Minimization of sewage sludge production as a solution for the managing problems in small WWTP

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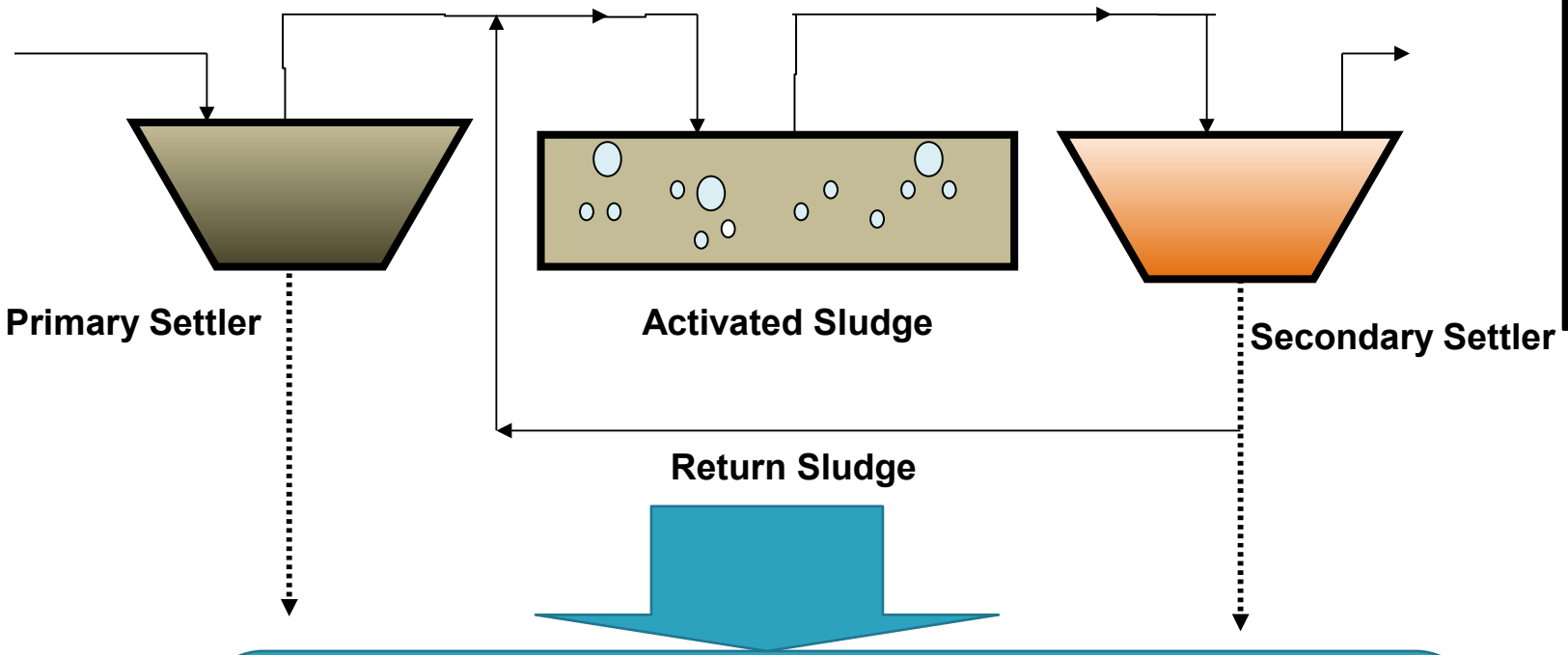
Sludge production in the ASP process



15-100 l/ Kg BOD5 removed

60-80 g TSS/(PE·day)

Dewatered sludge – 0.5 ‰ inffluent

Primary Sludge

60-70%
Organic
composition

Good
dewaterability

Total Solids
2-7%

High
putrescibility

Settling
property

Secondary Sludge

Importance of design variables as SRT

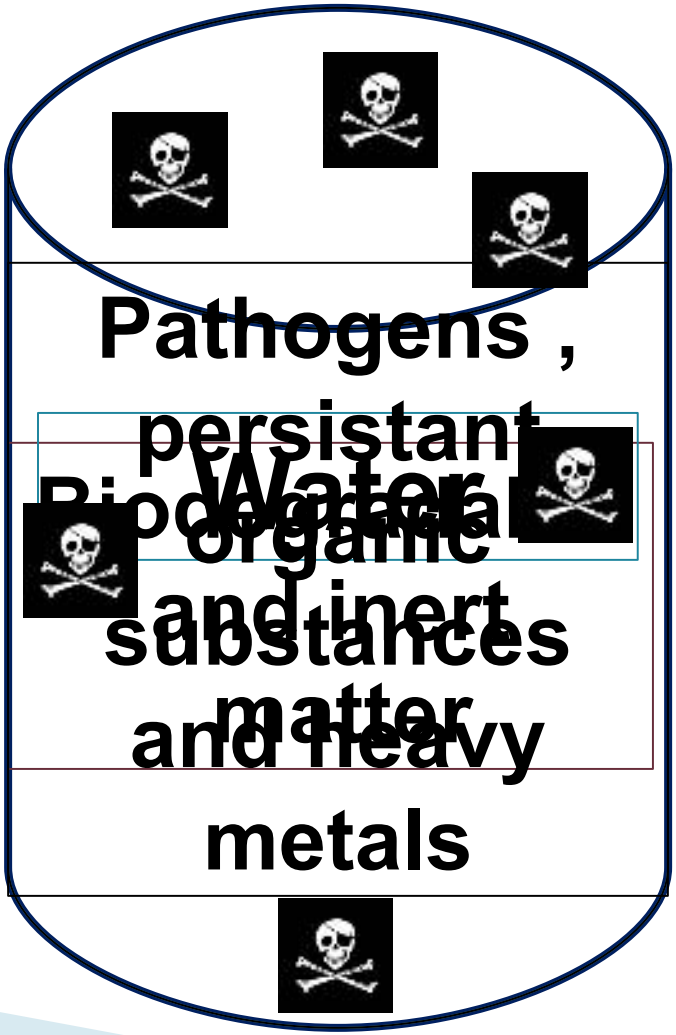
Total Solids
0.5-1.5%

Inert solids

Microorganisms

Biodegradable matter

Sludge Composition



Sludge production

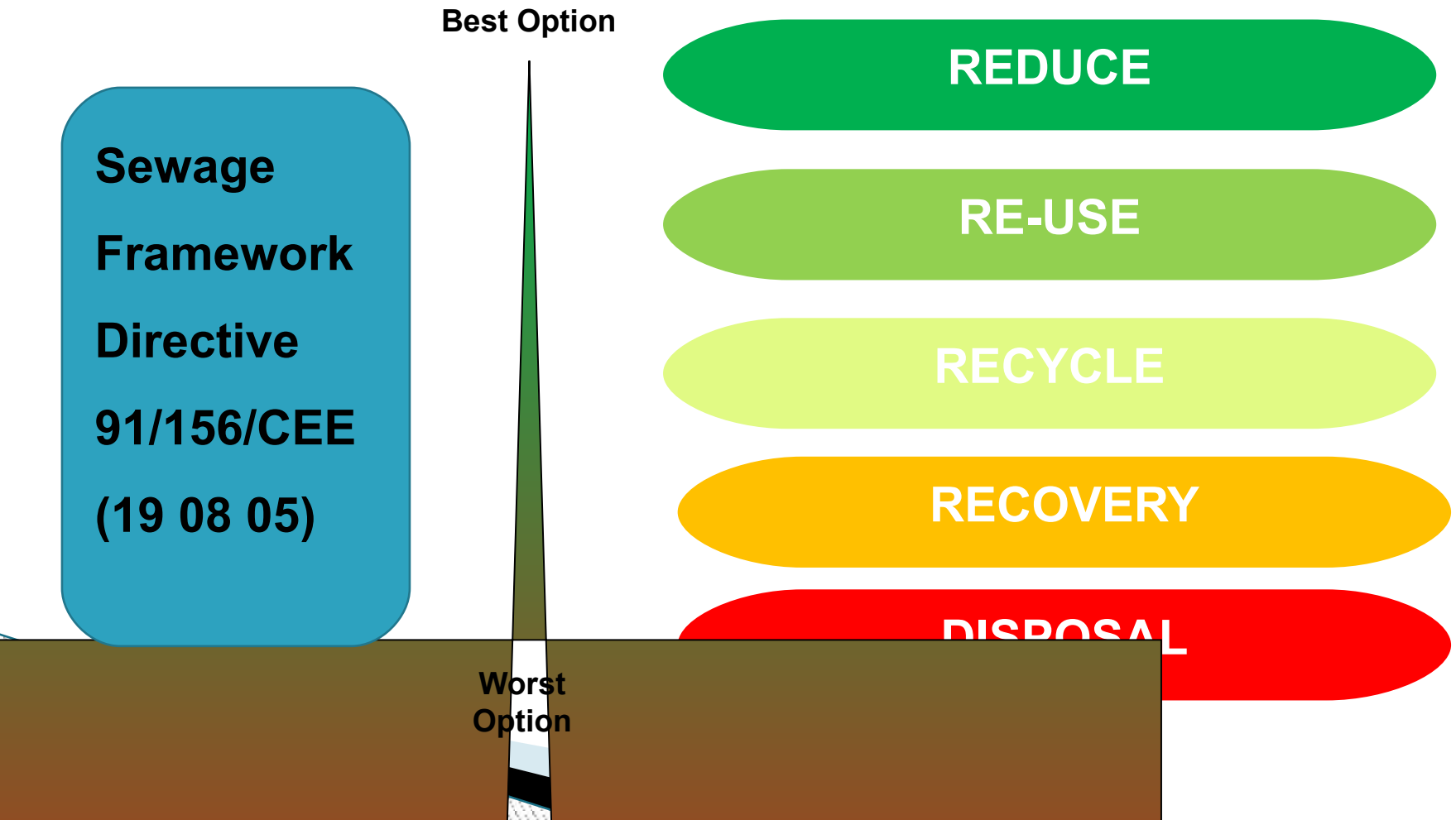
7.6 mil. ton dewatered sludge cake

35 mil. Ton dewatered sludge cake (2015)

10 mil. ton dewatered sludge cake

Sludge Management

Sewage Framework Directive 91/156/CEE (19 08 05)



Sludge disposal

Scarce land availability

Directive 86/278/CEE - Sludge disposal in landfill is limited

Directive 99/31/CEE - Dry solids weight >45% total sludge weight

Directive 91/271/CEE - Sludge see dumping banned

Energy recovery (incineration)

Cost intensive option and loss of organic matter and nutrients (P)

Directive 2000/76/CEE - Dry solids weight>33% total sludge weight

Bad public (and political!) consideration

Recycle (land uses)

Strictly regulated due to potential health risks

Directive 2001/688/CEE – Crops produced with sludge not suitable for ecolabelling

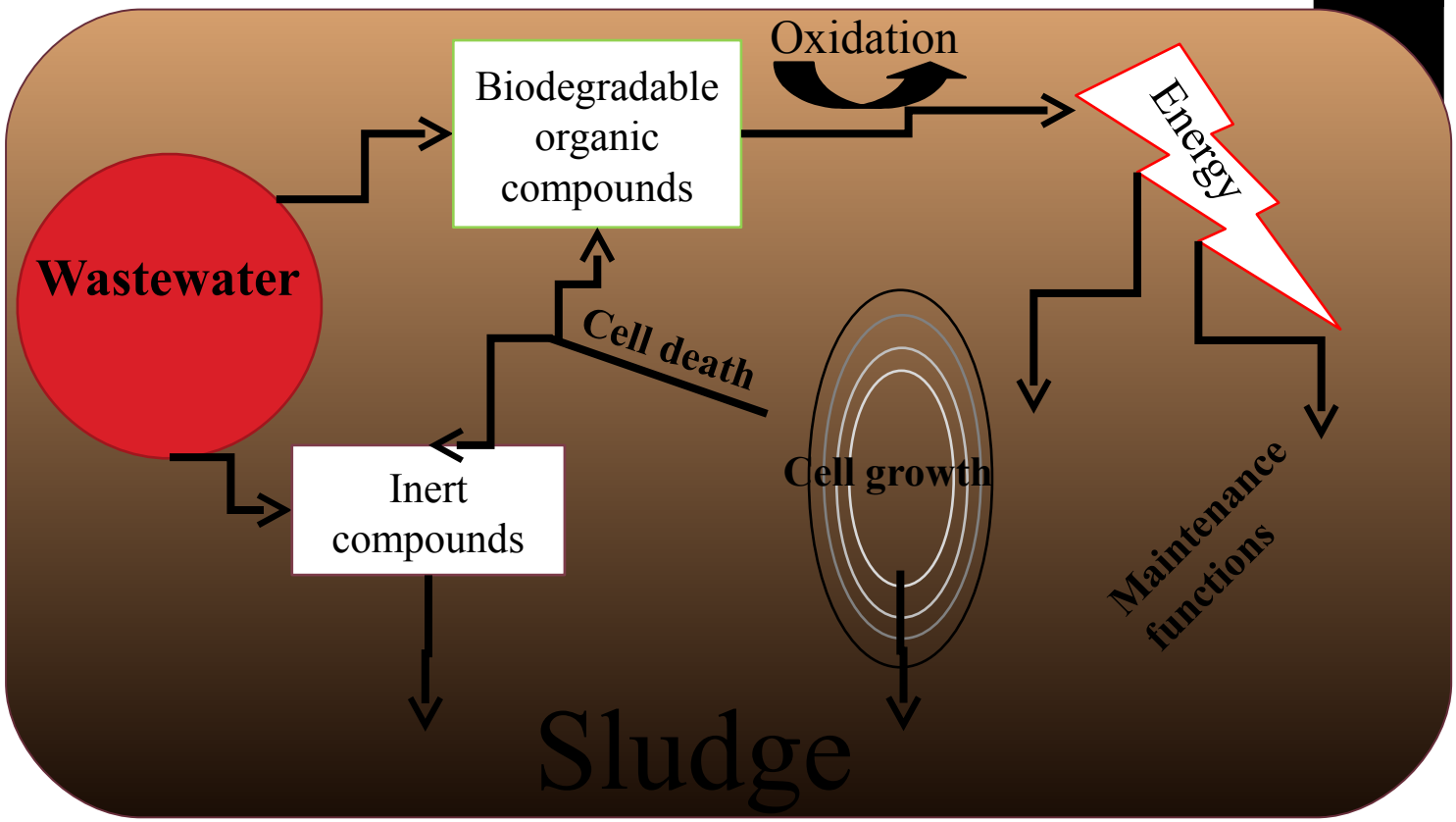
Bad public consideration

Reduction of production

250 - 1000
€/ton dw

Sludge reduction techniques

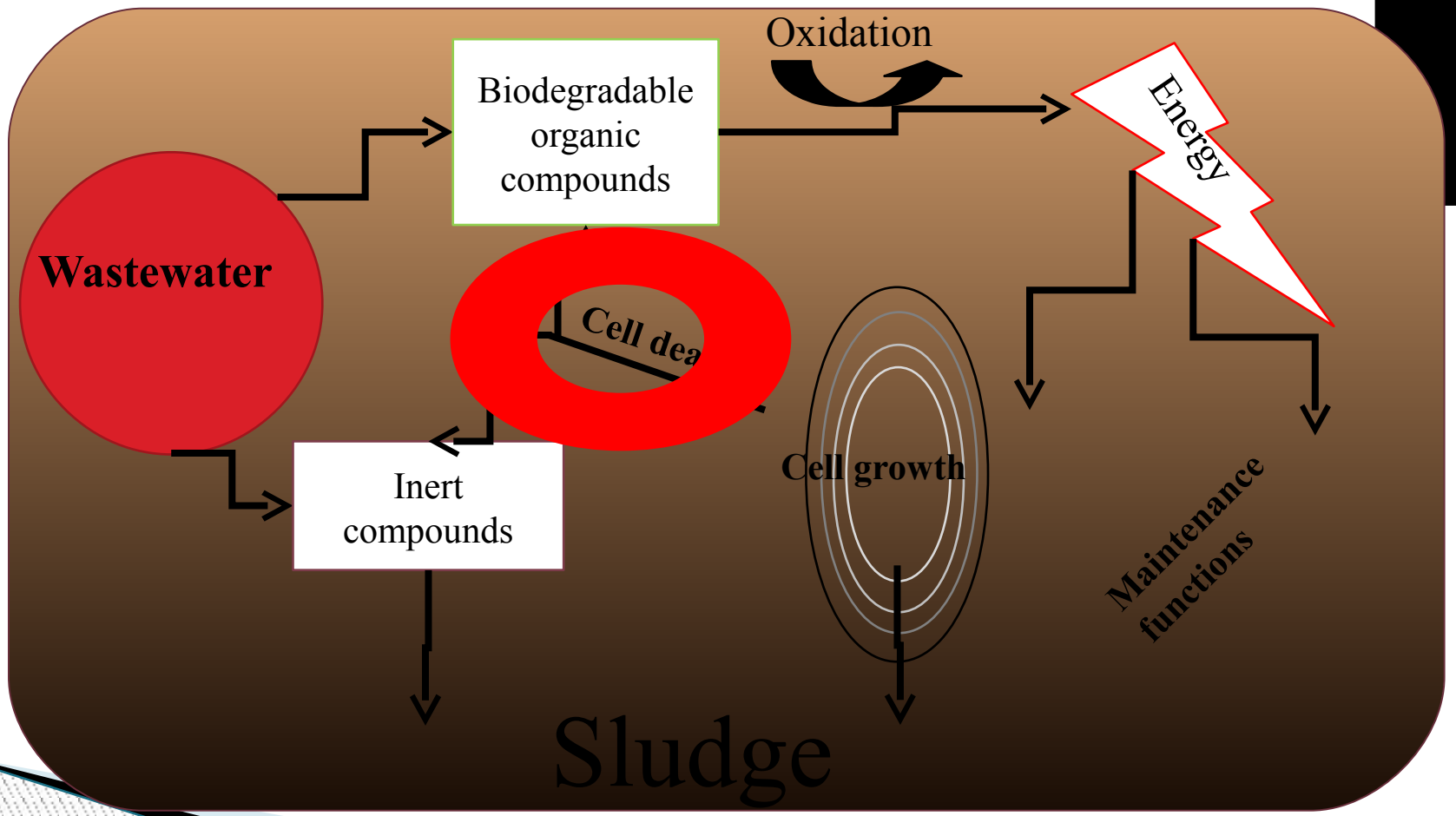
Sludge production scheme in an Activated Sludge Process



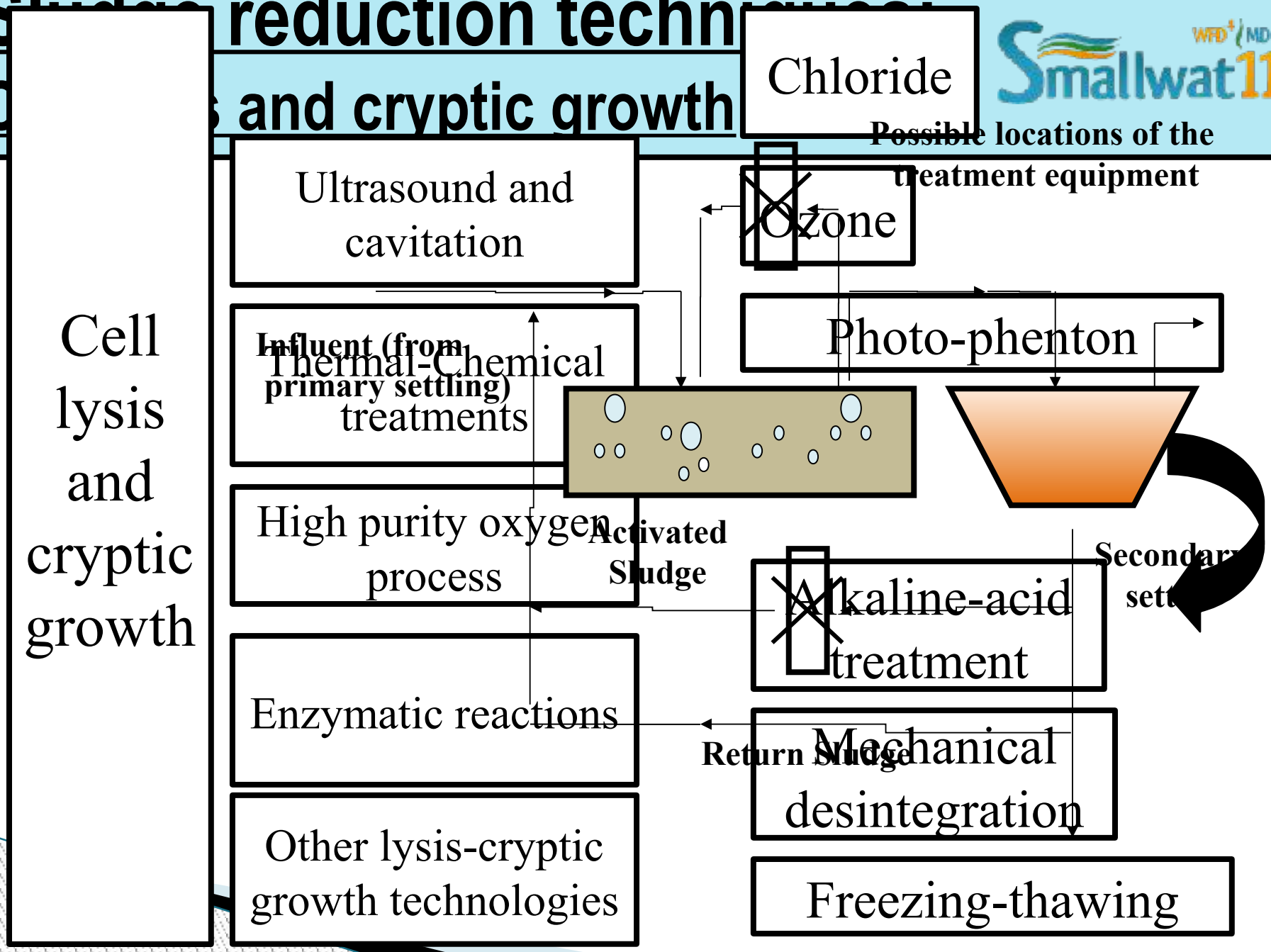
Sludge reduction techniques

Sludge reduction techniques:

Cell lysis and cryptic growth



Sludge reduction techniques: Cell lysis and cryptic growth



Cell lysis and cryptic growth:

Ozone

15% of plant maintenance cost

High efficiency COD and total nitrogen removal

Recommended dose 0.03-0.05 g O3/g TSS

Higher oxygen demand (OD) (1.2Kg adittional oxygen/ kg SS)

Cell lysis and cryptic growth:

Chloride

High risk of trihalomethanes' formation.

Lower cost alternative compared with ozonation

Poorer depurative efficiency and settleability

Cell lysis and cryptic growth:

Photo-Phenton

Not much

information yet

Reactives: H_2O_2

+ $Fe^{2+/3+}$

A 94% COD reduction

achieved

Cell lysis and cryptic growth:
Ultrasound and cavitation

A sludge fraction of 10% Vol reactor threated with cavitation leads to an sludge reduction of 80%

Optimum sludge fraction threated, 30% with an energy requirement: 20 kWh/Kg TS.

Reduction of sludge production of 15% with 0.012 KgTS/kWh.

A sludge fraction only once threated

Cell lysis and cryptic growth:
Thermal-Chemical treatments

Chemical-thermal treatments → better results Drawbacks: bad odour generation and corrosion

A 60% SP reduction achieved treating a recycled sludge current to 90ºC (3 h)

Lower temperature values lead to worse quality

Cell lysis and cryptic growth:
High purity oxygen process

High cost requirements

Reached a 60% decrease of biomass growth yield - Sludge production (25% reduction when dissolved oxygen pass from 2 to 6 mgO2/l)

An injection device achieved an 40% more effective oxygen transfer

Cell lysis and cryptic growth:

Enzymatic reactions

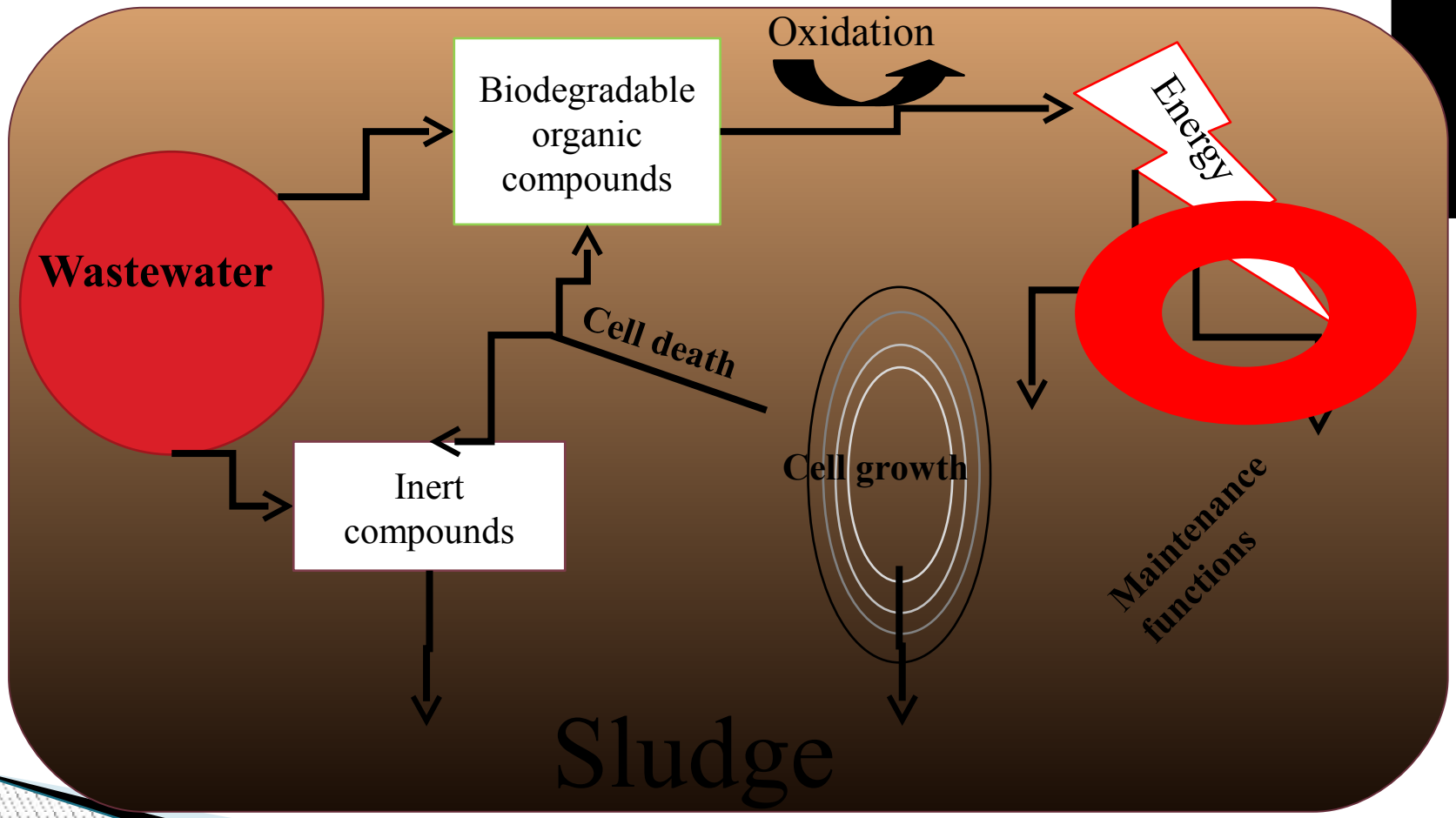
Higher Suspended Solids and COD values registered in effluents

A recycled sludge fraction (RSF) is inoculated into as thermophilic sludge digester

A ratio, inoculated RSF / total RS, of 2, results in an reduction of 49.6% of sludge

Sludge reduction techniques:

Endogenous Metabolism



Sludge reduction techniques:

Endogenous Metabolism

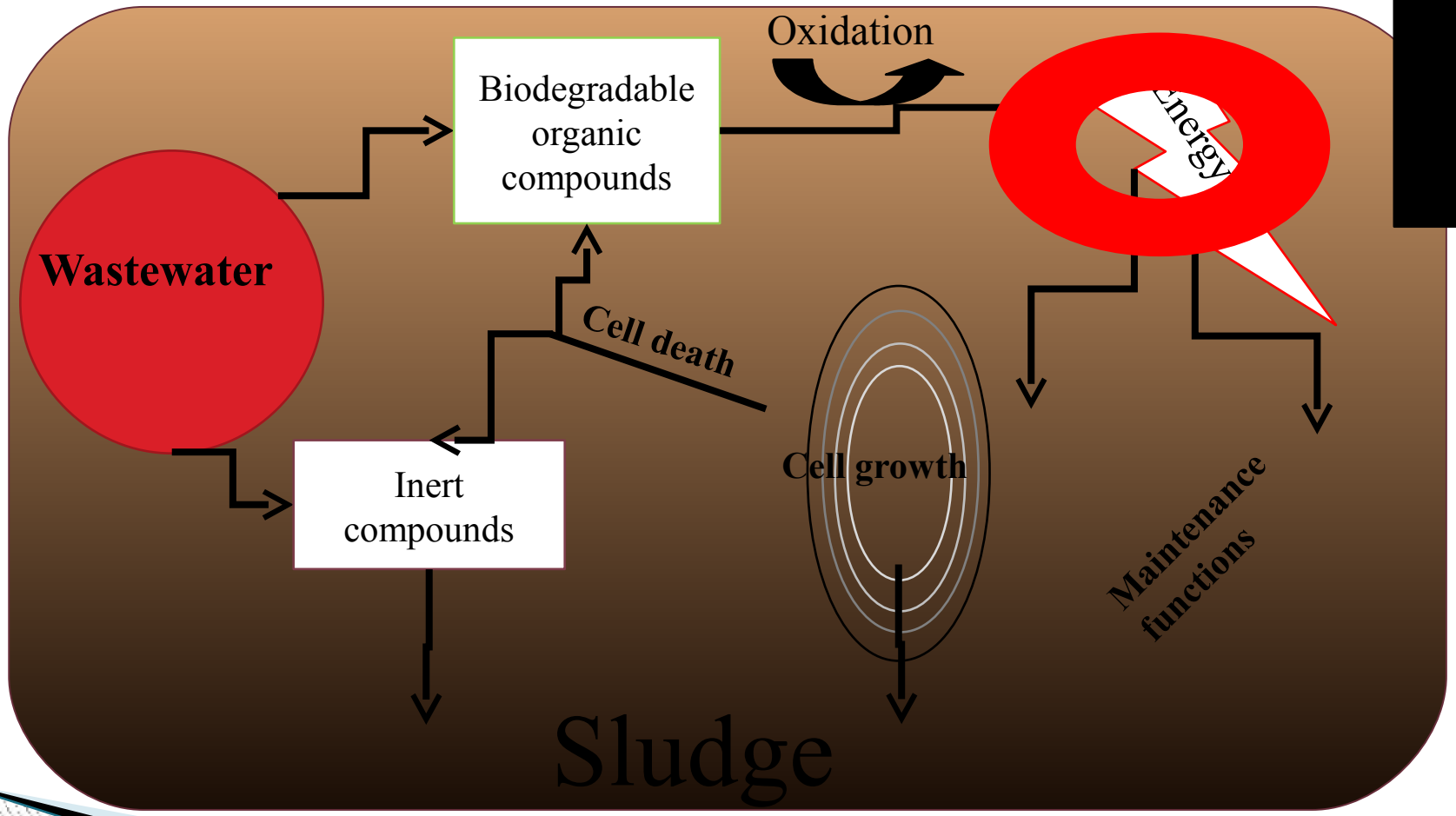
Membrane bioreactors - the most suitable facility for this technology → high management costs

A sludge reduction of 40% is achieved by long aeration time or low organic loading. (63% in 100 days)

Lesser BOD5 removal efficacy≈10%

Sludge reduction techniques:

Uncoupled Metabolism



Sludge reduction techniques: Uncoupled metabolism

Uncoupled metabolism

Chemical uncouplers

Oxic-settling-Anaerobic process (OSA)

Uncoupled metabolism:
Chemical uncouplers

Bioaclimatation and accumulation problems may occurs during longer applications

Compounds with chloride show effluent problems and damage general efficiency

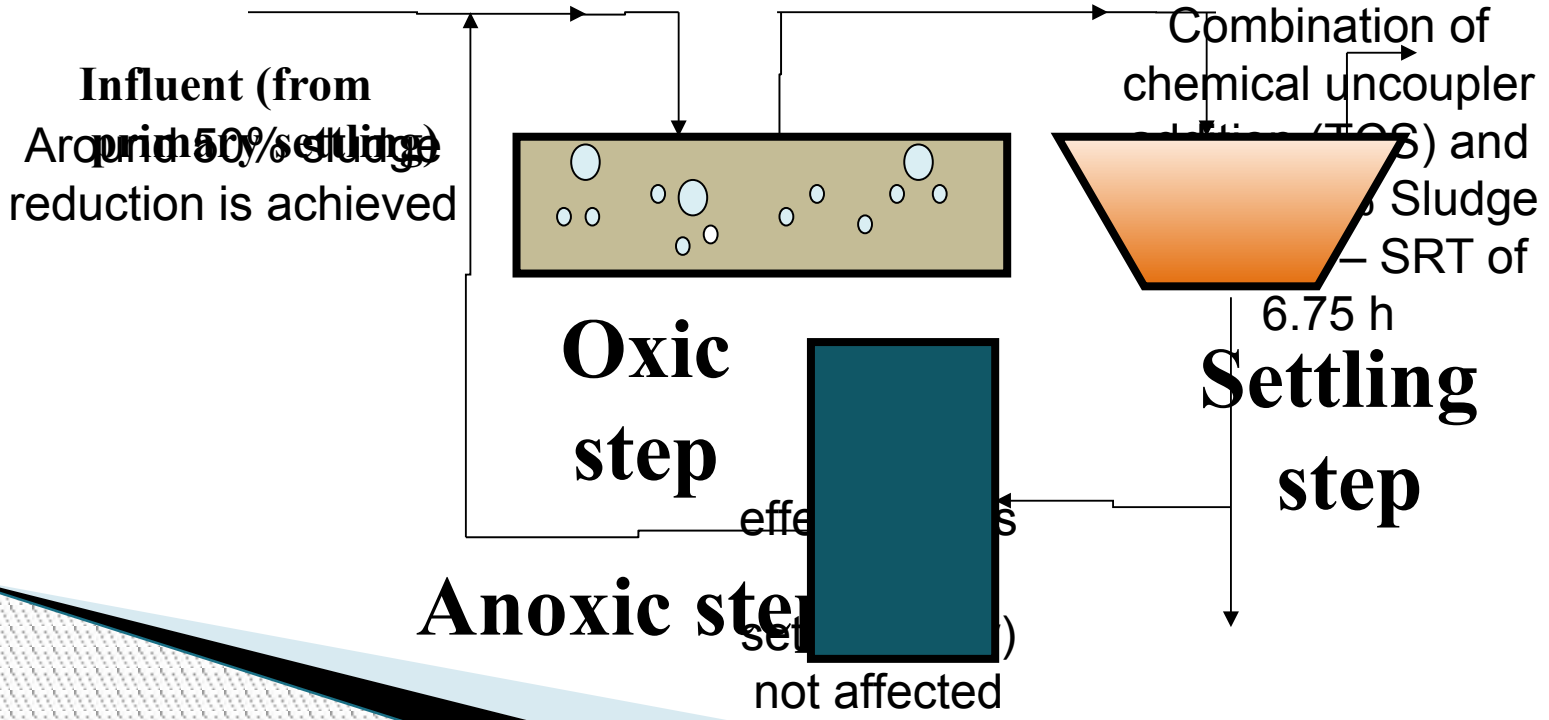
An increase in oxygen supply needed. Reactive use results in a increase of the maintenance cost

Among the CUs tested, the 3,3',4',5-tetracholorosalicylanilide is the most effective in sludge reduction, 30% sludge reduction with 0,8mg TCS/l

Uncoupled metabolism:
Oxic-settling-Anaerobic process

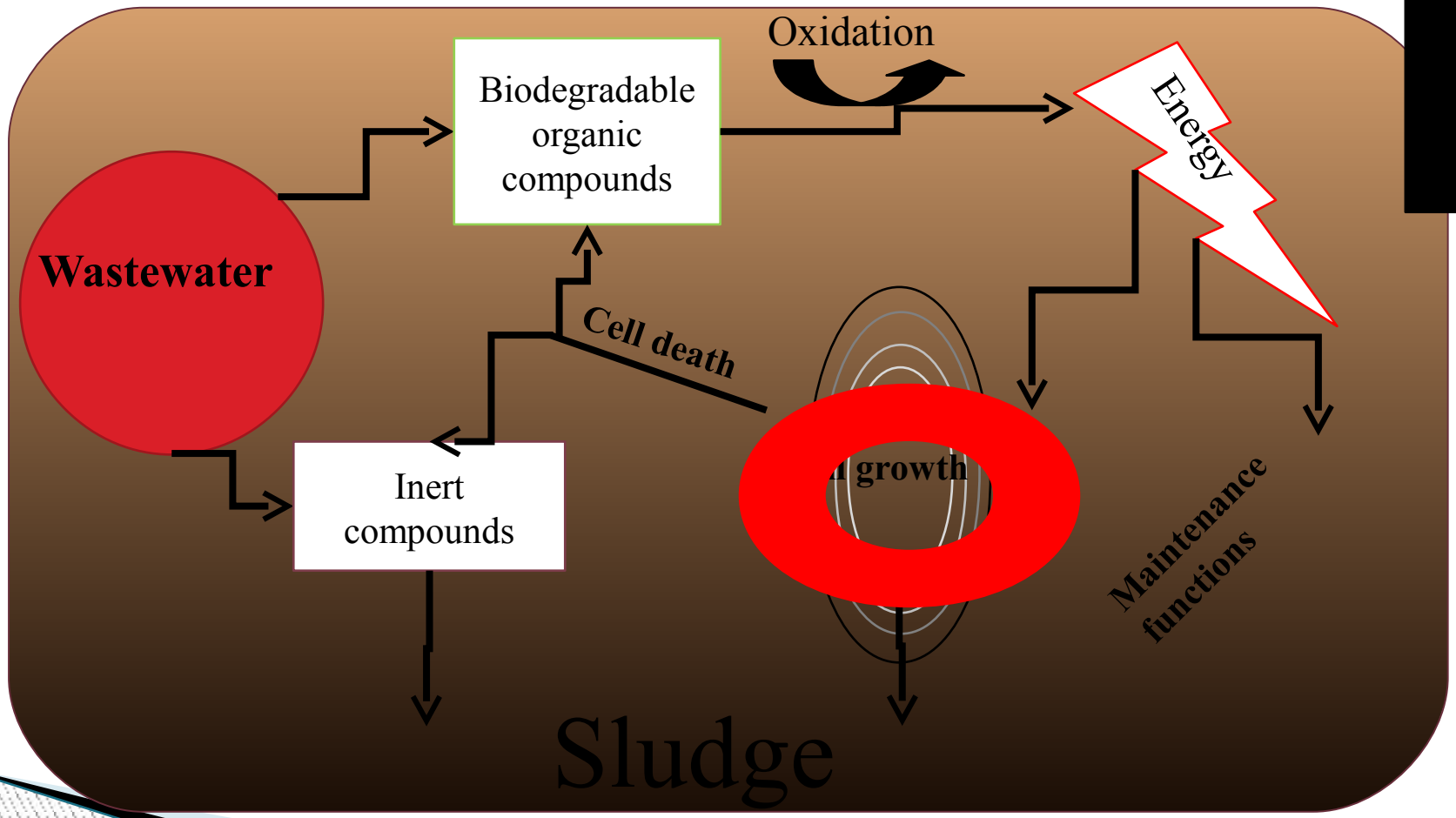
Low cost investment needed

An anoxic sludge-holding tank is introduced in the recycled sludge line. Long sludge retention time and enhanced catabolic activity → Low growth yield.



Sludge reduction techniques:

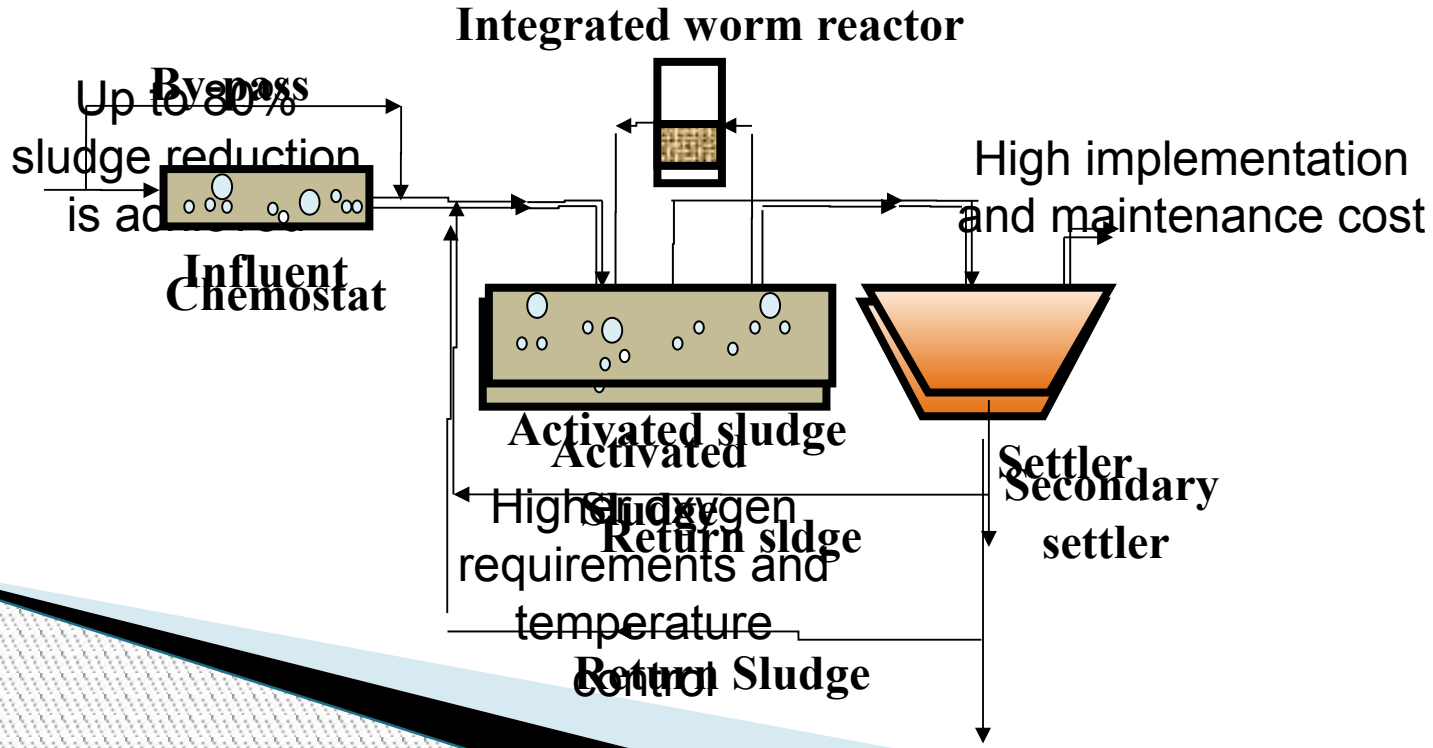
Predation on bacteria



Sludge reduction techniques:

Predation on bacteria

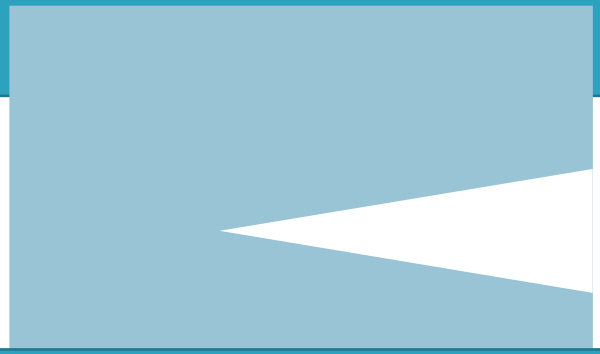
A low hydraulic retention time reactor located before the aeration reactor where bacterial growth is favoured. Effluent fed into aeration tank with higher bacteriovoric organisms. Another possibility is a recycled sludge reduction worm reactor.



Sludge reduction techniques :

An alternative strategy

Previews technologies → Reduction of growth yield in aeration tank



Sludge anaerobic treatment in the wastewater handlings units (low yield coefficient)

Sludge reduction techniques :

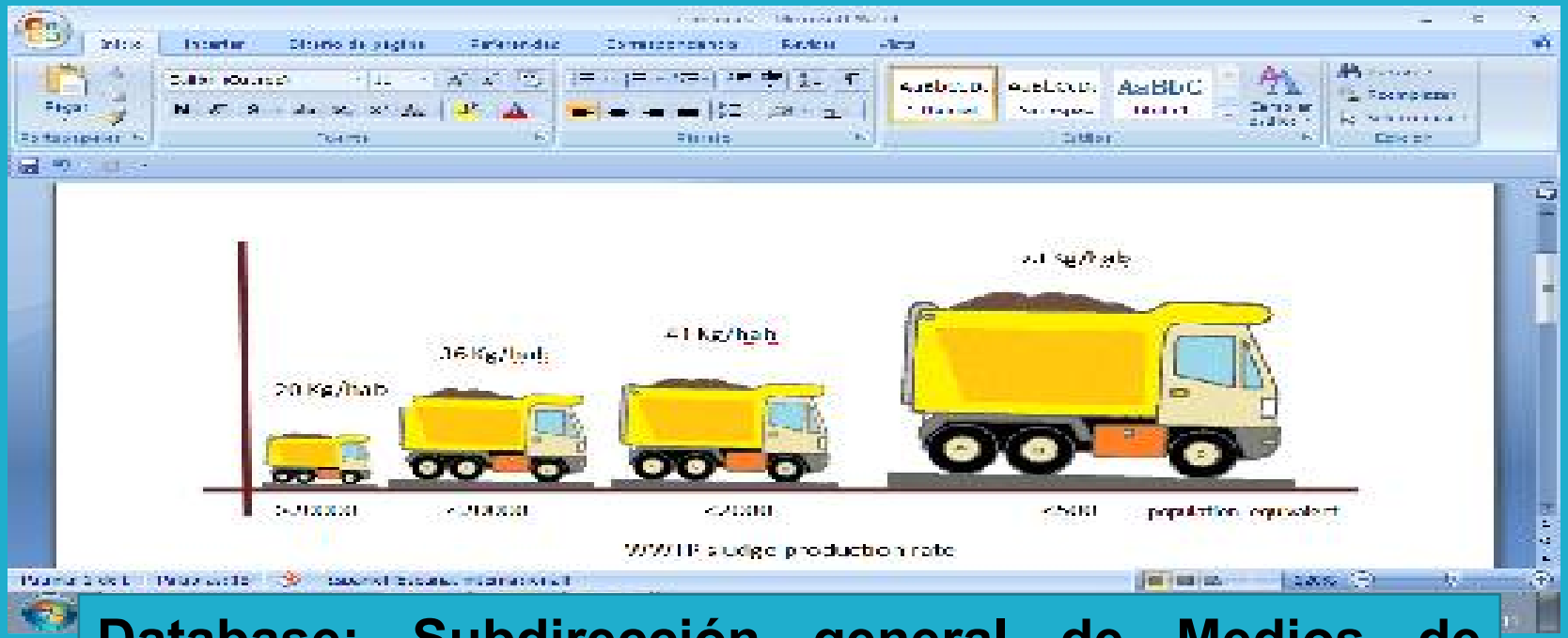
An alternative strategy

Suitable in integrated systems as one stage in the treatment flow-sheet

Good carbonaceous matter removal

Inadequate nitrogen and phosphorous compounds removal

Small wastewater plants



Database: Subdirección general de Medios de Producción agrícola 2010. WWTP of Andalucía

sludge treatment

Conclusions:

- Current and important challenge.
- Due to environmental, economical and legal reasons, in the future, attention will be paid to this issue as much as for the general efficiency of the WWTP
- Depending on the properties of the raw wastewater, it is possible to reject some strategies
- **According to other variables, establishment of some strategies are not possible (available budget, technical support, existing facilities)**
- R&D field

Smallwat11

WFD4/MDG4