Eco-industrial Park Performance Standards and Indicators and the Circular Economy

Raymond Côté

Professor Emeritus

School for Resource and Environmental Studies

Dalhousie University

Halifax, Canada

and

Zhe Liu

Postdoctoral Fellow

School for Resource and Environmental Studies

Dalhousie University

Halifax, Canada

DALHOUSIE UNIVERSITY

Devens, Massachusetts USA
2016. 06. 18

DALHOUSIE UNIVERSITY

Contents

Eco-industrial parks

" A community of businesses that cooperate with each other and with the local community to efficiently share resources (information, materials, water, energy, infrastructure and the local habitat) leading to economic gains, gains in environmental quality, and equitable enhancement of human resources for the business and local community." (*PCSD, 1996*)

Some key characteristics:

➢ **planning with the ecological capacity** of the area in mind;

➢ **energy production based increasingly on renewable resources;**

➢ **buildings designed and built to optimize conservation of materials and energy;**

➢ industries selected based in part on their compatibility for **symbiosis;**

➢ **webs of businesses** involving producers and consumers, scavengers and decomposers;

➢ **redundancy in material** sources built into the structure of the system;

➢ **water and wastewater infrastructure that recovers and reuses**;

➢ **information management system** which facilitates networking;

(*Cote and Cohen-Rosenthal, 1997*)

Are there different kinds of EIPs?

➢ **Virtual eco-industrial parks?**

➢ **Regional industrial symbioses?**

➢ **Recycling business cluster?**

➢ **A park with environmentally friendly infrastructure?**

TEDA, China

Devens EIP, USA

Burnside IP, Canada

Eco-industrial parks around the world

Ulsan EIP Center, Korea
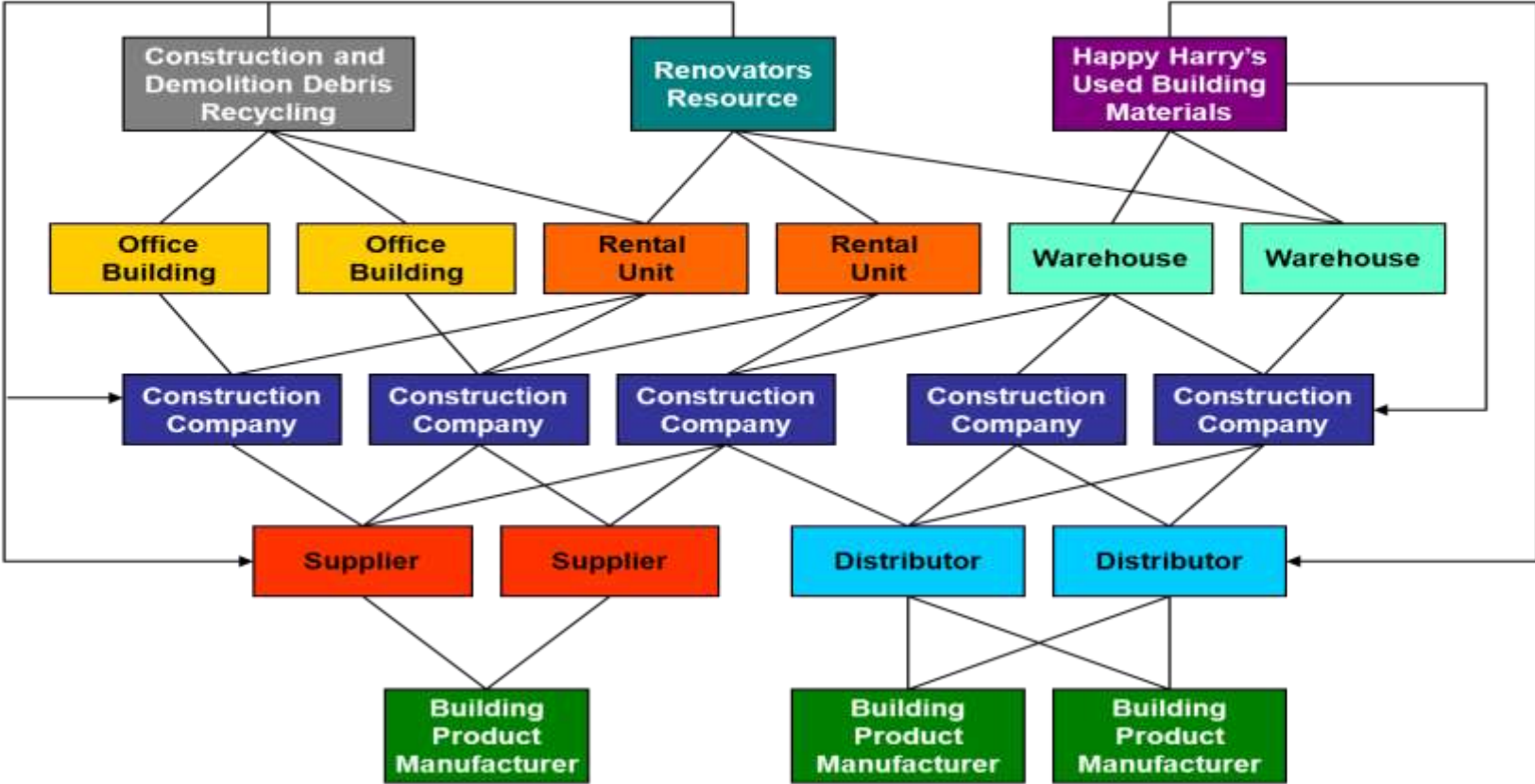

Kalundborg, Denmark

Kawasaki, Japan

Eco-industrial park characteristics

➢ **Efficient sharing of resources: symbiosis but what else?**

➢ **Economic gains: financial benefits to businesses, to local community?**

➢ **Gains in environmental quality: air quality, water use and reuse? Solid waste reduction and recycling?**

➢ **Equitable enhancement of human resources for business: risk reduction? employee engagement?**

➢ **Equitable enhancement of human resources for the community: long term jobs? education and training?**

   – **Based on Chertow, 2003**

An industrial food web
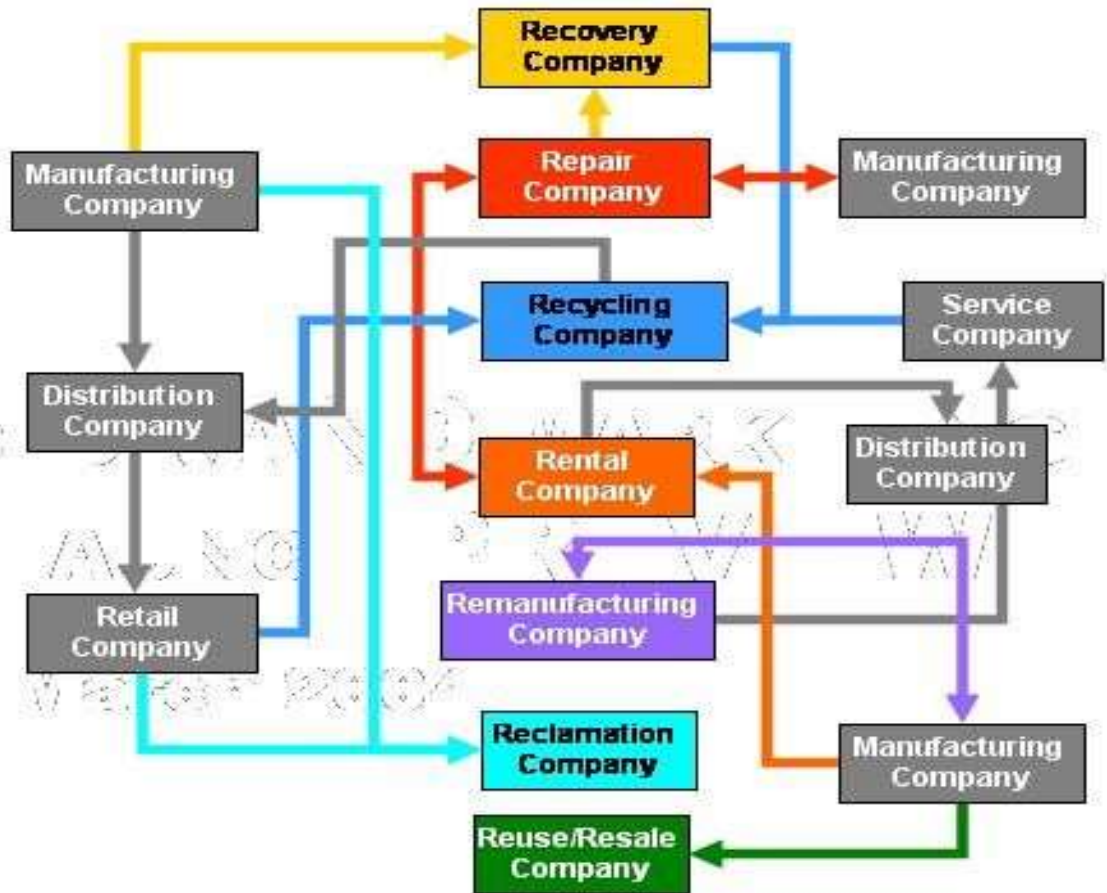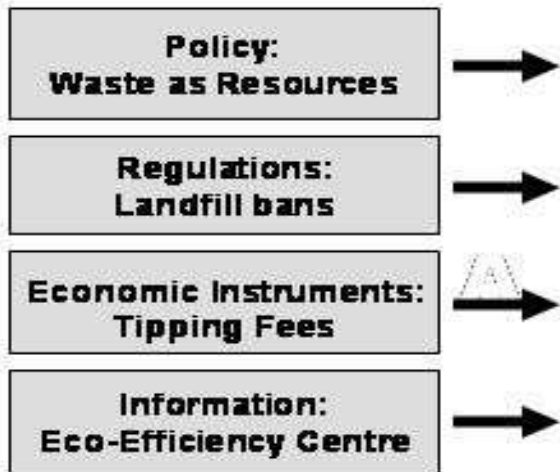

Burnside Industrial Park: An Industrial "Food" Web

Ecosystem model: Circular economy?

Circular Economy

OUTLINE OF A CIRCULAR ECONOMY

PRINCIPLE

1

Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows
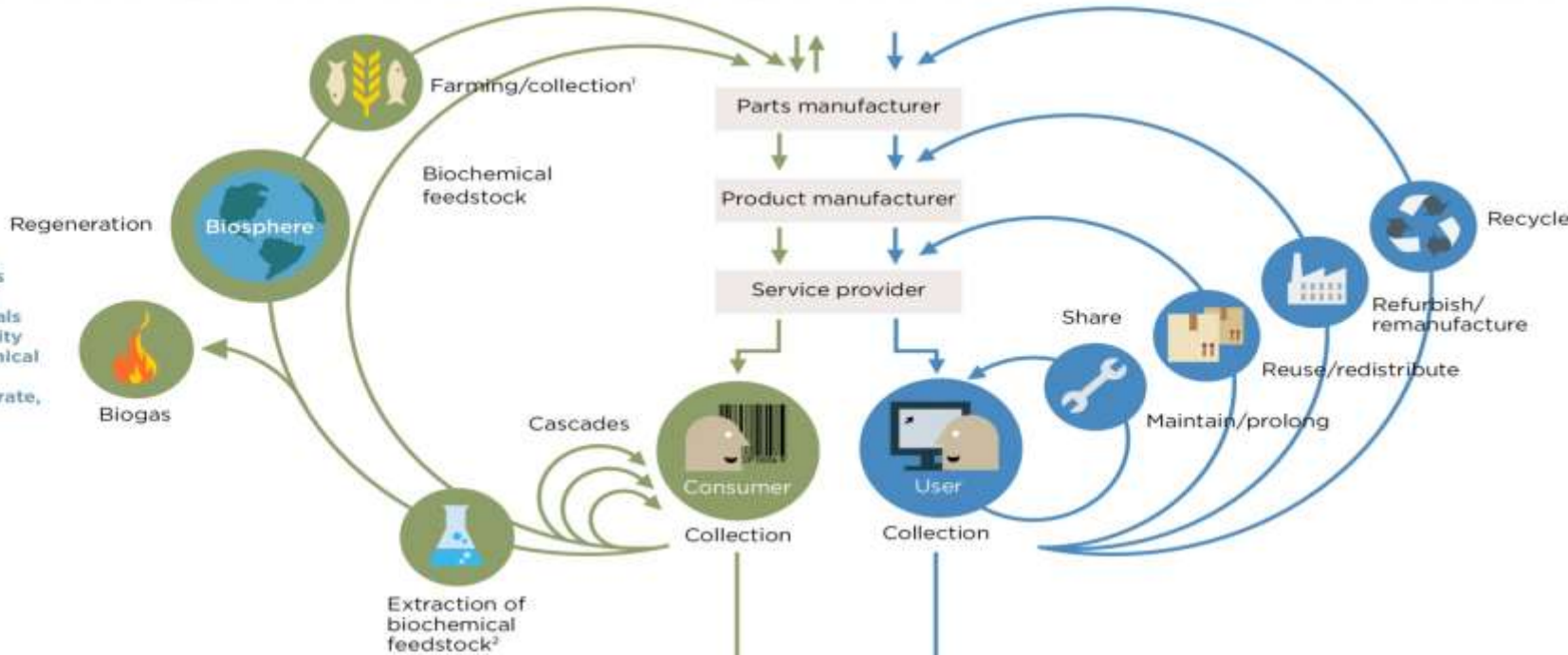ReSOLVE levers: regenerate, virtualise, exchange

PRINCIPLE

2

Optimise resource yields by circulating products, components and materials in use at the highest utility at all times in both technical and biological cycles
ReSOLVE levers: regenerate, share, optimise, loop

PRINCIPLE

3

Foster system effectiveness by revealing and designing out negative externalities
All ReSOLVE levers

Renewables · Finite materials

Regenerate · Substitute materials · Virtualise · Restore

Renewables flow management · Stock management

Farming/collection[1]

Biochemical feedstock

Regeneration · Biosphere

Parts manufacturer

Product manufacturer

Service provider

Recycle

Refurbish/remanufacture

Share · Reuse/redistribute

Biogas · Maintain/prolong

Cascades · Consumer · User

Collection · Collection

Extraction of biochemical feedstock[2]

Minimise systematic leakage and negative externalities

1. Hunting and fishing
2. Can take both post-harvest and post-consumer waste as an inp[...]

Source: Ellen MacArthur Foundation, SUN, and McKinsey Center fo[...]
Business and Environment; Drawing from Braungart & McDonough[...]
Cradle to Cradle (C2C).

Standards and indicators

- **Standards, goals, criteria**

  -**nature of the performance expected**

- **Indicators, metrics, targets**

  -**status or level of performance**

Performance standards and indicators

- Port of Cape Charles, Virginia

- Koenig's criteria for Thai EIPs (proposed)

- Devens EcoStar criteria

- Chinese EIP standard

- LEED standard for new developments

Port of Cape Charles
Sustainability guidelines and criteria, 1996

➢ **Basic requirements included noise limitations, waste management with 3Rs, energy efficiency, emergency preparedness, employee benefits.**

➢ **Additional social requirements included local residency of employees, support for vocational training, percentage of services from within region, percentage of input materials and products from within region, community service activities.**

➢ **Additional environmental requirements included inventory system for materials and wastes, percentage use of recycled materials or products, percentage use of by-products from other industries by a tenant, percentage use of a tenant's by-products by other industries.**

Koenig's proposed criteria for Thai EIPs

➢ **Minimum criteria I include an Environmental vision & policy; Compliance to standards/Regulations; Efficient resource use/Recycling cooperation with surrounding community; Preventive maintenance; Waste/Emission reduction**

➢ **Minimum criteria II include Emergency response Plan; Integrated waste water treatment central management of estate with Information center; Networking with stakeholders; Monitoring/Public Reporting**

➢ **Advanced criteria include Synergies (BPX, heat, wastewater, etc); Green Products & services; Transportation efficiencies; Educational eco-center ; Green/Sustainable infrastructure design**

Devens Regional Enterprise Zone (EIP)

The Devens Sustainability Framework addresses:

➢ **Economic and business sustainability**

➢ **Social matters**

➢ **Governance**

➢ **Public health**

➢ **Transportation**

➢ **Natural resources**

➢ **Environmental quality**

This framework is supported by a number of goals, and in turn the goals are supported by indicators.

Economic and Business Sustainability (Economic gains)

This category has a number of goals:

➢ Attraction and retention of companies within the carrying capacity

➢ Maintain unemployment rate below Mass. Average

➢ Increase in number of jobs especially high paying jobs

➢ Increase in participation in EEC events

➢ Increase in firms that purchase collaboratively, share equipment or personnel

Devens indicators

➢ **Attraction and retention: number of companies and non-profit organizations**

➢ **Unemployment: Rate compared to Mass. Average**

➢ **Jobs: number of jobs / employees; annual mean wage vs Mass. Average**

➢ **Participation: Percent of organizations involved with EEC**

➢ **Purchasing and sharing: Percent of firms that do joint purchasing or share.**

Chinese EIP standard

- The Chinese standards were developed pursuant to a national guidance document released in 2003.
- The actual standards were promulgated in 2006.

Chinese EIP standard for resource recovery parks

The criteria include:

- Contribution of recovery and recycling industries to the total; added industrial value of the park (%)
- Total amount of treated wastes (tons/year)
- Recovery rate of appliance, vehicles, tires, plastics
- Disposal rate of hazardous wastes (%)
- Wastewater effluent per added industrial value (tons/ 10000Y)
- Provision of common treatment facilities
- Area of park in green space
- Information platform
- Release of environmental report
  Note that the criteria for sector and integrated sector parks focus much more on eco-efficiency eg reductions per unit of production or GDP

LEED Standard for Neighborhood Development

Location

Ecological community conservation

Wetland and waterbody conservation

Floodplain avoidance

Brownfield remediation

Reduced parking footprint

Access to public transit

Housing proximity

Compact development

Connected community

Access to public space

Community outreach

Energy use reduction

Water use reduction

Pollution prevention

Stormwater management

District heating and cooling

Solid waste management

Assessment

1) **Practitioners and researchers have some options to work with.**

2) **Standards and indicators have been confused in some instances.**

3) **The majority of the "standards" are more or less comprehensive, involving much more than symbiosis. Several are quite specific.**

4) **Some of the sets of indicators address environmental, economic and social aspects as one might expect when discussing sustainability.**

5) **The majority of "standards" and indicators target the individual tenant rather than the park or development as a whole.**

Assessment

6) Many of the indicators are designed for quantification.

7) Other than the LEED standard, none have developed any international acceptance.

8) One set, the Cape Charles criteria has never been implemented although it has some very interesting but challenging characteristics.

9) The Chinese standard has the potential to be applied to a large number of parks, but at this time only in China. Arguably they are largely eco-efficiency oriented.

Performance standards (eco-criteria)

- Energy efficiency
- Renewable energy sources
- Waste management
- Water management
- Material / chemical flow
- Biodiversity
- Mobility, transportation
- Land use
- Air pollution prevention
- Noise prevention
- Environmental management systems
- Cultural, social, health and safety

Massard et al., 2014

Performance standards

Other "criteria" might include:

➢ **Governance**

➢ **Information sharing**

➢ **Diversity**

➢ **Connectance**

➢ **etc?**

Examples of indicators from the literature

- ➢ **Long term vision**
- ➢ **Ecological capacity and ecological footprint**

- ➢ **Water and land carrying capacity**
- ➢ **Wastewater treatment capacity**
- ➢ **Green transportation design**
- ➢ **Energy consumption per unit of production value**

- ➢ **Environmental reporting**
- ➢ **Environmental management systems**
- ➢ **Job creation**

- ➢ **Industrial value added per unit area**
- ➢ **Solid waste reuse ratio**

- ➢ **Recycling rate of industrial wastewater**
- ➢ **Waste and by-product utilization**

- ➢ **Connectance**
- ➢ **Emergy index**

Where do we go from here?

➢ **There is confusion in the research and practice communities regarding the definition of EIPs and whether a standard is needed.**

➢ **Ecological aspects should predominate but include economic and social aspects.**

➢ **Circularity of materials and energy should be an important aspect of an EIP.**

➢ **The community of industrial ecologists could be helpful in coming forward with an international standard that would assist in defining an eco-industrial park.**

➢ **A group composed of representatives from several interested countries could be brought together, perhaps under the auspices of the ISIE.**

➢ **The group should include several disciplines including planners, designers, engineers, ecologists.**

Some questions to consider

Given the diversity of reported eco-industrial parks, would a standard or set of criteria be helpful?

➢ If yes, should these be minimum or comprehensive standards?

➢ Should standards be supported by indicators?

➢ If yes, should a suite of indicators be developed allowing for national flexibility?

➢ What do you think?

Bibliography and References

➤ *Agarwal, A., Strachan, P., 2007. Literature review on eco-industrial development initiatives around the world and the methods employed to evaluate their performance and effectiveness. Robert Gordon University for Databuilding*

➤ *Chertow, M. 2003. Evaluating the success of eco-industrial development. P.258-268*

➤ *Ellen MacArthur Foundation Circularity Indicators : An Approach to Measuring Circularity Project Overview (2015)*

➤ *Cote, R.P., Hall, J., 1995. Industrial parks as ecosystems. J. Clean Prod. 3(1-2): 41-46*

➤ *Cote, R.P., Smolenaars, T., 1997. Supporting pillars for industrial ecosystems. J. Clean Prod. 5(1-2): 67-74*

➤ *Cote, R.P., Cohen-Rosenthal, E., 1998. Designing eco-industrial parks: A synthesis of some experiences. J.Clean Prod. 6(3-4): 181 -188*

➤ *Cote, R.P., 1998. Thinking like an ecosystem. J.Ind.Ecol. 2 (2): 9-11*

➤ *Cote, R.P., 1999. Exploring the analogy further. J. Ind. Ecol. 3(2-3): 11-12*

Bibliography and References

➢ *Felicio, M., Amaral, D.C., 2008. Environmental indicators applied to the reality of eco-industrial parks. 11th Global Conference on Sustainable Manufacturing, Brazil.*

➢ *Geng, Y., Cote, R.P., 2002. Scavengers and decomposers in an eco-industrial park. J. Sust .Dev. and World Ecol. 9 : 333-340*

➢ *Geng. Y., Cote, R., 2007. Diversity in industrial ecosystems. J. Sust. Dev. and World Ecol. 14(4): 329-335*

➢ *Geng, Y., Zhang, P., Cote, R.P., Qi, Y., 2008. Evaluating the applicability of the Chinese eco-industrial park standard in two industrial zones. J. Sust.Dev. and World Ecol. 15: 543-552*

➢ *Geng, Y., Zhang, P., Cote, R.P., Fujita, T., 2009. Assessment of the national eco-industrial park standard for promoting industrial symbiosis in China. J. Ind. Ecol. 13(1): 15-26*

➢ *John, M., Schianetz, K., 2014. Measuring sustainability performance in industrial parks: A case study of Kwinana Industrial Area. Int'l J. Sustainable Development. 17(3): 261- 268*

Bibliography and References

➤ *LeBlanc, R., Trachant, C., Gagnon, Y., Cote, R.P., 2016. Potential for eco-industrial development in Moncton, New Brunswick (Canada): A comparative analysis. Sustainability (accepted for publication)*

➤ *Li, WB., 2011. Comprehensive evaluation research on circular economy performance of eco-industrial parks. Energy Procedia 5:1682-1688. 2011*

➤ *Lowitt, P., Cote, R.P., Putting the Eco into Eco Parks. 2013. J.Ind.Ecol. 17(3): 343-344*

➤ *Massard, G., Jaquet, L., Jacquat, O., Zurcher, D., 2014. International survey on eco-innovation parks Learning from experiences on the spatial dimension of eco-innovation. Federal office for the Environment, ERA-NET, ECO-INNOVERA*

➤ *Sakr, D., Baas, L., El-Haggar, S., Huisingh, D., 2011. Critical success and limiting factors for eco-industrial parks: global trends and Egyptian context. J. Clean. Prod. 19, 1158-1169.*

➤ *Wright, R.A., Cote, R.P., Duffy, J., Brazner, J., 2009. Diversity and connectance in an industrial context, J. Ind. Ecol. 13(4): 551-564*

Bibliography and References

➢ *Yao, Y., Qiao, Q., Zhang, Y., Guo, J., Fang, L., 2014. The application of environmental performance evaluation in the administration of eco-industrial parks in China. App Mechanics and Materials. 522-524: 96-101*

➢ *Valenzuela-Venegas, G., Salgado, JC., Díaz-Alvarado, FA., 2016. Sustainability indicators for the assessment of eco-industrial parks: classification and criteria for selection. Journal of Cleaner Production 133, 99–116*

➢ *Veleva, V., 2012. Devens sustainability indicators report. 2000-2012 progress report. Devens Enterprise Commission*