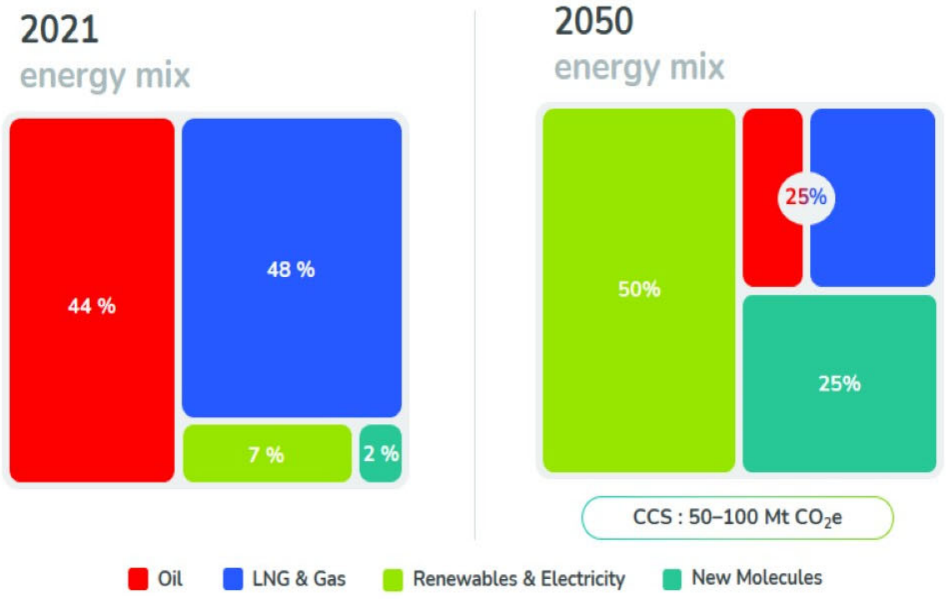
TotalEnergies

Decarbonization Ambitions, Objectives & Challenges

Moussa Kané - TotalEnergies E&P Research & Technology USA

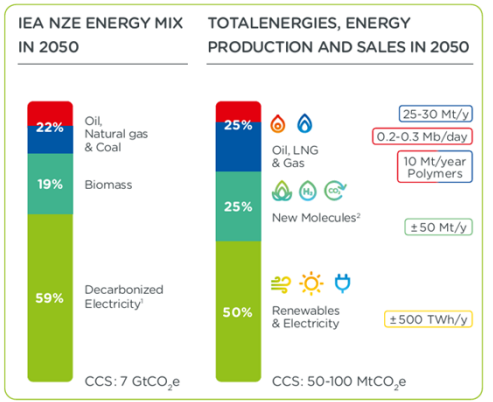
SwRI IPER Workshop, San-Antonio March 1st & 2nd 2023

Our vision for TotalEnergies in 2050



To preserve the planet in the face of the climate challenge, we are moving forward, together, towards new energies.

OIL GAS ELECTRICITY HYDROGEN BIOMASS WIND SOLAR



Sustainability & Climate 2022 Progress Report

A decade of growth and transformation to build a multi-energy company

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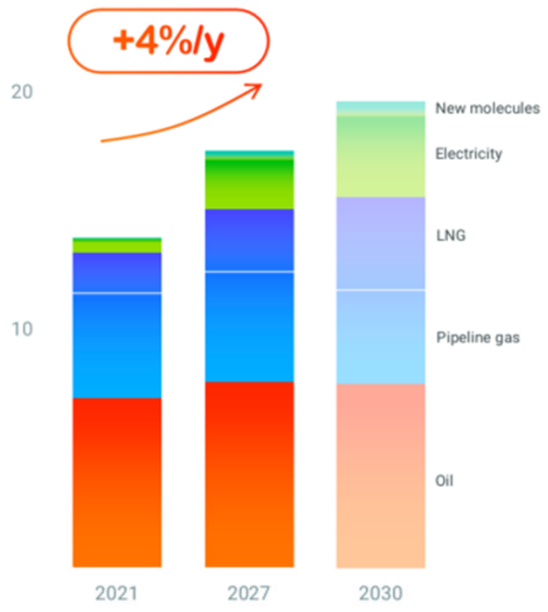
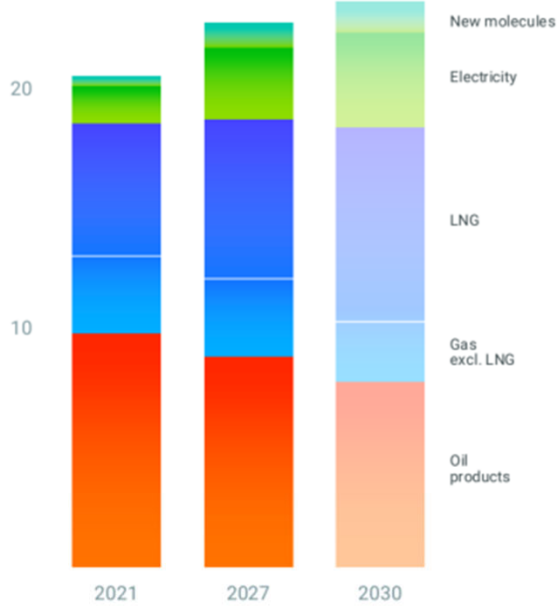
Energy production
PJ/d (excluding Russia)



Energy sales
PJ/d (excluding Russia)



Oil
- → Maintaining the engine of the transformation
- → Aligning sales to demand & production

Gas
- → Growing LNG production without Russia
- → Sustaining domestic production

Electricity & Renewables
- → Creating value from integration in electricity
- → Renewables: 100 GW by 2030, ROE > 10%

New molecules
- → Growing biofuels (SAF), biogas, CCS business
- → Launching first clean H2 projects

Growing returns while transitioning

Advancing on our emission targets by 2030

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			2020*	2021*	2030
Net Zero worldwide on operated activities	Scope 1+2 emissions	Mt CO_2	41.5	37	> -40%
		vs 2015	-9%	-20%	
	Methane emissions	kt CH_4	64	49	-80% ⊕ New
		vs 2020		-23%	
	Routine flaring	Mm^3/d	0.6	0.7	0
Net Zero worldwide for indirect emissions[1]	Scope 3 worldwide emissions	Mt CO_2	400	400	< 400
	Scope 3 worldwide Oil ⊕ New	Mt CO_2	320	285	> -30% ⊕ New
		vs 2015	-9%	-19%	
	Scope 1+2+3 emissions in Europe	Mt CO_2	239	241	> -30%
		vs 2015	-14%	-14%	
	Lifecycle carbon intensity[2] Scope 1+2+3	100 in 2015	-8%	-10%	> -20%

Less emissions

[1] Related to the use by our customers of energy products
[2] Average carbon intensity of energy products used by our customers worldwide
* Excluding Covid impact

Our Three Drivers

To get to net zero by 2050, we have been taking action for several years to limit the greenhouse gas emissions from our operations in accordance with the Avoid - Reduce - Compensate principle.

AVOID

We try to do as much as possible to avoid CO_2 emissions. A tangible example is the electrification of our industrial base. Even better, thanks to the development of our solar portfolio, we are increasingly supplying our sites with renewable electricity.

At our main refining and chemicals complexes, we are replacing the boilers and turbines that are necessary for the units' operation, but that are responsible for a large amount of the industry's CO_2 emissions, with electric motors.

In addition, we have been working since 2017 to solarize

4,600
of our service stations

and around **60**
industrial and commercial facilities worldwide with rooftop and canopy-mounted solar panels.

Find out more about our commitments and emissions reduction projects in the Sustainability & Climate 2022 Progress Report

REDUCE

We focus on reducing our direct emissions through continuous improvements in energy efficiency, the complete phase-out of routine flaring and an ongoing reduction of methane emissions from oil and gas production.

13% **improvement in energy efficiency at our operated facilities** since 2010. Our Company is pursuing its efforts in this area with the goal of making its industrial facilities 1% more energy efficient each year.

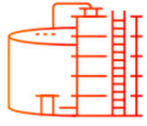
The methane intensity of our operated gas facilities is below

0.1%

In 2021, TotalEnergies announced the deployment of an innovative technology to significantly reduce methane emissions related to its operations on the Barnett gas field in the United States. Developed by Qnergy, this technology makes it possible

to convert methane-powered instrumentation to compressed-air-powered instrumentation, thereby eliminating the release of methane during operations.

Objective: zero **routine flaring** by 2030. In 2021, we were 91% towards meeting this objective in relation to 2010.



Nearly **10%** **of our R&D budget** is dedicated to carbon utilization and storage technologies.

COMPENSATE

In addition to our programs to reduce our greenhouse gas emissions, we invest in sustainable carbon capture and storage solutions that go beyond our own operations.

$100 **million**
That's the average amount we want to invest each year in developing natural carbon sinks.

5 Mt **of CO_2**
captured each year by 2030 thanks to natural carbon sinks.

Scope 1+2: mobilization on CO_2 reduction using best available technologies

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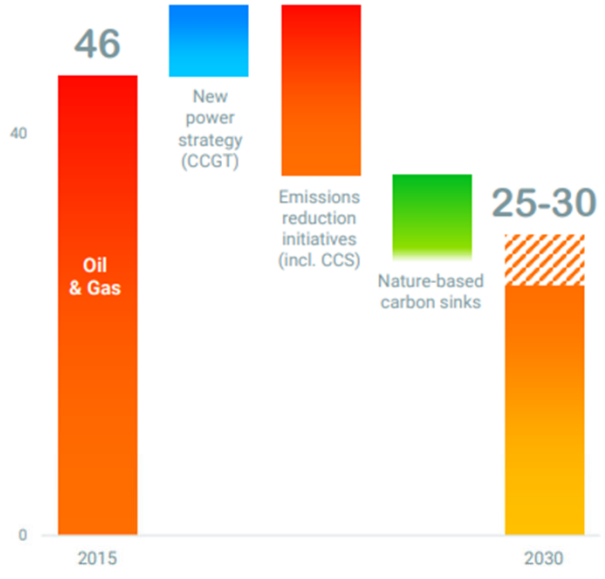
Levers

Scope 1+2 from operated facilities

$MtCO_2e$



Stop routine flaring + New

→ <0,1 Mm^3/d by 2025

→ Zero routine flaring by 2030

All new projects with closed flare

Reduce non-routine flaring

Improve energy efficiency

Reduce fuel gas consumption

Optimize power consumption

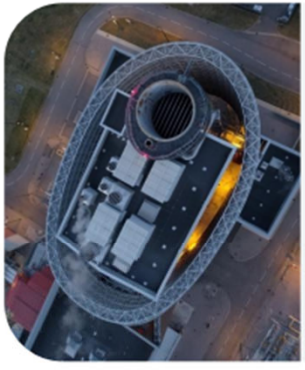
→ RC: 450 M$ over 2018-25

Deploy digital solutions

Green power

Cover all industrial sites' power needs with green electricity in Europe and the US

→ > -2 $MtCO_2/y$ Scope 2 emissions by 2025



Capture and store carbon

Decarbonize all grey H_2 used in our European refineries

→ -3 $MtCO_2/y$ by 2030

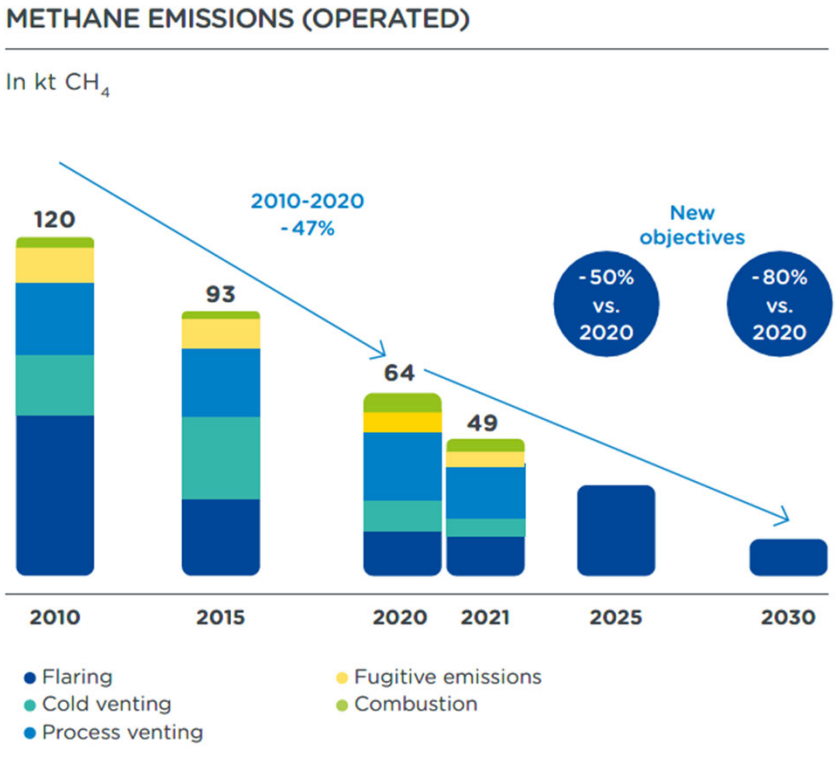
Develop carbon transport and storage projects

→ ~10 $MtCO_2/y$ capacity by 2030

Less emissions

Upstream Focus

Toward Zero Methane Emissions

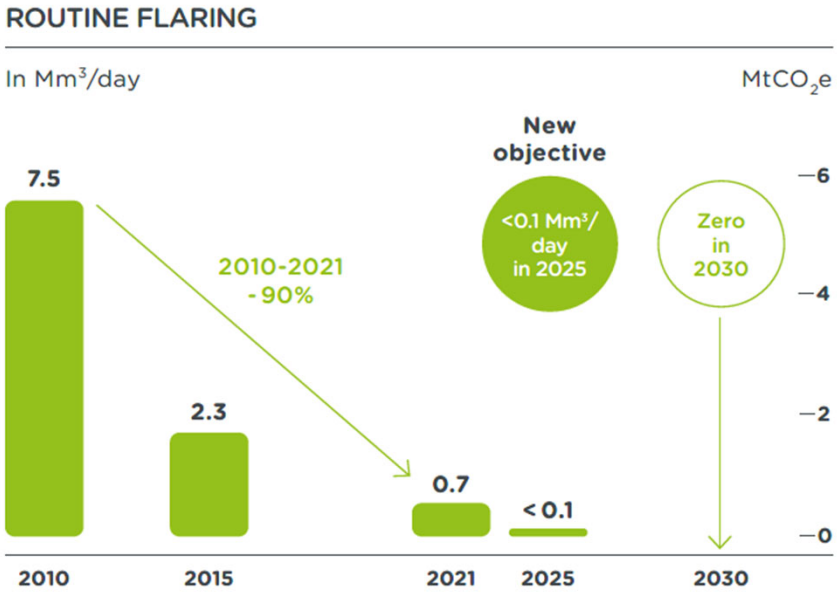


Sustainability & Climate 2022 Progress Report

Using drones to detect and measure methane emissions

AUSEA consists of a miniature sensor, weighing 1.4 kilograms and mounted on a drone, that quantifies emissions by measuring methane emissions in the plume and tracing them back to their source. It has proved more accurate than commercially available technology and has been successfully deployed in Nigeria, the Republic of the Congo and the Netherlands.

Towards Zero Routine Flaring

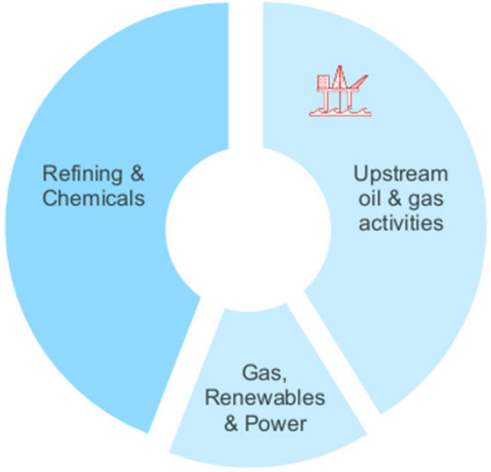


Sustainability & Climate 2022 Progress Report

- Since 2000 commitment not to include any routine flaring in new projects
- Pledge to end the practice altogether by 2030

Sustainability & Climate 2022 Progress Report

E&P Upstream Context & Challenges



34 Mt CO_2e emissions operated (Scope 1, 2021)

- Significant part of upstream emissions from offshore gas turbines with **high flue gas rates** and **low CO_2 content** (3-4 vol%)
- **Space and weight constraints** for brownfield modifications

Universal Registration Document 2021

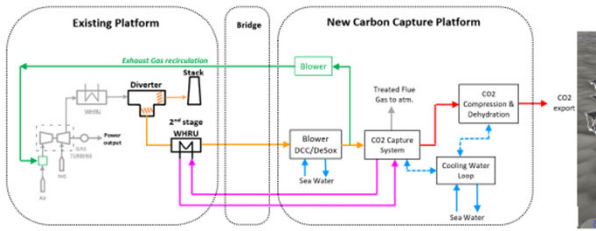
A. Pactat et al., 16th Intl. Conf. on GHG Control Technologies, GHG - 16

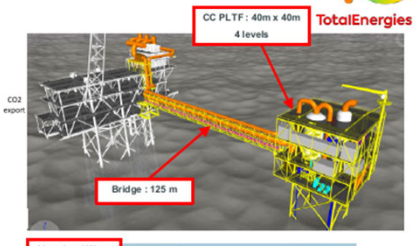
Screening Tech. for Carbon Capture from Offshore Power Gen.

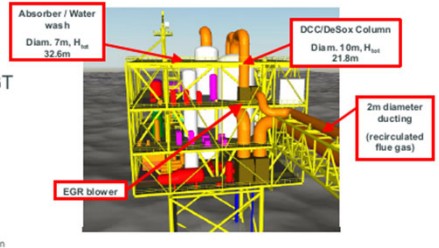
A. Pactat et al., 16th Intl. Conf. on GHG Control Technologies, GHG - 16

- **Techno-economic comparison** of the following **alternative concepts** with a base case developed using generic solvent-based CO_2 post combustion capture process:
  - Gas Turbine Exhaust Gas Recirculation (EGR)
  - Gas Turbine Selective Exhaust Gas Recirculation (SEGR)
  - Membrane Contactor absorber
  - Gravity Based Structure (GBS) with integrated carbon capture
  - Floating Power Generation with integrated carbon capture

Direct Exhaust Gas Recirculation (EGR)



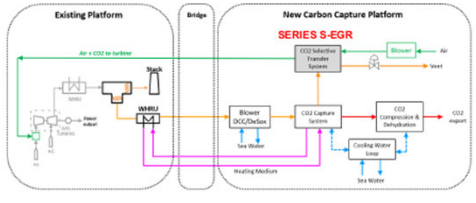


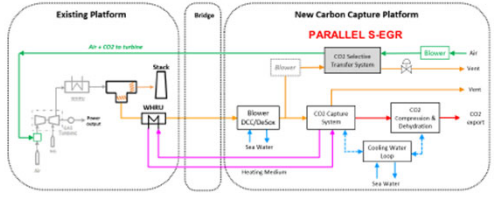


- @40% EGR => %CO_2 increase from 3,5 to 5,8 %mol
- Flue gas flow rate decrease from 645 t/h to 371 t/h
- DCC outlet temperature reduced to 21°C to limit impact on GT
- Significant absorber height reduction (40->32,6m)
- Carbon capture platform weight reduction (-200 tons)
- Increases weight (+480 tons) of bridge & brownfield works
- +4% increase in overall CAPEX

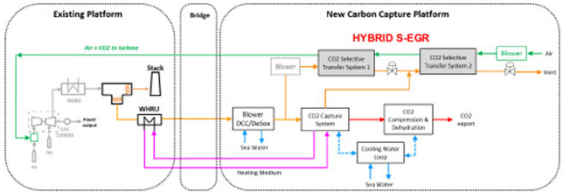
5 | 27th October 2022 – GHGT16 - Screening of technologies for carbon capture from offshore gas field power generation

Selective Exhaust Gas Recirculation (S-EGR)





- 12 possible configurations:
  - Series, Parallel, Hybrid
  - Transfer systems: rotary adsorption & membrane
  - 2 pressure levels (low and high pressure)
- @70% S-EGR => 17-19%mol CO_2 flue gas upstream DCC and 12-14%mol CO_2 in enriched air stream recirculated to Gas Turbines (@85% overall capture)



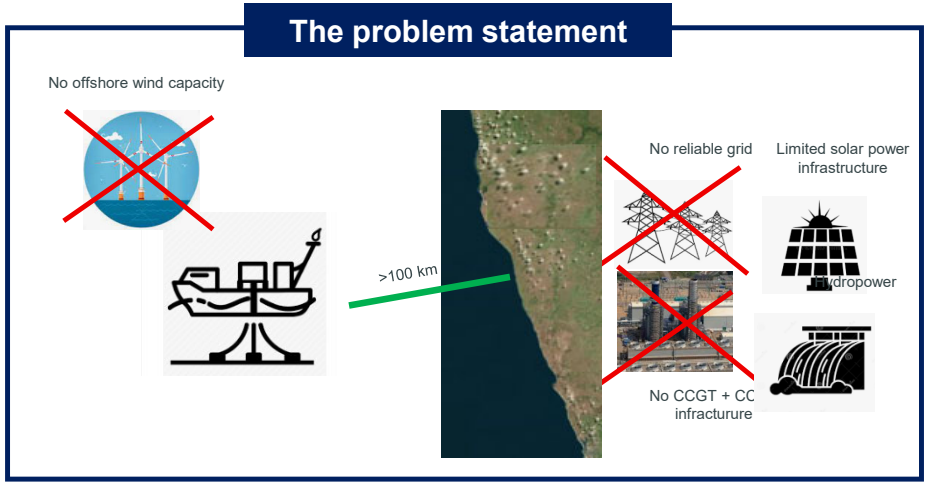
6 | 27th October 2022 – GHGT16 - Screening of technologies for carbon capture from offshore gas field power generation

Deep-Offshore R&D Challenges

The R&D challenges:

- **Massive decarbonization steps needed (disruptive technologies)**
- **Time… Achieve -40% by 2030, Net Zero by 2050**
- **Technical constraints (feasibility, layout, adapt to power need…)**
- **Costs ($/tCO$_2$)**

Which solution(s) to decarbonize remote offshore sites?



SBM 2022 Technology Conference - TotalEnergies

ZEREM R&D Roadmap

ZerEm R&D
Zero Carbon Emission Assets

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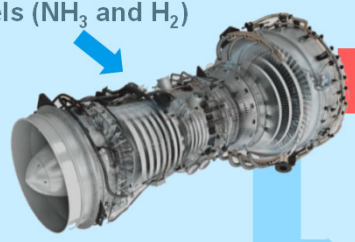
Reduce Residual Emissions

Combustion Real-Time Efficiency Monitoring

Zero Flaring by Design

Decarbonize Gas Turbines

Decarbonized fuels (NH_3 and H_2)



Exhaust Gas Recovery with Carbon Capture

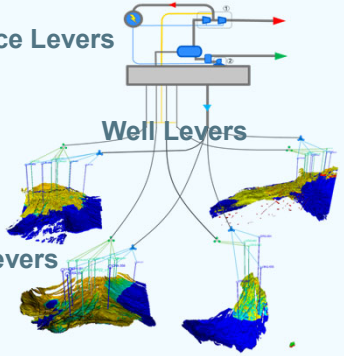
Compact & high efficiency CCGT*

Gas Turbine efficiency Optimization @part load

Integrated Asset Modeling

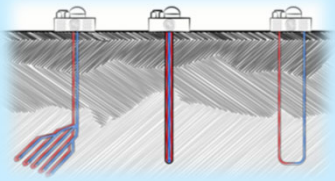
Lower Power Demand

Maximizing Production AND Minimizing Power Demand



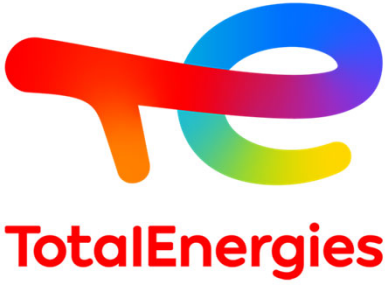
Obtain Zero Carbon Power On/Near Sites

Waves, Current & Tides, Ocean Thermal Energies



Well Heat Recovery

* CCGT : Combined Cycles Gas Turbines



Thank you

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