Biogas extraction from solid waste –

a sustainable and renewable energy resource to combat green-house emissions

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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

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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

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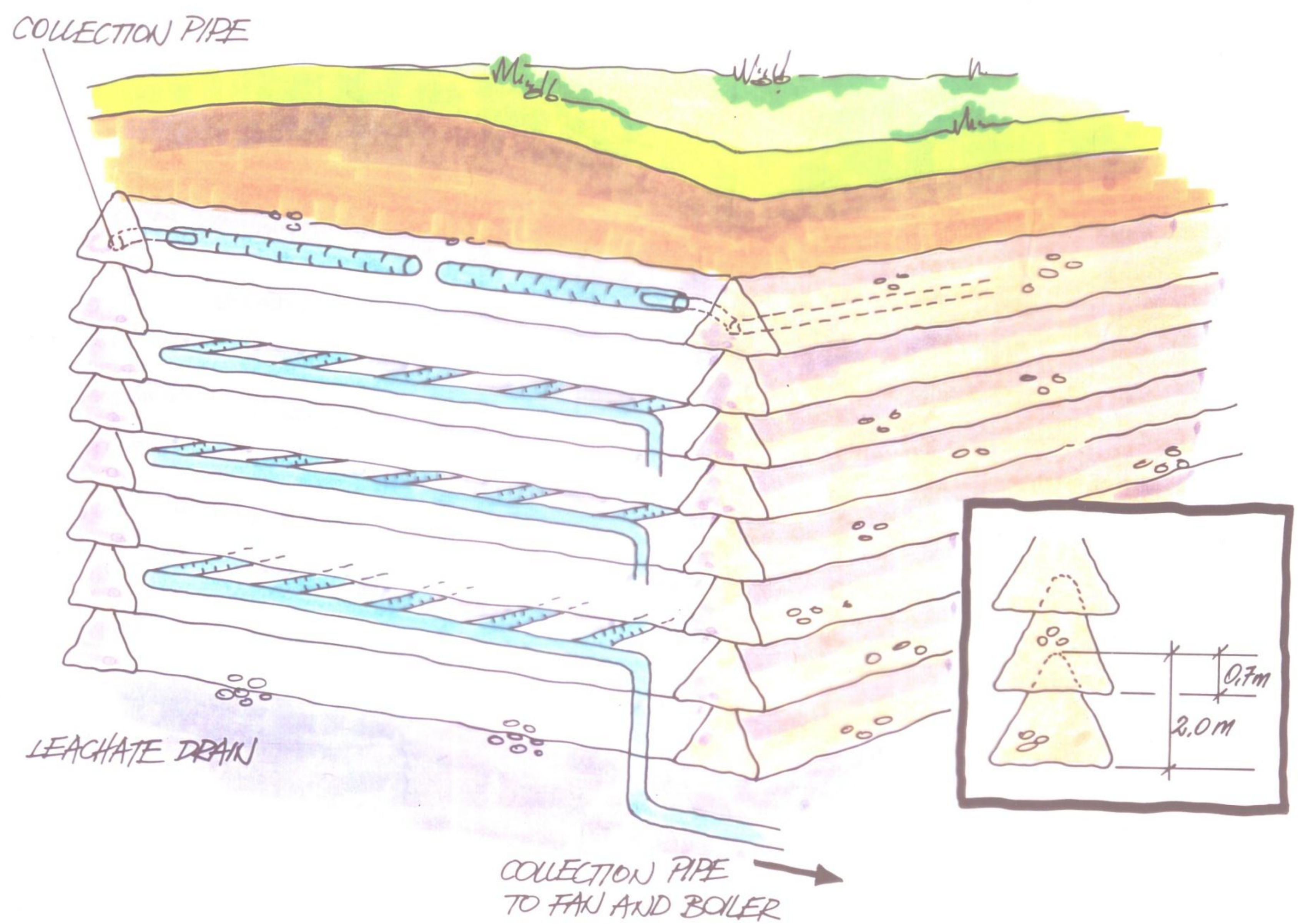

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Combination of techniques

- 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

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Bus depot in Helsingborg

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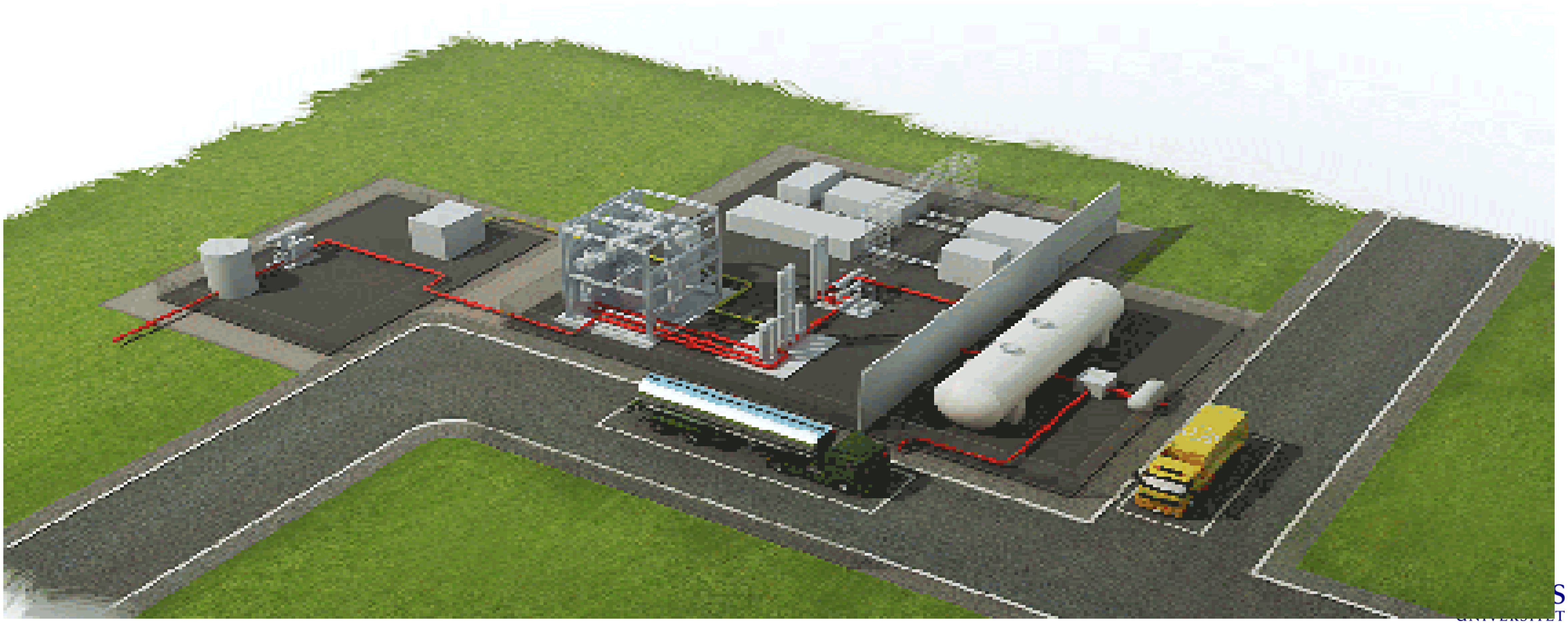
Liquified biogas



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

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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 75-85 % 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.)

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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 %..

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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.

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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.

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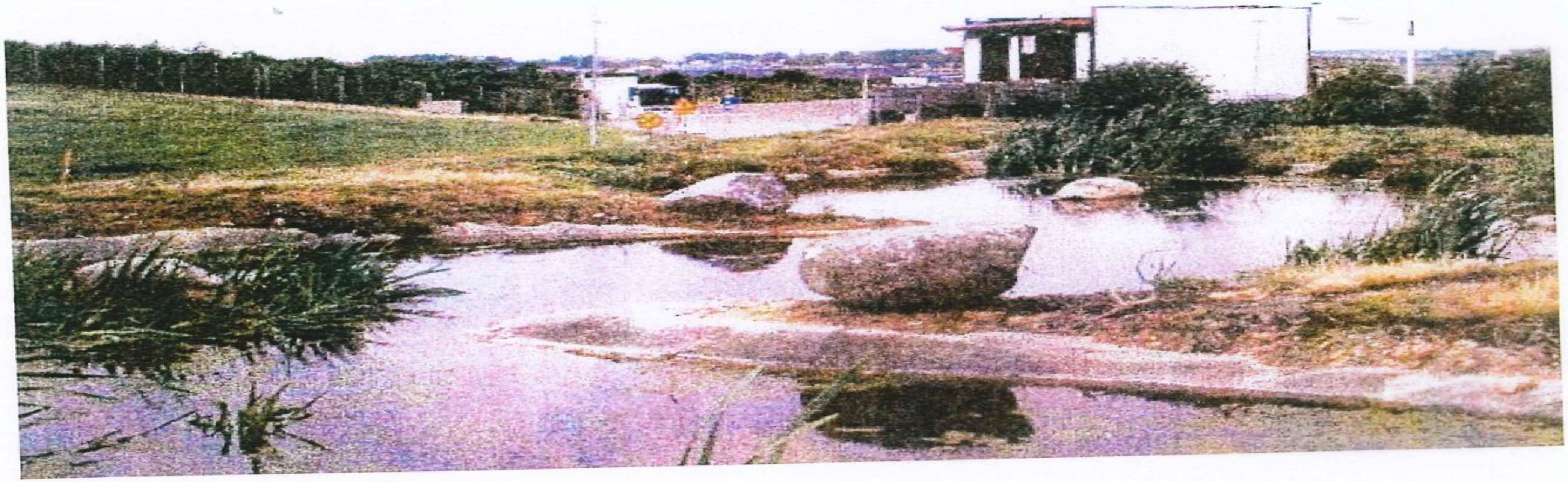

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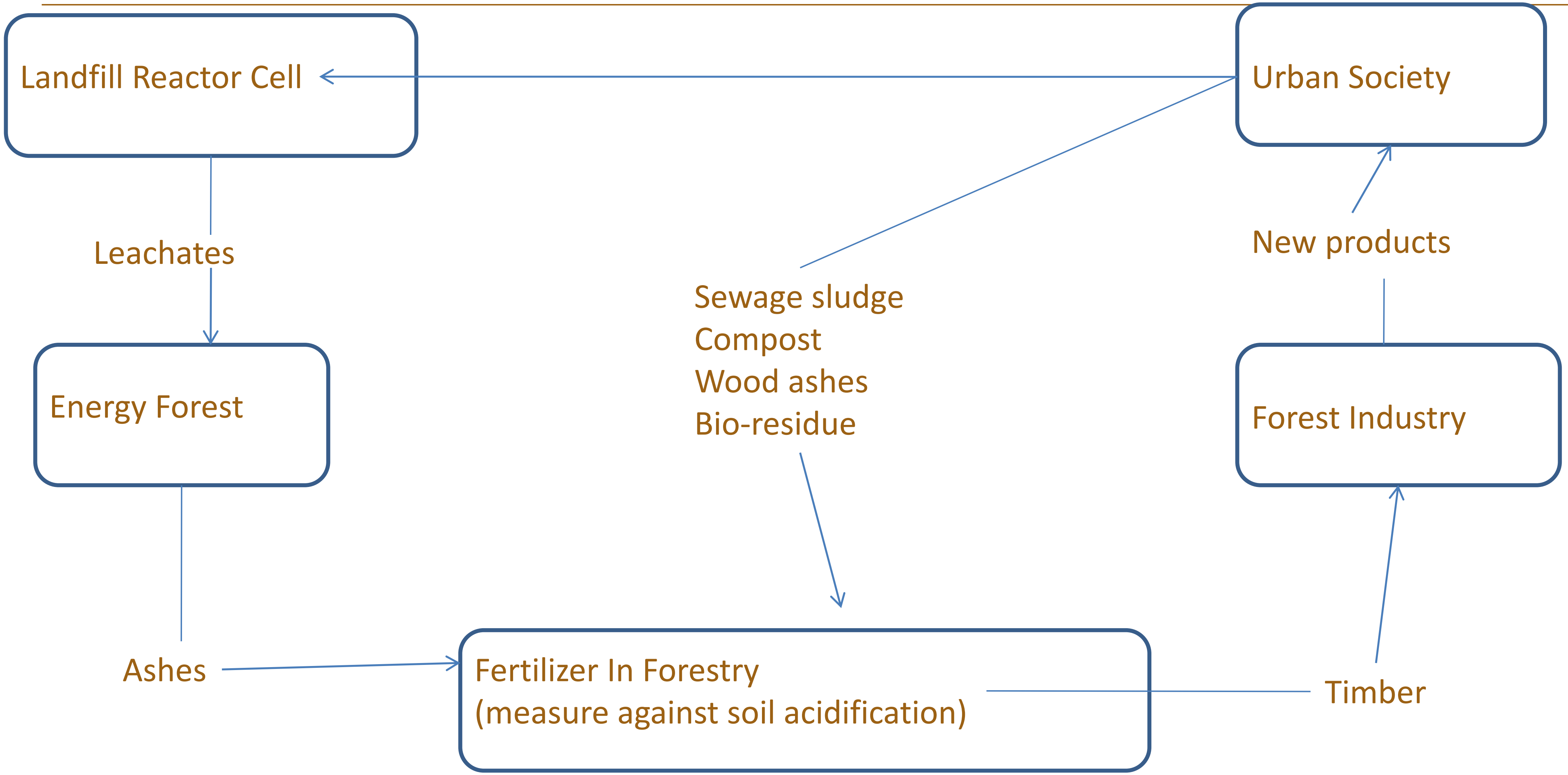
Cycling of nutrients



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THANK YOU

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Conclusions

- Landfilling of residual waste act as a carbon sink and counteracts increased CO2 concentrations
- With modern landfill techniques in improved landfill reactor cells over 90 % of the produced biogas can be collected and used
- Landfilling should be the recommended route for disposal of plastics, rubber and other products with a fossil origin
- A middle-sized landfill, receiving approx. 100 000 t MSW per year can compensate for the annual CO2 emissions from about 15-20 000 cars.
- Irrigation of leachates to a forest plantation increases biomass production and thus accumulation of organic carbon in soil and vegetation

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CONCLUSIONS

- Landfill reactor cells act as a carbon sink for long-term sequestration. Provided produced methane is effectively collected well-controlled landfills can counteract global warming. Organic matter in the landfill also stabilizes biochemical processes and is important to minimize leaching of heavy metals.

- With modern landfill techniques in improved landfill reactor cells over 90 % of the produced biogas can be collected and used.

- A middle-sized landfill system, receiving approximately 100 000 tons of waste per year, and with leachate irrigation in a forest plantation, can compensate for the annual CO2 emissions from around 15-20 000 cars.

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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.)

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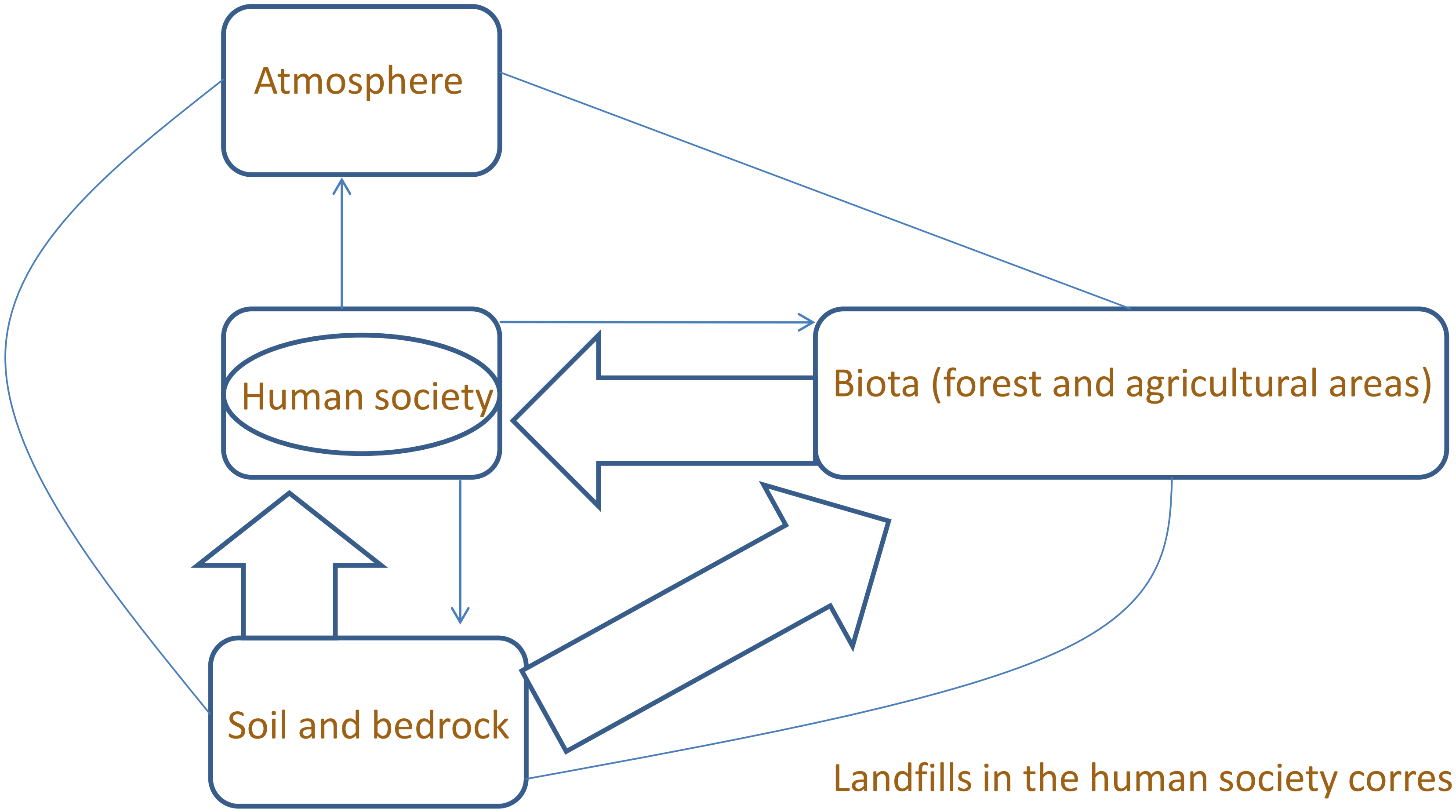
Biogeochemical cycles in the human society



Landfills in the human society corresponds to natural peatlands and lake sediments

AVAILABLE RAW MATERIAL

- Waste from agriculture
- Residues from forestry and pulp industry
- Best raw material depends on geographical location, available resources, a.s.o.
- This seminar concentrates mainly on municipal solid wastes

Processes counteracting increased CO_2 concentrations in the atmosphere

1. Uptake of CO_2 in oceans, accumulation in carbonates or amino acids
2. Increased accumulation of organic matter in soils (especially in forest and grassland soils). Most northern forest soils still are net-accumulators of carbon
3. Increased planting of trees and forests
4. Peat accumulation
5. Lake and sea sedimentation
6. Accumulation of organic carbon in human society (urban areas)
7. Landfills and urban organic sediments

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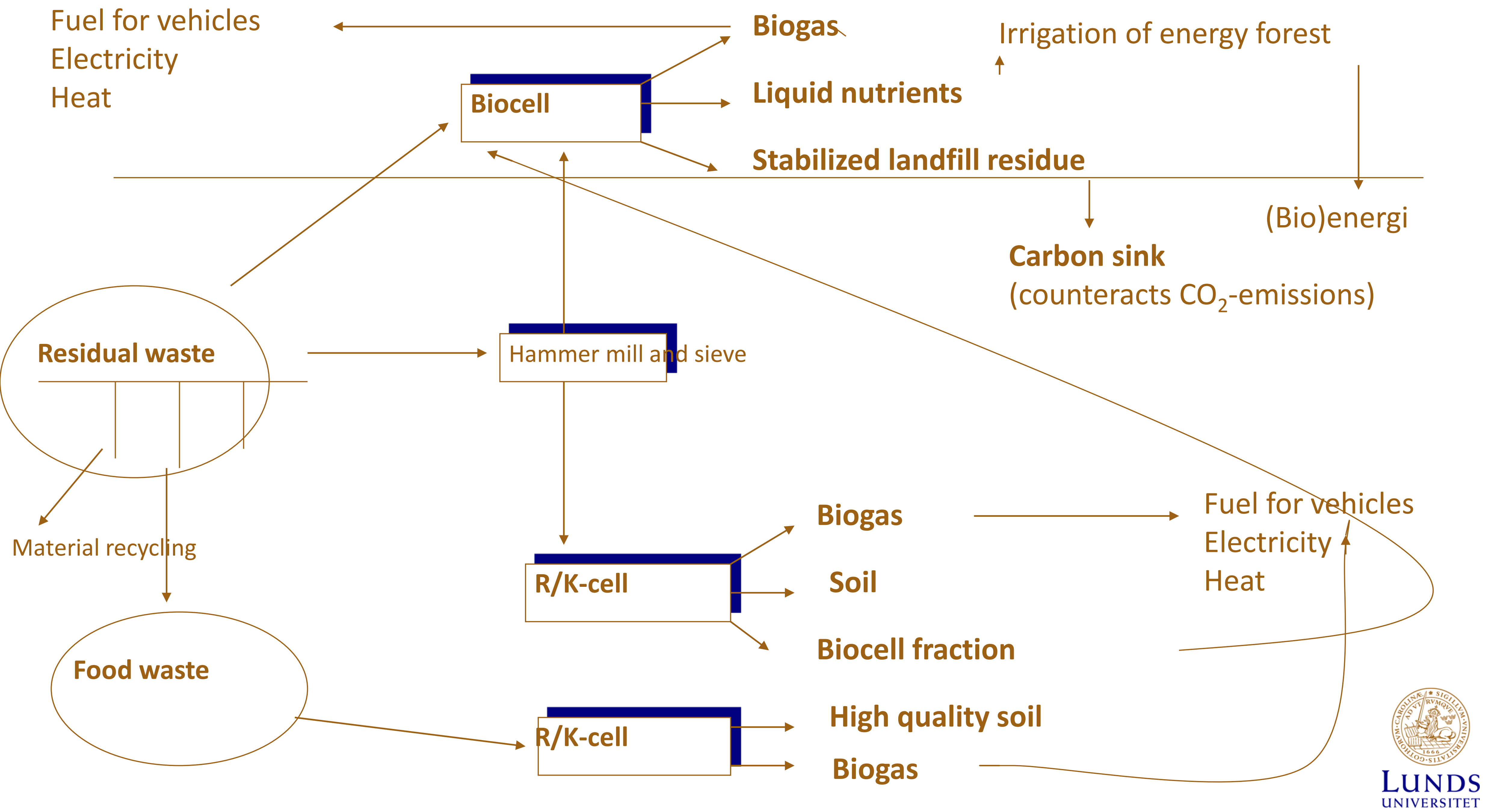
Fuel for vehicles
Electricity
Heat
Biogas
Irrigation of energy forest
Biocell
Liquid nutrients
Stabilized landfill residue
(Bio)energi
Carbon sink
(counteracts CO_2-emissions)
Residual waste
Hammer mill and sieve
Material recycling
Biogas
Fuel for vehicles
Electricity
Heat
R/K-cell
Soil
Biocell fraction
Food waste
High quality soil
R/K-cell
Biogas
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ENVIRONMENTAL ADVANTAGES

- Favours an eco-cycling of nutrients

- Creates a carbon sink

a. Residues in biocells/reactor landfills

b. Increased humus content in soil during fertilization with fermentation residues or compost

c. Use of leachates as fertilizer

- (increased biomass production).