ADREM IMPACTS

- On-site valorisation of methane from diverse sources
- Filling the processing gap of methane to avoid flaring
- Descreased carbon footprint
- Increased resource and energy efficiency

SAVINGS

20% LESS EMISSIONS

20% LESS ENERGY INTENSITY

10% BETTER OVERALL RESOURCE EFFICIENCY

EXPECTED OUTCOMES

Novel class of intensified adaptable modular catalytic reactor systems able to operate with changing feedstock composition and to deliver “on-demand” the required product distribution

New technology that will, in the long term, be based on renewable (green) electricity as the direct, primary energy source

Increased process flexibility and safety due to modular production
- more efficient equipment
- integration of green electricity
- more efficient process control

CONTACT

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ADREM PARTNERS

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SME:

SAIREM SAS, F

Academia and Research:

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Katholieke Universiteit Leuven, BE
Ghent University, BE
University of Zaragoza, ES
TU Dortmund, D
National Institute of Chemistry, SI
Danish Technological Institute, DK

ABOUT THE ADREM PROJECT

Start-Date:	1 October 2015
Duration:	48 months
Budget:	6 million €
Project Coordinator:	Prof. Andrzej Stankiewicz, TU Delft, NL
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ADREM
Adaptable Reactors for Resource- and Energy-Efficient Methane Valorisation

INNOVATIVE SOLUTIONS FOR A BETTER FUTURE

Adaptable reactors for resource- and energy-efficient methane valorisation

ADREM PROJECT CONCEPT

ADREM OBJECTIVES

ADREM aims at developing a resource- and energy-efficient valorisation of variable methane feedstocks (natural gas, biogas, etc.) to higher hydrocarbons and liquid chemicals/fuels by:

- Integral, four-domain Process Intensification (PI) methodology
- Smart modular reactor design with highly selective catalysts, easily (exchangeable) cartridges
- Adaptable reactors; easy switching of operating and control parameters
- Little or no feedstock purification required
- Energy- and emission-lean reactors using renewable electricity as a direct, primary energy source

TOWARDS RESOURCE- AND ENERGY-IMPROVED METHANE VALORISATION

- Concurrent development of four reactor concepts and their optimization at laboratory scale
- Selection of two concepts for subsequent TRL5 validation
- Construction of two mobile, modular bench-scale reactor units and validation in an industrially relevant environment
- Commercialization roadmap

ADREM CHALLENGES

- Diversity and distribution of the methane sources
- Adaptability with respect to feedstock and product distribution
- Specific catalyst design for single-step conversion
- Catalyst lifetime and exchangeability
- High energy efficiency of process

FROM		TO
Transformation of methane via synthesis gas	→	Direct, one-step transformation
Large-scale processing	→	Small to medium scale
Single-type feedstock	→	Multi-type feedstock
Difficult and expensive replacement of catalyst	→	Modular catalyst cartridges for easy switch
One fixed product distribution	→	"On-demand" product distribution
High process temperatures due to natural gas combustion in furnaces causing emissions	→	Low- and high-temperature methane valorisation without furnaces involved
Reactors use fossil fuel-based energy	→	Reactors use renewable electricity as the direct, primary energy source
Classical chemical reactor engineering methodology for reactor design	→	Integral, four-domain process intensification methodology for reactor development

ADREM REACTOR TECHNOLOGIES

MICROWAVE/RADIOFREQUENCY REACTOR

- Selective, energy efficient heating of the catalyst by electromagnetic waves
- Implementing a non-steady state operating cycle
- Reduction of undesired reactions

NON-THERMAL PLASMA

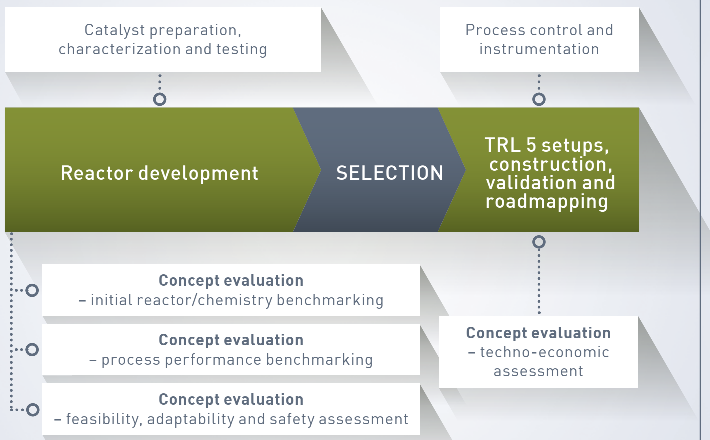
- Far from equilibrium plasma processing, using nanosecond pulsed discharges, favours conversion of electrical energy to heat and reduces the heating effect

GAS-SOLID VORTEX IN A STATIC GEOMETRY

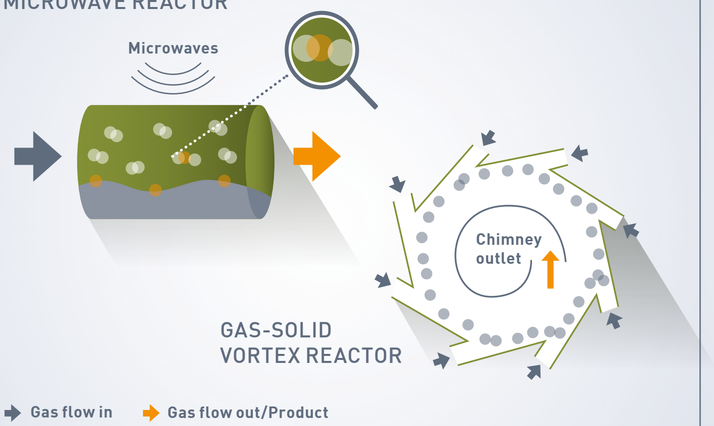
- Static, cylindrical geometriy with a solid catalyst
- Tangential injection of gas-phase causes the solid catalyst to rotate in the reactor
- Due to high gas velocities, high heat and mass transfer rates are achieved on both particle and reactor scale

TEMPERATURE GRADIENT PLASMA REACTOR WITH STRUCTURED CATALYST PACKED BED

- Merger of two unit operations (intensification): reactor and separator (separation of gas feedstock and liquid product) in outer reactor jacket
- Central reactor axis: plasma source



MICROWAVE REACTOR



NON-THERMAL PLASMA REACTOR