Exploring and modeling the impact of supply chain-related decisions in production and logistics on energy efficiency – Lessons learnt from the E²Log project

Andreas Pastowski

Wuppertal Institute for Climate, Environment, Energy

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Wuppertal Institute
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and Energy

E²Log
Energieeffizienz in Logistik und Produktion

Contributors to the E2Log Project and this Presentation

- Andreas Pastowski, Dorothea Schostok
  Wuppertal Institute for Climate, Environment and Energy
  Wuppertal (Germany)

- Frank Ellerkmann, Jan Cirullies, Kathrin Hesse, Emanuel Fuss
  Fraunhofer Institute for Material Flow and Logistics
  Dortmund (Germany)

Structure

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E²LOG – ENERGY EFFICIENCY IN LOGISTICS AND PRODUCTION

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WILO

UNIWHEELS UNITED WHEELS GROUP

KÜHNE+NAGEL

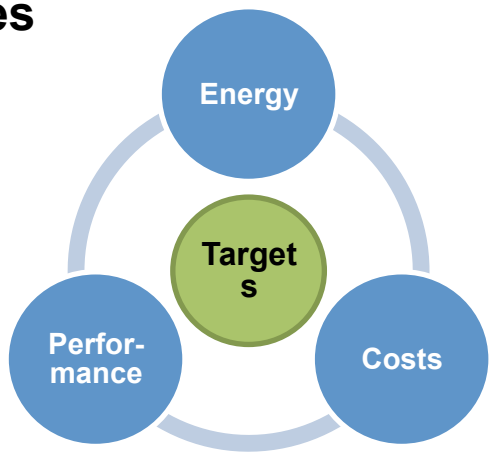
DB SCHENKER

KLINGELE PAPIERWERKE

Volkert Metall- und Kunststofftechnik GmbH

E²Log: facts & figures

- **Kick-off**: December 2010
- **Duration**: 3 years
- **Consortium**: 2 research institutes, 7 industry partners
- **Consortium leader**: Fraunhofer Institute for Material Flow and Logistics
- **Objectives**:
  - Increasing energy efficiency through **coordination of logistics and production processes**
  - Integration of energy into existing **enterprise targets**
  - Development of **methods and tools** for efficiency improvements
  - Derivation of **measures** on both the strategic and operational level



② TECHNICAL AND ORGANISATIONAL APPROACHES FOR ENERGY EFFICIENCY

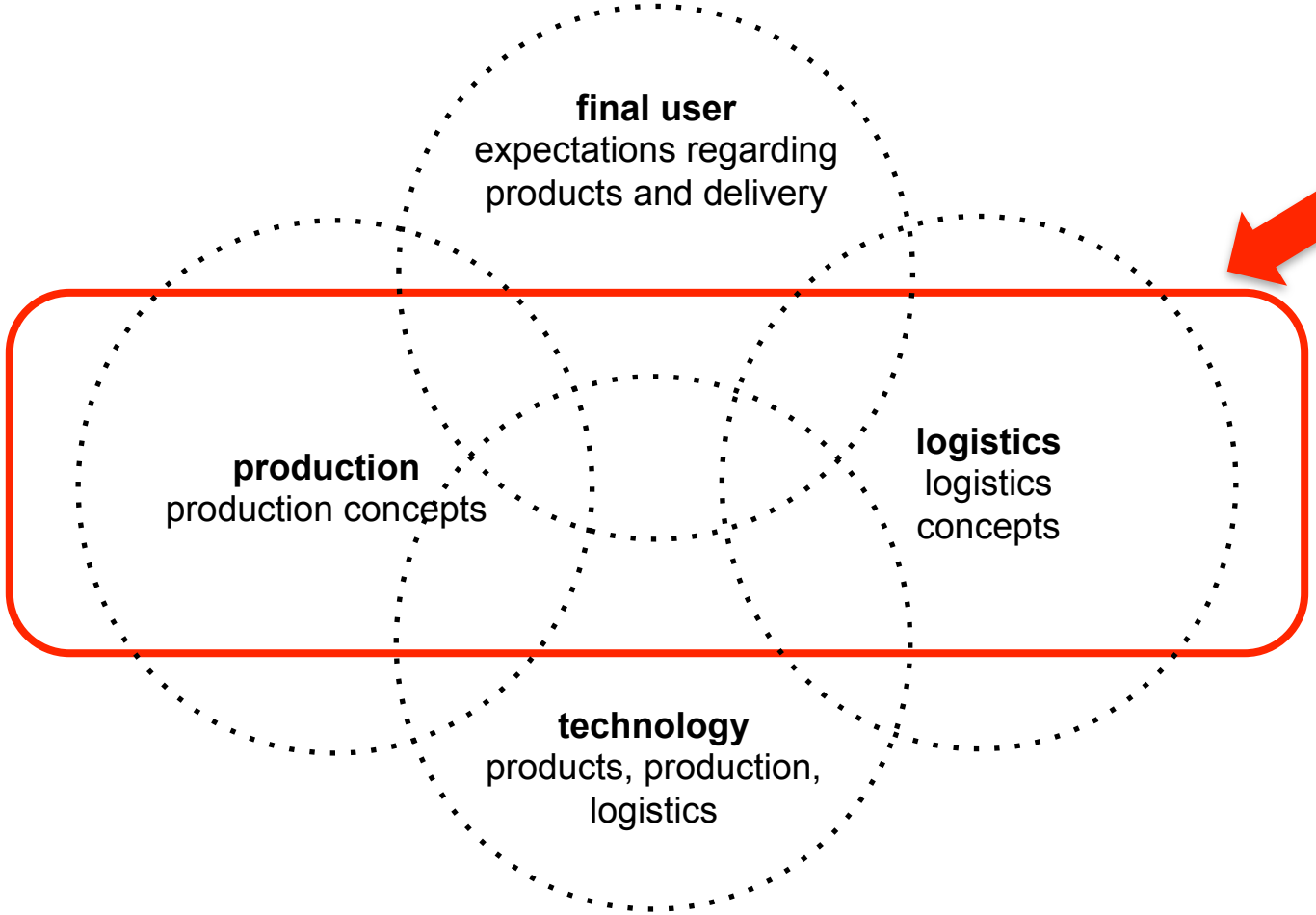
Dominance of technical efficiency in research and application

- Research: Invention and diffusion of technical efficiency improvements
- Focus: Components and cross-cutting technologies of limited complexity
- System boundaries: Equipment unit / plant
- Short comming: Scope below internal and external systemic interactions
- Practice: Diffusion of technical innovations via the investment cycle
- Moving target: Not only technologies but also application is subject to change

Systemic approaches required and fostered by developments in research and application

- Research has somewhat shifted towards factories and supply chains
- Diffusion of cost-effective technology for monitoring energy consumption is helpful
- Blackbox of highly aggregated electricity consumption is opened up
- For sophisticated data collection data mining is discussed
- However, very few meters e.g. for electricity consumption are still common
- Important initial step is the implementation of an energy management system
- Systematic and permanent measurement of energy consumption is crucial for any structured analyses or simulation excercises

Determinants of energy efficiency in production and logistics

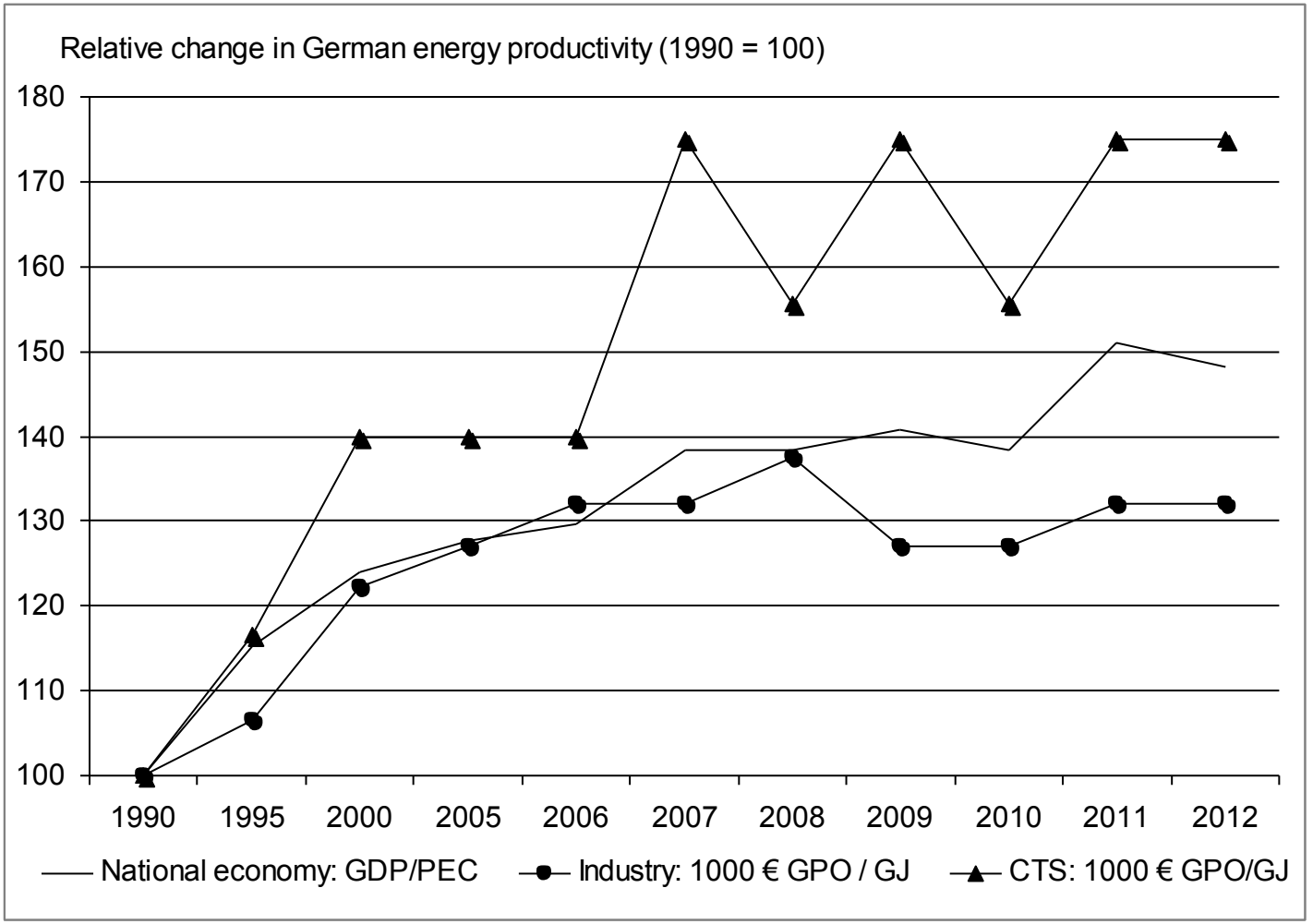


Properties of technical and organisational approaches towards energy efficiency

Issues	Energy efficiency by technology	Energy efficiency by organisation
Scope	Focus on single machinery	Systemic interaction of machinery and logistics
System boundaries	Rather tight, single processes or plants	Advanced across companies and supply chain partners
Actors	Company or plant, engineers / technicians	Companies and SC-partners, energy management staff
Trigger	Technology diffusion via the investment cycle	Analysis of operational data from existing systems
Focus	Development of single and cross-cutting technologies	Data-based evidence on drivers and interactions
Information required	Technical progress and change of specifications	Structural features and interaction of subsystems
Data needed	Specifications of technology in use versus state of the art	Differentiated energy consumption profiles
Investment required	Potentially high	Rather low

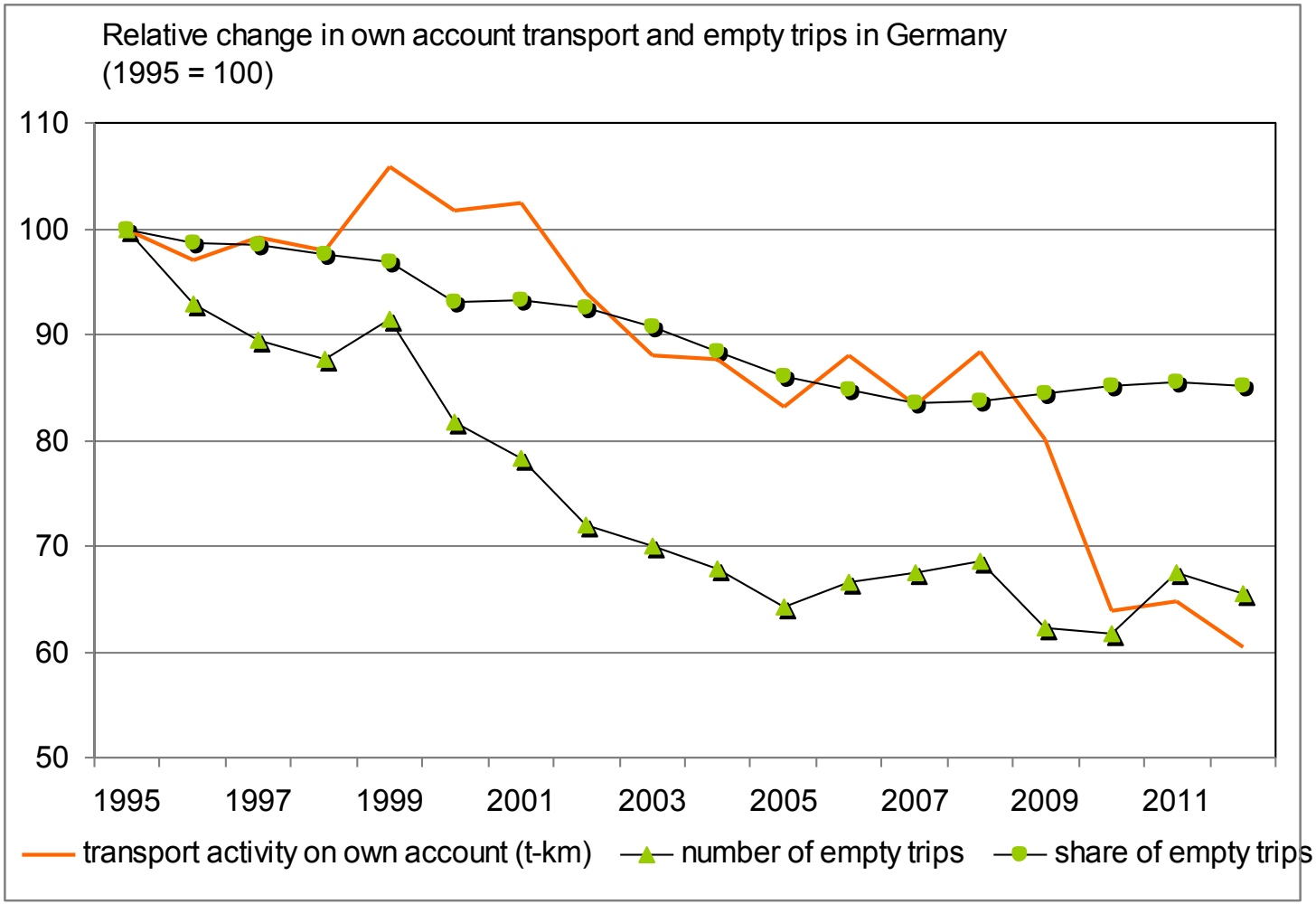
③ ENERGY EFFICIENCY AND TRENDS OF ORGANISATIONAL CHANGE

Energy productivity in the German economy and major sectors



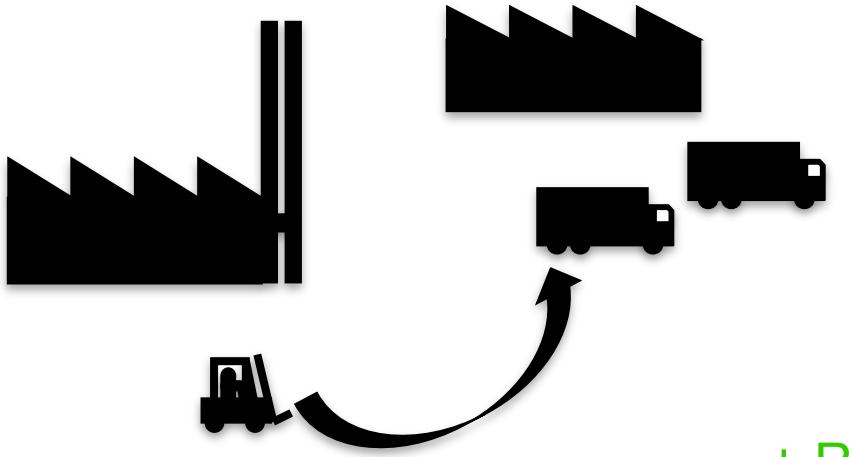
Eigene Darstellung in Anlehnung an
BMWi 2013 Energiedaten

Organisational change:
Declining transport on own account and empty trips



Source: Based on
Kraftfahrt-Bundesamt 2013

Organisational change: **the case of own-account transport**



Outsourcing of own-account transport to logistics service providers

+ Reducing empty trips by consolidation
+ Increase in energy efficiency

- No more direct access to data on energy use
=> Dependency on logistics service providers

Organisational change : Outsourcing of **transport** on **own-account**

- Transport on own-account is often characterised by high shares of empty trips and poor use of capacity.
- Lean Production has increased outsourcing of transport on own-account.
- Outsourcing of own-account transport may result in better consolidation by logistics service providers and increased utilisation of capacity.
- As a result, organizational change has contributed to increased energy efficiency in the provision of logistics services.

Organisational change: **24-hours delivery**

- 24-hours delivery was introduced by logistics service providers as a premium product for differentiation in quality competition.
- Instead it became the standard product and fostered the expectation that short-term ordering is normal.
- It reduces the flexibility in the provision of logistics services.
- With tighter time frames, consolidation and formation of optimal routes is more difficult.
- As a result, it rather decreases utilisation of capacity and requires more vehicles.
- This results in decreasing energy efficiency.

Organisational change: **Just-in-time delivery**

- Lean production is aimed, inter alia, at the reduction of lead times and capital tie that may result from increasing product variants and related inventory.
- Limited inventories require just-in-time delivery of smaller volumes of parts from suppliers.
- Suppliers must decide whether to build up inventory or to produce smaller batches.
- Smaller batches increase the frequency of retooling and thus the proportion of "non-productive" energy consumption in stand-by mode.

④ THE E²Log CASE STUDIES

Drivers of energy efficiency within the context of production and logistics in E2Log

Case study in-house production: Production Planning and Control

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Energy-efficient processes (melting and casting)

Case study regional production network: Lean Production

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Volkert Metall- und Kunststofftechnik GmbH

KLINGELE PAPIERWERKE

Tailored delivery: smaller batch sizes in production and logistics

Case study global supply chain: Global Production

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Transport distances and actual demand for large number of variants

E²Log: practical relevance through three case studies

Case Study
Global Supply Chain

Industry
Automotive

Production type
Mass production

Study focus
Procurement processes for the final assembly at the Pacheco plant

Partner
- Volkswagen Commercial Vehicles
- Kühne + Nagel (AG & Co.) KG
- DB Schenker Germany

Case Study
Regional Production Network

Industry
Machine building

Production type
Small-batch and mid-volume production

Study focus
Suppliers integration and evaluation of the production process for injection molded components

Partner
- WILO SE
- Volkert GmbH
- Klingele Papierwerke GmbH

Case Study
In-house Production and Logistics

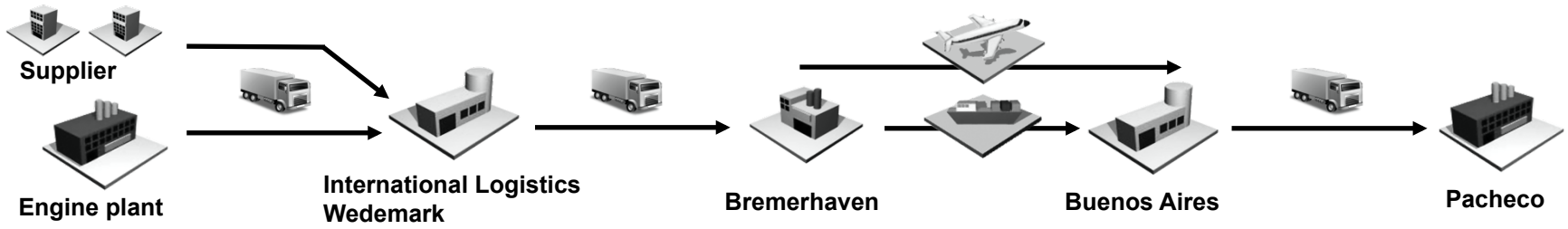
Industry
Manufacturing

Production type
Small-batch and mid-volume production

Study focus
Combination of thermal and mechanical processing

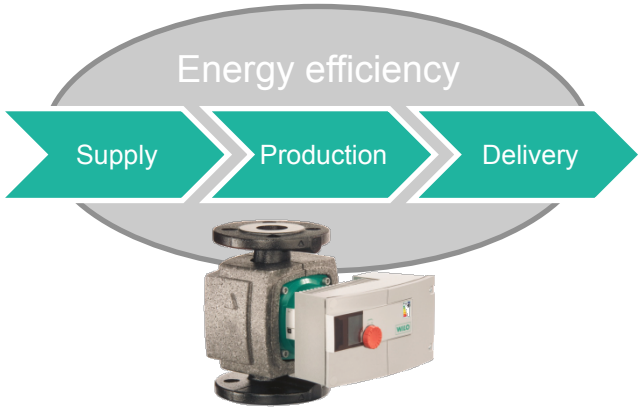
Partner
- Klingele Papierwerke GmbH
- Volkert GmbH
- UNIWHEELS Production (Germany) GmbH

Case study **global supply chain**



- **Challenges** for the global and multi-modal supply chain
  - Supply chain has an **extended lead time**
  - **Parts diversity:** approx. 1,000 different parts
  - Many different **IT systems**
  - Frequently large **express deliveries** (air cargo)
- Scope 1: **Design** (strategic level)
  - Assessment of energy efficiency of design alternatives in a simulation model
- Scope 2: **Execution** (operative level)
  - Continuous process monitoring for a fast and holistic analysis of options for action

Case study **production cluster**



Production and distribution of Wilo-pumps / pump systems, Dortmund

Supply of packaging material for Wilo-pumps (produced by Klingele, Werne)

Module and component supply for for Wilo-pumps (produced by Volkert, Bad Hersfeld)

- energy efficient alignment of Wilo production systems
  - energy efficient design of the supplier network
    - by identifying energy drivers and improvement measures

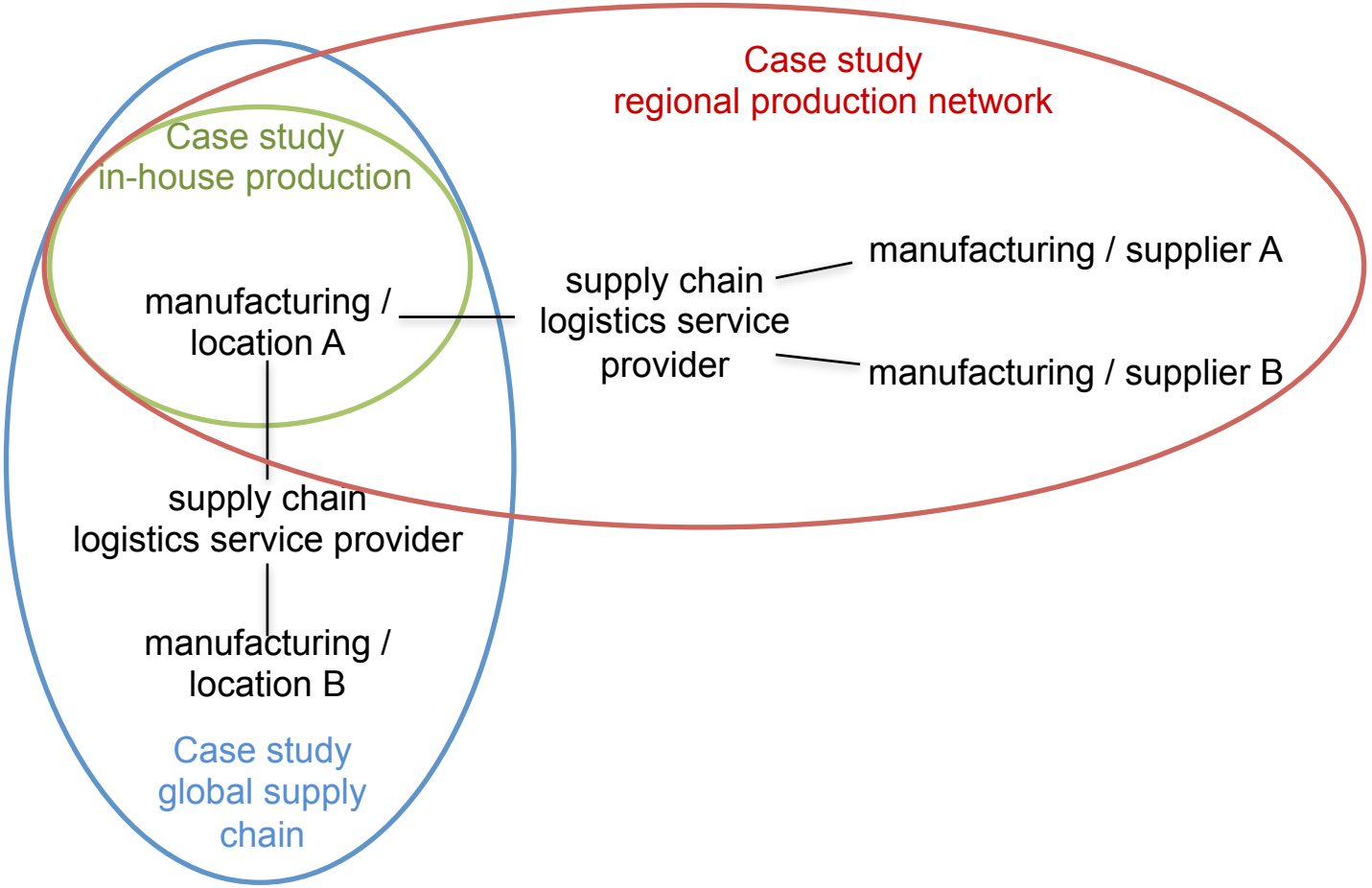
Case study **SME forum**

Level: Use-cases

- **Challenges** of processes of internal production logistics:
  - Complex interactions between material- and energy-flow, in particular regarding thermal processes
  - Different usage of energy sources on process level
  - Optimization potential by alternatives in logistics planning
  - Complex coherences between logistics output and energy demand
- Area of investigation: **Assessment of planning alternatives**
  - Assessing energy efficiency of different planning principals (e.g. lean-strategies, production planning, etc.) within simulation studies

- Development of **Ecoleano within SME forum**
  - Methodology for assessing energetic and logistic key figures
  - Transfer research results into recommendations for SMEs

Specifications and system boundaries of case studies in E²Log



Specifics of case studies in E²Log

Specifics	„in-house production“	„regional production network“	„global supply chain“
Scope	Local	Regional	Global
Actors	Manufacturer	Manufacturer, supplier, logistics service provider	manufacturer, logistics service provider
System boundary	Plant	Regional Supply Chain	Company, remote site
Focus	Production control	Production and supply strategy	Logistics optimisation
Processes	Melting and casting process	Lean Manufacturing “batch size 1"	Demand-oriented delivery
Information required	Cycle-dependent energy consumption	Machine scheduling and transport	Match of demand and supply
Data needed	Energy use by production	Energy use in production and logistics	Energy use in logistics
Investment	Low	Low	Low

⑤ CONCLUSIONS

Conclusions

- Organizational measures to increase energy efficiency are underexposed.
- Examples of trends in production and logistics concepts show the true meaning, albeit with different results..
- Organizational approaches to increase energy efficiency in companies require a systematic recording of energy consumption.
- They are usually not self-evident or easily calculable as investment in technology, but integrated into complex system contexts of production and logistics.
- If there are no differentiated measurements of energy consumption available, it will require a "long breath" to leverage the potential.

Thank you for your attention!

Wuppertal Institut
für Klima, Umwelt, Energie
GmbH

Andreas Pastowski
Wuppertal Institut für Klima, Umwelt, Energie GmbH
Forschungsgruppe: Zukünftige Energie- und Mobilitätsstrukturen
Döppersberg 19
D-42103 Wuppertal

Phone: +49 202 2492 - 118
E-Mail: andreas.pastowski@wupperinst.org
Internet: www.wupperinst.org