Special Report

Propane Dehydrogenation (PDH)

(Sample Version)

aranca

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About the report

- **Propane Dehydrogenation (PDH)** is an alternative route for propylene production, specially for the regions that have cheaper light feedstock availability. PDH is characterized by significantly higher propylene yield when compared with other existing production routes, which makes it a highly attractive alternative. Though it is not a new process, investments in R&D and new plants have gained momentum recently.

- The **Aranca Special Report on PDH** aims to provide a detailed perspective on the PDH landscape, by covering the key technologies, players, associated challenges and the potential impact PDH can make. Some of the information sources used to develop the report are the players active in the PDH space, general industry publications, patents and research papers, various secondary sources and Aranca analysis.

- This document is a sample of the complete report, outlining the report background, scope, illustrative of the report contents. Complete report can be made available to the clients who find the contents useful, with an option to customize the scope of the report.

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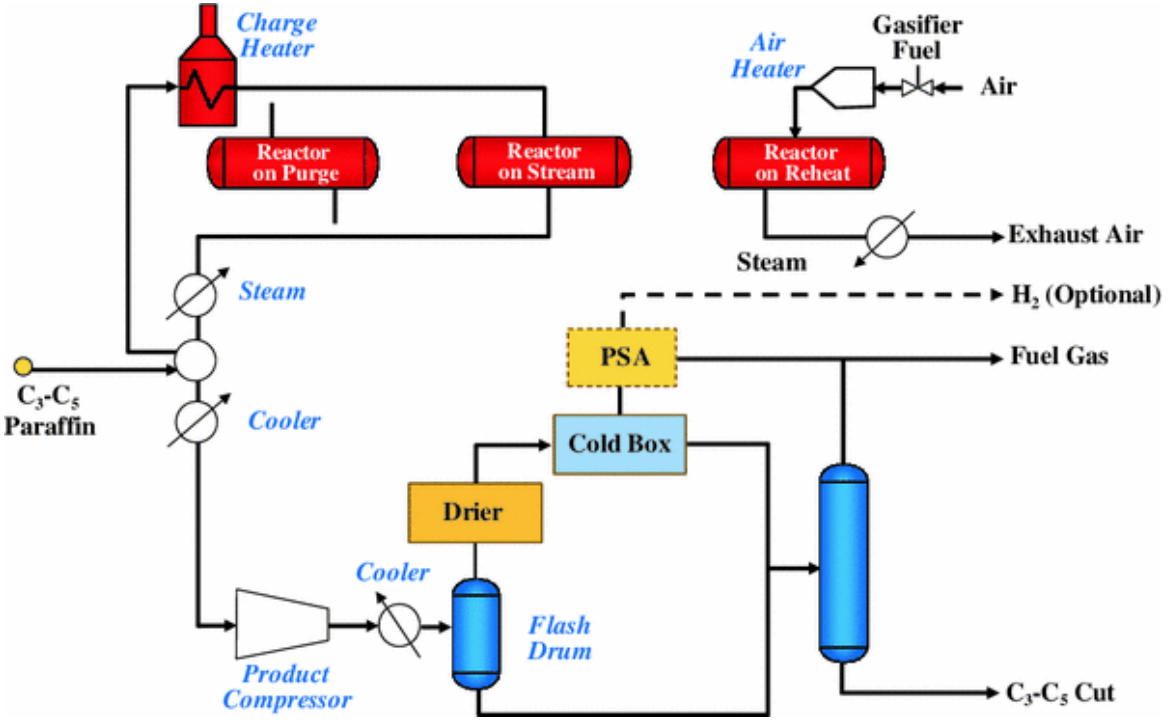
Overview

- There are two major steps in the PDH process: 1) propane feed dehydrogenation, and 2) product separation (removal of hydrogen). The process is highly endothermic and is usually carried out at high temperature (480-600 DegC) and low pressure.

- PDH processes are characterized by the following key parameters:
  - Propylene yield and selectivity
  - Reaction time and conversion (%)
  - Reactor configuration
  - Energy intensity of the process (T and P)
  - Catalyst life span

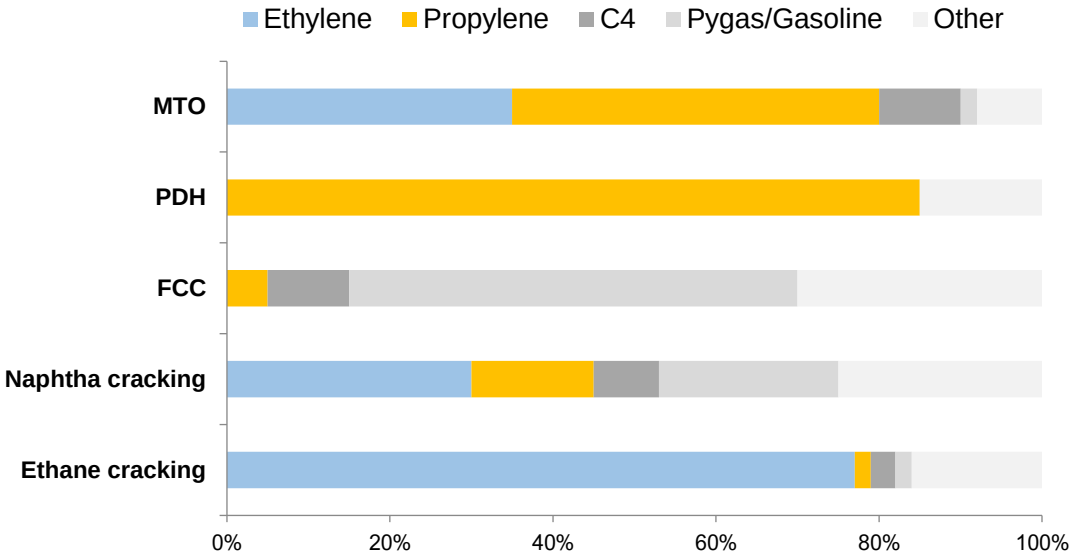
- Among the all PDH technologies, catalyst system lies at the heart as it primarily governs the process economics. Process economics is also governed by the type of feedstock used and accordingly, the cost of production varies from region to region. As of 2021, cost of PDH propylene production in the US and Europe ranges as USD 930-950 per tonne, whereas in the Asia region, the cost is USD 990-1,050 per tonne.



The CATOFIN process of PDH
Source: Lummus Technology

PDH Advantage

PDH offers on-purpose conversion of propane to propylene, offering significantly higher propylene yields when compared with traditional (e.g., naphtha cracking and FCC) and new (e.g., MTO) processes.



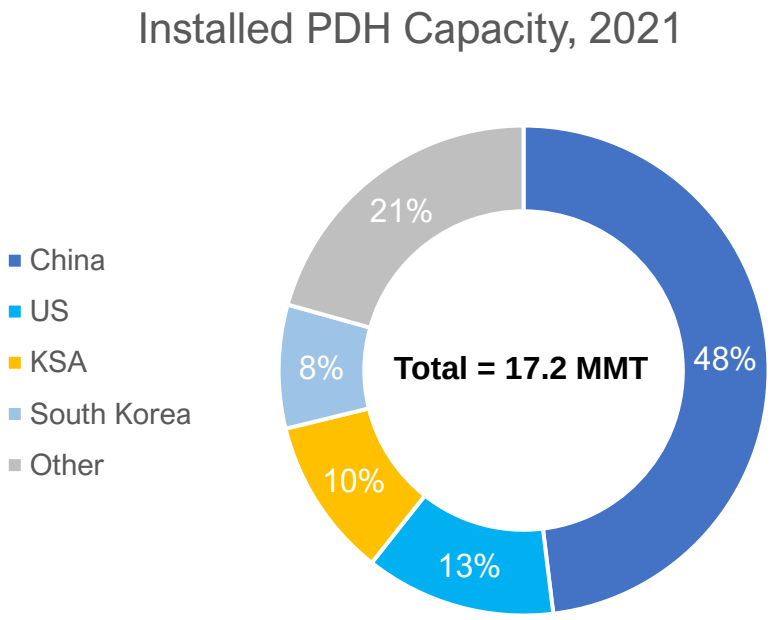
PDH offers the highest propylene yield among the commercial production processes

Note: Yields are indicative as there can be variations due to feedstock and process selection, and specific technology deployed.

Higher propylene yields have made PDH an attractive pathway for propylene production, given the current and projected propylene supply-demand gap in many regions.

Regional PDH Presence

China is the major PDH capacity holder due to its higher domestic propylene demand. US is expected to lead in PDH capacity growth, considering the propylene supply-shortage emerging due to the increasing focus on ethane crackers.

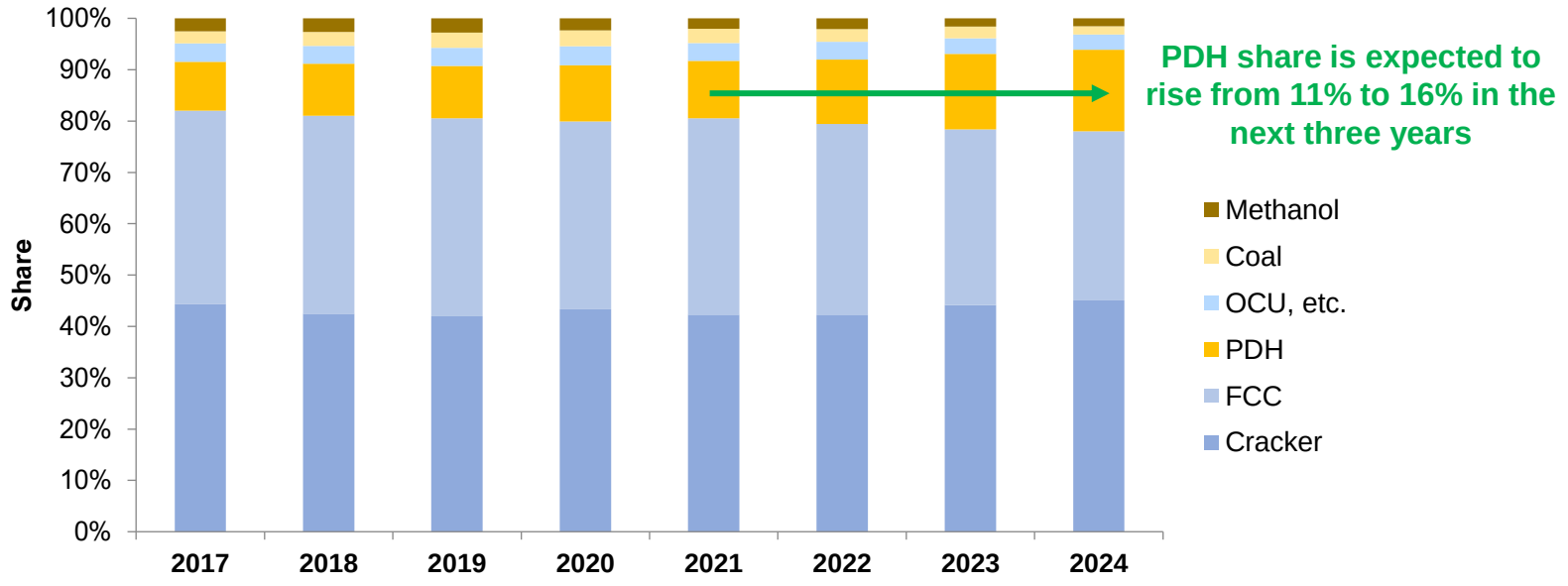


- China leads in terms of the PDH installed capacity globally by having almost half of it. In the coming years, China is also expected to add significant PDH capacity.
- United States is currently having a propylene supply shortage which is expected to widen in the coming years. This is mainly because of the limited FCC and naphtha cracking propylene output. New cracker plants are meant to process ethane, rather than naphtha due to abundance of NGLs. The US PDH capacity is expected to beat the global PDH capacity growth, with a CAGR of 27% during 2021-24.
- KSA also holds significant PDH capacity (10% of the global capacity). As of now, KSA has only one capacity addition announced during the next four years.

Regional distribution of the PDH capacity is expected to witness change in the years to come, as capacity expansion in the US is likely to be aggressive. Asia, other than China, shall also witness new plants coming up.

PDH Growth

Global PDH installed capacity is expected to grow at a CAGR of 18% during 2021-24, increasing share of PDH from 11% in 2021 to 16% in 2024. This shall necessitate the catalyst demand, regional technology and support availability, and auxiliary processing systems such as membranes, process additives, etc.



Share of processes in the global propylene production

Since there are several established and emerging PDH technologies, it represents an attractive area for the catalyst system developers, petrochemical and EPC players.

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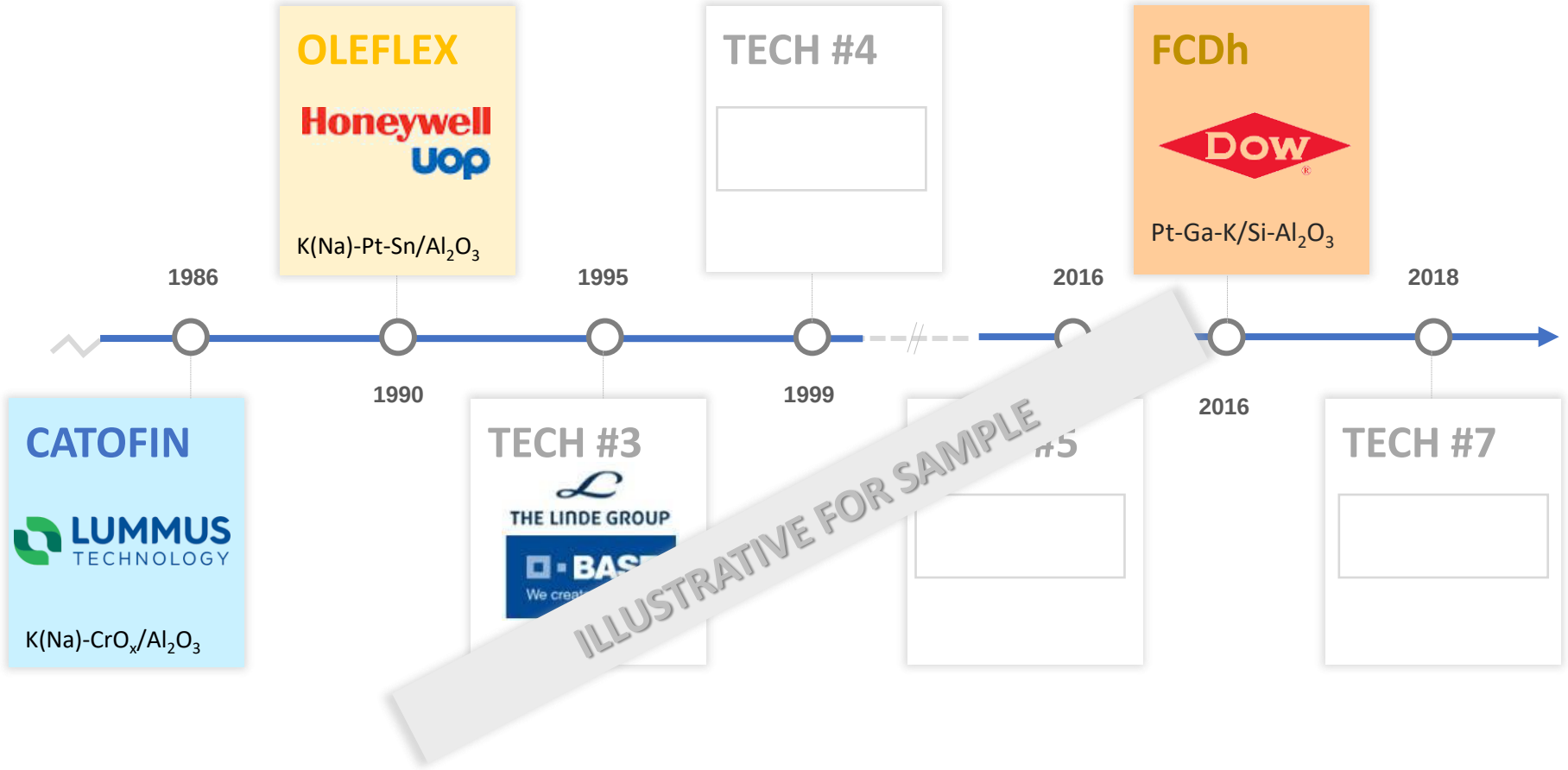
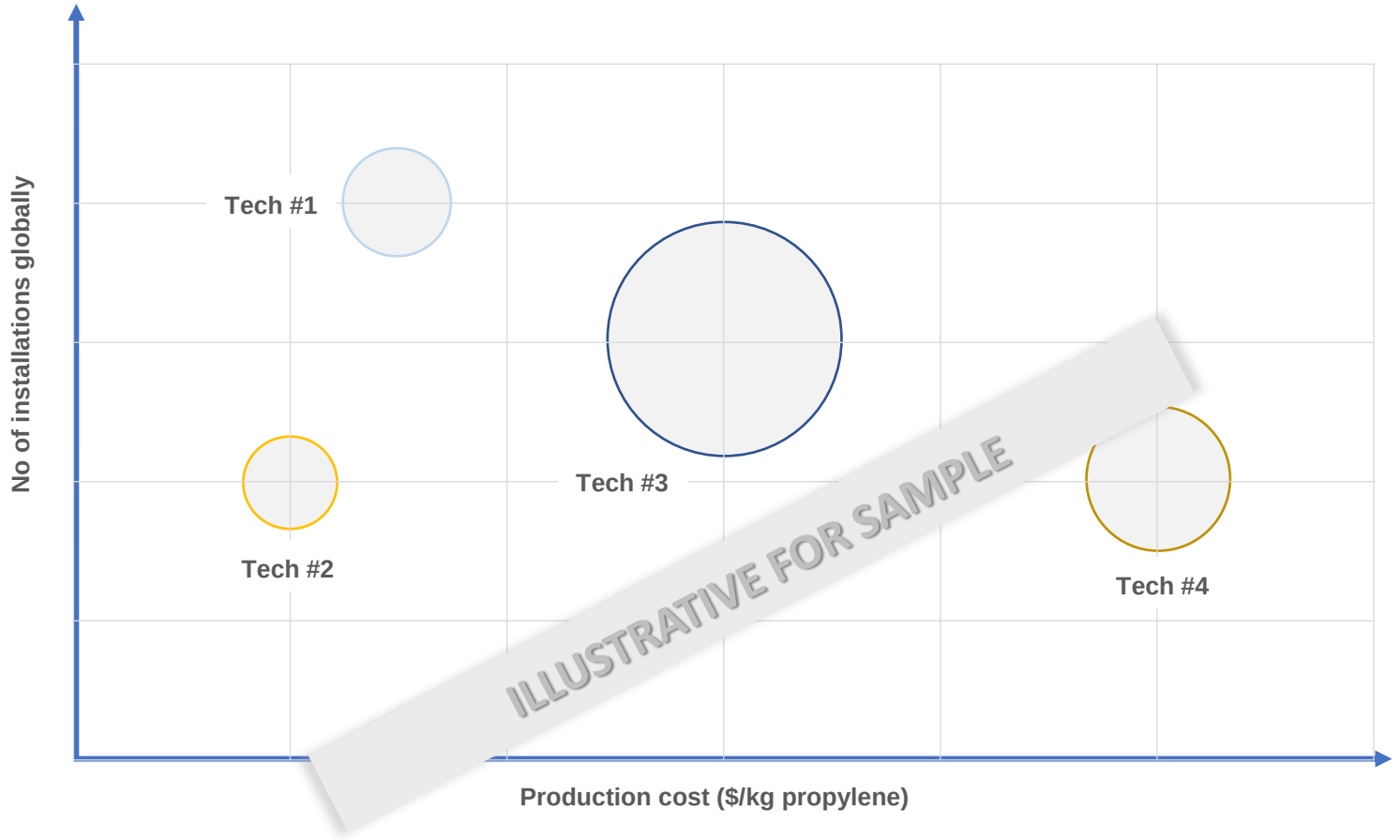
Technology Comparison Matrix

Technology >>	CATOFIN	OLEFLEX	TECH #3	TECH #4	TECH #5	TECH #6
Conversion range (%)	40-45%	xx	xx	xx	xx	xx
Reactor details	Fixed bed horizontal; Batch (20-25 min); T: 560-650 DegC; P: 0.2-0.5 bar	xx	xx	xx	xx	xx
Catalyst details	K(Na)-CrO_x/Al_2O_3	xx	xx	xx	xx	xx
Propylene selectivity	85%	xx	xx	xx	xx	xx
Technology readiness (TRL: 1−9)	Large-scale commercialization (9)	xx	xx	xx	xx	xx
CO2 emissions	xx g CO2/ kg Product	xx	xx	xx	xx	xx
Developer	Lummus Te	xx	xx	xx	xx	xx

Technology Evolution Map



Technology Impact Chart



Note: Bubble size indicates total installed capacity

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PDH Catalyst Systems

Catalyst Type		Chemistry									
Metal-based catalysts	Catalyst	Pt									
	Promoter	Sn	Ga	Fe	Mn	In	Cu	Zn	Ti	Zr	V
Metal oxide-based catalysts		CrO_x	VO_x	GaO_x	ZnO_2	$Cr_xZr_xO_x$	xx	xx	xx	xx	xx
Miscellaneous catalysts		CNT	Zeolite	Metal+ Zeolite	Carbide	Nitride	Sulfide	xx	xx	xx	xx
Support systems		Al_2O_3	SiO_2	CeO_2	$MgAl_2O_4$	xx	xx	xx	xx	xx	xx

	Catalyst System>>	Pt-Sn	Pt-Ga	CrO_x	GaO_x	Pt-I	xx	xx	xx	xx	xx
ASSESSMENT	Performance		xx	xx	xx		xx	xx	xx	xx	xx
	TRL		xx	xx		xx	xx	xx	xx	xx	xx
	Life span		xx			xx	xx	xx	xx	xx	xx
	Cost				xx	xx	xx	xx	xx	xx	xx
	Toxicity			xx	xx	xx	xx	xx	xx	xx	xx
	Competence		xx	xx	xx	xx	xx	xx	xx	xx	xx

Connect with our Team

Harveen Gandhi

Vice President – Business Development

harveen.gandhi@aranca.com

Rajesh Kumar

Technology Research & Advisory
(Chemicals)

rajesh.kumar@aranca.com

For more details: *www.aranca.com | https://www.linkedin.com/company/aranca | https://www.aranca.com/knowledge-library*

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