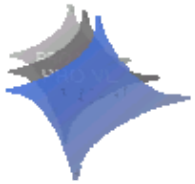

TECNOLÓGICO DE MONTERREY®

Green Virtual Enterprises and their Breeding Environments

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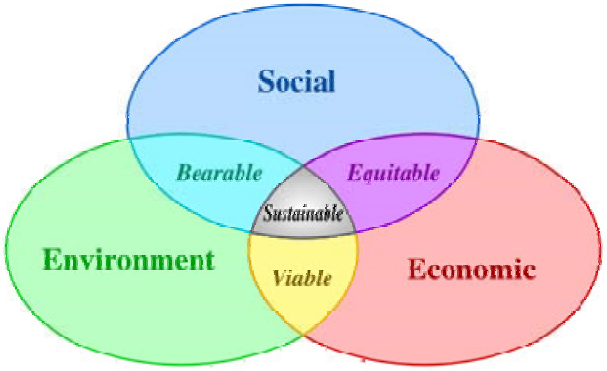
Introduction

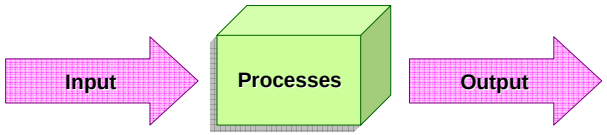
- Industrial Ecology (EI) is a new interdisciplinary field focused on sustainable development.
- IE aims to the shifting of industrial processes from open-loop systems where different resources move through a system to become wastes to a closed-loop system where wastes become inputs for new processes.

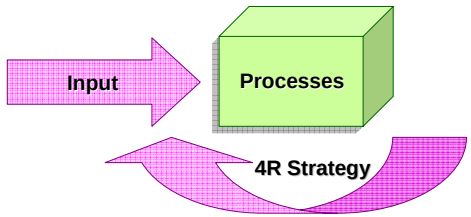


- Green Virtual Enterprise (GVE) model as an emerging sustainable manufacturing and logistics mode focused on offering, delivering and recovering green products to/from the market, under a lifecycle thinking and supported by its source network.
- GVEs creation is considered within a GVE breeding environment context, which acts as a long-term collaborative network aimed at offering the conditions to efficiently promote the sharing and recycling of resources such as: information, materials, water, energy and/or infrastructure with the intention of increasing economic gains and achieving sustainable development.

Industrial Ecology

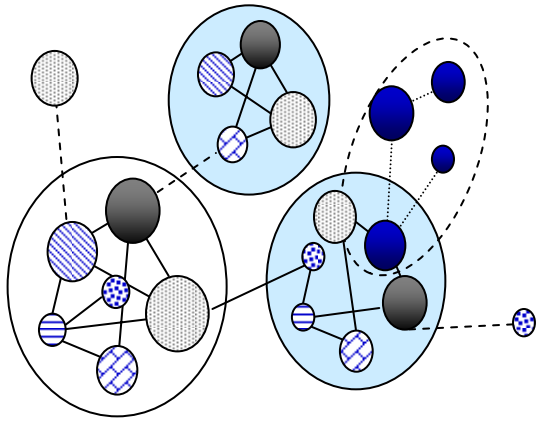
- Industrial Ecology stands for an important strategy to promote sustainable industrial development for enterprises and their related support institutions by providing a unique collaboration opportunity, with a "business sense"…
  - to integrate ecological, economic and social considerations into the creation and operation/evolution of new or existing industrial networks (e.g. industry clusters, industrial districts, eco-industrial parks).
- Industrial Ecology attempts to understand the potential improvement of industrial networks using an analogy between natural ecosystems and industrial systems.
- Industrial Ecology aims to evolve the industrial production systems from a linear to a cycle production approach, in order to reduce wastes and pollution and efficiently share and recycle resources within an industrial ecosystem.





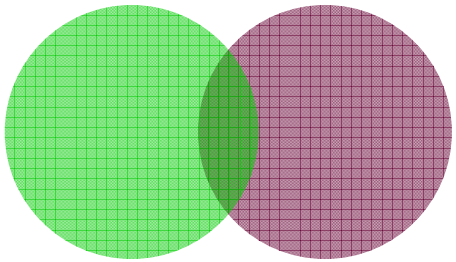
Collaborative Networked Organisations

- Collaborative Networked Organisations represent a promising paradigm in manufacturing and service industries to help organisations to cope with the challenges of turbulent market conditions in the context of ecological, economic and social pressures on the global industry.
- Collaborative Networked Organisations show a high potential as drivers of sustainable industrial development by joining of complementary capabilities and capacities for creating products that are non-polluting, conserve energy and natural resources, and that are economically viable and socially rewarding for all stakeholders involved.

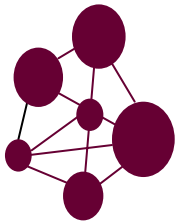


Industrial Ecology + Collaborative Networks

Industrial Ecology Scientific Discipline



Collaborative Networks Scientific Discipline



COLLAB ORATION

- As a challenge and at the same time as an opportunity…
  - for enterprises to re-engineer their production processes and/or networks in order to:
    - eliminate/recycle their wastes to maximise returns per unit of resource consumed,
    - share/reduce their costs over limited natural resources (e.g. raw materials), and
    - supporting infrastructure and increase their business opportunities and profit by establishing long- and short- term strategic coalitions to develop new competitive advantages (e.g. green products and processes) without compromising critical resources for the future.

Green Virtual Enterprise Breeding Environments

- Green Virtual Enterprise Breeding Environments (GVBEs) aims…

Traditional Bases

- Cooperation agreements,
- Common operation principles
- Common interoperable infrastructures
- Common ontologies
- Mutual trust

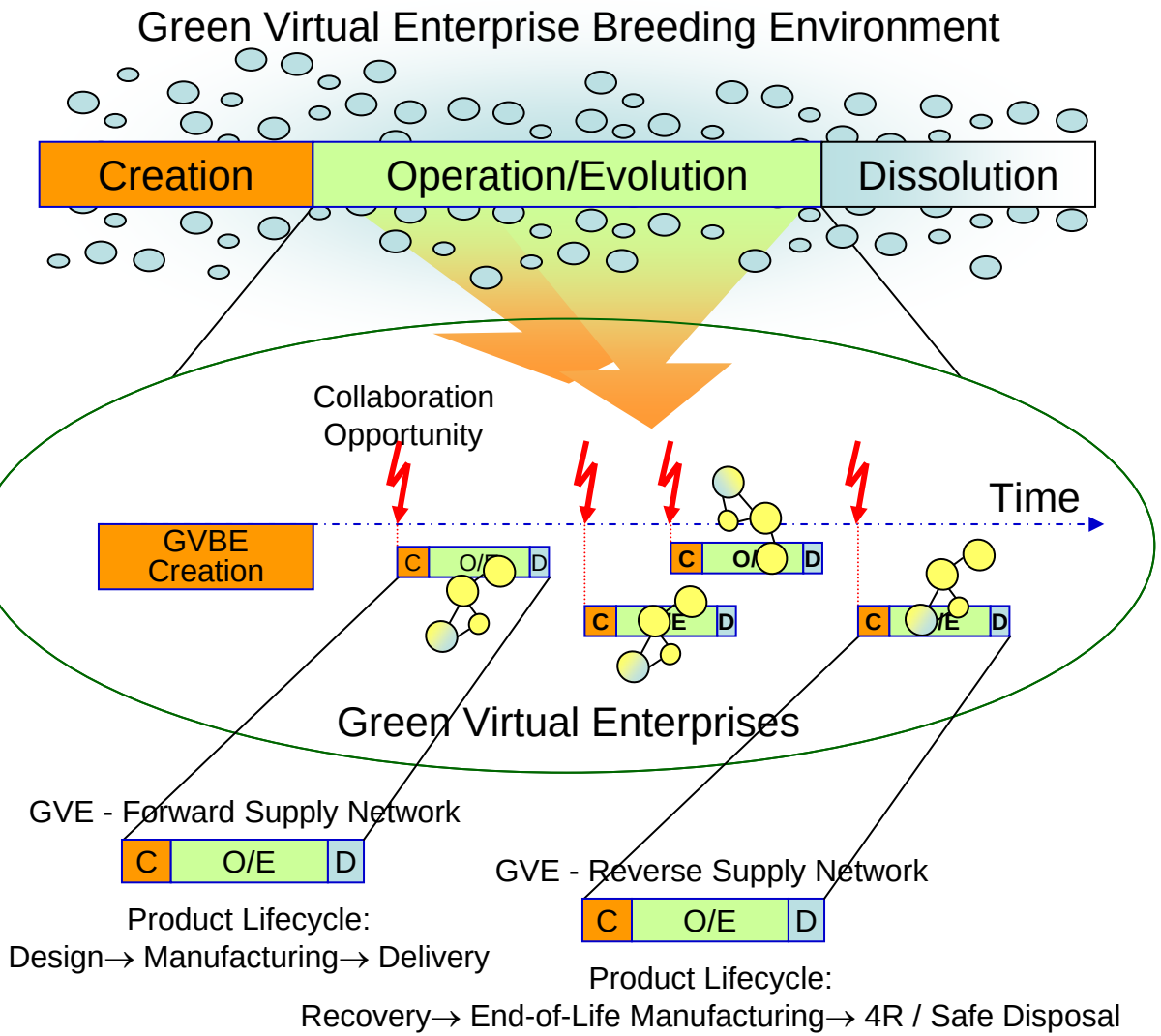
Innovative Bases

"Establish symbiotic mechanisms to create synergies towards an optimal production level and ecological balance in a virtual eco-industrial collaborative network"

- GVBEs concentrate on bringing their business ecosystems as close as possible to being a closed-loop system by keeping a close interaction of material, energy, information and technology among their members towards a near complete recycle or sharing of resources for producing and delivering green products with sustainable manufacturing and logistics practices through GVEs creation…

  … and by recruiting new GVBE members (green enterprises) that can enhance the network capabilities and capacities to grasp new green business opportunities in time and taking into account environmental impact and resources utility.

Green Virtual Enterprise Breeding Environments



Green Virtual Enterprises

- Green Virtual Enterprises (GVEs) are short-term and dynamic coalitions of green enterprises that may be tailored within a GVBE to respond to a single collaboration opportunity, through integrating the green technology (skills or core-competencies and resources) required to meet or exceed the quality, time and cost frames expected by the customer with a low ecological footprint, and that dissolve once their mission/goal has been accomplished, and whose cooperation is supported through computer networks.
- GVEs as goal-oriented collaborative networks can be designed within a GVBE with two different aims:

❶

Dynamic Forward Supply Networks for delivering New Green Products to the Market

❷

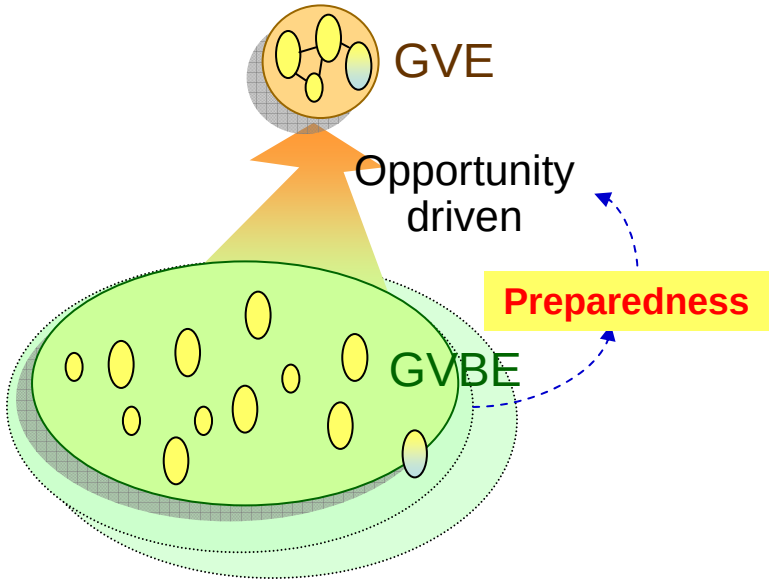
Dynamic Reverse Supply Networks for recovering the Products sold under the GVBE brand (product stewardship) for direct-use, repair, re-manufacture, recycle or safe disposal.

Green Virtual Enterprises as Dynamic Forward Supply Networks

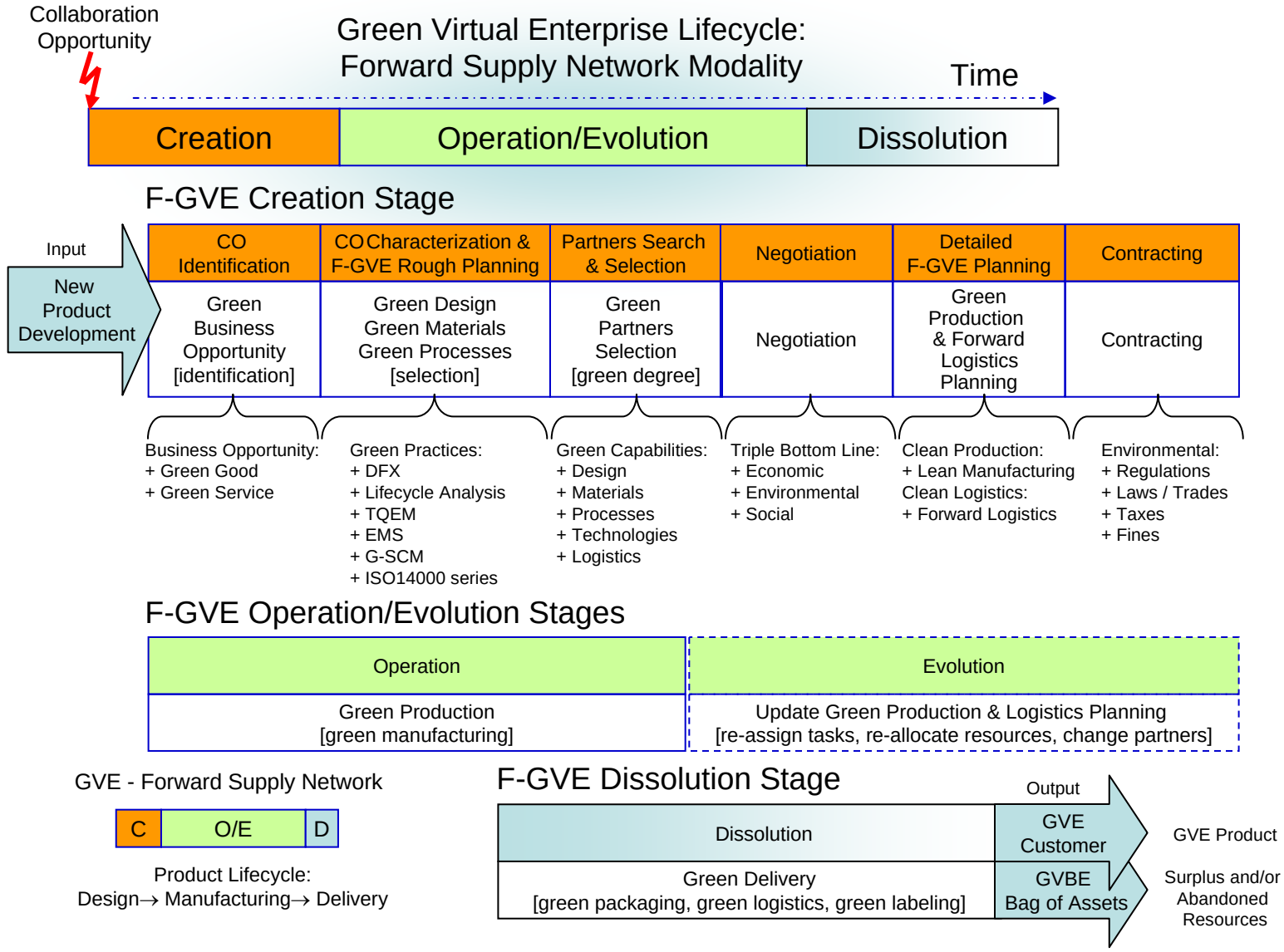
- Green Virtual Enterprises as dynamic forward supply networks…

  are temporary alliances of green enterprises that come together in order to better respond the market demands through the most efficient use of their complementary skills or core-competences and shared resources, for developing and delivering in a sustainable way new products (goods and services) to the customer with a minimal environmental impact.

"A Green Enterprise is an enterprise that strives to meet the triple bottom line by ensuring that all products, processes and manufacturing activities in its business operation address the sustainable principles"



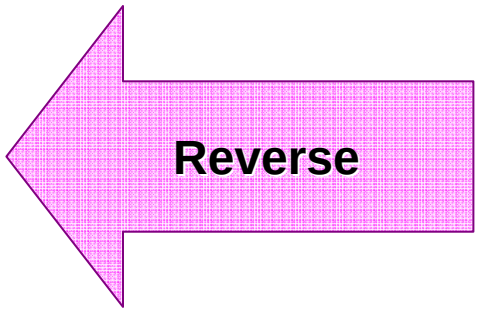
Green Virtual Enterprise - Forward Supply Network Modality: Lifecycle, Methods & Tools



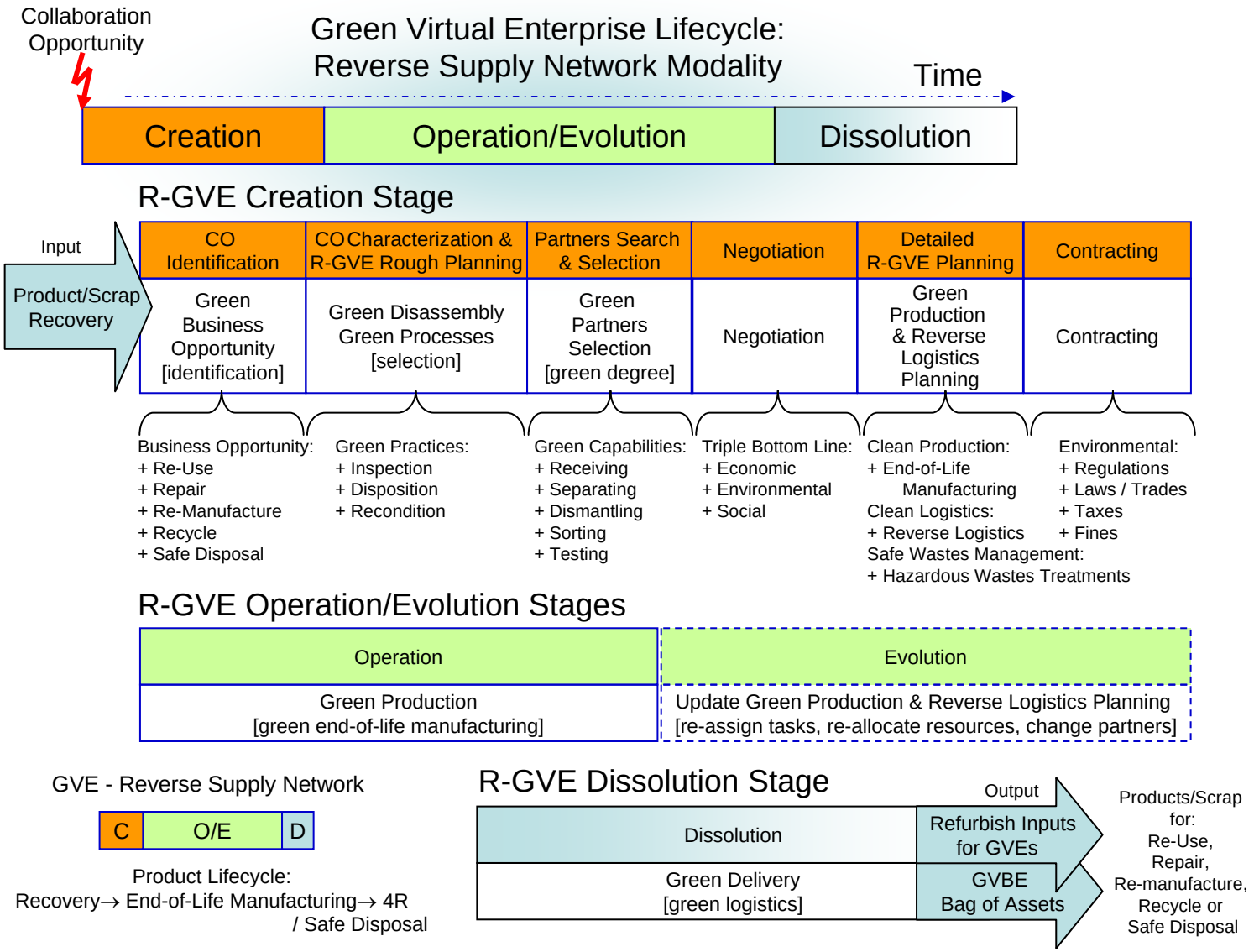
Green Virtual Enterprises as Dynamic Reverse Supply Networks

- Green Virtual Enterprises as dynamic reverse supply networks…

  are temporary alliances of green enterprises that come together in order to better respond a business opportunity based on a sustainable reverse logistics and end-of-life manufacturing approach for recovering products, parts, subassemblies and/or scrap through the most efficient use of their complementary skills or core-competences and shared resources for their direct-use (re-use), repair, re-manufacture, recycle or safe disposal - within a GVBE.



Green Virtual Enterprise - Reverse Supply Network Modality: Lifecycle, Methods & Tools



GVE Breeding Environments: Industrial Symbiosis

- Industrial Symbiosis (IS) can be defined as an industrial ecology strategy, based on collaboration and synergetic possibilities, aimed at sharing/ exchanging information, materials, water, energy and/or infrastructure (e.g. services) among industrial actors in order to increase economic gains and achieve sustainable development in a eco-industrial network.

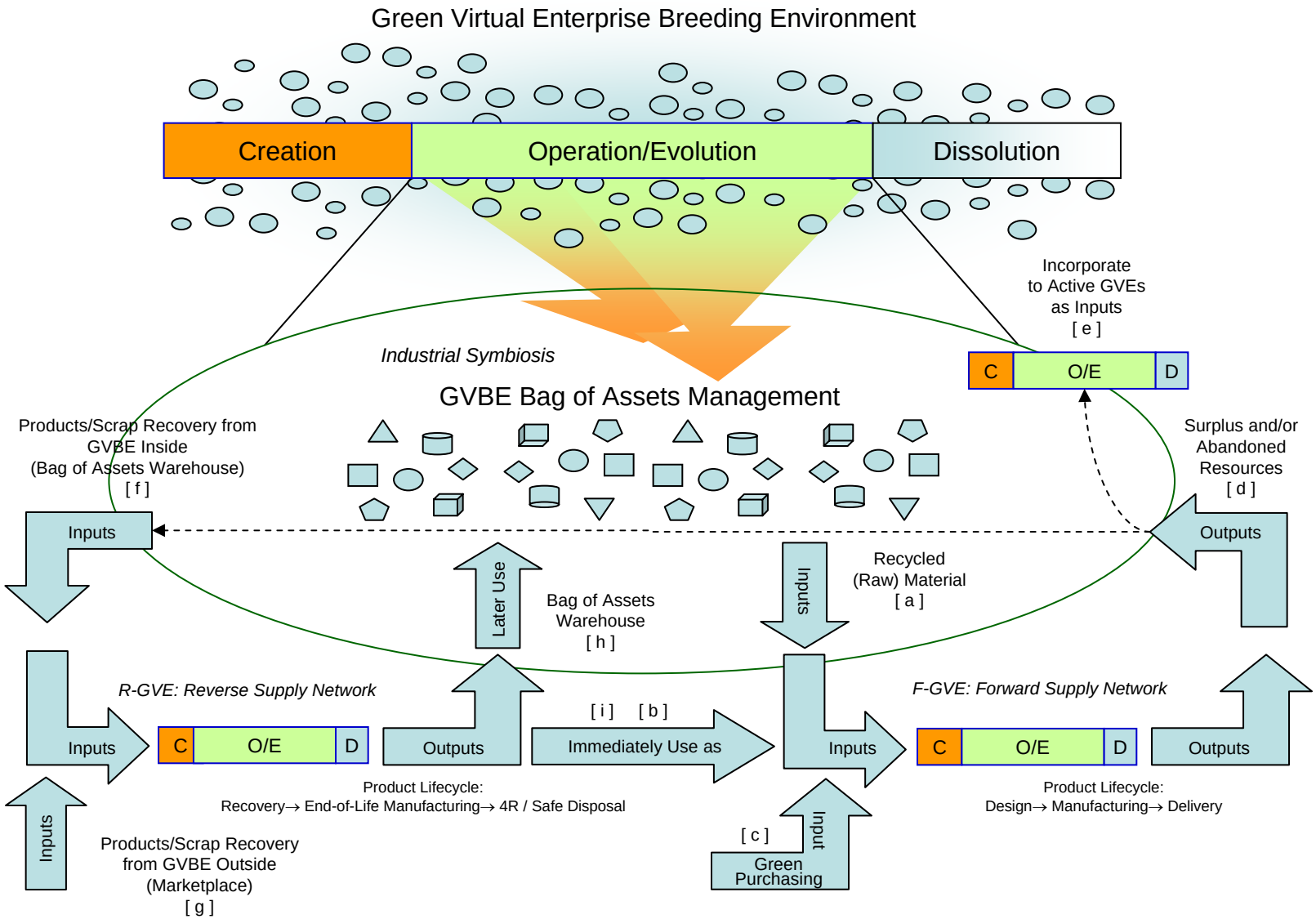
- IS systems like GVBEs, offer their members the opportunity to collaboratively optimise resources utility at efficiencies beyond those achievable by any single enterprise and at the same time open new possibilities to access/explore green business opportunities in the global marketplace that would not be possible, or would have a higher cost, if attempted individually.

GVE Breeding Environments: Industrial Symbiosis

- GVBEs are introduced as virtual eco-industrial collaborative networks with the capabilities and capacities to deploy innovative, cost-effective and green technologies and practices to promote sustainable industrial development through F-GVEs and R-GVEs creation, operation and dissolution.

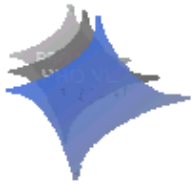
- GVBEs have as their main goal becoming intelligent networks for resources management (GVBE bag of assets) in order to match GVEs inputs and outputs (match-making) to maximise resources utility towards achieving industrial symbiosis.

Green Virtual Enterprise Breeding Environment "Industrial Symbiosis"



GVE Breeding Environments: Industrial Symbiosis

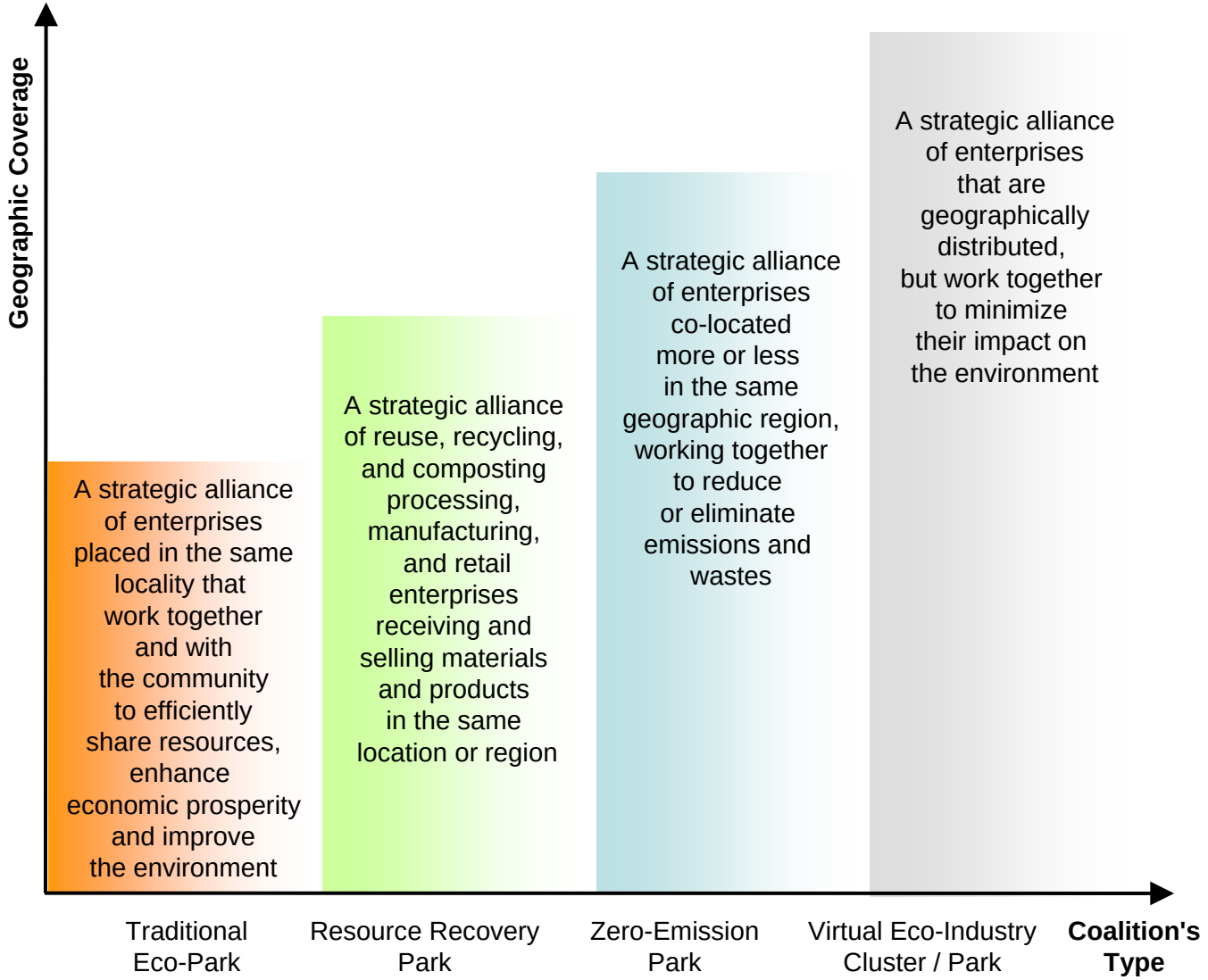
- General benefits/reasons for green enterprises to join a GVBE:
  - Reduce natural resources consumption,
  - Improve approaches for sustainable business operations,
  - Reduce (raw) materials costs,
  - Reduce treatment and disposal costs, etc.
- Collaboration benefits for green enterprises in a “business sense”:
  - Access/explore emerging green markets,
  - Increase activities/profit in a sustainable way,
  - Copying with market green trends and environmental regulations,
  - Joint purchasing (better negotiation power),
  - Joint promotion (eco-branding/ marketing),
  - Social and environmental responsibility prestige/reputation,
  - Sustainable innovation as differentiator, among others;
- Collaboration benefits for green enterprises in a “technical sense”:
  - GVBEs collaboration benefits offer possibilities for shared commuting and shipping, alternative (green) packing, integrated (green) logistics, common environmental information systems, (green) production technology sharing and integration, etc.



Traditional Eco-Industry Clusters vs. Virtual Eco-Industry Clusters

Eco-Industrial Parks (EIPs)	GVE Breeding Environments (GVBEs)
• Involve a strong investment and high environmental impact with a physical location construction and/or the re-development of an exiting one.	• Do not involve an investment in a physical location construction, but require a moderate investment in a collaborative business ICT infrastructure, which represents a lower environmental impact.
• EIPs most suitable members need to be collocated in a certain geographic location in order to participate in the industrial symbiosis and other collaboration opportunities, incurring in the costs associated and environmental impact to re-setup a green enterprise in a new location. Also potential EIP members will be limited to geography proximity.	• GVBEs most suitable members do not need to be collocated in the same place to participate in the industrial symbiosis and other collaboration opportunities, just need to create virtual linkages supported by computer networks without any geographic barriers that could limit the best green enterprises recruitment scope.
• Recruiting new EIP members in order to enhance the eco-industrial park capabilities and capacities can be extremely difficult because of the green enterprise reallocation.	• Recruiting new GVBE members in order to enhance the breeding environment capabilities and capacities can be very easy thanks to a GVBE membership management system.
• In an EIP more materials, water, energy and/or other waste exchanges seem to be possible in comparison to GVBEs, but this exchanges as well as enterprises skills and resources sharing are limited to the ones available in the geographical proximity.	• In a GVBE perhaps less materials, water, energy and/or other waste exchanges seem to be possible because of geographic distance, but more enterprises skills and resources sharing can take place by being able to have a large number of GVBE members.

Eco-Industry Clusters Typology



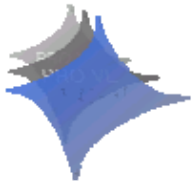
Eco-Industry Clusters Typology

- Different models for eco-industry clusters exist, from traditional eco-industrial parks with enterprises located at the same site to geographically distributed enterprises creating virtual linkages, in opposition to co-location, to form virtual eco-industry clusters.

- Each of these sustainable industrial development models or combinations of them are characterised by different activities and uses, including:
  - green manufacturing (e.g. producing green products),
  - closed-loop manufacturing (e.g. zero-emissions),
  - by-product exchange (e.g. using by-products rather than disposing them as wastes),
  - renewable energy,
  - resource recovery (e.g. 4R strategy),
  - green infrastructure (e.g. landscaping),
  - green building design,
  - cleaner production,
  - pollution prevention,
  - energy efficiency, and
  - partnerships between green enterprises.

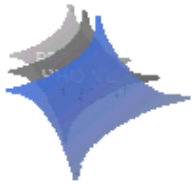
Eco-Industry Clusters Typology "Manifestation"

- First eco-industrial park, *Industrial Symbiosis* at Kalundborg, Denmark, where different industrial firms have been working together for more than 30 years exchanging waste materials and energy, and sharing resources.
- First virtual eco-industry cluster, established at *Brownsville, Texas* (1996) as a regional approach to exchange materials and by-products across the USA-Mexican boarder.
- Followed by other virtual initiatives such as:
  - *Karlsruhe* virtual eco-industrial park (1998), where different enterprises exchange organic and mineral by-products, share information and focus on dematerialisation chains, and
  - *Bioenergie und Rohstoffzentrum Dormagen* virtual eco-industrial park (1999), where companies focus on by-product exchanges and energy cascades, information sharing and extended collaboration with universities and public entities, both at Germany.
- Nowadays, different eco-industrial park projects can be found around the World, for some relevant case studies in America, Europe and Asia.



Conclusions

- The materialisation of a potential synergy between IE and CNOs scientific disciplines requires a further research on understanding these possible synergies and underlying principles for better GVEs and their GVBEs creation and management as sustainable industrial collaborative networks.
- Nevertheless, significant progress is already available in terms of conceptual frameworks and models, methods and processes, and software tools and systems in CNOs scientific discipline, and perhaps is just a matter of bringing from IE scientific discipline the sustainability element as a main driving force behind the future success of sustainable collaborative networks.
- Future looks for more “green” enterprises and sustainable industrial development models, and the proposed approach based on GVEs and their GVBEs appears to be well-suited to cope with emerging socio-economic and environmental challenges of the global industrial landscape.



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QUESTIONS?

PRO-VE'10 Conference Proceedings

Romero, D. and Molina, A. (2010). Green Virtual Enterprises and their Breeding Environments, Collaborative Networks for a Sustainable World, L.M. Camarinha-Matos, X. Boucher, and H. Afsarmanesh (Eds.), in International Federation for Information Processing, AICT 336, Springer, pp. 25-35, 2010.