OPPORTUNITY FOR CO_2 UTILIZATION AT KNPC

Shaima Ameen
Team Leader, Research & Technology
Kuwait National Petroleum Company

RESEARCH & TECHNOLOGY

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OVERVIEW

- Overview of KNPC
- CO_2 Challenge within KNPC
- Technology Tree
- Technology Profiles
- Key Technology Drivers

OVERVIEW OF KNPC

Upstream

- KUWAIT OIL COMPANY
- KUWAIT GULF OIL COMPANY
- KUWAIT FOREIGN PETROLEUM EXPLORATION COMPANY

Midstream

- KUWAIT OIL TANKER COMPANY

KUWAIT PETROLEUM CORPORATION

البترول الوطنية
KNPC
إحدى شركات مؤسسة البترول الكويتية
A Subsidiary of Kuwait Petroleum Corporation

Downstream

- KUWAIT NATIONAL PETROLEUM COMPANY
- PETROCHEMICAL INDUSTRIES COMPANY
- KUWAIT PETROLEUM INTERNATIONAL
- KUWAIT INTEGRATED PETROLEUM INDUSTRIES COMPANY

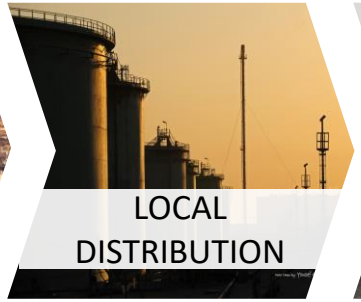
VISION

To be a World-Class Refiner through superior operating and financial performance

MISSION

Add value to Kuwait hydrocarbons, producing high quality fuels to meet local and international demand

OUR ASSETS



CO_2 Challenge within KNPC

CO_2 Challenge

There are large quantities of CO_2 produced as a byproduct in process units and flue gases from heater stacks in the refinery.

Key Sources of CO_2: *Hydrogen Production Units, FCC, Boilers*

Current Scenario

To mitigate CO_2, the current activities undertaken are:

- Supply for Enhanced Oil Recovery (EOR)
- Sell to the local private sector

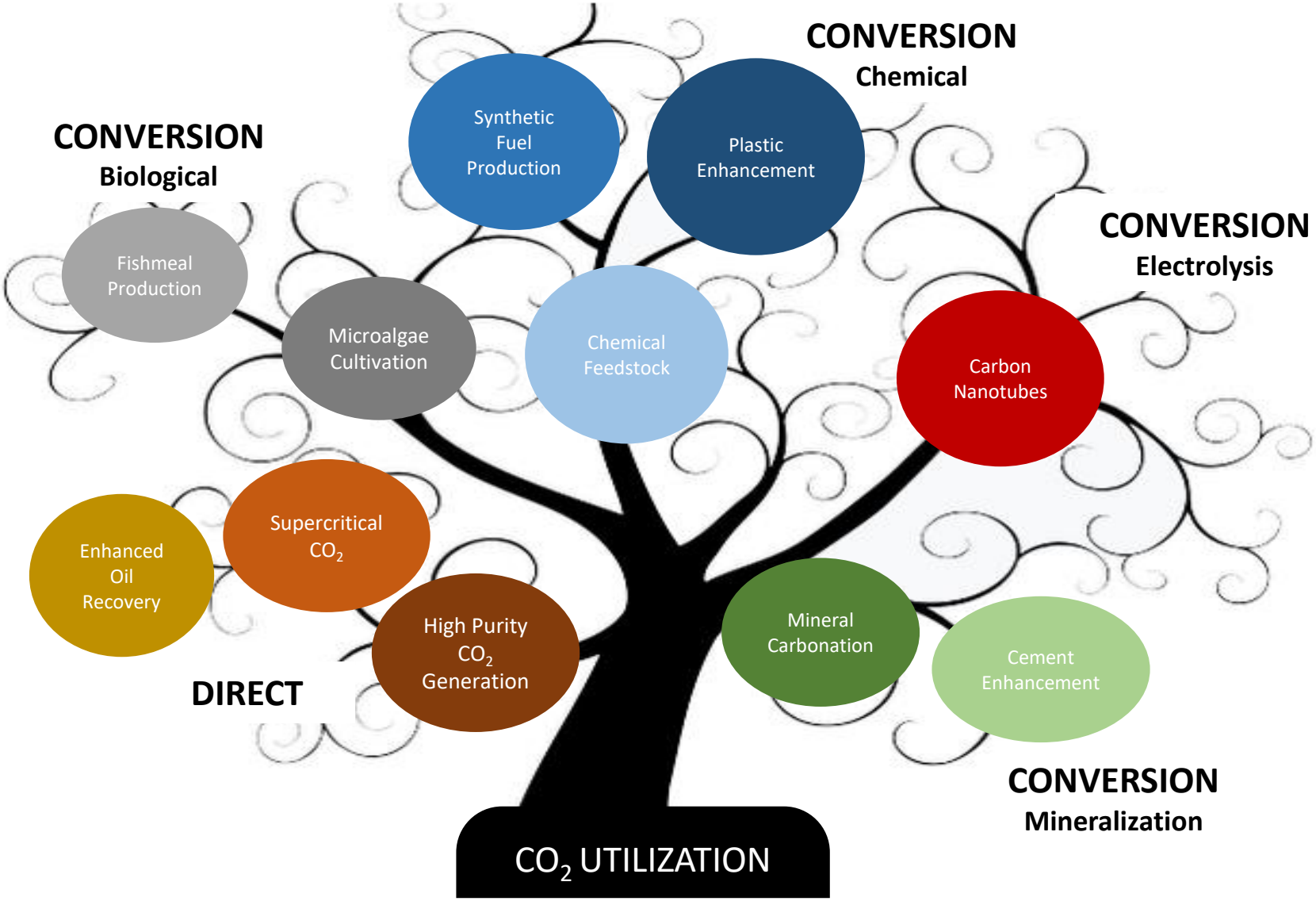
CO_2 Value Creation Objective

To explore emerging and disruptive technologies utilizing CO_2 as feedstock to manufacture valuable new products or green technologies relevant to Oil & Gas business

Approach

Develop Technology Portfolio → **Identify applicable Technologies** → **Deep-dive Technologies** → **Evaluate & Assess Technologies**

TECHNOLOGY TREE



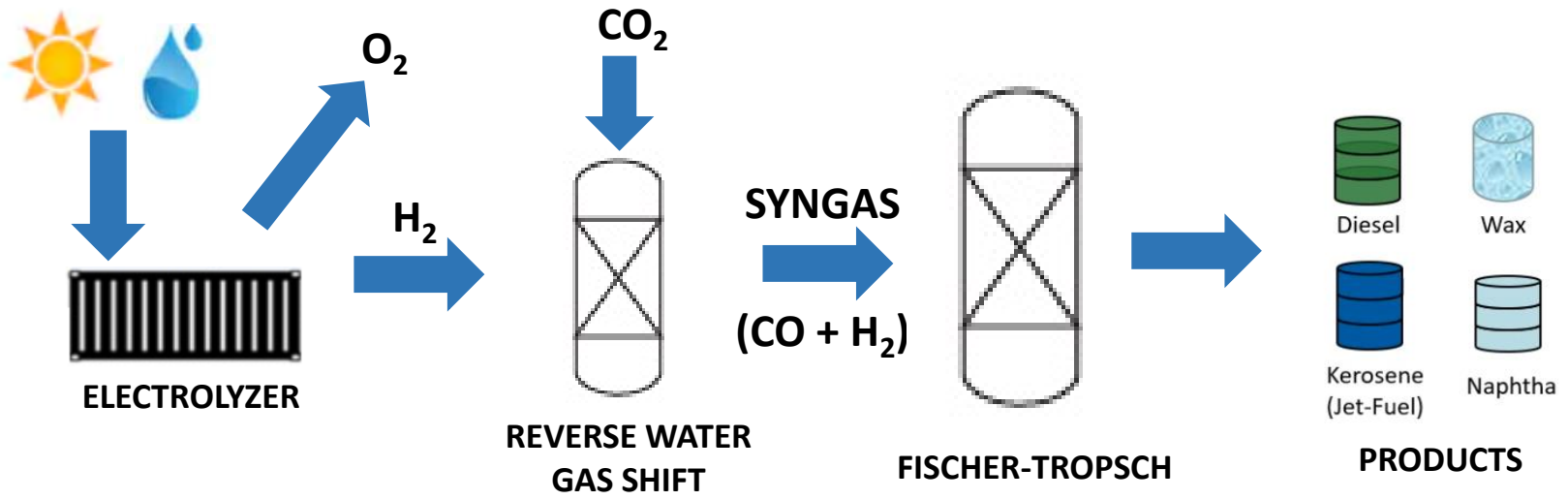
TECHNOLOGY PROFILE

Synthetic Fuel Production

Introduction

CO_2-based synthetic fuels are of increasing interest to the energy industry as a viable approach to reducing greenhouse gas (CO_2) emissions. Production of CO2-based synthetic fuels has been very limited to date but is expected to increase in the near future.

Technology Aspects



Technology Position

- Technology Types: Solid Oxide Electrolyzer Cell (SOEC), Membrane, Catalytic Systems
- Wide range of technologies with TRL 7-8 in piloting expansion Stage
- First commercial plant being built

Market Dynamics

- The global market for CO2-based synthetic fuels has not yet been estimated as it is at an early stage of development.
- Majority of the work conducted in Europe and North America

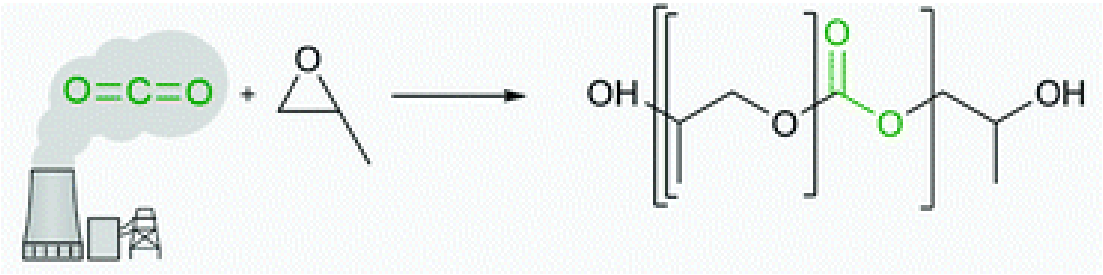
TECHNOLOGY PROFILE

Plastic Enhancement- Polyols

Introduction

CO2 can be utilized as a carbon source for polymer production. Processes are being developed to 're-activate' inert CO_2 into value added final products. Reducing, reusing and recycling CO_2 towards minimizing the carbon footprint of society.

Technology Aspects



CO_2 Epoxide Polyols

Plastics

Coatings

Absorbents

PRODUCTS

Technology Position

- As this is early stage development, researchers are identifying new reaction pathways and novel catalysts.
- Extensive R&D mainly on catalyst being conducted in companies as well as research institutions

Market Dynamics

- The expected global growth for Polyols is CAGR of 5.9% between 2019-2024 and estimated worth is $26 bn in 2019
- Asia-Pacific holds the largest polyol market

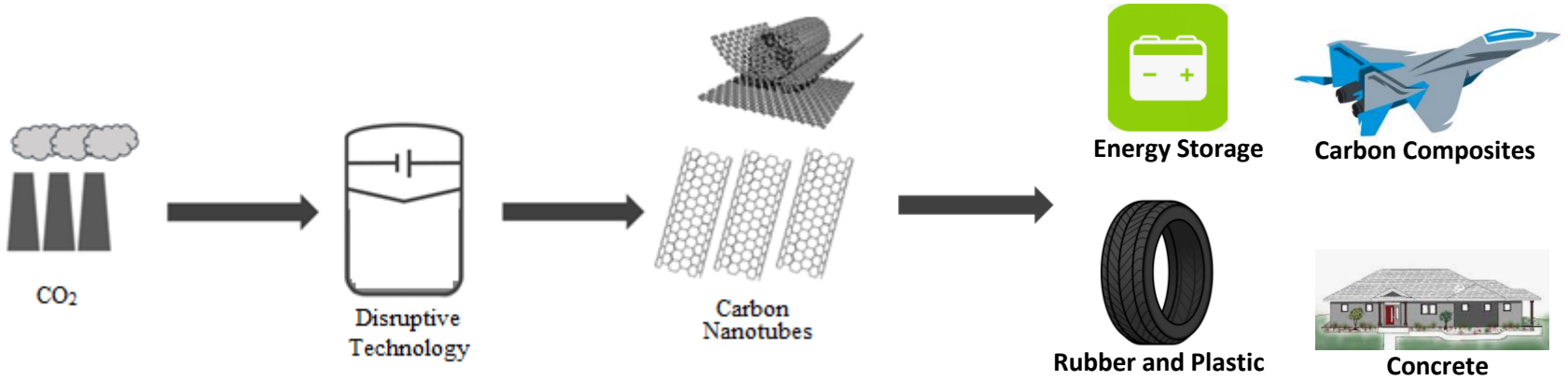
TECHNOLOGY PROFILE

Carbon Nanotubes

Introduction

Carbon Nanotubes (CNT) have a very broad range of uses and applications due to properties such as electrical conductivity, high tensile strength and thermal conductivity. Major applications in aerospace, medical, defense, batteries, capacitors, chemicals and polymers.

Technology Aspects



Technology to convert CO_2 into Carbon Nanotubes

PRODUCTS

Technology Position

- Technology Types: Catalyst Reaction, Molten Electrolysis
- Molten Electrolysis is one of the disruptive technologies
- Wide range of technologies due to intensive R&D

Market Dynamics

- The forecasted global market for CNT is $9.84bn by 2023 at CAGR of 16.7%.
- The forecasted global market for Synthetic Graphite is $26.71bn by 2022
- North America is the leading market

KEY TECHNOLOGY DRIVERS

TECHNOLOGY INNOVATION

REGULATORY FRAMEWORK

SUSTAINABILITY & ENVIRONMENT

THANK YOU

KNPC's commitment to scout for emerging and disruptive technologies in ***utilization of CO_2*** *is vital for being a major player in the realm of sustainable and green technologies in the future*