Joint Cost Allocation and Cogeneration

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Abstract

With the joint production of two goods, one subject to competition and the other being a natural monopoly, the threat of cost based price regulation should lead the rational producer to allocate as much costs as possible to the product under scrutiny. We investigate whether Swedish district heating companies allocate joint costs accordingly as well as the importance of these choices in terms of reported segment profitability. The study is conducted through telephone interviews with Swedish companies with combined heat and power (CHP) production, and by analyzing effects on segment profitability from different allocation policies in a DH firms. Our main findings are that most CHP producers do not allocate costs for purposes of reporting or decision making, but that they, implicitly or explicitly, consider electricity a by-product which is used to subsidize heat customers. The case study also suggests that the choice of allocation method has a substantial impact on reported business segment profitability.

Keywords: Joint cost allocation, Mark-up pricing, District heating, Combined heat and power, Cogeneration, Sweden

Background

The potential benefits from allocating costs between products that are jointly produced have been the topic of much research. If products are traded at competitive markets the reason for engaging an allocation exercises are not entirely clear. However, in non-competitive markets the issue of allocation becomes more important.

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Monopoly pricing is typically mitigated by law makers with some form of regulation, and historically the price that the regulated monopolist is allowed to charge often derives from the company's costs (c.f. European Court case 27/76). If the product under scrutiny is jointly produced with another product one must determine how much of the joint costs that should be allocated to each product. In such cases the principles of allocation have direct value consequences for supervised companies.

In this paper we study joint cost allocation schemes by analyzing Swedish energy companies where at least part of the energy is produced in combined heat and power (CHP)[1] plants, i.e. the joint production of electricity and district heating (DH)[2]. By increasing total plant efficiency CHP offers substantial contributions to energy security as well as mitigating climate change compared to when producing DH and electricity in separate utilities. In conventional power plants total efficiency amounts to 25-45 percent whereas CHP production raises that number to 70-95 percent (Fredriksen and Werner, 1993). Replacing central heating with district heating systems also makes possible the usage complicated fuels, better waste management and improvements to the local environment. These features have made the advancement of CHP a political priority. In Europe this is manifested in the European CHP directive (COM 2004/8/EC), where member states are urged to promote efficient cogeneration. In the United States the current administration has set up a goal of 40 GW new CHP capacity until 2020, which corresponds to a 50 percent increase in total American CHP capacity (USDE, 2012). In Sweden the share of total electricity production that stems from CHP is comparatively low, this because the Swedish electricity system in large relies on hydro and nuclear power.

In recent years the market for DH has been widely debated. In Sweden, which has one of the most developed DH markets in the world (measured as the DH's share of the market for heating), it has been claimed that district heating systems are to be considered natural monopolies[3] where producers allegedly use their market power for overpricing. The Swedish Competition Authority recently investigated two cases concerning possible overpricing in the municipalities of Stockholm and Uppsala (KKV, 2009:48), but these investigations were written off in late 2010 as it was deemed that any further investigation would not result in any clear conclusions. In the new District Heating Act[4] the relation between DH companies and their customers is addressed insofar that a special District Heating Board is created with the purpose to act as mediator in case of conflicts over terms. However, this body has no coercive competence and has been criticized by customer representatives for not being a satisfactory safeguard. This conclusion is supported by the Competition Authority (KKV, 2009) and the Swedish Energy Markets Inspectorate (EMI, 2009) where both want a price regulation put in place. Further, a regulation of Swedish DH prices is also advocated by the International Energy Agency (IEA, 2008). A cost plus regulation of DH has also been advocated by for instance the International Energy Agency (IEA, 2009).

[1] Also "cogeneration". Here the two terms are used interchangeably.
[2] District heating is a system for distributing centrally generated heat to commercial and residential buildings for space and water heating.
[3] It is not a controversial statement that *district heating systems* themselves are natural monopolies, as district heating is a decreasing cost industry. Rather, the counter argument has been that district heating is not a relevant market definition, what is relevant is *heating* – a need that could be satisfied also through electricity, heat pumps or another technology. In practice, other technologies have often not been feasible substitutes.
[4] Swedish code of statutes 2008:263.

If DH prices are to be determined based on costs one must establish how to determine costs, in particular in relation to joint production. A substantial part of the total energy production in many DH firms takes place in CHP plants, and with mark-up pricing joint costs should somehow be allocated between the products heating and electricity. Assuming rational agents one would expect that firms in industries subject to public debate or regulatory threat, like Swedish CHP producers, allocate as much costs as possible to the product invoking concerns. Such allocation would make the DH business segment appear less profitable and potentially help to avoid becoming the target for criticism for overpricing or, if regulation is enacted, push the possible price limit upwards. Conversely, consumers of the same product would prefer the size of costs addressed to DH to be as small as possible since that would strengthen their argumentative power in a price conflict. A competition authority would be in the middle, having the ungrateful task of finding the policy that would be most aligned with economic efficiency. In addition, the environmental benefits associated with CHP production provide arguments for not putting in place regulation which discourages investments in CHP plants.

In the context of the Swedish DH sector, given the threat of regulation that these companies face one could expect them to allocate as much costs as possible to the DH business segment and as little as possible to the electricity segment, and thereby lifting an upper price cap.[5] On the other hand, Swedish DH companies are in most cases municipally owned and were in the past not even firms, but municipal administrative units. This indicates that these firms do not come from a culture of profit seeking. Instead, municipally administered services in general are by law provided on a cost-coverage basis. It is important, however, to note that municipal energy companies are exempt from the requirement of prime production cost pricing. To the contrary, there is a phrasing in the law that these firms should conduct business on commercial basis. But that does not rule out that the historical administrative culture is lingering to some degree, or that politicians want to keep energy prices down in order to avoid upset voters. Even so, it is not clear why anyone should want to put avoidable pricing constraints on themselves. Even without for-profit motives, a CHP producer would gain some slack if more costs are attributed to the DH business segment.

This background suggests that how firms allocate joint costs has consequences for firm profitability, energy security, environmental performance and consumer welfare. Knowledge on these issues is therefore important, and any regulation or debate on companies' allocation choices should be rooted in an understanding of how CHP producing firms allocate joint costs today, and what implications they may have for firm performance. Consequently, the purpose of this paper is to increase our knowledge on how cogenerating companies allocate joint costs and how cost allocation policies influence company operations. This is met by answering two questions. First, a solid understanding is warranted for to what degree companies allocate costs today, how it is done, and for what purposes. Thus, our first research question is:

How and for what purposes do Swedish DH companies with CHP production divide joint costs between heat and electricity?

[5] The reason we expect any allocation to take place at all follows from a regulatory peculiarity. Since two years now Swedish DH companies must report income statements for their DH operations alone.

Second, we need to understand how different joint cost allocation principles affect perceived segment profitability. It could well be the case that effects of allocation choices are insignificant. If so, it would not make sense to engage in costly search for alternative allocation principles. So, we finally ask:

To what degree does the choice of joint cost allocation principle influences segment profitability in a CHP producing company?

This study leaves several. First, we are able to obtain information on how a large set of companies within the same industry actually allocate joint costs, and for what purposes. This in itself is interesting as access to firm often is a main problem for researchers. Second, cost allocation choices are commonly viewed as a firm internal affair, of little interest for external actors. This study illustrates that such choices indeed may be of importance for interests outside the company. Third, joint cost allocation in itself has attained little academic interest as the link to the firm's value creation has been vague. We highlight the role those choices might have for product pricing, something that indeed is of importance for value creation and thereby deserves further examination.

We find that for purposes of decision making the vast majority of CHP producing companies do not allocate costs, and that the CHP production is regarded an indivisible business operation. However, we also find that most firms, implicitly or explicitly, allocate costs in relation to pricing. This is done in a way so that heating consumers are fully benefiting from the electricity sales. Tax legislation also drives allocation, but it is not important when it comes to investment decisions or short-term production decisions. We also find that the choice of allocation method may have a substantial impact on reported segment profitability.

The remaining of the paper is organized as follows. The next section covers literature where possible purposes of joint cost allocation are discussed, tentative allocation principles identified and previous research on joint cost allocation in CHP production is presented.

Literature

The literature at date provides with some tentative explanations or purposes to why companies should bother with allocating joint costs. These could be grouped into what we coin purposes for: financial reporting, internal decision making, pricing, environmental reporting and taxation. Further, the literature also suggests numerous ways to allocate joint costs. Below, we introduce this literature and relate it to the case of cogeneration.

Allocation purposes

Joint cost allocation could provide input in internal decision making. For instance, it has been argued that allocation of joint cost may have an auxiliary function for managers in deciding whether a joint-product should undergo further processing beyond the split-off point (Lorig, 1951); although this is disputed (Hill, 1955; Lawson, 1956; Lorig, 1956; Lawson, 1957). Regardless of the acidity of these claims, they are of little relevance for this study. Nor is there any further processing beyond the split-off point. One could suspect however that allocation choices could affect investment appraisals and operative decisions if estimated costs are somehow incorporated in the decisions. For example, allocation choice could influence the perceived attractiveness of adding an additional customer to the DH system if the estimated DH costs are used in the cost-/benefit analysis.

If so, with mark-up pricing a higher proportion of CHP costs that are assigned to electricity increases the likelihood that additional investments are done in adding new DH customers.

The purpose of joint cost allocation for purposes of financial reporting is not entirely straightforward. Historically, the prime purpose has been inventory stock valuation (Avery, 1951; Lorig, 1955), and by prolongation profit measurement (Beckett, 1951). However, an external investor's primary concern is the value of the firm at large. Certainly, information on business segments normally is a valuable component in the analysis of overall firm performance (Hope and Thomas, 2008). But with joint production it is more complicated as any assignment of costs to the separate products must be based on some arbitrary principle (Thomas, 1975). This arbitrariness conveys the risk of making segment reporting a driver of obfuscation rather than clarification. Therefore, it is not self-evident that value is added through such reporting practices. In fact, for this very reason Thomas (ibid.) wants us to leave allocation reporting altogether. This is also applicable to cogeneration. What ought to be of interest from an strict investor perspective is how firm value can be augmented by combining the production of heating and electricity, well aware of the fact that the combination per se creates value. Concerning inventory valuation in particular, in CHP production there is no inventory as both DH and electricity are consumed at the same time as they are produced.

Joint cost allocation has also been put forward as being useful in pricing policy (Beckett, 1951) where mark-up pricing is used. It is not perfectly clear why this should be important to firms when they are price takers, or even when they are monopolists. What should be of interest is to maximize total profits. However, the fact that most Swedish DH companies are municipality owned increases the probability of a cost-plus pricing practice. According to Swedish law[6], fees charged by municipal administrations (e.g. fees for water and sewage, waste management and child daycare) may not exceed the cost price. This would potentially influence the pricing policy of a DH company owned by a municipality as well, despite the fact that DH companies should, by law[7] since 1996, be run on a commercial basis. With the municipal heritage it is reasonable to believe that although district prices in such companies are no longer cost prices, they could very well be cost based.

In environmental impact analysis allocation has become an issue of significance. As environmental awareness increases companies are under growing pressure to measure, quantify and lower their environmental impact (Lovins et al, 2007). For this purpose, methodologies have been developed to make possible comparisons between products and services in terms of their respective ecological (and social) consequences. The environmental damage that a company causes is an external cost (Coase, 1960) as it is not fully born by the company itself, and therefore not fully reflected in firm value. But if the environmental impact of a (jointly produced) product is to be communicated the choice of allocation method becomes important, and where the ISO 14041 standard provides with some basic principles (Baumann and Tillman, 2004). The customer wants only to know the environmental impact of his/her particular purchase and then allocation becomes unavoidable. This part is highly relevant for cogeneration. The energy industry is one of the main drivers of air pollution and large amounts of natural resources are plowed into energy production. In this context, the allocation of pollutants from

[6] The Municipality Act, Swedish code of statutes 1991:900.
[7] The Electricity Trade Act, Swedish code of statures 1994:618.

CHP plant (a joint external cost) has great influence in the perceived attractiveness of for instance electricity sold when customers compare it to other power sources.

Last, but not least, taxation should be an obvious driver of allocation choices. If the effective tax rate of a company is somehow affected by allocation principles there is also an incentive to pick the allocation scheme which minimizes tax payments. This is apparent in previous research for instance in relation to charity organizations where tax exemptions are relatively commonplace, and where the size of those exemptions are partly driven by joint cost allocation choices (Jones and Roberts, 2006). The intersection of cogeneration and taxation has been analyzed in several studies. For instance, Olsen and Munksgaard (1998) study the competiveness of CHP under different tax regimes, and analyze the contract zone (the set of possible cost allocation schemes that allow the CHP to compete against technologies where heat and electricity are produced separately) for three different CHP technologies. The researchers find that most CHP technologies are profitable even without taxes, and that energy taxes generally increase the contract zone. In their study on marginal costs in DH production Sjödin and Henning (2004) note heat is heavier taxed than electricity at the production stage. To the degree a producer can chose allocation method he would, under such a tax scheme, opt for assigning as much fuel costs to electricity as possible. However, the researchers also note that in the Swedish tax system allocation has been done proportional to heat and electricity production and that this allocation method attributes a relatively large share of total costs to the DH production due to the assumption of equal efficiency between heat and electricity.

Under a regulatory threat the intersection of financial reporting and pricing makes joint cost allocation a driver of firm value. Decreasing cost industries are often natural monopolies, and to ensure socially optimal outcomes pricing in such industries is often subject to some form of regulatory scrutiny. Often such regulation is cost-based. The determination and reporting of costs for business segments then becomes necessary, and allocation of joint costs will have consequences for companies' value creation. As already described in the introduction price regulation in the DH industry is in Sweden debated and regulation is advocated by many, including the Energy Markets Inspectorate and the Competition Authority.

Allocation methods

In an early article on the topic, Avery (1951) distinguishes between accounting for by-products and accounting for joint products. When accounting for by-products he proposes three alternatives. First, one could allocate all costs to the primary product and then use the sales from the by-product to reduce overhead expenses otherwise put on the manufacturing process. Second, one could treat the net income (sales minus selling expenses) from the by-product as a deduction to the total cost of the principal product. The third proposal is almost identical to the second, but in this case also includes costs for further processing after the split-off point when calculating the net income of the by-product. In the case of joint cost allocation, allocations by (1) volume/weight, (2) sales/value or (3) basically any arbitrary rule are identified. The alternatives in Avery (ibid.) are the ones commonly found in textbooks in management accounting (e.g. Drury, 1996). Of course, the arbitrariness in all of these approaches (already in determining whether it should be considered a by-product or joint product, where Avery (1951:233) makes reference to a ten percent rule), and Avery himself also concludes that the allocation problem *per se* is insolvable. This conclusion is in coherence with the call of Thomas (1975) to abolish allocation reporting.

The distinction between main product and by-product in Avery (1951) echoes a governmental investigation on separation of DH and electricity markets (SOU 2003:115), which argues that from a business perspective DH is to be considered a main product and electricity a by-product[8]. To regard DH as a main product and electricity as by-product, and therefore to allocate all costs to the DH operations and subtract electricity revenues as a "negative cost" is equivalent as to say that no part of the company's profits are to be attributed to the electricity production. This would push a possible price cap on heating downwards as DH costs are subsidized by power sales. Whether this investigation in turn reflects an already established practice in the DH industry or some other influence (e.g. literature) remains an open question. The usage of such a rule would on the one hand contradict the rationality assumption as electricity would subsidize district heating. On the other hand, it could be perfectly rational for politicians to let electricity subsidize heating.

The allocations Avery (1951) proposed for joint production is also used in relation to CHP. In particular, the *energy method* stipulates that joint costs in CHP are allocated proportionally to the energy content in the DH production and the electricity production respectively. For example, this method is used by Statistics Sweden (2012) when allocating fuel use between DH and electricity. A modified version of this method is the *exergy method* (Valero, 2006), in which the quality of bifurcated flows are taken into consideration. With exergy accounting a larger fraction of joint costs are allocated to electricity compared with when using energy accounting. A comparative analysis of energy- and exergy accounting is found in Nilsson (2007). Allocation proportional to sales, or economic value, between electricity and DH is rare, but has been touched upon by Gode et al. (2011) in relation to CHP plants based on waste incineration.

Despite the call for reporting free from cost allocation (Thomas, 1975) researchers continue to study allocation. Moriarity (1975:791) states that he does not want to argue any theoretical justification for his proposed model; instead he *"assumes that accountants will continue to be required to allocate cost for reporting purposes"* and that his proposition is *"justified to the extent that the results of* [his model does] *not possess the disadvantages of the allocation techniques of employed in current practice"*. In Moriarity's alternative production model (*ibid.*), joint costs are allocated proportionally to what the individual product's cost share would be in a portfolio where all products are instead obtained independently. One disadvantage with Moriarity's model is pointed out by Hamlen et al (1977), however, as they show that the model may result in suboptimal coalitions. But in response to the critique of Hamlen et al., Gangolly (1981) shows that the alternative production model can be outside the core only when there are three or more cost centers as well as non-increasing marginal costs.

Moriarity's model has gained importance in relation to CHP production (though reference is seldom made to him). This is essentially the same principle as the one used for preparation of Environmental Product Declarations (EPD) for electricity and heating when jointly produced (IEC, 2007) This principle is also mirrored in the CHP Directive (EC2004/8) when it is determined whether a CHP plant is to be considered highly efficient. In Sweden, this principle is also the foundation for the recently agreed upon method for allocating environmental impact of CHP plants between electricity and heating (SDHA, 2012). Moreover, the critique of Hamlen et al. (1977) is not very relevant in the case of cogeneration. Here, we look at the joint production of two products,

[8] It should be noted that the investigation does not make any recommendations concerning the design of accounting standards for the separation of DH and power production, although it explicitly states that such are needed.

district heating and electricity. However, in a nearby future we will see an increased production complexity as many DH companies are considering investing in bioenergy combines, in which some bioenergy product (e.g. ethanol, biogas or pellets) is coproduced with district heating and electricity (Axelsson et al., 2010).

Lastly, it could be argued that if a company adds a new product to its operations, and where the new product is jointly produced with an existent product the cost that should be assigned to the new product this the incremental cost from adding the new product to the portfolio. In this view it should not be the case that the new product subsidies the old product. In a cogeneration perspective this could be important. In Sweden CHP producers have historically regarded themselves DH suppliers first and foremost. Only at a later stage was electricity added to the production. Therefore, to break out electricity from this perspective one only excludes the identifiable incremental costs for electricity production, and electricity revenues are not included in the DH business segment. Of the approaches presented here, this is the one that probably favors the producer the most, almost all cost are assigned the DH segment but no part of the electricity revenues.

In addition to the abovementioned allocation schemes various game theoretic models are suggested for the allocation of joint costs (Shapley, 1953; Shubick, 1962; Schmeidler, 1969; Gangolly, 1981; Hamlen et al., 1977; Jensen, 1977; Billera, et al., 1978, 1981; Roth and Verrecchia, 1979; Hamlen et al., 1980; Balachandran and Ramakrishnan, 1981; Tijs and Driessen, 1986). The one that perhaps has gained the most academic attention is the usage of Shapley values (Shapley, 1953) as applied to cost allocation (Shubick, 1962). Here, each division pays a charge equal to the expected marginal cost (expected as the order of entering is unknown) that arises when entering. Although these game theoretic approaches provide with valuable insights into the potential problems of joint cost allocations, they are probably of minor importance in our empirical quest to understand how Swedish CHP producers allocate costs and why they do so. Would it not have been for studies such as Billera et al (1978) or Anadalingam and Nam (1997), I would have guessed that these models never left the academic den and been exposed to the light of reality. Nevertheless, I still find it implausible that we would find such methods when looking into the companies in our study; the prime reason for that would be that they probably do not know about them, nor would they find it easy to motivate the computational effort required had they known about them. But yet again, this needs to be corroborated empirically, and it could be the case that we will have reason to return to these approaches.

Research design

Our research design consists of two parts. First, we investigate how energy companies allocate joint costs through an extensive interview study. Second, by making an in-depth case study on a CHP producing company we analyze to what degree the choice of allocation method matters for reported segment profitability.

Interviews

All the companies in our study are located in Sweden, and produce district heating and electricity in CHP plants. These companies were identified in cooperation with the Swedish District Heating Association as they have already collected statistics on electricity and district heating production in member companies. The association provided with contact details for the persons responsible for CHP operations in the firms. We sent out an e-mail to these persons with the industry association as consignor, where we asked them to participate in interviews and

notified that we were to telephone them. The positions of the respondents vary. In some companies the respondent is the managing director, in others it is the head of operations or someone that is specifically responsible for the CHP plant in the company. Common for all these persons was that their names have been put there by the companies themselves as persons to contact regarding issues on cogeneration. In some cases we were, in response to our e-mail, immediately redirected to other employees, and this was also the case sometimes when we telephoned. For instance, for some companies we ended up talking with the financial manager of the company, and for a few companies we conducted two interviews with different persons as our questions covered areas that sometimes were organizationally separated. Hence, our interviews have not been directed to persons with a specific title. Instead, considerable effort has been spent in finding the person who is best apt to answer our questions.

In total, we interviewed 35 persons in 33 companies, recorded the interviews, and later summarized and analyzed them. The interviews are semi-structured, i.e. we have a battery of questions that we want to cover but there is room for discussion and elaboration. Mostly, each interview lasted between about 30 and 60 minutes, but in some case it was considerable longer. Moreover, the interviews were recorded and later summarized and analyzed. This is an important measure, as we as interviewers then can analyze the interviews as non-participants. When doing so, we realized on several occasions that the respondent's answer to a question was in fact something other than we had understood while we were interviewing. It also occurred that we in the subsequent analyses realized that respondents were giving us valuable insights into what problems they experience, and that we had not taken notice of this during the interview as we were eager to "ask the next question". In sum, the recording and summarizing of interviews are important tools to raise validity.

Each interview commenced with the respondent presenting him-/herself, the company and the CHP operations. This provides with an immediate understanding of the respondent's knowledge (from the description of work tasks and how long they have been in the company), as well as the relative importance of CHP production. The presentation was then followed by the actual interview, which in our initial battery of questions (see Appendix A) revolved around how joint costs are allocated in relation to external reporting, environmental reporting, pricing, investment decisions, operative decisions, and also how they have allocated in the past and whether they plan any changes in allocation principles. When possible we ask for actual examples to illustrate the point the respondent wants to make. Each interview is ended with the question if the respondent can think of any aspect of joint cost allocation that has not been covered in the interview and that could be of importance in any business matter.

The exact questions, and the framing of them, were slightly modified over the course. Earlier interviews revealed knowledge gaps of ours as well as interesting questions that we had not taken into consideration initially. These insights were therefore incorporated in later interviews. For example, in the first interviews we connected the issue of how joint costs are allocated to the reporting requirements of the Energy Market's Inspectorate. Soon we realized that the law is written in such a way that it is easily interpreted that reporting of CHP is to be done in a certain manner (all cogeneration costs are reported and electricity revenues from cogeneration is included as well). We therefore generalized the first question so that we asked whether they allocated joint cost in any context. In a similar fashion, questions we have included in the beginning turned out to be quite unproblematic

or difficult to research from a practical perspective. For example, we had prepared questions on the history of how allocation schemes are adopted. Initially, we suspected that companies might have allocated in a certain manner in the past but that these allocation schemes (with the surging debate on DH prices and call for regulation) later have been changed or that such a change was anticipated in the near future. Instead, we soon found that this issue was totally unproblematic for most respondents ("we have never discussed it, and have always done it this way"), and that it is even difficult to state when an allocation scheme was implemented, or by whom. Our development in understanding the problem matter therefore influences how we ask questions over time and perhaps also, to some degree, changes the focus of the research problem itself.

The interviews are thereafter analyzed through the lenses of for what purposes companies allocate joint costs as well as how they allocate joint costs, and what consequences that may follow from these choices. Accordingly, we try to establish how companies allocate in relation to internal decision making, financial reporting, pricing, environmental reporting and taxation. With *the purpose of decision making* we refer to how companies allocate joint costs in order to evaluate their economic performance over business segments, and how they compile and analyze information in relation to investment and operative decisions. We would argue that this closely reflects how company representatives also regard the nature of their own business operations. This includes the assessment of economic performance, investment decisions, and management accounting.

Case study

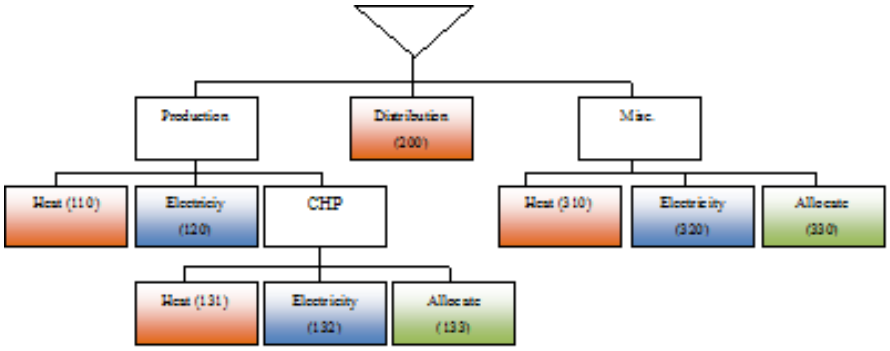
In order to evaluate possible effects of different joint cost allocation methods, we carry out a case study of the energy company Kalmar Energi AB (hereafter KEAB). KEAB is mutually owned by the municipality of Kalmar and the multinational utility company E.On. With net sales of SEK 221 Million in 2011, KEAB ranks 18 out of the 50 companies with CHP plants that reported their income statements for the DH business segment to the Swedish Energy Markets Inspectorate. Formerly being entirely dependent on a wood burned heat plant in the town centre, in 2009 they completed a SEK 1.2 Billion bio-fuel CHP investment. Following the inauguration in end 2009 the CHP plant stands for the bulk of the company's heat and electricity production. In 2011 (2010) the company's total heat production amounted to 406 (473) GWh, of which 359 (384) GWh were produced in the CHP plant together with 132 (136) GWh of electricity. KEAB also get revenues from district cooling, wood fuel services, electricity grid fees and electricity sales, as well as wind and solar power. One of the concerns that underlie this study is the risk of future underinvestment in cogeneration if allocation is too strict. That is why we consider KEAB to be a suitable study object; it is a middle size company and they have just put their CHP plant into operation – therefore, using this company as a study object may serve the needs for other companies that are similar in terms of size and new or projected CHP investments.

Our point of departure are the reports handed in to the energy market inspectorate, in which revenues and costs, as well as balance sheet items are reported for the DH business segment in particular. Accordingly, revenues and costs from district cooling, wood fuel services, electricity grid fees and electricity sales, and power production outside the CHP plant are not reported. Nor are these items included in our analysis. In the reporting to the Energy Market's Inspectorate KEAB have not made any allocation of costs. All costs associated with CHP operations are included in the DH business segment and the revenues from the electricity produced in the plant are included as revenues in the same report. Our task is to artificially construct two separate business segments

from this report: DH and electricity. Specifically, in close collaboration with the financial manager as well as two development engineers of KEAB we determine from the company's chart of accounts (at a fine grain level) what items should be allocated to either business segment.

Revenues are straightforward to allocate between business segments. Revenues from electricity production and green certificates are allocated to the electricity segment. Revenues from heat sales and connection fees are allocated to the DH segment. In addition, there are some minor items (e.g, services and activated work) which in our analysis are allocated to the DH business segment. Costs are re-categorized into one of the following categories: production, distribution or miscellaneous (see Figure 1). Production costs are associated with the heat plant and the CHP plant respectively, where the former are fully attributed to the DH business segment whereas CHP related costs are further divided into one of three sub-categories. First, CHP related costs could be directly attributable to an electricity business segment (e.g. turbine, generator and switchgear). Second, costs could be defined as strictly related to the DH business segment (e.g. flue gas condensation). The remaining CHP costs are allocated between the two segments. Distribution costs are costs directly associated with the distribution of district heating and thereby belong to the DH business segment. Miscellaneous costs include for instance sales costs and overheads. These costs are further divided in sub-categories in the same fashion as for CHP related costs. The units of analysis that are actually used are also codified with numerical values so that aggregation is made easy.

Figure 1 Cost categories



As a reference point we first present the original form, in which no allocation is done, but where costs are re-categorized to be compatible with our analysis. This is the base case. Second, joint costs are allocated following a main product/by-product methodology. That is, all costs are allocated to the DH business segment, and revenues from electricity production are subtracted from total costs. Next, costs are allocated proportional to sales (allocation proportional to economic value), followed by an allocation where joint costs are allocated proportional to production volume (energy method). In particular, joint costs from cogeneration are allocated proportional to the CHP production, but other joint costs (sorted under "miscellaneous") are allocated proportional to the total production (i.e. the heat load is based on the CHP plant as well as the heat plant). The fifth model we analyze is the alternative production model, which is used by the DH industry today for allocating environmental impact in CHP production between electricity and DH. Lastly, we use a method of marginal production. In this model all costs, save costs that are directly attributable to the electricity segment (again, turbine, generator, etc.), are allocated to the DH business segment. But none of the electricity related revenues

are included. Obviously, this latter method is the method that makes DH appears the least attractive from a profitability perspective.

Results

How are joint costs allocated?

We find that there are a number of different joint cost allocation schemes in use in Swedish CHP producing companies. But this variation is not primarily seen *between* companies; rather the variation is found *within* companies. What stands out is that the way joint costs are allocated depends largely on for what purpose they are allocated, and therefore one rarely sees in a company a unified approach in relation to cost allocation. From the results we can distinguish between at least five different purposes for which joint costs are allocated (or better yet, not allocated). These purposes we denote decision making, external reporting, pricing, tax planning, and environmental reporting.

Financial reporting and decision making

For purposes of internal decision making and financial reporting the ways of allocating coincides for almost all respondents. Therefore we present our findings for these two aspects jointly (see Figure 2). We find that the most common way to allocate costs between heat and electricity is actually to not allocate them at all, in three quarters of the companies included in our study this was the case. The revenues from sales of electricity and certificates are simply inserted as revenues from the heating business operation. This is also reflected in the mandatory reporting for the DH business segment required by the Energy Market Inspectorate, in which it is stipulated that revenues from electricity production in CHP plants should be reported separately and that costs from the same plants are included in full. The majority of the respondents explicitly state that they see this as a unified production process (it is the very point with it) and that any separation between the two does not make sense. Even though the absence of allocation is the most common approach for this purpose, the alternative approaches offer interesting perspectives.

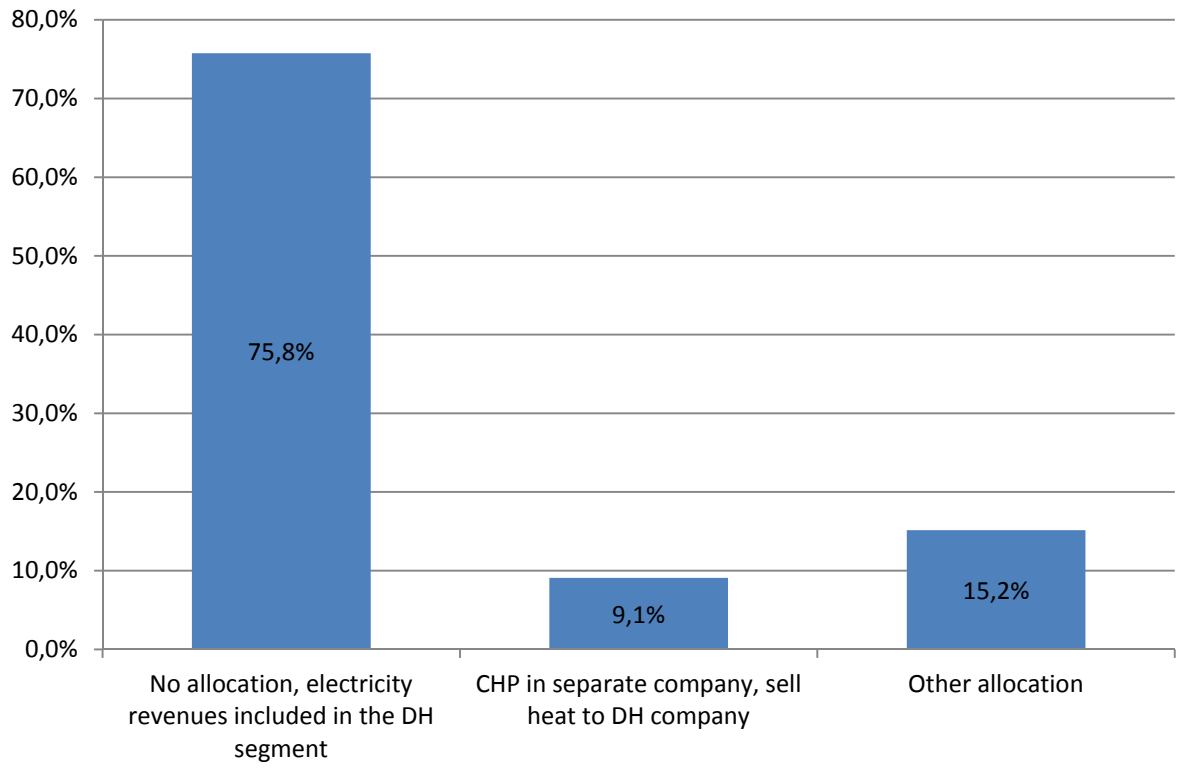


Figure 2 Joint cost allocation for purposes of decision making

Three out of the 33 companies included in our study have chosen to separate the CHP production from the DH business segment by putting it in a production company of its own. Implicitly, the production company produces electricity and then sells heat to a distribution company that is part of the same business group. There are different reasons that motivate such an organization of operations. First, this type of organizing is partly a response to the recent debate on third party access to the DH distribution system. Analog to the design of the electricity market, where production and distribution are separated, it has been proposed that the DH distribution system should be separated from the production so that other heat producers would be able to sell heat directly to end users. To meet this possible future state, a few companies have chosen to put production and distribution in different companies. Second, one company representative explained how one driving force has been tax planning. This company also have wind power production, and by placing the CHP production in a separate company, it was possible to utilize the electricity tax discount that is allowed if you produce wind power for own use in the DH segment. Third, an organizational separation could be motivated if there are additional complexities associated with the production. It could be that additional products (e.g. bioenergy combines or steam) are intertwined in the same production process, and/or that there are inter-organizational ties through production or ownership which calls for a separation of the two segments. The production company then becomes somewhat a nexus in tying together functions and interests.

A key question to address in this setting is how to determine the (transfer) prices which the production company charges the distribution company. The three companies in our study that have placed CHP production in a separate company have addressed this issue differently. For instance, one company has determined that the production company should meet some level of return on capital, and determine heat prices to the distribution

company on a cost-plus basis. Another company has a more advanced pricing construction. Heat prices to the DH company is determined based on alternative costs. The person we interviewed in this company argues that they can estimate with high precision what it would have cost to produce the same heat load in a separate heat plant, as they have another heat plant in use in the system, and that they know what the investment outlay would have been for a heat plant which can be compared with what they spent for the CHP plant. Moreover, this same company produces a bio-product which is partly used in the internal production. This bio-fuel is priced in the same way as when it is sold to external customers, and thereby cross-subsidization is avoided.

The remaining companies do not organize their business segments in separate legal entities, but they do however allocate CHP costs for internal decision making. These companies typically base their allocation on the energy method, i.e. costs are allocated proportionally to the produced quantities of each product. But not all of these companies allocate between heat and electricity. There are also examples where it is instead a third product, steam, which is broken out from the rest of the production.

In terms of decision making more specifically, we tried to find out whether these allocation choices might have any effect on investment appraisals and operative system optimization. With a few minor exceptions, we find that they do not. In relation to investment appraisal we mainly considered investments in production capacity and the connection of new costumers. It was clear that allocation has not been an item when investing in new capacity. Instead, investment appraisals were based on whole-system analysis where all incremental economic effects are taken into consideration. In relation to connecting new customers we suspected that allocation choices would influence the cost estimates being used for investment appraisals. Depending on allocation methodology that could lead to that the additional electricity sales that follows from the increased heat load would be excluded from the analysis. If so, the value added from connecting new customers would be slightly underestimated with the risk of underinvestment. Even though there were some companies that did not take into consideration the increase in electricity sales, most companies did. Either by making a whole-system analysis (e.g. by using the MARTES tool (see Sjödin and Henning, 2004)) or by adding estimated additional electricity sales to the cost-/benefit analysis. Moreover, the majority of the companies that did not take into account any effects from further electricity sales did so for a good reason. The effects were often non-existent or small, due to capacity constraints. These constraints often follow from the fact that the CHP plants are base-load production units or that they are waste incinerated, which implies that they are already working at full capacity.

Regarding the relation between joint cost allocation and operative decisions the separation between the two was complete. It was apparent how nearly all respondents were optimizing their systems in the short-term in a microeconomics text-book fashion. All that matters in the daily operations are how marginal revenues and marginal costs affect the system as a whole. The heat load is a constraint that has to be met and, to the degree it makes sense to alter the electricity output, prices on electricity and green certificates are set against marginal production cost (mainly current fuel prices). That means that in utilities with waste incineration where you are getting paid for the fuel you use it is always the best option to produce as much electricity as possible. The same parameters also determine what production units that will be put in operation. In a way one could perhaps say that there is an allocation method that is used indirectly, namely the main product/by-product approach. By deducting the revenues from electricity sales for a specific plant you can obtain a marginal heat production cost

which can be compared with other plants within the system in order to determine what order plant should be used, but the same result could be achieved by other means so we are somewhat hesitant we should call it a joint cost allocation in the sense that we have treated the term in this paper.

Pricing

For *pricing purposes* an overwhelming majority of DH companies use cost based pricing (Figure 3), only two of the firms (six percent) we interviewed does not use cost based pricing. This mean that estimated costs are first determined and then DH prices are set in order to cover these costs and meet some rate of return – but not more even if that would have added firm value. From profit maximizing competitive firms such behavior is unexpected. Instead, all else equal, one would expect that firms would charge as much as possible taking into consideration its competitors. The reason that we do not find this for the firms in our sample is simple. These are not profit maximizing firms. Rather, these are municipality owned firms acting under a multiple objective regime mandated by politicians, rather than under a single objective value maximization criterion. Returns are not maximized, they are satisfied. Instead, municipal DH firms are expected to meet additional goals such as contributing to the fulfillment of municipal environmental goals and to provide with cheap energy. The latter objective, in particular, is key for understanding the adoption of cost based pricing instead of charging market prices.

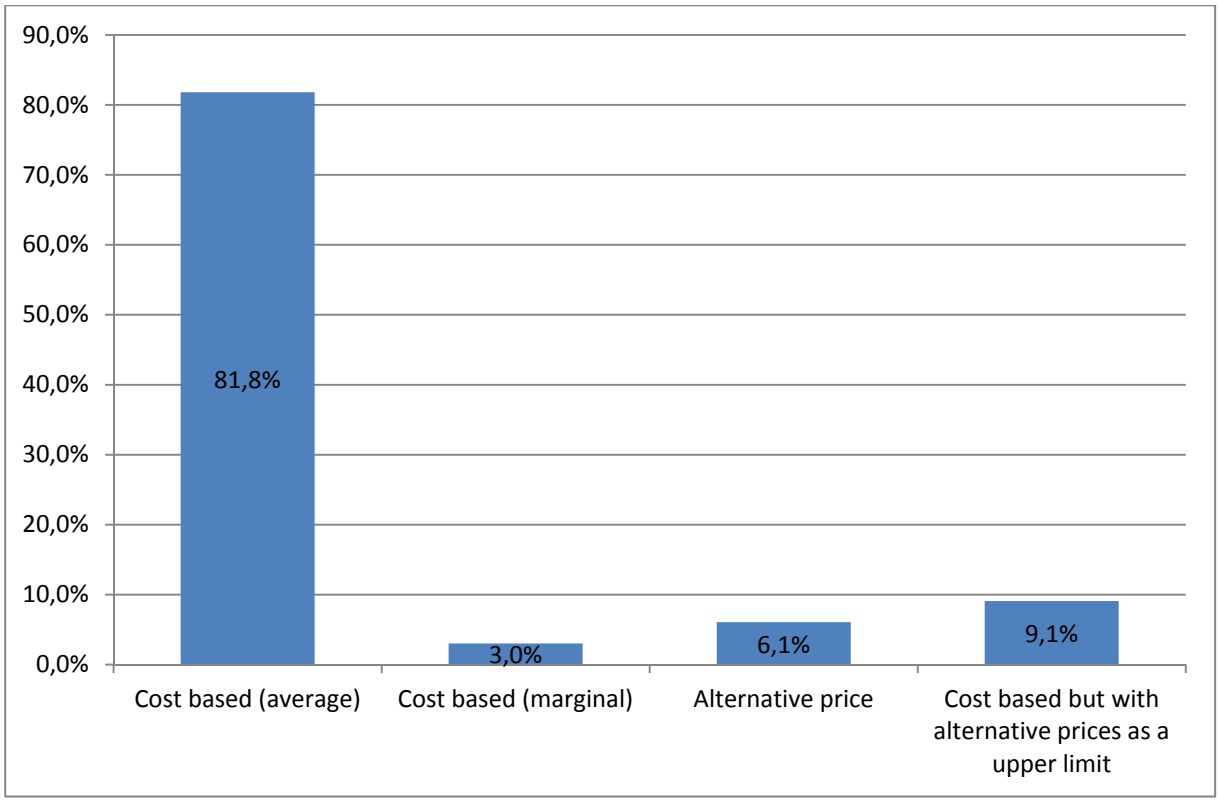


Figure 3 Pricing of DH in CHP producing firms

Regarding cost allocation in relation to pricing, DH customers typically get the full benefit from electricity production. This is ensured either through a main product/by-product approach or indirectly through the

budgetary process. The two approaches are equivalent in outcome. Both approaches imply that *average* costs are used for determining price per energy unit. Only one respondent states that they use marginal cost pricing. Therefore, not only does the mark-up pricing serve DH customers, they are also subsidized by the revenues that follow from the electricity production.

In relation to cost allocation in firms with mark-up pricing it is noteworthy that the companies that have gone the furthest in mimicking competitive forces in search for firm efficiency, and that have the most elaborated policy schemes for tax optimization, asset valuation and transfer pricing, *also* pass over the benefits from the electricity sales to the heat customers. Even in the business groups that have singled out production and distribution into separate companies, and argue that CHP is first and foremost an electricity utility where DH is a residual product which is sold at "market" rates to its sibling company, fully subsidize heat customers.

The other way to go about is to use alternative pricing instead of cost based pricing. With this approach, DH pricing is not contingent on production costs. Instead, the customers' feasible alternatives (typically heat pumps) determine how much that can be charged. Therefore, setting DH prices is about being only slightly cheaper than competitors. Only two firms state that they use alternative prices, and that prices are entirely unrelated to the costs of the firm. Unsurprisingly, the two firms that adopt this pricing strategy are the companies without municipal ownership. Obviously, decoupling costs and pricing makes cost allocation redundant, so for these firms no allocation is made for pricing purposes.

Note however that in addition almost a tenth (three firms) of the companies make a point that they do look at alternative prices. But in these cases the alternative prices form the upper price limit. That means that pricing is cost based in principle, but if average costs are higher than the prices of alternative heat sources these firms will not reach cost coverage. For these firms this was not a theoretical issue, to various degrees they experienced, or had experienced, difficulties in covering costs while at the same time adapting to upper price constraints. In essence, they eroded firm value.

Environmental reporting

Historically, the firms we have interviewed have to various degrees engaged in environmental reporting, from the minimum requirements stipulated by law to more elaborated and voluntary disclosure of the firm's environmental impact. Recently, however, the Swedish District Heating Organization on the one hand, and a number of customer organizations as well as the Swedish Energy Association on the other hand, have agreed upon principles for reporting the environmental impact of DH. In these agreements the environmental values of CHP plants are determined based on the agreed upon alternative production methodology. In practice, data on fuels and energy production is now sent to the Swedish District Heating Association and then environmental values are calculated centrally and made publicly available at their webpage. In this reporting the allocation of environmental impact (pollutants and natural resource usage) in cogeneration is included and disclosed.

It is also clear from the interviews that the link between how environmental impact is disclosed in relation to CHP production and how costs are allocated in other contexts (financial reporting, decision making, pricing) is non-existent. In fact, in several cases the persons we interviewed (in charge of e.g. operations or finance) were not aware of how the firm reported the environmental impact of their CHP production. I most cases, however,

the respondents were aware of the principles for environmental reporting but still no one had also considered to use the alternative production method (or the method they have used previously when applicable) to allocate joint costs.

We find that the lack of coherence between allocation in environmental reporting and allocation for other purposes is due to two main reasons. First, it has simply not been an issue. This could be because they did not know about the allocation principles in the environmental reporting framework, or simply because they had not considered the possibility that environmental impact could be considered a cost (though external) and that the same method could be used for also allocating other costs. Second, they disagree. Some of the respondents we interview expressed disappointment over the agreed upon principles for allocating environmental impact in CHP plants. Partly this is due to different views on what the marginal environmental effects should be, but there is also an explicit concern that these principles will be used in a future harmonization of reporting standards across societal sectors. In one word, if this would become the standard allocation principle also for taxation purposes this would negatively affect some CHP companies. The fact that the industry association has agreed upon the alternative production method in relation to environmental reporting could be regarded a legitimization of the allocation method itself which would increase the probability that it will be used for other purposes. If you accept this principle when allocating pollution, why should you not also accept it when it comes to cost calculation for tax purposes?

Taxation

Taxation is probably the prime reason to why cost allocation matters today, as the choice of allocation method drives the effective tax rate. Most importantly, fossil fuel taxes are levied on heat production but not on electricity production. Instead, consumers pay consumption tax on electricity. Therefore, the allocation of costs in cogeneration between heat and electricity has real value consequences. The companies with fossil fuel based production that we interview typically allocate cost iin accordance with the energy model. That is, joint costs are allocated proportionally to energy produced. In this model 1 MWh oh heat is considered as equivalent to 1 MWh of electricity and where no consideration to exergy is taken.

However, there are signs that CHP producers increasingly argue that CHP plants should be seen as electricity utilities first and foremost, and that DH is a residual product. With this view the bulk of the costs should be allocated to the electricity business segment and only incremental costs to the DH business segment. One respondent goes further and questions taxation on DH production altogether:

> *"Why should we be taxed for making use of excess energy, while at the same time nuclear power operators cool of excess heat into the ocean for free?"*
>
> (Interview with a DH director)

What this respondent claims is that their CHP plant is a power plant, and moreover with greater efficiency than the nuclear power plants, and that they are getting financially punished for reducing overall environmental

impact[9]. On the margin there is a tax incentive not to make use of residual energy which obviously goes against goals on increased energy efficiency.

This later approach, to regard CHP plants as electricity utilities has also led some companies to already adopt allocation principles that treat heat as a residual product, and where only incremental costs are allocated to the heat – this in order to minimize fuel taxes. One respondent describes how another company has been successful in making this argument vis-à-vis the Swedish Tax Authority, whereas they themselves have been denied the opportunity to use the same allocation method. This shows two things. First, CHP producers paying production taxes are likely to argue more forcefully that they should be regarded as power plants. Second, there seems to be a certain degree of arbitrariness in the decisions of the tax authority, which means that companies are treated differently on an issue that has direct value consequences.

Other taxes influence allocation choices as well. For instance, one company has chosen to organize their cogeneration in a separate company, partly because that allows them to make tax deductions for their wind power production. In Sweden an electricity consumer can deduct the electricity tax for electricity that he produces himself in windmills. This is one partial explanation to why we see that the total wind power capacity has a much more dispersed market structure than what is traditionally found in the electricity market. From this perspective it makes sense for a Swedish CHP producer that also has wind power in the portfolio to place the cogeneration in a separate company and the windmills in the DH company, as the tax deduction can be done for heat production but not for electricity production. Other consequences from taxes and economic policy instruments that are affected by allocation choices include for example the treatment of auxiliary power and also the number of emissions rights that are granted within the EU-ETS.

Summary

It is clear from our interviews that there is a fairly great variation in how joint costs are allocated. This variation, however, is not primarily found *between* firms. Instead we find the variation *within* firms. What is clear is that what is determining how costs are allocated is for what purpose the allocation is done. Actually, there is little variation between firms, as most of them tend to allocate in similar ways when taking into consideration for what purpose they allocate.

Having identified what allocation schemes that are used, and for what purposes they are used we can illustrate how schemes and purposes are related by placing them in a simple matrix (Table 1). The allocation schemes used are no allocation, a main/by-product allocation, alternative production allocation and a marginal production allocation. The purposes for which we allocate we call decision making, financial reporting, pricing, environmental reporting and taxation.

We find that, with some exceptions, that for purposes of decision making and financial reporting joint costs are typically not allocated at all. Executives do see this as an integrated business operation where separation between the two does not make much sense. For pricing purposes, on the other hand, the picture is different. Here, a

[9] If a reflection is allowed here, perhaps one could argue that the nuclear operators do not make money on the heat energy that is transmitted to the ocean whereas the CHP producers obtain revenues from their heat utilization. But that argument is somewhat less convincing when considering that additional revenues will be subject to ordinary corporate taxation.

strong tradition of identifying oneself as DH companies, in combination with a vivid political ambition to hold down local energy prices, has led to an allocation philosophy where DH is seen as a main product and electricity a by-product, and where the revenues from the latter is used to subsidize heating customers. This is in stark contrast to the view that DH companies in general use their market power to gain monopoly profits. Only two companies of the ones we interviewed use market (or alternative) pricing, and therefore they do not allocate costs for this purpose. For purposes of environmental reporting there is now an industry standard, and the alternative production method is used. For taxation purposes, finally, one typically uses the energy method but we also see that there is a tendency to the increased usage of a marginal production approach, i.e. that only the incremental costs are allocated to the heat business segment.

An result that might follow from this multitude of purposes and allocation schemes is that it might create some interesting internal conflicts, especially if there will be a political ambition to harmonize the principles of allocation as well as to put DH pricing under some form of cost based regulatory regime. Then CHP producers could face a situation where they want to allocate as much costs to the electricity segment as possible for tax purposes, as much costs as possible to the heating segment due to regulatory constraints, and where they themselves have provided legitimacy for an alternative production method in relation to environmental reporting.

Table 1 Allocation of joint costs with respect to the intended purpose.

	No allocation	Main product/ By-product	Alternative production	Energy method	Marginal production
Decision making	X				
Financial reporting	X				
Pricing	(x)	x			
Environmental reporting			X		
Taxation				x	x

However, the regulatory threat from an allocation perspective has substantially diminished in Sweden. A coming price regulation will most likely be decoupled from the cost structure of the company as it will encompass the changes in DH prices, and not the profits of the companies. But the possible conflict between tax minimization and maximizing the scope for raising prices should still be of interest for CHP producers in other parts of the world if ever cost-plus price regulation in the DH market would be considered.

To what degree does the allocation choice influence segment profitability in a CHP producing company?
From our case study we analyze the consequences for reported business segment profitability that follows from the choice of allocation method. Accordingly, in Table 2 we show the results for what the reported segment

probability would have been for the years 2010 and 2011 contingent on what method you should apply. In the first column we report the base case, which means that no allocation is done at all. This is also in the way that KEAB actually reports their operations to the Energy Market's Inspectorate. In 2011 KEAB had total revenues of MSEK 334, of which MSEK 115 derived from electricity production. The same year total costs amounted to MSEK 273 leaving an EBIT of MSEK 61 and a profit margin of 18 percent.

In the second column the results are given for the case in which we instead allocate costs according to a main product/by-product method, i.e. all costs are allocated to the DH segment whereas electricity revenues instead are treated as a negative cost. It follows trivially that as you reduce revenues and costs with the same amount EBIT will remain unchanged while the profit margin (i.e. EBIT over sales) will increase as the denominator is deflated. With this method KEAB would have shown in 2011 an EBIT of MSEK 61 and a profit margin of 28 percent – an increase by ten percentage points.

Next we show, in the third column, we show the consequences from allocating joint costs proportionally to sales (the economic value), the only method included in this analysis that no one seems to use among the companies we interview. With this method would have been perceives as doing much worse. The 2011 EBIT would have halted at MSEK 24 and the profit margin at 11 percent – a decrease by more than 40 percent compared to the base case. Allocating in proportion to production (column four) would yield even worse results – an EBIT of only six percent and a profit margin of less than three percent.

In the fifth column we present the results from using the alternative production method. Here the allocation factor is given by the environmental reporting disclosed at the webpage of the Swedish District Heating Association. In 2011 the electricity share with this allocation method was 55 percent and in 2010 it was 48 percent. With this method the calculated EBIT (MSEK 65) and profit margin (30 percent) are higher than for any other method analyzed herein. That is, under a cost-based price regulation, and for this company, the alternative production method would render the strictest pricing constraints.

I the last column we present the results from when applying a marginal production method to our case. In this case, practically all costs are assigned to the DH business segment, only the incremental costs directly associated with the electricity production are allocated to the electricity segment. Nor does the DH segment benefit from the electricity revenues. Obviously, this is the model that makes the DH segment look the worst. In our case it lead to negative results with an EBIR amounting to MSEK -57 and a profit margin of -25 percent.

Table 2 Reported segment profitability as a result of allocation choice (MSEK)

He CHP plant

	Base case		Main-/By-product		Prop. to revenues		Prop. to production		Alternative prod.		Marginal prod.	
	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010
REVENUES	**334 507**	**353 184**	**219 064**	**235 488**	**219 064**	**235 488**	**219 064**	**235 488**	**219 064**	**235 488**	**219 064**	**235 488**
Heat (incl connection fees)	214 869	233 504	214 869	233 504	214 869	233 504	214 869	233 504	214 869	233 504	214 869	233 504
Electricity (incl green certificates)	115 443	117 696										
Other (incl. activated work)	4 195	1 984	4 195	1 984	4 195	1 984	4 195	1 984	4 195	1 984	4 195	1 984
COSTS	**-273 485**	**-294 578**	**-158 042**	**-176 882**	**-195 796**	**-196 722**	**-213 254**	**-211 912**	**-154 685**	**-165 631**	**-273 114**	**-294 240**
FUEL	**-130 905**	**-149 605**	**-130 905**	**-149 605**	**-92 778**	**-110 501**	**-101 204**	**-118 915**	**-70 142**	**-93 280**	**-130 905**	**-149 605**
Heat	-20 427	-32 261	-20 427	-32 261	-20 427	-32 261	-20 427	-32 261	-20 427	-32 261	-20 427	-32 261
CHP	-110 478	-117 344	-110 478	-117 344	-72 350	-78 240	-80 777	-86 654	-49 715	-61 019	-110 478	-117 344
EXPENSES	**-134 457**	**-138 602**	**-134 457**	**-138 602**	**-96 055**	**-80 206**	**-104 830**	**-86 906**	**-78 268**	**-66 494**	**-134 086**	**-138 264**
Production	-107 309	-111 681	-107 309	-111 681	-74 335	-80 206	-81 540	-86 906	-54 979	-66 494	-106 938	-111 343
Heat	-10 045	-16 065	-10 045	-16 065	-10 045	-16 065	-10 045	-16 065	-10 045	-16 065	-10 045	-16 065
CHP	-97 264	-95 616	-97 264	-95 616								
Heat	-2 421	-1 843			-2 421	-1 843	-2 421	-1 843	-2 421	-1 843	-2 421	-1 843
Electricity	-371	-338										
To allocate	-94 472	-93 435			-61 868	-62 298	-69 074	-68 998	-42 512	-48 586	-94 472	-93 435
Distribution	-4 932	-5 459	-4 932	-5 459	-4 932	-5 459	-4 932	-5 459	-4 932	-5 459	-4 932	-5 459
Miscellaneous	-22 216	-21 462	-22 216	-21 462	-16 788	-15 991	-18 357	-17 796	-18 357	-12 751	-22 216	-21 462
Heat	-6 490	-5 045			-6 490	-5 045	-6 490	-5 045	-6 490	0	-6 490	-5 045
Electricity	0	0									0	0
To allocate	-15 726	-16 417			-10 299	-10 946	-11 868	-12 751	-11 868	-12 751	-15 726	-16 417
DEPRECIATION	**-8 123**	**-6 371**	**-8 123**	**-6 371**	**-6 963**	**-6 014**	**-7 220**	**-6 091**	**-6 275**	**-5 857**	**-8 123**	**-6 371**
Heat	-4 763	-5 301	-4 763	-5 301	-4 763	-5 301	-4 763	-5 301	-4 763	-5 301	-4 763	-5 301
CHP	-3 360	-1 070	-3 360	-1 070	-2 201	-713	-2 457	-790	-1 512	-556	-3 360	-1 070
To allocate/total costs	*81%*	*77%*										
EBIT	**61 022**	**58 606**	**61 022**	**58 606**	**23 268**	**38 766**	**5 810**	**23 575**	**64 379**	**69 856**	**-54 050**	**-58 752**
Interest revenues												
Interst expences												
EBT	**61 022**	**58 606**	**61 022**	**58 606**	**23 268**	**38 766**	**5 810**	**23 575**	**64 379**	**69 856**	**-54 050**	**-58 752**
PROFIT MARGIN	18.24%	16.59%	27.86%	24.89%	10.62%	16.46%	2.65%	10.01%	29.39%	29.66%	-24.67%	-24.95%

Of course, these results are specific for this particular company. If circumstances are changing, so will the calculated results. For instance, if it would have been a larger company with substantial production capacity besides the cogeneration, then allocation choices would have less effect as other production units are brought into the equation. On the other hand, if the CHP plant would incinerate fossil fuels instead the allocation choice becomes even more important as the company then has to pay fuel taxes. Despite this fact, and as we have argued above, it should still be relevant for CHP production in general. Most CHP firms are in the middle size group of companies with bio-fuel (or waste) incineration and are highly dependent on their CHP production. These results should therefore be of interest to other companies as well as to policy makers.

Conclusion

Historically, the companies that produce energy in CHP plants in Sweden have regarded themselves district heating companies first and foremost. To a large degree this self-image influences how they act, strategically and operationally, as well as how they report their activity. The electricity production has been an activity that has been added as a supporting activity to the main business model of district heating. For instance, many companies use electricity revenues as a means to hold back prices to DH customers. In this mindset the main problem has been to explain to customers why heat prices must be raised when electricity prices plunge. Many companies explicitly consider the DH to be their main product and electricity to be a by-product. In practice this means that no profits are allocated to the electricity production and all profits to the DH business segment (typically electricity is not even a business segment).

However, there is nothing in nature that says that the DH should be considered the main product. Looking outside Sweden the opposite is the norm as heat is considered the residual. Increasingly this view is adopted in Swedish CHP producing companies as well. They are comparing themselves with other electricity producers and find it harder to motivate why they should not be considered the same. Not surprisingly, the shifting in self imaging is to some (probably the main) part driven by tax considerations, and how policy makers regard heat and electricity respectively.

This study has implications for policy makers. If anything, this study that cogeneration offers significant challenges when it comes to achieving political goal congruence. On the one hand policy makers want to protect consumer welfare and avoid overpricing; on the other hand the promotion of cogeneration is a key component in achieving a more energy efficient society, both at a national and a global level. This makes cogeneration an issue that spans over several governmental competences, and where the risk of lacking policy coherence is obvious. The measures taken in order to promote the increase of cogeneration could to some degree be impeded by measures that are designed to protect consumers. Therefore, we recommend that policy makers establish some form of apparatus where coordination between competences is facilitated.

To the degree joint cost allocation will become an issue in such a coordination effort; one should recognize that the allocation of costs is done differently with respect to different purposes. Any harmonization of allocation principles should be preceded by the contemplation of the potential adverse consequences that follow for individual companies. It could even be the case that a harmonization of allocation principles is not desirable at all.

This study also has implications for CHP producing companies. For instance, we find that there are several local initiatives that could be of general interest and that there is some scope for intra-industry benchmarking. There seems to be a leeway for alternative allocation schemes in order to reduce tax payments. To the degree it is not already taken into consideration companies should explore this field further. Moreover, it could possibly be of interest for more companies to reorganize so that production is legally separated from distribution (or CHP separated from DH) by placing them in separate companies. It could be that this way of organizing conveys some tax advantages as well as facilitates transfer pricing. This could also be of growing importance as production systems become more complex with the adding of additional energy products. Of course, the reorganization could also convey more transaction costs as the management of the total operations would become more difficult. Nevertheless, it is our impression that those that have organizationally separated CHP and DH into different companies are somewhat more able to navigate in this terrain.

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Appendix A: Interview guide

I. **Presentation**
   a. The respondent.
   b. The company.
   c. The CHP production.

II. **Do you in any situation allocate joint costs between into costs related to electricity and DH, and if so how do you allocate joint costs?**

[*The initial phrasing of this question was: "How do you allocate joint costs in cogeneration?" and where we could follow up with a reference to the reporting made to the Energy Market's Inspectorate. We changed the phrasing early on in the process*]

III. **When was this method adopted?**

IV. **Did you use any other method to allocate joint costs prior to the current approach?**

V. **Why do you use your current method?**

VI. **Have you considered any alternative method?**

VII. **How did you first came to know about your present method?**

VIII. **How are decisions on allocations method made??**
   a. Who decides?
   b. In what forum?

IX. **Are joint costs allocated differently in any other (reporting) context?**

X. **Do you prepare any environmental impact analysis of your production?**
   a. How are resource usage and emissions allocated in CHP production?
   b. Is there any connection between how you allocate environmental impact and how you allocate joint costs? Has it been discussed internally?

XI. **According to which principles do you price heat?**
   a. Are you using cost-based pricing and, if so, does your joint cost allocation method affect the cost estimation used in pricing policy?

XII. **Does your allocation method form the basis for cost estimates used in investment appraisals?**
   a. If not, is any other allocation method used instead in conjunction to investment decisions?

XIII. **Does the choice of allocation method affect operative decisions?**

XIV. **Are you discussing any change in the methodology you use for allocating costs?**
   a. What is the reason for this discussion?
   b. What alternatives are you considering?
   c. Are you discussing any changes in what areas to apply your allocation method (e.g. in relation to investment decisions or pricing)?

XV. **Do you think that there is any topic related to joint cost allocation that we have not covered in this interview, and that should be added to the discussion?**