District heating systems under high carbon prices: the role of the pass-through from emission prices to power prices

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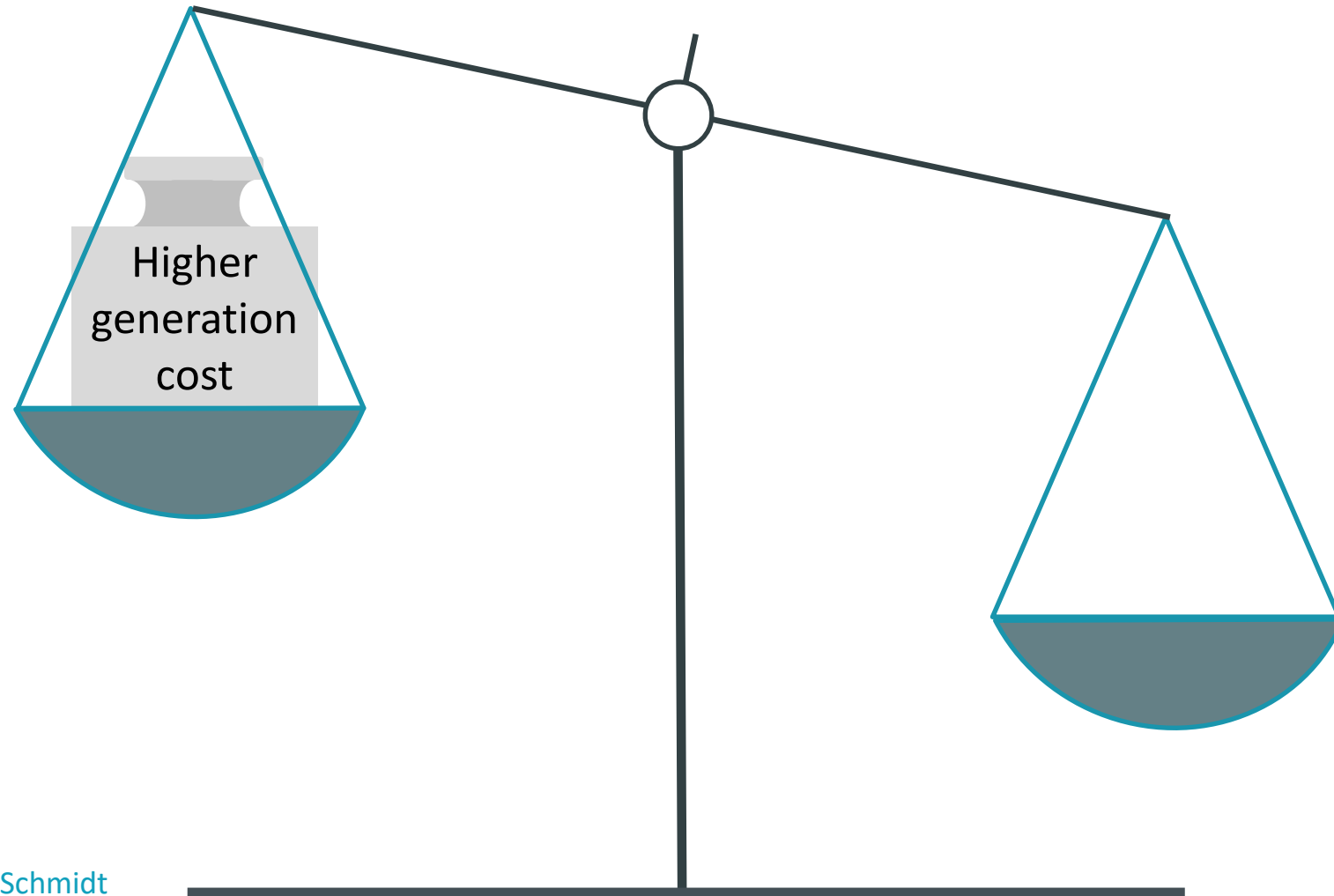
[1] University of Life Sciences and Natural Resources, Vienna
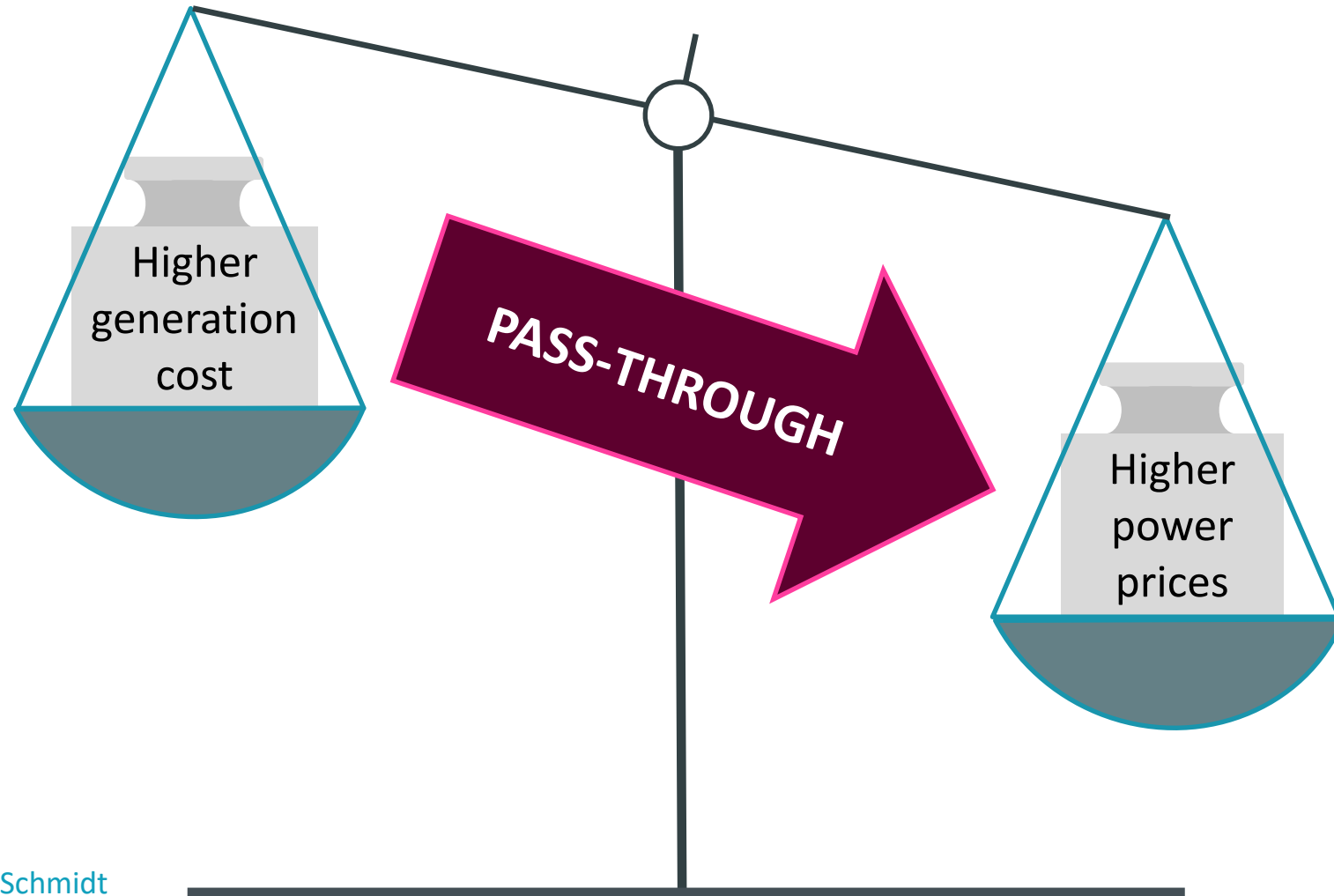
[2] Wiener Stadtwerke Holding AG

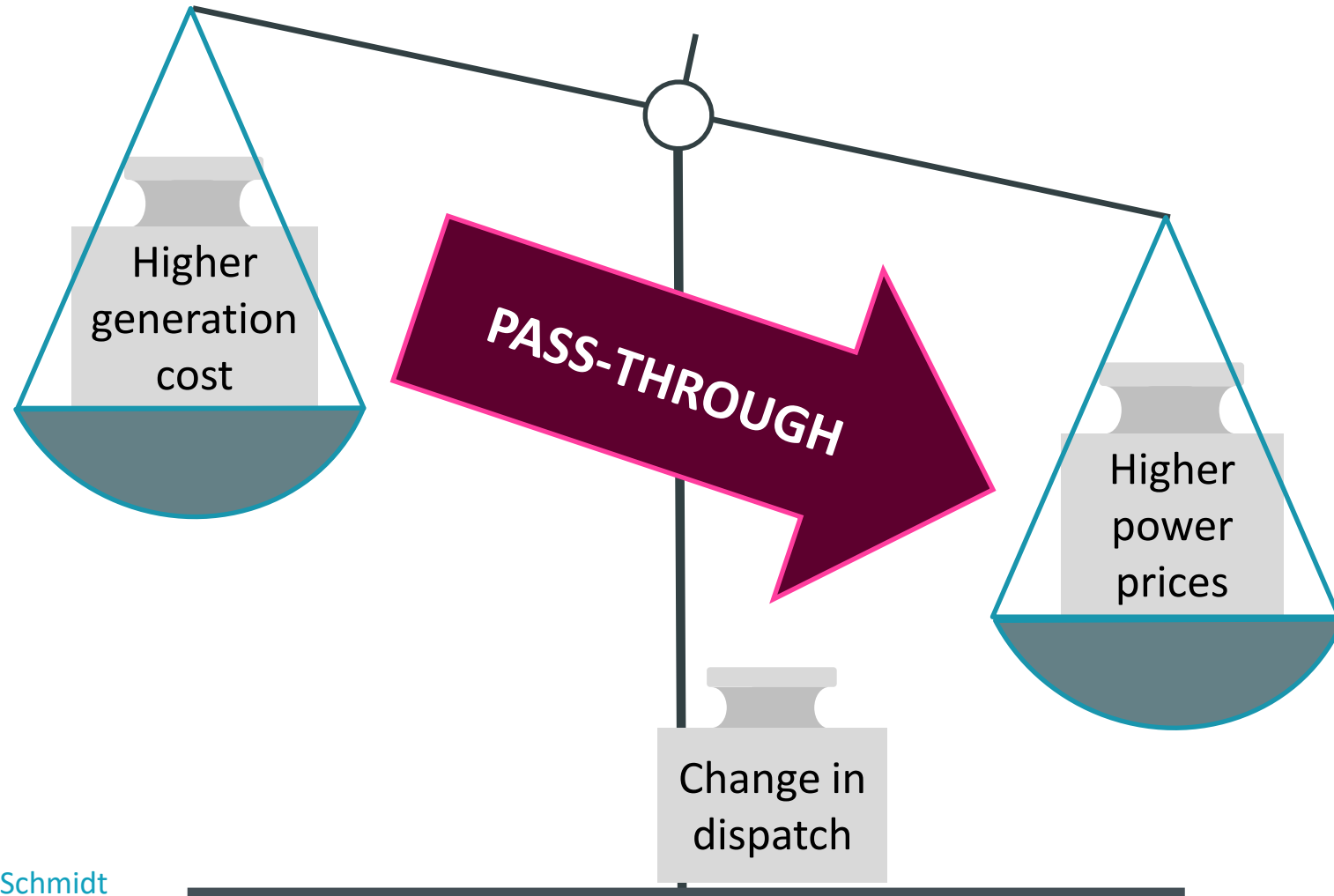IAEE European Conference 2017, Vienna

What do increasing emission prices mean for a DHC company?

Higher generation cost

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What do increasing emission prices mean for a DHC company?

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PASS-THROUGH

Higher power prices

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Change in dispatch
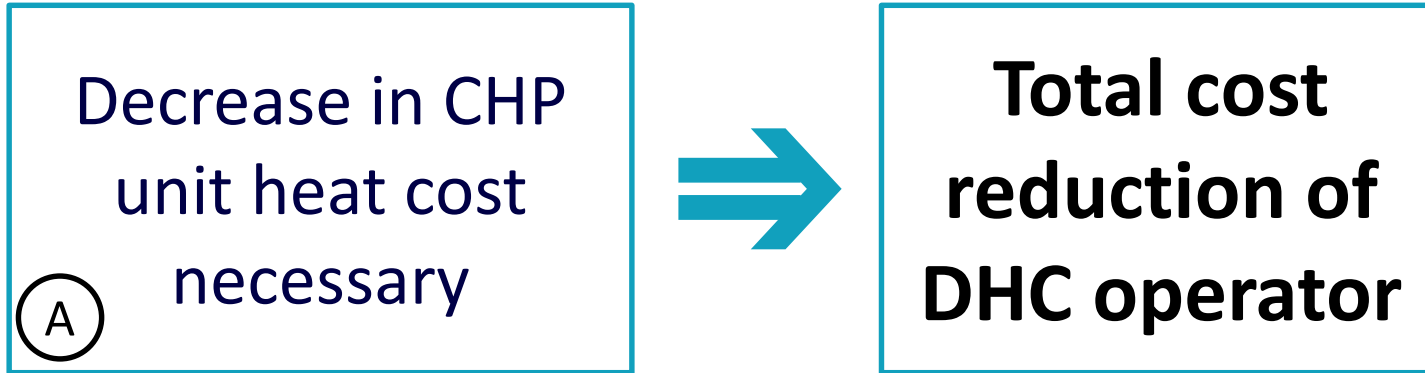
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Approach

1 How much of the emission cost increase must be passed through to power prices to make a DHC company better off?

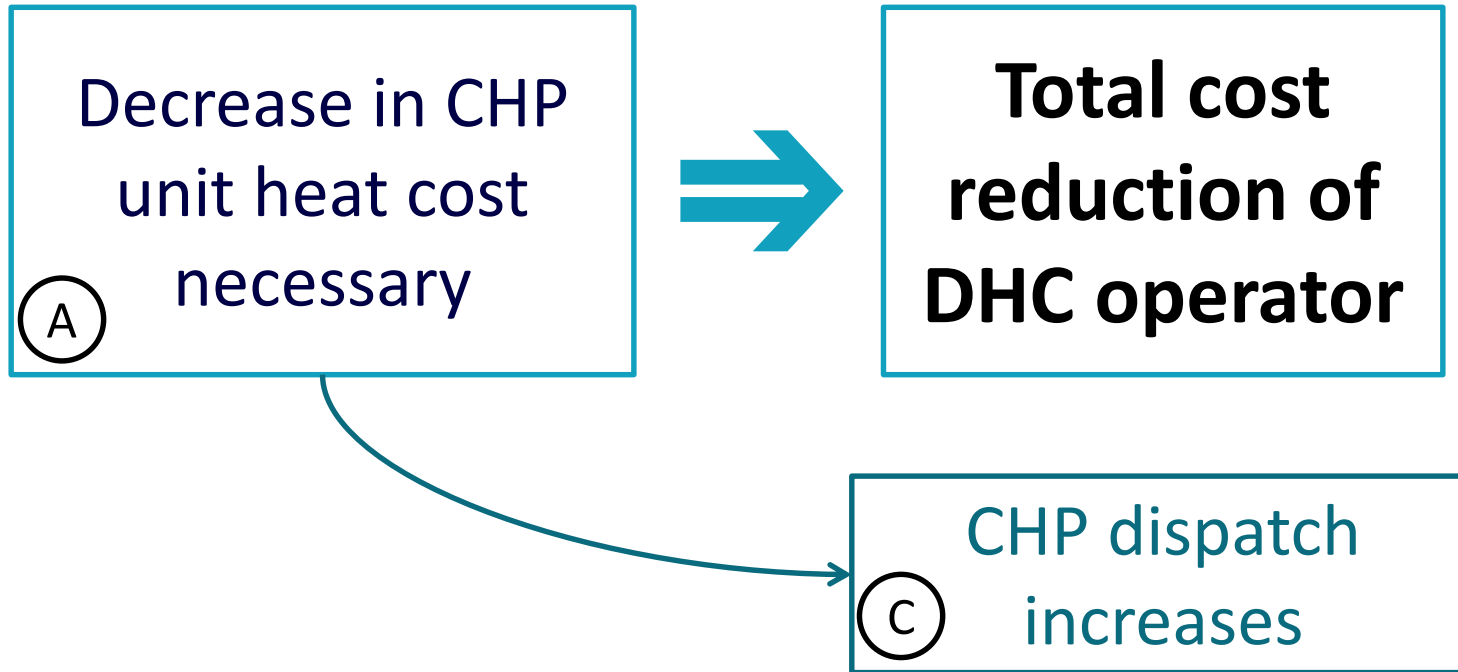**2** How much of the emission cost increase is actually passed through to power prices?

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Conditions for total cost reduction

Decrease in CHP unit heat cost necessary

(A)

➡ **Total cost reduction of DHC operator**

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Conditions for total cost reduction

Conditions for total cost reduction

①

Decrease in CHP unit heat cost necessary

Ⓐ

➡ **Total cost reduction of DHC operator** ⬅

CHP generation is sufficiently high

Ⓑ

CHP dispatch increases

Ⓒ

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Conditions for total cost reduction

①

| Decrease in CHP unit heat cost necessary Ⓐ | ⇒ | **Total cost reduction of DHC operator** | ⇐ | CHP generation is sufficiently high Ⓑ |

CHP dispatch increases Ⓒ
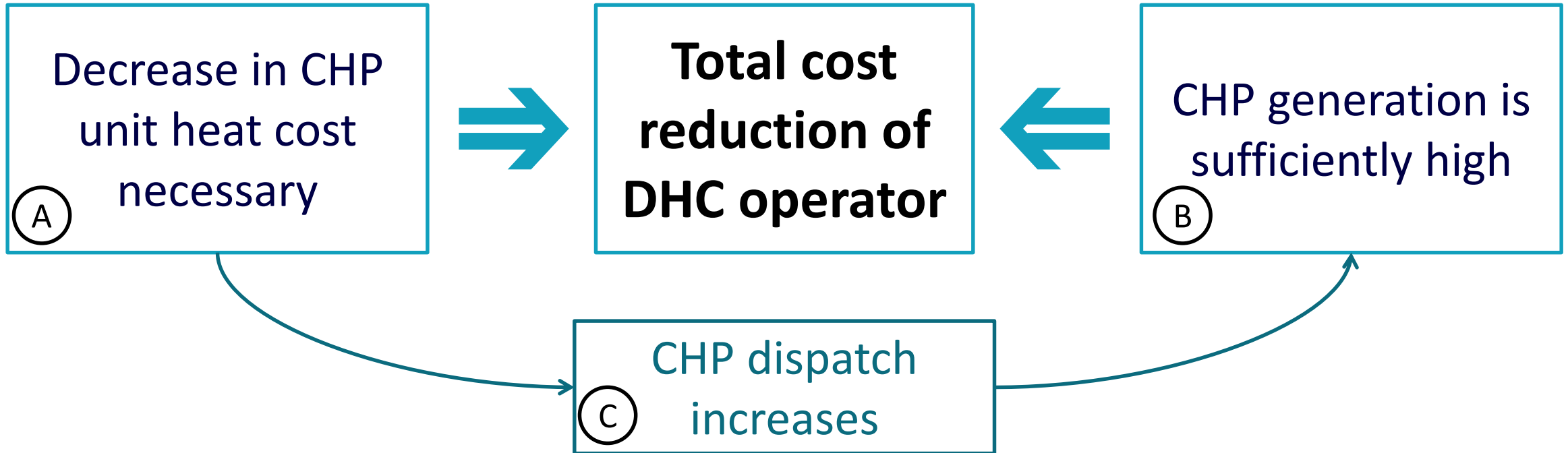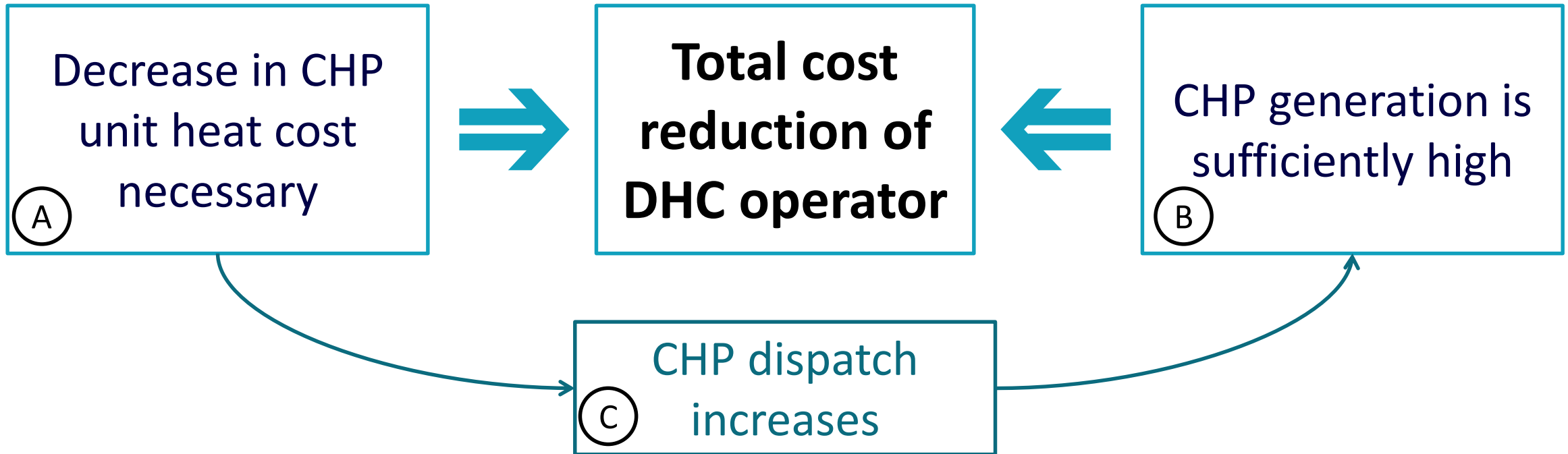
In a stylized model of DHC operations, we show that, for realistic assumptions on technology, if B is fulfilled, also A is fulfilled

(more precisely: B > A > C)

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Minimal CHP generation share that guarantees improved profitability as emission prices rise

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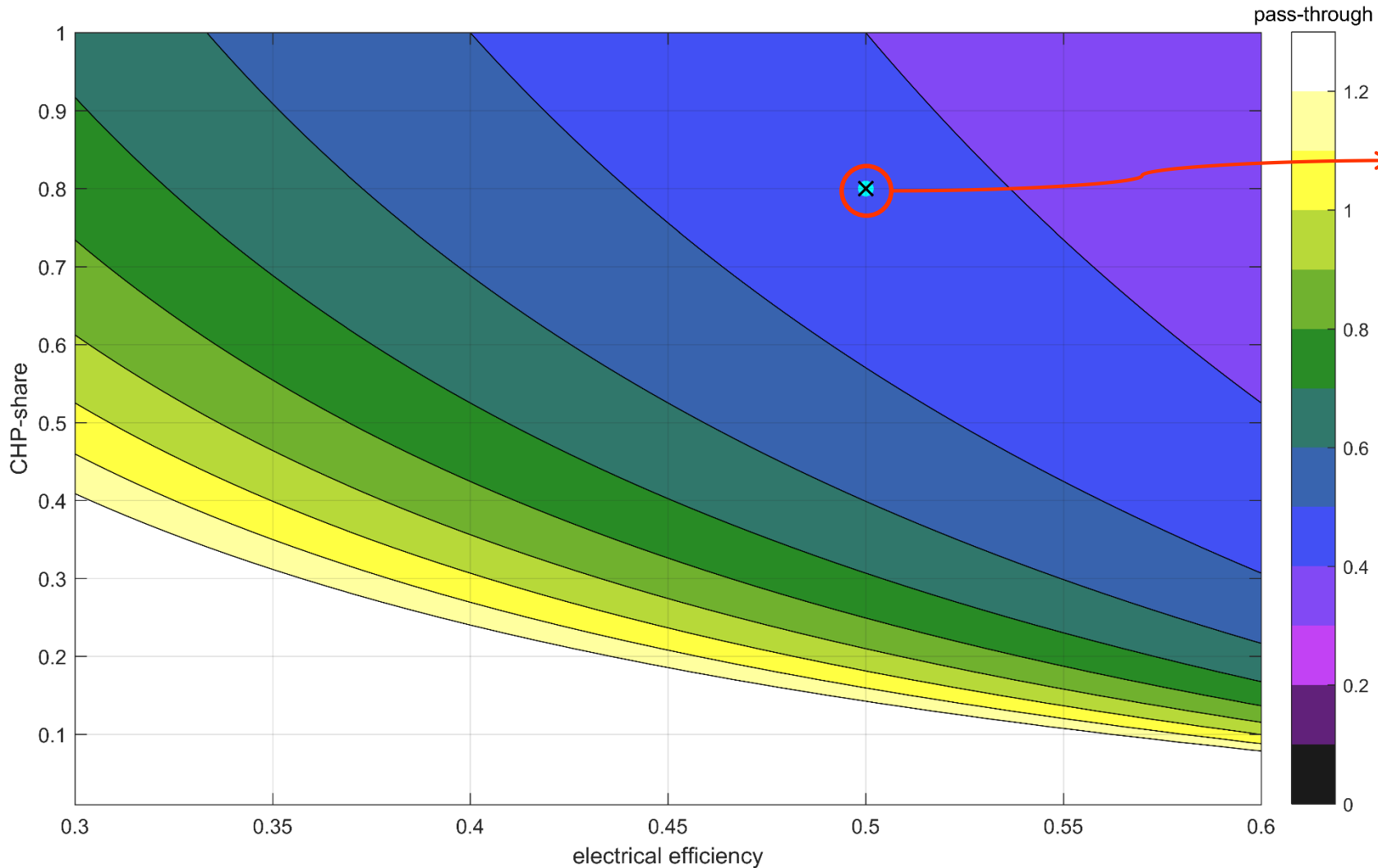
Dot indicates break-even pass-through for a **natural gas-fired** CHP (0.433) with electrical efficiency of 0.5 and a share in fossil generation of 0.8

For simplicity, total efficiency (electricity and heat) is held constant at 0.8

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Emission cost pass-through in the literature

- Fabra & Reguant (2014), AER 104(9)
  - Estimates from observed bid curves (supply & demand)
  - Spain, Jan 2004 – Feb 2006: **[0.77, 0.86]**

- Hintermann (2014), CESifo WP 4964
  - Econometric estimation
  - Constructs bids based on technical assumptions
  - Germany, Jan 2011 – Nov 2013: **[0.98, 1.06]**

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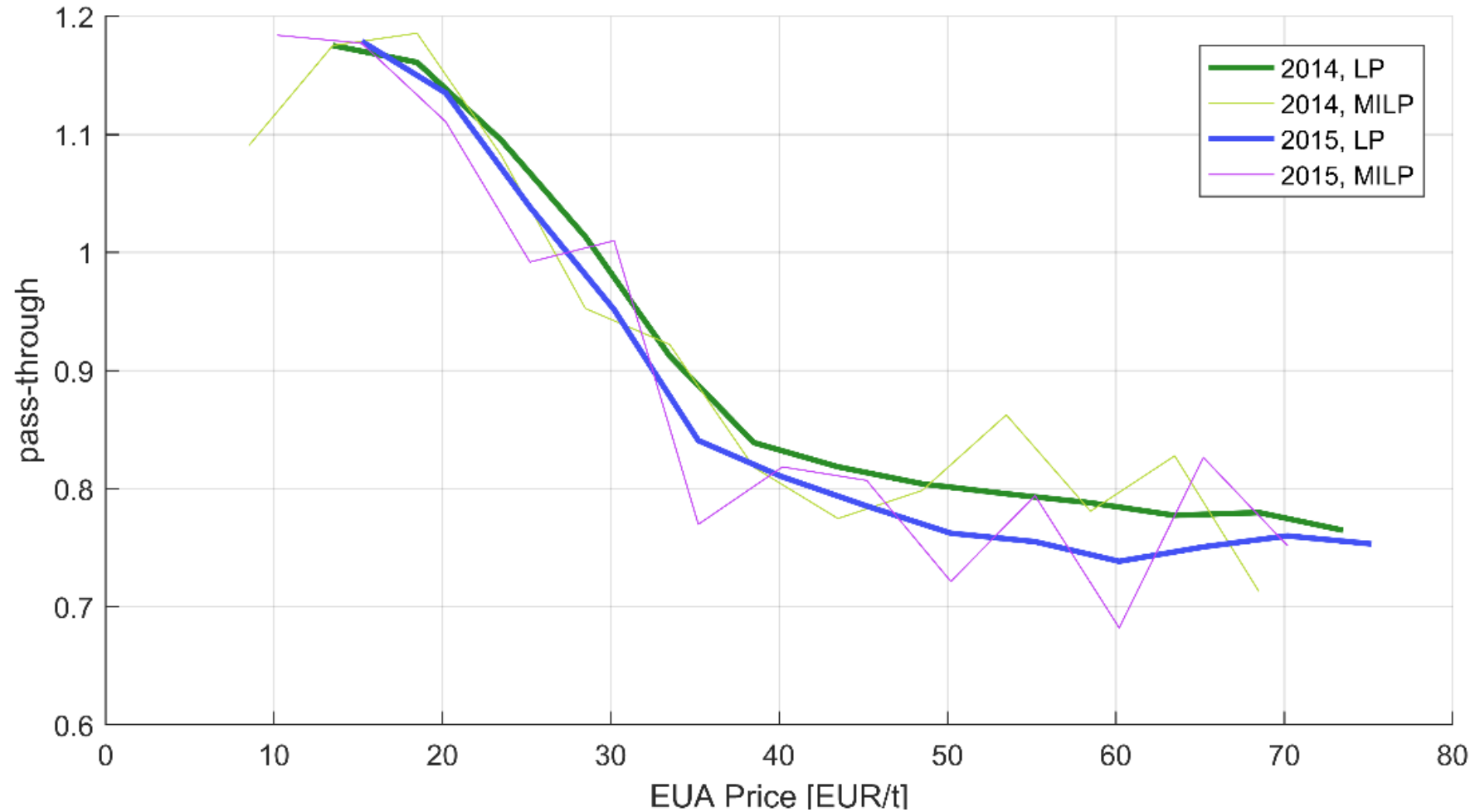# Estimation of cost pass-through using MEDEA

- Power System Model MEDEA
  - Technically detailed, numerical bottom-up dispatch model for AT/DE
  - Detailed system data (power plants, renewable generation, load, flows,…)

- Estimation strategy (base year 2015)
  - Hourly data on renewables feed-in, flows, load, prices (fuels, emissions)
  - Replicate power system in 2015 with MEDEA
  - Scenarios: increase (hourly) EUA prices by increments of 5 €/t, up to 75 €/t

- Compute pass-through estimate: $\dfrac{\partial p_{el}}{\partial p_e} \cong \dfrac{\Delta\, p_{el}}{\Delta p_e} = \dfrac{p_{el}^{s} - p_{el}^{s-1}}{p_e^{s} - p_e^{s-1}}$
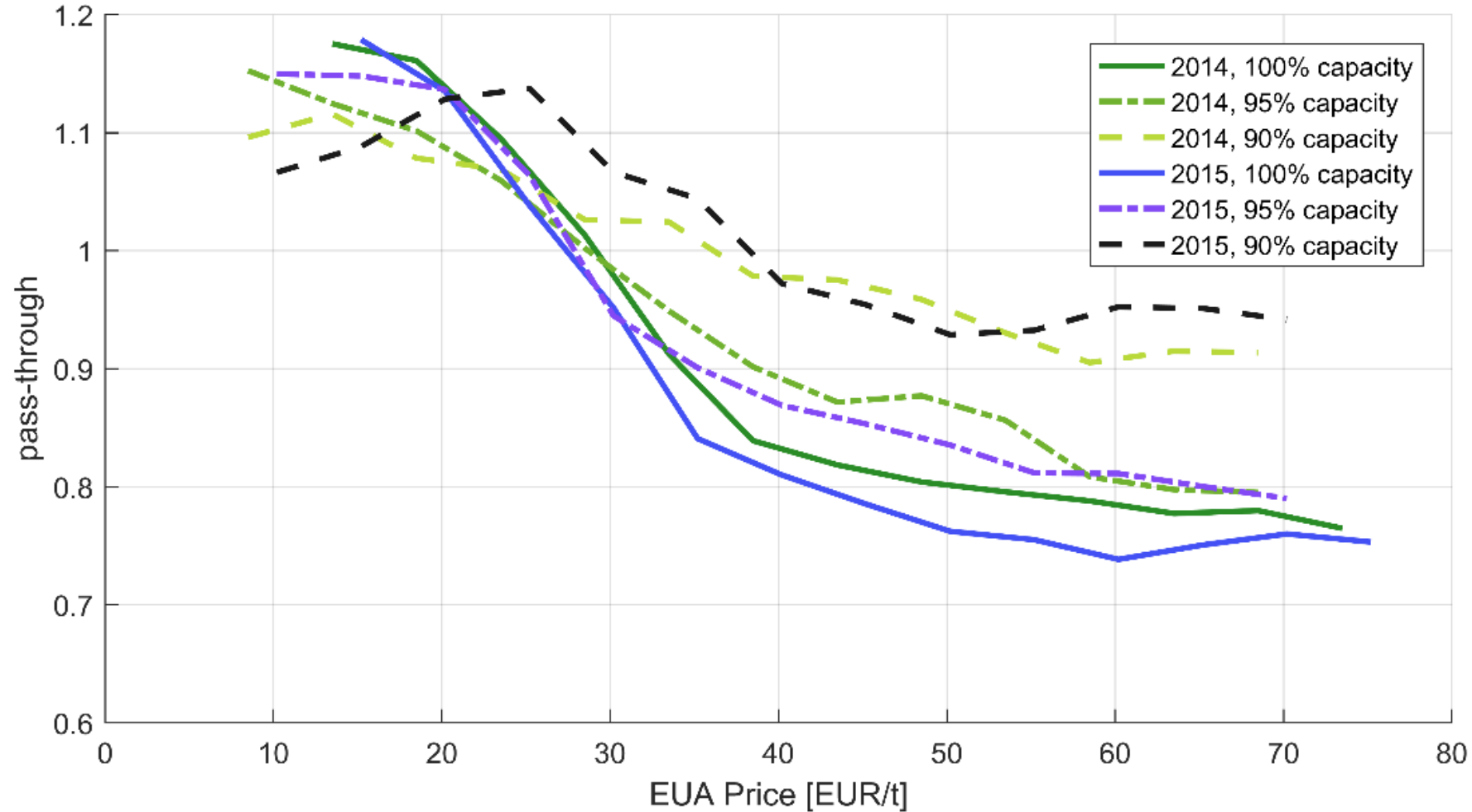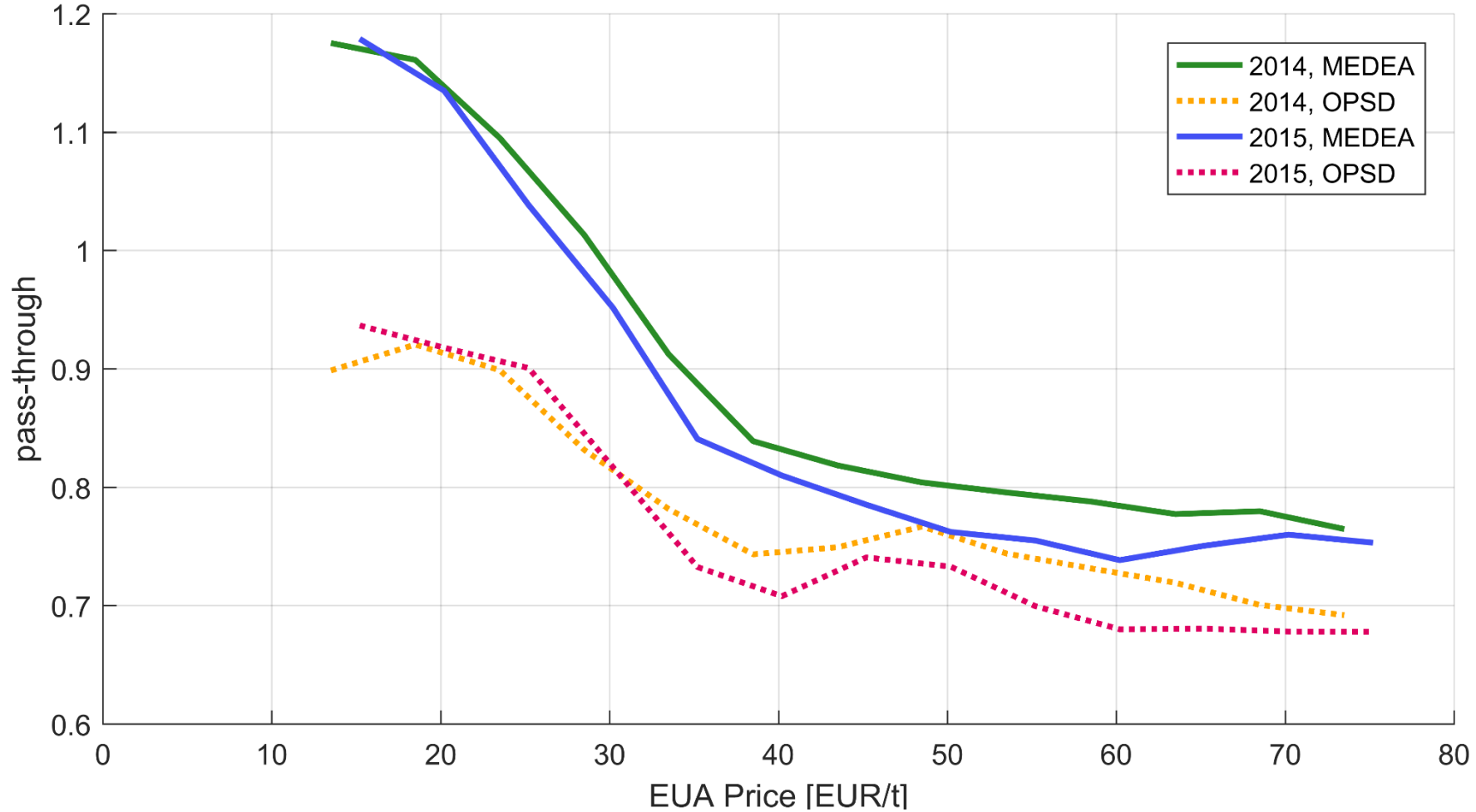
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Estimated pass-through

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Sensitivity – Capacities and Prices

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Sensitivity – Power Plant Data

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"OPSD" is Open Power System Data. 2017. Data Package Conventional power plants. https://data.open-power-system-data.org/conventional_power_plants/. (Primary data from various sources, for a complete list see URL).

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Discussion of results

- General limitations of the power system model MEDEA
  - heat demand not zonal
  - perfectly competitive markets, price-inelastic demand
  - static imports and exports, no investments

- Overestimation of pass-through?
  - Zonal heat demand would lead to less flexible dispatch and thus higher pass-through
  - Market power could reduce pass-through. Yet, no significant evidence of excessive market power in market area according to German Monopolkommission
  - Short-run price elasticity of electricity demand is very low
  - Imports from low-carbon producers may reduce pass-through
  - Long-term adaption through investments reduces pass-through
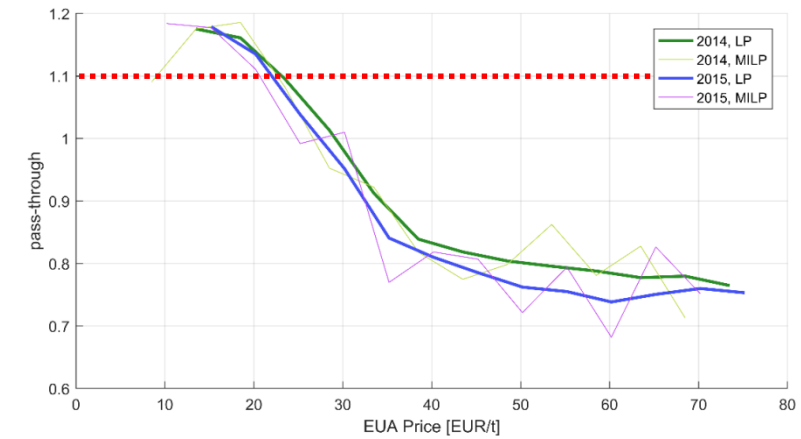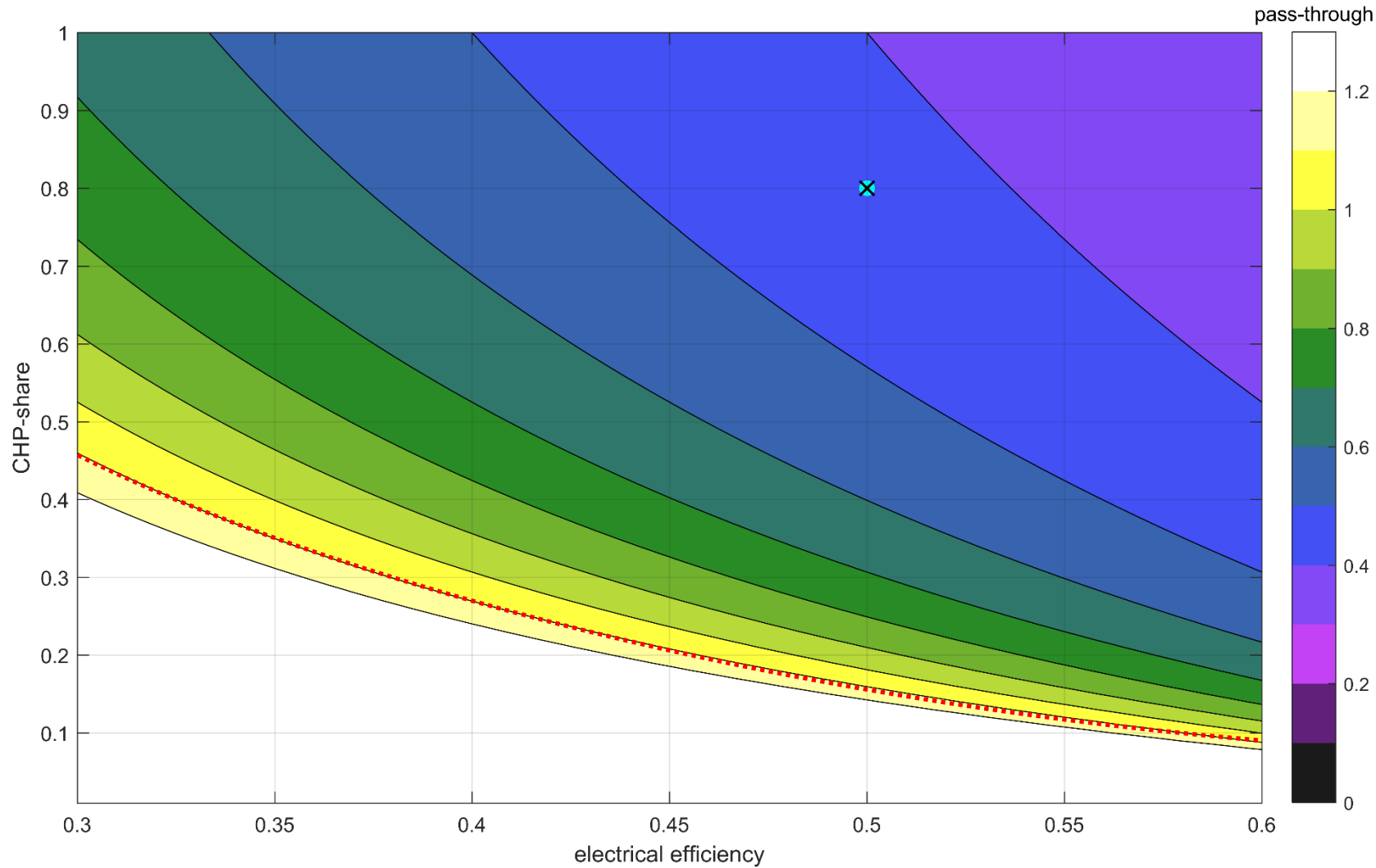
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Conclusions

At emission prices up to 20 €/t, pass-through estimates are high enough to make virtually all natural gas-fired DHC systems better off.
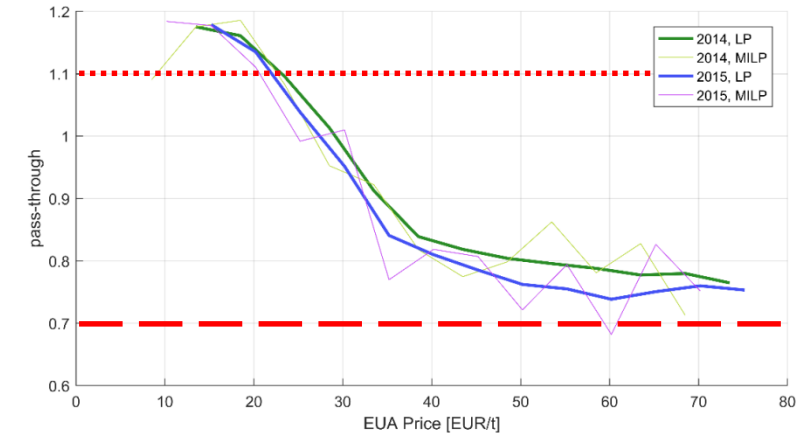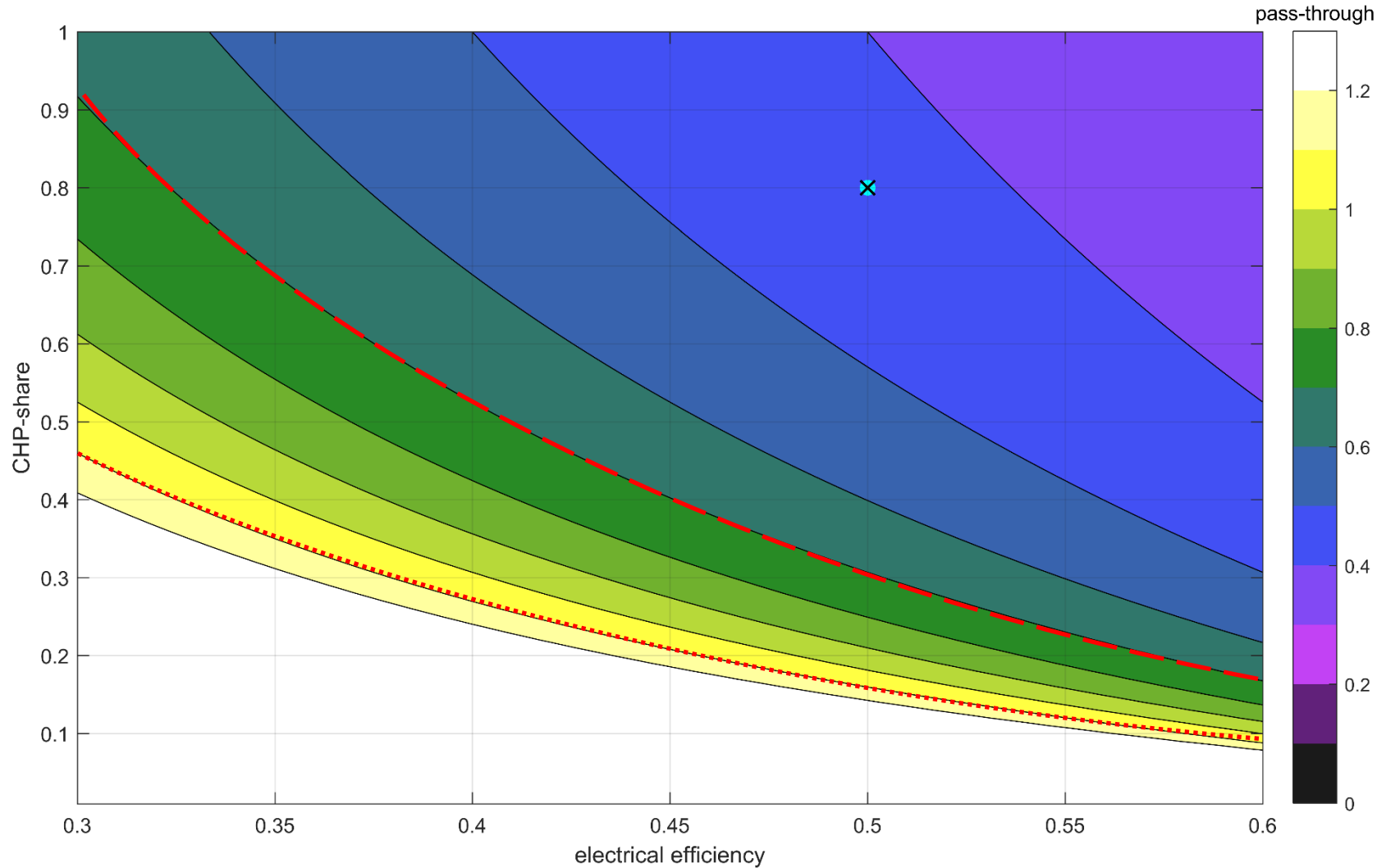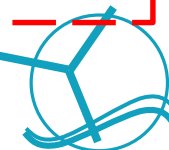
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Conclusions

At emission prices up to 20 €/t, pass-through estimates are high enough to make virtually all natural gas-fired DHC systems better off.

For emission prices in the range of 50€/t, profitability of the least efficient natural gas-fired DHC systems is likely to deteriorate

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Thank you!
I'm looking forward to discussing with you.

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