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Strategies for reducing greenhouse gas emissions at an industrial park level: a case study of Debert Air Industrial Park, Nova Scotia

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ABSTRACT

With the reality of climate change facing the planet, industry is being challenged to reduce greenhouse gas (GHG) emissions. Due to the large number of industrial parks around the world, they are an important and arguably, an appropriate level at which to manage GHG. The question being considered in this paper is whether a multi-disciplinary, muti-dimensional and integrated approach could result in a practical and cost-effective management plan for a carbon neutral eco-industrial park. Taking Debert Air Industrial Park (DAIP), Nova Scotia as an example, a combination of tenant and park strategies, which companies can adopt both individually and collectively in concert with industrial park planners and management are identified and are already being implemented in parks to reduce GHG emissions. The study also involved a survey of business managers. While we agree that some individual strategies such as enhancing renewable energy sources and energy efficiency initiatives will have significant impact, we conclude that a wider mix of strategies including land use planning will be necessary to result in a low carbon, resilient and ecologically sustainable park. Implementing these strategies will be helpful to reduce or offset GHG emissions at an industrial park level and facilitate the transition of industrial parks towards an eco-industrial development in both regenerative and preventative ways through planning, design and management.

1. Introduction

Climate is a key feature of the ecological system of Earth, which enables life and ecosystems to survive and prosper. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), it is very likely (>90% of likelihood) that the earth's climate has been affected by increases in greenhouse gas (GHG) emissions over the past 50 years (Solomon et al., 2007). It is widely accepted by scientists that it is human activities that result in the increased concentrations of GHG in the atmosphere (Dietz and Rosa, 1997; Ren et al., 2012). As one of the major contributors with heavy reliance on hydrocarbons, industry will be challenged to reduce emissions of GHG (Hashimoto et al., 2010). Achieving this objective will require new ways of producing and using energy and managing GHG emissions.

Because of the cumulative nature of GHG emissions resulting from a multitude of human activities, we argue that reducing and mitigating responses could be more effectively managed at spatial levels where people and industries are concentrated. UNEP's report on the Environmental Management of Industrial Estates recognized climate change and GHG emissions as aspects that would have to be addressed in the planning and operation of industrial parks (UNEP, 1997). The article written by Bühner (2013), which describes the content of a German report, refers to several projects in which strategies have been implemented to reduce GHG emissions. Industrial parks represent an important focus for encouraging a low carbon economy (Liu et al., 2012). Industrial parks are a growing feature in the global landscape as there are now tens of thousands of such agglomerations (Lowitt and Côté, 2013). Also, they are concentrated sources of GHG emissions, especially CO_2 (Dong et al., 2014). It is thus one of the bigger challenges that industrial park development is facing, which has not yet received much attention (Geng and Côté, 2004). Despite changing economic conditions, parks are being upgraded and new industrial parks are being established. In China, for example, there are more than 3000 industrial parks throughout the country, including nationally designated industrial parks and provincial ones (Chen et al., 2013).

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2. Literature review

Using life-cycle analysis, Chen et al. (2013) set up a GHG inventory which aims to calculate the GHG emissions of a high-end industrial park in Beijing. In the conclusions, the authors do identify a few strategies for controlling GHG emissions at the construction stage. Taking Shenyang Economic and Technological Development Zone (SETDZ) as a case, Dong et al. (2013a) examine the method of hybrid LCA for evaluating the carbon footprint of an industrial park. GHG inventories and carbon footprint calculations are important tools for managing GHGs in industrial parks. Munir et al. (2012) put forward an approach for managing carbon emissions using carbon exchange networks in industrial parks.

A paper by Block et al. (2011) describes initiatives taken in a small industrial park in Herdersburg, Belgium. The initiatives include district heating, renewable energy with wind turbines and solar voltaic panels, biomass fermentation, and the creation of a data base of supply and demand of hot and cold streams required by industries in the park. Maes et al. (2011) describe opportunities to lower the carbon intensity of a park in Flanders, Belgium. They begin with a focus on energy conservation and efficiency practices of the buildings in the park. The authors then discuss options for “attaining carbon neutral electricity” such as the “purchase of green electricity (from renewable sources), self-production of green electricity, individually or collectively, purchase of Renewable Energy Guarantees of Origin (RES-GO), purchase of emission credits” or purchase of cogenerated electricity (Maes et al., 2011, 1991). Finally Maes et al. (2011) discuss the potential for energy cooperation between neighbouring industries through exchange, distribution or collective production. In an earlier paper, Maes and Van Eetvelde (2010) on carbon neutral industrial parks, the research team identified a number of strategies including strong energy efficiency standards, protection against solar irradiation as well as active and passive cooling of buildings and clustering of industries to take advantage of heating and cooling opportunities.

In a paper on life cycle based sustainability evaluation of industrial parks, Yang et al. (2012) focused on energy density and proposed the use of low carbon construction materials. In another paper from China, Lu et al. (2012) discussed network analysis for a low carbon and high-tech industrial park. Two particular strategies were discussed: Taxation of carbon emissions and carbon capture. These are all valuable tools and strategies whose potential should be considered in each case.

However, while many strategies have been identified and several have been combined in the studies by Maes et al. (2011), Block et al. (2011) and Bühner (2013), there is actually limited research on the application of a multi-dimensional set of strategies for reducing GHG emissions at the industrial park level ranging from land use planning at one end and carbon emission trading at the other end of the spectrum. In this case, the dimensions are land use, infrastructure, buildings, heating and cooling, transport, etc. While every source must find ways of reducing GHG emissions, attempting to control them on a source-by-source basis (e.g., industrial plant, vehicles, heating) may not prove most efficient for the environment or the economy. However, in an industrial park, the larger opportunities for reducing GHG emissions may exist at the park-level and inter-firm levels. Symbiotic cooperation also need to be identified and explored (Bühner, 2013). It has been demonstrated that promoting symbiotic relations can reduce the CO_2 emissions at the industrial park level (Dong et al., 2014, 2013b; Hashimoto et al., 2010; Li et al., 2010; Park et al., 2008; Sokka et al., 2011; Van Berkel, 2010). The strategies and tools for mitigating GHG emissions at the industrial parks level from the literature are listed in Table 1.

3. Objectives

We are proposing that a systems and multi-disciplinary approach, essentially an industrial ecology approach, may allow managers to meet long-term objectives of GHG reduction through effective planning and management strategies. Businesses and park

Table 1
Strategies and tools for mitigating GHG emissions at the industrial parks level from literature.

Strategies	• Strong energy efficiency standards • Protection against solar irradiation as well as active and passive cooling of buildings • Clustering of industries to take advantage of heating and cooling opportunities	Maes and Van Eetvelde (2010)
	• Energy conservation and efficiency practices of the buildings in the park • Options for "attaining carbon neutral electricity" including the "purchase of green electricity (from renewable sources), self-production of green electricity, individually or collectively, purchase of Renewable Energy Guarantees of Origin (RES-GO), purchase of emission credits" or purchase of cogenerated electricity • Potential for energy cooperation between neighbouring industries through exchange, distribution or collective production.	Maes et al. (2011; 1991)
	• District heating • Renewable energy with wind turbines and solar voltaic panels, biomass fermentation • Creation of a data base of supply and demand of hot and cold streams required by industries in the park.	Block et al. (2011)
	• Use of low carbon construction materials	Yang et al. (2012)
	• Taxation of carbon emissions • Carbon capture	Lu et al. (2012)
	• On-site use of renewable energy facilities • Development of industrial symbiosis	Liu et al. (2012)
	• Controlling GHG emissions at the construction stage including the use of local construction materials and low-carbon and regeneration construction materials, and optimization of the construction progress	Chen et al. (2013)
	• Refurbish the building stock for energy efficiency • Capture waste heat from wastewater streams and production plants • Generate compressed air efficiently and fix pressure leaks • Use all suitable roof space for photovoltaic solar power generation • Save drinking water by installing rainwater capturing systems	Bühner (2013)
Tools	Ecological Network Analysis (ENA) to reveal the processes of carbon metabolism in a low-carbon high-tech industrial park	Lu et al. (2012)
	An approach for managing carbon emissions using carbon exchange networks in industrial parks	Munir et al. (2012)
	A GHG inventory based on life-cycle analysis which aims to calculate the GHG emissions of a high-end industrial park	Chen et al. (2013)
	A hybrid life cycle assessment approach for evaluating the carbon footprint of an industrial park	Dong et al. (2013a)