ACP S&T PROGRAMME

PEOPLE'S POWER AFRICA

CONVERTING WASTE INTO ENERGY

Agro-Ecological Environmental Biotechnology Systems for Food and Fuel Sovereignty in Southern Africa.

Presentation to the
African Caribbean and Pacific Group of States (ACP)
Science and Technology Programme,
Initiation Workshop: Sustainable Non-Food Fuel Sources,
Johannesburg, January 29, 2010

Agro-Ecology Farming Systems

The IAASTD (2008), the most comprehensive assessment of agricultural knowledge, science and technology to date and which is endorsed by 57 countries.

Calls for governments to redirect their focus from chemical and energy intensive conventional farming systems towards productive small-scale agro-ecological farming systems that provide

- greater yields per hectare
- more jobs per hectare
- resilient to drought and disease
- contributing positively towards climate change mitigation, adaptation and resilience.

Zero Waste Natural (non GM) Environmental Biotechnology

- In nature one natural kingdoms waste is food for another natural kingdom
- These natural processes can be used to produce energy and nutrients.
- Waste is not a problem but a resource!

Images Courtesy of ZERI SA

ENVIRONMENTAL BIOTECHNOLOGY

The optimal use of nature, in the form of plants, animals, bacteria, fungi and algae, to produce energy, food and nutrients in a synergistic integrated cycle of profit making processes where the waste of each process becomes the feedstock for another process.

Biogas is People's Power!

Biogas

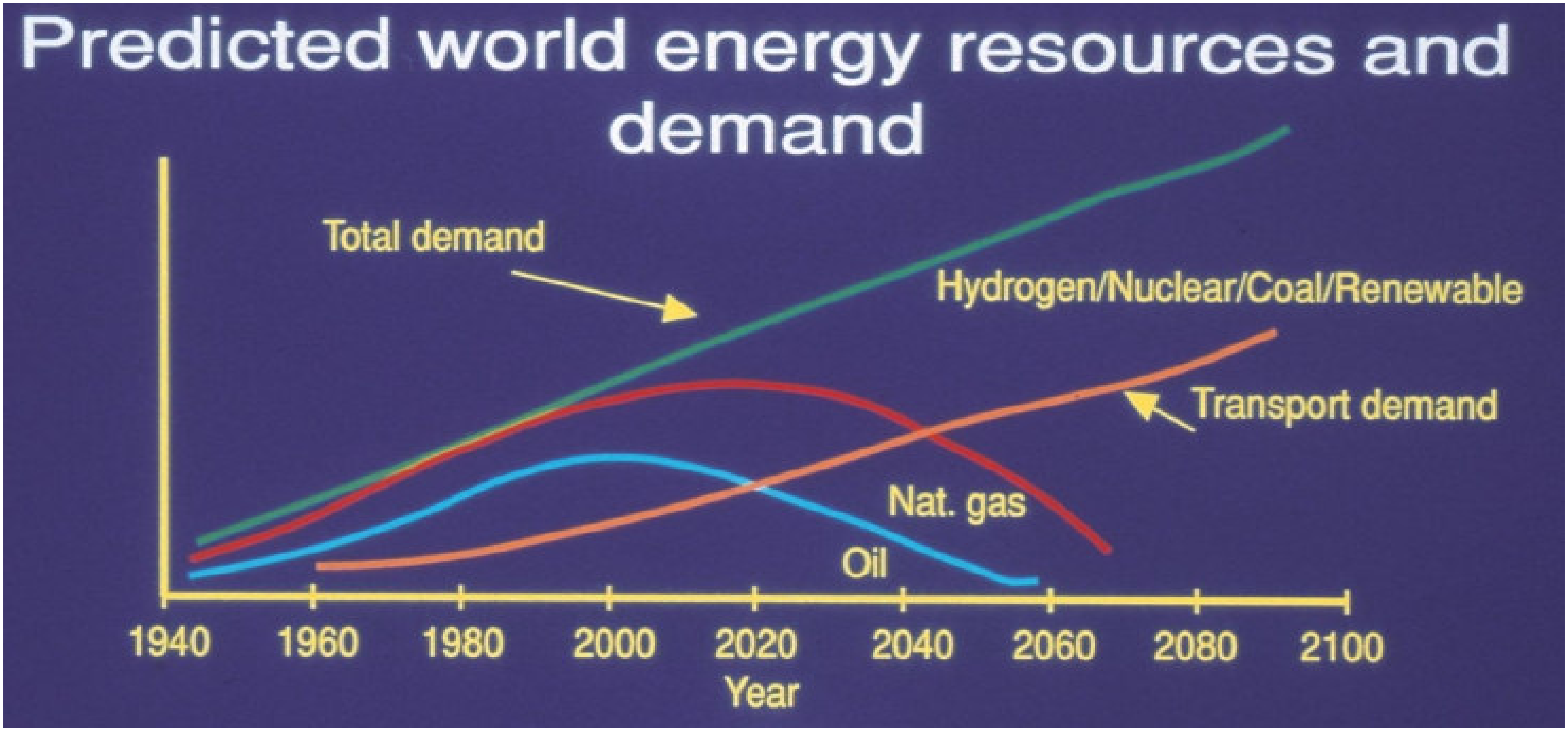
- Anaerobic fermentation is a 3000 year old technology
- There are over 15 million biogas digesters worldwide
- Sector growth is > one million digesters / year
- Produces useful methane rich biogas energy
- Produces useful biofertilizer sludge and effluent

Biogas digester advantages

- Low maintenance ecological sanitation
- Digests food waste (40% of solid waste), leads to 80% reduction of municipal waste removal cost
- Enhanced Nutrient capture & fertilizer production
- Water recycling & purification
- No Chemical and Electrical Inputs
- No bad smells

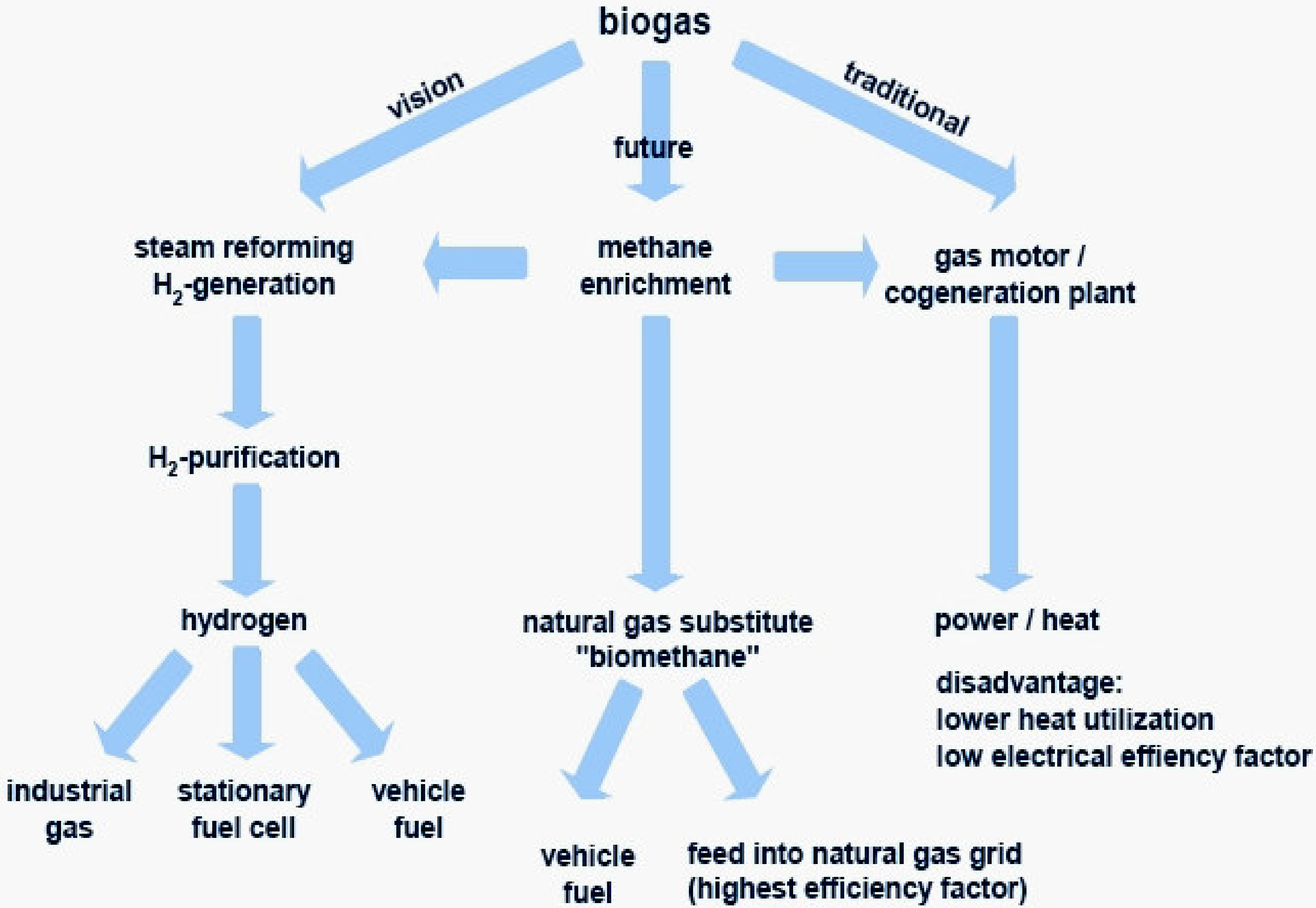
BIOGAS COMPOSITION

Composition of biogas		
Substances	**Symbol**	**Percentage**
Methane	CH_4	50 – 70
Carbon Dioxide	CO_2	30 – 40
Hydrogen	H_2	5 – 10
Nitrogen	N_2	1 – 2
Water vapour	H_2O	0.3
Hydrogen Sulphide	H_2S	Traces



Biogas is rich in bio-methane, a sustainable renewable fuel not linked to the unstable price of fossil fuels

Route of Biogas Utilization



Source (Japan for Sustainability, 2009)

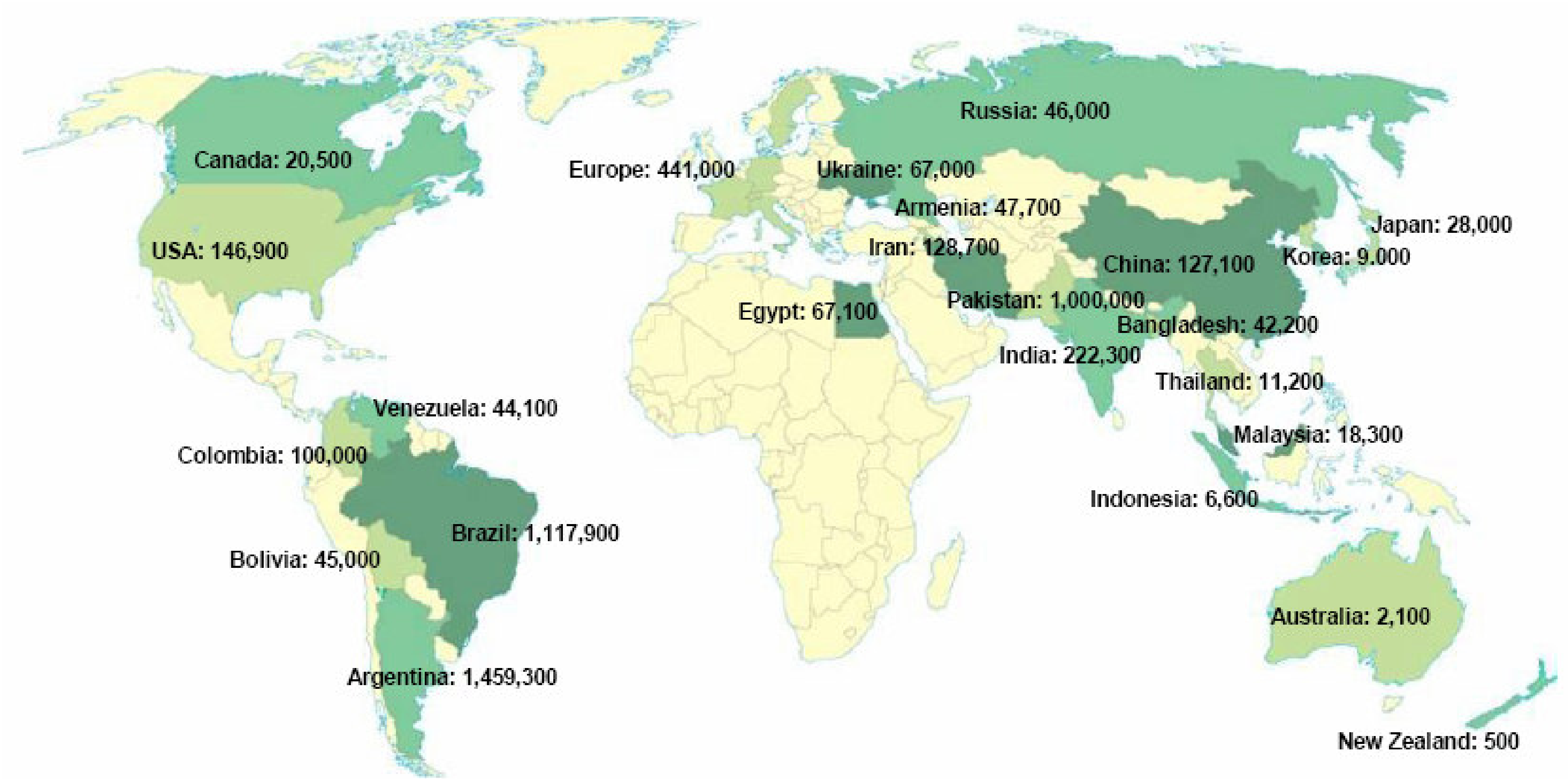
Biogas powered vehicles?

Source (Examiner, 2009)

Twin-turbo 3.0-liter Audi A4 Quattro
364.6km/h speed record on biogas from grass clippings,
Maximum Horse Power = 800 (597 kW)

Biogas powered vehicles, Sweden

Over 7 Million Natural Gas Vehicles (NGVs)



30 Million NGVs by 2020

Traditional farmers can utilize their kraal and biowaste resource to produce food, energy, feed & fertilizer.

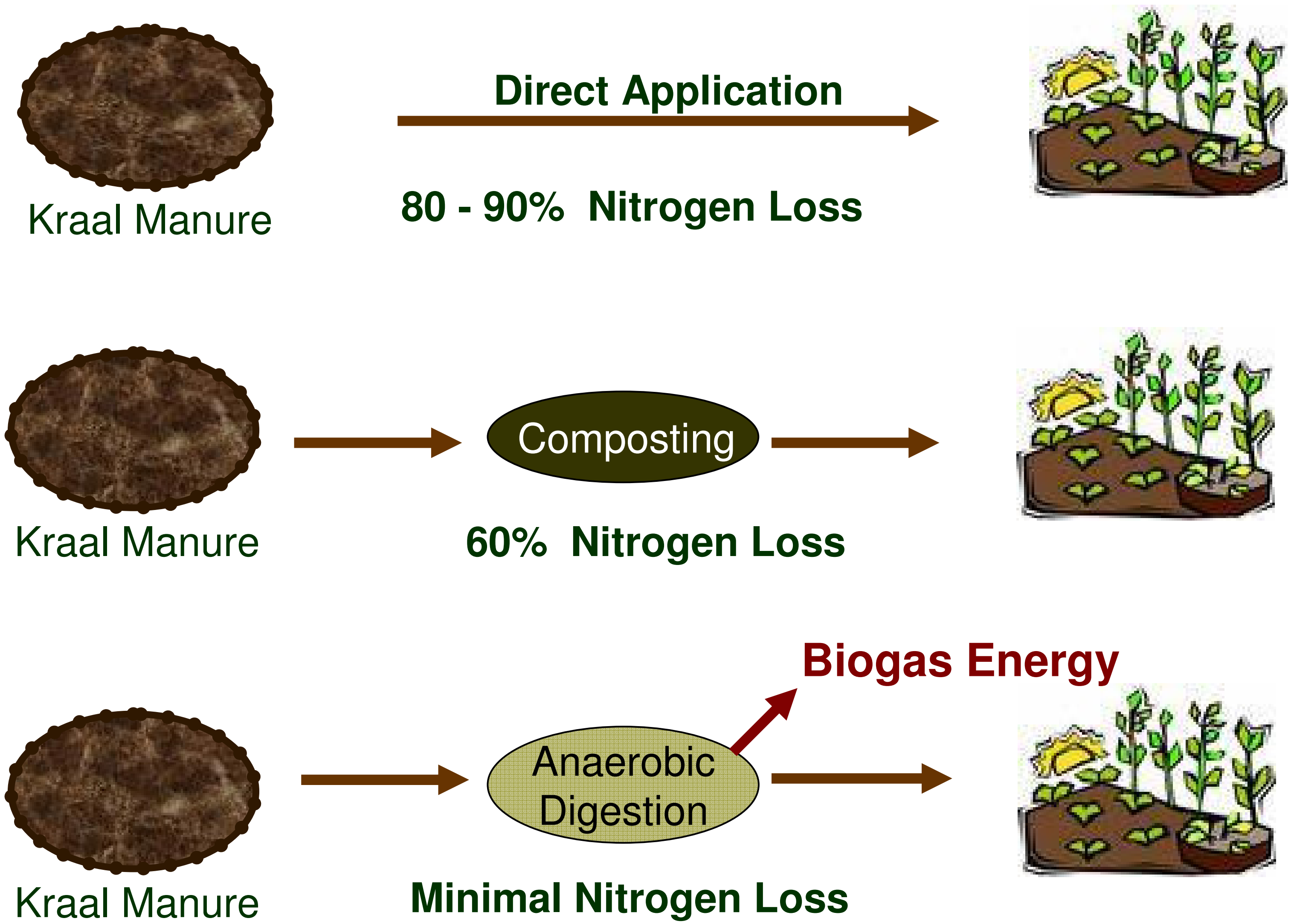
1.7 million smallholders with access to arable land

1.2 million cultivate crops like maize and sorghum

0.9 million have animals other than chickens biogas burner.MPG

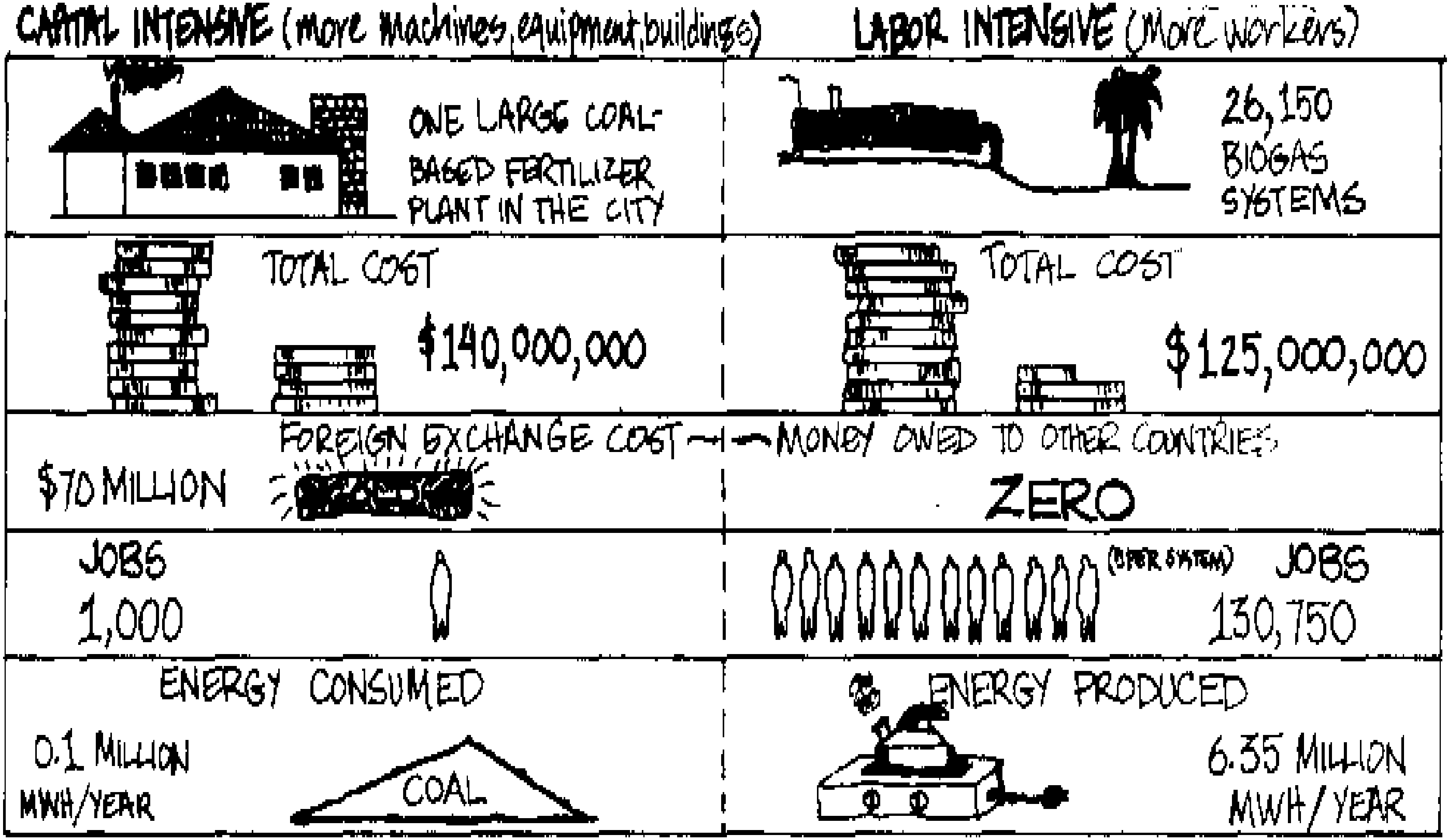
Low cost tube biogas digester for kraal waste at the Agro-ecological Cooperative in Chintsa, East Cape

Biogas for Biofertilizer



+ 20% more available Nitrogen after digestion

= 1200% more Nitrogen Available



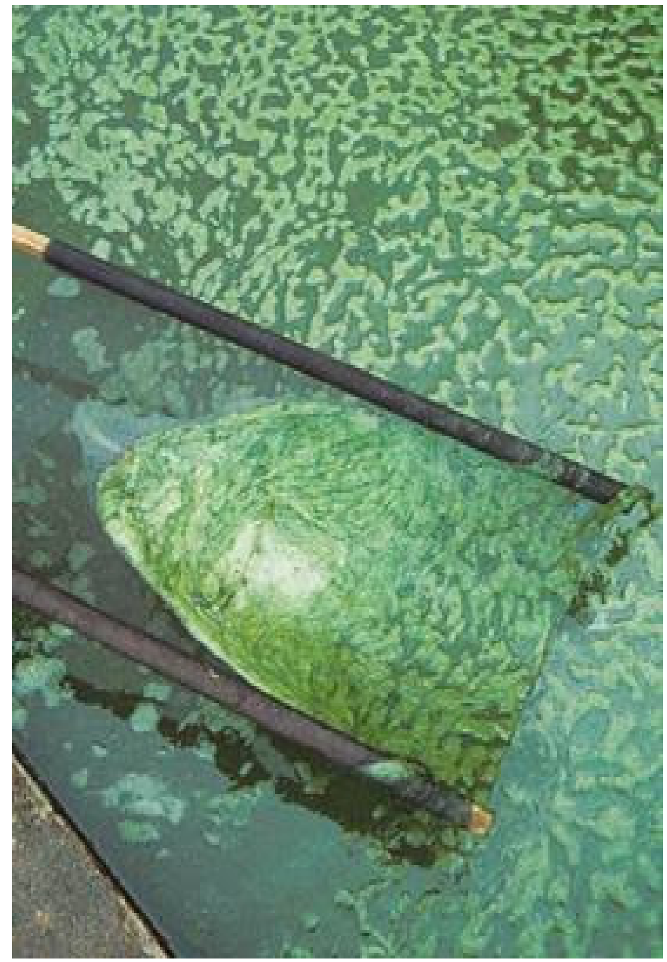
Source: US Peace Corp, 1985

Two Ways of Producing 230,000 Tons of Nitrogen-rich Fertilizer

Integrated Algal Systems

The production of microalgae such as Chlorella is a tried and tested oxidation method for the treatment of effluent from both large and small scale biogas digesters.

Integrated Biogas and Algal Sytsems were pioneered by Golueke and Oswald in 1970's and enhanced by Professor George Chan from the Zero Emission Research and Initiatives (ZERI) organisation.



Source (Chan, 2006)

Micro Algae farming in India
(Pioneered by Oswald & Golouke)

Source (Chan, 2006)

Integrated Biogas & Algal System in Fiji

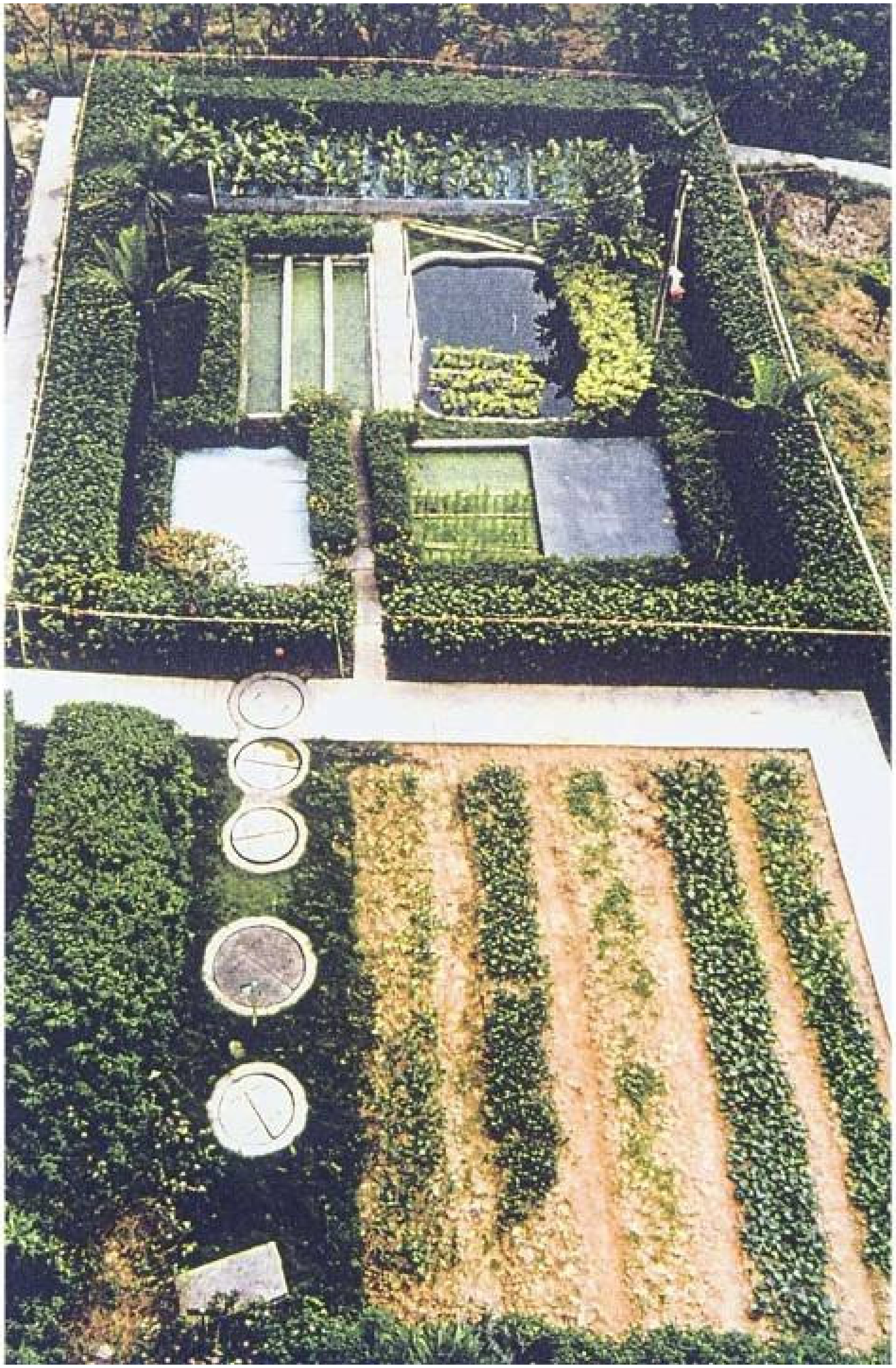
Source (Chan, 2006)

With Integrated Aquaculture

Source (Chan, 2006)

High Rate Algal Ponds, Brazil

Algal production is enhanced by movement of liquid with paddles in the basins for more exposure to solar energy & dissolved oxygen.



Urban Integrated Biogas and Algal System

Ponds at 3 blocks of apartments, Hamburg Institute, Dongguan, China

Consists of:

Biogas Digesters,

Settling tanks,

Algal oxidation basins,

Fish pond,

Hydroponics,

Garden.

Source (Chan, 2006)

Aquaponics on nutrient rich organic fertilizer

Source (Chan, 2006)

Young PAPAYA Trees were Irrigated and Fertilized by nutrient rich water after the algal ponds show quick growth and early fruit bearing.

Daily irrigation with nutrient pond water produces more growth than chemical fertilizer applied twice a year.

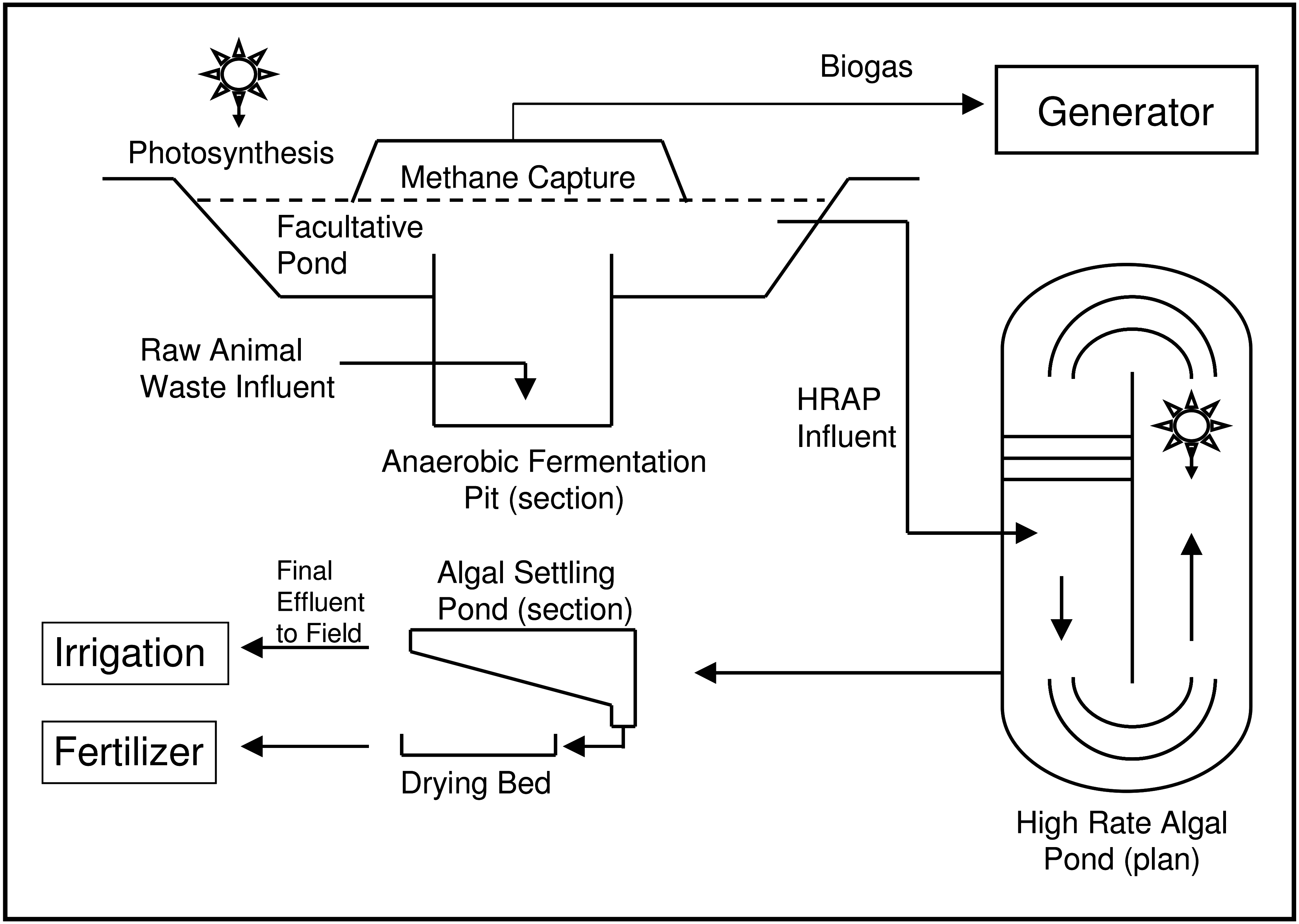
Source (Chan, 2006)

Source (Render, 2008)

Integrated System AIPS™ reference plant at EBRU, Grahamstown

AIWPS® or AIPS Algae technology

- The AIPS™ system has been used for wastewater treatment for more than 30 years
- There are hundreds of AIPS™ plants internationally with the largest plant processing 7.2 million litres of waste water per day
- The Dept of Water Affairs and Forestry DWAF brought the patent into the public domain in South Africa after 12 years of extensive tests at the 500 person reference plant at the Institute of Environmental Biotechnology, Rhodes University (IEBRU)



Source (Render, 2008)

The AIPS Process

AIWPS® or AIPS Benefits

- Fermentation pit design captures heavy metals
- Algae is excellent source of nutrients
  - Fertilizer & Foliar feed
  - Oils for biodiesel
  - Nutracueticals & Metabolites
  - Pigments
  - Amino Acids
  - Plant Hormones
  - ß-carotene

Source (Render, 2008)

High Rate Algal Ponds sized for 1000 people

AIPS Disinfection mechanism

Combined interaction of:

- Anaerobic fermentation
  - Digestion of solids into elemental nutrients
  - Prolonged (100+ day) oxygen free environment destroys most aerobic pathogens
- Algal Ponds with
  - Sunlight (UV)
  - DO (Dissolved Oxygen) – Supersaturated to 30mg per litre
  - pH – up to 10.5 (ph of 9.2 will kill 100% ecoli)

Source (Render, 2008)

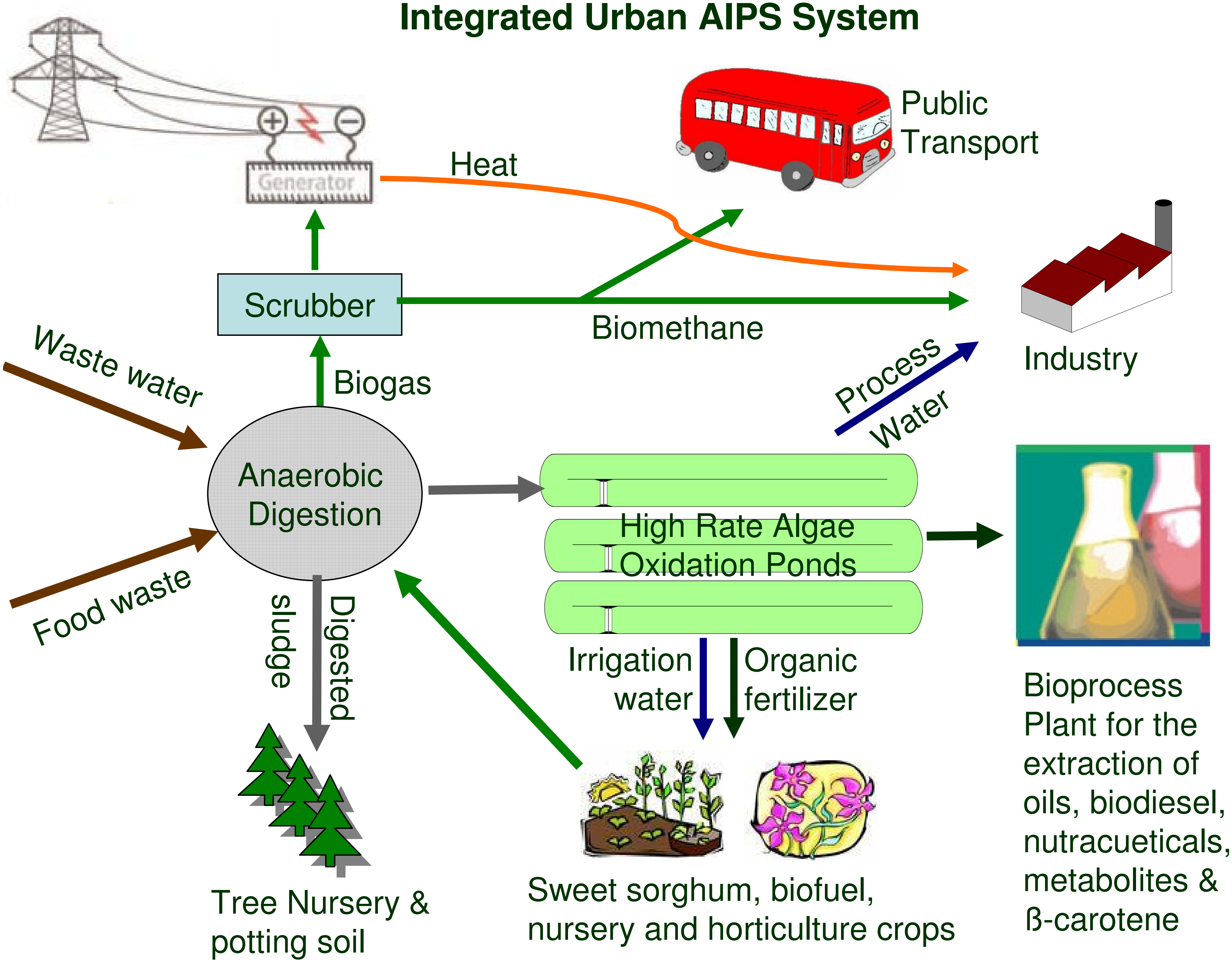
Pathogen free ‘bright’ water from algal pond

Source (Render, 2008)

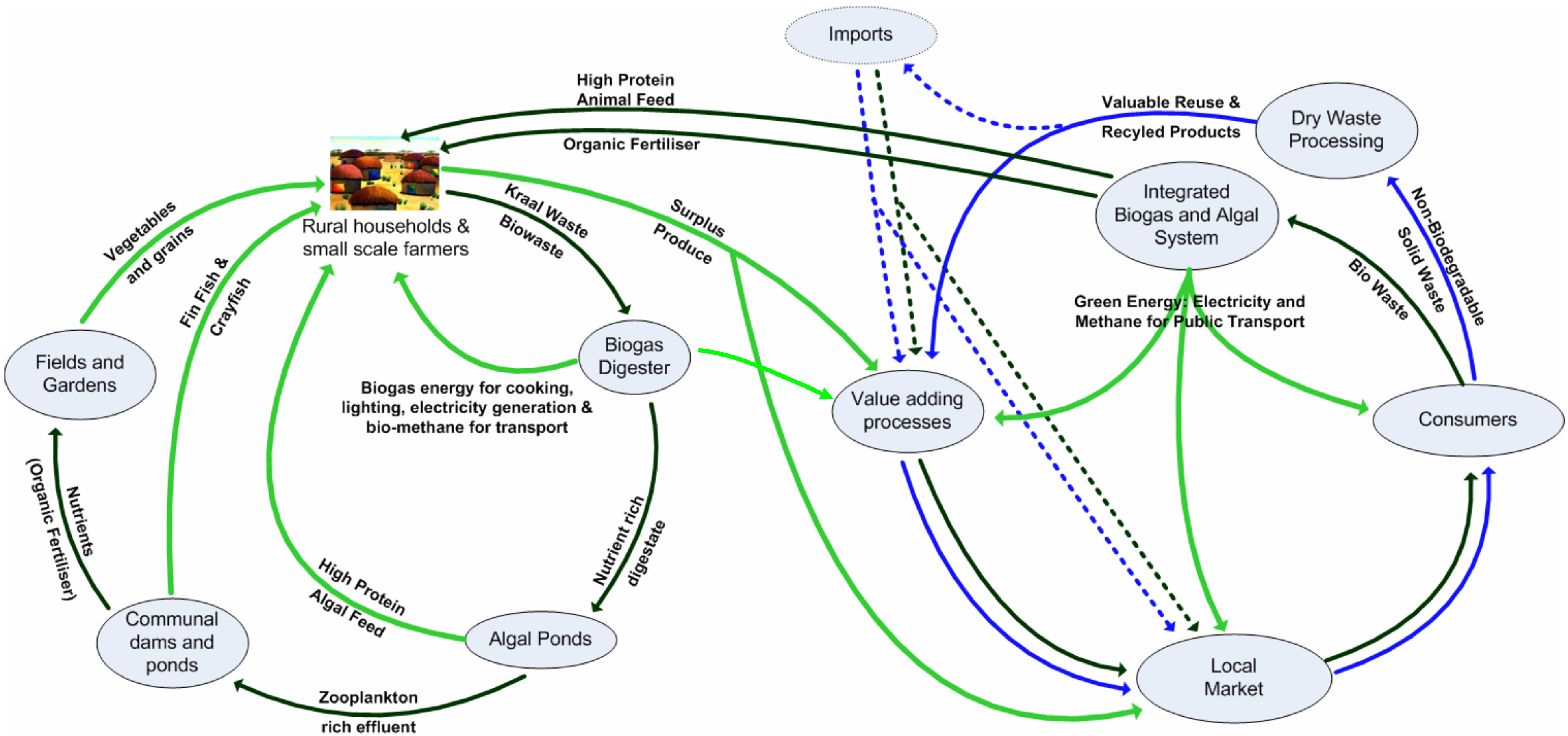
Pathogen free algal biofertilizer

1.4 x more effective than 2:3:2, N:P:K fertilizer (Horen, 2004)

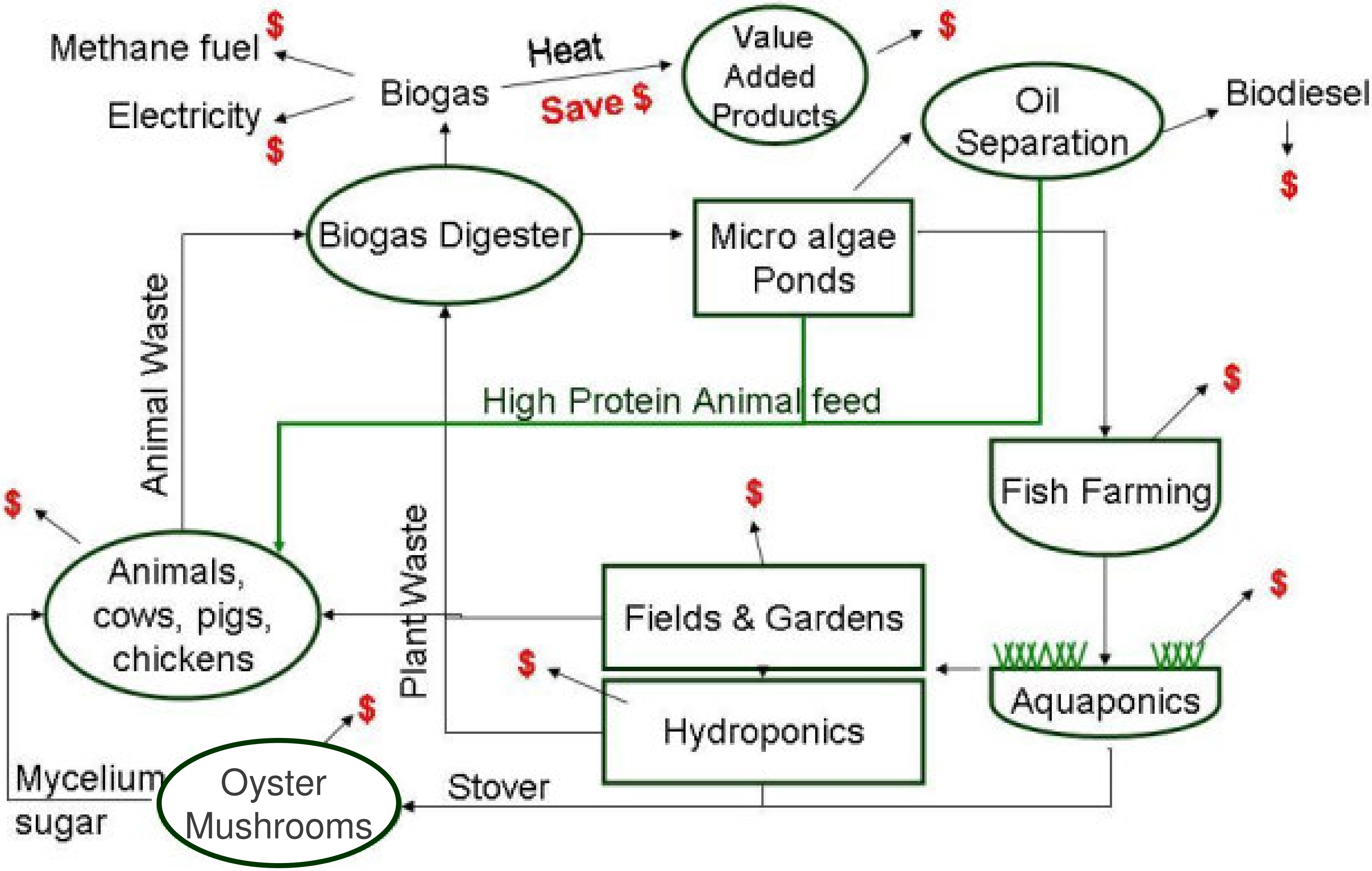
Integrated Urban AIPS System



Closing the Rural and Urban Loop in a Zero Waste Economy



Job creation, food security, energy & fuel security, environmental protection, and nutrient beneficiation



Simple Integrated Agro-Ecological System

Aquaculture

Aquaponics


Aeroponics and Hydroponics from aquaculture effluent


Mushroom Production from Stover and Grass using biogas for sterilisation

Water Fowl

Many different organisms can be incorporated into the system to suite the particular needs of the region, the farmer and market.

Rapidly growing grasses and course macrophytes can be harvest as cheap feeds for the ducks.

While the ducks and other fowl are growing towards harvest size, their excrement provides additional nutrients for the pond and the system itself.

Ducks and other fowl can be used to provided add enrichment to the pond water. Coarse macrophytes such as lemma, azolla, pista are cheap feeds for ducks.

Final Polishing

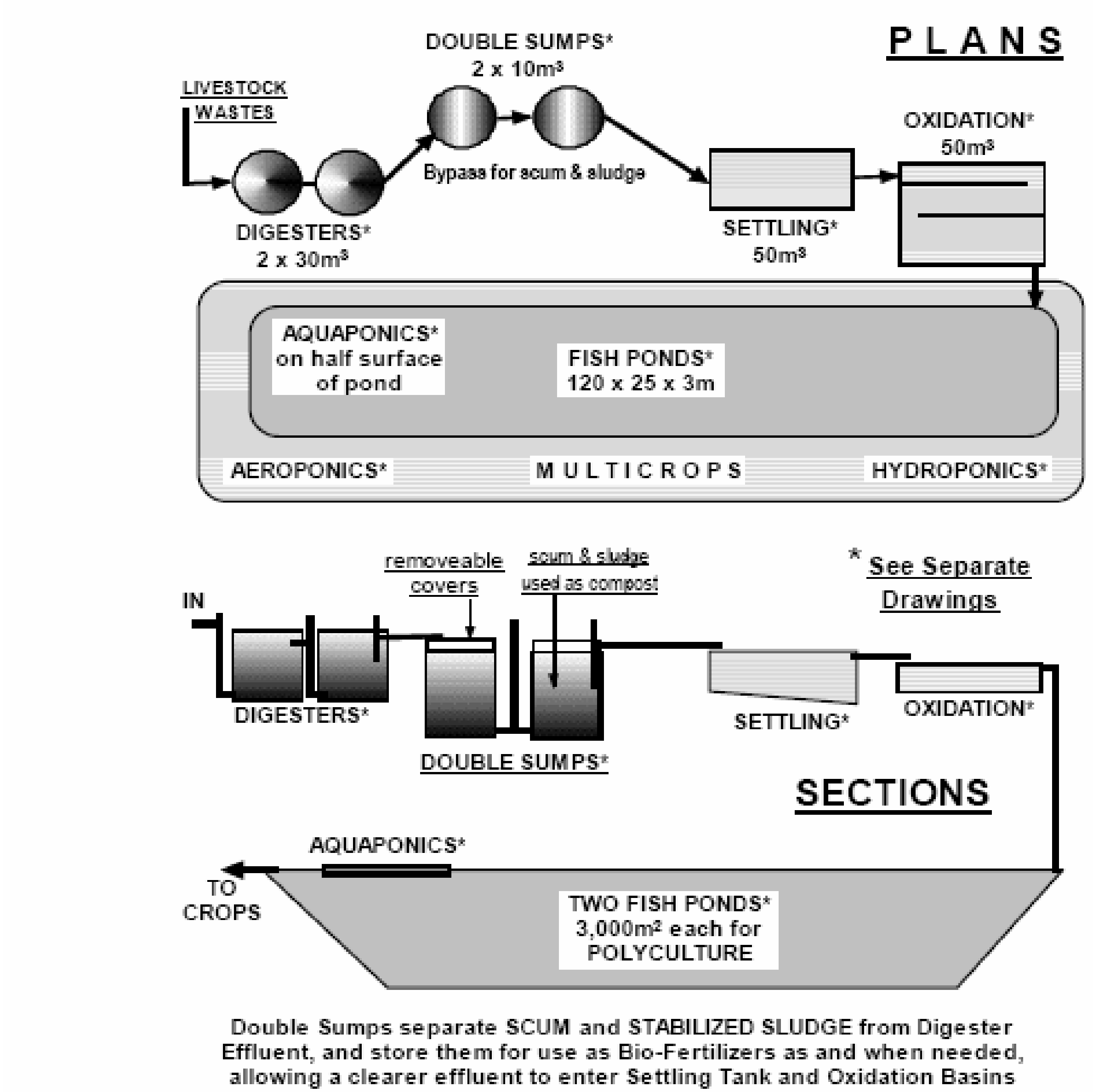
- The final stage of the system is final polishing.
- After sand filtering this water can be used to grow medical and nutritional grade algae such as spirolina.
- Macrophytes can be used as feed for various animals in the farm or can be even harvested for human consumption as in the case of water cress.
- Water can also be recycled in the integrated farming system or used as potable water with minimal additional filtration.

Above Macropyhtes do their work in the final polishing tank, removing remaining impurities in the water that remained after processing in the fishpond.

Source (Chan, 2006)

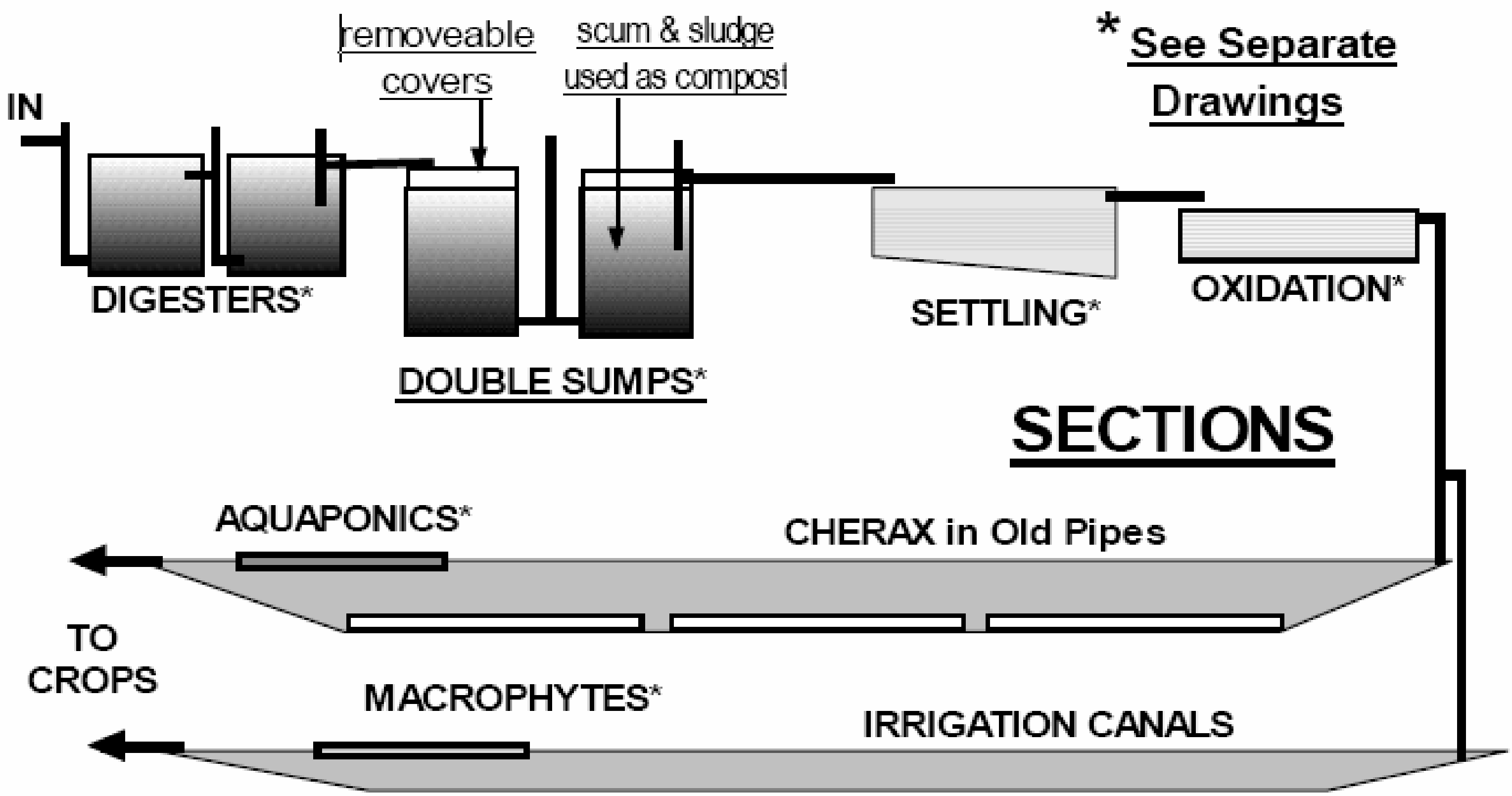
Algal Pond Design

- Different design methodologies exist linked to factors such as influent flow volumes, BOD, turbidity, nitrogen content, volatile solids content, algal types, temperature.
- Pond depth typically 10cm to 35 cm.
- Retention time for high rate pond 3-7 days
- Retention time for oxidisation basins 20-30 days



Source (Chan, 2006)

Generic design for fin fish production



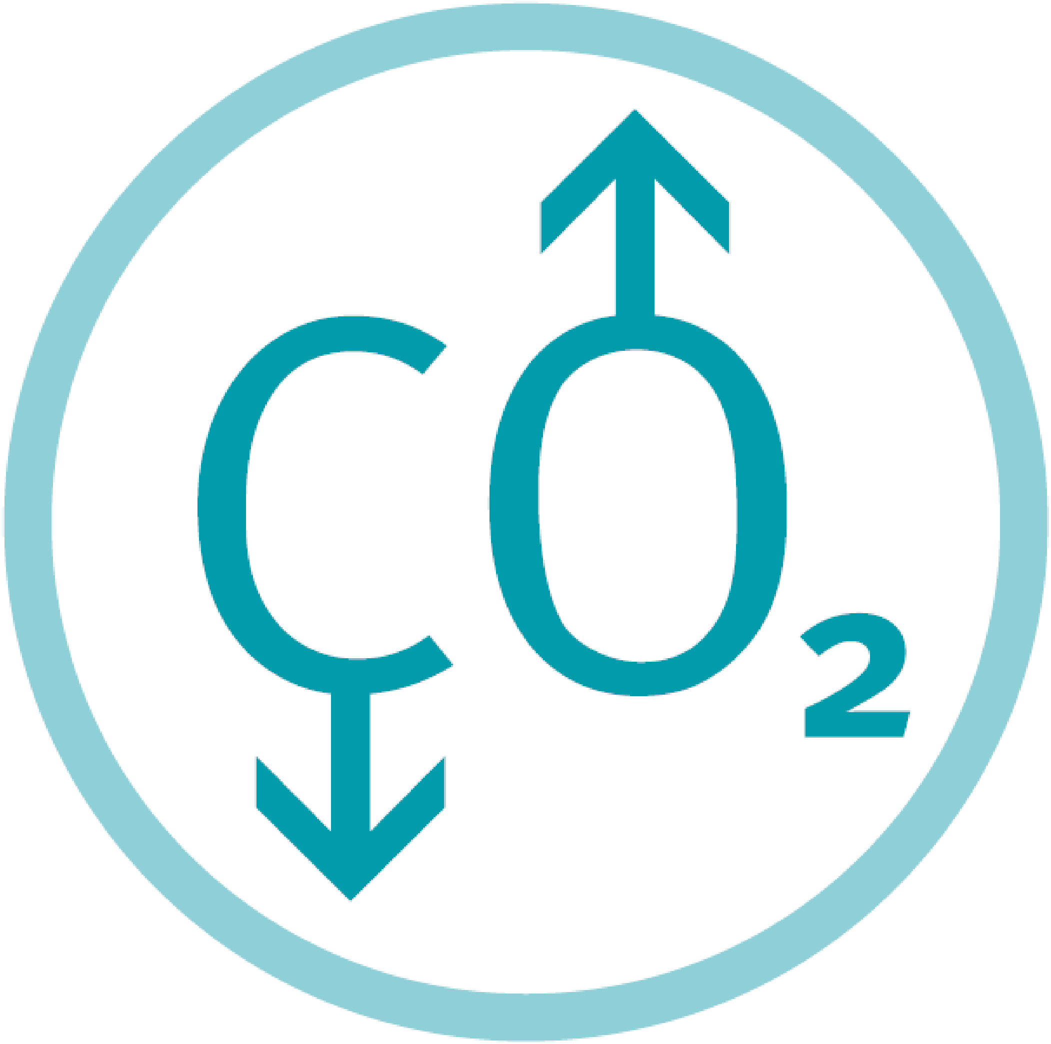
Double Sumps separate SCUM and STABILIZED SLUDGE from Digester Effluent, and store them for use as Bio-Fertilizers as and when needed, allowing a clearer effluent to enter Settling Tank and Oxidation Basins

Source (Chan, 2006)

Generic design for fresh water crayfish production

Action Required

- Establish environmental biotechnology agro-ecological reference centres that demonstrate food and fuel production and distribution for smallholders
- Development of appropriate process technologies for agro-ecological farmers and cooperatives to **get Methane to the market**:
  - Biogas scrubbing, compression and bottling plants
  - Biogas powered pumps, generators, tractors
  - Biogas fuelled rural transport service (convert existing taxi's)
- Develop integrated biogas upgrade, algal oil and nutrient extraction technologies such as super critical counter flow extraction
- Ancillary support for agro-ecological development:
  - Access to information and training / extension
  - Market support for small scale farmer produce (eg. distribution cooperatives)
- Ongoing research to enhance productivity of integrated systems



Support smallholder Agro-ecological and equitable distribution systems for low green house gas agricultural food and fuel systems!

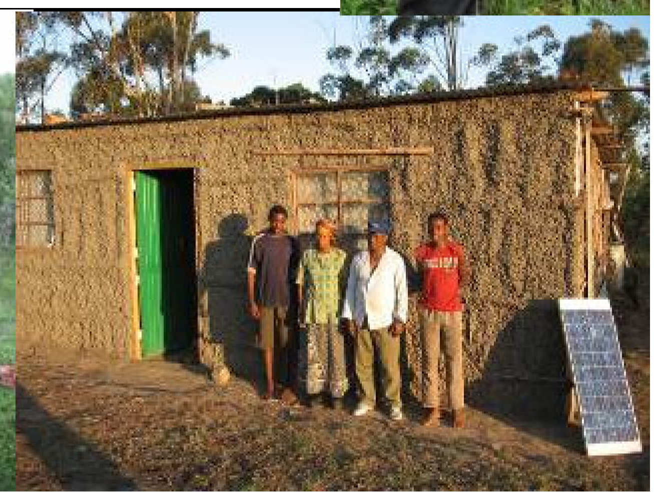



AGRO-ECOLOGICAL FARMING COOPERATIVE

Facilitating the Cooperative Development
of Local Sustainable Community Based
Integrated Food & Energy Production
& Distribution Systems

UNITY COOPERATION CREATIVITY



Thank you

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