# HOW CCS CAN HELP TO TACKLE THE CLIMATE CHANGE CHALLENGE

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AND GUSTAVO R S ÁSSI (USP)

ABC – CLIMATE ENGINEERING – JUNE 11 2019

CLEANER ENERGY FOR A SUSTAINABLE FUTURE

Research Centre for Gas Innovation

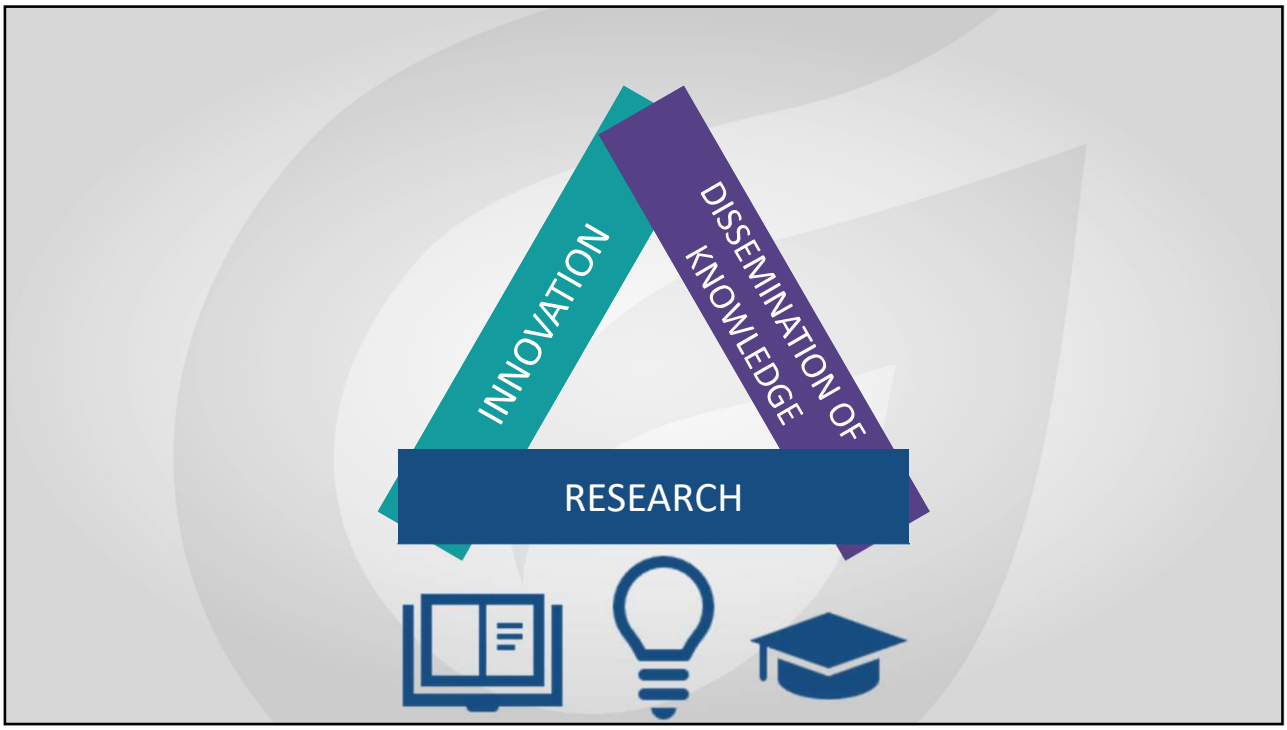
1

Research Centre for Gas Innovation

energia limpa para um futuro sustentável

A centre for advanced studies on the **mitigation of green-house gases**, investigating the sustainable use of natural gas, biogas, hydrogen and abatement of $CO_2$ emissions.


2

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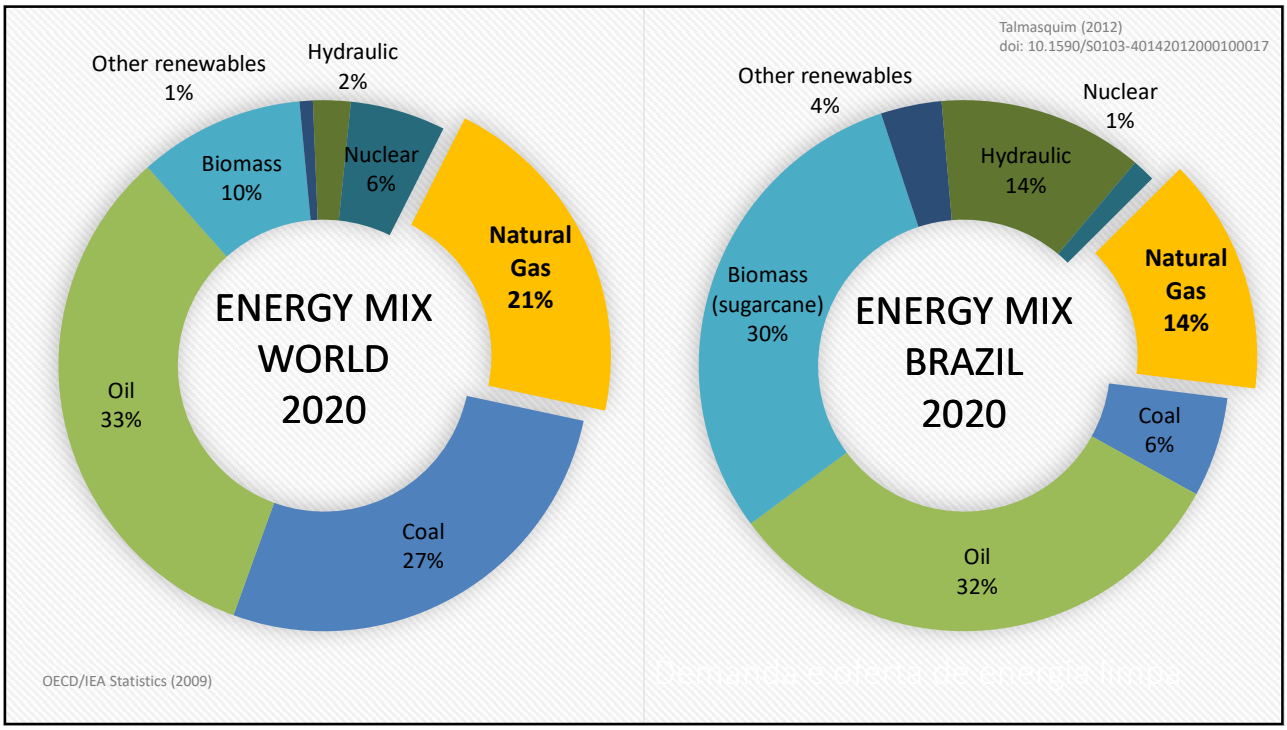
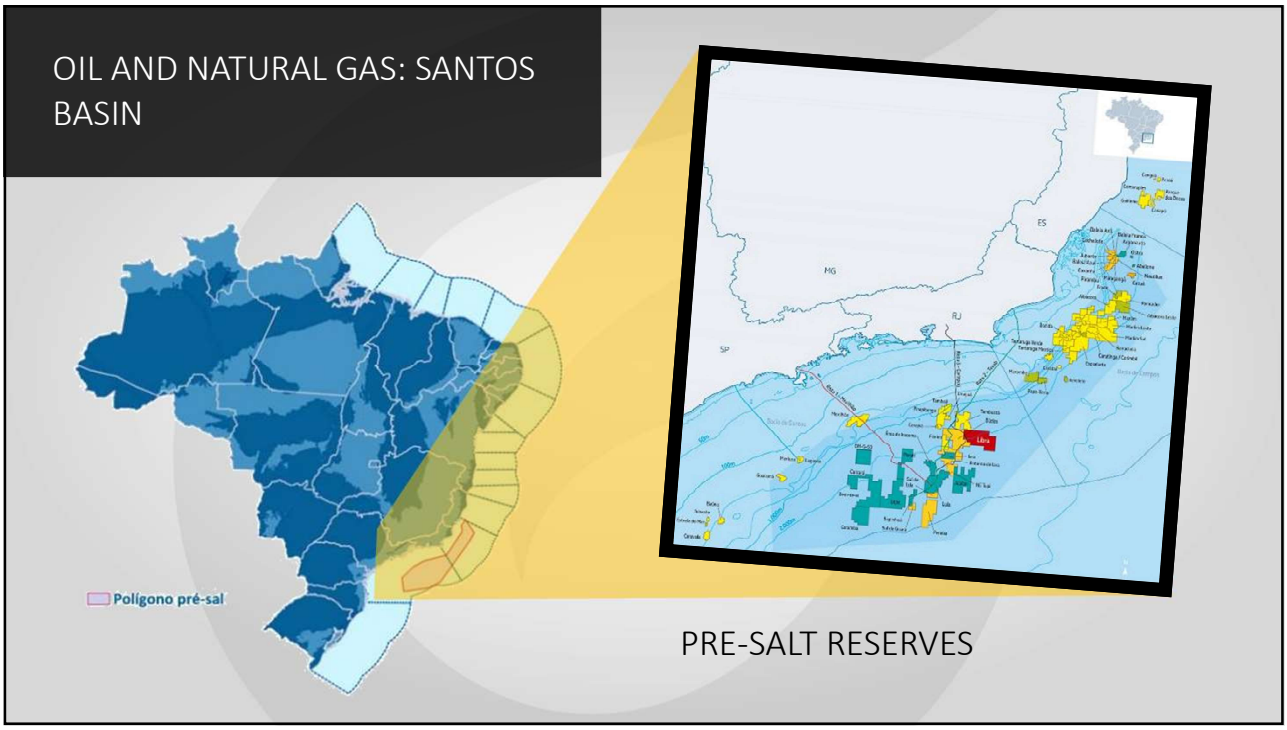
# CLEAN ENERGY FOR A SUSTAINABLE FUTURE

## RCGI'S MOTIVATION

4

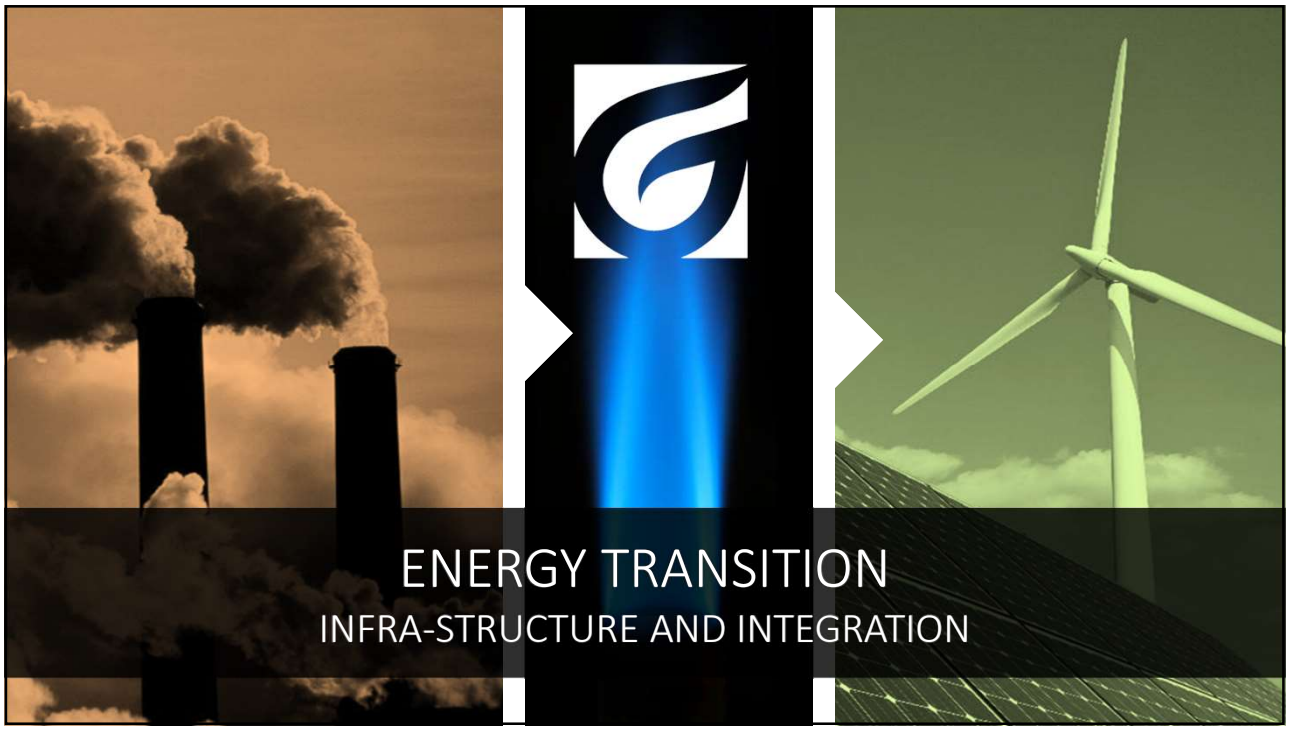

Talmasquim (2012)
doi: 10.1590/S0103-40142012000100017
ENERGY MIX WORLD 2020
Other renewables 1%
Hydraulic 2%
Nuclear 6%
Natural Gas 21%
Coal 27%
Oil 33%
Biomass 10%
OECD/IEA Statistics (2009)
ENERGY MIX BRAZIL 2020
Other renewables 4%
Nuclear 1%
Hydraulic 14%
Natural Gas 14%
Coal 6%
Oil 32%
Biomass (sugarcane) 30%

5


OIL AND NATURAL GAS: SANTOS BASIN
Polígono pré-sal
PRE-SALT RESERVES

6

7

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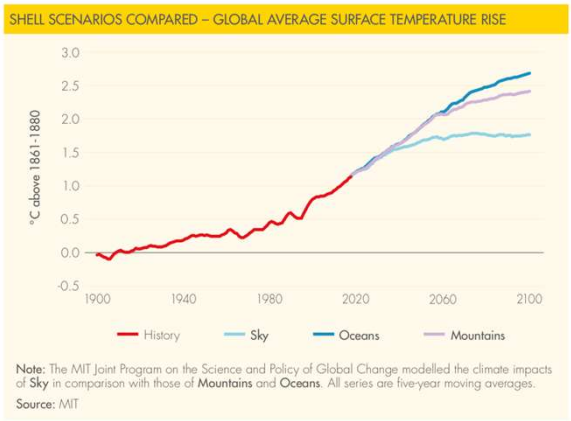
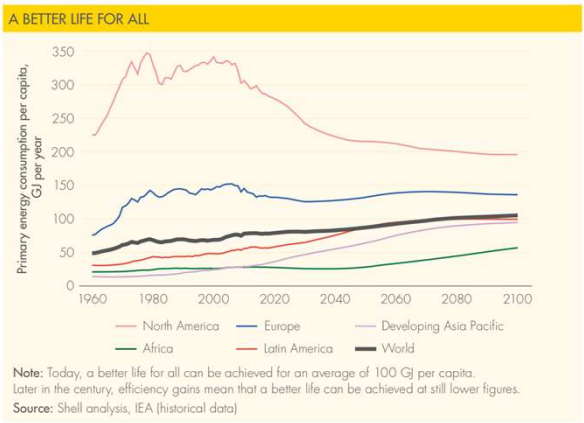
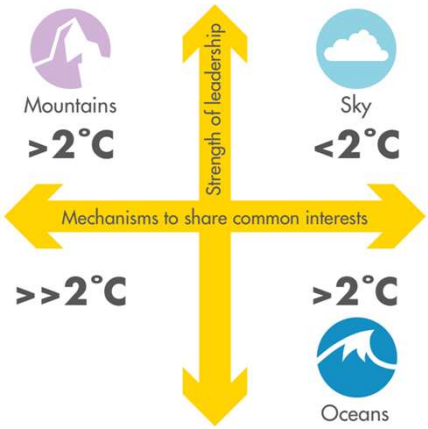
## Energy increase demand (per head) in the World

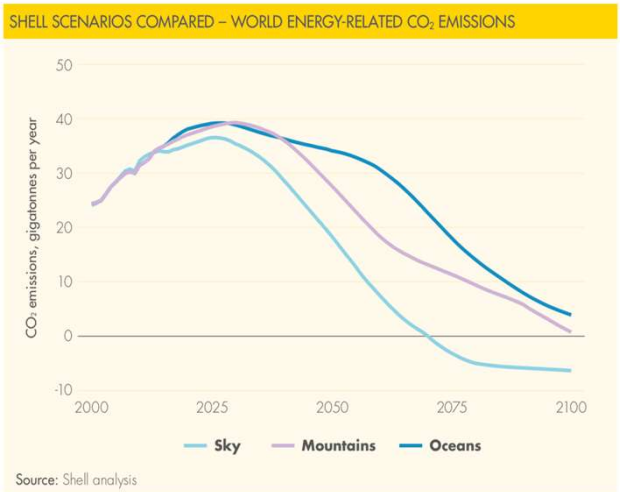


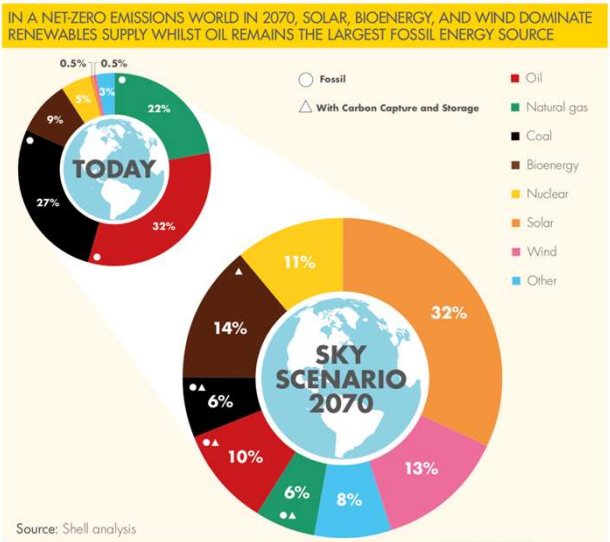



## GHG emissions and Climate Change



## SHELL Sky Scenario



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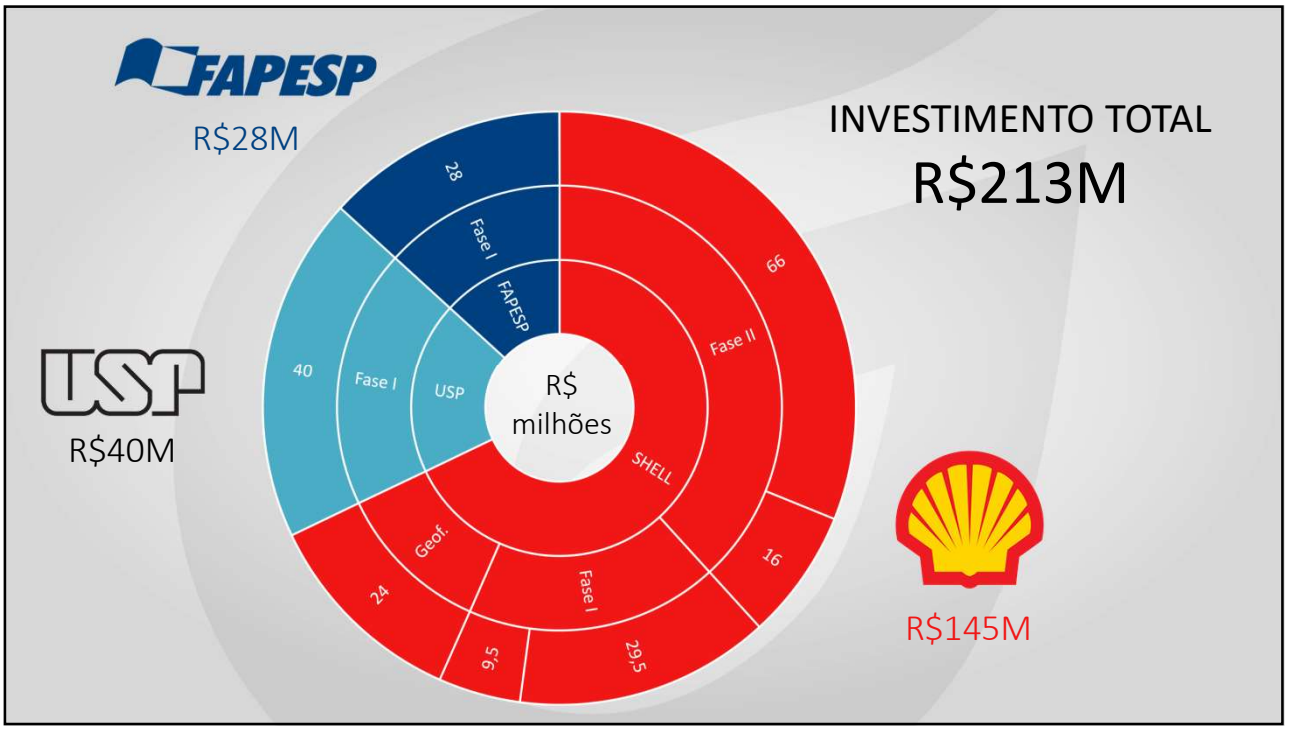
## FOUNDING SPONSORS

FAPESP

USP

10 years

12

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# INSTITUIÇÕES PARCEIRAS

USP
FAPESP
POLI USP
IEE USP
ipen
Universidade de São Paulo Instituto de Química
INSTITUTO MAUÁ DE TECNOLOGIA MAUÁ
ufscar
UNIFESP UNIVERSIDADE FEDERAL DE SÃO PAULO 1933
SUSTAINABLE GAS INSTITUTE
GOVERNO DO ESTADO SÃO PAULO Secretaria de Energia e Mineração
anp Agência Nacional do Petróleo, Gás Natural e Biocombustíveis

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## RESEARCH CENTRE FOR GAS INNOVATION

350+ researchers

46 research projects

5 programmes

International Collaborations

15

## RESEARCH PROGRAMMES

ENGINEERING

PHYSICAL-CHEMISTRY

ECONOMICS & ENERGY POLICIES

CO2 ABATEMENT

GEOPHYSICS

16

# CHOSEN PROJECTS

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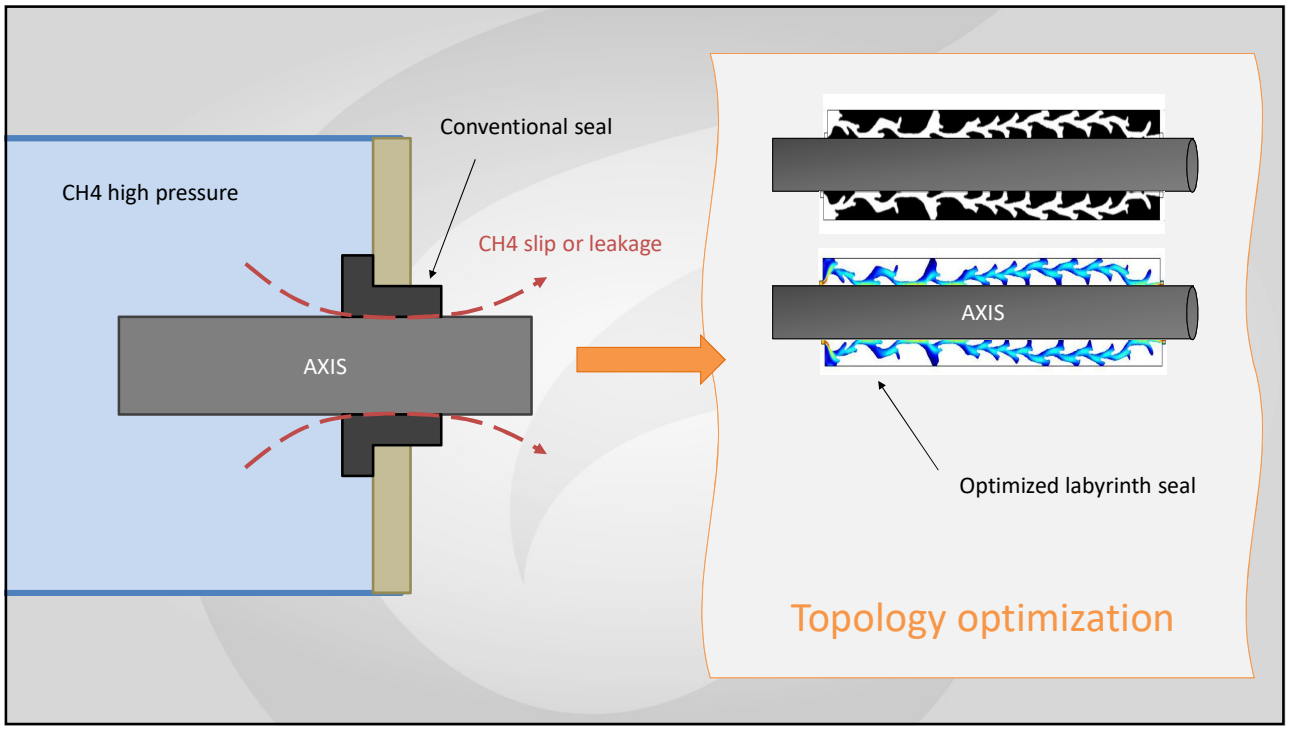
ENGINEERING PROGRAMME

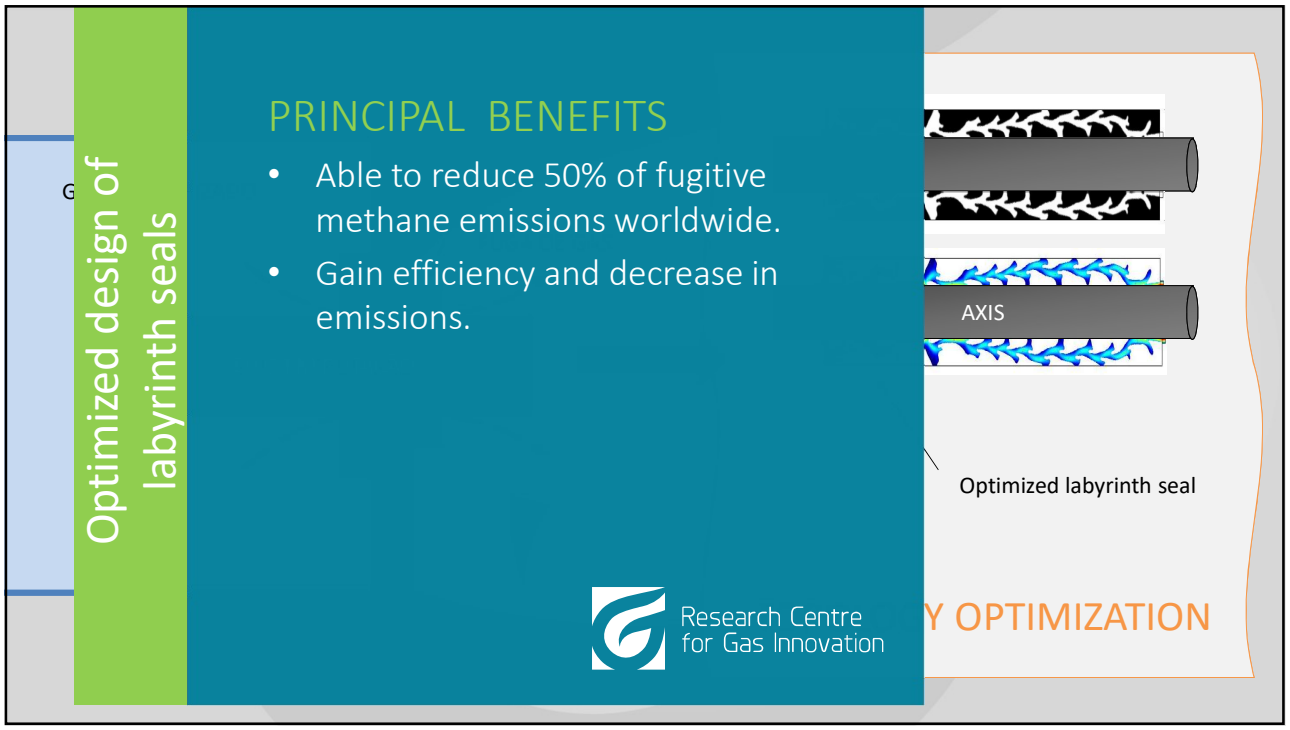
## METHANE SLIP

PROJECT 10
Optimized labyrinth seal designto

18


Conventional seal
CH4 high pressure
CH4 slip or leakage
AXIS
AXIS
Optimized labyrinth seal
Topology optimization

19


Optimized design of labyrinth seals
PRINCIPAL BENEFITS
• Able to reduce 50% of fugitive methane emissions worldwide.
• Gain efficiency and decrease in emissions.
Research Centre for Gas Innovation
AXIS
Optimized labyrinth seal
Y OPTIMIZATION

20

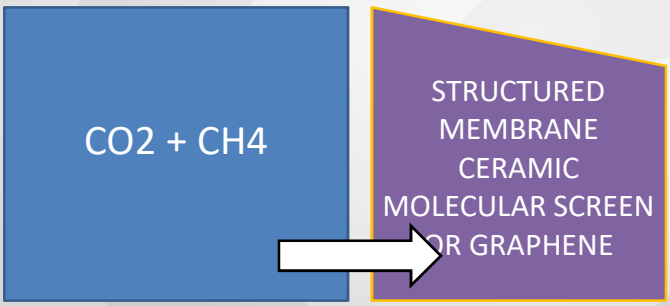
PHYSICAL CHEMISTRY PROGRAMME

# GAS SEPARATION

PROJECT 39

Separation of CO2 and CH4 with structured membranes

21

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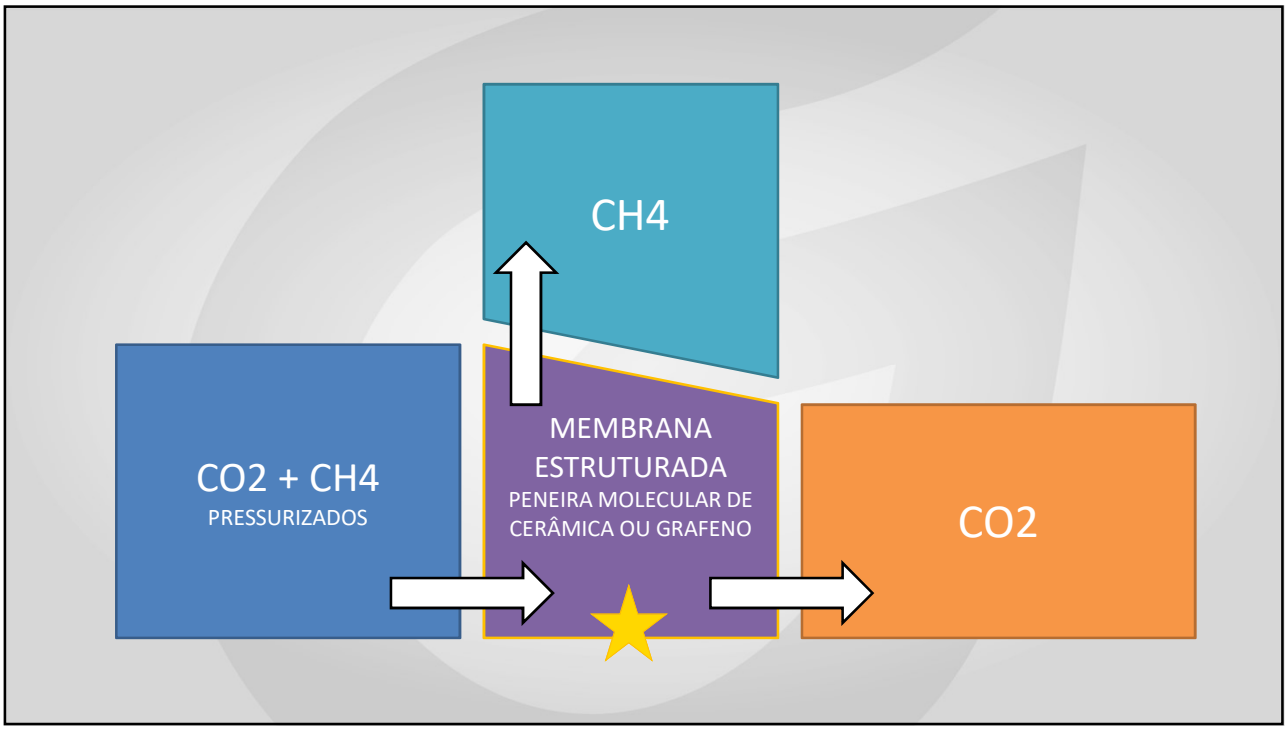
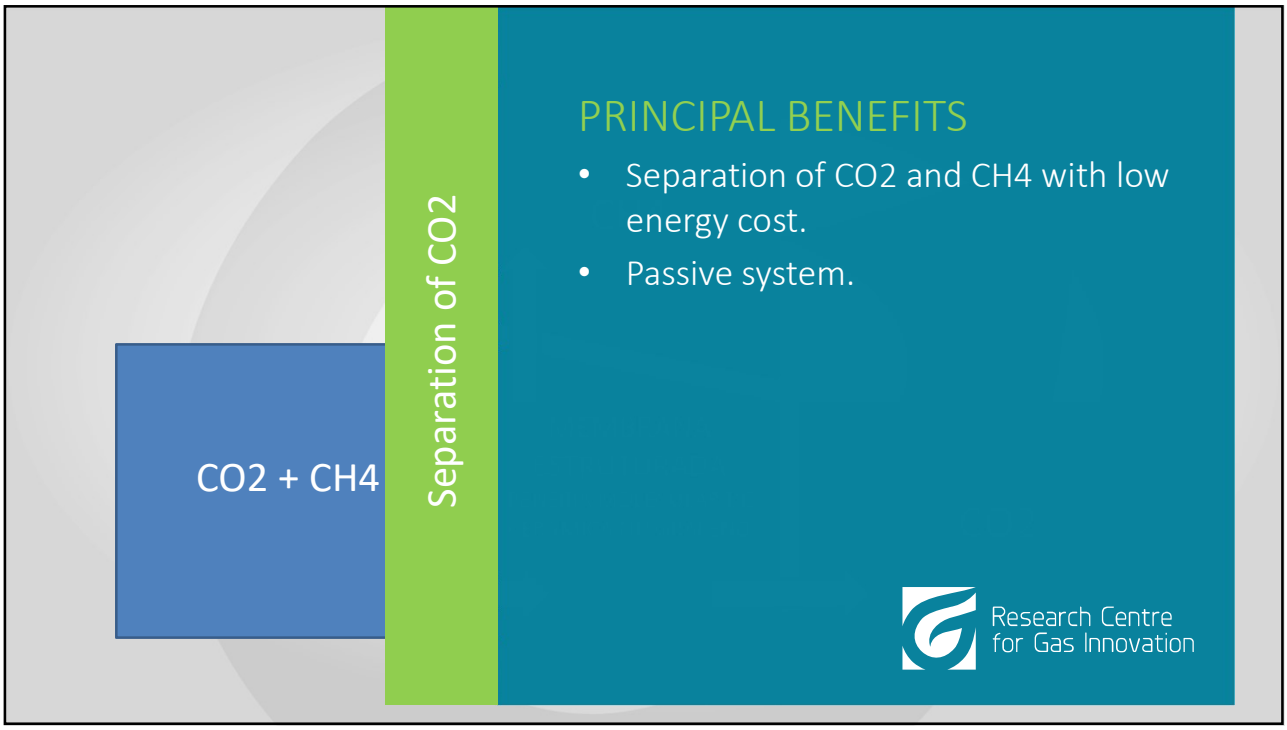

CH4
CO2 + CH4
PRESSURIZADOS
MEMBRANA
ESTRUTURADA
PENEIRA MOLECULAR DE
CERÂMICA OU GRAFENO
CO2

23


CO2 + CH4
Separation of CO2
PRINCIPAL BENEFITS
• Separation of CO2 and CH4 with low energy cost.
• Passive system.
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CO2 Abatement Programme

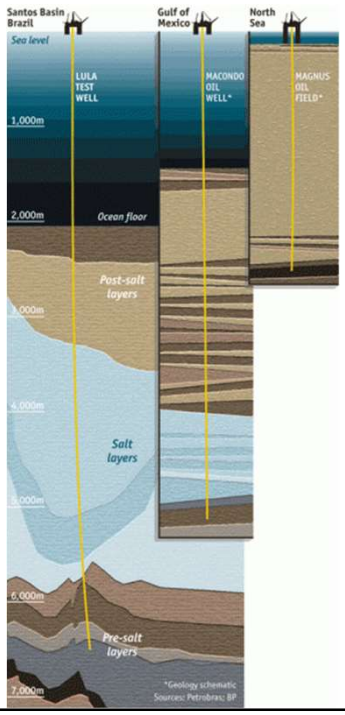
# CCUS

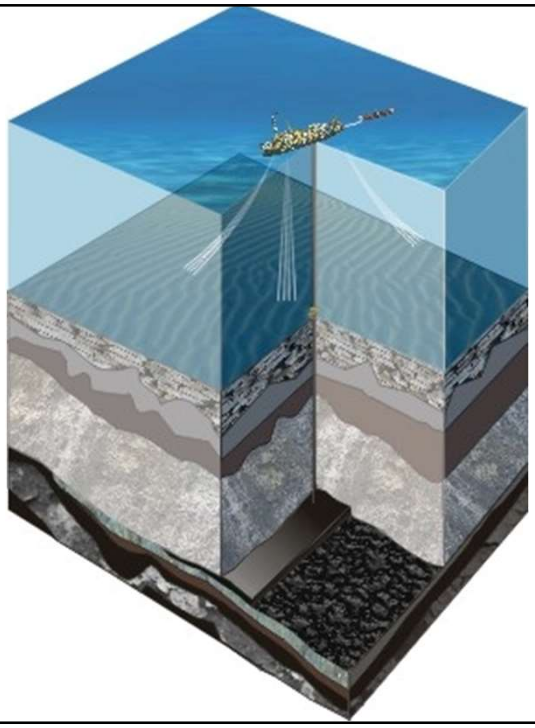
## Carbon Capture, Utilization and Storage

PROJECT 34

Storage and Separation of CO2 e CH4 in salt caverns (pre-salt basin)

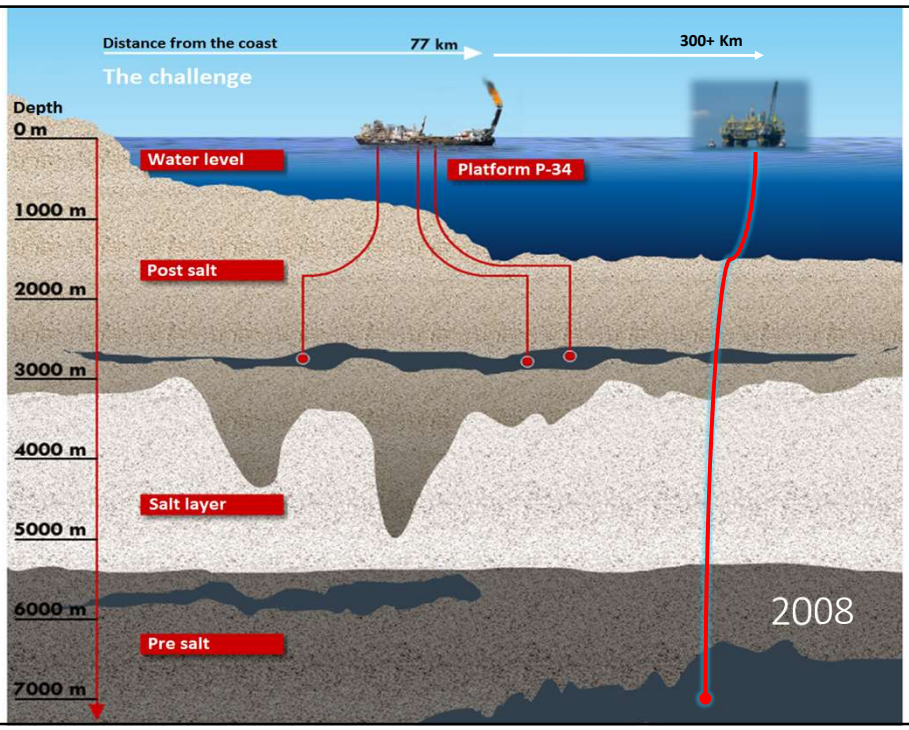
25



Challenges of the Pre-salt

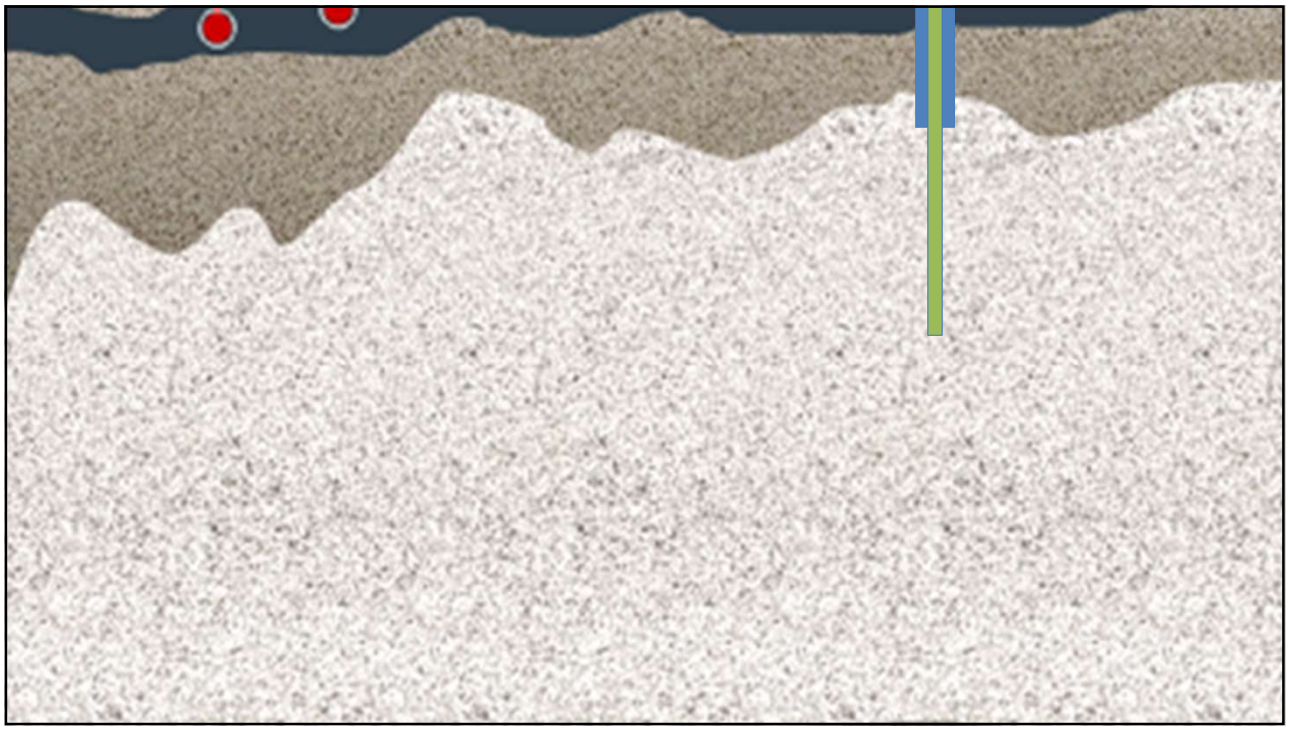
26




Challenges of the Pre-salt

27

28



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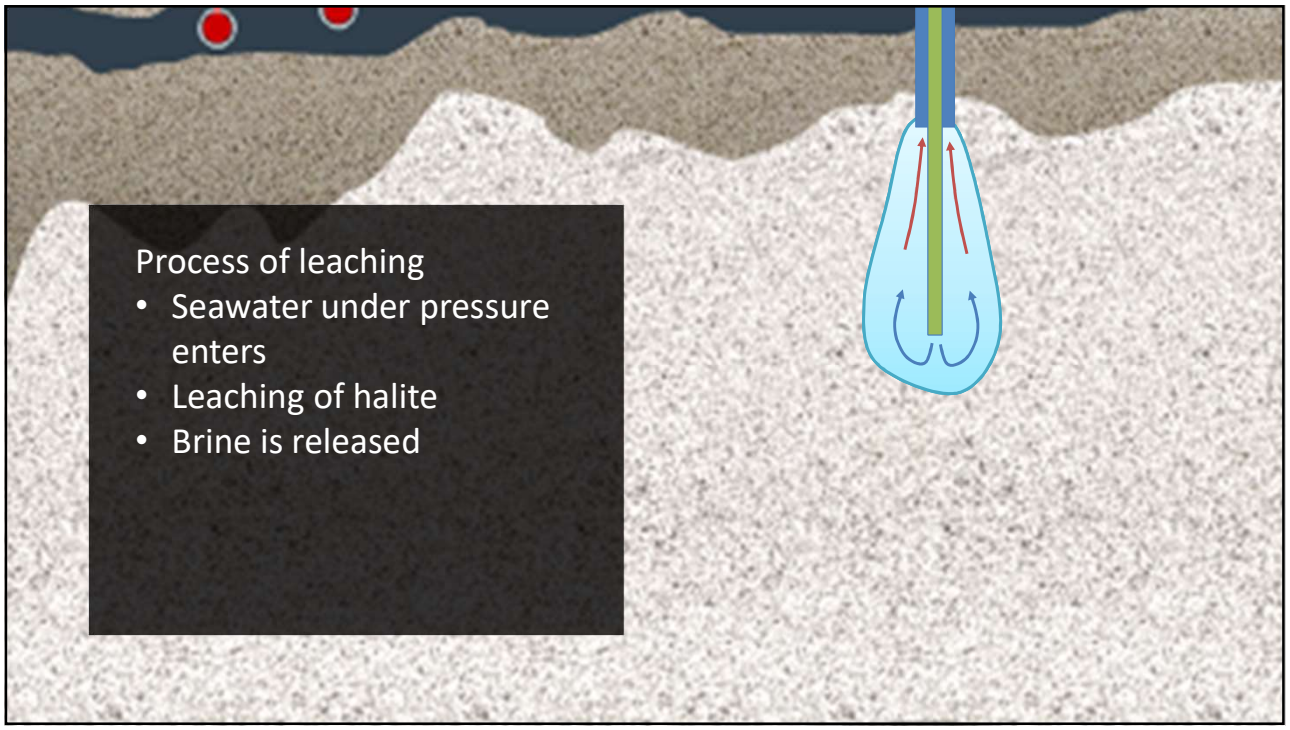
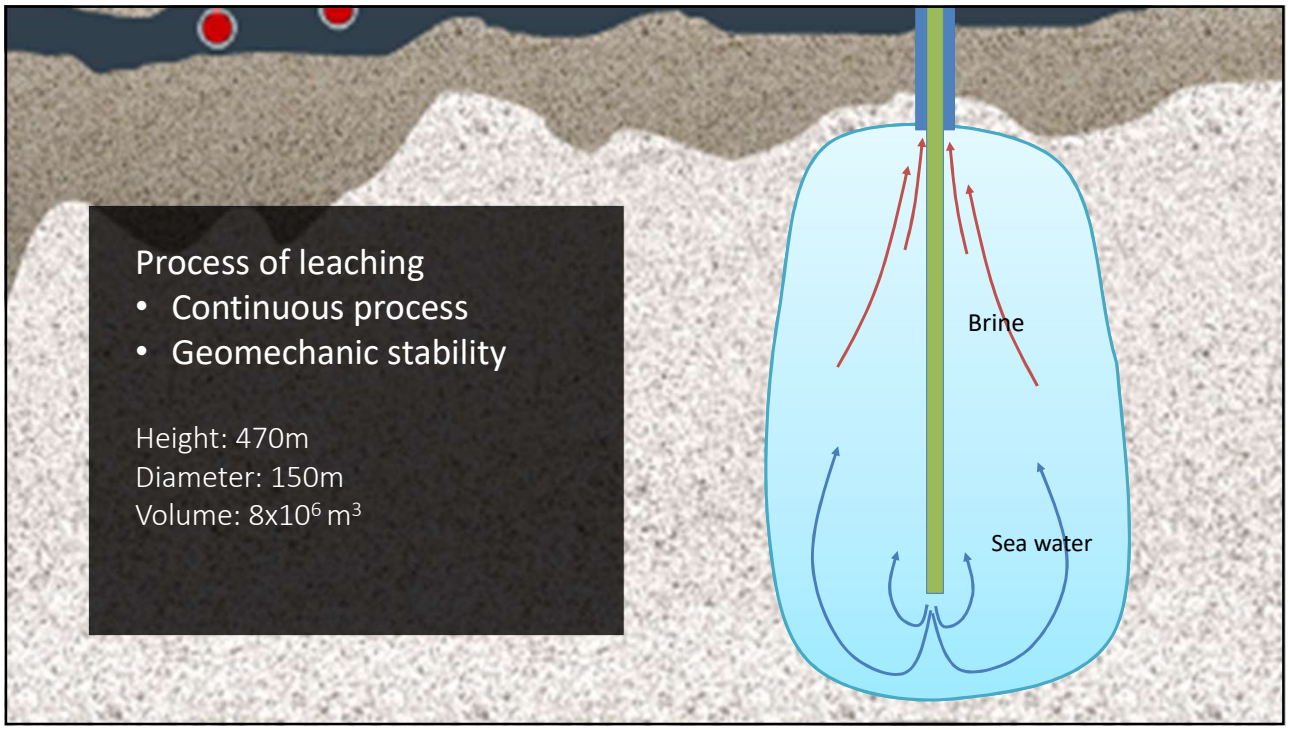
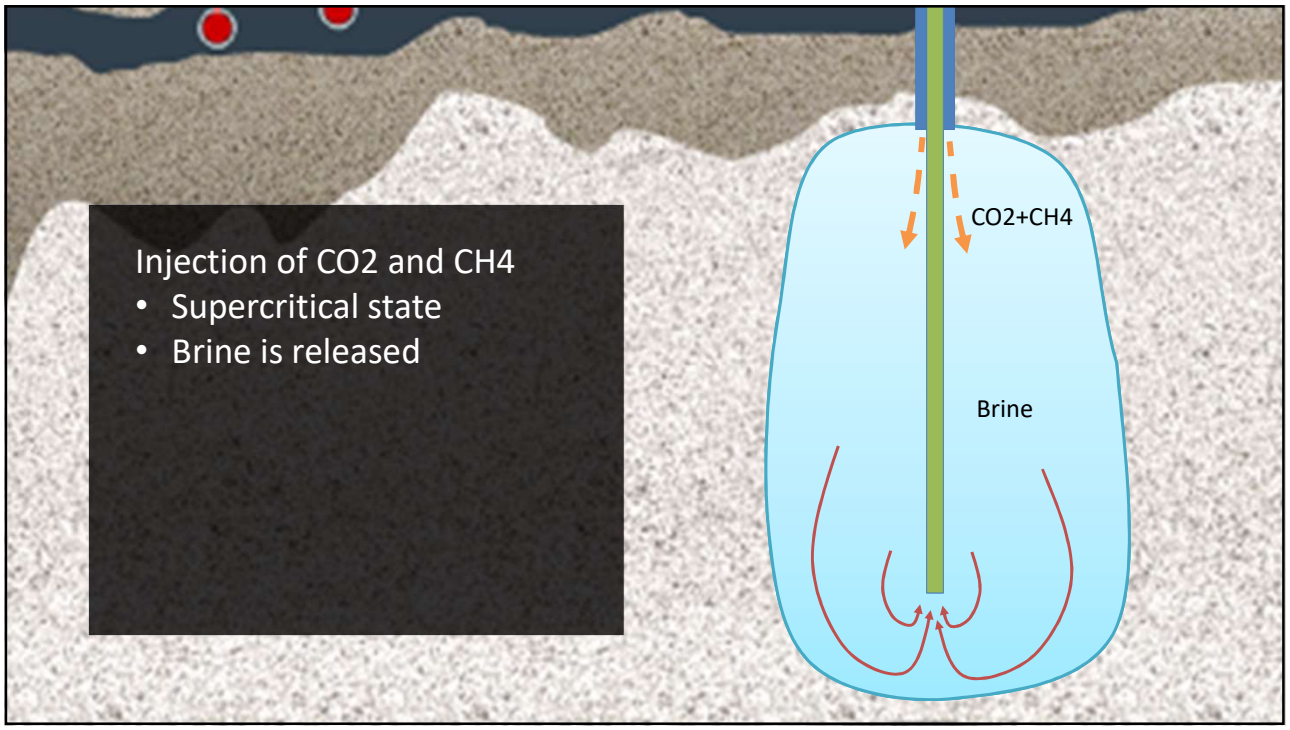

Process of leaching
• Seawater under pressure enters
• Leaching of halite
• Brine is released

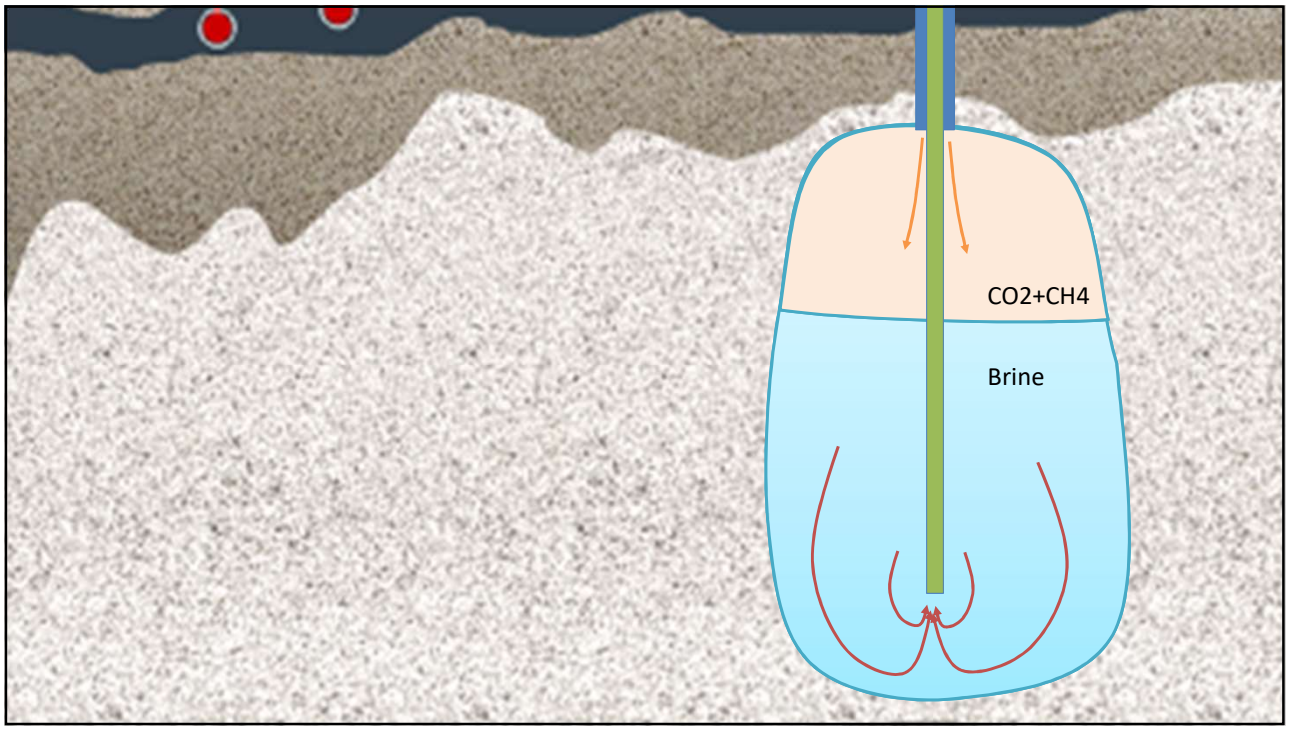
30


Process of leaching
• Continuous process
• Geomechanic stability
Height: 470m
Diameter: 150m
Volume: 8x10⁶ m³
Brine
Sea water

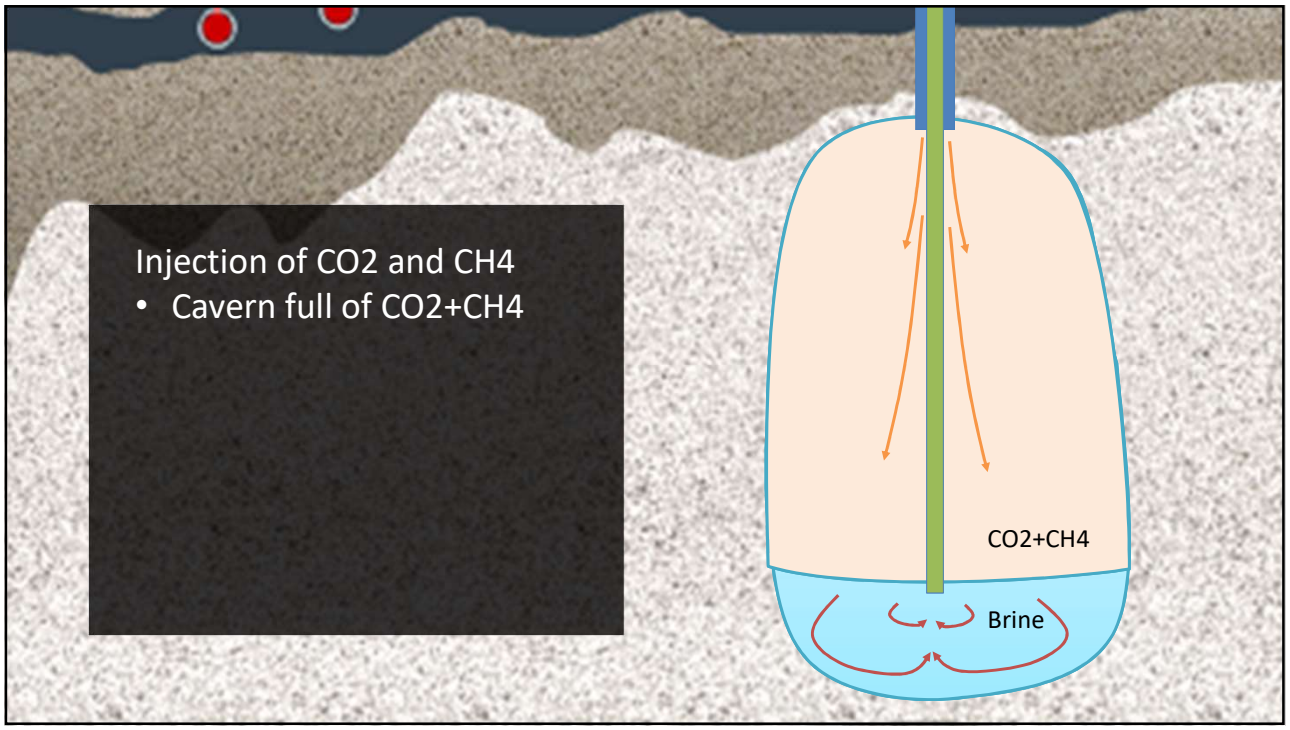
31


Injection of CO2 and CH4
• Supercritical state
• Brine is released
CO2+CH4
Brine

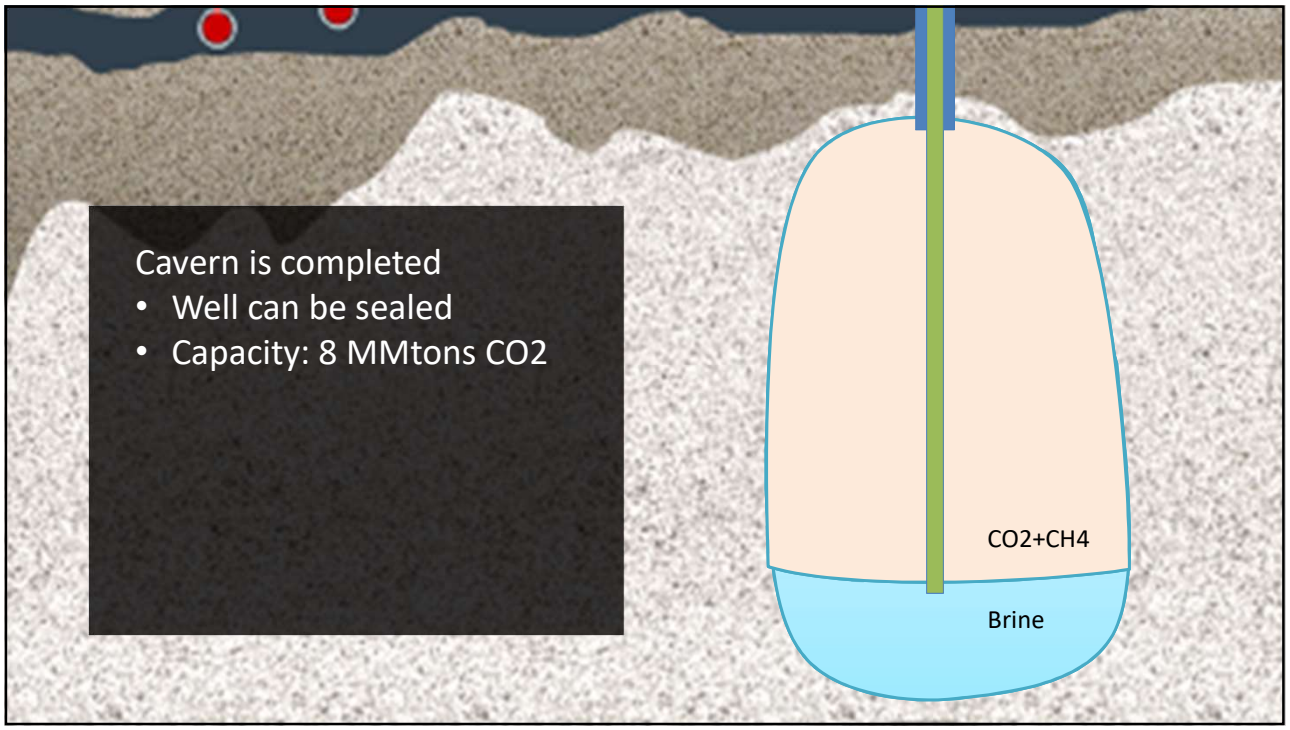
32


CO2+CH4
Brine

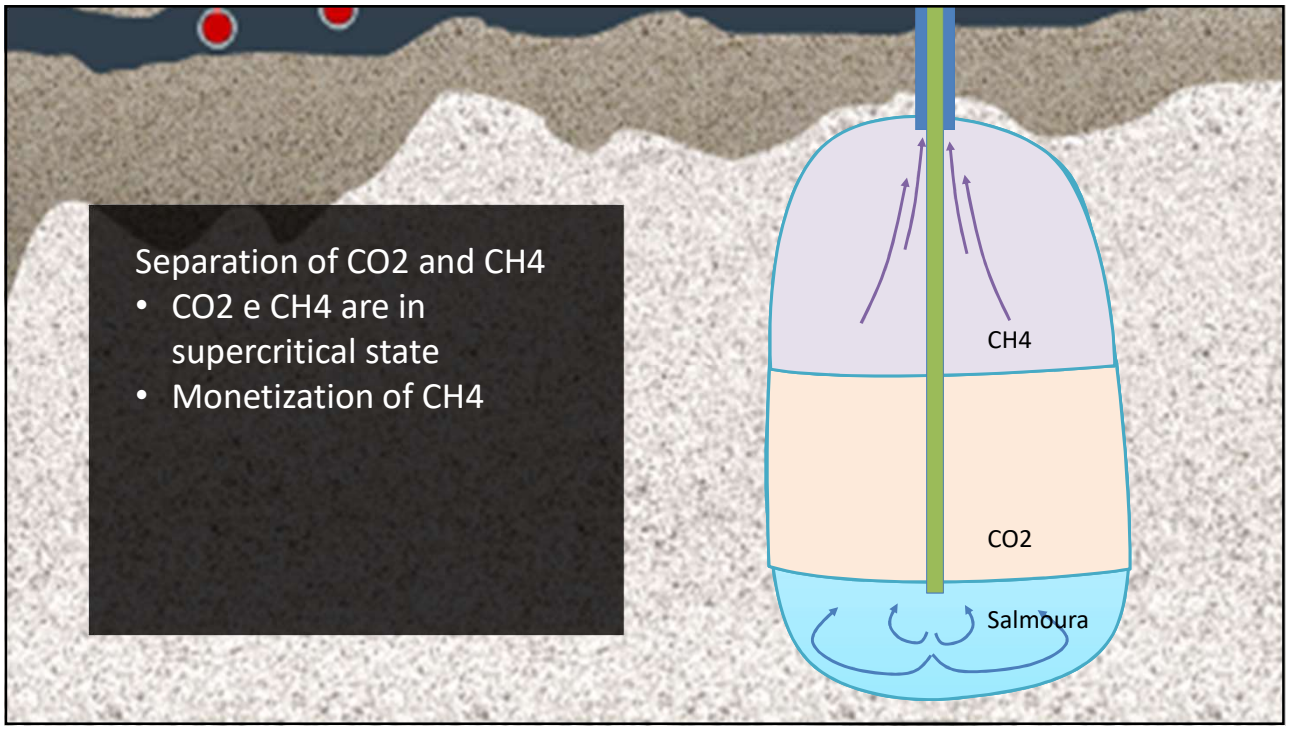
33


Injection of CO2 and CH4
• Cavern full of CO2+CH4
CO2+CH4
Brine

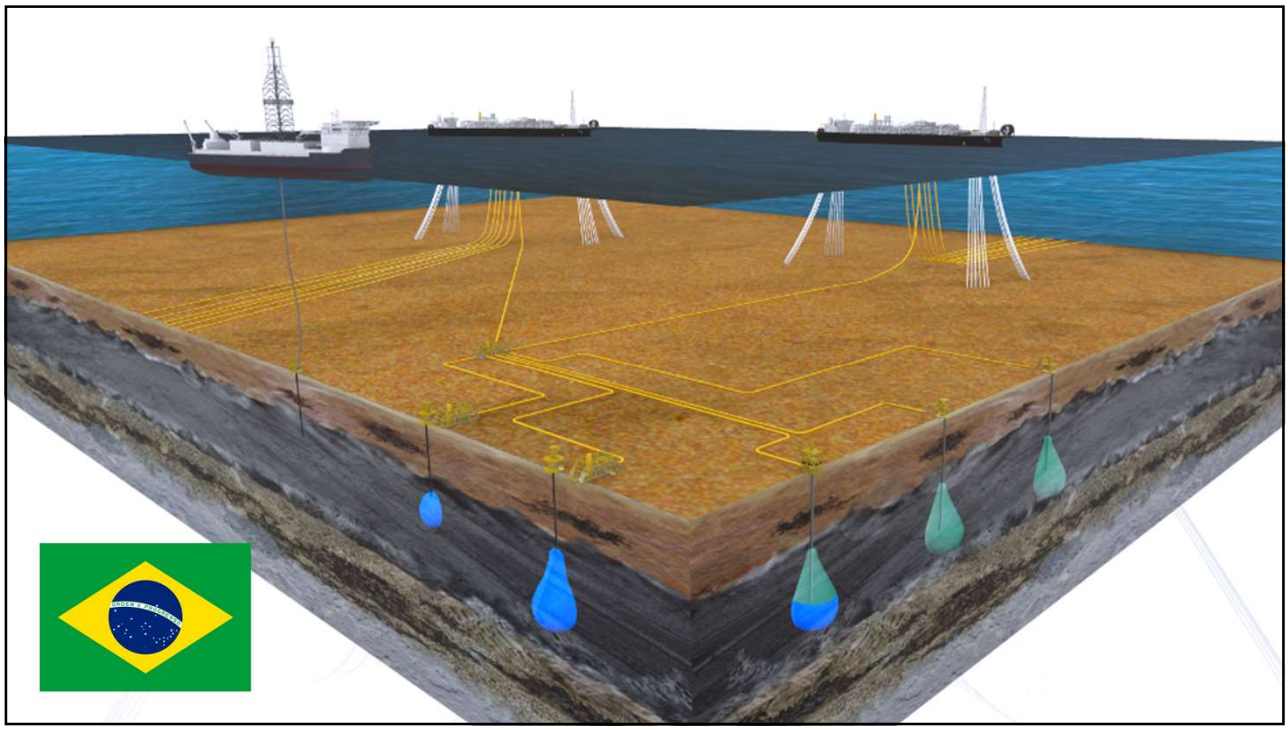
34


Cavern is completed
• Well can be sealed
• Capacity: 8 MMtons CO2
CO2+CH4
Brine

35


Separation of CO2 and CH4
• CO2 e CH4 are in supercritical state
• Monetization of CH4
CH4
CO2
Salmoura

36



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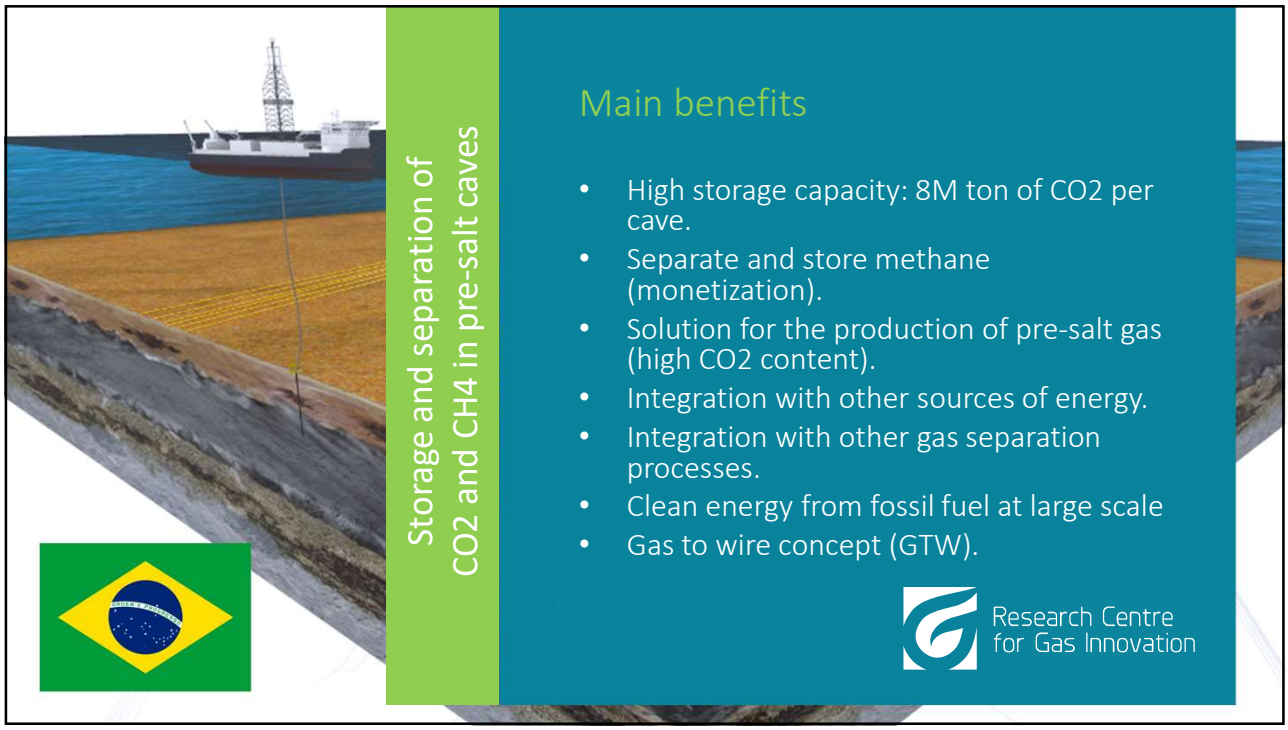
Storage and separation of
CO2 and CH4 in pre-salt caves
Main benefits
• High storage capacity: 8M ton of CO2 per cave.
• Separate and store methane (monetization).
• Solution for the production of pre-salt gas (high CO2 content).
• Integration with other sources of energy.
• Integration with other gas separation processes.
• Clean energy from fossil fuel at large scale
• Gas to wire concept (GTW).
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# NEW PROPOSALS

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PROGRAMME OF ENERGY POLICIES AND ECONOMICS

## BECCUS

Bioenergy Carbon Capture, Usage and Storage

BECCS of CO2 from ethanol production

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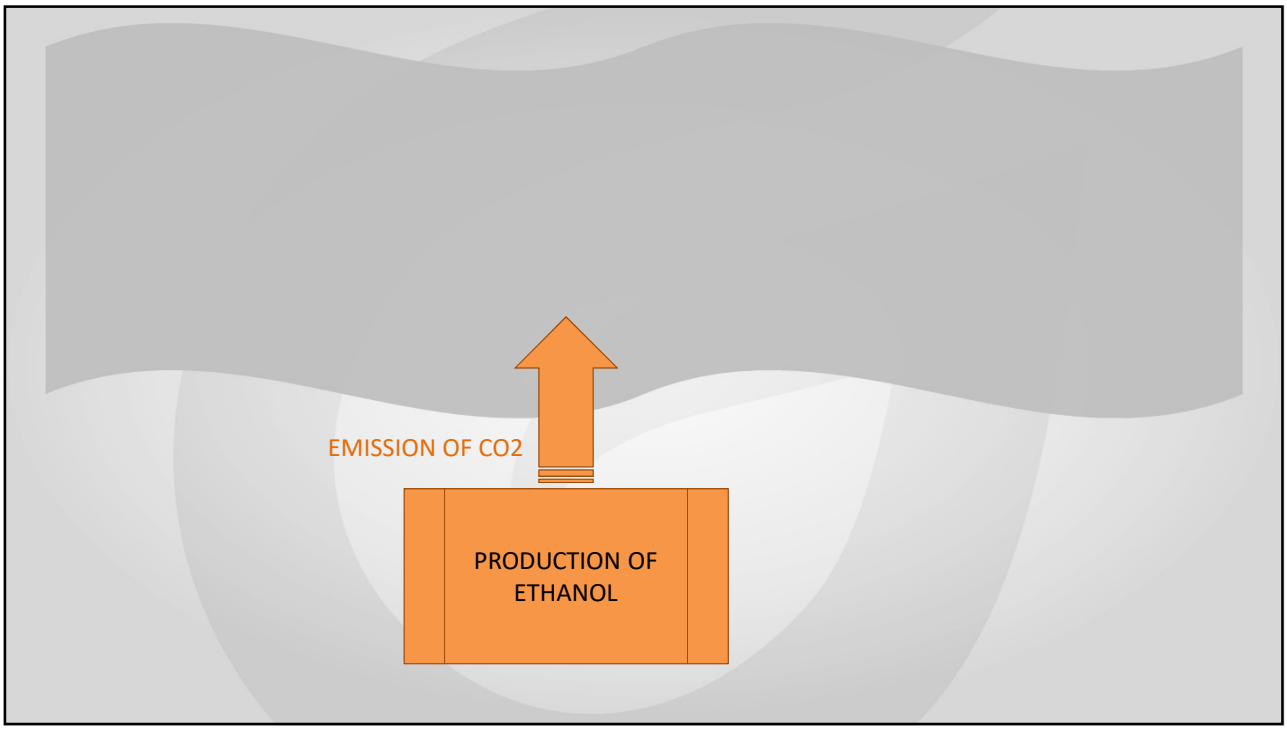
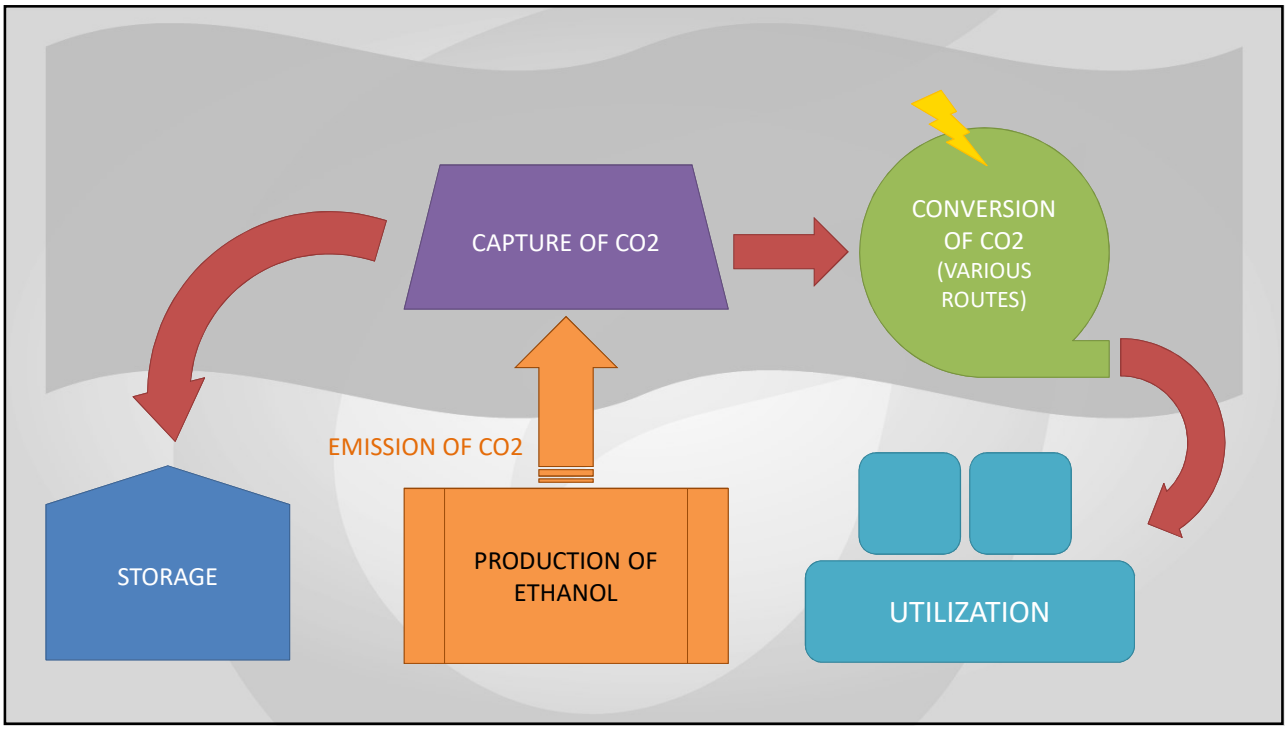
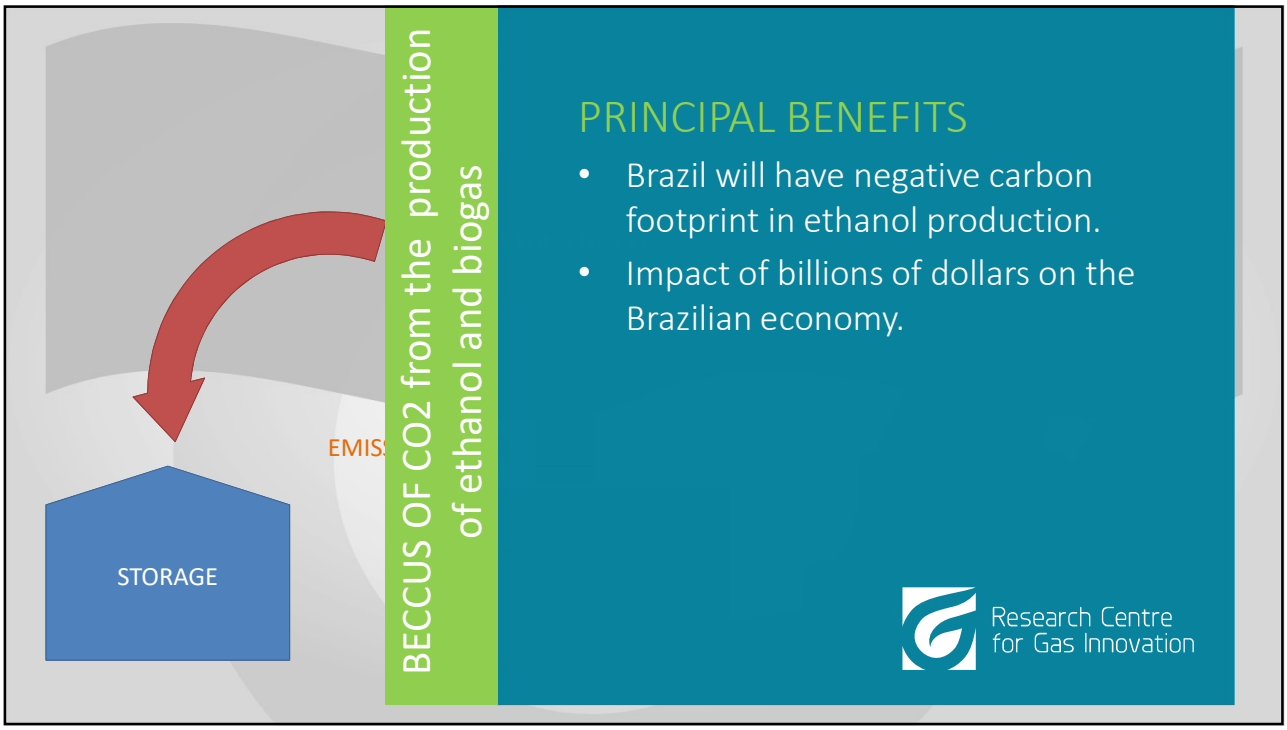

EMISSION OF CO2
PRODUCTION OF ETHANOL

41


CAPTURE OF CO2
CONVERSION OF CO2 (VARIOUS ROUTES)
EMISSION OF CO2
STORAGE
PRODUCTION OF ETHANOL
UTILIZATION

42


STORAGE
EMIS
BECCUS OF CO2 from the production of ethanol and biogas
PRINCIPAL BENEFITS
• Brazil will have negative carbon footprint in ethanol production.
• Impact of billions of dollars on the Brazilian economy.
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cleaner energy for a sustainable future
THANK YOU
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twitter.com/rcgipage
www.usp.br/rcgi

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