

# 60 Years of History in LNG



Air Liquide

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The world leader in gases, technologies and services for Industry and Health

# 1

## 60 YEARS OF LNG



1958/1964

2018



1958: Air Liquide LNG pilot in Nantes (France)  
1964: Skidda LNG - 450 MMscfd

Air Liquide mid-scale liquefaction cold box being shipped for an LNG project under construction in Europe

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This year marks the 60th year since Air Liquide started the 1<sup>st</sup> LNG pilot plant in France. LNG trade reached over 280 Million tons in 2017 and is now part of the biggest trades in the world.

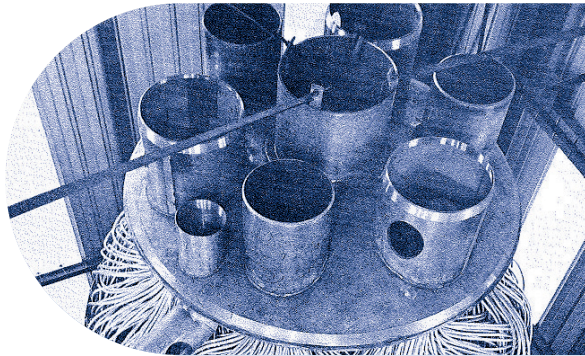
# 2

## EXCHANGERS: FROM COIL WOUND TO PLATE FIN HEAT EXCHANGERS



1964

2018



Air Liquide Coil Wound technology was used on Skidda plant in 1964



Mid-scale LNG plant - Air Liquide Brazed Aluminium PFHE

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Heat Exchangers have been at the heart of LNG liquefaction innovation. Historically centered on Coil Wound Heat Exchangers, Brazed Aluminium are gradually entering the market due to better efficiency and smaller footprint.

# 3

## REINVENTING LNG PEAK SHAVING



1967

2018



Air Liquide designed Memphis Peak Shaver  
5 MMscfd



Kinetrex: Air Liquide supporting the conversion  
from Peak Shaver to LNG retail plant

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LNG has been a valuable solution since the 80s to peak shave gas grids. Recently with the development of the small-scale market, Peak Shavers find a new life by converting into LNG retail plants.

# 4

## MONETIZING THE COLD FROM LNG



1972



Fos Tonkin - Integration of Air Liquide Air Separation Unit with the LNG terminal (exchanger LNG/N<sub>2</sub> highlighted)

2006



Hydroedge - Air Liquide Air Separation Unit integrated in LNG terminal (only daily start&stop shift)

The cryogenic temperature of LNG (-164°C) makes energy efficiency essential. Cold power monetization in LNG terminals such as liquid O<sub>2</sub> and N<sub>2</sub> production started in the 70s.

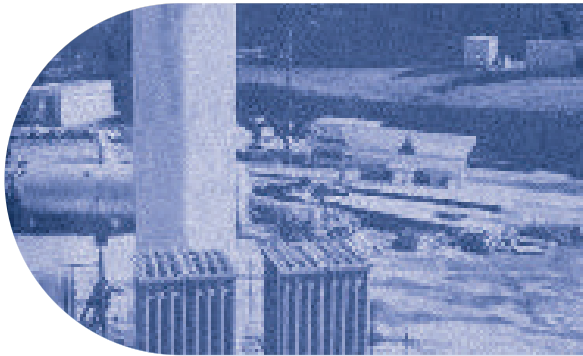
# 5

## LNG FOR OFFGRID INDUSTRIAL



1970-1987

2018



Air Liquide installs 16 LNG regasification satellite systems for industrials in Spain



Cryolor, a subsidiary of Air Liquide provides LNG satellite station and the biggest 78,000L jumbo LNG trailers

Offgrid industrial users started using LNG as a fuel in the 70s. Recently, increasing numbers of industrials are switching from coal or diesel to LNG due to environmental concerns.

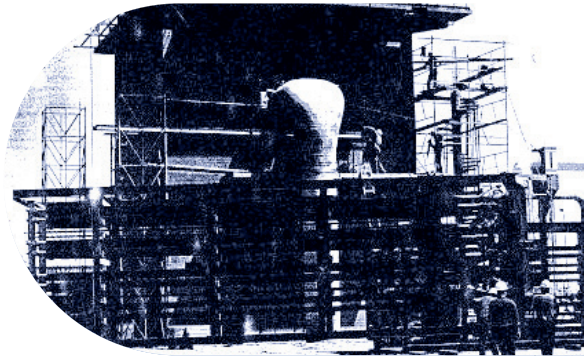


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# VAPORIZERS



1970-1990



Air Liquide sells 12 vaporizers to LNG import terminals in Spain, Taiwan, South Korea and France

2018



Air Liquide atmospheric vaporizers on Valade Lubersac satellite station

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From very large sea water supercritical vaporizers for national gas grids to small atmospheric vaporizers for local usage.



# 7

## LNG: AN ALTERNATIVE FUEL FOR CLEAN MOBILITY



1973



Air Liquide demonstrates that LNG is a fuel for transportation

2018



Air Liquide operates >60 bio Natural Gas vehicle stations in Europe, including 10 with LNG/bio-LNG (Here Fléville-devant-Nancy station, France)

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After pioneering LNG mobility in the 70s, LNG and bio-LNG are developing today as some of the essential fuels favoring the energy transition, alongside Hydrogen, CNG, and compressed Natural Gas.

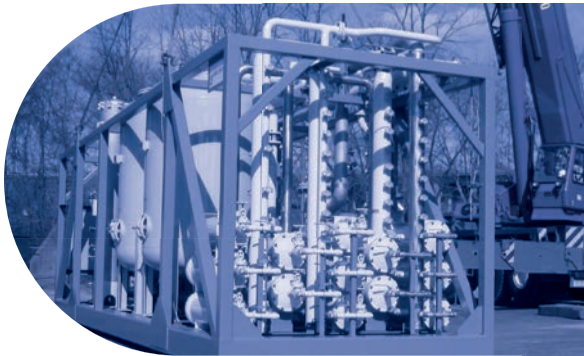


# BIO-LNG: FROM BIOGAS TO BIOMETHANE



2006

2018



MEDAL's 1st purification unit from biogas to biomethane, Johnston, 3,500 Nm<sup>3</sup>/h



Air Liquide operates 10 biomethane production units in the world, incl. the Bio-LNG plant in Lidköping, Sweden

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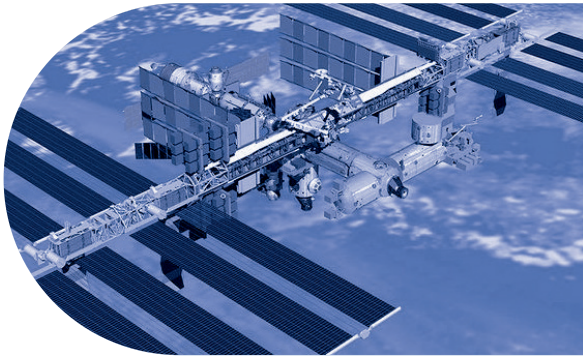
In a world where energy needs and sources are changing, the ability to transform organic resources into renewable and carbon-free energy is poised to become part of the new energy mix.

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# FROM SPACE TO LNG RELIQUEFACTION



2006



Installation of Minus Eighty Degree Laboratory Freezer for the ISS (MELFI) in the International Space Station

2017



Air Liquide Turbo Brayton for LNG Boil Off Gas Reliquefaction in the 1<sup>st</sup> LNG bunker vessel

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The Turbo Brayton technology developed for the International Space Station, found its way into the LNG Boil-Off Gas Reliquefaction market.

# 10

## DOWNSIZING THE LNG MARKET



2018



Air Liquide mid-scale (0.66 Mta) LNG project under construction in Europe

2018



Converting Peak Shaving to LNG retail: Conversion under construction in the US

While LNG large-scale liquefaction market is transitioning towards “mid-scale” projects, small-scale LNG is increasingly developing around the world.

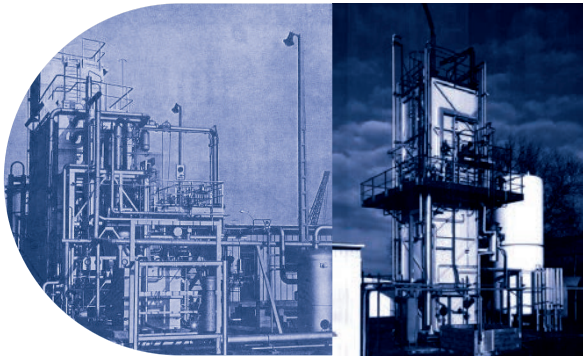
# 11

## LNG: 60 YEARS OF INNOVATION



1958/1979

2018



1958: 1<sup>st</sup> LNG pilot in Nantes, France by Air Liquide  
1979: LNG R&D pilot, Les Loges en Joscas, France



Air Liquide's Cryogenic Technology Center is constantly improving our design of Plate Fin Heat Exchangers

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60 years of innovation in LNG from the first LNG pilots in the 50s to new developments on Plate Fin Heat Exchangers.

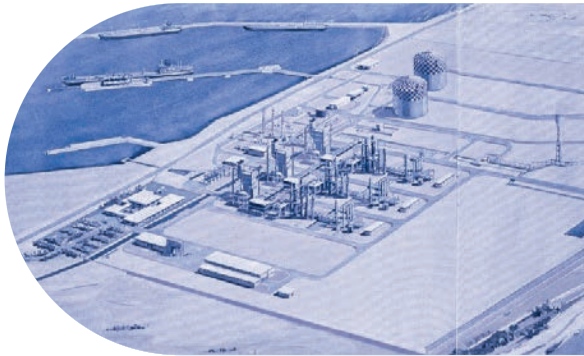


# 12

## REINVENTING THE BASELOAD: LIQUEFIN™

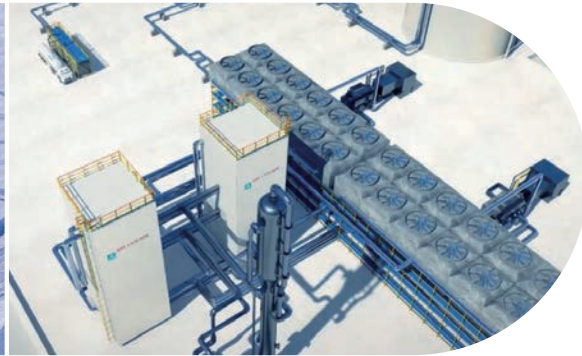


1964



1<sup>st</sup> LNG baseload  
Skidda design picture

2018



Air Liquide's efficient Liquefin™ design  
for baseload LNG liquefaction

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 Liquefin™

The most efficient technology based on Braze  
Aluminium Plate Fin Heat Exchangers.





Discover our technologies for LNG  
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