International Society for Industrial Ecology

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12th Industrial Symbiosis Research Symposium

University of Lausanne
4 to 6 July 2015

Activity report

Organized by

Université de Lausanne
IDYST
Industrial Ecology Group
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International Society for Industrial Ecology (ISIE)
Industrial Symbiosis and Eco-industrial Development Section (IS-EID)
http://www.is4ie.org

Figure 1 : Group picture of the 12th ISRS participants

Table of Contents

1 Introduction to Industrial Symbiosis

Industrial symbiosis (IS), as a part of the field of industrial ecology, demands resolute attention to the flow of materials and energy through local and regional economies. Industrial symbiosis engages traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and/or by-products. In theory, key factors for industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity (Chertow, 2000). However, in practice, industrial symbiosis networks can exist even in the absence of geographic proximity depending on the transport cost of energy and material compared to the financial benefit of the collaboration (Lombardi et al., 2012).

IS includes energy and by-product exchanges between economic players as well as services and infrastructures sharing at the industrial park scale (van Beers et al., 2005; van Berkel et al., 2006; Chertow et al., 2009; Massard, 2011). Current trends in the implementation of industrial symbiosis focus on the following types of inter-firm collaboration:

- **By-product exchanges:** converting waste into valuable productive resources such as chemical product or solid waste (plastic, textile, wood, etc.);
- **Waste heat recovery**: turning energy losses into revenue by designing inter-firm energy cascading systems using heat exchangers and heat pumps;
- **Shared infrastructures** for water purification and supply, energy production using cogeneration and other utilities for example for generic chemical production;
- **Shared waste management** infrastructure for handling and sorting and the active development of innovative recycling technologies and value chains;
- **Shared services** such as like security, training, catering, meeting rooms, etc.

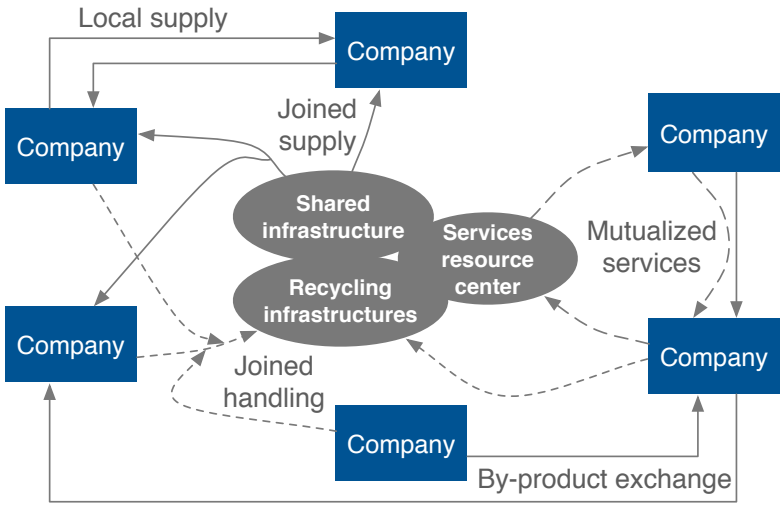

Figure 2 : Representation of the different types of Industrial Symbiosis

Such collaboration creates a sustainable production ecosystem, reducing waste and pollution, while promoting efficiencies and knowledge sharing. These strategies also indirectly benefit the community by reducing environmental and health hazards.

2 Program of the event

Day 1 - Sunday July 5

On Sunday, the 12th industrial symbiosis research symposium organizes visits to industrial symbiosis projects in Geneva, focusing on innovation and new technologies for industrial symbiosis, and eco-industrial park management.

09.00	Pick-up point at Lausanne railway station (main hall meeting point)
10.30	Visit of the Plan-les-Ouates écoParc (ZIPLO) with Ms Da Canal (Energy 8) project manager, waste heat recovery network under construction
12.00	Lunch in Geneva
14.00	Presentation of the écoParc program and of the collaborative platform Genie.ch at the Industrial Land Foundation of Geneva (FTI) with Mr. Marc Sneiders (FTI) and David Martin (Sofies)
15.45	Departure with the bus to the Zimeysa écoParc, Meyrin
16.00	Viewpoint on the écoParc Zimeysa, Meyrin: discussion with David Martin (Sofies) about industrial symbiosis development and densification issues
16.30	Return to Lausanne
17.30	Arrival at Lausanne lakeside, next to the restaurant Le Carrousel de Vidy. Walk along the lake
19:00	Aperitif and Dinner at the Restaurant Le Carrousel de Vidy

Day 2 - Monday July 6

Monday, July 6, ISRS focuses on two main issues of industrial symbiosis detection and implementation.

8.15 -8 .45	Welcome of participants at Lausanne University, Amphimax Building, room 410
8.45	Introduction speech by Guillaume Massard
9:00	Introduction speech by Olivier Jacquat, Swiss Federal Office for Environment
9.10	Conference by Prof. Suren Erkman: Global trends in eco-industrial parks development
9.40	International Industrial symbiosis status and forecast. Moderated by Guillaume Massard and Vincent Moreau
10.30	Coffee break
11.00	Identifying innovative on-going symbioses around the world Group discussion moderated by Vincent Moreau and Guillaume Massard, UNIL
12.15	Lunch
14.00	Conference by Céline Weber: District energy systems, a partner of industrial ecology
14.30	Taking on the challenge of comparing across projects in industrial symbiosis Group discussion moderated by Dr, Frank Boons, Dr. Marian Chertow, Dr. Jooyoung Park, Wouter Spekkink, Dr. SHI Han
16.30	Coffee break
17.00	Concluding remarks, all participants
17.45	End and departure by bus to Geneva airport (for those attending ISIE)

3 Industrial symbiosis around the world: status and forecast

The 12th ISRS brings together researchers and practitioners from 19 countries and 5 continents (Figure 1). This section presents the results of the international industrial symbiosis status and forecast session that has taken place on July 6th. During this knowledge exchange session, participants where asked to group by country and to prepare a 2 to 3 minute speech about the last development of industrial symbiosis in their country.

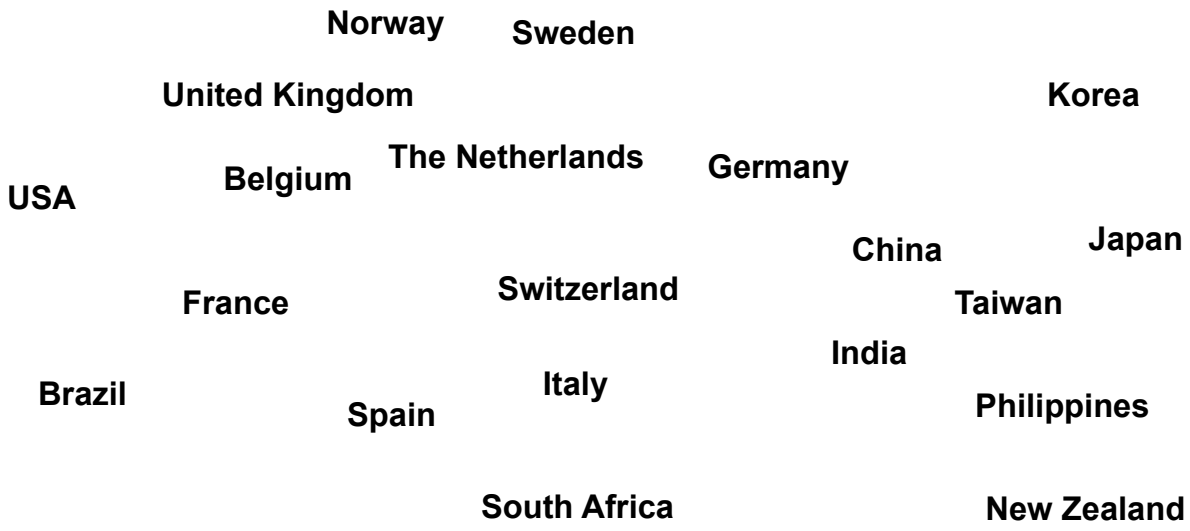

Figure 3 : List of countries represented at the 12th ISRS and geographical distribution

Country	Recent activities
Belgium	• Development of the association called FISCH (www.FI-SCH.be) for sustainable chemistry and integration of industrial symbiosis • Development of the Belgian SusChem platform (www.suschem.be) as a partner of Suschem Europe (www.suschem.org) • Development of low carbon industrial parks by the government
Brazil	• On-going work on service sharing, urban symbiosis at the local level, collaborative economy, sharing infrastructure and knowledge, waste synergies in industrial districts • Organisation of industrial symbiosis match-making workshops by the National Confederation of Industry. Collaboration with NISP-UK in the state of Minas Gerais • Development of several waste exchange online platforms • Future challenges for IS implementation: build cooperation culture, adapt regulation to foster dialogue, develop a solid waste management national policy • Implementation: development by the government of a virtual industrial / technological park in Parana Region • Implementation: development of mutualization, waste exchanges and waste treatment facilities in a petrochemical complex in Camacari, Bahia • Implementation: development of bio-based industrial ecology in biorefinery to produce

	succinic acid from sugar cane bagasse • Implementation: Development of an eco-industrial park in Rio EcoPolo
China	• Circular economy promotion law: the reference model for implementing industrial symbiosis in industrial parks. More than one hundred on-going EIP initiated by the Chinese EPA. Main focus is on solid waste exchange, waste heat exchange and information exchange. • Cleaner production promotion law: Supports process efficiency approaches and provide subsidies • National Development and Reform Committee: Provides guidance on industrial ecology • Implementation: Development of wind energy, solar energy and cars using renewable energy. • Implementation: Tianjin is the oldest IS network in China (TEDA eco-center) • Implementation: Guitang group is an IS network in an agro-food sugar based industrial complex
European Union	• Research and implementation programs: H2020, SPIRE 6, COST, Life+ are supporting industrial symbiosis • EU project EPOS: new research project to assess IS potential and development of business cases
France	• New national law on energy transition includes changes in the definition of waste and an article (n°40) on circular economy • Development of many regional initiatives on circular economy and industrial ecology • Organization of an industrial ecology workshop for national ports (energy transition, mutualisation) • Implementation: Port of Strasbourg is implementing an energy sharing and exchange symbiosis project • Implementation: Sedimatériaux platform allows the sharing of competences for sediment valorisation in civil engineering • Implementation: Port of Marseille is developing a new « plug and play » chemical platform called PIICTO • Implementation: AUSSOIS, development of a territorial ecology approach for high mountain villages • Implementation: MAMP project, development of prospective study on the future metropolitan area of Aix Marseille Provence. • Implementation: Circular economy program of Paris, including a study of flows, supply and innovative transformation systems for a giant city. • Implementation: Industrial ecology project in Plaine du Var focuses on construction and demolition waste synergies, organic material and heating networks • Implementation: Epinal (Golbay) wood industrial cluster, development of IS for wood resources • Implementation: Act'if platform for transport mutualisation and material exchange with plastic bag reuse to make pillows
Germany	• German Industrial Ecology Network: grouping together 15 to 20 institutions around industrial ecology

	• Implementation: Development of a geographical information system for waste heat monitoring in Bavaria
India	• Policy development for specific conditions to discharge dumping • Industrial symbiosis is used as a low carbon intervention strategy in Indian cities • Development of an application for information recycling and of biobased material exchanges to increase collaboration between farmers and big industries. • Integrating the informal sector and the organized crime into recycling and IS networks through the auctioning of waste streams and the documentation of tacit knowledge. • Development of recycling clusters to formalize existing informal ones • Implementation: In the state of Andra Pradesh, an IS pilot was implemented by GIZ, using the Eco profit tool in Vishakapatnam (2300 ha)
Italy	• Law on Environmentally equipped industrial areas (APEAs) since 1998. Several on-going pilots across the country • Industrial clusters are integrating industrial symbiosis in the agricultural, furniture, tanning and oil/wine sectors • Implementation: Emilia-Romagna project • Implementation: Industrial symbiosis platform in Sicily (Eco-innovazione sicilia)
Japan	• Development of a low-carbon monitoring system pilot project targeting energy consumption • Development of industrial symbiosis using waste heat from power plants to supply nearby factories or residential areas • Development of industrial-agriculture symbiotic networks • Implementation: Planning of an « innovation coast » and the development of new industrial parks in the coastal area using industrial ecology principles (after Great Japan Earthquake of 2011) • Implementation: Industrial symbiosis for waste heat reuse networks in Fukushima recovery region • Implementation: The Eco-town project successfully implemented a waste plastic and PPT bottles recycling system to turn them into substitution fuels for the iron and steel industry
Korea	• Continuous development of the Korean EIP program (2005 – 2018). The program focuses on the development of energy networks, water networks and solid waste exchanges, involving local communities
Philippines	• Development of a national policy on Sustainable Consumption and Production, including national material flow analysis studies • Implementation: Mactan Ecozone, Cebu is implementing an energy efficiency project, funded by GIZ • Implementation: UNDP funded 5 EIP projects in industrial estates (BPX project) in 1997
The Netherlands	• On-going national and regional policy efforts towards eco-industrial park and similar concepts • Implementation: Build up of infrastructure (research) bio-based clusters • Implementation: INES (Port of Rotterdam) is not active anymore

	• Implementation: Biobased Delta in Southern Netherlands to link agriculture to chemical industry • Implementation: heat exchange network at Moerdyk (EnergywebXL)
Norway	• Many on-going research focuses on sustainable consumption at household's level • Implementation: Work on transportation systems in Miljodirktoratet • Implementation: Oil companies (such as Statoil) are working on industrial symbiosis
Spain	• National trend on the development of district heating and cooling networks • Implementation: District 22@Barcelona continuous improvement and development
South Africa	• Industrial symbiosis is being included in industrial policy (industrial policy action plan 2016/2017) of the Department of trade and industry. IS is perceived as an enabler for sustainable economic development and regional development • The national strategy focuses on embedding IS in the industry, including stakeholders such as the government, businesses and local programmes. • Implementation: WISP, Western Cape Industrial Symbiosis Programme, funded by the government to facilitate IS (the team includes 1 manager and 4 facilitators) • Implementation: Valorisation of agricultural waste in the Western Cape province • Implementation: Two new regional pilot projects under development in Ganteng (GISP) and Kwazulu Natal (KISP), both run by the NCPC-SA and funded by the NCPC / DTI • Implementation: Development of an EIP project in Atlantis industrial park (currently in the feasibility phase by UNIDO / DTI)
Sweden	• Industrial symbiosis as a leverage of bio-based economics • Development of public-private partnerships for operationalizing industrial symbiosis • Development of a national industrial symbiosis resource centre and network coordinated by Linkoping University • Several on-going strong local initiatives labelled as industrial symbiosis • Market emergence of commercial facilitating actors for waste and heat exchanges • Future challenge: Development of a new waste policy • Existing collaborative platforms: « spill till gold » (waste to gold) / « valuefromwaste.sw » / «Re!Source » (Vinnova) / Processum (bio-ref) • Implementation: Port-City integration for combined bio-economy and sustainable urban development work • Implementation: Kimi-Kluster project to exchange fossil ethylene to renewable (green chemistry) • Implementation: Insects as bio-conversion process (grown on food waste and WWTP sludge) to produce proteins, heat and biogas • Implementation: Forest industry is developing activities for tall oil (by-product of wood pulp manufacturing) upgraded to be used by oil company PREEM • Implementation: CO_2 capture and valorisation in an ethanol plant • Implementation: Substitution of fossil ethylene with renewable at the Kemikluster in Stenungsund • Implementation: Integration of district heating with a gasification plant (GoBiGas)

	• Implementation: Use of residual low-grade heat in industry and urban food production
Switzerland	• Development of the REFFNET network for resource efficiency (www.reffnet.ch) • International survey on eco-innovation parks released in 2014: open access to data and development of inferential statistics analysis by the Federal Office for the Environment • Implementation: Development of the new concept of Swiss Innovation parks • Implementation: In Geneva, development of an écoParc program and policy at the state level, piloted by the Foundation for industrial land (FTI). Launch of the Geneva Network for Industrial Ecology (www.genie.ch)
Taiwan	• Green purchasing and green operations are well implemented in electronic industry • Firms record all processes in their ERP (Enterprise Resource Planning) systems • Implementation of the recycle, reuse and remanufacture concepts at the national level
United Kingdom	• Latest development of NISP focuses on the publication of case studies in relation with NGOs including the Mac Arthur Foundation • On-going comparison studies between UK and China on IS development • Implementation: The company British Sugar Ltd developed industrial symbiosis for the last 20 years for animal feed, electricity production, tomato production.
USA	• USBCSD developed a virtual marketplace for industrial symbiosis and waste exchanges • Implementation: Several on-going projects targeting ash and metal mining. Metals recovered from waste-to-energy combined with ash (ferrous + non-ferrous) for reuse • Implementation: On-going industrial symbiosis experiences in Detroit, Austin, Houston • Implementation: On-going work in Devens on services and infrastructures sharing, as well as by-product exchanges facilitated by the park management • Implementation: In Chicago, development of an urban agriculture and food business incubator in net-zero energy, including closed loop (called The plan). Located in a former industrial facility (95.000 sq ft) and including 10 tenants: brewery, aquaponics mushrooms, farms • Implementation: ReVenture Park, Charlotte, NC, is an energy showcase for various energy generation technologies as 1.5 multiplier for renewable energy credits

4 Research perspectives for industrial symbiosis

4.1 Comparing industrial symbiosis dynamics

Industrial symbiosis is currently being implemented in many countries around the world, driven by various public and private players. The comparison of dynamics of action and policy is an emerging research topic in the field of industrial symbiosis. Therefore, the 12th ISRS dedicated part of its program to a presentation of a forthcoming paper called *Industrial Symbiosis Dynamics and the Problem of Equivalence*. Frank Boons, Marian Chertow and Wouter Spekkink presented and discussed the paper that they co-authored with Jooyoung Park and Shi Han. The paper aims to build on knowledge that has been accumulated on numerous cases of Industrial Symbiosis (IS) in the past 15 years to propose a conceptual and theoretical framework that provides a basis for the comparative analysis of IS.

During his presentation Frank Boons discussed in detail the *problem of equivalence*, which arises whenever one tries to compare a phenomenon of interest across the different cultural and institutional contexts in which it occurs. To study the phenomenon of interest we introduce concepts that are shaped by the particular context from which we come, and in which the phenomenon of interest comes about. Inevitably, this will lead to conceptual divergence. We face this *problem of equivalence* in the field of IS. As a result, it is difficult to arrive at a shared definition of IS that respects the various ways in which it instantiates across different contexts. Therefore, a central question addressed in the presented paper is how, at a conceptual level, we can distinguish variation from commonalities in instantiations of IS, in a way that facilitates comparative research. In the paper we address this challenge in two ways:

1. By developing a vocabulary (or shared language) of IS that enables an informed discussion of various instances of IS in different contexts. Researchers can use the vocabulary to make clear on what ground they are looking for comparison in their research.
2. By calling for the need to explicitly study the way in which the concept of IS acquires a different meaning in various contexts.

A conceptual starting point for the definition is that IS is best understood as a process. An inclusive description of this process is given in the paper, and the paper discusses in detail various aspects of IS that we find in different extents across the globe.

After introducing the vocabulary, the paper lists seven typical pathways (IS dynamics) through which IS has unfolded in different places of the world. The typology is based on a review of case studies that have been accumulated in the past 15 years (based on experiences from the US, Europe and Asia), and it is developed in a way that enables empirical testing of the proposed dynamics as well as further refinement of the typology. Each dynamic is identified by indicating:

- Initial actor(s)
- Actor motivations
- Actions
- Overall storyline (composition and sequencing of actions)
- Outcomes

The presentation of the typology dynamics is accompanied by 3 research questions:

1. Are different dynamics triggered under specific conditions?

2. What outcomes (environmental impact, network structure and network function) are linked to different types of dynamics?
3. How do dynamics add up into phase models (assuming that multiple types of dynamics can occur in one case)?

After presenting the paper, three group discussions were held with attendees of the 12th ISRS, in order to discuss whether the approach provides a conceptually useful way forward, whether the typology presented in the paper is useful and more or less representative of our current stage of knowledge of IS cases, and whether the presented approach to comparative analysis is a useful way forward for the field.

The paper is intended as an agenda for comparative research on IS. The typology of seven dynamics is not intended as a 'final' list, but as a starting point for research efforts to gain a deeper understanding of the different ways in which IS unfolds across the globe, and why it unfolds in those ways. In that sense, the authors see the typology as a 'living' typology that will be refined in the future, from which certain dynamics may be removed, or to which new ones may be added. The overarching aim of the effort is to facilitate an approach to comparative research on IS that embraces and respects diverse instantiations.

4.2 Reproducing, adapting and scaling-up industrial symbiosis

The status and forecast session detailed in section 2 shows a large number of on-going research, development and implementation projects around the world. By looking more deeply into the case studies in each country, several resource categories are currently researched or implemented in many countries such as: biomass, chemicals and waste heat based heating networks.

The difficulty to reproduce existing symbiosis call for more intensive knowledge exchange events and platform, as well as the development of a market for IS transfer and adaptation in order to foster replication.

5 Contributions and conferences

All the material presented during the symposium can be found in annexes to this report.

Annex 7.1: Welcome to the 12th Industrial Symbiosis Research Symposium
Dr. Guillaume Massard
Université de Lausanne and Sofies SA

Annex 7.2: Today's objectives vs. Swiss Government Activities
Dr. Olivier Jacquat
Swiss Federal Office for the Environment

Annex 7.3: The Industrial Ecology Research Group
Prof. Suren Erkman
Université de Lausanne

Annex 7.4: District energy systems, a partner of industrial ecology
Dr. Céline Weber
Amstein+Walthert

Annex 7.5: Industrial Symbiosis Dynamics and the Problem of Equivalence
Prof. Frank Boons, University of Manchester
Marian Chertow, Yale School of Forestry
Wouter Spekkink, Delft University of Technology
Joo Young Park, Universidad de los Andes
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7 Annex: Presentations of the 12th Industrial Symbiosis Research Symposium

7.1 Welcome to the 12th Industrial Symbiosis Research Symposium, Dr. Guillaume Massard

The symposium was possible thank to

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Umwelt BAFU
Office fédéral de l'environnement OFEV
Ufficio federale dell'ambiente UFAM
Uffizi federal d'ambient UFAM

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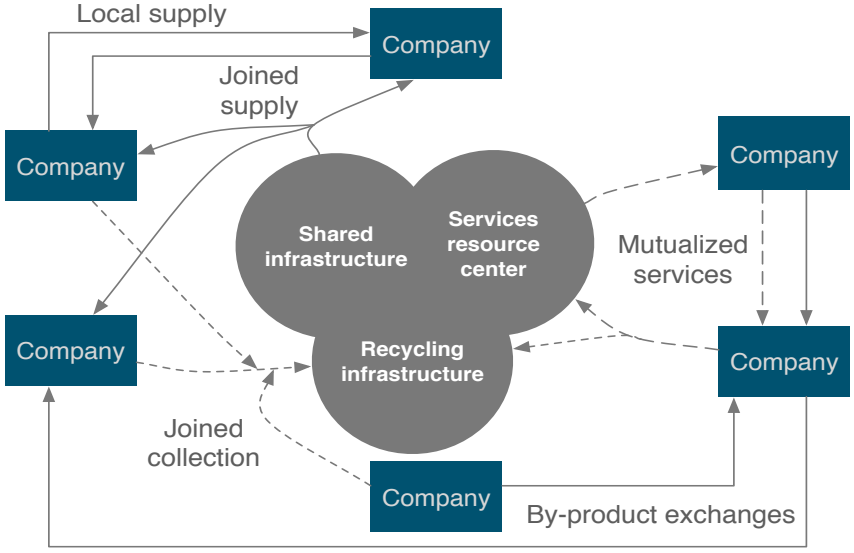
Program of July 6

8.45 9:00	Introduction speech Introduction speech by Olivier Jacquat, Swiss Federal Office for Environment
9.10	Conference by Prof. Suren Erkman: Global trends in eco-industrial parks development
9.40	International Industrial symbiosis status and forcast
10.30	Coffee break
11.00	Identifying innovative ongoing symbioses around the world
12.15	Lunch

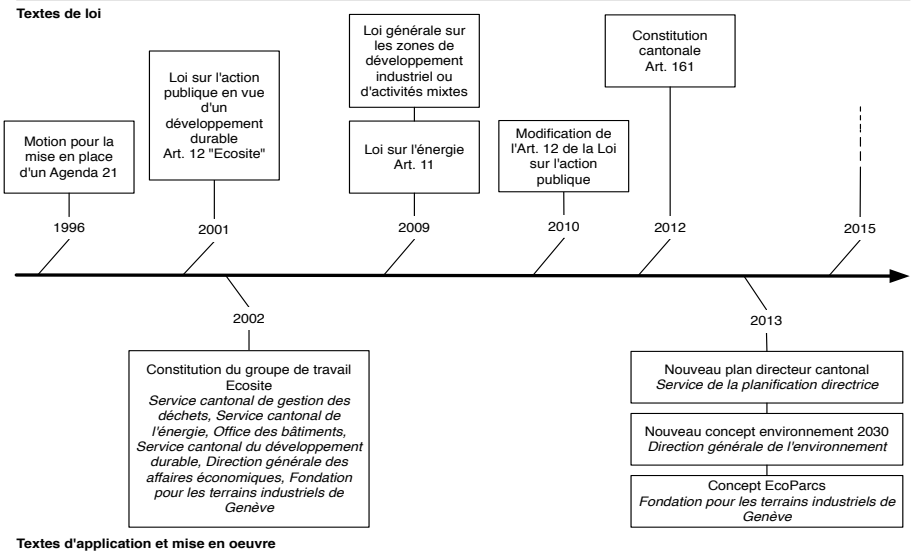
Program of July 6

14.00	Conference by Céline Weber: District energy systems, a partner of industrial ecology
14.30	Taking on the challenge of comparing across projects in industrial symbiosis Group discussion moderated by Dr, Frank Boons, Dr. Marian Chertow, Dr. Jooyoung Park, Dr. Wouter Spekkink, Dr. SHI Han
16.30	Coffee break
17.00	Concluding remarks, all participants / Group picture
17.45	End and departure by bus to Geneva airport (for those attending ISIE)

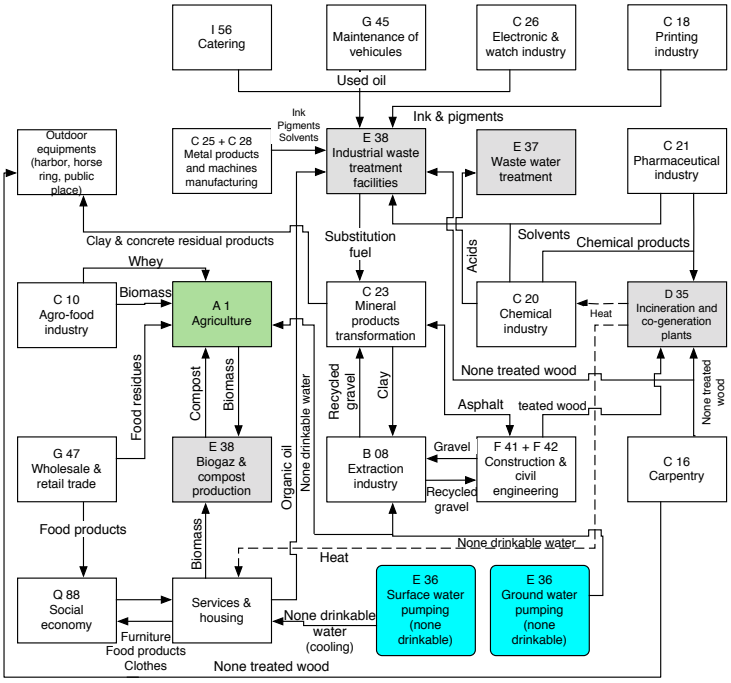
Industrial Symbiosis in Switzerland



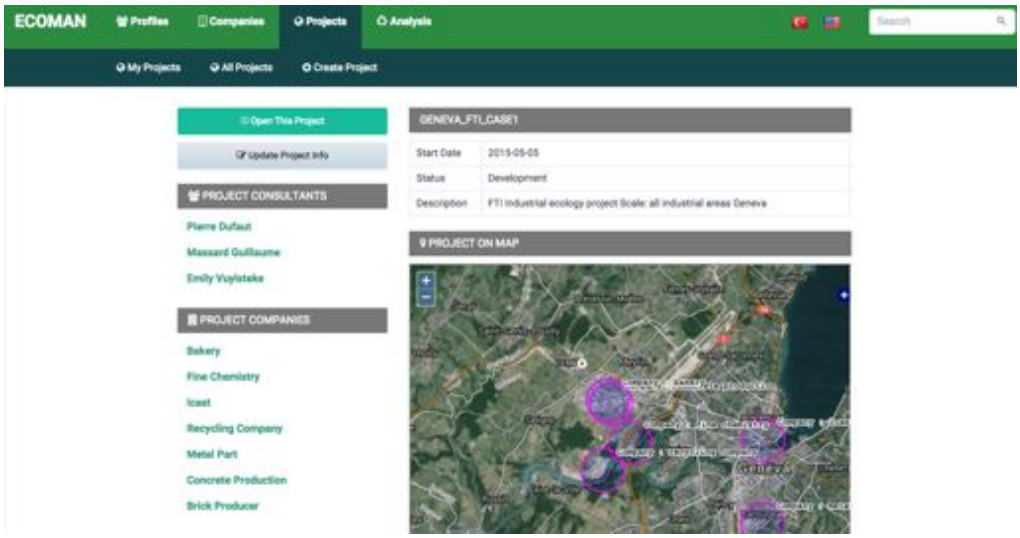
Industrial Symbiosis in Geneva



Industrial Symbiosis in Geneva



REIS: Resource efficiency and industrial symbiosis open platform



REIS: Resource efficiency and industrial symbiosis open plateform

PUPLIC RELEASE IN JANUARY 2016

How to get involve ?

- Start a project in your region to implement and scale-up cleaner production and industrial symbiosis
- Enter the community of developers to add new features and functionalities

Contact us to know more:

guillaume.massard@unil.ch

Around the world

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The Netherlands
Germany
China
Japan
France
Switzerland
Taiwan
India
Brazil
Spain
Italy
Philippines
South Africa
New Zealand

Identifying innovative ongoing symbioses around the world

What are the 2 or 3 most innovative industrial symbiosis currently under development or implementation in your country?

7.2 Today's objectives vs. Swiss Government Activities, Dr. Olivier Jacquat

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of the Environment,
Transport, Energy and Communications DETEC

Federal Office for the Environment FOEN
Section Innovation

Today's objectives vs. Swiss Government Activities

Olivier Jacquat, PhD

06.07.2015

Green Economy: The big Frame

- Citizen initiative and revision of the Environmental Protection Act
- National Action Plan with 27 Measures:
  - Consumption and production
  - Wastes and raw materials
  - Cross-cutting instruments
  - Targets, monitoring, information, reporting

- Masterplan Cleantech: promotion of cleantech innovation

REFFNET

Status

Reffnet.ch
Network Resource efficiency Switzerland

- Creation of REFFNET: Network Resource efficiency

Up to 5 Free Consulting Days

Potential Analysis
Action Plan
Implementation
→ Process

Competitive advantages
Environmental impact
→ Success monitoring

Swiss innovation park

SWISS INNO VATION PARK

ERA-NETs

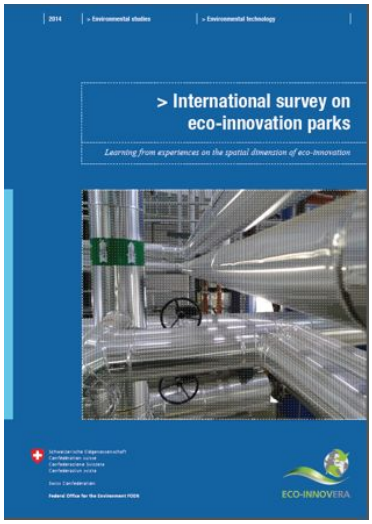
- European Research Area Network on Eco-innovation to support R&D on eco-innovation by
  - (i) coordinating national funding programmes
  - (ii) joint transnational funding of research projects

- Common calls: 6+1 Swiss Projects; 1 project on tool development for managing Cleaner Production and industrial Symbioses at the park level

- Diverse Publications, Follow-up Programme

ERA-NET ECO-INNOVERA

- 168 Parks described
- 27 countries
- 12 Eco-Criteria
- 8 Success Factors



- Download : http://www.bafu.admin.ch/uw-1402-e

7.3 The Industrial Ecology Research Group, Prof. Suren Erkman

«Taking Stock of Industrial Ecology»

The Industrial Ecology Research Group

Prof. Suren ERKMAN

ISIE - 12th Industrial Symbiosis Research Symposium

Lausanne, 6 July 2015

IE Group at UNIL 2014/2015

Integrative approach, interdisciplinary group:

- **3 environmental engineers / scientists**
- **1 chemist**
- **1 biologist**
- **1 mineralogist**
- **1 mathematician**
- **1 anthropologist**
- **1 philosopher**

Background:

- Philosophy, Biology, Science and business journalism
- Consultant, first study on IE (1993-1994)
- 1993-2005: International network for dissemination and field testing of IE, funded by FPH in Paris/Lausanne
  - Industrial Maturation Multiplier (1993-1999)
  - Industrial Ecology Praxis (2000-2005)

Background:

- First international workshop in Kalundborg (1996), creation of The Symbiosis Institute
- 1999: IE conference in India (Ahmedabad)
- 2000: IE Conference in Algeria
- 2001: EID Conference in Manila (with UNEP)
- 2006: EID Conference in Hangzhou (with UNEP)
- 2005: Joined University of Lausanne (UNIL)

Applied Industrial Ecology:
A New Platform for Planning Sustainable Societies

1. Case Study Of The Textile Industry In Tirupur, Tamil Nadu
2. Case Study Of The Foundries In Haora, West Bengal
3. Case Study Of The Leather Industry In Tamil Nadu
4. Case Study Of A Corporate Paper-Sugar Complex, Tamil Nadu
5. Case Study Of The Damodar Valley Region, Jharkhand

http://www.roionline.org/

Resource Optimization Initiative (ROI)

Bangalore, Inde

www.roi-online.org

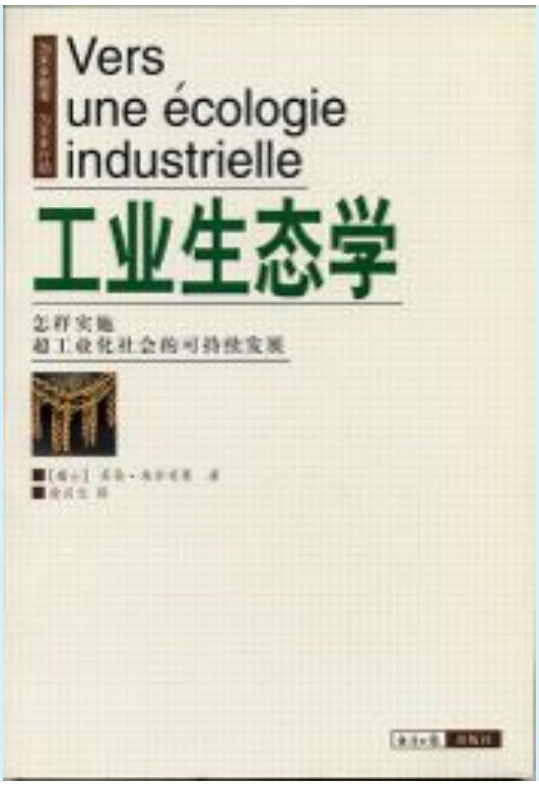
ROI

S. Erkman & R. Ramaswamy: ***Applied Industrial Ecology.***

Bangalore, Aicra Publ., 2003

Documents:

Chinese version available on the Internet

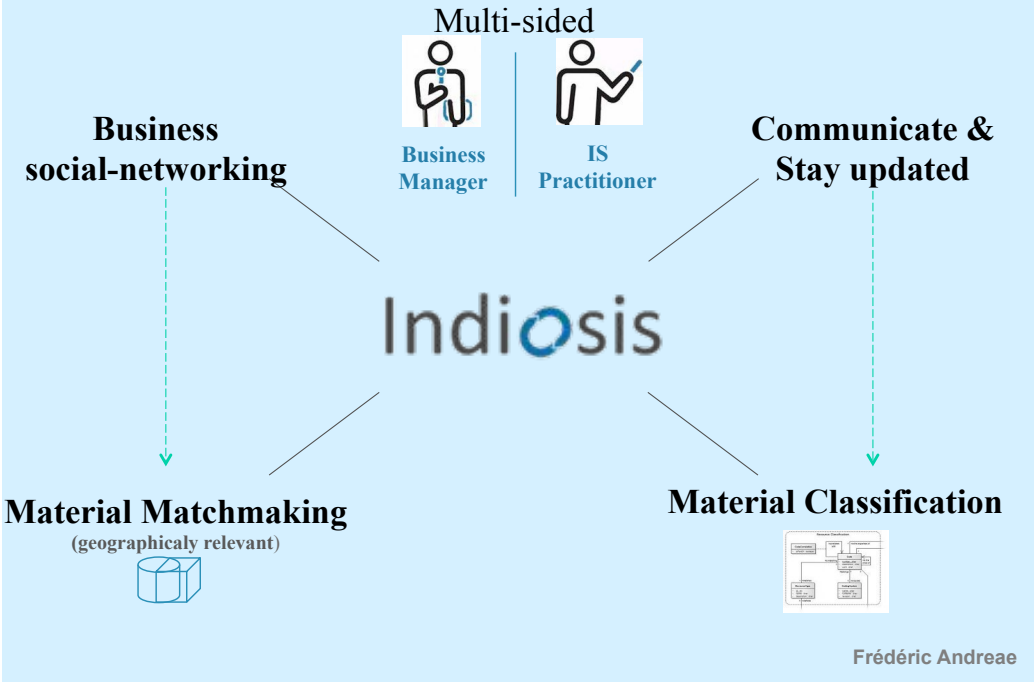


Geographical Information Systems (GIS) for identification of potential synergies

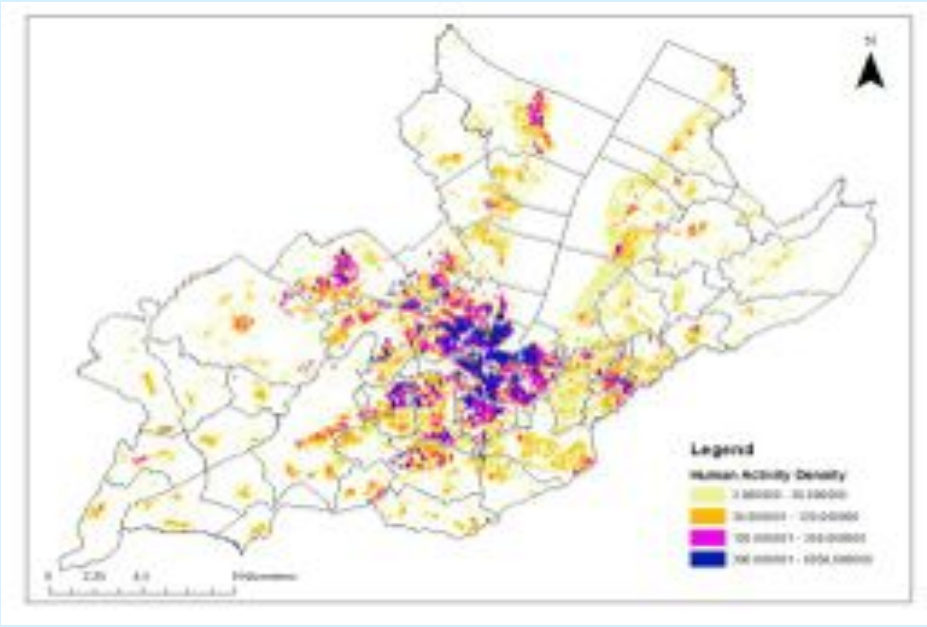
Republic and Canton of Geneva (249 km²)

http://ge.ch/environnement/ecologie-industrielle

Social Platform for IS



Stock of copper in the electrical network (Geneva)



Source: Antoine Fredericq, EPFL

Test wall with recycled gravel (Ecosite, dec. 2002)

Source: D. Chambaz

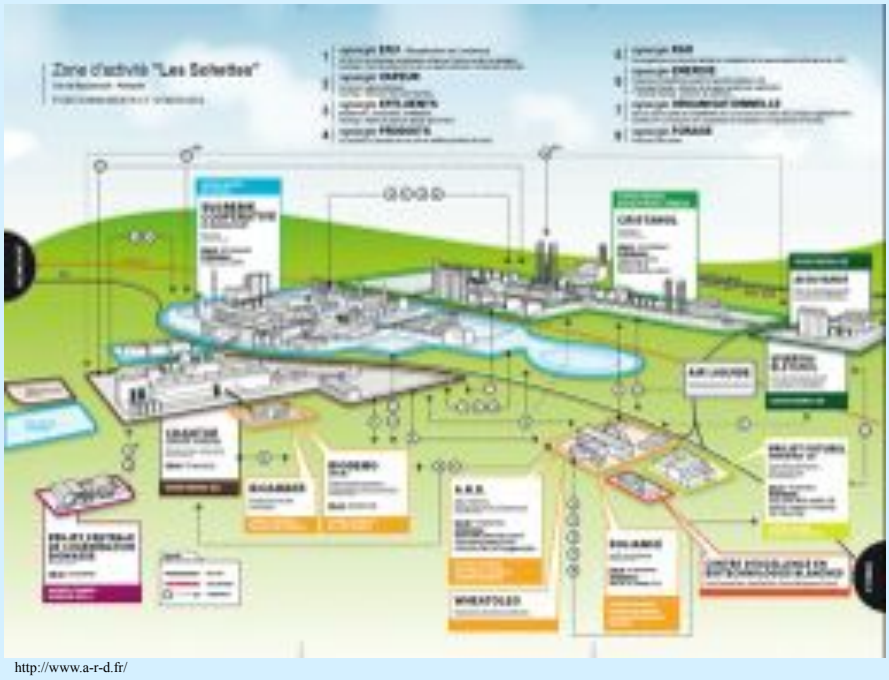
Solutions for Industrial Ecosystems (SOFIES)

Geneva – Zürich – Paris – Bangalore

www.sofiesonline.com

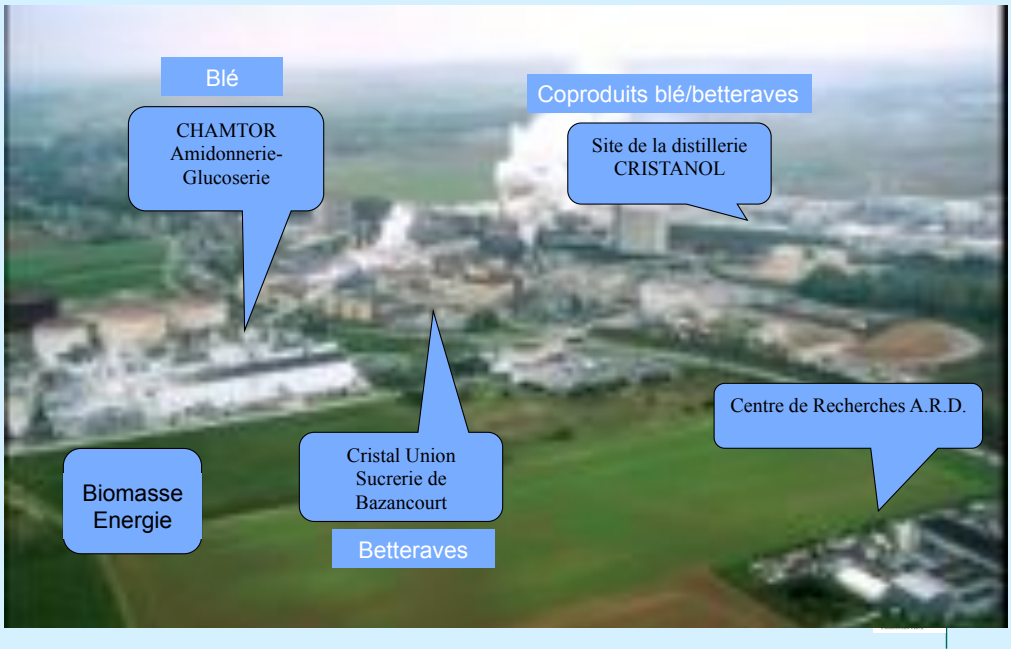
sofies leading sustainability

Bio-based economy – Biorefinery (France)



http://www.a-r-d.fr/

BIORAFFINERIE DE POMACLE-BAZANCOURT (PRÈS DE REIMS)



Biorefineries: diversity of processes

(Un)Sustainable Food Consumption Dynamics in South/Southeast Asia: Changing patterns, practices and policies among "new consumers" in India and the Philippines

Main research question:

In what way are food consumption patterns and practices changing in Bangalore and Metro Manila, in relation to "sustainable consumption" policies, and how does this inform transitions towards "sustainable pathways" ?

Project funded by
Swiss Network for International Studies (SNIS)

Mr. Arab Hoballah
Ms Garette Clark
UNEP/DTIE
Sustainable consumption and production group
Team members: Fanny Demassieux and Fabienne Pierre

Dr. Uma Rani
ILO
International Institute for Labour Studies
Senior development economist

Mayuri Ghosh
Consumer industries and global ladership (NYC)

Understanding (un)sustainable consumption ?

What, how much:
Biophysical perspective: material and energy stocks and flows

?

Why, in what way:
Sociological perspective: consumption behaviour and practices

IE Group at UNIL: recent / ongoing research projects

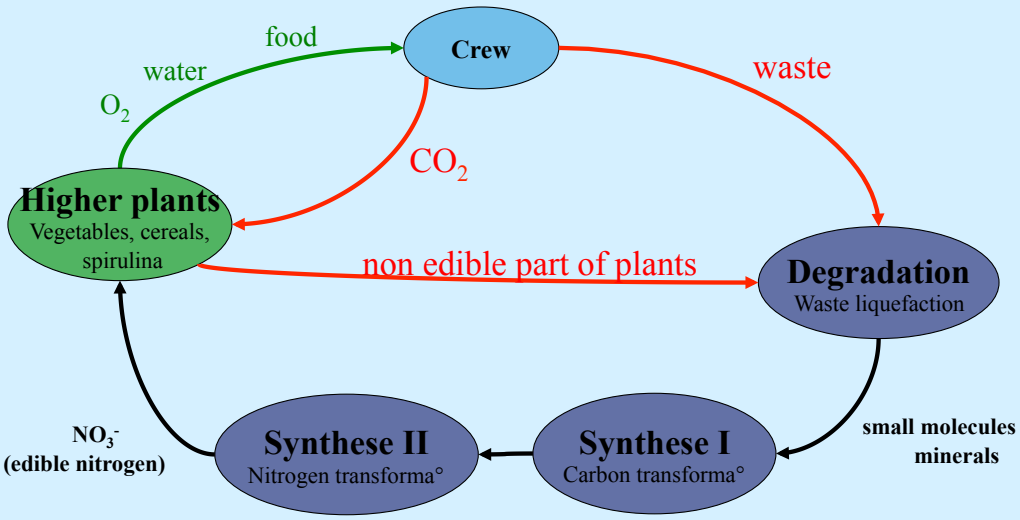
- **Comparative assessment on eco-industrial parks: 46 case studies in 12 countries (UNIDO/SECO)**
- **Methodologies for implementing Industrial Symbioses (BAFU/FP7)**
- **Urban Symbioses for energy efficient and low carbon cities (EPFL/UNIL)**
- **Understanding household electricity consumption (National Research Programme 71)**

IE Group at UNIL: ongoing research projects

- **Scientific traceability of primary gold (isotopic fingerprinting)**
- **Artifical Closed Ecosystems as drivers for eco-innovation (European Space Agency)**
- **«Global Carbon Wealth»: valorization of carbon (EPFL/ UNIL)**

Biological life support system: artificial closed ecosystem (ACE)

Loop with humans, micro-organisms and higher plants



ESA's Melissa pilot plant in Barcelona

Oïkosmos programme: terrestrial research fields

Industrial Ecology

- Fine regulation of ecosystemic conditions
- Cleantech / Material loop closure / Highly efficient recycling systems
- Ecotoxicolgy
- CO_2 valorisation / Biorefinery

Systems Biology ("OMICS")

- Health biomonitoring
- Monitoring of biomolecules systems (genomic, proteomic, metabolomic)
- Functionnal food / Nutrigenomic
- Microbiomic (microbial flora)

Monitoring & Regulation of Artificial Closed Ecosystems

(organisms' health, environmental conditions)

Information and Communication Technologies

- Computational sciences / Bioinformatics / Mobile and ubiquitous computing
- Human-machine interactions
- Embedded technologies / smart monitoring
- Telehealth / Telemedecine

Sustainable Habitat

- Ecohabitat
- Ecomaterials / Advanced materials
- Self-sufficient habitat
- Healthy living habitat
- Autonomous habitat
- Smart building
- Habitability / Ergonomy

Resource management under strong constraints:

Earth Space Technical Ecosystem Enterprises

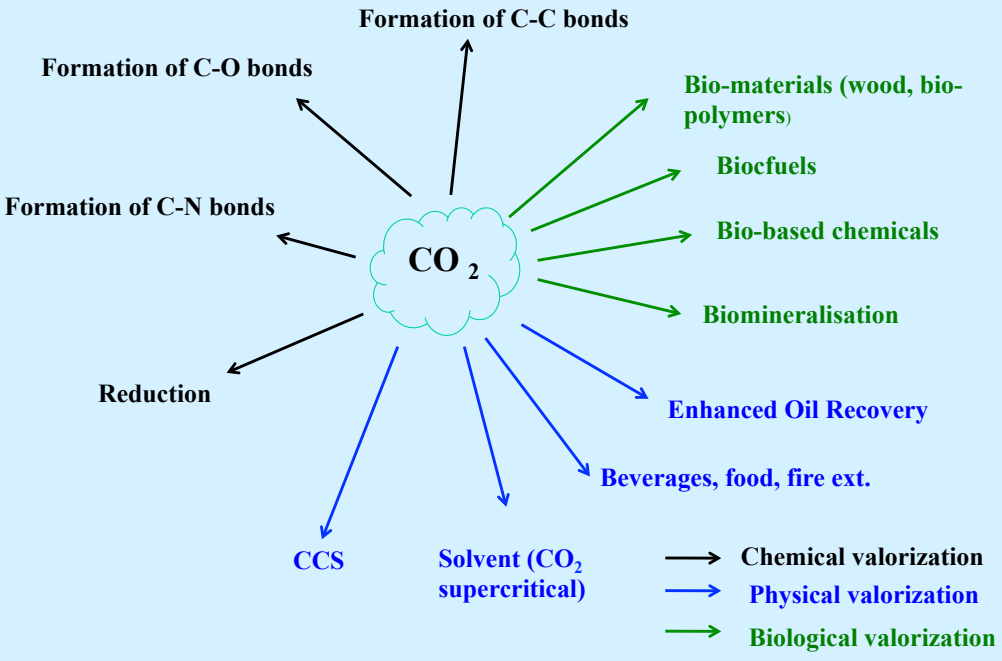
http://est2e.com

ESTEE
EARTH SPACE TECHNICAL ECOSYSTEM ENTERPRISES

Industrial ecology: Towards an anthropogenic carbon cycle

- «Artificial mine» of carbon (gaseous) in the atmosphere
- Idea: «To mine the atmosphere» and valorize the carbon (dioxide)
- Creation of an «anthropogenic cycle of carbon»

«Global Carbon Wealth»: valorisation of CO_2

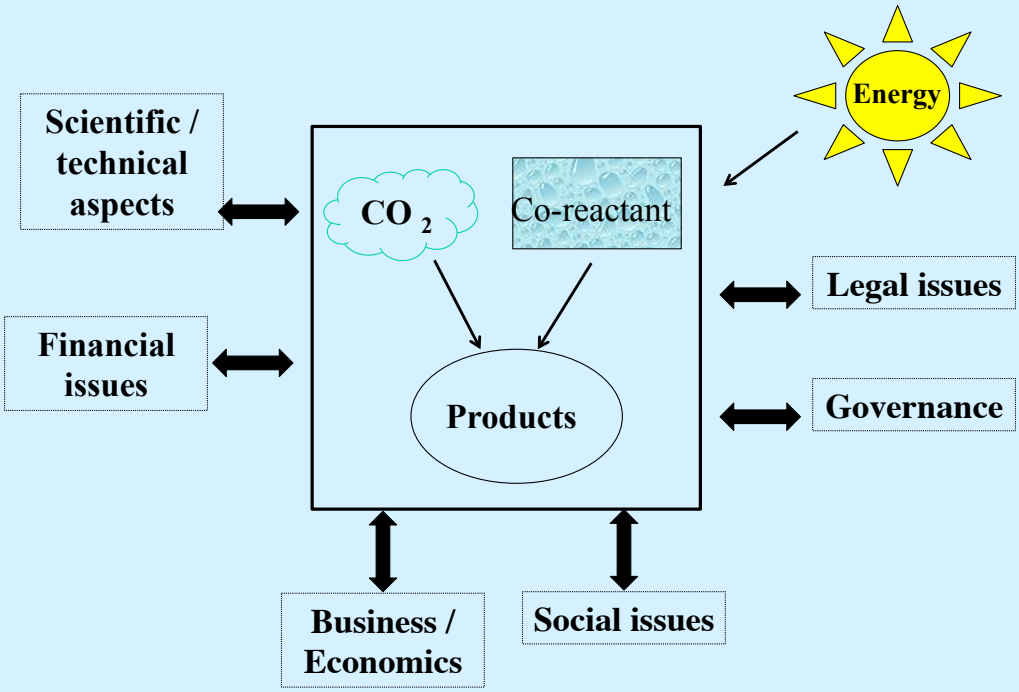


CO_2 utilization in the perspective of industrial ecology, an overview

Frédéric D. Meylan*, Vincent Moreau, Suren Erkman
Institute of Earth Surface Dynamics, University of Lausanne, Switzerland

Contents lists available at ScienceDirect
Journal of CO_2 Utilization
journal homepage: www.elsevier.com/locate/jcou

«Global Carbon Wealth» project



IE Group at UNIL: research projects in preparation

Investigating «blind spots»:

- **Green ergonomics**
- **Social and Solidaristic Economy in the perspective of IE**
- **Resource flows and organized crime**
- **Disruptive technological trajectories**

Technological trajectories : aviation, airports, etc.

Cf. Project Clip – Air: http://clipair.epfl.ch

UNIDO Global Review of Eco-industrial Parks (EIPs) in Developing and Emerging Countries

UNIDO Project Manager: Dr. René van Berkel

International Lead Expert: Prof. Suren Erkman,
Industrial Ecology Group, University of Lausanne

2013 - 2014

UNIDO Global review:

Eco-Industrial Parks in Emerging and Developing Countries: achievements, good practices and lessons learnt

- **Reasons for the project:**

- **Need for RECP upscaling and mainstreaming**

- **Existing studies focus on industrialized countries**

UNIDO Global review:

Eco-Industrial Parks in Emerging and Developing Countries: achievements, good practices and lessons learnt

- **~ 40 industrial estates (including some EIPs)**
- **12 countries: Cambodia, China, Columbia, Costa Rica, El Salvador, Egypt, India, Marocco, Peru, South Africa, Tunisia, Vietnam**

UNIDO Global review:

Eco-Industrial Parks in Emerging and Developing Countries: achievements, good practices and lessons learnt

- **National Assessments: specific case studies of (eco-)industrial parks + national policy reviews**

- **Global Comparative Assessment**

The synthesis in a nutshell:

Governance and management

- **Large number and categories of stakeholders**
- **Lack of cohesion between stakeholders**
- **Many different types of management (PPP, etc.)**
- **Key role of industrial policies**

The synthesis in a nutshell:

Assessment and evaluation

- **Rather rare (with a few exceptions)**

The synthesis in a nutshell:

Challenges and lessons learned

- **Implementation of environmental regulations**
- **Start by entering the «formal» sector…**

Drivers and success factors

- **Physical presence of a «catalyst» on site**

Dunkirk Industrial Harbor: www.ecopal.org

Dunkirk EDF LNG Terminal: ~ 800 million Euros

Storage capacity (- 163 °C) 600'000 m^3

EDF nuclear power plant at Gravelines (6 x 900 MW el.)

EDF LNG Terminal: industrial symbiosis (waste heat)

EDF LNG Terminal: industrial symbiosis (waste heat)

EDF LNG Terminal: industrial symbiosis… waste cold ?

UNIL | Université de Lausanne

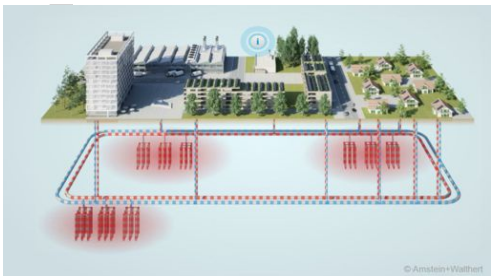
Thank you !

Prof. Suren Erkman: suren.erkman@unil.ch

7.4 District energy systems, a partner of industrial ecology, Dr. Céline Weber

AMSTEIN+WALTHERT





[District energy systems, a partner of industrial ecology]

ISRS, July 6th 2015, University of Lausanne

Dr. Céline Weber, Amstein+Walthert

AMSTEIN+WALTHERT

[Amstein+Walthert]
[District energy systems]
[Examples]
[CO_2 network]
[Conclusions]

Agenda

- Amstein+Walthert
- District energy systems
- Examples
- The CO_2 network
- Conclusions

2

AMSTEIN+WALTHERT

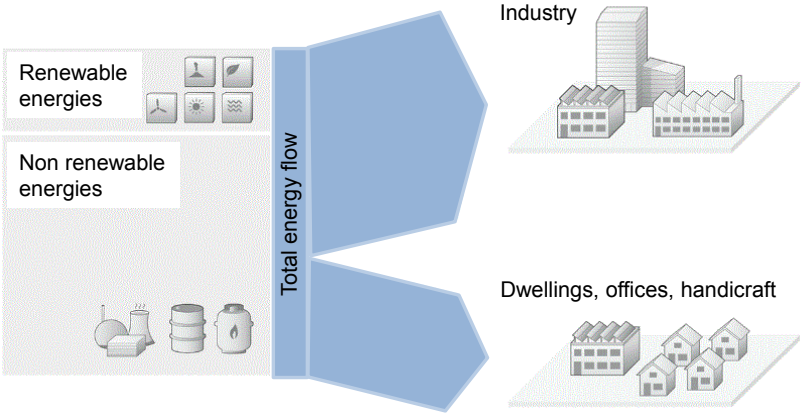
Amstein+Walthert

- Building services consulting company established in 1927
- Our services : **Building services** (Heating, cooling, ventilation, air conditioning, building control, fire safety, lighting design, plumbing, electrical engineering),
  Energy consulting (renewable energy systems design, energy strategies, district energy systems, building modelling and energy systems design, building physics)
- Staff of about 75, including 25-30 PhDs, engineers and university graduates

AMSTEIN+WALTHERT

[Amstein+Walthert]
[District energy systems]
[Examples]
[CO_2 network]
[Conclusions]

Introduction



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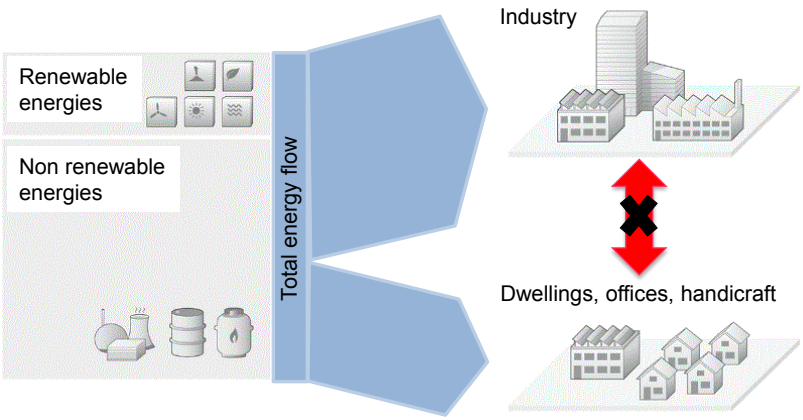
[Amstein+Walthert]
[District energy systems]
[Examples]
[CO_2 network]
[Conclusions]

Tomorrow



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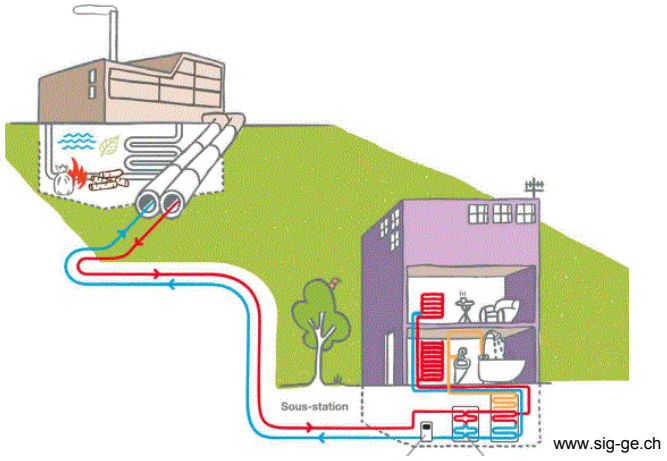
[Amstein+Walthert]
[District energy systems]
[Examples]
[CO_2 network]
[Conclusions]

District heating systems



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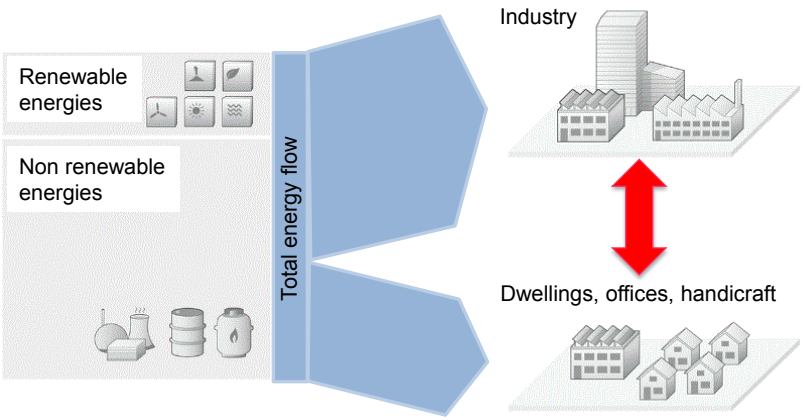
Tomorrow



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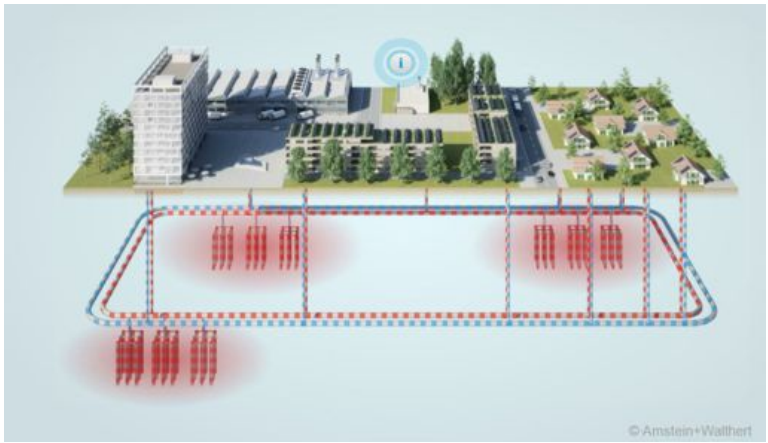
Advanced district energy systems : principles



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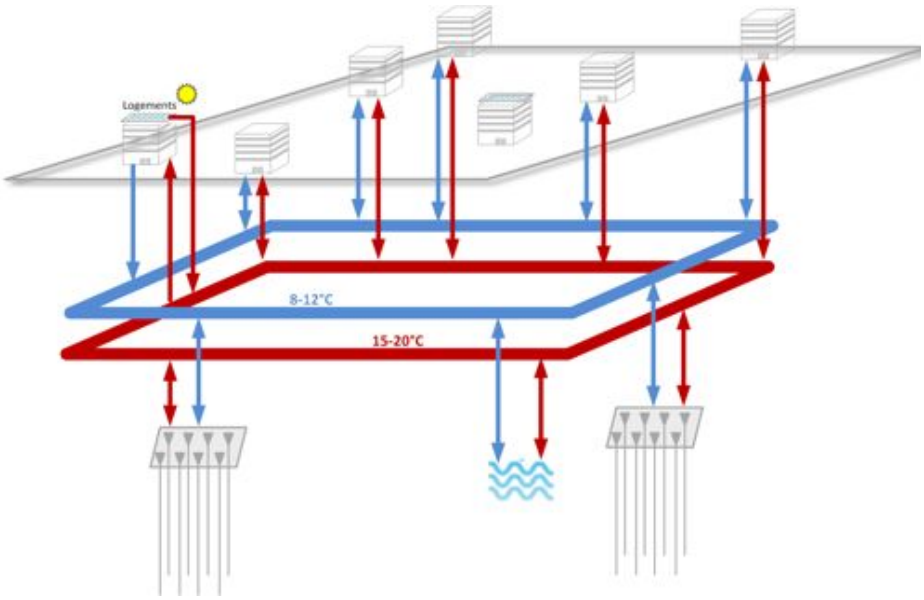
[Amstein+Walthert]
[District energy systems]
[Examples]
[CO_2 network]
[Conclusions]

Advanced district energy systems : technical aspects



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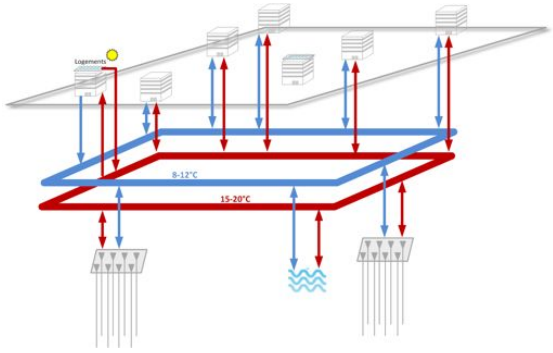
[Amstein+Walthert]
[District energy systems]
[Examples]
[CO_2 network]
[Conclusions]

Advanced district energy systems : technical aspects



- Make of use synergies (industrial symbiosis) instead of making use of non renewable energies
- Reduce waste heat
- Foster the utilization of local renewable energies
- Free up the space required for towers and chimneys on the roofs

10

Legal aspects

- Heat provider :
  - accepts to make his heat available for others, via the district energy system,
  - ensures that the space needed to put in place any required equipment is available (heat exchanger, pipes,…).
- Heat consumer :
  - accepts to make use of the waste heat (as far as needed),
  - ensures that the space needed to put in place any required equipment is available (heat exchanger, pipes,…).
- Energy service company :
  - sets up the financial arrangement to support the investment and operation of the system,
  - guarantees heating and cooling at any time for allt he consumers (n.b.: a heat provider can become a heat consumer and vice-versa)

11

Examples

12

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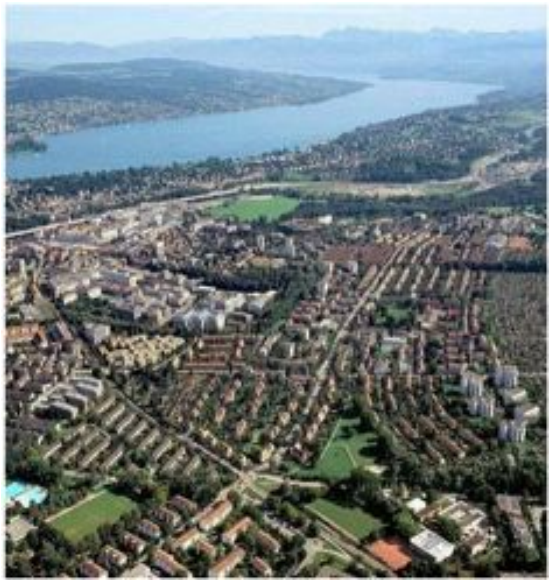
[Amstein+Walthert]
[District energy systems]
[Examples]
[CO_2 network]
[Conclusions]

Advanced district energy systems



5'500 inhabitants
ERA: 167'850 m^2
Heating : 35 GWh/an
DHW : 3 GWh/an

13

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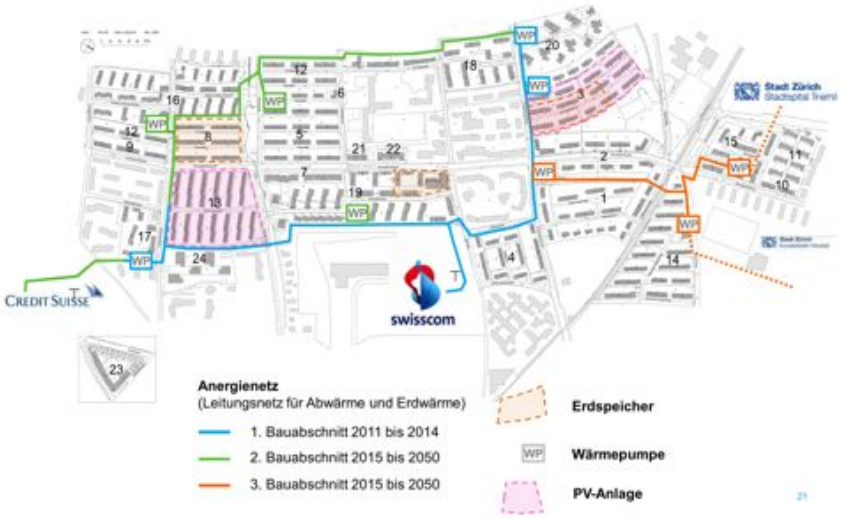
[Amstein+Walthert]
[District energy systems]
[Examples]
[CO_2 network]
[Conclusions]

Advanced district energy systems



14

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Advanced district energy systems

Energy price : 18 cts/kWh

15

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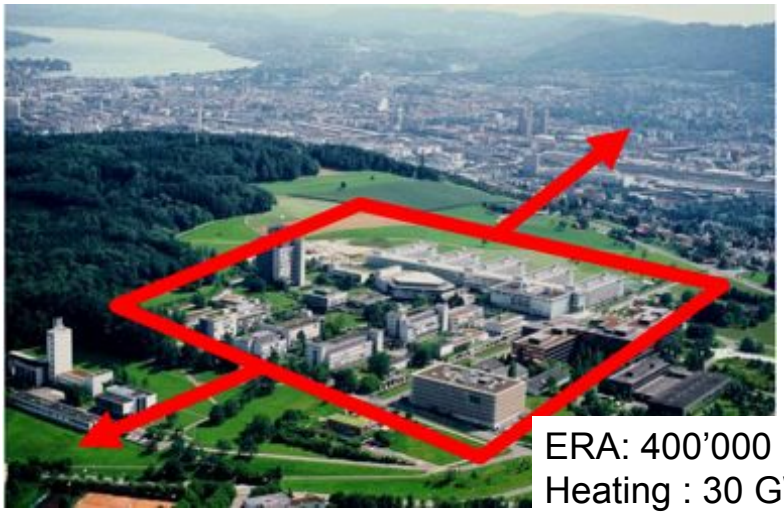
[Amstein+Walthert]
[District energy systems]
[Examples]
[CO_2 network]
[Conclusions]

Advanced district energy systems



ERA: 400'000 m^2
Heating : 30 GWh/an
Cooling : 13 GWh/an
Geothermal storage

16

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[District energy systems]
[Examples]
[CO_2 network]
[Conclusions]

Advanced district energy systems

Energy price : 12 cts/kWh

17

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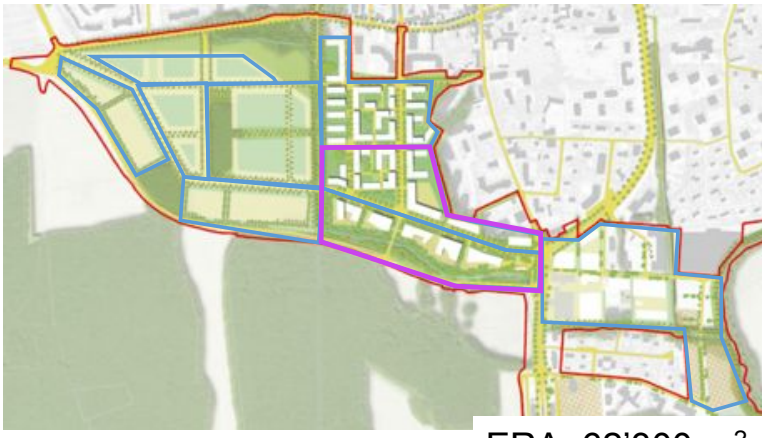
[Amstein+Walthert]
[District energy systems]
[Examples]
[CO_2 network]
[Conclusions]

Advanced district energy systems

18

Advanced district energy systems



ERA: 62'300 m^2
Heating : 3 GWh/an
Cooling : 1 GWh/an
Geothermal storage

19

CO_2 Network

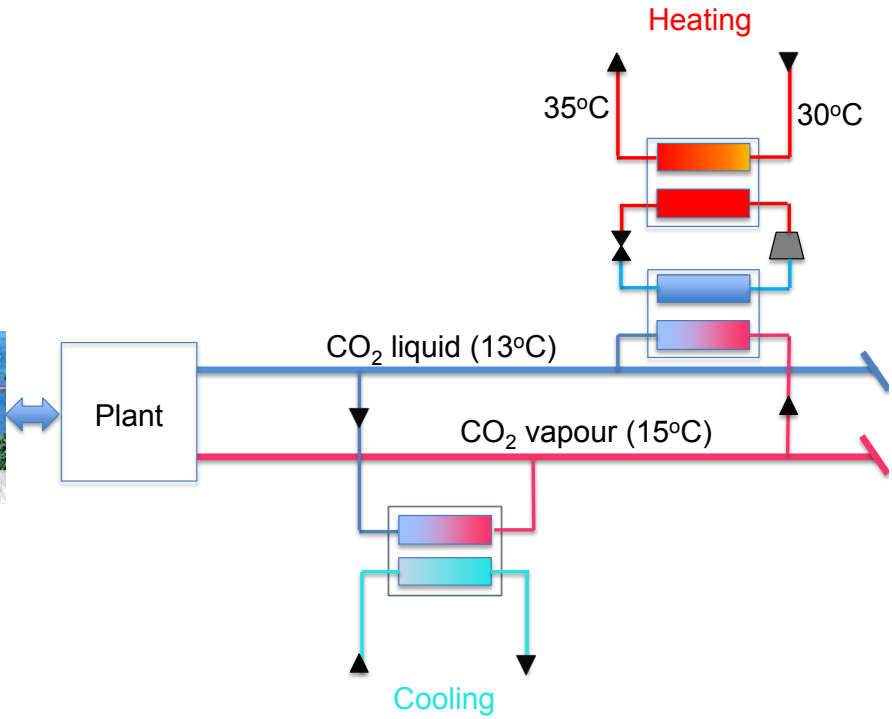
- Water is not welcome everywhere
- Use latent heat of CO_2 => Smaller pipe diameters
- Better heat transfer coefficients
- Non toxic, non flammable working fluid
- Allows more features than a water network

20

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

AMSTEIN+WALTHERT

CO_2 Network



ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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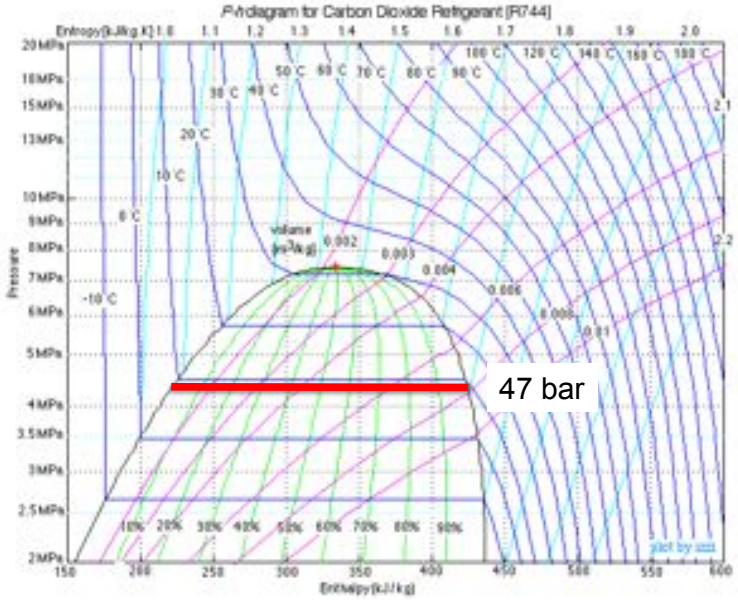
CO_2 Network

[Amstein+Walthert]
[District energy systems]
[Examples]
[CO_2 network]
[Conclusions]

http://www.ville-geneve.ch

CO_2 Network : Challenge



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CO_2 Network : Challenge

R&D work in progress with EPFL and SIG

Conclusions

Advanced district energy systems :

- make use of synergies between consumers and thus have better overall performance than conventional systems,
- Are able to meet the needs according to customers' specific requirements despite the timely mismatch between cooling and heating profiles,
- foster industrial symbiosis between buildings and the use of local renewable energies, thus reducing the CO_2 emissions,
- are independent of international energy prices,
- are still at an early stage of development and suffer from slightly higher prices than conventional systems => can suffer from a lack of acceptability among the wider public,
- require an adequate mix of buildings, which is not often given in European cities, given the history of our cities.

[QUESTIONS ?]

Thank you very much for your attention

Dr. Céline Weber

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7.5 Industrial Symbiosis Dynamics and the Problem of Equivalence, Prof. Frank Boons, Prof. Marian Chertow, Wouter Spekkink, Prof. Joo Young Park, Prof. Shi Han

Industrial Symbiosis Dynamics and the Problem of Equivalence

Discussing a comparative framework

Frank Boons, University of Manchester
Marian Chertow, Yale School of Forestry
Wouter Spekkink, Delft University of Technology
(with: Joo Young Park, Universidad de los Andes &
Shi Han, City University of Hong Kong)

This presentation is based on:
Industrial Symbiosis Dynamics and the Problem of Equivalence: Proposal for a Comparative Framework, Journal of Industrial Ecology (accepted for publication)

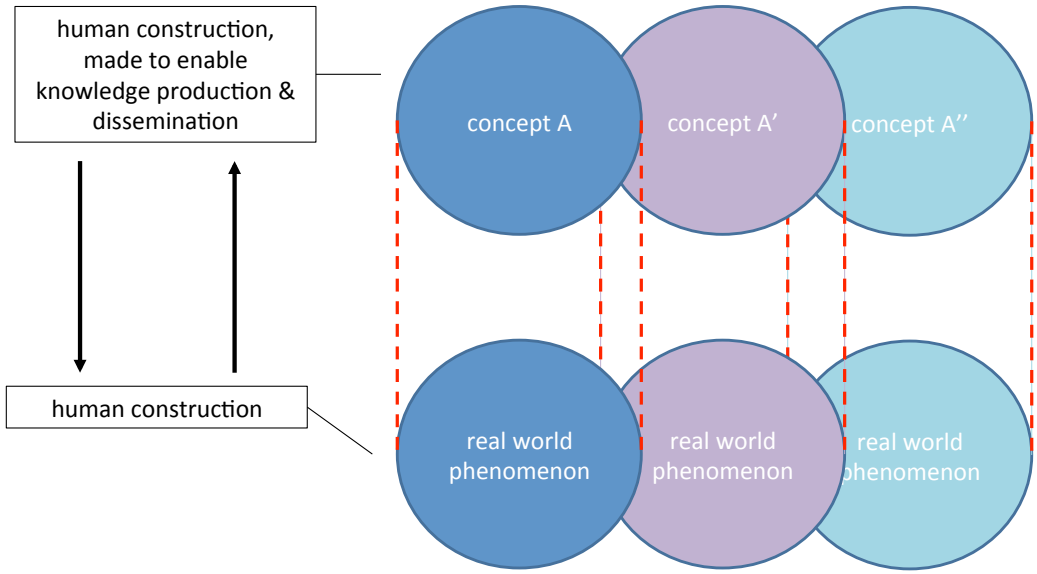
Background

- In recent years we have witnessed a growing interest in comparative research on IS
  - 8th Annual Industrial Symbiosis Research Symposium (2011)
  - European network of researchers (2010)
- Diversity of industrial symbiosis:
  - The emergence and development of industrial symbiosis (process) unfolds in different ways around the world
  - The type of industrial symbiosis networks that result from these dynamics (outcomes) are also diverse
- Ambition: How can we effectively build on this diversity?

Overview

- The problem of equivalence in comparative research
- A way forward in two parts
- Discussion

The problem of equivalence in comparative research



the problem of equivalence:

When we compare, we study variations in a certain social phenomenon:

- How can we distinguish the variation from the commonalities?
- Our definitional struggle is to some extent a product of the diverse (institutional) contexts from which we come (which produces the phenomenon in co-evolution with the concepts)

A way forward 1: Vocabulary

if our concepts are part of, or at least influenced by, the phenomenon we study, then:

- arriving at a shared definition is extremely difficult;
- having a shared language to discuss conceptual differences is vital
- we need explicit accounts of how specific concepts come about

→ **a vocabulary**

(sneek peek into the vocabulary)

- A process of connecting flows…
  - Industrial symbiosis as a sequence of events
  - Build up, maintenance and dissolution of connections between actors
  - ***IS dynamics***: typical pathways through which IS unfolds
- …between economic actors…
  - Firms, governments and NGOs
  - A network of actors (at least three)
- …through he use of secondary resources…
  - Materials that are being put to circular use after being generated by a process of production or prior use
  - Utility and service sharing also included

(sneek peek into the vocabulary)

- …which entails, to varying degrees, the mobilization of intangible resources…
  - Intellectual capital
  - Social capital
  - Focus on coordinated activities (e.g. joint visioning, negotiation, policy making)
- …and is distinguishable from other multi-actor economic processes by its recognition of environmental benefits from connecting flows.
  - Intentional or unintentional
  - Long term or short term

A way forward 2: Dynamics

Typology is a form of theory building (Doty and Glick 1994), when:

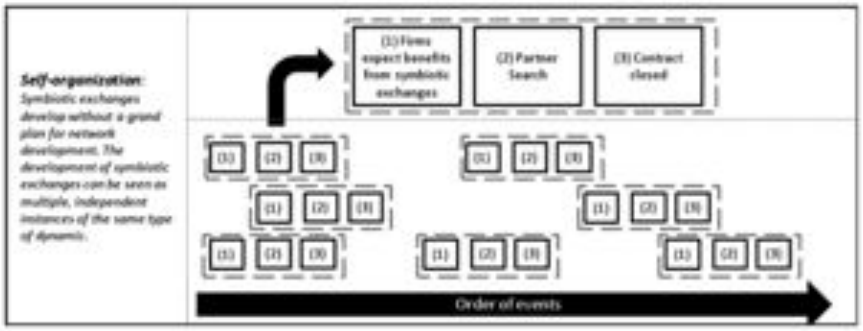
- we aim beyond classification/taxonomy (which calls for mutually excluding, logical categories)
- but instead define types in terms of empirically distinguishable combinations of elements that together produce a certain outcome (cfr. ideal types, Weber)

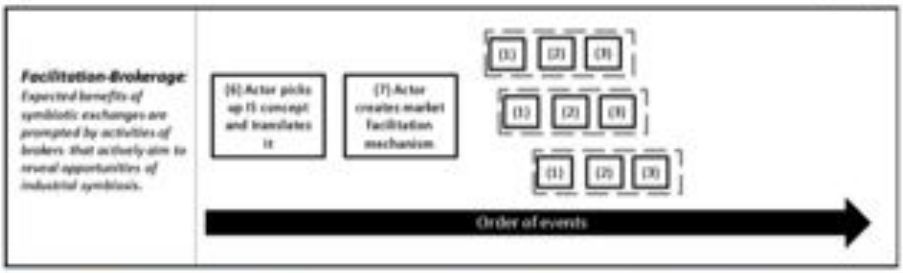
→ we propose a typology of IS dynamics

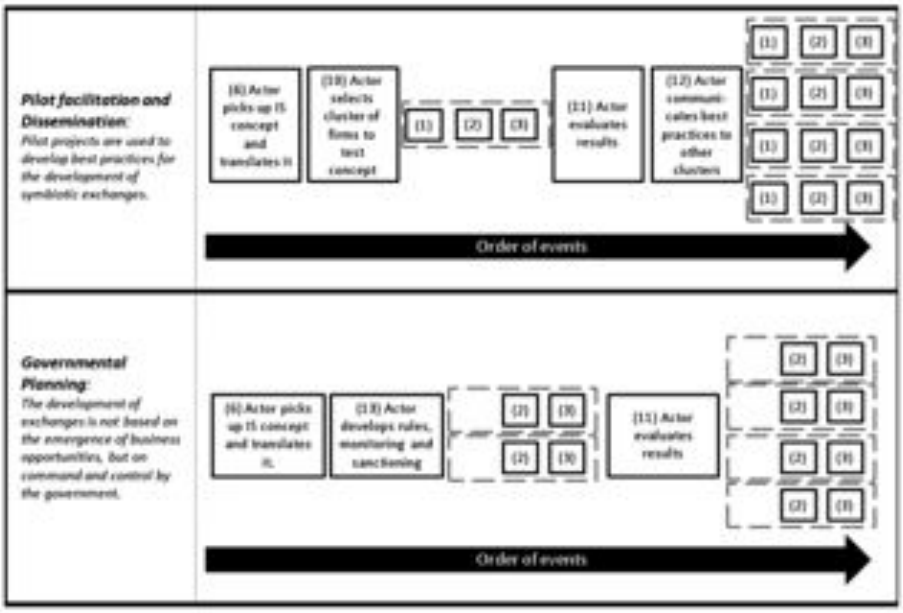
IS Dynamics (theory building)

- A number of typical pathways to IS can be identified based on existing empirical material
- The number will expand over time (empirical calibration)
- Each dynamic is identified by
  - initial actor(s)
  - actor motivations
  - actions
  - overall storyline (composition and sequencing of dynamic)
  - outcomes

Dynamics Typology	Initial Actor(s)	Motivation of the Initial Actor(s)	Following Actions / Overall Storyline
Self-organization	Industrial actor	See economic and/or environmental benefits from IS	industrial actors expect benefits in developing symbiotic linkages → industrial actors search for suitable partners (existing partners in vicinity or new partners attracted from further away) → after finding a suitable partner, contracts are negotiated → linkage becomes operative → [repeat]
Organizational Boundary Change	Industrial actor	Eco-efficiency and business strategy	An industrial actor expands its activities through vertical integration and develops internal exchanges → the industrial actor changes its strategy from vertical integration into outsourcing → the linkages remain and the system evolves into an inter-organizational network.
Facilitation- Brokerage	A public or private third-party organization	Establish/increase transparency of market for firms to develop IS	A third-party organization sets up a brokerage system → the broker establishes a market for industrial symbiosis development → industrial actors engage and develop symbiotic exchanges through the market system
Facilitation – Collective Learning	A public or private third-party organization	Enable firms to develop tacit knowledge and exchange experiences	A facilitator picks up the concept of industrial symbiosis from existing examples → the concept is translated into specific regional context → industrial actor and facilitator engage in collaborative learning to develop symbiotic network.
Pilot Facilitation and Dissemination	A public or private third-party organization	Learn from non-local existing IS cases and experiment in a local context	A facilitator picks up the concept of industrial symbiosis from existing examples → the concept is translated into specific national/regional context → groups of co-located industrial actors are selected to serve as exemplary cases → further refinement of the concept occurs through learning in pilot projects → the experiences from pilot projects are transmitted by the facilitator to other groups of co-located industrial actors.
Government Planning	Governmental actor(s)	Learn from existing IS cases and implement	A governmental actor picks up the concept of industrial symbiosis from existing examples → the concept is included in policies and translated to the specific national/regional context → the governmental actor develops a plan for the development of linkages through stimulating and/or enforcing policy instruments → the progress of implementation is monitored → the results of evaluations are fed back into the policy to realize continuation/renewal/closure.
Eco-Cluster Development	Governmental and/or industrial actors	Innovation, economic development	Local governments and/or industrial actors develop a strategy for the development of an eco-cluster → symbiotic linkages are developed through participatory process among multiple stakeholders as part of the broader eco-innovative strategies.

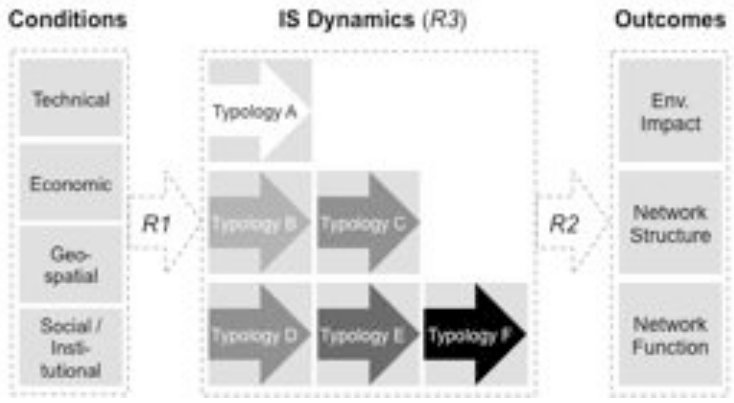

Self-organization:
Symbiotic exchanges develop without a grand plan for network development. The development of symbiotic exchanges can be seen as multiple, independent instances of the same type of dynamic.
(1) Firms expect benefits from symbiotic exchanges
(2) Partner Search
(3) Contract closed
Order of events


Facilitation-Brokerage:
Expected benefits of symbiotic exchanges are prompted by activities of brokers that actively aim to reveal opportunities of industrial symbiosis.
(6) Actor picks up IS concept and translates it
(7) Actor creates market facilitation mechanism
Order of events


Pilot facilitation and Dissemination:
Pilot projects are used to develop best practices for the development of symbiotic exchanges.
(8) Actor picks up IS concept and translates it
(10) Actor selects cluster of firms to test concept
(11) Actor evaluates results
(12) Actor communicates best practices to other clusters
Order of events
Governmental Planning:
The development of exchanges is not based on the emergence of business opportunities, but on command and control by the government.
(9) Actor picks up IS concept and translates it
(13) Actor develops rules, monitoring and sanctioning
(11) Actor evaluates results
Order of events

Research questions

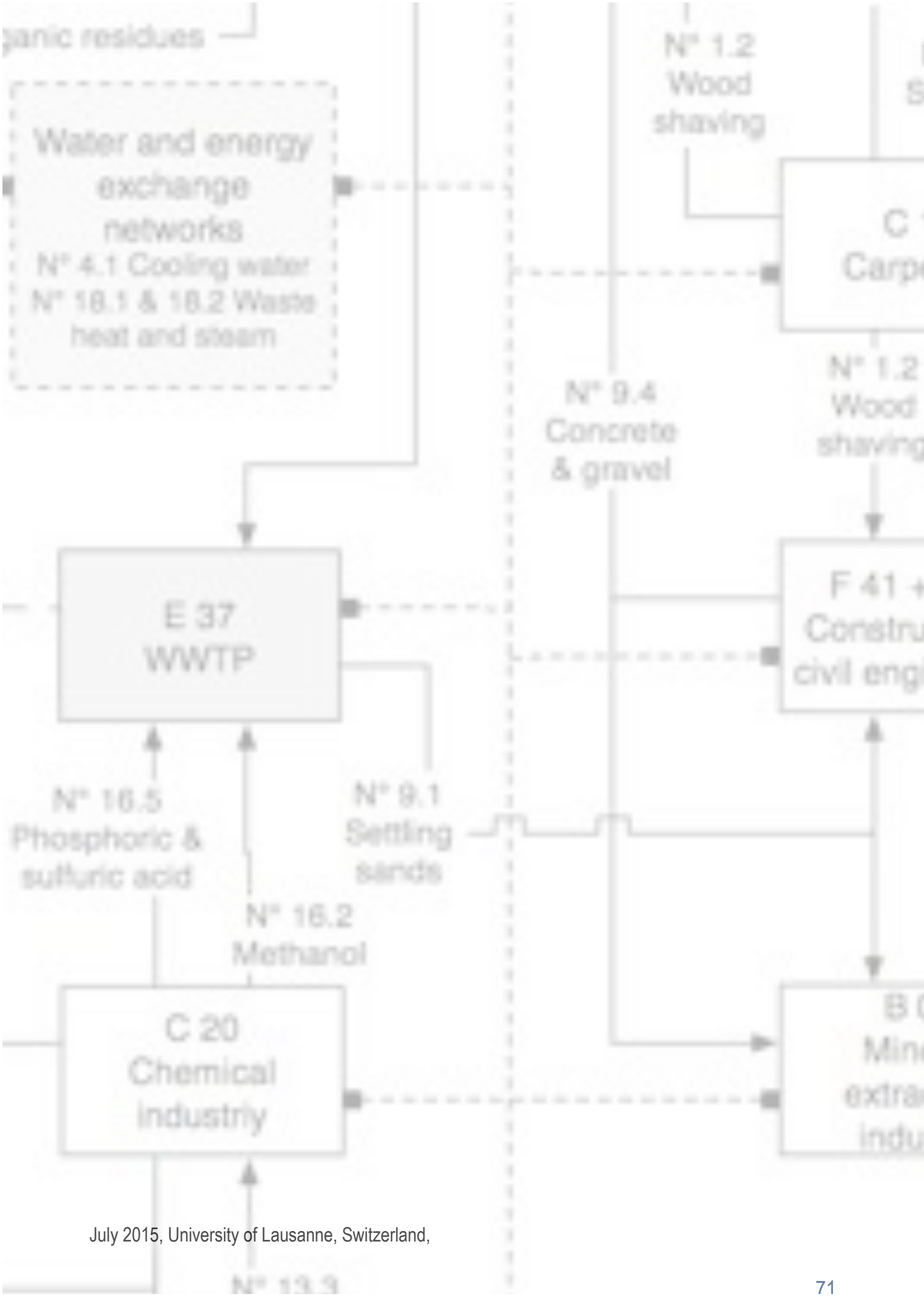
1. *Are different dynamics triggered under specific conditions?*
2. *What outcomes are linked to different types of dynamics?*
3. *How do dynamics add up into phase models?*



Themes for discussion

A. Does the approach of "IS vocabulary & dynamics" provide a conceptually useful path forward ?
B. Does the typology represent an advance and do the similarities and differences of this particular set of dynamics seem clear? Should other dynamics be added or currently proposed ones be altered?
C. Do the ideas presented for accomplishing comparative analysis offer advances for research designs in IS?
D. [theme X]

Thank you!


ganic residues
Water and energy exchange networks
N° 4.1 Cooling water
N° 18.1 & 18.2 Waste heat and steam
N° 1.2 Wood shaving
N° 9.4 Concrete & gravel
E 37 WWTP
N° 16.5 Phosphoric & sulfuric acid
N° 16.2 Methanol
N° 9.1 Settling sands
C 20 Chemical industry