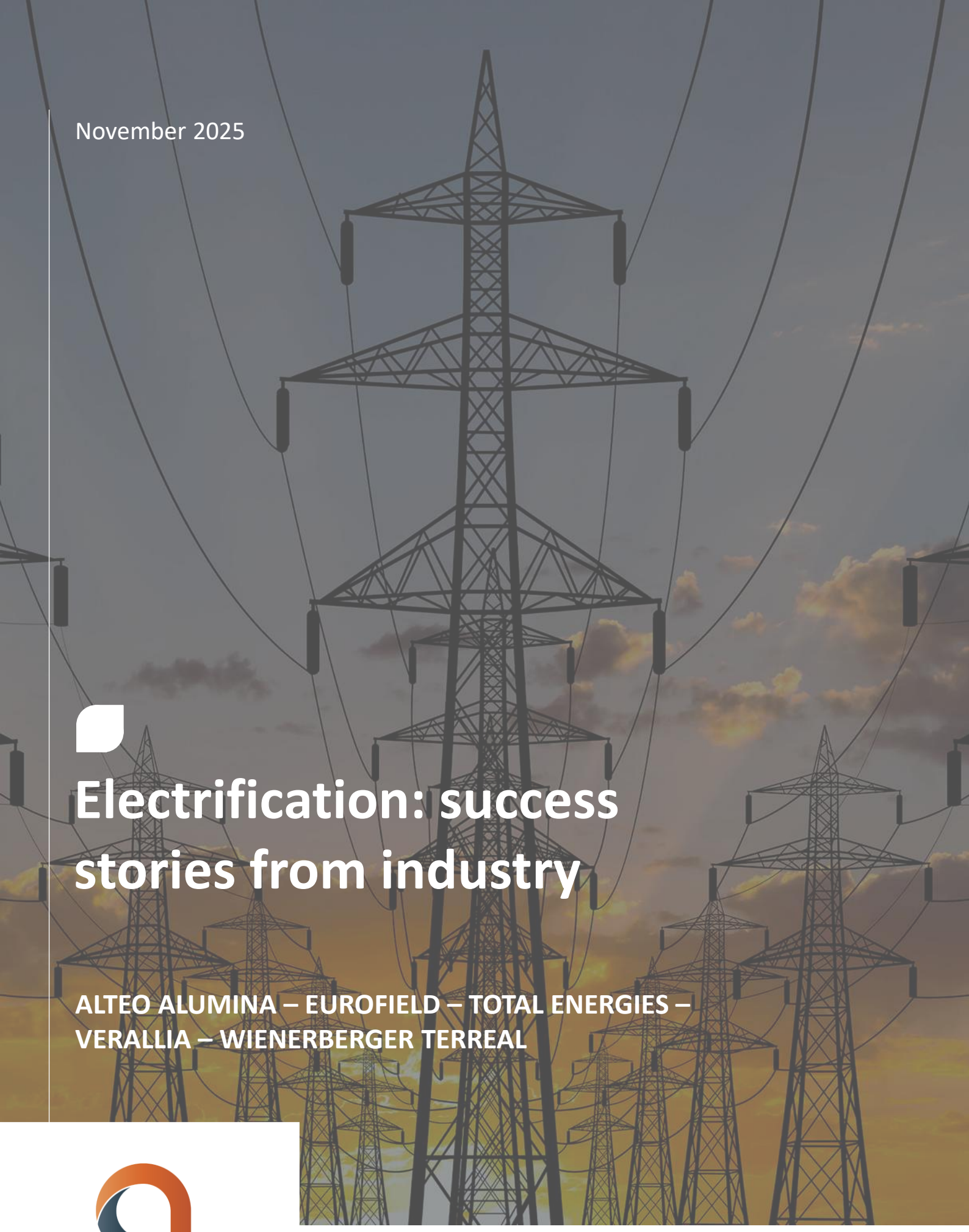


November 2025

Electrification: success stories from industry

ALTEO ALUMINA – EUROFIELD – TOTAL ENERGIES – VERALLIA – WIENERBERGER TERREAL

ALLICE

With the support of:

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

ADEME
AGENCE DE LA TRANSITION ÉCOLOGIQUE

About ALLICE

Our raison d'être

Facilitate the **emergence of new solutions** and support innovation with a cross-cutting approach, bringing together supply- and demand-side industrial players, specifiers and centres of competence.

Our activities

Collective projects

- ✓ Collective studies
- ✓ Summaries, analyses and infographics
- ✓ Technology watch

Leadership of the ALLICE network

- ✓ Meetings between members
- ✓ Meetings between researchers and industrial players
- ✓ Search for partners

Promotion of the decarbonisation sector

- ✓ Scientific and technical forums
- ✓ Biennial conference
- ✓ Collective representation

Support & services

- ✓ Expertise for institutions
- ✓ Awareness campaigns
- ✓ Tailor-made services and support

Our structure

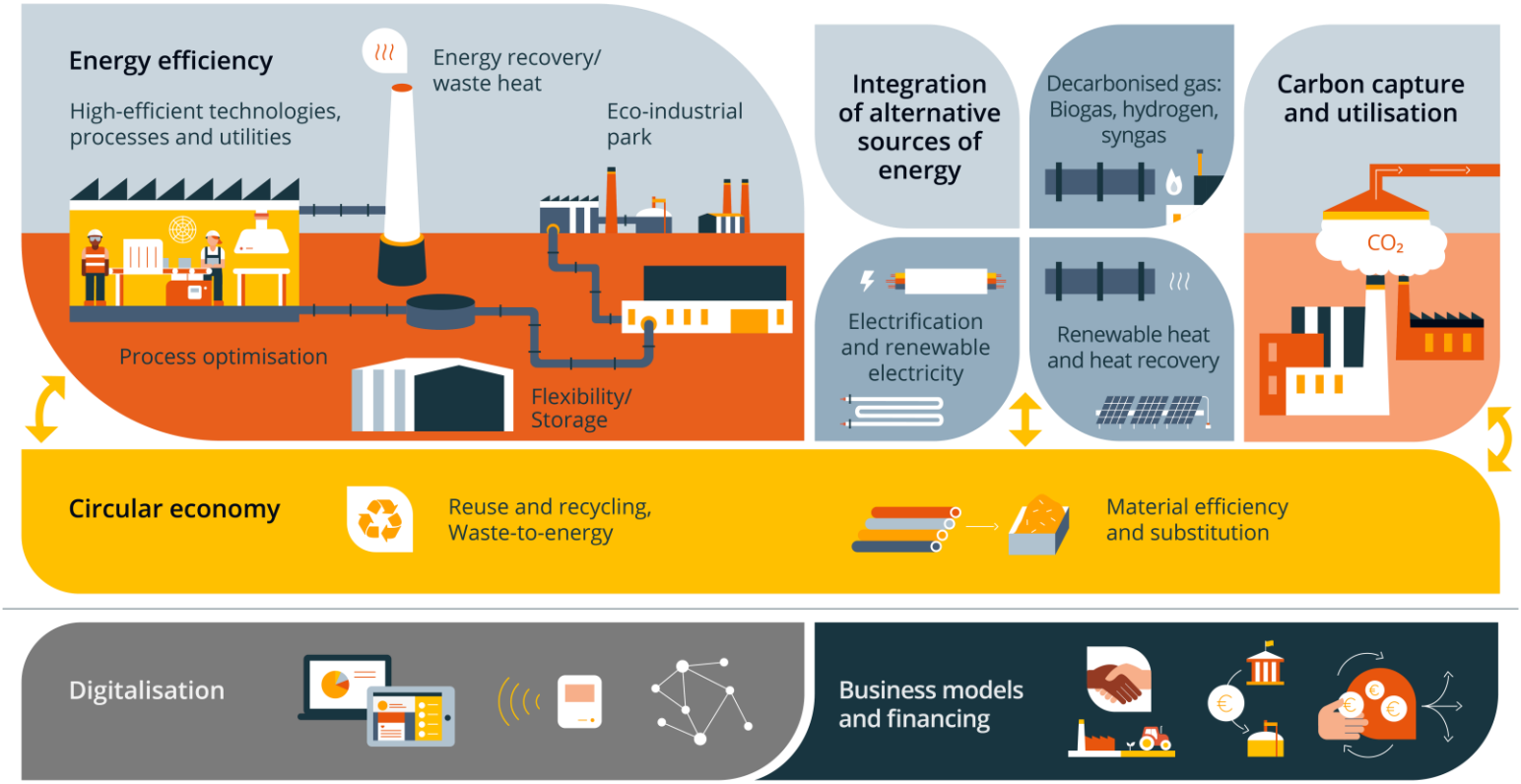
- An **impartial** organisation
- A model based on **memberships**
- Governance that meets the **needs of members** and ensures a **strategic vision** of industry challenges

Founders: cetiat, CETIM, blunomy, CTCPA, CTMNC Tuiles & Briques, ctp

Partners: axelera, atee, PEXE, Tenerrdis, Je-decarbone, Techtera, AEE INTEC

Scientific Committee: LRGP, Laboratoire de Génie Chimique, cea liten, Mines Paris, PSL, LAGEPP

Our areas of expertise



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First in France: a flexible industrial electric boiler

The Gardanne plant produces alumina (aluminium oxide) from alumina hydrate. This white powder is produced on the site at a rate of 250,000 tonnes of alumina per year (including 100,000 tonnes of redissolved alumina).

Industrial operator

Aggregator

France
Gardanne (Bouches-du-Rhône)

Metallurgy
Alumina production

Electrical flexibility
Electrode-type steam boiler

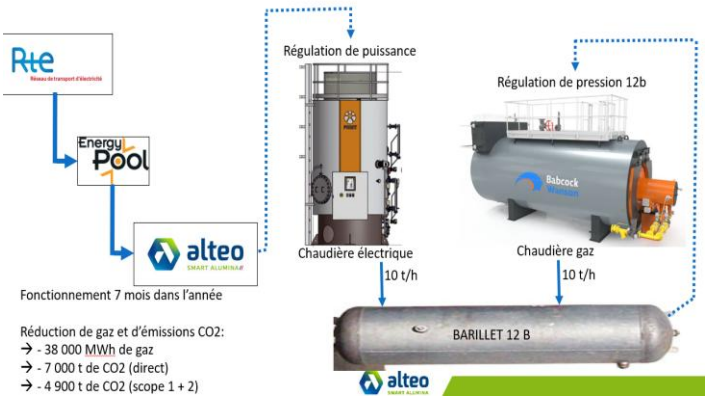
July 2024
Commissioning date

ALUMINA PRODUCTION PROCESS

The raw material, aluminium hydroxide, is either directly calcined or redissolved to produce higher quality alumina. In this second option, the "Bayer" process is used to produce specific alumina hydrate for the calcination kiln. This chemical process requires a lot of thermal energy in the form of pressurised steam produced using natural gas. The hydrate obtained is then transformed into alumina, calcined to a greater or lesser degree depending on the customer's requirements, in a workshop equipped mainly with large rotary kilns heated by natural gas, before being ground, packaged and shipped.

PRODUCTION LINE

The project scope is that of the dissolution line (100,000 t/year).
Continuous production
Steam requirement: 12 bar at 210°C
Heating power: 14 MW of steam, i.e. 20t/h of steam at 12 bar.



→ *Production of steam via a gas boiler and an electric boiler controlled by the RTE mechanism*

OPERATION PERFORMED

A 7MW electric boiler was installed to complement the existing gas boilers. During the "summer" period (7 months) when the steam cogeneration installation is not operating, the electric boiler is used to produce steam. It is controlled to regulate its power according to RTE's* network balancing needs (contribution to the secondary reserve for network frequency regulation).

**RTE is the French electricity TSO.*

DECISION-MAKING CRITERIA

A few years ago, Alteo took part in ADEME's voluntary EXPEDITE programme. Introducing meters demonstrated potential for participating in the flexibility mechanism via the grinding process. Energy Pool met Alteo's needs, and participation in the tertiary reserve was introduced (1 day's notice for peak consumption days in winter).

→ Electric boiler installed and controlled for frequency regulation

> “With the price of gas half that of electricity, we are using a number of levers to maintain our economic equilibrium while reducing our carbon footprint. The flexibility mechanism introduced allows consumption when electricity prices are low, reduces the cost of the TURPE tax and the costs associated with the ETS CO_2 quotas.”

Marc Fournon, Energy Manager at Alteo Alumina

Operation

The boiler operates under automatic control, with a 12-bar steam buffer tank. The project required staff to be trained in the new production equipment (basic operation and maintenance training).

Project timetable

The project took 1 year (from Alteo's decision until commissioning).

Financing

The project was financed with equity, with a subsidy via ADEME's "DÉCARB IND" call for projects (€2.5m for 25% of the CAPEX).

Reproducibility factors

Very easy to reproduce from a technical point of view.
Flexibility mechanisms are accessible via an aggregator, either directly if the power is sufficient (>1MW), or with an asset pool set up by the aggregator.

OBSERVED RESULTS

CO_2 reduction: 7000 tCO_2/year (4900 t in scopes 1+2)

The extra cost of the electricity can be offset in various ways:

- counter-cyclical consumption in summer reduces the TURPE transmission tax
- the cost of electricity is also lower in summer – in 2024 and 2025, electricity was purchased at the ARENH price during off-peak hours
- remuneration linked to participation in the secondary reserve mechanism for flexibility

Project contact

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ALLICE 2025 – with the support of ADEME

Installation of an electric IR roof* for latex gelling of synthetic turf

Eurofield produces synthetic turf for sports pitches (football, etc.), made from tufted** fabric.

**IR roof: the roof is the ceiling of an oven that is not completely closed.*
***Tufting: tufting is a method of inserting pile into a fabric (e.g. carpet design).*

Video available (old gas-fired roof)

Industrial operator

Solutions provider

France
Isbergues (Pas-de-Calais region)

Textiles
Synthetic turf

Electrification
Electric radiant panels

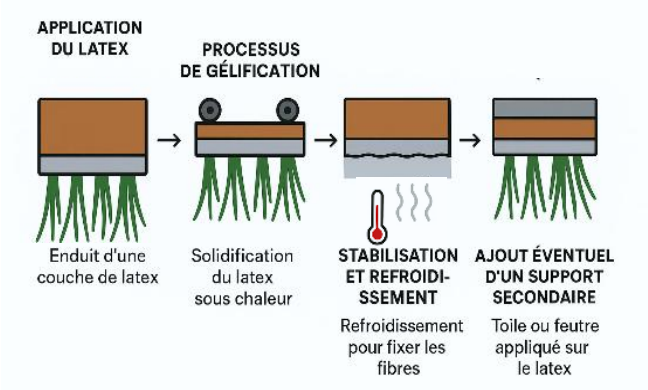
2019
Commissioning date

SYNTHETIC TURF PRODUCTION

Latex gelling on synthetic turf transforms the latex applied to the back of the turf into a solid, stable layer, ensuring the artificial fibres are fixed and the covering is cohesive. Before the drying oven, an infrared pre-gelling roof allows the coating to heat up quickly.

At this stage, heating must be controlled so as not to close the latex surface through excessive polymerisation, which could hinder subsequent drying.

→ *Photo showing the product and the IR roof*



→ *Turf production process*

PRODUCTION LINE

Operates 5 days a week
Requirement: a few tens of seconds at 90°C
Power: 260 kW electric (400 kW gas)

OPERATION PERFORMED

The gas-fired IR roof was replaced by electric radiant heating panels, with a frame that can be raised and an extraction system adapted by the customer to evacuate the vapours emitted. A pyrometer to measure the temperature of the product was added, to prevent the crusting phenomenon that occurs above 100°C.

DECISION-MAKING CRITERIA

The gas equipment was outdated and prone to breakdowns. The electric solution was chosen because of the customer's commitment to the environment, and also because of the flexibility of the control system, which allows the heating to be adjusted to the covering (modulation of the ALUTHERM radiant panels from 0 to 100%).

→ *Roof-mounted electric infrared heating panels*

> “Our customer is very happy with their choice: the new electric infrared equipment is more reliable and easier to use, in terms of both production and maintenance.”

Madeleine Oriol, Sales Manager at Sunkiss Matherm

Operation

The existing gas-fired roof was replaced by an electric roof. Eurofield installed and designed the new frame. The new equipment took a week to install.

Project timetable

Commissioning took place 8 months after Eurofield's investment decision.

Financing

Eurofield funded the project with equity.

Reproducibility factors

This type of operation can be reproduced for the surface treatment of flat products.

OBSERVED RESULTS

Energy savings (estim.): 250 MWh/year
CO_2 savings (estim.): 155 tCO_2/year

- By modulating the power of the radiant heaters, you can precisely control the temperature and avoid any quality problems.
- The air extraction rate was reduced because there are no longer any combustion fumes.
- Maintenance of electrical equipment is simpler than for gas-fired radiant heaters:
  - If necessary, the heating elements can be replaced when the oven is switched off.
  - There are no leak/pressure checks or sparking issues on start-up.
- The addition of the infrared sensor has improved product quality, enabling more precise control.

Contact

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ALLICE 2025 – with the support of ADEME

Replacement of a gas furnace by an electric heater in a bitumen production unit

As France's leading hydrocarbon processing platform, the Normandy platform relies on the infrastructure of the port of Le Havre for its supplies and exports, and on the Seine corridor to serve the French market.

TotalEnergies — Industrial operator

CHROMALOX Advanced Thermal Technologies — Solutions provider

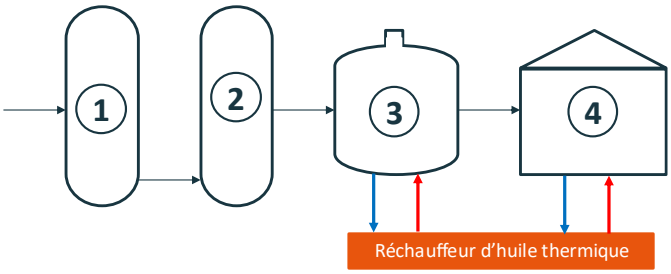
France
Harfleur (Normandy region)

Construction
Production of bitumen

Electric furnace
Heater type

January 2025
Commissioning date

BITUMEN PRODUCTION PROCESS



1. Atmospheric distillation of crude oil, in order to separate the light fractions of the crude (~350°C)
2. Vacuum distillation of the heavy residues to separate them, without thermal cracking of these compounds
3. **(Optional) Oxidation or air-blowing, which modifies the properties of the residue to obtain the required grade of bitumen (~250°C)**
4. Hot packaging/storage (~150°C)

→ The thermal oil heater is used in step 3. Direct heating could cause uncontrolled thermal cracking, so **indirect heating with thermal oil is preferred.**

→ *Aerial view of the Normandy platform*

OPERATION PERFORMED

The electric furnace was installed to replace the gas furnace.

PRODUCTION LINE

Continuous production
Heating power: 2 MW
Heating temperature: 240°C

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DECISION-MAKING CRITERIA

In-house studies identified the electric furnace as a relevant technical solution. The site's electrical infrastructure was sufficient to add the necessary power. The project is part of a site-wide decarbonisation strategy, which is divided into 3 areas:

1. Reducing emissions through energy efficiency
2. Using low-carbon energy to avoid emissions: a multi-energy platform (green H_2, heat recovery, process electrification and low-carbon electricity production)
3. Reducing Scope 3 emissions

→ *Electric heater installed*

> This project is part of our decarbonisation strategy and was commissioned without difficulty in January 2025, with excellent support from Chromalox. This project is reproducible and offers additional benefits, such as ease of operation and precise power modulation.

Guillaume Bessec, Energy Transition Manager at Total Energies

Operation

The unit started up without difficulty and has been running smoothly ever since.

Project timetable

Commissioning took place 8 months after the investment decision by Total Energies.

Financing

The company funded the project with equity.

Reproducibility factors

This type of operation can be reproduced for identical processes, and also more generally in industry, for any heating processes that use heat transfer fluids, or for any direct heating of process fluids.

OBSERVED RESULTS

Energy savings: 15 GWh_{NCV}/year (1.3 ktoe)
CO_2 savings: 4.8 $ktCO_2$/year

- The start-up procedure has been greatly simplified for operators.
- An improvement in safety has been noted at operational level, with the elimination of the steps involved in handling the gasket and igniting the gas furnace using an igniter.
- The new furnace represents a major space saving (two to three times less volume occupied than the previous equipment).
- The new equipment enables precise power modulation without inertia.

Project contact

Janick.Laithier@chromalox.com

World first: 100% electric glass melting furnace

Verallia is Europe's leading and the world's third largest producer of glass packaging for beverages and food products. The factory where the furnace is installed produces cognac bottles.

Industrial operator

Technology provider

France
Cognac (Charente region)

Glass
Production of glass bottles

Electric furnace
Glass melting furnace

Q1 2024
Commissioning date

CONTAINER GLASS PRODUCTION PROCESS

The stages include preparation and mixing of the raw materials (1) (sand, limestone, soda ash, cullet), high-temperature melting (4), forming (8) (blowing, pressing or stretching), then annealing (10) and finally quality control (12) before shipping.

1,500°C: this is the temperature at which the furnaces have to heat the mixture of solid raw materials (cullet, sand, soda ash, calcium carbonate) for around 24 hours so that the molten glass is perfectly homogeneous and can flow through the distribution channels to the forming machines where the glass moulds are located. Glass furnaces are designed to operate continuously for several years (often 10 to 15 years). Shutdowns, when they do occur, are exceptional and planned well in advance for major maintenance or reconstruction operations.

OPERATION PERFORMED

The site deployed its first electric furnace to replace the existing regenerative gas furnace. This new type of furnace has a smaller capacity than the gas equivalent, but it is a major innovation in terms of tonnage for this type of glass. Fives and Verallia agreed on a design to secure this first project, before deploying larger capacity furnaces.

→ *View of the Verallia site and 3 glass melting furnaces*

PRODUCTION LINE

Continuous production, 160 t/d of glass produced
Heating temperature: 1500°C (24h)
Installed power: 9 MW

ALLICE 2025 – with the support of ADEME

DECISION-MAKING CRITERIA

In the wake of the Paris Agreement, the European glass industry began looking for solutions to decarbonise, via industry federation FEVE and a pilot project launched in 2018. Two promising technologies were identified: hybrid electric/gas furnaces and 100% electric furnaces. Verallia, the market leader, followed up by approaching Fives in 2020 to develop an electric melting furnace and start converting its existing equipment.

→ *Model of the electric furnace installed*

WORK ON SITE

Electrifying a high-power furnace requires adaptations to the electrical network. The Cognac site was selected because only an HV transformer substation had to be installed.

> “This 100% electric oven is at the crossroads of our sustainability, innovation and development challenges. This is a powerful symbol for Verallia, as well as being a major step forward for the food packaging glass industry, and we are very proud to be pioneers in this field.”
>
> *Patrice Lucas, Chief Executive Officer of the Verallia Group*

Operation

As this is a major technological first, a great deal of effort was devoted to managing the change at the site, in particular by planning development of the teams' skills.

Project timetable

After the initial contact in 2020, the contract was signed in 2022.

Financing

€57m, including €13m of funding via the "*Industrie zéro fossile*" (Zero-Fossil Industry) call for projects.

Reproducibility factors

The project can be replicated for the production of transparent glass. The furnace capacity is an intermediate step on the way to reaching the maximum capacity of current furnaces (400 t/d). R&D is underway for flat glass, for which tonnage is higher.

OBSERVED RESULTS

Energy savings: 20 GWh/year
CO_2 savings: 12 $ktCO_2$/year

- **Major point: The efficiency of the electric furnace is greater than that of the regenerative gas furnace, reducing the energy used by 40%.**
- Eliminates pollutants in the flue gases (NOx, SOx, etc.). The flue gases are "cold" (around 100°C), and mainly composed of H_2O and CO_2.
- The quality of electrical melting generally results in better product quality.
- Dust has been drastically reduced, as has the heat and noise of the furnace during operation.

Project contact

hubert.dedivonne@fivesgroup.com

ALLICE 2025 – with the support of ADEME

Recovery of drying vapours with thermal enhancement via a heat pump

Terreal is a leading French manufacturer of clay products for the building industry, in particular roof tiles, bricks and roofing solutions. Its production site in Ségala specialises in the manufacture of clay roof tiles and accessories.

TERREAL – wienerberger — Industrial operator

dalkia GROUPE EDF — Technology provider

France
Le Ségala (Aude region)

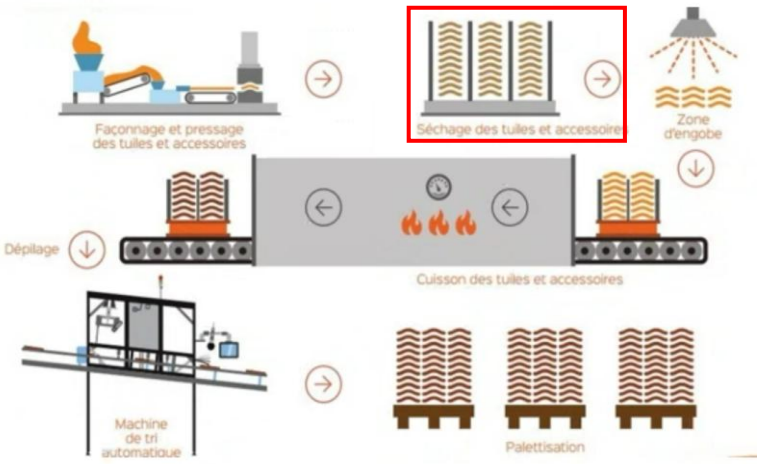
Ceramic
Tile production

Heat pump
NH_3 fluid, vapour condensation and waste heat recovery

December 2024
Commissioning date

TILE PRODUCTION PROCESS

1. Extraction and preparation: The clay is extracted, crushed and kneaded to form a homogeneous paste. Water is added to facilitate shaping.
2. Shaping and drying: The paste is extruded, cut and pressed into tiles, then dried slowly in a drying tunnel to prevent cracking (on a cycle from 25 to 90°C).
3. Firing and finishing: The tiles are fired at high temperature (~900/1000°C) for several hours to give them their mechanical strength and their final colour. They are then inspected and packed before shipping.



OPERATION PERFORMED

A heat pump was installed to preheat the air entering the dryer's gas burners. It recovers latent energy from the vapours leaving the dryer at the heat sink, and the condensed vapours are reused in the plant's process.
Characteristics of the ammonia heat pump:
P_{elec} = 375 kW P_{heat} = 1500 kW

→ *View of the two-stage heat pump*

PRODUCTION LINE

Continuous production, capacity of 46,000 tiles/yr
Heating temperature: 90°C (~11h)
Installed power: 2 MW

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DECISION-MAKING CRITERIA

TERREAL carried out an overall assessment of how to optimise its energy utilities. The project was selected for several reasons:

- The cost performance of decarbonised heat and the possibility of guaranteeing performance over time via an EPC.
- Water efficiency is a key issue for the plant, in particular to maintain activity during the summer season, as the south-west of France is particularly affected by drought.

WORK ON SITE

The project was carried out without any additional shutdown of the roof tile production lines, and the coil interfaces were integrated during the plant's usual maintenance periods.

→ *Heat pump cooling coil*

> “The use of a heat pump at our site is an important step in the Group's drive to decarbonise its production activities. This is new equipment for our site, which we have secured through an Energy Performance Contract and by entrusting maintenance and operation to Dalkia's teams.”
>
> *Thierry Quiquandon, Process Division Manager, Terreal Group*

Operation

As this is a technological first for the industry, a 5-year EPC has been signed. Dalkia is responsible for design, construction and maintenance, with performance guaranteed for the duration of the contract and shares operation of the facilities with Terreal, enabling teams to gradually build up their skills.

Project timetable

Contract signed in December 2021. Commissioning in December 2024.

Financing

For a CAPEX of €3m, the project benefited from DECARB FLASH funding (€345k) and specific CEEs with additional bonuses (€1072k) with a minimum guaranteed by the EPC, giving an expected payback time of around 5 years.

Reproducibility factors

This technological brick can be replicated for all industrial equipment with dryers, especially at low temperatures. It will be deployed at other French plants from 2026 onwards.

OBSERVED RESULTS

Energy savings: - 11 GWh/yr of gas + 2.75 GWh/yr electricity
CO_2 savings: 2 $ktCO_2$/year

Water savings: condensate recycling covers 2/3 of the production line's water consumption

- Sensors and a dedicated monitoring system were added as part of the project, enabling the dryer to be closely monitored.
- The new equipment and associated instrumentation have enabled a better understanding of the process, optimising the dryer.

Project contact

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