The regulatory framework for Combined Heat and Power – addressing risks and realising benefits

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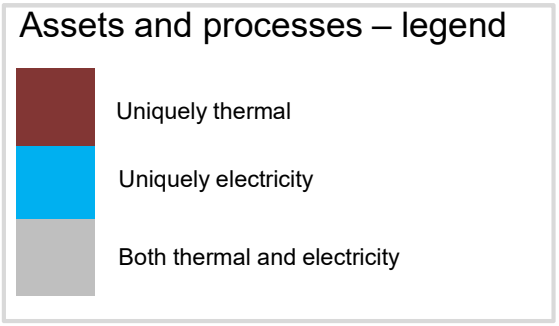
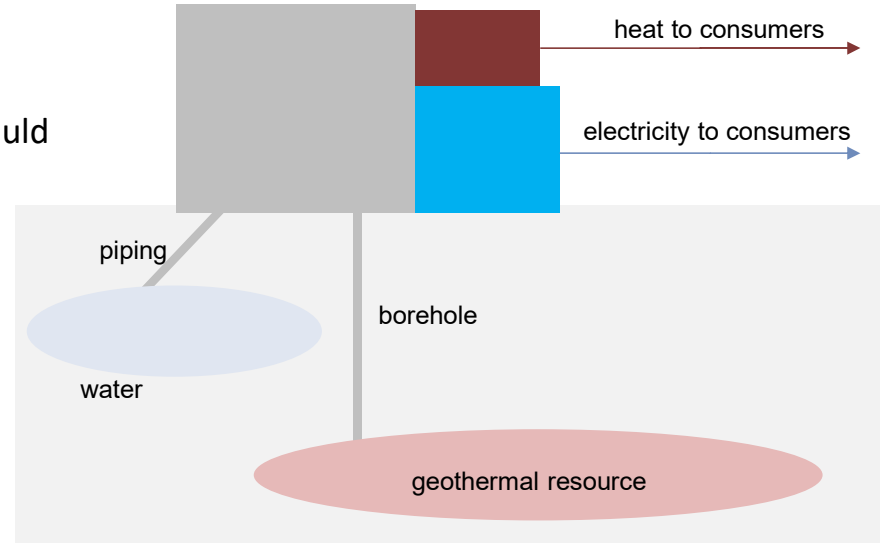
Background

- Cross subsidy concern
  - Owner of CHP (Combined Heat & Power) plant has incentive and ability
  - to allocate ´excessive´ cost in regulated monopoly district heat sector
  - enhancing the company´s profitability in the competitive electricity sector, meaning
  - integrity of electricity market is compromised – undermining electricity system efficiency
  - both heat and electricity consumers pay excessively

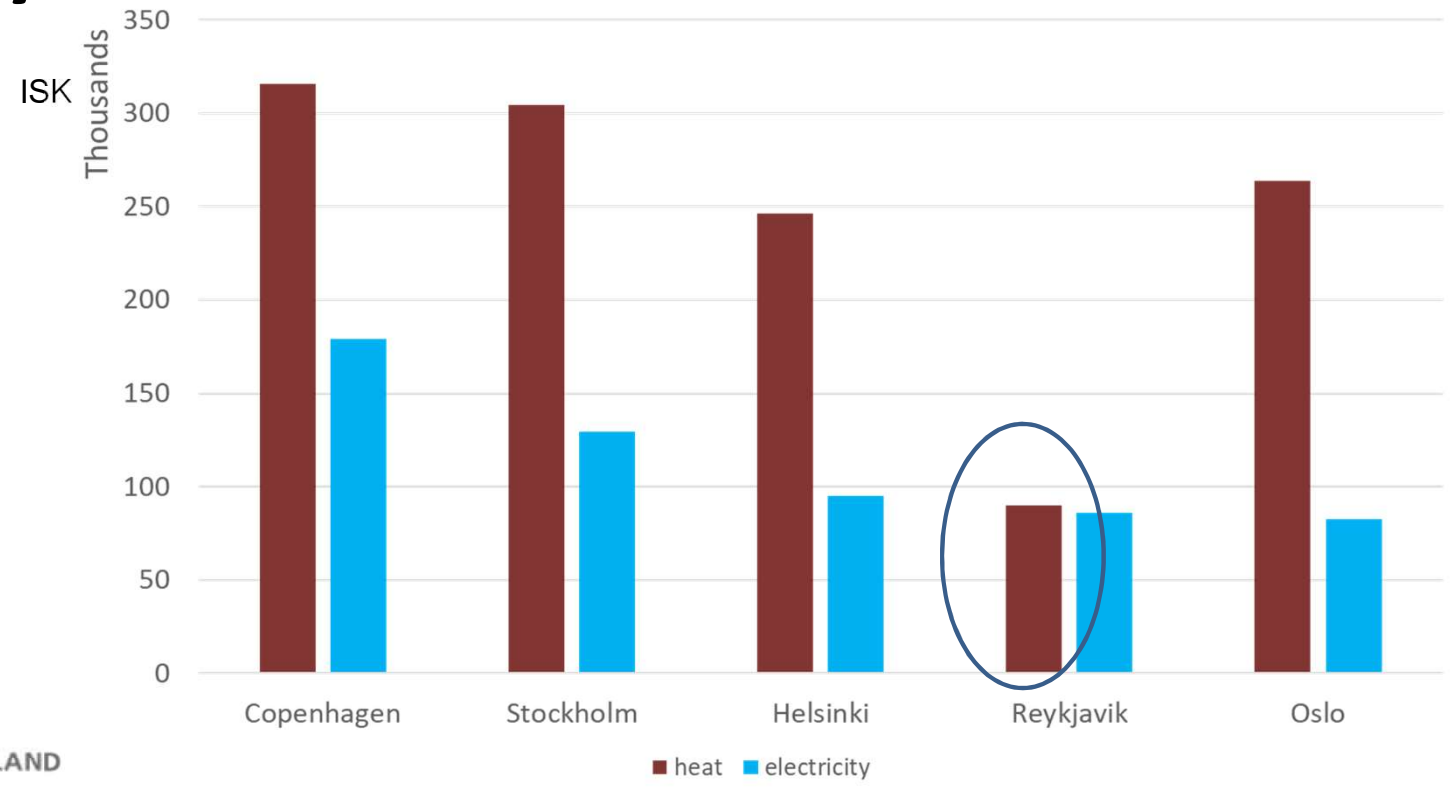
- The Icelandic Government has helpfully intervened – with the objective of protecting competition in the electricity market
  - (Cross-)subsidy is prohibited (Competition Act, Electricity Act)
  - The regulator has issued ´guidelines´ showing an allocation it will accept
  - Electricity Act outlines a ´back-stop´ allocation method to be applied should the regulator not wish to approve the CHP owner´s proposed method
  - Electricity Act also requires transparent reporting of cost allocation

- Scope for light-touch reform





Estimated annual bill of domestic heating and electricity in 2018



Source: Samorka
Notes: 100 m^3 house, 4.8 MWh consumed / year

How would you split the common cost to ensure against cross subsidy?

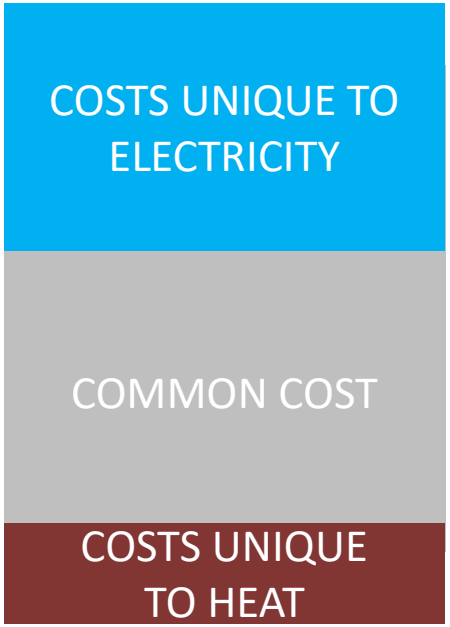
A. Any allocation is ok

B. 50:50

C. Relative size of unique costs

D. Zero common cost to heat

E. Some other method



Illustrative CHP cost

Findings

Finding 1. the solution can be defined in terms of counterfactual cost

- Faulhaber – key condition: if the provision of heat by an enterprise producing heat and power leads to prices for heat no higher than those required to recover costs of heat provision by itself, the price structure is ´subsidy-free´ (paraphrased)

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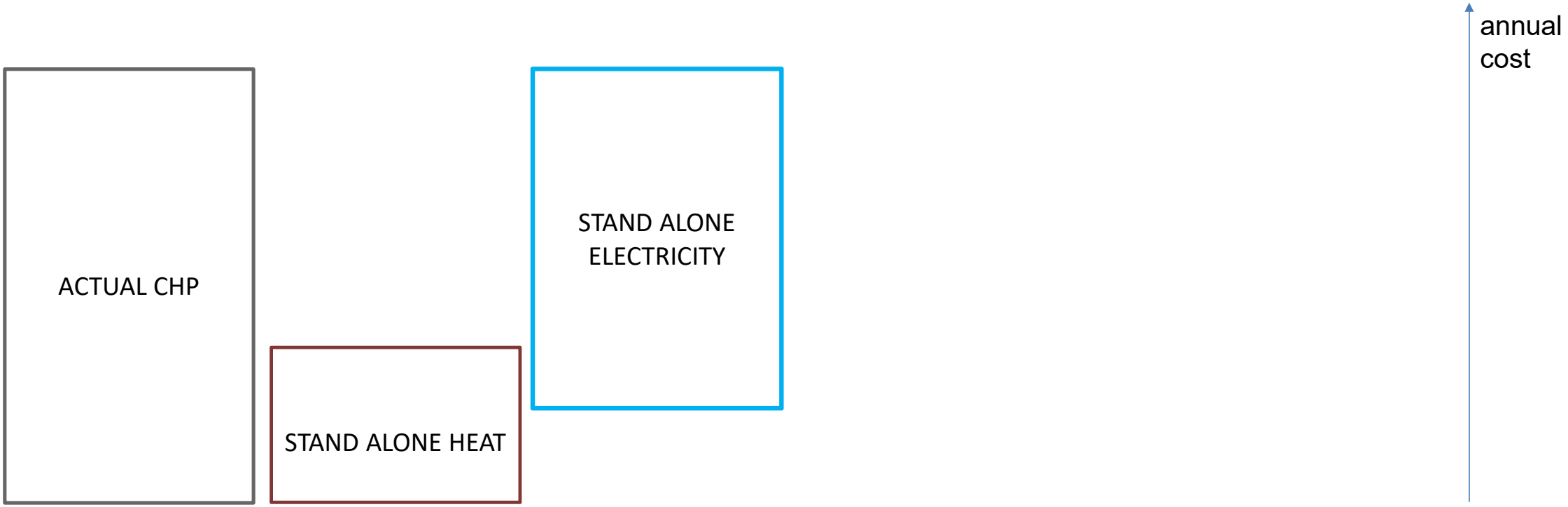

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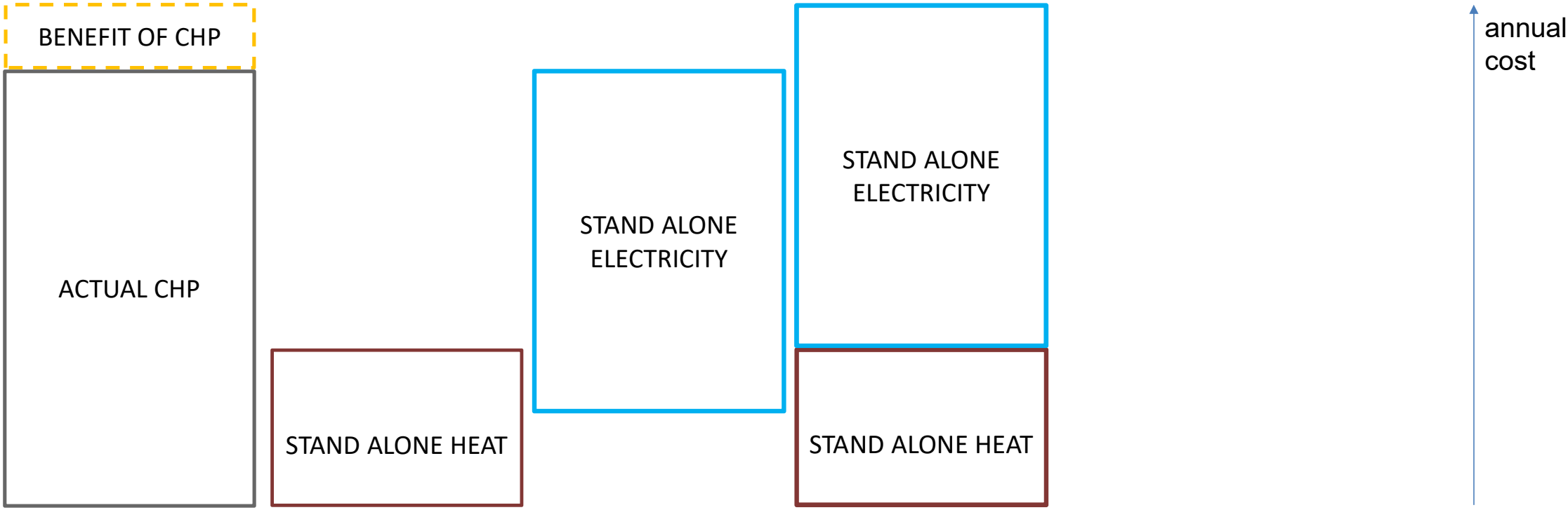

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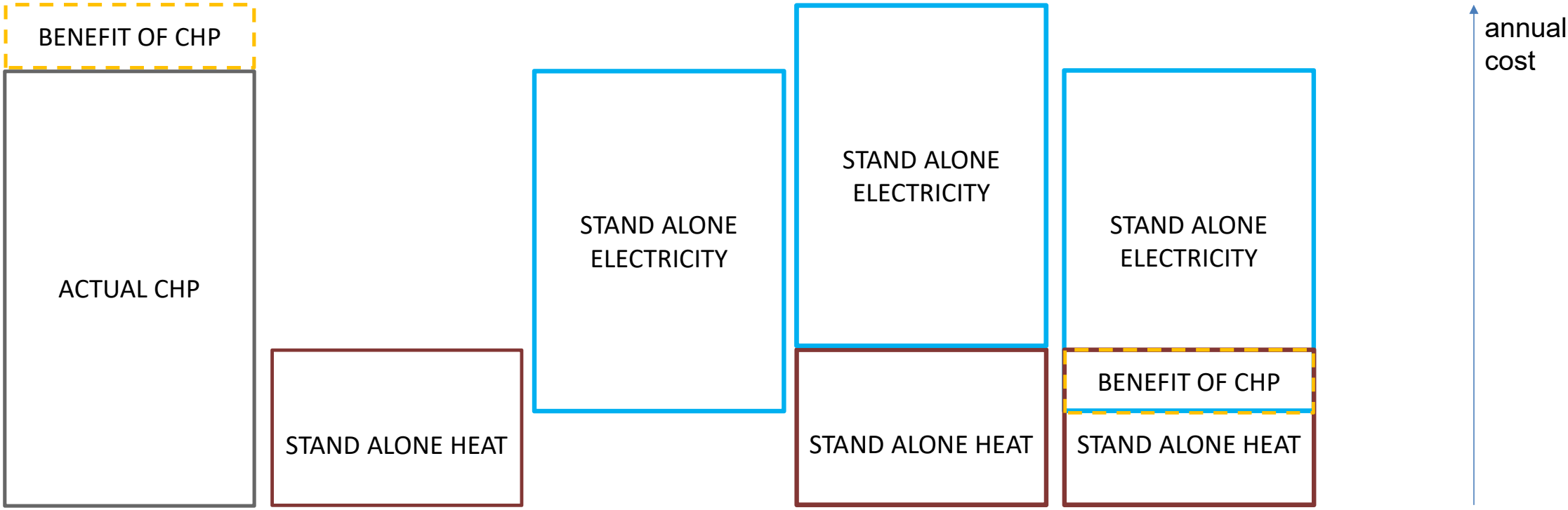

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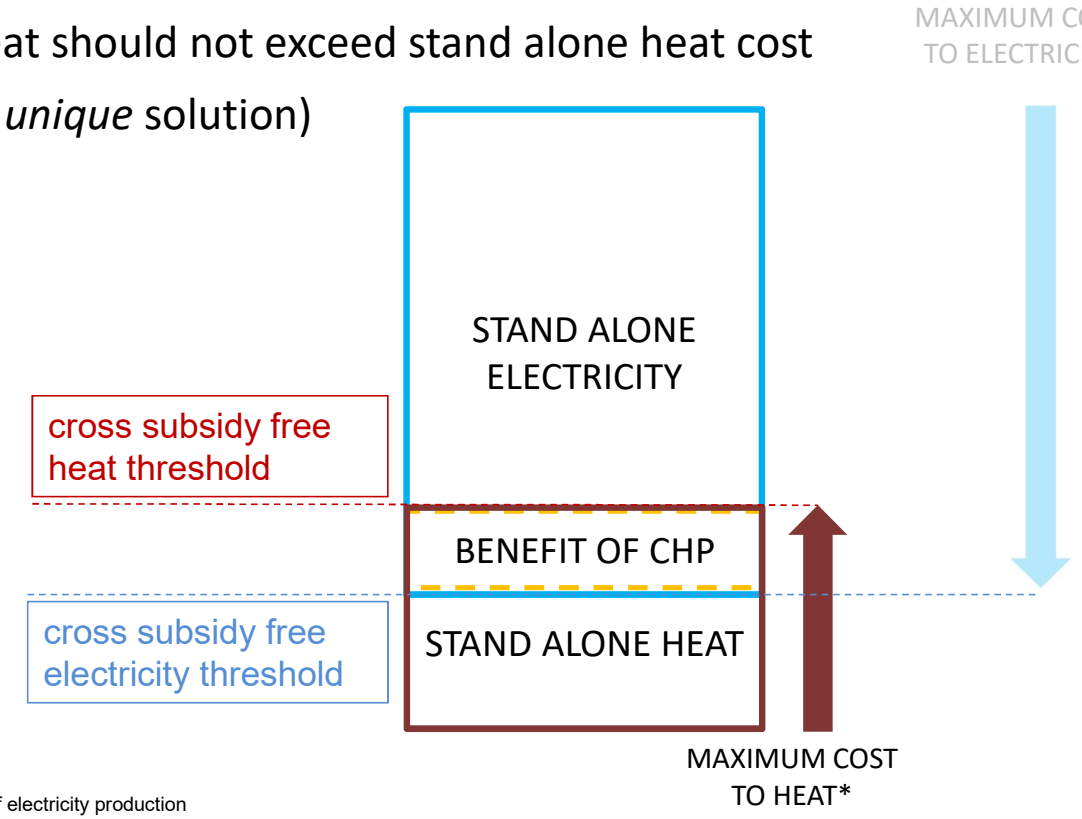
- "Cross subsidy free" prices require costs allocated to heat should not exceed stand alone heat cost
- There may be a *subset* of acceptable allocations (not a *unique* solution)
- Defining the counterfactual is incredibly important.



*and costs allocated to electricity must at least cover marginal costs of electricity production

Finding 2. the Icelandic framework may merit reform

- the ´back-stop´ and the ´guidelines´
  - do not clearly link to the definition of the issue – the cost of the counterfactual
  - offer pin-point solutions – to a problem with multiple solutions

- ´back-stop´ rules provide for a cost allocation that is built on prices – when prices themselves are a function of cost allocation (circularity)

- it is not clear any company has had its cost allocation approved by the regulator in recent years; and the back-stop solution has not obviously been implemented

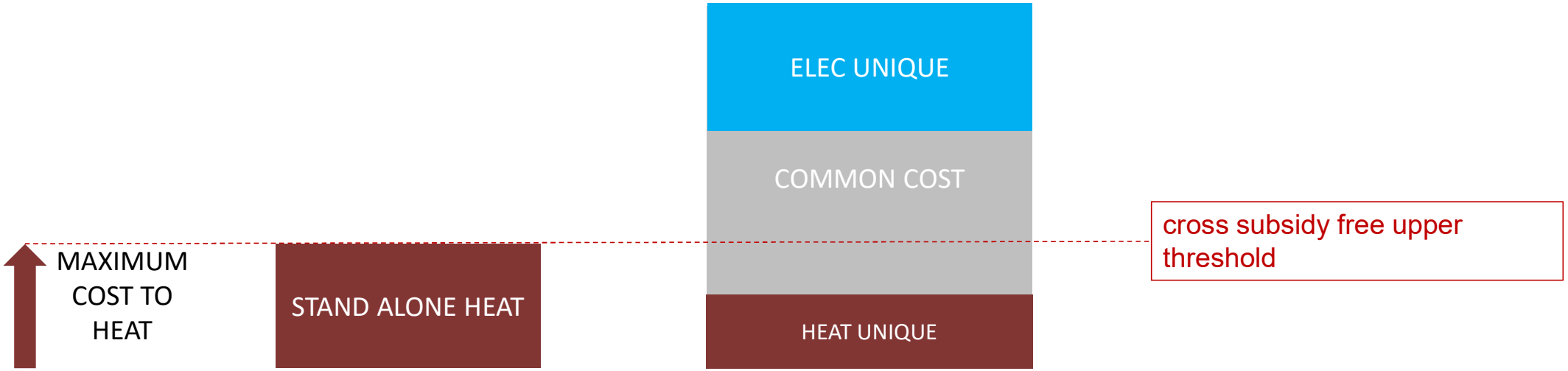
- disagreement on rules and their application has consumed resources (appeals etc)

Finding 3. law requiring transparent reporting of cost allocation may be more far-reaching than necessary

- the most important component is visibility of total cost allocated to heat
- other elements – electricity costs in particular – may however be commercially sensitive
- it is debateable whether it is necessary for these to be published or simply shared with the regulator
- it is not clear anyway all parties fully comply with all requirements

Finding 4. OR´s allocation of cost in 2018 ensured against cross subsidy

- Orkuveita Reykjavíkur (OR) operates two of the three big CHP plant in Iceland
- I optimised counterfactual plant – drawing on schematics by Mannvit – to estimate cost of meeting heat needs efficiently
  A. Existing CHP
  B. Blank sheet
- Both methods suggest the 2018 allocation sits the right side of the cross subsidy free pricing threshold (as it should)
- Achieving broad agreement with stakeholders on the counterfactual may be an on-going and iterative process.



Illustrative OR actual annual CHP costs

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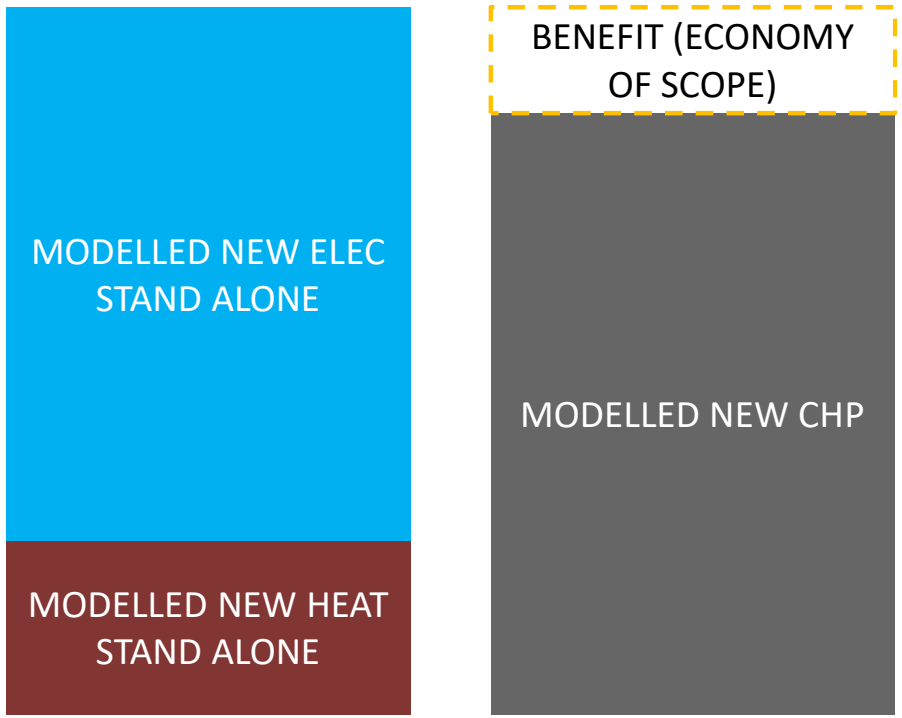
Note blocks are illustrative and do not represent actual OR costs

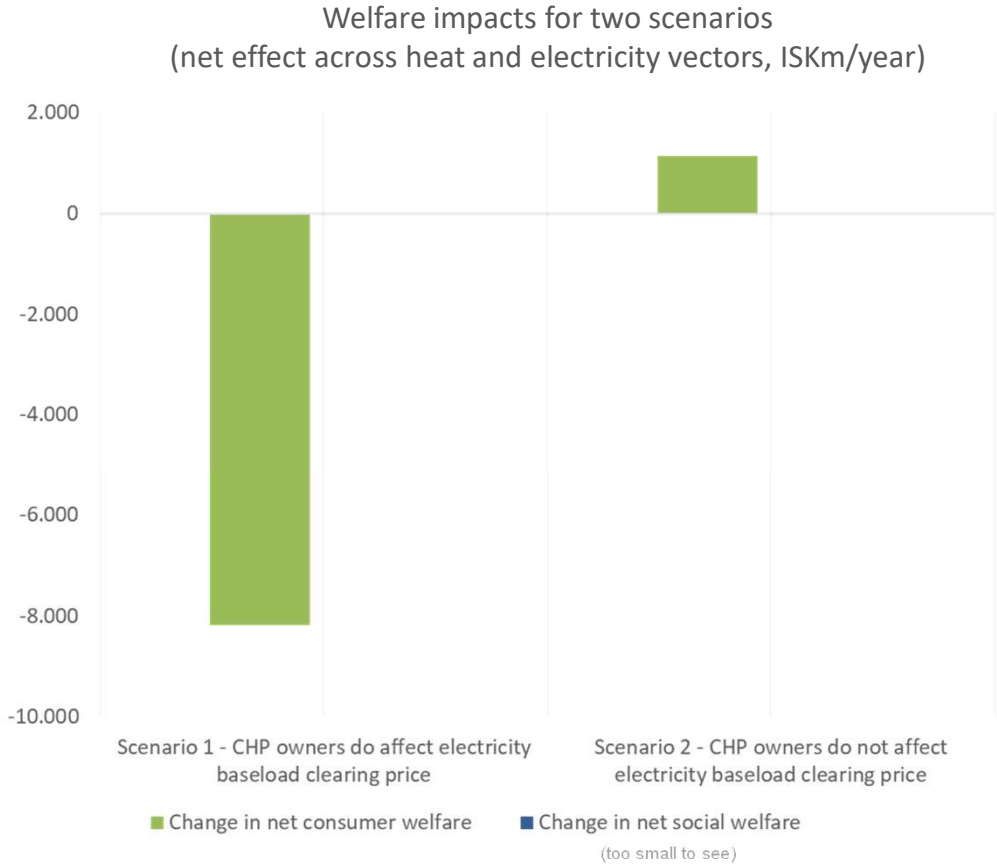
Finding 5. Benefits of investment in *CHP* (Hengill counterfactual)

- Analysis (optimisation of Mannvit schematics) suggests economies of scope between heat and power support cost benefits of co-production
- Against this counterfactual, resource costs might be ~15-20% higher had OR elected to build stand alone plants rather than CHP
- Scaling by actual OR annual costs gives a substantial annual resource cost saving
- Benefits could be larger for future investments.



Finding 6. allocating as much cost to the electricity vector as allowable does not necessarily serve welfare in Iceland

- The effect of hypothetically moving cost allocation from heat to electricity (without breaching cross subsidy free thresholds) depends on factors such as
  - Responsiveness of consumers to price changes: electricity market is well-researched, and I conduct new heat market research (annex)
  - Competitiveness of electricity market and extent to which CHP owners might influence baseload prices
- Modelling suggests substantial variation and uncertainty →
- Given electricity companies are largely state owned and consumers are large multinationals, will the allocation of maximal cost to electricity vector extract most value for "Icelanders"?
  - possibly, but -
  - such intervention steps beyond stated motivation to protect competition, and
  - risks interfering in neutrality of technology, as well as competitive position of smaller electricity generators (with CHP expertise) versus dominant electricity generating co, and
  - goal of maximising Icelandic welfare may be achieved more effectively by other policy (such as resource tax?)
- Onus => policing adherence to cross subsidy free thresholds.



Finding 7. distortions risk disadvantaging heat investment through CHP over stand alone

- Potential differences – such as when heat-related costs may be recovered
  - CHP: *after* heat generation begins
  - Stand alone: *before* heat generation begins
- Differences could impede investment in CHP and with it realisation of synergies.

Recommendations

Recommendations – Government / authorities

- **Regulator and Competition Authority police arrangements with recourse to cross subsidy free pricing**
- the ´**back-stop´ rules are removed –** these rules are the Government´s method for allocating cost in the event the NEA refuses to approve the CHP owner´s proposed method as outlined in the Electricity Act
- **CHP owners have discretion over exact cost allocation** within cross subsidy free bounds – World Bank recommendation
- **the NEA may approve allocations** where compelling evidence is provided of adherence to cross-subsidy free outcomes
- **distortions in regulatory framework are addressed** that favour heat investments through stand alone solutions over CHP solutions
- in the longer term, **feasibility of competition in heat generation is explored**, noting if feasible – say in the capital area – this would remove the rationale for regulatory intervention.

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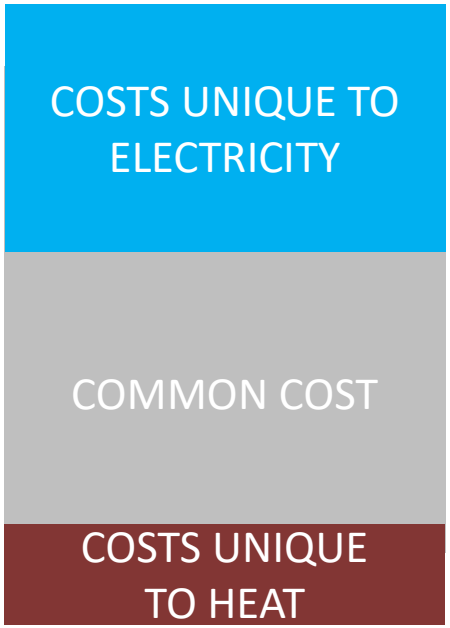


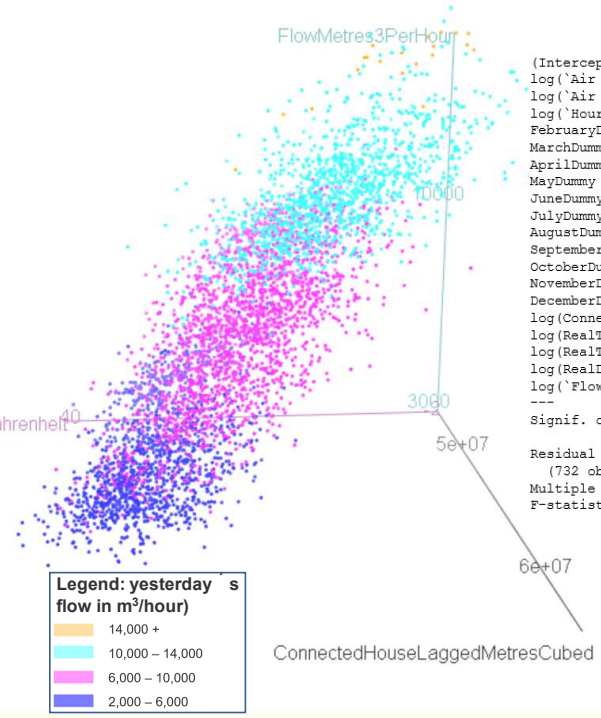
Illustrative CHP cost

Annexes

No evidence heat consumers will increase demand in response to lower tariffs

Demand (flow)= { Air temperature corrected for WindChill (and lags of -1day, -2days, -3days) + Hours of sun + Demand from yesterday
+ MonthDummy + Volume of connected housing + Income (disposable, real, lagged) + Tariff (real) + intercept + error

- Modelled in Rstudio, using daily data from 2005-2018
- Results
  - Model explains around 97% of variation (but could nevertheless do with further refinement)
  - Weather/elements, inertia, time of year – first four variables – are statistically significant explanators of movement in demand
  - Volume of connected housing is important (I drop population variable, given multicollinearity with housing, noting results are not v sensitive to inclusion/exclusion)
  - Income may matter – a little
  - ***Key finding: No evidence that lower tariffs will stimulate demand (including exploring further lags)***
  - *Result is backed up separately by grainger causality tests.*




```
                                  Estimate Std. Error t value Pr(>|t|)
(Intercept)                     -3.9741393  0.5354665  -7.422 1.39e-13 ***
log(`Air temperature F WindChill`)  -0.0885868  0.0038754 -22.859  < 2e-16 ***
log(`Air temperature F WindChill Lag1Day`)  0.0103535  0.0040583   2.551 0.010771 *
log(`Hours of sun`)             -0.0010477  0.0002961  -3.539 0.000406 ***
FebruaryDummy                   -0.0024655  0.0048503  -0.508 0.611260
MarchDummy                      -0.0125873  0.0048327  -2.605 0.009230 **
AprilDummy                      -0.0357246  0.0052402  -6.817 1.06e-11 ***
MayDummy                        -0.0743536  0.0059819 -12.430  < 2e-16 ***
JuneDummy                       -0.1198326  0.0073952 -16.204  < 2e-16 ***
JulyDummy                       -0.1504340  0.0084763 -17.748  < 2e-16 ***
AugustDummy                     -0.1310639  0.0081755 -16.031  < 2e-16 ***
SeptemberDummy                  -0.0857564  0.0066675 -12.862  < 2e-16 ***
OctoberDummy                    -0.0437358  0.0054179  -8.073 8.91e-16 ***
NovemberDummy                   -0.0129854  0.0047931  -2.709 0.006772 **
DecemberDummy                   -0.0047186  0.0047221  -0.999 0.317728
log(ConnectedHouseImprovedLagged)  0.1752126  0.0227568   7.699 1.69e-14 ***
log(RealTariffImprovedLag1Year)  0.0343319  0.0130516   2.630 0.008558 **
log(RealTariffImprovedLag2Year)  0.0463714  0.0120493   3.848 0.000121 ***
log(RealDisposableIncomeImprovedLag1Year)  0.0352129  0.0132563   2.656 0.007930 **
log(`Flow lag 1 day`)           0.7609111  0.0093500  81.381  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.06118 on 4199 degrees of freedom
  (732 observations deleted due to missingness)
Multiple R-squared:  0.9692,   Adjusted R-squared:  0.9691
F-statistic:  6952 on 19 and 4199 DF,  p-value: < 2.2e-16
```

NEA guidelines

The guidelines allocate cost to each energy vector according to the ´value of energy´, which is considered to be composed of power and energy in equal proportions as follows

Electricity: $\sum R + \frac{1}{2} * \left(\frac{E}{E + s \times Q} + \frac{P}{P + s \times Q'} \right) * \sum S$

Heat: $\sum V + \frac{1}{2} * \left(\frac{s \times Q}{E + s \times Q} + \frac{s \times Q'}{P + s \times Q'} \right) * \sum S$

R = direct cost of electric power,

V = direct cost of thermal processing,

S = common asset costs of the power plant,

s = replacement factor

(defined as the lowest hourly value of the 5% highest rated period)

E = produced electricity kWh_r

P = the calculated maximum demand in kW,

Q = produced hot water in m^3 and

Q '= maximum flow of hot water in m^3 / hr

Potential issues

- No direct link to issue of cross-subsidy
- Pin-point solution
- Value of energy is considered to be composed of power and energy in equal proportions
- Definitions of capacity
- Technical parameters eg s.

The back-stop

- The back-stop rules stipulate a cost allocation as follows
  - common costs are divided in proportion to the value of the energy delivered,
  - the value of electricity is proxied by the *average price* leaving the plant,
  - the value of heat is to be determined by Orkustofnun taking into account the price of the energy when it arrives at the purchaser but less the cost of its transfer, distribution and sale
  - a similar return is achieved with respect to fixed assets between the two energy vectors
  - costs need to adhere to generally accepted accounting principles
- Potential issues
  - No link to definition of issue
  - Pin-point solution
  - Circularity? – prices are a function of historical cost allocation.

Declaration

- This presentation draws on a thesis submitted to the faculty of business for the Environment & Natural Resources programme in the University of Iceland.
- Some firm-specific results have been redacted from this presentation.
- The following interests are declared:
  - Dominic Scott has a temporary contract – which has enabled this work – with Orkuveita Reykjavíkur (OR),
  - Gylfi Magnússon (Associate Professor in Business Administration at the University of Iceland, and lead supervisor of thesis) is vice-chair of OR.
- The additional supervisor is Friðrik Már Baldursson, Professor of Economics at University of Reykjavik.