ENERGY EVALUATION EUROPE CONFERENCE 2025

SHOW ME THE EVIDENCE: EVALUATION AS THE DECISION MAKER'S BEST RESOURCE

25 SEP - 26 SEP 2025

BERLIN

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TALTECH

INDUSTRIAL ENERGY USE, EFFICIENCY, AND SAVINGS:

METHODS FOR QUANTITATIVE ANALYSIS

SESSION 11 – TOP-DOWN ANALYSIS AND MONITORING

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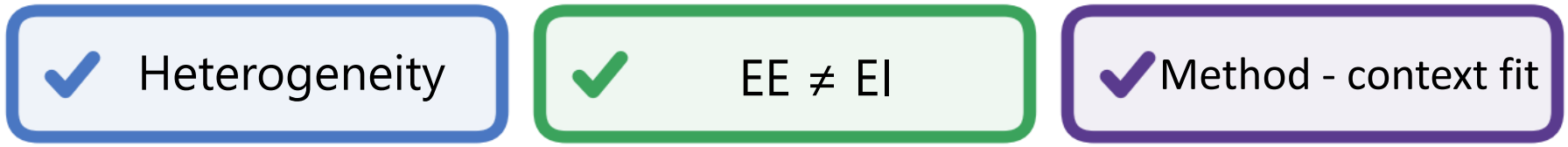
26.09.2025

TALLINNA TEHNIKAÜLIKOOL

THE MEASUREMENT TRAP IN MANUFACTURING EE

Aggregation can hide order-of-magnitude differences in manufacturing.



Today: methods landscape → evolution → quality risks → methods→ practical checklist

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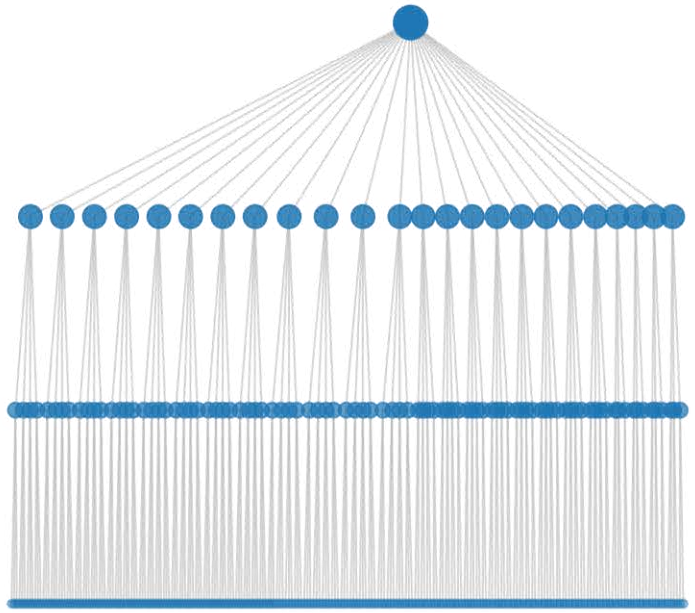
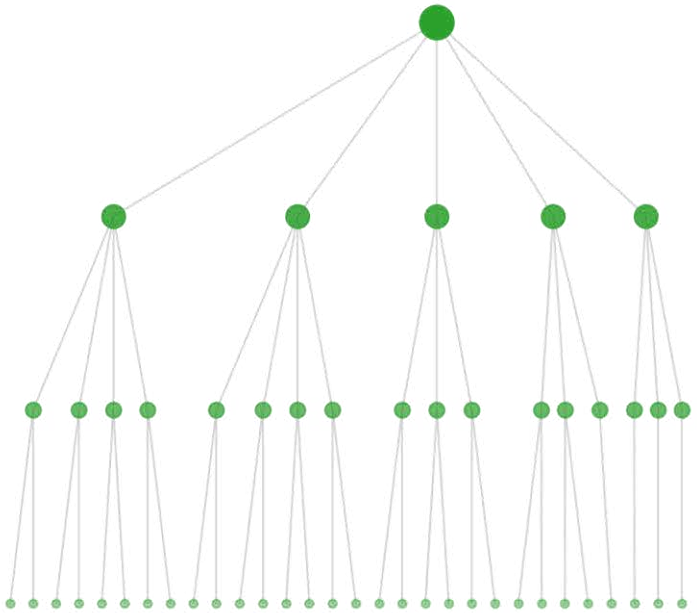
NACE SECTORAL COMPLEXITY

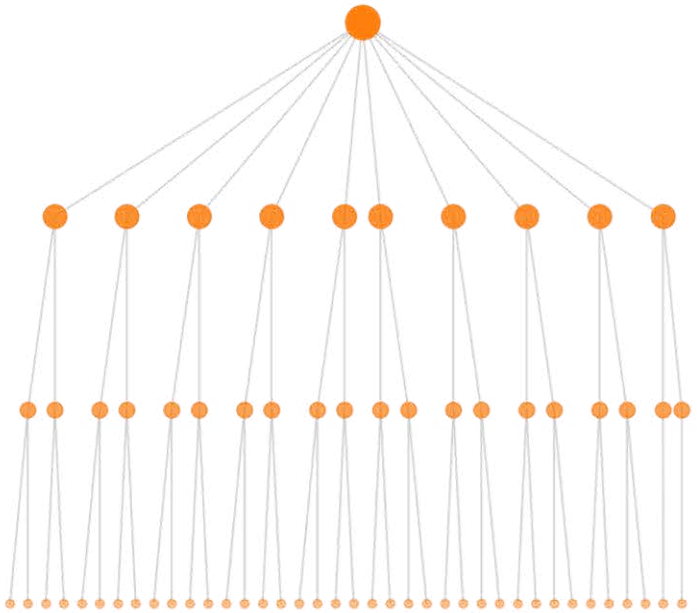
Manufacturing
232 classes



Transport
30 classes



Mining+Utilities
38 classes



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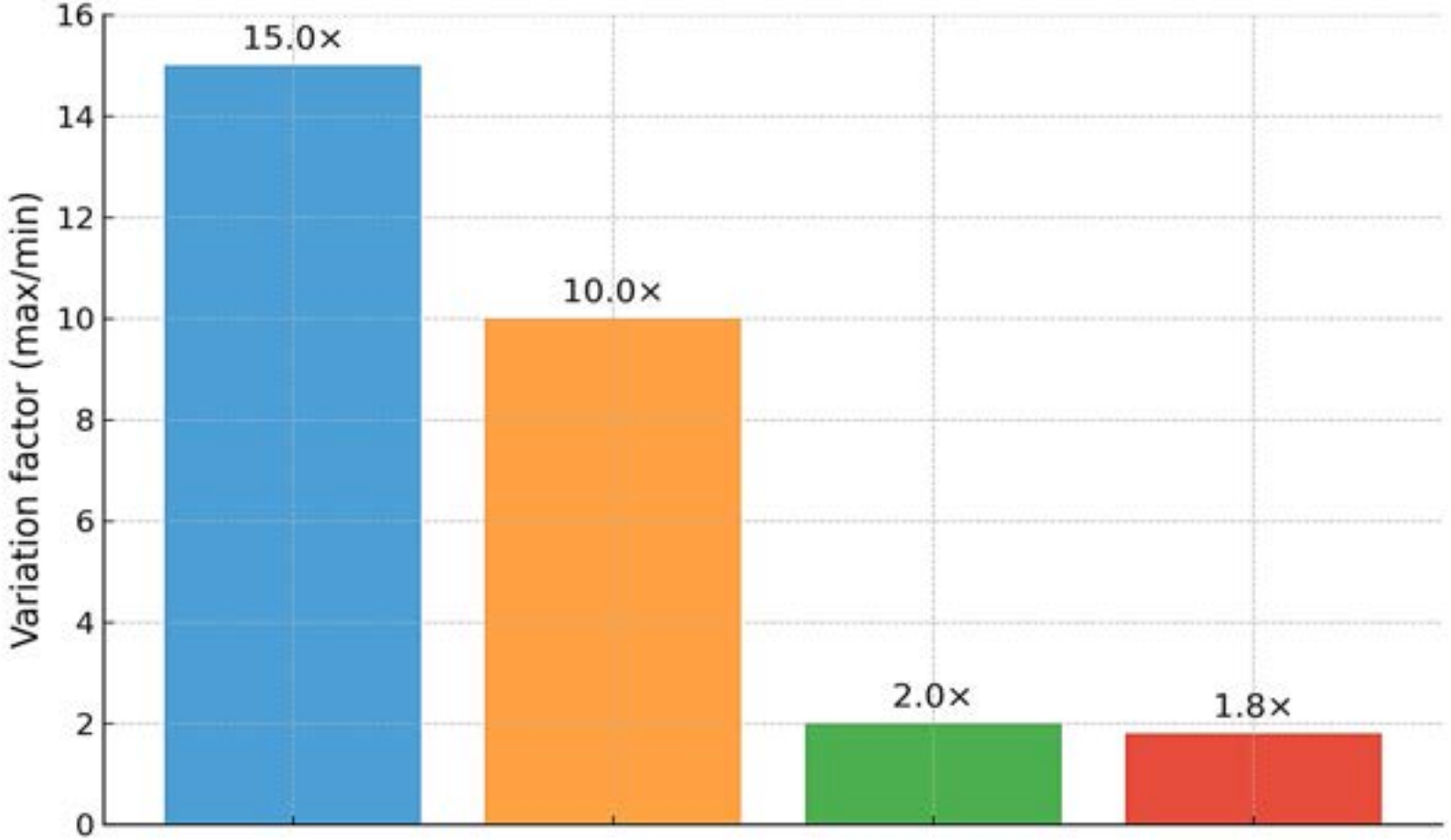
- **Division = 2-digit**
- **Group = 3-digit**
- **Class = 4-digit**

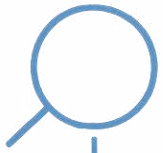
WHY MANUFACTURING IS A DIFFERENT BEAST

WITHIN-CLASS VARIATION



References: Worrel et al. (2010); Ramírez, Patel & Blok (2006); IEA Iron & Steel Roadmap (2017); BPIE, Europe's Buildings under the Microscope (2011); IEA Energy intensity of passenger transport (2018); EEA TERM (2000)

RESEARCH QUESTIONS



Methods for country-level EE in manufacturing: evolution

How data & method choice affect reliability of EE assessments

Contribution: first cross-method comparative review for manufacturing EE

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SYSTEMATIC REVIEW DESIGN

- Search & screening: Scopus (query in annex) → **7,229** records →

  title/abstract + full-text screening → **110** included (2005–2024).

- Assessment criteria:
  - definition consistency,
  - data granularity,
  - method-context alignment.

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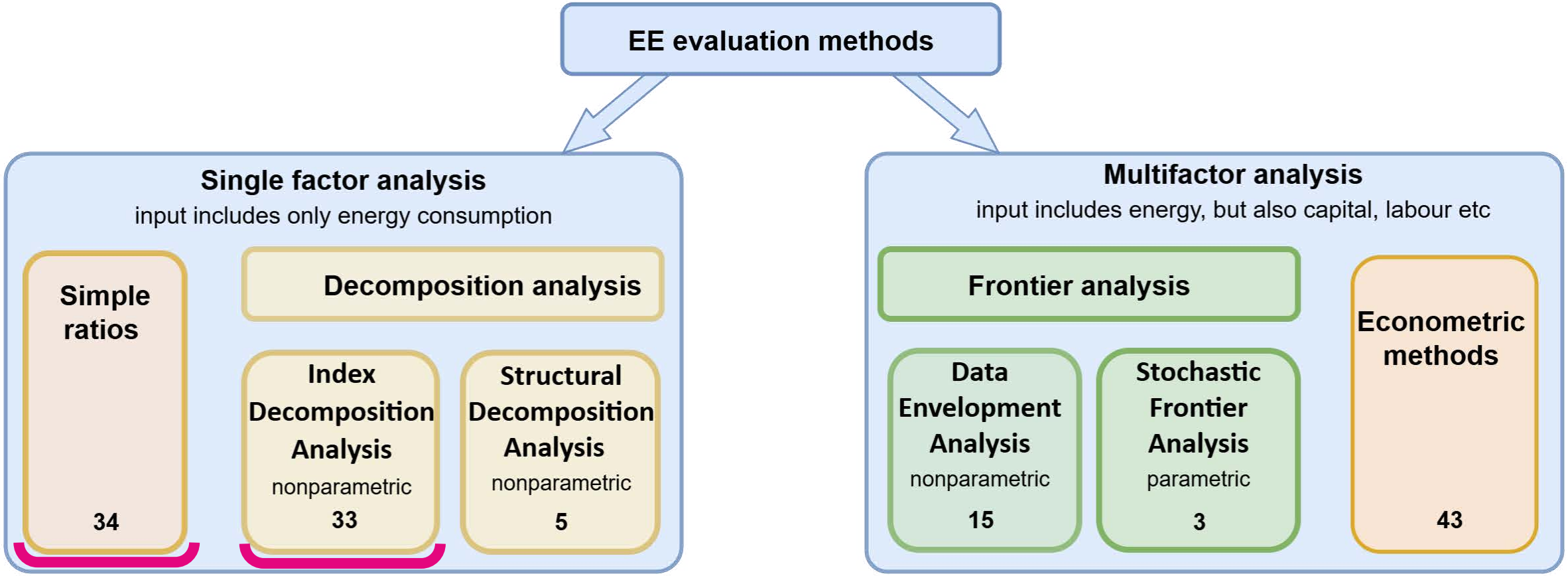
METHODS LANDSCAPE



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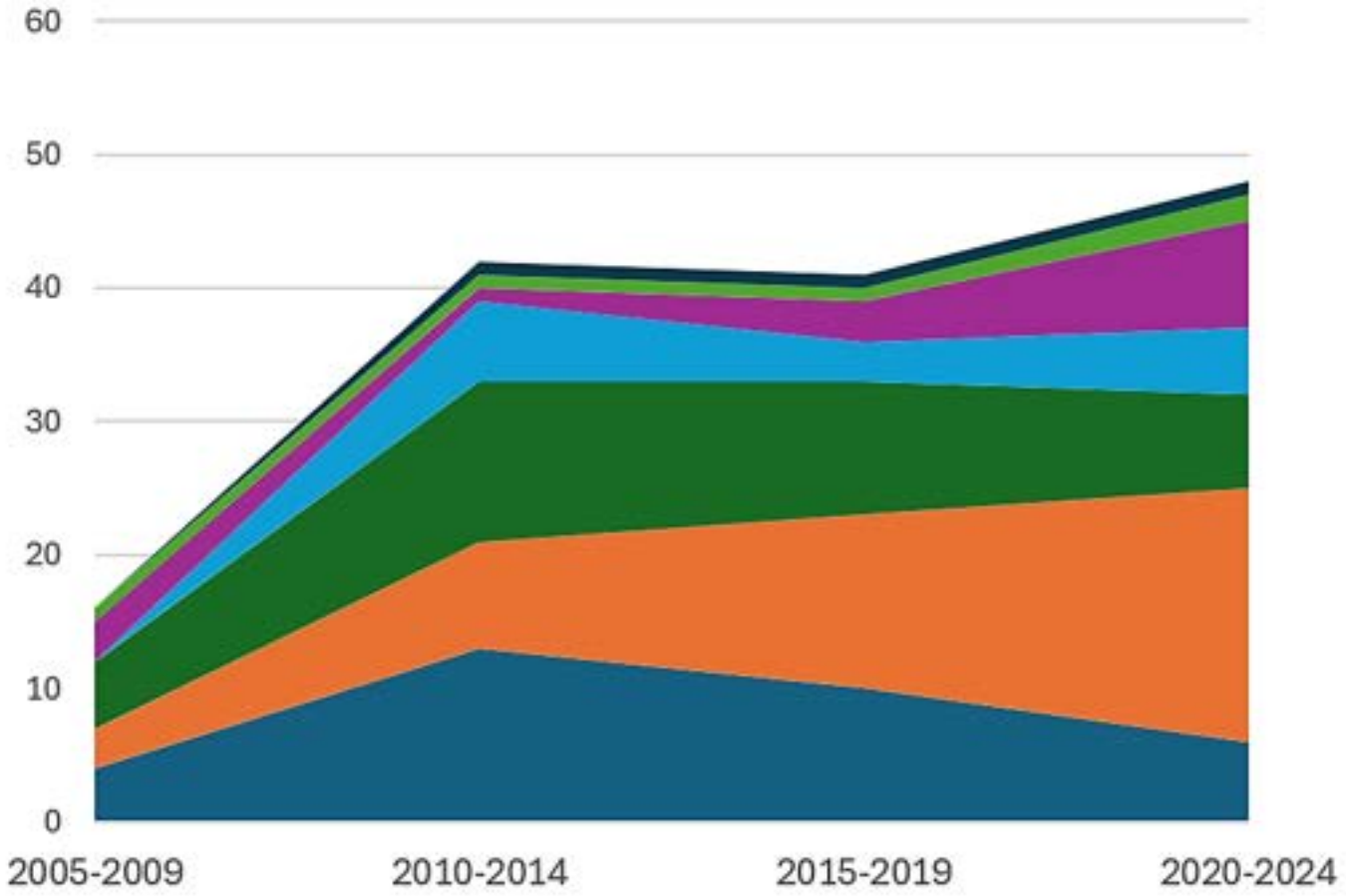
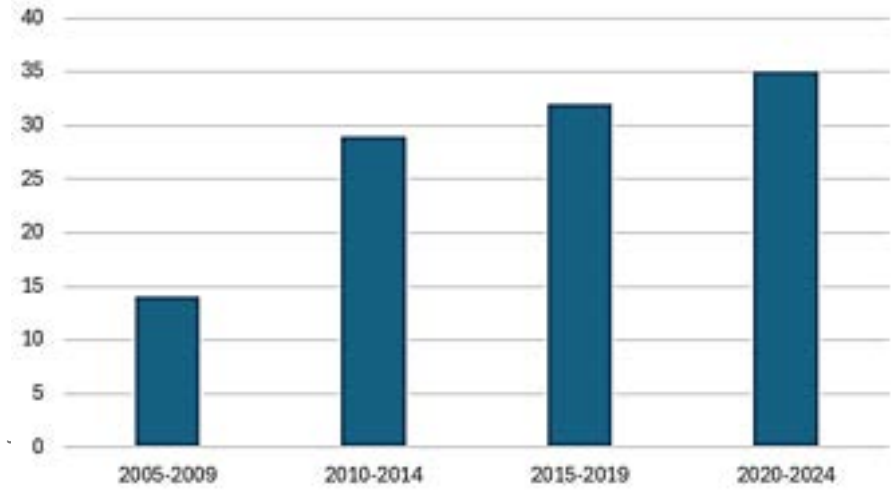
TRENDS OVER TIME (NUMBER OF SCIENTIFIC PAPERS)





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QUALITY AT GLANCE

Method	Studies (n)	Definition consistency	Data granularity	Method-context alignment
Ratio methods	34	62%	50%	44%
Index Decomposition Analysis, IDA	33	36%	15%	18%
Structural Decomposition Analysis, SDA	5	0%	0%	0%
Data Envelopment Analysis, DEA	15	47%	20%	13%
Stochastic Frontier Analysis, SFA	3	0%	0%	0%
Other econometric methods	43	23%	6%	6%

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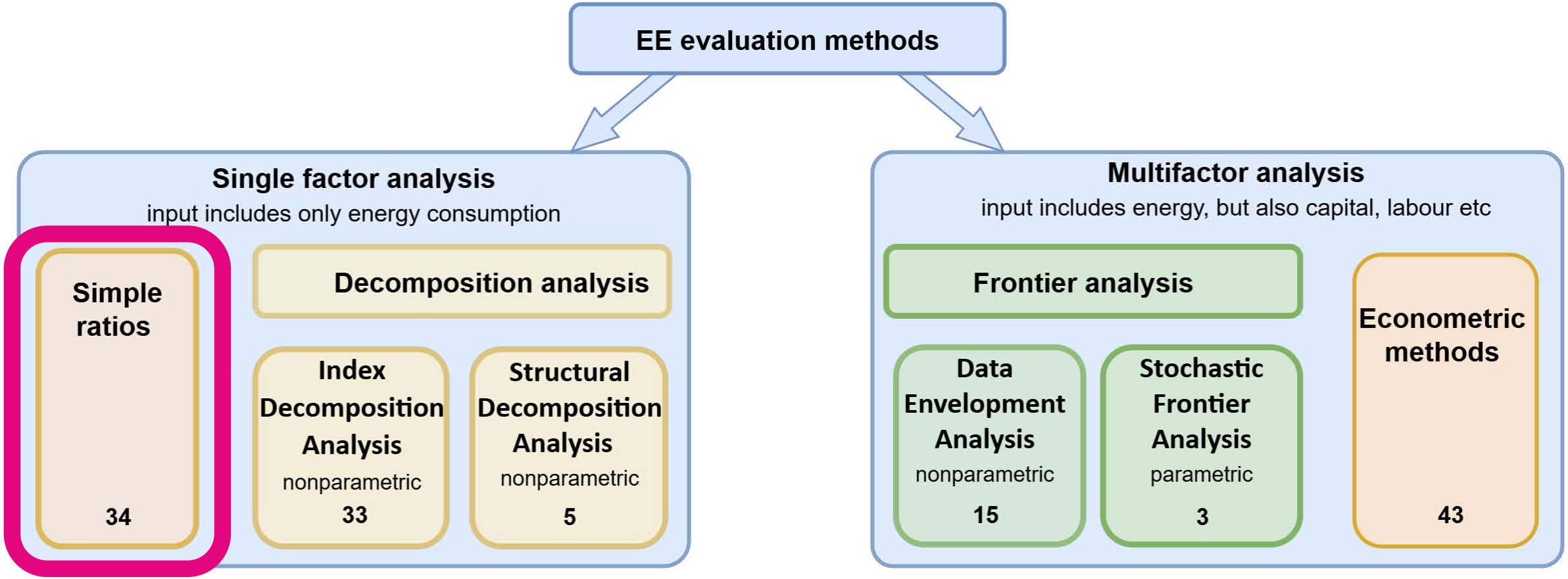

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1. RATIO-BASED METHOD

Approaches

- **Energy Intensity (EI):** energy per € output (often used as proxy for EE)
- **Energy Productivity (EP):** inverse of EI
- **Specific Energy Consumption (SEC):** energy per physical unit (e.g., GJ/t steel)
- **Energy Efficiency Index (EEI):** actual energy vs reference/best practice (=100 baseline)

How used in studies

Pros

Transparent, easy to communicate & benchmark,

Works well when **physical output** is available

Watch-outs

EE ≠ EI: economic denominators embed prices/structure/cycles.

Can't by themselves separate technical efficiency from product mix or external factors.

62% 50% 44%

1. RATIOS - CASE: DAIRY IN 4 EU COUNTRIES — WHY PRODUCT MIX MATTERS

Ramírez, Patel & Blok (2006), Energy

Data & setting

Sector: Dairy (NACE 155); Countries/years: FR, DE, NL, UK (late-80s/90s).

Energy: by carrier (electricity, fossil/steam), corrected to primary (×2.5 for electricity); NCV/GCV and climate corrections applied.

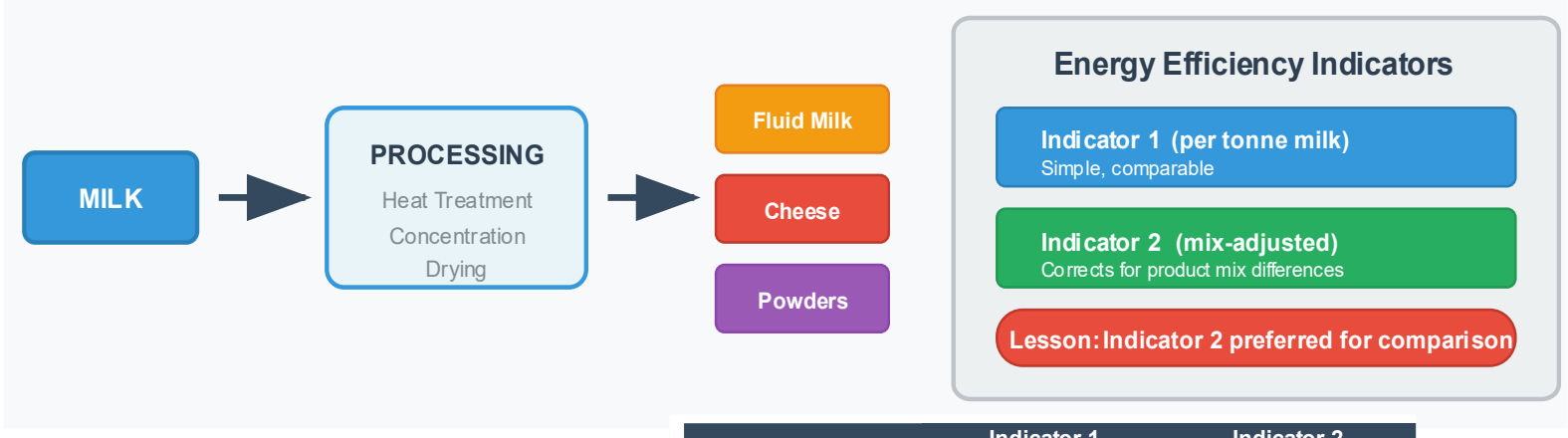
Outputs: raw milk delivered + product volumes by branch (fluid milk, cheese, powders, etc.).

Method & what's special

Two ratio indicators:

Indicator 1 = energy per tonne of raw milk (SEC); simple, communicable.

Indicator 2 = mix-corrected SEC (energy use/output) using product-specific reference SECs (counterfactual). Preferred for cross-country/over-time comparison.



Country	Indicator 1 trend	Indicator 2 improvement
France	+0.7%	-0.4%
Germany	+1.0%	-2.1%
Netherlands	-0.4%	-1.2%
UK	-3.1%	-3.8%

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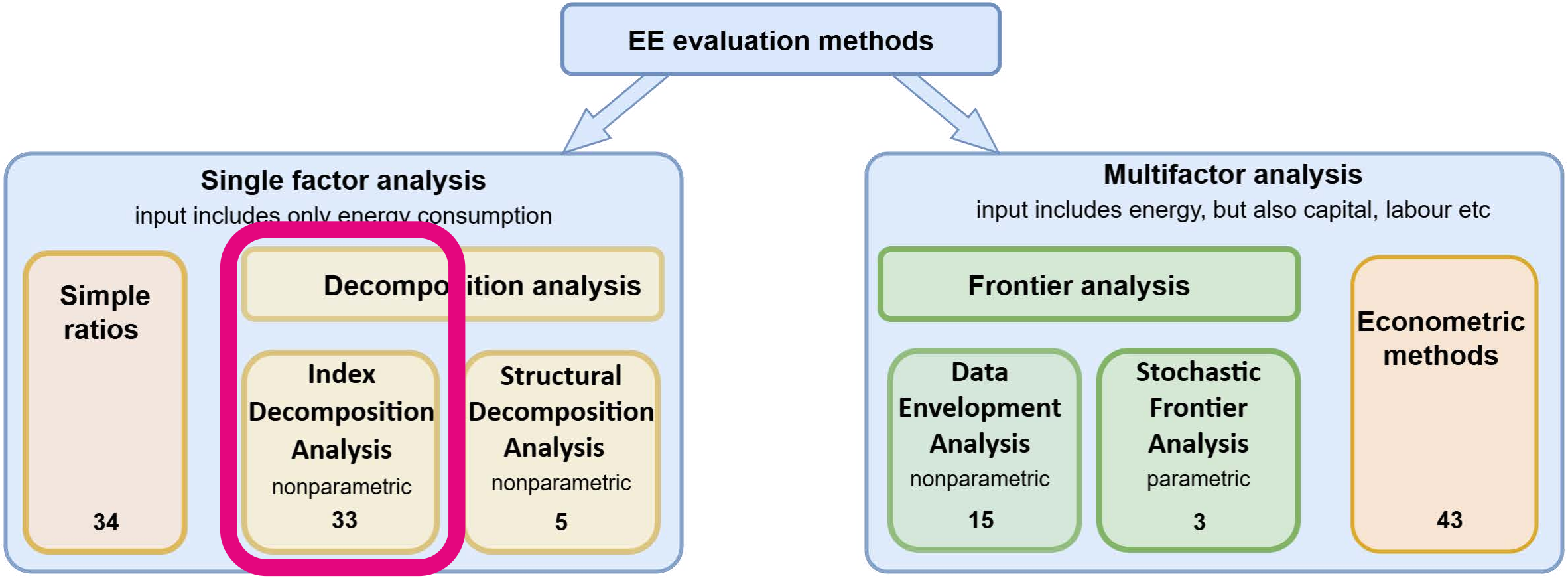

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2. DECOMPOSITION (IDA/LMDI): SEPARATING DRIVERS OF ENERGY CHANGE

Approach

- **Goal** - split ΔE or $\frac{E^T}{E^0}$ into contributing factors
- **Typical decomposition**:
  activity, structure, intensity
- **Why LMDI?**
  robust theory, no residuals; additive for absolute impacts, multiplicative for relative shares.

How used in studies

Pros

Clear attribution of what drove change (activity vs structure vs intensity).

Works well with official statistics/time series; easy to align with policy narratives.

Watch-outs

Intensity effect ≠ pure technical EE

Coarse (1–2 digit) aggregation hides tech routes; factor independence.

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12% 15% 18%

IDA - CASE: UK MANUFACTURING (1997–2012), AR-LMDI

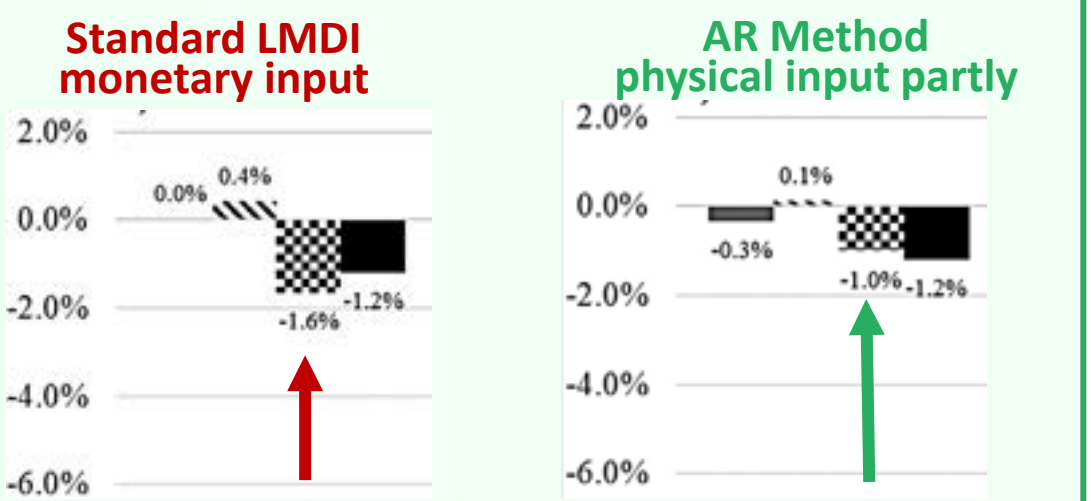
Norman (2017), Energy

Data & setting

Sector: Whole UK manufacturing, 43 subsectors, **EI vs NEI** split.

Data: CCA scheme (energy, physical output), ONS Environmental Accounts, ABS (costs, number of enterprises),

physical output for steel & cement injected via AR.



Energy intensive sector, 1997-2007

Method & what's special

LMDI (additive, chained): ΔE = Activity + Structure + Intensity.

Activity-Refactorisation (AR): blends monetary + physical outputs → reduces bias when monetary output alone misstates physical change. Overcomes overestimation of "efficiency."

Findings

AR matters: using only monetary output overestimates efficiency gains; adding physical output shrinks the intensity contribution, esp. in EI (steel/cement).

Policy ask: publish physical outputs with national energy accounts to track true EE.

A 4-LEVEL RISK → MITIGATION MAP

	Definition	Data	Method	Interpretation
Risk	Misaligned with technical EE	Aggregation hides within-sector heterogeneity.	Mismatch with data; ignoring method's assumptions.	Misinterpreting indicators as direct technical EE measures. Overstating findings due to limited contextual understanding.
Mitigation	Use precise, technically grounded definition that ensure comparability across manufacturing contexts.	Use the most disaggregated data available; clearly report aggregation level.	Match method to objective and data. Verify assumptions.	Add supporting sources to strengthen validity of conclusions (incl. expert opinions and physical indicators).

PRACTICAL CHECKLIST FOR EVALUATORS

- State EE definition (in manufacturing context; EE vs EI);
- Prefer physical indicators;
- Fully grasp the heterogeneity of the manufacturing sector;
- Disaggregate (≥3-digit, 3-4 digit for e.g. Food & Bev);
- If IDA then show sensitivity to aggregation; consider injecting physical output;
- If DEA then ensure DMU homogeneity; choose input-orientation; use VRS; group by technology or use metafrontier;
- Pair top-down with expert/process evidence.

DEFINITION | DATA | METHOD | CONTEXT

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SUMMARY/TAKEAWAYS

1. **Manufacturing ≠ buildings/transport:**
   heterogeneity makes method-context fit decisive

2. **In 110 studies, context alignment is weakest;**
   data granularity is the other major weakness

3. **Ratios can be most credible when physical & mix-corrected**

4. **Priority: physical-output series with national energy accounts – or,**
   employ audit data to inject sectoral and process detail.

Better Data + Better Methods = Better Policy

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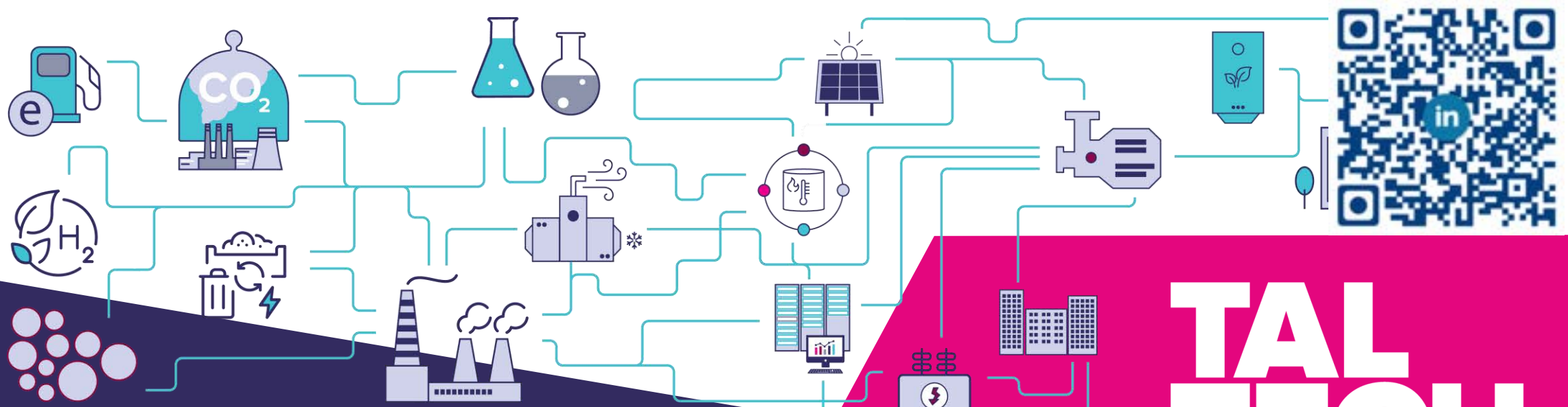

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Hoonete Energiatõhusus Andmepõhiselt

Data-driven Energy Efficiency in Buildings

Eesti Teadusagentuur

ODYSSEE-MURE

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