MATERIAL RECYCLING AND BIOLOGICAL WASTE TREATMENT FOR BIOGAS AND NUTRIENT RECOVERY– Important parts in a CO2 smart and circular economy

PROFESSOR TORLEIF BRAMRYD

Material recovery

- Waste avoidance
- Waste minimization
- Source separation of recyclable material (curb side collection)
- Recycling stations
- Mixed recyclable factions to central sorting

PURPOSES OF BIOLOGICAL WASTE TREATMENT

1. Nutrient recovery (in solid or liquid form)

2. Humus production

3. Bio-energy recovery

4. Stabilization (pre-stabilization or in-situ stabilization before landfilling)

5. Detoxification (contaminated soils, a.s.o.).

Biological treatment techniques

- Composting for production of soil improvement

- Anaerobic fermentation for biogas production (new chemicals, fuel for vehicles, electricity, heat)

- Phyto-remediation

AVAILABLE RAW MATERIAL

- Source separated food waste (industry and municipal)
- Residual waste (slow processes where cellulose is hydrolyzed) (reactor cells, biocell reactors, reactor landfills, a.s.o)
- Energy crops (some waste derived, fertilized with leachates, fermentation residues or compost)
- Agricultural crops

LUNDS UNIVERSITET

DIFFERENT FERMENTATION ALTERNATIVES

- Closed reactor fermentation (liquid or solid phase). Ca 100 m3 biogas per ton. Process time 3 weeks.

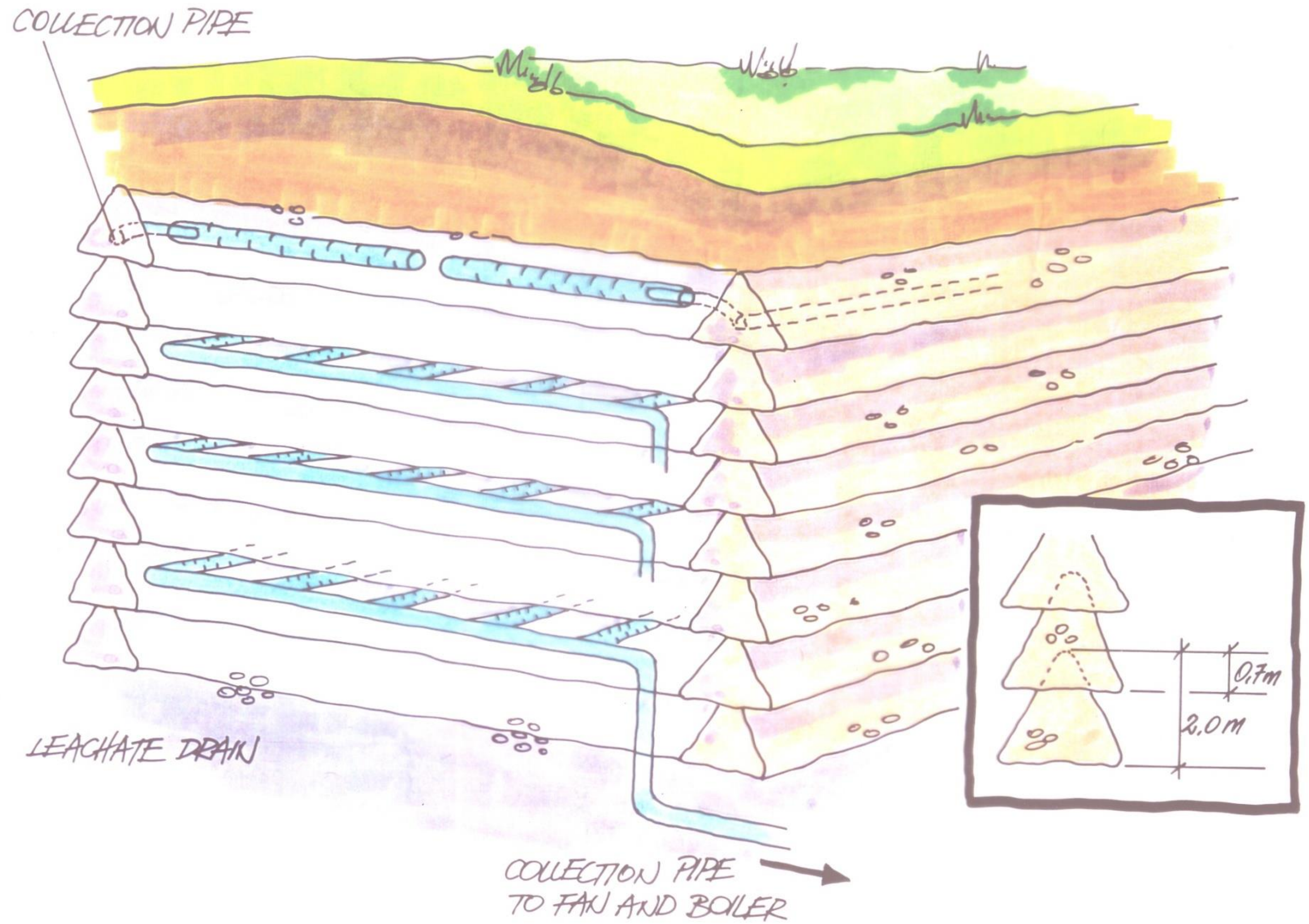
- Static reactor cells for source separated food waste. About 150-200 m3 biogas per ton. Process time 1-3 years.

- Biocell reactors, reactor landfills. About 200-250 m3 biogas per ton. Process time 5-10 years, or longer

LUNDS UNIVERSITET

LUNDS UNIVERSITET

LUNDS UNIVERSITET



COLLECTION PIPE
LEACHATE DRAIN
COLLECTION PIPE
TO FAN AND BOILER
0,7m
2,0m

LUNDS UNIVERSITET

Combination of techniques

- Liquid technique combined with solid phase reactor fermentation.

- Reactor cell fermentation for waste rich in cellulose (plant fibres, cellulose paper a.s.o)

- Bioreactor cell fermentation for residual waste

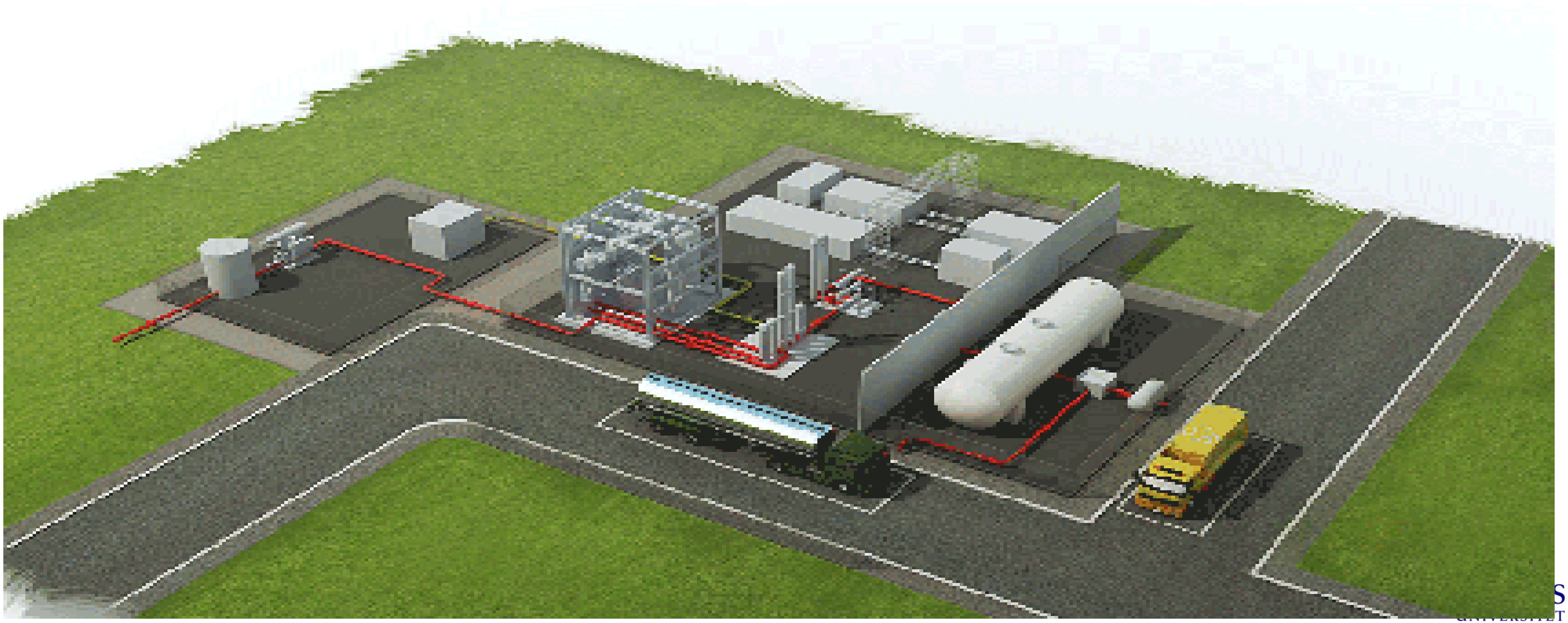
The Bioreactor Cells for Extraction of Energy

- Organic matter is converted to biogas. Organic matter with a slow turn-over rate and good water-holding capacity retains water and ensures stabilized anaerobic conditions
- Biogas from a full scale bioreactor cell contains approximately 60-70 % methane
- Annual energy yield approximately 15-20 m3 biogas per ton waste
- Total energy yield approximately 200-250 m3 per ton waste
- The biogas can be used directly in power plants, or can be upgraded to pure methane (99 %) to be stored and used as motor fuel in cars, busses and lorries

LUNDS UNIVERSITET

Bus depot in Helsingborg

Liquified biogas



Carbon Balance of a Major Swedish Bioreactor Cell Plant

- A typical bioreactor cell treats about 100 000 t/year of MSW:
- approx. 25 000 tonnes org C per year
- approx. 15 000 t/yr of long-lived org C remains. This equals about 45 000 tonnes of CO_2
- This corresponds to the CO_2 emissions from 12 000 – 15 000 cars per year running 15 000 km per year and emitting approx. 212 g CO_2 per km

LUNDS UNIVERSITET

LANDFILLS AND CLIMATE

- If more than 65 % of the produced biogas in a landfill or reactor cell can be collected, there is a positive net-effect of landfilling on climate change.

- Normally a good landfill in Europe or the US collects 80-90 % of produced biogas

- Results from test-cells: 93-95 % collection of biogas

EFFECTS ON CLIMATE CHANGE

- Carbon dioxide balance:

a. Sequestration of organic carbon in landfills

b. Biogas as renewable energy source substituting fossil fuels

c. Down-stream effects (increased soil organic matter after application of compost or fermentation residues as compost) Increased plant-growth

d. Accumulation of fossil organic carbon (plastics, synthetic rubber and textiles, a.s.o.)

FOSSIL EMISSIONS FROM INCINERATORS

- Concentration of fossil material in combustible fraction of MSW: 30-40% (plastics, synthetic textiles and rubber), a.s.o.

- Concentrations of fossil material is higher in RDF/WDF, over about 50-60 %..

LUNDS UNIVERSITET

THE LANDFILL BIOREACTOR FOR RECOVERY OF NUTRIENTS

- The bioreactor cell acts like an aerobic filter immobilizing heavy metals as insoluble metal sulphides or oxides. Nutrients will remain soluble and can be extracted with the leachates

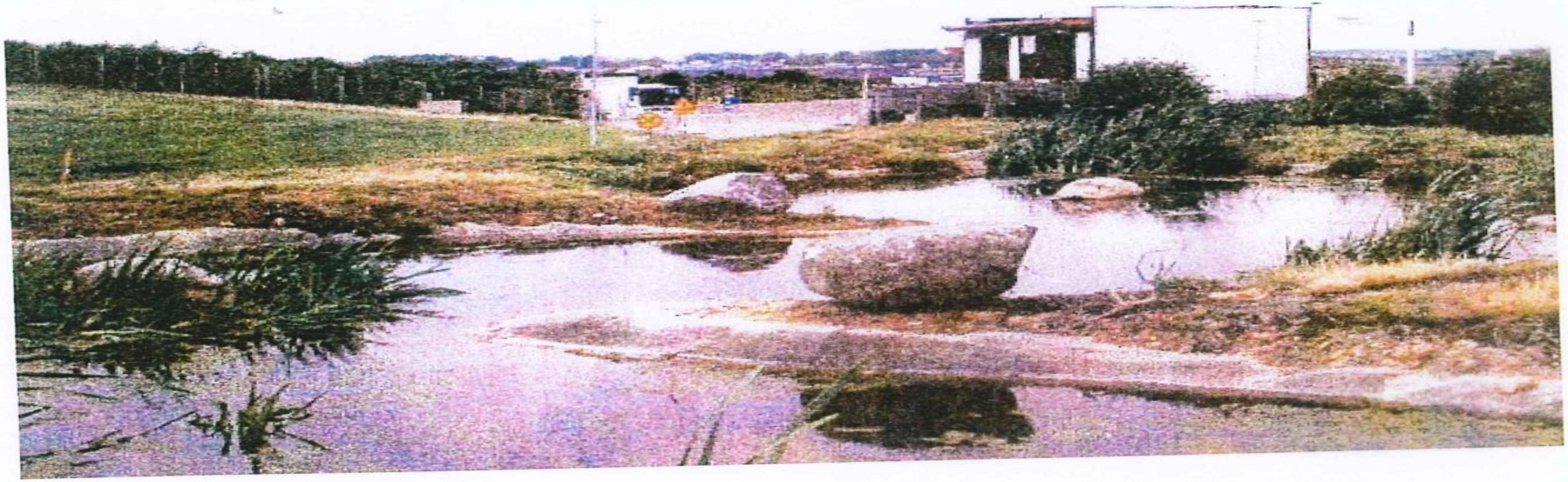
- Long-lived organic matter (mainly from the degradation of lignin) maintains optimal moisture, which promotes stabilized anaerobic conditions.

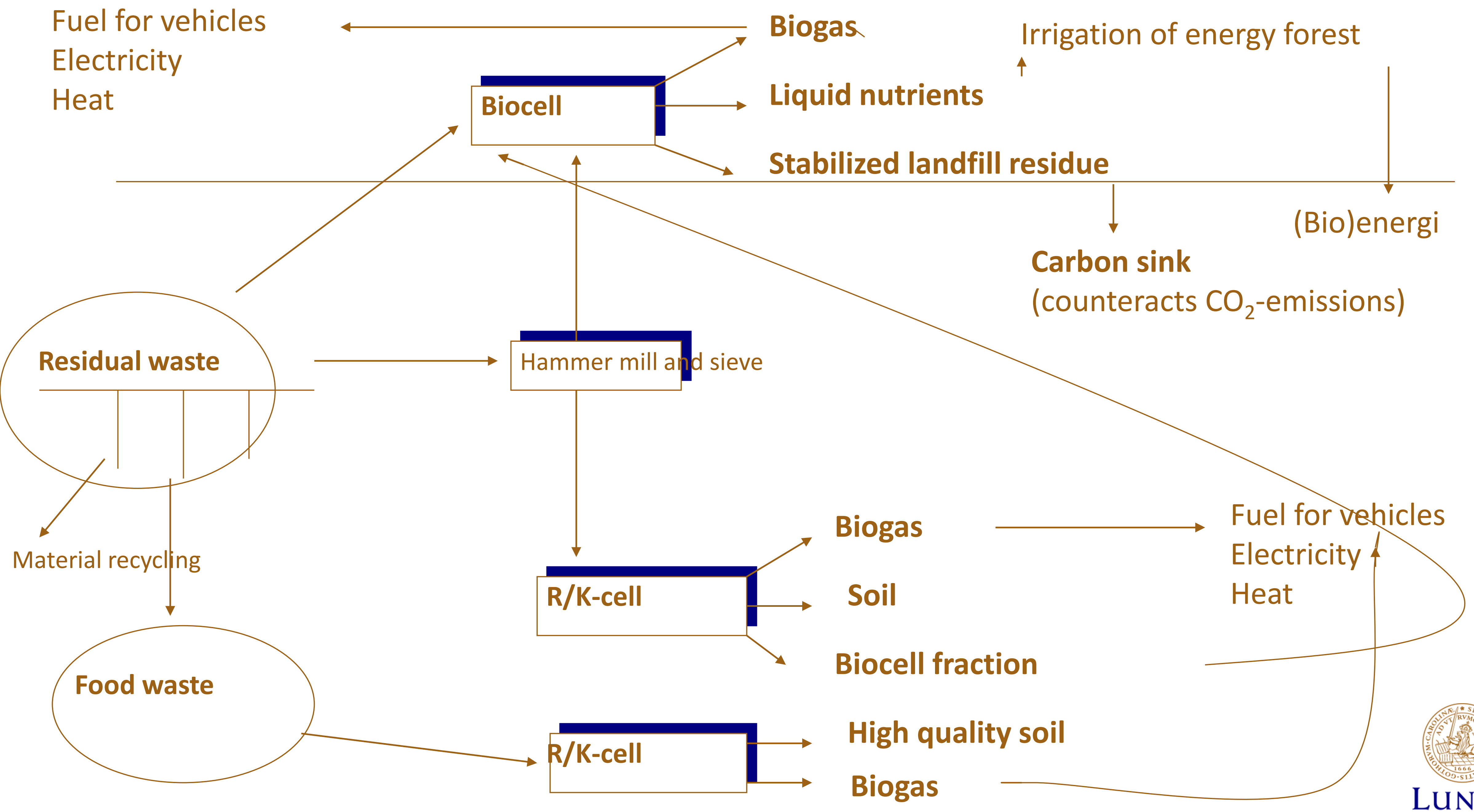
THE LANDFILL BIOREACTOR FOR RECOVERY OF NUTRIENTS

- Heavy metals form chemical complexes with organic matter, which also minimizes leaching effects

- Heavy metals will be retained or leached out in very low concentrations, below back ground concentrations, in natural streams and lakes.

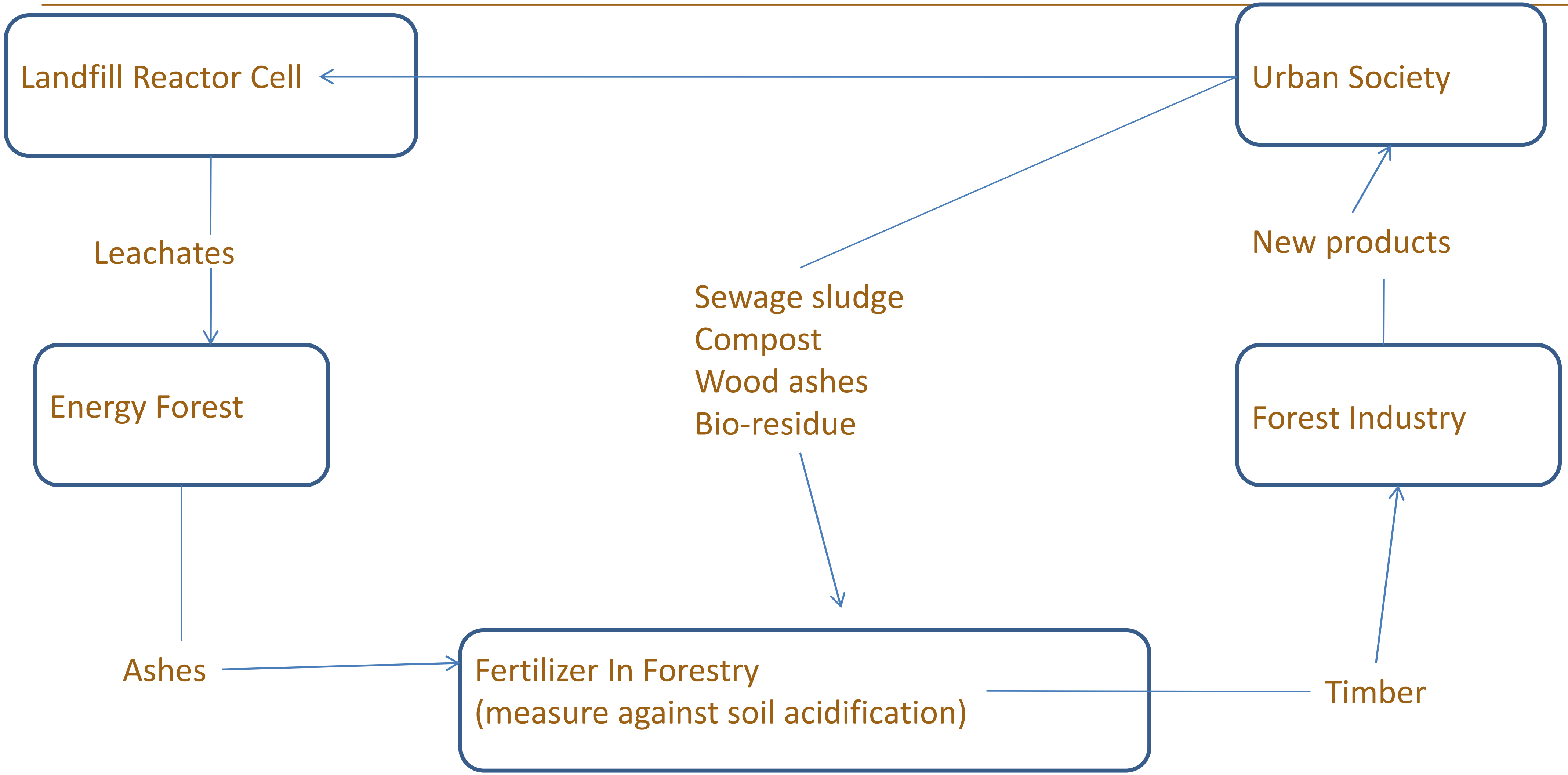
LUNDS UNIVERSITET





LUNDS UNIVERSITET

Cycling of nutrients



CONCLUSIONS

- A sustainable urban development includes:

- Waste avoidance and effective material recycling
- Biological treatment of residual waste for energy and nutrient recovery
- Stabilization of residues and long term accumulation of organic matter in bioreactor landfills

- Sustainable transportation and mobility (decreases the need for hard urban infrastructure, decrease emissions)

- Preserve Ecosystem Services (blue and green environments, vegetation filters,
- Sustainable building and house construction (wood as carbon sinks in houses, avoid concrete, a,s,o)

LUNDS UNIVERSITET

THANK YOU

Professor Torleif Bramryd
Environmental Strategy, ISM
Lund University, Campus Helsingborg
PO Box 882
SE-251 08 Helsingborg, SWEDEN
E-mail: torleif.bramryd@miljostrat.lu.se

LUNDS UNIVERSITET