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Fuel Oil Upgrading Schemes

Economics and Project Development

5th December 2017 | 2017 Bottom of the Barrel Iranian Conference Tehran, Iran

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Agenda

1. Overview of Case Studies

2. Summary of Refinery Upgrade Economics

3. Project Development

Key Economic Drivers

BOB Upgrading

- Product Price Differentials
  - Transport fuels v Fuel Oil
  - Euro V v Local Prices
  - Diesel v Gasoline
  - Gasoline v Propylene
  - BTX v Gasoline
- Capital Cost
  - Local Factors
  - Plot Congestion
- Cost of Finance
- Specifications
  - Euro V for Gasoline, Diesel
  - Fuel Oil / Pitch

New Refinery

- Crude oil price / availability
  - Crude quality
- Crude v product differential
- Demands, Specifications
  - Euro V for Gasoline, Diesel
  - Fuel Oil / Pitch
- Capital Cost
  - Local Factors
  - OSBL v ISBL
- Cost of Finance

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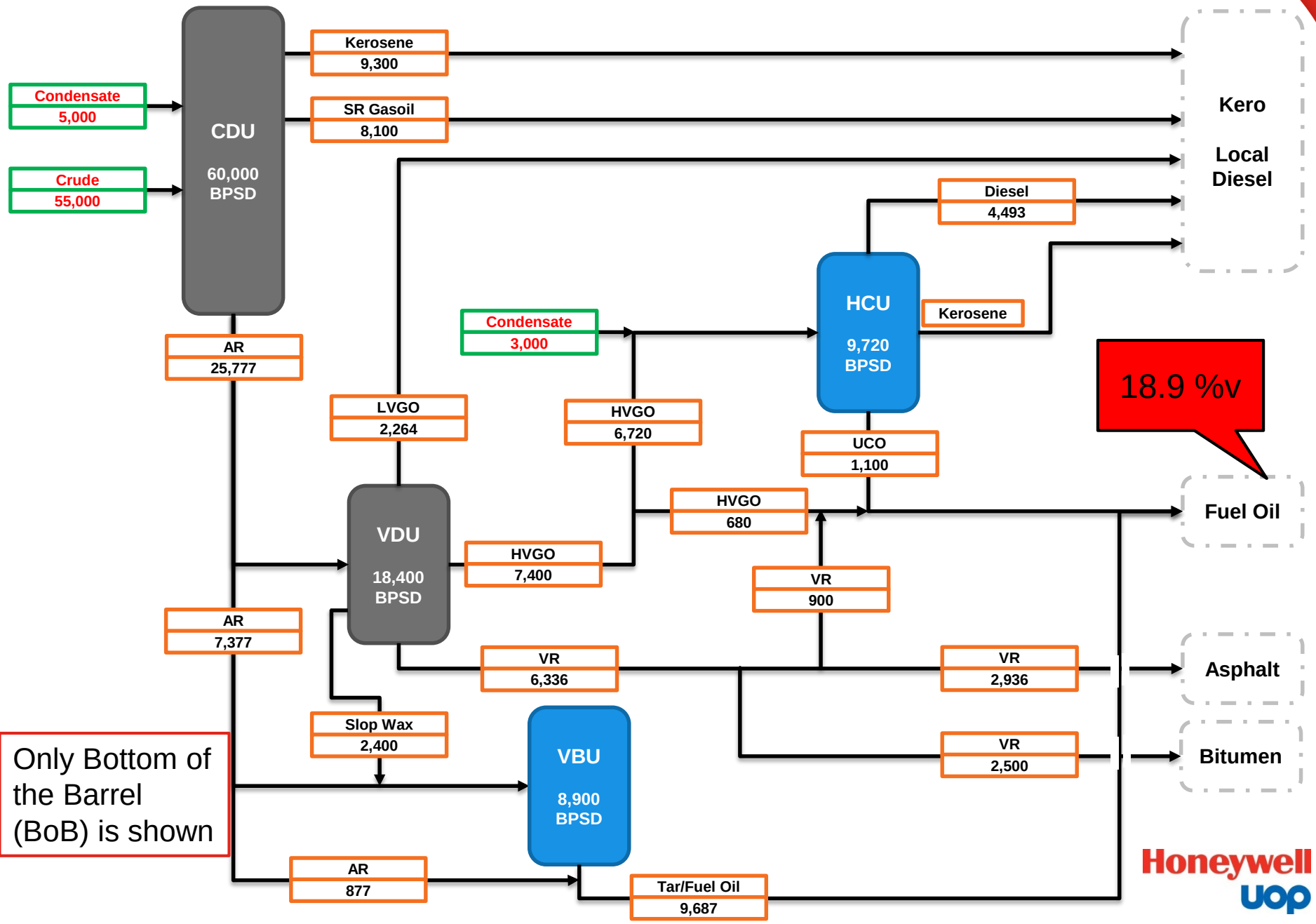
Current Refinery Configuration



Only Bottom of the Barrel (BoB) is shown

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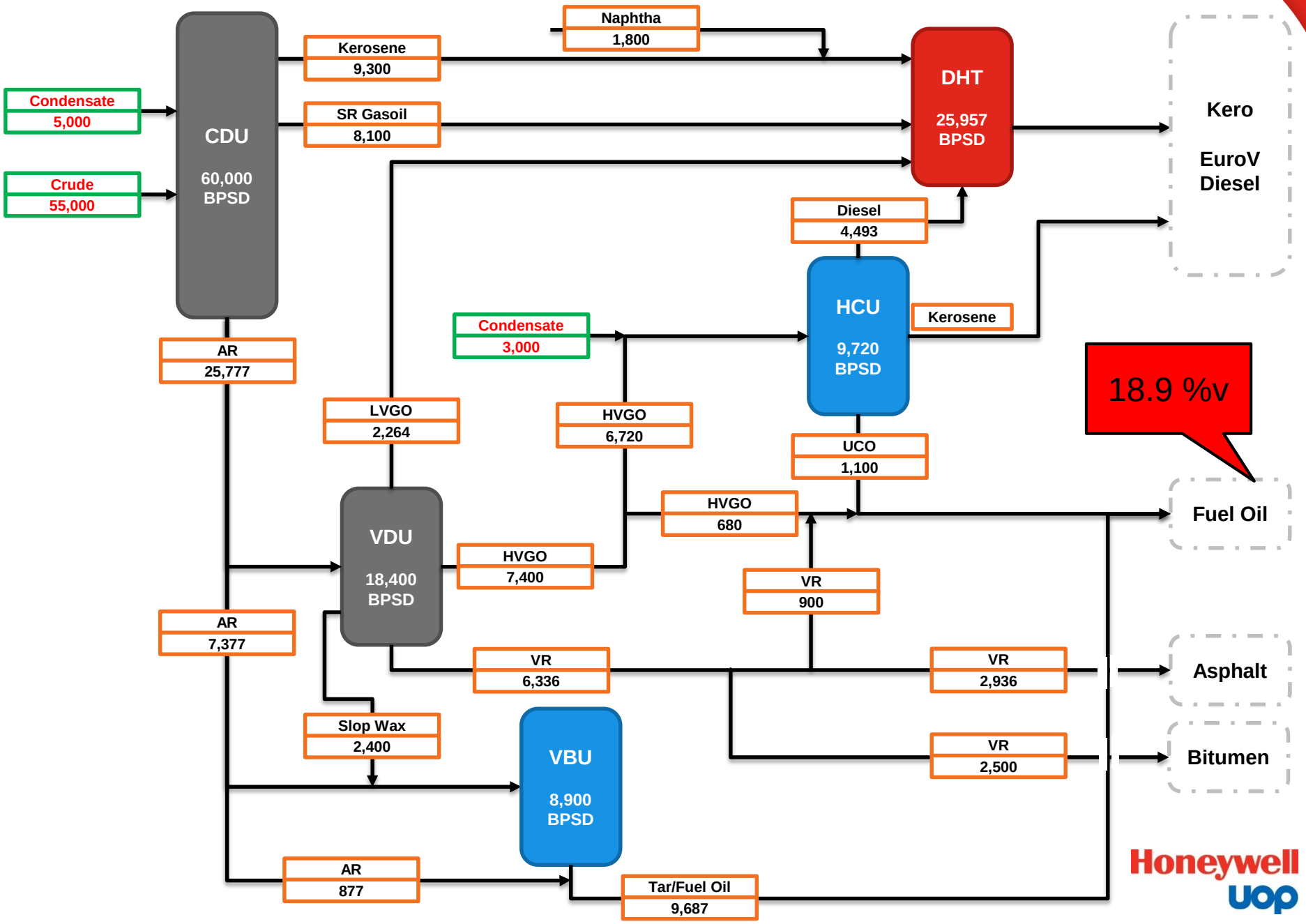
Step 1: Moving to Euro-V Diesel



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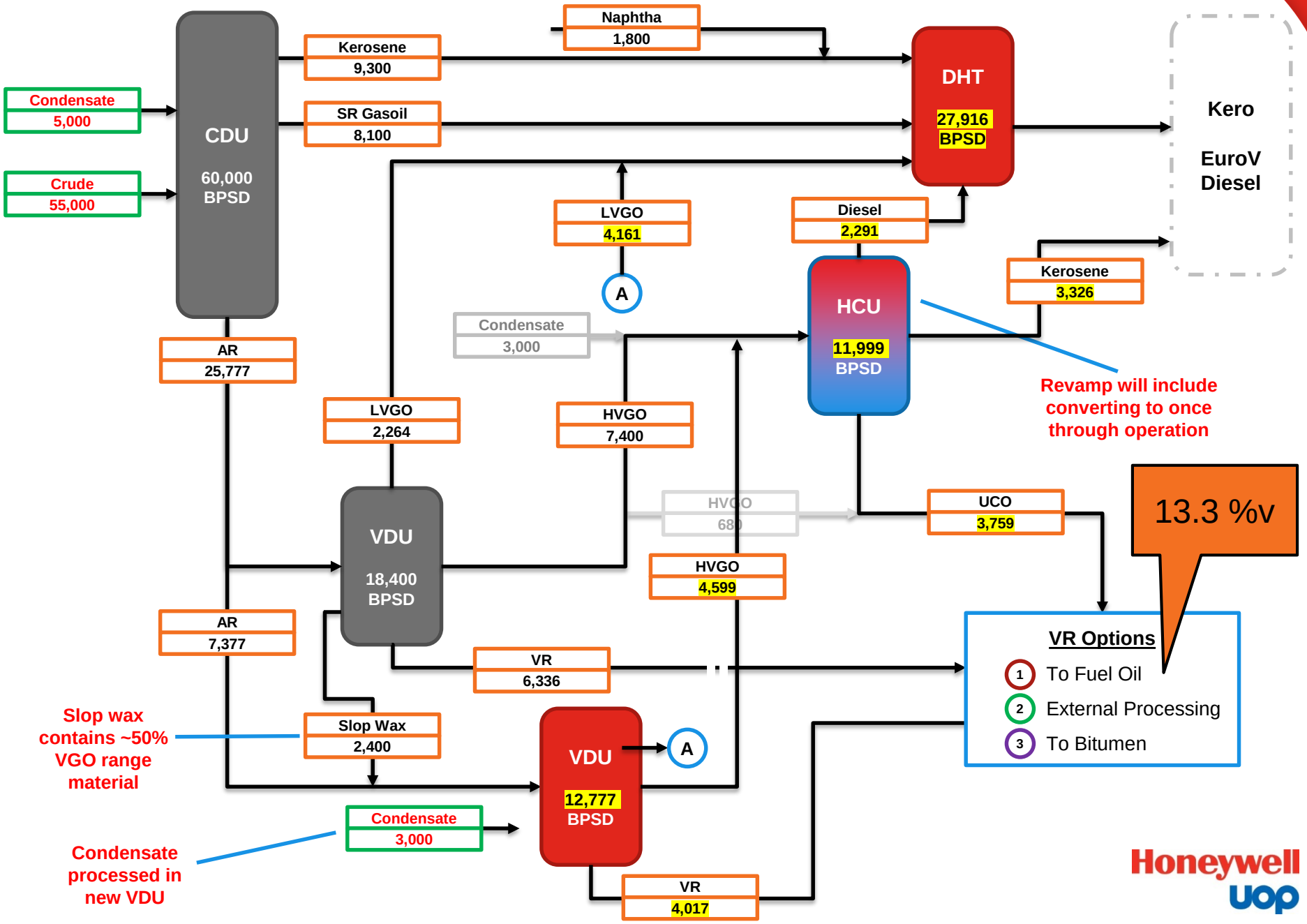
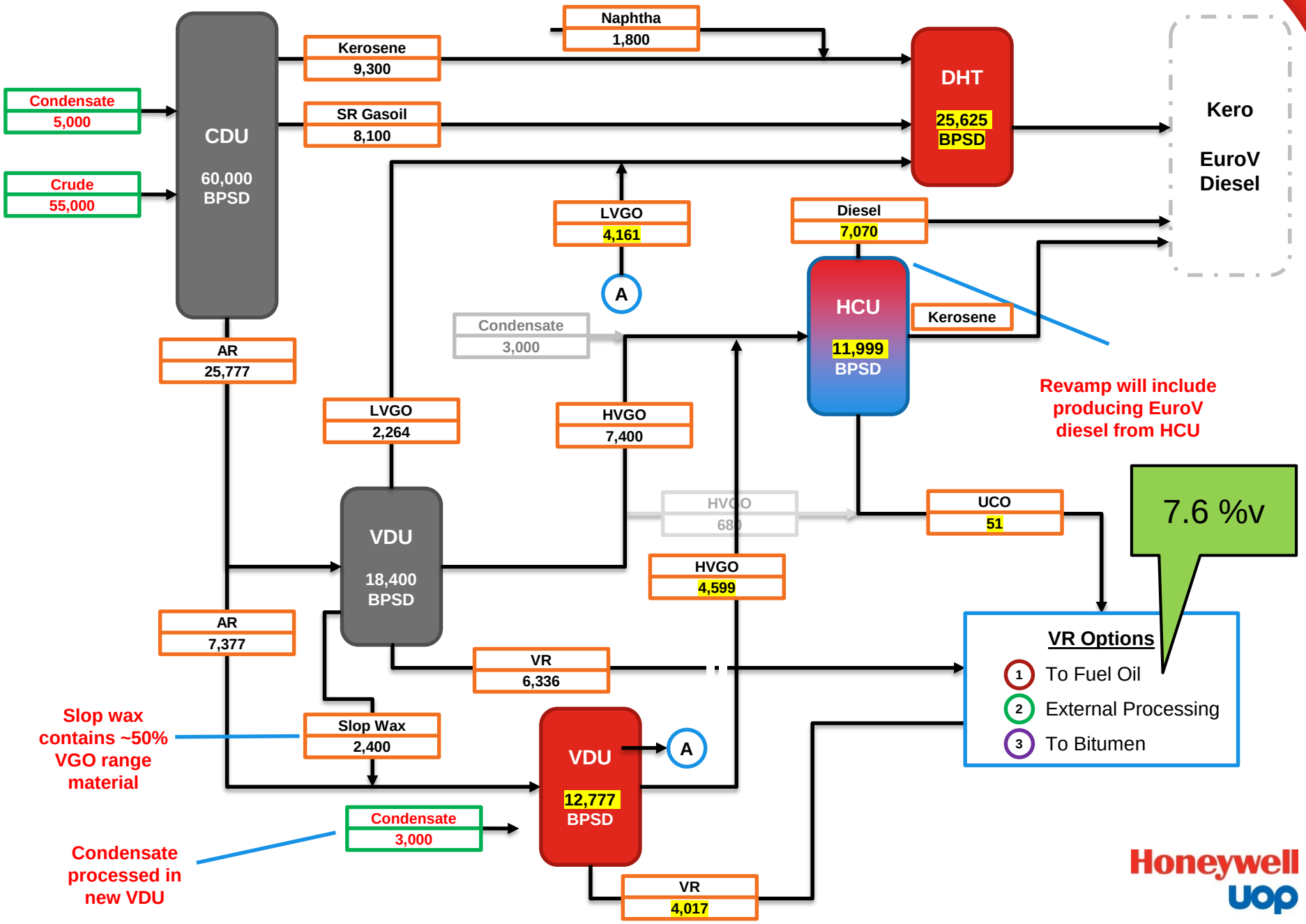
Step 2: Add VDU (HCU in once through mode)



Step 3: Add HCU 1st Stage for High Conversion



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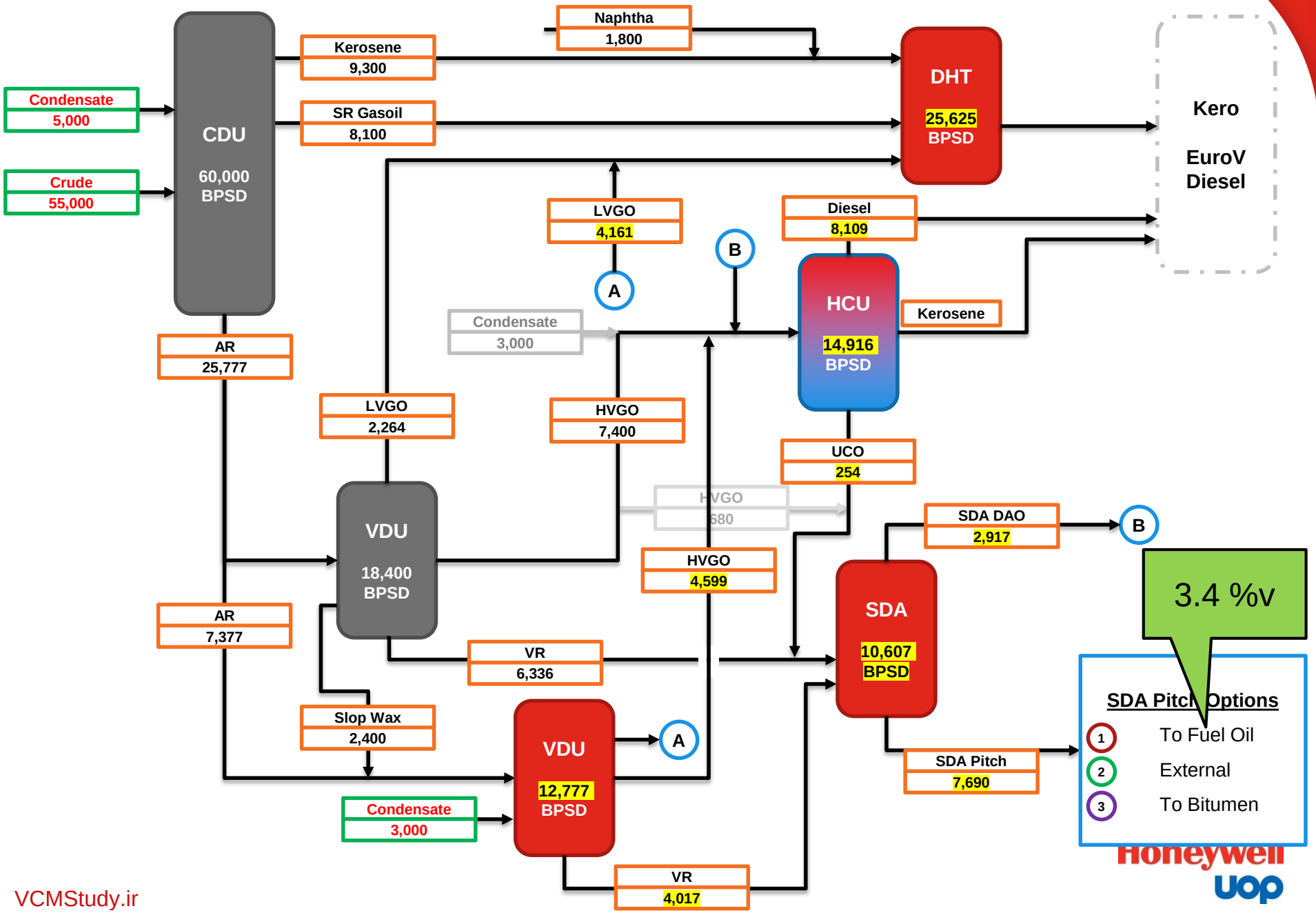
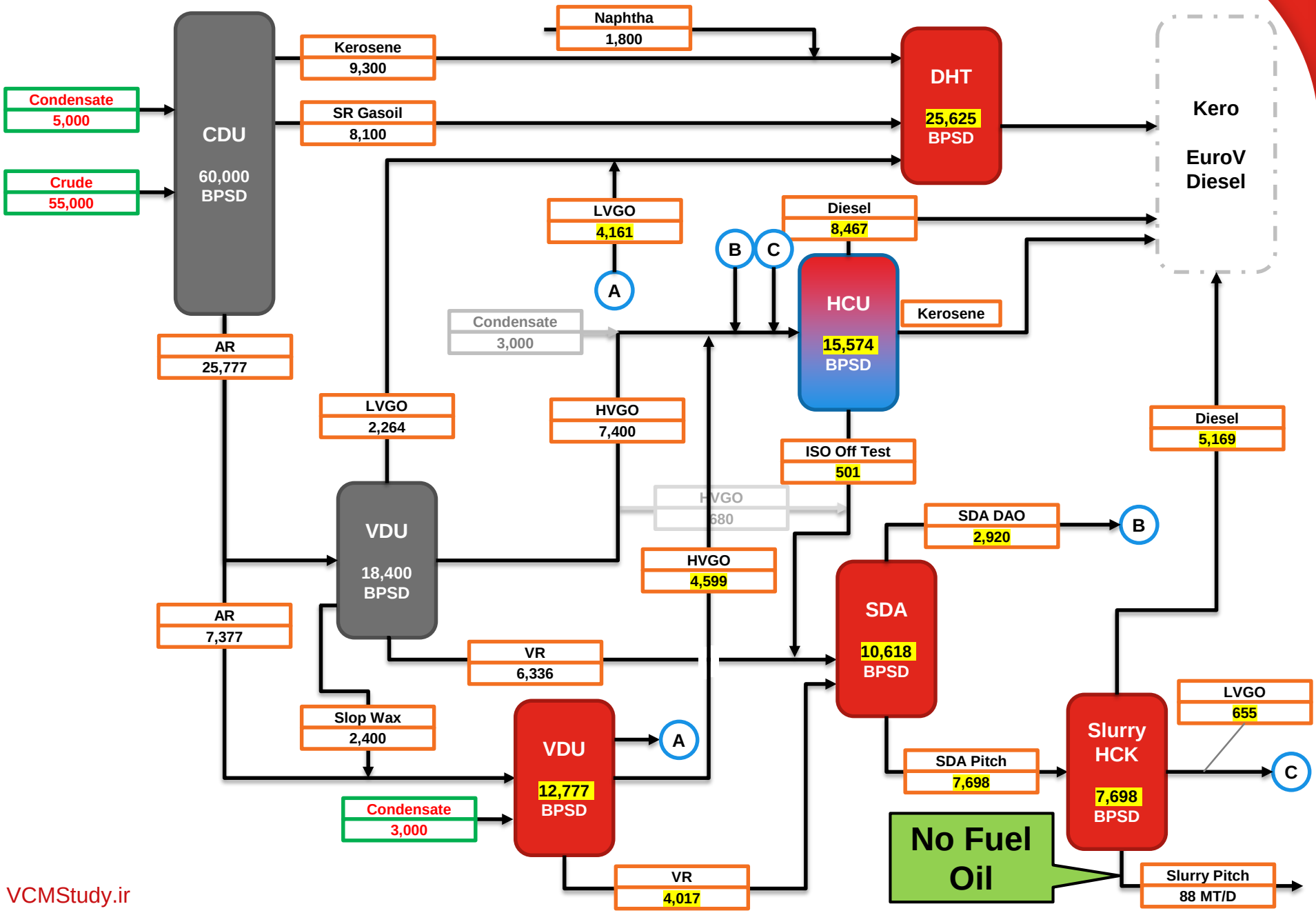
Step 4: Add SDA



Step 5: Slurry HCK



Summary of Fuel Oil Upgrading Concept Study

Case	1	2	3	4	5
Scope	Add DHT	Add DHT & VDU & revamp Isomax (to single stage OT)	Add DHT & VDU & revamp Isomax (add new 1st stage)	Add DHT, VDU, SDA & revamp Isomax (add new 1st stage)	Add DHT, VDU, SDA, Slurry HCU & revamp Isomax (add new 1st stage)
Complexity	Lowest	→	→	→	Highest
Δ Gross Product Value vs Base, MM USD/year	42	102	150	186	238
Estimated Payback, years	3.5	3.2	4.4	4.4	4.8
Estimated CAPEX, MM USD	+ 150	350	664	822	1146

1) CAPEX estimates are Total Installed Cost (TIC), including 50 % allowance for OSBL costs. US Gulf Coast.
2) Gross Product Value is based on typical Persian Gulf product prices

Payback < 5 year for all options
Diesel production is 100 % EURO 5, no HS gasoil production
Hydrocracker Revamp in Step 2 consistent with future Steps 4, 5
Each phase is consistent with the next – "no regret" investment
Phased investment for optimal return on capital invested

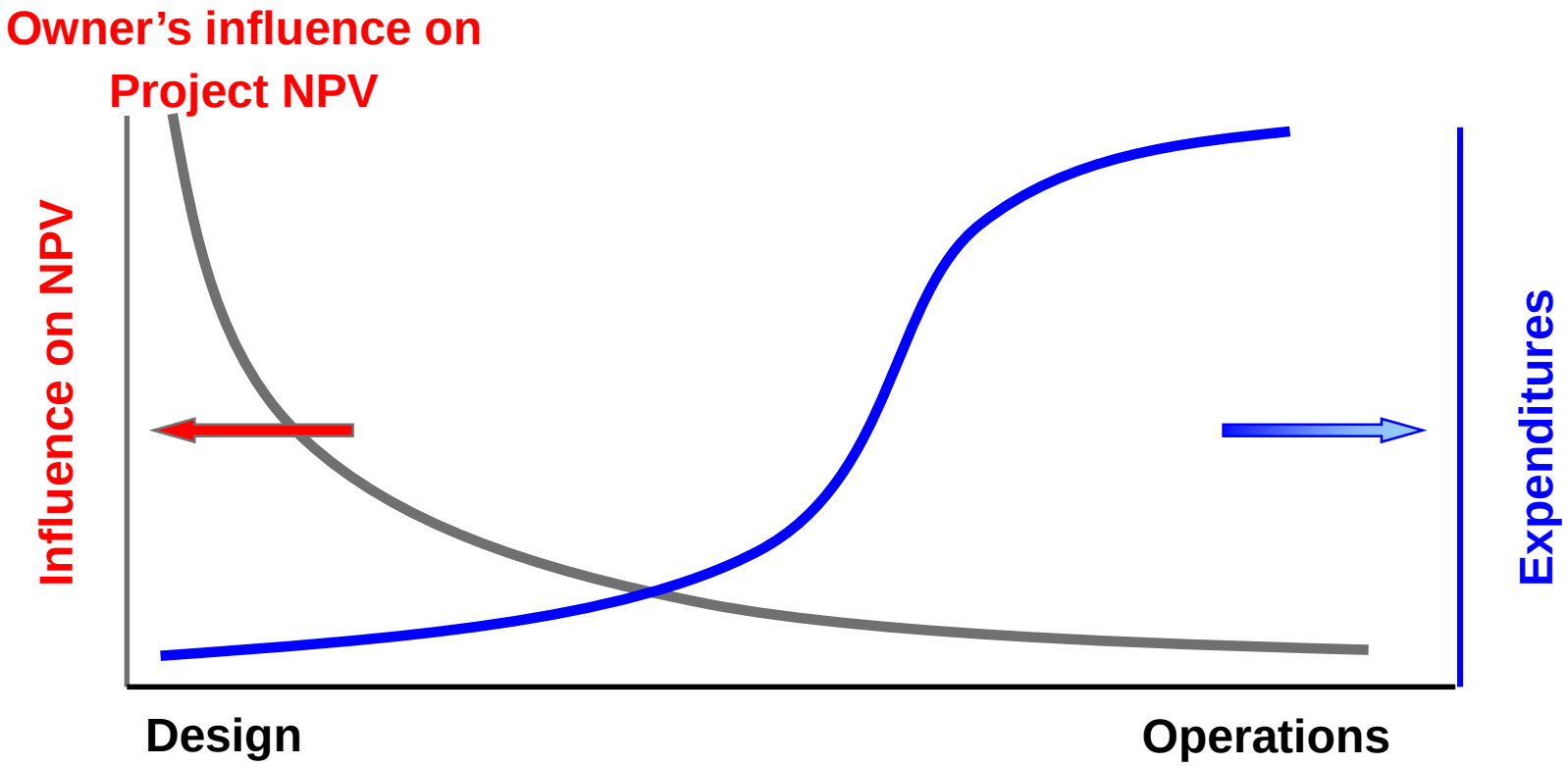
Summary of Fuel Oil Upgrading Concept Study - Phased Investment

Phase	1	2	3	4	5
Scope	Add DHT	Add DHT & VDU & revamp Isomax (to single stage OT)	Add DHT & VDU & revamp Isomax (add new 1st stage)	Add DHT, VDU, SDA & revamp Isomax (add new 1st stage)	Add DHT, VDU, SDA, Slurry HCU & revamp Isomax
Δ Gasoline vs. prior phase, %	No Change	+13.0%	-5.2%	+3.3%	+1.7%
Δ EURO 5 Diesel vs. prior phase, kMTA / %	Base + 1,117	+8.7%	+17.3%	+4.4%	+16.8%
Δ Fuel Oil Yield vs. prior phase, %	No Change	-22.8%	-42.7%	-54.6%	No Product
Δ Gross Product Value, MM USD/year vs. prior phase, kMTA	42	60	48	36	53
Estimated Payback PER PHASE, years	3.5	3.4	6.5	4.4	6.1
Δ CAPEX vs. prior phase **MM USD**	147	203	314	158	324

Opportunity to phase investment to suit capital budget - reduces fuel oil, increase EURO 5, step by step

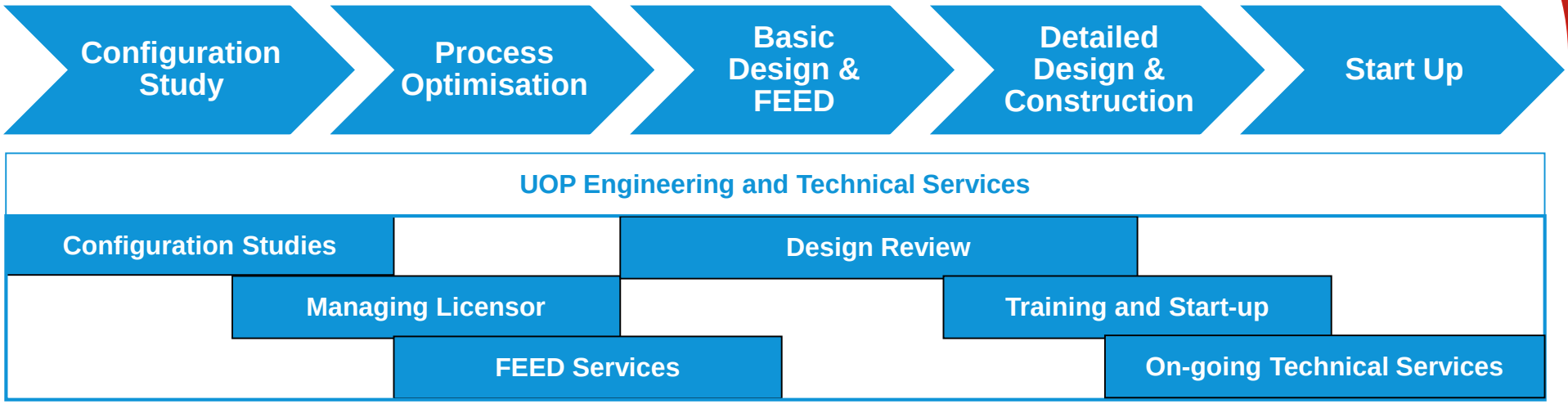
Fuel Oil is already below 10% by Phase 3

Project Development:
Front End Analysis Determines Project Value



Front end definition, key to maximizing project economics

Major Capital Project Work Flow



Front End Work

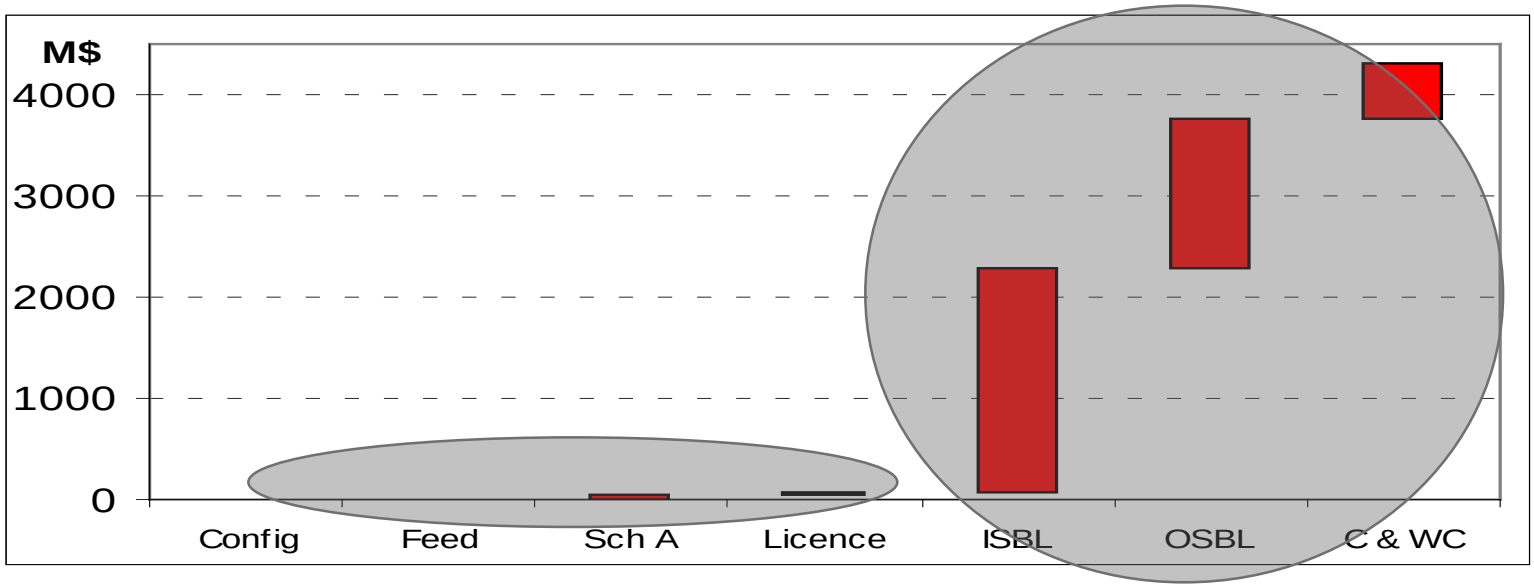
- Optimize Process Units Integration and Basic Design

Maximize Project Economics

- Ensure Business objectives are met
- Minimize project schedule

Optimized front-end work minimizes project schedule

Example Mega-Project Cost Build Up



- Front End Engineering Services (Including Configuration Study Work) ~$ million
- Basic Design Packages ~$$ million
- License fees for provided technology ~$$ million
- Engineering, procurement and construction ~$$$$$$$$$$... million

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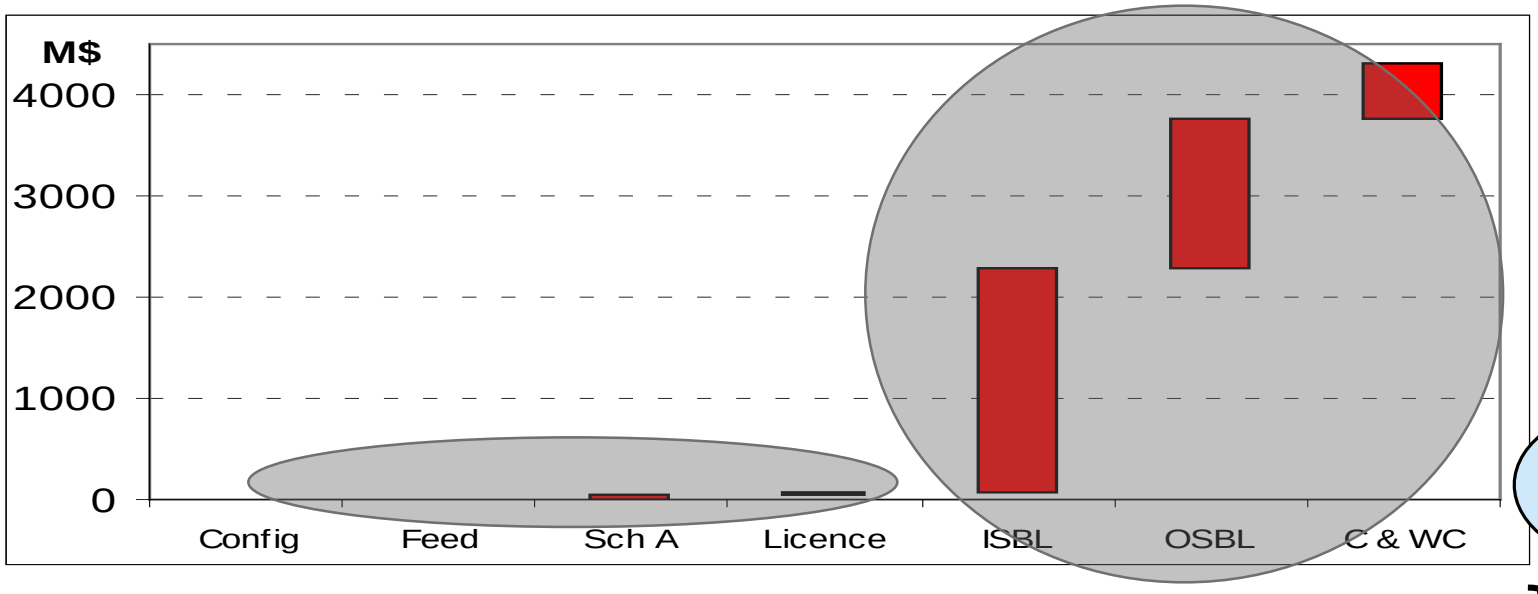
Example Project Cost Build Up



- Front End Engineering Services (Including Configuratio Work) ~$ million
- Basic Design Packages ~$$ million
- License fees for provided technology ~$$ million
- Engineering, procurement and construction ~$$$$$$$$

ECA Funding requires 15% Equity Minimum

< 5% of total

15% more than covers Configuration, Optimization, License and BED

Configuration and Process Integration has profound impact on project economics for small financial outlay

Conclusions

Opportunities exist for successful and profitable BOB projects in Iran

A phased investment strategy generates early income to fund subsequent high conversion investments

Maximizing Project Economics requires a complex analysis of multiple variables and process/design interactions

Each Refinery has different challenges and opportunities which should be carefully evaluated

UOP has the Technologies and Design Experience to Deliver Optimized Solutions to Maximize Return on Investment


Q&A