Renewable energies witnessed a 19 Percent growth in 2011, making it the ninth year of double digit growth for renewable Energy. Bio-fuels like Bio ethanol & Bio Diesel alone grew by more than 13 Percent. Power plants, local authorities and industry are applying for grants throughout the UK and Ireland to build Biomass and Waste to Energy facilities.

These are now becoming the biggest growth in Green field installations, as countries come to terms with their waste problems. Processes handling a combination of Dust, Gas and Vapour hazards are beginning to be developed, requiring the full range of Explosion prevention and protection systems available.

What implications does this have for safety? If you look at the news section of our website, explosions are being reported every month from Wood processing facilities, Bio diesel plants, Sewage treatment works, Grain Silos, Coal fired plants, Saw dust mills (with pine beetle killed wood, now coming in drier than before), even the pellet drying plants are having incidents. In the UK, the Tilbury incident highlights the need for closer scrutiny as power plants convert from coal to biomass. Cement plants are well down the road in converting to various forms of alternative fuels.
Introduction

In deciding our philosophy for Explosion Prevention and Protection, we need to identify the components of the basic fire triangle; fuel, oxygen and ignition, with the further components, especially for dust explosions; of dispersion and containment.

The Fuel

So what are the primary fuels for Biomass: wood, grasses, crops, agricultural and municipal wastes? Energy from biomass and waste is often referred to as Bio Energy. When plant material is burned for Energy purposes carbon dioxide is released. However, because plants absorb carbon dioxide during their life cycle, the net emissions of carbon dioxide are zero. In this way, wood is said to be carbon neutral. Similar fuel consuming industries are utilising by-products from: Waste Water Treatment or Pelletized Sludge Pellets (PSP), Municipal Solid Waste (MSW), household garbage or fluff, Refuse Derived Fuel (DRF), Solid Recovered Fuel (SRF), Car Shredders, Tire Chips, Land Fill Replacement Plants, Landfill gas, Meat and Bone Meal (MBM). Agricultural types such as animal slurry and manure, chicken litter, etc.

Oxygen:

Many industries have oxygen reduced atmospheres as their primary prevention/protection against fire and explosions. The Cement industry has a long history of using re-circulated exhaust, with Nitrogen and CO2 to extinguish or inert the hazardous atmosphere. The steel industry has an abundance of nitrogen which it is now using to inert its plant and reduce its reliance on explosion venting. Most industries use air in their process, so oxygen is unavoidable.

Ignition Sources:
The ATEX standards EN 1127 or the HSE websites give exhaustive lists of ignition sources. Many times a change in fuel may totally change the normal ignition sources in a facility.
Ignition sources may include:

- Flames
- Direct fired space and process heating
- Use of cigarettes/matches etc
- Cutting and welding flames
- Hot surfaces
- Heated process vessels such as dryers and furnaces
- Hot process vessels
- Space heating equipment
- Mechanical machinery
- Electrical equipment and lights
- Spontaneous heating
- Friction heating or sparks
- Impact sparks
- Sparks from electrical equipment
- Stray currents from electrical equipment
- Electrostatic discharge sparks
- Lightning strikes
- Electromagnetic radiation of different wavelengths
- Vehicles, unless specially designed or modified are likely to contain a range of potential ignition sources
- Sources of ignition should be effectively controlled in all hazardous areas by a combination of design measures, and systems of work
- Using electrical equipment and instrumentation classified for the zone in which it is located. New mechanical equipment will need to be selected in the same way
- Earthing of all plant/equipment
- Elimination of surfaces above auto-ignition temperatures of flammable materials being handled/stored
- Provision of lightning protection
- Correct selection of vehicles/internal combustion engines that have to work in the zoned areas
- Correct selection of equipment to avoid high intensity electromagnetic radiation sources, e.g. limitations on the power input to fiber optic systems, avoidance of high intensity lasers or sources of infrared radiation
- Prohibition of smoking/use of matches/lighters
- Controls over the use of normal vehicles
- Controls over activities that create intermittent hazardous areas, e.g. tanker loading/unloading
- Control of maintenance activities that may cause sparks/hot surfaces/naked flames through a Permit to Work System
- Precautions to control the risk from pyrophoric scale, usually associated with formation of ferrous sulphide inside process equipment
The containment

Industry processes used to convert the fuel to Energy:

- Direct combustion of biomass material. Some processing may be carried out prior to combustion e.g. sorting, chipping, pelleting or drying.
- Thermochemical processes - where solid is upgraded to a liquid or a gas by pyrolysis and gasification
- Decomposition of solid to liquid or gaseous fuels by processes such as anaerobic digestion and fermentation.

Also extremely popular are combined heat and power (CHP) down to your more domestic wood stove burners.
Dispersion:

It is generally accepted that most carbon based products have a lower explosion level of 30 to 60 g/m³. We illustrate to clients that you cannot “see the hand on the end of your arm” at greater than 30g/m³. In the United States they have a rule of thumb; if the dust layer is “greater than the thickness of a dime” you have a problem.

When bringing fuel in on conveyors, road or rail, you will have attrition, and settling of a percentage of the dust fines. Wood pellets from overseas will have large percentages of fines at the bottom of their hull. Does that mean that the last 3 train loads coming into a power plant contain only fines?

Whether you use dry fog or spot filtration you will have accumulations of dust either in the duct or at the final collection points or filters. Dropping product large distances from the top of a silo creates dust dispersion. Plants, during start up and shutdown or during cleaning or abnormal operations, may also create dust clouds.

Many incidents still happen from air jet cleaning, simple room blowers or brushing instead of vacuuming.
Prevention and Protection

There are 2 primary approaches to Fire and Explosion Protection in any industry:

1. **Prevention**: what do you do to prevent the incident from ever happening. This involves in any industry good design practises, risk assessment, hazard identification, and consequence prevention, implementation of good risk reduction measures and, documenting every step in the process. Good training and management responsibilities should be put in place; operating procedures should be established and reviewed frequently, good engineering practices and quality monitoring of all the safety aspects above. Typical equipment options are spark detection, dry fog, and gas or temperature monitoring, alignment sensors.

2. **Protection**: despite all your best prevention systems being in place you now must protect your people and plant from the harmful effects of that event and minimise the consequences. Typical equipment options are containment (6 to 10 bar) barrier or rotary valves or Explosion Venting either with doors (self-reclosing) or vent panels sometimes incorporated into flameless assemblies for indoor venting. **Explosion Suppression protection** and or chemical barriers using dry chemical are an alternative if the other systems are not practical. Other less frequently used options are product plug, screw chokes, and Slamshut valves. Many wood applications still use Flap valves and flame diverters but they are being challenged as real explosion isolation devices by ATEX. Proper and safe process shutdown procedures are critical to prevent an escalation of the event as secondary explosions are frequently worse than the original event.
Systematic Approach to Industrial Explosion Problems

When deciding your hazard in any industry everyone has to define the problem. This frequently involves a systematic approach.

Does the product pose as an Explosion Hazard? Well obviously as the product is going to be used as a fuel, it is probably combustible! So we can dispense with the A/B classification test.
Generic Biomass values

- Assuming 95% of the product is < 75µm. With particle sizes less than 500 µm, these are potentially explosive with less than 5% moisture.

- Maximum Explosion Pressure in an Explosion test rig; \( P_{\text{max}} = 6.5-7.0 \text{ bar} \)

- Maximum speed of the explosion, relative to a 1m³ test vessel; \( K_{\text{St}} = 100 - 140 \text{ bar m/s} \)

- Most dust will not explode if the dispersion is too rich or too lean, Minimum Explosion Concentration \( \text{MEC} = \sim 30 - \text{or} >1000\text{g/m}^3 \)

- Minimum Ignition Energy typical for most hazardous dusts, \( \text{MIE} = 10 \text{ to } 30 \text{ mJ} \)

- Minimum Ignition Temperature \( \text{MIT} \sim 250^\circ \text{C} \text{ which is relatively low for most industrial dusts, but then} \text{ it is been processed to be a fuel.} \)

- When designing your Protection System it is important that you are aware of the plant strength, because if the Pred –reduced explosion pressure is greater than your vessel strength then the rupture can have fatal consequences.
A typical protection method for a Sludge Plant

The sludge starts as a wet mix at the start of the Drum Dryer, and as it makes its way to the discharge screw, it becomes drier and potentially more unstable. The product, if thermally unsafe, is discharged to a safe bin outside or cooled in a series of cooling screws before being lifted to the Sifter for grading into different sizes. Unusually, the screws after the Drum Dryer have been the most dangerous risk, due to thermal instability. Protection is mostly chemical barriers along the screws with venting either to a safe area outside or if that not’s possible, flameless venting inside the building. Good housekeeping is important as sludge pellets are a fuel source and dispersion of the dust layers is to be avoided.
ATEX have developed their highly successful Dry Chemical System by totally redesigning the release valve itself. Providing a reusable valve lowered the cost of system reconditioning and therefore the total operational cost.

The first generation system discharged through a flanged membrane in an open orifice, which did not provide the best hygienic seal, required in Dairy Systems. ATEX again went to their proven Dry Chemical T System Spreader. By enlarging the diameter, to handle the hot water flows, the system provided a reusable nozzle for system release. The design with flush seal provided a food grade nozzle for the industry it served.
As for the controls system, ATEX had already developed a Suppression Based System for system control and maintenance. Using ATEX Log Modules the entire system became field addressable with the ability to monitor not only system components but also the subcomponents of each suppressor. It no longer took a factory trained technician days to find a wiring fault or damaged component. Components and wiring problems could be pinpointed to the individual component or wire length. The system could be restored to proper service, with ATEX assistance before a manufacturers engineer could get to the airport!

As for the sensors, ATEX PXD (Pressure Explosion Detector) analogue sensors replace the old static sensors. These sensors provide an unsurpassed detection principle performed by an ATEX exclusive calculation algorithm. Each sensors data is stored, so if an actuation occurs, the activating sensors signals can be compared to determine the cause of an event.

With ATEX you don't have to choose reliability verses false release protection. With ATEX the sensors are programmed in a series type confirmation mode, to prevent false release. If the system determines that the sensor is not responding, it will automatically reprogram itself to a single sensor response providing the higher degree of reliability without compromising the false alarm signal processing.

Bottles and sensors are modular and addressable. You can have one bottle in a one zone system, with 2 sensors or 1 to 60 bottles or multiple zones depending on the enclosure you request. Each Zone has a log read out in real time, for all system activity. You can download the sensor data, 25% recording the pressure before the actual event from its black box in the sensor head. From one central point you can monitor all the bottles and sensors with an option to connect via modem.
All ATEX Systems offer ANSI SIS SIL approvals for reliability. By designing all components with total functional supervision and providing redundancy where a component cannot be supervised as required, the system has been independently certified as providing SIL 2 level protection.