

MASTER

A joint TU/e and Shell study on the business case, incentive regimes and opportunities for the implementation of industrial electric boilers in the Netherlands, Germany and the UK

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Assessing the Potential of Industrial Electrification using E-boilers in Europe

A joint TU/e and Shell study on the business case, incentive regimes and opportunities for the implementation of industrial electric boilers in the Netherlands, Germany and the UK.



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Abstract

The transition to a sustainable energy system is accelerating, with the European Union setting ambitious targets to increase renewable energy production and reduce greenhouse gas emissions. While the decarbonisation of the electricity sector is progressing rapidly, the industrial sector's reliance on fossil fuels remains a challenge, posing a significant barrier to achieving climate goals. Although several industrial decarbonisation technologies are commercially available, their implementation has yet to advance significantly. Since a significant part of Useful Energy (UE) demand in industry consists of steam, electric steam boilers are seen as possible alternatives to traditional gas boilers. This thesis conducts an analysis into the potential for industrial hybrid e-boiler implementation in Europe, in conjunction with Shell's Electrification Platforms Technology department.

The methodology in this study focuses on the business case, policy environment, national context factors and company perspective in the Netherlands, Germany, and the UK. Through a cost benefit analysis including a 15-year day-ahead market outlook and policy evaluation, the business case and its policy influences are quantified in each market. Then, four national context factors are assessed to provide information on wider electrification trends: (1) current e-boiler installed base, (2) industry steam demand, (3) availability of renewable energy and (4) location of renewable energy. Finally, the concept of "Heat-as-a-Service" (HaaS) is considered as a potential application to progress e-boiler implementation for energy service companies such as Shell. Therefore, semi-structured interviews are conducted with industry companies to take a user-perspective to the matter. Together, these analyses identify key drivers and opportunities for the adoption of e-boilers and HaaS.

Results indicate that hybrid e-boilers present a viable alternative to gas boilers in the Netherlands, with conditions in Germany and the UK showing potential for future adoption. Sensitivity analyses highlight the importance of subsidy schemes, grid fees and CO₂-prices to accelerate this transition. Policy inconsistencies between the EU and UK and differing national strategies on electrification versus hydrogen are influential political elements. National context factors point to the Netherlands and Germany as countries with suitable industry and growing renewables capacity. Interviews reveal that required knowledge of power markets is a barrier to implementation of e-boilers, but that companies are reluctant to involve third parties when considering Heat-as-a-Service. A literature review reveals gaps in HaaS literature regarding industrial applications, which this study addresses by redefining potential industrial e-boiler users through a "HaaS-spectrum". The recommendations include simplifying energy cost components and improving transparency in national regulation. This study emphasises the need for a unified, long-term policy vision at the EU-level to support industrial decarbonisation and establish a competitive, sustainable industry in Europe.