
Access Matters

# Transforming Refining and Petrochemicals

## into a more efficient and sustainable industry

## reducing CO2 emissions via more performing catalysts

# CHALLENGES

World Refining and Petrochemical industry has to **incorporate climate goals**

**Energy intensive industry:**

With its conventional technologies, it accounts for 18% of all industrial-sector $CO_2$ emissions and add substantially to the 40 billion tons of global carbon emissions.

**Profitability in changing market dynamics:**

- Large refiners suffer from fluctuating margins.
- Hence, refiners are looking to produce significantly less gasoline, slightly less diesel, and more jet fuel and petrochemical feedstocks.

To become more profitable, meet their sustainability goals and deal with changing product demand, refineries **have to become more resource efficient.**

Investments today in new technologies support a **gradual shift to more sustainable feedstocks.**

**Promising applications:**

Waste plastics recycling, sustainable fuel production, lubricants, biomass conversion and CO2-to chemicals are the most promising applications.

**Challenging feedstocks:**

To deal with a variety of feedstocks, including biomass and CO2, new catalysts are required bringing enhanced efficiency, robustness and versatility to the sector

To contribute to the world's sustainability targets, these new technologies **have to become less capital intensive**, **less costly and more robust.**

These challenges drive the **demand for versatile and efficient catalysts**, specifically tailored to meet the requirements of these applications.

# ZEOPORE's SOLUTION

## ► OPTIMIZE CATALYTIC PROCESSES THROUGH MEZOPORIZATION TECHNOLOGY

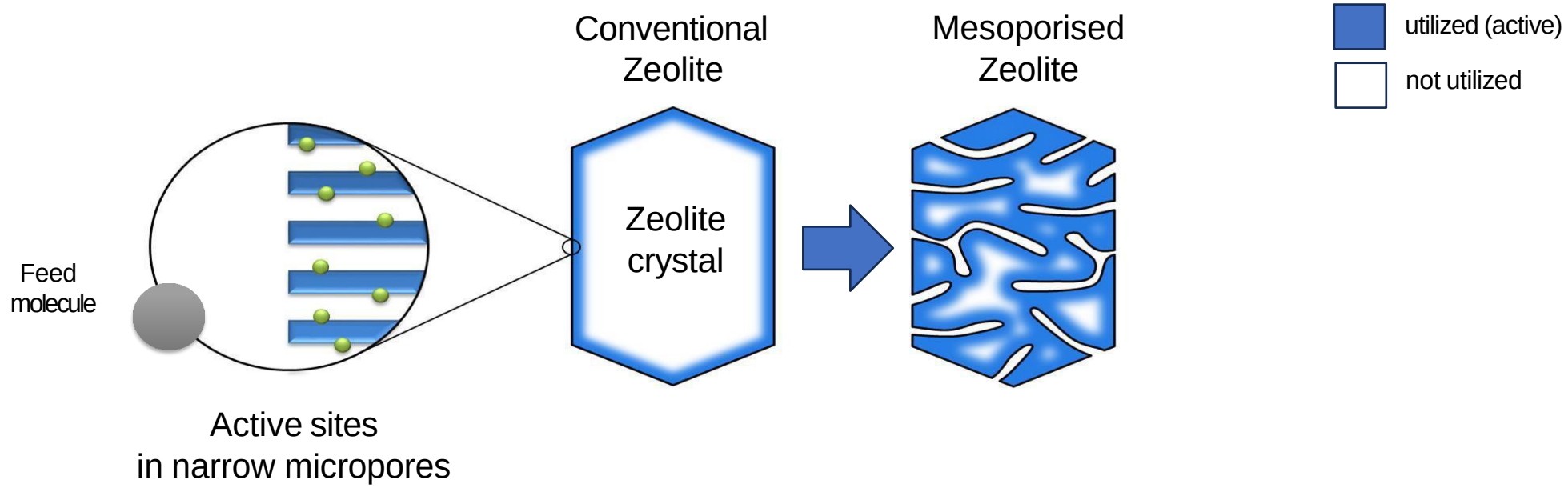
- **Established industrial scalability**
- **Economical, high productivity process**
- **Unique process tunability**
  - > Porosity, acidity, composition, etc
  - > Also unique technology to embed additives

## › Proven benefits in a range of applications


## > Enabling in ongoing sustainability shift

# ZEOPORE's SOLUTION

## zeolite optimisation based on mesoporisation




### Mesoporisation

- Increases accessibility of active sites with factor 2 to 5.
- Boosts selectivity, activity and lifetime.
- Low-cost processing.
- Applicable to all industrial zeolites

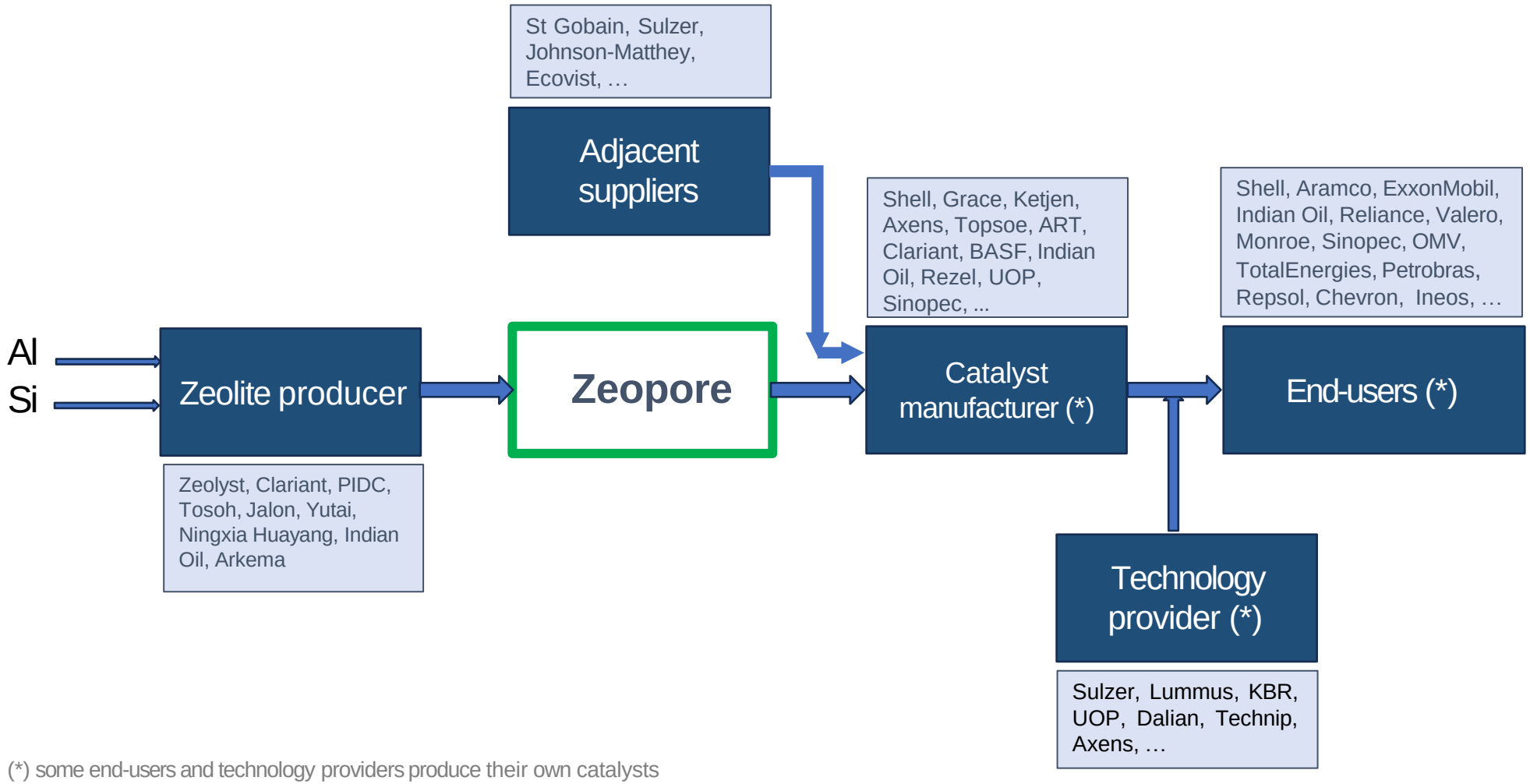
### Metal inclusion

- Metal inclusion during mesoporisation.
- Maximized dispersion into zeolite crystals.
- Enhances catalytic benefits.
- Easy processing.

### Low-cost zeolites enhancement

- Ability to improve sub quality, low-cost zeolites and upgrade to high-performing zeolites .
- Opens route to cheaper high-performance zeolites and improved security of supply.

# BUSINESS ENVIRONMENT




(*) some end-users and technology providers produce their own catalysts

# TARGET MARKETS

## growing and strong fit with Zeopore's technology

### FCC

- Largest zeolite market (900.000 ton/yr), moving away from fuels towards (petro)chemicals.
- Zeolite based catalysts boost production of valuable products (propylene and diesel/jet fuel)
- Better catalysts needed to transition to circular feedstocks

### Advanced Plastics Recycling

- Growing market following European recycling targets.
- Upgrading of pyrolysis oil or gas from waste plastics or direct catalytic conversion.
- Conversion to Aromatics opens a worldwide market of more than 150 million ton.

### Hydrocracking

- Money maker in refining: > 300 million $ market globally
- Challenge: deal with more complex and heavier feed.
- Strong fit with Zeopore's technology

### Sustainable Aviation Fuel & Re-Diesel

- Largest "green" market in the world.
- The market share of Sustainable Aviation Fuels is forecasted to grow from 2% in 2025 to 70% in 2050.
- Today they are too expensive to produce.

### Dewaxing

- Dewaxing improves the use of diesel and lube-oils in cold conditions and more demanding (motor) requirements.
- Shift to biomass derived feeds with less favourable cold-flow properties needs better catalysts.

### Biomass conversion

- Biomass feed conversion into aromatic building blocks is a starting but promising and attractive market.
- Mixed biomass feedstock is also used in the Sustainable Fuel business.

### Crude to Chemicals

- Strategic to Oil Majors: transforms the refinery business.
- Today 15% of the crude is converted into chemicals. This is expected to move to more than 60%.
- Strong fit with Zeopore's technology.


### CO2 to Methanol to Chemicals

- Methanol from CO2 and (green) hydrogen is one of the most important building blocks of a carbon neutral industry.
- The 1st step is the conversion of methanol to olefins.
- This market is predicted to grow considerably.
- Strong fit with Zeopore's technology.

# ZEOPORE's TECHNOLOGY

proven benefits in target market **applications**

## FCC

- More valuable light olefins - representing an added value for the refiner of 6 million €/a for an average FCC plant.
- Easy integration in existing refineries.
- Good stability in harsh regeneration cycles.

## Advanced Plastics Recycling

- In all processes, excellent results in boosting aromatics yield. More valuable products and 10 times higher activity.
- **Adaptable to variable waste streams.**
- Cost-effective upgrading of pyrolysis streams.

## Hydrocracking

- **Zeopore's technology** gives between 3 to 7% more diesel with improved catalyst stability and less H2 consumption.
- Benefits: 0.5 $/barrel or 15 million $ for an average cracker.
- Start from lower quality zeolites allows competitive pricing.

## Sustainable Aviation Fuel – Re-Diesel

- **Zeopore** reduces losses with a factor 5.
- **Zeopore** reduces capacity-limiting gas formation.
- **Considerable improvement in activity in Renewable Diesel**

## Dewaxing

- **Zeopore drastically reduces the loss of raw materials and optimizes the process.**
- Improved product quality.
- Works on multiple fossile and renewable fuel products.

## Biomass conversion

- Biomass process suffers from too low conversion rates and coke formation.
- **Mesoporisation is essential to improve catalysts**.
- **Zeopore** reduces coke formation and increases productivity.

## Crude to Chemicals

- **Zeopore provides Higher conversion and Better products**
- Halving coking
- Increased production of desired products.


## $CO_2$ to Methanol to Chemicals

- **Zeopore boosts the productivity by 15 to 25%**
- 25% more propylene
- 3 times longer catalyst lifetime
- Better valorisation of captured $CO_2$

# ZEOPORE’s BUSINESS MODEL

## licensing

Zeopore’s technology is licensed to zeolite- or catalyst producers.

## partnering

Zeopore and the catalyst producer join forces to service the final customer and share the value created.

## produce & sell

Zeopore sells the desired mesoporised zeolite to the catalyst producer.

Zeopore is open to work with industry-partners along the business model of their choice.

# ZEOPORE's BUSINESS MODEL

**example: produce and sell**

## Standard zeolite


Standard (cheap) NaY-zeolites purchased on the open market.

at < 5 USD/kg

commercial relations built globally

## Zeopore

Semi-industrial unit (CAPEX: 500 k€) able to produce 175 ton/a.

Modular approach to higher volumes.

## Catalyst producer


Sell to catalyst manufacturers with captive use (f.ex. Shell, ExxonMobil, Aramco, Indian Oil, BP, Sinopec, …).

Or partner with a catalyst producer and sell the catalyst to end-users in Refining, Petrochemicals or Emerging industries (W.R. Grace, Ketjen, Axens, Evonik, ….)

## End-user (refiner)

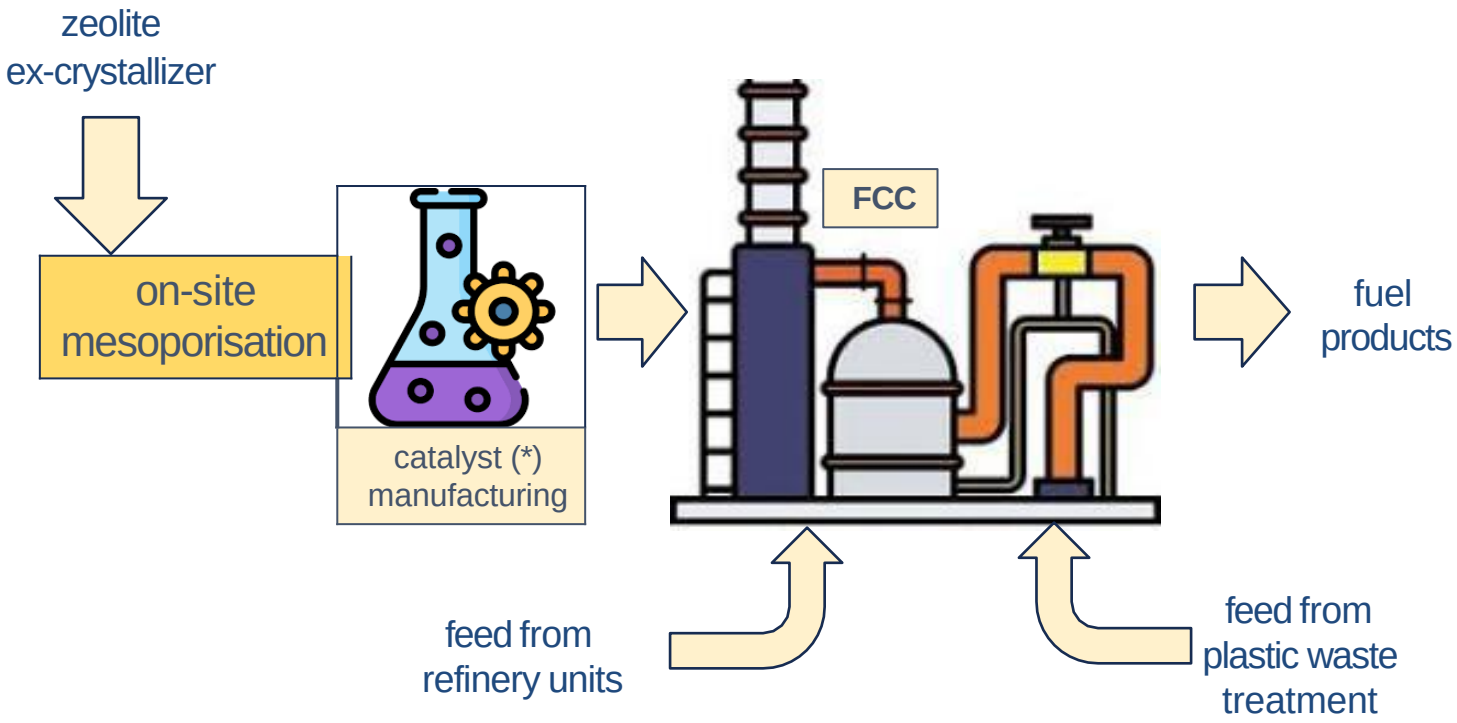
Zeopore's technology brings additional value to refiners: 250 USD/kg catalyst via 3 to 7 wt% more middle distillates

Zeopore is testing/negotiating with several O&G majors.

Zeopore is negotiating with a reputed global company.

# ZEOPORE's BUSINESS MODEL

## example: lICENSING




**Licensing for FCC**

FCC operations are very cost competitive, and commoditised, putting large pressure on the catalyst prices.

The physical integration of the Zeopore mesoporisation step in the overall catalyst production process is mandatory for cost and logistical reasons.

As a consequence, licensing of the mesoporisation technology to the FCC catalyst producer is the preferred business model.
Ease of Zeopore's technology allows to embed mesoporisation into existing FCC catalyst hardware.

# ZEOPORE's MILESTONES

## Maturity level timeline:

### TRL 1-2

**2018-2020**

Spin-off from KUL (Belgium)

•

Toolbox of zeolite modification recipes developed

•

Processing at lab scale

### TRL 3-5

**2021-2024**

Technology catalytically proven at pilot scale in all major applications, both in traditional industries and emerging sustainable processes

•

Construction of a semi-industrial unit

•

Tests in relevant environment with key partners and customers

### TRL 6

**2025**

**ISO certifications in progress**

•

**Ton-scale production of industrial samples in 3 major applications**

•

**Commitment letters from** large refining and catalyst manufacturing entities

Process optimization, market demos, authorization, LCA

### TRL 7 -> 9

**2026-2029**

Industrial adoption of Zeopore zeolites in real-life refineries and chemical plants.

•

Maximising plant capacity in Leuven, preparing for 1-2 kton plant towards 2030

•

Geographical position in China, India, Arabic world

**2029-2035**

Growth to a profitable business in a global market

•

€200m revenue in 2035

Process knowhow & production of high value mesoporous zeolites in industrial scale

**Historical financing**

**Growth financing**

# GROWTH TO A PROFITABLE BUSINESS

## 4 steps in parallel to capture value

### Operations

take full advantage of the semi-industrial unit

Focus on streamlining of the production process, further reduce its cost, attain reliability of supply and minimize capex

### Conventional refining and petrochemicals in Europe and the US

efficiency increase in key processes.

Focus on catalyst developers with captive use in hydrocracking, dewaxing and crude to chemicals. Launch first dewaxing and hydrocracking catalyst via partnering with catalyst manufacturer.

### Sustainable applications

make them financially attractive

Accelerate the market introduction of sustainable applications through consortia formation over the complete supply chain (biorefineries, sustainable fuels, advanced recycling of plastic waste, …)

### Develop the fast-growing Asian market,

primarily India and China

Focus on FCC, dewaxing, methanol conversion and sustainable fuels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