UiT The Arctic University of Norway

Firm internal drivers for energy efficiency in manufacturing firms

Learnings from the literature and the Norwegian context

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I. Introduction

- Norwegian context
- Status of research on industrial EE
- .

II. Drivers for energy efficiency (EE)

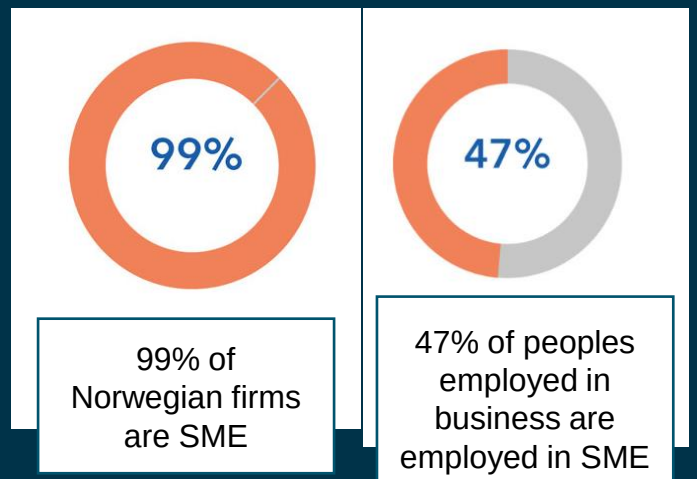
- Research project – three studies
- Results
- Learnings and implication

The School of Business and Economics, UiT

- UiT is the world's northernmost university
- The School had approximately 2,500 programme students in 2020.
- We offer both on-site and digital study programmes spread across four campuses

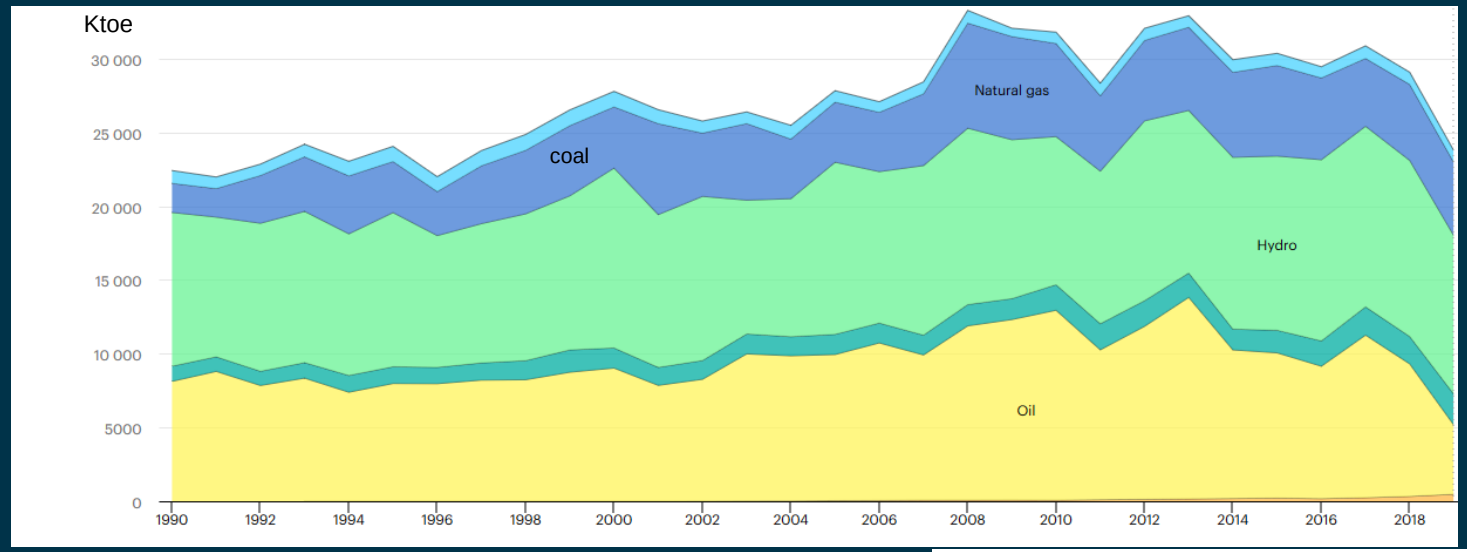
The Norwegian context:
relevance of industrial energy efficiency (EE)

- International commitments - Paris Agreement
- Energy intensive industrial sector
- Significant industrial EE gap - 40 % emission reduction potential (Enova, 2019).
- Moral responsibility
- Export of hydropower to the Nordic electricity market
- Preparing the national economy for a future after oil and gas



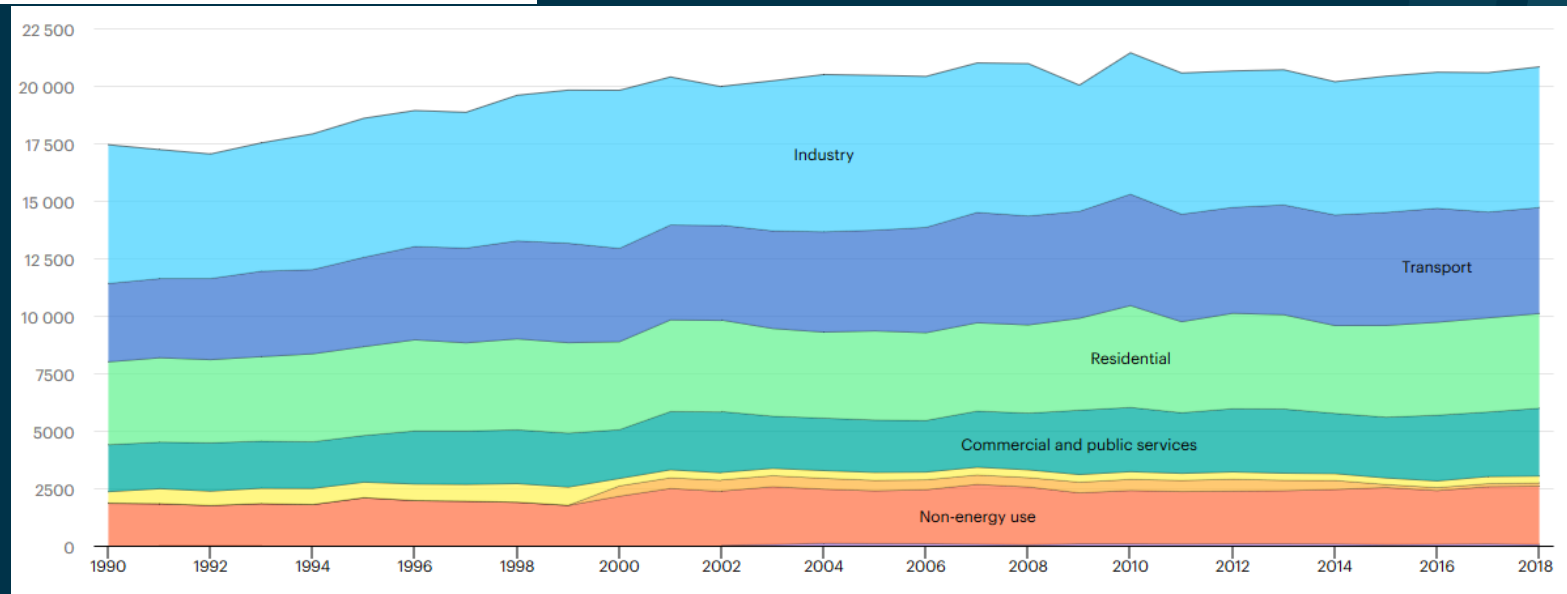
External trade in goods	External trade in goods	External trade in goods
y 2020	NOK Billion	Share in %
Imports	**762,8**	**100 %**
Exports	**773,2**	**100 %**
Crude oil and natrual gas	326,1	42,20 %
Mainland exports	442,3	57,20 %
The trade balance	**10,4**	
The mainland trade balance	-312	

The Norwegian context:
energy supply and consumption



Total energy supply (TES) by source

Total final consumption (TFC) by sector:



Source: IEA

Status and main focus in research on EE in industrial SME

- **The barrier model** explaining the discrepancy between the optimal and current level of industrial energy efficiency.
- **The choice step**, rather than the decision-making process.
- **The economic and information barriers** are perceived as the strongest, though the perception of barriers alternate along the process
- Energy policies are often oriented towards these barriers through energy **audit programs and economic policy instruments**
- Energy audit programs are the most popular individual policy measure, though the major EE potential is found in the support processes, not in the production processes
- The development of guidelines, best practices and assessment models intended to promote industrial EE

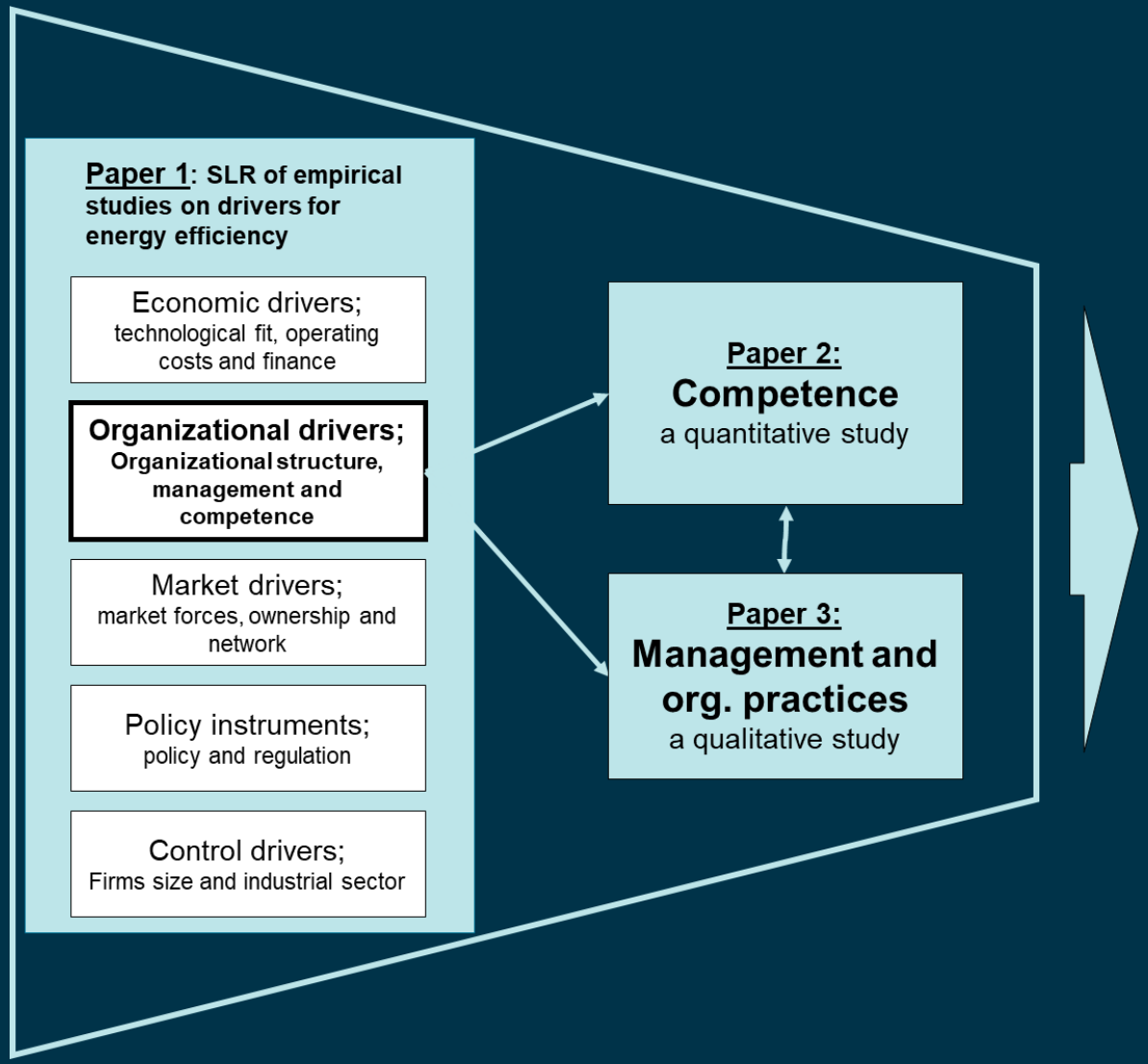
(sources: Cagno et al., 2013, Johansson et al., 2019, Trianni et al., 2016)

Background

The core question driving my work:

Why are some manufacturing firms willing and able to change their behaviour and become more energy efficient?

Research and Results



Results: a new typology of internal drivers for industrial energy efficiency

1. Environmental leadership

- Managers' environmental awareness
- Long-term environmental strategies and commitment
- Employee involvement and engagement
- Including environmental and economic objectives in all practices and decision processes

2. Absorptive capacity

- Education and training of employees
- Competent environmental managers
- Innovation experiences
- Cooperation with knowledge institutions

3. Organisational structures and routines

- Environmental managers position in the org.
- Environmental teams across org. departments
- Routines for employee engagement
- Routines and systems for measuring, monitoring, and communicating environmental performance

4. Translation competence

- Editors' ability to understand the original idea, the local recipient context and master the translation instruments
- Energy mangers often serve as key translators

Paper 1: Literature study (SLR)

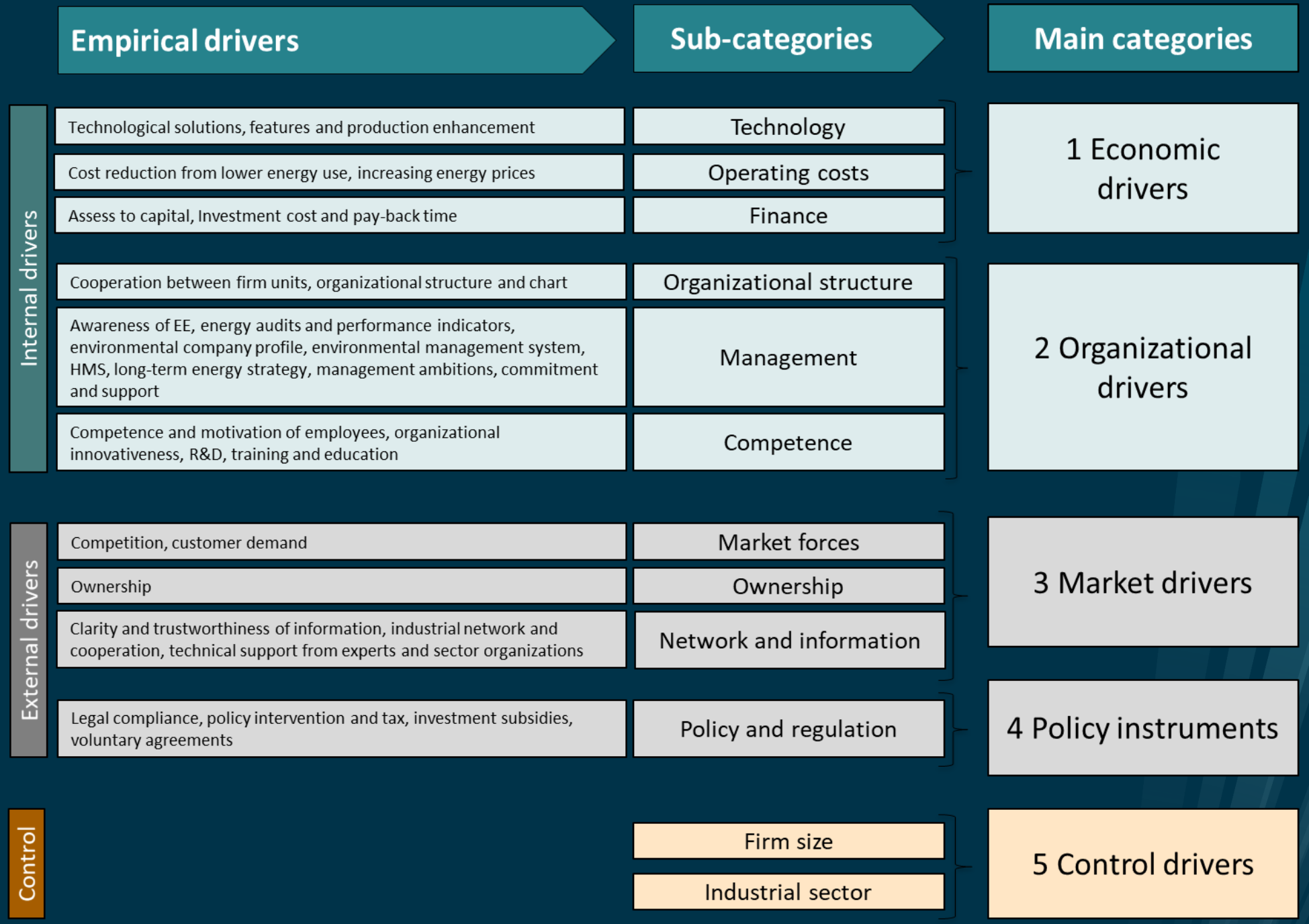
58 empirical papers on drivers for energy efficiency in manufacturing firms

Main findings:

- Increase in publications around 2013
- Geographical focus on Western Europe; Italy, Sweden, Germany
- Three major research milieus located in Italy, Sweden and The Netherland.
- Mainly multidisciplinary quantitative studies with large variation in the operationalisation of the “Energy efficiency” variable
- Drivers for EE seem to vary with factors such as size, sector, production complexity and geographic location, however the results are inconclusive.

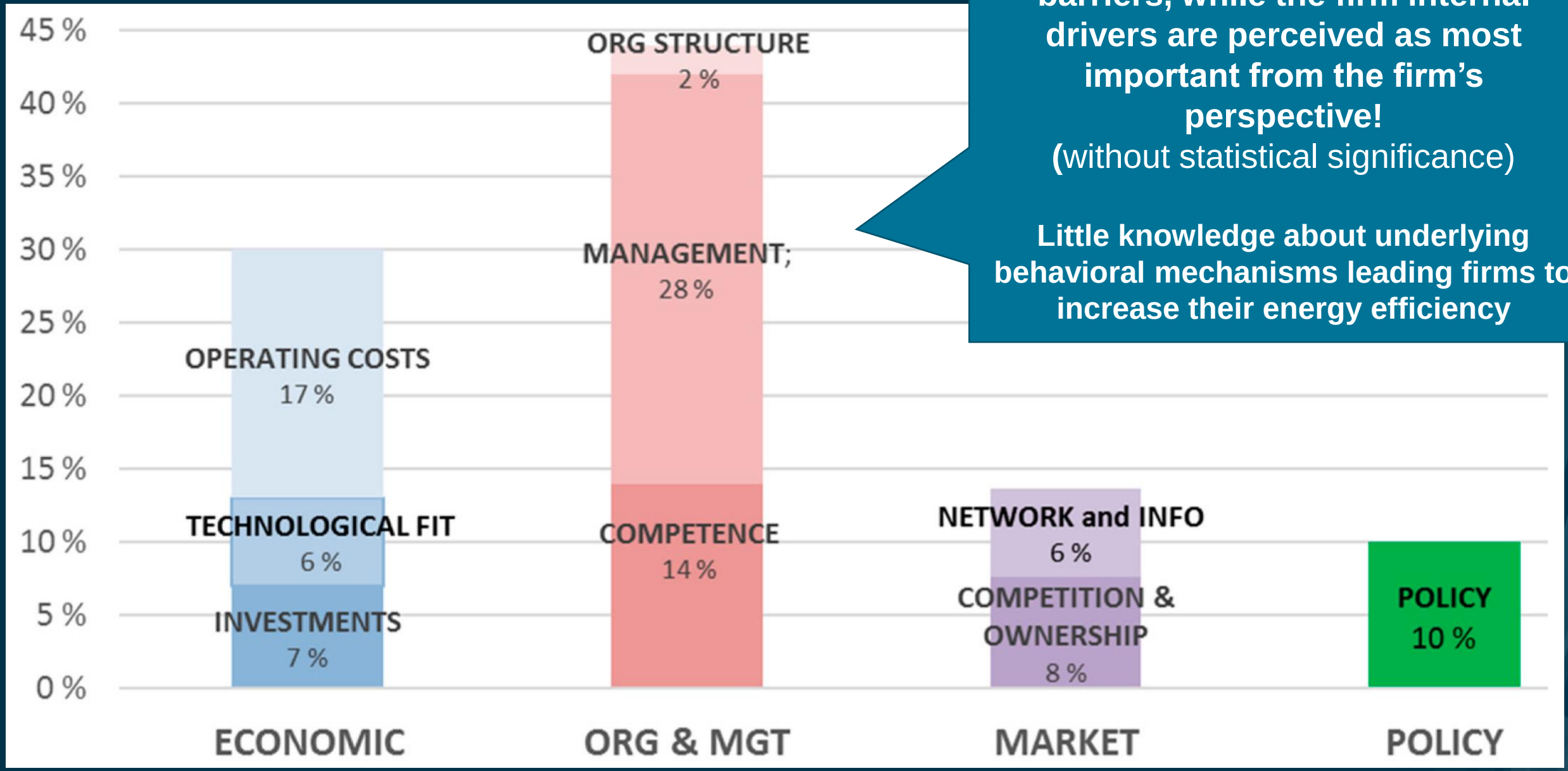
Identification of the most important drivers for EE:

- Selected the three drivers reported as most important from each study
- Grouped the drivers into 5 main categories
- Converted the qualitative data into numerical figures and counting frequency



Research and policies tend to focus on economic and information barriers, while the firm internal drivers are perceived as most important from the firm's perspective!
(without statistical significance)

Little knowledge about underlying behavioral mechanisms leading firms to increase their energy efficiency



Paper 2: Competence as a driver for EE

RQ:

- *What is the relationship between manufacturing firms' absorptive capacity and EE innovation?*

Theory: Absorptive capacity

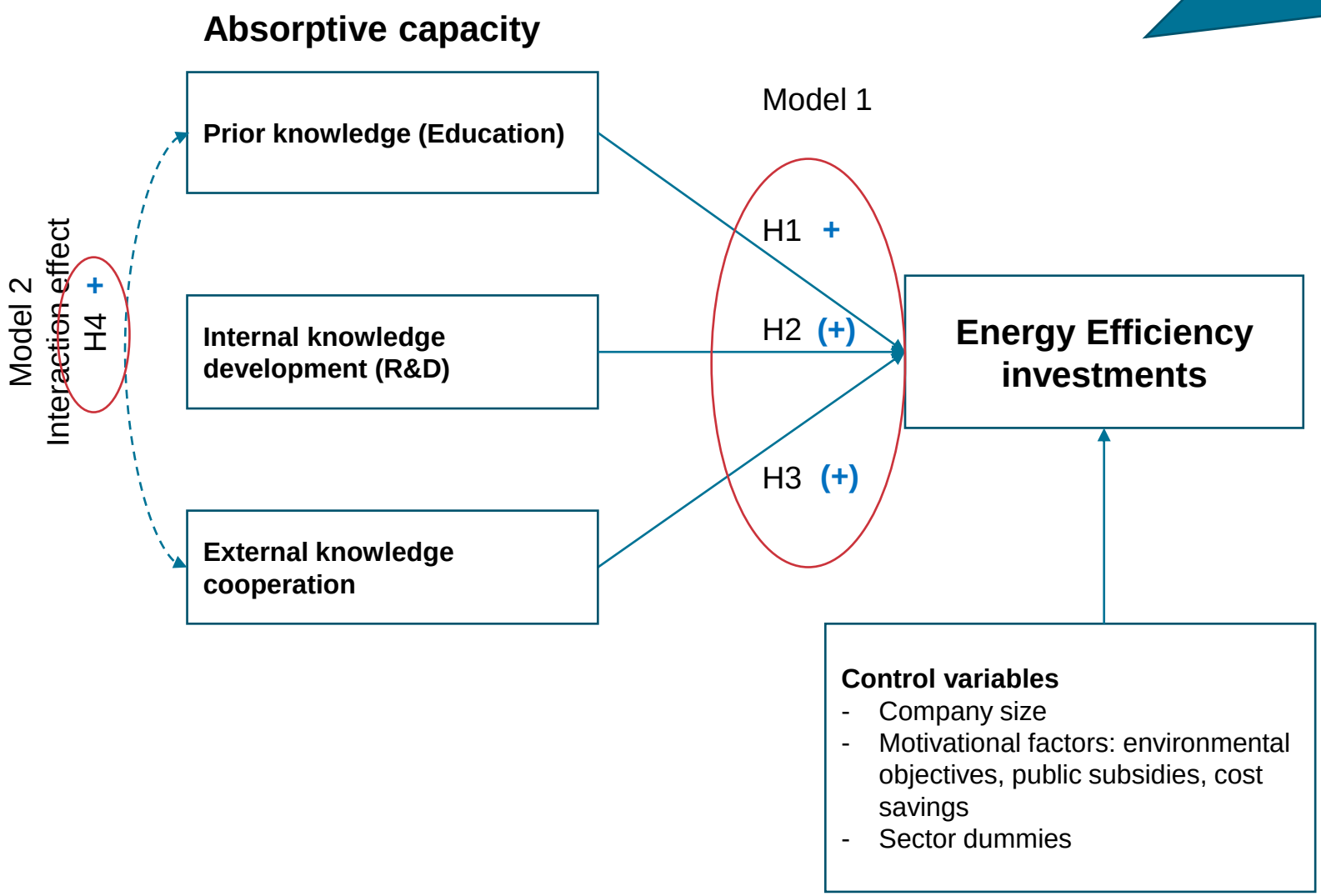
- "a firm's ability to recognize the value of new information, assimilate it, and apply it to commercial ends"(Cohen and Levinthal, 1990)

Data:

- the Norwegian Community Innovation Survey (CIS) and the Norwegian Business Enterprise R&D survey, 2010-2014.
- panel dataset

Analysis model:

- Comparing innovative firms with EE innovative firms and analysing for significant differences between the two categories (quantitative logit regression model)



The need for energy information programs (energy audits) is acknowledged, however firms seem to encounter difficulties in assimilating and fully exploiting available information.

This model indicates a positive relationship between firms' absorptive capacity and EE investments

Paper 3: Energy management (EnM)

- EnM is guidelines, standards and certification systems intended to promote industrial EE
- When implemented the EnM must be transformed into EnM practices in the organisation, involving both production and support processes, implementation/operation and culture
- Important EnM practices: top management support and awareness, energy strategy and planning, employee involvement and training, information and communication routines, energy controlling and monitoring, investment decision processes.
- How do you go from Program to Practice?

Paper 3:
From corporate Program to local Practice

Objective:

- Explore the implementation of and energy management (EnM) program and observed the role of managers and other critical factors relevant for succeeding with the implementation process.

Method and data :

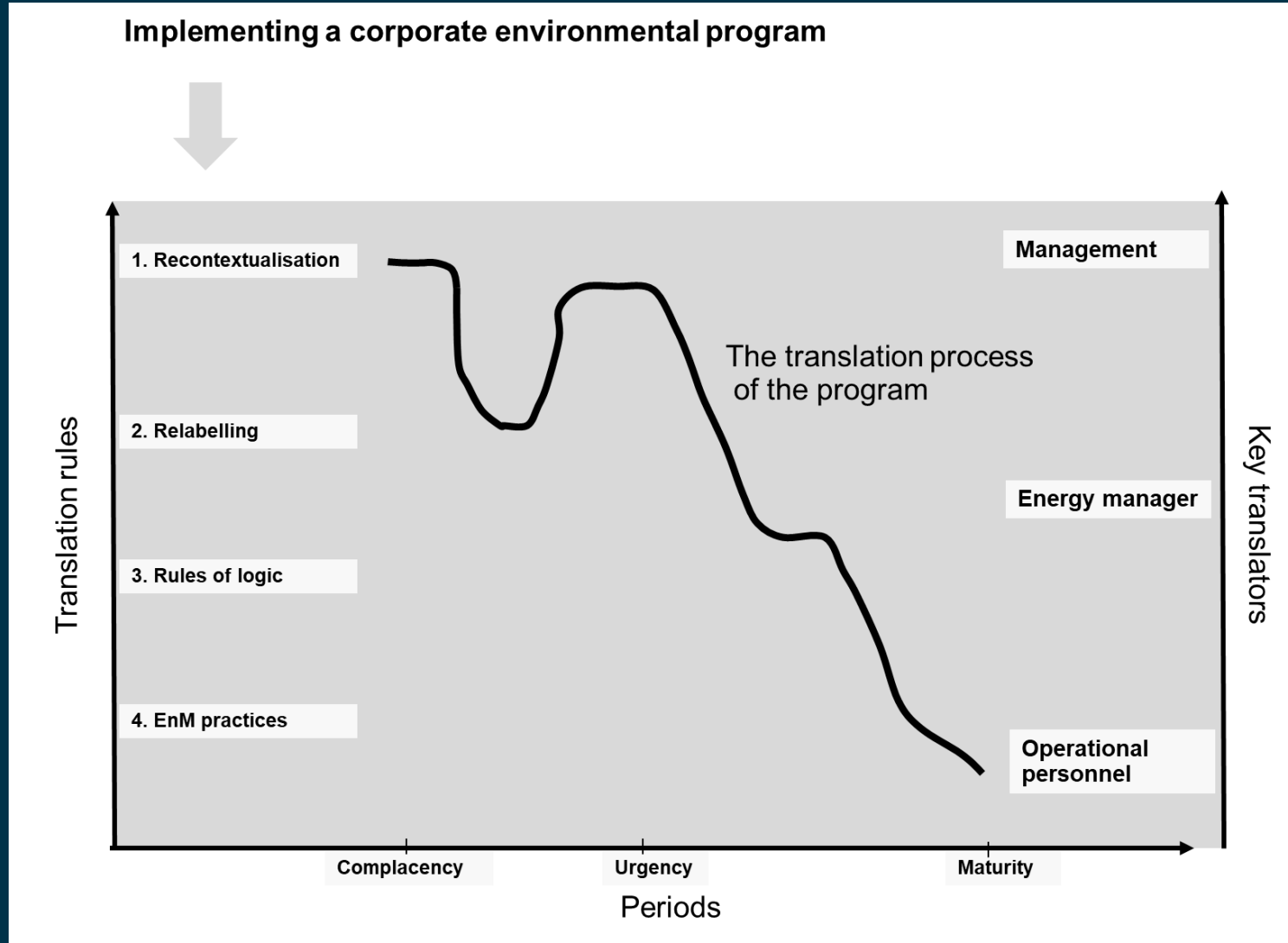
- A qualitative single case study
- Period 2004-2014, data collected retrospectively

Theory:

- Translation theory and the ‘travel of management ideas’ (Sahlin-Andersson, 1996; Røvik, 2016).
- Literature on Energy management practices (EnM)

From corporate program to local practice

- For EnM programs (and policies) to result in EE practices, EnM programs must be **translated to fit the firm's context**, rhetoric and organisational logic.
- **The design of the program** affects how easily it can be translated into the local setting of the firm
- The implementation of EnM programs is a **lengthy process** that is recognised by changes in intensity and involvement of different translators.
- The **energy manager** often serve as a key translator
- **Translation competence** increases the likelihood of succeeding with the implementation process.



Results:
Internal behavioral drivers for industrial EE

1. Environmental leadership

- Managers' environmental awareness
- Long-term environmental strategies and commitment
- Inclusion of environmental and economic objectives in all practices and decision processes
- **Employee engagement**!

2. Absorptive capacity

- Assimilation and exploitation of new and available information
- Education and training of employees
- Competent energy managers
- Innovation experiences
- Cooperation with universities

3. Organisational structures and routines

- Routines and systems for measuring, monitoring, and communicating environmental performance
- Employee involvement
- Formal and informal structures and routines
- Environmental teams across org. departments
- Energy manager's position in the org.

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Learnings from the Norwegian context

Norwegian energy policy strategy

- "The development of new technologies and markets is central to the transition to a low-emission economy…..support for developing and implementing zero-emission solutions in Norway can also contribute to solutions making low emissions cheaper. Thus, they can be adopted globally"

(White Paper, 13. 2020)

Norwegian energy efficiency policy programs

- Main programs:
  - The Green Platform initiative (2021), research program, investing NOK 1 bill/3y),
  - Enova (2001) managing the The Climate and Energy Fund, investing NOK 2 bill/annually
- The economic instruments are frequently used. Requiring public-private collaboration and technology development, and thus favouring larger firms that have the competence and capacity to enter such consortiums.
- SMEs seem to be forgotten in the Norwegian industrial EE policies
- The EE programs resonates with the Norwegian energy policy strategy

Management implication

- The firm itself can play an active role in environmental translation and transition towards low emission activities.
- The study points to four drivers that managers should master, use, stimulate and balance for successful implementation of EE
- Acknowledging the relevance of a long-term perspective on behavioural changes for EE
- Be aware of the importance key stakeholders at all levels in the organization, particularly the energy manager

Policy Implication

- Behavioral drivers, at organizational and individual level, are significant for industrial EE. To be more efficient policy programs should also stimulate these ‘soft’ aspects.
- The energy manager plays a prominent role in the development of new practices.
- Context matters! Underlines the need for more of regional, sector and firm specific studies on drivers (and barriers) prior to a public policy programme design.
- Research is a premises for research-based education. Education and university collaboration are significant drivers for industrial EE in SME. Policy makers worldwide should stimulate national research programs on the topic.
- EE policy programs must have long terms perspectives and be designed so that they are easily translated into the local setting of the firm

Thank you for your attention!

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