CARBON CREDITS—A POTENTIAL SOURCE OF OPERATIONAL COST RECOVERY IN WASTEWATER TREATMENT PLANTS

By

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Presentation Outline

- Kyoto Protocol (KP)
- Carbon Credits
- Clean Development Mechanism (CDM)
- CDM Projects in Egypt
- CDM in Wastewater Treatment Sector
- CDM Opportunities in WWTP in Egypt
- Case Study: Cost Recovery at **Gabal El Asfar WWTP**
  - Greenhouse Gas —Generation and Management
  - CERs vs VERs — Revenue from Sale of Carbon Credits

Kyoto Protocol (KP)

- International agreement under which countries commit to reduce greenhouse gas (GHG)
- *Goal:* reduce climate change & impacts
- Adopted in December, 1997 (Japan)
- Ratified on Jan, 2005 by over 180 countries, including Egypt
- In effect until 2012, next phase under negotiation

Carbon Credits

- *Carbon Credits*: a key component of national and international attempts to mitigate & reduce greenhouse gases (GHGs) in the atmosphere.
- *1 carbon credit* =1 metric ton of CO_2.
- *Carbon Trading* : a system that allows a company that reduces its emissions below a target level to sell the extra reduction as a credit to a company that has not met the target level

Definitions -Carbon Credits (Cont.)

- CDM :Clean Development Mechanism – The prerequisite of the Kyoto Protocol that manage project – carbon credit transactions between developed and developing countrie

- CER :Certified Emission Reduction – Carbon credits created by Clean Development Mechanism projects; 1 CER corresponds to 1 tonne of CO_2e emission reductions

- VER : Verified Emission Reduction – Emission reductions created by projects which have been verified outside of the Kyoto Protocol; 1 VER corresponds to 1 tonne of CO_2e emission reductions.

Why Clean Development Mechanism (CDM) — Projects?

- GHG reduction is critical to control **global climate change**
- Allows KP signatories to invest in GHG-reduction projects in developing countries
- Multiple benefits:
  - Assists developed countries in achieving GHG-reduction targets & commitments
  - Provides funding to developing nations, where GHG-reduction's implemented projects would be too expensive .

CDM PROJECTS — TYPES

- Energy efficiency projects (e.g. fuel switching,..etc)
- Methane recovery (e.g. anaerobic digesters, landfill …etc)
- Industrial process changes
- Cogeneration (e.g. use of waste heat from electric generation
- Transport (e.g. vehicle fuel efficiency/ switching etc)
- Agricultural sector (e.g. solid wastes/ Manure management
- Land use (e.g. afforestation and reforestation activities)

CDM in Wastewater Treatment

- Managing methane ***(CH4)*** emissions in wastewater treatment processes & use it for energy/electricity
- KP approved *6 CDM methodologies* for assessing emission reduction in wastewater treatment:
  - ***CH_4*** emissions reduction from bio-organic solid waste using co-composting — *Version 2*
  - Mitigation of greenhouse gases emissions with treatment of wastewater in aerobic wastewater treatment plants — Version1

CDM in Wastewater Treatment (Cont.)

- ***CH4*** recovery in wastewater treatment— *Version 14*
- Mitigation of greenhouse gas emissions from treatment of *industrial wastewater* —*Version 3.1*
- Avoidance of CH_4 production in wastewater treatment through replacement of anaerobic systems by aerobic systems— *Version 8* (*if there is no system for recovery*)
- ***CH4*** avoidance through separation of solids from wastewater or manure treatment systems—*Version 2*

CDM Projects — Egypt

- Catalytic N_2O Destruction Project in Abu Qir Fertilizer Co. (07 Oct. 2006);
- Onyx Alexandria Landfill Gas Capture and Flaring Project (15 Dec. 2006);
- Zafarana Wind Power Project (22 June 2007);
- Waste Gas-based Cogeneration Project at Alexandria Carbon Black Co. (26 July 2008);
- Zafarana KfW IV Wind Farm Project (02 Mar. 2010);
- Egyptian Brick Factories GHG Reduction Project (July 2010).

Wastewater CDM Opportunities in Egypt

- Applicable to any wastewater treatment facility where:
  - Anaerobic treatment systems replace existing aerobic systems
  - Anaerobic sludge treatment is introduced at a facility with no existing sludge treatment
  - Biogas recovery and utilization is introduced to a sludge treatment system without existing recovery capabilities

Case Study - Gabal El Asfar WWTP

GAWTP—Background

- Conventional Biological treatment process for activated sludge, both primary and secondary treatment
  - Serve a population of ~ *10 million residents* (approx 1.7 M m3 / day)
  - Initial phase completed in 1993, development ongoing
  - Significant removal efficiency in pollution paramètres (BOD, COD and TSS removal reached to more than 95%)
  - Treated WW's are currently used for agriculture

GAWTP—Background (Cont.)

- 20 primary anaerobic digesters with a capacity of 11,000 m3 each;
- 10 secondary anaerobic digesters with a capacity of 9,000 m3 each,
- 2 biogas holding tanks with a capacity of 11,000 m3 each,
- 10 internal combustion engines with a capacity of 2.3 MW each.

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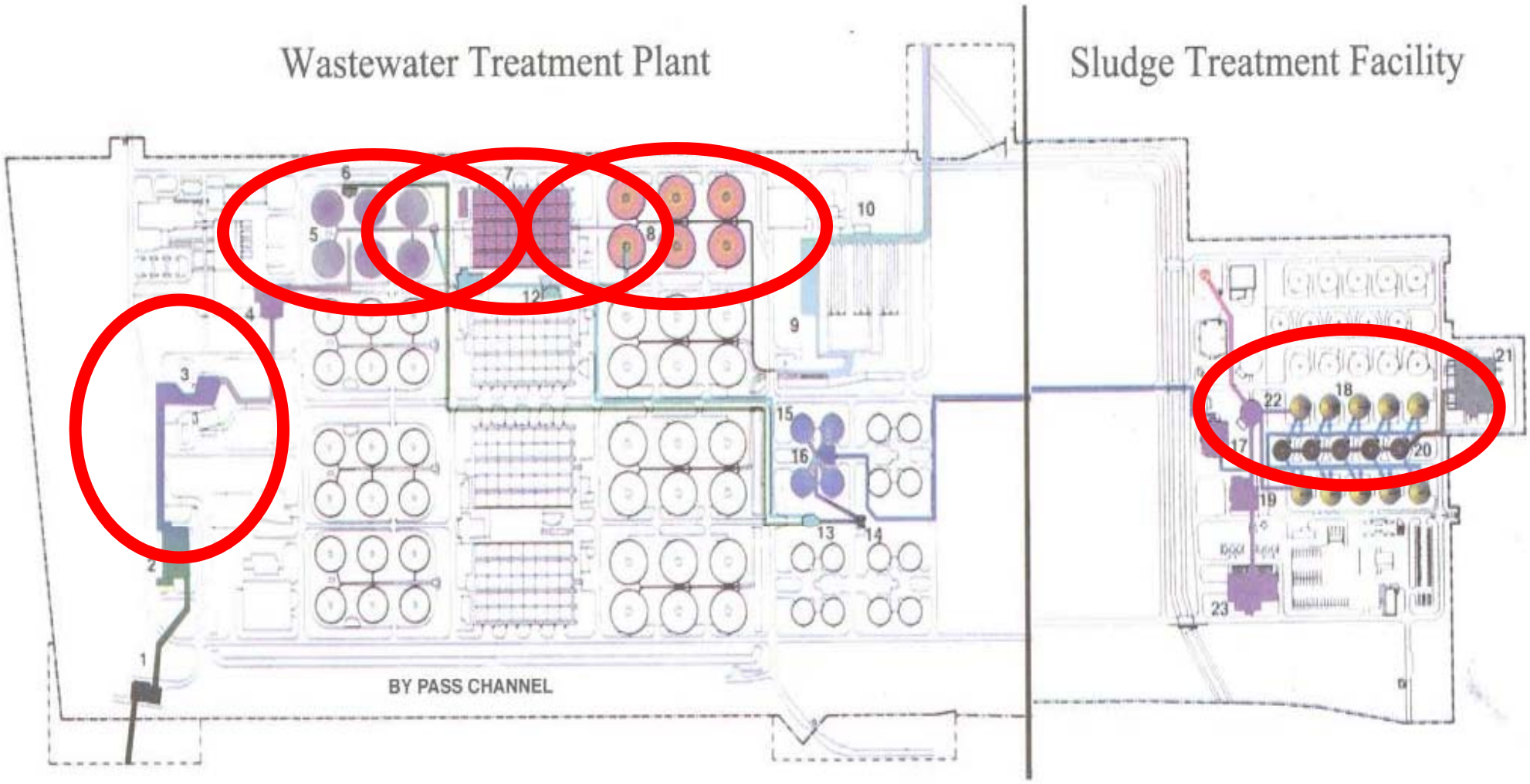
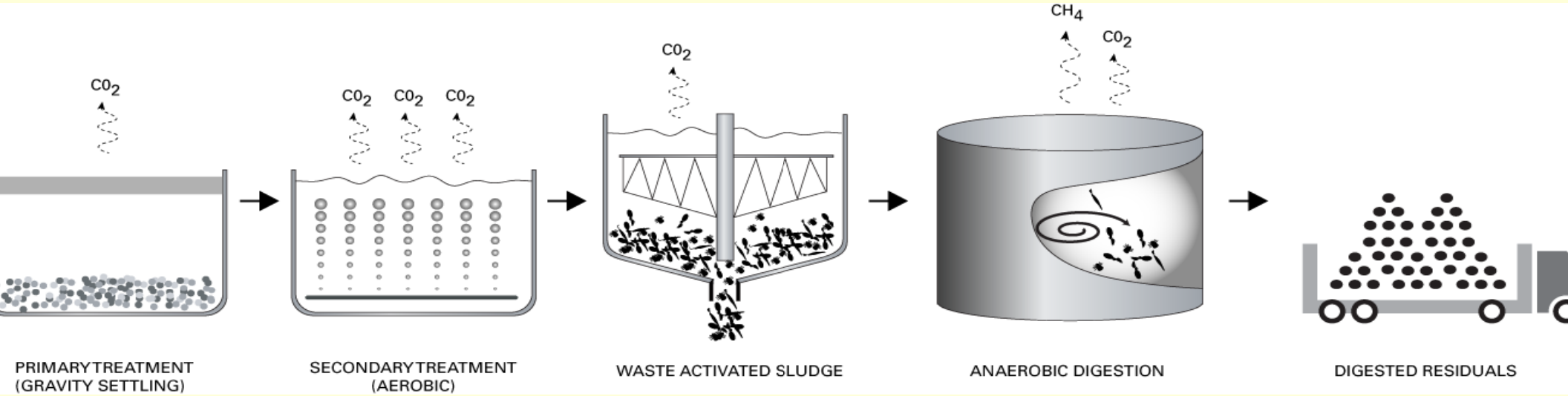
Gabal el Asfar WWTP

Gabal el Asfar WWTP

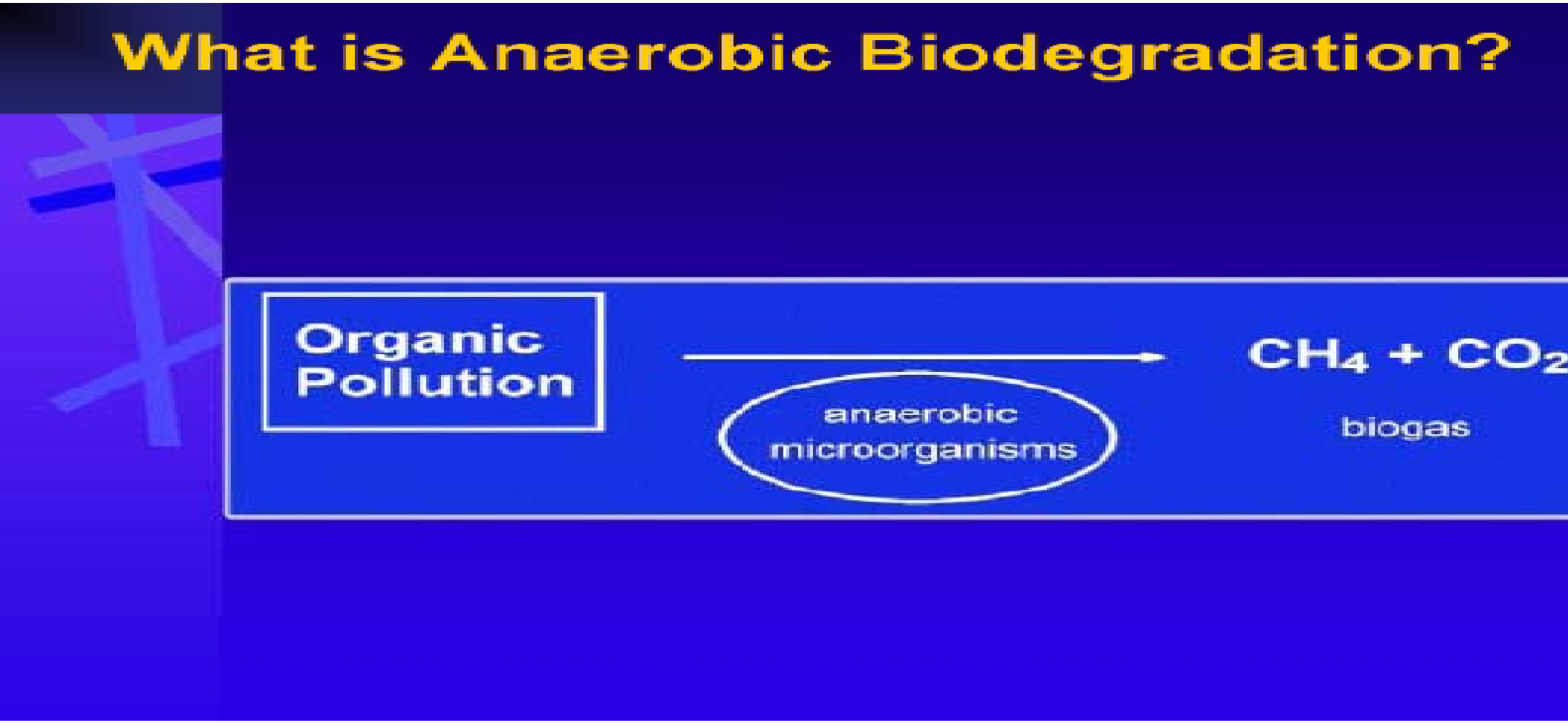


How WWTPs generate GHGs ?

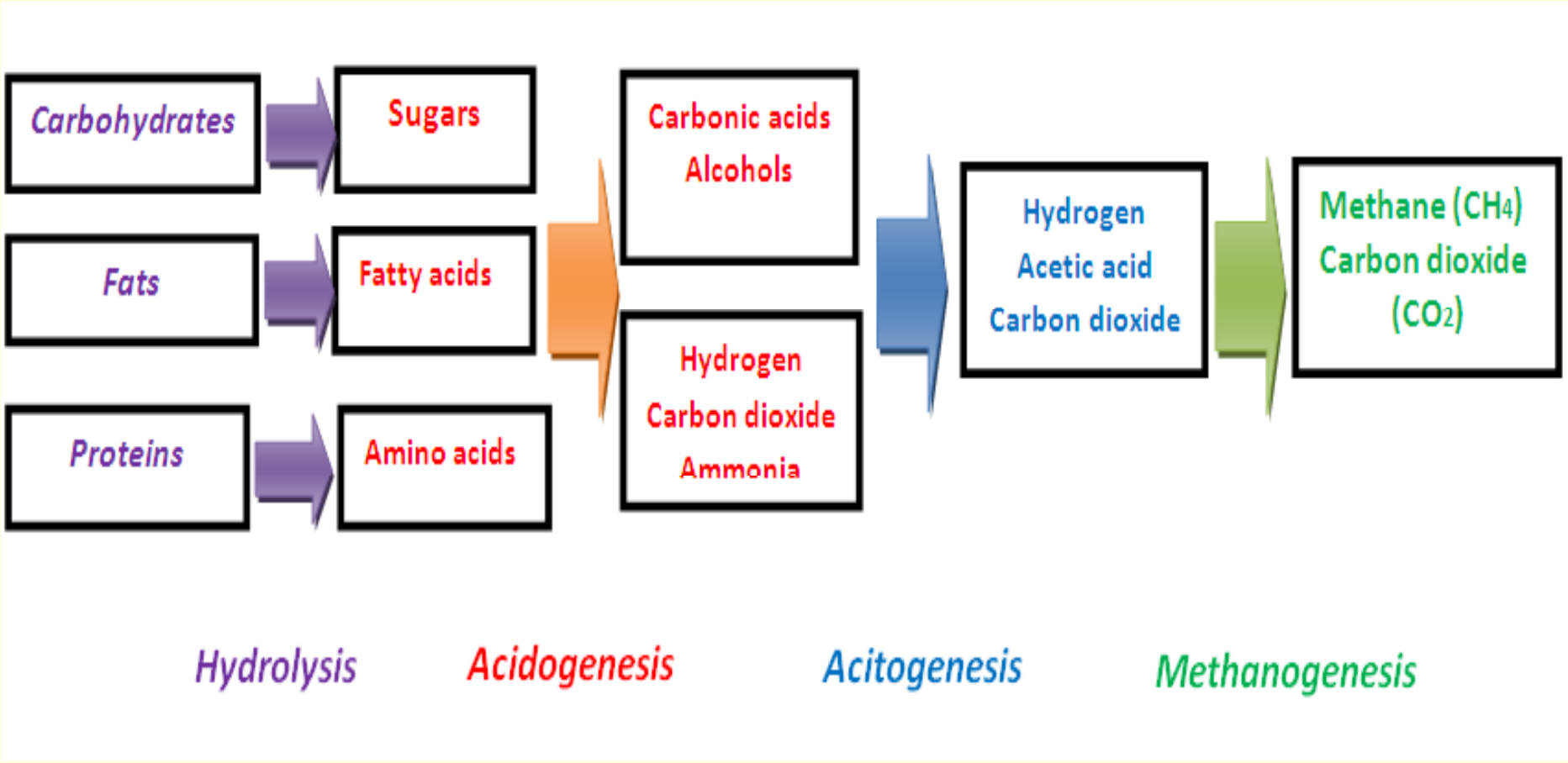
- By consuming electricity and natural gas
- By generating CO2 from biological wastewater treatment
- By generating excess sludge that require :
  - Trucking and disposal
  - Decompose/ biodégradations, forming CH_4, CO_2, N_2O



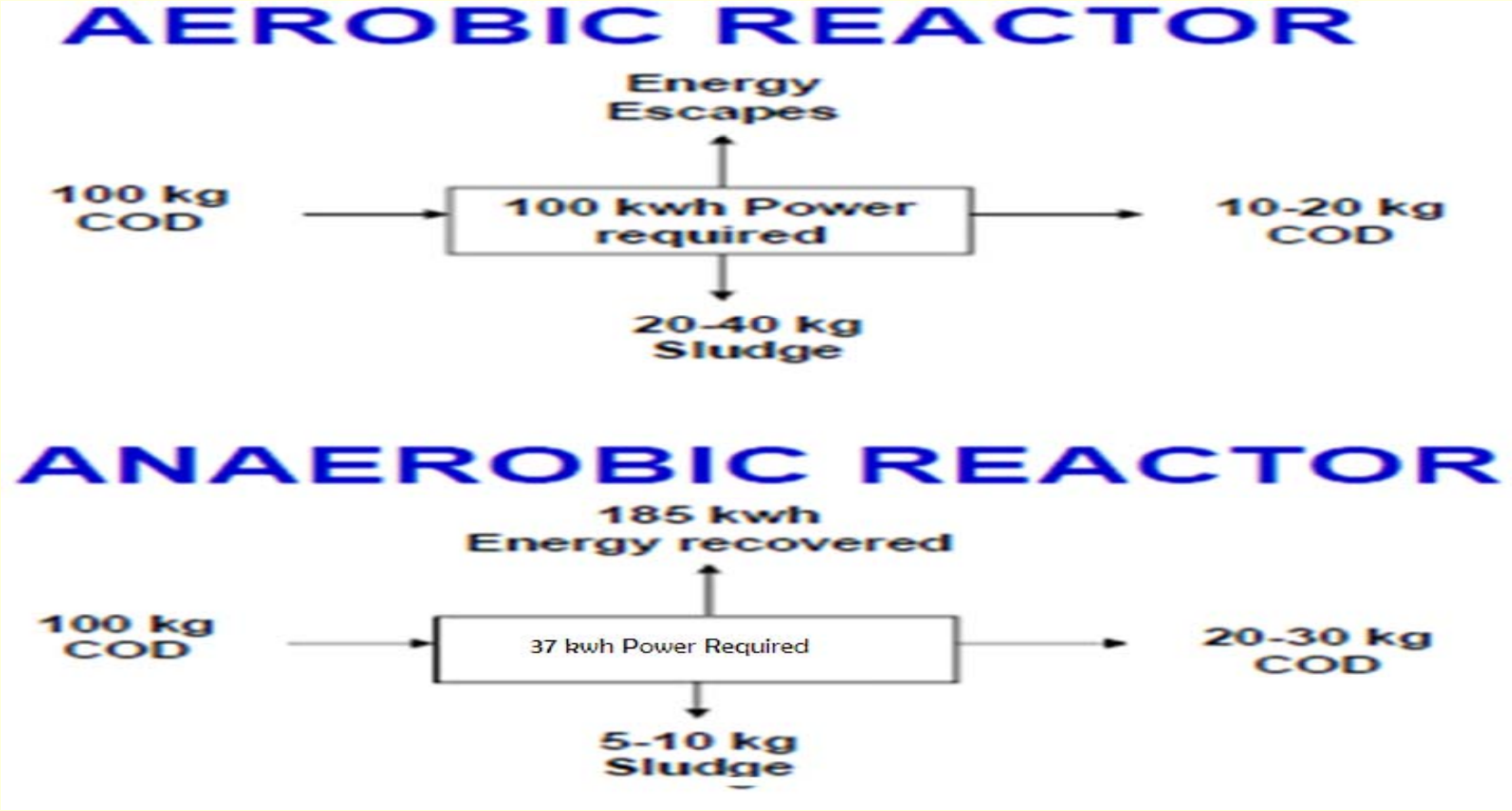
What is happening inside the anaerobic digestor?



Flowchart indicating the main stages in Anaerobic Digestion



Anaerobic Digestion & Energy Recovery



Biogas energy potential of sludge*

Description	Units	Value
Raw Sludge	**Dry tonne**	1
Volatile Solids Solids (VSS)	%	80
Potential Biogas Production	m^3	936
Methane Content in Biogas	%	64
Energy Value of Methane	kWh/m^3	9.94
Biogas Energy Potential	kWh	**4,764**

** Source: Abdel Wahaab, R. (1995)*

Global Warming Potential (GWP)

*Potential Impact and presists for a different length of time in the atmosphère over 100 years (**UNFCCC**)*

- Carbon dioxide (**CO_2**) —1 x
- Methane (**CH_4**) —25 x more powerful
- Nitrous oxide (**N_2O**) —298 x more powerful.

CH4 is a more potent greenhouse gas than CO_2, its mass is multiplied by 25

GAWWTP
Greenhouse Gas —Generation and Management

- Biogas production averages ~90,000 m3/day
- ~60,300 m3/day CH_4 x 0.717 kg/m3 (density of CH_4)
- ~43.2 tonnes CH_4/day
- ~15,725 tonnes CH_4/year
- ~393,120 tonnes CO_2e/year
- ~3.93 *Million CER/VER* credits generated from avoided methane emissions *over 10 years*
- *Credits sold on the global carbon credit market at market price*

Greenhouse Gas —Generation and Management (Cont.)

- Additional carbon credits earned via electricity demand displacement, assuming 61% electricity conversion efficiency
- ~43.2 tonnes CH_4/day
- ~149,000 MWh/year
- ~79,000 tonnes CO_2e / year
- *~0.79 Million CER/VER* credits generated from avoided methane emissions *over 10 years*
- *These reductions generate additional credits to be sold on the global carbon market*

Greenhouse Gas —Generation and Management (Cont.)

- **10-Year Project *(Legal Period of KP)* :**
  - ~ 4.5 billion m3 wastewater treated
  - 4.74 Million tonnes CO_2e reduced (3.93+0.79)
  - 1,500 GWh energy generated = 1500 x 60min x60second =5.4 million Gigajoule
  - 5.4 Million GJ (Gigajoule)

10 Years Revenue from Sale of Carbon Credits

If CER:

- **Revenue from sale of carbon credits (4.74 M Tonnes CO_2e * $20 = $94.8M)**

If VER:

- **Revenue from sale of carbon credits (4.74 M Tonnes CO_2e * $8 = $37.92)** ~ $3.8-million/Year

Conclusion

- **GAWTP** has10 internal combustion engines (2.3 MW each)
- Methane captured provides ~17 MW(~ 70% of the plant's energy requirements)
- *Average O & M costs for the anaerobic sludge treatment and methane management/on-site electricity generation components in Al Gabal El Asfar are 45- 50 million EGP /year.*

- Al Gabal El Asfar project could generate *annual VERs* carbon-credit revenues of about $3.8-million (*about EGP 22-million*), which represents a potential *44% - 49% cost-recovery* of the annual operating cost for this facility.

Conclusion (Cont.)

- Efficient use of biogas from anaerobic digestion of wastewater can result **not only** a potential source of *operational cost recovery* in wastewater treatment plants **but also** a *full ROI* within short period of time.

- The combination of environmental and economical value characterize ***biogas*** ***as a very attractive source of green energy & reduce climate change impacts.***

Thank You
for Your Attention!