

Eco-Industrial Development

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"Waste is a resource left in a wrong place"

Overview of Presentation

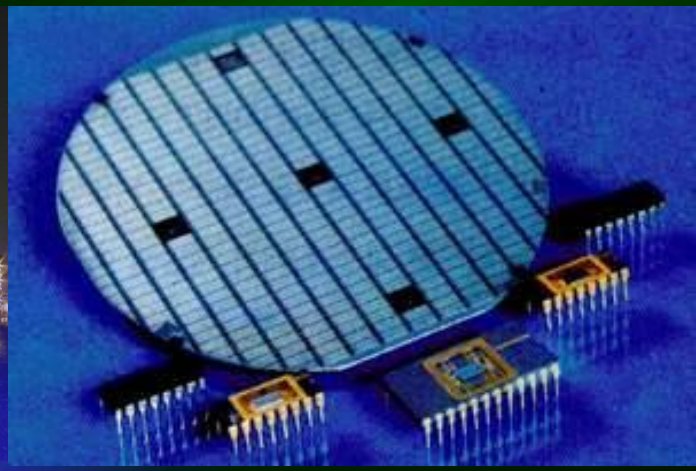


- Introduction of eco-industrial development
- EID cases in the world
- Main benefits of EID
- Implication to Chad
- Summary and discussions

Industrial Development of the World







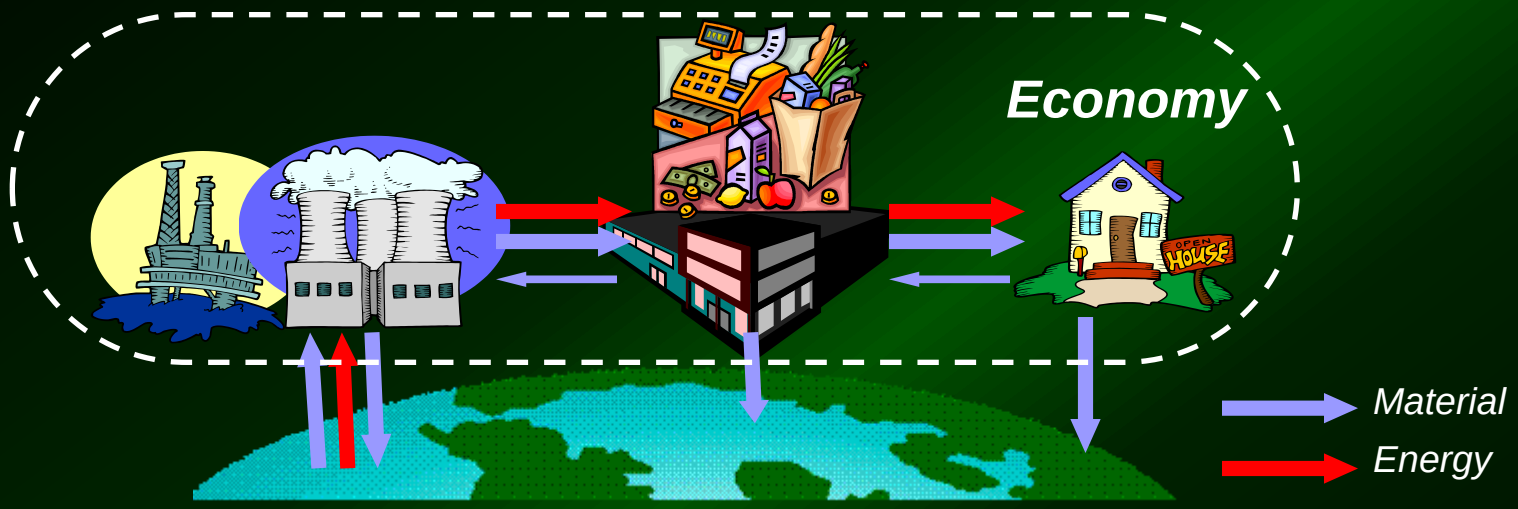
Indispensable but shady





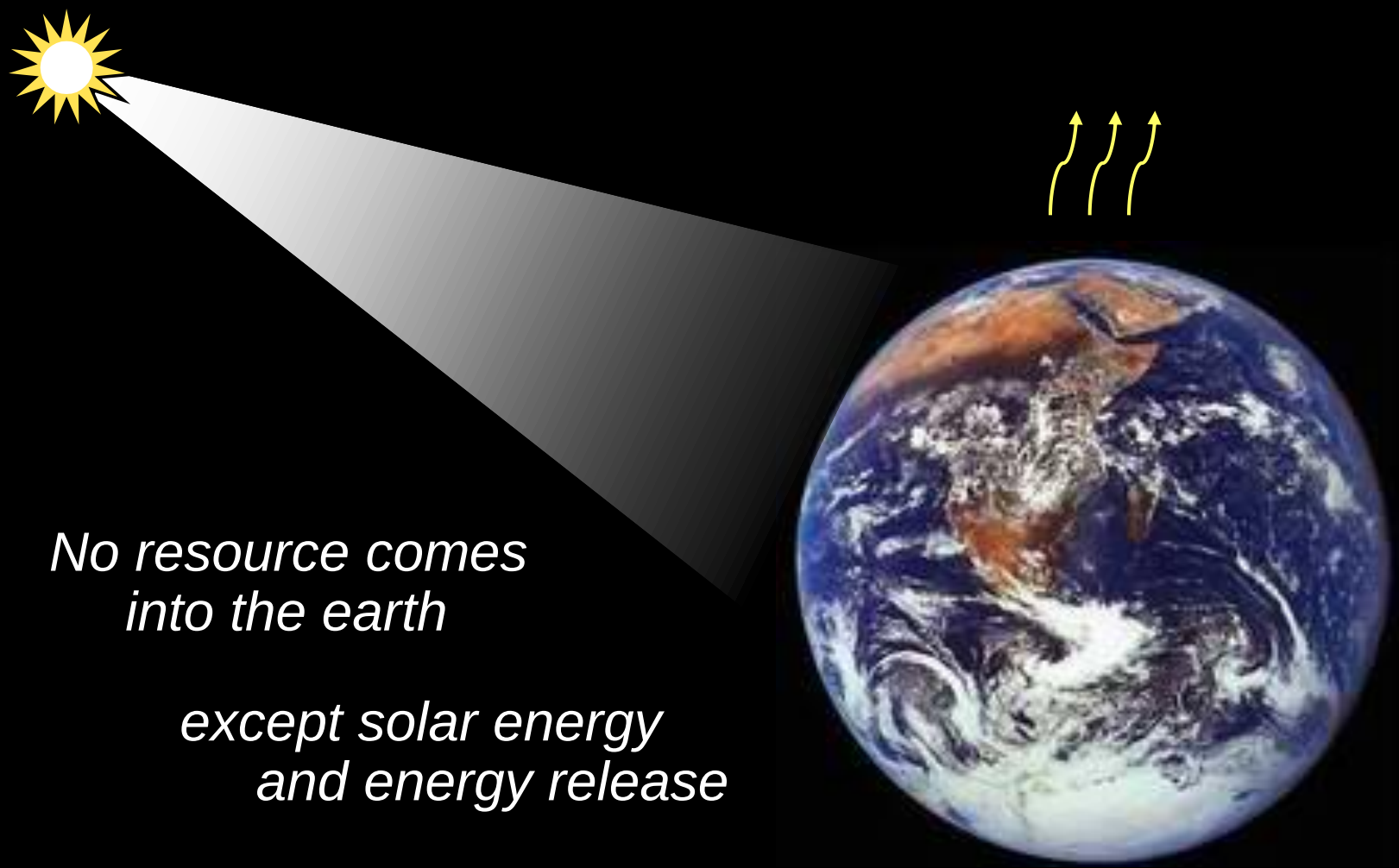


Conventional Industrial System



- Materials and energy are extracted, processed, used and dumped
- Low resource efficiency: While a wide range of resources are funnelled into the production processes, only a small proportion is effectively incorporated into the final product and the rest are wasted.
- New substances are produced during manufacturing processes
- Unbalanced production and accumulation of waste cause imbalance in a particular material cycle

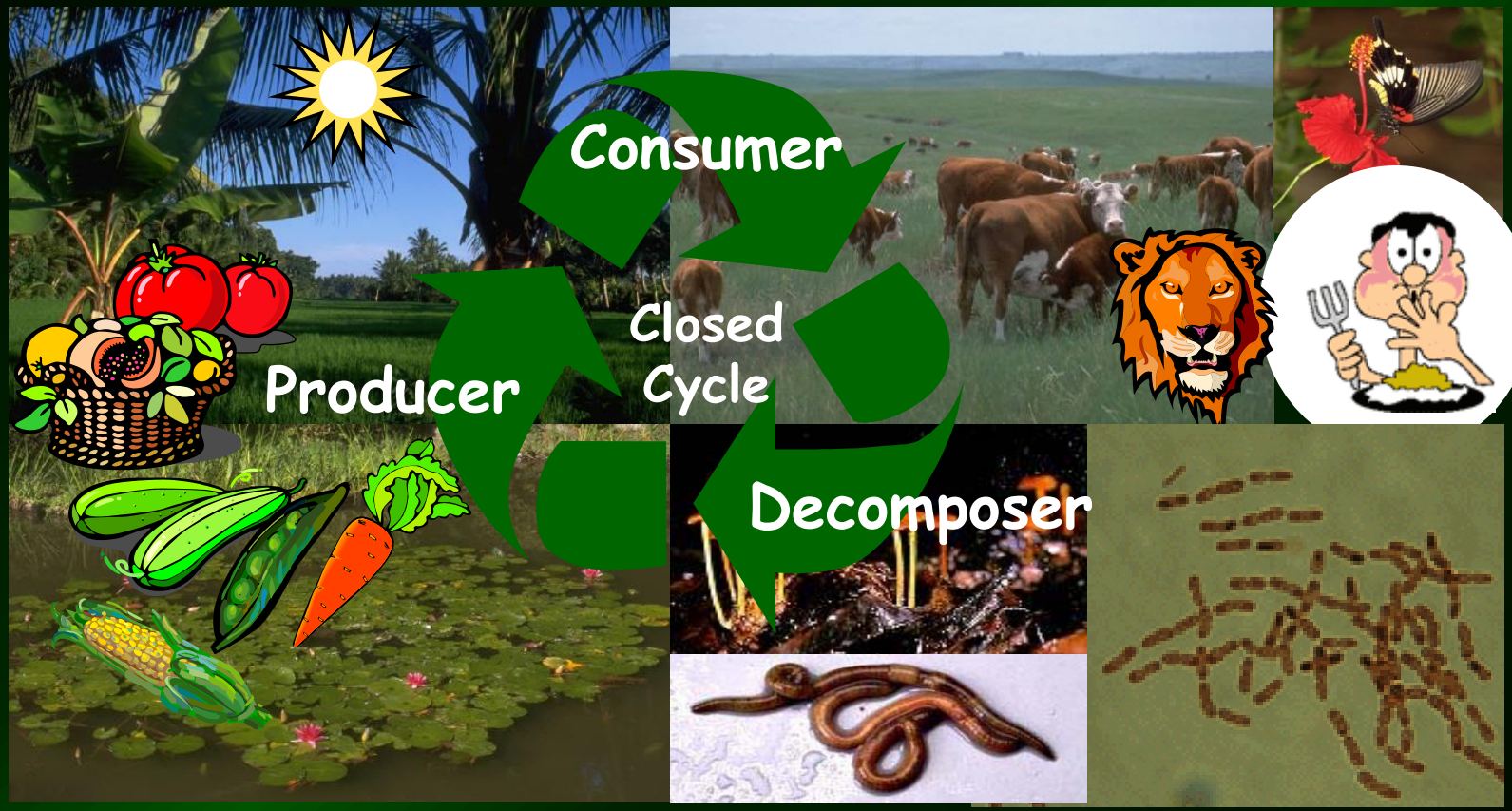
Isolated Earth



No resource comes into the earth

except solar energy and energy release

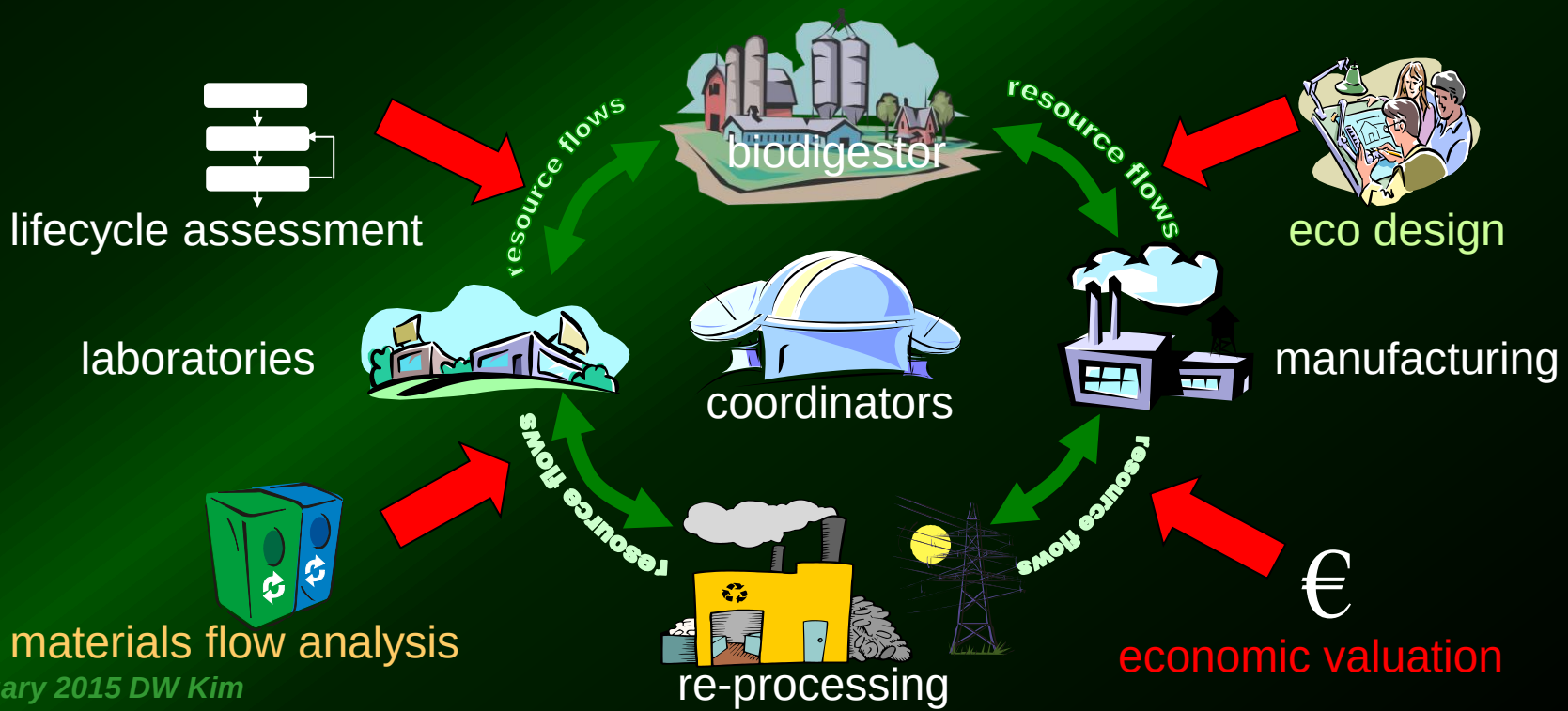
Food Web in Natural Ecological System



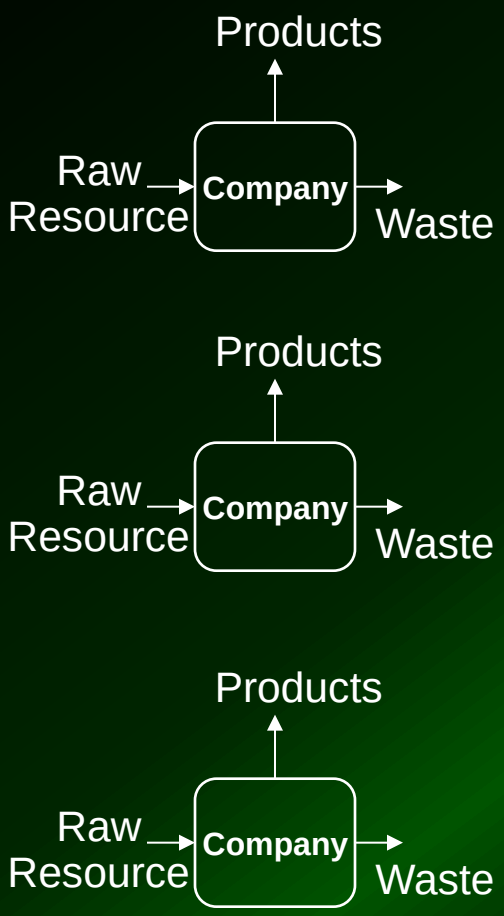
All excretions or any by-products from one creature is used as feeds of others and no waste is left in nature eventually. (Closed loop cycle)
Ex) Cholesterol

Industrial Ecology

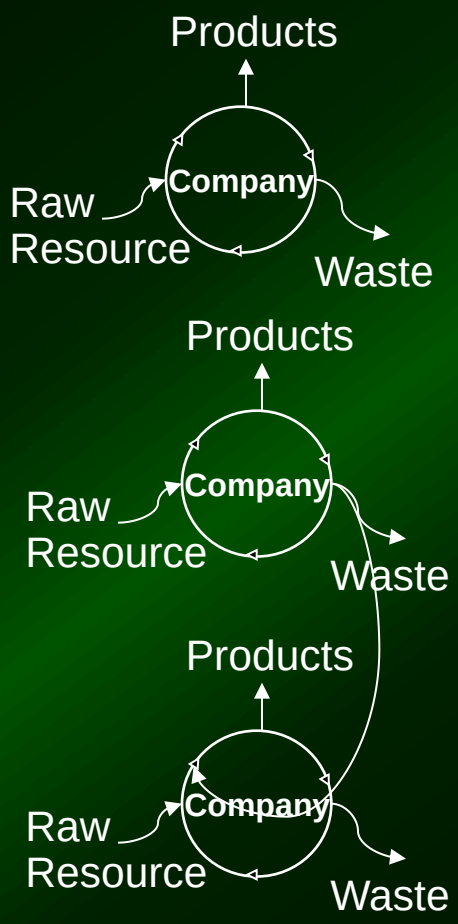
- New emerging discipline to articulate industry with ecology
  - Transforming industrial system toward the way of natural eco-system
- Optimise resource use by integrated recycling & closed loop through inter-firm collaboration in an industrial network
- Reconcile economic development with the environment
  - Economic growth with minimum environmental footprint on nature including global warming



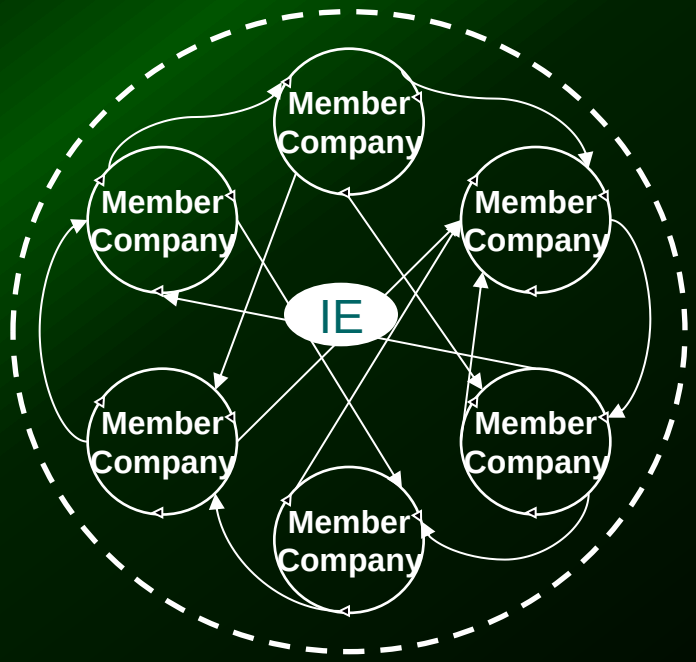
Evolution of Industry toward Circular Resource Use



Conventional

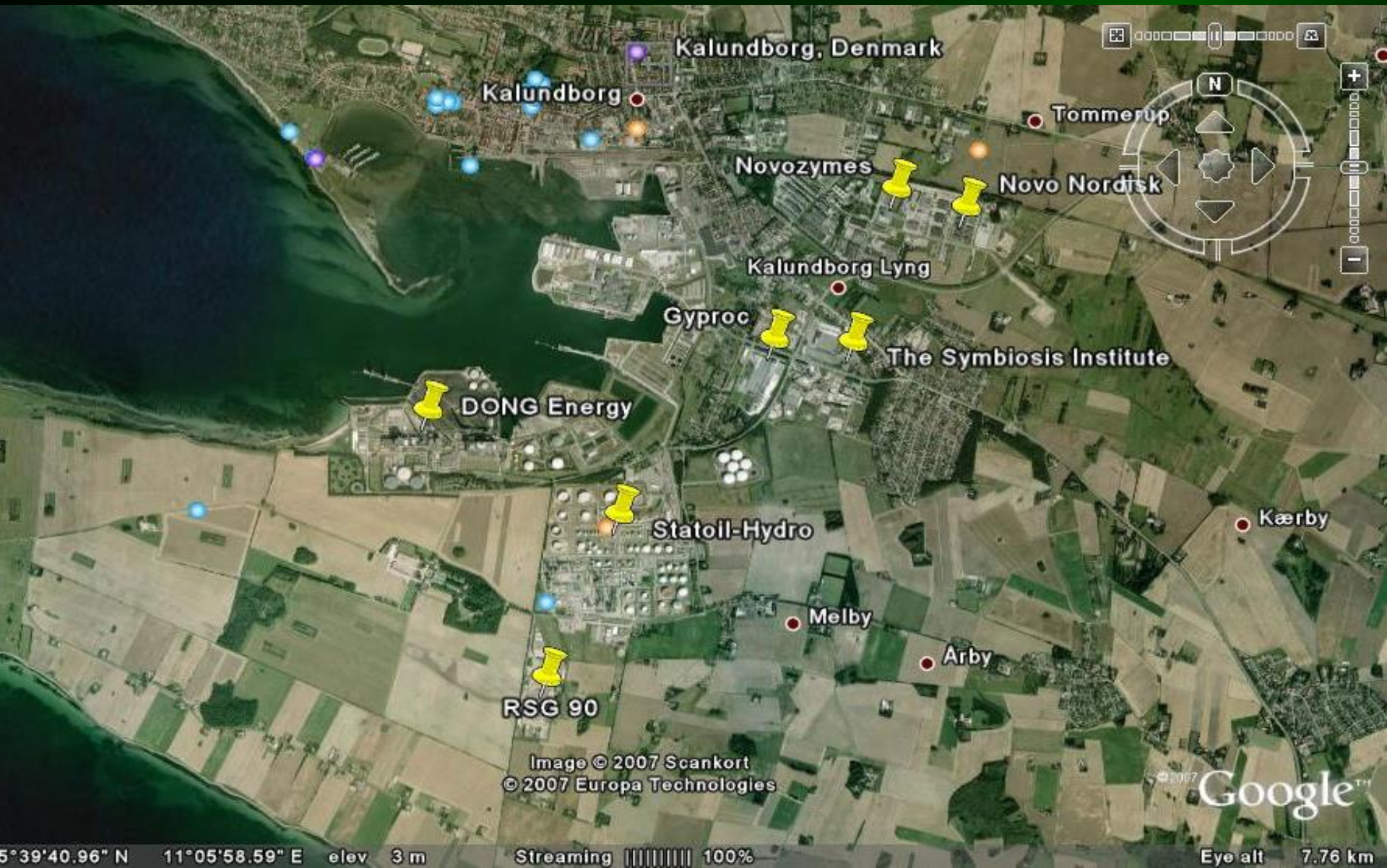


Self-Recycling (Quasicyclic)

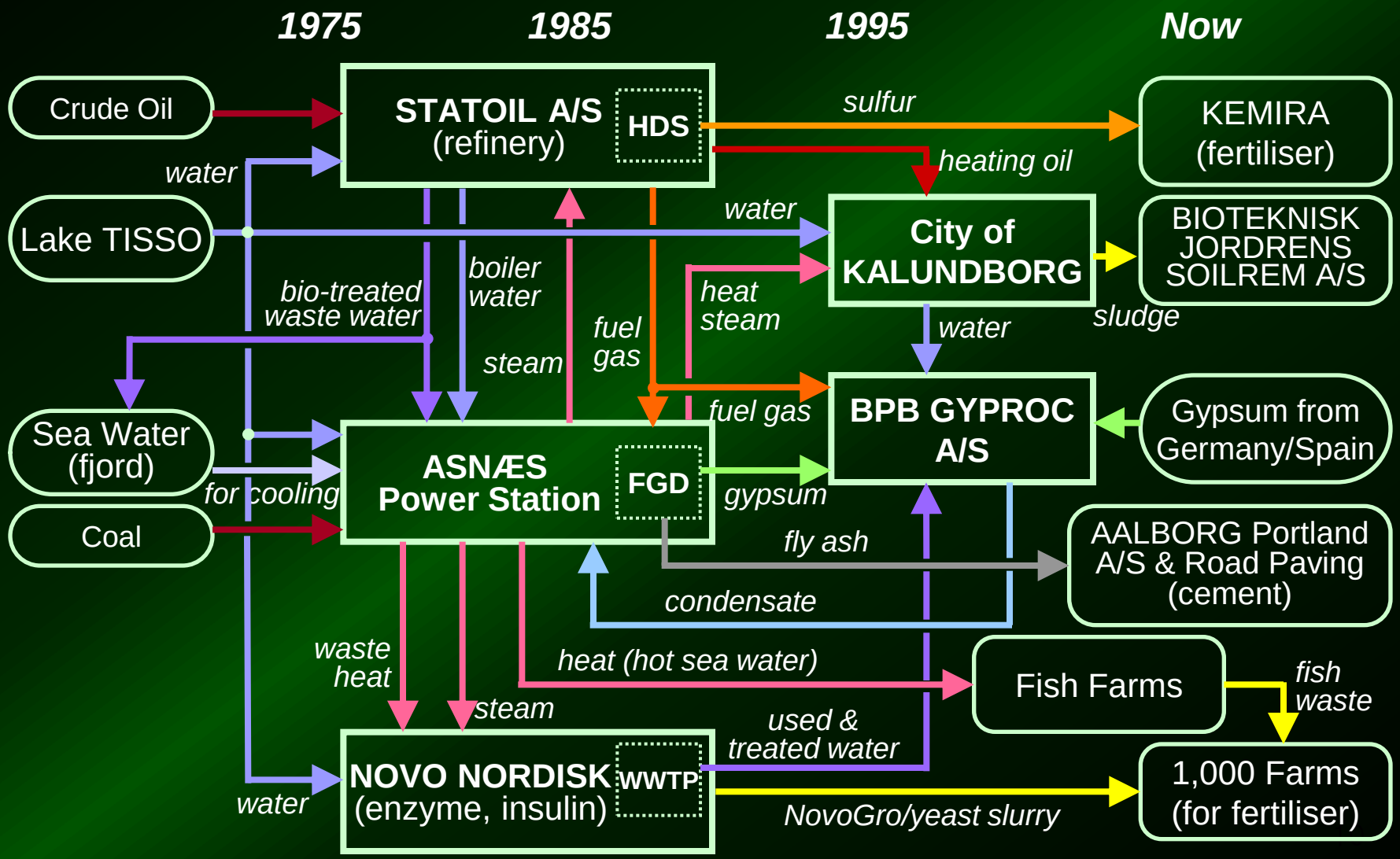


Eco-industrial Networking (Cyclic Mat'l Flow)

Kalundborg, Denmark



Industrial Symbiosis Network in Kalundborg, Denmark



February 2015 DW Kim

Kalundborg Industrial Symbiosis, Denmark

The first IS in the world

- Developed slowly but voluntarily for about 30 years without whole network plan
- Discovered in 1989 and triggered the research of industrial ecology
- Coordinated by business council

Driving forces

- Triggered by the problem of waste disposal and resource scarcity
- Negotiated on a bilateral basis based on economic attraction
- Close location and relationship between partners

Limitations

- Inflexibility in partner matching
- No action in non-core business of the companies
  no matter how environmentally attractive
- No system-wide evaluation of performance
- Spent long time
- Spatially isolated

National Industrial Symbiosis Programme (NISP)

The 1st national scale regional EID initiative in the world

- Officially launched in 2005 as a national organisation grounded on four precursor programmes and experiences since 2001
- Consists of H/Q (Birmingham) and 12 regional offices
- Led by ISL (International Synergies Limited) and jointly operated by regional organisations such as Energy Link, URS and U. of Teesside

Business centred approach and most sectors involved

- Voluntary involvement of businesses (Bottom-up) covering most industries in the UK with cross-sector (>15,000 firms)
- Support of authorities (DEFRA, EA, DTI, local authorities) & industrial associations
- RE-KTN (Resource Efficiency Knowledge Transfer Network)

Diverse public funds provided

- Mainly funded by DEFRA (£15 M over 4 yr since April 2005 from BREW; Business Resource Efficiency & Waste)
- Partially funded by Development agencies & EU
- Expanding fund of global organisations (World Bank, EU) for global projects to address the reduction of government fund



1. SISP (Scotland) 2003.03
2. Northern Ireland 2007
3. NISP North East 2005.04 (2003)
4. NISP North West 2005.04 (2001)
5. NISP Yorkshire & Humber 2003.09 (2001)
6. MAP-IS (Wales) 2006.04
7. NISP West Midlands 2003.03 (2001)
8. NISP East Midlands 2005.04
9. NISP East of England 2005.10
10. NISP South West 2005.04
11. NISP South East 2005.04
12. NISP London 2005.09

NISP®
NATIONAL INDUSTRIAL SYMBIOSIS PROGRAMME

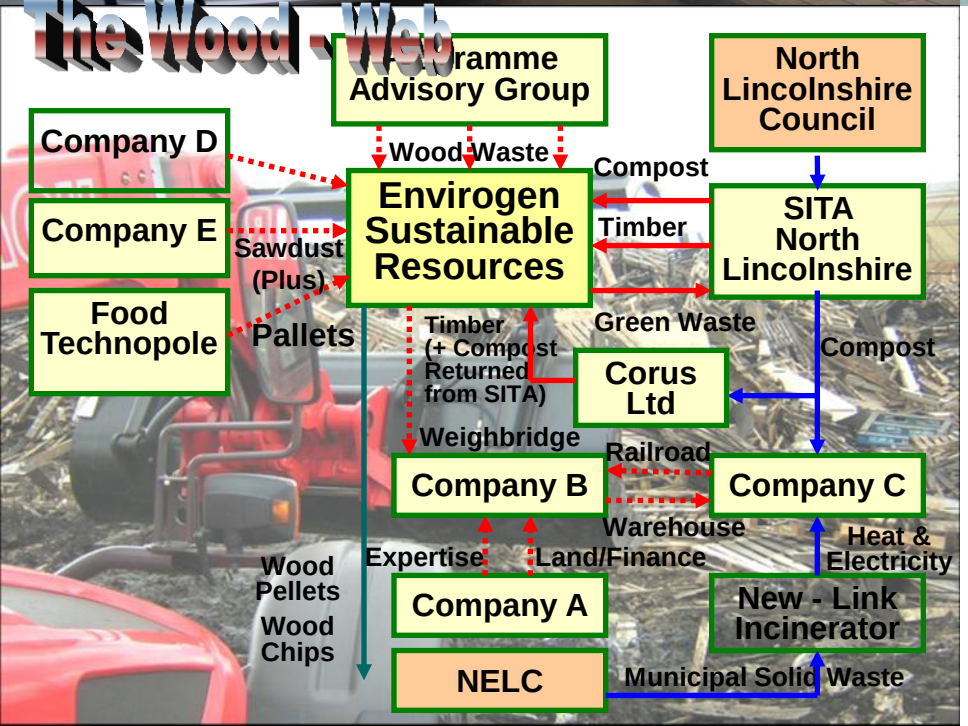
NISP Achievements

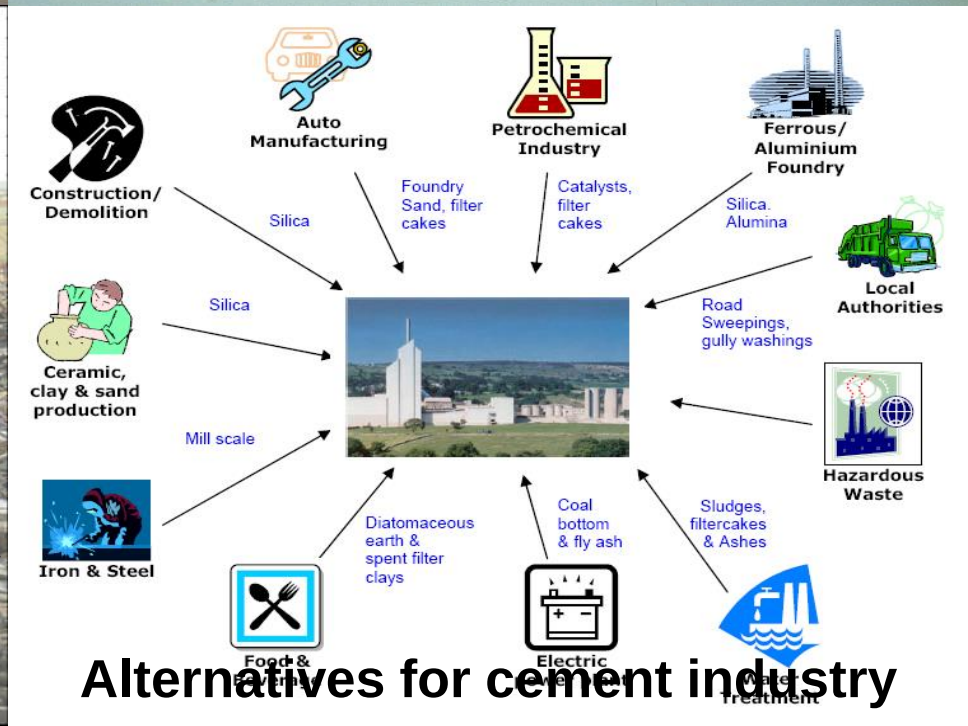


Bio-diesel from tallow



Bone to Bricks





Alternatives for cement industry

NISP Achievements (April 2005 ~ March 2010)

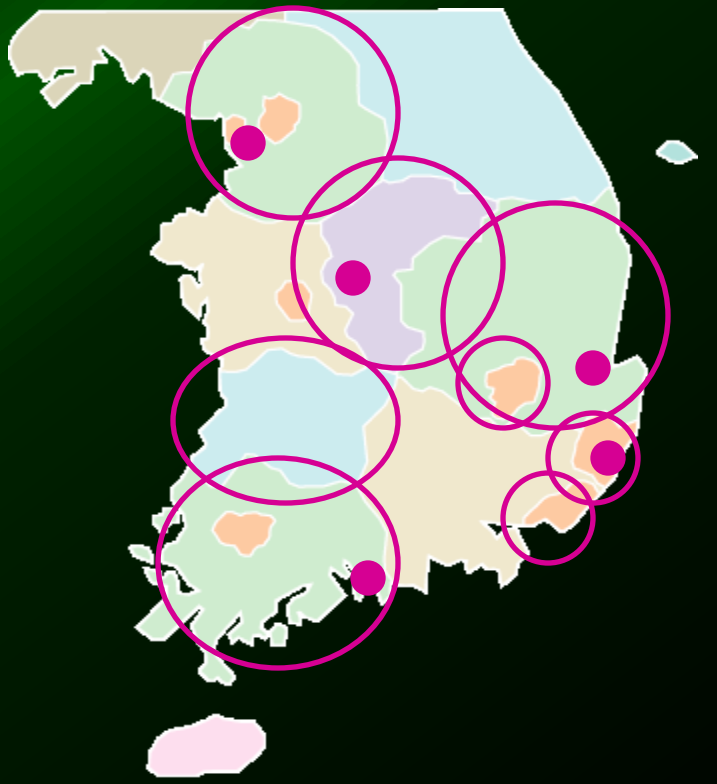
		Actual	*Accumulated*
Economic Benefits	• Additional sales	£176 Mil.	£880 Mil.
	• Cost reduction	£156 Mil.	£780 Mil.
	• Private investment in reprocessing/recycling	£131 Mil.	
Environ. Benefits	• Waste diversion	7.0 Mil. T	35.1 Mil. T
	(hazardous wastes)	0.4 Mil. T	1.8 Mil. T
	• CO_2 savings	6.0 Mil. T	30.2 Mil. T
	• Virgin material savings	9.7 Mil. T	48.5 Mil. T
	• Water savings	9.6 Mil. T	47.8 Mil. T
Social Benefits	• Job created	3,683	
	• Job saved	5,087	

- 14,000 member companies
- Benefit-cost ratio in excess of 32:1 25:1 (cf, 3:1 is good, 8:1 excellent)
- Treasury receive €9 in direct receipts for every €1 invested in NISP

Eco-industrial Parks in Korea

Environmental improvement

- About 500 conventional industrial estates exist with high industry density
- Increasing environmental/resource costs and industrial waste problems
- Address the environmental problems



Pilot EIPs in Korea

- After feasibility studies, pilot scheme EIP projects have been launched in 2005
- Five pilot EIP projects : Ulsan, Pohang, Yeosu, Banwol-Sihwa and Cheongju

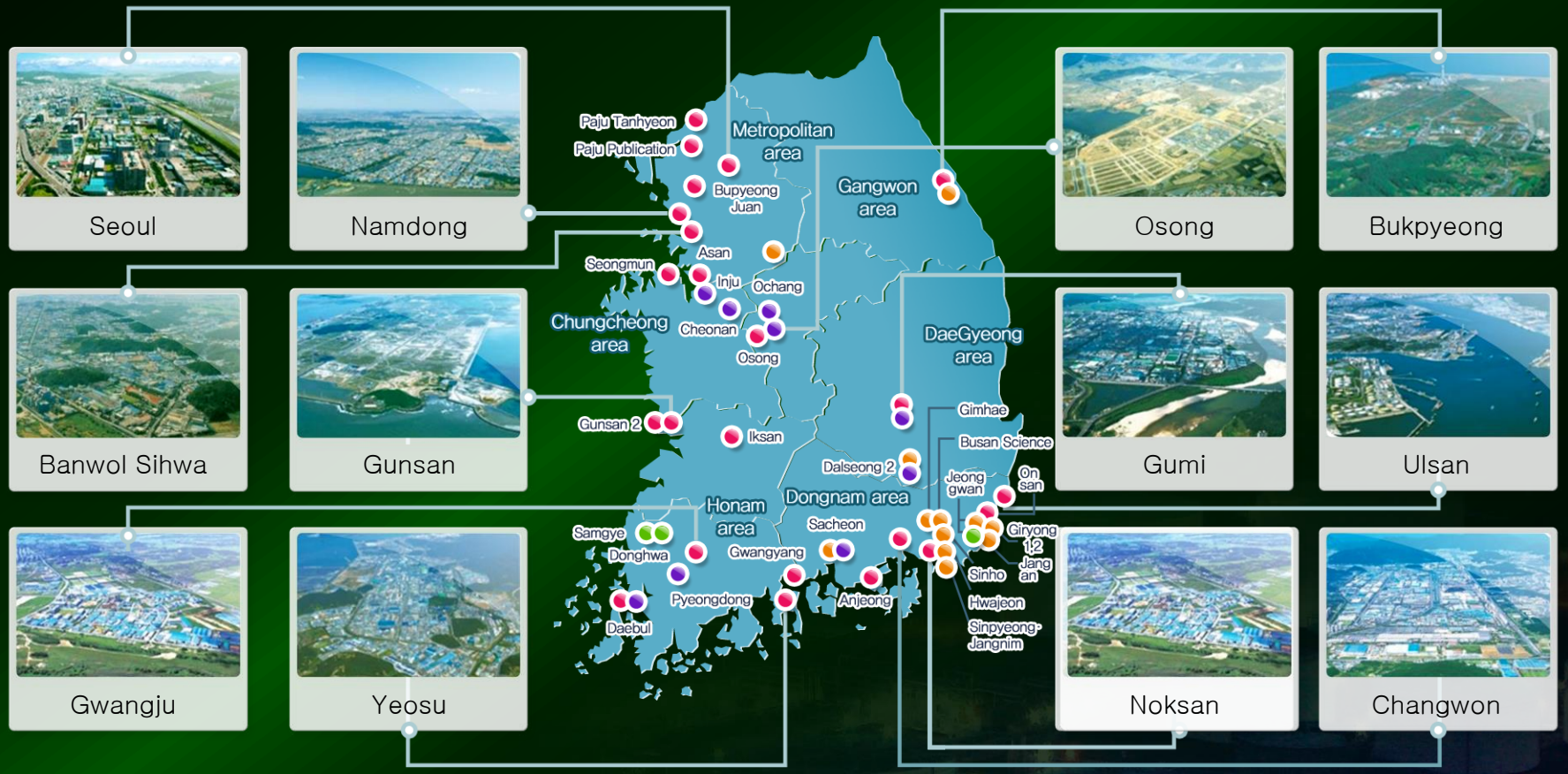
Region-based hub EIPs

- 8 Hubs: Gyeonggi, Chungbuk, Jeonbuk, Jeonnam,, Gyeongbuk, Daegu, Ulsan, Busan
- Hub & Spoke model

51 EIPs in Korea Supported by KICOX

With 47,000 Companies

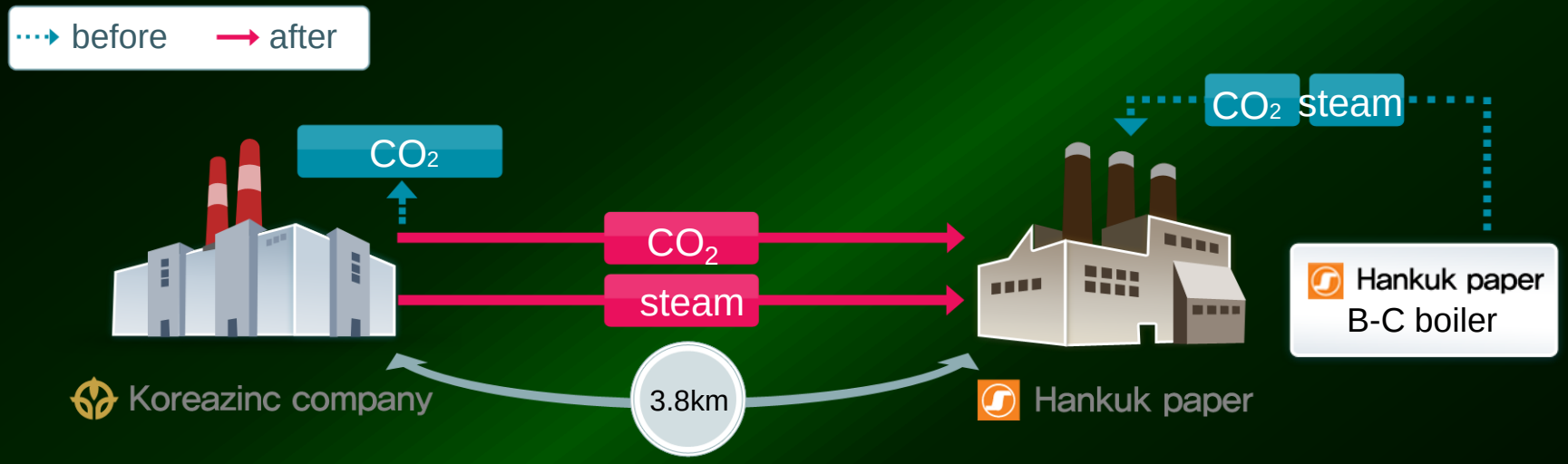
34% in Domestic Product, 39% in Export, 23% (0.8 mil.) in Labors (2010)



National Industrial Complex General Industrial Complex Foreign Investment Zone Rural Industrial Complex

Korean EIP Case 1

CO_2 and Steam Networks between Paper Mill and Zinc Smelter



Input (Initial Investment)

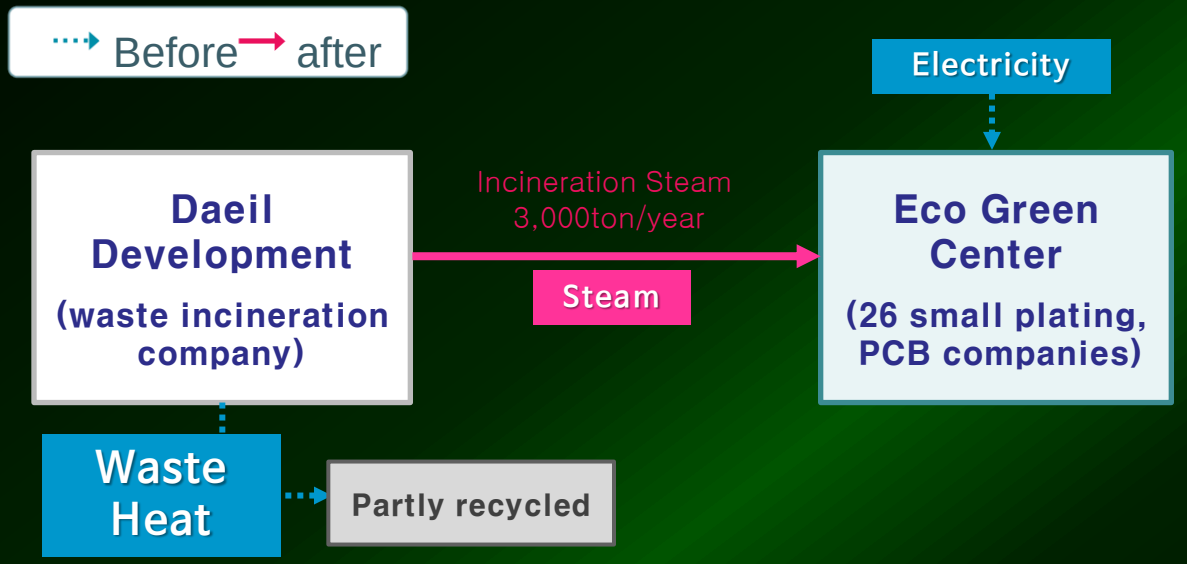
- Facility investment : steam and CO_2 pipe (3,872m): $22.0 M.

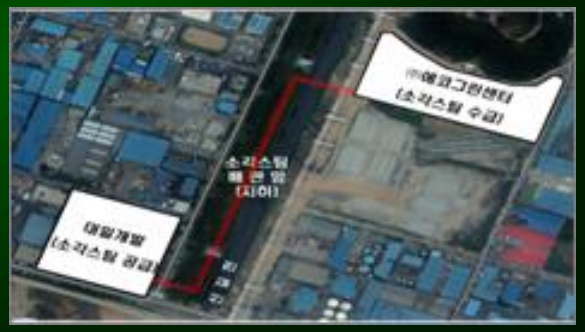
Output (Business scale : steam 50~80 ton/hr, CO_2 50 ton/hr supply)

- Reduction of greenhouse gas emission : CO_2 63,643 ton/yr (about $ 0.7 mil./yr)
- Cost Cut from raw material & waste reduction : $6.6 mil./yr

Korean EIP Case 2

Steam Network for SMEs through the Integrated Center





Integrated wastewater treatment plant newly being operated

Output

- Reduced greenhouse gas emission : CO_2 4,997 ton/yr
- Energy saving : 1,636 TOE/yr
- Cost Cut from energy saving : $840 thousand./yr
- Cost Cut from integrated wastewater treatment plant : 60% reduced compared to th

Korean EIP Case 3

Waste-to-Energy and Fertilizer Networks among Rural, Urban and Industrial Sectors



Input

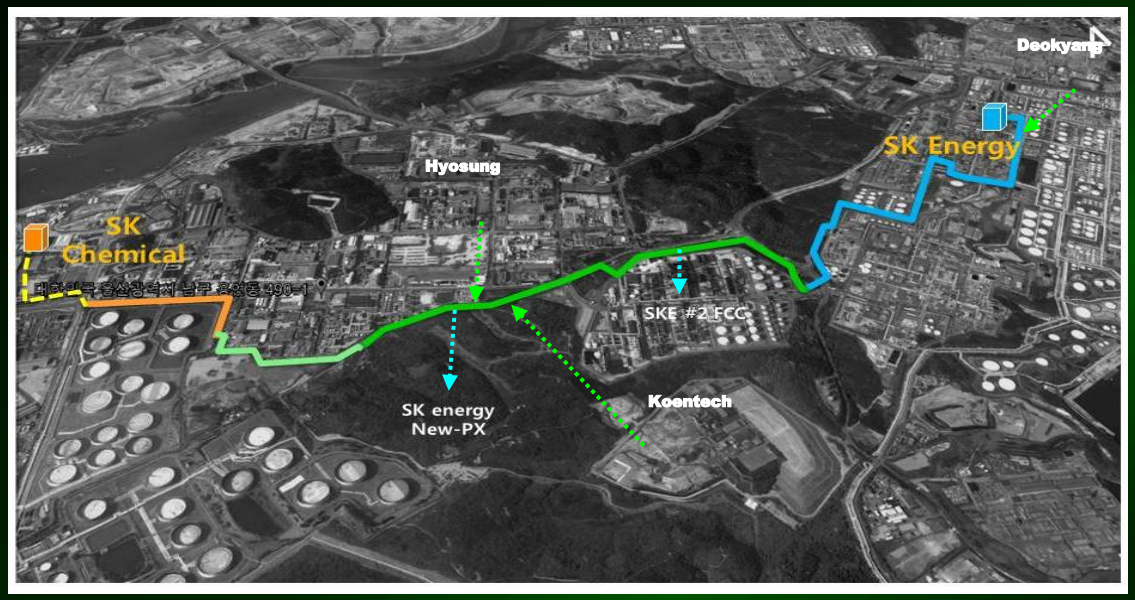
Facility investment : $1.2 million

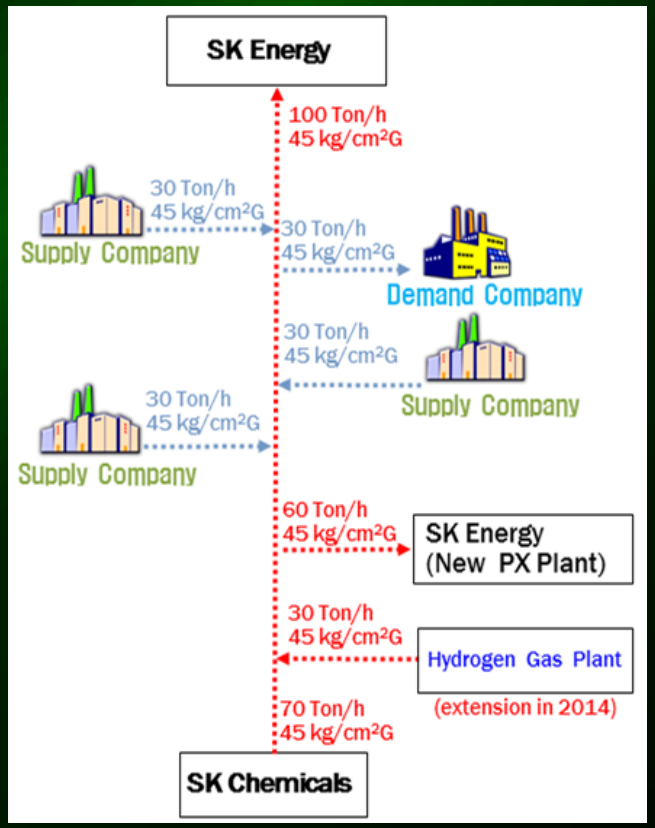
Output

Reduced greenhouse gas emission : 4,757 ton/yr
Energy saving : 2,037 TOE/yr
Steam sale and cost cut from energy saving : $1.8 million/yr

Korean EIP Case 4

Steam Networks by Public-Private Partnership





Steam Highway for industrial competitiveness and energy efficiency

Expectation:

- **(Economy)** $19.7million/year energy supply & cost cut
- **(Environment)** 48,470 ton GHG (CO_2) Reduction /year

IS PPP:

- **(Public sector)** invested a steam pipeline(highway) with several entrances and exists, to facilitate steam networking among companies in the area
- **(Private sector)** participated in the network development to reach their own facility

Korean EIP Outcomes (by 2013)

Project: 452 Identified 296 Supported 205 Completed 118 are in Business
(57.6% among completed IS R&D projects are in business)

Economic

- Cost cut from Raw Material & Waste Reduction
- Added Revenue from New product Sales

	'13 Outcomes From New Project (USD$ Million/yr)	Outcomes ('07~'13) including previous projects
Cost cut	34.0	394.1
Revenue	20.3	532.3
Total	54.3	926.4

Environment

- Reduction of energy consumption
- Reduction of greenhouse gas emission
- Reduction of solid waste emission
- Reduction of water consumption
- Reduction of SO_x, NO_x, emission

Energy	55Ttoe/yr	734TTOE
CO_2	190Tton/yr	3,298Tton
By-product	45Tton/yr	2,541Tton
Water	48Tton/yr	568Tton
Air	-	774Tton

Social

- Promotion of new investment to recycle facility
- Job creation

Investment	117.3	376.5
Job creation	108	514

* Currency Exchange Rate: $1=₩1,000

Eco-industrial Development in the World

Industrial symbiosis (IS)
- Kalundborg IS, Denmark
- NISP, UK
- Mexico, Brazil, Hungary, Slovenia, Turkey

Eco-industrial Park (EIP)
- USA, Canada
- Korea, China

Eco Town
- Japan

Recycling network
- Styrian RN, Austria
- Germany (Oldenburger Münsterland RN, Ruhr region)

Eco-industrial Network
- *AGUM Env. Mgt. Network, Rhine-Neckar Region, Germany*
- *Ora Ecopark, Fredrikstad, Norway*
- *Regional Energy Supply System of Jyväskylä, Finland*

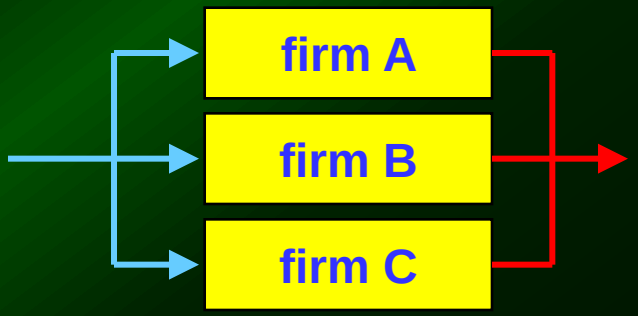


※ Diverse meanings of "**Eco**"
- Environmentally friendly (Eco-centre, Eco-park, Eco-town, Eco-village…)
- Resource circulation (EID, EIP, EIN…)

Types of inter-firm collaboration

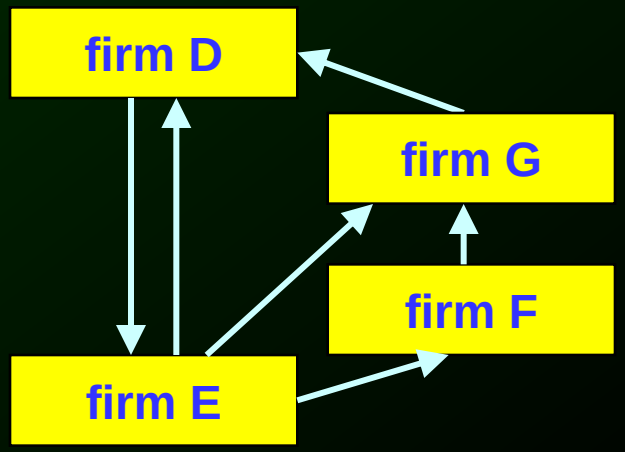
Sharing

- Information share (matching demander and supplier, regulations)
- Utility share such as water, heat and gas (N2, Comp air, H2..)
- Facility share (purified/waste water, specific material..)



Exchange

- Direct exchange between firms
- Collecting small amount to meet critical economic volume
- Intermediation of recycling firms for pretreatment to link by-products



Main Benefits of EID

Economic benefits & competitiveness of business

- Reducing production cost (raw material & waste)
- Increasing resource efficiency & business competitiveness
- Creating additional business opportunities

Environmental benefits

- Reducing the use of natural resources
- Reducing contamination in industrial region
- Mitigating global warming
- Extending the lifetime of landfills
- Upgrading environmental technologies & the level of sustainability

Social benefits

- Developing regional economy through creating new jobs
- Better circumstances for industry with less environmental conflicts
- Upgrading the overall standard of industry
- Developing “win-win-win” culture in the society

Main Risks of EID

Instability in business

- Leak of Biz information
- Instability of process/quality
- Reshuffle of waste market
- Uncertainty of practically flexible inter-firm networking against disconnection

Conflict in interests between

- Individuals on economic benefit
- Economic and environmental benefits
- Individual private benefits and net societal gain

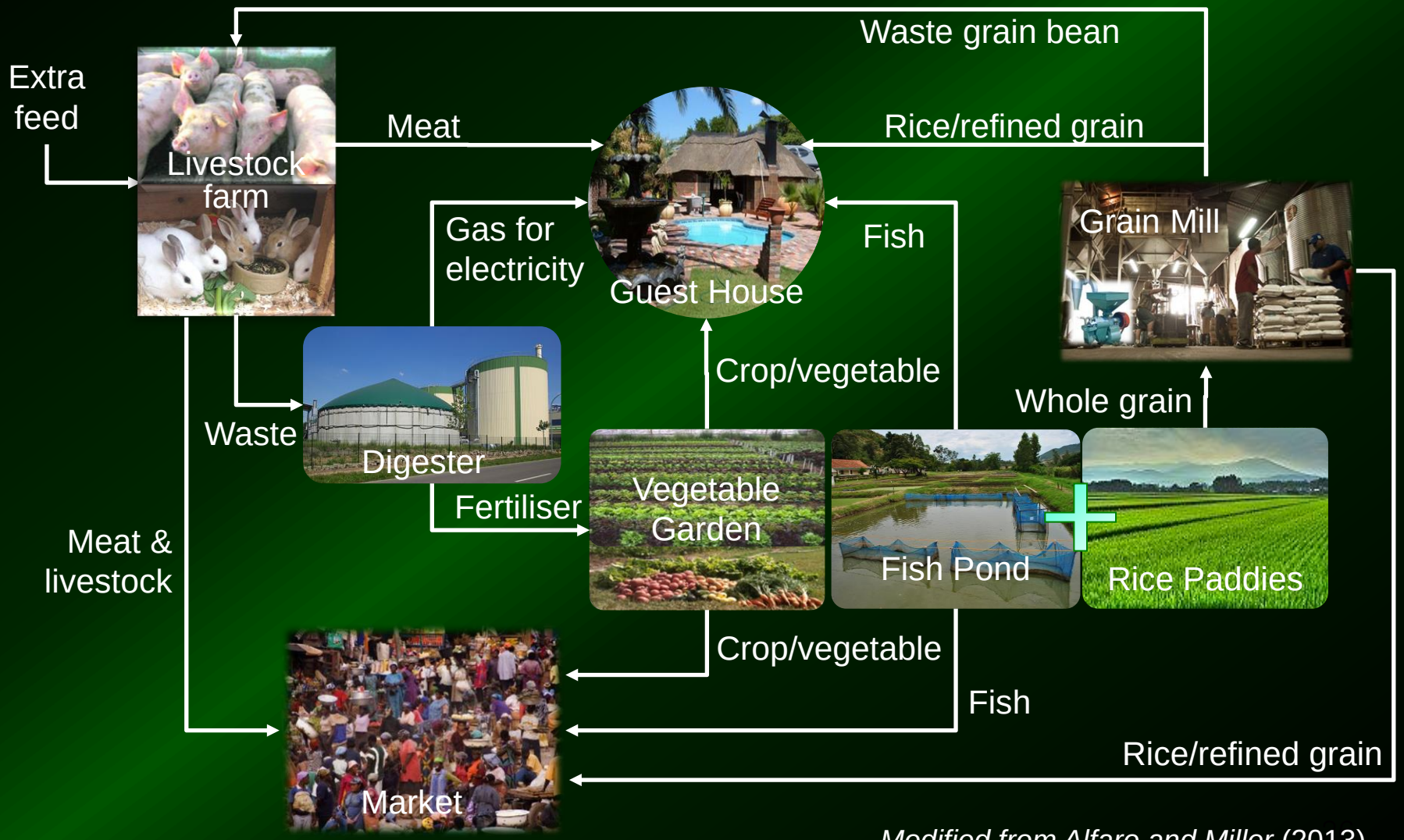
Incorrect EID management

- Green wash
- Marketing tool

** Strongly manufacture based

* BPX: By-product Exchange

Agriculture based EID (Design of Liberia Model)



Modified from Alfaro and Miller (2013)

Design Process of EID in Chad

Identify main industries, resources and by-products in a region:

- agricultural industry
- energy industry (refinery, bio-fuels)
- chemical industry
- food industry
- water recycling
- wood industry

Quantify main resources available based on natural capability

Identify links and synergies between

- Industries
- by-products
- resources

Identify missing industries (decomposers)

Agricultural Industrial Symbiosis (further design)















Extra feed

Waste grain bean

Meat

Rice/refined grain

Gas for electricity

Fish

Crop/vegetable

Waste

Fertiliser

Meat & livestock

Livestock Waste

Whole grain

Crop/vegetable

Mango

Fish

Rice/refined grain

Power plant
Refinery

Sugar Cane

Water plant

Bio-company

Others
Waste Plastics (PET, PE, PP…)

Summary & Discussions

Sustainability of Eco-industrial development (EID)

- Improve not only the environmental benefits but also economic and social benefits at the same time
- Improve resource efficiency through integrated optimisation
- Requires strategic framework for effective implementation of EID

Dissemination of diverse EID programmes to the world

- EID has developed in industrialised countries such as West Europe, North America and Eastern Asia
- EID has been expanded to industrialising countries such as Eastern Europe, South America, South Eastern / Middle Asia and Africa
- Current EID models are strongly based on manufacturing industries

EID is required of newly developing countries such as Chad

- Sustainable development of a region avoiding errors of conventional development in industry
- Requires creative model based on its own industries including agriculture