

CARBON AND ENERGY MANAGEMENT ON ECO-INDUSTRIAL PARKS: CASE STUDY FLANDERS' CARBON NEUTRAL INDUSTRY PARKS

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ABSTRACT: Industrial parks and business sites offer a welcome opportunity to promote and implement local investments for higher carbon efficiency. Such parks are geographic concentrations of energy consuming, and increasingly even energy producing enterprises. Moreover, an active management team running the park, keeping close contact with the enterprises and delivering collective services, is gaining ground in industrial environs. The importance of a sustainable management of business clusters is fully recognised in Flanders. It is the cornerstone of the 'carbon neutrality' objective –zero CO₂ emission in electricity consumption– launched in 2007 and is integrated in the act concerning public co-financing of the (re)development of industrial and business parks in Flanders. Despite the incentive, however, the approach still mainly focuses on individual companies instead of business clusters. Collective energy production opportunities and clustering in energy exchange, though, are slowly but surely regarded as an alternative, promising approach of 'carbon neutrality' management, paving the way to smart energy applications such as microgrids and encouraging local renewable energy production.

INTRODUCTION

After the industrial and the ICT revolution, the economic system seems to be right ahead its next transformation: the climate revolution. What outcome this transformation ultimately will have again is under great uncertainty. Yet it is known that business profiling in carbon neutrality is part of the inclination.

"From manufacturers to retailers to financial institutions, companies that want to protect their brands are tripping over themselves to declare their companies to be carbon neutral."

Joseph Stanislaw, Deloitte (2008).

Numerous businesses claim full carbon neutrality or carbon neutral premises. Others offer zero emission services as freight or people transport, some move companies in a carbon emission free way. A growing number of companies sell green products such as green electricity and green gas. Lots set goals to reduce carbon emissions drastically, while some are even pushing their suppliers to follow. (Stanislaw, 2008; Carbon Constraint Initiatives, March 9th 2010; Carbon Disclosure Project, March 9th 2010; Climate Neutral Group, March 9th 2010; CO2Logic, March 9th 2010; The Carbon Trust, March 9th 2010; The Climate Group, March 9th 2010)

McKinsey&Company believe "that the shift to a low-carbon economy is already under way and that business must get ready for it [...]; the value at stake over the next two decades and beyond is going to be enormous" (Enkvist *et al.*, 2008). "The smartest companies will understand that creating products whose production results in reduced carbon emissions and fossil fuel consumption is the only way they can be sustainable. The stubborn ones will go out of business." (Stanislaw, 2008).

Governments must follow and support the changing internal market potential, in order to keep up with international competitiveness in low-carbon economy. "Business, more than some governments, is taking a long-term view and is becoming a driving force in the fight against climate change, asking for a coherent, stable and efficient policy framework to guide investment decisions." (Commission of the European Communities, 2007). However, according to McKinsey, companies should not even wait for governments to enact legal frameworks. They must proactively raise the carbon productivity of their current assets and pursue new business growth by developing new products, services, business models and interfirm business connections in order to introduce the green products and services needed in a low-carbon economy (Enkvist *et al.*, 2008).

FLEMISH CO-FINANCING FOR CARBON NEUTRAL INDUSTRIAL AND BUSINESS PARKS

Carbon neutrality for industrial and business parks has been introduced by the Flemish government as an important policy focus since 2007. A carbon neutrality amendment is incorporated in the act concerning public co-financing of the (re)development of industrial and business sites in Flanders. Grants to park developers and managers are guided by driving forces built upon carbon emission reduction and sustainable energy policy measures. Yet carbon neutrality covers many overtones. In its widest meaning, it refers to the broader climate neutrality, meaning a zero emission of all substances causing a greenhouse effect, such as CO₂, CH₄, N₂O, halogenated hydrocarbons, SF₆, black carbon, CO, volatile hydrocarbons in the first place (Gore, 2009), emitted due to energy consumption, through processes and transport, embedded in infrastructures, machinery, raw materials, products, etc. In this case, the prerequisite of a carbon neutral business park narrows down to a zero net CO₂ emission based upon electricity consumption. Direct use of green electricity (renewable energy) or compensation of carbon emissions is the prime business objective; moreover it's an obligation for all companies on a carbon neutral business park. The responsibility lies with the park developer to pass on this obligation to the companies located on the concerned park and to enforce if necessary. If not, the park manager is likely to be deprived from its public financial support (Flemish Government, 2007a, b, 2009).

A small survey carried out by the Flanders' Chamber of Commerce and Industry, Voka, indicated that the electricity share covers 50 to 90 percent of the primary energy use at the companies site (Decraecke, 2008). Moreover, CO₂ in case of electricity production is considered an acceptable target, as it covers more than 99 percent of at least the greenhouse gas emissions (CO₂, CH₄, N₂O, halogenated hydrocarbons, SF₆) due to electricity production, transport and distribution in Flanders in 2006 (Lodewijks *et al.*, 2009). Unfortunately the electricity consumption share of the total greenhouse substances emission for premises, organisations and across full value chains can be low for many businesses (The Carbon Trust, 2008). Therefore the carbon neutrality requisite can be remarked as a starting point, an introduction to a green image. It may however also be a stimulus for (further) corporate responsibility in the environmental and climate change issue. Certainly the creation of an activated energy conscience is considered necessary in order to attain a cost-effective sustainable energy strategy that is part of a company policy. Hence the co-financing regulation is narrowed down to a welcome igniting tool by redirecting the focus from carbon neutrality of the electricity consumption to the energy use itself, the energy efficiency and even productivity. It may induce a sustainable energy strategy, that is characterised by the Trias Energetica concept¹ focusing on process optimisation and energy efficiency first and in a second step reaching for renewable energy use or carbon neutrality (Lysen, 1996). However, to ensure global emission reductions, carbon footprint calculation and optimisation of entire premises, organisations and value chains should also be encouraged, in order to detect and address the key sources first (The Carbon Trust, 2008).

Carbon neutral Kazerne Lissewege in Bruges

Kazerne Lissewege of the West-Flemish Intermunicipality² (wvi) is one of the first realisations under the new Flemish carbon neutrality regulation and serves as an example of field practice. It is a reconversion of an old army barrack of 2.3 ha, now offering a number of building lots, industrial and office modules for small companies.

It is wvi's view to install the carbon neutrality requisite as an operational and strategic benefit for its companies. Therefore it focuses on a rational energy use prior to carbon neutrality. Wvi has designed a spatial plan focused on compact building and developed a set of guidelines invoking a cost-cutting energy strategy in buildings and machinery:

- Newly built and renovated industrial halls have to meet almost 30%, and offices and dwellings 40% stronger isolation standards than the common Flemish standard.
- Offices also have to meet 40% stronger energy standards, dwellings 25% in relation to the improved Flemish standard.
- The use of active cooling is only allowed after installing protection against solar irradiation and analysing passive cooling strategies.
- Lighting appliances should meet minimum efficiency criteria.
- A quick scan detects possible investments in the machinery for core activities. Investments characterised by a pay-back period of maximum 3 years should be executed.

Secondly businesses can decide on different options for attaining the carbon neutral electricity: purchase of green electricity (from renewable sources), self-production of green electricity, individually or collectively, purchase of

¹ www.triasenergetica.com.

² West-Vlaamse Intercommunale, www.wvi.be or co2n.wvi.be.

Renewable Energy Guarantees of Origin (RES-GO)³, purchase of emission credits issued under the Clean Development Mechanism or Joint Implementation programmes and meeting the Gold Standard⁴, or finally purchase or production of blue electricity, using cogeneration, if all electricity qualifies as green electricity (through using renewable fuel or purchasing RES-GOs) or if all emissions are compensated. All electricity consumed and produced should meet carbon neutrality.

Next to the requirements primarily focusing on the building phase, wvi's park management is specialised in rational energy use and sustainable energy technologies. Wvi introduces and guides companies so as to implement the carbon neutrality requirements in a cost-effective and strategically sound manner. Moreover, the park management insists on companies picking the fruits of the coming low-carbon economy by developing and distributed green products and services.

As wvi, other industrial and business park developers set up a carbon neutrality strategy focusing on the Trias Energetica principle. The Provincial Development Agency of Antwerp (BECO Belgium, 2008) and Veneco² (2007), a park developer in the region of Ghent, play a pioneer role. It is believed that many actors will follow, even on short notice, as markets evolve to greater energy efficiency. Besides guidelines will become more stringent, even more demanding, thus sidetracking developers and managers who don't tag along.

TRANSITION TO LOW-CARBON INDUSTRIAL AND BUSINESS PARKS

Multiple carbon neutrality initiatives on industrial and business parks stimulate low energy building, energy efficiency and renewable energy production. In the future, buildings will increasingly be "passive"⁵ and strive to energy autonomy. New allotments should be designed for compact buildings and considering the orientation in relation to climate parameters, such as irradiation. Industry will endeavour the maximum of process optimisation and energy efficiency, and energy production will switch to renewables as quick and as far as possible. This is conditional to meet the energy efficiency rise of 20% as dictated by the EU Energy and Climate package (VMM, 2009).

In order to stabilise the global warming effect under 2°C, developed countries should reduce their greenhouse emissions by 60 to 80% by 2050 in relation to 1990 and by 80 to 95% following the Intergovernmental Panel on Climate Change, according to the Stern Review (Stern *et al.*, 2006; IPCC, 2007). The EU Energy and Climate package has set the goal to a 20% reduction in 2020 in relation to 1990, which may become 30% in case of a new and progressive global emission reduction agreement (Commission of the European Communities, 2007; Europa.eu, March 9th 2010). However, scenario calculations expect only a 12% reduction of greenhouse gas emission by 2020 and 36% reduction by 2030 being accomplished (VMM, 2009). Society is in need of more structural change, of a transition reaching further than just product and process optimisation. In the building sector, energy autonomy should be strived for individually, indeed, but also collectively. A group of dwellings and other buildings is perfectly fit for collective local electricity and heat production and distribution. Moreover, industrial and business parks should become energy autonomous on local renewable energy production and operate in industrial clusters. New business models are to be introduced (VMM, 2009), e.g. based upon the experience gained with interfirm collaboration and eco-industrial parks (Van Eetvelde *et al.*, 2005).

Without structural changes Flanders could be threatened, not only by a climate crisis but also by a new economic, structural crisis. The Environmental Exploration 2030 of the Flemish Environment Agency investigated the possibilities of reducing greenhouse emissions within industry and energy production. The study starts from an expected carbon price of 77,6 euro per ton CO₂ from 2020 to 2030⁶, needed to cope with a 50% greenhouse gas emission reduction by 2030 and a 60 to 80% emission reduction by 2050 in the EU-27. Flemish installations falling under the European Emission Directive will not reduce their emissions under the level of 2006. VMM calculates that it is more economically sound to meet the European and expected global emission goals by purchasing emission credits in other regions and countries of the European Union or abroad (VMM, 2009). This means that the competitive strength of Flanders could be heavily damaged unless a more structural transition in the socio-technical system is accomplished. Eliminating the

³ www.aib-net.org.

⁴ www.cdmgoldstandard.org.

⁵ www.passiv.de.

⁶ Carbon spot price today around 13 euro per ton CO₂ (Bluenext - 04/03/2010).

extra costs for the purchase of emission credits is a prime requirement, even allowing selling credits and earning more profit when located in Flanders is called for.

“To help companies benefit from the coming transition, their managers should carefully begin to reposition them for a low-carbon landscape” (Enkvist *et al.*, 2008). The same counts for countries offering a competitive or uncompetitive operational and physical framework for low-carbon businesses to develop, to compete on a local and/or international market and finally to grow. The physical framework of industrial and business parks therefore should not only focus on internally directed energy and emission constraints. The latter only prepare internal markets and hope to induce an early movers benefit, since eventually it all will be implemented due to upcoming European directives and global protocols. Still the physical framework, installed for many years for companies to operate in, should also be compatible with the long term structural changes needed to be competitive in a low-carbon economy.

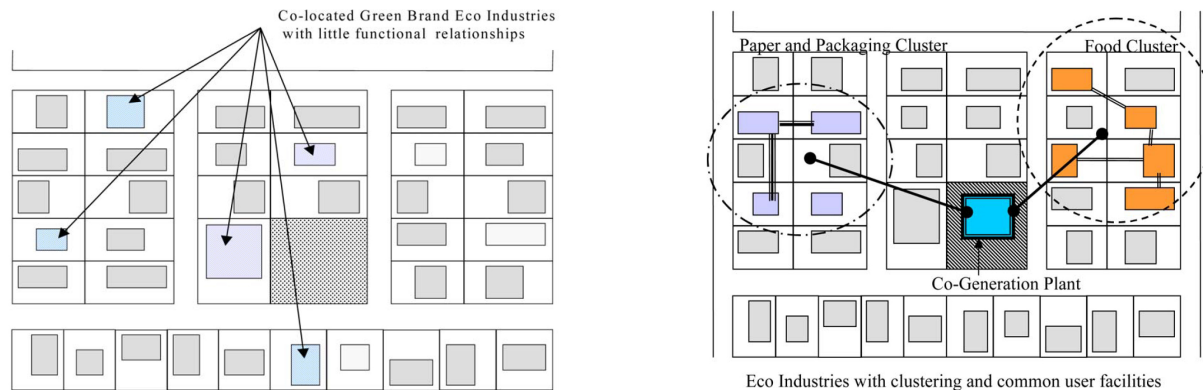


Figure 1. Green industry parks versus integrated eco-industrial parks (Roberts, 2004)

There are two types of eco-industrial parks, according to (Roberts, 2004). ‘Green industry parks’ include a range of enterprises that apply cleaner production technologies, process much of their waste and/or reduce the emission of greenhouse gases, in situ. ‘Integrated eco-industrial parks’ are specifically designed to encourage the development of industrial ecosystems, meaning the inter-company exchange of materials and energy. Frosch & Gallopoulos (1989) already in the late '80s emphasised “that the traditional model of industrial activity, in which individual manufacturing processes take in raw materials and generate products to be sold plus waste to be disposed of, should be transformed into a more integrated model: an industrial ecosystem” meaning “a community or network of companies and other organisations in a region that choose to interact by exchanging and making use of by-products and/or energy in a way that provides one or more of the following benefits over traditional, non-linked operations: reduction in the use of virgin materials as inputs; increased energy efficiency leading to reduced systemic energy use; reduction in the volume of waste products requiring disposal; and increase in the amount and types of process outputs that have market value” according to Gertler (1995). Industrial ecosystems can be global, regional or as well site based: eco-industrial parks (Lowe (1997)).

Consequently, the Flemish ‘carbon neutral’ industrial and business sites could be denoted as an attempt to evolve into ‘green industry parks’, while a long term competitive physical framework should prepare for industrial clustering. Of course, the physical framework and the much broader legal and fiscal framework should act together.

However, Lambert and Boons (2002) oppose to the automatic and unique attention for industrial clusters concerning eco-industrial parks. The growing number of mixed industrial parks holds characteristics that are completely different from traditional industrial parks. They require a broader strategy to sustainability. Mixed industrial parks are characterised by a strong diversity in business sectors (production, manufacturing, logistics, services, depots, wholesale, retail, recycling, etc.), in scale (numerous small and medium sized enterprises), even in function (business, residential, leisure, etc.) and by a rapid change in population. “The enterprises experience no advantage of each other’s vicinity, there might be competition on the one hand, indifference and difference in interest on the other hand. Coherence is poor.” (Lambert and Boons, 2002) Key issues in the sustainability strategy on this type of areas are the choice of location and the park’s spatial design, the installation of a structural platform for inter-company deliberation, and site or park management. Their presence or availability is recognised to lead to various PPP-projects, including the collective purchase of services and investment in infrastructure (Lambert and Boons, 2002; Van Eetvelde *et al.*, 2005; Van Eetvelde *et al.*, 2007; Van Eetvelde *et al.*, 2008).

Interfirm cooperation in energy is a type of industrial clustering that binds traditional industrial parks and mixed industrial parks. In casu, it binds energy-intensive companies and non energy-intensive companies. Lambert and Boons (2002) proof the natural tendency on traditional industrial sites for process integration, within a single company but also exceeding the companies' borders. They expect interest in collective energy purchase and production, but less in heat exchange on mixed industrial parks. To uphold the maximum changes for energy symbiosis, a new business park typology should therefore be worked out, aiming to group similar or precisely complementary businesses into subclusters.

- Companies having opportunities for traditional energy exchange (and by extension material and water exchange) should be regrouped within one or more zones on an industrial park (figure 2). Upon internal capacity, process and energy efficiency optimisation, residual energy (heat, electricity, steam, cold, biogas, etc.) can be delivered to other companies. Vice versa, a company can search for residual energy sources of neighbouring firms and use or upgrade them.
- Offices or industrial halls incapable of exchanging energy flows, can be built in horizontal and vertical strings. Here, collective heating, ventilation and cooling installations can be implemented.
- In both cases, collective production of energy could be profitable, using local renewable energy sources. A large scale production unit is an option, as well as combining multiple smaller scaled units, identical or diversified but complementary.

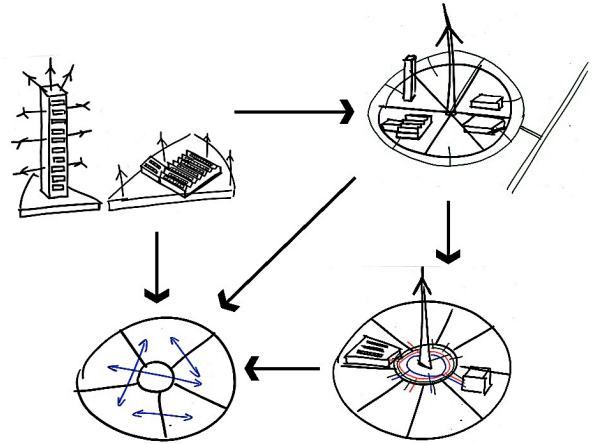


Figure 2. From individual energy production to energy clustering (pure individual production - pure collective production - interfirm energy exchange - multi-energy smartgrid)

Most important technical factors in energy exchange and collective energy production are the distance between production and consumption sites, the possibility of connecting them and their energy profiles. On existing areas, these parameters are merely known; on new (mixed) industrial parks, however, the time path is determined by the data collection and processing period. The most important social factor for intensive interfirm collaboration, is the creation of mutual trust and the management for self-organisation (Lowe, 1997). Energy cooperation can also entail a variety of services, such as maintenance, energy monitoring, energy and by extension carbon management. Eventually, investments for local energy production or integration, can be outsourced to overcome operational, technical, legal and economical barriers, bringing in so-called 'energy service companies' (ESCO) for their expertise, capital, services, etc. Stanislaw (2008) denotes: "The new energy company will no longer profit from selling a commodity such as oil, gas, or electricity. Instead, it will be a high-value service company that provides light, heat and mobility, being rewarded for doing so in the most environmentally acceptable way." Energy companies are preparing themselves. Hence, e.g. Essent Local Energy Solutions provides an integrated "Trias Synergetica" service, "meeting local energy demand by using local energy sources and realising energy efficiency" (de Man, 2009). Also Nuon is been shifting to services instead of pure utility delivery, as it provides a concept of industry park management where Nuon "creates the most efficient and environmental friendly energy infrastructure, also searching for synergy benefits by cooperation between multiple companies" (Ovink, 2009). From such ESCOs various types of guarantees can be demanded: supply; saving; function, operation and maintenance; quality and comfort (Waldmann and Keuc, 2009). Likewise, different types of management and legal structures can be developed, ranging from full outsourcing to special purpose vehicles (SPV). Interfirm cooperation for energy cooperation thus is thought to be beneficial, especially to small and medium sized companies. Via clustering, advanced installations and services can be acquired whilst reducing (investment and) operational costs.

Industrial parks can be defined as geographically dense clusters of larger energy consuming entities, each more or less bearing the opportunity to produce renewable electricity and to minimise heat losses. When exceeding the company's borders and considering the industrial area as a whole, the optimisation potential strongly increases. When translating the carbon neutrality principle into a practical strategy, from park design over issuing and management, industrial clustering is a high perspective concept. Planners, park developers and managers should maximise this potential, by adapting the park design for physical links, setting the energy standards and dedicating zones for companies with large energy consumption profiles within (mixed) industrial parks. However, the highly supported distributed energy generation, or more general the future distributed resources, also require distribution networks being able to actively manage power flow and to allow storage of energy for later use (Kueck and Kirby, 2003; Jiayi *et al.*, 2008; Battaglini *et al.*, 2009; Bayod-Rújula, 2009). Hence business parks are invited to launch a long-term adaptation strategy and prepare for being equipped with low-cost electrical lines linking local energy producers and consumers

into local electrical networks. Research and innovation is needed to allow these low-cost networks and to setup a specific regulation. Even an adapted tariff structure is required, covering all costs and benefits of increasing autonomy and eventually delivering ancillary services to the distribution network. To stimulate industrial clustering for companies themselves, local (renewable) energy coverage, demand and storage management has to be stimulated: short energy paths and storage will have to be remunerated.

CONCLUSIONS

To stabilise global warming, the transition to a low-carbon economy is needed. Numerous individual companies have started their transition in order to be prepared. It is time for governments to react now and support this revolution in view of the country's competitiveness. The Flemish carbon neutrality initiative on industrial and business parks is a prime step towards more energy efficient buildings and processes, and a stimulus for the production and consumption of green electricity. It should entail further investments that support the low-carbon economy. However, premises and process optimisation is not considered sufficient so as to limit the emission of greenhouse gasses in Flanders. Society is in need for more structural changes. Carbon neutral industrial and business parks are prepared to grow into autonomous energy clusters. Cooperation is initiated and thus ready to intensify by clustering buildings, energy exchange, collective production and even joint outsourcing of energy services. In this process it is crucial to select the companies having opportunities to cluster, and assign them to specific zones within industrial parks. Business parks that operate in unity stand more chances for energy autonomy over local renewable energy sources. Yet then, energy networks must be capable to function as a local (two-ways) smart grid, managing and remunerating the energy autonomy on a cluster level.

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