

Axens Marketable Solution from Residue to Final Products



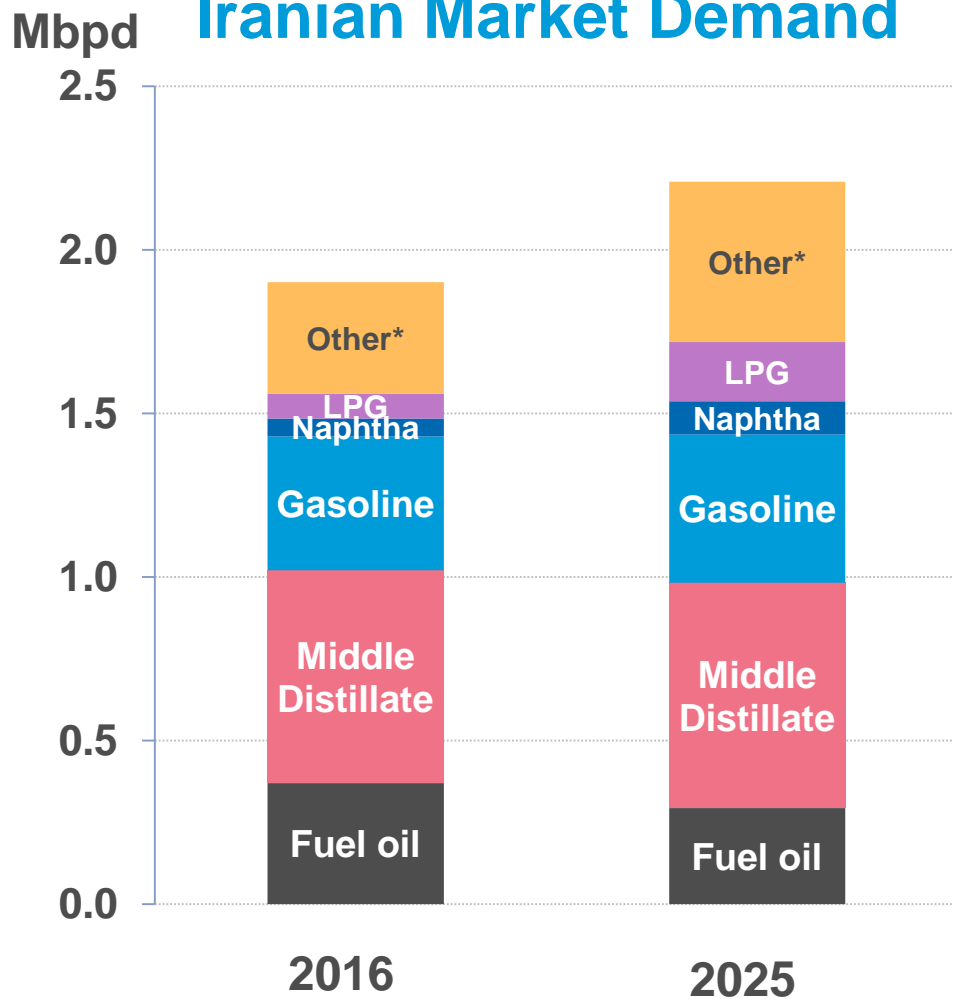
Alexandre Javidi

Synopsis



- **Market driver for Residue Conversion**
- **H-Oil effluent upgrading possibilities (Iranian Heavy Vacuum Residue)**
- **Iranian Light Case Study**

Iranian Market Petroleum Products

Iranian Market Demand



Iranian Market Demand 2016-2025

-  **Naphtha, Gasoline
Middle Distillate**
-  **Fuel Oil**

Other* = Refinery Gas, Ethane, Aviation Gasoline, Jet Gasoline, Kerosene (except Jet Kerosene), Petroleum Coke, Crude Oil etc, NGL, Non Crude (Orimulsion etc), Lubricants, Bitumen, Paraffin Wax, Other Oil, Refinery Losses

Fuel Oil Market

- Fuel Oil **Iranian market**

 - 50% is used for power generation

 - Gas is more and more used and replaces fuel oil for power generation

 - Largely available
 - Better for environment

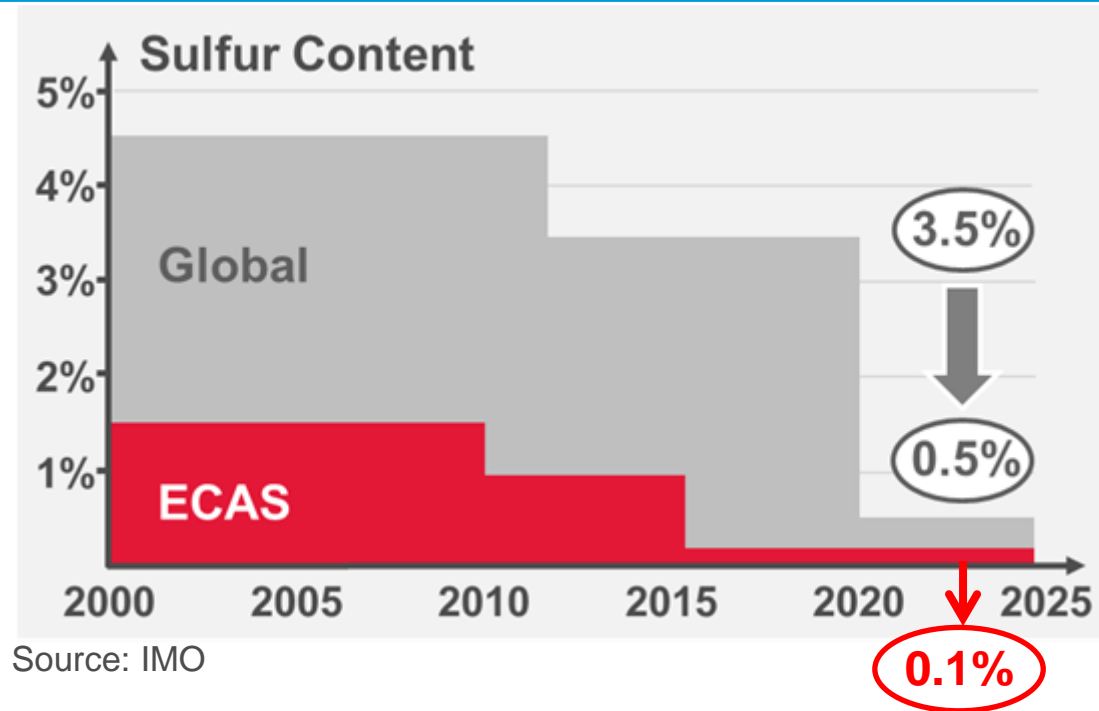
- Fuel Oil that is not consumed in Iran is **exported mainly to Asia**

Possibility to increase profitability by making more valuable products

Focus on Marine Bunker Fuels

Global Impact of 2020 Spec Change

2020: Sulfur Specification Decrease in Bunker Fuels

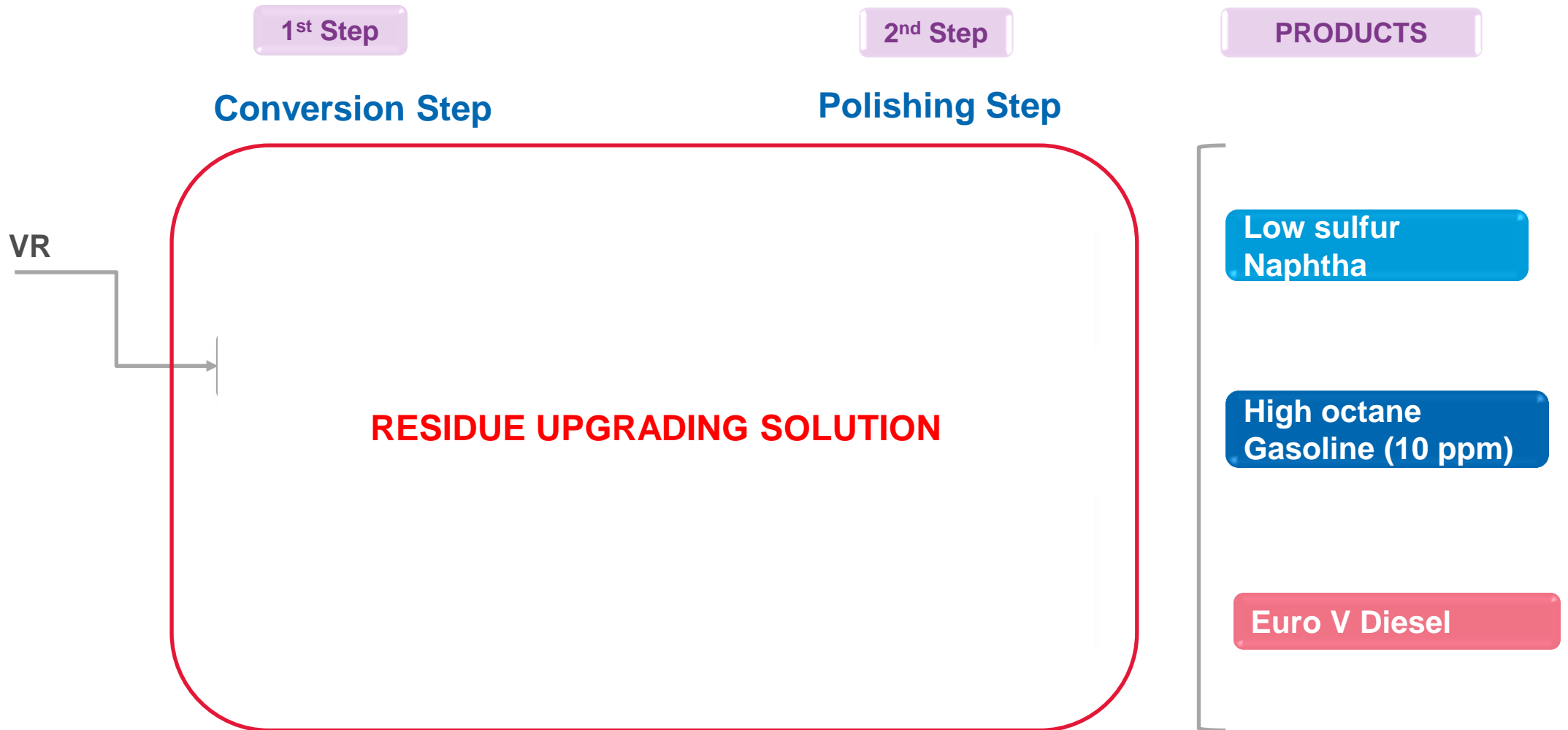


- 2016 Decision by International Maritime Organization (IMO): **global switch in 2020 to 0.5 % Sulfur** (from currently 3.5 % High Sulfur Fuel Oil (HSFO))
- ECA's (Emission Controlled Areas): S specification remains at 0.1 %
- In 2020, **demand for HSFO will strongly decrease worldwide**

Need for Residue Desulfurization and Conversion

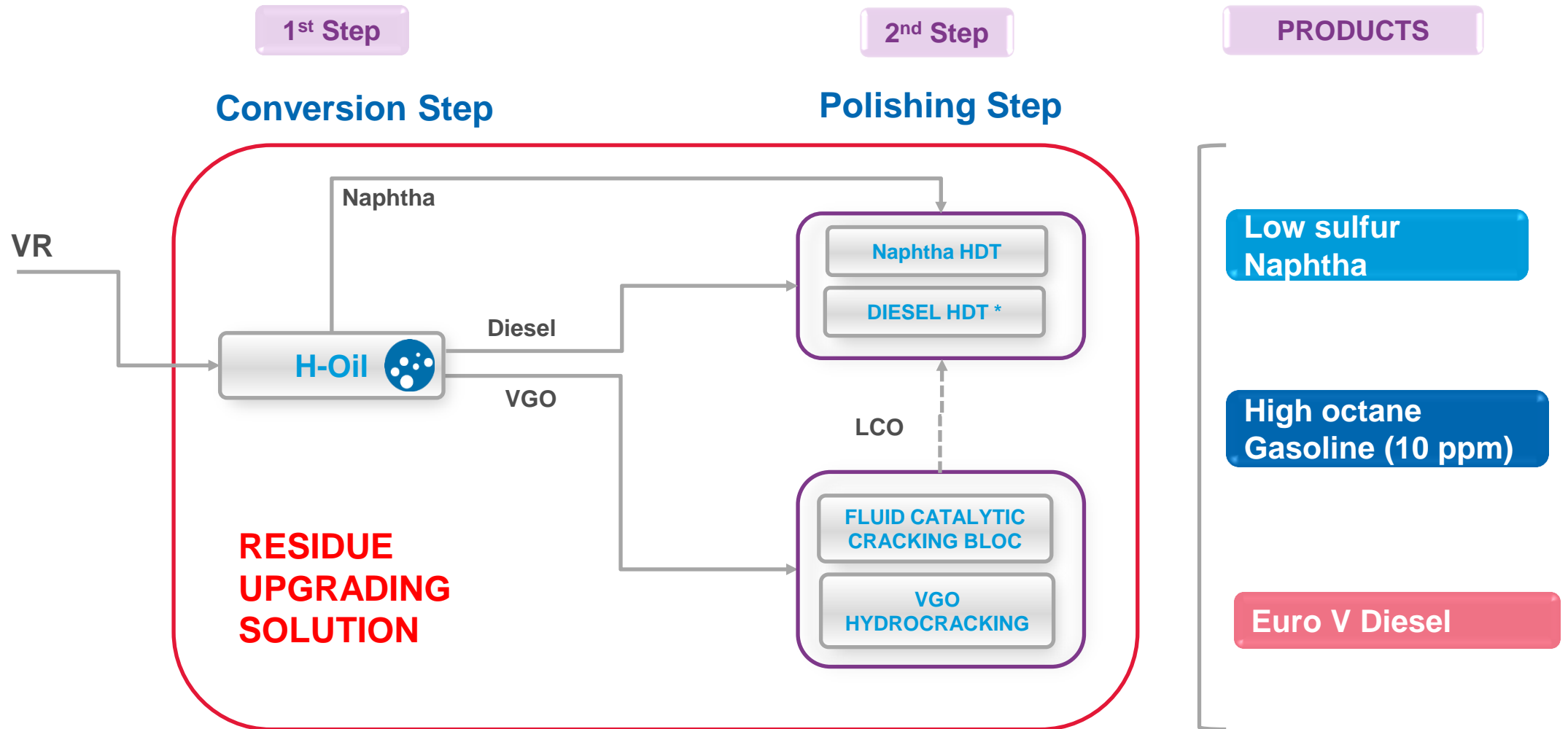
Conversion Options

Overall scheme from VR to on Spec Products



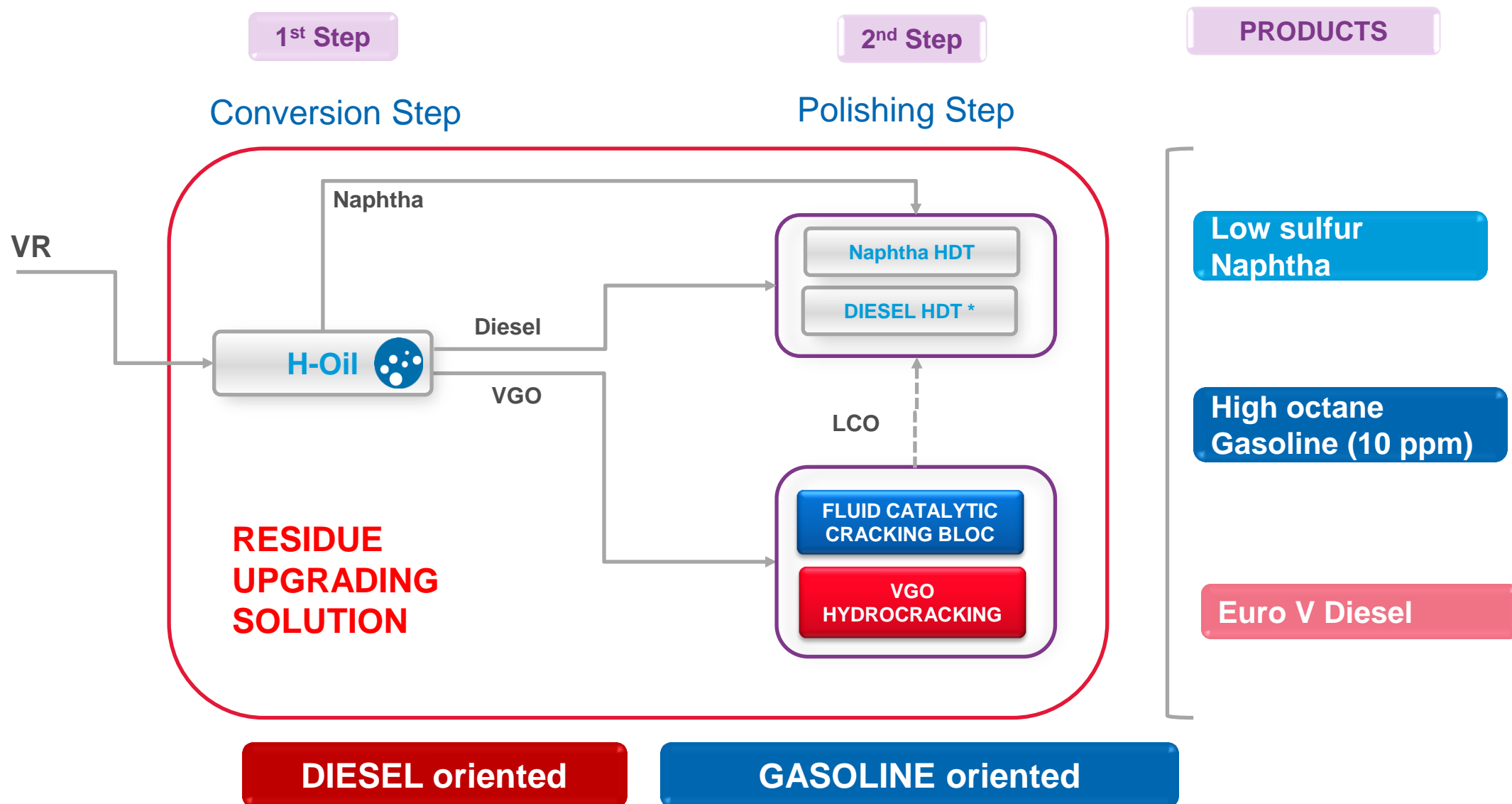
Conversion Options

Overall scheme from VR to on Spec Products



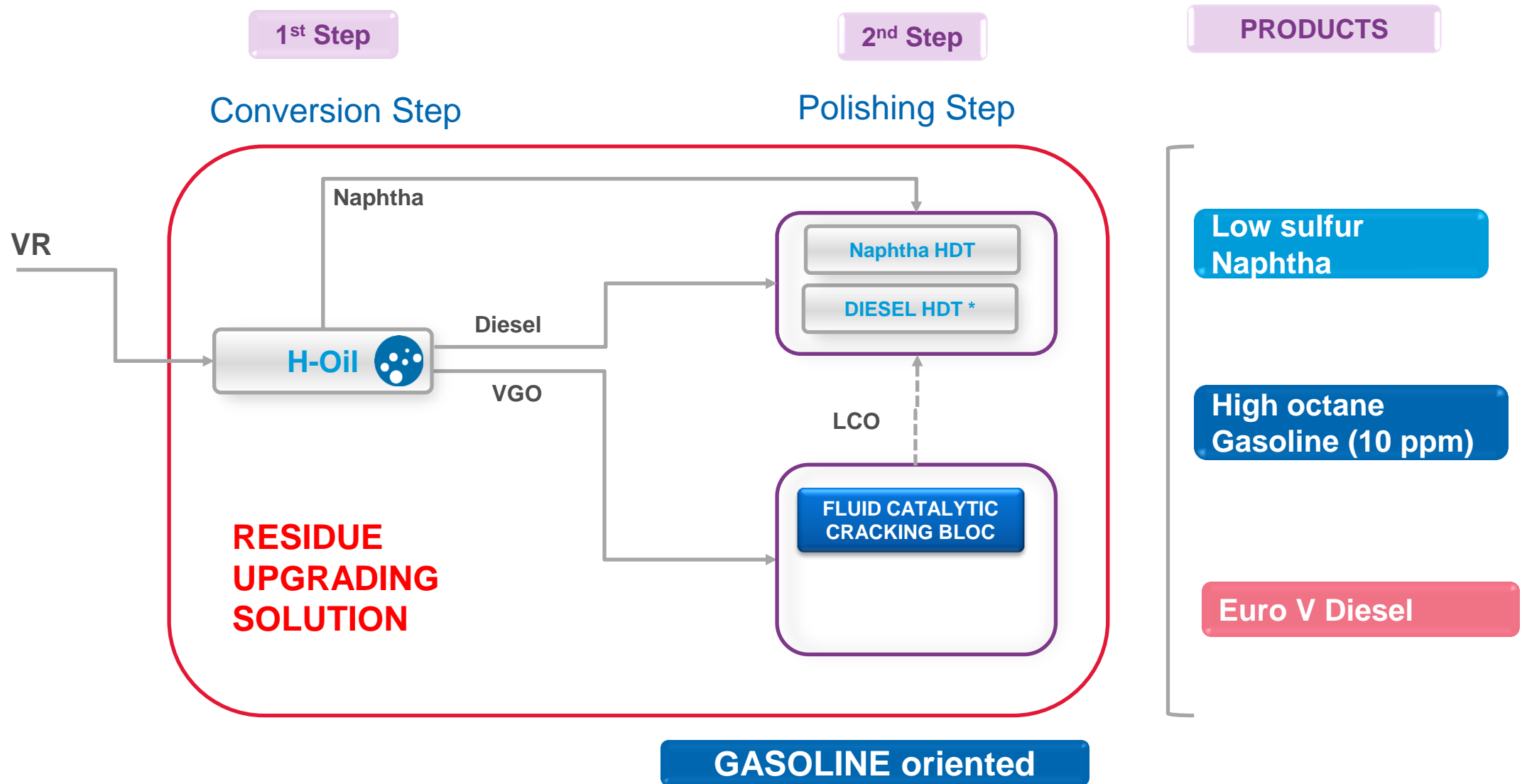
Case study : Conversion Options

Overall scheme



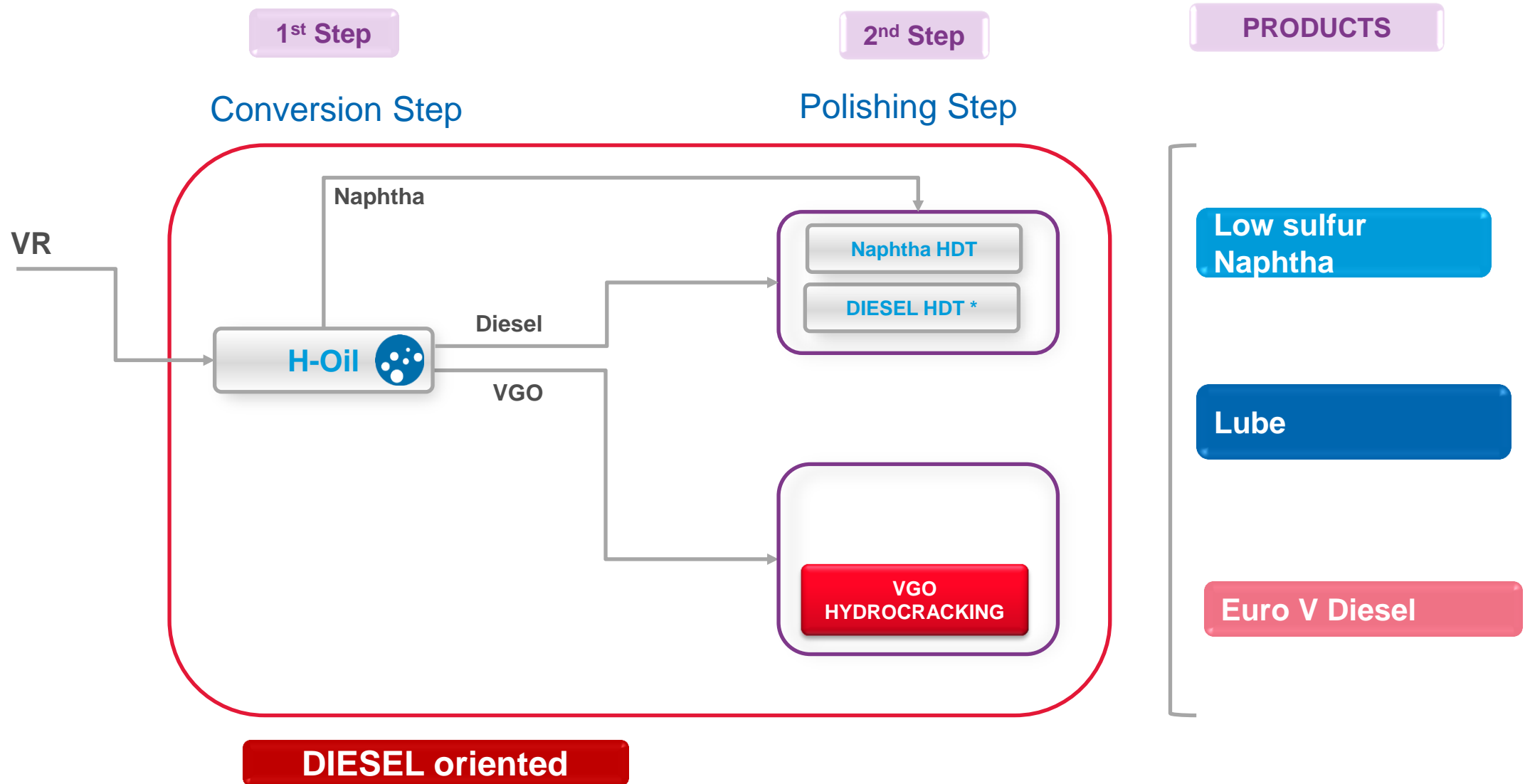
Conversion Options- Gasoline oriented

Overall scheme



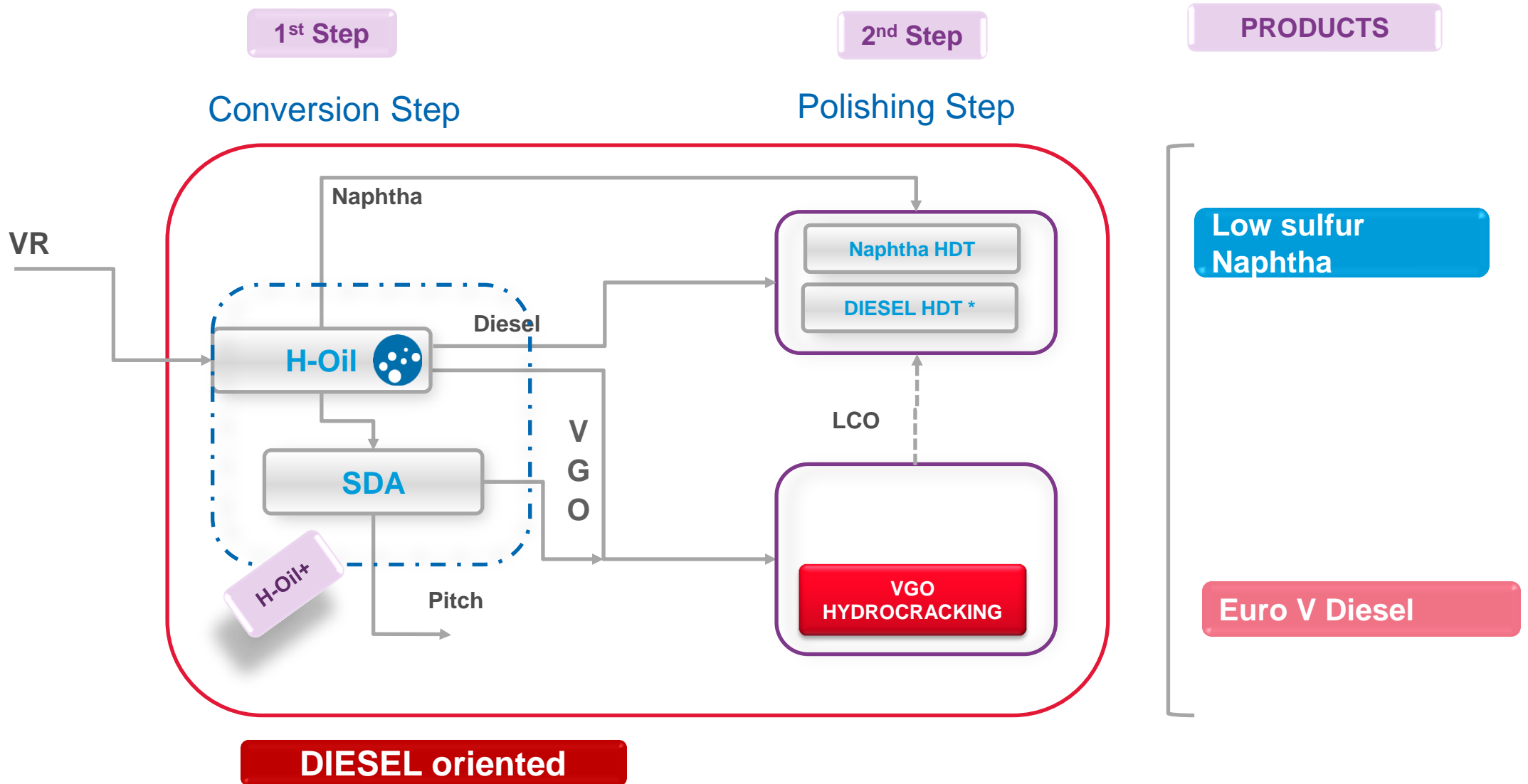
Conversion Options- Diesel oriented

Overall scheme



Conversion Options- Diesel oriented- H-Oil+

Overall scheme

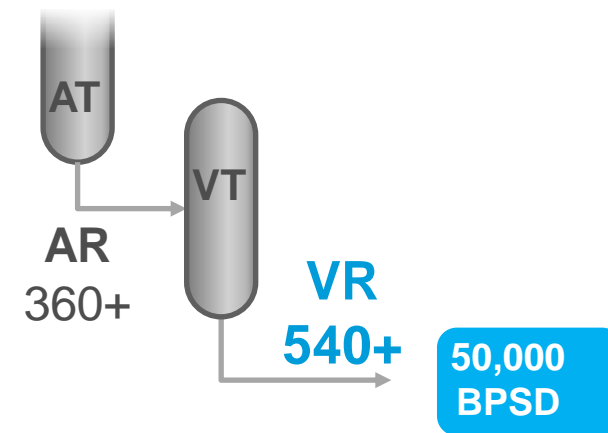


Vacuum Residue Properties

- Feed capacity: 50 000 BPSD

VR 540+ Properties	Iranian Heavy Blend
Spgr	1.066
Sulfur wt%	4.20
Nitrogen, ppmwt	6700
Ni+V, ppmwt	520
CCR, wt%	24.6
C7 asph. wt%	15

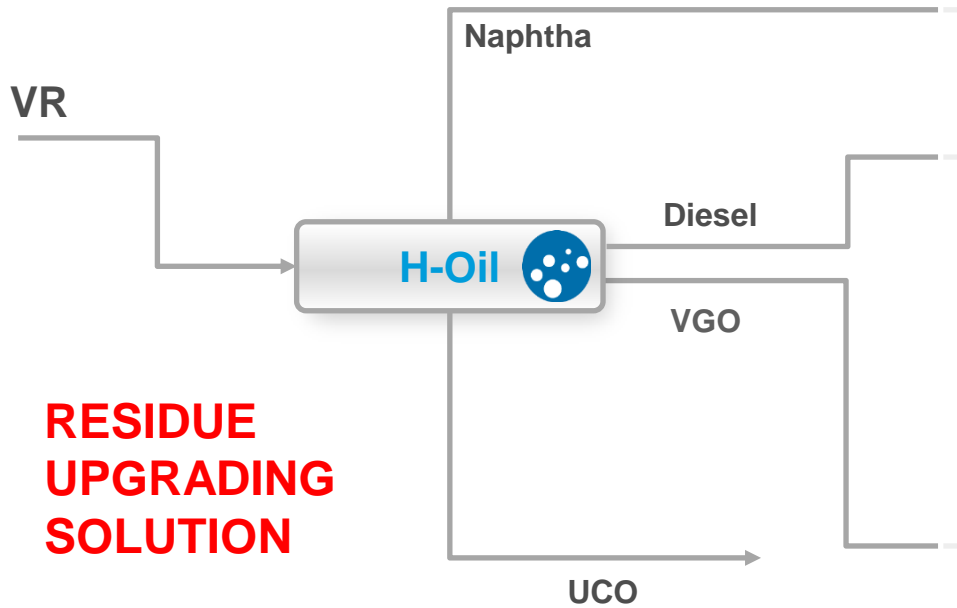
Iranian Heavy Blend



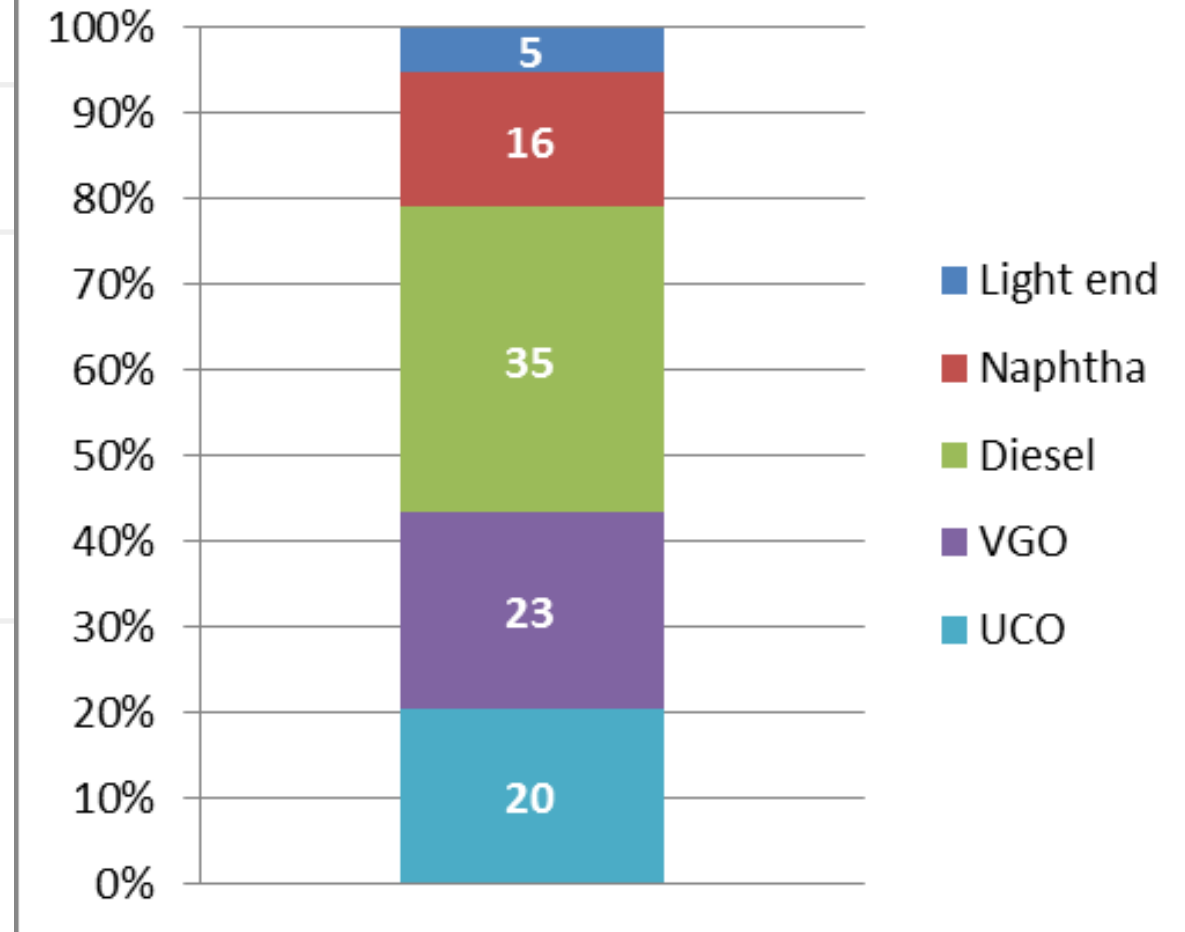
Conversion Options H-Oil Iranian Heavy Case

1st Step

Conversion Step 77 wt%

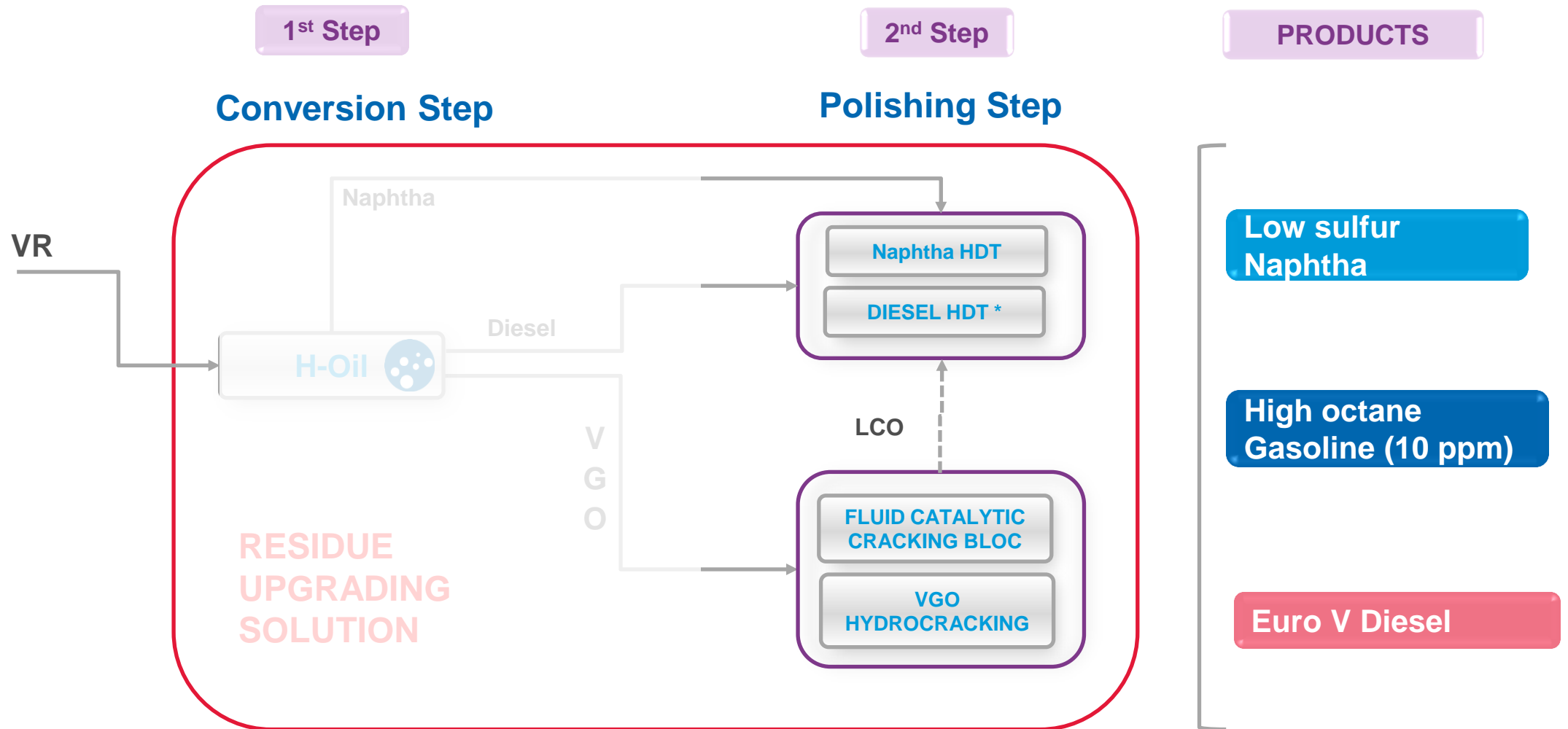


Iranian Heavy Yields

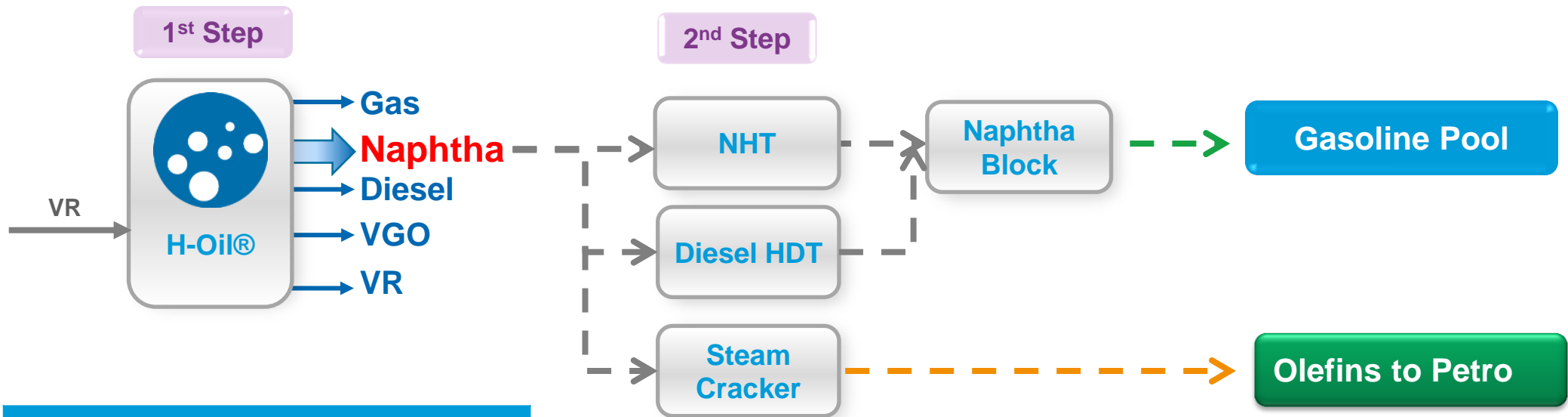


Conversion Options

Overall scheme from VR to on Spec Products



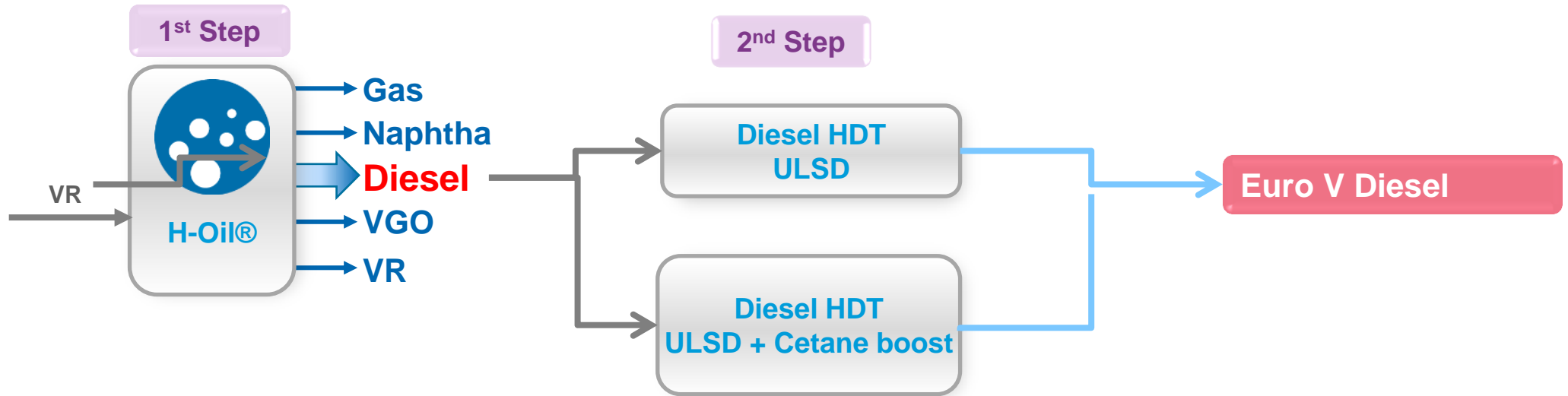
Naphtha Processing



Naphtha properties on Iranian Heavy		
Spgr		0.715
S	wt%	0.041
N	wt ppm	40
RON		48
MON		47

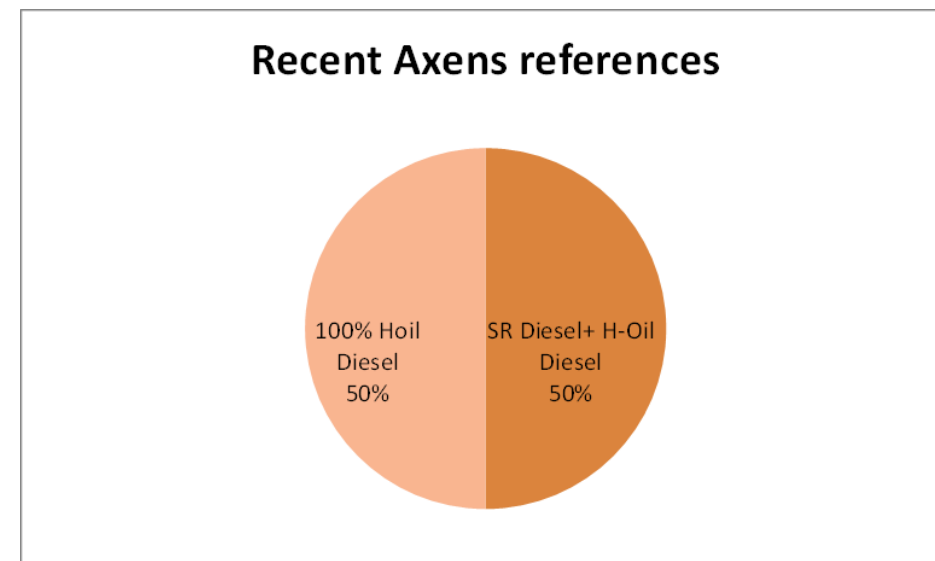
- Naphtha from H-Oil
 - High Nitrogen, after HDT, can be sent to Reforming
 - Paraffinic naphtha, RON to be increased in reforming
 - Reduced Yields in comparison with SR Naphtha:
 - › Typically, Naphtha from H-Oil < 10% of SR Naphtha

Diesel Processing

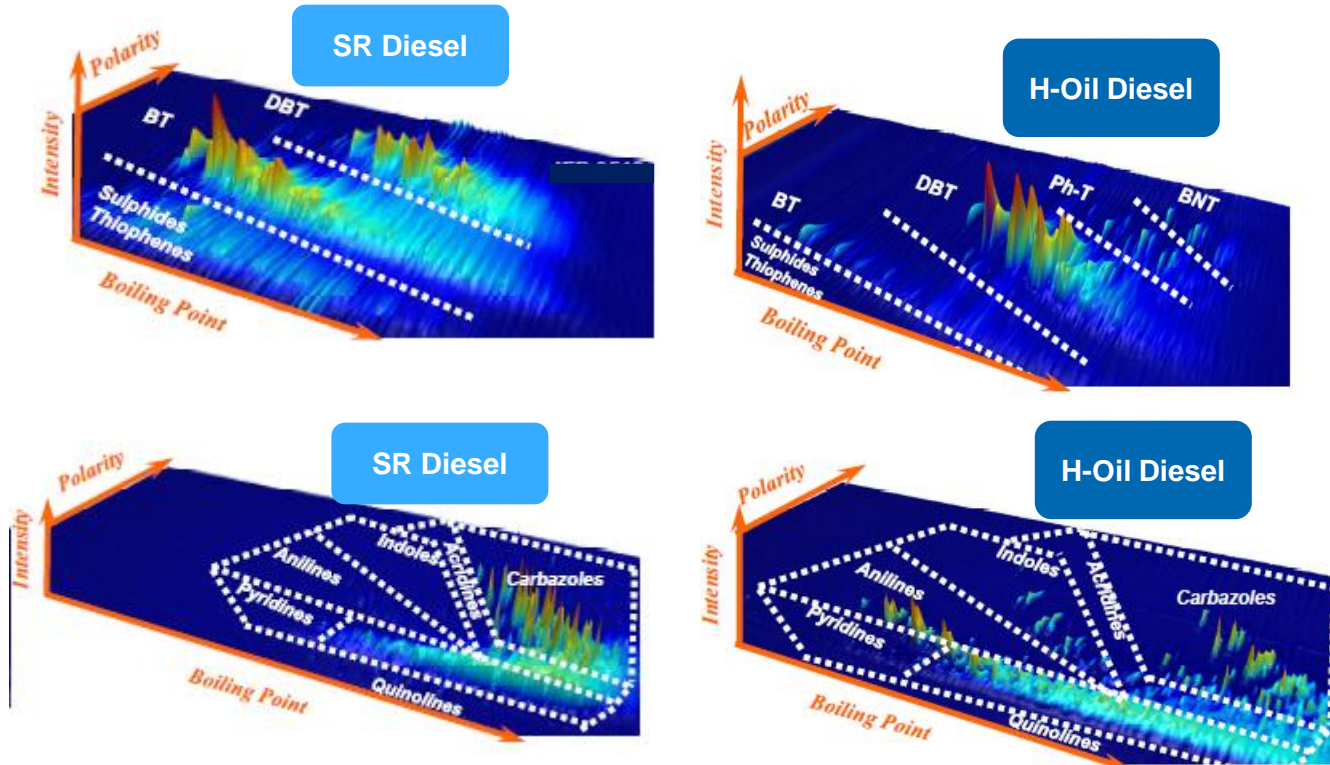


■ Diesel Properties

	Diesel From H-Oil	Euro V Spec
Sulphur, ppwt	1883	10 Max
Nitrogen, ppwt	1365	NA
Density	0.850	0.820- 0.845
Total Aromatics, %wt	35-40	No spec
Cetane Index D4737	44	46
Cetane Number D613	40-45	51



Diesel from H-Oil Analyses



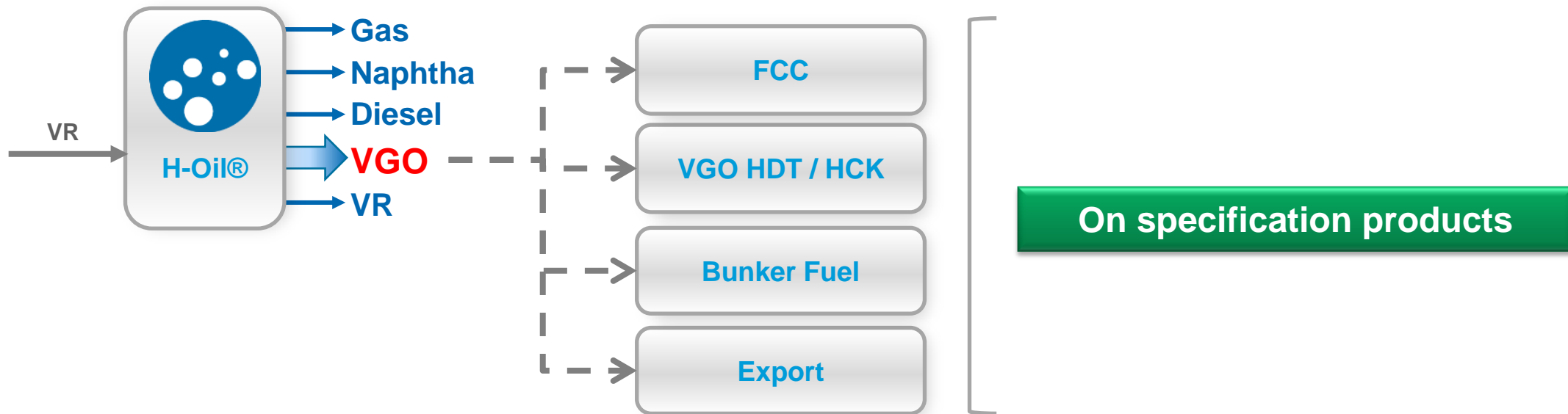
GC-2D	SR Diesel	Hoil Diesel
Sulphide/Thiophene	27%	5%
BT	54%	24%
DBT	18%	58%
Ph-T, BNT	0%	12%
Total Sulphur, ppmwt	8892	1835

Basic Nitrogen	SR Diesel	Hoil Diesel
Aniline	0%	2%
Quinoleine	27%	43%
acridine	13%	11%
Total Basic	41%	56%
Total Nitrogen, ppmwt	114	1832

■ Diesel from H-Oil

- Refractive Sulfur,
- High Basic Nitrogen (HDS/ HDA inhibitor)
- Heavy feed : high proportion of Mono Aromatics and Condensed Aromatics

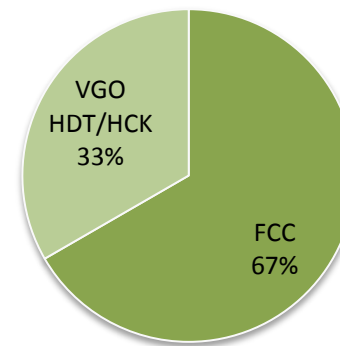
VGO Processing



■ VGO from H-Oil

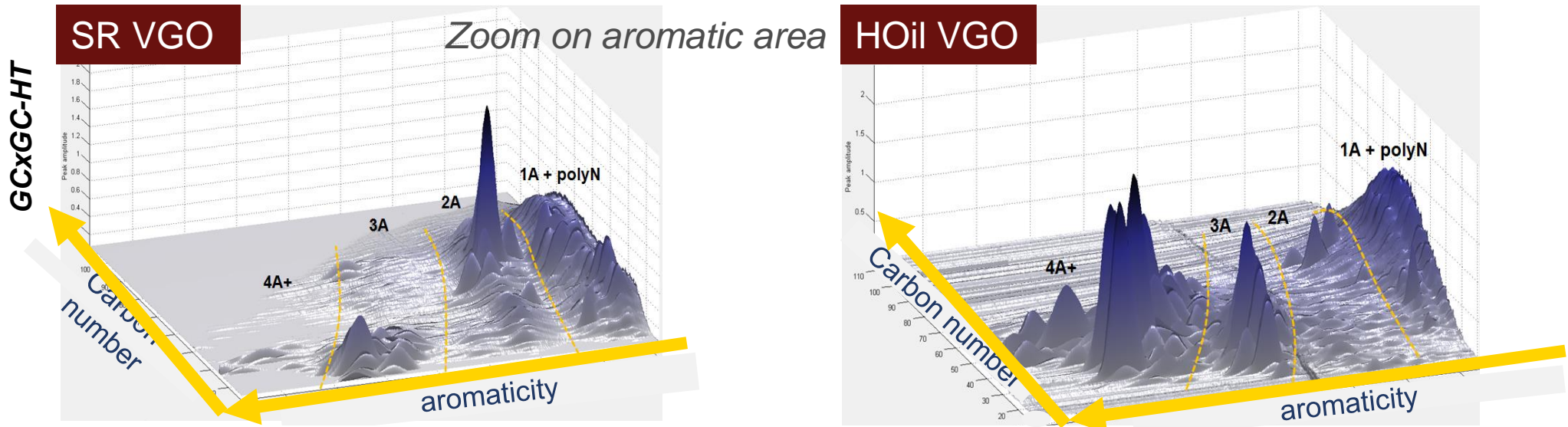
Typical Values	VGO from H-Oil
Sulphur, %wt	1.09
Nitrogen, ppwt	7200
Metals, Ni+V, ppwt	<1
Hydrogen, %wt	11.4 - 12.2

All Axens references VGO Processing

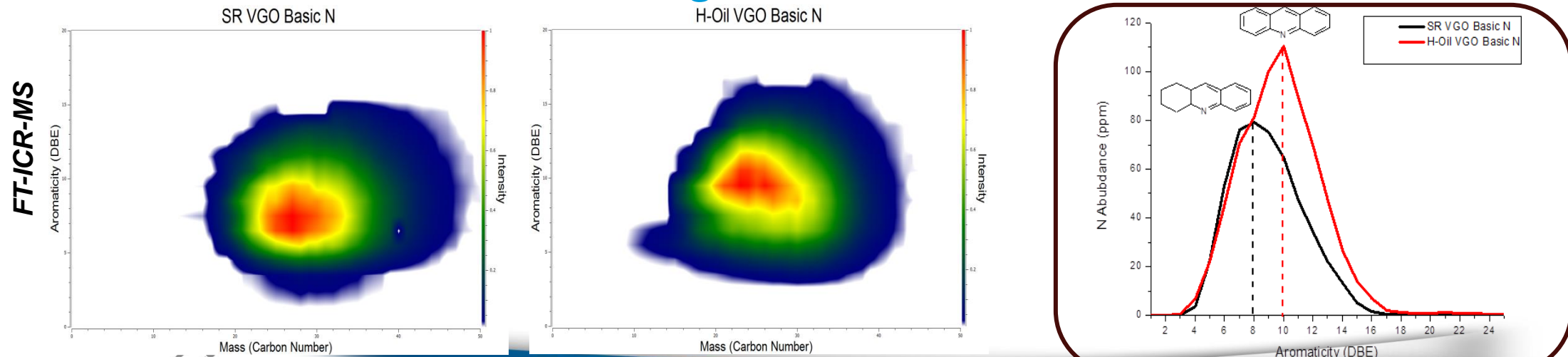


VGO Feed Characterization

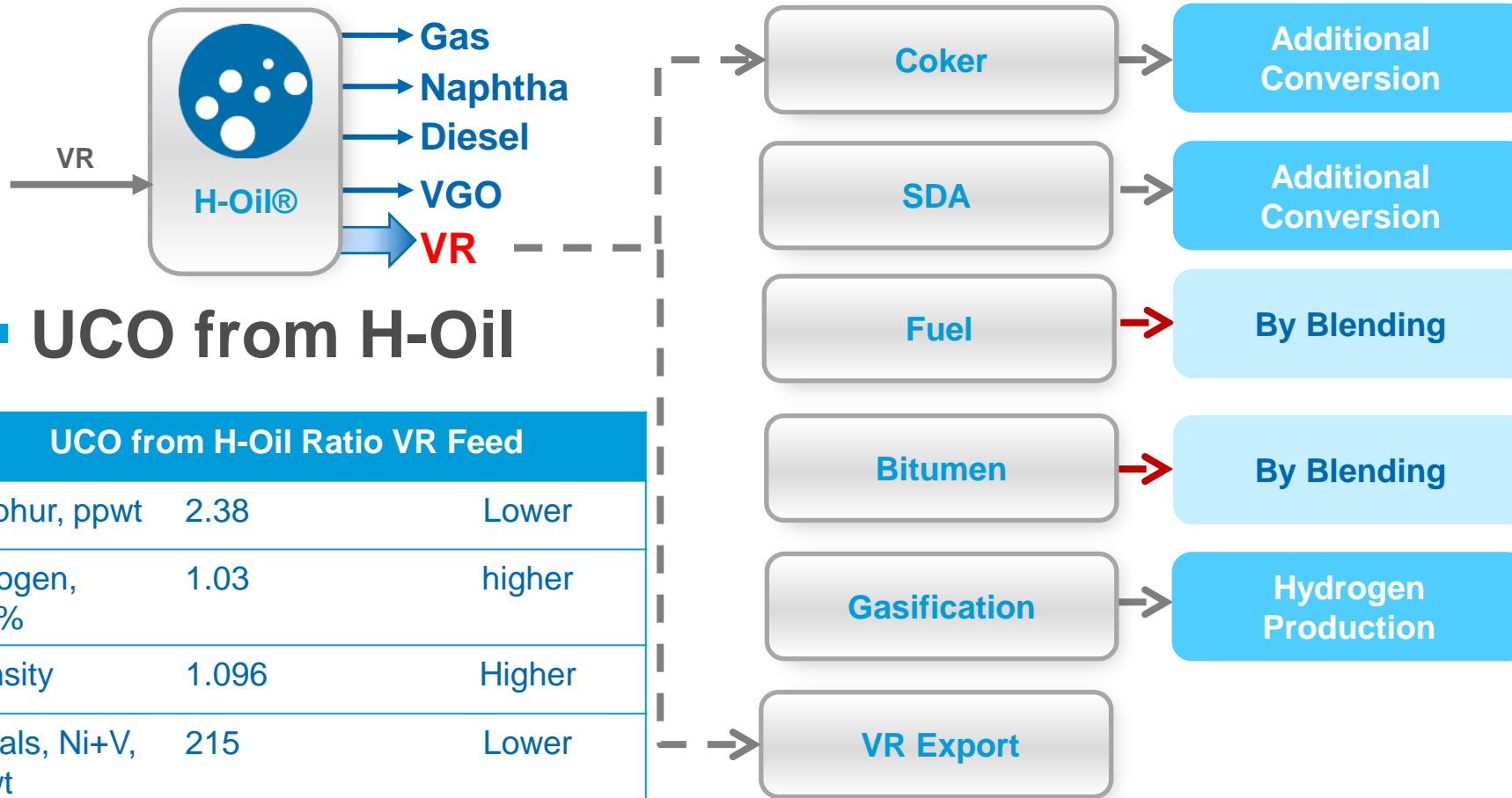
➔ *More polyaromatics in H-Oil feed*



➔ *More aromatic basic nitrogen molecules in H-Oil feed*



UCO Processing

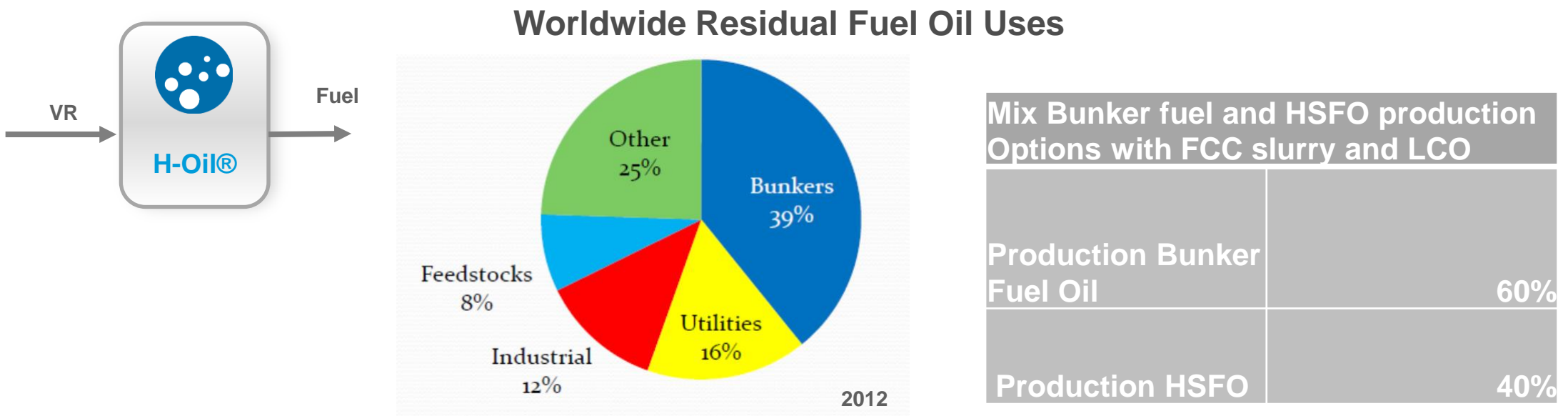


■ UCO from H-Oil

UCO from H-Oil Ratio VR Feed

Sulphur, ppwt	2.38	Lower
Nitrogen, wt %	1.03	higher
Density	1.096	Higher
Metals, Ni+V, ppwt	215	Lower
CCR, %wt	39	Higher

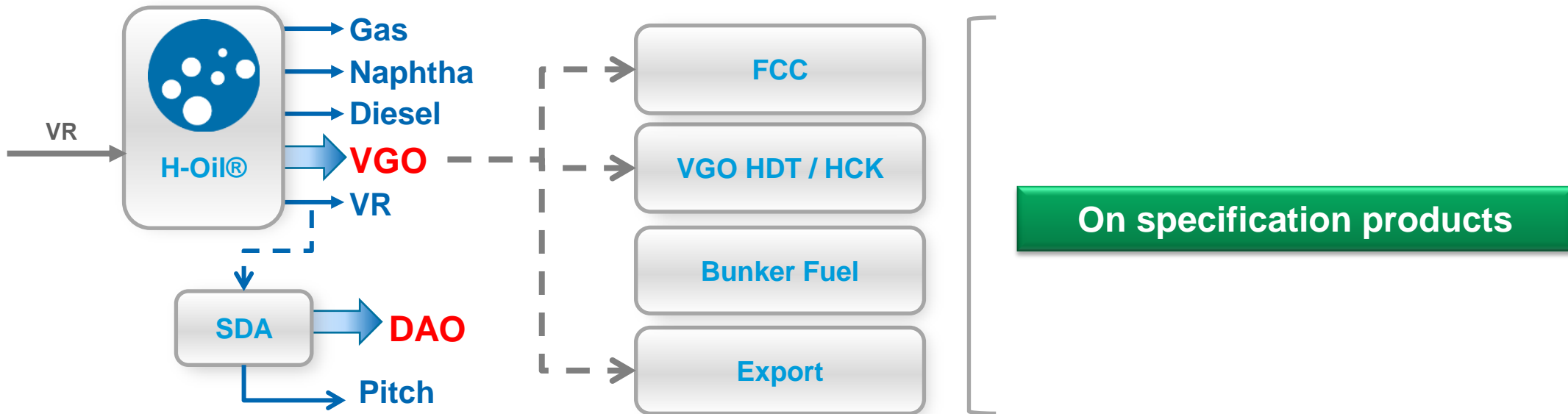
UCO Processing – Fuel Oil



- Large panel of specification for Bunker Fuel or Fuel Oil
 - Sulphur
 - Density
 - Viscosity at 50C
 - Sediment / Stability

Thanks to FCC Slurry, LCO dilution, UCO is compliant with Fuel Market

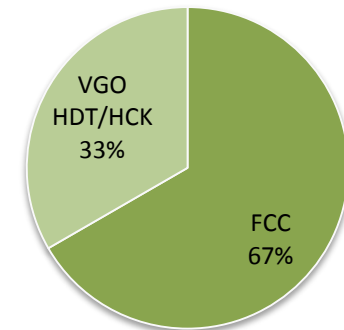
UCO Processing Through SDA



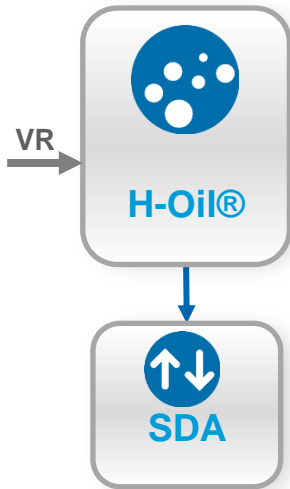
■ VGO from H-Oil and DAO from SDA

Typical Values	VGO from H-Oil	DAO from H-Oil + SDA
Sulphur, %wt	1.09	0.8 – 1.7
Nitrogen, ppwt	7200	1,600 -3,000
Metals, Ni+V, ppwt	<1	C4 Solvent <3.5
Hydrogen, %wt	11.4 - 12.2	11.0 – 12.4

All Axens references
VGO Processing



UCO / Pitch As Bitumen



VR quality depends on:

- Crude origin
- H-Oil conversion
- Operation SDA

Main Bitumen Specification – European Market

Property	Unit	Test method	20/30	35/50	50/70	70/100	100/150	160/220
Penetration at 25°C	0,1 mm	PN-EN 1426	20-30	35-50	50-70	70-100	100-150	160-220
Softening point R&B	°C	PN-EN 1427	55-63	50-58	46-54	43-51	39-47	35-43
Flash point	°C	PN-EN ISO 2592	≥ 240	≥ 240	≥ 230	≥ 230	≥ 230	≥ 220
Retained penetration after hardening	%	PN-EN 1426	≥ 55	≥ 53	≥ 50	≥ 46	≥ 43	≥ 37
Change of mass after hardening ^a	% m/m	PN-EN 12807-1	≤ 0,5	≤ 0,5	≤ 0,5	≤ 0,8	≤ 0,8	≤ 1,0
Increase of softening point R&B after hardening- Severity 1 or Increase of softening point R&B after hardening- Severity 2 ^a	°C	PN-EN 1427	≤ 8 or < 10	≤ 8 or < 11	≤ 9 or < 11	≤ 9 or < 11	≤ 10 or < 12	≤ 11 or < 12

Wide range for Bitumen Specifications
+ local specifications

Example of Bitumen quality	Crude 1	Arabian / US	Canadian Heavy Crude
VR From H-Oil	Yes	Yes	Yes in blend
VR from H-Oil + SDA pitch	Yes	No	NA
After blowing treatment	Yes	yes	NA

UCO to Bitumen has been validated without dilution requirement
Bitumen could be an alternate destination to increase refinery margins

UCO/Pitch to Boiler

- **Conventional Boilers for Steam Production**
 - Limited by Feed viscosity max 40cst @ 100°C

- **Mitsubishi technology solution**
 - Pulverised Fire Boiler operating at high temperature
 - Steam Production and / or Electrical Power
 - Advantages :
 - › Fouling Resistant
 - › Technology proven on similar services (SDA Pitch)

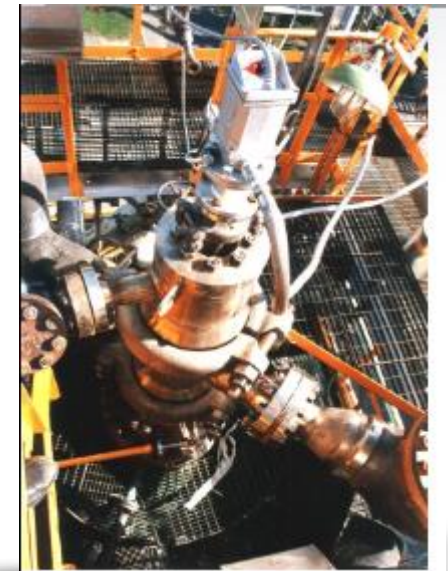
UCO/Pitch to Gasification

- **Two options:**
 - **Solid Feed**
 - slurry of pitch + water sent to gasification
 - requires intermediate granulation
 - **Liquid Feed**
 - on-line pitch or UCO product sent to gasification unit*
 - No issue for pelletisation, storage and transportation*
 - Preferred option*

- **In both cases, several schemes possible**
 - **Co-production of CO+H₂ and steam**
 - **Production of electricity (IGCC): Gasification + gas turbine + steam turbine**

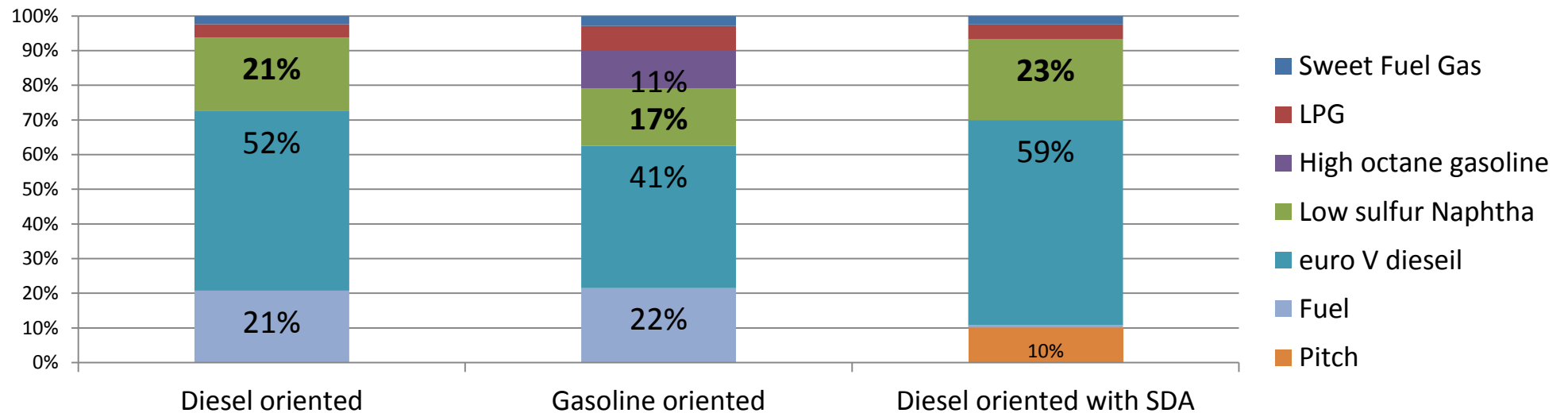
UCO/Pitch to Gasification

- **Gasification of UCO From H-Oil / pitch directly from the SDA**
- **MPG technology from Lurgi is the most suitable one for oil-base streams.**
 - **No limitations on Flash Point of Feedstock**
 - **Viscosity up to 300 cst**
 - **Long burner life time result in higher reliability and availability of plant**



Final Product Slates

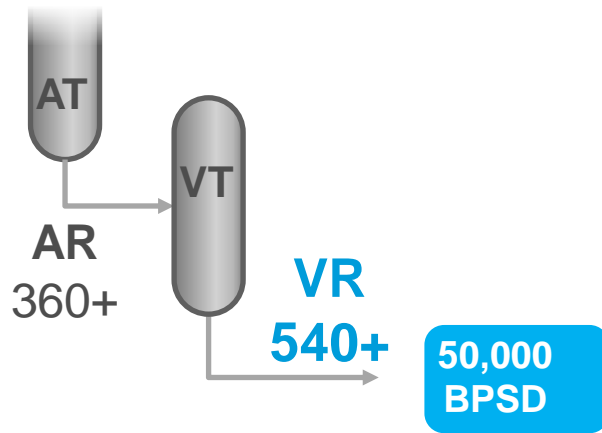
Product Slates on VR from Iranian Heavy



Conversion Options

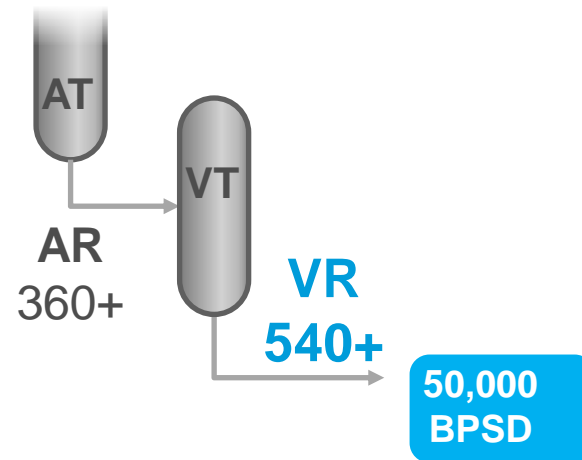
Feeds description

Iranian Light crude



Light Iranian	VR 555+
Sulfur wt%	4.12
Nitrogen, ppmwt	2600
Ni+V, ppmwt	92
CCR, wt%	23.7
C7 asph. wt%	6.4

Iranian Heavy crude

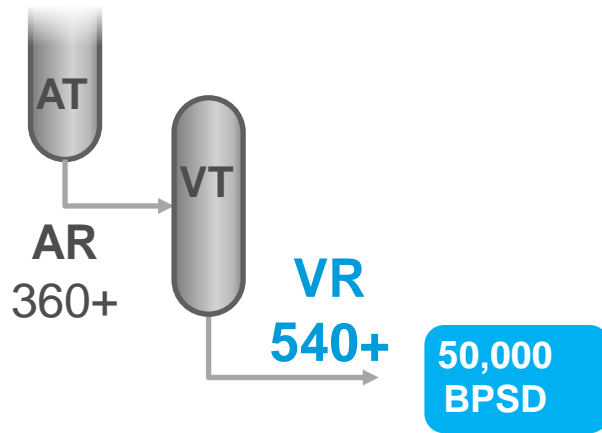


Heavy Iranian	VR 540+
Sulfur wt%	4.2
Nitrogen	6700
Ni+V	520
CCR	24
C7 asph. wt%	15

Conversion Options

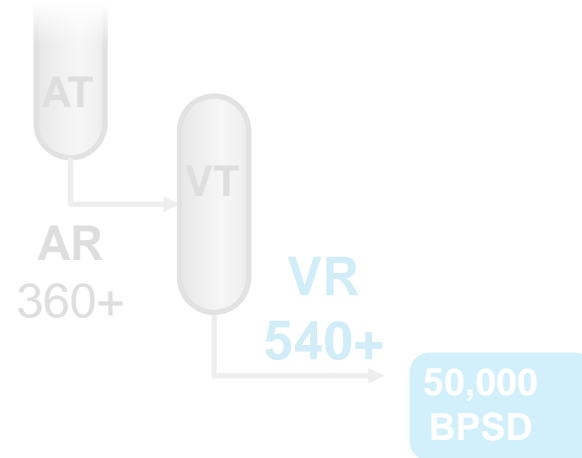
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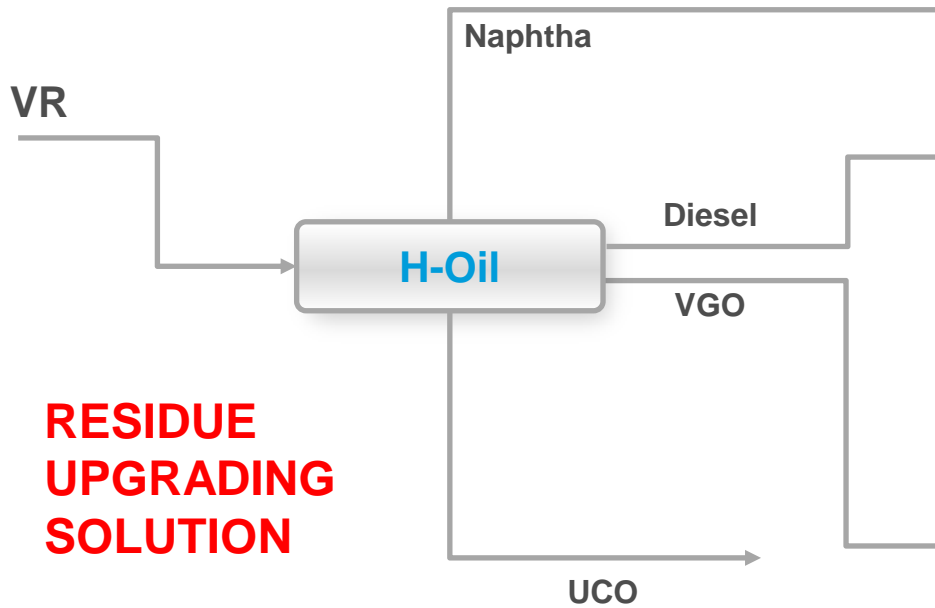
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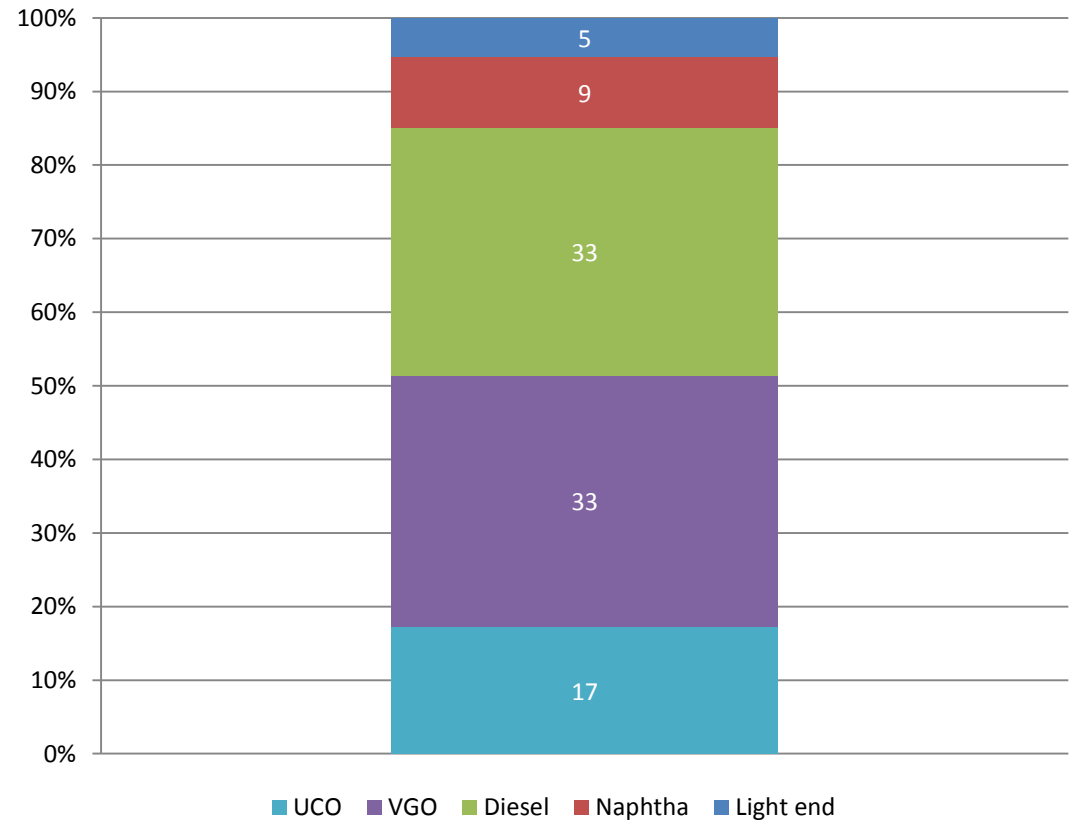
H-Yields on Iranian Light VR

1st Step

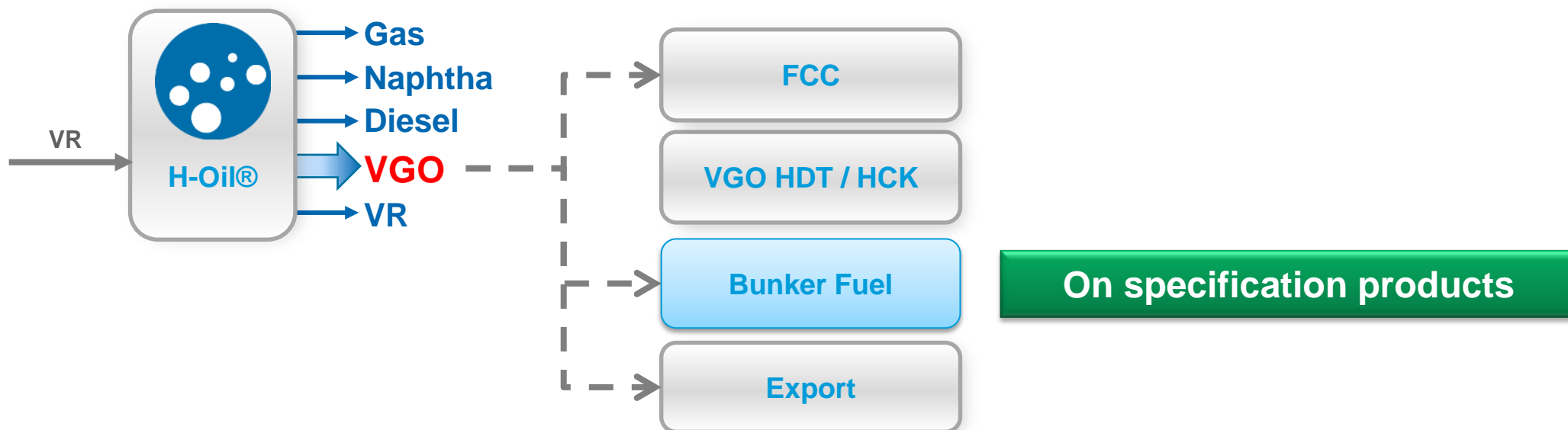
Conversion Step : 80% wt



Wt % Yields



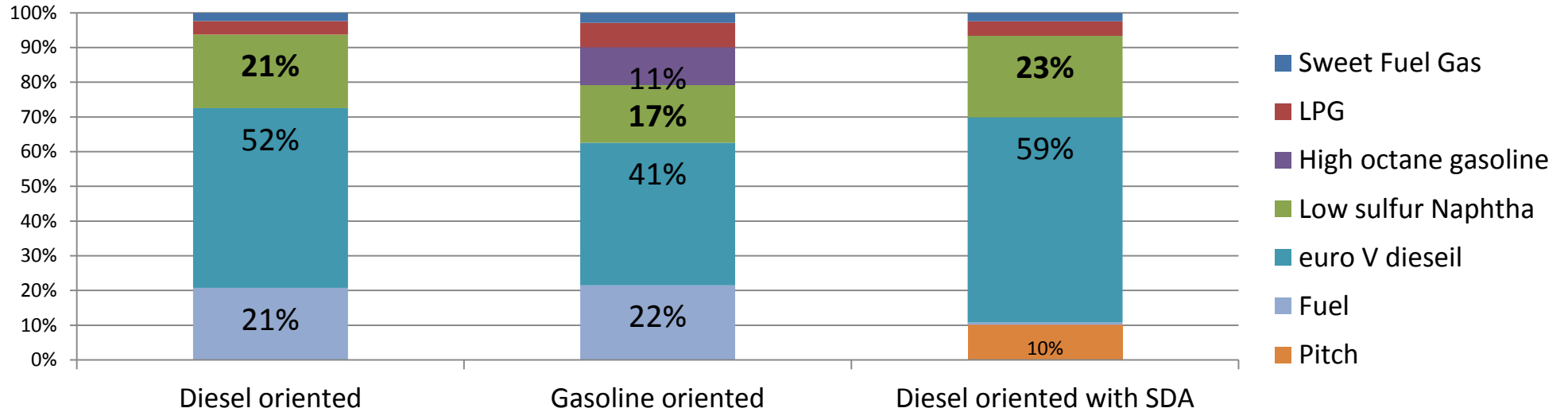
VGO Processing



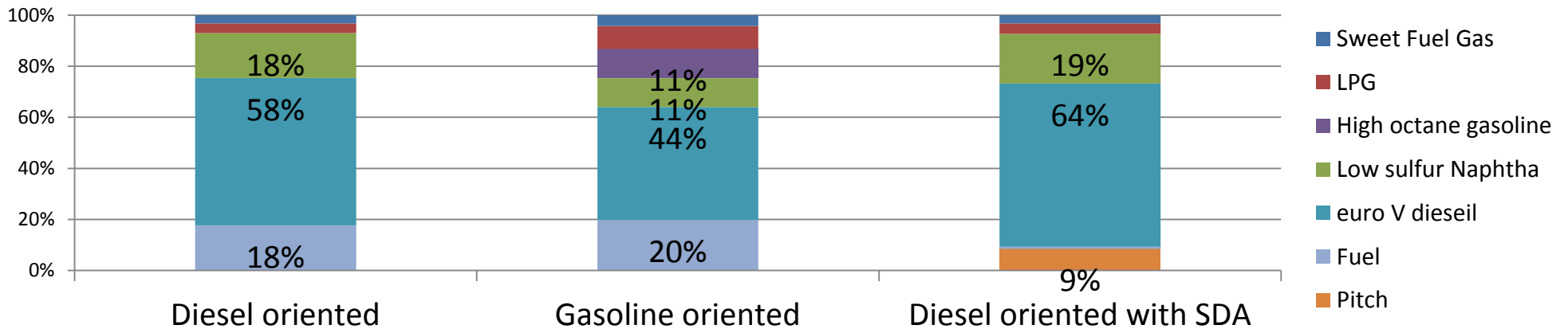
Typical Values	VGO from H-Oil
Sulphur, %wt	0.45
Nitrogen, ppwt	1529
Metals, Ni+V, ppwt	<1
Hydrogen, %wt	11.4 - 12.2

Final Product Slates comparison

Product Slates On VR from Iranian Heavy



Product Slates On VR from Iranian Light



Conclusion

- H-Oil[®] is part of whole conversion scheme and each solution is unique and taylor made for a refiner
- Axens is a unique licensor with all the technology to provide the most competitive scheme for refinery market demand
- H-Oil technology permits :
 - To lower your fuel oil production
 - Reach high conversion with most competitive economics

Thank you! And see you on Axens' Blog axens.net/blog

