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Centre de Recherches et
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université de technologie
Troyes



*The COMETHE programme.
Industrial Ecology applied to industrial parks
in French context*

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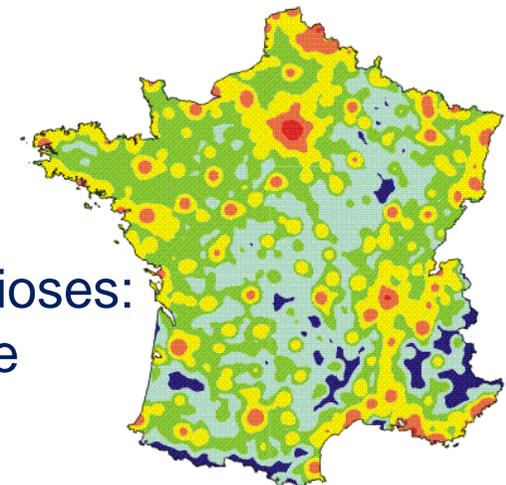




- Context of research
- Issues, definition, Kalundborg case
- COMETHE : a better understanding of IE



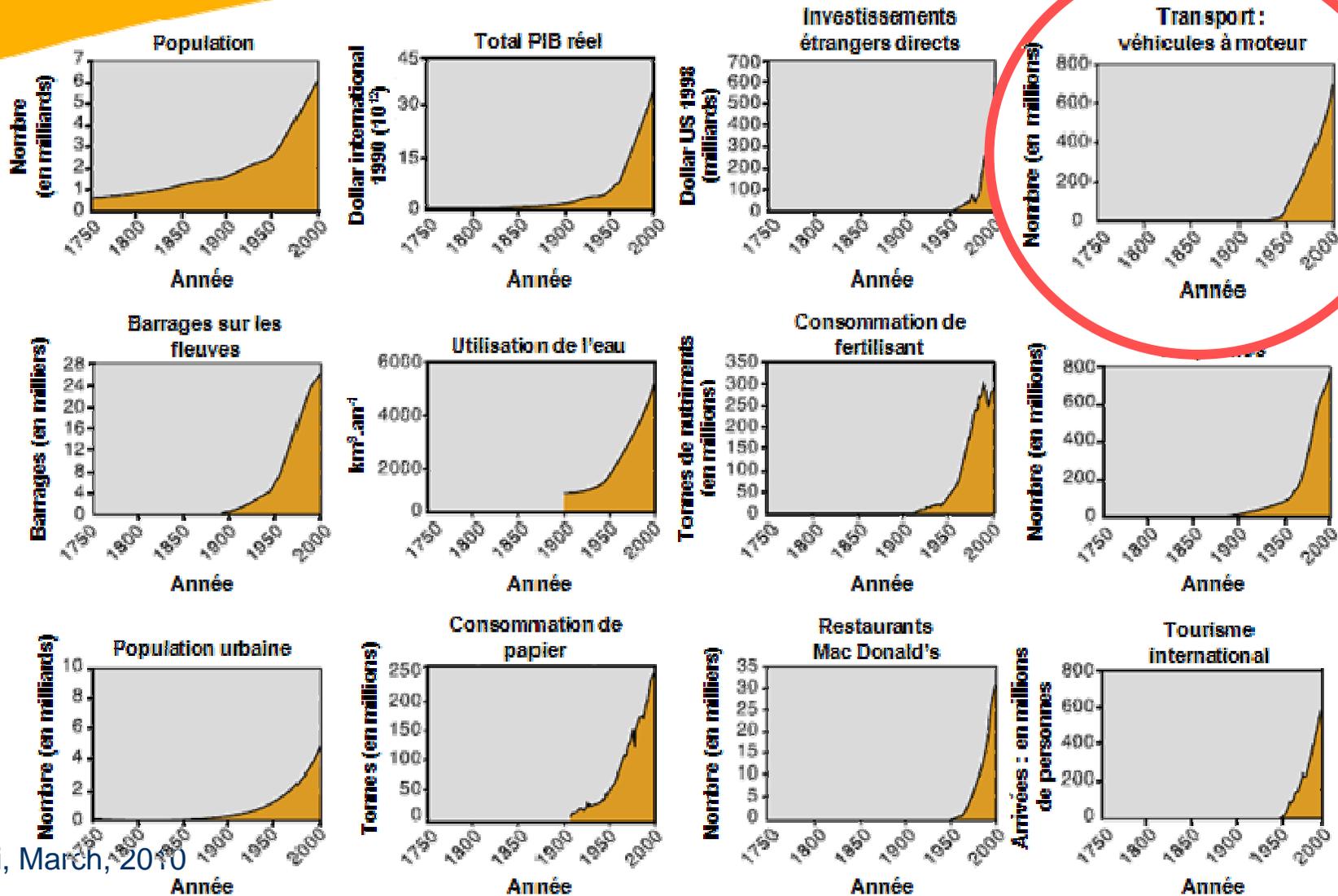
- Few industrial symbioses effectively implemented all over the world [Gibbs, 2007; Eilering, 2004]
- Emerging concept in France (5 years).
- Tools and methods available are insufficient and unsuitable for French context
- A successful kind of areas to achieve industrial symbioses: between **25 000** and **30 000** industrial parks in France



density  < 80 p/km²

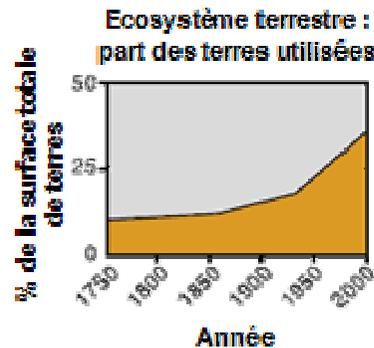
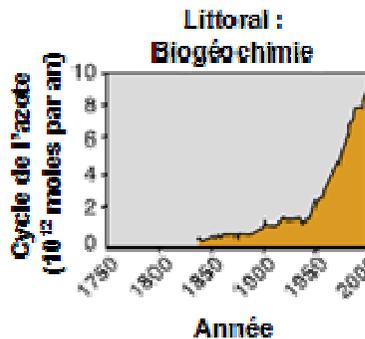
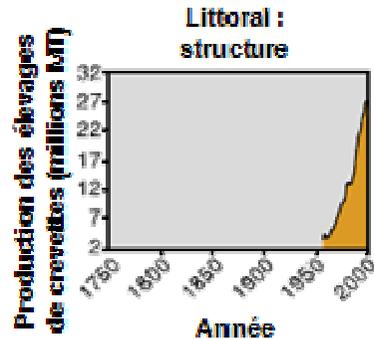
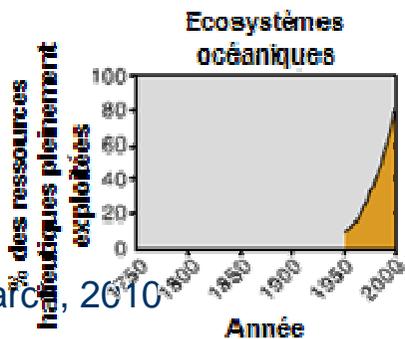
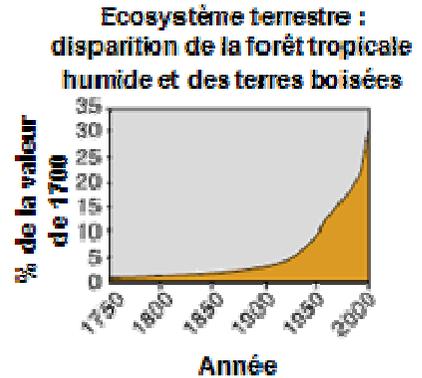
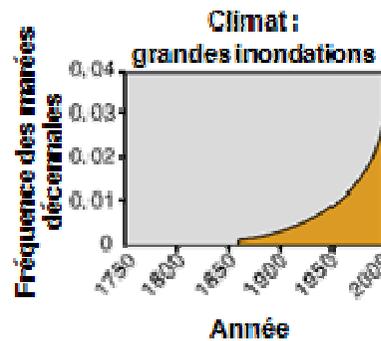
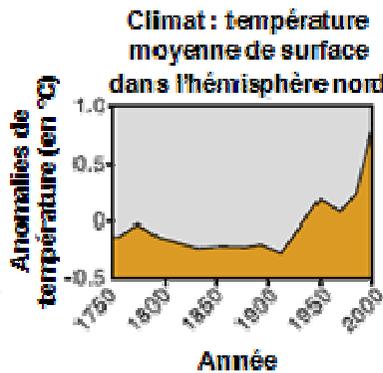
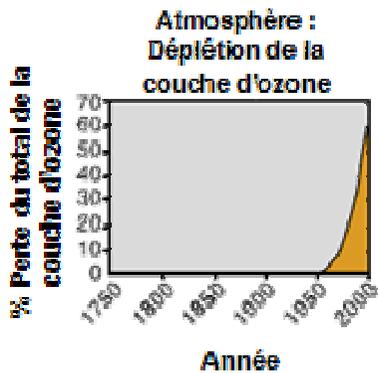
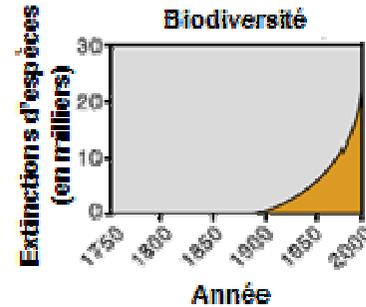
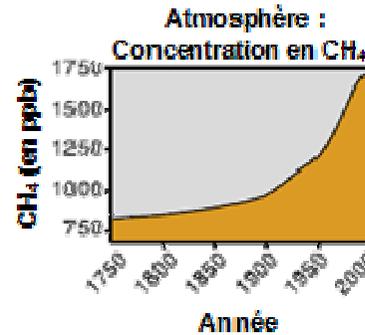
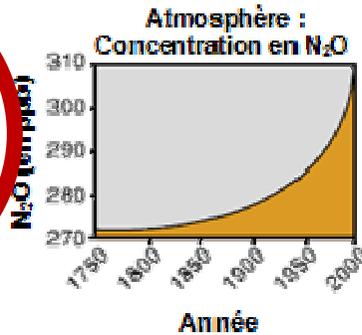
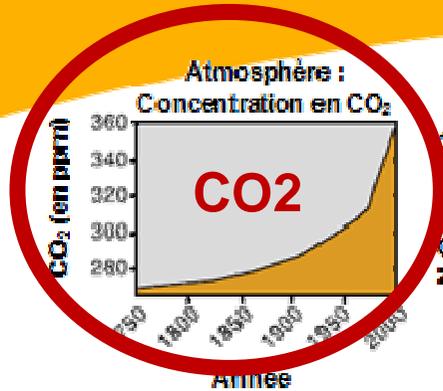
Exponential consumption

French indicators



Taipei, March, 2010

Associated environmental impacts





- Integrate many complex issues of local authorities and firms to implement sustainable development strategies
- Develop stronger methodological and technical tools to lead the decision-making process of involved public and private actors

COMETHE programme

(Conception of methodological and assessment tools for industrial ecology)

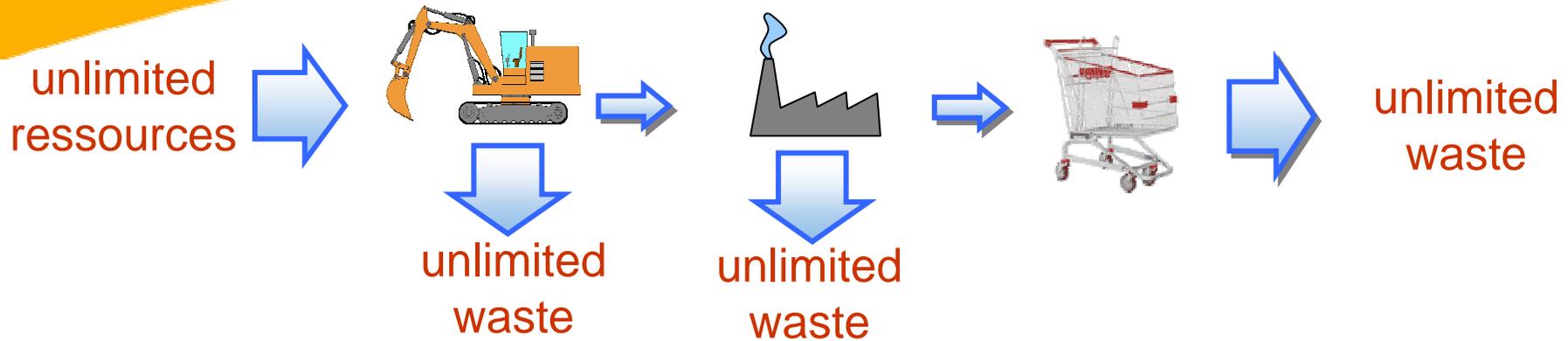
French National Research Agency funding (2008-2011)



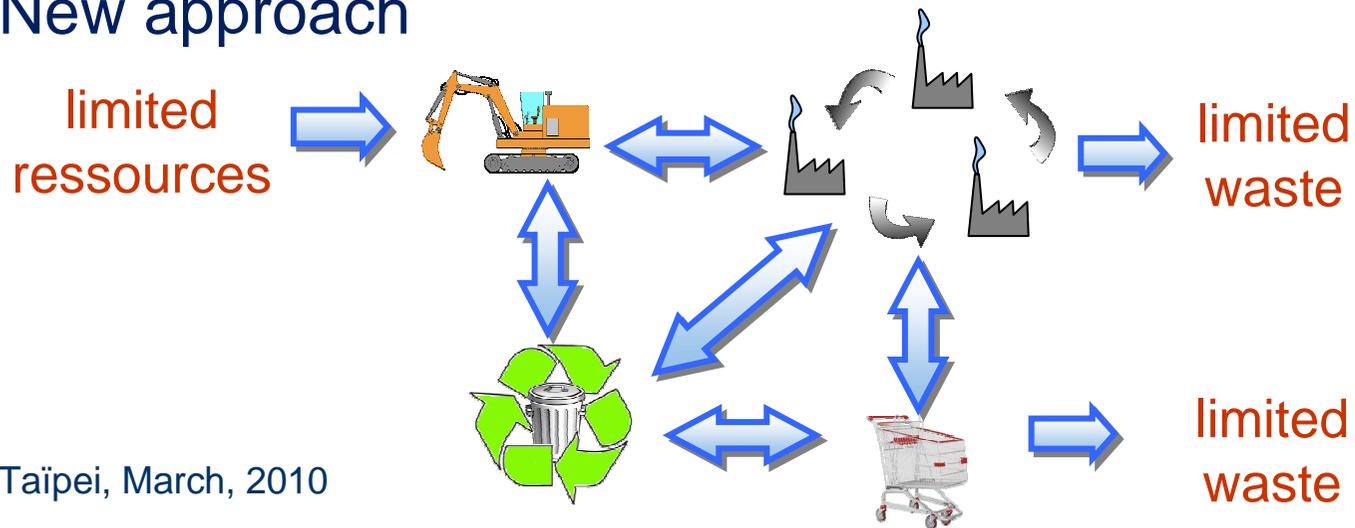
- ➔ **industrial ecology** concerns all economical activities (agriculture, commerce, industry, service, ...),
Known as Circular Economy, or Territorial Economy
- ➔ The industrial system is considered as an ecosystem. Industrial metabolism can be also used.



Former approach



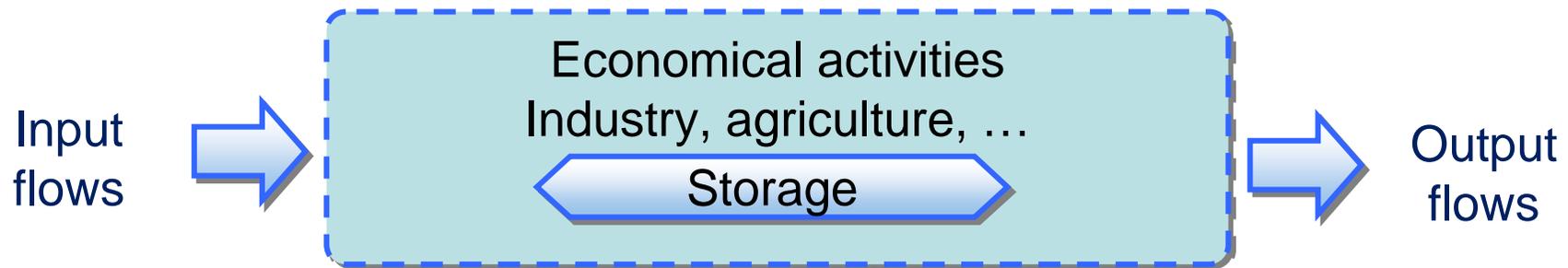
New approach





2 key ideas

→ **Industrial metabolism** : material and energy flows balance, storage



→ Industrial Ecology try to create **synergies**

Synergy = **flows substitution** or **flows mutualisation**





The Industrial Symbiosis of Kalundborg is built as a network co-operation between **6 processing companies**, **1 waste handling company** and the **Municipality** of Kalundborg.

DONG ENERGY Asnæs Power Station,
Plasterboard factory Gyproc A/S,
Pharmaceutical plant Novo Nordisk A/S,
Enzyme producer Novozymes A/S,
Oil refinery Statoil-Hydro A/S,
Recycling company RGS 90 A/S as well as the waste company
Kara/Noveren I/S and Kalundborg Municipality

They exploit each other's residual or by-products on a commercial basis.

Water



Gas & gypsum



Ash



Fertilizer



Steam



Sludge

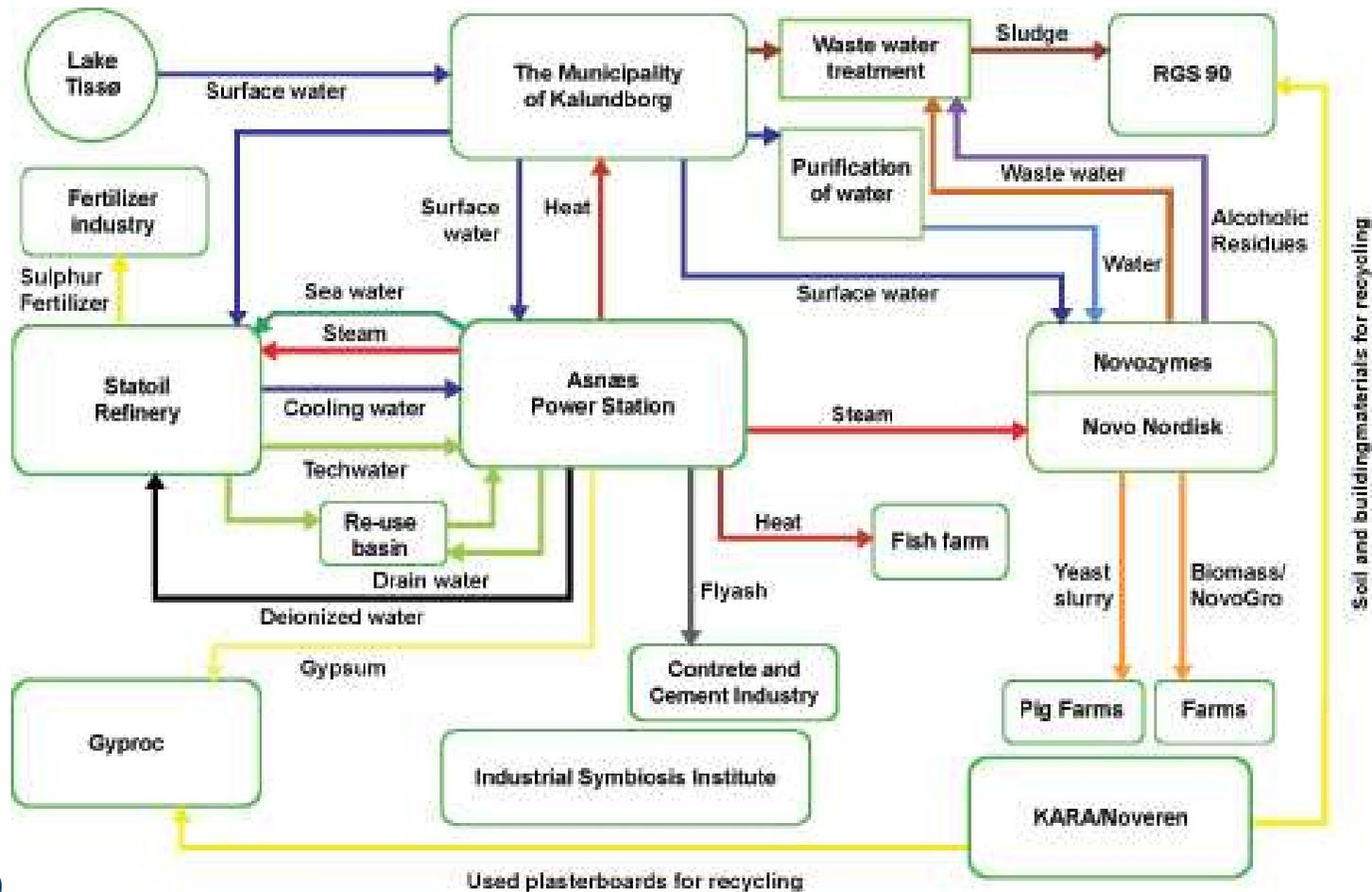


Waste





Kalundborg (Danemark) www.symbiosis.dk





Ressources saving

45 000 T/y gas
15 000 T/y de coil
600 000 m³/y water

Waste reuse

130 000 T/y ash for ciment industry
90 000 T/y gypsum for plasterboard
products for the construction industry.
150000 m³/y solid biomass used by 600
farms as fertilizer

...

Environmental impact saving

- 175 000 t/y CO₂
- 10 200 t/y SO₂

Economical data

- Investment 60 millions \$ US (16 projects for 20 years, waste exchange)
- Income/y (waste sale) 10 millions \$ US
- (average) 5 years to recoup the cost

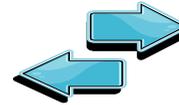


COMETHE aims at developing methodological tools to achieve industrial ecology implementation in France

Research activity

- Hypothesis
- Methodological guidelines

Test /
enforcement



Validation /
improvement

Experimentation

7 pilot areas in 4 different
French regions

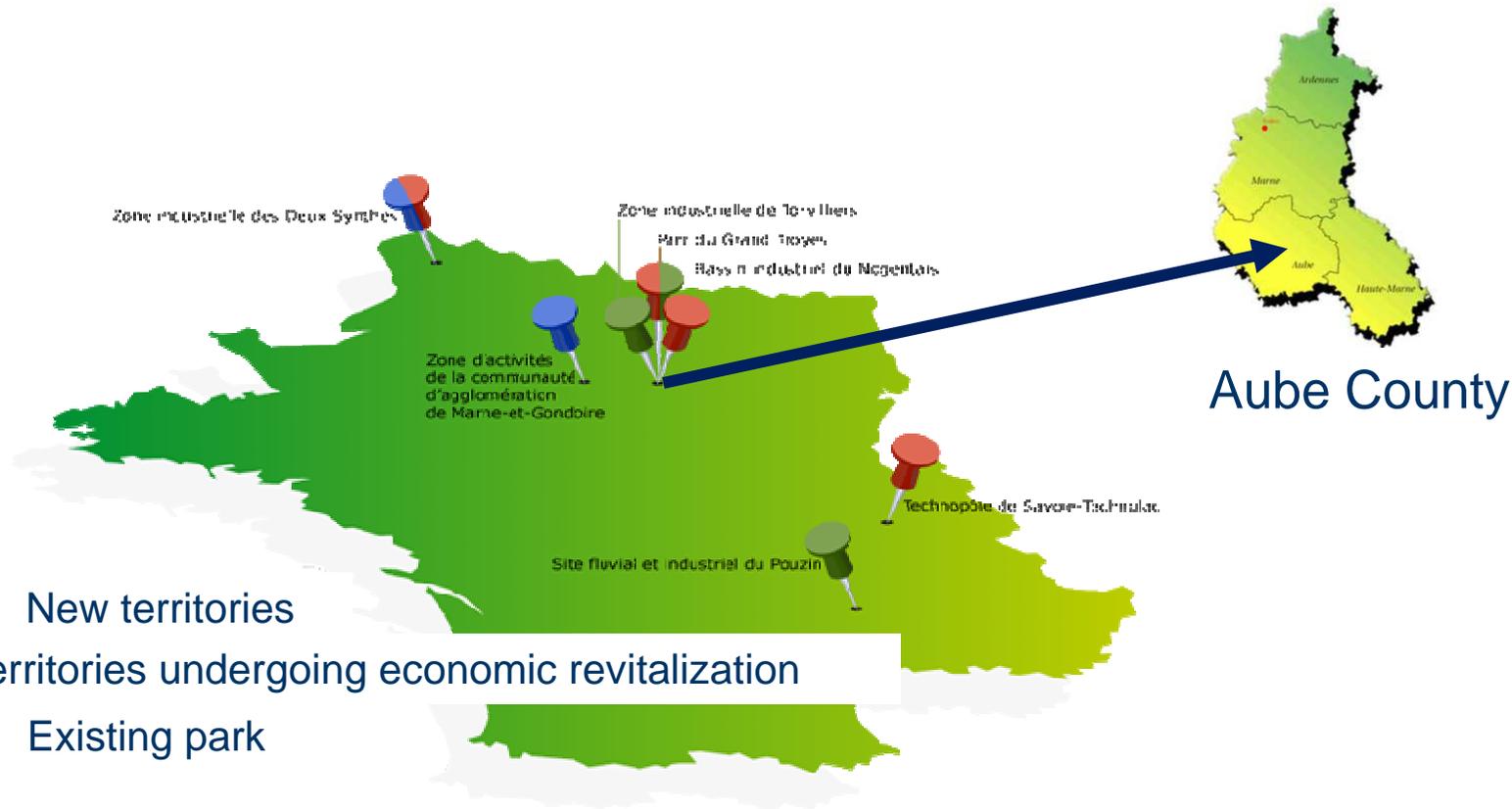
Research / expert actors : Orée, Coordinator, CREIDD (UTT), CLERSE (Univ. Lille 3), Systèmes Durables, Auxilia, Evéa

Local actors (public authorities & firms) : Yprema, Ecopal, CNR, Aube county, Chamber of Commerce Troyes, CEIA

12 partners - 36 months

Budget ~ 1.8 M€ - ANR funding ~ 50 %

7 pilot areas



Industrial park of Nogent

River port

340 firms / 3500 employees

Cogeneration, bioethanol, biodiesel



Industrial park of « Grand Troyes »

145 ha

50 firms, 950 employees

Bioenergy, agro-resources

textile, metal

Attractive tax system



Industrial park of Torvilliers

Area = 30 ha

Agro-industries

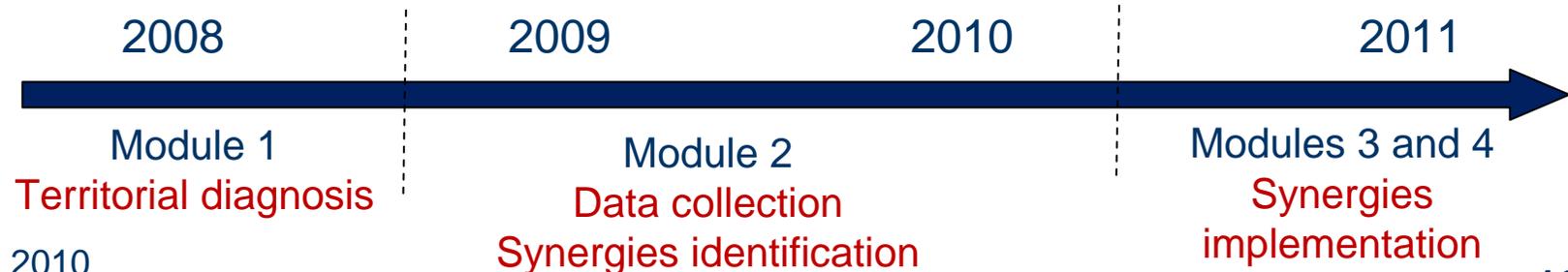
Attractive tax system





An integrated tool based on 4 Modules

- **Module 1:** diagnosis of the industrial areas
- **Module 2:** feasibility studies and assessment of eco-industrial synergies' impact
 - Risk analysis
 - Technical and economic feasibility
 - Regulatory feasibility
 - Environmental assessment
- **Module 3:** creation of prospective scenarios for sustainable development using multi-criteria analysis
- **Module 4:** Approach on the long view / How to enforce sustainable development in an industrial park ?





Reliability measure of synergistic system

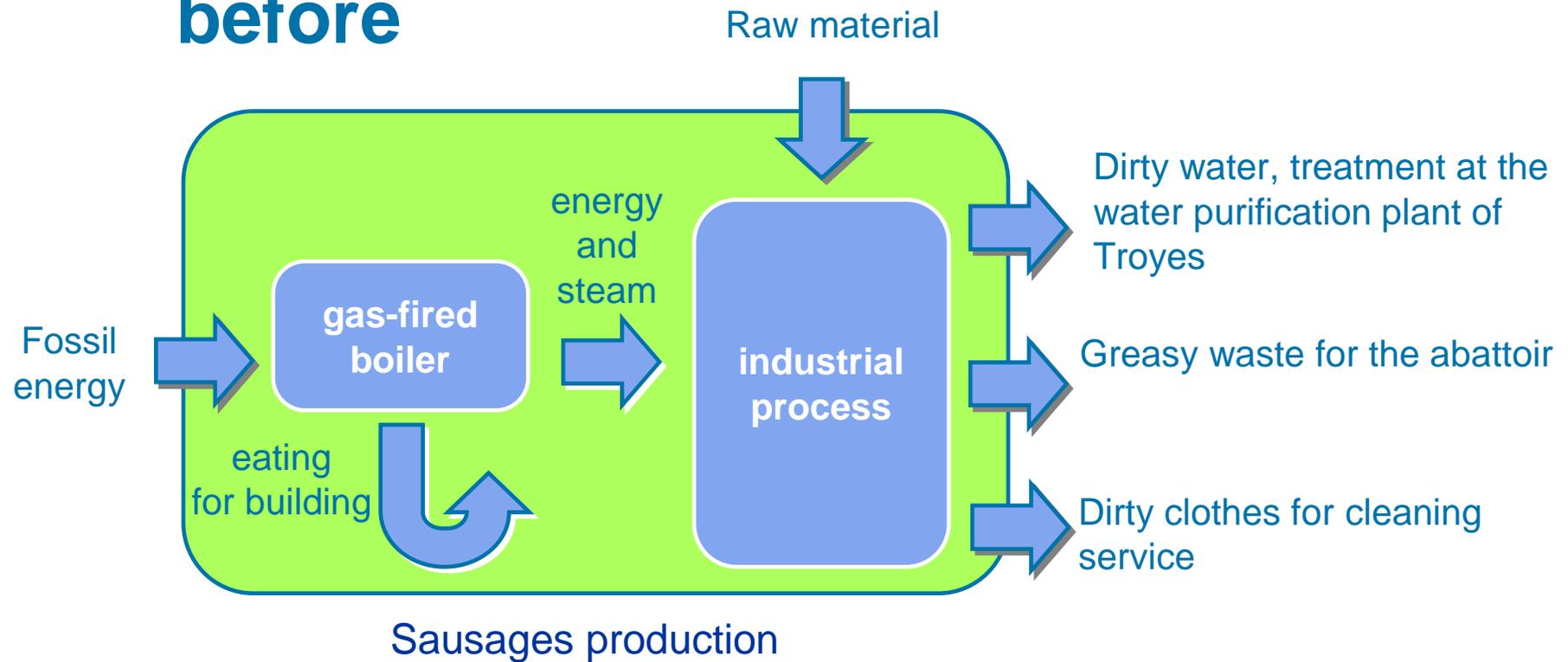
Developed at University of Technology of Troyes by Yung Chia HSU, Post-doctoral student, National Taiwan University
Excel tool, simulation (LHS), Visual Basic

Failure states of synergistic systems
60% <= p < 80%
p = failure flow number / total flow number

Prof. of each state	Heavy	Severe	Company reliability after synergy
0,004	0,000		C D E
0,018	0,001		0,980 0,950 0,948 0,948
0,020	0,000		Company reliability
0,021	0,000		C D E
0,004	0,000		0,910 0,902 0,802 0,829 0,826
0,130	0,028	0,001	0,46
0,020	0,000	0,000	200 Iterations
0,101	0,008	0,001	1000 Loops
0,004	0,000	0,000	02:15:21 PM Company A B C D E
0,018	0,001	0,000	30 August 2009 Reliability 0,980 0,980 0,949 0,950 0,949
0,020	0,000	0,000	10000 Iterations
0,020	0,000	0,000	4 Loops
0,004	0,000	0,000	05:40:40 PM Company A B C D E
0,113	0,017	0,002	31 August 2009 Reliability 0,918 0,929 0,803 0,829 0,883
0,020	0,000	0,000	200 Iterations
0,073	0,012	0,002	1000 Loops



before

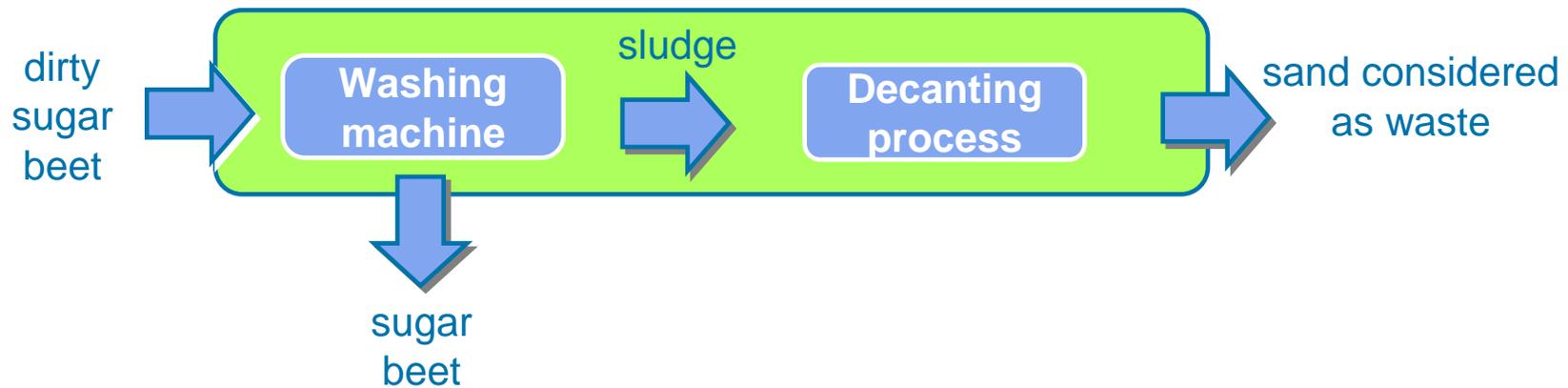




- ➔ Investment = 900 k€ for water treatment and gas-fired boiler. 200 k€ for the laundry
- ➔ No waste for the abattoir
- ➔ 30% gas saving
- ➔ 15 k€/year with the laundry
- ➔ Environmental impact decreased

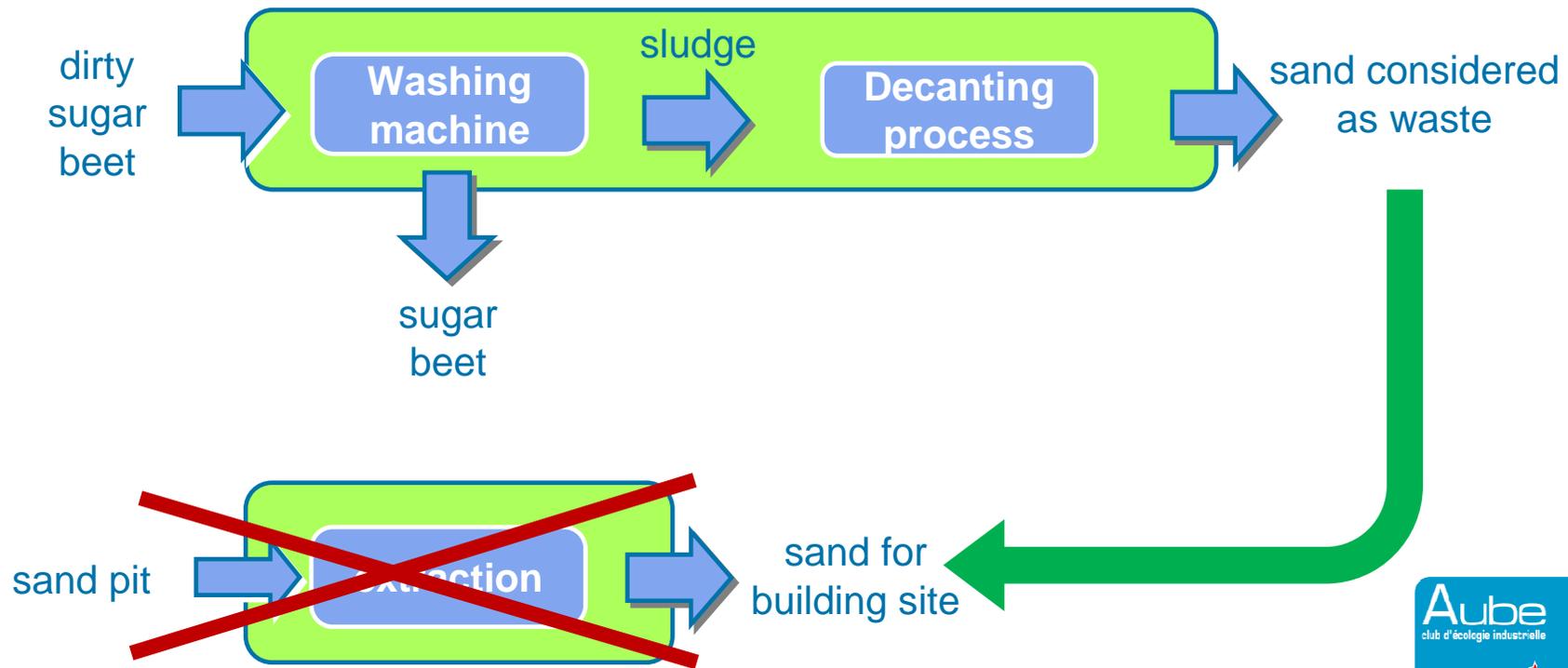


Before : 2 independent process





After



➔ Resources saving: 3 000 up to 20 000 t/y sand





Environmental impacts

- Decrease the organic pollution, water consumption,...
- Increase the value of waste,
- Increase the use of renewable energies,
- ...

Social impact

- Improve the firm's image,
- Employees awareness, training ,
- Hard tasks suppressed
- ...

Economical impacts

- Bills reduced (electricity, water, gas,...),
- Good control of the costs,
- ...



- ➔ Complete the diagnosis,
- ➔ Use of the tools : risk analysis, environmental analysis, technical analysis, financial analysis,
- ➔ Application of the synergies,
- ➔ Evaluation of the synergies,
- ➔ IE Guideline writing.