Approaches for determining the price-elastic demand for heat in Swiss industry

Graduate

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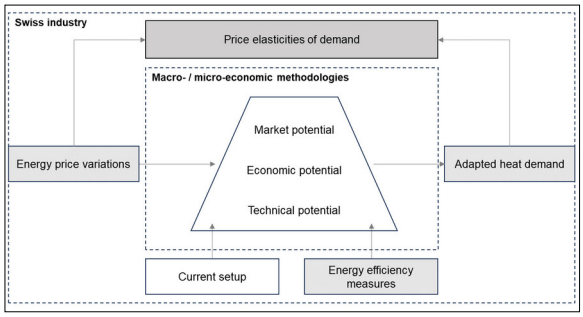
Definition of Task: The industrial sector in Switzerland is a major energy consumer due to its substantial heat demands, significantly contributing to greenhouse gas emissions. Achieving greenhouse gas reduction targets necessitates a reduction in energy consumption, for which the adoption of energy efficiency measures offers a promising solution. While technical potential for energy demand reduction exists, practical adoption is often constrained by economic and market factors. Understanding these barriers requires an examination of the complex relationship between energy prices, efficiency measures, and their impact on final energy demand. This relationship is investigated in this master's thesis, with the primary objective of developing methodologies to quantify it and analysing the price elasticity of heat demand, with a specific focus on Swiss industry.

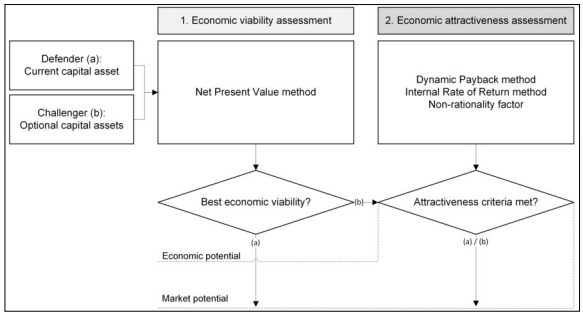
Approach: To achieve the research objectives, technical and economic aspects of energy efficiency measures in industrial environments were analysed, providing essential insights for modelling adoption behaviour. An adapted investment decision framework was developed, incorporating rational investment assessment through net present value analysis while integrating real-world decision-making factors such as dynamic payback periods, internal rates of return, and a non-rationality factor. This framework enables the estimation of economic and market potentials based on the technical potential at given energy prices.
To contextualise the approach within Swiss industrial energy demand, two complementary methodologies - bottom-up and top-down - were developed. The bottom-up approach offers high accuracy by analysing efficiency potential at the facility level but requires significant effort. In contrast, the top-down approach is less resource-intensive by evaluating the entire industrial capital stock, though it relies on multiple assumptions, reducing accuracy. Case study analyses validate the applicability of these methodologies and reveal key sensitivities, including thermal efficiency, energy prices, investment costs, and discount rates.

Result: The findings enabled the development of qualitative, hypothetical price elasticity curves for industrial heat demand. These curves reveal demand saturation at both very low and very high energy prices, where no price-elastic response in energy demand is observed. In contrast, mid-range energy prices drive the adoption of efficiency measures, leading to a sharp decline in energy demand as prices rise. However, the resulting demand elasticity remains limited, as the percentage change in energy demand is small compared to the high percentage change in energy prices.
This thesis contributes to understanding how energy price variations influence industrial heat demand through efficiency measures, offering actionable methodologies and insights that bridge theoretical research and practical application. The developed approaches are generally applicable beyond industrial heat purposes and hold international relevance. Nonetheless, the investigation faces limitations, primarily due to its focus on long-term heat demand adjustments driven by energy price variations, which are assumed to remain static over an infinite time horizon.

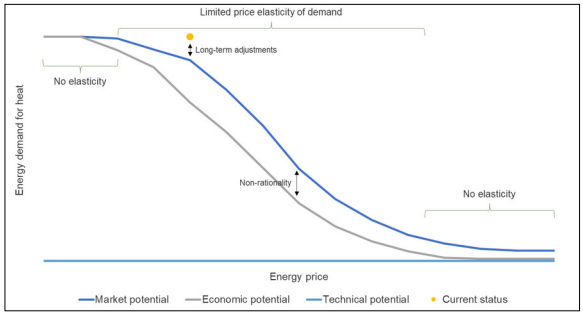
Investigation framework
Own presentment



Developed investment decision approach for determination of economic- and market potential based on energy price changes
Own presentment



Hypothetical price elastic energy demand curve for Swiss industrial heat
Own presentment



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Subject Area
Energy and Environment