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Centre for an Energy Efficient and Competitive Industry for the Future

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Abstract

This handbook is the output of Shared Resources – a research project within the FME High EFF (Centre for an Energy Efficient and Competitive industry for the Future) – aiming to explore new possibilities and enablers for resource and energy collaborations in Norwegian industry. The handbook focuses on guiding businesses into establishing energy collaborations when it is reasonably easy to do so which is when it is technically feasible, the different partners' needs and values are compatible, and when such a partnership is close to being profitable.

The handbook is divided into the several chapters and appendices. Chapter 1 consists of an introduction where the project background and main stances are presented. Chapter 2 provides a brief introduction to resource and energy collaboration. Chapter 3 outlines a step-by-step guideline to establish and perform energy and resource collaborations. Chapter 4 sums up the identified enablers for resource and energy collaboration. This handbook also contains several appendices with additional information on issues not in the core of the handbook, for those who seek more in-depth descriptions.

Executive summary

This handbook is the output of *Shared Resources*, a research project aiming to explore new possibilities and enablers for resource and energy collaborations in Norwegian industry. *Shared Resources* has focused on the "low hanging fruits", that is, the cases in which collaboration is technically feasible, close to being profitable and reasonably easy to do so – when the different partners needs and values are compatible. The project has been carried out by NTNU Samfunnsforskning in collaboration with the Department of Industrial Economics and Technology Management, and funded by the Centre for an Energy Efficient and Competitive Industry for the Future (hereafter HighEFF). HighEFF partners and local stakeholders have played an important role in sharing experiences and knowledge about energy collaborations.

This handbook aims to provide HighEFF partners and other readers with the following:

- An understanding of what is involved in a resource and energy collaboration
- When and why such collaborations are useful to your business
- Steps required to implement collaborative contracting that meets your business demands
- A list of enablers that can facilitate resource collaboration with other businesses and make it economically profitable

The handbook is divided into the several chapters and appendixes. **Chapter 1** consists of an introduction where the project background and approach are presented. The departing point was the observed lack of energy and resource collaborations in the Norwegian industry. The project's objective was to shift the focus away from barriers and challenges to enablers by providing an overview of ideas and tips that could increase the possibilities for successful inter-organisational agreements on reuse of surplus energy. To do so, the project mapped experiences and explored new ideas for elements to be included in such arrangements – including alternative business models, contract elements and value creating options beyond the traditional buying and selling of surplus energy.

Chapter 2 provides a brief **introduction to resource and energy collaboration**. Various types and differences in resource and energy collaborations are discussed. In particular, the four dimensions that are found particularly important when establishing such collaborations and therefore important to consider at an early stage, namely: contractual aspects, actors involved, location; and energy characteristics. The first two dimensions are related to preferred form of collaboration, while the latter two concern opportunities and limitations for possible collaborations. Furthermore, the chapter includes a brief account of the different case studies and different sources and methods through which empirical data was gathered – internal collaboration with HighEFF; mapping of two main cases (Elkem Salten and Alcoa Mosjøen) and four secondary ones; and interviews with 18 relevant informants. Finally, a list of enablers identified through the project are presented.

Chapter 3 outlines a **step-by-step guideline to establish and perform energy and resource collaborations**. The guideline comprises a set of four stages and an array of factors that build a *foundation for potential future collaboration*. Such factors can be grouped into three categories: culture and values; innovative environments; and external relations. *Stage 1* deals with the *opportunities and possibilities (and potential downsides)* for energy collaboration. The primary goal is to map the different ways in which the energy surplus can create value. There are five key issues for value-related consideration: characteristics of

the energy, value proposition factors, public incentives schemes and external elements. *Stage 2* aims to find *potential actors* that may be interested in energy and resource sharing partnership. There are two major categories of potential partners: main partners –energy surplus producer or user; and other relevant partners and stakeholders – those who might benefit from the establishment of the collaboration and want to contribute to its realisation. *Stage 3* is concerned with suitable contract forms and *negotiation between (main) partners*. The contract form should comprise several and interrelated elements defining ownership, pricing, potential spillover-effects, the added value and the regulations; as well as crosscutting issues such as risk, power, time dimensions, and termination aspects. Finally, *stage 4* describes important aspects for the successful *implementation and operation of the energy and resource collaboration* such as: understanding, anchoring and commitment.

Chapter 4 sums up the **enablers for resource and energy collaboration** identified in the project and suggested throughout the handbook. The enablers are shorted by phase: before, during and after the establishment and over time.   This handbook also contains several appendices with additional information on issues not in the core of the handbook, for those who seek more in-depth descriptions.

Appendix A presents a taxonomy of barriers and enablers for developing and implementing energy efficient technology in the industry based on the insights gathered in three workshops organized by HighEFF in 2017 with different industries –food and chemical sector, metal and materials sector, and oil and gas sector. **Appendix B** describes the characteristics and issues of interest of each of the project's case studies, namely: ALCOA Mosjøen and Elkem Salten. **Appendix C** deals with energy management, i.e. the forecasting and administration of both energy production and consumption units. It presents different energy management contracts: contract without Energy Service Companies (ESCO); contract with ESCO; energy performance contract; energy supply contract; bilateral contract; time-of-use contract; and the subcontractor model. **Appendix D** explains two major strategies in negotiation: 1) distributive and (2) integrative. The *distributive* approach is typically viewed in the light of the 'fixed-pie' or 'win-lose' dichotomy, which emphasises that there are a limited number of ways to distribute goods or settle disputes within any given area of interest. The integrative approach to negotiation is based on outcomes being reached that provide high levels of satisfaction for all parties and 'expand the pie'. Finally, **Appendix E** presents a comprehensive list of dimensions and factors potentially affecting circular economy business models.

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1 Introduction

1.1 Background

This handbook is the output of *Shared Resources*, a research project aiming to explore new possibilities and enablers for resource and energy collaborations in Norwegian industry. The project has been carried out by NTNU Samfunnsforskning in collaboration with the Department of Industrial Economics and Technology Management, and funded by the Centre for an Energy Efficient and Competitive Industry for the Future (hereafter HighEFF). Industrial HighEFF partners and local stakeholders have played an important role in sharing experiences and knowledge about energy collaborations.

HighEFF has the ambition to spearhead the development of emerging, energy efficient and cross-sectorial technologies for the industry with the following purposes: supporting industry to meet the EU target of 40 % reduction in greenhouse gases and at least 27 % increase in energy efficiency by 2030; increasing the competitiveness of Norwegian industry through development of energy and cost efficient plant operations, energy recovery and utilisation of surplus heat; enabling 27 % reduction in energy use in the Norwegian industry by 2030; and enabling competence building and recruitment of experts within energy efficiency. One way in which to meet these challenges is through increased utilization of surplus heat from industry.

1.2 The re-use of by-products: From challenges to enablers

The project's departure point is the observed potential for more energy and resource collaboration in Norwegian industry. This project is concerned with the exploitation of industrial surplus heat, which is a common by-product from combustion and energy intensive production processes. Despite the large potential for reutilisation, surplus heat is often released into the ambient (air and water). Access to cheap energy is seldom a sufficient incentive to establish reutilisation agreements, since the savings in energy costs are simply not enough to bear the costs of neccessary infrastructure. Moreover, geographical proximity is normally a prerequisite for the utilisation of surplus heat, but due to the localisation of most of the energy intensive industry in Norway, there is relatively limited heat demand in the surrounding areas. Thus, the utilisation of surplus heat across companies is rather poor.

Previous projects have identified an array of barriers that restrain these types of energy collaborations in Norwegian industry, including organisational, technical, economic and cultural (see Appendix A for a more detailed description of barriers). The aim of this project, however, is to shift the focus away from barriers and challenges to enablers. The objective is to provide an overview of ideas and enablers that can increase the possibilities for successful inter-organisational agreements on reuse of surplus energy. To do so, the project has mapped experiences and explored new ideas for elements to be included in such arrangements – including alternative business models, contract elements and value creating options beyond the traditional buying and selling of surplus energy. In particular, this project has focused on the "low hanging fruits", that is, the cases in which collaboration is technically feasible and close to being profitable.

1.3 From business models to collaborative contract strategies

A business model is a description of a company's activities, and the costs and revenues associated with these. It describes where and how costs are generated, and where and how values are created and captured. It also describes how the activity or product is to create value for the customer (Aasen & Amundsen, 2011). Thus, a business model also reflects a company's expectations of customer needs. Value does not only refer to financial value, but also includes social, cultural and other types of value.

Developing business models is a key part of a company's strategy, and involves mapping out all available resources and how these should be used for the business to achieve its goals (Aasen & Amundsen, 2011).

The term business model came into prominence in the internet era, as many new business models were based on internet marketing strategies.

General theories on business model generation typically focus on identifying sources of costs and revenues; key activities and collaboration partners; and the customer base and how to reach it (see e.g. Osterwalder & Pigneur, 2010; Wolcott & Lippitz, 2009). Having a structured process helps companies to realise their visions in a economically viable way. Business models range widely in terms of content and development process (Osterwalder & Pigneur, 2010; Wolcott & Lippitz, 2009), as companies vary greatly in production methods and how they operate in the market. Examples include models of manufacturing, distribution and franchising. One single company can also hold several business models. If a company profits from different brands, products or services, it often develops and implements one business model for each line of business.

The following classification is loosely based on Osterwalder and Pigneur's (2010) business model canvas, applied to an example illustrating certain key elements of the business model for a company having excess heat end energy (based on the case studies in this project). What distinguishes the way we use and develop business models in this handbook, compared with such tasks in general, is that the main idea in these cases is *not* to conquer and expand a market, but to establish an agreement for energy collaboration.

Key partners

The main partner is the company holding the surplus energy – the owner of this business model. Partners are companies that may utilise this energy, as well as other companies that have an interest in this arrangement. Examples of partners in joint business opportunities and collaborations include:

- Energy customer (see below)
- Financial institutions
- Public authorities – urban planners and decision-makers
- Owners of large buildings and infrastructure

Key Resources

- Excess heat
- Electricity (produced from own excess heat)
- Other supplements that can be included to achieve broader exchange arrangements (physical, financial or intellectual). These add-ons can be what changes the collaboration from non-profitable to profitable. Examples are listed in chapter 3.2.

Key activities

This involves the activities that the partners plan to conduct together. Relevant examples include:

- Deliver excess heat (amount, continuity, quality, etc.)
- Produce electricity
- Establish connection with and/or between stakeholders
- Preproduction and planning
- Other activities resulting from possible add-ons in the agreement, e.g. providing storage, experts, laboratories (se chap.3.2).

Customers

Classical business theory also describes the potential customer segments that are involved. Examples include:

- Other industry
    - Horticulture
    - Aquaculture

    - Food processing
    - Clothing
    - Etc.
- Building owners
    - Public: schools, hospitals, offices etc
    - Private: residential areas, office buildings, shoppping centres, airports, industry, etc
- Local district heating (DH) utility

Channels

Different channels through which the customer base can be targeted. Examples include:

- Private agreements – industry to industry or industry to public (large customers)
- Public/private coop – housing areas (small customer)
- General promotion – visits, website, emails, etc.
- District heating infrastructure – invoice, customer support

Customer relations

The running relationships between the partners and their customer base. Examples include:

- Cooperation with partner industries
- Mass market
    - Electricity
    - District heating
- Cooperation with public authorities
- Degrees of assistance – automated services, personal assistance, etc.
- Personal assistance (large customer)
- Automated service and self-service (small customers)

Value proposition

The mapping of stakeholders, activities and resources should result in an overall value proposition, describing the total benefits of the model for the parties involved. This includes creating and capturing value in economic, environmental, social, cultural or other contexts. Examples include:

- Stable secure supply, long term prices, low maintenance, ease and comfort
- Political benefits: domestic production, public health, innovation potential
- Environmental benefits: renewable, low emissions
- Social benefits: Increased activities in local community, jobs

The final value proposition also defines the financial flows of costs and revenues that the business model will include.

In this handbook, these theoretical models, while having substantial merit, may be too general for the purpose. *Shared Resources* mainly focuses on the supply side, as the stakeholders involved often may be included as partners rather than customers or as markets to conquer. The partners involved in resource sharing activities can be more broadly defined than what is most usually recognized. A district heating company may, for instance, in principle be defined either as a supplier or a demander of heat, based on the chosen collaboration model. Also, the sharing of resources in a broad context it will be dependent on developing relations that do not already exist. For this reason, this report is inspired by **inter-organisational collaboration** and **collaborative contracting** approaches.

Furthermore, the focus of a traditional business model is on a single organisation and can therefore be characterised as narrow. Experience from the last few decades demonstrates that some of the most successful companies' business models can be characterized as wide, tacking the form of network-based business ecosystems where different players are interdependent (*BRU21 Better Resource Utilization in the 21st century*, NTNU Strategy for Oil and Gas. 2017. NTNU). One important driver for better business models of complex, adaptive, platform-based economic systems, will be to redefine the relationship between companies and suppliers, by understanding the organisational field as a network-driven economic system, and transforming the basic character of buyer-supplier relationships from zero sum games to profitable partnerships. One of the most obvious targets stemming from this will be to develop new contract models for projects. Traditional business models often fail to include stakeholders that may be important in the present context, e.g., local interest groups, neighbours, competitors, environmental organisations, and local or central governments. These may potentially be included as partners in a resource sharing collaboration, to ensure public support for projects that may have broad societal impact and may also demand goodwill from planning authorities and involvement of public support schemes.

Following this, we focus mainly on the **key partners**, **key activities**, and **key resources** side of the canvas, and put emphasis on models of collaboration, rather than the capturing of existing markets. We choose to describe different forms of partnerships, starting from the simplest situation where there is one provider and one receiver of the resource, and expanding to include several stakeholders, such as contractors, intermediaries, financial institutions, multiple customers and the general society.

1.4 Handbook structure

This report aims to provide HighEFF partners and other readers with the following:

- An understanding of what is involved in a resource and energy collaboration
- When and why such collaborations are useful to your business
- Steps required to implement collaborative contracting that meets your business demands
- A list of enablers that can facilitate resource collaboration with other businesses and make it economically profitable

In order to do so, the rest of the handbook is divided into the several chapters and appendices. Chapter 2 provides a brief introduction to resource and energy collaboration. Chapter 3 outlines a step-by-step guideline to establish and perform energy and resource collaborations. Chapter 4 sums up the identified enablers for resource and energy collaboration. This handbook also contains several appendices with additional information on issues not in the core of the handbook, for those who seek more in-depth descriptions.

2 Resource and energy collaboration?

To establish an energy collaboration, one must know what that entails. The purpose of this chapter is to provide an insight into the elements of energy collaboration, and its limitations and opportunities. We will provide you with information about different types of resource collaborations and reasons for entering such collaborations. At the end of the chapter is a list of challenges/barriers for entering such collaborations with handling oppurtunities/enablers to overcome them, based on data collected through HighEFF.

2.1 Resource and energy collaborations – What and why

Resource and energy collaboration is an arrangement in which at least two parties (e.g. industries, local authorities) exchange energy, wastes and other resources for the benefit of all parties involved. Benefits may vary greatly and can comprise economic savings, waste reduction, new opportunities and reduced negative environmental impact. Resource and energy collaborations is one of the key elements in the ongoing shift from linear to circular economies – from "take – make – dispose" models to forms where resources are kept in use for as long as possible.

So why should your company support resource exchange? It can provide a good opportunity to work together with one or more parties toward a common goal, with project and organisational objectives. These collaborations can range from informal to formal agreements, with lengthy contracts in which the parties may also exchange equity, or contribute capital to form a joint venture. These collaborations should bring benefits for all parties involved. Business and other relevant actors may enter into resource collaboration and/or exchange arrangements for a number of different reasons, such as:

- Environmental concerns (e.g. energy efficiency, regulations and quotas)
- Access to resources (e.g. energy, bi-products)
- Potential economic benefits, including net cost savings (e.g. change in the cost of virgin inputs, waste management, operations, transportation and transactions) and revenue (e.g. by-product sales)
- Reputation (stakeholder pressure)
- Access to new knowledge and critical expertise
- Local and regional development (e.g. goodwill, job creation, local community support)

2.2 Types and differences in resource and energy collaborations

Resource and energy collaborations may take several forms, enganging different types of resources and involving different types of actors. This handbook focuses primarily on collaboration concerning reuse of surplus energy from Norwegian industries. There are four dimensions that are found particulary important when establishing such collaborations and therefore important to consider at an early stage. The first two dimensisons are related to preferred form of collaboration, while the latter two concern opportunities and limitations for possible collaborations.

1. Contractual aspects

a) Non-equity collaborations: an alliance between two or more companies, aimed at achieving a common objective by coordinating efforts, while each party retains its organisational independence and no new equity entity or corporation is created.
b) Equity collaborations: an agreement between two or more companies to enter into a separate business venture together, thereby sharing more equity ownership and voting power with partners.

Alliances can be defined as medium and long-term agreements between companies, which involves the mutual transfer of resources with or without administrative structure.

2. Actors involved

a) Bilateral collaboration: involving just two partners
b) Multilateral collaboration: involving more than two partners
c) Private collaboration: involving two or more private actors (e.g. industrial or commercial partners)
d) Hybrid collaboration: involving two or more actors from both public and private spheres (e.g. a municipality using industrial heat surplus for district heating)

3. Location

a) Brownfield: a previously developed location used for industrial or commercial purposes and with existing infrastructure. This is rarely the case in situations where this handbook will be used.
c) Greenfield: a location that has not been previously used for industrial or commercial purposes and where infrastructure has not been developed.
d) Urban areas: present larger energy use needs but are usually far removed from the surplus heat sources.
e) Rural areas: often where energy intensive industry is located, yet they have a relatively limited heat demand.

4. Energy characteristics

These are of importance for technical and operational compatibility of partners. More on this subject can be found in other deliverables from HighEFF (see: Deliverable 6.4_2018.01 *Cross-industry exploration for external utilization of waste heat*. HighEFF. SINTEF)

a) Type of energy:
   - Hot water (typical low-grade energy used in heat exchangers)
   - Steam (typical heat exchangers and electricity production)
   - Hot flue gas (typical heat exchangers, steam production)
   - Radiation
   - Work (e.g., pressure release)

Energy could be split into categories defined by energy levels (high-grade to low-grade), but since technology makes it possible to move from lower to higher levels (a matter of cost), we rather focus on the different sources of energy surplus. Each source has its advantages and the opportunities for use are further presented in Deliverable 6.4_2018.01 *Cross-industry exploration for external utilization of waste* heat. HighEFF. SINTEF.

b) Operational aspects which are particularly important for partner compatibility:
   - Batch or continuous production
   - Seasonal (or other) variations in energy supply/consume
   - Predictability in operation, and consequences of unexpected stops

2.3 Energy collaboration's challenges and enablers

This handbook is concerned with collaborations that are technically feasible – of the "low-hanging fruits" that could potentially be realized. Therefore, we are not addressing technological barriers. There are, however, other barriers limiting the potential for utilisation of excess heat and other resources. As a result, only a small share of the potential is realised. Processes to establish energy surplus collaboration might be complex, comprising many different stakeholders, timelines, high costs, risk, cultures, needs, etc., that need to be addressed and orchestrated. The utilisation of surplus heat might need large investments, thereby necessitating close collaboration with financial institutions and authorities that can offer financial support schemes. At the same time, the necessary infrastructure, e.g., to deliver heat to residential areas, requires planning and cooperation with public authorities. This may lead to long bureaucratic processes, such as the granting of different licenses and permits. The long planning horizon and high initial investments involve risk, which constrain the likelihood of going into collaboration. Indeed, such processes are characterised by uncertainty related to future marked conditions and energy prices, dependencies, stability of partners, viability, profit and survival in the long term, as well as political uncertainty. Insurance coverage and risk management solutions need to be considered. One possible solution is to divide the risk between different partners, yet the involvement of several partners also makes the decision process and its timing more complicated.

As mentioned earlier, our intention is to shift the focus away from barriers to enablers. To do so, we conducted case studies with selected HighEFF's industrial partners, in ordet to gather experiences and suggestions on how to overcome these barriers – and to shed light on possible enablers from which others can learn and be inspired.

Data collection and case studies

Data has been collected mainly by means of:

- Internal collaboration within HighEFF:
    - Building on the work of Research Activity 6 (RA6) from the basis for selected industries. RA 6 comprises HighEFF's case studies within different industries (metal and material; oil, gas and energy; food and chemical; and industry clusters).
    - Sharing empirical data (interviews with actors from aquaculture and greenhouse farming) with Research Activity 5 Society (RA5) – RA5 comprises HighEFF's innovation activities. This includes research on enablers and barriers for innovation and the realization of HighEFF technologies; innovation through workshops and conferences; and HighEFF's dissemination and communication with both internal and external stakeholders.
    - Interviews and meetings (incl. RA5 contribution)
    - Insights from reference group for case selection
    - Insights from HighEFF workshop (mini-workshops)
- Mapping existing relevant cases:
    - Two main cases: Elkem Salten and Alcoa Mosjøen (description of cases in Appendix B).
    - Four secondary cases (incl. one external case and cases in RA5)
- Interviews:
    - 18 informants representing a variety of actors from industry, local authorities and other local public and private actors with interest in the particular/potential energy collaboration.

There are barriers for resource and energy collaboration related to the economy and each company's financial situation, knowledge and competence level, technical challenges, management and bureaucracy, situational and operational issues. Through all the data sources mentioned, especially the two main case studies, we have identified several action opportunities/enablers that can be used to overcome these challenges. Main findings from the case studies are displayed in Table 1.

Table 1 List of enablers by challenge identified in the studied cases

BARRIERS	ACTION OPPORTUNITIES / ENABLERS
ECONOMIC/ FINANCIAL	– Financial support schemes from public authorities (e.g., ENOVA, regional and national authorities) – Financial opportunities for pilot projects (N.B. industrial parks can usually help with application processes) – Public instruments for risk management (e.g., local governments can provide payment guaranty for bank loans to carry out energy collaboration projects) – Risk management strategies (e.g., sharing risk among partners) – An open mindset regarding cost, risk and profitability considerations (e.g. a long-term perspective; socioeconomic profitability; alternative contract forms, business and price models; spillover effects and added value) – Expand range of exchanges and also include exchange of services (reduce costs by sharing/exchanging warehouse, equipment, special expertise, manpower pool, on-call services, administration services, HSE, canteen, etc.)
LACK OF KNOWLEDGE AND COMPETENCE	– Collaboration with other municipalities in the area to attract and share relevant competence – Collaboration with R&D and university sector (expertise on different areas, new graduates, summer jobs for students to map needs/opportunities, etc.) – Intra-organizational knowledge sharing on special areas (e.g., IT, logistics, automation, etc.) – Attract new expertise by promoting municipality as an attractive place to live for potential employees – Facilitate flexible working conditions to attract new expertise (e.g., shifts to commute, adjustable working load) – Promote and strengthen local competence by supporting local suppliers – Mainstreaming of circular economy content in curriculum (high school, business schools, engineering, etc.)
TECHNICAL CHALLENGES	– Investments in R&D – Collaboration with other companies/industries to solve technical challenges
MANAGEMENT	– Open mindsets (comprising long-term perspectives and pro R&D investements management) – De-centralized and community-oriented decision-making – Meeting arenas as greenhouse for new ideas (creating local environments for interaction among different actors) – Space and leeway for enthusiasts

BUREAUCRACY	– Facilitate easy and effective case processing – Promote close and long-term dialogue between local authorities and industries (beyond a specific case) – Take advantage of local actors "wearing different hats"
OPERATIONAL CHALLENGES	– Understanding and alignment of the partners' expectations, needs, and routines at early stage – Facilitate meeting arenas for employees at different levels of the organisation (including operators)

In the following section, the handbook provides a guideline comprising several steps. Our intention is that this guideline will both steer and inspire the Norwegian industry in their process of establishing energy and resource collaborations.

3 A Roadmap to Energy Collaboration

This section describes the main stages in establishing energy collaborations, specifically exchange and use of surplus heat. The handbook's premise is that such collaborations are technically feasible. This guideline is for those interested in utilising energy surplus, both in the demand and the supply sides. The stages are, however, written with the supply side in mind since surplus energy is the resource in focus and the natural point of departure for such collaborations. Furthermore, the fact that the majority of the energy surplus in Norway comes from the smelter industry limits the mobility of the supply side. Therefore, it is more realistic to assume that energy surplus users (demand side) have mobility capacity since geographical proximity is normally a prerequisite for resource sharing.

The process of establishing energy and resource collaborations is presented through a set of four stages. This is not a linear process, and sometimes several stages need to be paid attention to simultaneously. Minor loops and returns to previous stages are necessary to reconsider work and decisions in light of new information or as a result of the negotiation process (Figure 4). The roadmap starts with outlining some factors that might not be part of the process per se but are important as a foundation for the rest of the stages. Building such a foundation for potential future collaborations might be a continuous work. It is recommended to be aware of and work on this issues for all parties who consider entering into this form of collaboration at one time or another.

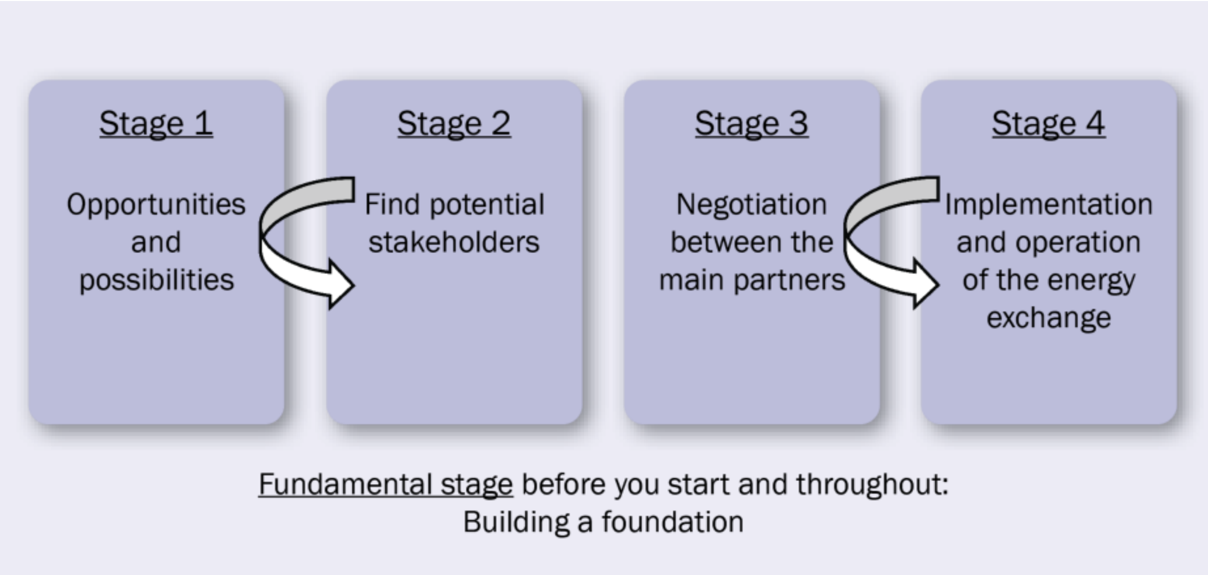


Figure 1 Important stages in energy collaboration processes

3.1 Building a foundation for potential future collaborations

There are several factors that may not be directly related to any of the steps involved in establishing and carrying out energy collaboration, yet are important in increasing awareness, promoting collaboration and/or facilitating a supporting foundation. Such factors may be grouped into three categories:

- **Culture and values**
  - Interest in energy efficiency at all levels of the company
  - Open-minded and pro-experimentation attitude that allows flexibility
  - Awareness of the company's role and position in the community
  - Ability to appreciate and seek value beyond economic profit

- **Innovative environments**
  - Proactive intrafirm R&D environment, increasing the potential to identify and engage in new opportunities (knowledge and expertise).
  - Management style that encourages and facilitates innovative energy collaboration projects (support creativity and original thinking)
  - Type of ownership that encourgages and facilitates collaboration initiatives
  - Room for enthusiasts
- **External relations**
  - Long-term relationships between different local actors in the community (good dialogue among e.g local authorities, industries and other important actors in order to identify and engage with new opportunities)
  - Reputation, goodwill and local engagement (industries can engage in the local community by sponsoring different cultural or sport initiatives, supporting employees' voluntary work in local development activities, etc.)
  - Collaboration with universities and other R&D environments (gaining access to knowledge and expertise, new workforce, master students, PhD students, etc.)
  - Knowledge about trends in society potential changes in regulations, plans for the local area that may facilitate or hinder energy collaborations (e.g. green public procurement requirements)
  - Up-to-date knowledge on environmental regulations
  - Up-to-date knowledge on public support schemes

3.2 Stage 1 – Opportunities and possibilities (and potential downsides)

Stage task:

Find out how and in which ways the utilisation of energy surplus can be valuable (reduce cost and generate profit), and search for other elements that can contribute to making the agreement profitable for all parties.

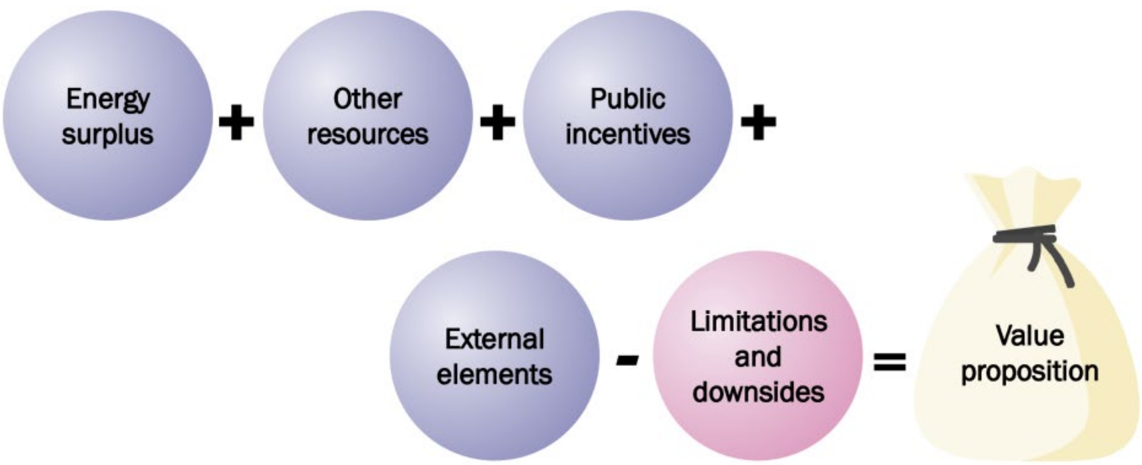


Figure 2 Value proposition in energy collaboration

Guiding questions:

- **In which ways can this resource be valuable for others?**
- **What is the potential value of this energy surplus?**
- **How to capture the value of it?**
- **What else can bring value to the collaboration?**
  - **What else do you have to offer potential partners?**
  - **What could a partner possibly offer you?**
- **What are the potential downsides of the energy collaboration?**

Important energy characteristics to be considered are:

- **Type of energy in its original form (gas, liquid, particles in the streams, radiation)**
- **Energy (flow, inlet/outlet temperatures, variations, etc.)**
- **Is it possible to root the stream of the site to a potential user (direct or indirect utilization of the heat)?**
- **Limitations and opportunities related to available surplus energy**

Other important factors

- **Possible areas available for placement of exchanger, infrastructure, new industry in the vicinity etc.**

This is an important stage, and a stage that has not been given sufficient attention in previous attempts to establish energy collaborations. The primary goal of this stage is to map the different ways in which the energy surplus can create value. To do so, it is important to understand the characteristics of the energy surplus, identify other possible value elements for the agreement, get a brief understanding of the value proposition (i.e. the potential opportunities and downsides that the external use of energy surplus and exchange of other services or resources can bring to the negotiation table), and establish an overview of the existing public incentives and other external issues that may both facilitate or hinder the establishment of such collaborations. Examples of additional elements that can be included in the agreements between the partners are listed below.

There are five key issues for value-related consideration:

1. **Characteristics of the energy**: It is important to be aware of the type of heat surplus at hand. This will define the type of collaboration that can be established. Important factors are: type of energy (low temperature heat, high temperature heat), energy amount (volume), characteristics of the energy production (continued or discontinued stream, variations, stability ad predictability) (see: Deliverable 6.4_2018.01. *Cross-industry exploration for external utilization of waste heat*. HighEFF. SINTEF and Johansen and Haavik (2019))
2. Other **types of resources and services** available that may be of relevance for the collaboration:

   - Excess heat
   - Energy/electricity back-up solutions
   - Waste and bi-products
   - Services (administration, HR, marketing, canteen, fire brigade, security services, second-call night duty, IT, purchasing and accounting, hire of external services etc.)
   - Lobbying

- Infrastructure (control room facilities, storage units, laboratories, offices and other buildings, harbour infrastructure, outdoor areas like parking, other type of infrastructure, etc.)
- Expert knowledge and competence (control room operations, manpower pool, etc.)
- Financial resources
- Transportation
- Equipment (special equipment, business equipment and inventory, etc.)

NB! This list is intended to serve as inspiration when searching for opportunities to increase the prospect of realising a collaboration

3. **Value proposition**: What are the potential opportunities and downsides of an exchange? Value can be economic (savings and/or earnings), , societal value (contributing to the local community by creating jobs), environmental value (increasing energy efficiency), and/or reputational.
4. **Public incentives schemes**: It is important to have a good overview of existing incentives and public schemes that can facilitate the establishment of such collaborations. Therefore, incentives and public schemes should be included in value-related considerations.
5. **External elements** affecting the possible process, such as changes in regulations and development plans from public authorities.

Advice: Be open-minded and creative in regard to what might be included in this kind of collaboration. These collaborative arrangements may require a flexible approach to delivering outcomes.

NB! The handbook draws on the premise that the energy collaboration is technically feasible.

3.3 Stage 2 – Mapping of potential stakeholders

Stage task: **Find potential actors that may be interested in an energy and resource sharing partnership – both main partners and other relevant stakeholders.**

This stage aims to search, map and select potential partners. In particular, there are two major categories of potential partners:

1. **Main partners** (energy surplus producer or user)
   Typical surplus heat sources:
   - Industry with excess heat
   - Data centers (low temperature)

   Typical energy consumers:
   - District heating companies
   - Owners of large buildings and infrastructure
     - Public: schools, hospitals, offices, etc.
     - Private: residential areas, office buildings, shopping centres, etc.
   - Other industry in need of energy (steam, hot water, etc.)
     - Horticulture
     - Aquaculture

  - Food industry
  - Other manufactories (clothing, etc.)

2. Other relevant partners and stakeholders

This category includes any other potential actor who might benefit from the establishment of the collaboration and want to contribute to its realisation. It also includes stakeholders who only have an interest in the collaboration being established. Thus, it is important to get an overview not only of potential stakeholders interested in getting involved, but also the extent of such interest. The list in Table 2 is based on the findings from our empirical data. This is not an exhaustive list, but rather it aims to serve as inspiration for those seeking to establish an energy and resource collaboration.

Guiding questions:

- **What kind of industry is a good match? Could you contribute to establish such industry in the area?**
- **What opportunities are offered to potential partners?**
- **What are the potential partneres in the area?**
- **What are the consequences of establishing a collaboration for each party?**
- **Are there other stakeholders that may have an interest in this collaboration being realised?**

Table 2 Potential elements to include for relevant stakeholders

Potential stakeholders	How can they contribute to facilitate the collaboration? (enablers)
Local and regional authorities	– Facilitate the establishment of industry nearby by offering regulated and available area – Facilitate processes by having an effective bureaucracy (i.e. reducing case processing time) – Facilitate meetings between potential partners – Undertake measures to have a good municipality/company collaboration – Serve as payment guarantee for potential loans – Take an active role in heat surplus use by promoting district heating (e.g. warm up all the public buildings) – Have an active role in community development, e.g. promoting energy collaborations and making the municipality an attractive place to live (infrastructure, activities, recreational paths, commerce)
R&D activities	– Collaborate with education institutions in the design of programs and opportunities that respond to identified industrial needs
Industrial parks organisations	– Find opportunities and potential partners, – Facilitate communication between potential partners, seek funding opportunities, give advise on applications, provide support in the establishing process (e.g. towards public offices, support schemes)
Investors, champions, enthusiasts	– Find local support, build alliances with other actors, establish trust – Explore and finance local solutions
Trade unions	– Facilitate flexibility in terms of organisation of work to attract labour force – Push environmental concerns forward in the company, at every level

	– Collaborate to seek alternative solutions, e.g. sharing of personnel between partners
Insurance companies	– Offer tailored and flexible products that fit energy collaboration arrangements
Other suppliers of services	– Be involved in local community development to make the location an attractive place to live for potential new employees – Have local community in mind when accepting/looking for potential resource users

This stage draws on input from previous stage concerning the kind of energy collaboration that has a potential (characteristics of the energy sources) and the potential value of it. The characteristics of the energy surplus play a crucial role in the selection of main partner, since there must be an optimal **match** in terms of **temperatures and types and operational characteristics of available energy surplus**.

SINTEF Energy, as part of their work within HighEFF, has explored the different possibilities (temperatures) for the different potential industries (for a detailed description see *Deliverable 6.4_2018.01 Cross-industry exploration for external utilization of waste heat).* This report concludes that the sector *food, beverages and tobacco* appears to have the highest potential for energy surplus utilisation. Industries within this sector span a large variety of different processes and unit operations, which potentially require temperatures provided by the surplus heat. It is also an easily scalable sector, which will remain important for national food security.

The use of surplus heat for direct heating exhibits the highest levels of energy efficiency. However, in areas where the source of surplus heat is far from where the heat is needed, or if there exists no possible consumers, power generation is a potential option that offers high levels of flexibility in terms of energy recycling. Furthermore, there are two additional key aspects for potential users of energy surplus to take into consideration: the location of the heat surplus source and the added costs (e.g. infrastructure, transportation, operation). We do not go into detail on such caluculations considering each case being uniqe, and just mention some examples. If it is necessary to transport low-value and high-mass goods to and from the integrated, new plant (e.g. materials for drying which mass is mostly given by water), it may result in an even worse energy balance and increased CO2 emissions. Corresponding calculations must be considered for transportation of products. Location may also restrict the size of new industry processes in the neighbourhood.

The distance in which energy can be viably transported is limited due to energy loss and need for pumping. The first is especially relevant in Norway due to the climate. The feasible distance for transportation can be seen as complement to the space constraint at the smelter side. A model for calculating the energy cost for transporting hot water was developed by Kavvadias et al. (2018). This model can be used to evaluate the possibility to construct processes further away from the plant location if space is not available. The actual viable distance depends the outside air temperature, the temperature of the heat, the insulation used, and the cost of electricity, if the heat can be provided by heat pumps instead (SINTEF).

It is important to identify the **operational energy costs of the potential partner in an energy collaboration**. If the energy costs correspond to a large percentage of the overall operating costs of the process, it may be beneficial to co-locate. If these costs correspond to a small percentage of the overall costs, it may be less tempting to base the location of a plant purely on the availability of cheap waste heat - if other aspects of the collaboration do not balance this cost. Here, it would be more beneficial to produce either close to markets or the required resources. Therefore, there must be a balanced technological match with the efforts needed to establish collaboration – and other contractual elements.

The search criteria for partners should include business with **compatible cultures**, **shared values** and **long-term interests**. Compatible parties reduce possible future conflict in the execution of the collaboration.

3.4 Stage 3 – Negotiation between (main) partners

Stage task:

Find a suitable contract form.

The negotiation of an energy collaboration contract between main partners should rest on an *integrative* approach. An integrative approach to contract negotiation considers the interests of all parties and promotes alternative ways of solving problems. Value is created by taking advantage of common ground, diminishing conflicts, and building long-term business relationships. It differs from the traditional distributive approach in that it strives to find solutions for all parties involved (see Appendix C for a more detailed description of negotiation types and strategies). This section details the different aspects that must be taken into accout by the contract form, namely: the type of ownership, the pricing model, potential spill-overs and added value effects, regulation, as well as crosscutting issues such as risk, relational power, time and termination aspects.

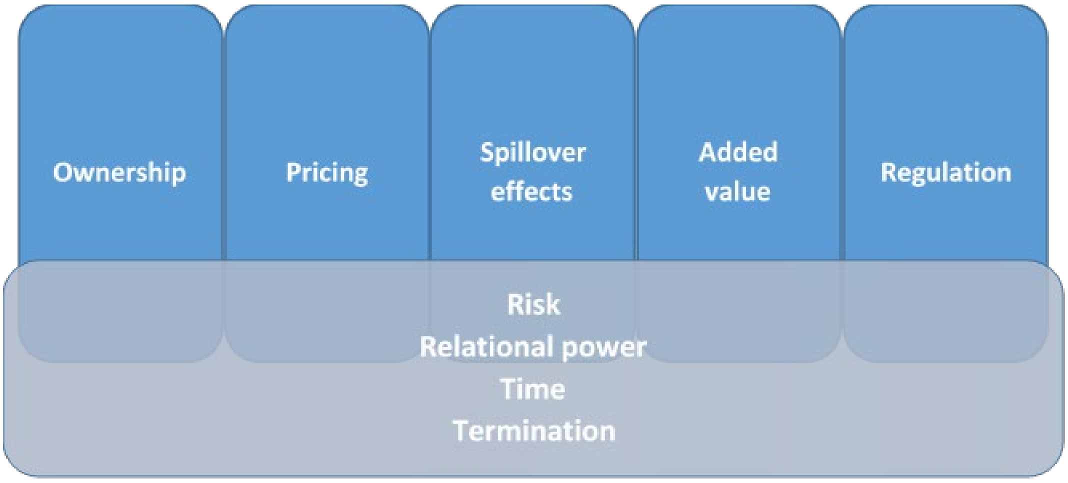


Figure 3. Contract elements to consider in the negotiation process

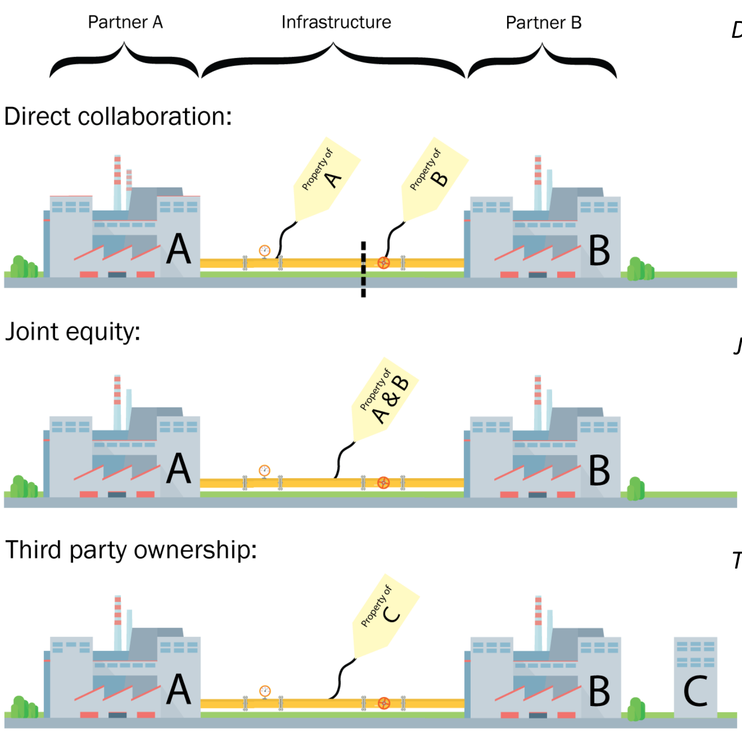
The contract form comprises several and interrelated elements defining ownership, pricing, potential spillover-effects, the added value and the regulations, as well as crosscutting issues such as risk, power, time dimensions, and termination aspects (Figure 3).

Guiding questions:
- **What kind of ownership type is suitable for the exchange?**
- **What kind of pricing model might work (best) for the exchange?**
- **How do we regulate spillover-effects from the collaboration?**
- **What kind of added value elements should be included in the contract?**
- **Are there any existing or expected regulations affecting the exchange?**
- **How do we deal with crosscutting issues such as risk, power, time and termination strategies?**
- **How do we ensure progress in the negotiation process?**
- **Are there any critical deadlines or decision points for any of the partners that need to be taken into consideration?**

Contractual aspects:

1. **Ownership – from loosely agreed short-term partnerships to long-term joint venture partnerships**

Existing energy collaboration contracts can be divided according to the type of **ownership**. The most common shareholding situations include market exchange collaboration, joint equity collaboration and third party owned equity collaboration. This is illustrated in **Figure 4**. A and B are the main companies establishing the energy collaboration (provider and consumer), while C is a third party entering for the purpose of ownership. Blue colour signalises existing companies in the partnership, while green colour represents new or external company/organisation. Each contract type has its own advantages and barriers, and fits into different scenarios.



Direct collaboration

- A and/or B own infrastructure, separately
- Choice of interface between A and B defining the two partners' ownership of the infrastructure
- F. ex. Elkem Salten and Sisomar, district heating

Joint equity between the main partners

- A and B own infrastructure together
- F. ex. Elkem Salten and Kvitebjørn

Third party ownership

- A third party owns and runs the infrastructure and distributes energy (other resources)
- F. ex. industry parks

Figure 4 Examples of different contract models

The three different models in **Figure 4** can be described as follows:

a) **Direct collaboration** refers to an alliance between two or more companies, aimed at achieving a common objective by coordinating efforts, while each party retains its organisational independence and no new equity entity or corporation is created. The partners own the necessary infrastructure separately, with either one or both/all holding ownership of separate predefined parts (split in ownership illustrated with red line in the figure).

This kind of collaboration is a relatively loose relationship, and the cooperation among parties is regulated through contracts. There is no sharing of equity in market exchange collaboration, making the interdependence among parties relatively low. The collaborative parties can terminate the collaboration rather easily, and they have high flexibility to look for new partners. Moreover, the start-up cost is relatively low, so the parties can also avoid substantial risk from having high up-front specific investment. Each party needs to perform their obligations in accordance with the collaboration agreement. Moreover, this type of collaboration can avoid high management costs, and is comparably more adaptive to changes in the external environment.

However, the parties engaging in these kinds of agreements generally have little control or influence over their partners. It is easy to terminate the relationship, but this may increase the searching cost for new partners.

b) **Joint equity collaboration** refers to the cooperation between two or more parties who jointly fund and establish a shared equity relationship, such as joint ventures and minority equity ventures (cross-shareholdings and minority shareholding). One possible design is that the joint equity owns the necessary infrastructure for energy and resource exchange between the partners. Via this type of contract, an agreement between two or more companies to enter into a separate business venture is established, therefore, the parties with more shared equity ownership have higher voting power within the collaboration. Alliances can be defined as medium and long-term agreements between companies, which involves the mutual transfer of intangible resources to take shape with or without administrative structure.

This kind of cooperation agreement depends on the relationship between parties, which can help the collaborative parties to establish a link to their property rights and enhance their inter-dependency. Because of the inter-dependency among parties, they should be willing to communicate and coordinate with each other, which may moderate potential contradictions and conflicts in the collaboration. Since this type of equity arrangements are rather complicated to implement as well as to dissolve, they usually exist for longer time periods compared to the market type.

However, joint equity collaboration may lead to high administrative costs and control costs, and decrease the flexibility of the collaborative relationship. Moreover, the start-up cost for joint equity collaboration is usually high, with each party's specific investment into the collaborative relationship, making it difficult to end this type of contract.

c) **Third party owned equity collaboration** refers to the collaboration contract where a third party owns and runs the joint equity (infrastructure) and distributes energy and resources to the engaging parties. This type of contracting form can usually be found in industry parks.

This type of contract can be a good way to overcome financial barriers for collaborative parties, such as the initial costs with a long payback period. In addition, extra costs such as operation and maintenance cost can also be avoided with the engagement of the third party. Moreover, a professional third party with advanced technological and managerial skills can also ease the risk from the collaborative parties in a joint equity contract.

However, having a third party owned equity contract usually means higher energy or resource price, where the collaborative parties need to pay for the service and the reduced risk. They also risk getting over-charged in cases when they are highly depended on the third party.

2. Pricing models

With respect to pricing models for energy exchange, all contracts need to cover at least **two** categories of costs for the supply of energy:

1) Generation costs, i.e. the production and modification of energy
2) Distribution costs, i.e. the transportation of energy from producer to consumer

In addition, taxes and fees are mandatory parts of the contract. There could be some fixed pricing independent of how or when energy is used. In addition, there are up to **three** variable elements of a pricing contract for delivery of energy:

1) Energy-based pricing (price per kWh)
2) Power-based pricing (price per kW)
3) Volume-based pricing[1] (price per m^3)

Energy generation costs are usually covered with **energy-based pricing**. Energy distribution costs usually also include energy-based pricing, but they could in addition be fully or partly covered with **power-based pricing** and/or **volume-based pricing**. The idea of power-based pricing is to generate incentives to avoid 'rapid' extraction of energy (e.g. high energy use over short time periods). Volume-based pricing gives signals for efficient extraction of energy per volume of distribution medium, for example higher prices when unnecessary volumes of water is pumped through a district heating system (e.g. when the return temperature is too high).

For households/residential consumers, all variable costs (including both generation and distribution) are generally covered with energy-based pricing, which is the least complicated way of pricing energy. With energy-based pricing, there could two categories of pricing:

1) a fixed price per kWh
2) a time-varying price per kWh

A fixed energy-based price only requires energy metering over a measuring period *without* any time stamps (accumulated kWh). A time-varying energy-based price requires energy metering *with* a time stamp for when a certain amount of energy was used (load profile). The time-varying energy price could be fixed for certain time periods (e.g. day/night, summer/winter), usually referred to as 'time-of-use' pricing, but there could also be a more granular price change (e.g. hourly pricing).

Power-based and volume-based pricing are pricing structures currently used for non-residential consumers, partly because these structures are more complicated to comprehend, administer and react to. The power-based pricing requires energy metering *with* a time stamp. Independent of whether the energy price is high or low for a certain time period, the power price is only dependent on the extraction rate of energy per time. Power-based pricing schemes usually price the highest extraction rate of energy per time over a measuring period, usually referred to as 'metered power' pricing. Volume-based pricing requires volumetric metering of the energy distribution medium, alternatively metering of the return temperature in a district heating system. If big amounts of an energy distribution medium is used to meet a small demand (e.g. if the return temperature is high), the volume based energy price is high because a lot of potential energy in that

[1] Only relevant when energy is non-electric and transported through a medium (water, gas, etc.), typically a district heating system

distribution medium is not used. Note that the volume price is independent of both the energy price and the power price, as it depends on the characteristics and operation of different thermal consumption assets to utilise energy from a volume of distribution medium at a consumer site (as well as the supply temperature) rather than total energy use or extraction rate.

Table 3 sums up the different options for pricing schemes for energy trading. Note that the pricing schemes could be used in combination if required metering is present. The choice of energy pricing scheme depends on the characteristics of the energy trade, and time-varying pricing schemes will be relevant if it is difficult to match supply and demand in different time periods. The need to use power and/or volume price will be relevant if the distribution system has potential to be operated and developed more efficiently.

Table 3 Summary of characteristics of different pricing schemes for energy trading

Pricing scheme	Description	Metering required	Cost coverage	Preferable if…
Fixed energy price	Equal price per kWh for all energy consumed	Energy metering w/o time stamp	Generation and distribution	Energy production and consumption is rather constant
Time-varying energy price	Time dependent price per kWh for all energy consumed	Energy metering w/ time stamp	Generation and distribution	Energy production and/or consumption does not match in time
Power price	Price per kW dependent on the energy extraction rate per time	Energy metering w/ time stamp	Distribution	Distribution network dimensions are stressed and/or under-utilised during certain times
Volume price	Price per m^3 dependent on the total volume of distribution medium used	Volumetric metering of distribution medium	Distribution	Return temperatures are too high meaning there is unnecessary distribution medium used

In terms of price quantification and determination, it depends on the fixed and variable costs for the energy product. In general, the price (together with anticipated energy consumption) must at least cover all generation and distribution costs. Further, the price for energy should not go beyond the *alternative cost* of supplying the energy (e.g. the electricity price). However, the contract could include elements that are valued beyond only the energy exchanged. If covering generation and distribution costs necessitates it, parties could agree on a price higher than the alternative cost if compensated by other contractual elements (e.g. shared services). For example contracts for district heating supply from Statkraft Varme, see https://www.statkraftvarme.no/produkter-og-tjenester/Prismodell/

> Consider competition regulations to ensure legal pricing models, and also be aware of potential reactions (both positive and negative) in market surroundings if the pricing is set low compared to alternative energy sources.

3. Added-value and spill-over effects

Contracts can also include the regulation of other types of elements that might add value to the collaboration. As mentioned earlier, it is important to be creative and include other types of resources or services that can make the collaboration economically feasible. Some of the **added-value elements** can be:

- Sharing complimentary resources and capabilities (competence and expertise)
- Other services (shared manpower pool, second-call night duty, cantina, administration, fire brigade, laboratory services, process control)
- Other bi-products that can be used in other processes
- Buildings (e.g. storage, harbour, offices)

Furthermore, the contract should also deal with **spill-over effects**, i.e. intended or anticipated positive and negative outcomes from the collaboration:

- Guidelines for dealing with different unforeseen events
- Policies and procedures for communication and determination of conflicts or issues that arise
- Intellectual Property Rights created as a result of the collaboration or background IPR will need to be managed and royalties assigned for a number of years

> Tip:
>
> It is an important task to seek a profitable and viable solution for all parties. Be creative, look for solutions and opportunities! What might be considered attractive elements will vary for each potential partner. Take partners' needs and offers into consideration, and find the ones that are relevant for each separate case.

4. Regulation and context

Finally, the negotiation of the contract should consider any existing regulation that may affect the energy collaboration, for instance:

- Any regulations on various legal matters, e.g. confidentiality and nondisclosure agreements, ownership and licensing of intellectual property rights, and indemnity provisions
- Adverse action by regulatory authorities

Cross- cutting elements: Risk, termination, time and relational power

Risk, termination, power and time are cross-cutting elements affecting each of the above discussed contractual elements.

Risk is the effect of uncertainties in every realm of the collaboration, from the technical aspects to the financial ones. A suitable collaboration model will depend greatly on the degree of risk which the partners are prepared to undertake. The acceptance of risk will also depend on the rewards that the identified opportunity can bring.

> Risk can be best handled when values and culture are shared and, therefore, values and culture are critical as selection criteria for any collaboration partners.

Energy exchange collaborations may come to an end. Collaborations may terminate for any number of reasons:

- The collaborative relationship may break down
- Failure to achieve objectives
- Expiration of term of the collaboration
- Adverse action by regulatory authorities
- Partner strategies may change thus eliminating the need for the collaboration

Termination. The collaboration might come to an end due to a breakdown in the relationship, a failure to meet objectives, adverse action by regulatory authorities, or a change in the partners' strategies. The parties should consider their exit strategies from the very beginning by specifying in the initial agreement what happens to assets, customers and existing contracts at the end of the life of the collaboration.

Time comes into play during the negotiation process (compatible timelines and decision points), and in both the duration of the contract and the pricing model. The pricing model can be divided into time segments (separated by defined time periods or events, or regulated/adjusted in proportion to external parameters) with different price regimes. Contracts should last long enough to cover the often high initial cosats and risks.

> Time is important during the negotiation process. Be aware of your partners decision points and deadlines and seek to establish compatible timelines where interdependencies are coordinated.

In inter-organisational relationships, power is rarely equally distributed, leading to **power imbalances** (not the kW). The latter is crucial to the negotiation between parties and should be considered before engaging in potential energy collaborations.

There are three different types of powers within organizations that may lead as well to power imbalances among employees (positional, relational and expertise-based). Positional power is tops-down and comes from the title, budeget, haeadocound and/or role that a person holds in an organization. Relational power can be defined as the probability that one actor in a social relationship will be in a position to carry out their own will despite resistance. This is the primary currency in large organizations and can comprise reciprocity and other ways that people related to and persuade each other .Finally, expertise-based power can be practiced by actors that have especific education, experience and/or real thinking.

> Preliminary discussions should explain in detail each partner's commitment in terms of resources, time and efforts.
>
> Tip:
>
> Start with small projects first to get to know each other, before committing too many resources (if possible).

> Tip:
>
> Be open-minded and creative towards what might be included in this kind of aggreements. These collaborative arrangements may require a flexible approach to delivering outcomes.

3.5 Stage 4 – Implementation and operation of the energy exchange

Task:

Find out what is important for the partners to achieve a successful implementation and operation of the energy and resource collaboration. This task must be considered througout the entire process, particulary during Stage 3.

Guiding questions:

- **What is important for the partners to achieve a successful implementation and operation of the energy and resource collaboration?**
- **How can employees be involved to facilitate and secure successful flexible operation?**

The organisation studies literature points to three elements as key in a successful implementation and operations of new projects and processes of change within organisations, such as establishing an energy collaboration between two or more parties:

- **Understanding**: A prerequisite for all collaboration is that those who collaborate have a common understanding of goals, roles and responsibilities. With collaboration between two or more parties, it is important that central employees at every level of the organisation and in each of the parties perceive reality in the same way – i.e. that they have a common understanding of the current situation, their concrete contribution to the collaboration and the expectations they may have to each other. Employees involved in the collaboration should have a good understanding and knowledge of the partners' activity, needs and operational characteristics.
- **Anchoring:** The prerequisite for good anchoring of change processes is that the overall goal of the collaboration is understood and accepted by everyone involved. At the same time, there must be consensus regarding the need to enter an energy collaboration. The work with anchoring can be time-consuming and all key players must be given enough time to understand what the changes consist of and what consequences this may have for their own work. Good anchoring requires that employees have confidence in the organisation and their leaders in terms of both competence and intentions.
- **Commitment**: Good cooperation requires that each person feels that they have a responsibility and a role in the implementation of what is planned, and that they are made responsible by following up plans and measures. Both parties should have procedures for follow-up and feedback. It is particularly important that key roles, responsibilities and tasks are well described, understood and anchored.

Tip: These collaborative arrangements may require a balance between flexible and rigid approaches to implementation and operation.

The cases studies carried out for these projects are in line with the literature. They point to the importance of dedicating time and other resources to the planning of the energy collaboration implementation. It is especially important to involve operators at existing facilities in early phases of the implementation planning, to reduce resistance. The contract should comprise sufficient agreement details so that it is possible to put it in practice. Yet, at the same time, it should be loose enough to be able to adapt and respond to unexpected events along the implementation. The establishment of arenas for interaction between different partners and employees in different positions is very important. Regular dialogue between operators across the companies is critical, not only to share knowledge and important details about different processes (partners' needs, intentions, plans), but to be able to respond to ongoing operation challenges in a better way. It is also important to have a clear distribution of responsibilities, and that contact details of the responsible person for each process is given in case something happens during operation. Enthusiastic individuals can play an important role in every stage of the implementation and operation of the energy collaboration. While at the same time, it is important to enhance a sense of community and ownership.

4 Conclusion: Summary of enablers by stage

Throughout the handbook, several tips and ideas are suggested – including lists of possible elements to include in these energy and resource collaborations. These may increase the profitability for such agreements, and hence also the likeliness for establishment (examples listed in Stage 2, page 18). The lists and suggestions in this handbook are not complete overviews. The original idea behind this handbook was to inspire partners both to seek such partnerships *and* broaden their horizon to what and who might be included in such collaborations.

Table 4 lists a summary of enablers related to the stages of the process in which they are of most importance. It is recommended to pay attention to these enablers during the process.

Table 4 List of enablers by phase

TIMELINE	ENABLERS
Before establishing collaboration	- Develop a common understanding of different parties' needs, aims, possibilities, visions, timeframes - Work towards a shared project - Stimulate ownership and anchorage in every level of the chain - Gather knowledge about the industry and the market and regulatory frameworks - Assess location/ industry - Conduct risk assessment
During the establishment	- Find suitable price and risk management model - Agree on legal and financial liability issues - Consider competition regulations (distortion of competition) - Create third parties when beneficial - Be aware of the timing and interdependency of different parties' decisions
After the establishment	- Promote operators' communication and collaboration - Stimulate dialogue with R&D environments to find solutions to possible challenges and problems - Develop understanding, commitment and anchorage at every level of the organisation
Throughout the whole process	- Engage in a good dialogue with municipality and other relevant actors (regional and national authorities, business organisations, investors, etc.) - Stimulate a sense of ownership and anchorage in the organisation - Promote a creative environment to develop new ideas to optimise existing collaboration (involve employees from every level of the chain/organisation and not only leaders, rewards) - Have a dialogue with universities and R&D environments - Invest in R&D activities

Appendix A Barriers and enablers

In 2017, HighEFF arranged three workshops with different industries: Food and chemical sector, Metal and materials sector and Oil and gas sector. A big part of these workshops has been to make the industries and the researchers in the different research areas communicate with each other through facilitated group sessions. A reoccurring theme was enablers and barriers for developing and implementing energy efficient technology in the industries, and we want to present the views and opinions that came up during these sessions. Since there were many coinciding views between the industries, we will not at this stage separate the findings in the three workshops, but give a summary presentation. We use Cagno, Worrell et al.'s (2013) utilised taxonomy (presented earlier) categorising barriers inside an organisation. This taxonomy does not contain categories outside an organisation. We have, therefore, added two categories: inter-organisational and external. While the taxonomy original only categorises barriers, it will in our purpose also include enablers (and preconditions). The findings are summarised in Table 5 (see also HifgEFF delivery 'D5.1_2017.05 SOTA Barriers and enablers').

What is important to bear in mind, is that several of these enablers and barriers can be placed in more than one category, and that enablers/barriers in one category influence enablers/barriers in other categories. In future work, we will explore this mutual impact and look at how changes in one factor can also change other factors.

Table 5 Summary of barriers and enablers

Category	Barrier	Enabler
Technology-related	Need for heat exchangers with efficient transfer of heat	Energy consuming industry is a major producer of surplus heat
	Storage of surplus heat (or transformation to electricity) without major energy losses or high cost	High potential for improved use of surplus heat
	Upgrading low-grade heat to high-grade energy	Examples of successful surplus energy storage (e.g. N-rgie Nürnberg)
	The costs in high-temperature parts are high	
	Weight limitations and lack of space is a challenge at e.g. off-shore installations	
Information-related	Many facilities are not built with appropriate sensors and logging of data to make efficient use of energy accounting	

Economic	Cost efficiency	Economic viability is a basic premise
	The energy expenses or the utilisation of heat is (still) rarely of big enough magnitude to be a decisive cost for localisation of factories or plants	The dairy industry has relatively high costs on energy expenses, and express a need to improve overall energy recovery to reduce the costs
	Limited resources lead to limited funding of R&D activities. Only the best, cost-efficient ideas will be funded. Non-profit solutions will be driven by government and incentive systems.	
	The investment costs for infrastructure for shared resources in industry clusters are high	
	Area costs for low temperature solutions using huge areas	
Behavioural	The industry is aware of the danger of being "to clever" developing new technology (useful, but expensive) leading to new legislations ordering all to use this technology	
	Reluctance to handle uncertainty and risk makes it difficult to get new, groundbreaking technology to the market	
Organisational	Internal barriers and lack of communication e.g. between departments	
Competence-related	Difficult to map all possibilities, both technical and commercial	The sector believes establishing clusters is the way to go
	We need to seek "alignment" between technical and political approaches	The industry exceeds the government in competence and knowledge on future technologies and possibilities, and the government should therefore cooperates with the industry when developing legislations

Awareness		
Inter-organisational	Most plants/factories are already situated at one place, so to be incorporated in a cluster therefor often means establishing the cluster in the nearby region, or moving the site. The latter is unrealistic. The potential savings on energy costs are not big enough.	
	Who will handle the costs "between the fences"? Who will provide the necessary backup?	
	Energy collaborations between companies is difficult to establish	
	Secrecy between companies	
External	Metal industry mostly located in rural areas where there is limited use for surplus heat	The surroundings and local means are important (e.g. county authority, municipal, local interests, other industry and commerce, demography)
	Seasonal variations affect energy use	Legislations and incentives (e.g. CO_2-tax, or the government require reduction in energy consumption)
	Political decisions hinder alternative solutions, e.g. legislation stopping the industry from giving the surplus energy away to another company because of competitive advantages, or stopping reuse of slag categorised as harmful waste	Emissions from the oil and gas industry are high, and industry clusters is one of the most important solutions to reduce emissions from the energy sector
	The legislations are different in the different countries in which a company operates. This affects the company's decisions. It may also lead to companies moving their activity out of a country.	A "match-making strategy or database" for co-localisation of businesses

	Constant changing legislations and regulations makes long-term planning difficult, and also to maintaining profitability in established/implemented solutions.	It can be important to get the power producers onboard to succeed
	If Enova move their support schemes towards new technology rather than smarter and more efficient exploitation of what already exist	Peoples opinion / reputation

Appendix B Case studies

Case: ALCOA Mosjøen

Alcoa is a world-leading supplier of bauxite, alumina and aluminum. Alcoa established itself in Norway in 1962 through a collaboration with Elkem ASA. Together they operated a smelter in Lista and one in Mosjøen. Today, these two plants are 100 % Alcoa-owned and run on clean hydropower. Through modern casting technology and pure electrolysis metal, Alcoa Norway supplies Europeans rolling mills, presses and foundries with quality products in aluminum.

- Of interest:
    - Clean hydropower: Alcoa Norway has a 15-year power contract with Guleslettene Vindpark AS. Alcoa will purchase all production capacity from the planned wind farm in Western Norway. This is Alcoa's third wind power agreement, and the agreement strengthens the company's position as one of the leading buyers of sustainable wind power in the European energy market.
    - Engagement with local community: the company has an array of good measures for the local community (contributes financially, encourages employees to volunteer on local activities, encourages local youth to educate in environmental protection, cleans the seabed around Mosjøen, etc.)
- Characteristics:
    - 24-hour continuous production throughout the year, assumes that the amount of excess heat is relatively stable
    - Classic metal industry example
    - High energy consumption, a lot of excess heat
    - Located in a relatively small area in the district
    - District Example
    - Brownfield

Case: Elkem Salten

Elkem Salten is one of the world's largest and most modern silicon production plants. It has been operative since 1967. Located in Staumen (Sørfold municipality, near Fauske and Bodø), it produces silicon (96-99% purity), microsilicon and SIDISTAR.

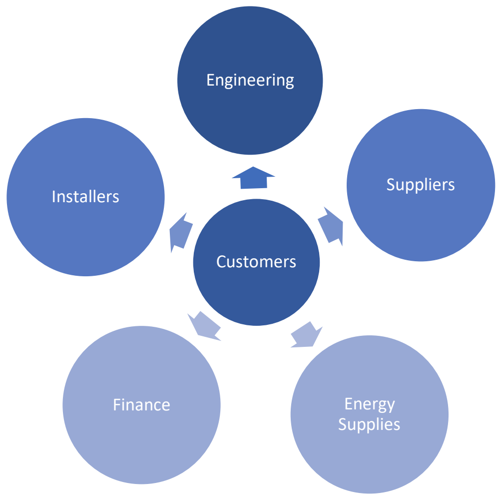
- Of interest:
    - Surplus heat from this plant is currently used for heating of water in flow-through aquaculture farm (fishery plant). The farm is located in the municipality's industrial area about 1 km from Elkem Salten. This is a deal with pure financial win-win.
    - Has decided to build an energy recovery plant that aims to recycle 28% of Elkem Salt's energy consumption. To be completed in the last quarter of 2020, producing 270 GWh of electricity annually. Has established a new company, Salten Energiutvinning AS, which is a partnership between Elkem ASA and Kvitebjørn Energi. Enova has allocated NOK 350 million for the development of the plant.
    - The heat from Elkem Salten has been used in several ways in the past (both successfully and unsuccessfully):
        - Elkem Salten supplied waste heat to Sisoflor's horticulture. Sisoflor was Norway's largest rose producer, established in 1993, bankrupt in 2011. In 2005, they tried the cultivation of gourmet mushrooms, and later they produced cucumber.
        - Heating of the football field at Straumen (80s)

- Characteristics:
    - 24-hour continuous production throughout the year, assumes that the amount of excess heat is relatively stable
    - Classic metal industry example
    - High energy consumption, a lot of excess heat
    - Located in a relatively small area in the district
    - District Example
    - Brownfield

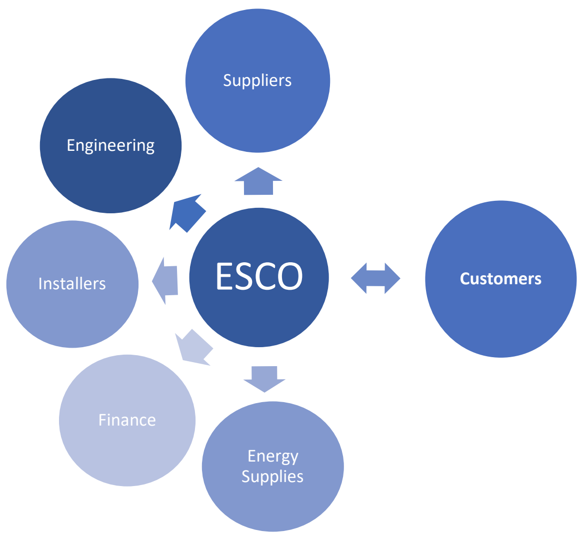
Appendix C Energy Management

Energy Management is the forecasting and administration of both energy production and consumption units. The main aim is resource and climate conservation, and price reduction - whilst clients have perpetual access to the energy required. *Energy Management* is based on creating collaboration within the energy supply chain through alternative approaches to contracting. Thus, it is hands-on, organised and methodical procurement, adaptation, supply and utilisation of energy to meet the requirements of multiple actors. The principles pertaining to *Energy Management* are particularly vital for entities such as Energy Service Companies (ESCOs), because the performance of a contract, or implementation of a project, is grouped as a single stakeholder in regard to the final customer.

<u>Contract without ESCO:</u>



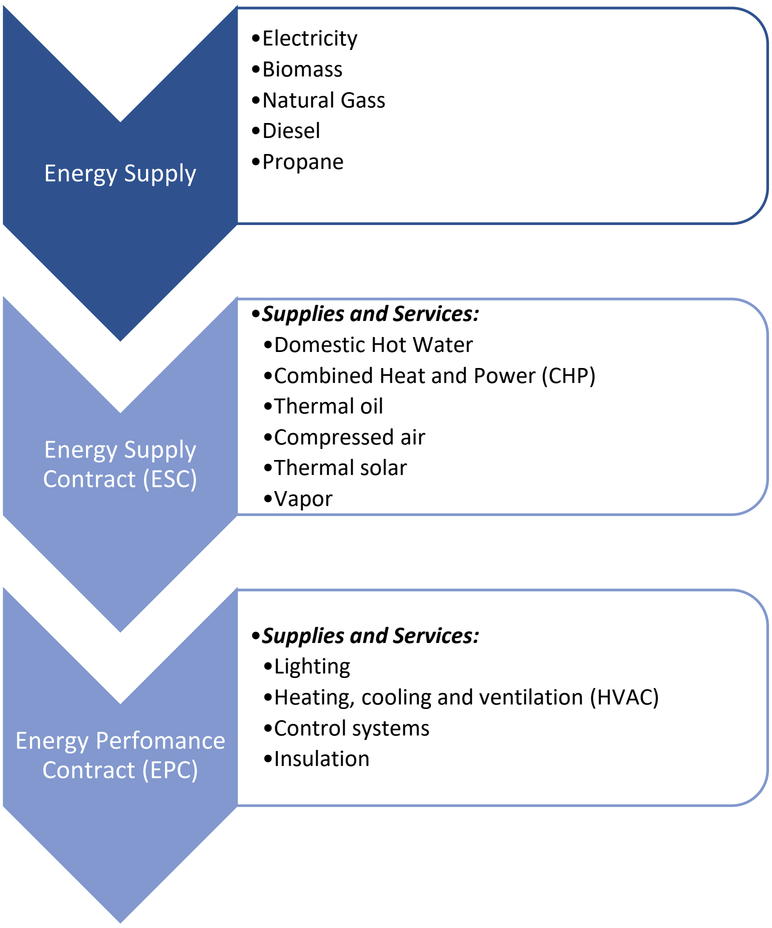
<u>Contract with ESCO:</u>



Energy Performance Contract (EPC)

EPC is a tool for consolidating energy efficiency financing. EPC comprises an Energy Service Company (ESCO) that delivers various options, such as commercial investments and energy savings. The compensation of the ESCO is contingent on the attainment of the energy savings. The ESCO is involved in the measurement and certification process for the energy savings in the reimbursement time-frame. ESCO and energy performance contracting is typically found in the public sector and to a smaller degree in commercial building sectors.

Energy Supply Contract (ESC)



ESC is the effective supply of energy. The contracting partner provides main services like heat, chilling, compressed air or electricity. The focus of the contract is not the energy rate, but the utility rate: charged per volume items of, for example, heat, steam or compressed air. Funding, industrial design, preparation, assembling, setup and upkeep of energy plants, as well as administration of energy delivery, is included in the whole service bundle. The ESC is a service mainly applied in the corporate and industrial areas, but residential schemes, such as district heating schemes, may also be included. This commercial framework covers the whole procedure from the buying of raw material to the transportation and billing of energy. Plants and renewable energy options are incorporated additionally in ESCs. The remunerations of ESC are a substantial improvement in productivity, improved operational costs, greater supply guarantees and the application of contemporary safety criteria. The client no longer needs to be concerned about energy supply concerns and environmental performance. The focus of the ESC framework is on the effectiveness of the energy supply with the objective to carry the effectiveness to the fullest whilst at the same time safeguarding security of supply.

The major dissimilarity between these two is that EPC is broader than ESC in scale and scope. While ESC is founded on a commercial model that guarantees energy supply, EPC is a commercial model for effective energy savings. The objective is to circumvent energy waste and to direct the savings in energy effectiveness.

Bilateral Contract

The bilateral contract model comprises generators and buyers entering into bilateral agreements for the sale of energy. Generators can also be buyers when they do not generate enough power themselves. Intermediaries can also facilitate the exchange between buyers and sellers. These trading parties generally negotiate a set of agenda items and factors that form the foundation of exchange between them. When a master agreement has been settled, energy trading can commence on contracts of any length. Contracts stipulate the amount and price of energy to be traded and when it will take place. At a set time before delivery, actors disclose their net contract transactions to the system operator. Every generator chooses when to dispatch and the system operator is obligated to administer the disparities that transpire. Because the system operators do not own the generating capabilities to balance the system, a method ought to be created to recompense the imbalances. There are two possibilities: a market or punitive price. Several elements affect the option the market implements, including pricing for retaining system security. In some markets where, for example, electricity is generated via low-cost plants and energy is sold through contracts where minor parts are sold in the spot market, the rate from the spot market is used to resolve disparities. This differs to other markets, which fine shortfall disparities and incentivise oversupplies through a dual pricing system.

Time-of-Use (TOU) Contract

TOU contracts are designed to allow changed rates at different times of day that correspond to the time throughout the day when costs of power are higher. An assortment of structures can be utilised, some with off-peak, shoulder or peak-prices, others with even off-peak and peak rates. The utility offers these rates to match differential costs of power purchases, and charges the client based on use of energy when it is used. The rewards from the TOU contracts comprise the simplicity of use to the client who is aware of the rates during the day and the benefit that the service is now charging prices that reflect power purchase rates. Test cases that have implemented TOU contracts largely find that customers both change loads to off-peak times and save on energy usage, granted these results differ with the expenditures of implementation.

The subcontractor model

In this model, the suppliers will be contractually accountable for the grid service for the consumer, and operations managers, such as Distribution System Operators (DSOs), will merely have a contractual responsibility towards the supplier. The legal significance is that operations managers at the onset have no independent contractual accountability in regards to consumers, and consumers have no independent contractual rights against the operations managers. The only exceptions are for obligations under a grid connection agreement where consumers experience issues with the service; where any claim would at the onset be solely against the supplier. The supplier may then have their own claim against a DSO, centered on the contractual agreements with the DSO.

Appendix D: Negotiation

There are two major strategies in negotiation: (1) distributive and (2) integrative. The *distributive* approach is typically viewed in the light of the 'fixed-pie' or 'win-lose' dichotomy, which emphasises that there are a limited number of ways to distribute goods or settle disputes within any given area of interest. The distributive approach to negotiation relates to how the parties concerned divide the different elements between them and maintain a stringent focus on their own objectives. The concept of distributive bargaining is based on the notion that the interests of the parties are negatively correlated. From that, an increase in the value of one party's outcome is associated with a corresponding decrease in the value of the other party's outcome. In this type of a negotiation event, the respective participants have a stipulated bottom-line figure, which they will not move from for the sake of accomplishing a deal.

The *integrative* approach to negotiation is based on outcomes being reached that provide high levels of satisfaction for all parties and 'expand the pie'. This is achieved by ensuring that none of the parties concerned suffer a major loss, with the entire negotiation process being based on this fundamental objective. The two concepts fundamental to understanding this process are that participants must first create as much value as possible for the other party and themselves, and then claim as much value as possible for themselves. This aims to create 'win-win' solutions, but since all parties rarely get exactly what they want, there are trade-offs. This serves as the backdrop to the concept of integrative negotiation, which can produce sound outcomes when utilised by skilled practitioners.

An integrative negotiation approach considers the interests of all parties. The goal is an outcome that is based on the merits of individual claims, at the same time as it serves each party's desires as much as possible. However, to effectively deal with the challenges associated with integrative relational negotiation and case specificity, a methodical negotiator needs to thoroughly analyse the bargaining situation, develop an overall strategy, and implement tactics in accordance with the former elements.

In essence, the notion of creating value stems from integrative negotiation, which promotes alternative ways of attacking problems, and differs from the traditional distributive approach in that it strives to find solutions for all parties involved. The main reason for applying this approach to negotiation is to generate value and enable all parties to reach their objectives. This is done through a process of recognising alternative uses of assets or finding distinct and original ways of using available resources. Value creation can be accomplished in many different ways and as a result, identifying core factors of the process is important. This is done by accepting that negotiators do not always see all issues as equally important and that by exploring compatibility through communicating different concerns, the parties can unlock the conundrum of value creation. In this context, value is created by taking advantage of common ground, diminishing conflicts and building long-term business relationships.

Key points in this framework include: separating people from the problem, focusing on interests rather than positions, generating a variety of possibilities before deciding what to do, basing results on an objective standard, and creating an environment that will not hinder future relations. This approach, also referred to as principled negotiation, has been instrumental in developing interest-based bargaining.

Appendix E: Business Models for Circular Economy

The table below includes a comprehensive list of main dimensions and factors that potentially affect Circular Economy Business Models. The list of factors may indicate the readiness of the country and sector for Circular Economy in order to understand the overall business context.

Dimensions	Factors	Examples
Political and legal factors	Overarching framework	Existence of CE roadmap/ initiative at the national level
		Setting of national end-goals and monitoring (CO2, noise, movements)
	Legal issues	Legality of activities, intellectual property rights, warranties, contracts
	Environmental and Industrial regulation	Resource efficiency targets, requirements of reusing percentage of components and raw materials in new products
		Waste regulation, recycling regulation, water regulation, energy regulation and choice restriction
		Effect-based control regulation
		End of life regulations
		Mandatory take-backs
		Extended Producer Responsability
		Materials and design standards (national and across industries)
	Tax policies	Fiscal measures (green taxes): land-value taxes, value-extracted tax, product levy and recovery rewards
		Resource taxes (add quantum, ad valorem)
		Differentiated VAT rates (e.g. products with high recycled content included among VAT reduced goods)
	Public procurement	Green public procurement
		Performance procurement (services instead of ownership)
Economy and market factors	Green industries	Existence of a critical mass of businesses, cluster, in CE-related activities
	Employment	Existence of a critical mass of workers in CE-related activities (green industries, engineering and science-related jobs)
	Sectoral economic trends	General economic "health" of incumbent companies in a sector (crisis, decline, stability, growth)

		CE and environmental trends among existent and new players in the sector
		Existence of companies with CSR reports and other voluntary measures in the sector
	Market geography	Existence of relevant CE/environmentally oriented market segment in the region/country
	Infrastructure	Regional infrastructure for recycling and recovery
		IT-enabled transparency and information sharing. Joint collection systems, match-maker mechanisms
		Extensive raw materials information service
	Resource prices	Sectoral stress regarding price volatility of primary and secondary raw materials, water, energy
Sociocultural factors	Urban/rural concentration	General patters of population distribution
	Age patterns	Ratio of young vs old population
	Environmental attitudes and value system	Attitudes towards waste and recycling
		Attitudes towards eco-friendly production and consumption
		Attitudes towards water use
		Public awareness of environmental problems
		Perceptions of green brands by consumers
		Perception of environmental problems by businesses
Technology and system innovation factors	Technology trends	Major technological trends in the sector, new sectoral developments
	R&D infrastructure	R&D centres: strengths in CE (Innovation agency, university research groups)
		Business parks, cluster of SMEs
	R&D funding and investment	Public support for CE-related R&D and innovation (new materials, new products/services, supply chain resource tracking)
		Venture and risk capital for environment-related investment and green tech (seeds and start-ups)
		Demonstration and commercialisation support for CE (eco-design, eco-innovation)
		Green lending programmes from banks

	High education and training	Masters and PhD programs dealing with CE, environmental and resource use
		Training courses orientated towards CE

Table from: http://www.r2piproject.eu/wp-content/uploads/2018/08/R2Pi-D3-35775-63432.2a-Case-Study-Methodology_v1.0.pdf

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