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One biomass energy based system, which has been proven reliable and had been extensively used for transportation and on farm systems during World War II is wood or biomass gasification. Biomass gasification means incomplete combustion of biomass resulting in production of combustible gases consisting of Carbon monoxide (CO), Hydrogen (H2) and traces of Methane (CH4). This mixture is called producer gas.Producer gas can be used to run internal combustion engines (both compression and spark ignition), can be used as substitute for furnace oil in direct heat applications and can be used to produce, in an economically viable way.Wood wastes can be used in fuel boiler but the equipment is expensive and energy recovery is low. As a result it is often advantageous to convert this waste into more readily usable fuel from like producer gas. The price of petroleum fuels is high or where supplies are unreliable the biomass gasification can provide an economically viable system provided the suitable biomass feedstock is easily available. During both world wars and particularly World War II, shortage in petroleum supplies led to widespread introduction of gasification.The production of generator gas (producer gas) called gasification, is partial combustion of solid fuel (biomass) and takes place at temperatures of about 10000C. The reactor is called a gasifier. The combustion products from complete combustion of biomass generally contain nitrogen, water vapor, carbon dioxide and surplus of oxygen. However in gasification where there is a surplus of solid fuel (incomplete combustion) the products of combustion are combustible gases like Carbon monoxide (CO), Hydrogen (H2) and traces of Methane and non useful products like tar and dust. The key to gasifier design is to create conditions such that a) biomass is reduced to charcoal and, b) charcoal is converted at suitable temperature to produce CO and H2.Since there is an interaction of air or oxygen and biomass in the gasifier, they are classified according to the way air or oxygen is introduced in it.There are three types of gasifiers Downdraft, Updraft and Crossdraft.Types Of GasifiersThe choice of one type of gasifier over other is dictated by the fuel, its final available form, its size, moisture content and ash content. therefore, the advantages and disadvantages generally found for various classes of gasifiers.Advantages: Small pressure drop, Good thermal efficienty, Little tendency towards slag formation.Disadvantages: Great sensitivity to tar and moisture and moisture content of fuel, Relatively long time required for start up of IC engine, Poor reaction capability with heavy gas load.Advantages: Flexible adaptation of gas production to load, Low sensitivity to charcoal dust and tar content of fuel.Disadvantages: Design tends to be tall, Not feasible for very small particle size of fuel.Advantages: Short design height, Very fast responce time to load, Flexible gas production.Disadvantages: Very high sensitivity to slag formation, High Pressure Drop.The combustible gases from the gasifier can be useda) in internal combustion engines,b) for direct heat applications andc) as feedstock for production of chemicals like methanol.However in order for the gas to be used for any of the above applications it should be cleaned of tar and dust and be cooled. link to Top Branches of Mechanical Engineering link to Shree Ram Ayodhya Murti, idol - Vector , Wallart Biomass gasification involves burning of biomass in a limited supply of air to give a combustible gas consisting of carbon monoxide, carbon dioxide, hydrogen, methane, water, nitrogen, along with contaminants like small char particles, ash and tars. The gas is cleaned to make it suitable for use in boilers, engines and turbines to produce heat and power (CHP).Biomass gasification provides a means of deriving more diverse forms of energy from the thermochemical conversion of biomass than conventional combustion.The basic gasification process involves devolatization, combustion and reduction.During devolatization, methane and other hydrocarbons are produced from the biomass by the action of heat which leaves a reactive char.During combustion, the volatiles and char are partially burned in air or oxygen to generate heat and carbon dioxide. In the reduction phase, carbon dioxide absorbs heat and reacts with the remaining char to produce carbon monoxide (producer gas). The presence of water vapour in a gasifier results in the production of hydrogen as a secondary fuel component.There are two main types of gasifier that can be used to carry out this conversion, fixed bed gasifiers and fluidized bed gasifiers. The conversion of biomass into a combustible gas involves a two-stage process. The first, which is called pyrolysis, takes place below 600C, when volatile components contained within the biomass are released. These may include organic compounds, hydrogen, carbon monoxide, tars and water vapour.Pyrolysis leaves a solid residue called char. In the second stage of the gasification process, this char is reacted with steam or burnt in a restricted quantity of air or oxygen to produce further combustible gas. Depending on the precise design of gasifier chosen, the product gas may have a heating value of 6 19 MJ/Nm3.Layout of a Typical Biomass Gasification PlantThe products of gasification are a mixture of carbon monoxide, carbon dioxide, methane, hydrogen and various hydrocarbons, which can then be used directly in gas turbines, and boilers, or used as precursors for synthesising a wide range of other chemicals.In addition there are a number of methods that can be used to produce higher quality product gases, including indirect heating, oxygen blowing, and pressurisation. After appropriate treatment, the resulting gases can be burned directly for cooking or heat supply, or used in secondary conversion devices, such as internal combustion engines or gas turbines, for producing electricity or shaft power (where it also has the potential for CHP applications).See some of our favoriteinspirational quotes Overview Biomass Gasification Biomass gasification is an alternative option of thermal biomass utilisation for the production of heat and power based on biomass or for the production of synthesis gas. Within the last 20 years several different gasification technologies have been developed and demonstration plants have been realised. Based on the experience from these demonstration plants the gasification technologies have been further developed. Thus, some gasification technologies have now entered the market or are close to market introduction. In addition to the evaluation and process implementation of existing gasification technologies, BIOS is intensively working on the development of new processes based on a fuel-flexible fixed-bed countercurrent gasification technology which has been invented by BIOS. Figure 1: Updraft gasification concept schematic drawing Gasification technology Gasification plants consist of several process steps, which are shown in Figure 2. The solid biomass fuel delivered needs to be adjusted (fuel conditioning and handling) to the fuel characteristics (particle size, water content) required for the gasification process. The conditioned fuel enters the gasification process, which produces raw product gas. The raw product gas needs to be cleaned in order to achieve the product gas quality needed for further utilisation. The cleaned product gas is used for the production of electric power, heat, liquid fuels or synthesis gas depending on the technology applied. Figure 2: Basic process steps of a biomass gasification plant Explanations: The dark green rectangles show the process steps while the arrows show the conversion stages of the fuel during the gasification process. The light green rectangles below show the different technological options for each process step. During the thermo-chemical biomass gasification process solid biomass is cracked by thermal energy and a gasification agent and converted into a product gas. The product gas is cleaned and used for the production of heat and power, e.g. by gas engines (biomass CHP) or converted into a liquid biomass fuel or synthesis gas. The main advantage of the biomass gasification technology is the high electric efficiency due to the power production with gas engines or fuel cells. Even more than 40% electric efficiency (related to the net calorific value of the product gas) are achievable with fuels cells (solid oxide fuel cells SOFC), a technology which is presently under development at BIOS within R&D projects. Furthermore, alternative applications of the product gas such as production of liquid fuels or synthesis gas are possible. The high temperature waste heat of the gasification process and the gas engine resp. SOFC system can be used in an ORC unit in order to produce additional electric power and further increase the electric plant efficiency. Low temperature waste heat can be used for space and process heat supply as well as for biomass fuel drying. An efficient heat utilisation is necessary in order to achieve high overall plant efficiencies and to improve the economy. Procedure for the selection and evaluation of biomass gasification technologies The following procedure is recommended for the evaluation of the feasibility of biomass gasification technologies: Technological evaluation and comparison of different biomass gasification systems important, since many systems are still under development or demonstration and no long-term experiences are available Economic evaluation of the gasification technologies compared to a reference system (e.g. biomass CHP plant based on combustion) important, since a high electric efficiency does not necessarily mean a better economic performance (investment and operation costs as well as availability have to be considered as well) Evaluation of already available reference plants for a particular gasification technology important, in order to obtain information regarding reliability and availability Verification of the emissions (exhaust gas, waste water, ash) of gasification plants compared to expected emission limits and guiding values important since an ecological operation based on economically meaningful side constraints is required Overall evaluation of the systems based on the results of topics 1) to 4) BIOS BIOENERGIESYSTEME GmbH performs this evaluation procedure based on appropriate expertise and in a neutral way. Working field of BIOS BIOENERGIESYSTEME GmbH Development, comparison as well as technical, economic and ecological evaluation of different biomass gasification technologies as a basis for the selection of an adequate technology Planning of add-on power production systems for efficient waste heat utilisation (e.g. based on an ORC process) Feasibility studies including technological comparisons and screening for funding Preparation of permit applications as well as applications for funding Detailed design, request for proposals (RFP) Supervision of plant construction and commissioning Plant monitoring, process and performance optimisation R&D projects regarding the development of new and innovative biomass CHP technologies based on biomass updraft gasification with gas utilisation in gas engines, fuel cells and for the production of green chemicals Share copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Form of energy conversionThis article is about the process. For the water carbonator, see Gasogene. For the automobile device, see Wood gas generator.Part of a series onSustainable energyEnergy conservationArcologyBuilding insulationCogenerationCompact fluorescent lampEco hotelEco-citiesEcohouseEcolabelEfficient energy useEnergy auditEnergy efficiency implementationEnergy recoveryEnergy recyclingEnergy saving lampEnergy StarEnergy storageEnvironmental planningEnvironmental technologyFossil fuel phase-outGlass in green buildingsGreen building and woodGreen buildingHeat pumpList of low-energy building techniquesLow-energy houseMicrogenerationPassive housePassive solar building designSustainable architectureSustainable citySustainable habitatSustainable refurbishmentThermal energy storageTropical green buildingWaste-to-energyZero heating buildingZero-energy buildingRenewable energyBiofuelSustainableBiogasBiomassCarbon-neutral fuelGeothermal energyGeothermal powerGeothermal heatingHydropowerHydroelectricityMicro hydroPico hydroRun-of-the-riverSmall hydroMarine current powerMarine energyTidal powerTidal barrageTidal farmTidal stream generatorOcean thermal energy conversionRenewable energy transitionRenewable heatSolarWaveWindCommunityFarmFloating wind turbineForecastingIndustryLensOutlineRightsTurbineWindbeltWindpumpSustainable transportGreen vehicleElectric vehicleBicycleSolar vehicleWind-powered vehicleHuman-electricTwikePlug-inHuman-powered transportHelicopterHydrofoilLand vehicleBicycleCycle rickshawKick scooterQuadracycleTricycleVelomobileRoller skatingSkateboardingWalkingWatercraftPersonal transporterRail transportTramRapid transitPersonal rapid transitCategory Renewable energy portalvteGasification is a process that converts biomass- or fossil fuel-based carbonaceous materials into gases, including as the largest fractions: nitrogen (N2), carbon monoxide (CO), hydrogen (H2), and carbon dioxide (CO2). This is achieved by reacting the feedstock material at high temperatures (typically >700C), without combustion, via controlling the amount of oxygen and/or steam present in the reaction. The resulting gas mixture is called syngas (from synthesis gas) or producer gas and is itself a fuel due to the flammability of the H2 and CO of which the gas is largely composed. Power can be derived from the subsequent combustion of the resultant gas, and is considered to be a source of renewable energy if the gasified compounds were obtained from biomass feedstock.[1][2][3][4]An advantage of gasification is that syngas can be more efficient than direct combustion of the original feedstock material because it can be combusted at higher temperatures so that the thermodynamic upper limit to the efficiency defined by Carnot's rule is higher. Syngas may also be used as the hydrogen source in fuel cells, however the syngas produced by most gasification systems requires additional processing and reforming to remove the contaminants and other gases such as CO and CO2 to be suitable for low-temperature fuel cell use, but high-temperature solid oxide fuel cells are capable of directly accepting mixtures of H2, CO, CO2, steam, and methane.[5]Syngas is most commonly burned directly in gas engines, used to produce methanol and hydrogen, or converted via the FischerTropsch process into synthetic fuel. For some materials gasification can be an alternative to landfilling and incineration, resulting in lowered emissions of atmospheric pollutants such as methane and particulates. Some gasification processes aim at refining out corrosive ash elements such as chloride and potassium, allowing clean gas production from otherwise problematic feedstock material. Gasification of fossil fuels is currently widely used on industrial scales to generate electricity. Gasification can generate lower amounts of some pollutants as SOx and NOx than combustion.[6]Adler Diplomat 3 with gas generator (1941)Energy has been produced at industrial scale via gasification since the early 19th century. Initially coal and peat were gasified to produce town gas for lighting and cooking, with the first public street lighting installed in PallMall, London on January 28, 1807, spreading shortly to supply commercial gas lighting to most industrialized cities until the end of the 19th century [7] when it was replaced with electrical lighting. Gasification and syngas continued to be used in blast furnaces and more significantly in the production of synthetic chemicals where it has been in use since the 1920s. The thousands of sites left toxic residue. Some sites have been remediated, while others are still polluted.[8]During both world wars, especially the World War II, the need for fuel produced by gasification reemerged due to the shortage of petroleum.[9] Wood gas generators, called Gasogene or Gazogne, were used to power motor vehicles in Europe. By 1945 there were trucks, buses and agricultural machines that were powered by gasification. It is estimated that there were close to 9,000,000 vehicles running on producer gas all over the world.Another example, the Xe than (literally, "coal car" in Vietnamese) was a minibus that has been converted to run on coal instead of gasoline. This modification regained popularity in Vietnam during the subsidy period, when gasoline was in short supply. Xe than became much less common during the i Mi period, when gasoline became widely accessible again.In a gasifier, the carbonaceous material undergoes several different processes:Pyrolysis of carbonaceous fuelsGasification of charThe dehydration or drying process occurs at around 100C. Typically the resulting steam is mixed into the gas flow and may be involved with subsequent chemical reactions, notably the water-gas reaction if the temperature is sufficiently high (see step #5).The pyrolysis (or devolatilization) process occurs at around 200300C. Volatiles are released and char is produced, resulting in up to 70% weight loss for coal. The process is dependent on the properties of the carbonaceous material and determines the structure and composition of the char, which will then undergo gasification reactions.The combustion process occurs as the volatile products and some of the char react with oxygen to primarily form carbon dioxide and small amounts of carbon monoxide, which provides heat for the subsequent gasification reactions. Letting C represent a carbon-containing organic compound, the basic reaction here is C + O2 CO2.The gasification process occurs as the char reacts with steam and carbon dioxide to produce carbon monoxide and hydrogen, via the reactions C + H2O H2 + CO and C + CO2 2CO.In addition, the reversible gas phase water-gas shift reaction reaches equilibrium very fast at the temperatures in a gasifier. This balances the concentrations of carbon monoxide, steam, carbon dioxide and hydrogen: CO + H2O CO2 + H2.In essence, a limited amount of oxygen or air is introduced into the reactor to allow some of the organic material to be "burned" to produce carbon dioxide and energy, which drives a second reaction that converts further organic material to hydrogen and additional carbon dioxide. Further reactions occur when the formed carbon monoxide and residual water from the organic material react to form methane and excess carbon dioxide (4CO + 2H2O CH4 + 3CO2). This third reaction occurs more abundantly in reactors that increase the residence time of the reactive gases and organic materials, as well as heat and pressure. Catalysts are used in more sophisticated reactors to improve reaction rates, thus moving the system closer to the reaction equilibrium for a fixed residence time.Hydrogasification is a gasification process where hydrogen is used in place of oxygen to produce methane/natural gas from coal or biomass.[10][11][12][13]Main gasifier typesSeveral types of gasifiers are currently available for commercial use: counter-current fixed bed, co-current fixed bed, fluidized bed, entrained flow, plasma, and free radical.[1][14][15][16]A fixed bed of carbonaceous fuel (e.g. coal or biomass) through which the "gasification agent" (steam, oxygen and/or air) flows in counter-current configuration.[17] The ash is either removed in the dry condition or as a slag. The slagging gasifiers have a lower ratio of steam to carbon,[18] achieving temperatures higher than the ash fusion temperature. The nature of the gasifier means that the fuel must have high mechanical strength and must ideally be non-caking so that it will form a permeable bed, although recent developments have reduced these restrictions to some extent.[citation needed] The throughput for this type of gasifier is relatively low. Thermal efficiency is high as the temperatures in the gas exit are relatively low. However, this means that tar and methane production is significant at typical operation temperatures, so product gas must be extensively cleaned before use. The tar can be recycled to the reactor.In the gasification of fine, undensified biomass such as rice hulls, it is necessary to blow air into the reactor by means of a fan. This creates very high gasification temperature, as high as 1000 C. Above the gasification zone, a bed of fine and hot char is formed, and as the gas is blow forced through this bed, most complex hydrocarbons are broken down into simple components of hydrogen and carbon monoxide.[19]Similar to the counter-current type, but the gasification agent gas flows in co-current configuration with the fuel (downwards, hence the name "down draft gasifier"). Heat needs to be added to the upper part of the bed, either by combusting small amounts of the fuel or from external heat sources. The produced gas leaves the gasifier at a high temperature, and most of this heat is often transferred to the gasification agent added in the top of the bed, resulting in an energy efficiency on level with the counter-current type. Since all tars must pass through a hot bed of char in this configuration, tar levels are much lower than the counter-current type.Visualisation of proposed fluidized bed gasification facility in Amsterdam designed to convert waste materials into biofuels[20]The fuel is fluidized in oxygen and steam or air. The ash is removed dry or as heavy agglomerates that defluidize. The temperatures are relatively low in dry ash gasifiers, so the fuel must be highly reactive; low-grade coals are particularly suitable. The agglomerating gasifiers have slightly higher temperatures, and are suitable for higher rank coals. Fuel throughput is higher than for the fixed bed, but not as high as for the entrained flow gasifier. The conversion efficiency can be rather low due to elutriation of carbonaceous material. Recycle or subsequent combustion of solids can be used to increase conversion. Fluidized bed gasifiers are most useful for fuels that form highly corrosive ash that would damage the walls of slagging gasifiers. Biomass fuels generally contain high levels of corrosive ash.Fluidized bed gasifiers uses inert bed material at a fluidized state which enhance the heat and biomass distribution inside a gasifier. At a fluidized state, the superficial fluid velocity is greater than the minimum fluidization velocity required to lift the bed material against the weight of the bed. Fluidized bed gasifiers are divided into Bubbling Fluidized Bed (BFB), Circulating Fluidized Bed (CFB) and Dual Fluidized Bed (DFB) gasifiers.A dry pulverized solid, an atomized liquid fuel or a fuel slurry is gasified with oxygen (much less frequent: air) in co-current flow. The gasification reactions take place in a dense cloud of very fine particles. Most coals are suitable for this type of gasifier because of the high operating temperatures and because the coal particles are well separated from one another.The high temperatures and pressures also mean that a higher throughput can be achieved, however thermal efficiency is somewhat lower as the gas must be cooled before it can be cleaned with existing technology. The high temperatures also mean that tar and methane are not present in the product gas; however the oxygen requirement is higher than for the other types of gasifiers. All entrained flow gasifiers remove the major part of the ash as a slag as the operating temperature is well above the ash fusion temperature.A smaller fraction of the ash is produced either as a very fine dry fly ash or as a black colored fly ash slurry. Some fuels, in particular certain types of biomasses, can form slag that is corrosive for ceramic inner walls that serve to protect the gasifier outer wall. However some entrained flow type of gasifiers do not possess a ceramic inner wall but have an inner water or steam cooled wall covered with partially solidified slag. These types of gasifiers do not suffer from corrosive slags.Some fuels have ashes with very high ash fusion temperatures. In this case mostly limestone is mixed with the fuel prior to gasification. Addition of a little limestone will usually suffice for the lowering the fusion temperatures. The fuel particles must be much smaller than for other types of gasifiers. This means the fuel must be pulverized, which requires somewhat more energy than for the other types of gasifiers. By far the most energy consumption related to entrained flow gasification is not the milling of the fuel but the production of oxygen used for the gasification.In a plasma gasifier a high-voltage current is fed to a torch, creating a high-temperature arc. The inorganic residue is retrieved as a glass like substance.There are a large number of different feedstock types for use in a gasifier, each with different characteristics, including size, shape, bulk density, moisture content, energy content, chemical composition, ash fusion characteristics, and homogeneity of all these properties. Coal and petroleum coke are used as primary feedstocks for many large gasification plants worldwide. Additionally, a variety of biomass and waste-derived feedstocks can be gasified, with wood pellets and chips, waste wood, plastics and aluminium, Municipal Solid Waste (MSW), Refuse-derived fuel (RDF), agricultural and industrial wastes, sewage sludge, switch grass, discarded seed corn, corn stover and other crop residues all being used.[1]Chemrec has developed a process for gasification of black liquor.[21]HTCW reactor, one of several proposed waste gasification processesWaste gasification has several advantages over incineration:The necessary extensive flue gas cleaning may be performed on the syngas instead of the much larger volume of flue gas after combustion.Electric power may be generated in engines and gas turbines, which are much cheaper and more efficient than the steam cycle used in incineration. Even fuel cells may potentially be used, but these have rather severe requirements regarding the purity of the gas.Chemical processing (Gas to liquids) of the syngas may produce other synthetic fuels instead of electricity.Some gasification processes treat ash containing heavy metals at very high temperatures so that it is released in a glassy and chemically stable form.A major challenge for waste gasification technologies is to reach an acceptable (positive) gross electric efficiency. The high efficiency of converting syngas to electric power is counteracted by significant power consumption in the waste preprocessing, the consumption of large amounts of pure oxygen (which is often used as gasification agent), and gas cleaning. Another challenge becoming apparent when implementing the processes in real life is to obtain long service intervals in the plants, so that it is not necessary to close down the plant every few months for cleaning the reactor.Environmental advocates have called gasification "incineration in disguise" and argue that the technology is still dangerous to air quality and public health. "Since 2003 numerous proposals for waste treatment facilities hoping to use... gasification technologies failed to receive final approval to operate when the claims of project proponents did not withstand public and governmental scrutiny of key claims," according to the Global Alliance for Incinerator Alternatives.[22] One facility which operated from 20092011 in Ottawa had 29 "emissions incidents" and 13 "spills" over those three years. It was also only able to operate roughly 25% of the time.[23]Several waste gasification processes have been proposed, but few have yet been built and tested, and only a handful have been implemented as plants processing real waste, and most of the time in combination with fossil fuels.[24]One plant (in Chiba, Japan, using the Thermoselect process[25]) has been processing industrial waste with natural gas and purified oxygen since year 2000, but has not yet documented positive net energy production from the process.In 2007 Ze-gen erected a waste gasification demonstration facility in New Bedford, Massachusetts. The facility was designed to demonstrate gasification of specific non-MSW waste streams using liquid metal gasification.[26] This facility came after widespread public opposition shelved plans for a similar plant in Attleboro, Massachusetts.[27] Today Ze-gen appears to be defunct, and the company website was taken down in 2014.[28]Also in the US, in 2011 a plasma system delivered by PyroGenesis Canada Inc. was tested to gasify municipal solid waste, hazardous waste and biomedical waste at the Hurlburt Field Florida Special Operations Command Air Force base. The plant, which cost $7.4 million to construct,[29] was closed and sold at a government liquidation auction in May 2013.[30][31] The opening bid was $25. The winning bid was sealed.In December 2022, the Sierra BioFuels Plant opened in Reno, Nevada, converting landfill waste to synthetic crude oil. [32]Syngas can be used for heat production and for generation of mechanical and electrical power. Like other gaseous fuels, producer gas gives greater control over power levels when compared to solid fuels, leading to more efficient and cleaner operation.Syngas can also be used for further processing to liquid fuels or chemicals.Gasifiers offer a flexible option for thermal applications, as they can be retrofitted into existing gas fueled devices such as ovens, furnaces, boilers, etc., where syngas may replace fossil fuels. Heating values of syngas are generally around 410MJ/m3.Currently Industrial-scale gasification is primarily used to produce electricity from fossil fuels such as coal, where the syngas is burned in a gas turbine. Gasification is also used industrially in the production of electricity, ammonia and liquid fuels (oil) using Integrated Gasification Combined Cycles (IGCC), with the possibility of producing methane and hydrogen for fuel cells. IGCC is also a more efficient method of CO2 capture as compared to conventional technologies. IGCC demonstration plants have been operating since the early 1970s and some of the plants constructed in the 1990s are now entering commercial service.In small business and building applications, where the wood source is sustainable, 2501000 kWe and new zero carbon biomass gasification plants have been installed in Europe that produce tar free syngas from wood and burn it in reciprocating engines connected to a generator with heat recovery. This type of plant is often referred to as a wood biomass CHP unit but is a plant with seven different processes: biomass processing, fuel delivery, gasification, gas cleaning, waste disposal, electricity generation and heat recovery.[33]Diesel engines can be operated on dual fuel mode using producer gas. Diesel substitution of over 80% at high loads and 7080% under normal load variations can easily be achieved.[34] Spark ignition engines and solid oxide fuel cells can operate on 100% gasification gas.[35][36][37] Mechanical energy from the engines may be used for e.g. driving water pumps for irrigation or for coupling with an alternator for electrical power generation.While small scale gasifiers have existed for well over 100 years, there have been few sources to obtain a ready-to-use machine. Small scale devices are typically DIY projects. However, currently in the United States, several companies offer gasifiers to operate small engines.Gasification plant, Gssing, Austria (20012015)In principle, gasification can proceed from just about any organic material, including biomass and plastic waste. The resulting syngas can be combusted. Alternatively, if the syngas is clean enough, it may be used for power production in gas engines, gas turbines or even fuel cells, or converted efficiently to dimethyl ether (DME) by methanol dehydration, methane via the Sabatier reaction, or diesel-like synthetic fuel via the FischerTropsch process. In many gasification processes most of the inorganic components of the input material, such as metals and minerals, are retained in the ash. In some gasification processes (slagging gasification) this ash has the form of a glassy solid with low leaching properties, but the net power production in slagging gasification is low (sometimes negative) and costs are higher.Regardless of the final fuel form, gasification itself and subsequent processing neither directly emits nor traps greenhouse gases such as carbon dioxide. Power consumption in the gasification and syngas conversion processes may be significant though, and may indirectly cause CO2 emissions; in slagging and plasma gasification, the electricity consumption may even exceed any power production from the syngas.Combustion of syngas or derived fuels emits exactly the same amount of carbon dioxide as would have been emitted from direct combustion of the initial fuel. Biomass gasification and combustion could play a significant role in a renewable energy economy, because biomass production removes the same amount of CO2 from the atmosphere as is emitted from gasification and combustion. While other biofuel technologies such as biogas and biodiesel are carbon neutral, gasification in principle may run on a wider variety of input materials and can be used to produce a wider variety of output fuels.There are at present a few industrial scale biomass gasification plants. Since 2008 in Svenljunga, Sweden, a biomass gasification plant generates up to 14MWth, supplying industries and citizens of Svenljunga with process steam and district heating, respectively. The gasifier uses biomass fuels such as CCA or creosote impregnated waste wood and other kinds of recycled wood to produces syngas that is combusted on site.[38][39]Examples of demonstration projects include:The 32 MW dual fluidized bed gasification of the GoBiGas project in Gothenburg, Sweden, produced around 20MW of substitute natural gas from forest residues and fed it into the natural gas grid since December 2014.[40] The plant was permanently closed due to technical and economical problems in April 2018. Gteborg Energi had invested 175 million euro in the plant and intensive attempts to sell the plant to new investors had failed for a year.[41]Those of the Renewable Energy Network Austria, [42] including a plant using dual fluidized bed gasification that has supplied the town of Gssing with 2MW of electricity, produced utilising GE Jenbacher reciprocating gas engines[43] and 4MW of heat,[44] generated from wood chips, since 2001. The plant was decommissioned in 2015.[45]Go Green Gas' pilot plant in Swindon, UK has demonstrated methane production from waste feedstocks at 50kW. The project has prompted the construction of a 25million commercial facility that aims to generate 22GWh per annum of grid-quality natural gas from waste wood and refuse derived fuel, due for completion in 2018.[46]Chemrec's pilot plant in Pite that produced 3MW of clean syngas from entrained flow gasification of black liquor.[21] The plant was closed down permanently due to financial problems in 2016[47]The High Temperature Winkler (HTW), a pressurized circulating fluidized bed gasification process. During the 1990s HTW was tested with a variety of different feedstocks, including low-rank coals and various forms of biomass; wood, refuse derived fuel (RDF) and municipal solid waste (MSW). The last HTW facility closed permanently in 2002. Since 2015 tests of the process continues at a 0.1 t/h pilot unit at Darmstadt University, while redesigned full-scale units are proposed in Amsterdam and Rotterdam[48][49]Energy portalRenewable energy portalCoal gasificationFluidized bed combustionHistory of manufactured gasIsle of Wight gasification facilityList of solid waste treatment technologiesPlasma arc waste disposalRenewable natural gasWater gasOutdoor wood-fired boilerChemical looping reforming and gasificationSublimation (phase transition)^ a b c National Non-Food Crops Centre. "Review of Technologies for Gasification of Biomass and Wastes, NNFCC project 09/008" (PDF). Archived (PDF) from the original on 2017-08-10. 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Explore our latest gallery of EditorsPicks.Browse Editors' FavoritesGasification is a technology that converts material containing carbon, such as coal, biomass, and waste, into synthetic gas.As an exchange, it is used to produce electricity and other valuable products like chemicals, fertilizers, and fuels.Gasification uses little or no air or oxygen in a closed reactor to directly convert carbon-based materials into synthetic gas or syngas, and it does not involve combustion.The energy locked in biomass and municipal solid waste could be retrieved through gasification, transforming those materials into valuable products and removing the need for landfilling or burning.Biomass is a renewable organic material from plants and animals. Biomass is a significant fuel in different countries, especially for heating and cooking in developing countries.Using biomass fuels for electricity and transportation generation is increasing in several developed countries to avoid carbon dioxide emissions from fossil fuel use.History of GasificationThe first gasification plants were built in the 18th century to produce town gas for lighting.The process was later applied industrially to generate heat and power.In the 1930s, synthetic fuel production from coal became important during World War II as crude oil supplies were interrupted.In the 1970s, during the energy crisis, interest in gasification escalated as a way to generate synthetic natural gas from coal.In the 1990s, environmental regulations favored cleaner processes such as gasification over traditional combustion.Gasification can capture and utilize pollutants like sulfur dioxide (SOx), nitrogen o