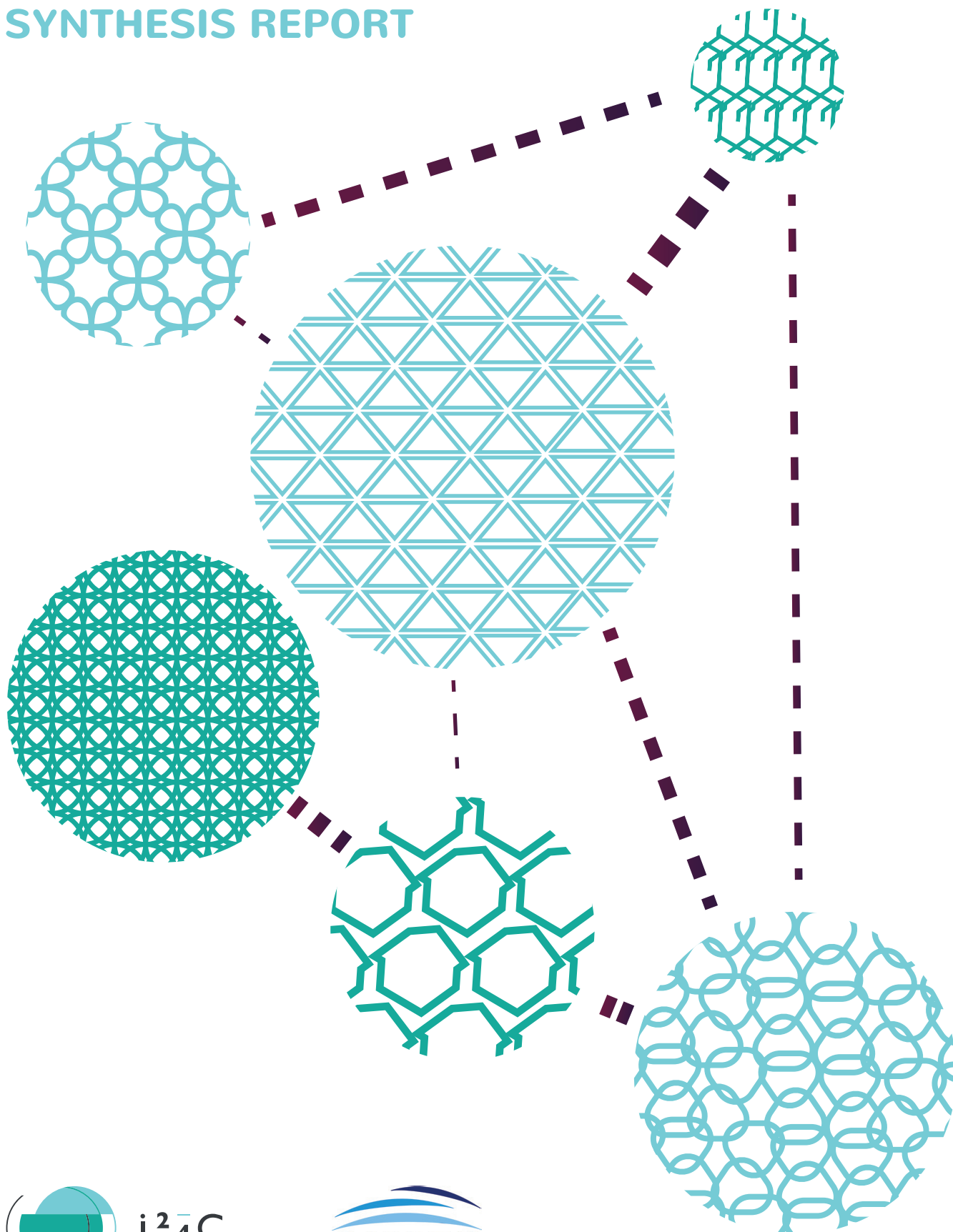


# INDUSTRIAL INNOVATIONS DRIVEN BY MULTI-STAKEHOLDER ECOSYSTEMS

## SYNTHESIS REPORT



**i<sup>2</sup>4C**  
INDUSTRIAL INNOVATION  
FOR COMPETITIVENESS



This report has been independently authored by the Carbon Trust on behalf of i24c.

## Industrial innovations driven by multi-stakeholder ecosystems

### SYNTHESIS REPORT SEPTEMBER 2016

The Carbon Trust undertook this study on behalf of i24c whose research agenda explores the role of innovation in simultaneously achieving decarbonisation and European industrial competitiveness. The Carbon Trust wrote this report based on independent research, analysis and expert stakeholder engagement. The Carbon Trust's mission is to accelerate the move to a sustainable, low carbon economy. It is a world leading expert on low-carbon policy, finance and technology. As a not-for-dividend group, it advises governments and leading companies around the world, reinvesting profits into its low-carbon mission.

We are grateful for the support of the many stakeholders who agreed to be interviewed for this report.

#### i24c project team:

Dr Julia Reinaud  
Director, Research Programme and Partnerships  
[julia.reinaud@i2-4c.eu](mailto:julia.reinaud@i2-4c.eu)

Romain Ioualalen  
Associate  
[romain.ioualalen@i2-4c.eu](mailto:romain.ioualalen@i2-4c.eu)

---

#### Authors:

Tom Jennings  
Director, Carbon Trust  
[tom.jennings@carbontrust.com](mailto:tom.jennings@carbontrust.com)

Andrew Johnson  
Manager, Carbon Trust  
[andrew.johnson@carbontrust.com](mailto:andrew.johnson@carbontrust.com)

Joshua Brunert  
Analyst, Carbon Trust  
[joshua.brunert@carbontrust.com](mailto:joshua.brunert@carbontrust.com)

# CONTENTS

---

<b>EXECUTIVE SUMMARY</b>	4
<b>1. APPROACH</b>	8
<b>2. KEY FACTORS OF SUCCESS FOR MULTI-STAKEHOLDER ECOSYSTEMS</b>	10
2A. LEADERSHIP	10
2B. CROSS-VALUE-CHAIN COLLABORATION	18
2C. PROXIMITY	22
2D. COMMUNICATION	26
<b>3. KEY BARRIERS TO SCALING AND REPLICATING MULTI-STAKEHOLDER ECOSYSTEMS</b>	29
<b>4. KEY LEARNINGS AND POINTS FOR FURTHER ENQUIRY</b>	31
<b>5. APPENDIX: SUMMARY TABLE OF THE CASE STUDIES</b>	33
<b>FACTSHEETS:</b>	
• Autolib'	38
• Beta Renewables	40
• Sustainable City Hyllie	42
• Energiesprong	44
• HafenCity	46
• Kalundborg Symbiosis	48
• Lontra	50
• Philips Lighting	52
• Sonnen GmbH	54
• Textiles Recycling Valley	56

# EXECUTIVE SUMMARY

---

The outlines of the next industrial economy are becoming much clearer - shaped by globalisation, disruptive technologies, emerging business models and growing sustainability concerns. There is an overarching need for transformative innovation if Europe's significant industrial assets are to realise their new competitive potential in this new economy - whether through technology, resource-efficiency or high skills - or by focusing on how clusters can connect disparate value chains across finance and end-markets.

For Europe to reap the benefits of this transformation, its policymakers as well as its business leaders and entrepreneurs need to better understand how innovations really materialise, and what could be done by both the public and private sectors to enable rapid commercialisation. While innovations often occur within the boundaries of a single company, they are also often driven and nurtured by an ecosystem of actors working together. They are also not limited to just technological change, but can take the shape of innovative business models, processes, products, and policy.

In both innovation and industrial policy, new thinking actively explores the full set of stakeholder relationships involved as the focus of its work. In the domain of innovation policy, this is expressed most frequently through terms such as actor networks and, in particular, ecosystems. In the domain of industrial policy it is expressed through terms such as value chains and clusters. For this study, we use the term ecosystem as the one that best captures this overall picture and its focus.

This reframing toward a so-called "meso-level" ecosystem focus has profound implications both for policy design and for business strategy. Policymakers need new capabilities and instruments, which are relevant to such ecosystems. Business strategists need a new framework, which is not exclusively centred on their own firm but situates them within a wider network of competitors, suppliers and customers. Linked to this is also a recognition that the boundaries between the private and public sectors have become more permeable, and that many of these networks will be hybrid in nature, with a variety of sources of knowledge or finance that cross the divide.

Using a case study approach of industrial innovations across Europe, this study has sought to identify what are some key factors of success for these ecosystems. It analyses ten case studies in-depth across diverse sectors, which include innovative technologies, business models, processes, and products (see full list below). The conclusions we have drawn are based primarily on these specific case studies and so their wider applicability remains a task for further research.

Four broad key learnings stand out from this selected sample, highlighting interesting lessons and forming the basis for potential further enquiry when studying successful ecosystems.



The key learnings are that:

1. **Ambitious ecosystem leadership through challenge-driven goals and programmes** can have an impact in addressing difficult systemic challenges;
2. **Independent facilitating agents** can lead and coordinate complex ecosystems, fostering cross-value-chain collaboration that targets systemic change;
3. **Defining supply and demand within specific proximities** can nurture important market visibility; and
4. **Communication practices** should build on current themes and trends that help sell the benefits of the innovation and convey a convincing business case to attract newcomers to the ecosystem.

The case studies in focus are outlined in the following table<sup>1</sup>.

CASE STUDY (COUNTRY OF ORIGIN)	SECTOR	TYPE OF INNOVATION	DESCRIPTION
Autolib' (France)	Transport	Business model	The world's first city-wide electric car-sharing platform that began in Paris.
Beta Renewables: Proesa™ (Italy)	Transport	Technology	Second generation biofuel that uses non-food agricultural waste products with a much lower carbon footprint, and at a cost competitive price, when compared to alternatives.
Energiesprong: Stroomversnelling (Netherlands)	Housing	Business model, Process, Product	Programme for creating the market conditions for nationwide energy-neutral refurbishments of domestic housing stock.
HafenCity (Germany)	Urban development	Business model	Europe's largest inner-city development project with an innovative procurement practice that emphasises whole-life sustainability.
Kalundborg Symbiosis (Denmark)	Energy, refining, chemicals and more	Business model, Process	One of the world's first industrial symbiosis networks, with over 50 exchanges of water, energy and materials between seven core industries and the local municipality.
Lontra: Blade Compressor (UK)	Waste water	Technology	A rotating blade air compressor that is over 20% more efficient than the ubiquitous piston design that has remained nearly unchanged for over half a century.
Philips Lighting: Circular Lighting (Netherlands)	Lighting	Business model, Product, Technology	Providing consumer lighting solutions as a service through a circular business model that utilises "smart" light systems.
Sonnen GmbH: SonnenCommunity (Germany)	Energy	Business model, Technology	A virtual power plant connecting distributed energy generators, creating a peer-to-peer energy market.
Sustainable City Hyllie (Sweden)	Urban development	Business model, Technology	A collaboration between the City of Malmö and two utilities to create a district with 100% renewable and reusable energy by 2020.
Textiles Recycling Valley (France)	Textiles	Business model, Process	An initiative connecting the textiles manufacturing and recycling industries in Northern France to protect jobs through sustainable manufacturing.

<sup>1</sup> For more information on the individual case studies, there is a more detailed summary table outlining who was involved, the key factors of success and the GHG and economic impact of each in the Appendix. In addition, there are complementary two-page fact sheets for each case study that outline their individual narratives in more depth.



Our research into these case studies identified four overarching key factors of success: (A) leadership, (B) cross-value-chain collaboration, (C) proximity and (D) communication. These elements, as well as the most important interactions between them, contribute to the key learnings we have drawn from this study, and are summarised in relation to a number case studies below.

## A. Leadership

Our case studies emphasise the role of leadership in kick starting and sustaining successful ecosystems. Leadership can come from policymakers setting out ambitious goals and programmes that galvanise new ecosystems into action. For instance, Energiesprong was set up by the Dutch government with the ambition of creating a new market for domestic energy efficient refurbishments. Market leaders in the private sector can also stimulate ecosystems through their willingness and ability to take on risky innovations, in the shape of new technologies such as Beta Renewables' second-generation biofuel, or business models, such as the Philips Lighting's Circular Lighting initiative.

In a number of our case studies we found that dedicated facilitators, often established by public authorities, provide continued sources of leadership for, and organisation of, complex ecosystems. This is essential for HafenCity, and other large-scale projects, that require managing a vast number of individual actors. But it is also relevant for ecosystems on a smaller-scale, with Lontra receiving facilitation support from an incubator.

## B. Cross-value-chain collaboration

We found that where ecosystems transcend conventional value chains, through collaboration between businesses and industries that would not normally work together, they can be successful in acquiring new skills, knowledge and addressing complex problems. We call this cross-value-chain collaboration.

It is evident in cases where there are multi-faceted challenges that require a holistic response from numerous actors at once, as exemplified by Sustainable City Hyllie, where the target is to develop an integrated city district that uses 100% renewable and re-usable energy. This requires top-down direction from the leaders of the ecosystem to ensure successful collaboration. Cross-value-chain collaboration can also be spontaneous, and driven by bottom-up initiatives. An example of this is when Sonnen GmbH needed to develop expertise to manage a virtual power plant in the form of the SonnenCommunity, and so sought out assistance from actors outside of its conventional value chain.



## C. Proximity

---

Proximity of supply and demand can make ecosystems easier to manage and more attractive to newcomers. The density of supply in examples such as the Kalundborg Symbiosis helped to ease collaboration practicalities with closer connections between suppliers. The density of demand in the case of Autolib' and others provided a visible market, therefore identifying and supporting a clear business case for an ecosystem.

## D. Communication

---

Lastly, effective communication practices are vital for growing ecosystems. Philips Lighting used tactical communication to capitalise on current trends around energy efficiency, "circular economies" and the "internet of things" to educate and persuade newcomers. In addition, successful strategic communication of the intrinsic value of an ecosystem<sup>2</sup> was seen to be important for attracting new investors, both public and private, in many cases, such as the Textiles Recycling Valley.

---

<sup>2</sup>We focus on two different types of communication: tactical and strategic communication. Tactical communication is about building on the public knowledge of contemporary trends to support awareness, education and persuasion for attracting newcomers to ecosystems. In contrast, strategic communication is about successfully developing a convincing business case around the intrinsic value proposition of an ecosystem and its innovation. Fundamentally, strategic communication centres on the intrinsic worth of an innovation, whereas tactical communication emphasises how an innovation sits within an external environment.



# 1. APPROACH

---

We have analysed ten multi-stakeholder, ecosystem-led innovation case studies to understand their key factors of success and identify potential lessons. The objective of this project is to provide relevant, engaging, and useful case studies of innovation ecosystems that have had a positive economic impact in Europe by supporting new markets, exports and/or jobs while being consistent with the transition to a low carbon future. The case studies provide an evidence base for a variety of European stakeholders, including policymakers, to draw potential lessons from the success of a variety of different ecosystems.

We define ecosystems as collections of companies, research institutes, public bodies, non-governmental organisations, and other assorted organisations, which work together towards a common goal. In our case studies these goals are end-use functionalities such as hygiene, mobility or thermal comfort, which provide solutions to societal needs or challenges. Best satisfying these end-use functionalities in the new industrial economy requires innovative business models, technologies, processes and/or products. Our case studies represent significant shifts from the conventional deployment and operation of technologies, business models, processes and products in order to solve societal problems. In this sense, we term them systemic innovations<sup>3</sup> because they are challenge-driven in their goals, and collaborative in their methods.

To identify appropriate case studies we conducted literature research, held interviews, and hosted an internal workshop with innovation experts. From there we constructed a list of thirty case studies which were selected and analysed to ensure sufficient coverage across different geographies, sectors, types of innovation and ecosystem.

From this long list we selected ten case studies for in-depth analysis to investigate what the key factors of success were for these ecosystems and their innovations. This included an interview programme with representatives from each case study. It resulted in a series of two-page fact sheets that outline the narrative of each case study, its ecosystem and its key factors of success.

These fact sheets form the evidence base for this report. The report focuses specifically on what has underpinned the success of these ecosystems, distilling four key factors of success: (1) leadership, (2) cross-value-chain collaboration, (3) proximity and (4) communication. The report synthesises the similarities and differences between the case

---

<sup>3</sup>In System Innovation: Synthesis Report (2015) the OECD states that system innovation is a concept used to illustrate a horizontal policy approach that mobilises technology, market mechanisms, regulations and social innovations to solve complex societal problems in a set of interacting or interdependent components that form a whole “socio-technical system”. In some ways it is similar to “whole-of-government-policy” approaches that aim to enhance coherence (or in the best case align policies in different domains), but system innovation aims to achieve much more than coherence or policy alignment since it involves actors outside government – notably firms and civil society - and takes a longer term view. System innovation is problem oriented and focused on addressing systemic problems in particular sectors/technology areas. To constitute systemic change, an impulse should be complemented by a response. This takes the form of “new production and consumption arrangements, new skills, new infrastructure, subsequent innovations (many of them specific to the system’s context), new social arrangements (e.g. professional associations), new rules and new forms of governance, to name but a few.”





studies and looks at how the four key factors of success have been important for the ecosystems in focus.

The following pages go through the four key factors of success, breaking them down into sub-components, with contextual analysis of some of the most relevant case studies. In addition, we have also included a brief analysis on some of the barriers that may prevent the scalability and replicability of the ecosystems we have analysed. Ultimately this leads to a selection of high-level key learnings that draw on the prominent similarities from within our sample.



## 2. KEY FACTORS OF SUCCESS FOR MULTI-STAKEHOLDER ECOSYSTEMS

### 2A. Leadership

Leadership plays a vital role in kick-starting ecosystems and providing a focal point for their coordination. Ecosystems often have an actor, or multiple actors, who take a leading role. This helps establish important degrees of direction and confidence, and encourages other actors to the table. Continued leadership acts as an important focal point for ecosystems which often need to coordinate multiple interests. Across our case studies, leaders have taken different forms and used different methods. This section is framed by the different types of leaders, and the detail will explain the methods they deployed.

**Table 1 Summary table of the case studies and where the different types of leaders are found**

<b>POLICYMAKERS</b>	<b>MARKET LEADERS</b>	<b>FACILITATORS</b>
Energiesprong	Beta Renewables	Energiesprong
Sustainable City Hyllie	Philips Lighting	Sustainable City Hyllie
Autolib'	Sonnen GmbH	Autolib'
HafenCity	Lontra	HafenCity
		Lontra
		Kalundborg Symbiosis
		Textiles Recycling Valley



## Policymakers

---

Policymakers can take a crucial leadership role by kick-starting ecosystems through setting ambitious legislation and programmes that draw multiple actors, usually from different sectors and value chains, together in pursuit of societal challenges.

One such example is how the Dutch government set a series of ambitious targets that led to the formation of Energiesprong. In 2013 Dutch policymakers set a decarbonisation target of an 80-95% reduction in CO<sup>2</sup> emissions by 2050. For a country with an aging and energy inefficient housing stock, this would necessitate refurbishing six million homes to make them energy-neutral. Historically refurbishing domestic buildings has been tackled incrementally. But these incremental improvements do not address the systemic problem of split incentives between homeowners and home users that discourage major refurbishments from going ahead. This lack of demand consequently stymies any potential supply chain.

To tackle this systemic problem, the Dutch government legislated in 2013 to establish a challenge-led organisation, Energiesprong. It was created with the ambitious objective of delivering an initiative that could have the potential to alter the underlying market conditions that prevent the widespread energy efficient refurbishment of the domestic housing stock, by creating new sources of supply and demand. Significantly, the legislation stipulated that the homes had to adhere to an ambitious energy-neutral target.

Therefore, overall there are three levels of governmental action here that play an important role:

- Deep cuts required in national CO<sup>2</sup> emissions;
- Ambition to create new market conditions for domestic energy efficient refurbishments; and
- Establishing a challenge-led organisation to deliver energy-neutral homes.

A crucial dimension to the success of Energiesprong has been that although its highly ambitious objectives have been proscribed, the means by which they are to be achieved has not. This is indicative of a risk-taking culture in the policy environment whereby the Dutch government is prepared to commit resources to untried, innovative thinking. This has given Energiesprong the freedom to address the challenge by conceiving its Stroomversnelling programme that brings together an ecosystem including the social bank WSW, housing associations and market-leading manufacturers of energy efficient refurbishments to make 111,000 houses energy-neutral by the end of the decade.

In our sample, there are other examples of policymakers kick-starting ecosystems through ambitious targets. A similar example of a challenge-led ecosystem is Sustainable City Hyllie, where the City of Malmö collaborated with two utilities, E.ON and VA SYD, to set a goal of developing an entire district that used 100% renewable and re-usable energy by 2020. This challenge set the foundation for a complex ecosystem that includes these three initiators working in tandem with research and developing (R&D) laboratories, construction



companies and residents to deliver the target. Interestingly, once again this case study also represents goal-setting by policymakers without specifying the means by which to achieve it.

Lastly, the policymakers in the City of Paris also displayed considerable leadership qualities in setting the foundation for Autolib'. In this instance, it was a competitive tender put out by the policymakers to create the world's first city-wide electric car-sharing platform.

Across all of these case studies, there is a clear leadership role for policymakers in kick-starting ecosystems. This is particularly true for societal challenges that the private sector may not address on its own, such as: creating new market conditions for energy neutral homes; developing a city district with 100% renewable and re-usable energy; and establishing a city-wide electric car-sharing platform. In all cases there was a high level of ambition combined with an openness to potential solutions, providing the implementing agents with freedom to innovate.

However, there are also differences between the roles of policymakers across these case studies. Whilst for Energiesprong, the role of national policymakers was paramount in setting the necessary legislation, for Sustainable City Hyllie and Autolib' the respective city authorities were the instigators. In addition, although Autolib' was set up through a competitive tender, Sustainable City Hyllie was formed as a public-private partnership between the utilities and the City of Malmö. In contrast, Energiesprong was established by the Dutch government as an organisation in its own right. This shows how policymakers can set up challenge-led ecosystems through a variety of methods.

## Market leaders

A number of case studies also reveal how companies in the private sector can help create successful ecosystems through market leadership. By implementing high levels of ambition, investment and new ways of working, private companies can attract newcomers to ecosystems formed around their innovations. This is indicative of a risk-taking culture, where the private sector is prepared to embark on potentially risky endeavours in order to create new business models, processes, products and technologies that will place them at the forefront of markets.

The development of Beta Renewables' Proesa™ technology is an example of how the private sector can take the initiative in creating a successful ecosystem through market leadership. Proesa™ is the world's first example of biofuel production from cellulose using plant and agricultural waste that is 80% lower carbon than fossil fuels. From 2006 to 2011, Mossi Ghisolfi Group, a €2.3 billion turnover per annum multinational conglomerate, channelled €150 million into searching for early-stage bio-technologies and researching the Proesa™ product through their daughter company Biochemtex.

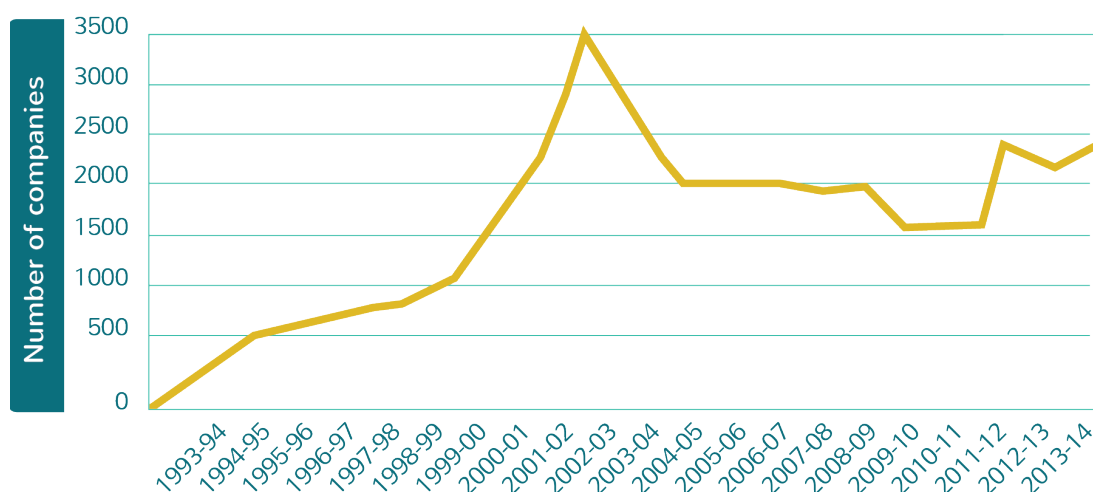
This represents a large risk-taking investment entailing extensive laboratory research. But it has incubated the technology and drawn in new partners in the form of private equity firm, Texas Pacific Group, and Novozymes, a technical expert in enzymes production, as



well as attracting funding from the Piedmont Regional Government and, most recently, the European Commission. Their success in creating this ecosystem is a result of aiming to be market leaders in low carbon biofuels and potentially creating a lucrative product that the newcomers were keen to help commercialise.

However, trying to encourage a risk-taking culture necessary for creating market leading companies is not something that has traditionally come easily to European markets when compared to the United States<sup>4</sup>, where much larger quantities of venture capital have helped to launch innovative ecosystems<sup>5</sup>. This has led some policymakers to try and stimulate greater entrepreneurial investment. One successful example of such is the UK's Enterprise Investment Scheme (EIS). This scheme increases the returns from investing in start-up companies by providing 30% income tax relief to investors.

**Figure 1. Number of companies using EIS to raise funds**  
Source: UK government, Her Majesty's Revenue and Customs



A clear example of where it has been effective is for Lontra, a start-up company that has created a revolutionary air compressor. Their Blade Compressor has impressive efficiency gains of over 20% when compared to existing piston-based models that have been around for over sixty years. Over the course of the last decade, it has been able to attract £2.9 million (c. €3.7 million) in equity finance thanks in part to the return-increasing benefits of the EIS. It is a working example of how incentives can be used by policymakers to foster a risk-taking culture that consequently supports the formation and success of market leading ecosystems.

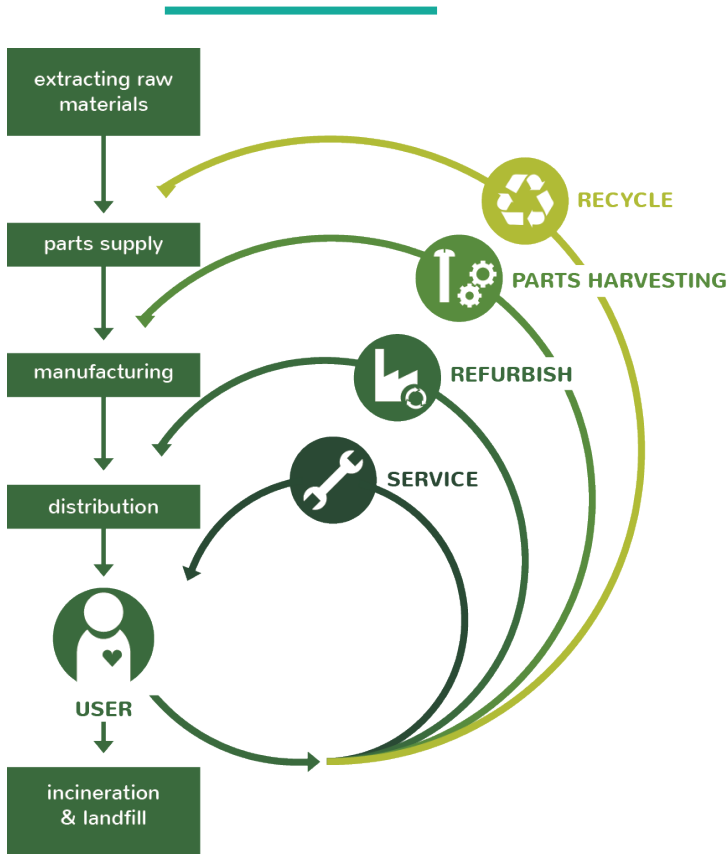
<sup>4</sup>Ernst & Young (2014), *Adapting and Evolving: Global venture capital insights and trends*.

<sup>5</sup>OECD (2015), *System Innovation: Synthesis Report*.



**Figure 2. Diagram illustrating Philips Lighting's Circular Lighting business model**

Source: Philips Lighting



In contrast to the two technological innovations mentioned above, Philips Lighting's Circular Lighting initiative highlights how innovative business models can also represent market-leading qualities that help create successful new ecosystems. The premise of Circular Lighting is that Philips Lighting no longer sell customers hardware in the form of lighting systems, but instead provide light as a service at a rental rate. Servitisation of products is not entirely novel – for instance Rolls-Royce have been running their power-by-the-hour programme for jet engines for decades – but servitising such a ubiquitous consumer feature as lighting marks Philips Lighting out as a market leader.

By shifting their business model to providing a service, there is different emphasis on how lighting as a whole is produced and consumed. There is a greater onus on providing a high quality service that keeps the customer loyal to the provider, as opposed to creating a product that sells for the highest possible mark-up. In

this case, this amounts to Philips Lighting keeping their energy and replacement costs down by providing the most efficient, long-lasting light bulbs and innovatively planning the location of lights. Once the lighting systems reach the end of their life, as a service provider Philips Lighting recycles and replaces them, constituting a circular economic model.

The consequences of this shift have had significant effects on Philips Lighting's supply chain. It has spurred a shift in focus for lighting technology, which now needs to be optimised to provide the most effective service. As a result, Philips Lighting have been a leading developer of "smart" light bulbs that can communicate directly with the provider and the user to enhance performance and highlight potential maintenance needs. This last aspect also creates the need for a local maintenance partner to manage the operation of the service. Sensors and monitors are also integrated into the systems, accounting for a further 20% electricity use saving. This increasingly high-tech, high-quality approach to lighting could have wider ramifications for manufacturing whereby there could be a shift towards placing factories close to laboratories and highly skilled workforces in Europe to create the best possible lighting systems as opposed to mass producing hardware using cheaper labour in other geographies. Here it is clear that a market leading business model can recalibrate a value chain and foster a new ecosystem.

However, it must be noted that Philips Lighting is able to innovate in such a way because



its pre-existing market leadership qualities enable access to the necessary resources and existing client base for commercialising its new business model. Similarly, the Mossi Ghisolfi Group is a large conglomerate that has the requisite funding to invest in a risky technology. These ecosystems therefore highlight that pre-existing market leaders can be in strong positions to take the necessary risks for creating innovation ecosystems.

Overall, market leaders in the private sector can have a stimulating effect for ecosystems. They open up new ways of solving problems by charting new paths that attract others to ecosystems. In particular, the private sector can be prepared to take greater risks on more niche areas of interest than public bodies. Although the fundamental risk-taking culture is not always forthcoming and so this is where policymakers can also play a role in creating an encouraging environment for potential market leaders to attract partners to their ecosystems.

## Facilitators

Whilst in our cases studies so far, market leaders and policymakers have been shown to be key in leading the genesis of ecosystems, there is also a need for continued leadership once ecosystems are established. Amongst our sample, we found that this role is often performed by a facilitating agent who acts as a vital focal point for coordinating the many actors involved.

HafenCity highlights a prime example of a facilitator leading a complex ecosystem. In 1997 the City of Hamburg started planning the redevelopment of the city's former port area. Due to be completed by 2025-2030, the redevelopment will include extensive residential and commercial areas, educational institutions, cultural facilities, parks and other public spaces. It is Europe's largest inner-city development project and has adopted an innovative procurement process that prioritises sustainability concerns.

For the purpose of undertaking such a large project, the City of Hamburg established a facilitating agent. HafenCity GmbH is a limited liability company that was set up by the city government to manage the project and the "Special Fund for City and Port" that finances the development. It is relatively autonomous in its ability to conduct the procurement process and manage the overall project.

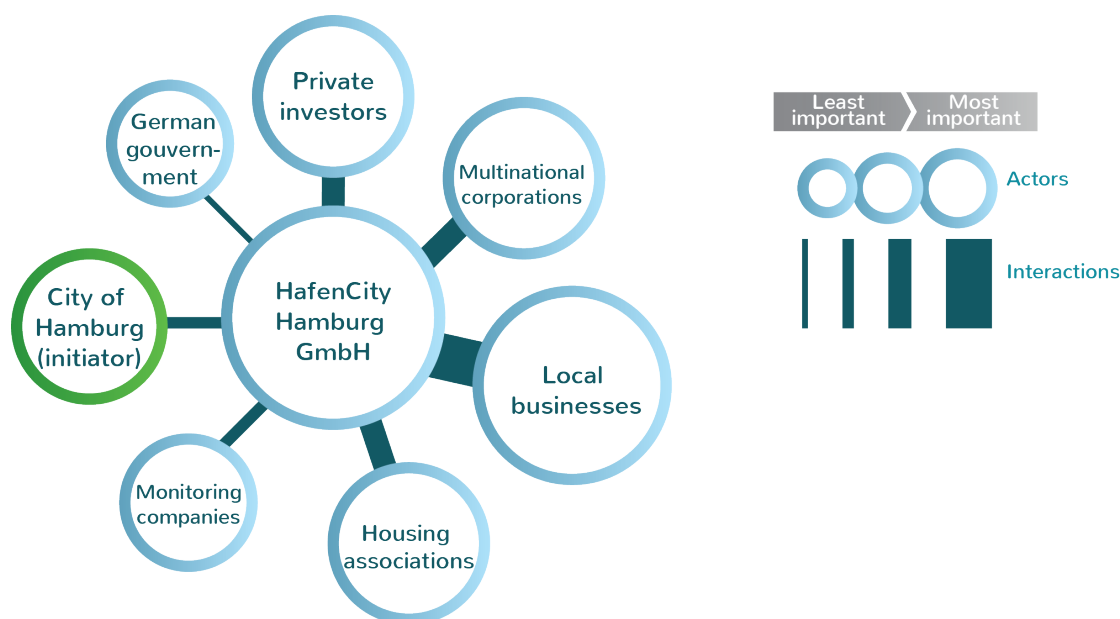
HafenCity GmbH facilitates coordinated action between different private contractors, who can be involved with different parts of the development and from different geographies or sectors. It acts as the central actor in the ecosystem, performing a key governance role that ensures there is a single, coherent locus of authority. This enables efficient decision making within a very complex ecosystem, establishing a source of continued direction and leadership.

Facilitators were also created at the outset of three other case studies. Energiesprong acts as the central facilitating agent for directing the ecosystem around its Stroomversnelling programme, bringing together the social bank, WSW, housing associations, manufacturers and installers. It helps manage dialogue between them to deliver the energy efficient refurbishments on a mass scale. E.ON plays the important facilitation role in the





**Figure 3. HafenCity ecosystem**



Sustainable City Hyllie project, coordinating a large amount of individual projects within the development to fully integrate the energy system of district. Lastly, Autolib' Metropole act as the mediator between dozens of municipalities, the Parisian public and Société Autolib', ensuring that the different voices have a common outlet and can be synchronised to deliver an effective service that satisfies all parties. In all these cases, the facilitator was set up at the start of the ecosystem with the specific function of coordinating the many different actors.

However, not all facilitating agents are set up at as soon as an ecosystem emerges. The Kalundborg Symbiosis, where seven core industries and the municipal authorities utilise each other's waste for their own products through a sophisticated industrial ecosystem, did not have a single facilitator for over three decades since it began. The ecosystem originally evolved in a spontaneous fashion from 1961 onwards, with individual industries situated in the Kalundborg industrial park seeking out potential partners across Denmark, and vice versa, for mutual benefit.

As the ecosystem became more complex, a collective board was established in 1995 as a vehicle for formal communication between the seven core industries and the municipal authorities. This body has helped build trust in their cooperative system and also enables them to consider future partners and solutions for the wider benefit of the whole ecosystem rather than individual actors.

In recent times the board has been complemented by the Symbiosis Centre Denmark that encourages connections with engineering firms and research institutes who can contribute to progressing the symbiosis network both from within, and disseminate its learning without. Here it is clear that although the Kalundborg Symbiosis could serve itself well without facilitating agents, it has been able to add new layers of complexity to its ecosystem as a result of channelling communication through formalised facilitators.





The final type of facilitating agent we found in our case studies is that of an incubator. The value of an incubator who can facilitate a multi-stakeholder ecosystem is demonstrated in the Lontra case study. In 2005, Lontra won the support of the Carbon Trust, which at the time was a government-owned agency responsible for incubating promising low-carbon technologies and accelerating their transition to market through trials and demonstrations. The Carbon Trust used their experience with scaling innovative technologies to help Lontra target the best industry for commercialising their Blade Compressor. As a result, they focused on wastewater treatment, where compressed air is used in an aeration process that accounts for 1% of all energy used in the UK – illustrating the potential market visibility for an energy efficient technology.

In 2010, this led to the Carbon Trust negotiating funding for a demonstration project at a working facility with Severn Trent Water, which supplied water to over four million households and businesses in the UK. The two companies provided Lontra with £700,000 (c. €800,000) to develop a prototype. Significantly this prototype was created in close collaboration with the end user – so it was tailored to their exact needs, accelerating the process by which they could test their product.

This is unlike the typical process for industrial innovations, where the innovators often have to undertake many different stages of modification without the direct collaboration of the end-user to fit their needs. In the end, this facilitation process proved to be a resounding success when the demonstration in 2012 resulted in Lontra's Blade Compressor outperforming every other model in use at Severn Trent Water's facility by using over 20% less energy. In an industry where 1-2% is seen as an impressive improvement, it was a significant leap forward to commercialising the technology.

Across all of these case studies, the leadership role of a facilitator provides a vital level of coordination amongst different actors within an ecosystem. They act as a mediator between various parties and formalise important avenues of communication that are key to the success of ecosystems. Whilst in certain cases – such as E.ON in the Sustainable City Hyllie programme – they play a role implementing an innovation, often they are solely focused on managing the ecosystem. This highlights how integral effective communication is to lead actors in complex ecosystems, so much so that it can require a dedicated organisation for just that purpose.

The ways in which the different facilitators acquire their legitimacy as focal points for these ecosystems are likely to be varied, but there are two features that stand out across our sample. First, in many instances the policy and legalisation that either mandates the existence of a facilitator, or is interlinked with their aims, is paramount for providing necessary long-term credibility to their management function. HafenCity, Energiesprong, Sustainable City Hyllie, Autolib' and Lontra are all case studies that have facilitating agents linked to policy and legislation that underpins a commitment to their role. Second, for a selection of these case studies - in particular HafenCity, Energiesprong and Sustainable City Hyllie - the supporting policy framework also includes significant amounts of patient capital. This funding further supports the credibility of these facilitators because it underlines the long-term commitment to their aims, as well as making the ecosystem attractive to potential newcomers who can identify potential market visibility.



## 2B. Cross-value-chain collaboration

Cross-value-chain collaboration is where existing value chains are reconfigured to create novel ecosystems. To elaborate, it is when businesses and industries that would not normally work directly with each other cut across conventional value chains to cooperate within ecosystems. Through our case studies we have identified that such collaboration can emerge through top-down or bottom-up initiatives.

The difference between the two is that top-down initiatives are directed by a central agent that is a key player in coordinating a complex ecosystem. Often this agent is a public body or a corporate in charge of delivering a project that has many sub-components. In contrast, bottom-up initiatives appear more spontaneously and involve smaller ecosystems where the aims are more specific to particular actors. However, we appreciate that the two are not necessarily mutually exclusive and note that these bottom-up initiatives can occur within top-down arrangements, and vice versa. Yet amongst our case studies we focused on the differences between them.

**Table 2 Summary table of the case studies and where the different types of cross-value-chain collaboration are found**

TOP-DOWN	BOTTOM-UP
Sustainable City Hyllie Energiesprong HafenCity Textiles Recycling Valley	Kalundborg Symbiosis Philips Lighting Sonnen GmbH Lontra

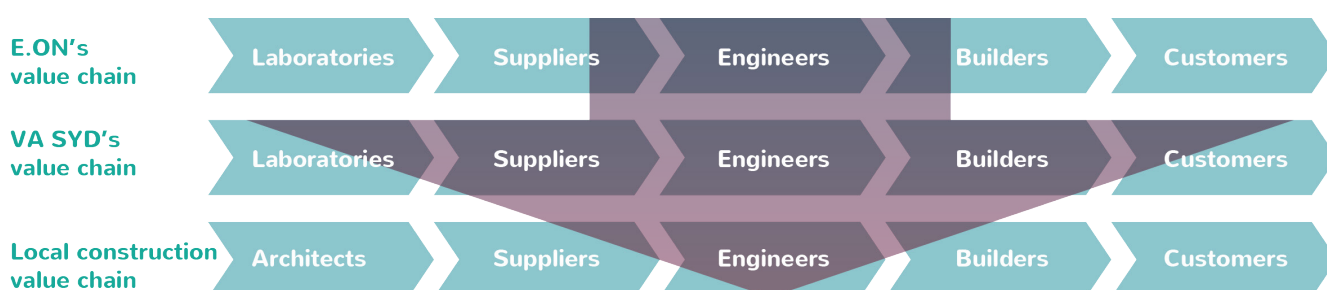
### Top-down

An example of a top-down initiative leading to cross-value-chain-collaboration can be found with Sustainable City Hyllie. Hyllie is a district in Malmö, Sweden that is undergoing extensive redevelopment with the aim of becoming a world leader in low carbon urbanisation. As described above, in 2011, the City of Malmö got together with the energy utility, E.ON, and the water utility, VA SYD, to sign a contract that stipulates that the district of Hyllie will use 100% renewable and reusable energy by 2020. This ambitious challenge necessitated the initial collaboration between the two utilities – crossing their value chains – and has subsequently seen cross-value-chain collaboration with local suppliers and residents.



All of Hyllie's 9,000 residences and 9,000 offices are to be zero-carbon buildings. This entails ensuring they are constructed to very high energy efficient standards, fitting them with "smart" technologies to enable demand side response and connecting them to renewable or re-usable sources of energy. Given the scale of the development, this necessitated a holistic approach that cuts across different value chains. To illustrate, E.ON has had to collaborate with its supply chain to develop and demonstrate the latest smart grid technologies, engage local construction companies to create fully integrated systems and energy efficient buildings, as well as reach out to the public secure local buy-in.

**Figure 4 Sustainable City Hyllie top-down cross-value-chain collaboration**



The approach to managing the Hyllie project is one of communication and flexibility in pursuit of its ambitious goals but individual solutions are not prescribed in advance. There is a clear willingness to implement innovative solutions and an appreciation that they can be best achieved in an environment that encourages cross-value-chain collaboration. It is an example of 'improved governance mechanisms and better means of engaging a range of stakeholders that are needed to facilitate system innovations<sup>6</sup>.

Once again, there are strong similarities between Sustainable City Hyllie and both HafenCity and Energiesprong. HafenCity is another significant urban development that requires extensive cross-value-chain collaboration to achieve its aim of a fully-integrated, sustainable city district. Energiesprong's Stroomversnelling programme forges a novel three-way collaboration between housing associations, who provide the demand, the bank WSW, who provide the finance, and manufacturers and installers of cutting-edge energy efficient refurbishments, who provide the supply. These three parties work together to create a novel ecosystem that is capable of changing the market conditions for domestic energy efficient refurbishments by working across both the supply and demand side of the value chain.

Interestingly, these top-down cross-value-chain collaborations are all supported through facilitation agents, as touched upon earlier. This emphasises how complex collaborative ecosystems that address large-scale challenges benefit from leadership from facilitators.



## Bottom up

---

We identified bottom-up initiatives where businesses take it upon themselves to transcend their traditional supply chains. For instance, Sonnen GmbH evolved their business model from supplying hardware in the form of batteries for domestic energy storage, to controlling a virtual power plant in the form of the SonnenCommunity. To achieve this significant transformation, they needed to acquire new resources and skills beyond their conventional value chain as hardware suppliers.

The context for their change in business model is that in 2014 the German government began moving away from subsidies for utility-scale solar plants, therefore increasing the prospect of similar moves for distributed generation. Such a move would threaten Sonnen GmbH's core business model of selling batteries to domestic producers of energy. This prompted them to look into how they would survive in a post-subsidy world, highlighting how incentives can stimulate growth in nascent markets, but also threaten businesses when they are removed.

Sonnen GmbH created the SonnenCommunity as a result. It uses an innovative software technology that works as a virtual power plant, where users who generate and store their own energy are linked up to each other through the electricity grid and can receive revenue for their under-utilised energy, or receive energy when their supply is low. This innovative business model could protect Sonnen GmbH, and the wider distributed energy market by providing a new source of revenue.

However, when Sonnen GmbH first came up with this idea, they only made batteries, and although they had a wealth of data about their usage, they had no experience managing an electricity grid like the SonnenCommunity. As a result, Sonnen GmbH transcended its conventional value chain to collaborate with:

- Software developers, who helped turn their data into a platform that could allow consumers to trade energy;
- The utility company LichtBlick, who helped them with assistance on technical issues and provided knowhow regarding how to manage an electricity grid like a utility; and
- An extensive public engagement programme through publicity and trials with existing customers to scope out the potential market and refine their platform so it was customer-friendly.

These collaborations helped Sonnen GmbH develop new resources, such as software to create a virtual power plant, and skills, in order to manage an electricity grid, which it did not have previously. This exemplifies how bottom-up cross-value-chain collaboration can create successful ecosystems by introducing and unlocking new facets for the existing actors.



**Figure 5 SonnenCommunity bottom-up cross-value-chain collaboration**



Similar examples can be found with Lontra and Kalundborg Symbiosis. In the case of Lontra, as previously mentioned, there was extensive collaboration between the innovator and the user of the technology. This enabled it to reach commercialisation at a far faster rate as they could refine the innovative air compressor together. Here again, this cross-value-chain collaboration was supported by the role of a facilitator, in this instance an incubator. On the other hand, the Kalundborg Symbiosis achieved cross-value-chain collaboration between a variety of previously autonomous industries spontaneously, without the aid of a facilitating agent for many decades. However, it is recognised that this is an exceptional case, and usually industrial symbiosis networks require a significant level of top-down direction and/or facilitation.

The examples above highlight how bottom-up cross-value-chain collaborations have their own unique characteristics given their inherent spontaneity. Therefore, from an external perspective, replicating the success of these ecosystems is more about encouraging notions of cooperation that go beyond traditional values chains, rather than directing such collaboration. However, similarly to top-down, bottom-up cross-value-chain collaboration can underpin ecosystems that are capable of addressing challenges and market failures through innovative forms of cooperation.



## 2C. Proximity

Proximity of supply and demand makes ecosystems easier to manage and more attractive. Fundamentally proximity provides a useful boundary for ecosystem collaboration – making it manageable for leaders and attractive to newcomers. Throughout our case studies, this has been evident across two dimensions: density of supply and density of demand. Importantly, they often appear to work very well in tandem.

**Table 3 Summary table of the case studies and where the different types of proximity are found**

DENSITY OF SUPPLY	DENSITY OF DEMAND
Kalundborg Symbiosis Energiesprong Sustainable City Hyllie Textiles Recycling Valley Lontra	Kalundborg Symbiosis Energiesprong Autolib'

### Density of supply

Density of supply makes ecosystems easier to manage. In our research, we have found this ease of management can come from different aspects: from helping leaders to grow an innovation by providing clear links to supply chains, to generating local industry buy-in by providing them with access to the ecosystem.

As an example of the former, in the Kalundborg Symbiosis case study, density of supply has been key to attracting new partners by making the business case of the network attractive. The costs of connecting each other has been kept low enough so that the business case for newcomers has remained strong. This has been supported by advanced infrastructure constructed by the core industries themselves. In addition, the geographical density of the network has made regular communication easier. Therefore, in sum, the close proximity of suppliers has provided the essential visibility for establishing a complex, but efficient, system that has been manageable for the ecosystem.

Another very similar example from our case studies is that of the Textiles Recycling Valley. This initiative is driven by organisations that specialise in the manufacturing and recycling of textiles in Northern France in an attempt to create a “circular economy” between the two industries. This task is made easier by the density of manufactures within the region.

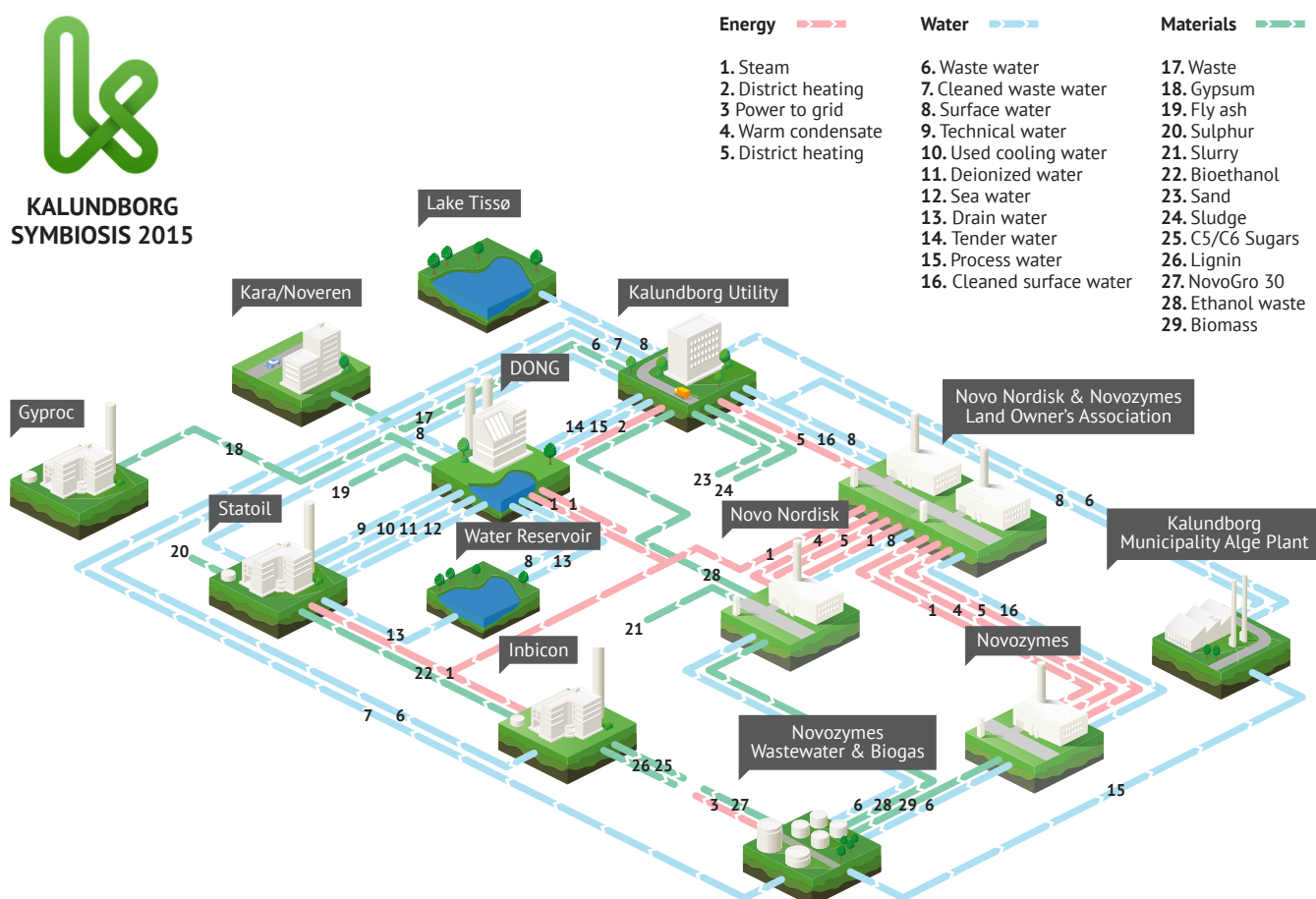


However, on the other hand, overcoming the dispersion of suitable textiles material is a challenge that the ecosystem is trying to address.

The Sustainable City Hyllie case has also shown that a density of supply, in this case local contractors, has made the project feasible. In addition, the extensive engagement with these businesses and residents has fostered local buy-in to the project, which is key for it to be a success. Local ownership can help mitigate against potential opposition and also provide an economic boost to businesses in the surrounding area. This helps create a tighter, more resilient ecosystem that is subsequently easier to manage.

Another interesting case study in this area is Lontra. They have strategically selected their location in Napton, UK, for the purpose of attracting highly skilled individuals from the nearby world-leading engineering departments at Jaguar, Maclaren, Rolls-Royce and more. With the company set up to profit from its intellectual property, its location near the best technicians has been very important for attracting a sufficient supply of skills<sup>7</sup>. This intelligent use of proximity has been key for the success of the ecosystem.

**Figure 6 Diagram of Kalundborg Industrial Symbiosis network (source: Symbiosis Center Denmark)**







## Density of demand

---

Density of demand provides a visible market for actors to focus on before scale-up. It is related to market visibility and can be important for attracting newcomers to ecosystems by highlighting the potential for new revenue sources. Often density of demand is geographical, but with growing digitalization, we have observed technology making proximity less of a factor for certain ecosystems.

The success of Autolib' and its ecosystem is predicated on the concentration of demand within the city of Paris. The car-sharing platform can potentially access a market of millions of people who would like the freedom of a private vehicle at a price that is competitive with public transport. What was important to the visibility of this demand was the precedent set by the successful city-wide bicycle-sharing scheme. This provided the impetus for the city authorities to think about an innovative electric car-sharing service in a similar mould, and also outlined the potential scalability of a service to potential bidders. It reveals how similar precedents can play an important role in highlighting potential future markets through making innovations easier to grasp for both producers and consumers.

Interestingly, Autolib's success has been because it complements this density of demand with a density of supply with its parking spaces. Within a city notorious for its lack of parking space, Autolib's charging stations are only 300-400m apart across 86 districts. This underlines the ease-of-use of the service, and is fundamental to its popularity. However, there was significant public disapproval around allocating such a large number of scarce parking spaces. Here again, local engagement and buy-in had to be a keystone for the ecosystem in order to overcome this potential barrier and succeed.

The aggregation of demand within defined proximities is also critical to the success of Energiesprong. The business case for domestic energy efficiency is not very convincing if it focuses on only one residency at a time. This is counter-intuitive for suppliers who are incapable of mass producing solutions without the visibility and certainty of future demand. That is why Energiesprong has targeted housing associations with its Stroomversnelling programme. This move made the ecosystem attractive to the suppliers, who can manufacture large quantities of sophisticated energy efficiency solutions.

In addition, this ecosystem is another example where the density of demand is complemented by the density of supply. Within the Netherlands, there are a sufficient number of highly skilled manufacturers and installers of solutions for energy-neutral homes. This density of supply ensures that they are able to model, pre-fabricate and install their products within 10 days per residency. Such speed is enticing for housing associations and residents who wish to incur minimal disruption whilst taking part in the ecosystem.

Throughout both of these case studies, the close proximity of demand provides important visibility of potential markets. This is crucial for attracting newcomers to ecosystems by outlining a convincing business case.

However, we have found that the digitalization of the world can reduce the value of geographical proximity for certain ecosystem by making density of demand virtual. For





instance, Sonnen GmbH's SonnenCommunity utilises the advanced technology of the German energy infrastructure to connect distributed energy generators around the entire country. This nationwide ecosystem constitutes a density of demand that exists on a purely virtual level. Importantly, this is only possible where infrastructure is at a sufficient technological level to enable distributed generators to trade their energy across the grid. Therefore this technology is a fundamental prerequisite for the SonnenCommunity's ecosystem of distributed energy.



## 2D. Communication

Communication and awareness practices play a fundamental role in growing successful ecosystems by attracting newcomers. To be successful, ecosystems need to make the most of different forms of communication. There are two relevant modes: tactical communication and strategic communication. It must be emphasised that these are very much interdependent and not mutually exclusive. Indeed, we have found that they often work well in combination with each other.

**Table 4 Summary table of the case studies and where the different types of communication are found**

TACTICAL COMMUNICATION	STRATEGIC COMMUNICATION
Philips Lighting Textiles Recycling Valley Sonnen GmbH Autolib'	Beta Renewables Textiles Recycling Valley Sustainable City Hyllie Kalundborg Symbiosis Lontra

### Tactical communication

Tactical communication is about exploiting contemporary trends to support awareness, education and persuasion about an ecosystem and its innovation. This amounts to when actors capitalise on a critical mass of information surrounding relatively novel or fashionable ideas, which can include, but are not limited to, the current policy climate, media attention and technological breakthroughs, to communicate their message to potential newcomers to the ecosystem. In essence, it is about ecosystems capitalising on visions of positive cultural and economic change to encourage new actors into the fold.

A strong example is how Philips Lighting have been able to grow the ecosystem around their Circular Lighting innovation through tactical communication on a number of levels:

- Sustainability and energy efficiency have become increasingly popular amongst businesses and public authorities, which has prompted an increasing focus on how to make energy savings through lighting;
- The well-publicised existing precedents for the servitisation of products and the growing



prevalence of ideas around the “circular economy” have been influential in educating and convincing senior staff at Philips Lighting as well as attracting clients; and

- A burgeoning amount of attention in the public domain surrounding the internet of things has been a significant factor in informing potential customers about how the circular model will be implemented, and instils confidence that it is feasible and beneficial.

Other examples across our case studies can be found in the Textiles Recycling Valley initiative, and the SonnenCommunity. First, the Textiles Recycling Valley capitalises on a similar trend to Philips Lighting in the shape of growing knowledge about the uses and benefits of the “circular economy”. In this instance, the notion that manufacturers and recyclers of textiles can close the loop for the benefit of them both requires a sufficient level of appreciation and understanding about how a circular model could work for mutual benefit. This communication need is supported by growing awareness around the “circular economy”, which the initiative can exploit for attracting new actors to the ecosystem.

Sonnen GmbH have used tactical communication to grow their ecosystem through capitalising on existing knowledge around peer-to-peer markets. Their growing prevalence throughout the world has laid the foundation for effectively convincing distributed energy generators to join into their virtual power plant ecosystem.

By resonating with popular trends, these ecosystems could smooth the education and persuasion phase for attracting newcomers, therefore helping to build wider and stronger ecosystems. In this instance, deploying tactical communication effectively is about smart communication strategies that reference important trends for the purpose of engendering confidence in novel ideas and highlighting market visibility in order to convince newcomers.

## Strategic communication

Strategic communication is about effectively communicating the intrinsic value proposition of a business case for an ecosystem. This can involve applying for public funding, enticing private investors and persuading potential commercial partners to join the ecosystem based on the merits of the business case. Ultimately it centres on the intrinsic value of an innovation, rather than tactical communication, which highlights how the innovation fits with external dynamics.

Our case study of Beta Renewables’ Proesa™ technology outlines how successful strategic communication can draw new actors into the ecosystem and unlock vital sources of funding. This began in 2009 by attracting €10 million of patient capital from the Piedmont regional government in Italy to construct a pilot plant that could produce one tonne per day of Proesa™. The strategic communication needed to be effective to attract this partner. In particular, the communication on the merits of how the innovation could boost the local economy and provide a potential export product was pivotal.

Another important event in 2009 was the signing of new European legislation to regulate the low carbon quality of biofuels. The Renewable Energy Directive and the Fuel Quality



Directive assert that fuels will no longer be considered 'bio' unless their CO<sup>2</sup> sequestration capacity is above 50% from 2014, rising to 60% in 2017. With Proesa™ achieving these targets, its business case has been significantly bolstered. Capitalising on this required both tactical communication to exploit the policy climate for, and strategic communication to use this regulatory environment as part of the intrinsic business case for the innovation.

Following the success of the pilot plant, two new partners were drawn to the ecosystem. These were the Texas Pacific Group, an American private equity firm who had worked with the Mossi Ghisolfi Group on other projects, and Novozymes, a technical specialist in enzyme production who had worked with Biochemtex since 2006. They formalised their partnership with Biochemtex by jointly creating Beta Renewables' in 2011 – the company that manages and markets the Proesa™ technology. Attracting these two partners was in part due to the historical relationships, but primarily it was also due to the strategic communication of the business case of Proesa™. Most importantly, Proesa™ could be cost competitive with other fuels and fitted within the regulations that were to be enforced later in the decade. At the time, this would make it not only cheaper than first-generation biofuels, but also cost-competitive with fossil fuels. The potential for commercialising this product was therefore very attractive.

Since then, Beta Renewables have made significant steps to commercialising Proesa™ by securing large amounts of patient capital from the European Commission to help build and operate a commercial-scale demonstration plant. This includes a €6 million EU grant was provided through the 7th Framework Programme that targets demonstrations of low carbon technologies, and incentives per tonne of fuel produced through the NER 300 programme have created an additional revenue stream for Beta Renewables of €28 million over 5 years.

It is worth noting that the Textiles Recycling Valley initiative also deployed effective strategic communication alongside their tactical communication to grow its ecosystem. Similarly to Beta Renewables, they were able to strategically communicate the value proposition of rejuvenating the textiles industry in Northern France as a source of economic benefit and job protection to both the regional government and the EU. This led to both public organisations joining the ecosystem by providing funding, with the regional government also helping with technical assistance.

The importance of strategic communication across these case studies is how it can convince newcomers by being smart and effective at emphasising the benefits of an ecosystem and its innovation. This may seem like a truism, but as an illustrative counterpoint, it is also the case that only a few ecosystems have the ability to unlock significant sources of funding from public bodies and private investors, as the above case studies do. Their success in attracting these actors into their ecosystems is an indication of how effective their strategic communication would have been.



## 3. KEY BARRIERS TO SCALING AND REPLICATING MULTI-STAKEHOLDER ECOSYSTEMS

---

In our study we found that in spite of the relative success of our case studies, there were some significant obstacles that they had to overcome. Moreover, there are some remaining obstacles that could prevent the future growth of the innovations in focus. They are summarised below.

### Accessing sources of external funding is a consistent barrier to growth

---

Unlocking investment from new actors is pivotal for ecosystems to grow and succeed. Even for our relatively successful cases, it was a problem that was highlighted often. In particular, this is because the innovations and ecosystems were often novel and unproven. It is an issue that cuts across the innovation landscape in general, given the competition for access to the limited resources available.

Even in the case of Sustainable City Hyllie, where the local government was backing the project, E.ON struggled to raise sufficient funds to trial potentially revolutionary smart grid technologies until the Swedish Energy Agency agreed to provide assistance.

This consistent barrier may be in part because the investment climate in Europe is not as encouraging for venture capital as say in the US. Although innovators such as Lontra have received policy support through initiatives such as the EIS in the UK, there is a need to consider and implement measures that could increase the flow of funding to innovators and their ecosystems across Europe if the continent is to attract and grow new ecosystems.

### An absence of sufficient skills can prevent ecosystems breaking out of their conventional modes of working

---

If ecosystems are to address systemic challenges, given their inherent complexity, they are often going to need to engage in knowledge and skills acquisition. We have seen this throughout our research, from Sonnen GmbH learning moving from producing batteries to managing a virtual power plant, to the Textiles Recycling Valley having to train textile manufacturers in the art of working with secondary, rather than virgin, materials. Acquiring sufficient expertise is limited by the amount of time, money and contacts an ecosystem can access and so can prevent significant scaling and/or replicability.



## Geographical constraints can limit the scalability and replicability of ecosystem

The conditions of particular geographies are often hard to find elsewhere, and this can make ecosystems that centre on a response to such also hard to implement elsewhere. For instance, the Kalundborg Symbiosis emerged due to water pressures at first, and then spontaneously grew as a result of a concentration of certain industries in a certain place – all of which is hard to replicate in other locations.

This could also relate to infrastructure – where there are geographies that lack adequate infrastructure, ecosystems can struggle to take root. For example, the SonnenCommunity would not be possible without the German grid being able to sufficiently manage a virtual power plant of distributed energy generators, and the Sustainable City Hyllie would have found its scalability difficult without the pre-existing district heating and cooling network in Malmö, which it could build upon.

Lastly, the cost of services and materials can be prohibitive to the scaling-up of ecosystems depending on what geography they are based. For instance, to scale-up the ecosystem for the Textiles Recycling Valley, recycled materials need to be cost-competitive with virgin ones, which is not always the case.



## 4. KEY LEARNINGS AND POINTS FOR FURTHER ENQUIRY

---

Throughout our analysis we have identified some consistent themes regarding the key factors of success for the ecosystems we have studied. Summarised below are some of the key learnings that can be taken from our research. However, given the limits of this sample, they could also form the basis for further enquiry.

### **Ambitious ecosystem leadership through challenge-driven goals and programmes can have an impact in addressing difficult systemic challenges**

---

Across many of our case studies we have found that policymakers that display high levels of ambition can have an influential roles in galvanising novel ecosystems for addressing systemic problems that are often very large and complex. When applied to specific issues, ambitious goals represent a clear signal of intent and lay the foundation for visibility in future markets that may not fully exist yet, drawing new actors into an ecosystem. This is particularly pertinent for challenges that seem to have been neglected by the existing markets in place.

In a number of the ecosystems we looked at, these ambitious goals are often complemented by challenge-led organisations or programmes. Importantly, in our sample these entities often have a significant degree of freedom that encourages innovative thinking and solutions to address the challenge.

### **Independent facilitating agents can lead and coordinate complex ecosystems, fostering cross-value-chain collaboration that targets systemic change**

---

The ability of purpose-built facilitating agents to represent, and mediate within, complex ecosystems provides a pivotal point of reference for direction, communication and implementation. Their central role can ease the process of cross-value-chain collaboration that we have seen to be very important in tackling problems that necessitate a holistic response from a variety of actors at once. Facilitators provide a common channel of communication between actors who may be unfamiliar with each other, and can utilise their leadership over large projects that may have many sub-projects ongoing within them.



## Defining supply and demand within specific proximities can nurture important market visibility

Ecosystems need to be able to identify their suppliers and customers to successfully deliver their innovations. On the supply side, this can be achieved by ecosystems locating near sources of raw materials, factories and/or technical expertise. Or alternatively the issue of location can be minimised by the existence of infrastructure, related to either transport or technological domains, which effectively shortens the divide between supplier and producer.

On the demand side, ecosystems that target well-defined markets appear to be successful in that they can focus their attention on visible markets. This can be especially helpful when nurturing an immature business case that needs proving before scaling-up.

## Communication practices should build on current trends and convey a convincing business case to attract newcomers

The ecosystems we have investigated are constituted in many different ways, but the common trait that runs through many, if not all, of them has been their ability to attract newcomers. This relates to how a number of ecosystems exploit contemporary trends in the public eye, through smart tactical communication, to capitalise on awareness-raising and education for newcomers. It also includes formulating convincing strategic communication, to align the objectives of ecosystems with potential newcomers and emphasise the intrinsic value and business case for innovative technologies, business models, processes and products.





## 5. APPENDIX: SUMMARY TABLE OF THE CASE STUDIES

---

The following table outlines the categorisation of each case study, the qualities of its ecosystem and the significance of its outcomes. This information was collected through desk research and interviews. It outlines the following:

- Case study name - by company or project;
- Country of origin – by flag;
- Maturity of the innovation - from development, to demonstration, to mature;
- End-use functionality - what purpose the innovation serves when it is deployed;
- Global megatrend - the wider context on what the innovation responds to and/or builds upon;
- Type of innovation – technology, business model, process and/or product;
- Ecosystem actors – who was involved, according to their relative importance;
- Engagement process – top-down versus bottom-up initiative;
- Key factors of success – relevant to the innovation and the ecosystem;
- Greenhouse gas (GHG) mitigation potential – the decarbonisation impact of the innovation;
- Economic impact – where available, data on the revenue or investment in the ecosystem and its innovation.

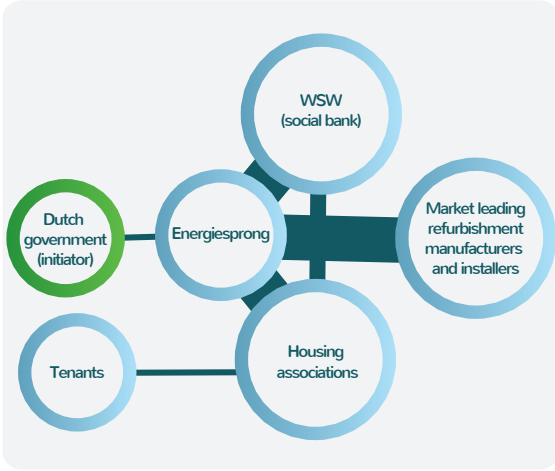
		Features						
Case Study	Categories	Ecosystem			Outcomes			
	End-use functionality	<p>Key    Least important    Most important</p> <p>Interactions    Actors</p>			Engagement process (top-down vs bottom-up)	Key factors of success	GHG mitigation potential	Economic impact
Maturity	Type of innovation							
<b>Autolib'</b> 	Mobility					<b>Innovation</b> <ul style="list-style-type: none"> <li>Market visibility</li> <li>Patient capital</li> </ul> <b>Ecosystem</b> <ul style="list-style-type: none"> <li>Ambitious leadership</li> <li>Challenge-led</li> <li>Proximity</li> </ul>	50,000 tons (t) since 2011	Sales of €35-45 million in 2015
	Decarbonisation Innovation breakthrough Urbanisation	Business model						
Mature								
<b>Beta Renewables</b> 	Mobility					<b>Innovation</b> <ul style="list-style-type: none"> <li>Regulation</li> <li>Market visibility</li> <li>Patient capital</li> <li>Skills</li> <li>IPRs</li> </ul> <b>Ecosystem</b> <ul style="list-style-type: none"> <li>Market leader</li> <li>Strategic communication</li> </ul>	20-30% lower emissions than first generation biofuels	€200+ million of investment
	Decarbonisation	Technology						
Demonstration								

### Energiesprong



Demonstration

- Shelter
- Thermal comfort
- Decarbonisation
- Urbanisation
- Business model
- Process
- Product



- Innovation**
- Incentives
  - Patient capital
  - Market visibility
  - Skills
- Ecosystem**
- Ambitious leadership
  - Challenge-led
  - Market leadership
  - Risk-taking culture
  - Facilitator
  - Cross-value-chain

Up to 430,000 t/year when the programme is complete

Turnover estimated at over €55 million in 2014

### HafenCity



Development

- Mobility
- Shelter
- Decarbonisation
- Urbanisation
- Business model
- Process



- Innovation**
- Regulation
  - Market visibility
  - Patient capital
  - Skills
  - IPRs
- Ecosystem**
- Market leader
  - Strategic communication

20-30% lower emissions than first generation biofuels

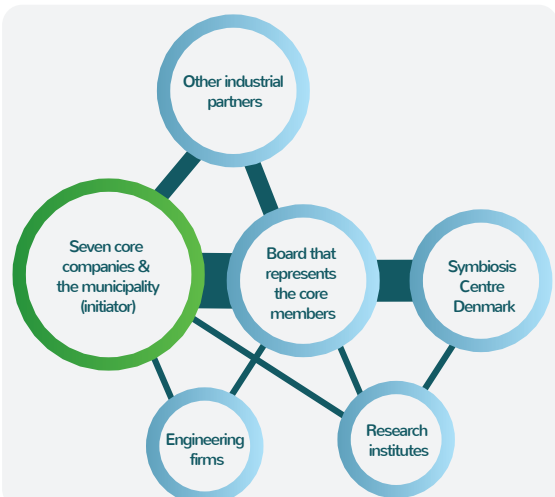
€200+ million of investment

### Kalundborg Symbiosis



Mature


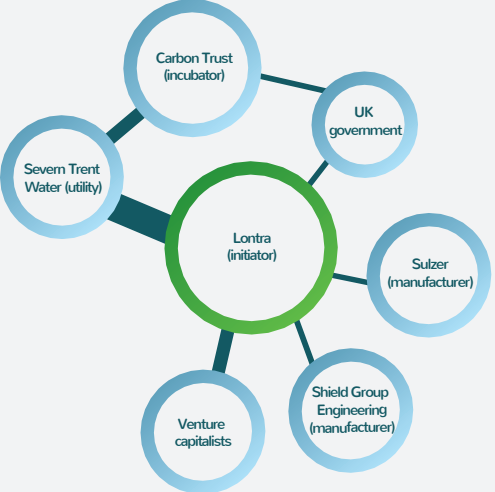


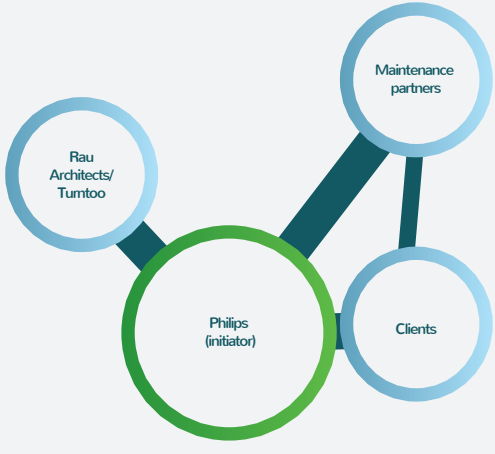


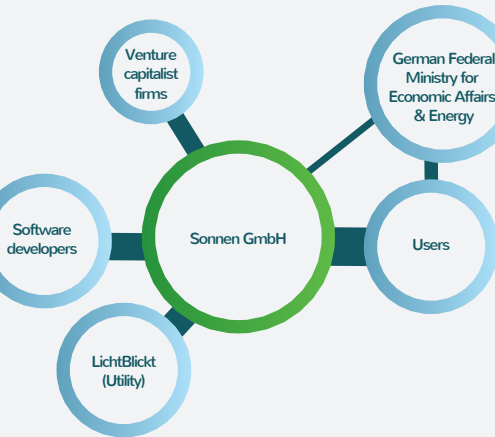

- Thermal comfort
- Lighting
- Resource scarcity
- Business model
- Process



- Innovation**
- Regulation
  - Infrastructure
- Ecosystem**
- Facilitator
  - Cross-value-chain
  - Proximity
  - Strategic communication

As of 2008 275,000 t/year

Turnover estimated at hundreds of millions of euros across the park

<p><b>Lontra</b></p>  <p><b>Mature</b></p>	<p>Hygiene</p> <p>Decarbonisation</p> <p>Technology</p>			<p><b>Innovation</b></p> <ul style="list-style-type: none"> <li>• Incentives</li> <li>• Incubation</li> <li>• Market visibility</li> <li>• Skills</li> </ul> <p><b>Ecosystem</b></p> <ul style="list-style-type: none"> <li>• Market leader</li> <li>• Facilitator</li> <li>• Cross-value-chain</li> <li>• Proximity</li> <li>• Strategic communication</li> </ul>	<p>Over 20% energy saving on existing air compressors</p>	<p>Turnover estimated at tens of millions of euros in 2014</p>
<p><b>Philips Lighting</b></p>  <p><b>Mature</b></p>	<p>Lighting</p> <p>Decarbonisation</p> <p>Innovation breakthrough</p> <p>Business model</p> <p>Product</p> <p>Technology</p>			<p><b>Innovation</b></p> <ul style="list-style-type: none"> <li>• Market visibility</li> </ul> <p><b>Ecosystem</b></p> <ul style="list-style-type: none"> <li>• Market leader</li> <li>• Tactical communication</li> </ul>	<p>Potentially 1,400 Mt of global savings by 2030</p>	<p>Estimated sales at hundreds of thousands of euros in 2015</p>
<p><b>Sonnen GmbH</b></p>  <p><b>Development</b></p>	<p>Lighting</p> <p>Thermal comfort</p> <p>Decarbonisation</p> <p>Innovation breakthrough</p> <p>Business model</p> <p>Technology</p>			<p><b>Innovation</b></p> <ul style="list-style-type: none"> <li>• Incentives</li> <li>• Market visibility</li> <li>• Infrastructure</li> <li>• Skills</li> </ul> <p><b>Ecosystem</b></p> <ul style="list-style-type: none"> <li>• Market leader</li> <li>• Cross-value-chain</li> <li>• Tactical communication</li> </ul>	<p>Estimated at thousands of tons per year if deployed nationwide</p>	<p>Sales of €30 million in 2015</p>

### Sustainable City Hyllie



Development

- Communication
- Lighting
- Thermal comfort
- Decarbonisation
- Innovation breakthrough
- Urbanisation
- Business model
- Technology



#### Innovation

- Patient capital
- Skills
- Infrastructure

#### Ecosystem

- Ambitious leadership
- Challenge-led
- Facilitator
- Cross-value-chain
- Strategic communication

Aims to save 20,000 t/year by 2020

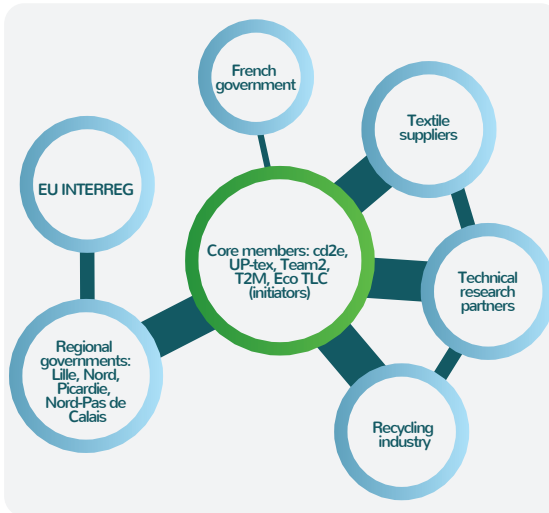
Estimated at hundreds of millions of euros of investment

### Textiles Recycling Valle



Demonstration

- Thermal comfort
- Global connectedness
- Resource scarcity
- Business model
- Process
- Product



#### Innovation

- Regulation
- Market visibility
- Patient capital
- Infrastructure
- Skills

#### Ecosystem

- Facilitator
- Cross-value-chain
- Proximity
- Tactical communication
- Strategic communication

3.6kg of CO<sub>2</sub> saved per 1kg of textiles recycled

Estimated turnover at millions of euros per year across the participants



# Factsheet: Autolib'



Country	Sector	End-use functionality	Innovation type
France	Transport	Mobility	Business Model

Initiated by the Parisian municipal government, Autolib' is the world's first electric car-sharing service that aims to provide the freedom of private vehicles at a cost competitive rate with public transport. Based in Paris, and 89 neighbouring municipalities, subscribers can pick up an electric car at one of the 6,000 charging points for €12 per hour. These spaces can also be used by private electric car owners for charging on subscription basis. Société Autolib', which operates the service, is a subsidiary of a larger organisation, the Bolloré Industrial Group. Autolib' was formed in December 2011 as a public-private partnership with Autolib' Métropole, representing all the municipalities in which the service is deployed, through a competitive tender to provide the city with an electric car-sharing service. Autolib' Métropole was established to facilitate the public engagement and the synchronisation multiple cities, whilst Société Autolib' supplies the charging points, electric vehicles and software. The zero-emission vehicles have contributed to reducing CO<sub>2</sub> emissions by 15,000 tons so far. It has become a popular means of transport within the city and today boasts more than 100,000 annual subscribers (for 180,000 unique users since beginning), whilst beginning its expansion to Lyon, Bordeaux and other potential cities across Europe.

## Key factors of success

### Innovation

Autolib' was formed as a **challenge-led innovation**. The government offered a contract for a specific challenge, to construct and maintain an electric car-sharing network in Paris that encouraged innovative thinking.

**Market visibility** existed through the precedent set by an earlier bicycle-sharing scheme. Alongside the credibility of the government tender, this helped to provide the necessary confidence in a market of consumers and meant that the learnings could be carried through to the car-sharing service.

**Patient capital**, through an investment subsidy from municipalities, allowed Autolib' to expand their service into districts that otherwise would not be able to afford it. This created a large, and dense, enough network of charging stations across Paris.

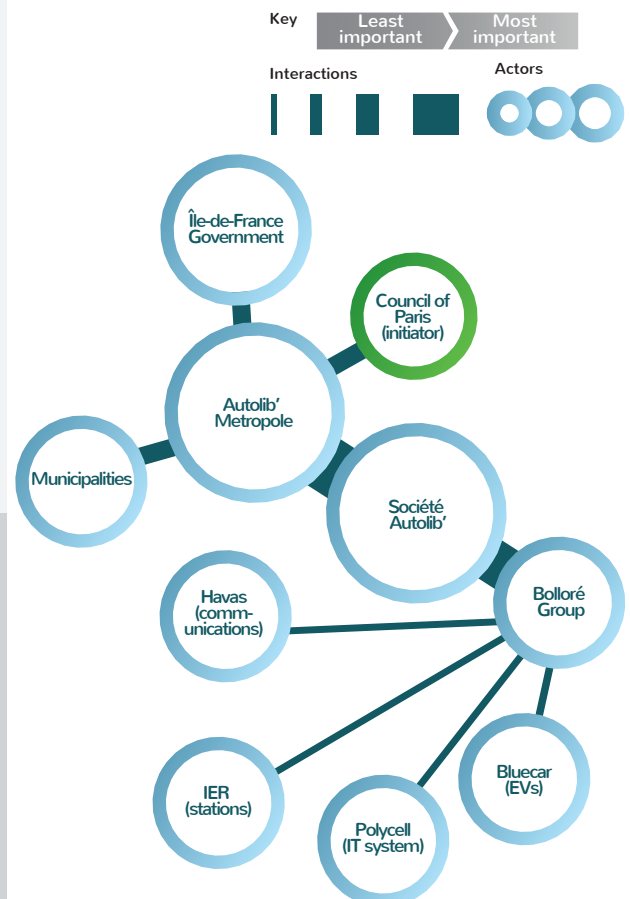
### Ecosystem

The initial tender was **ambitious** in its aim to create an integrated electric car-sharing network across Paris - setting the bar high for the bidders and municipalities, and aiming for a systemic impact on transport in the city.

**Proximity** is key to Autolib'. Having charging stations every 300-400m ensures that there is a suitable **density of supply** for the car sharing service to be easy to use for users who want the freedom of a private vehicle. Density of demand within Paris also provided a business case for the bidders.

**Tactical communication** that built on the growing profile of electric vehicles was successful in attracting customers and expanding to other cities.

## Ecosystem – who is involved



## Timeline

2007	2011	2011	2013	2015
Velib'- the city-wide bike sharing service -started and proved to be successful	Bollor� win Parisian government contract with Autolib'	<b>Key moment:</b> 18 districts were involved in trialling the project, subsidised by state funding	The scheme expands to other French cities, Lyon and Bordeaux, and in Indianapolis in the USA	A similar scheme is prepared for London



## Case study profile

**Employees:** 300 employees

**Facilities:** Bolloré factory in France, Autolib' head offices in Paris, with additional offices in Bordeaux and Lyon and international offices in London and Indianapolis

**Products:** Over 4,500 patented Bluecars, and a charging network of 6,000 spaces across Paris

**Sales:** Estimated at €35-45 million in 2015

## Background

In 2007, the Paris launched a bicycle-hire scheme, Velib'. Its success prompted local authorities to consider creating a similar model for electric vehicles (EVs). After undertaking consultations with the municipalities around Paris, it was decided the best way to set up an electric car-sharing network was to form a competitively tendered public-private partnership (PPP). In 2011, the Bolloré Group won the contract and created Autolib' as a subsidiary business.

Bolloré Group provides many components of the service: it makes the EVs, charging points and software. One important consequence is that Bolloré could trial its own EVs and systems in a real life setting, gaining valuable consumer confidence in its products in a nascent, but growing, market of EVs. As a result, it has been prepared to underwrite Autolib's losses of up to €60 million so that because it has an unprecedented opportunity to demonstrate its technology with potential customers. Recently, Bolloré has partnered with Renault to expand the manufacture of EVs for the service.

## Innovation

The innovative quality of Autolib' is that it is a mode of transport that sits between public and private. Whilst members of the public do not own the cars, they subscribe to a service for €120 per year, and then €11 per hour of use, which gives them access to over 4,500 cars at charging points no more than 300-400 meters apart across Paris and 89 municipalities. A reservation can be made within 30 minutes of the required time via a smart phone or computer, and a guaranteed parking spot can be reserved for up to 90 minutes. This ease-of-use crucially provides users with freedom that is close to using a private vehicle in a city with very limited parking space, whilst paying a competitive rate comparable to public transport.

Providing the service requires a high level of integration across the municipalities and so necessitates interaction between them. Each station of 6 charging points costs the local authorities an average of €60,000. Autolib' is responsible for the construction and maintenance of charging stations, and pays annual rent to the arrondissement of €750 per place over a 12 year contract, after which the charging point will belong to the local authorities and open for competitive tender. To manage this interaction between the service provider, Société Autolib', and the municipalities, Autolib' Metropole was established as a facilitator. This organisation synchronises the needs and arrangements for the municipalities, enabling them to communicate to Société Autolib' with a coordinated voice. This ensures that the delivery of the service is efficiently integrated.

Autolib' has not only been significant in providing a city-wide car-sharing service, but it has enabled vital public engagement with EVs at a time when their deployment is nascent. Their charging points are also available for private EVs on a subscription basis. This has increased consumer awareness and confidence in zero-emission vehicles, whilst allowing Bolloré to prove its own EVs in a real-life environment.

To generate early demand, municipalities made funding available to subsidise arrondissements which lacked the initial capital to construct the stations.

## Impact

Autolib' has successfully attracted over 180,000 customers, saving approximately 50,000 tCO<sub>2</sub> since its inception in 2011. Its impressive sales figures of €135 million in 2015, coupled with the ease-of-use, indicate that its model is appealing for potential replication for both suppliers and consumers. It has already rolled out partner schemes in Bordeaux and Lyon and is preparing for expansion in other European cities such as London. However, public protest about the removal of scarce parking spaces is a potential barrier to expansion.

## Ecosystem

The original tender set out a challenge for the competitors and gave the city authorities the liberty to choose the best possible bid. The contract was attractive to bidders because it provided scale and visibility to a future market of millions of potential customers. Since the bidding process, the city government has had minimal involvement in delivering the service.

In addition, the service has led the way in proving the quality, and increasing the publicity, of EVs, which will be vital for decarbonisation and are likely to represent a significant future market for European automobile manufacturers.





# Factsheet: Beta Renewables: Proesa™

Country	Sector	End-use functionality	Innovation type
Italy	Energy	Mobility	Technology

Beta Renewables is the proprietor of Proesa™ – the world’s first example of biofuel production from cellulose using plant and agricultural waste that is 80% lower carbon than fossil fuels. It is the result of half a decade’s development by the Mossi Ghisolfi Group (MG Group), a multinational conglomerate who focus on plastics and biofuels. They channelled €150 million into researching the product through their daughter company Biochemtex. The first pilot plant for Proesa™ was constructed in 2011 in Italy with the help of the Piedmont regional government. Beta Renewables, who market the technology, was subsequently established as a collaboration between Biochemtex, their technical partners Novozymes, and the private equity firm, Texas Pacific Group. Two years later a full-demonstration plant at Crescentino in Northern Italy was built, with a capacity to produce 40,000 tons of fuel a year. Today Beta Renewables is a leader in the field of advanced biofuels and biochemical compounds. It is poised to expand internationally with new plants producing Proesa™ to be constructed across the EU, and new contracts in China and Brazil.

## Key factors of success

### Innovation

**Regulation** has been very important to the success of Beta Renewables. EU directives have set stringent requirements for CO2 footprints that puts Proesa™ ahead of first generation biofuels.

Access to **patient capital** has been essential to the development of Proesa™. This was first available through the MG Group and then from other private capital, as well as the EC and Piedmont Government grants. Proesa™’s development has also been dependent on **incentives**. Subsidies secured through NER 300 programme that funds commercial-scale demonstration of low carbon technologies amounts to €28 million over 5 years.

Proesa™’s **intellectual property** is protected by more than 30 patent families, which is essential for attracting private investment through the potential for lucrative returns.

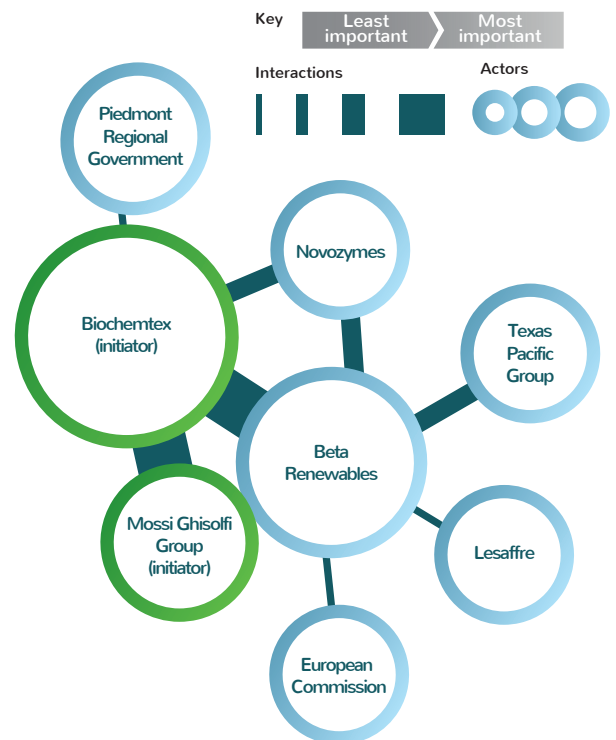
Beta Renewables has utilised the key technical **skills** of its partners to develop the technology. Biochemtex are elite biochemical engineers, whilst Novozymes are leading experts in enzyme research.

Proesa™ can use various types of agricultural material and waste, unlocking greater **supply-side market visibility** and **scalability** through its potential to use different stocks. This provides confidence in its growth potential because it can secure supply chains in a variety of locations.

### Ecosystem

Proesa™’s success is in part due to the **risk-taking culture** of the MG Group, which is large enough to fund both a €150 million R&D programme in a very early stage technology, and then invest in a demonstration plant. Both risks have been crucial to the commercialisation of the technology, and have made Beta Renewables a **market leader**.

## Ecosystem – who is involved



The **strategic communication of the business case** has been fundamental to bringing in new actors to the ecosystem. The appeal of a near-zero carbon biofuel that can be cost competitive is important for private investors, and Beta’s emphasis on European fuel production has helped leverage significant public funds.

## Timeline

2006	2009	2011	2013	2015
The Mossi Ghisolfi Group first starts researching second-generation biofuels	The first pilot plant for the production of Proesa™ receives regional government funding	Beta Renewables is formed as a joint venture between Biochemtex, Texas Pacific Group and Novozymes	<b>Key moment:</b> Crescentino demonstration plant is completed, creating 40,000 tons of Proesa™ per year	Beta Renewables begins to sell its licences internationally in Slovakia, Brazil and China





## Case study profile

**Employees:** Beta Renewables has 15 employees, while Biochemtex employs over 100 people

**Facilities:** A pilot plant with a capacity of 1 t/day and a demonstration plant producing 40,000 t/year

**Products:** Proesa™ second generation biofuel and the necessary IP for producing Proesa™

**Sales:** Estimated annual turnover of tens of millions of Euros

## Background

Biochemtex, a daughter company of the Italian MG Group, started researching second-generation cellulosic biofuels in 2006. Working with the Danish company Novozymes, specialists in enzymes, technologies from across the world were procured and tested in a process which lasted half a decade and cost €150 million. Once appropriate compounds had been identified for a second generation cellulosic biofuel, a pilot plant was constructed with additional funding from the regional Piedmont government, and finished in 2011. Beta Renewables was then created to manage and market the technology. It is 67% owned by Biochemtex, with the Texas Pacific Group and Novozymes the other partners.

## Innovation

Proesa™ is a second generation biofuel. Unlike first generation biofuels which uses primarily arable crops, second generation fuels are made from lignocellulosic biomass, such as wood crops or agricultural residue and waste. Proesa™ uses a second-generation process which extracts fuel from this low-grade biomass at little cost; the price could be comparable to first generation biofuels and fossil fuels.

Proesa™ has a number of advantages over first generation biofuels and fossil fuels:

- The efficiency of the process is such that fuels can be produced at competitive costs without incentives;
- During the process biogas and lignin are produced as by-products, both of which can also be used for energy;
- Proesa™ is designed to use non-food biomass such as wheat straw, so that land for food is not replaced; and
- It is up to 30% less carbon intensive than first generation biofuels and 80% less than fossil fuels.

## Ecosystem

Biochemtex, with the support of the MG Group, have been the most significant actor in developing the Proesa™ technology. They conducted the initial research for the fuel and were also responsible for beginning the scale-up of the technology by constructing the first pilot plant. With EC 7th Framework Programme (FP7) research and innovation funding, they then constructed a second demonstration plant at Crescentino, at a cost of €150 million. In operation since 2014, it is able produce 40,000 tons of fuel per year – about 60-70% the scale of a commercial plant.

Technical assistance was also necessary. Novozymes helped the initial research from 2006 and are now involved financially in the commercialisation of Proesa™, being a 10% shareholder in Beta Renewables.

Suppliers, such as Lesaffre, have a business partnership with Beta Renewables, supplying Proesa™ licensees with bioengineered yeast.

Patient funding has been essential to Proesa™'s scale-up. The MG Group invested significant capital into R&D and the demonstration plant. Additional private investment from the Texas Pacific Group and Novozymes has contributed to forming Beta Renewables. Public funding from the regional government of €10 million helped develop the pilot plant, whilst for the construction of the demonstration plant, a €6 million EC grant was provided through the FP 7 programme. Subsidies through the NER 300 programme have created additional revenue streams for Beta Renewables of €28 million over 5 years. Crucial to securing all of this funding is strategic communication of Proesa™'s business case as a potentially cost competitive, low carbon alternative to first generation bio- and fossil fuels.

The EC has also played an important indirect role in enforcing legislation to support improved biofuels. Both the Renewable Energy Directive and the Fuel Quality Directive have been crucial in creating and sustaining demand for biofuels. Regulation that asserts that fuels will no longer be considered 'bio' unless their CO<sub>2</sub> sequestration capacity is above 50% from 2014, rising to 60% in 2017 has also aided Proesa™.

## Impact

Beta Renewables could have a significant economic impact. They are hoping to access an estimated biofuel market of €9-10 billion, creating up to 25,000 indirect and direct jobs through commercialising Proesa™.

Proesa™ has 80% lower emissions than fossil fuels, and 20-30% lower emissions than first generation biofuels. Using 15% of the total of EU agricultural waste Beta Renewables could save up to 8 MtCO<sub>2</sub> per annum.

They are looking to build their first commercial plant in Slovakia, but their growth in Europe is reliant on the correct policy environment for incentivising biofuels. Particularly as raw agricultural waste products are about a third of the price in China and South America, where Beta Renewables have also started to sign contracts. Their business model is also vulnerable to low oil prices.



# Factsheet: Sustainable City Hyllie

Country	Sector	End-use functionality	Innovation type
Sweden	Urban development	Communication, Lighting, Thermal Comfort	Business Model, Technology

The City of Malmö, energy utility company E.ON, and water utility VA SYD have embarked on an ambitious project to set a new benchmark for sustainable development internationally. The project represents an innovative business model that centres on a challenge-led contract signed in 2011 between the three core parties to supply the district of Hyllie, near Malmö, with 100% renewable and reusable energy by 2020. E.ON is coordinating a holistic approach that integrates renewable generation, district heating, demand side response and other smart grid technologies with the input of local actors such as building owners and developers. Sustainable City Hyllie will pioneer the new technological solutions, and E.ON have received national and European funding to demonstrate cutting-edge smart grid technology. Once completed, the project will see 9,000 residences and 9,000 offices built to zero net energy standards. This ground-breaking, challenge-driven innovation could set an important example for systemic change in urban development as Europe moves towards a low carbon future.

## Key factors of success

### Innovation

The development is a **challenge-led innovation** that is driven by an ambitious target set out in the original contract. This contract sets the foundation for systemic change, whilst allowing freedom for innovative solutions.

**Scalability and replicability** is fundamental to the innovation's significance. The programme mantra is "no one solution fits all, but rather one approach", outlining its holistic goal to exemplify a transferable model for other cities.

Existing integrated **infrastructure** (district heating and cooling) in Malmö laid a foundation for the project.

External **funding** from national government and EU agencies has been important to scaling the project and enabling the demonstration of technologies. Technical partners and suppliers have also been pivotal for using their **skills** to develop cutting-edge solutions

### Ecosystem

The contract signed between the City of Malmö, E.ON and VA SYD sets a **high ambition target** to instigate systemic change. It has contributed to a **risk-taking culture** and encouraged innovative problem solving.

The Hyllie project cuts across several value chains to effectively integrate the urban planning for this large development. This **top-down cross-value chain collaboration**, necessitated by the original contract, is integral to achieving the projects goals. The **density of supply** of local expertise has aided this collaboration.

## Ecosystem – who is involved



Key performance indicators are closely monitored by steering groups that provide essential **leadership and facilitation roles** for the multiple stakeholders involved. Effective **strategic communication** of the business case has been key to motivating local businesses and residents to buy into the development.

## Timeline

2001	2007	2010	2011	2013	2020
The City of Malmö & E.ON deliver 100% renewable energy for the harbour	Development around Hyllie starts - the railway station is constructed	Dialogue between the City of Malmö, E.ON and VA SYD starts	Setting of Swedish renewables target of 50% by 2050 <b>Key moment: Hyllie contract signed</b>	Received €5 million from Swedish Energy Agency	Received €0.6 million from the EU  Predicted project completion – 100% renewable and recycled energy



## Case study profile

**Employees:** E.ON provides 3 dedicated employees, with significantly more from other organisations involved

**Facilities:** Local construction expertise as well as E.ON's research laboratories in Sweden and Germany.

**Products:** Smart energy infrastructure including intelligent buildings, demand side response, energy storage and more

**Sales:** Estimated investment in the development in the hundreds of millions of Euros

## Background

E.ON's sustainability collaborations with the City of Malmö date back to 2001. Their first project successfully implemented 100% renewable energy to power a harbour area in the city. E.ON has also equipped Malmö with district heating and cooling networks.

Development in Hyllie started in 2007, with a new train station connecting it to the city centre and Copenhagen. This sparked dialogue between the City of Malmö, E.ON and VA SYD to try and set a global standard for low carbon urban development. Support for this idea was strengthened in 2011 with the new national target of achieving 50% of energy from renewable sources by 2020. This added further impetus to take the Hyllie development forward ambitious energy saving and generation targets.

## Innovation

The public-private partnership, signed in 2011, specified the target of 100% renewable and reusable energy for the whole district by 2020. The district will eventually include 9,000 work places and 9,000 residences by 2030. It is one of the largest urban sustainable developments ever undertaken, and importantly, the contract has provided E.ON, VA SYD and their partners with an end goal, but allows them flexibility in how they achieve it.

This challenge-led business model requires holistic thinking and innovation for such a large development. As a result, the contract has provided an opportunity for demonstrating and implementing cutting-edge energy technologies. A whole smart grid is being developed, with each building given the opportunity to connect their own automation system to the smart grid platform for the intelligent and sustainable use of energy through demand side response. As well as smart electricity management, the project also builds on existing infrastructure for a smart district heating and cooling network. These systems underpin a completely integrated, flexible and sustainable energy system for the city district.

## Ecosystem

The Hyllie project has been dependent on effective communication between the City of Malmö, E.ON and VA SYD to set objectives, management structures and risk mitigation policies. Throughout the project, specific KPIs have been set by a central steering committee.

These form the parameters against which individual projects are routinely assessed to ensure they are contributing towards the ultimate target.

VA SYD are in charge of optimising the management of waste and water, whilst E.ON are responsible for the energy infrastructure.

E.ON have been able to leverage their wide skills base throughout Europe in not only delivering the project, but also including suppliers and developers of advanced smart grid technologies. These resources have enabled Hyllie to act as a real-life demonstration of future energy technologies, such as smart buildings and infrastructure, which could play a key role in Europe's cities. This demonstration programme has been supported by funding from the Swedish Energy Agency and the EU.

Very importantly, the public-private partnership's successful communication of the business and social case of the programme to local developers and residents has been vital for securing their support for the development of project, whilst also aiming to promote wider behavioural change in the local population. To date, its success boosted the local economy and engendered a sense of local ownership with the project.

Universities have also used their facilities to test some of the new technologies. This has led to a wider incorporation of skills.

## Impact

The project has already had a large impact on the local economy, stimulating growth and supporting industries by involving local businesses in building the district from the bottom up.

With its ambitious aim of providing zero net energy across 18,000 buildings, the project could save 20,000 tCO<sub>2</sub> per year by 2020.

Significantly, the project has been designed to be transferable. Its mantra is that "there is not one solution which fits all, but rather one approach". If it proves successful, such an approach could be replicated across other urban developments and local economies throughout Europe.



# Factsheet: Energiesprong: Stroomversnelling

Country	Sector	End-use functionality	Innovation type
Netherlands	Construction	Thermal Comfort, Lighting	Business Model, Process, Product

Energiesprong was set up in 2013 as a challenge-led organisation by the Dutch government with the objective of creating a new market for energy-neutral housing across the Netherlands. It was given freedom to come up with its own solution, which resulted in the establishment of the Stroomversnelling (“Rapids”) programme. This initiative unites a social bank, refurbishment manufacturers and installers, housing associations and their tenants with the aim of refurbishing 111,000 residences to be energy neutral and ‘zero-at-the-meter’ by 2020. Each building will be fitted with innovative, tailor-made solutions through a combination of state-of-the-art insulation, appliances, distributed renewable energy generation and more. Ease-of-deployment is pivotal, and each residency is refurbished in less than 10 days. The novel financial structure of the programme ensures that the tenants pay no more for their bills as a result of the ‘zero-at-the-meter’ energy savings. The facilitation role of Energiesprong, and its revolutionary Stroomversnelling programme, have laid the foundations for systemic change by creating new market conditions in the residential refurbishment sector. The model is now being tested in other European countries and the feasibility of applying this concept in the private housing sector is being actively investigated.

## Key factors of success

### Innovation

Energiesprong represents a **challenge-led innovation** with the organisation free to create a solution for changing the market conditions – promoting both the need, and the creativity, for systemic change. It is backed by €45 million of government **patient capital funding** which underwrites its ability to take the time to think of a holistic and innovative solution.

**Market visibility** has been a keystone. From the **supply side**, the social bank, WSW, has made €6.6 billion of government-backed loans available, whilst the critical mass of large housing associations has aggregated **demand**.

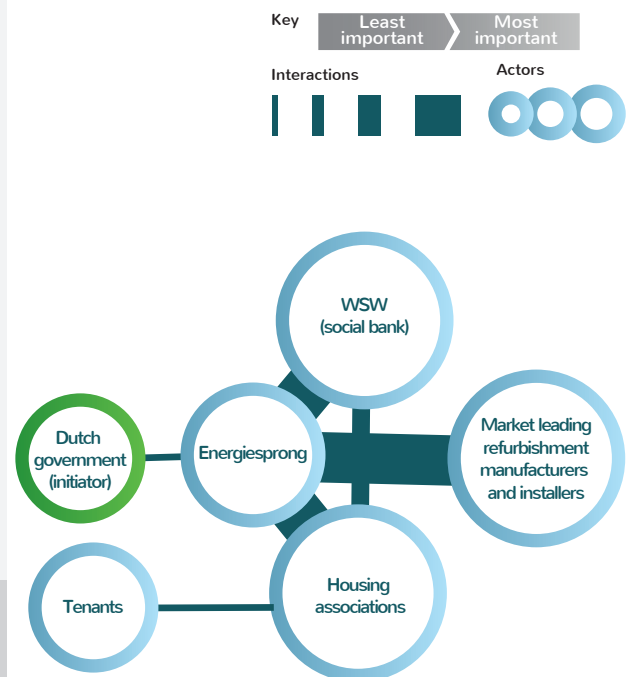
Government incentives for domestic solar PV have played a role in strengthening the business case for the renovations.

The manufactures in the Stroomversnelling programme utilise the **technological breakthrough** of 3D printing to mass produce pre-fabricated insulation solutions that can be easily configured to individual houses and rapidly deployed.

### Ecosystem

**Leadership** has played a crucial role in a variety of different ways. The Dutch government set an **ambitious target** for energy neutral homes. Energiesprong acts as a credible **leader and facilitator** for all the other parties, and its model is being tested in France and the UK. The developers chosen are at the **forefront of residential refurbishments**, proving their cutting-edge concepts so that others can follow. The housing associations have **led the way in innovating their service models**, by managing both housing and energy.

## Ecosystem – who is involved



**Cross-value-chain collaboration** between the sectors involved has enabled the sufficient resources, communication and speed of action to implement systemic change. This has benefitted from the **proximity** of the suppliers and customers within the Netherlands.

## Timeline

2013		2014	2015	2020
Energiesprong established	Stroomversnelling begins with six corporations and four building lots signing up to renovate the first 11,000 homes	<b>Key moment:</b> First 1,000 homes successfully renovated	Energiesprong model begins replication in UK and France	Aim to have 111,000 homes refurbished in the Netherlands



## Case study profile

**Employees:** Estimated at hundreds of people involved in the Stroomversnelling programme

**Facilities:** Factories for the insulation solutions, suppliers for renewable energy and other appliances

**Products:** Insulation, heat pumps, solar PV, HVAC plant, low-energy appliances

**Sales:** Estimated at €55 million in 2014

## Background

In 2013 the Dutch government set an ambitious target of an 80-95% reduction in CO<sub>2</sub> by 2050. This would necessitate renovating 6 million homes across the country to make them energy-neutral. Typically the problem of renovating domestic buildings has been tackled in incremental steps. But these can take a long time, and so act as an obstacle to systemic change within the domestic sector, as they do not address the holistic problem of the underlying market conditions which do not encourage domestic energy efficiency refurbishments.

## Innovation

Therefore, the Dutch government legislated to establish a challenge-led organisation to modify the underlying market conditions needed for systemic change. Energiesprong was given the freedom to come up with its own solution to the problem.

Stroomversnelling is its answer. It is targeting the renovation of 111,000 social housing residences so that they produce as much energy as they use – making them ‘zero-at-the-meter’.

To achieve this, it deploys an innovative business model: housing associations invest €40-70,000 per residency, making their investment back through a “rent and energy” fee paid by the tenants, which is no increase on their existing rent due to the energy savings from the renovation. This represents a clear business case for implementing low carbon renovations for the customers.

In addition, Stroomversnelling involves an innovative refurbishment process. Energiesprong facilitate collaboration between manufacturers, installers and housing associations so that renovations are tailored specifically to each building using software modelling and 3D scanning. This allows the manufacturer to create a standardised platform to prefabricate non-standardized dimensions for the modules, leading to cost savings.

The hardware is manufactured off-site, and installed in less than 10 days per building, minimising the inconvenience for the client. By focusing on housing associations, this enables a large quantity of high-specification renovations to take place in a very short timeframe. However, there is a potential obstacle in that planning permission can take much longer to obtain.

Together, the attractive business model and innovative renovation process have created a market-leading initiative that has laid the foundations for systemic change.

## Ecosystem

The initial commitment from the Dutch government to set-up Energiesprong provided it with the freedom to create its own solution that has been paramount to its success. It enabled the organisation to take on risks and create something novel, whilst underlining confidence in its relationships with suppliers and consumers given its credible position with the government.

In addition, the ambitious ‘zero-at-the-meter’ standard in the original legislation set the bar high for Energiesprong and its partners to deliver systemic change. Plus, government subsidies for domestic solar PV users has indirectly helped support the business case for the energy-generation aspect of the refurbishments.

The role of Energiesprong as a facilitator across the value chain has been pivotal to its success. It has brought social housing organisations, their tenants, renovation developers, manufacturers and financial institutions together for a common cause, whilst engendering important confidence in a future market.

The social bank, WSW, has provided the government-backed loans of €6.6 billion for the housing associations to invest in the renovations. It then generates a 5.25% return on its loans in proportion to the energy savings that the renovations create for the housing associations and their tenants.

The 27 housing associations involved so far are crucial for aggregating sufficient demand to create a market. Their residences may all be unique, but they have strong similarities, simplifying the manufacturing process, and represent a highly visible customer base for suppliers.

Lastly, the Stroomversnelling programme includes developers and manufacturers who are frontrunners in refurbishing low carbon homes. These market leaders can meet the high performance requirements, whilst proving their concepts, with the hope that the mainstream will follow their example.

## Impact

Once the initial programme is complete, it will save c. 430,000 tCO<sub>2</sub> per year – equivalent to 2.5% of the emissions in the Dutch residential sector. In addition, the investment in the programme will support over 55,000 jobs for the national construction industry.

This transformational model is now being tested internationally, with an emerging UK organisation run by housing providers, charities and construction companies, as well as a similar initiative in France.





# Factsheet: HafenCity

Country	Sector	End-use functionality	Innovation type
Germany	Infrastructure, Urban Development	Mobility, Lighting, Thermal Comfort	Business Model

Based in Hamburg, HafenCity is currently Europe's largest inner city development project. A former port area, measuring 157 hectares, is being transformed into a district with living, working, education and leisure space, as well as public open spaces and transport connections. The development is overseen by a subsidiary of the local government, HafenCity Ham-burg GmbH. The organisation uses an innovative procurement process that takes into account the life cycle of each individual project and a strong commitment to sustainability. This emphasis on sustainability was not in place when the redevelopment initially began in 1997. However, a stringent sustainability criteria has become central to the procurement process. Ambitious benchmarks are set as part of the initial bidding process, and throughout the lifetime of each individual project, there is continuous monitoring of its performance – illustrating an innovative procurement model. When completed in 2025 / 2030 the redevelopment will have attracted €8.5 billion from private investment, €2.4 billion from public sources, created thousands of jobs and promoted significantly lower carbon intensity across shelter, mobility, energy and other target areas.

## Key factors of success

### Innovation

The HafenCity development was initiated as a **challenge-led process** by the City of Hamburg. The local government set out the need to redevelop the area but with a flexible outlook on how this was to be achieved. This has ensured HafenCity Hamburg GmbH has the relative freedom to address the challenge innovatively. The result being a highly ambitious redevelopment with ingrained sustainability solutions.

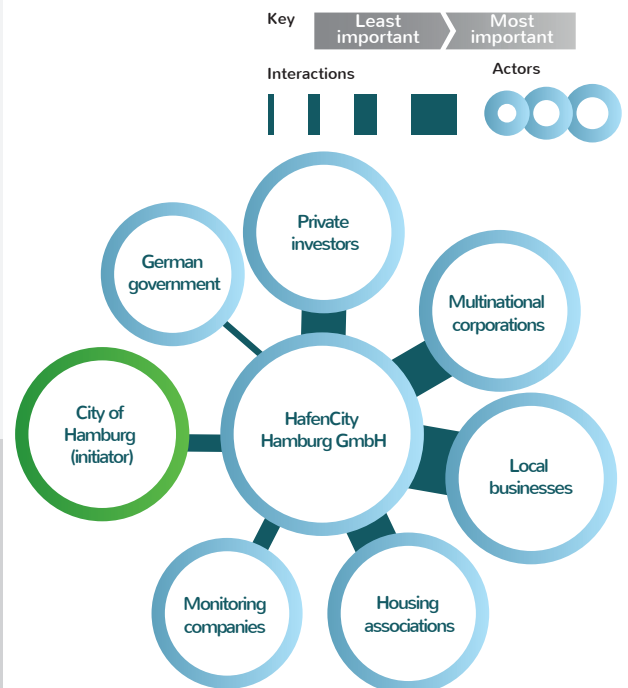
HafenCity Hamburg GmbH's procurement process sets the clear sustainability goals, along with its long-term credibility, has helped create **demand side market visibility** for innovative sustainability solutions. The confidence in this future demand has encouraged investors to support the project, generating €8.5 billion in private funding.

### Ecosystem

HafenCity Hamburg GmbH has taken a **leading role** as the **facilitator for multi-stakeholder cooperation**, coordinating top-down cross-value-chain collaboration. This is essential for implementing the innovative urban planning, where a multitude of different sectors are required to integrate their services to deliver a space with maximum social utility and sustainability. HafenCity Hamburg GmbH acts as the focal point of the ecosystem and must communicate successfully with all the different interested parties to coordinate the development.

Key to its success is the effective **strategic communication of the business case**. Potential contractors are educated early on and thereafter monitored continuously according to the stringent requirements for sustainability.

## Ecosystem – who is involved



The procurement process is **ambitious** in its aims for social utility and sustainability, which are weighted above price concerns. This has set the bar high for potential contractors and encourages innovative thinking to address these concerns. It exemplifies a **risk-taking culture** that is prepared to prioritise issues with wider social consequences.

## Timeline

1997	2000	2003	2007	2010	2025-30
City of Hamburg starts HafenCity project	<b>Key moment:</b> "Masterplan" for the development is formalised. For the first time, sustainability is ingrained into the blueprint development.	Construction begins on the first residential neighbourhoods	Introduction HafenCity Ecolabel for sustainable building	Revision of the masterplan, seeing the planning of new areas and expansion of the development	The development is scheduled for completion



## Case study profile

**Employees:** The programme should support 45,000 jobs by the time of its completion; Hafencity GmbH has around 50 employees that oversee it

**Facilities:** Hafencity Hamburg GmbH is run from a central office within the Hamburg development

**Products:** Work facilities, residential buildings, commercial spaces, energy generation, public areas, cultural facilities, educational institutions and transport infrastructure

**Sales:** The development has received €8.5 billion in private funding and €2.4 billion from public sources

## Background

In 1997 the City of Hamburg started planning the redevelopment of the city's former port. Due to be completed by 2025-2030, the redevelopment includes extensive residential and commercial areas, educational institutions, cultural facilities, parks and other public spaces. It is Europe's largest inner-city redevelopment project.

Hafencity Hamburg GmbH is a limited liability company that was set up by the city government to manage the project and the "Special Fund for City and Port" that finances the development. It is relatively autonomous but its work is monitored by members of the Hamburg senate, chaired by the first mayor.

Originally, sustainability was not a major consideration, however over time it has become a high priority and entrenched into the fabric of the development. The first Masterplan for the development, introduced in 2000, formalised an approach that was conscious of the liveability, urbanity and environmental impact of the development.

## Innovation

Hafencity Hamburg GmbH has a holistic procurement process with sustainability at the forefront of the bidding and monitoring procedures for all the individual projects.

Hafencity's procurement process, is broken down into five stages, which all emphasise sustainability concerns:

- Phase 1 – knowledge mobilisation of clear and stringent criteria for the utility and sustainability requirements for a given plot of land;
- Phase 2 – a competitive bidding process where 50% of marks focus on the utility of the concept, 20% on sustainability and resilience, and 30% on price;
- Phase 3 – cooperation phase where the successful bidder gets 18 months to stage an architectural competition, prepare building approval and commission site surveys. Hafencity Hamburg GmbH, the authorities and the buyer remain in constant dialogue;
- Phase 4 – only now is a sales contract signed, which states development must begin within 6 weeks; and
- Phase 5 – mandatory sustainability certification and monitoring occurs continuously throughout the lifetime of all of its projects, to ensure their actual performance meets their pre-construction objectives.

Through this process Hafencity has embraced modes of sustainable design. Mobility is a key concern, with spatial systems which encourage transport on foot or bike, while electric charging and hydrogen filling facilities

are being introduced. Energy supply for the district is also sustainable with many buildings fitted with solar panels, and the whole development is served by a bio-fuelled CHP unit.

## Ecosystem

Hafencity Hamburg GmbH is the key facilitator for the entire development: managing the funds, engaging the private sector and implementing the procurement process. Its relative freedom from the city authorities helps it to think innovatively about how to redevelop the area.

The systemic challenge of meeting ambitious sustainability goals necessitates cross-value-chain collaboration between urban planners, constructors, utilities and more to create a deeply integrated development. Hafencity GmbH acts as a crucial focal point for coordinating such.

By completion the whole development will have secured considerable funding from both public and private sources - €2.4 billion and €8.5 billion respectively. Public funding was generated through the sale of land, with some from the federal government for a new subway line. The lion's share of funding comes from private firms investing in the development, who can see the potential returns from a well-communicated business case.

Whilst there is no geographical bias towards contractors – multinationals have delivered many of the projects – local expertise often stand out as particularly valuable, and local industry has dominated the development so far.

## Impact

The development will support in excess of 45,000 job opportunities, providing homes for 14,000 people and the construction of 2.4 million square metres of office space.

Hafencity, when complete, will emit around 50% less CO<sub>2</sub> than comparable urban locations. For example, heat production carbon intensity is 89g/kWh in the east of the development and 175g/kWh in the west, significantly less carbon intensive than the national average of 240g/kWh.

Hafencity is regarded as an internationally renowned model for sustainable urban development, setting a new benchmark for other projects across Europe. It has successfully incorporated sustainability concerns into its wider business model, meaning that all aspects of the development consider broader environmental impact. This model, focused around a revolutionary procurement process, is replicable and could apply to other urban development schemes and large-scale infrastructure projects.



# Factsheet: Kalundborg Symbiosis

Country	Sector	End-use functionality	Innovation type
Denmark	Multiple	Lighting, Thermal Comfort	Business Model, Process

Situated in Zealand, Denmark, the Kalundborg Symbiosis is one of the world’s most successful industrial symbiosis networks. The different industrial plants on the site have formed an “industrial ecosystem”; where the residual produce of one enterprise is used as a resource by another in a closed cycle of over 50 regular exchanges of water, energy and materials. The initial collaboration took place in the 1960s, involving just two actors. The key tipping point came in 1972 when a plaster-board manufacturer connected through using the excess hot gases of the refinery. It has since grown into a core network involving seven companies and the municipality, who form the board and connect to other auxiliary partners. Research institutes and engineering firms operate as auxiliaries. The dissemination of knowledge from the network is supported by the Symbiosis Centre Denmark, which promotes symbiosis uptake with other businesses across Denmark and internationally. Whilst direct replication of the processes related to the Kalundborg network may be difficult because of the specific industries involved, the innovative business model and management of its evolution can provide important lessons for other symbiosis ecosystems.

## Key factors of success

### Innovation

Strict **regulation** on waste in Denmark has been influential in promoting the business case for the symbiosis – incentivising companies to sell their waste rather than pay a penalty for disposing it. Where this has been less stringent internationally, the same incentive is missing.

Complementary **infrastructure** has been important by providing the foundation upon which the symbiosis network could develop. This includes pipelines, roads and other key connecting infrastructure that enable the exchanges to take place and was mainly built by the core participants.

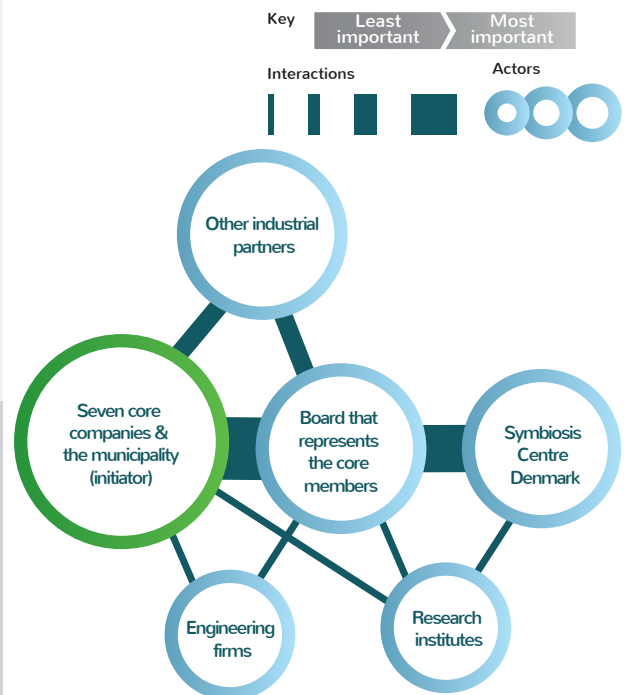
### Ecosystem

The board includes a member of each core member and has been key to **leading and facilitating** the multi-stakeholder co-operation through formal communication links that help synchronise and grow the ecosystem.

**Proximity**, though not the most important factor in attracting new partners, has made communication easier and kept the costs of the network attractive. Without this **density of supply**, many transactions would not have been appealing.

Crucial to Kalundborg’s success was **bottom-up cross-value-chain collaboration**, which utilised new materials and energy across a number of distinct supply chains.

## Ecosystem – who is involved



The effective **strategic communication** of the business case has been very important to the growth of the innovation – by clearly communicating the economic benefits, more so than the sustainability concerns, new partners have been attracted to the Kalundborg Symbiosis.

## Timeline

2007	2011	2011	2013	2015
Oil refinery established next to existing coal power plant and uses the water from nearby Lake Tissø	<b>Key moment:</b> Plaster-board manufacturing plant begins using excess hot gas from the refinery	The board was established between the core members to facilitate the management of the network	The Symbiosis Centre Denmark is established to disseminate knowledge	Over 50 exchanges are taking place every day within the network





## Case study profile

**Employees:** Estimated at 4,000 across all the participants

**Facilities:** Power plant, oil refinery, plaster-board factory, pharmaceutical plant and more

**Products:** Energy, water, chemicals and more

**Sales:** Estimated at hundreds of millions of euros across all the participants

## Background

The Kalundborg Symbiosis began due to a pressure on available water resource in northern Denmark. The first exchange at the Kalundborg industrial park was in 1961, when Statoil needed water for their new refinery in the area and collaborated with the municipality to build a pipeline from the nearby lake. This first exchange soon expanded to include the local power plant in the sharing of waste water streams.

## Innovation

The key moment for the growth of the symbiosis network was when a local plaster-board manufacturer, Gyproc, was brought into the system to utilise the excess hot gasses from the refinery to dry their product. The motivation for such was the advantageous business case of using the waste product for a cheaper price rather than generating it itself.

From this stage onwards the innovative network grew steadily through a naturalistic process of incremental company-to-company engagement, primarily amongst companies in the immediate area but expanding across Denmark over time.

Its growth has been underwritten by the clear communication of the business case between the different industrial companies. This process was formalised in 1995 with the establishment of the board, which represents all the core companies and the municipality, coordinating the growth of the network in their interests.

Today there are over 50 regular exchanges of water, energy and materials, involving over the core members and some auxiliary partners.

## Ecosystem

As previously eluded to, the ecosystem initially grew without specific direction of formal structures. This highlights its bottom-up, opportunistic evolution of attracting and integrating one new industry at a time. This process was important for attracting new participants because there was no single dominant

agenda, meaning that new partners trusted the business case put forward to them.

The clarity with which the business case emerged for attracting individual organisations was key to both its inception and expansion. In this instance, the security of supply offered by the symbiosis, given the volatility of markets, was central. This highlights how vital it is to link resource efficiency with strong economic incentives. The business case was also indirectly aided by regulation on waste disposal imposed by the Danish government. Elsewhere, where this regulation may be less stringent, there symbiosis may not be as attractive.

Since the establishment of the board in 1995, the core members have formally communicated and strategically planned in the interests of the network as a whole. By creating formal avenues of communication between them, the multiple different actors can build further trust as well as consider wider solutions beyond their immediate concerns.

In 2011 the Symbiosis Centre Denmark was set up to disseminate the learnings about industrial symbiosis. They publicise the process and bring in academia to study it, turning the industrial park into a research hub, as well as introduce engineering firms who help to optimise the system. It has also helped to screen over 600 companies in Denmark, and internationally, to facilitate new, separate instances of symbiosis.

## Impact

For all the companies involved, the Kalundborg Symbiosis has helped them realise significant financial savings, underlining their motivations for participating. Although emissions reduction is not an explicit goal, the efficiency increases as a result of the symbiosis network have led to significant savings. The last study in 2008 found savings of 275,000 tonnes of CO<sub>2</sub> per annum.

Its legacy as a flagship for industrial symbiosis has promoted the image of symbiosis and the circular economy, now further reinforced by the outreach of the Symbiosis Centre. Direct replication may be challenging because of the specific industries involved, but this leading example of cross-industry collaboration has been crucial in creating the awareness and confidence for symbiosis initiatives to take root elsewhere in Denmark and internationally.



# Factsheet: Lontra: Blade Compressor

Country	Sector	End-use functionality	Innovation type
UK	Waste Water	Hygiene	Technology

Lontra's Blade Compressor is a complete redesign of traditional air compressors, which are found in a diverse range of applications, from factories to automobiles to household appliances. Instead of using the two-way linear piston motion, the Blade Compressor operates as a one-way constant turbine, realising significant energy savings whilst not using oil-based lubricant. Within the wastewater industry, which contributes as much as 1% of Europe's total energy consumption, Lontra has demonstrated a successful prototype that has operated for over 10,000 hours and achieved efficiency gains of greater than 20% compared to other models. This success has led to commercialisation, with the Swiss company Sulzer buying the rights to manufacture the wastewater aeration technology worldwide. The technology has large potential to move beyond just this industry, and recently Lontra has begun exploring avenues in the industrial manufacturing sector. Its success is indicative of how a revolutionary technology can achieve scale-up through multi-stakeholder collaboration with both public and private organisations.

## Key factors of success

### Innovation

Lontra benefited from early **incubation support** from the Carbon Trust. This helped them apply for grants and reach out to contacts. It was essential to them forming relationships with future partners and strategically targeting the most appropriate market.

**Incentives** for private investors in the form of tax relief from the UK government for start-ups enabled Lontra to attract the necessary equity to grow

### Ecosystem

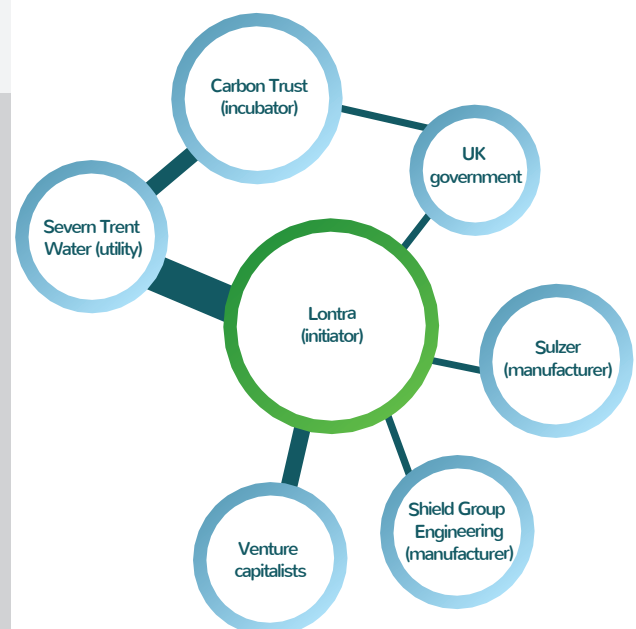
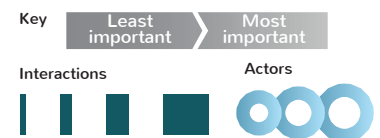
The Carbon Trust's **incubation** role helped facilitate collaboration between Lontra and a potential customer, Severn Trent Water. This ensured the prototype was made to specification and could be trialled in a real-life setting, both of which accelerated the commercialisation of the technology.

This **bottom-up cross-value-chain collaboration** has been important to Lontra's growth. Close work with the end-user of the technology accelerated the vital demonstration.

Effective **strategic communication** of Lontra's **market leadership** potential has attracted additional investors to the ecosystem.

Proximity to a highly skilled workforce has helped Lontra's recruitment. A **density of supply** of skilled engineers around Napton, UK, has been important for drawing talent from the automotive industry and leveraging **technical expertise**.

## Ecosystem – who is involved



## Timeline

1999	2004	2005	2010	2012	2014	2015
Steve Lindsey patented the Blade Compressor	Lontra founded	Incubated by the Carbon Trust	<b>Key moment:</b> £400,000 grant from the Carbon Trust and £300,000 from Severn Trent Water to run a trial	Trial proves technology is over 20% more efficient than incumbents	Licensed to Sulzer for production worldwide	Collaboration agreement with Shield Group Engineering



## Case study profile

**Employees:** 20

**Facilities:** Design office in UK, outsources manufacturing to other companies based in Europe.

**Products:** Wastewater treatment blower, and has begun looking into industrial manufacturing compressors

**Sales:** Signed a license supply agreement with Sulzer for tens of millions of pounds in 2014

## Background

Air compressors are found in vast quantities across the world due to their wide application, and represent a market worth approximately €30 billion. Yet, their fundamental design had not changed for over 60 years despite being notably inefficient. This is what motivated the entrepreneur Steve Lindsey to completely redesign it and create the revolutionary Blade Compressor.

## Innovation

Traditional air compressors use the linear piston motion to draw air in before pushing it out in a two-way motion. The Blade Compressor uses a rotating piston that draws air in for the first 180 degrees and pumps out compressed air in the following 180 degrees. These two processes work continuously – while one volume of air is exhaled, the next is being drawn, making it much more efficient.

In 2012 the Blade Compressor was trialled in a working wastewater aeration process. Where a reduction of 1-2% in energy is regarded as significant, the Blade Compressor achieved 21.2% in savings. It has now run for more than 10,000 hours at its demonstration site without any problems – the equivalent of more than 3 years of normal operation for a compressor. The absence of the need to lubricate the device with oil confers an additional benefit of uncontaminated air.

Perhaps most importantly, the technology has potential to be modified and implemented across the many uses of air compressors – indicating a technology that could bring about systemic change.

## Ecosystem

Lontra have strategically selected their location in Napton, UK, for the purpose of attracting highly skilled individuals from the nearby world-leading engineering departments at Jaguar, McLaren, Rolls-Royce and more. With the company set up to profit from its IP, its location near the best technicians has been very important.

In 2005, Lontra won the support of the Carbon Trust, which was at the time a government subsidiary responsible for incubating promising low-carbon technologies. The incubator helped Lontra set up useful contacts and strategically assess the best route to

market. They focused on wastewater treatment, where compressed air is used in an aeration process that accounts for 1% of all energy used in the UK – illustrating the market potential for the technology.

In 2010, the Carbon Trust negotiated a demonstration project at a working facility with Severn Trent Water, which supplied water to over 4 million households and businesses in the UK. The two companies provided Lontra with £700,000 to develop a prototype. Significantly this prototype was created in close collaboration with the end user – so it tailored to their exact needs, accelerating the process. The demonstration in 2012 was a resounding success, with Lontra's compressor outperforming every other model in use at Severn Trent Water's facility.

Following this success, Lontra signed a license supply agreement worth tens of millions of pounds with the leading manufacturer of aeration systems, Sulzer of Switzerland. Sulzer worked with Lontra's previous suppliers in Ireland to ship the product worldwide.

In 2015, Lontra moved beyond the wastewater sector, and brokered a collaboration agreement with Shield Group Engineering - which supply Caterpillar, JCB and others – to create an industrial compressor to boost manufacturing competitiveness in the UK.

Lontra have benefitted from the UK government's Enterprise Investment Scheme which reduces the risks of investing in start-up companies by providing 30% income tax relief to investors. Through this, Lontra leveraged £2.9 million in equity finance, contributing to a total of £5 million from all sources, including a UK government grant.

## Impact

The wastewater sector is very energy intensive, and therefore Lontra's technology could contribute to saving millions of tons of CO<sub>2</sub> if deployed internationally in this sector alone. If it succeeds in expanding into other sectors, such as industrial manufacturing, its energy saving potential could be even more.

Since 2013, Lontra has doubled its revenue year-on-year. If it can unlock more of the €30 billion global market for air compressors, its focus on high-skill, high-tech manufacturing could have significant implications for industrial growth in Europe.

Lontra are aiming to grow their influence as a market leader for transformational technological innovations, so that new innovators and investors can follow their lead and take risks for the benefit of wider European industry.



# Factsheet: Philips Lighting: Circular Lighting

Country	Sector	End-use functionality	Innovation type
Netherlands	Lighting	Lighting	Business Model, Product, Technology

In 2010, Philips Lighting and the consultancy Turntoo collaborated to introduce the world's first lighting service. Branded as "Circular Lighting", the business model innovation has transformed their offer from providing lighting as a hardware product, to a service where energy efficient lighting is paid for at a fixed rate per hour. The result was highly efficient lighting installed to bespoke needs and designed to be "intelligent" with sensors and controllers integrated into its design. These technological modifications, combined with an innovative business model that puts the responsibility to save energy in the hands of Philips Lighting, has resulted in 60-80% reductions in energy use across its projects so far. The innovation has repercussions for not only the product on offer, but also the manufacturing of lightbulbs where there is now an emphasis on delivering fewer high-quality, long-lasting "smart" hardware rather than low-cost mass produced alternatives.

## Key factors of success

### Innovation

Philips Lighting's ownership of the innovation has meant it could utilise worldwide its laboratories and factories. This has provided **supply side market visibility**, with a strong and sophisticated research and manufacturing base from which to produce advanced lighting systems for the service.

In addition, its global brand and customer base has provided **demand side market visibility**. Its existing global clientele provides an excellent avenue for rapid commercialisation of the innovation, whilst its brand engenders important confidence in customers.

### Ecosystem

The initial work between Rau Architects and Philips Lighting represents **bottom-up cross-value-chain** collaboration, where the supplier worked closely with the end-user to create an innovative ecosystem and product.

Philips Lighting were willing to embrace a novel concept and experiment with lighting as a service. This risk-taking culture led to the creation of a dedicated team exploring and promoting the innovative business model and has made Philips Lighting a **market leader**.

Philips Lighting and Turntoo have used **tactical communication** to exploit the growing popularity of cradle-to-cradle business models to promote their shift in strategy effectively to their clients. Tactical communication is about utilising the contemporary Zeitgeist to educate and persuade people about an innovation, increasing the chances of supplier and consumer buy-in.

## Ecosystem – who is involved



## Timeline

2003	2006	2010	2012	2020
Philips Lighting takes action to include energy efficiency into its business model	Philips Lighting start to consistently collect and measure the energy use of their lighting, calculating its carbon footprint	Rau Architects renovates their offices and propose lighting as a service to Philips Lighting. Turntoo is formed, discussions begin about a partnership	<b>Key moment:</b> Philips Lighting forms an international team dedicated to "Circular Lighting"	Philips Lighting signs international contracts with clients such as Schiphol Airport, Carrefour and Deloitte



## Case study profile

**Employees:** Estimated to be low hundreds across all of Philips Lighting's branches and its partners

**Facilities:** Philips Lighting has offices and factories worldwide, whilst maintenance partners are often local to the client

**Products:** Lighting provided as a service that is paid for through a regular fee, with customised and off-the-shelf energy intelligent lights and lighting sensors

**Sales:** Estimated to be in the hundreds of thousands of euros in 2015

## Background

Philips Lighting's Circular Lighting innovation came to existence when two key concepts were having an increasing influence on corporates such as Philips Lighting: energy efficiency and the circular economy. Awareness of these global issues was beginning to influence corporate behaviour and laid the foundations for Philips Lighting to change its business model.

The more immediate context was the renovation of the offices of Thomas Rau – the founder of Turntoo – which included Philips Lighting's involvement in 2010. Rau proposed that Philips Lighting sell him light, rather than lighting. Discovering that no such service existed, a gap in the market was identified. Discussions between Philips Lighting and Turntoo progressed over the following months and in 2012 a formal partnership was formed to commercialise the service.

## Innovation

This innovative business model has since been formalised into Philips Lighting's Circular Lighting service. The premise is that customers pay for the light provided for a regular fee. This puts an onus on providing the most efficient, long-lasting lightbulbs, as well as innovative planning of the locations of lights, in order to minimise the energy costs for Philips Lighting. The model enables organisations to take advantage of LED lighting and minimize energy costs without major capital outlay. Once the lighting reaches the end of its life, Philips Lighting recycles and replaces them. Therefore, not only has the business model changed, but also the product on offer.

In addition, this has spurred a shift in focus for lighting technology, which now needs to be optimised to provide the most effective service. As a result, Philips Lighting has pioneered the development of "smart" lightbulbs that can communicate directly with the provider and the user to enhance performance and highlight potential maintenance needs. Sensors and monitors are also integrated into the systems, accounting for a further 20% electricity use saving.

## Ecosystem

Philips Lighting is the central actor in the ecosystem, leveraging their industry expertise to great effect to realise the scale-up of the innovation. Their large revenue

as a major multinational allowed them to take on the risk of experimenting with a new business model alongside their traditional income streams. They created a dedicated team for conceiving the service, indicative of a corporate culture that places a premium on innovation. In addition, Philips Lighting benefitted from its ability to coordinate a shift in various significant resources and operations, from laboratories to facilities to sales and marketing teams, towards a very different business model and product offer. Their global brand presence also provides international publicity and access to a large variety of markets, enabling rapid scale-up.

The initial spark came through Philips Lighting's relationship with Rau Architects and Turntoo. This collaboration put the idea of Circular Lighting into practice, and acted as an optimum testing environment for developing the innovative customer-centric angle. Turntoo continues to communicate the benefits of Circular Lighting to its clients.

Communication with clients is pivotal to the success of the innovation. Due to its novelty, there needs to be a concerted effort to educate potential customers on the logistics and benefits of this innovation. It is necessary to work closely with clients to tailor lighting systems specifically to their needs – maximising the quality and efficiency of the service. This includes strategic visits where lighting options and placement are optimised.

As the service has progressed other partners have been included within the ecosystem. A maintenance partner is involved in each contract, which is sometimes the client themselves.

## Impact

Circular Lighting has already won contracts across Europe, with one of their most recent contracts being made with Schiphol Airport, Europe's fifth busiest airport. With a global lighting market of €272 billion, this new business model could have a major impact on manufacturing with a much greater emphasis on high-quality, long-lasting "smart" lights rather than mass produced, low budget stock.

Circular Lighting typically results in 60-80% energy savings per project. With current plans for expansion beyond Europe, Philips Lighting predict that global savings of 1,400 MtCO<sub>2</sub> could be achieved by 2030.





# Factsheet: Sonnen GmbH: SonnenCommunity

Country	Sector	End-use functionality	Innovation type
Germany	Energy	Lighting, Thermal Comfort	Business Model, Technology

SonnenCommunity is a virtual power plant that connects a German-wide community of distributed generators and energy storage users with each other. It enables members to purchase excess energy located elsewhere within the community, creating revenues for users and exploiting under-used energy. Due to be launched in February 2016, it has the potential to transform the energy market in Germany by establishing a network of self-sufficient, 100% green energy producers. The concept has been created by the SME, Sonnen GmbH, who previously supplied the SonnenBatterie domestic battery system which grew off the back of a booming, but subsidised, solar PV market in Germany. They used their expertise in distributed generation and energy storage to collaborate with software developers and a utility to expand their business model and create the virtual power plant. SonnenCommunity is open to anyone who has the means to generate and store their own energy across Germany, creating an important avenue for distributed green energy in a post-subsidy environment.

## Key factors of success

### Innovation

**Incentives** offered by the German government for domestic renewable energy systems were vital for creating the demand that grew the wider distributed generation market, and benefitted Sonnen GmbH through sales of advanced domestic batteries. The changing policy environment away from subsidies later caused Sonnen GmbH to think innovatively about how to protect its business while creating economical grounds for storing energy instead of supplying it to the grid for Feed-in Tariffs.

The advanced energy system **infrastructure** provided by the German government is crucial to the deployment the SonnenCommunity, allowing distributed energy generators to connect intelligently through the existing electricity grid.

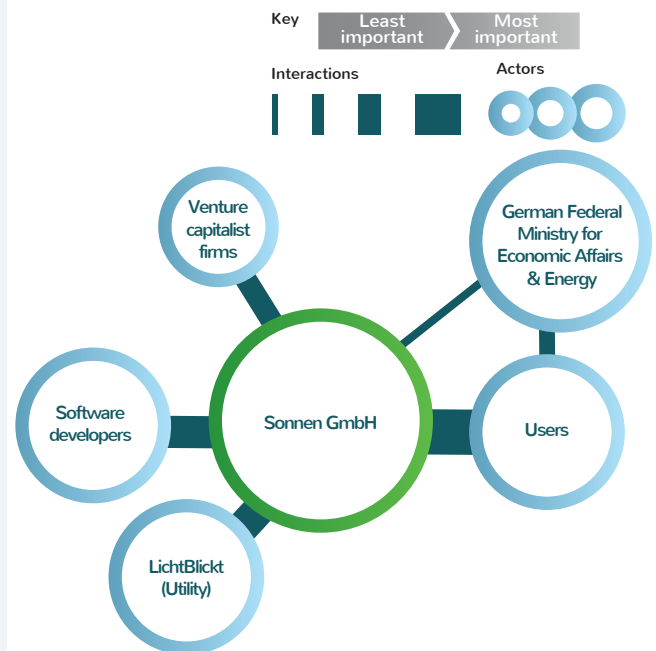
Sonnen GmbH demonstrated **tactical communication**, with their innovation coinciding with the expanding popular interest in emerging peer-to-peer market models, providing **demand side market visibility** for Sonnen GmbH and its partners for their innovative energy sharing business model.

Demand side market visibility has been further enhanced by Sonnen GmbH opening up the SonnenCommunity to all who generate and store renewable energy in Germany.

### Ecosystem

The **cross-value-chain collaboration** initiated by Sonnen GmbH beyond its hardware market was crucial for changing its business model. This bottom-up collaboration with software developers, an energy utility and domestic users, was important to the development of new skills and technology that enabled it to build the SonnenCommunity

## Ecosystem – who is involved



and learn how to effectively manage an electricity grid. This has helped Sonnen GmbH become a market leader.

Key to its success is the effective **strategic communication of the business case**. Potential contractors are educated early on and thereafter monitored continuously according to the stringent requirements for sustainability.

## Timeline

2010	2011	2014	2015	2016
Sonnen GmbH was established with €20 million from four venture capitalist firms	Batteries commercialised and deployed in Germany and Austria	<b>Key moment:</b> German government begins to phase out utility solar power subsidies, prompting anticipation of similar moves in the domestic market	Sonnen GmbH begins changing its business model with software developers and a utility to develop and refine the virtual power plant	SonnenCommunity launched



## Case study profile

**Employees:** 150

**Facilities:** R&D laboratory and factory in Germany. Offices in Germany, Austria, Italy, Switzerland, UK and USA

**Products:** Batteries for domestic energy storage, software enabled virtual power plant

**Sales:** €25 million in 2015

## Background

Sonnen GmbH was founded in 2010 to provide advanced battery storage for domestic users of distributed energy generation. They created their first commercial batteries in 2011 without a large market, but their subsequent growth was fuelled by the rapidly growing customer base for distributed generation. This was at a time when a favourable policy environment was accelerating the deployment of distributed energy generation – particularly solar PV – in Germany.

The feed-in-tariff (FiT) subsidy regime enabled consumers to cover the overhead costs of renewable energy generation, and supported the growth of the SME with a rapidly increasing customer base for their battery storage hardware. The subsidies not only appealed to individual consumers, but also helped create a significant degree of visibility and confidence in an emerging market, where investors and suppliers could see a clear return on commercialising energy storage solutions.

From the beginning, Sonnen GmbH saw the benefit of not just focusing on hardware development, but also on intelligent integration through software. They built up a large database of information from their customers, which set the foundation for a change in their business model.

## Ecosystem

Initially Sonnen GmbH's growth was supported by a €20 million investment from four venture capitalist firms, which provided them with essential financial stability and enabled them to expand a factory in Germany and grow their business.

The recent shift in their business model, away from just providing hardware, presented a significant challenge in that they needed to acquire the necessary skills for managing an electricity grid like a utility. Sonnen GmbH worked closely with software developers, who helped turn their data into a platform that would allow consumers to trade energy through the grid. They also collaborated with LichtBlick to learn about managing a grid like a utility.

They also ran an extensive public engagement programme through publicity and trials with existing customers to scope out the potential market and refine their platform so it was customer-friendly. Lastly, they had regular dialogue with the German government to ensure that their innovation was deployable. This was a pivotal challenge because they were entering into a strictly regulated energy market that is difficult for newcomers to enter.

## Innovation

This evolution was catalysed by the changing policy environment in Germany. Most importantly, the German government began moving away from FiTs for utility-scale solar plants in 2014, therefore increasing the prospect of similar moves for distributed generation. This prompted Sonnen GmbH to look into how they would survive in a post-subsidy world, highlighting how incentives can both stimulate growth in nascent markets and encourage innovation because of their temporary nature.

The SonnenCommunity was created as a result of the changing policy environment. It uses an innovative software technology that works as a virtual power plant, where users who generate and store their own energy are linked up to each other through the electricity grid and can receive revenue for their under-utilised energy, or receive energy when their supply is low. This innovative business model could protect Sonnen GmbH, and the wider distributed energy market by providing a new source of revenue.

## Impact

This innovation has the potential to have a lasting transformational impact on the German, and even European, energy market by promoting a peer-to-peer economy. Importantly, membership to the SonnenCommunity is not limited to previous Sonnen GmbH customers, though they get more benefits, and is open across the entirety of Germany. Based on their early public engagement, SonnenCommunity is projecting thousands of customers in their first 6 to 12 months alone - this could have a major impact on GHG emissions if its popularity continues to grow.

Most importantly, this innovation will protect customers and suppliers of distributed renewable generation systems from the cutting of future subsidies by providing an alternative source of income. It can also therefore act as a market pull on manufacturers of distributed generation and storage technologies by supporting a robust future market of customers.



# Factsheet: Textiles Recycling Valley

Country	Sector	End-use functionality	Innovation type
France	Textiles, Recycling	Thermal Comfort	Business Model

The Textiles Recycling Valley initiative is a large collaboration partnership between textiles manufacturers and recyclers with the objective to reinvigorate the textile industry in Northern France through innovations in material use, waste and recycling. Its ultimate aim is to create profitable businesses and sustainable jobs in the textiles sector in the region through making a circular value chain. Since 2013, five organisations – cd2e, UP-tex, Team2, T2M and Eco TLC - have formed a core partnership, where each brings their own specific knowledge and skills to work with textiles manufacturers and recyclers across Northern France. It is focused on tackling four key areas: “closed loop” manufacturing processes, using textile waste to make similar articles; “open loop” manufacturing processes, using textile waste to make new articles; nationwide collection and sorting logistics; and eco-design. Its industrial rejuvenation programme has attracted regional, national and European government funding, and is now looking to expand by working with new partners in Belgium and other businesses and researchers across Europe.

## Key factors of success

### Innovation

Government **regulation** that suppliers have to take greater responsibility for the end-of-life of their product has encouraged the business case for the circular model promoted by the Textiles Recycling Valley collaboration.

Public **patient capital** from the regional, national and EU governments has been unlocked due to synchronisation with their priorities of industrial regeneration.

**Market visibility**, where there is a clear supply and demand of textiles, has ensured confidence in the collaboration. **Supporting infrastructure** for both textile production and recycling in place is efficiently exploited by this new business model for connecting the two sectors.

The collaboration model is **scalable** and **replicable**, and has already explored opportunities to work in new

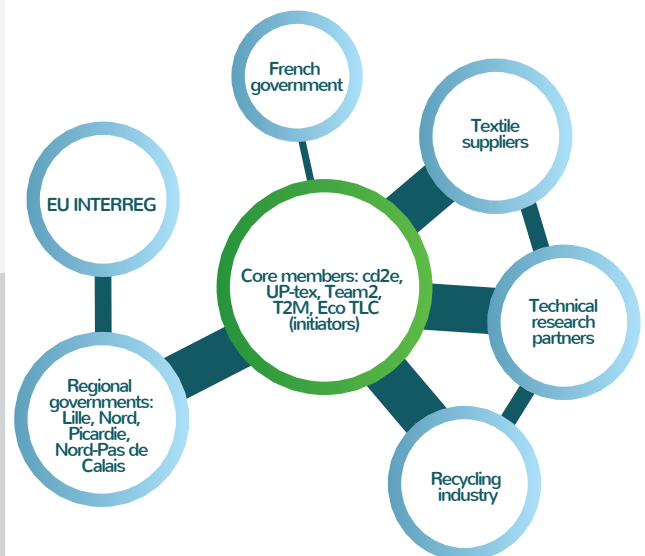
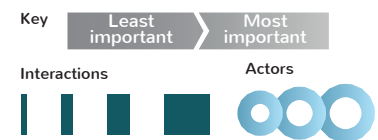
### Ecosystem

The Textiles Recycling Valley has displayed **leadership and facilitated multi-stakeholder co-operation** by engaging actors from different sectors through **strategic communication**, conferences and workshops to build a circular system.

**Top-down cross-value-chain collaboration** is fundamental to the circular system. Cooperation between the textile suppliers at one end and the recyclers at the other is vital for realising objectives such as standardisation of materials for a strong circular system.

Geographic **proximity** of the industrial cluster has provided density of supply, which is important for connecting the different ends of the value chain and creating a business case where transport costs are minimised.

## Ecosystem – who is involved



## Timeline

2002	2009	2013	2014	2016
Cd2e, a hub for eco-enterprises is formed, working with recyclers in Northern France	Cd2e, followed by UP-tex, start specific work on textile recycling	Textiles Recycling Valley is formed through a partnership of 5 core organisations	<b>Key moment:</b> The first Textiles Recycling Valley Congress is held	New projects set to start covering new materials and industries across Europe





## Case study profile

**Employees:** 250 – 500 direct jobs associated with the programme so far

**Facilities:** Estimated to be in the tens of textile factories and recycling plants across Northern France Indianapolis

**Products:** Innovative techniques and strategies for producing new or similar articles from textile waste

**Sales:** Innovative techniques and strategies for producing new or similar articles from textile waste

## Background

Northern France is home to two well-established industries: textiles production and recycling. Both industries have suffered economically in recent years and have had difficulty in maintaining their employment base. Combining these two areas of expertise has revealed an effective way to regenerate the local economy, whilst pursuing sustainability goals.

There has been interest in sustainable development in the region since the early 2000s with several organisations working in the field:

- Cd2e, a team of environmental and business experts, support the environmental sector in Northern France;
- UP-tex is devoted to the economic development and industrial revival of textiles manufacturing;
- Team2 is an organisation which focuses on life cycle innovation and recycling;
- T2M coordinates economic activities of the textiles and clothing sectors; and
- Eco-TLC set standards for recycling and sustainable waste management for textiles.

However, until recently the aforementioned initiatives had operated without a formal collaboration agenda.

## Innovation

In 2013, the initiator of the Textiles Recycling Valley, cd2e approached the other organisations. A convention was signed between them to develop a three year plan for economic regeneration and closed-loop manufacturing.

The Textiles Recycling Valley promotes four actions through workshops, focused technical assistance and more general knowledge dissemination:

- Research and deployment around “closed loop” manufacturing processes looking at the technical potential of using textile waste to make similar articles;
- Overcoming technical barriers and encouraging business models for “open loop” manufacturing processes using textiles waste to make new articles;
- Nationwide collection and sorting logistics of recycling – including promoting standardisation in the industry; and
- Sustainable design practices and eco-designed products.

## Ecosystem

Cd2e and UP-tex were instrumental in the formation of Textiles Recycling Valley. Working together they approached the other key partners (T2M, Team2 and Eco-TLC) to form a partnership for cross-value chain collaboration. This generated the critical mass in the region necessary for instigating systemic change and closed loop manufacturing. Other local suppliers, researchers and the wider nationwide recycling industry were subsequently engaged through conferences and workshops to build a significant network across Northern France.

Technical partners, such as engineering schools and research centres, have also been involved. These organisations worked with the core members to provide technical assistance across the value chain.

Once the five key members came together, they engaged the regional government, and received financial and administrative support, given their objectives’ alignment with the broader strategy for sustainability and economic growth. This was later further supported by funding from national French government.

Through its Interreg programs, the EU has become an important contributor. A project initiated by the Textiles Recycling Valley, has 10 European partners, it aims to bring the textile industry in the circular economy.

## Impact

Textiles Recycling Valley is having a clear impact on the regional economy in Northern France. The initiative is on track to create 5 new businesses and safeguard 250 – 500 jobs over the 3 years of this initiative. There is the potential to expand with around 1,000 people working on textile recycling in Northern France and further 15,000 working in the wider textiles industry.

On average, each kilogram of textiles recycled through the initiative represents 3.6kg of CO<sub>2</sub> saved. France produces over 600,000 tons of waste textiles each year, and therefore the potential decarbonisation impact is large.

There is already the possibility of extending the programme to work with textile companies in Belgium and other European value chains. As a leader in the field, the Textiles Recycling Valley sets a precedence for encouraging regional-scale, circular business models.



