Renewable organics for sustainable use

Two questions to decision makers:

1) Why is production of methane in biogas carried out in outdated systems by inefficient methods and why combustion and thermal gasification is privileged?

2) Do we need to produce so much reactive nitrogen as artificial fertilizers when we can recycle nitrogen and also most of plant nutrients?

Some facts about organic materials – renewable or fossil, bioenergy, plant nutrients, reactive nitrogen

Any organic material, fossil or renewable, consisting of
- Approximately 16-21 chemical elements that are essential for growth and development of plants
- Bioenergy which is biochemically linked solar energy in all organic structures.

Renewable organic materials (ROM) are originally from living organisms - from the biomass of plants and animals and are no more than 1000 years old (peat).
Fossil organic materials (FOM) are also derived from living organisms but from prehistoric ones (coal, oil).

Bioenergy

In ROM more than 90 % of dry weight is carbon (C), oxygen (O) and hydrogen (H). These are the basic elements for bioenergy. They are released during biochemical oxidation in aerobic process as carbon dioxide (CO2) and water (H2O) or in anaerobic process as biogas - CO2 and energy rich methane (CH4). Therefore anaerobic digestion carried out in biogas plants using efficient methods is very important for bioenergy recovery as methane in biogas.

Plant nutrients

There are **16 chemical elements essential**[1] for most of green plants. These elements are in renewable organics and by unsustainable management ends up as emissions of air, water and soil. Most of these essential elements can be recycled by biological transformation locally in decentralised biogas plants. When carbon, oxygen and hydrogen are used in biogas more concentrated plant nutrients are in remained biofertilizers. It is important to use systems of biological transformation to Closing Loops for creating Sustainable Cities, for supporting productivity of cultivated soils and for mitigating climate change.

Reactive Nitrogen (Nr)

Production of artificial nitrogen fertilisers increase since 1940. The negative effects doe to reactive nitrogen in the environment are enormous. For example decrease of organic matter in cultivated soils, eutrophication of rivers, lakes and seas, and increased health problems. (Human Sources of Reactive Nitrogen http://www.medscape.com/viewarticle/482775_3 Where does all this human-generated reactive nitrogen come from? The largest contributor is nitrogen fertilizer.)

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[1] 16 essential elements: H, C, O, N, K, Ca, Mg, P, S, Cl, Fe, B, Mn, Zn, Cu, Mo according to Sune Pettersson, prof. emeritus at Swedish University of Agricultural Sciences. Stimulating elements include Co, Cr, Ni, V, Sn, Li, F, Se, Si etc.

Bioconversion by microorganisms – life supporting process - sustainable
During anaerobic digestion the *biochemical oxidation* of ROM causes stepwise release of bioenergy storied in organic structures as methane in biogas. Second product is biofertilizer with part of bioenergy remained in organic structures and in beneficial microorganisms. In modern closed systems most of the 16 essential elements that are necessary as plants nutrients (and also stimulating elements) can be recycled and used in cultivation systems.

Combustion - life frightening process - unsustainable
Burning, or rapid *chemical oxidation* of organic structures, is accompanied by release of bioenergy in the form of heat and light. Combustion causes air pollution. Sulphur dioxide reacts with water vapour and sunlight to form sulphuric acid. Likewise nitrogen oxides (NOx) are forming nitric acid in the air. These reactions take hours, or even days, during which polluted air may move hundreds of kilometres. Second product of combustion is ash - without energy.

All kind of **combustion** is source of **Reactive Nitrogen (Nr)**. When organic is used as fuel (fossil or renewable) for combustion, nitrogen in the air combines with oxygen to make nitrogen oxides (NOx) that are **nitric oxide** (NO) and **nitrogen dioxide** (NO2) and both oxides participate in ozone layer depletion.

Nitric oxide (NO) in the air may convert to nitric acid, which has been implicated in acid rain and can fall back to earth on fields, forests, lakes ands seas. The **Nr in acid rain** kills insects and fish in rivers and lakes. **Nr** is carried by runoff to the coast and **contributes to eutrophication** and the formation of **dead zone.** It is then converted to **nitrous oxide** (N_2O) which contributes to **global warming.**

Although nitrogen accounts for less than 1 percent of all the gases emitted by burning of organic material in waste and in residues (carbon, oxygen and hydrogen compounds account for the rest), **the nitrogen cycle is vital for plant and animal nutrition**. Nitrogen is an irreplaceable element in proteins.

Thermal gasification - life frightening process - unsustainable
From Internet: “Gasification is a thermo-chemical process that uses heat to convert any carbon-containing fuel into a clean burning gas commonly referred to as “syngas”. Gasification differs from combustion because it uses just 20% to 30% of the air or oxygen needed for complete fuel combustion. The organics are converted to a flammable gas in the gasification plant. This so-called **synthesis gas is purified and then upgraded in a methanation plant to biogas** with a quality comparable to natural gas.”

Do we need to use energy to produce biogas? What's left after these two processes?
What happened to all the elements we have to recycle for sustainable cultivation of new plant biomass?

Plant production is essential for life. The solar energy, carbon dioxide, water and nutrients - the essential chemical elements - are essential for all living beings as food, feed, fiber and fuel.

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