



[www.albemarle.com](http://www.albemarle.com)

# Advances in Upgrading Heavy Crudes and Coker Gas Oil Through Hydroprocessing

**Hiroshi Toshima**  
**Albemarle Catalyst Company**  
(Email ; [hiroshi.toshima@albemarle.com](mailto:hiroshi.toshima@albemarle.com))

# Outline

[www.albemarle.com](http://www.albemarle.com)

- **Fuels and Oil Refining Trends**
- **Oil Sands Production in Canada**
- **Albemarle's Catalyst Portfolio for Bitumen Hydroprocessing**
- **Summary and Recommendation**

# Fuels Trend by YR 2020

[www.albemarle.com](http://www.albemarle.com)

- **Steadily Growing Oil Demand at + 1.7 %/yr**
  - Global Crude Demand from 80 to 100 mmbpd
- **More Distillate Than Mogas**
  - Distillate demand increase at + 2.2 %/yr (29 → 40 mmbpd)
  - Gasoline demand increase at + 1.5 %/yr (21 → 26 mmbpd)
- **Tighter Regulation in Mogas, Distillate and Fuel Oils on Global Scale**
- **Oil Refining Expects More Upgrading w/ Heavy Sour Products**

# Oil Refining Trend YR 2020

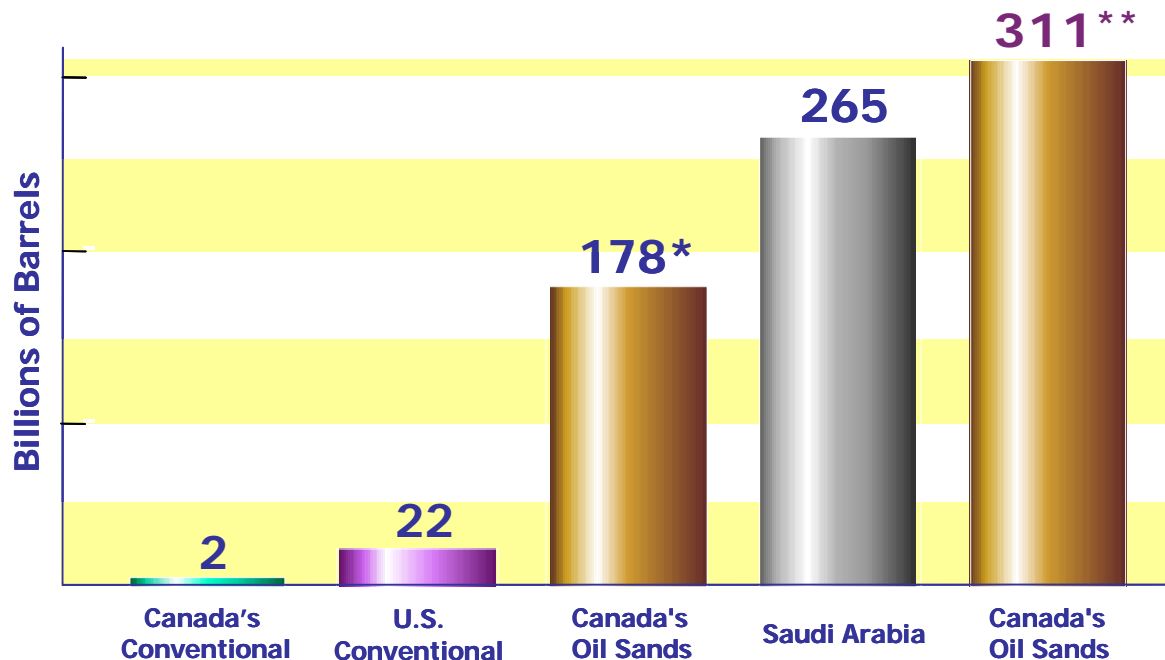
[www.albemarle.com](http://www.albemarle.com)

- **More Heavy / Sour Crudes**
    - Lower API (32.7→32.3), More Sulfur (1.15→1.35wt%)
  - **More Unconventional Crudes**
    - Oil Sands in Canada ; 3.5 mmbpd (YR 2020)
    - Orinoco tar in Venezuela ; 1.4 mmbpd (YR 2010)
  - **Imbalance Fuel Oil Demand / Production**
    - 8 – 10 mmbpd Surplus Resid
    - More Bottom of The Barrel (Coking, E-bed, RDS, etc)
  - **More Secondary Upgrading w/ Heavy Sour Products**
- ➔ Need Robust Catalytic Technology for Heavy Oils!**

# Oil Sands in Canada

www.albemarle.com

- Canada is the second largest oil reserve country with the enormous reserve of Unconventional crude of Oil Sands.
- Canada is aggressively increasing the production of Bitumen and Synthetic Crude Oil (SCO) applying primary (APS/VPS, Coker, E-bed) and secondary (HT, HC) upgraders.



\* 178 billion barrels established reserves

\*\* 311 billion barrels recoverable with current technology

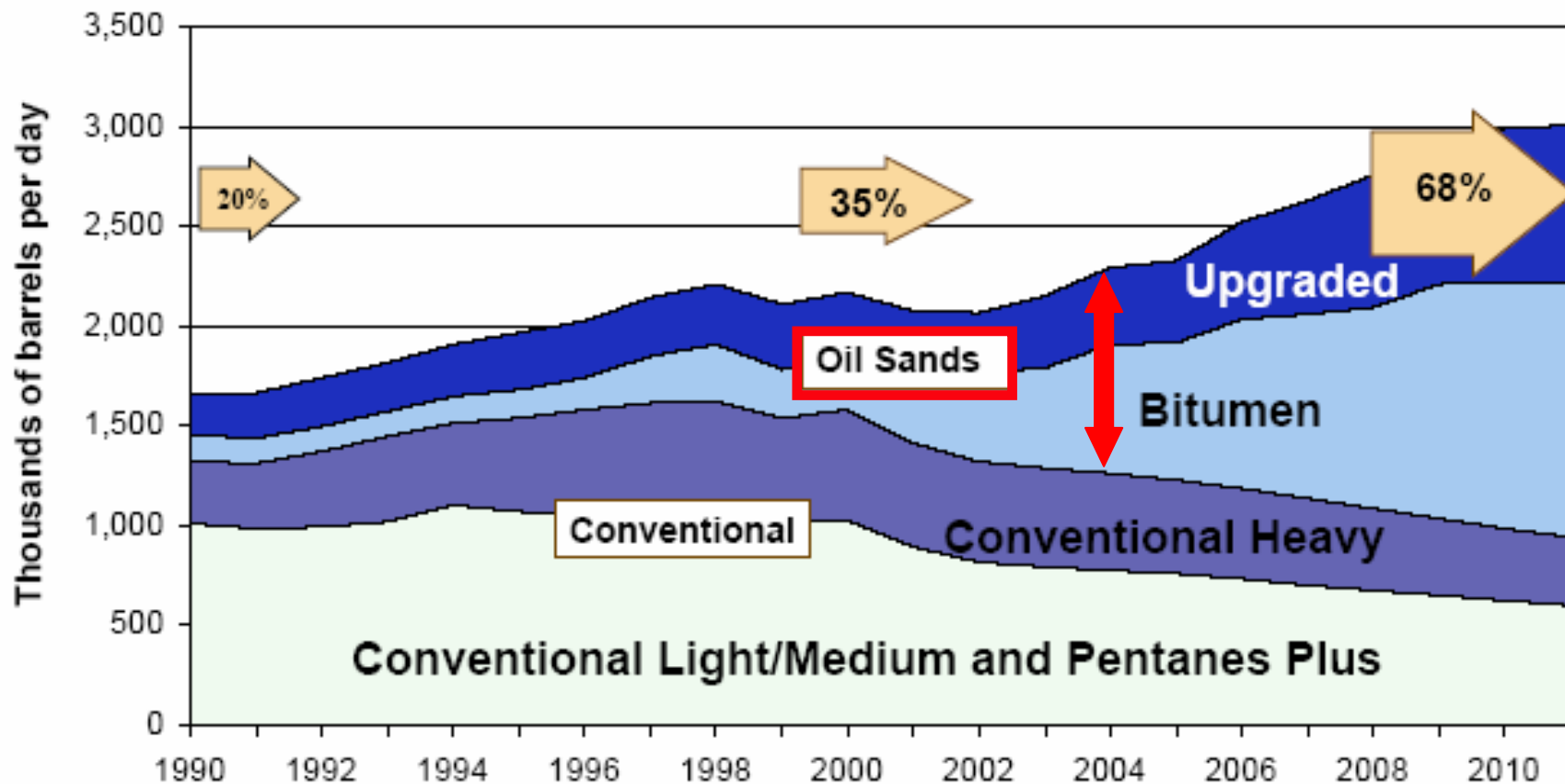
1.7 trillion barrels in place

\*\*\* ACR Oil Sands Roadmap assumes 5,000 kbbl/d by 2030

OSTF Update February 2003

# Increasing Oil Sands Production

www.albemarle.com



Source: 1990 to 2002 – CAPP plus forecast of Conventional and heavy  
2003 to 2011 Oil Sands Forecast – RIWG June 2004

# Oil Sands Production (Mining Area)

www.albemarle.com

## Mining



## Heating / Sand Separation

Sand



Bitumen



## Blending

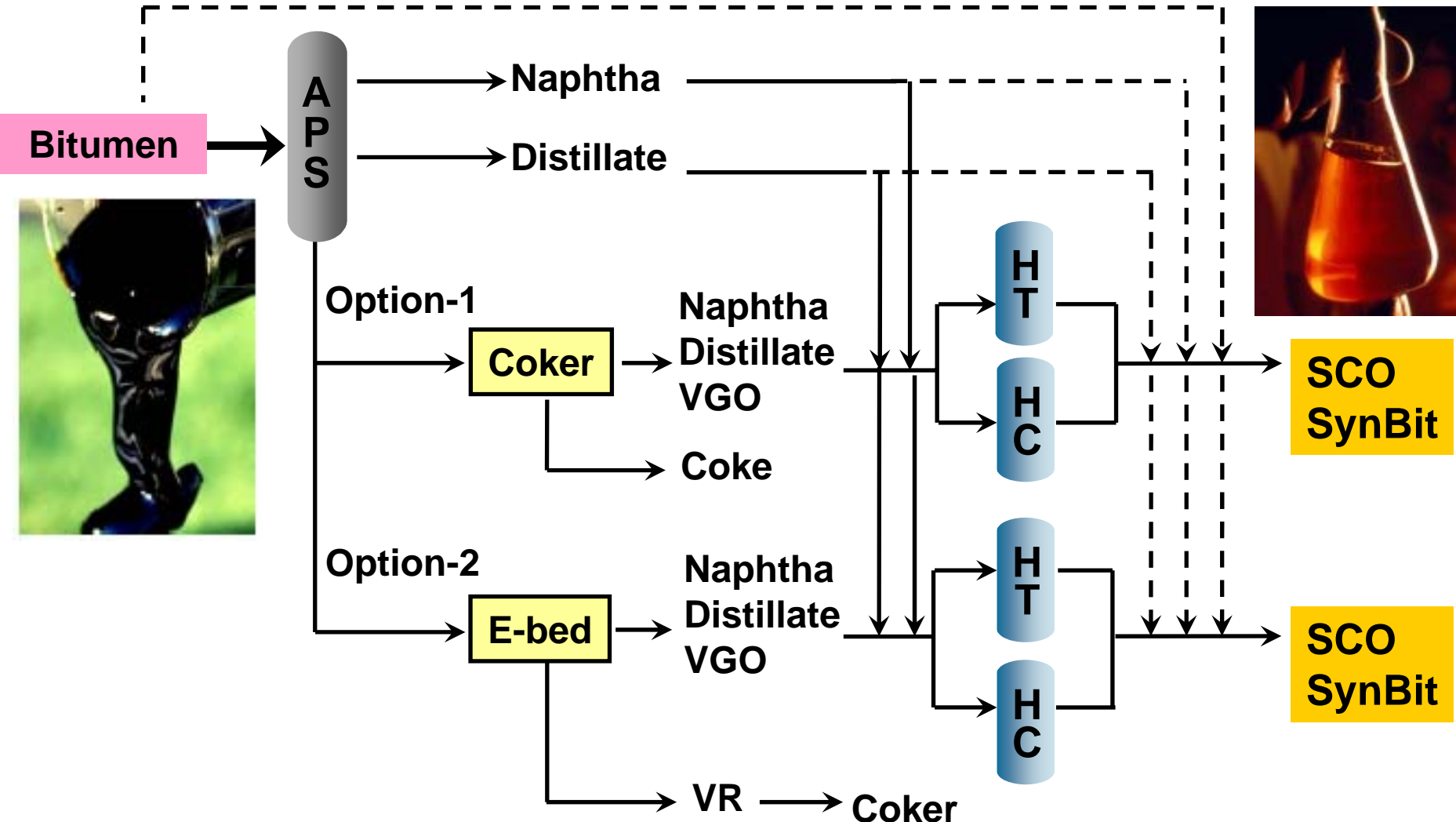
Condensate  
Naphtha, SCO

ConBit  
Synbit  
SynDilBit

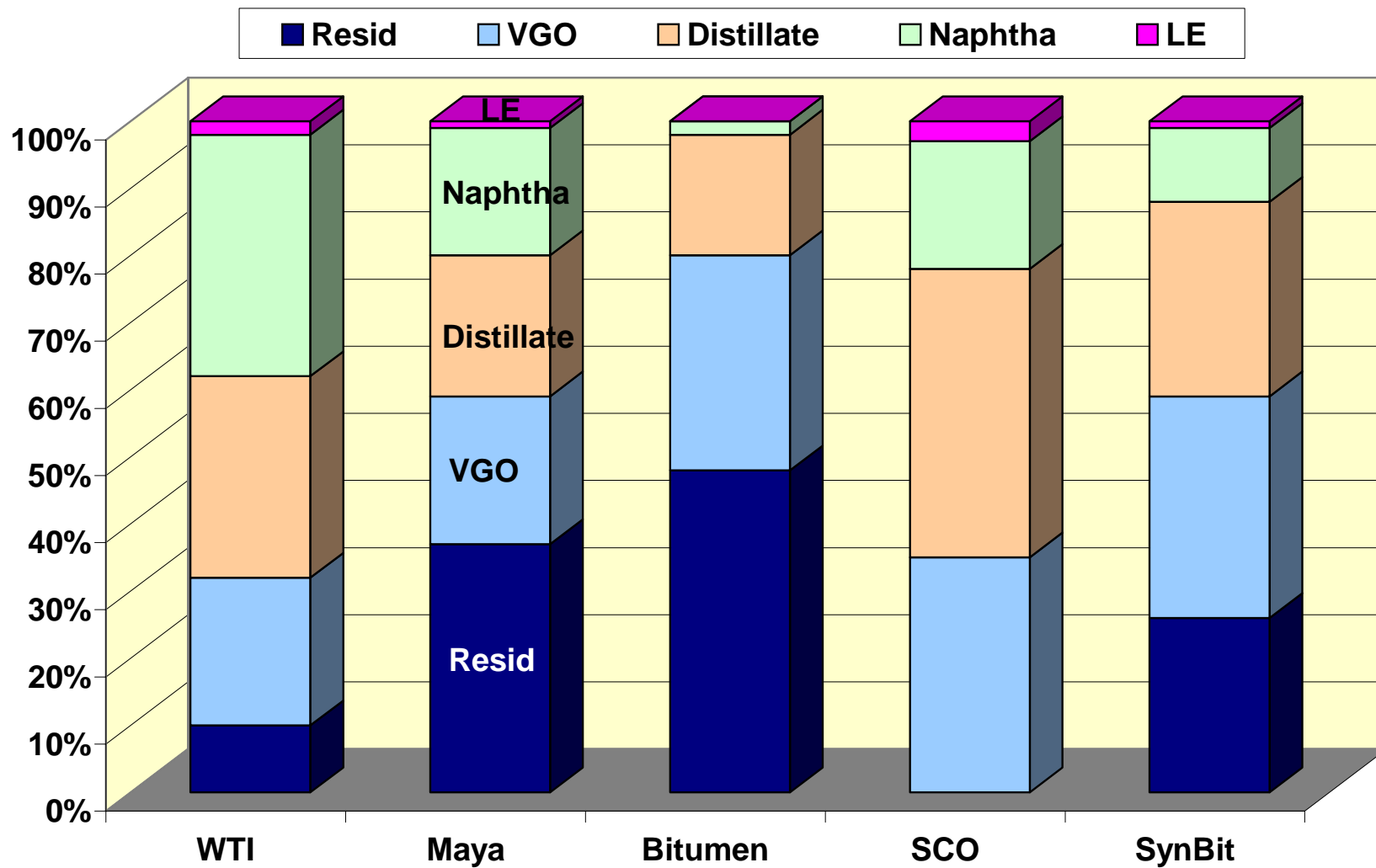
Refinery  
Market

# Bitumen Upgrading in Refinery

www.albemarle.com



# Crude Distillation



# Challenge for Tougher Feeds

www.albemarle.com

- **More Streams from Bitumen and Coker Products**
- **More Refractory Sulfur, Nitrogen and Aromatics**

Typical Properties	Unit	Distillate		VGO	
		Oil Sands	AL-XL	Oil Sands	AL-XL
Density	g/ml	0.88	0.82	0.98	0.92
Sulfur	wt%	3.0	1.0	4.0	2.0
Nitrogen	wppm	1,000	200	4,000	800
Aromatics	wt%	40	25	70	40

# Albemarle's Vision on Heavy Oils

[www.albemarle.com](http://www.albemarle.com)

- **Albemarle will be the leader in emerging heavy oil fuels technologies.**
  - **Albemarle will be the company that provides the suitable catalytic solutions for producing the fuels of the future.**
  - **Albemarle will leverage the cutting-edge catalytic technologies for the Bitumen upgradings.**
- **Albemarle has expanded the application range of STARS and Nebula catalytic technologies into the secondary upgrading of Bitumen processing.**

# Albemarle's VGO Catalytic Technology

[www.albemarle.com](http://www.albemarle.com)

- **KF-859 Non-STARs NiMo**
  - **Conventional NiMo catalyst of high HDS and high HDN for cost effective solution**
  
- **KF-857 STARs NiMo**
  - **A new STARs NiMo catalyst developed for FCC-PT applications combining high HDN and high HDS**
  - **Also applicable for HC-R1 for high HDN**
  
- **KF-757 STARs CoMo**
  - **The most active HDS CoMo catalyst for FCC-PT**
  
- **KF-905 STARs NiCoMo**
  - **A new STARs NiCoMo catalyst succeeding KF-901 providing economical solution with high HDS**

# Nebula™ Catalytic Technology

[www.albemarle.com](http://www.albemarle.com)

## ■ Nebula™

- Unprecedentedly high HDS, HDN and HDA activities (2 – 4 times)
- New tool to accomplish the hydrotreating objectives previously considered “ difficult ” or “ impossible ”
- Optimized loading of Nebula and STARS boosts activity by 2 – 3 times in a comparable hydrogen consumption
- Awareness of Nebula’s ultra high activity in ULSD and HC-PT is spreading rapidly in the industry

# Pilot Testing with Extra-Heavy VGO

[www.albemarle.com](http://www.albemarle.com)

- **Operating Conditions**
  - 100 barg, 6,000 scf/bbl hydrogen, 370-390 °C
- **Feed Source and Properties**
  - Heavy Bitumen VGO + Coker VGO
  - Density                      0.98 g/ml
  - Sulfur                         3.44 wt%
  - Nitrogen                      4,000 ppm
  - PNA                            48 wt%
- **Product Properties**
  - Sulfur                         30 – 1,500 ppm
  - Nitrogen                      3 – 1,500 ppm
  - PNA                            5 – 17 wt%

# Catalysts Tested

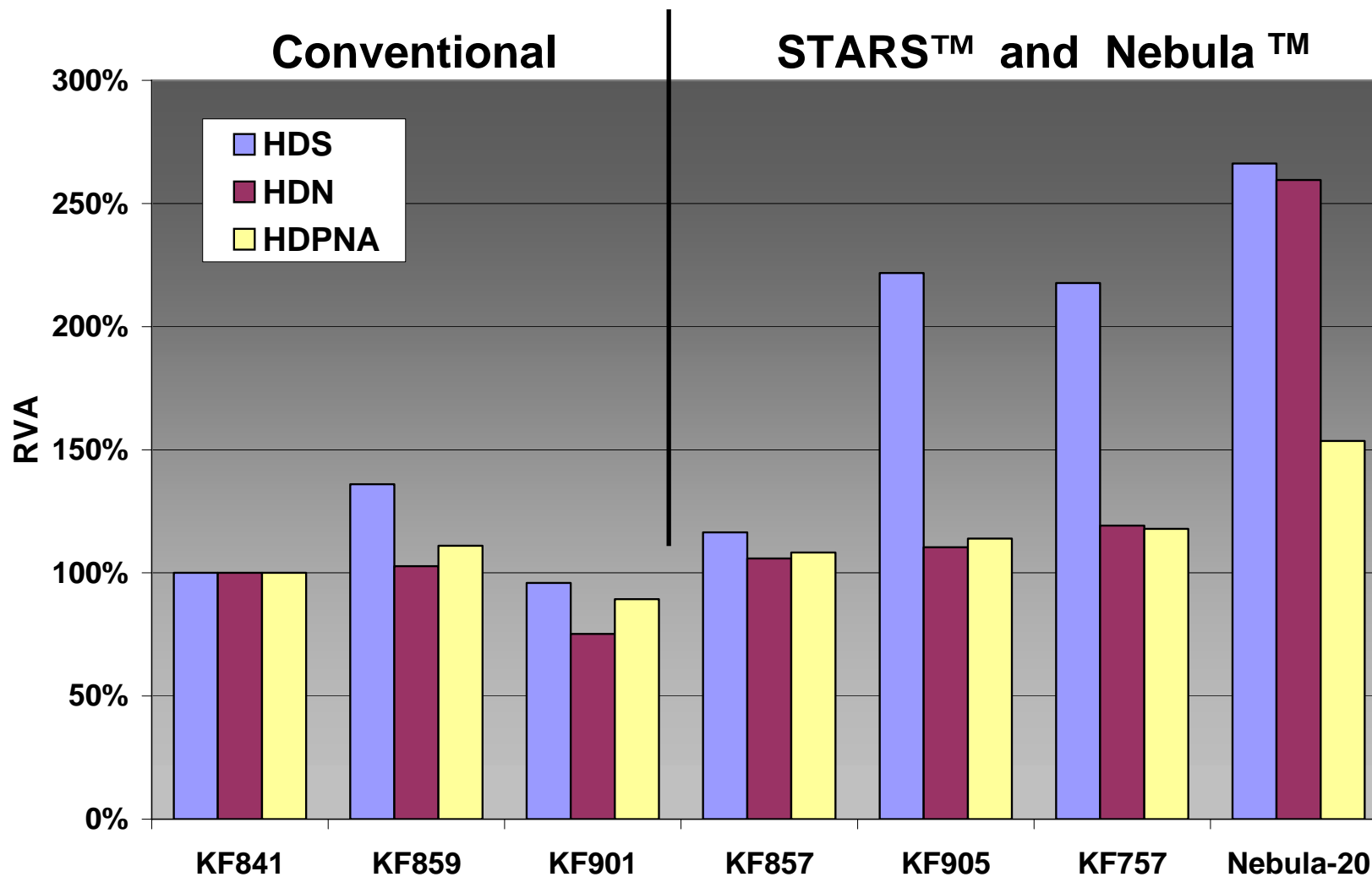


- **Conventional**
  - » **KF841 (NiMo), KF859 (NiMo), KF901 (NiCoMo)**
- **STARS™**
  - » **KF857 (NiMo), KF905 (NiCoMo), KF757 (CoMo)**
  - » **Emerging New STARS**
- **Nebula™**
  - » **Nebula-20**

# Activities in Bitumen Application

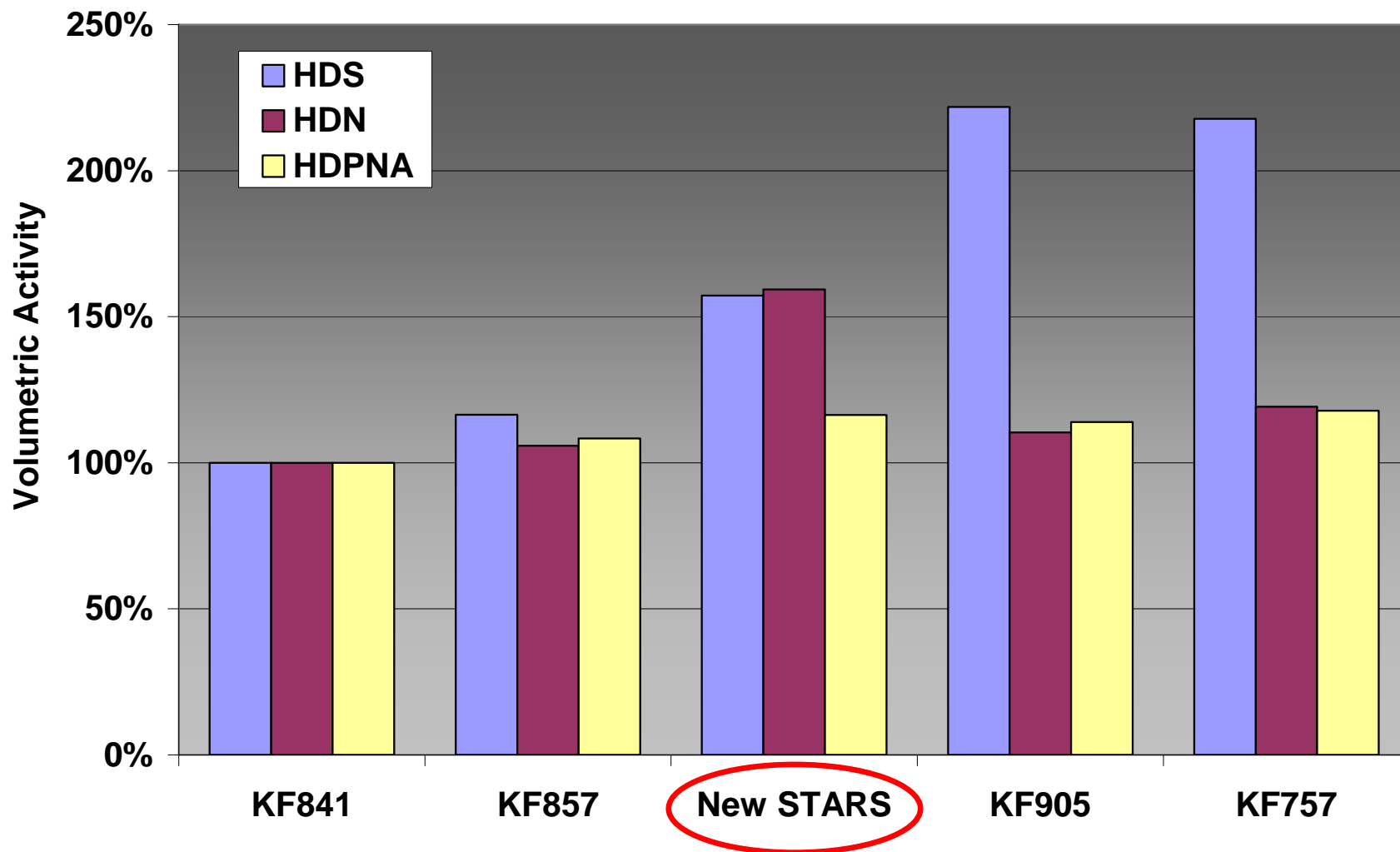


www.albemarle.com

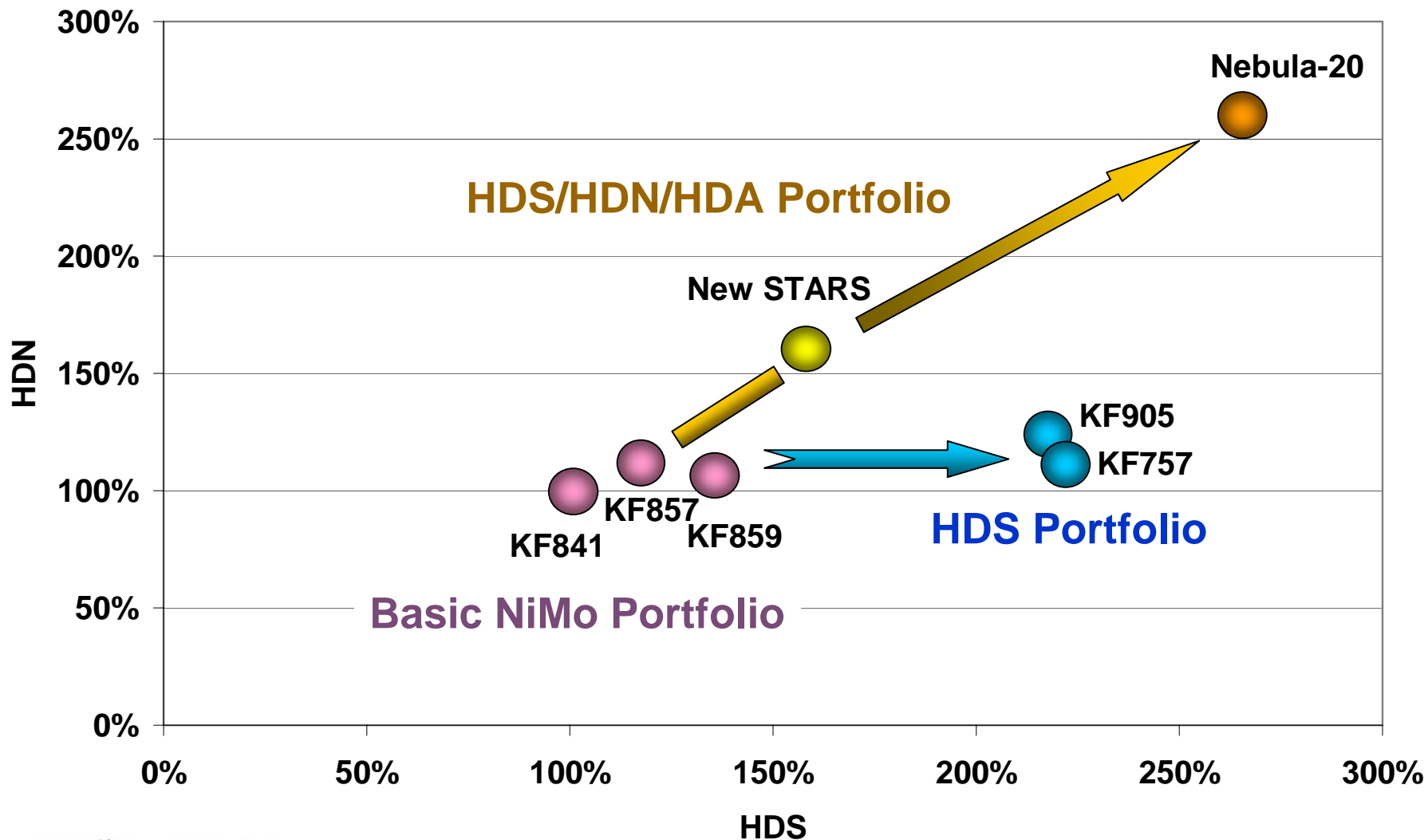


# New STARS Catalyst

[www.albemarle.com](http://www.albemarle.com)



# Catalyst Portfolio



# Summary

[www.albemarle.com](http://www.albemarle.com)

- **Albemarle's STARS™ and Nebula™ catalyst technologies show robust performance in Bitumen and Coker VGO applications.**
  - **The Non-STARS KF859 shows 135% HDS and 105% HDN to KF841.**
  - **The latest STARS NiMo of KF857 shows 115% HDS and 110% HDN to KF841.**
  - **The new STARS shows robust HDS and HDN of both 160%.**
  - **The STARS NiCoMo KF905 and CoMo KF757 both show extremely high HDS of 220%.**
  - **The Nebula-20 shows sky high activities of 270% HDS and 260% HDN.**

# Recommendations

[www.albemarle.com](http://www.albemarle.com)

- Refiners looking for reasonable activities of low cost
  - » KF841, KF859
- Refiners looking for high HDS activity for FCC-PT or Syncrude production
  - » KF905, KF757
- Refiners looking for max HDN/HDA with improved HDS for enhanced FCC or Syncrude production of high quality - more volume expansion
  - » KF857, New STARS
  - » Nebula-20
  - » STARS / Nebula-20 Stacked-bed Application



# Advances in Upgrading Heavy Crudes and Coker Gas Oil Through Hydroprocessing

**Hiroshi Toshima**  
**Albemarle Catalyst Company**  
(Email ; [hiroshi.toshima@albemarle.com](mailto:hiroshi.toshima@albemarle.com))