CHAPTER 5

Industry-Level Collaboration in mCHP Standardisation and Regulation

Abstract This chapter provides in-depth insights into the extensive collaboration across multiple actors in the European heating industry during micro Combined Heat and Power's (mCHP) development. Actors in the industry cooperated both in developing mCHP technology and related standardisation/regulation processes. The chapter outlines the role of non-company actors (e.g. industry associations) and the industry's intellectual property rights approach (IPRs) in facilitating this cooperation. This chapter gives a detailed account of the particularly dynamic and contentious processes of standardising and regulating access to the electricity grid and requirements for energy efficiency labels. These examples show how innovators can jointly create conditions that support their innovation, even if major stakeholders (including government) oppose the technology. The examples also show how innovators can handle important policy and societal issues.

Keywords Cross-company collaboration · European Commission Energy efficiency policy · Electricity grid access · Intellectual property rights · Co-opetition

In addition to the internal activities described in Chapter 4, the actors in the industry also reached outside their companies as part of managing standards and regulation for mCHP. This resulted in extensive collaboration between actors in the industry. In Sect. 5.1 we

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provide an overview of these activities, outlining aspects like the venues where this collaboration took place, the involved actors, the topics of cooperation, and how intellectual property rights (IPRs) were considered in this context. In Sect. 5.2 we then describe how standards and regulation for mCHP evolved as a result of this collaboration and the input of other stakeholders, based on two examples that were central to the case.

5.1 Collaboration Across Actors in the Industry

Having identified standards as an important issue for the development of mCHP, the actors in the industry also recognised that successfully bringing mCHP to market would be very difficult if companies tried to do so without collaboration in the industry. For example, the conflicts, which we describe in Sect. 5.2, would have been extremely difficult to resolve by any company from the industry on its own. This awareness resulted in extensive collaboration within the industry, both to develop the technology and its market, and to pursue standardisation and regulation-related activities together. This collaboration took place in a number of formal and informal settings with different aims and varying involved parties, many of which engaged in multiple collaborations with others. Table 5.1 provides an overview of the most important collaborations that were mentioned in our interviews.

We outline these collaborative efforts in more detail below. We first consider the initiatives which were specifically initiated for mCHP and included aspects related to technology development, but also standardisation and market development for the technology (Sect. 5.1.1, the four rows at the top in Table 5.1). We then outline the efforts in already established forums (concentrating on industry associations) which focussed much more on standardisation and regulation instead of technology development (Sect. 5.1.2, the two rows at the bottom in Table 5.1). These efforts led to some interesting 'group dynamics' between actors in the industry which we outline in Sect. 5.1.3. Finally, such collaboration also raises the question how the involved actors handled intellectual property. We take a closer look at the approach to this topic in Sect. 5.1.4.

Table 5.1 Overview of collaborations related to mCHP technology

Organisational setup of collaboration	*Forum for collaboration*	*Aims of collaboration*
Consortium, specifically initiated for mCHP	Initiative Brennstoffzelle (IBZ)	Promote and jointly develop fuel-cell-based mCHP, organise large-scale field trials of the technology
Ad hoc agreements between participating companies	Collaboration between a Japanese fuel cell manufacturer and a German appliance manufacturer	Jointly develop fuel-cell-based mCHP appliances for the European market
	Collaboration between several appliance manufacturers and a manufacturer of Stirling engines	Jointly develop Stirling-based mCHP technology and prepare the market for the technology. Later, the appliance manufacturers invested in the supplier involved in this cooperation
	Various one-on-one collaborations between appliance manufacturers and suppliers	Jointly develop components and other aspects of the technology
Established industry associations	European and national industry associations (e.g. EHI, COGEN Europe, BDH)	Provide a forum to coordinate the industry's input in standardisation committees and a channel for the involved companies to influence regulation for mCHP
Formal standardisation activities	Standardisation committees in European and national SSOs	Develop standards to support mCHP

5.1.1 Collaborating in Technology Development

Collaborations to develop mCHP technology began already in the early stages of development before the engagement in standardisation started and took place in settings that were specifically established for mCHP. Throughout our interviews, many instances of collaborating with suppliers and others to develop components were mentioned. Three of these technology development collaborations stand out because of their links to market development, standardisation, and regulation: (1) a collaboration between a Japanese fuel cell manufacturer and a major established

German OEM; (2) a German industry forum for domestic fuel cell applications and two associated field trial projects for mCHP appliances; and (3) a collaboration between several parties to develop Stirling-based mCHP technology.

In the first example, a Japanese manufacturer of fuel-cell-based mCHP appliances brought its extensive knowledge of the technology into the partnership. While this manufacturer produces entire mCHP appliances in Japan (where the technology has already reached widespread diffusion), it partnered with a German appliance manufacturer because of its limited knowledge of both European market requirements and European regulation and standards for mCHP. In this partnership, the Japanese company supplies the fuel cell components which are integrated into the appliance by the German appliance manufacturer who also has been responsible for questions related to standards and regulation.

In the second case, the German industry forum ('Initiative Brennstoffzelle', IBZ) brought together a large number of mCHP appliance manufacturers and other stakeholders, including academic research institutes, utility operators, industry associations, and a German government body in charge of promoting fuel cell technology ('Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie', NOW). Its aims included information exchanges between actors, raising awareness for the technology but also developing technical specifications and political lobbying for the technology (see also Initiative Brennstoffzelle, 2017). The IBZ also had links with two large field trial projects ('Callux' and 'ene.field') which aimed to gain experience with the technology and testing prototypes in the field, but also linked to standardisation and regulation. The field trials relied on standards (e.g. for communication between the involved appliances), and produced findings that fed into further standardisation efforts later on.

The third major collaboration in the case aimed to develop Stirling-based mCHP technology. It involved the major appliance manufacturers which pursued the technology (although some of them have stopped their engagement before bringing Stirling-based mCHP appliances to the market, see Sect. 2.2.2). This collaboration took place in the early stages of development, as the following quote shows:

> In the beginning, meaning before our actual product introduction phase, we developed this Stirling engine together with competitors, mainly with

> two competitors from the European industry. And then at some point we separated, so these common meetings eventually did not take place anymore. (translated from German)

In addition to the appliance manufacturers, a manufacturer of Stirling engines has been playing a key role in the collaborative development of Stirling-based mCHP appliances, being "*very deeply involved in that process, from the very first contact with [name of one OEM] right through to them producing and certifying their first model*". In this context, the manufacturer not only developed the Stirling engine as an individual component but also was involved in integrating it into the appliances. This collaboration between the appliance manufacturers and the manufacturer of Stirling engines culminated in the appliance manufacturers jointly buying the Stirling manufacturer together with an external investor when the original owner (a large utility firm) decided to leave the mCHP appliance business.

One important motivation for this close cooperation between competitors was increasing the speed at which economies of scale could be reached for mCHP technology. The collaboration allowed them to standardise new components that were not shared with other products, such as the Stirling engine component or control electronics, across manufacturers. In addition, considerations about creating the market and being able to manage standards and regulation were further reasons for this collaboration. An interviewee at the company that initiated this collaboration explained why they decided to share their innovation with others, rather than protect it through patents and licenses:

> We were also active at that time to enlarge the circle of companies coming with micro CHP. So, we invited competitors because we thought it would be good that, when you have to create a new market for a new kind of product – If it is only the product of [company name] then it would be very much like the regulations had to be tailor made for [company name], for one company. And that was not the issue if it was for a sector. So, we collaborated with these different companies – also in lobbying on the regulations.

This sentiment of needing to collaborate in order to jointly develop the technology and the environment in which it is placed was also echoed by other interviewees, as the following quote shows:

> If I had tried to distinguish myself from a competitor in this way and I wanted […] to prevent him from implementing his technology – that would be absolutely counterproductive. The market first has to develop. The market for mCHP is not developed yet. It is a small plant and it needs to be watered well for it to start growing. (translated from German)

Based on these initial technology development efforts with their links to standardisation, the industry also engaged in established standardisation bodies and industry associations to further coordinate their activities in standardisation and regulation processes, as detailed in Sect. 5.1.2.

5.1.2 Collaborating in Standardisation and Regulation

In addition to the technology-focused collaborations outlined in Sect. 5.1.1, which also affected standardisation and regulation to varying degrees, there were a number of collaborative efforts directly concerning standardisation and regulation. They took place in different forums, such as the IBZ; the national and European industry associations[1]; and standardisation committees which were only "*one part of the network surrounding this technology*" (translated from German).

While there also was collaboration in the standardisation committees, it is particularly interesting to consider how collaborating in already established industry associations supported the industry's standardisation activities and provided the actors with access to regulatory processes. Especially the established appliance manufacturers engaged in the mCHP working groups at the industry associations but also some smaller players were members. By using the opportunities that these working groups provided, the industry was better able to cooperate in pursuing standardisation and regulation for mCHP beyond what would have been possible by only engaging in committees. Below, we outline how they used their membership in these associations both in the context of (1) standardisation and (2) regulation processes.

[1]These associations included the 'Association of the European Heating Industry' (EHI) and the 'European Association for the Promotion of Cogeneration' (COGEN Europe) on the European level and the 'Bundesverband der Deutschen Heizungsindustrie' (BDH) on the German national level.

5.1.2.1 Industry Associations in the Standardisation Context

Several interviewees reported that the actors in the industry used the associations to develop a common position which they could then pursue in standardisation committees, making them a venue to jointly prepare standardisation activities. For this reason, the companies were often represented by the same people in standardisation committees and the industry associations' working groups:

> It is often the case that there is an overlap of around 70% in people, who are on one hand active in standardisation topics and on the other hand in topics related to the associations. Yes, I would say that between 50% and 70% of these people are identical. (translated from German)

In order to facilitate this process, a representative of the European heating industry's associations participated in many relevant standardisation committees as an observer without voting rights. This allowed him to identify potential areas of conflict and facilitate compromises between the association's members in these areas. He also saw it as part of his role to ensure that the interests of smaller companies in the industry, who were not directly represented in standardisation committees, were also taken into account in these agreements. In instances when these interests were at threat in the committees, he intervened in the discussions. The following excerpt from an interview sums up this role:

> *Interviewee*: In the expert group, where the standard is being drawn up, only experts are present. This means that everyone has the same weight and everyone may speak or not speak – whatever they want. And I have been nominated as an expert. Of course, I hold off when members [of the association] voice specific demands. But if one member, for example, wants to push through certain things vis-à-vis other members of our association, then I have to intervene and say 'no, no, just a moment, there we have to find a compromise' because everyone sitting at the table, all members, must be able to survive. It cannot be allowed that someone raises a demand, let's say for example all appliances must be green, and the others want to have green, blue, pink. […] Then I have to intervene and say: 'No, no, that's not how it goes. Let's see whether we can leave the question of colour fully open.'
>
> *Interviewer*: Good, this means that, if that were the case, this member would have to go into the standardisation committee itself and say there 'we want green' and not through the industry association.

> *Interviewee*: Yes, or he is sitting in the committee and demands this. Then I have to say 'no, no, that's not how it goes'. There are two ways.
> *Interviewer*: This means you also counter this in the committee and say 'the consensus in our association is that we do not want to commit to anything here.'
> *Interviewee*: Exactly. And if absolutely no compromise is found we go back to our internal working group and resolve the situation there. And usually this works out. (translated from German)

This role of the industry associations was mostly appreciated by the interviewed companies although a few clashes on minor topics with the association's representative were mentioned by one interviewee. This may also have been related to the representative working for both the German national and the European industry associations, making it sometimes unclear for actors from other countries on whose behalf he was speaking. In addition to these activities related to facilitating compromise and finding common positions for standardisation, the associations played one more role in standardisation for mCHP. Their staff also attended standardisation committees on topics which did not warrant the manufacturers' participation but were nevertheless relevant for mCHP and reported back on progress in these committees.

In some (mainly electrotechnical) areas of standardisation that were important for mCHP, this collaboration went even further than only agreeing on common positions for standardisation. In technological fields where actors in the industry sometimes lacked the necessary expertise and direct participation in standardisation would have been too resource intensive, they hired an external consultant through an industry association to act on their behalf in standardisation committees[2]:

> There is an international standardisation committee where a strong electrotechnical aspect was included. There, we are not directly involved, but only through a consultant who we have mandated, together with our competitors, to represent our interests there. Doing this, with meetings in Tokyo and I don't know where else, is of course very resource intensive. This is why Mr [name of the consultant] is there. And Mr [name of the consultant] is paid for not by us as [company name] but by us as industry to represent our interests in international standardisation. (translated from German)

[2]The same external consultant also worked for many of the companies individually (see Sect. 4.2).

An additional reason for choosing the external consultant, rather than a member of the association's working group, to represent the entire industry was his neutrality resulting from having no links to a particular company:

> I was approached whether I could represent these bundled interests. It was also clearly said that it is better if a neutral non-producer of appliances does this instead of an appliance manufacturer. (translated from German)

5.1.2.2 Industry Associations in the Regulation Context

While engaging in the industry associations was (partly) complementary to directly participating in standardisation committees, it played a much more central role for the manufacturers in order to gain access to regulatory processes. This access was needed in particular when developing a calculation method for energy efficiency (see Sect. 5.2.2).

With the exception of one appliance manufacturer which is part of a larger conglomerate that operates its own substantial lobbying presence at the EU level, none of the actors in the industry would have had much clout in policy making on their own.[3] While the European Commission and other policy makers could be accessed by individual companies at industry roundtables and similar consultations about new regulation, the existing contacts of the industry associations helped to get more direct access:

> I think first they [the industry associations] know the way, they are close to the process, so they know what happens, they have the contacts already and so this is how this usually works indeed. […] I must say, I have also been to – sometimes the European Commission themselves are organising a kind of round table meeting where you can register yourself. I have also been to that meeting but then there were 25 people in too small a room, and no individual talks.

In such instances, when members of the industry got access to policy making through the channels of the industry associations, they did so after a common position had been determined between the members of

[3]This manufacturer's ability to use its parent company's lobbying resources contributed to some interesting dynamics in the development of energy efficiency standards for mCHP, as outlined in Sect. 5.2.2.

the associations' working groups. They were then speaking on behalf of the entire group, also reflecting the reasoning for collaboration quoted in Sect. 5.1.1:

> The first time I was there [at the European Commission], that was through EHI – also with other people – and representing EHI. I've also been there later when EHI and COGEN Europe joined forces. I was there on behalf of and also together with people of EHI and COGEN Europe. So the general secretary of EHI was there, a colleague of [name] was there, […] the general secretary or director of COGEN Europe was there together with someone who was responsible for micro CHP and I was there.

In particular the interviewee who initiated much of the collaboration in the industry, and also was described as the leading force behind many of the common activities by others, was chosen to represent the industry together with staff of the associations (and—in some cases—additional external experts who were jointly hired by the industry) in this manner.

5.1.3 'Group Dynamics' in the Industry Resulting from the Collaboration

All interviewed parties who were involved in the collaborative efforts outlined above described them as very trusting. This trust was built throughout all of these efforts (i.e. technology cooperation, standardisation activities and collaboration in consortia and industry associations). The following quote from our interview with an academic engineering researcher, who participated in the process without commercial stakes and therefore played a more neutral role, sums up this sentiment:

> The nice thing about standardisation is that one tries there to work together and not against each other. This means that the idea of competition is secondary in a standardisation committee once the door closes. Evidently, everyone represents the interests of their company. This is clear. Nevertheless, one knows 'okay, one somehow has to enter compromises', otherwise nothing comes out and one eventually wants to have something on the table. This is similar to conducting a common research project where it is clear that one enters the whole thing as partners and tries to do something together. And this is the same in standardisation, at least in the micro CHP area, where – according to my experience – there are fewer

> conflicts and diverging positions. Instead, the industry is saying – especially at such a new technology – 'okay, we pull together and we want to advance our niche products and our not yet established technology'. (translated from German)

This was sometimes also described as resulting in strong 'group dynamics' where all involved actors know each other very well and it may be difficult for outsiders to join these efforts. Some interviewees also saw these collaborations not only as a way to facilitate mCHP's development but also to fend off demands for requirements in the standards which would have been problematic for the technology. For example, one interviewee mentioned NGOs who participated in standardisation committees and who tried to raise the minimum levels for safety and exhaust emissions in the standards to such a high level that the industry would not have been able to produce mCHP appliances at a price point with sufficient market demand. A final purpose of these collaborations was strengthening mCHP's position in the competition with other technologies, such as heat pumps. The following excerpt from an interview illustrates this:

> This means that we need to show the competition which has competing products, for example heat pumps, that our technology is a good one. And then, once out technology – micro CHP – is established and has reached a certain market penetration, we can start competing against each other once again. (translated from German)

Particularly one interviewee, who was leading many of the efforts to cooperate to promote mCHP, stressed repeatedly that the aim of these efforts was to achieve a fair treatment for mCHP vis-à-vis other technologies whose backers he accused of using unfair practices in some instances to give these technologies an unfair advantage over mCHP or disadvantage mCHP unfairly. Many of the activities outlined in Sect. 5.2 were driven by this motivation for which the following quotes are exemplary:

> We don't need a bonus, we only need a fair treatment. And the advantage shouldn't come and isn't from the standard, but the advantage is from the real world and the standard should reflect the real world in a fair way.

> I had the suspicion that they wanted to get a privileged position of, for instance, electrical heat pumps by pushing micro CHP down.

5.1.3.1 Industry Actors Not Supporting mCHP

Despite these observations of broad collaboration in the heating industry to drive mCHP forward, this did not concern the entire industry. One major appliance manufacturer with little involvement in mCHP technology was critical about these efforts. Representatives of this company participated in standardisation committees and working groups at the industry associations in order to prevent what they saw as formulating rules which would give mCHP an unfair advantage over other technologies. An interviewee working for this company relayed the opposite narrative to that of the supporters of mCHP, claiming that their activities were geared towards giving mCHP unfair advantages over other technologies:

> I am not a friend of the manner how one tried this [Stirling-based] appliance with the corresponding label[4] – because all of this no longer has anything to do with physics. This is just about marketing. And in this place – I know we also have to sell our products – but we as [company name] still try it in a reasonably fair way and this is not fair anymore. (translated from German)

The interviewee voiced his admiration for what he saw as one company with particularly strong interests in the technology pulling an entire industry on their side. He claimed to also speak on behalf of other companies that were sceptical about the rest of the industry's efforts but which were too small to effectively participate in the activities related to standardisation and regulation. This difference in viewpoints about mCHP technology and the cooperation in the industry then led to major conflicts during the development of standards and regulation (see Sect. 5.2.2).

5.1.4 The Role of Intellectual Property in the Industry's Collaboration

Based on our literature review, we expected IPRs to play an important role in the collaboration between different actors in developing mCHP. In particular, we assumed that they would be important in standardisation

[4] See Sect. 5.2.2 for details regarding this issue.

for mCHP. We therefore specifically asked interviewees how they had dealt with IPR as part of their NPD and standardisation activities.

5.1.4.1 Protecting Intellectual Property Related to mCHP Technology

The interviews show that IPR was indeed an issue that they considered and that they aimed to protect their innovations where possible. Based on these observations, the interviewed companies can be divided into (1) two companies which considered IPR an important strategic issue and (2) a larger group where IPR was dealt with as a lower-level issue.

Two of the interviewed smaller start-ups stressed that it had been essential for them to think about IPR strategically while building their business. One of them was initially launched with the aim of building entire mCHP appliances but later focused on supplying advanced fuel cells to others in the industry. In this role, keeping the IPR of the fuel cell designs and either producing them on behalf of the customers or licensing the designs was key to the company's business model. The other company in this group also carefully considered how to best use IPR protection to support their business, as the following quote shows:

> We talked about the GSE board, the burner control and the essential air sensor where we place great importance on having the [intellectual] property ourselves. We therefore have patents. We are interested in the Hot BOP, Hot Balance of Plant, we wanted the stack ourselves. There we wanted to have ownership. In this area, in coatings, in compositions and the burner itself, we have patents. We want to be the owner of key parts. But otherwise – and this is part of our strategy, also to keep costs down in this area – we developed the relevant parts together with our suppliers. We have often done this and then afterwards made the part available to our competitors or other actors in the market. (translated from German)

The larger part of the interviewed companies, including the large established players, treated the IPR issue in a more matter-of-fact way. They saw the topic as one that needed to be taken into account when managing mCHP's development but did not portray it as a topic with strategic relevance similar to how this was seen by the first group. The following quote illustrates this approach:

> In some parts we built [intellectual property] ourselves and applied [for patents] ourselves. And we naturally conducted patent searches. This is

> even more important, to make sure that you do not introduce something as a product which you may not introduce, quasi conducting a patent violation with the product. This is something which belongs to a product development process by default. The patent search about what one wants to introduce, what one wants to develop. This is an item in the product development process. (translated from German)

5.1.4.2 (Not) Using IPRs in Standardisation for mCHP

While interviewees recognised the importance of IPR in developing mCHP in general, they did not consider the topic as relevant for standardisation. Indeed, when asked about how IPR issues were addressed in the standardisation process, interviewees saw no link whatsoever between the two topics and sometimes were even surprised that such a link was suggested. They claimed that practices such as declaring patents as standard-essential and basing standards on an individual party's IP have not been used in the mCHP context and even were unheard of in the European heating industry, as the following excerpt from an interview shows:

> *Interviewee 1*: There was no such thing [attempts to place IP in standards] here, no.
> *Interviewer*: Okay, this means that this is not common in your industry?
> *Interviewee 2*: No. In any case not in the context of standards. Of course, obviously one tries to protect one's intellectual property, maybe also if one sees that one can trigger something at the competitor. But especially in the fuel cell area and standardisation, or CHP and standardisation, this was not a big topic. (translated from German)

Beyond this, the interviewees even considered bringing IPR issues into the standardisation debate as counterproductive and as being contradictory to the purpose of standardisation. They shared an approach to standardisation which strived to write standards that support all companies in designing their own mCHP appliances, rather than applying solutions that were covered by one party's IPRs. Interviewees also argued that it would not be in their own long-term interest to place their IP in the standard, thereby limiting other companies' options in developing their technological approaches for mCHP, because this would weaken the development and eventual chances of market acceptance of the technology as a whole. The following two excerpts from interviews exemplify these arguments:

Interviewee 1: No. Patents can actually not play a role in standardisation. At least, I have no examples in our area. (…)

Interviewee 2: (…) If you have developed something technologically and you think that you should protect this for yourself, then you register this [as a patent]. But if you want to develop this into a standard, then you initiate a standardisation committee (…) so that you eventually get a standard which you can build into the product and sell without hindrance or [also decide to] leave out [of the product]. (translated from German)

Interviewee 1: We have of course tried to place our own ideas in the standards without revealing, for example, what our safety concept looked like. Especially in early phases, we tried not to show in too much detail what we were doing, especially for the safety concept. And there one always has to achieve a balance.

Interviewee 2: So, enabling the own concept without revealing it and recognising the same at the colleagues from our competitors and leaving them the same wiggle room. We had no interest in preventing or hindering competition in this early stage because this would have weakened the technology as a whole. (translated from German)

The reason why such an approach was seen as weakening the innovation was that it might have caused other actors in the industry to lose interest in mCHP. Following on from the reasoning for collaborating across the industry (see Sect. 5.1.1), this was seen as a potential problem because it would have left the company alone in promoting the technology, e.g. in discussions with government, which would have been unlikely to succeed:

> It would have been an extreme risk to weaken the technology in this way and suddenly being left as the only vendor, which would definitively not have been constructive. If the entire [German industry association] had not been interested, [company name] could also not have gone to Berlin on its own to accomplish anything there. Because of this, the others, the competitors had to remain interested in the whole thing. (translated from German)

5.1.4.3 The Overall Impact of IPR on mCHP's Development

Overall, IPRs were considered an important element of managing mCHP's development by the industry. We observed broad consensus

among interviewees that protecting own technological developments was important, also when cooperating with other parties. However, there was equally broad consensus among interviewees that IP had no place in the development of standards for mCHP. The interviewees who spoke on this topic all agreed that including proprietary knowledge in the standard would have been counterproductive and eventually resulted in substantial difficulties for the technology's development and eventual success.

5.2 Conflicting Interests in Standardisation and Regulation for mCHP

As outlined in Chapter 3, several standards needed to be changed or newly developed in order for mCHP to be sold into the European market with the intended value proposition. On most questions, such as electrical installations in buildings, other players in standardisation committees adopted a constructive approach towards the innovation. With their support, standards were adapted so that they would accommodate mCHP and provide a basis for the technology's safe and efficient operation. However, two areas of standardisation turned out to be controversial because of competing interests by actors from other technological fields: (1) Questions related to connecting to the electricity grid and (2) developing a calculation method for mCHP's energy efficiency based on the European Union's requirements for energy labels (part of the product standard EN 50465). In addition, several interviewees identified reuse, recyclability, and reparability (RRR) as a new field of standardisation with relevance for mCHP where they expect potential conflicting interests in the future:

> According to a new mandate, RRR – meaning reuse, recyclability and reparability requirements – must also be included in the standard. What exactly this contains is now under discussion. (translated from German)

Because the questions related to the electricity grid and the efficiency calculation method are recurring themes across our interviews and many interviewees stressed their importance for the development of mCHP, we focus our discussion of standards' and regulation's evolution on these two areas.

5.2.1 Standards and Regulation for Connecting to the Electricity Grid

As outlined earlier, being able to connect mCHP appliances to the electricity grid and feeding the generated power into the grid were key to implement the innovation's value proposition. This key importance made the topic one of the focus areas in the standardisation and regulation efforts. During this engagement, the actors from the heating industry encountered a range of stakeholders from other industries, most importantly the electricity grid operators, who were used to a different approach to standardisation:

> There are various actors, typically settled in the energy business, or around the energy business. And for them [the actors from the heating industry], these are quite uncharted waters although meanwhile they have been acting more and more confidently. (translated from German)

> Feeding into the electricity grid is usually shaped monopolistically because utility companies typically used to have monopoly structures. (…) They were not used to developing standards in the same way as, for example, in the gas or (…) household appliance industries, where notified bodies, manufacturers and users sit together in standardisation committees and are looking for compromises. For feeding into the grid, this is different. It has been a long process and we have not yet arrived at the goal that there is equal representation in committees (…). There [in this field of standardisation], one is used to the grid operators determining what [rules] apply. (translated from German)

In the remainder of this chapter, we describe the industry's efforts in dealing with the opposing interests in this field. We start by outlining the environment in which the industry found itself and the conflicting and converging interests resulting from this. We then explain how the stakeholders interacted and how the conflicts between them were eventually resolved.

5.2.1.1 Background: Electricity Grid in Transition

At the time when mCHP's developers worked on the topic, several parallel developments occurred, such as the spread of renewable energy sources and the exit from nuclear power in Germany. These developments had (sometimes substantial) implications for the electricity grid. Traditionally the electricity grid was built around a small number of large

power stations, meaning that electricity production could be relatively easily balanced with demand for electricity. With the new developments, a large number of small electricity producing appliances (including mCHP appliances, solar panels, wind turbines, etc.) started appearing in the grid which resulted in substantial changes to the grid's structure:

> Around 20 years ago, we had maybe, say, 1000 generators in Germany and now we have 20 million or 15 million or some number in that range, if you include all the solar panels that feed into the grid. (translated from German)

Furthermore, the spread of renewable energy also means that parts of the electricity production can no longer be adjusted to demand fluctuations because it depends on factors like sunshine and wind. This made mCHP one of several factors[5] in a major transition, which challenged grid operators' and utility firms' traditional approach to managing the electricity grid. According to most interviewees, mCHP was therefore met with certain degrees of resistance by some of these actors, while others participated in partnerships to develop the technology (see below).

> If you look at what the four big [German utility companies] have lost in market capitalisation through shutting down nuclear power stations, through the increase in photovoltaic, through the prioritisation of renewables before [other energy sources], and the fact that for economic reasons the most modern gas fired power stations are not operated anymore today, even though they would produce the lowest emissions out of the fossil [fuels]. And then, politics exerted such a massive influence on the industry that they [grid operators and utility companies] fight helping any other sector tooth and nail. They have so many problems of their own (…) and that's why they resist helping even the smallest CHP or even developing understanding. If you want to see it positively, it is slowly beginning [to change], but much too slowly. (translated from German)

Given this background, some interviewees reported that the established players in the grid field sometimes made demands based on their experience with large power stations, which the interviewees interpreted as

[5] Although in the grand scheme of things, mCHP was a comparatively small factor relative to the other developments.

aiming to hinder mCHP's development by imposing unreasonable requirements in the standards and regulation:

> *Interviewee 1*: In standardisation and regulation on the electrical side (…), they crack nuts with sledgehammers and we often came across attempts to prevent technology through standardisation.
>
> *Interviewee 2*: They really put obstacles in one's way. I am thinking of one example regarding how the amount of electricity that is produced by an mCHP appliance should be measured and where the measurement device should be placed. Traditionally, it is clear that, if you build large equipment, then you have some (…) measurement device (…) and if this is not directly on the turbine it is in an electrical cabinet far away. And one tried to transfer this concept to a small electricity generator [even though there] you do not have a separate electrical cabinet (…) but everything that is needed for the operation has to be built into the appliance, into one enclosure. (translated from German)
>
> On the grid connection side we had the occasional discussion because the utility companies inherently have a different view on the technology. I remember a discussion (…) where the utility companies (…) wanted to draw upon a standard to enable communication between the fuel cell and a higher-level control unit to create a 'virtual power station' (…) and where we said 'wow, that's totally excessive, they want to impose a standard on us that can communicate with a network control centre and that would ask way too much from our appliance'. (translated from German)

5.2.1.2 Converging and Competing Interests with Other Technologies

As the development of mCHP coincided with other technologies' emergence, the actors in the heating industry were not only confronted with the traditional grid operators and utility firms, but also with the interests of these other technologies' developers. Most importantly, the needs of renewable energy sources (which also enjoyed some political support) were a major factor in the development of standards and regulation for grid access. In some cases, the heating industry's interests converged with the ones of these other actors. For example, mCHP was seen as a potential technical solution to ensure grid stability in the future when renewable energy would make up a large part of the electricity generating capacity, thus providing complementary value:

> The idea is basically that one can smoothen the volatile energy production of renewables a little bit with a large number of mCHP appliances in the grid. Because when you look at the energy generation curve of an mCHP appliance, this is quite complementary to a photovoltaic module. (…) When the sun is shining heavily, I don't need heat and the mCHP appliance does nothing. When a lot of heat is required – usually in the winter, in the evening, or in the morning – then I have electricity generation from the mCHP appliance. (translated from German)

The interests of mCHP's developers and other technologies' proponents conflict ed on other questions. One example that was mentioned in several interviews is the requirements for dealing with frequency changes outlined in Sect. 3.4.2, which poses a substantial hurdle for Stirling-based mCHP appliances. The introduction of this requirement was driven by the expectation that large sudden changes in wind or sunshine would make the grid frequency volatile when many renewable energy electricity generators are connected.

5.2.1.3 Activities in Standardisation and Regulation for the Electricity Grid

Given this background of an electricity grid in transition and other technologies developing in parallel, the interviewed actors aimed to influence standards and regulation so that workable solutions for mCHP could be found. Our interviewee at the European industry association summarised this goal as follows:

> To be able to feed the one kilowatt [of an mCHP appliance] into the grid, the supporting conditions must be right. There must not only be supporting conditions for 500 kilowatt [appliances]. This is like traffic on the roads. If you have lots of racing cars on the roads, they of course have other interests, they drive at different speeds than (…) a small car in between which can only drive 100 instead of 250. (…) And therefore, a compromise has to be found where we say 'he may also use the road, but he may only drive in the right hand lane'. (translated from German)

To reach this goal, the actors engaged in standardisation and regulation pursued various activities to increase the impact of this engagement. These activities can be grouped as (1) forming coalitions, (2) establishing evidence about the technology and informing other stakeholders about its needs, and (3) adapting mCHP technology itself where necessary and possible.

The first group of activities (coalition forming) was in many cases based on the collaboration forums outlined in Sect. 5.1. For example, the 'Callux' project that was undertaken as part of the IBZ in Germany included several energy suppliers as collaboration partners. Especially smaller, local energy suppliers sometimes saw mCHP as an opportunity to shift the balance of power generation away from centralised power stations owned by their large competitors. Gas suppliers who "*were interested in selling gas*" (translated from German) were also supportive of mCHP in questions related to grid access. However, being able to form these coalitions and operate these field trials was not always easy, as the following quote shows:

> It already started with having to find people who conducted field trials together with us. Of course, these appliances then also have to be approved, that is clear. But these were people who, let's say, accommodated us with a certain goodwill and then maybe also interpreted grid connection rules generously and did not make it impossible from the start. Because they knew that these were small appliances with initially small quantities. (…) [And these people] also saw new business opportunities in the technology [although] it took a while for the utility companies to recognise these opportunities. (translated from German)

Such collaborations across stakeholders also were directly linked to informing stakeholders, making them aware of the technology, and establishing evidence about it. This second group of activities was necessary because many actors involved in developing requirements for grid access were unaware of the technological characteristics of mCHP:

> But they [the grid operators] of course have their large power stations and rotating machines with their inertia in mind. Feeding into the grid with a small appliance – the needs that exist there were not in their focus. And there we needed to vehemently [argue] on the European level when the Network Code Requirements for Generators [were developed]. (…) And it was not easy to convince these circles that mCHP behaves in a special way. When you switch an mCHP appliance off, you need to restart the thermic process. But they assume that the rotating machine runs anyway or that a solar panel can immediately feed electricity into the grid when you switch the semiconductor. (…) A fuel cell needs to be restarted. This takes minutes and they want to switch it on immediately at the right

> frequency. These are basic principles which are difficult to convey. (translated from German)
>
> Neither had we experience with the electricity generating sector, nor did the electricity generating sector know anything about these small generating appliances. And only once the electricity producers realised that these small generating appliances must be taken seriously, that they are not a temporary phenomenon (…) [but] actually enter the market, then one also reacted accordingly in that group, respectively started trying to establish the rules. (translated from German)

To support this information of other stakeholders, the developers of mCHP relied on evidence created by field trials, such as the 'Callux' project mentioned above where "*a few hundred fuel cell mCHP appliances were brought into the field*" (translated from German) and their effects on the electricity grid were measured on behalf of utility companies by an independent research institute.

Finally, the developers of mCHP also adapted their technology to make it more acceptable to other stakeholders in the electricity grid. Some interviewees stressed that the interaction with these stakeholders helped their understanding of the issues faced by the electricity grid operators and mCHP's possible positive and negative impacts. This increased awareness allowed them to facilitate these other stakeholders' concerns and sometimes even work out technical solutions jointly with these actors, as the following quote shows:

> For example, there was the need to cover wider scopes of grid frequency and different technical solutions existed for this [issue]. And the one which we preferred and also finally implemented (…) [was based on] considerations which we worked out together with the grid operators and the power station operators in this VDE [Verband der Elektrotechnik, German association for electrotechnology] committee. (…) [And there would have been other solutions which] would not have been so accommodating for us, which would have been much more expensive. (translated from German)

5.2.1.4 Limited Influence on Standards and Regulation for the Electricity Grid

Despite the efforts to influence the development of standards and regulation, the actors in the heating industry remained relatively small players in the field with limited influence on the process. Some interviewees

acknowledged this as a problem for dealing with issues related to these requirements:

> *Interviewee 1*: The difference to the standards that we talked about a moment ago [standards relating to gas-safety and efficiency] is that we get the standards [relating to the electricity grid] on the table and we have very, very little influence to make a difference there.
> *Interviewee 2*: The electrical side is extremely difficult.
> *Interviewee 1*: Exactly. There are also completely different structures and [company name] is not necessarily a big player – I would even say – not at all. (translated from German)

Consequently, the actors in the heating industry were not entirely successful in reaching their goals. The rules for dealing with grid frequency changes mentioned in Sect. 3.4.2 are an example where the heating industry's limited influence on the process made it unable to prevent a change in the standard that was against their interests. These rules were introduced during the development of mCHP, replacing earlier requirements that were easy to fulfil for Stirling-based mCHP appliances:

> The requirements for connecting to the grid. (…) There was a standard and we complied with that standard and then what was previously required was now forbidden or the other way around. So there, the standards are not fixed situations, they are temporary.

Technical solutions to design Stirling-based mCHP appliances in line with these changed requirements have a high impact on the devices' costs and efficiency. At the time when we conducted our interviews, the companies using Stirling engines relied on provisions in the grid access regulation which exempt new, innovative technologies from certain requirements and allow them to continue operating according to the old requirements (see European Commission, 2016, secs. 66–70). However, these temporary provisions only apply until a limited number of appliances using the new technology have been connected to the electricity grid. Consequently, the actors relying on Stirling technology were still in the process of working on this issue at the time of our interviews:

> We've been fighting that [the new requirements] for two years and there's hopefully a special dispensation within that.

5.2.2 *Conflicts Surrounding the Calculation Method for mCHP Appliances' Energy Labels*

A second major topic of standardisation was the calculation method for assessing mCHP appliances' energy efficiency, which underlies the efficiency label that each appliance needs to carry according to the ErP and Energy Labelling Directives (see European Parliament & Council of the European Union, 2009, 2010). The topic was particularly important and contentious due to its relevance for European legislation and the European Commission's involvement in the standardisation process.

The calculation method is part of the product standard (EN 50465, the latest version of which was published in 2015), which did not yet exist when the technology's development started (see Sect. 3.1).[6] This standard "specifies the requirements and test methods for the construction, safety, fitness of purpose, rational use of energy and the marking of micro Combined Heat and Power appliance[s]" (CENELEC, 2017). While development of most of the standard's elements proceeded relatively smoothly, there were major conflicts regarding the energy efficiency calculation methods:

> Within standardisation, the range of opinions about calculating the efficiency was, in my opinion, the biggest problem. (translated from German)

These conflicts related to two fundamental issues: (1) There was disagreement about the formula which underlies the calculation and for which different options were being discussed. (2) The way in which the European Commission was involved in the process was seen by most actors as exceeding the role that it should play in developing harmonised standards (also see the explanation of harmonised standards in Sect. 3.2.1).

Actors from the heating industry were the major players when developing EN 50465. Because this standard only covers mCHP appliances, parties who had high stakes in the technology (mostly overlapping with the actors covered in Sect. 5.1) dominated the relevant committees where it was developed. In addition, European consumer

[6] EN 50465 was an already existing standard on gas-powered fuel cells which was extended in scope to cover all mCHP appliances, rather than developing an entirely new standard to fill this gap.

and environment protection NGOs were involved although, according to the interviewees' depiction of the process, these actors did not have a major impact on the outcomes. The European Commission was not represented in the committees but nevertheless influenced the standard's development in a major way.

Below, we first outline the conflicting positions regarding the calculation method. We then summarise the conflicts between the heating industry and the European Commission during the development process. The chapter then ends by describing the process's outcome and giving an outlook to future developments expected by our interviewees.

5.2.2.1 Conflicting Positions Regarding the Calculation Method

Deriving a calculation method to assess mCHP appliances' efficiency was not trivial because this formula needed to incorporate both the heat and electricity produced by mCHP appliances and at the same time give a result which would allow a meaningful comparison with other heating technologies for consumers:

> And now you have an additional problem: How do you grade this new segment, which delivers two forms of energy as an output, among the existing heat generators and energy products? (translated from German)

Consequently, there were different views regarding how the electricity produced by an mCHP appliance should be rewarded when assessing the appliance's energy efficiency:

> There were companies who wanted to have this calculated in specific ways. We even had three different methods before we finally agreed on one in a compromise [within the industry association]. (translated from German)

Most of the industry agreed on this compromise, which was developed in standardisation committees and industry association's working groups. However, a minority of industry actors including one major appliance manufacturer (also see Sect. 5.1.3) was in favour of a different method, which was also supported by the European Commission. These different preferences for calculation methods resulted from different views on how to consider aspects like the produced electricity, reduced needs for electricity from (relatively inefficient) power stations, and where to draw the boundary of the system for the purpose of assessing its efficiency:

> There were long discussions about where the system boundary of the appliance lies. How do you actually calculate the efficiency of such a Stirling product? Do you include the efficiency of the boiler or do you only take the efficiency [of the Stirling engine]? And finally, we brought ourselves to write into the standard that the entire system is considered. (translated from German)

The parties disagreeing with the industry compromise argued that using this formula is inappropriate for assessing an mCHP appliance and that the underlying approach would only be suitable for assessing the energy efficiency of an entire building but not of a standalone heating appliance. They accused other actors in the industry to push this formula through in order to make their appliances look more energy efficient than they actually are, stating that "*this no longer has anything to do with physics [and] is all about marketing*" (translated from German).

On the other hand, interviewees supporting the industry compromise argued that this was the best way to reflect physical realities and ensure that the results enable consumers to compare mCHP to other technologies. They claimed that the alternative formula did not sufficiently factor in the electricity produced by mCHP appliances in addition to heat.

> And this [the alternative formula] was in such a way that electrical heat pump s were clearly treated preferentially in the resulting efficiency values, compared to micro CHP. And then we intervened and said: 'The micro CHP appliance cannot be nearly put on the same level as classic condensing boilers. And a heat pump has an efficiency value up to a third higher compared to the micro CHP, this is not reasonable.' That a heat pump has a higher efficiency than a classic condensing boiler is clear. (…) This is absolutely OK. But how does an mCHP appliance fit into this? (translated from German)

This view of the alternative calculation method being wrong was also supported by an interviewee at an academic engineering research institute based at a German university:

> One of the colleagues made a nice example calculation. (…) Same primary energy in, (…) identical amount of useful energy out. And then he (…) applied the EU calculation for the labels. And for a heat pump-based solution he got an A++and for the micro CHP-based solution, he got an A+. This means that the methodology of the European Commission is wrong insofar that two different technologies generate the same useful energy

> with the same input of primary energy but get different labels. And there, the working group said: 'No that cannot be the case, this is physically wrong. And it is also confusing the customer.' (translated from German)

5.2.2.2 Interactions Between the Industry and the European Commission

Throughout the standardisation process (including before a formal standardisation request was made to CEN/CENELEC), the European Commission promoted an—in most interviewees' eyes—unjustified calculation. Together with the 'group dynamics' outlined in Sect. 5.1.3, this caused strong resistance among mCHP's developers and also made the topic highly emotional for some of them. In their view, the European Commission had overstepped their role in supporting this contentious formula which they saw as problematic:

> There was a high level of frustration within the standardisation committee because the engineers simply said: 'Hey, we are (…) calculating in the physically correct way. And if anybody can calculate correctly, that is us, the engineers, and not the civil servants. (translated from German)

> It is not so easy for them [the European Commission] to see what their real role is. You see a kind of imperialistic approach. On the one hand, the Commission wants to regulate technical details and technical content which is not according to the New Approach and where they don't see their role. Are they a stakeholder? Are they forcing something? So, I think (…) there's a problem area here.

Initially in the process, the industry faced unclear guidelines from the European Commission:

> At certain moments in that standardisation group we saw [that] we seem to be shooting at a moving target. There was from the side of the Commission and the consultant, which the Commission had appointed, a kind of calculation model which became more complex and more complex and more complex (…). And then, at a certain moment, the Commission changed their ideas about the calculation procedure and then it seemed that we were (…) shooting at a moving target. So then, in the standardisation committee, we said 'we will put this on ice for a certain time, first see where the Commission will move and where the negotiations between the associations and the Commission will move'. And then, finally, we had an agreement with the Commission that we would propose a standard and then we would discuss it. And then we went ahead and took the initiative again.

As the ambiguity of the European Commission's position on this issue eventually ended, it became obvious that the European Commission favoured a different calculation method than the compromise supported by most of the industry (see above). Given this situation, the members of the standardisation committee nominated two representatives (one of our interviewees at an appliance manufacturer and the consultant who accompanied the industry) to negotiate directly with the European Commission (also see Sect. 5.1.2). Both of them described these negotiations as very difficult because the process was lacking transparency from their perspective. They had the impression that other parties' lobbying and political interests not directly connected to mCHP influenced the European Commission's position to a large extent, but it was not transparent to them who was behind this influence and which arguments were used by these parties. Nevertheless, there was a clearly visible bias in favour of renewable energies at the expense of mCHP:

> I have seen many drafts [from the European Commission] of these requirements over the last five years. And in one draft, they had an explanatory memorandum. And there (…) they said: 'Micro CHP is an efficient technology but it is not renewable, it is not solar or wind power (…). And therefore (…) it should come to a result which is lower than renewable.' And then they said 'renewable is defined if the efficiency is at minimum 115%, so the efficiency should be below 115%'. Completely not logical, and it shows indeed that they were very biased.
>
> And finally, at some point there was a comment from the European Commission – of course only verbally and not in writing – 'we don't need to discuss this anymore, micro CHP ought not be better than A+, full stop.' (translated from German)

The European Commission's support for its preferred calculation method was documented in Commission Communication 2014/C 207/02 (European Commission, 2014).[7] This communication took many actors in the industry by surprise:

> I saw the latest draft which was going to the parliament and then I saw these words and I thought: 'Oh, what now? Now they're choosing already

[7] Such a Commission Communication is an official document where the European Commission outlines its policy on a specific topic (Overy, 2016).

> although we had the agreement that we would first have a discussion and then be able to exchange arguments etcetera. And now they have done it this way.' So at first instance, it was very disappointing.

Around ten months after publishing the Commission Communication with its preferred calculation method, the European Commission released a formal Standardisation Request on the matter (European Commission, 2015).[8] This request asked industry, among other things, to develop a standard that specifies energy efficiency calculation methods for mCHP. Several interviewees pointed out that this request was released with a tight deadline and "*came when the standard was finished almost*". Furthermore, they mentioned that the earlier events implied that the standard was expected to use the European Commission's calculation method as a foregone conclusion.

While this conflict with the European Commission was ongoing, there were also discussions within the industry about the best way to proceed. As part of this process, some actors sought expert advice about the legal implications of a Commission Communication, which revealed that it was only an opinion of the European Commission and was not legally binding. This encouraged these actors to keep pursuing the compromise found earlier within the industry. However, other actors were in favour of proceeding with the European Commission's formula, as the following exemplary quote from our interview with a representative of the industry association shows:

> There were definitely also different opinions [in the industry]. And some also gave up and said: 'No, this is not the way it goes. I am sticking my head in the sand, just do whatever you want.' Again, the standard is [based on industry] consensus and all [industry actors] committed to it. But especially for the efficiency calculation [where] the Commission had different ideas, there also were actors [who said] 'it doesn't matter what our opinion on this is, the Commission wants this and then we do this'. And there were others who said: 'No, we don't do it this way. We got an answer from the Commission which (…) in our opinion is completely wrong. We want it our way.' (…) We had two meetings with heated discussions about which method is more correct. (translated from German)

[8]The European Commission uses Standardisation Requests to initiate development of standards needed to support 'essential requirements' in European directives with the intention to harmonise the resulting standards (see Sect. 3.2.1).

Much of this discussion revolved around whether to prioritise the standard's harmonisation or a physically correct calculation of mCHP's energy efficiency. One interviewee highlighted that it was foreseeable that the European Commission would not harmonise a standard with the formula favoured by most of the industry. According to this position, which was shared at the time by the British national mirror committee, it could not be in the interest of anyone in the industry to develop a standard that would eventually not be harmonised by the European Commission. Other interviewees did not see this as a major problem. Because the energy labels are based on self-declaration,[9] appliance manufacturers would be able to choose which formula to base their labels on, even if the standard was not harmonised. In this scenario, it was uncertain whether and how the national market surveillance authorities would react but the majority of the industry considered the risk of negative consequences small. They expected that applying a standard developed by an ESO would give them good arguments in a hypothetical investigation by the market surveillance authorities, even if the standard was not aligned with the European Commission's position.[10] They therefore saw an—in their eyes—fairer calculation method as more important than the standard being harmonised under the ErP and Energy Labelling Directives. In addition, they expected that the product standard could still be harmonised under the Gas Appliance Directive due to its gas-safety-aspects.

At the end of these discussions, the supporters of the European Commission's calculation method were outnumbered and the committee put a draft standard to vote at CEN/CENELEC. This draft included the energy efficiency formula supported by the majority of the industry and was transparent about the issues in the standardisation process. This caused the European Commission to intervene in CEN/CENELEC's voting process, although this intervention was eventually unsuccessful:

[9] This means that companies may calculate their products' efficiency themselves and use the appropriate energy label. Notified bodies are not needed for certifying a product's energy efficiency.

[10] One interviewee deviated from this position: In his opinion, especially in the wake of the Volkswagen Diesel scandal, the industry should avoid any semblance of making its own rules in the matter which deviate from regulation. However, the majority of actors in the industry argued that an—in their eyes—physically correct formula was more important, also from these ethical and public opinion points of view.

> Finally, we have written a foreword to the standard to make completely transparent – for the people who had to vote on the standard – that the standard was deferring from the Commission Communication, which is an opinion of the Commission without binding effect. And the standard was finally accepted but the Commission several times tried to intervene and really obstruct the voting process. So, they first asked – (…) As joint working groups, as technical committee, we had decided 'we are going for a formal vote'. We sent it to CENELEC for formal vote and first the Commission asked CENELEC not to send it for formal vote but CENELEC did. Then, they asked CENELEC to stop formal vote, even in the middle of the process. And finally, in the last step, after the vote was positive, there was a ratification by the technical board of CENELEC. And they tried to influence the technical board not to ratify the standard. So, in fact, three times they really tried to obstruct the standard and they didn't succeed.
>
> There also was the story that CEN/CENELEC published the standard and the EU Commission reprimanded CEN 'how can you publish something that has nothing to do with our mandate?' Whereupon the top level of CEN got into the game and said: 'Just a moment, slowly. You may give us a mandate but we are completely independent about how we write our standards and what we write in them. Because it is <u>us</u> who have the technical expertise, and you don't.' There was a quite interesting exchange of letters between the Commission and CEN where the top level of CEN distanced itself and said (…): '<u>We</u> are writing technical standards. And if our engineers consider this standard correct from a technical point of view, then it <u>is</u> correct from a technical point of view.' (translated from German)

5.2.2.3 Outcome of the Conflicts and Outlook to Future Developments

Looking back at the process, most interviewees remained critical of the European Commission's role. However, two interviewees in particular also reflected critically on the industry's activities. One of these interviewees questioned whether it was wise to accept the European Commission's standardisation request, given the development of the process up to that point:

> The problem is that one does not (…) occupy oneself sufficiently with the mandates [before accepting them]. The mandate goes to CEN/CENELEC, goes to the working groups [and] the committees, there is an appeal period when one can say 'this is nonsense, we are not interested'. This did not happen in this case and then, at some point, [the mandate]

> is accepted. And then it is on the table and one is stuffed. (translated from German)

The second interviewee concluded that involving additional stakeholders in the process might have been helpful in addressing the issues with the European Commission:

> This clearly is something that did not go well. Maybe, we would have had to involve the national governments much stronger? Because the Commission is not deciding on its own and it is always easy to say 'yes, the European Commission (…), that circle does not appreciate our course of action'. But if we had activated the country representatives of different countries at an early stage, for example [commissioner] Oettinger in our case… (translated from German)

Nevertheless, EN 50465 was eventually published including the calculation method favoured by most of the industry. As foreseen during the standardisation process, this meant that the European Commission did not harmonise the standard under the ErP and Energy Labelling Directives. When the standard was published, the UK mirror committee included a national foreword in line with its earlier position in the British version of the standard, advising against the use of the calculation method included in the standard:

> The UK committee advises, for the calculation of μs and μson of cogeneration space heaters the methodology described in the Commission Communication, reference 2014/C 207/02 should be used. This method is robust, scientific, provides a fair comparison across all technologies and is aligned with the established methods for assessing and comparing cogeneration performance. (BSI, 2015)[11]

[11] Clearly, the foreword to the standard was written before the Brexit referendum… Nevertheless, some interviewees also found this remarkable:

> *Interviewee*: As I already said, as often in Europe, the Brits think that they need to do their own thing. And they do this thoroughly.
> *Interviewer*: (Laughing) Only this time with the unique situation that they share an opinion with the European Commission.
> *Interviewee*: Yes, in this case they agree with the European Commission. This really is – one should make a big poster of this and put it up on the wall somewhere. Happens seldom enough… (translated from German)

Despite this standard not being harmonised, most companies in the industry have so far been using it in calculating their appliances' energy efficiency for the self-declared energy label without negative consequences from the national market surveillance authorities:

> The Ecodesign and the Energy Labelling Legislation have started to be applicable from September 2015, so that is two years ago now. And I think (…) the vast majority of companies have been using the standard and also the calculation method of the standard. I know of one exception which is using the Commission Communication and the regulation and which really, I think, is using it to their own advantage.

In our final interview in August 2017, we also learned that the European Commission has in the meantime started its regular review of the directives in question. As part of this review, the Commission also ordered an assessment of the directives' impacts:

> *Interviewee*: Currently, the process of review of the legislation is starting, or has started some months ago. The European Commission has already announced that to us as CHP representatives. Now the regulation is written but then you have new chances. They had their attempt to change physics but they were open for review and improvements of the legislation during that official review, which was announced that it should be ready, I think, five years after adoption of the regulation. (…) At least, they have ordered a consultant to make an evaluation. (…)
>
> *Interviewer*: And then, potentially it could be harmonised after the review changes this legislation?
>
> *Interviewee*: Yes, perhaps. Or, perhaps, the legislation will even be changed more so that the other standards have to follow anyhow.

Depending on this assessment's outcome, the European Commission may therefore change its position on the calculation formula. In addition, fundamental changes to the directives are also possible, if the review finds that they need to be improved. This outcome would possibly also require the industry to develop entirely different standards. The future development of this issue is therefore still open.

5.3 Interviewees' Evaluation of the mCHP Case

In Chapter 3, we presented the various ways in which standards and regulation influenced the development of mCHP, which triggered the extensive company- and industry-level activities depicted in Chapter 4, Sects. 5.1 and 5.2. We also asked every interviewee to evaluate the effects of these activities on mCHP and the relevant standards and regulation. Because all mCHP appliances must fulfil the same set of requirements, these evaluations were similar across manufacturers despite the sometimes-different approaches to managing standards and regulation.

Most applicable standards and regulation were already available and supported mCHP's development before the industry actors initiated their activities (see Chapter 3). These activities therefore mainly focussed on topics where standards and regulation were still missing and/or not supporting mCHP. Because of these efforts, standards and regulation now support mCHP technology in three additional ways: (1) The new requirements for access to the electricity grid provide a workable solution to connect mCHP appliances to the grid. (2) The new product standard defines requirements for safety, energy efficiency, and related topics for mCHP, which support conformity assessment of the technology. (3) Despite the conflicts with the European Commission detailed in Sect. 5.2, the energy efficiency calculation methods in the product standard support the industry in fulfilling the requirements of the European directives related to energy efficiency. Furthermore, some interviewees also mentioned supporting effects of these new standards beyond now being able to fulfil regulatory requirements. They also help the companies in the field to communicate the technology's benefits to their customers and provide confidence to adopters of the innovation.

These changes in standards and regulation enabled the industry to market mCHP appliances in Europe. All interviewees at major manufacturers stressed the importance of aligning their company-level management with the industry-level work to reach this outcome, estimating that they might even not have been able to sell mCHP products at all in the European market without the activities at both levels:

> *Interviewer*: Can you already estimate whether this collaboration between new product development and standardisation was successful or not? Or is the result still pending?
>
> *Interviewee 1*: This is positive.

Interviewee 2: Yes.
Interviewee 1: It definitely is. We can say that we most likely would not have a product if one had not intensively worked on this. This is definitely very, very crucial, also specifically the network connection requirements (…). It could absolutely have been the case, if we had not worked on this topic and had not been interested in it, that we would not have had a product at some stage. Or a product that does not conform to these standards.
Interviewee 2: This could have happened, yes.
Interviewer: OK, this means that the worst-case-scenario would be that you could not sell it?
Interviewee 2: Yes, exactly.
Interviewee 1: Exactly, exactly. (translated from German)

Consequently, apart from one company which favoured other technologies in its product portfolio, the interviewed major appliance manufacturers have mCHP appliances in the market at the time of writing. While some companies exited the development of Stirling-based mCHP appliances (see Sect. 2.2.2), this was due to reasons unrelated to standards and regulation.

Although the smaller companies did not participate in the industry-level activities to develop standards and regulation, they still benefitted from the changes that resulted from these activities. While the interviewed start-ups did not yet produce mCHP appliances at full commercial scale when we interviewed them, they were confident that their products could be marketed under the partly revised requirements from standards and regulation:

> Last year, we reached a milestone which was important for us. We received the CE batch approval for the system. This means that we can install the system in limited numbers across Europe. The next step, which we are taking in parallel to the system's market introduction, is that we seek the full CE mark. This means that we can build an unlimited number of appliances but on the other hand we may then change nothing on the appliance [without having to re-certify it]. (translated from German)

> As I already said, we are now at the stage of commercialising [where] it [the appliance] goes to the first customers and the first field tests [and] once it goes out, everything will be 100 per cent adapted to the standards. (translated from German)

In line with these results, the interviewees generally were very happy with the outcomes of their activities but had reservations about the needed steps to get there, as the following quote summarises:

> I'm happy with the results [of the process], I'm not often happy with what we needed to do to get these results. Sometimes, it was really tough and time-consuming, and involving a lot of lobby work and convincing people etcetera. It would have been nice if that had been more efficient.

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