Adptation des schémas de raffinage à la future demande

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Vice-President
Marketing & External Communications

Axens Group in Brief

5 markets covered

- Refining
- Petrochemicals
- Gases
- Alternatives & Renewables
- Water

over **2,900** industrial units **under license**

over **2,000** Process furnaces

60,000 tons of catalysts and adsorbents produced each year completed by Catalysts Regeneration Services

over **500** Modular units

Offices in **15** different countries all over the world

9 Production Sites

Axens was created in 2001 through the merger of Procatalyse with the Technology Licensing & Service Division of IFP Energies nouvelles.

In 2017, Axens successfully acquired more than 95% of Heurtey Petrochem (including its fully owned subsidiary, Prosernat) and integrated 50% of Eurecat.

Axens
IFP Group Technologies

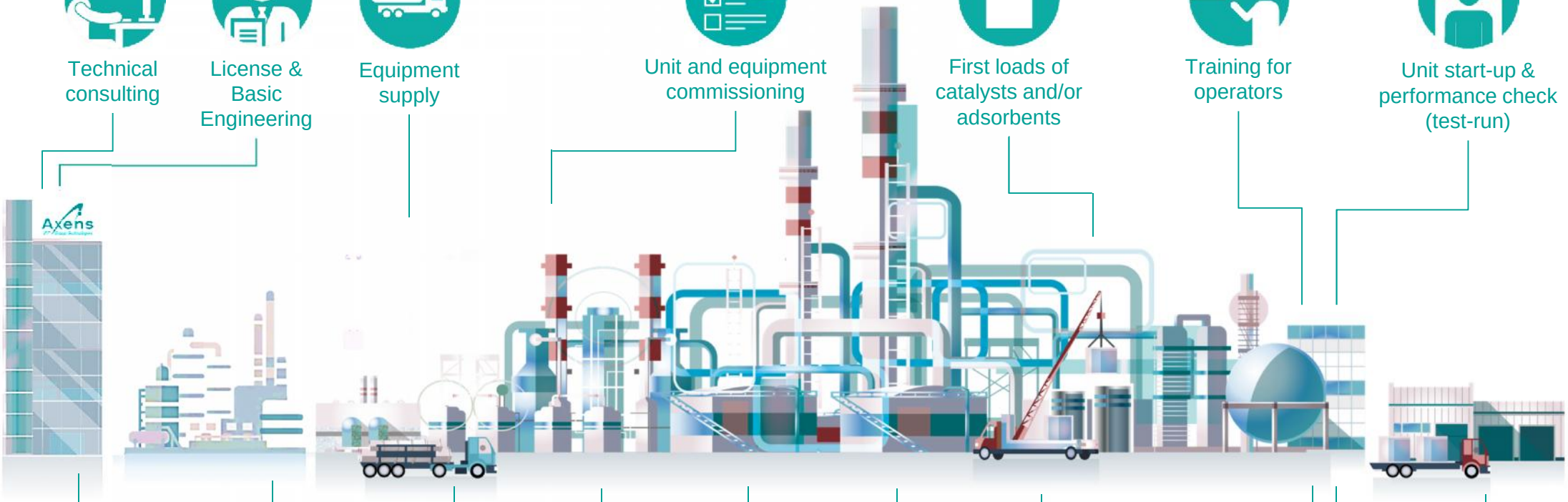
Axens Group:
A Complete Range of Solutions

1 FROM DESIGN TO CONSTRUCTION

- Technical consulting (C, H)
- License & Basic Engineering (T, H)
- Equipment supply (S, H)
- Detailed Engineering (H)
- Fabrication of furnaces & modular units (H)
- New equipment supply (S)

2 PLANT START-UP

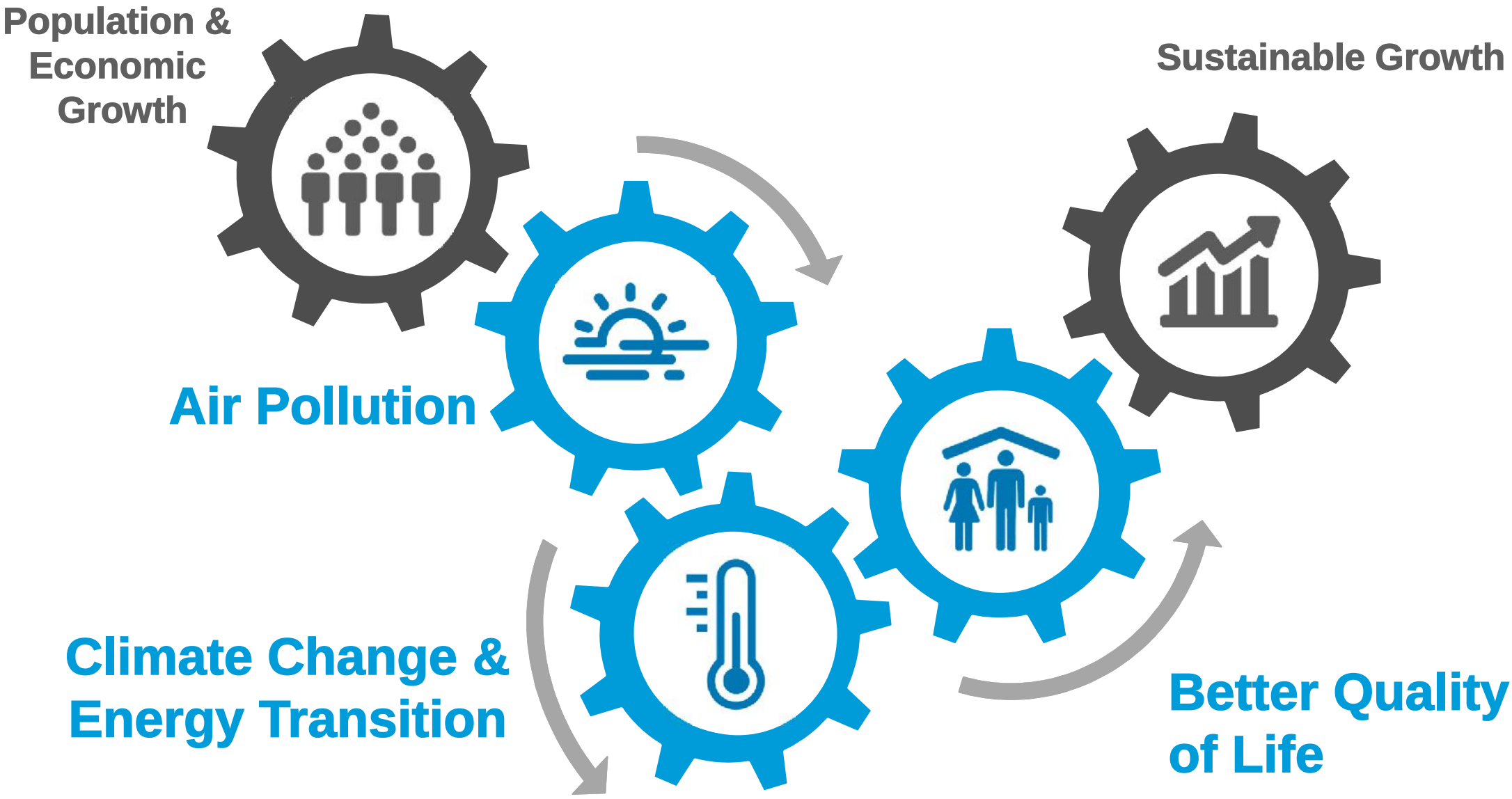
- Unit and equipment commissioning (S)
- First loads of catalysts and/or adsorbents (P)
- Training for operators (S, H)
- Unit start-up & performance check (test-run) (S, H)
- Follow-up & assistance (S, H)
- Energy & water audits (C)
- Unit revamping (T, H)
- Re-loads of catalysts and/or adsorbents (P)
- Refresher training for operators (S)
- Advanced software & applications (S, H)
- Product life-cycle management (P)



3 OPERATION SUPPORT THROUGHOUT THE LIFE-CYCLE OF THE PLANT

P Products | T Technologies | C Consulting services | S Support to Operations | H Heurtey Petrochem & Prosernat

Challenges for Refiners



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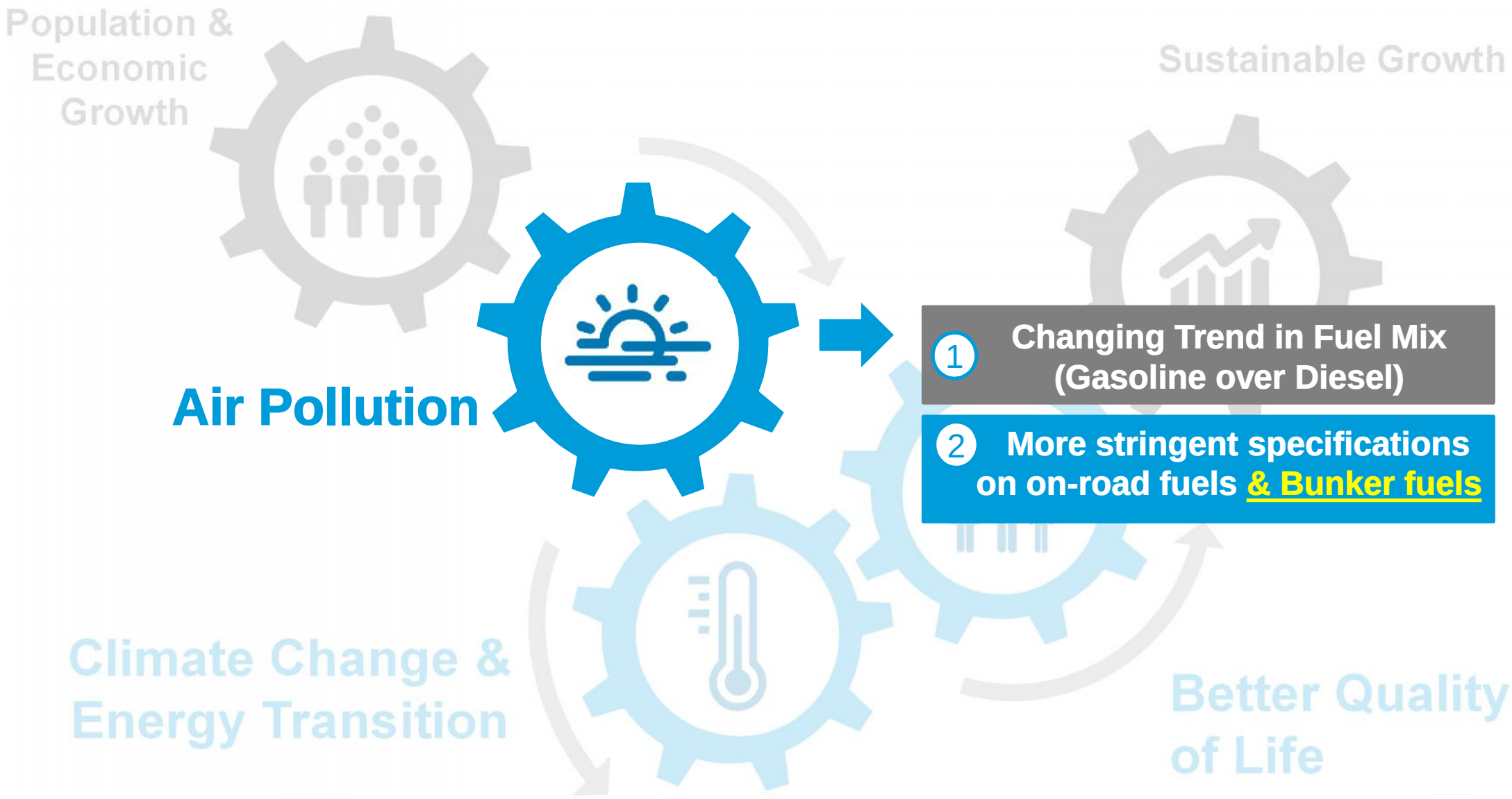
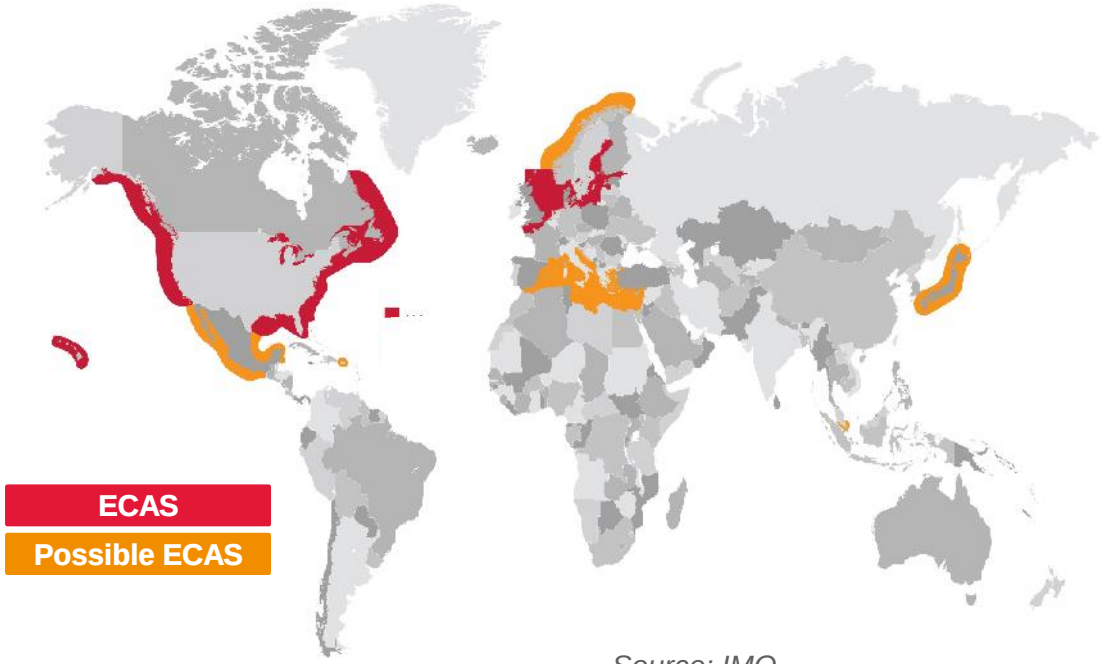


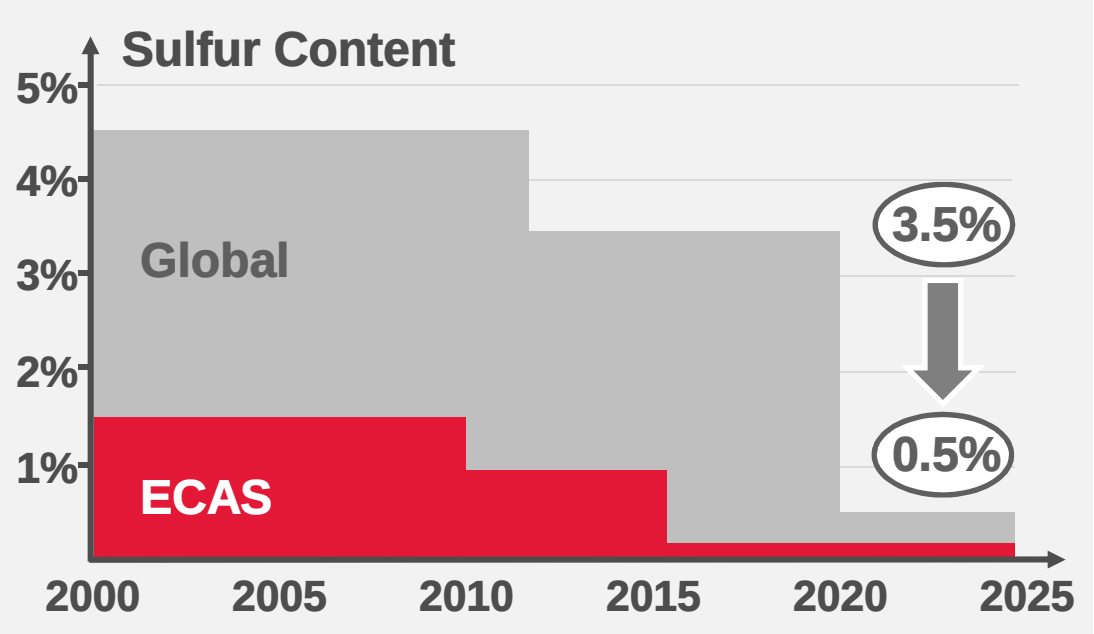
1. **Changing Trend in Fuel Mix (Gasoline over Diesel)**
2. **More stringent specifications on on-road fuels & Bunker fuels**

Marine Fuel Challenges

Marine Fuel Sulfur Specification Change by 2020 (IMO)



Source: IMO

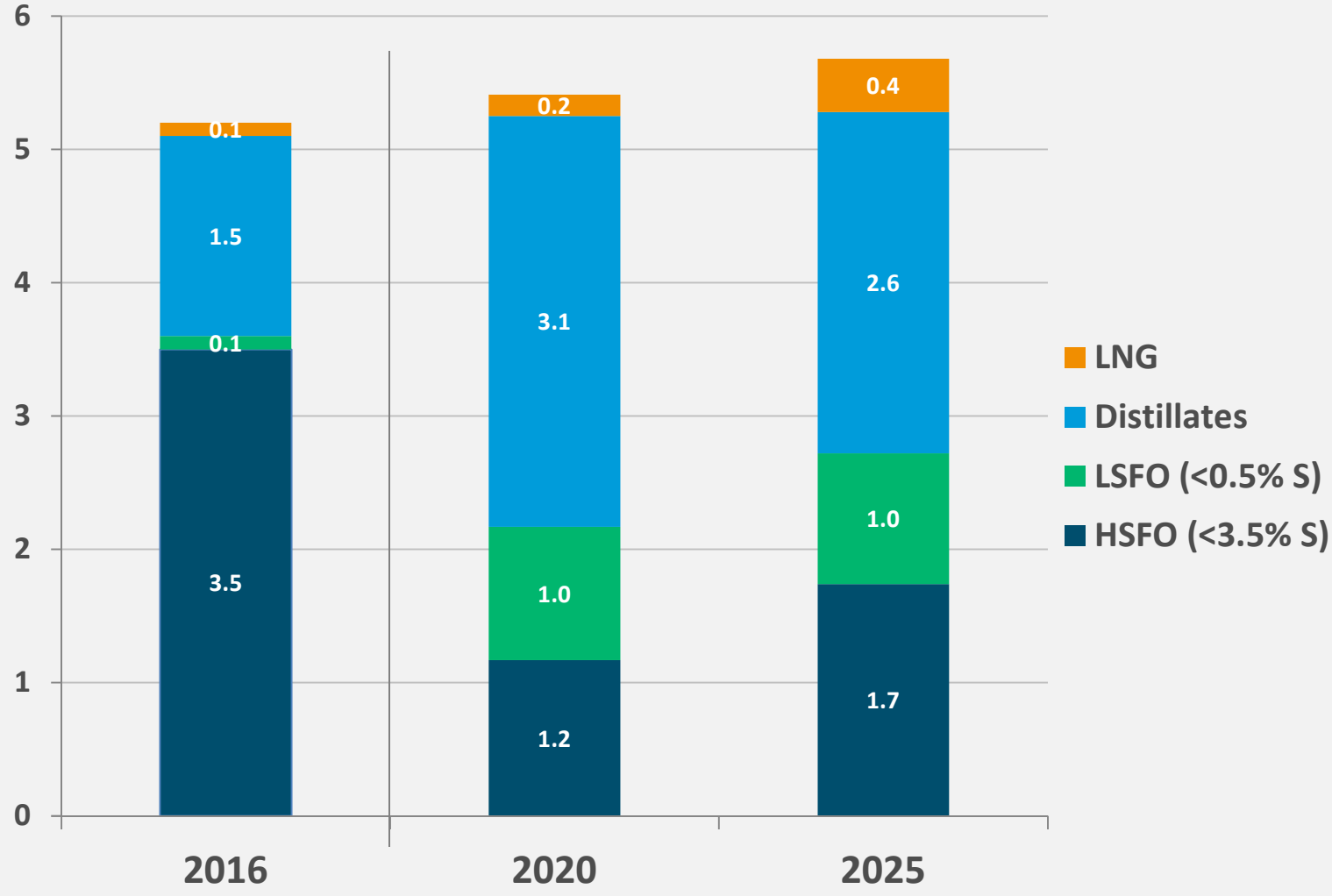


Further Reduction of NOx, PM and other Pollutants Emission Limits?

What are the Options?

Marine Fuel Outlook by Type

AVERAGED DEMAND FORECASTS (Mbpd)



- **~2 Mbpd of HSFO to be replaced by 2020**
- **A sizeable amount of MGO will be required**
- **LSFO (<0.5% S) market ~1 Mbpd**
- **HSFO catch-up by 2025 (scrubber)**
- **LNG limited use**

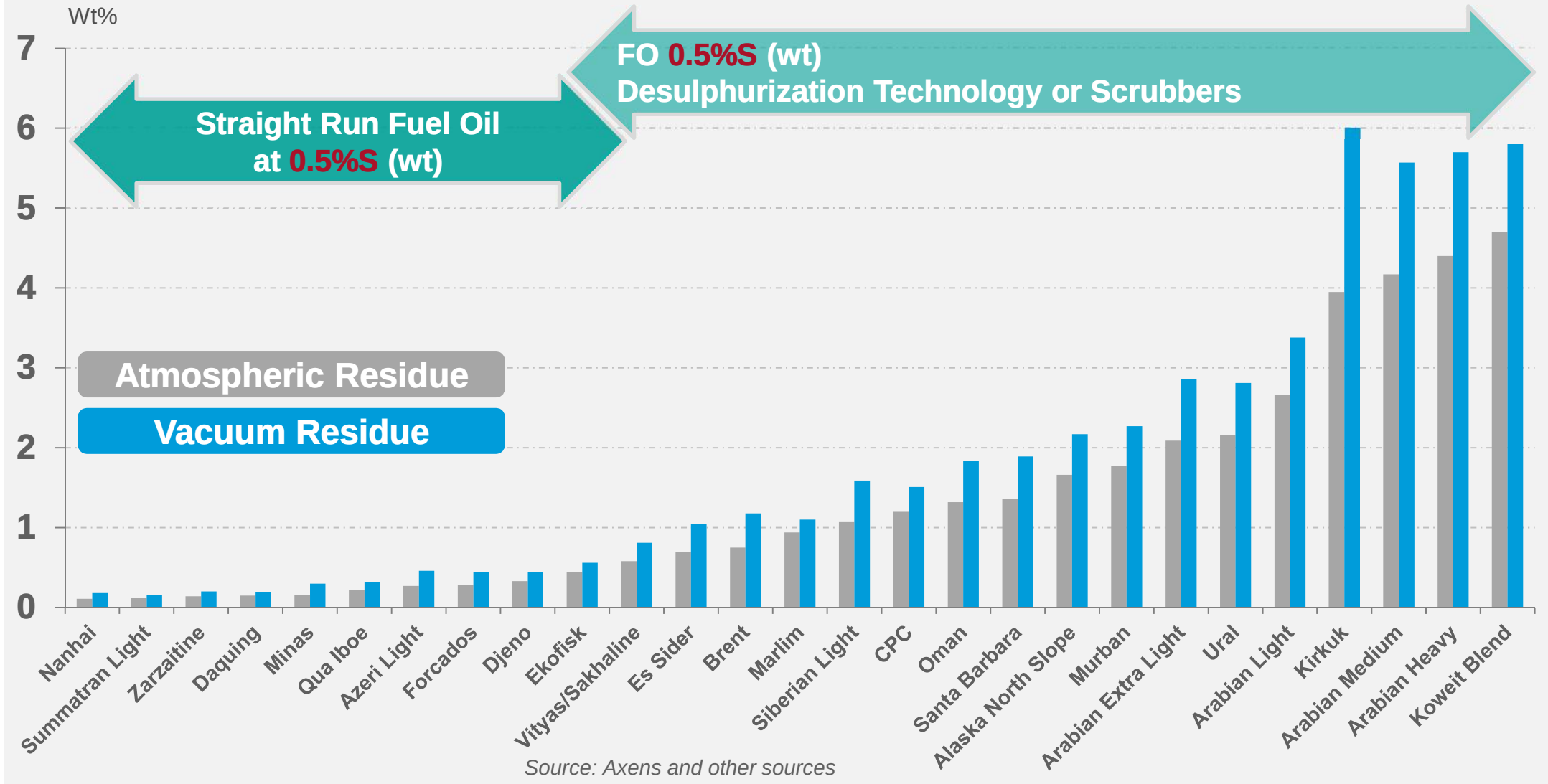
Source: Platts PIRA, Wood Mackenzie, Nexant, IFPEN

Refiners' Strategies to address IMO 2020
Technically feasible routes

- **Ways for a Refiner to respond to the IMO 2020 regulations:**
  - **Crude Selection**
    - **Sweet crudes if technically possible and financially viable**
  - **Technology Investment to produce LSFO (<0.5% S)**
    - **Desulfurization of residue if LSFO price can justify the CAPEX**
  - **Technology Investment to convert HSFO**
    - **Partial or total destruction of HSFO preferably towards lighter products**
  - **Production of HSFO**
    - **Reliance on the persistence of an attractive HSFO market**

Crude Quality

ATMOSPHERIC & VACUUM RESIDUES SULFUR CONTENT



Source: Axens and other sources

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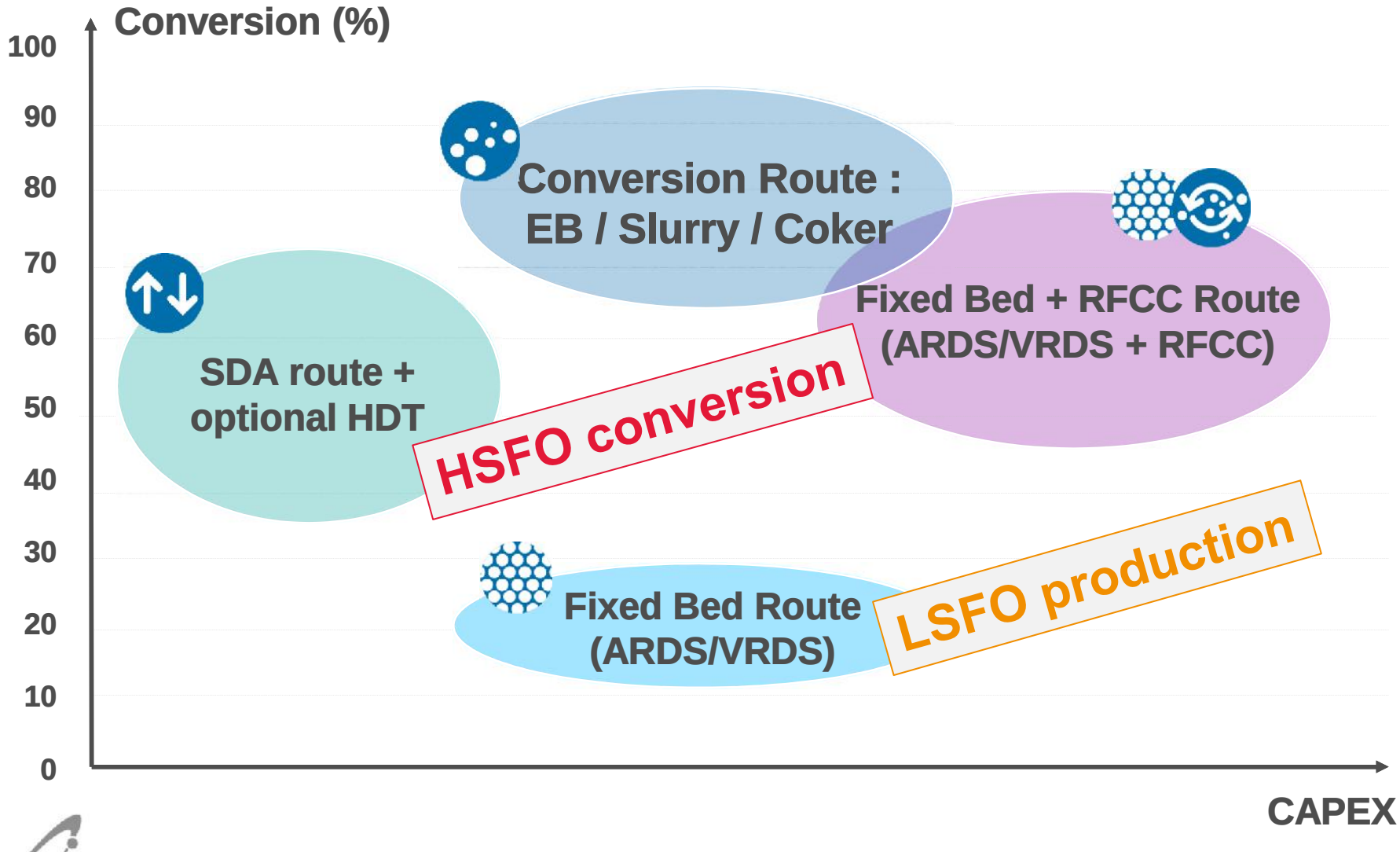
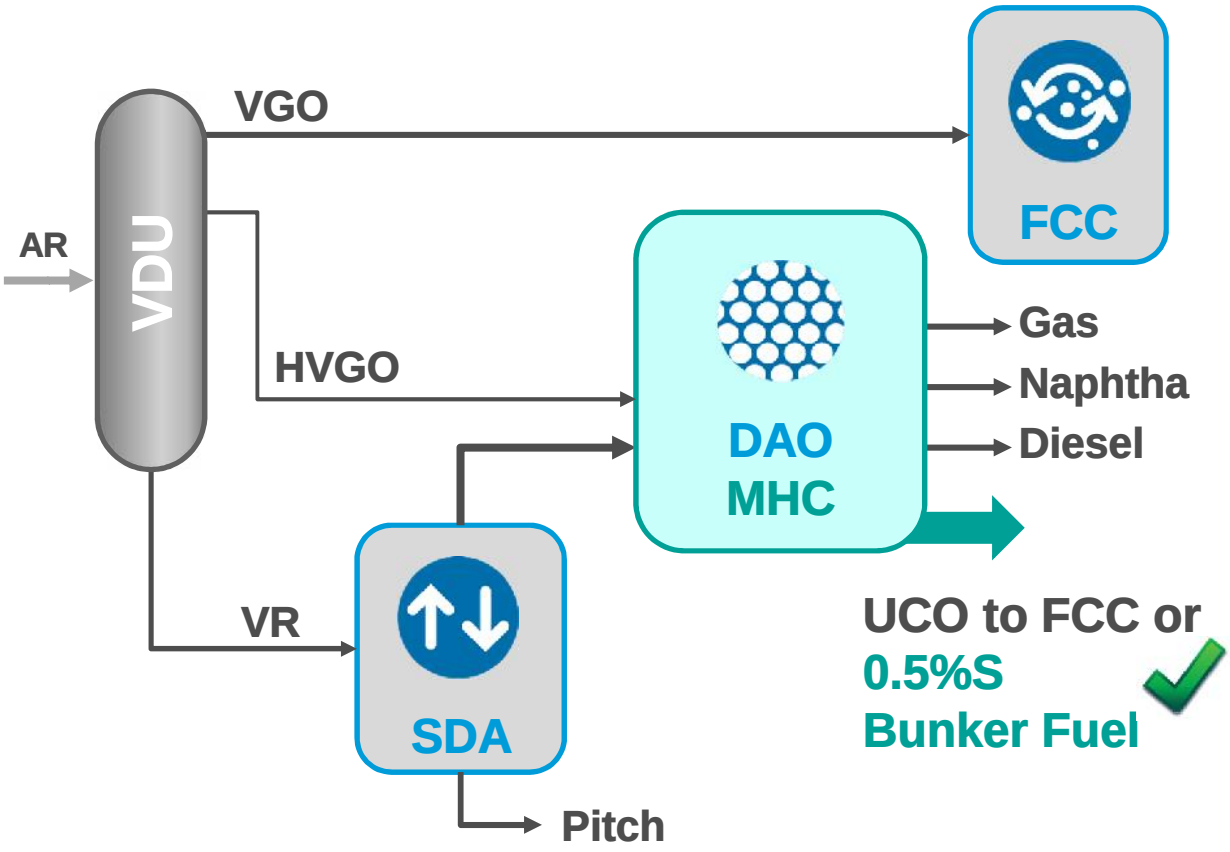
Technology Investment as 2020 IMO Solution
Several proven technologies in the market

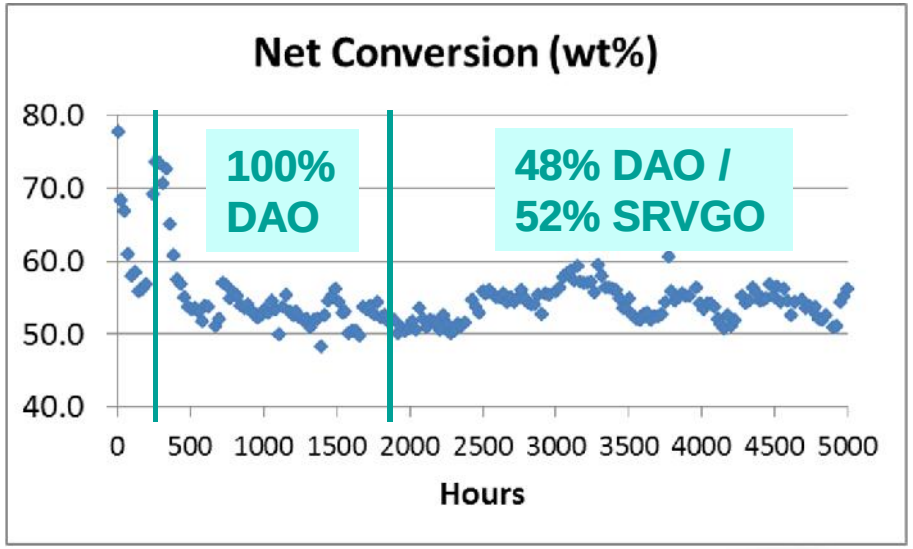


Carbon Rejection Pathway: Industrial Reference

- European refinery
- FCC refinery scheme
- Varying crude basket



- MHC in operation since 2Q 2016
- Axens selected after long duration pilot test confirming estimates of >55%wt conversion
- Excellent product quality



Technology Investment as 2020 IMO Solution
Challenges in implementation

- **Marine Fuels: not the priority product for many refineries**

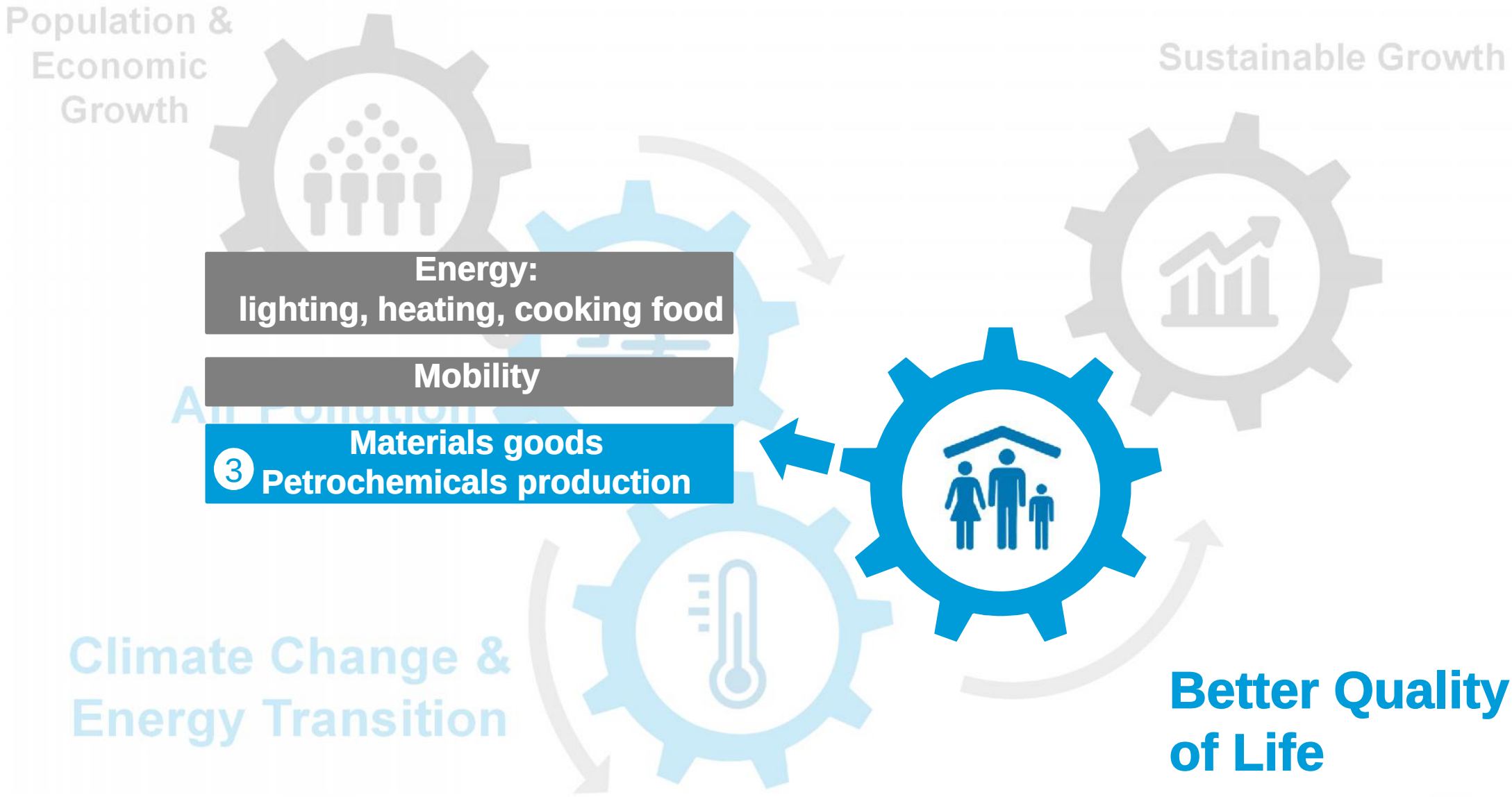
- **New residue conversion / HDT unit: US$200 – 600 million**
- **Install/expand SRU or H_2 production unit: US$20-50 mil.**

- **Typical refinery project design & construction timeline: 4-7 yrs**
- **Typical refinery project profitability timelines: 15-20 yrs**

- **What price for LSFO?… and for how long?**

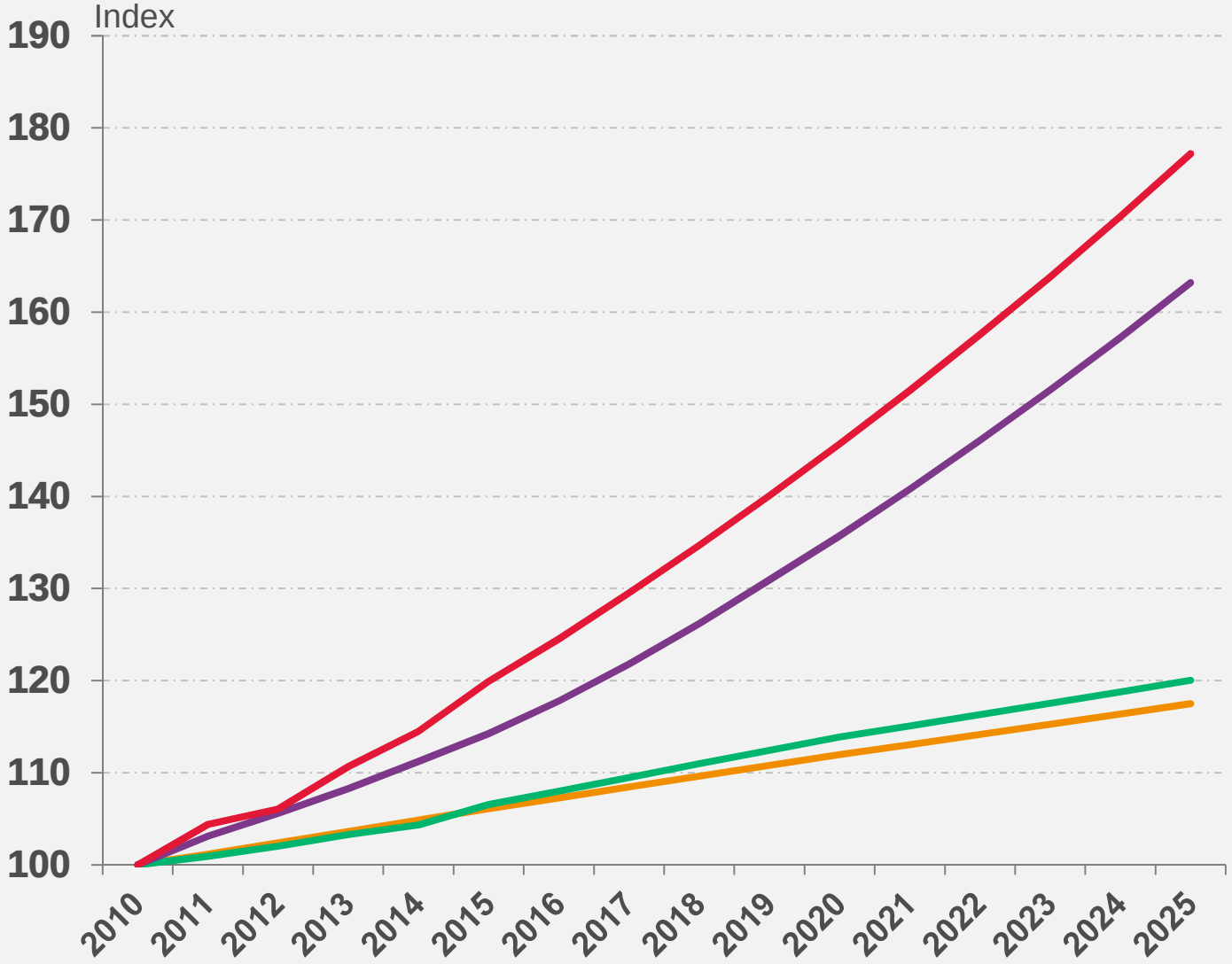
Focus on clean fuels & petchem feeds is a more secure strategy for refiners

Challenges for Refiners



Strong Petrochemicals Demand

MARKET DRIVERS GROWTH (Base 100: Year 2010)



AAGR 2016-2025

Petrochemicals*

+4.0%/y

**Ethylene, Propylene, Butadiene, BTX, Methanol*

GDP

+3.7%/y

Oil Demand

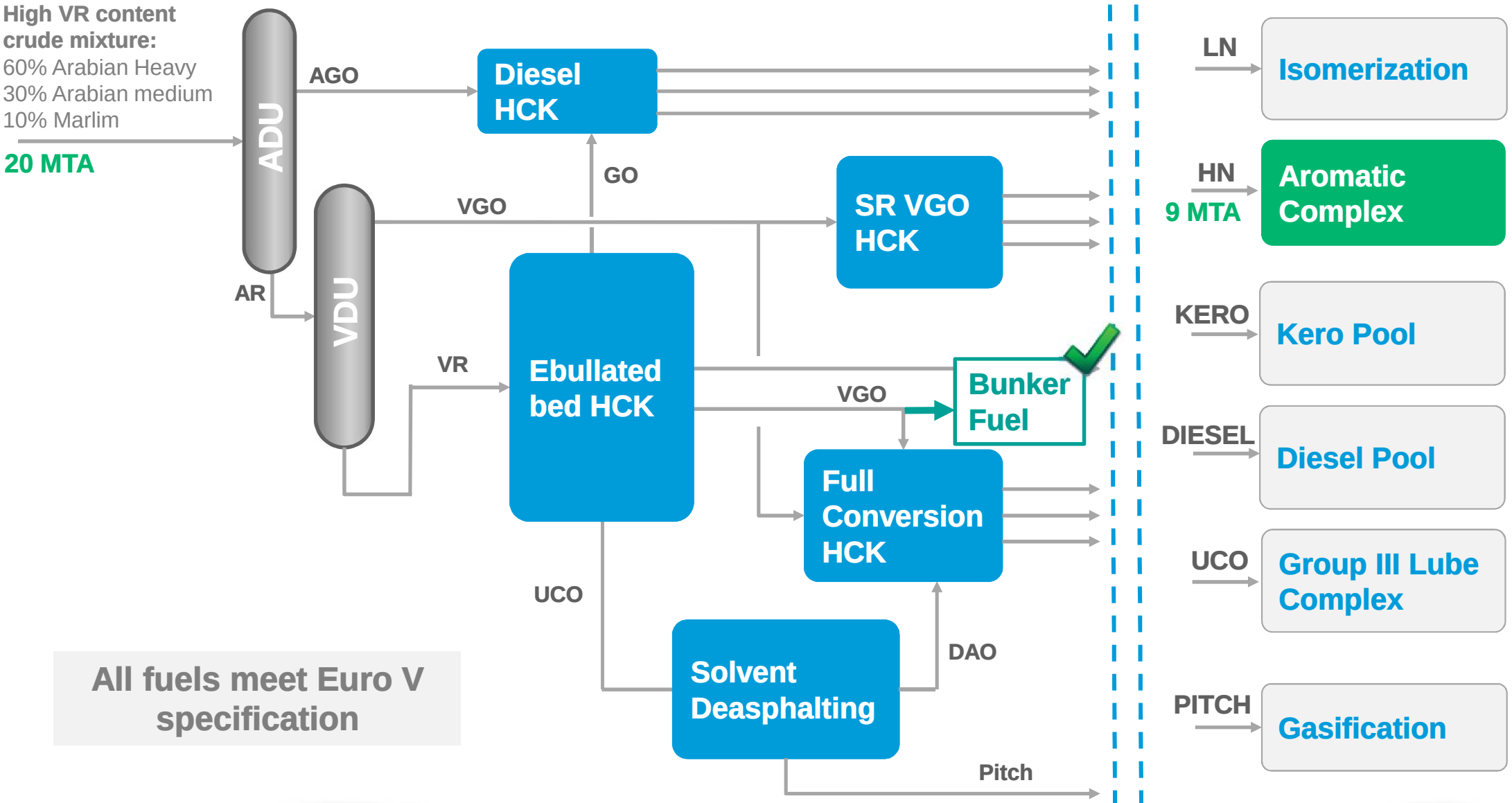
+1.2%/y

Population

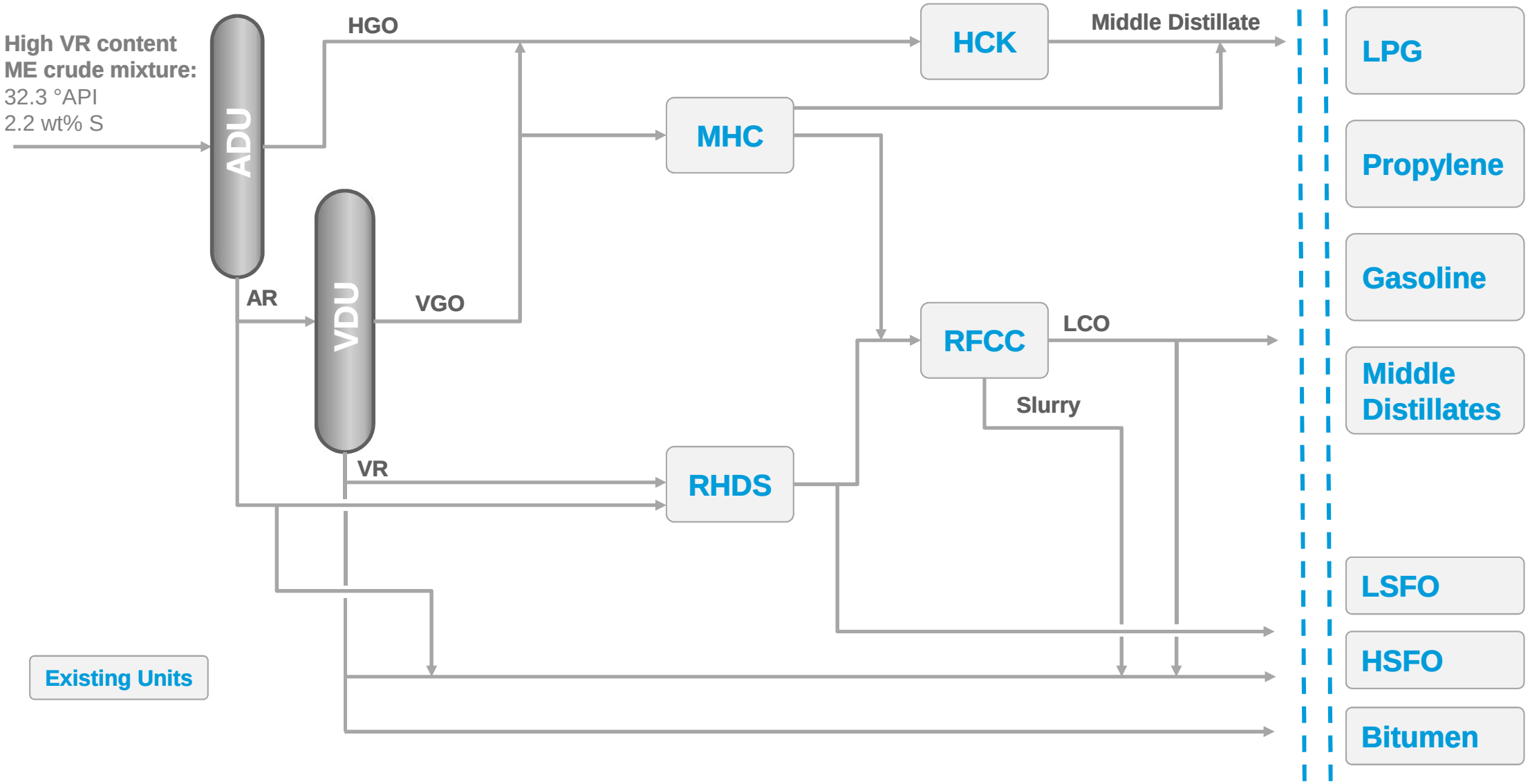
+1.0%/y

Source: World Bank, CEH, Various sources (2017)

Crude to Chemicals
Maximize Paraxylene Production - Grassroot



Crude to Chemicals
Maximize Olefins Production - Revamp



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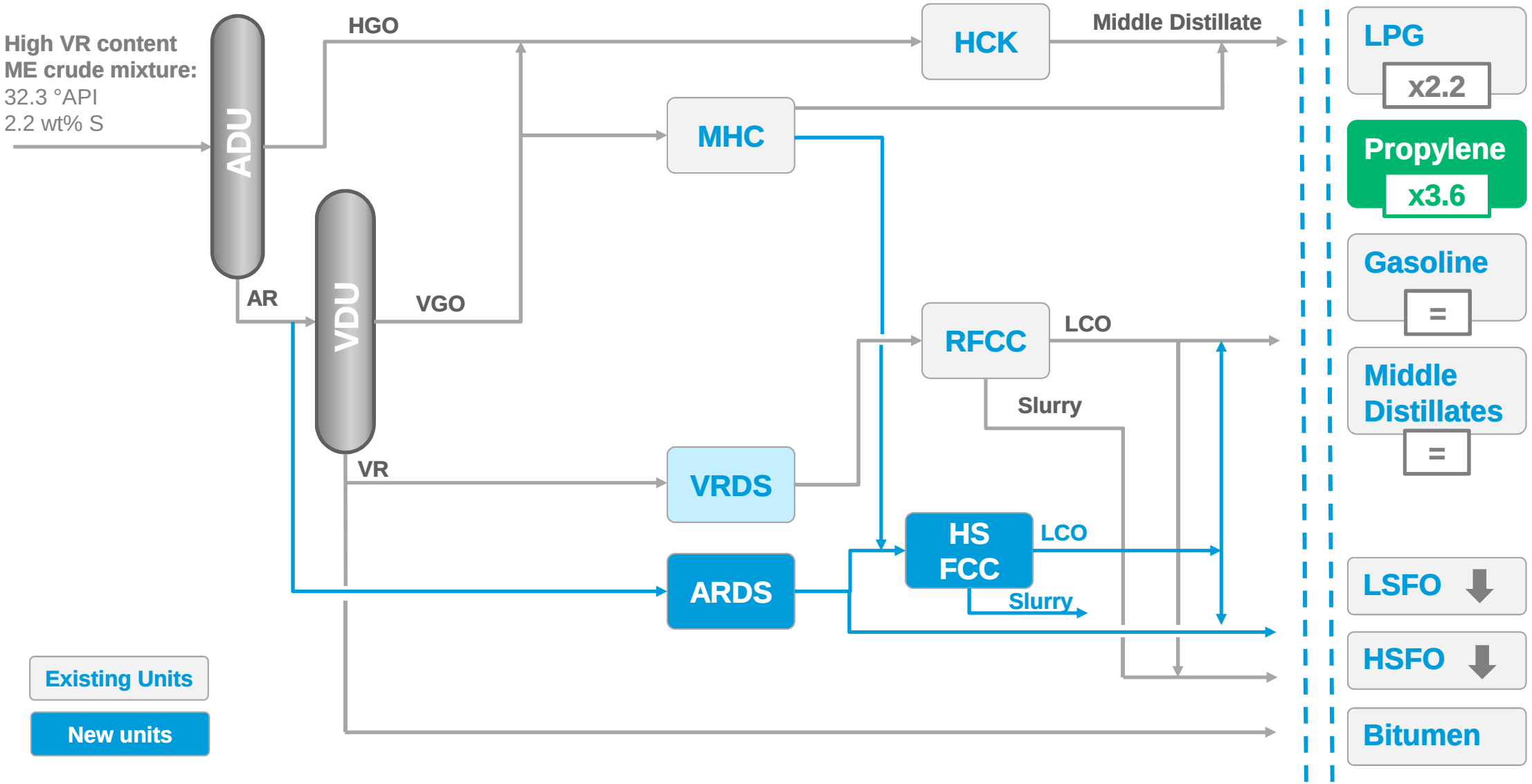


Challenges for Refiners

Population & Economic Growth

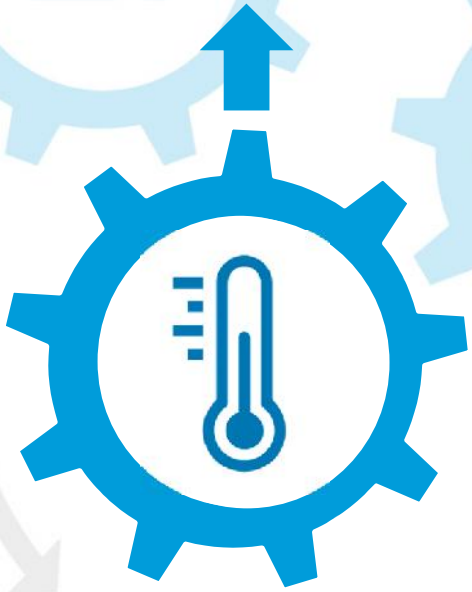
Sustainable Growth

Air Pollution

Better Quality of Life

4 Transport: more efficient engines, low carbon energy, Biofuels

5 Industry: energy efficient processes



Climate Change & Energy Transition

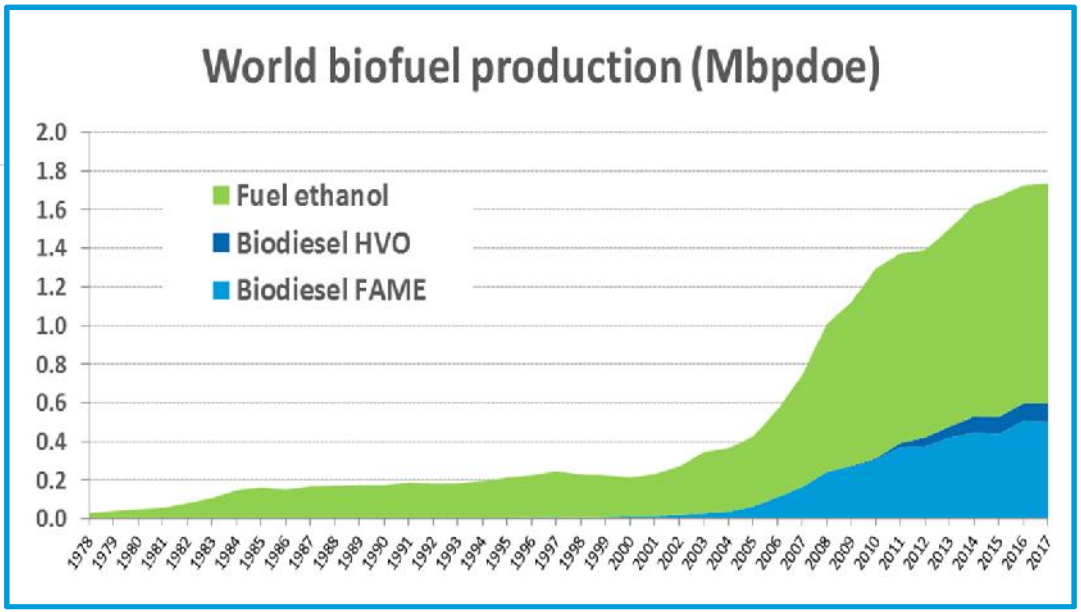
Biofuel Markets
Dynamics

- **2005 – 2014: Strong development**

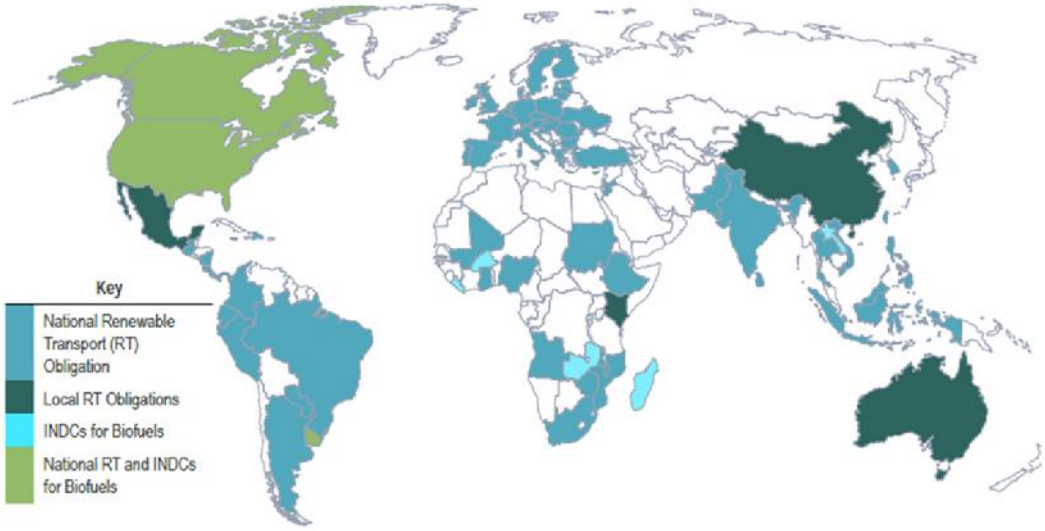
- **Controversies regarding sustainability & food vs. fuels concerns → policy debates**
  - ✓ **Investments decreased**
  - ✓ **Production growth slowed** (+2% in 2016, +1% in 2017)

- **2016: 4 % of road fuel demand**
  - ✓ **USA + Brazil ~ 70% of current production**

- **Still #1 strategy to reduce transport CO_2 emissions** (Paris Agreement)

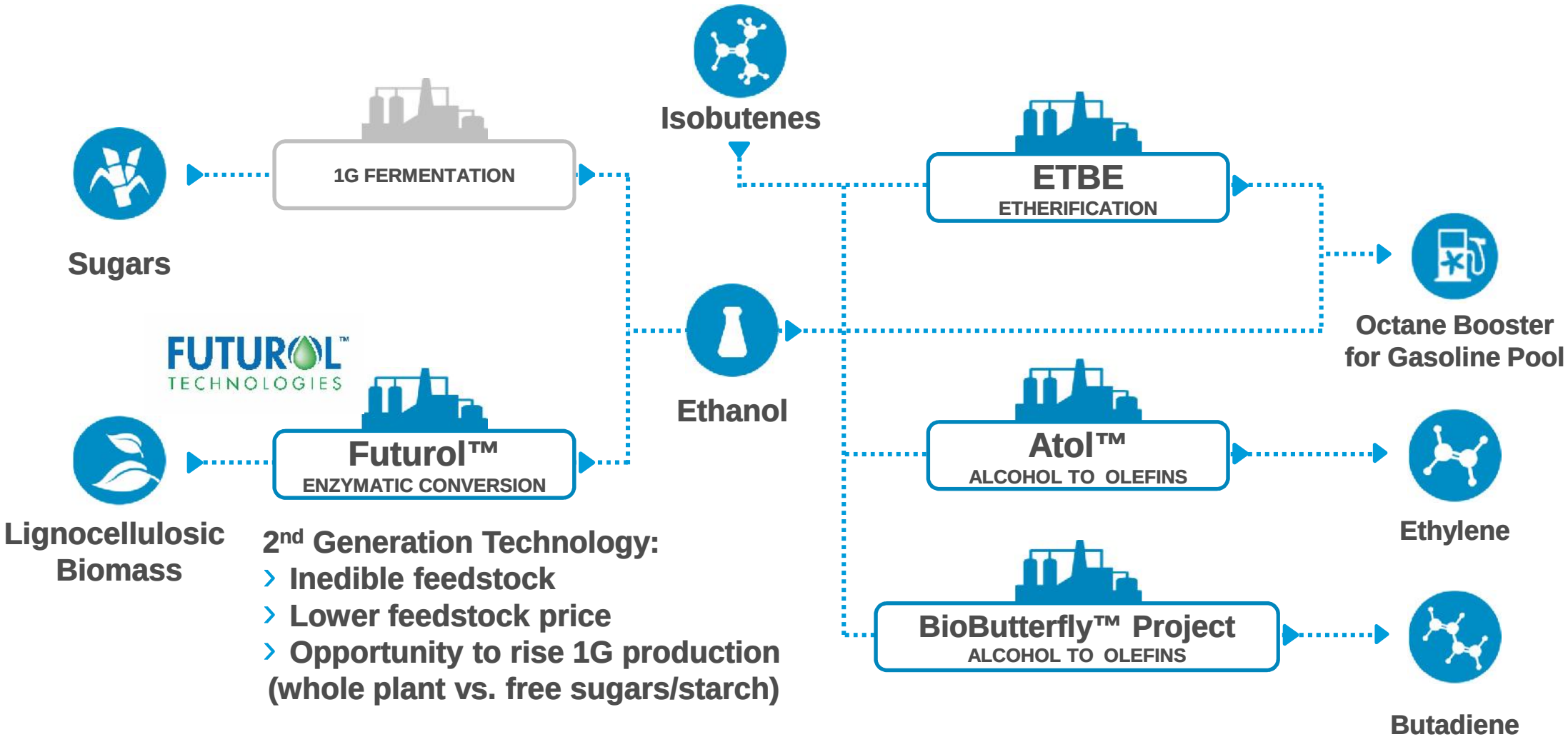


Renewable Transport Obligations & INDCs that Reference Biofuels



Sources: Future Fuel Strategies citing data from Renewables 2016 Global Status Report, REN 21; Intended Nationally-Determined Contributions (INDCs) Offer Opportunities for Ambitious Action on Transport and Climate Change, Partnership for Low Carbon Transport; Global Renewable Fuels Alliance

Ethanol Value Chain – Axens' Portfolio



Zoom on Futurol Technologies™

FUTUROL™ TECHNOLOGIES

Lignocellulosic Biomass

1 PRETREATMENT

- Regularity
- Standardization step
- Low moisture
- High C_5 sugars yield and cellulose digestibility

2 BIOCATALYSTS PRODUCTION

- On-site production
- Tailor-made enzymes/yeasts
- High resistance to inhibitors
- Fully adapted to substrate

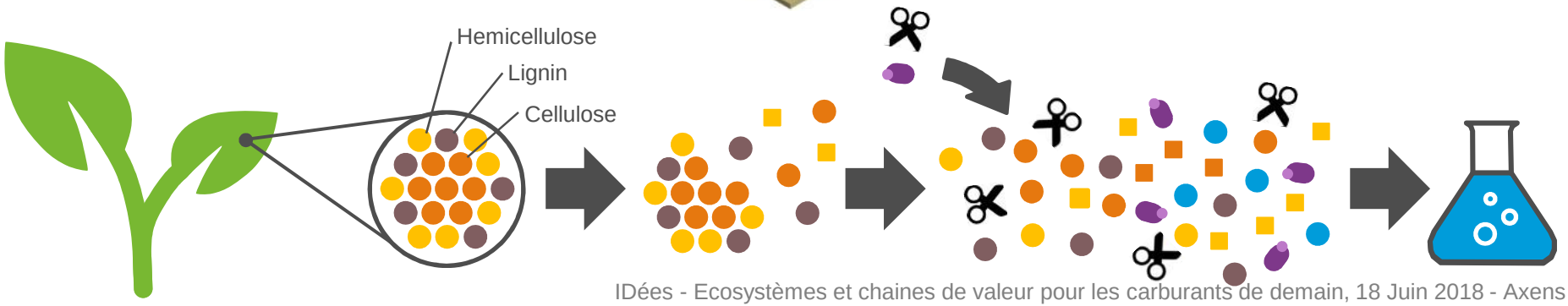
3 HYDROLYSIS & FERMENTATION

- One-pot process
- CAPEX and OPEX minimization
- Full C_5 and C_6 sugars conversion
- High ethanol yield and content

4 PRODUCTS RECOVERY

- Energy and process integration:
  - Self-sufficiency
  - Water/stillage direct recycle

Ethanol



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axens.net/blog