

ENERGY SAVINGS CERTIFICATES (ESCS) AS A LEVER FOR COMPETITIVE DECARBONISATION IN THE CERAMICS INDUSTRY

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ABSTRACT

In the ceramics industry, energy costs typically account for around 25%–30% of production costs, although in certain sub-sectors, plants, or contexts where prices are high, this figure may approach or exceed 40%. In thermal processes such as firing and drying, energy efficiency ceases to be merely an operational improvement and becomes a critical factor in regard to competitiveness and industrial viability.

This paper presents the Spanish Energy Savings Certificates (ESCs) scheme, established by Royal Decree 36/2023 and recently strengthened by Royal Decree-Law 7/2026, as an innovative financial mechanism that enables ceramics companies to monetise their investments in energy efficiency, significantly shortening payback periods and accelerating the transition towards more competitive and sustainable processes.

It describes the regulatory framework, the implementation methodology, the eligible energy-savings measures specific to the ceramics sector, and the digital tools that enable the process to be managed on a scalable basis. Three anonymised case studies are presented from industrial companies with high thermal energy consumption, which can be extrapolated to the ceramics industry, and a standard ESC management procedure is proposed that can be integrated into ISO 50001 systems.

The innovative aspect of this paper is the transfer - for the first time at a technical conference in the ceramics sector - of an energy efficiency funding mechanism aimed at the specific needs of the ceramics industry. It details a replicable management model, demonstrating its economic viability with real data, along with the methodology and challenges involved in measuring, verifying, and certifying energy savings using international standards specifically applied to production operations in the ceramics industry.

1. INTRODUCTION: THE ENERGY CHALLENGE FACING THE CERAMICS INDUSTRY

The Spanish ceramics industry is one of the most energy-intensive sectors in the country's economy. **Its spray drying, drying, and firing processes** reach temperatures of up to **1200 °C** and rely almost entirely on **natural gas**, which provides around **90% of the energy consumed by the sector**.

The **Castellón ceramics cluster** accounts for about **94% of Spanish ceramics production** and represents approximately **32.2% of the province's industrial GDP**. In 2024, the sector had a turnover of about €4.818 billion, produced nearly 400 million square metres and exported approximately 72% of its sales to 186 countries. Its **annual energy consumption** stands at about **14 TWh of natural gas and 1.4–1.5 TWh of electricity**, i.e. 50–60% of industrial gas consumption in the Valencia region and between 7% and 8% of Spain's entire industrial gas consumption.

In such a context, **energy efficiency** is no longer simply an option for continuous improvement but has become a **prerequisite for competitiveness**. However, many **energy efficiency projects require significant investment**, particularly in the refurbishment of burners, heat recovery units, kiln automation and energy management systems; they call for investment, technical integration and rigorous economic assessment.

The **Energy Savings Certificates (ESC) scheme** has emerged as the Spanish regulators' response to this structural problem. It is a mechanism that allows successful energy savings to be monetised, converting each kWh saved into a transferable economic asset. This paper analyses how this mechanism can be systematically applied in the ceramics industry, the tools it requires and the actual economic benefits it affords.

2. THE ENERGY SAVINGS CERTIFICATES (ESCs) SCHEME IN SPAIN

2.1. Definition and logic behind the scheme

The Energy Savings Certificates (ESCs) scheme is a **regulated mechanism** that enables the **final energy savings** achieved through energy efficiency measures to be converted into a **verifiable and transferable economic asset**. Each ESC is **official certification of an energy saving** achieved after implementing a specific measure. Examples include equipment replacement, heat recovery, improvement to heating systems, or process automation, provided such savings are real, measurable, additional, and validated by an independent verification body.

The end consumer implementing the measure monetises part of the savings generated by transferring their rights to an **Obligated Party or to a Delegated Party in return for a financial remuneration**. The result is a reduction in the net cost of the investment and a direct improvement in the return on efficiency projects through direct income.

2.2.Regulatory framework

Spain implemented the Energy Savings Certificates scheme through **Royal Decree 36/2023** of 24 January, transposing **Directive (EU) 2023/1791**. The scheme sets out annual energy-savings obligations for certain energy distributors and marketers (the Obligated Parties), which they can fulfil by contributing to the **Spanish Energy Efficiency Fund (FNEE)** or by **submitting Energy Savings Certificates (ESCs)** attesting to verified savings.

The system also introduces the role of the **Delegated Party, a company specialising in the design, calculation and measurement of energy savings**, qualified and recognised by the Ministry for Ecological Transition, which acts as a technical and financial expert between consumers who implement energy-savings measures (savings owners) and the **Obligated Parties** that must **verify those savings**. Achieving such a status calls for a high level of technological expertise and financial soundness.

The ESC scheme process

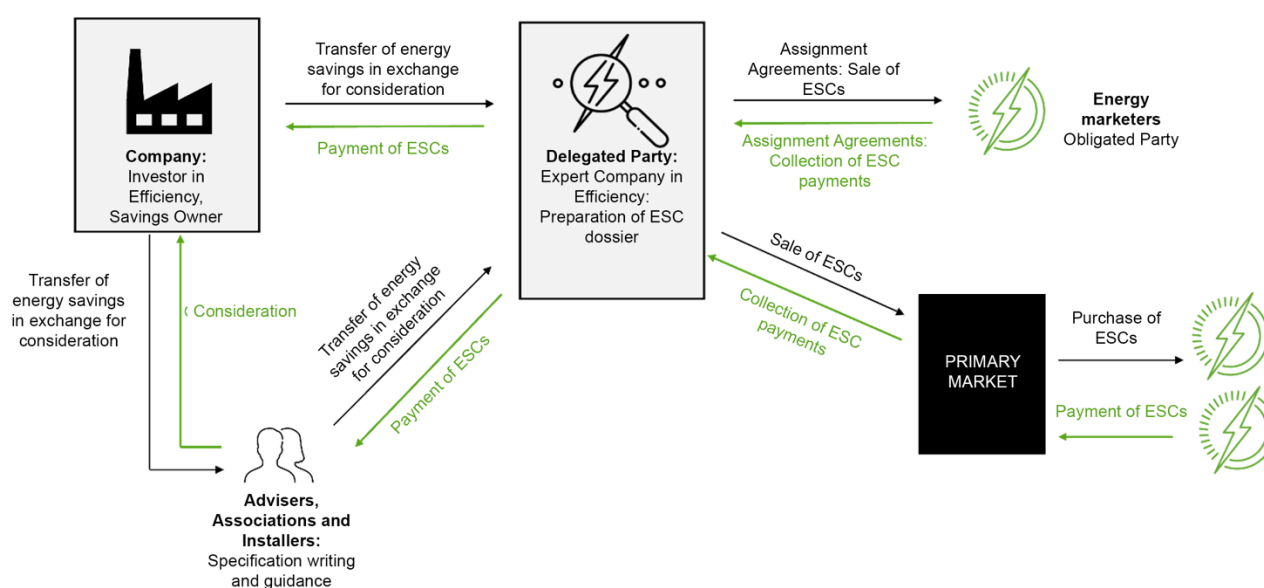


Figure 1: Diagram illustrating the ESC scheme

2.3. Current status of the scheme (2024–2026)

The scheme has undergone rapid consolidation since its implementation:

- In 2024, **696 applications** were submitted for the issuance of ESCs for **1,102 measures**, equivalent to **1.9 TWh** of energy savings.
- By 2025, **3,922 applications** had been submitted for **17,059 measures**, equivalent to **5.8 TWh** of requested savings.

- In 2026, the national target of the Spanish System of Energy Efficiency Obligations (SNOEE) has risen to **801.822 ktep**, equivalent to **9,325 GWh**, equivalent in financial terms to **€198.62 per MWh**.
- The **mandatory minimum contribution** to the Spanish Energy Efficiency Fund (FNEE) has been reduced to **8%**, meaning that Obligated Parties can **cover up to 92%** of their obligation through **ESCs**; this implies the creation of a potential ESC procurement market worth €1.7 billion.

Industry is the most active sector in the scheme, having certified 82.7% of the monetised savings, according to data from MITECO's ESCs System Monitoring.

3. APPLICABILITY OF THE ESC SCHEME TO THE CERAMICS INDUSTRY

3.1. Eligible measures in the standard catalogue

The ESC scheme's catalogue of standardised measures includes pre-approved calculation files applicable to the ceramics industry:

ESC file	Efficiency measure	Applicability in the ceramics sector
IND010:	Improving insulation of pipes and flat surfaces in facilities and equipment used in industrial processes at temperatures exceeding 60 °C	Insulation for kilns and fluid tanks
IND240	Variable-speed drives for motors	Spray dryers, compressors, ventilation
IND010	LED replacement lighting	Production and warehouse buildings
IND040	Replacement of existing combustion boilers with heat pumps	Offices and auxiliary areas
IND050	Replacement of current lighting with a system using LED light sources and/or LED luminaires	Production and warehouse buildings
IND060	Replacement of an air-conditioning generator with an electrically driven heat pump	Air-conditioned areas
IND090	Replacement of an air compressor with a more efficient model	Compressed air circuits
IND110	Heat recovery from a compressor used for heating purposes	Areas which require heating

ESC file	Efficiency measure	Applicability in the ceramics sector
IND120	Replacement of a modulating burner in a gas-fired boiler	Replacement of obsolete burners with modulating burners featuring oxygen control and low-NOx combustion technology in kilns and dryers
IND140 / IND150	High-efficiency cooling facilities	Mould and process water cooling
IND170	Replacement of electric induction motors	Production lines
IND230	Heat recovery from exothermic processes to other endothermic processes within the same plant	Transfer of surplus process heat to other heat consumers

3.2. Measures specific to ceramic processes

Apart from the standard catalogue of measures, the ceramics industry offers even greater opportunities given its specific thermal processes, which are incorporated into the ESC system via individual case dossiers for which no standardised file is applicable:

- **Heat recovery in roller kilns:** exhaust gases range from 200 to 500 °C. Channelling them into spray drying or drying processes yields documented savings of up to 65% in spray drying and 10–23% in firing.
- **Upgrading to low-emission burners:** reductions in gas consumption of between 8% and 15%, with payback periods that the ESC can shorten from 3–4 years to less than 2.
- **Optimisation of gas flow and advanced combustion control:** electronic regulation and continuous monitoring of O₂ in flue gases, resulting in savings of 6%–13%.
- **Increased solids content in the slurry:** achieved through the use of deflocculants and formulation, resulting in savings of up to 48.7% in the spray dryer.
- **Partial electrification of the drying process:** replacing gas burners in the initial stages with electric infrared systems or high-temperature heat pumps, which are particularly cost-effective in contexts of energy parity.
- **Submetering and energy management systems:** automated monitoring and control, delivering additional savings of 3%–8%.

Methodology note regarding savings ranges

The savings ranges expressed in this section are indicative and based on technical preliminary sizing estimates. Certifiable savings will depend on the initial situation, actual operating conditions, the integration of the specific measure, and the independent verification required by the ESC scheme.

4. STANDARD ESC MANAGEMENT PROCEDURE FOR THE CERAMICS INDUSTRY

A six-phase procedure is proposed, designed to be integrated into the ISO 50001 energy management systems at ceramics plants. Its systematic and replicable nature makes it particularly suitable for multi-year efficiency programmes.

PHASE 1: Preliminary energy diagnostic

An energy audit is carried out in accordance with Royal Decree 56/2016 or by simplified diagnostic. The Energy Savings Measures (ESMs) eligible for the ESC scheme are identified and quantified. The volume of ESCs that can be generated and the associated revenue are estimated, as a criterion for prioritising investments.

PHASE 2: Selection of the measure and opening of the specific process dossier

The applicable calculation file is decided on. For one-off projects, a specific calculation method is developed prior to implementation. The ESC Agreement is signed between the developer and the Delegated Party where the financial terms of the agreement are set out.

PHASE 3: Execution and documentation

Implementation of the measure with comprehensive documentation: equipment invoices, installation certificates, meter readings before and after, and all technical evidence required by the applicable calculation file are collected.

PHASE 4: Calculation and verification of savings

Application of the calculation methodology to determine annual energy savings in kWh. Third-party verification of the savings by an accredited body as required by the regulations. Determination of the number of ESCs to be issued (1 ESC = 1 kWh/year of savings).

PHASE 5: Processing by the Ministry

The Delegated Party submits the application to the Spanish Ministry for Ecological Transition and the Demographic Challenge (MITECO), providing all the supporting technical documentation. Following the Ministry's assessment, the ESCs are issued in the Register of Energy Savings Certificates.

PHASE 6: Settlement and transfer of value

The Delegated Party sells the ESCs to the Obligated Parties at current market prices. The resulting value is transferred to the developer (the ceramics company), net of the service fee. The proceeds may be used to reduce the investment or as an additional return on measures that have already been amortised.

5. EXAMPLES OF APPLICATION IN INDUSTRIES WITH HIGH THERMAL ENERGY CONSUMPTION

Hereunder are three anonymised case studies illustrating the application of the ESC scheme in an industry with high thermal energy consumption.

Case 1: Large-format ceramic tile manufacturer

A manufacturer of ceramic floor and wall tiles had three continuous kilns with cooling stacks, from which waste heat was being exhausted without recovery. The project involved channelling this heat flow into four horizontal dryers, thereby replacing the energy supply from natural gas.

Sector	Ceramic floor and wall tile manufacturing
Actions taken	Heat recovery from the cooling stacks of 3 kilns to 4 horizontal dryers. A single ESC.
Verified ESC savings	25,289 MWh/year
ESC financial return	≈ €3.3 – €3.5 million

Case 2: Ceramic tile manufacturer

With a similar setup to that of the previous case but on a smaller scale, this plant recovered the waste heat from two kilns to feed two horizontal dryers.

Sector	Ceramic floor and wall tile manufacturing
Actions taken	Heat recovery from the cooling stacks of 2 kilns to 2 horizontal dryers. A single ESC.
Verified ESC savings	21,071 MWh/year
ESC financial return	≈ €2.7 – €3.0 million

Case 3: Ceramics company

A company that relies on diesel for a specific thermal process replaced its existing boiler with an electric element heating system, gaining access to the ESC scheme via a special application procedure as no standardised calculation file was applicable.

Sector	Ceramics manufacturer using continuous thermal processes
Actions taken	Energy audit, implementation of an ISO 50001 management system and management of standardised energy performance contracts (file IND040). Replacement of atmospheric gas boilers (121 kW) and condensing gas boilers (194.4 kW) with heat pumps with a heating seasonal coefficient of performance (SCOP) of 6.19 and a domestic hot water (DHW) SCOP of 4.83 in three areas of the plant.
Verified ESC savings	894,282 kWh/year
ESC financial return	≈ €115 000 – €135 000

Joint review of the above cases

The three cases detailed above demonstrate that the ESC scheme is operational, scalable and economically viable in industries with high-intensity thermal processes. The ceramics industry meets precisely the conditions that make this mechanism most valuable: high-temperature continuous kilns, large flows of recoverable waste heat, high natural gas consumption, and efficiency measures involving significant investment that benefit from additional funding.

The potential ESC return on investment from heat recovery projects in ceramic kilns, as demonstrated by Case Studies 1 and 2, frequently exceeds €2.5 million per project – a figure that transforms any feasibility study of investments which, in the absence of such a mechanism, might not otherwise meet the criteria for commercial viability.

6. THE ESC DIGITAL MANAGEMENT PLATFORM AS A SYSTEM ENABLER

The **efficient management of the ESC scheme** requires a significant level of technical, documentary and analytical expertise. The complexity of the process – from choosing the calculation file through to ministerial processing and settlement – can represent a real barrier for industrial companies that do not have specialised in-house staff. The **digitalisation of this process** is, therefore, **a critical enabler** for the widespread adoption of the scheme in the ceramics sector.

6.1. Features of an ESC management platform

A professional-grade **ESC management platform** must integrate the following features into a single working environment:

- **Automatic calculation of savings:** by entering the minimum parameters for the equipment or installation, the system instantly calculates the energy savings and the ESCs that can be generated, in line with the official data files published in the Spanish Official State Gazette. Within minutes, the user receives an estimate of the expected ESC payback before making an investment decision.
- **Profitability simulator:** projection of the combined economic impact (savings on bills + ESC revenue) on the project's payback period, taking into account sensitivity to fluctuations in energy prices and the ESC market.
- **Centralised document management:** a dossier-based checklist that specifies, at each stage, which documents are required and their review status. This removes any uncertainty regarding the completeness of the dossier before it is submitted to the Ministry.
- **Real-time tracking:** this monitors the status of each dossier, with automatic alerts for legal requests or critical deadlines.
- **Integrated technical support:** a direct line of communication with the Delegated Party's specialist team via a ticketing system, with access to up-to-date regulations and the resolution of technical enquiries without leaving the management environment.
- **Importing data from energy performance certificates:** integration with external data sources to speed up analysis and reduce manual input errors.
- **Monitoring of savings:** the measures implemented must be monitored and the savings recorded over the useful life specified in the dossier by measuring and recording the variables involved in the savings

The result: full traceability of the dossier, reduced processing times, and the conversion of energy savings into auditable and quantifiable data.

7. THE EUROPEAN REGULATORY FRAMEWORK AND OUTLOOK

Directive (EU) 2023/1791 establishes the 'Efficiency First' principle as the cornerstone of European energy policy, meaning that improving efficiency must be the primary consideration in any decision regarding investment in energy.

The Spanish transposition of that EU legislation reinforces the concept and raises the bar for large industrial consumers. Companies with high energy consumption will be required to move towards regular audits, energy management systems and the effective implementation of energy-savings measures, directly affecting a significant proportion of the Castellón ceramics cluster given its high thermal intensity and dependence on natural gas.

Added to this is the Carbon Border Adjustment Mechanism, governed by Regulation (EU) 2023/956. Although its current scope is focused on certain carbon-intensive sectors, the CBAM reinforces a clear trend in European industrial policy: linking competitiveness, carbon costs and emissions traceability. For the ceramics industry, reducing its energy footprint through verified efficiency measures could become a strategic advantage over international competitors facing lower environmental standards or less regulatory pressure.

With such a scenario, ESCs provide an additional layer of value. They enable real, measurable and verified energy savings to be demonstrated, whilst improving the return on the investments required to reduce consumption, emissions, and exposure to energy volatility.

8. CONCLUSIONS

- The Spanish ceramics sector's energy and CO₂ costs exceed €800 million per year and are the main structural factor behind its loss of competitive edge over foreign manufacturers.
- The ESC scheme converts the kWh saved into a transferable financial asset and enables the payback period for efficiency investments to be significantly reduced.
- The ceramics industry's greatest potential for generating ESC lies in its thermal processes: heat recovery from kilns, insulation, combustion control, partial electrification and the integration of spray dryers, dryers, and kilns.
- Documented cases show economic returns in excess of €2.5 million per individual project, a figure that redefines internal criteria regarding the viability of investment in energy efficiency.
- The proposed six-phase procedure constitutes a standard that can be replicated and integrated into ISO 50001 systems and is suitable for multi-year efficiency programmes.
- A specialised digital platform is a critical enabler for scaling up the model, reducing the administrative burden and ensuring the document traceability required by the scheme.
- When combined with the European 'Efficiency First' framework and the CBAM, the ESC scheme ceases to be a one-off financial tool and becomes a strategic component in the competitive decarbonisation of the ceramics cluster.

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