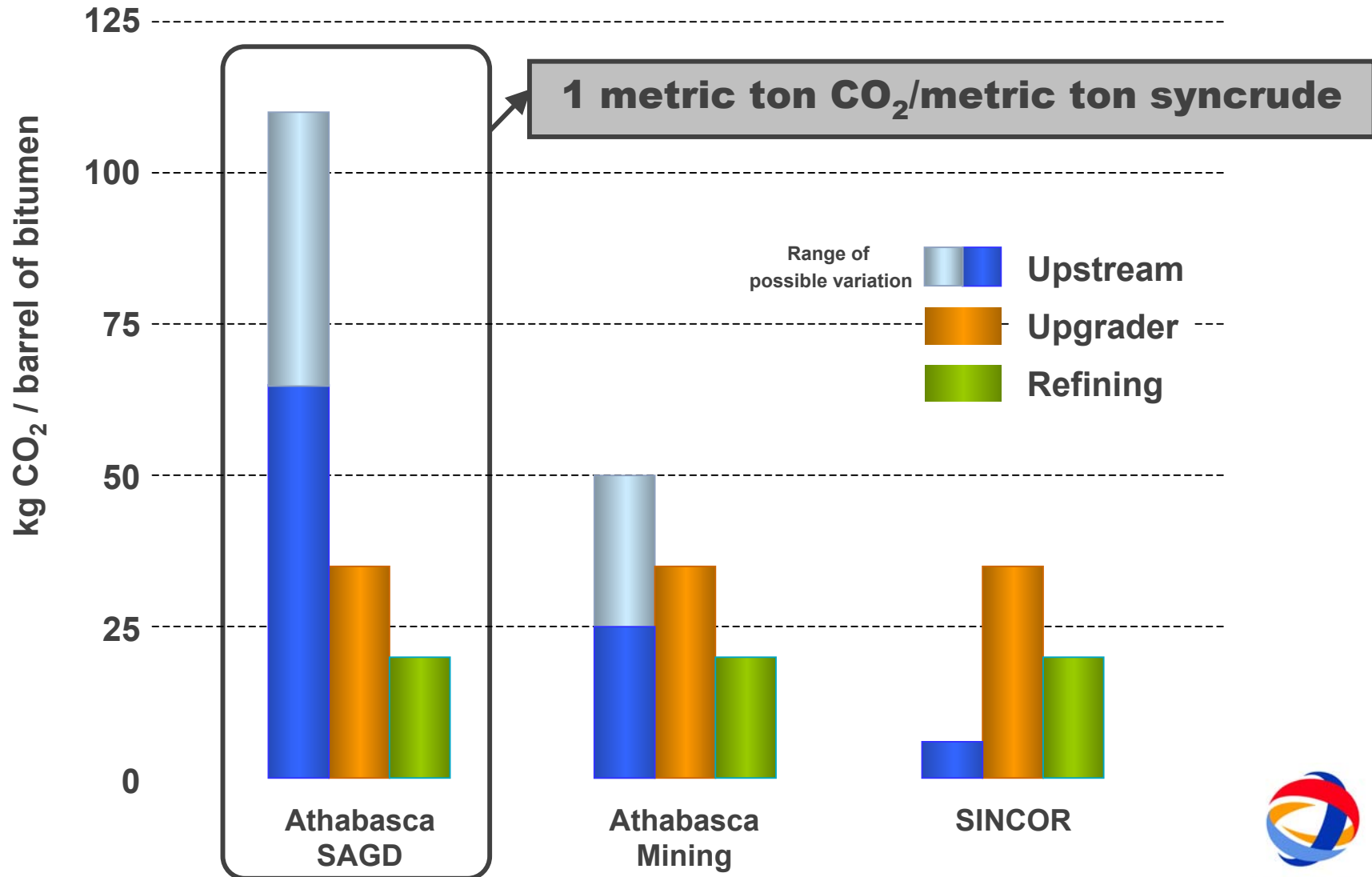


Heavy Oil Challenges: reducing steam production costs

Athabasca

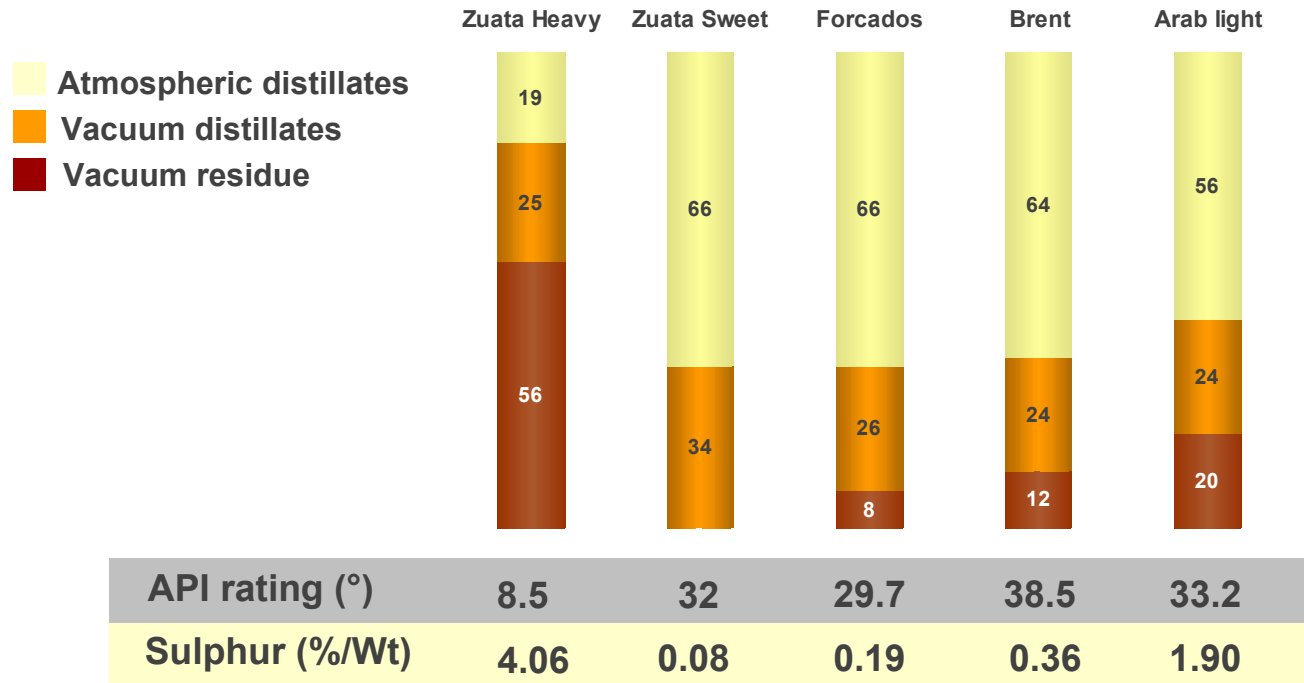


Heavy Oil Challenges : CO₂ emissions



Marketing issues

Orinoco: accessing world's markets by upgrading



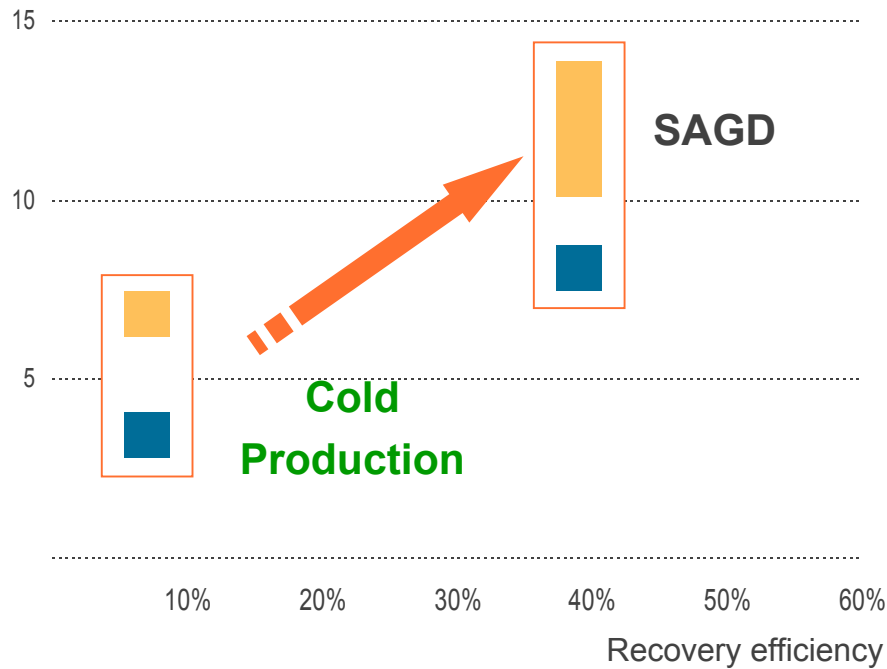
Athabasca: large market nearby but:

- Bitumen blend: expected pressure on pricing and on diluent availability
- Synthetic crude: upgrader size and location matter to optimize synergies
- Regional upgrader?

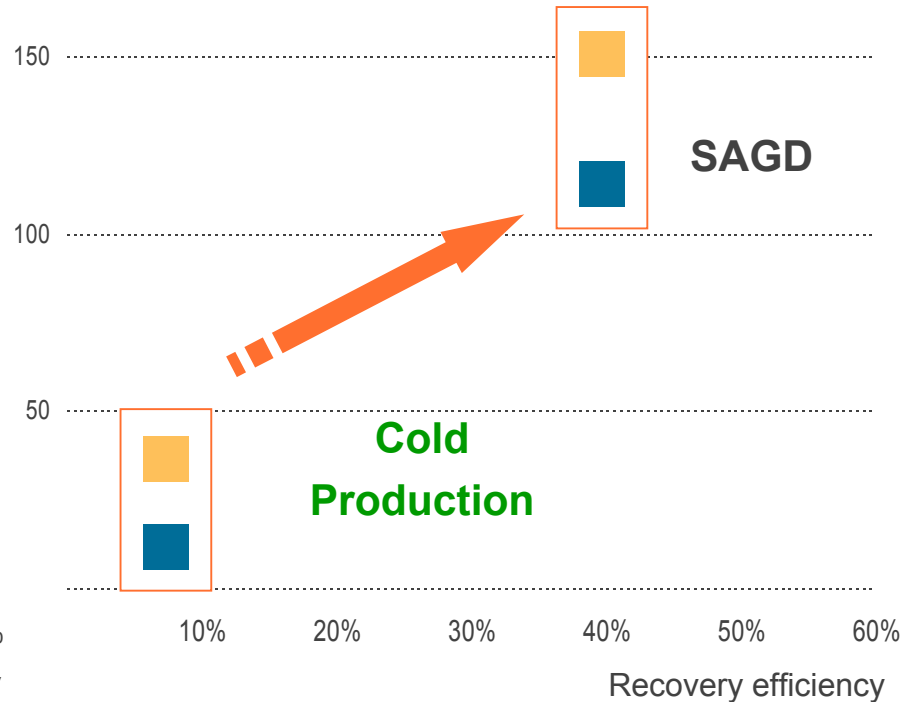


Recovery & Costs

Technical cost
(US\$/b)



CO₂ Emissions
(kg/b)



■ Upstream only (no upgrading)

■ Upstream + Downstream



TOTAL

Conclusions

- **Our search for new business opportunities is leading us to explore more complex, longer production chains downstream the wellhead, such as:**
 - Heavy oils, with improved recovery techniques
 - Thermal in situ production and upgrading

- **Key drivers:**
 - ▶ Integration of processes
 - ▶ Lower costs
 - ▶ Improved yields and taking into account environmental considerations (CO₂, etc.)

