Cleaner Use and Management of Agricultural Waste for Biogas Fuelled Power Generation and Biofertilizers Production

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MORE THAN 2 BILLION PEOPLE AROUND THE WORLD LIVE WITHOUT CONNECTION TO THE GRID...

...WORLDWIDE HIGH GROWTH RATES FOR STAND-ALONE POWER GENERATION SYSTEMS...

...FOSSIL FUELS REPLACEMENT BY RENEWABLES.

Unsafe Electricity Supply

- Cripples country economics
- Causes chaos in the cities
- Affects production costs
- Poses important technical problems to key consumers

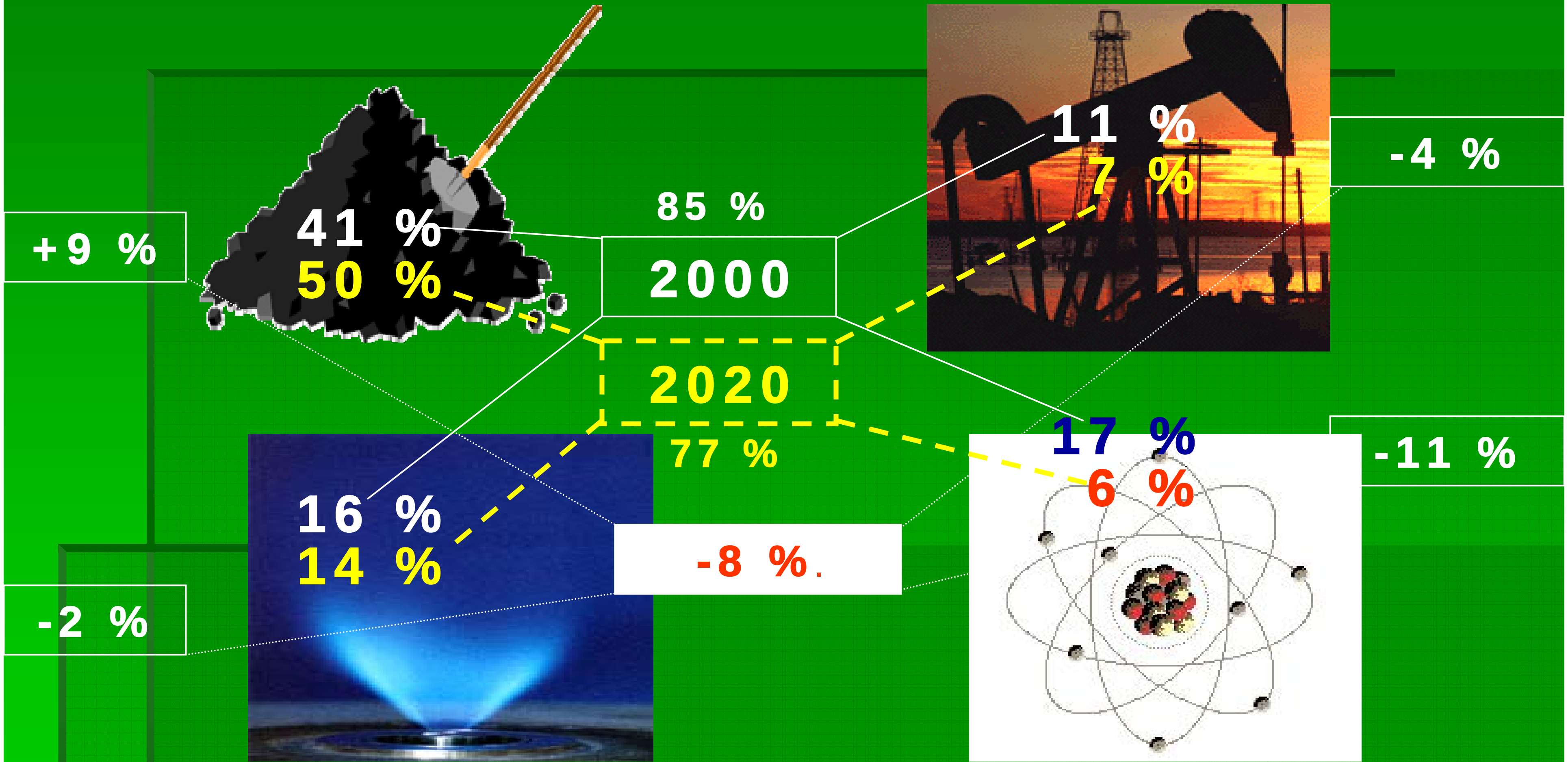
North America 2003 Blackout

- 66% lost at least 1 business day
- 24% lost > 50’000 USD/hr downtime
- 4% lost > 1 million USD/hr downtime
- 11% consider relocation
- 38% consider investment in alternate power generation systems.

Choice of Power Supply

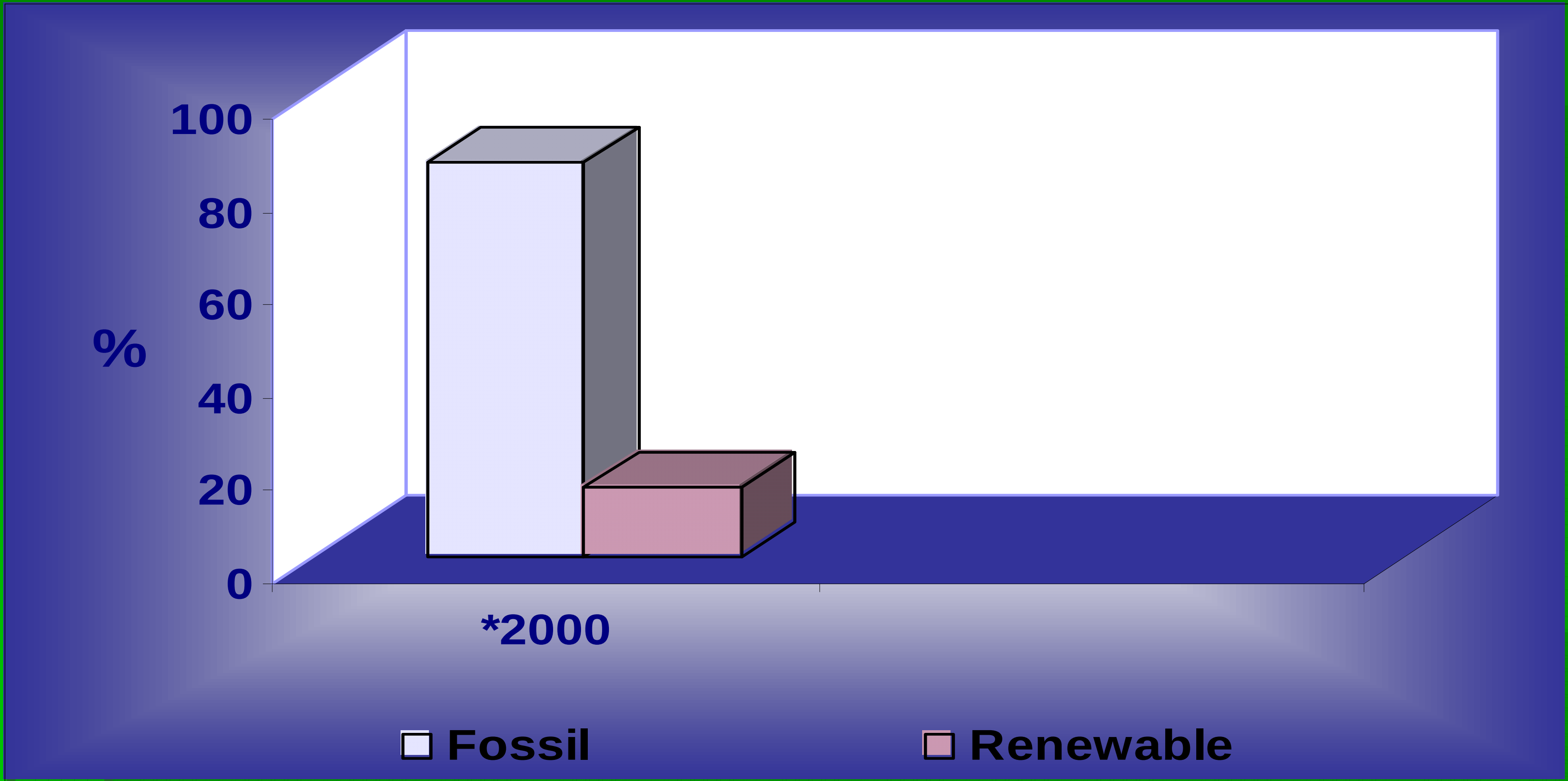
- Grid availability
- Fuel availability
- Consumers structure
- Electric power production reliability and costs

Fossil Fuel Options

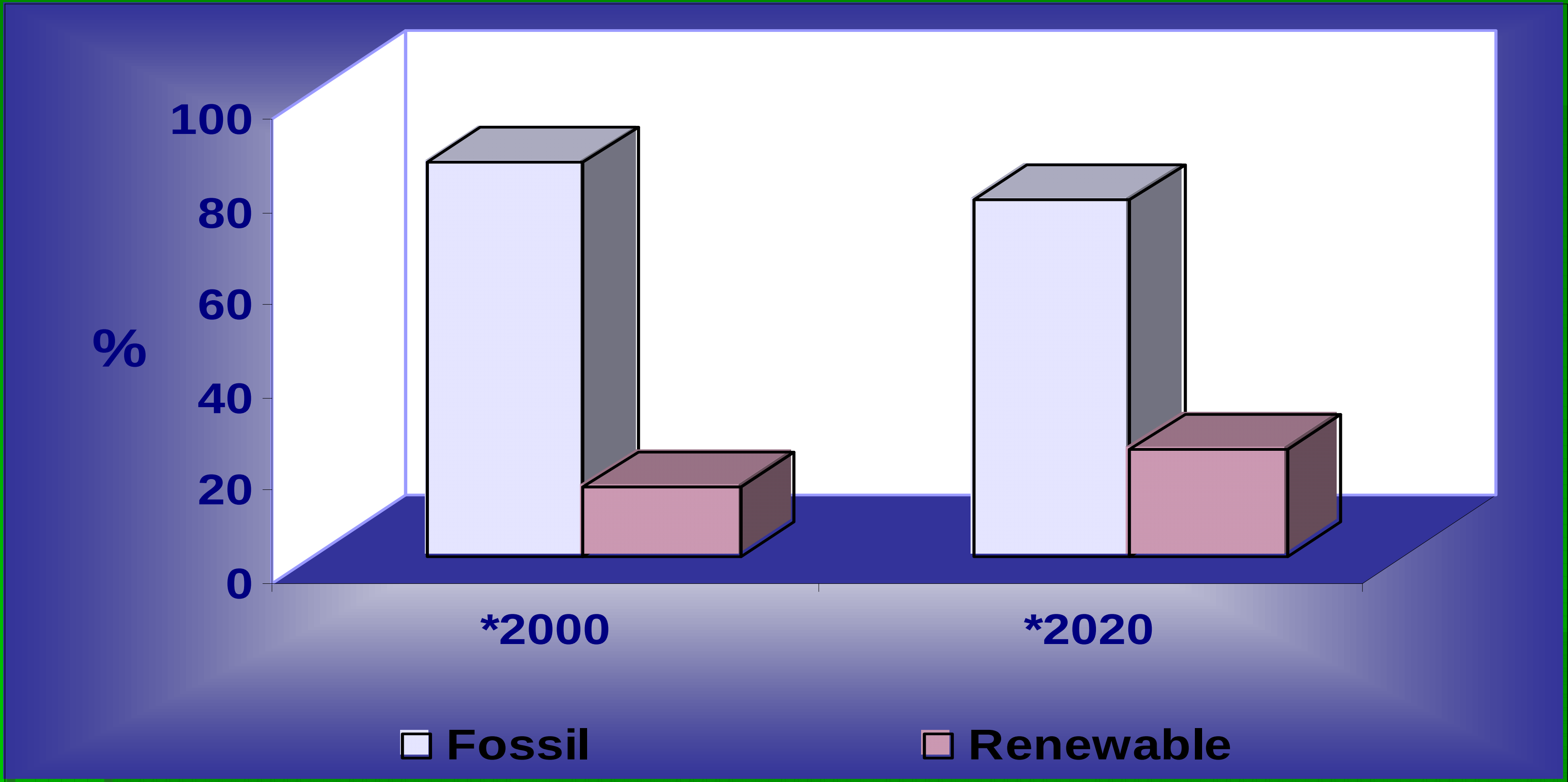


Renewable

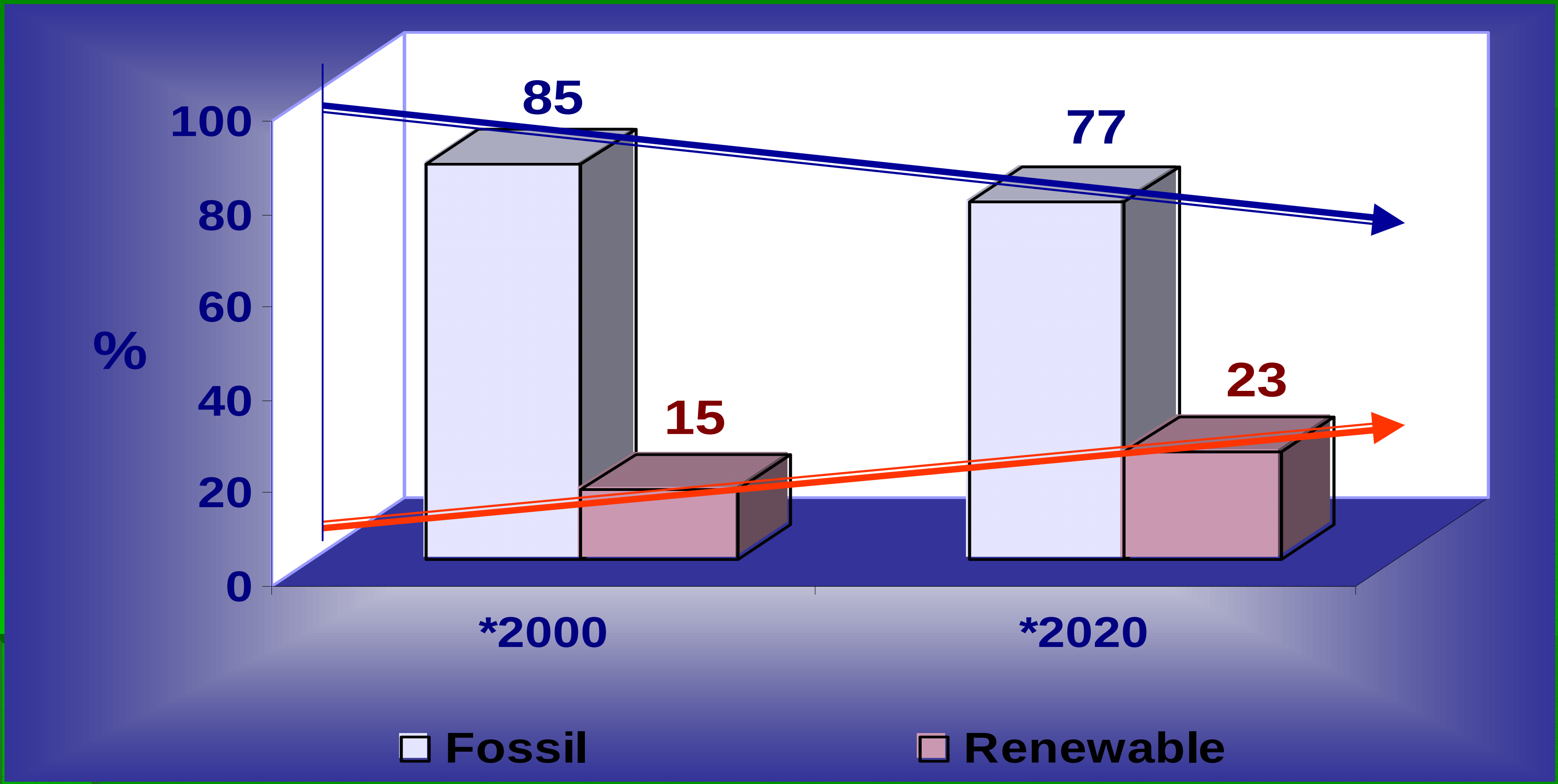
Fossil vs. Renewable



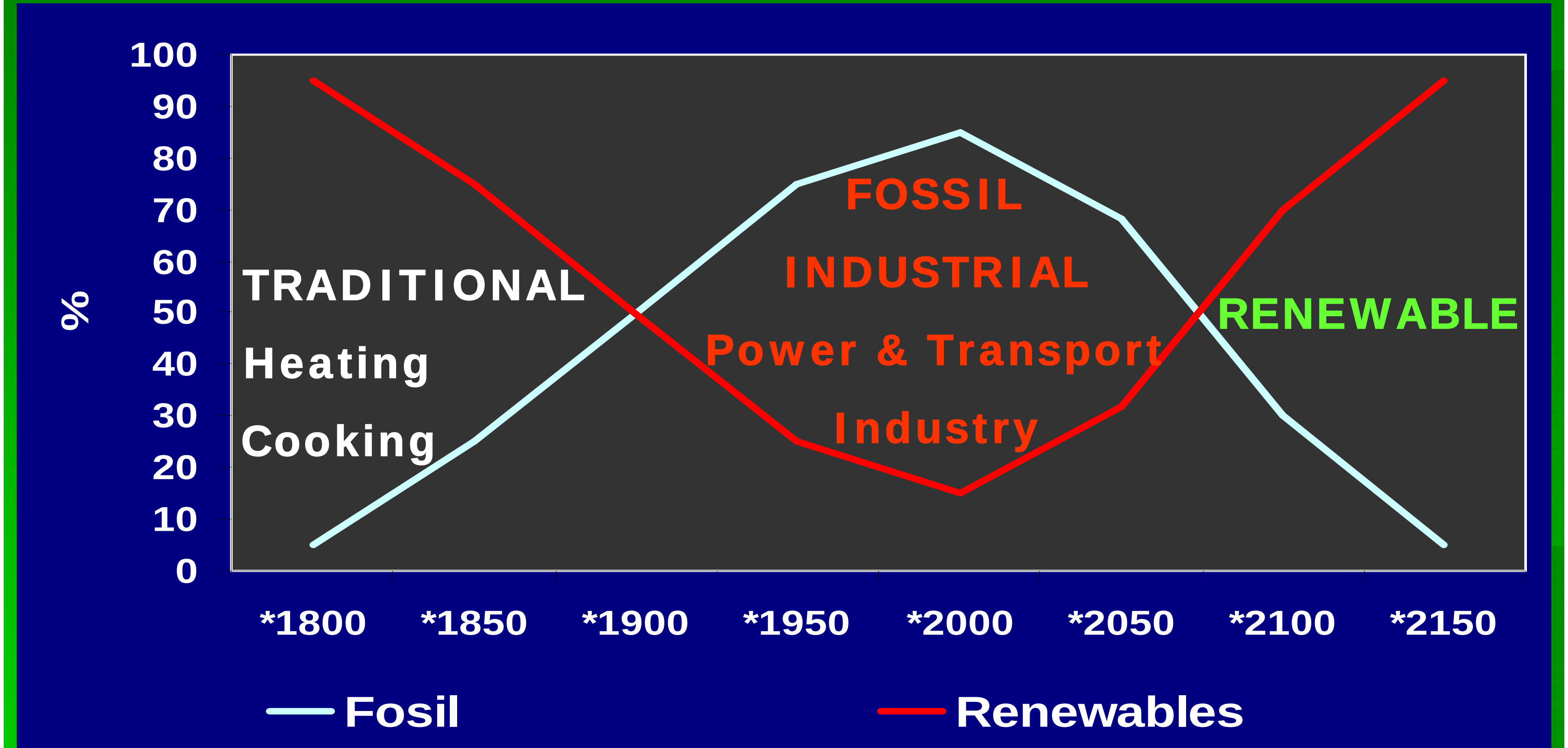
Fossil vs. Renewable



Fossil vs. Renewable



Evolution of Energy Use



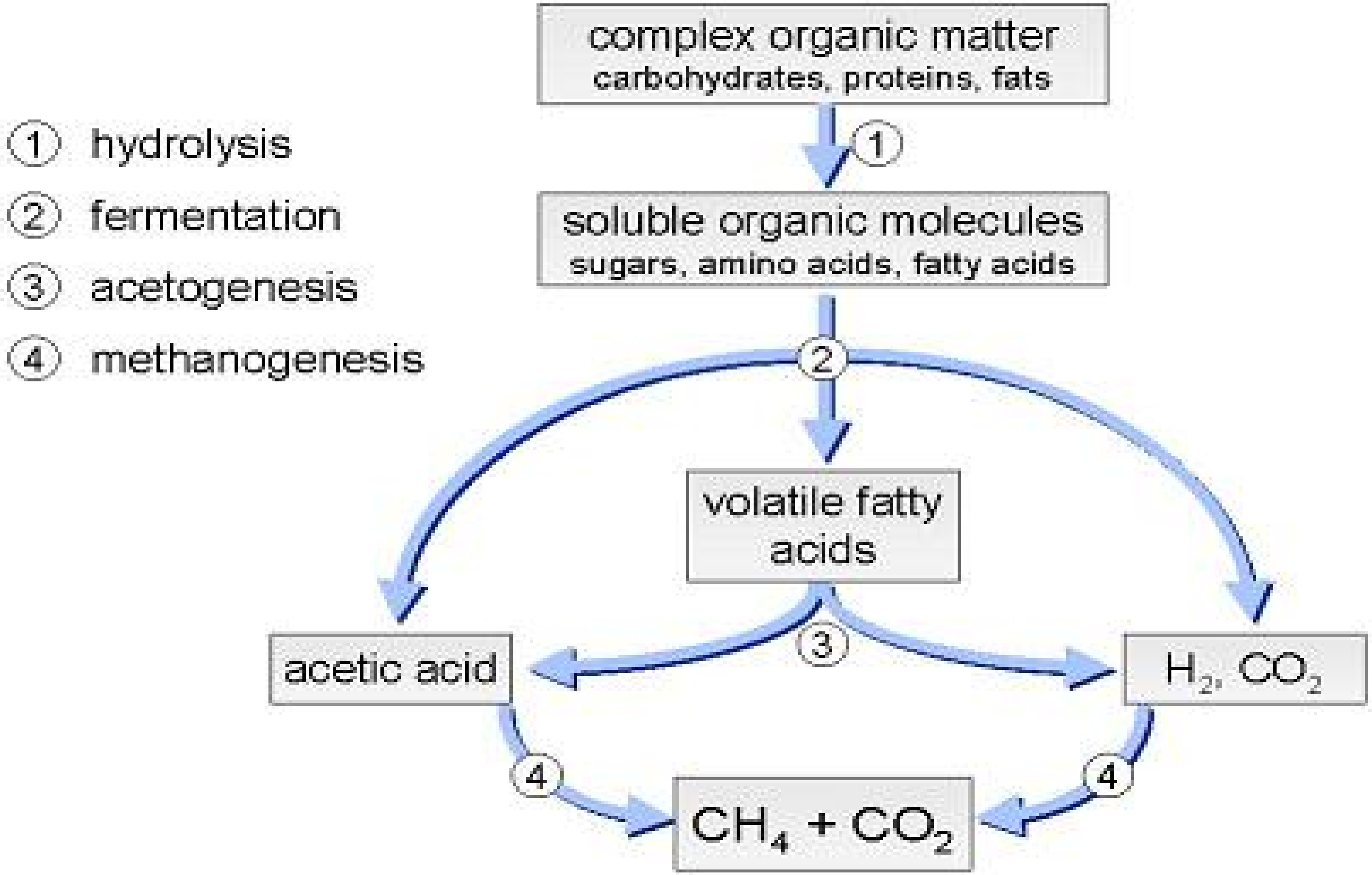
- The Forest Residue → Heat & Syngas
- Free Field Residue → Heat & Syngas
- Wood Processing Industry → Heat & Syngas
- Urban Wood, Paper & Cardboard Waste → Heat & Syngas
- Waste from Agricultural Products Processing Industry → Biogas & Syngas
- Organic Components in Town Waste → Syngas & Biogas
- Solid & Liquid Animal Manure → Syngas & Biogas
- Agricultural Plant Waste → Heat, Biogas, Syngas, Methanol & Ethanol
- Waste Waters → Biogas
- Landfills → Biogas (Landfill gas).

Conversion Technologies

- Direct Combustion PRODUCT→ Heat
- Thermo-Chemical Conversion PRODUCT→ Syngas & Charcoal
- Bio-Chemical Conversion PRODUCT→ Biogas, Methanol & Ethanol.

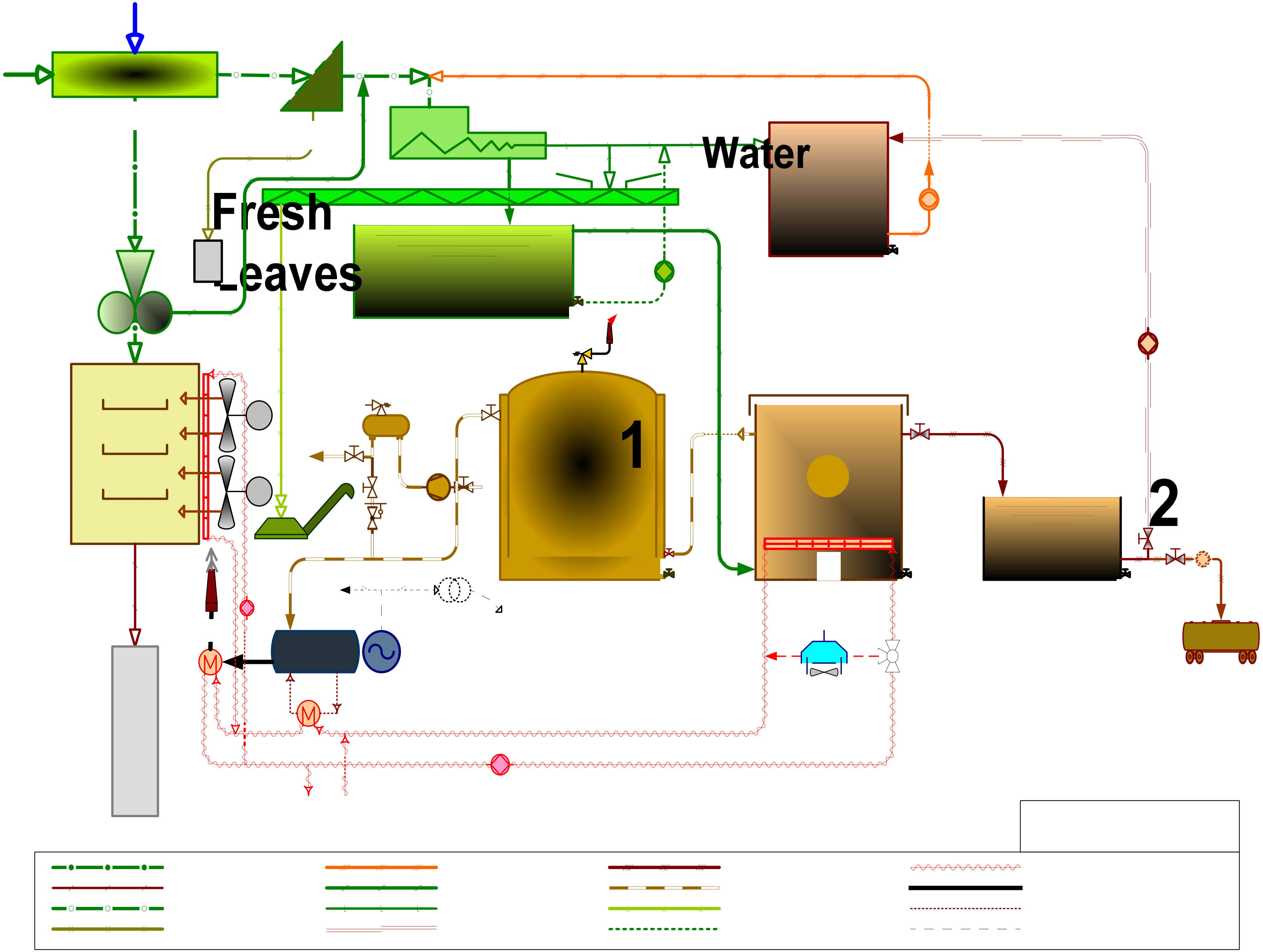
Biogas

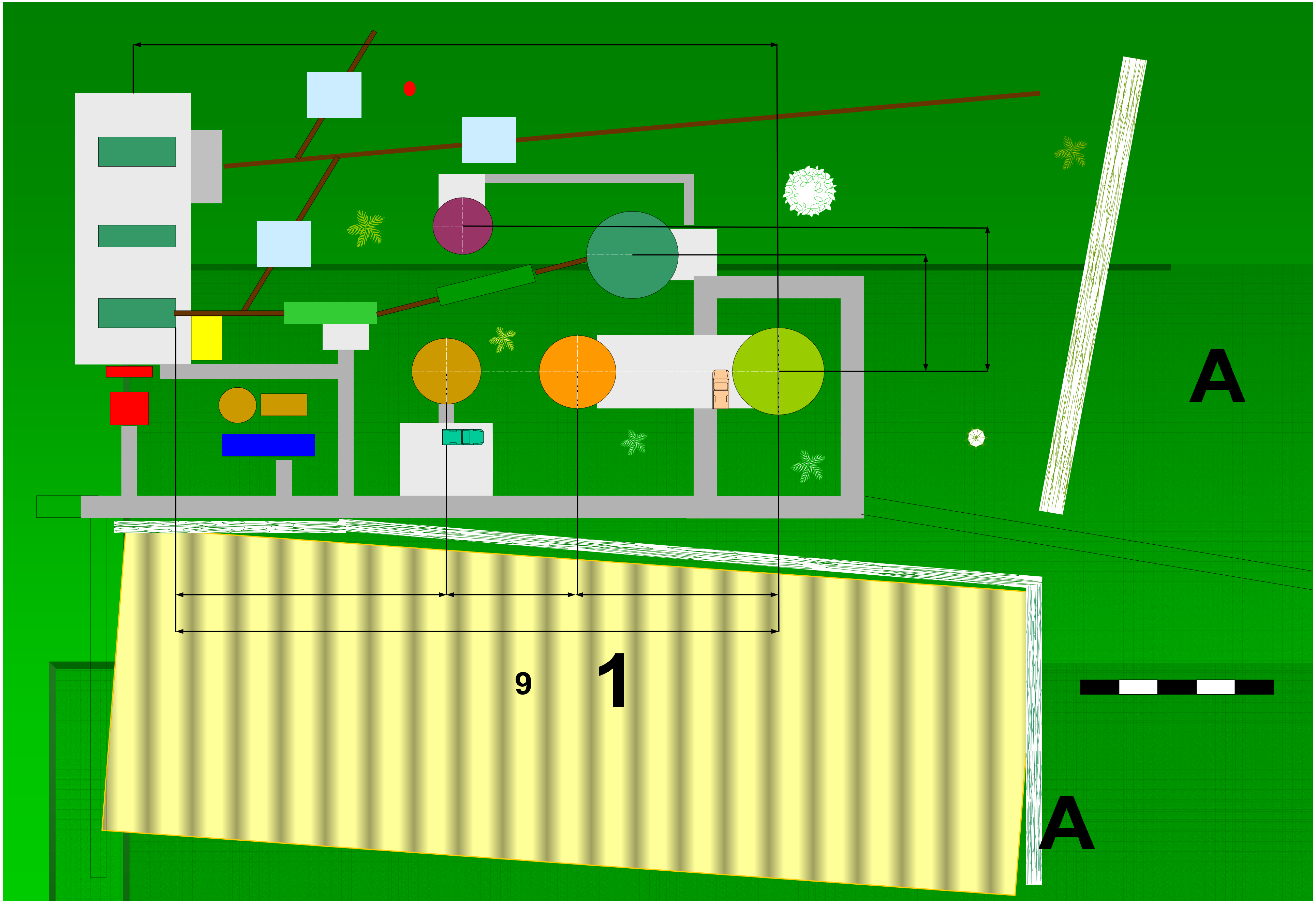
- Anaerobic Digestion → Decomposition in absence of O_2
  - → Psychrophilic 20 - 25°C
  - → Mesophilic 25 - 35°C
  - → Thermophilic 50 – 60°C
- 55% - 65% CH_4 ** 35% - 45% CO_2 ** H_2S ** N ** H_2
- Hu → 20 -24 MJ/Nm^3 (Natural Gas ~40MJ/Nm^3).


① hydrolysis
② fermentation
③ acetogenesis
④ methanogenesis
complex organic matter
carbohydrates, proteins, fats
1
soluble organic molecules
sugars, amino acids, fatty acids
2
volatile fatty acids
3
acetic acid
H_2, CO_2
4
4
$CH_4 + CO_2$

Demonstration Pilot Project for Biogas Production from Sisal Waste

Sisal is long hard fiber used primarily in cordage (ropes & cords)


Water
Fresh
Leaves
1
2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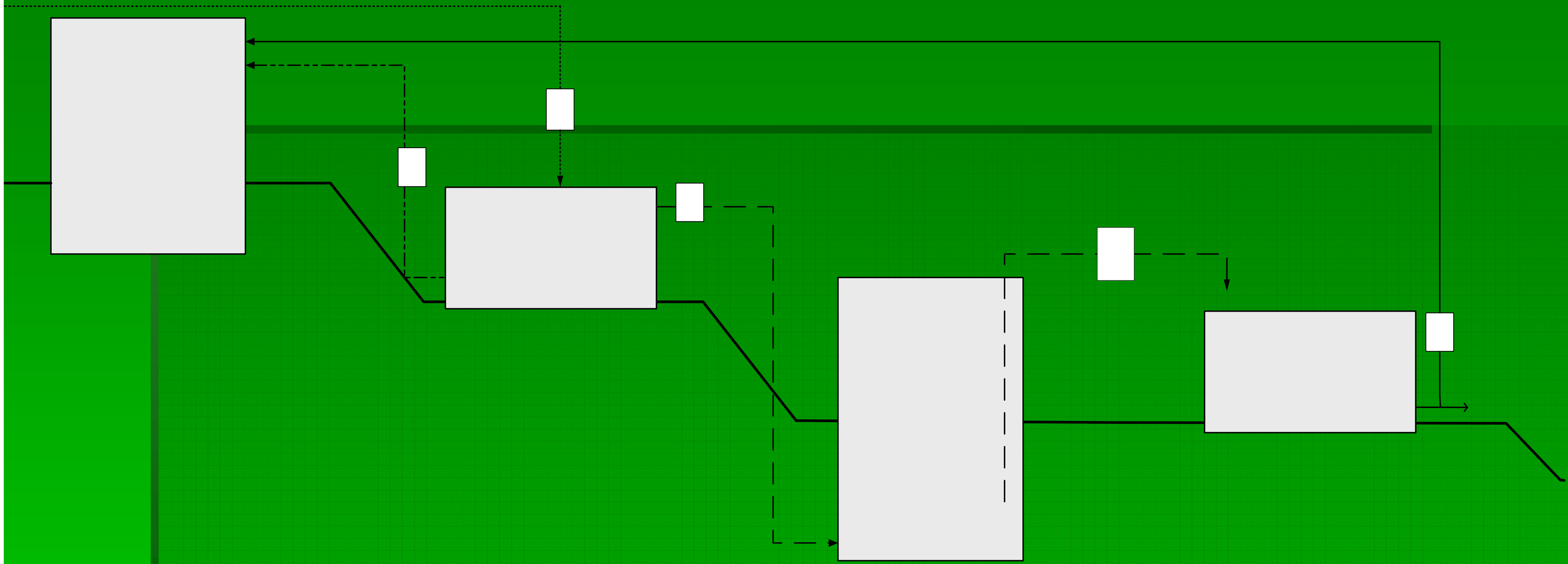
9
1
A



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Process Selection

Digestion Process	Description	Advantages	Disadvantages
Dry	Dry solids content of > 25-30%	Compact, lower energy input, better biogas quality (<80% CH_4), maintenance friendly	Restricted mixing possibilities
Wet	Dry solids content of < 15%	Better mixing possibilities	Higher energy input, lager reactor
Psychrophilic	Digestion temperature around 20° C	Long process time, very slow rate	Minimal energy input
Mesophilic	Digestion temperature between 25° C and 35° C	Longer process time, slower rate	Low energy input
Thermophilic	Digestion temperature between 50° C and 60° C	Shorter process time, higher degradation, faster rate	Higher energy input
Batch	Substrate in closed reactor during whole degradation period	Suitable for small plants with seasonal substrate supply	Unstable biogas production
Continuous	Reactor is filled continuously with fresh material	Constant biomass production through continuous feeding	

Upflow Anaerobic Sludge Blanket (UASB) type digestion

- → More efficient treatment of warm & high strength waste liquids
- → Minimal electrical power usage
- → High organic loading rates
- → Suitable for tropical climate
- → Longer digester shutdown possible.

Process Parameters

Input/Output	Unit	Quantity	TS (%)
Fresh Sisal Leaves	Tons/day	34	18
Process Water	Tons/day	150	0
Long Fibers Dry	Tons/day	1.3	89
Solid Fertilizer	Tons/day	6	24.6
Liquid Fertilizer	Tons/day	170	0.4
Biogas	Nm^3/day	1’470	-
Net Electric Power	kW_{el}	142	-
Heat Energy	kW_{th}	172	-

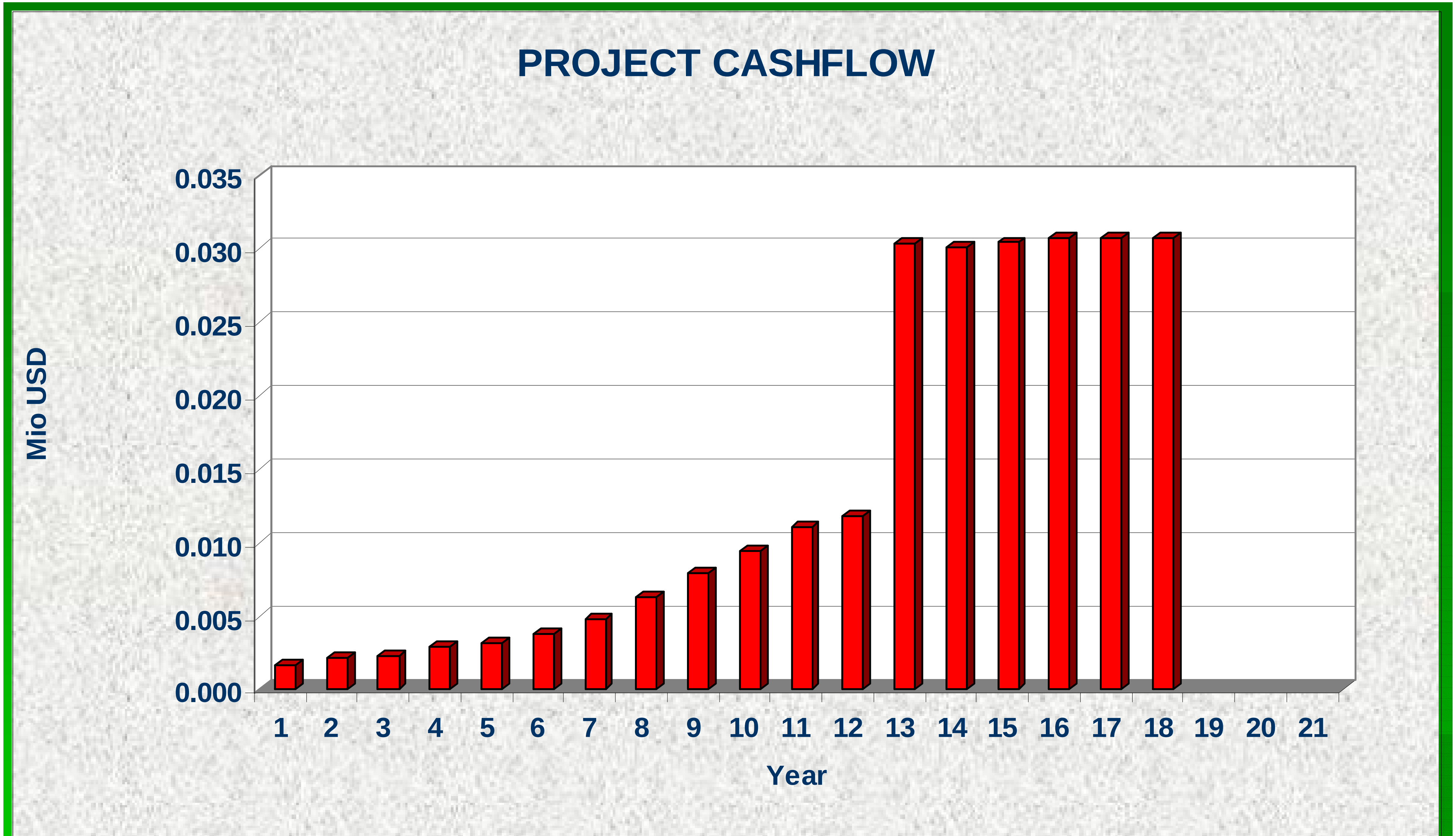
Hydraulic Retention Time

HRT

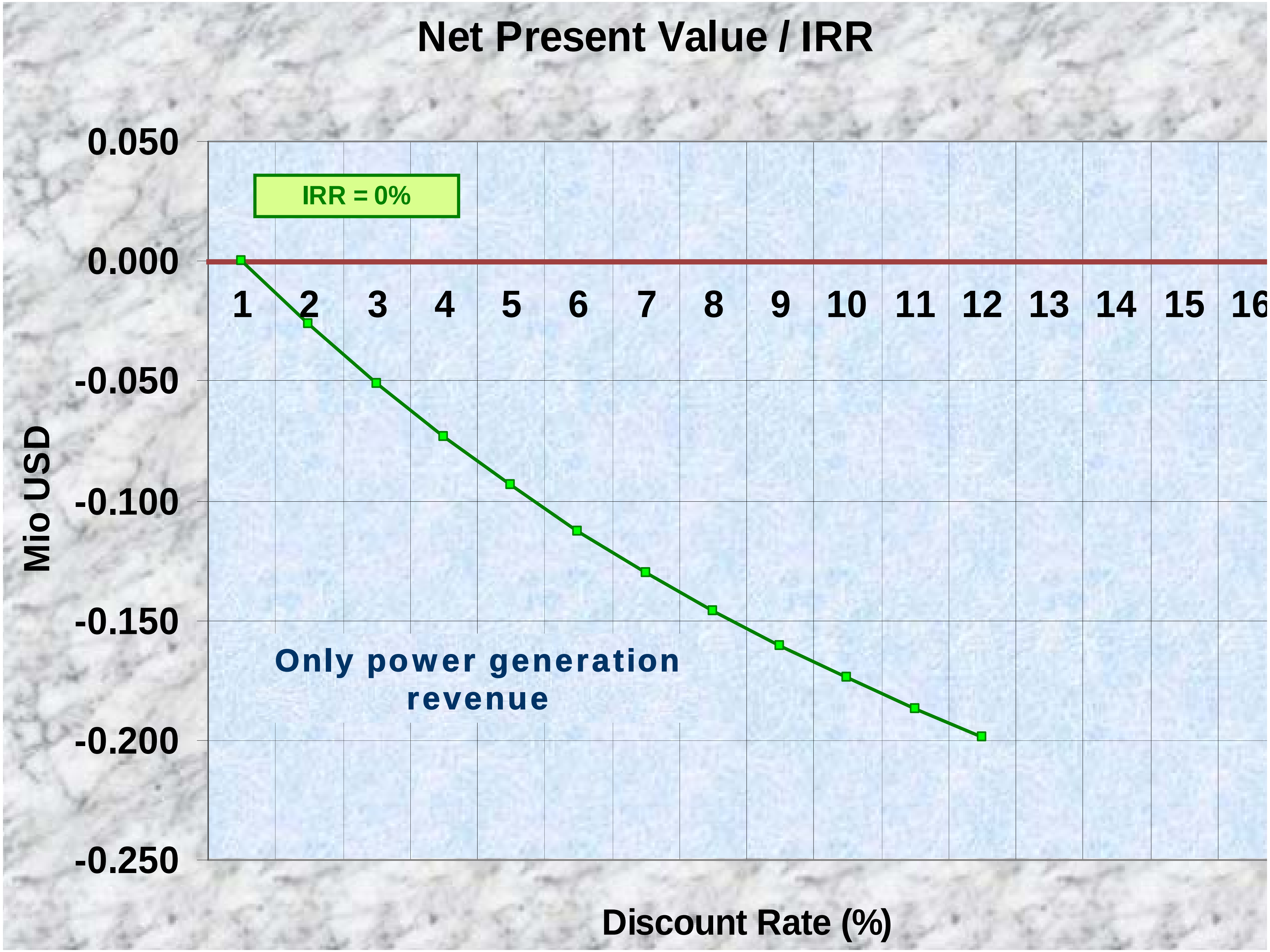
5 - 10 Days

Project Economics

- Project Cost → 440’000 USD
- Electricity Production → 1’050 MWh/year
- Specific Investment → 0.042 USD/kWh/year (12 years period)
- Solid Fertilizer Production → 6 ton/day
- Liquid Fertilizer → 170 ton/day



Only power generation revenue



Net Present Value / IRR
IRR = 0%
Only power generation revenue
Mio USD
Discount Rate (%)
0.050
0.000
-0.050
-0.100
-0.150
-0.200
-0.250
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

Anticipated Time Schedule

- Project Development & Tendering → 3 Months
- Design, Procurement & Delivery → 5 Months
- Construction & Erection → 5 Months
- Commissioning & Trial Run → 2 Months
- Total → 15 Months

Application in Malaysia?

Example: Palm Oil Mill POME

33 – 38 Millions of POME per year

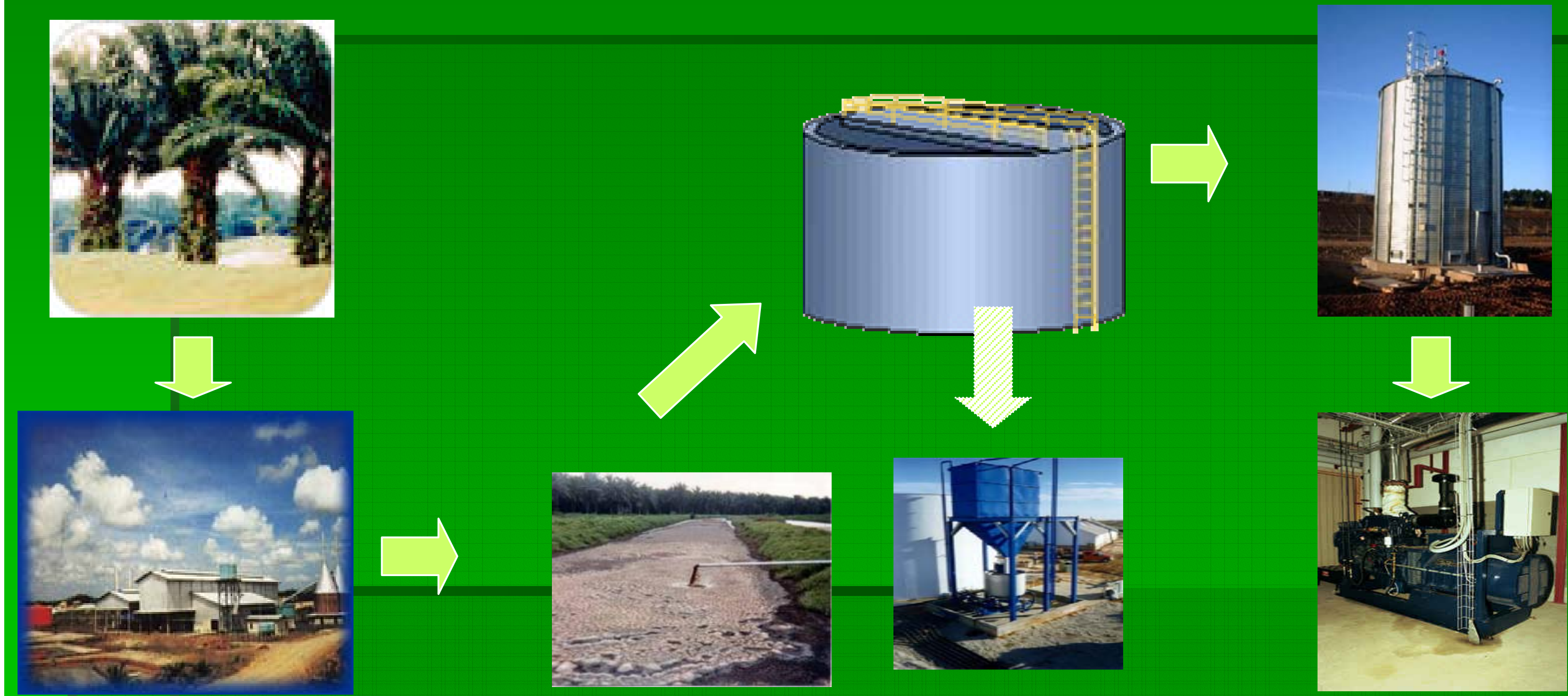
CHARACTERISTICS OF POME

- pH → 3.4 - 5.2
- BOD → 10,250 - 43,750 mg/L
- COD → 16,000 - 100,000 mg/L
- TS → 11,500 - 75,000 mg/L
- SS → 5000 - 54,000 mg/L

POME Characteristics vs. DOE Standards

Parameters	Unit	POME (Average)	DOE Standards
pH	-	4.3	5 - 9
BOD	mg/L	27'000	100
Suspended Solids	mg/L	29'500	400
Total Nitrogen (N)	mg/L	707	200
Ammonia Nitrogen (NH_3-N)	mg/L	35	100
Oil and Grease	mg/L	8,000	50
Temperature	^oC	80-90	45

POME a Fuel for small Power Generators?



Malaysian Potential

(Based on Yearly Average FFB Production)

- FFB → 43 Mio tones
- Crude Oil → 13 Mio tones
- POME → 36 Mio tones
- $\text{Biogas}_{\text{POTENTIAL}}$ → 860 Mio Nm^3
- $\text{El. Power}_{\text{POTENTIAL}}$ → 200 MW_{EL}
- El. Energy → 1'400 GWh
- $\text{Usable Heat}_{\text{POTENTIAL}}$ → 240 MW_{TH}
- $\text{Fertilizer}_{\text{POTENTIAL}}$ → 40 Mio tones

UTILIZATION OF EFB IS NOT CONSIDERED IN ABOVE FIGURES

Beneficial Factors

- ✓ No additional pollution from renewable energy;
- ✓ Locally available and sustainable energy source;
- ✓ Fossil fuels are deplorable, biomass is renewable;
- ✓ Increase of importance as major energy carrier;
- ✓ Growing recognition among international institutions resulting in stronger support.

Constraints

- Funding limitations;
- Lack of statutory framework;
- Competitvenes under current energy market conditions
- Lack of biomass technology dissemination;
- Lack of feedstock delivery infrastructure;
- Lack of reliable data on lifecycle benefits and emissions, technology performance and feedstock availability.

What has to be done?

- Accelerate the transition to biomass waste energy resources;
- Encourage and reward use of biomass waste energy by utilities and all power consumers;
- Stop substitution of outdated energy sources and support use of biomass waste based renewable energy;
- Promote implementation of biomass waste based energy for “green” energy generation;
- Make all efforts to reduce the pollution that causes global warming.

Summary - Conclusions

- 15 % saving in fossil fuel consumption means 15 % less emissions;
- Small biomass waste plants → "green", decentralized, electricity generators;
- Biomass conversion technology is evolving rapidly and the time-span is being reduced;
- Significant advances have been made in gasification, co-firing, biogas and bio-fuels production;
- Fossil fuels price increase will put biomass based renewable energy onto a more equal footing with fossil fuels.

There is only one planet names EARTH in the Universe.

This is a place where we are living and where the following generations supposed to live..

..there is no escape if we irreversibly damage it.

Transition of fossil fuels to renewable energy is one of the most important steps to preserve life on our precious blue planet EARTH.

Thank you

QUESTIONS

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