SYMBIOSIS
INDUSTRIEL COOPERATION

by

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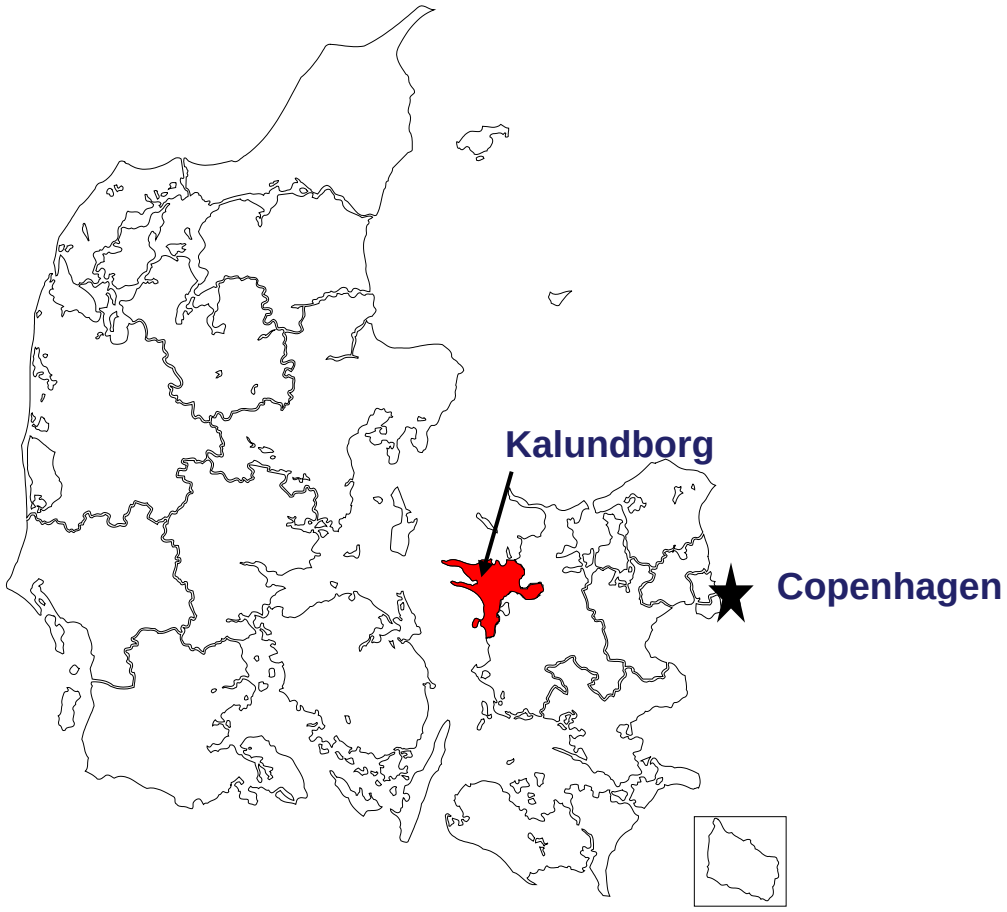
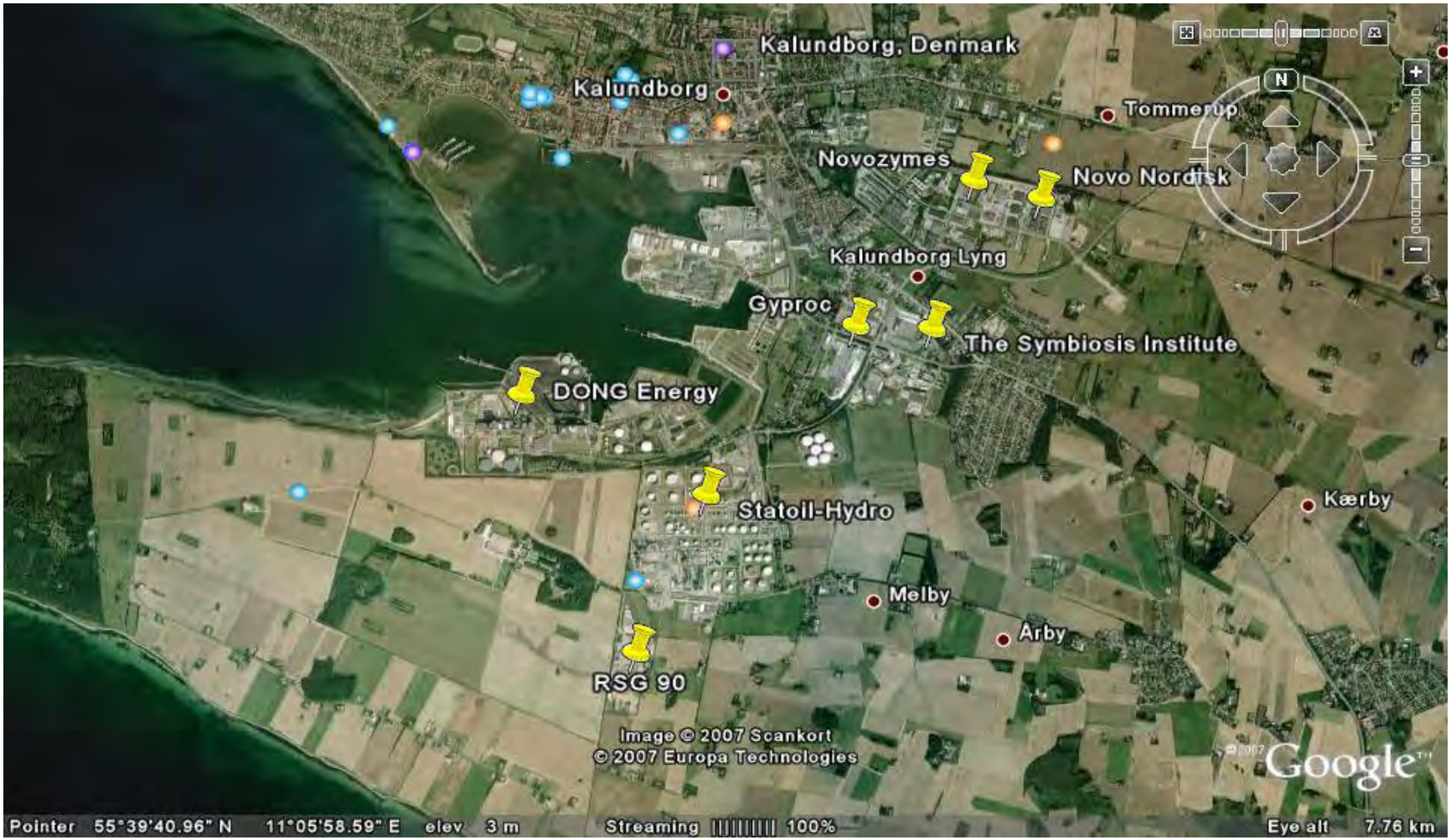

Kalundborg
Copenhagen

Kalundborg Symbiosis



The Industrial Symbiosis at Kalundborg

is a resource and environmental network,

consisting of more than thirty agreements between five industries, two waste handling companies, a wastewater treatment plant and the municipality.

Asnæs Power Station

Production of **electricity and heat**

120 employees

Denmark's largest power station

DONG energy

Statoil Refinery

Production of petrol and other oil-based products

350 employees

Denmark's largest oil refinery.

NOVO NORDISK A/S

Production of insuline etc.

Altogether >4000 employees

NOVOZYMES A/S

Production of industrial enzymes

Gyproc

Production of plaster boards.

165 employees

RGS 90

Remediation of 250.000 tons oil and metal polluted soil per year.

65 employees

KARA/NOVEREN

Waste handling company, owned by 9 municipalities.

Kara/Noveren handles 350.000 tonnes of waste per year, recycling 82%

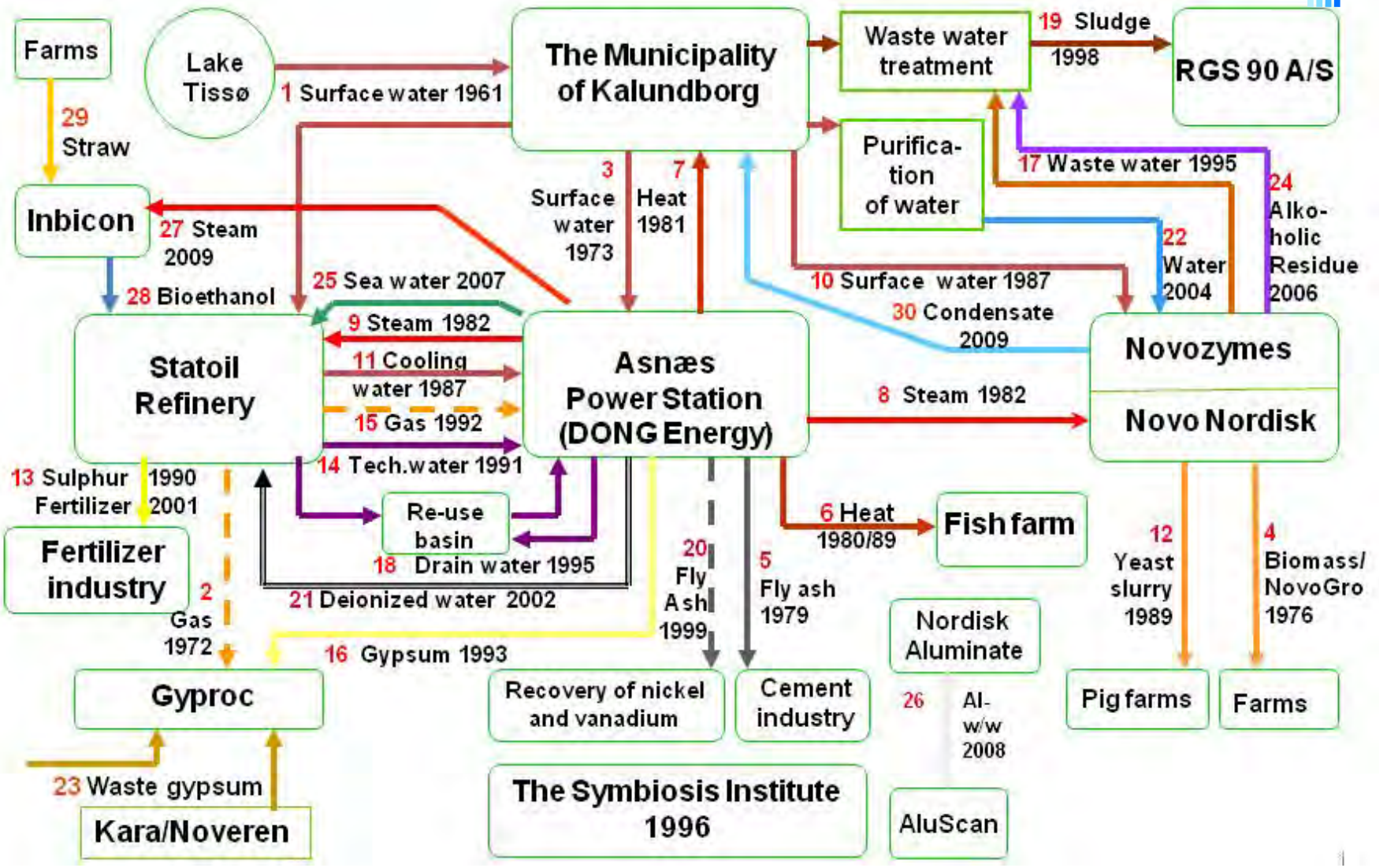
KARA / NOVEREN
- SIKKERHED FOR MILJØET

Kalundborg Community

Supply of water and heat

50,000 inhabitants

The Symbiosis projects 2010



What is Industrial Symbiosis?

Our definition of
Industrial Symbiosis:

It is collaboration between different industries for mutual economic and environmental benefit

Principles for a Symbiosis project:

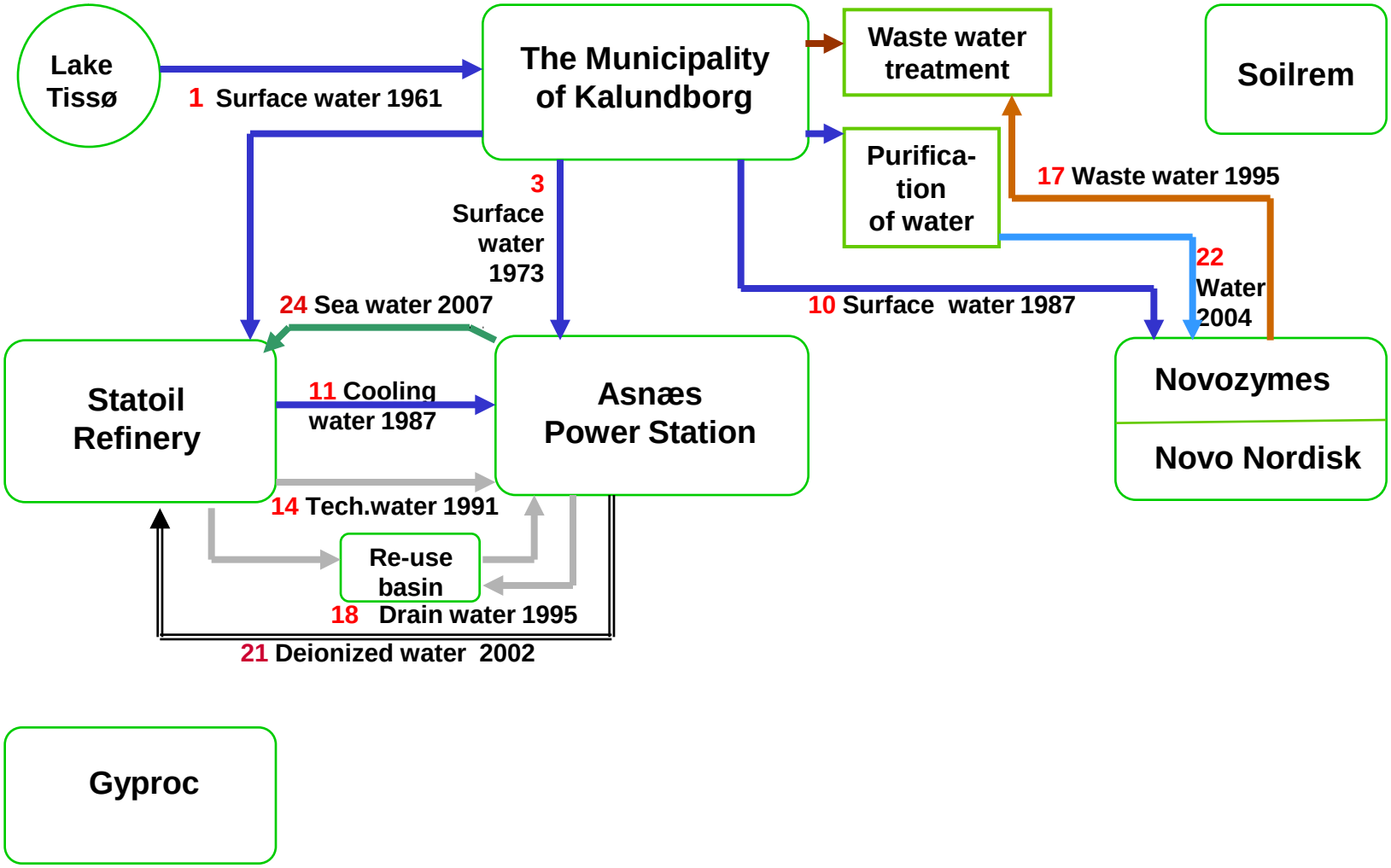
- ”Someone’s waste is another one’s raw material”
- Economically and environmentally profitable
- Partners should be independent (”across the fence”)

Three types of projects:

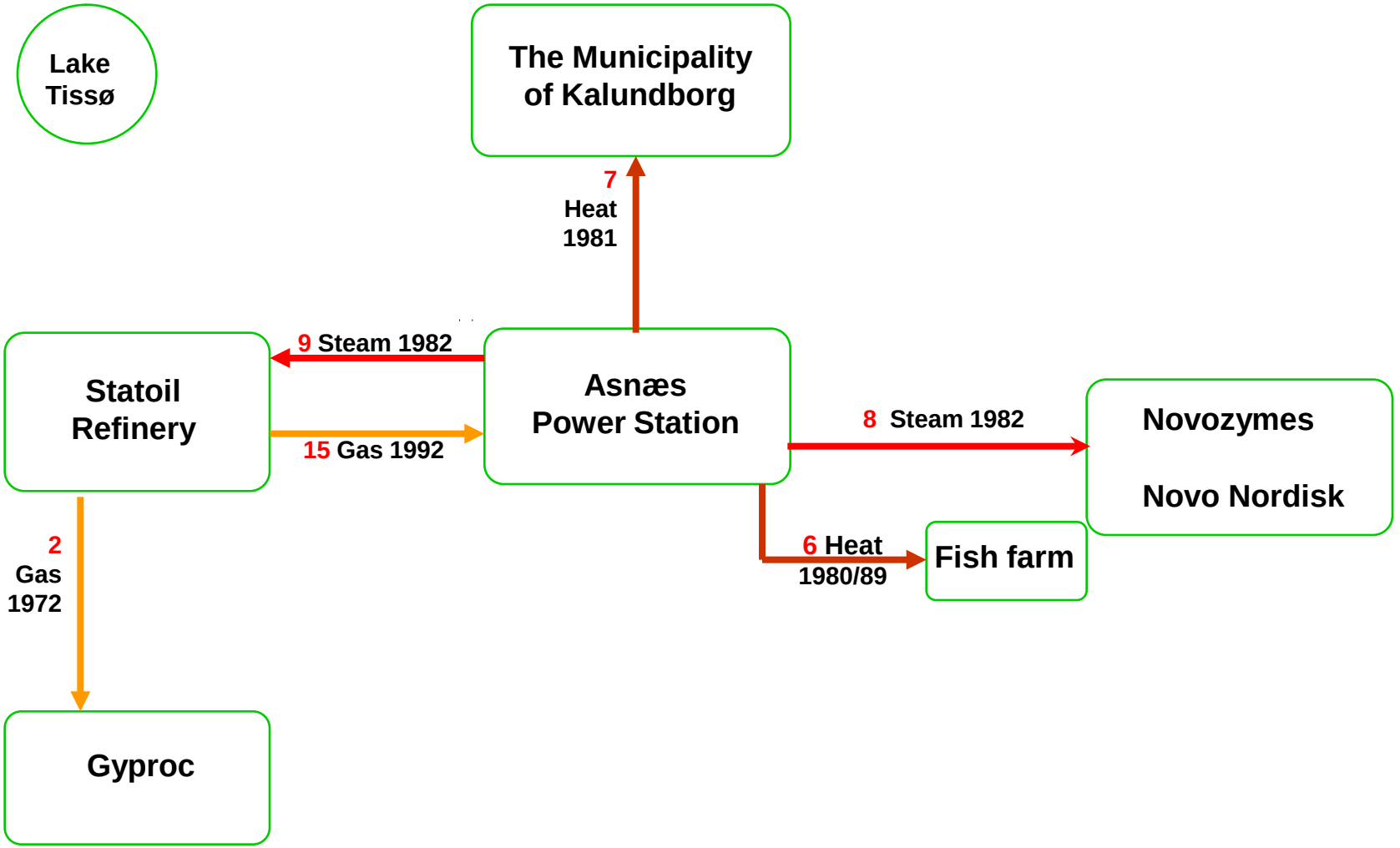
Recycling of water:	14 Projects
Exchange of energy:	7 Projects
Recycling of waste products:	12 Projects

+ a special project: The Industrial Symbiosis Institute

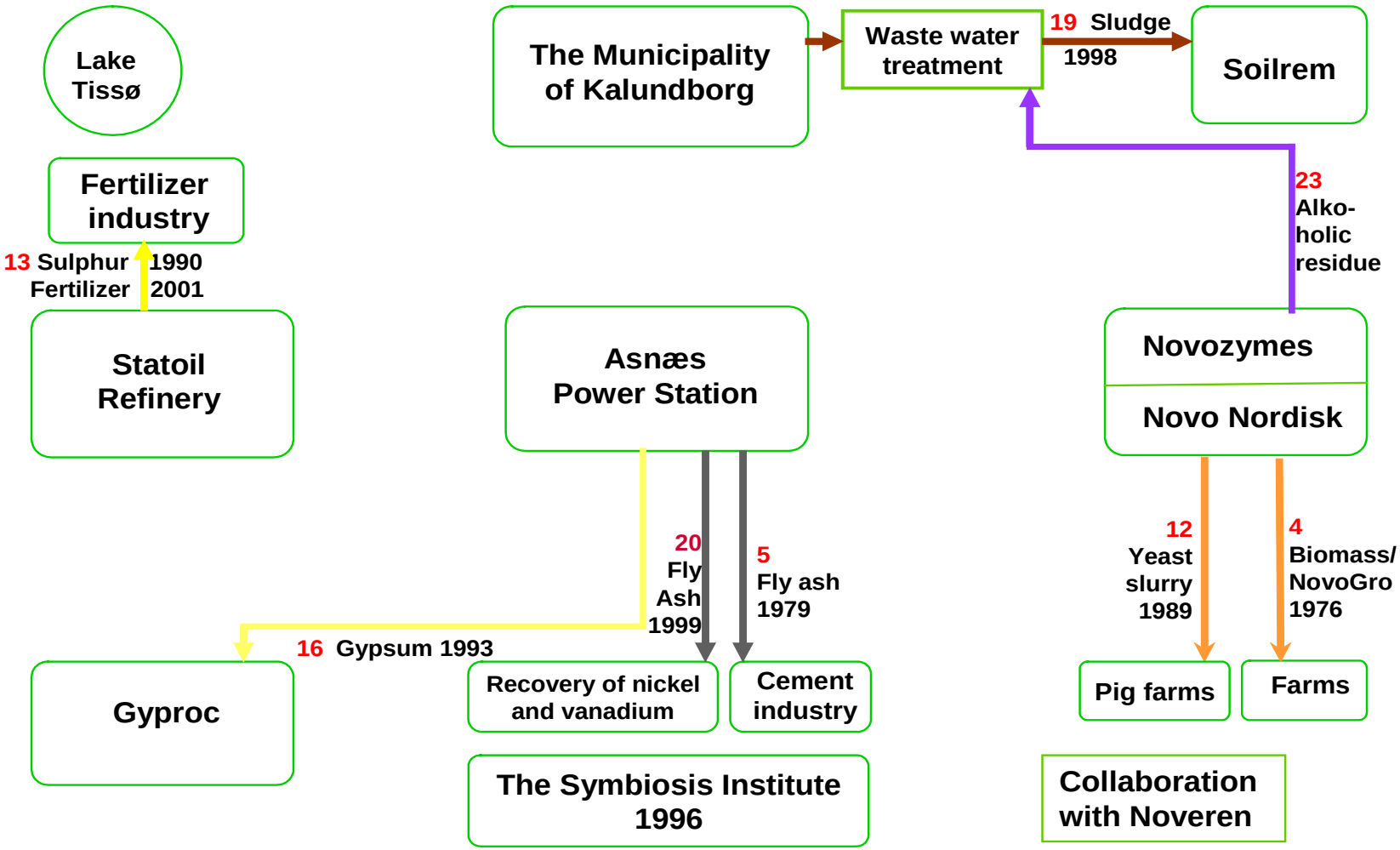
WATER PROJECTS



ENERGY EXCHANGE



(SOLID) WASTE EXCHANGES



Gypsum production in 2009

98.039 tons from Asnæs block 5

How did the symbiosis develop?

- A “non-project” made by a “non-organization”
- Not invented, but evolved through 3 decades
- Not by one person, but by many
- Projects were initiated independently
- The name “Industrial Symbiosis” was not introduced until 1989
- After that, the “symbiotic consciousness” spread

Why did it evolve at Kalundborg?

- The industrial potential existed:
  - Several large industries
  - Limited physical distances
  - ”A good fit”
- The economic incentive existed
- There were no legal barriers
- The communication was good

Resource savings.
Examples:

- Ground water …….. 1,9 mill. m^3/year
- Surface water …….. 1,0 mill. m^3/year
- Natural gypsum …….. 200,000 tonnes/year
- Oil ……20,000 tonnes/year

Reduction of emissions to water and air
is E.g. 240.000 t CO_2 per year.

- Economic Results (as of 1998):

- Total investments in 18 projects: ~ 75 mio. US$
- Annual savings: > 15 mio. US$
- Total savings until 1998: ~ 160 mio. US$

- The economic results is much better to-day!

Important factors for an industrial symbiosis:

- Participants must fit, but be different.
- Projects must be environmentally and commercially attractive
- There has to be a short physical distance between the participants.
- There has to be a short mental distance between the participants.
- Communication is more important than technology.

Lessons to be learned from Kalundborg:

- The Kalundborg I.S. is a spontaneously developed network, - a bottom-up, not a top-down phenomenon.
- Economy was the initial incentive, - environmental idealism came later
- In practice, the mutual dependence between the partners has never been a problem
- Kalundborg has been used as a model for other IS projects
- Regulation can be an incentive to projects, but may also become a barrier
- Communication is more important than technology.

Systems make it possible,

- but people make it happen!