



DP Biomass Solution

Background

DP's High Pressure High Temperature, combustion boiler technology originated in Denmark in the 1980's. Designed and engineered specifically to efficiently combust straw biomass, it is the most successful, commercially proven technology for biomass and is behind the best performing power plants today. With over 100 reference plants around the world, DP is acknowledged as the leading expert in biomass straw-fired combustion.



Our biomass technology portfolio has been extended to include multiple fuel types and 'complex' fuels as well as other technologies such as gasification. We have also established partnerships and licensing agreements with companies providing complementary or synergistic solutions and expertise in order that our clients' requirements are matched with appropriate, fit-for-purpose technologies that are technically advanced; economically viable; reliable and sustainable.

DP Technologies

DP Combustion

DP's HTHP boiler technology + Water Cooled Vibrating Grate (WCVG) solution was initially designed for optimum straw-fired combustion. The technology has been further developed to handle and combust complex fuels.

Operating at high steam and temperature parameters – typically 92bar and 540°C; and using heat recovery from flue gas cooling, flue gas condensation and additional residual heat, the plant can achieve very high boiler and overall plant efficiency. Design parameters are ~8,000 hours per year at full capacity.

The fuel is fed via a stoker feeder and is combusted on a Water Cooled Vibrating Grate (WCVG) under carefully controlled conditions. Unlike many grates, the WCVG can effectively accommodate mixtures of woody and herbaceous biomass fuel. With fewer moving parts than a moving grate, it requires less maintenance and is also the most reliable combustion grate available. The 5-10 second vibrating movements occur in 1.5-3 minutes cycles; and serve to regulate combustion by

allowing combustion air to be fed from both above and beneath the grate. The vibration also inhibits the formation of large slag particles which are a common result of biomass combustion.

The grate ignition zone is stabilized by a patented ignition air supply system. Water cooling of the grate ensures even temperature distribution and a grate surface temperature that is well below ash melting point. This prevents ash from melting and adhering to the grate, which makes the WCVG suitable for burning fuels with high slagging and sintering propensities.



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Such fuel types are now more prevalent, and DP engineers have made many additional groundbreaking modifications and improvements to ensure that the characteristics of complex fuels, tropical fuels and non-traditional fuel sources are effectively accommodated within the boiler island and auxiliary equipment. The development of corrosion-resistant capabilities and integral emissions control are now standard options for such solutions. DP has experience in over 60 types of design fuels and mixed fuel variants. Additional auxiliary equipment has been well integrated and clients need look no further than DP to provide cohesive solutions that range in scope from boiler islands to turnkey power plants.

DP Gasification



Gasification is a new generation technology which is proving very well suited to meet the increasingly stringent emissions criteria being imposed in many countries. It is suitable for biomass but is also appropriate for handling the potentially hazardous emissions from MSW fuels, as the gasification process produces lower emissions than combustion and flue gas treatment. The gasification process emits no pollution and no particulate matter. NOx emissions are low, and SOx emissions are negligible. The system is easy to build and can be operated effectively on a smaller scale than direct combustion plants. DP has partnered

with European waste-to-energy gasification company Energos to provide their proven, patented, commercially successful technology in Asia. The proprietary technology is designed to optimize the clean conversion of all woody biomass and other types of non-recyclable commercial and household waste through a 2 stage gasification process. The modularity of the design facilitates flexibility in materials and plant scale, and can be used with a wide range of unrefined waste materials.

DP Emissions and DP Water Treatment



Emissions management technology is already incorporated into DP biomass solutions, but increasingly strict emissions standards are being imposed worldwide which may necessitate additional emissions management solutions. DP's specialized flue gas cleaning technology is a state-of-the-art Dry Scrubbing System, which can be effectively incorporated into most existing plants, or as part of a new project to ensure that such standards are met. DP's Flue Gas Cleaning engineers are based in the UK and have extensive experience in redefining complex requirements in order to deliver specialized solutions.

Waste water management and treatment is an essential process for all power plants, and the correct water treatment solution can improve performance, reduce waste and ensure compliance to health, safety and environmental legislation. DP has a partnership with leading UK-based Watercare International, which delivers a comprehensive range of services from concept designs to complete plant; with each service and recommended solution tailored to specific plant needs. The Watercare International team has unsurpassed experience across a wide range of industries, providing independent advice and solutions for the most cost effective results.

DP Advanced Control and Automation

Automation is critical in order to optimize operational and financial performance, and DP has designed and implemented an Advanced Automatic Boiler Control solution which controls the complete boiler process. Automatic regulation of the boiler load and output ensures a stable boiler operation and enhanced performance, whilst reducing cost. As a standalone improvement, automation can minimise the number of staff and reduce human error to have a positive and significant impact on performance and lifetime of the boiler. DP offers advanced, customised automation packages for integration with both new and existing plants; as well as providing the commissioning and operator training to ensure that the benefits are fully realised.

Biomass Fuel types



The chemical composition and combustion characteristics of biomass fuels differ widely; and even more so as many abundant waste biomass previously considered unsuitable for fuel (tropical, complex fuels) are now being seen as viable options. DP has fuel analysis experience in over 60 types of biomass fuel and DP engineers have adapted our technologies accordingly. We are constantly adding to our knowledge and database.

The pre-processing, sorting and packaging of fuel can have an impact on the boiler design and on the storage, conveyor and fuel feeding auxiliary equipment. This varies significantly by country and the nature of the prevailing logistics infrastructure. DP understands these numerous variables and how to manage the feedstock for best results.



DP Expertise

DP Understands the Business of Biomass



Performance Certainty



Minimise Execution Risk

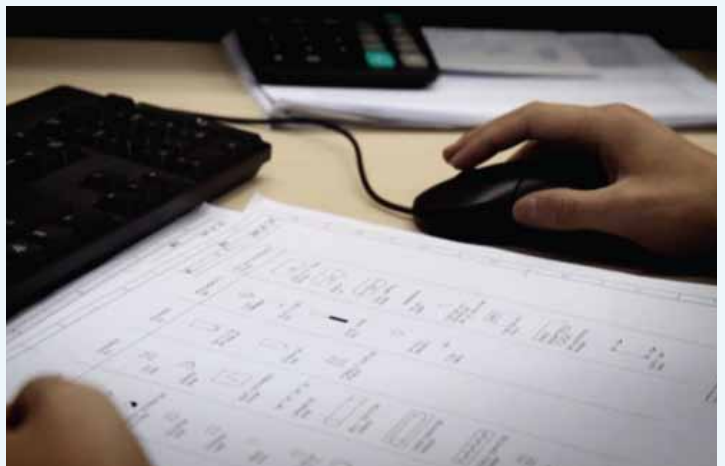


Cost Efficiency

The equipment is not the solution - it is DP's knowhow in selecting the appropriate technology; and correctly designing for different fuels, conditions and required outputs that is the key to sustainability and profitability. Beyond that, automation of the equipment and the correct installation and integration of equipment within the boiler island are fundamental to the long term performance of a power plant. These are all also core areas of DP's expertise. Operational excellence is essential for optimal performance and DP's knowledge and experience is hugely important in training operators and providing maintenance advice or packages.

DP Consultancy, Feasibility Studies And Industry Insight

- DP has always led changes in the global biomass industry, accumulating knowledge and gaining experience with which to expand our capabilities and add value.
- For clients seeking to better understand or capitalise on the industry's global dynamics and opportunities, we offer a unique business and operational perspective which reflects our multidimensional, multicultural expertise and longstanding reputation.

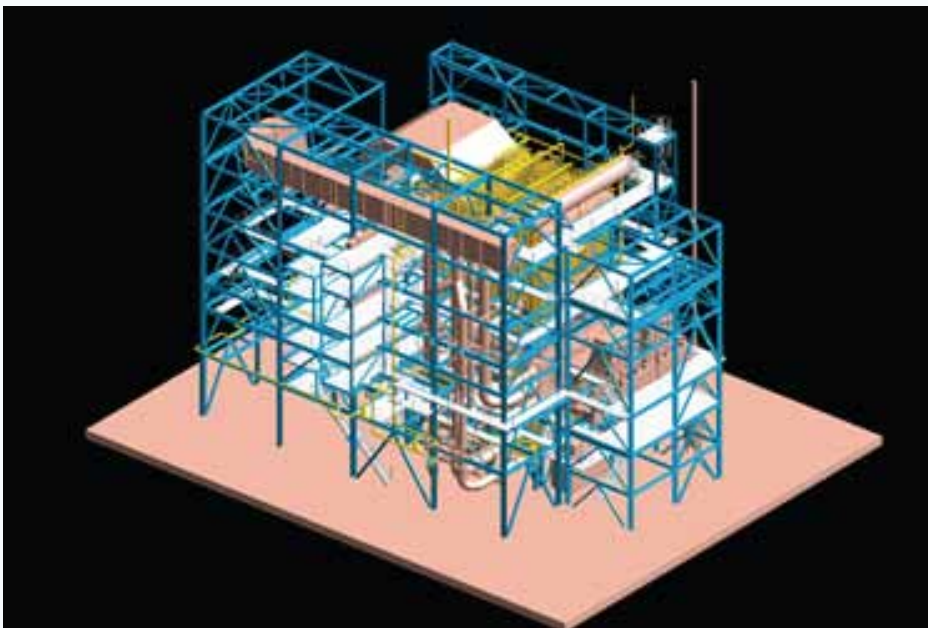


Understanding Your Business objectives

- Despite different specific requirements, our clients all seek solutions with predictable and reliable performance, a low risk profile; at a competitive cost. Our first task is to advise our clients on the underlying factors and dynamics affecting their business objectives; around which we can recommend, design and build effective solutions.
- We deliver the appropriate advice, solutions and implementation – from project feasibility to after-sales and plant optimisation.

Planning

- Fuel characteristics affect the design, performance and longevity of a power plant. We combine profound experience in biomass analysis and combustion with considerable operational experience to ensure that DP solutions are fit for operational purpose and are proven, reliable and performance guaranteed.
- We conduct expert fuel assessment to determine the chemical composition; calorific value and moisture content of proposed fuels and provide advice on fuel logistics to optimize utilization. Our advice on technology and logistics is invaluable for assessing plant feasibility and plant economics.



Design and Engineering

- Multidisciplinary Engineering teams collaborate through our Global Engineering platform and follow best practice to design customised, fit-for-purpose solutions.
- Conduct pre-engineering studies to facilitate faster project delivery.
- Full database CFD 3D design and simulation software is used to simulate boiler conditions based on the specific fuel or fuel mix.
- Design guarantee for plant efficiency (92% efficiency) and availability.

Project Delivery and Cost Management

- State-of-the-art ERP system and project management frameworks ensure on-time on-budget project delivery.
- Dedicated quality departments, manufacturing facilities in Poland and strategic partnerships with key suppliers around the world.
- High quality global supply chain and skilled project management reduce the cost of production and the execution risk.
- EPC turnkey delivery
- First class quality assurance and flexibility for your project.
- Enhanced performance solutions, reduce the life cycle cost.



Commissioning, Automation and Training

- Robust plant commissioning and automation are crucial elements of success. Our practical experience in building over 100 plants has reaffirmed the need for specialist skills in this field, and DP's specialized commissioning and automation teams ensure that the integration process between installation and full operation is flawless.
- We provide automation solutions that will ensure the most efficient plant operation whilst reducing staff overheads.
- Our package includes plant testing, preparing documentation, training operating staff and making appropriate changes for automation.



Plant Services, O&M

- Ongoing, reliable and consistent performance is highly dependent on proper, scheduled maintenance. DP provides service and maintenance packages and operator training to protect your investment.
- When problems do arise or a plant is not performing well, DP's experts can rapidly diagnose the issues and provide the solutions to address or optimise plant performance.

DP Retrofit, Upgrade and Plant Optimisation



With a reference list of over 100 plants, DP has a wealth of knowledge in modification work and servicing for retrofits and upgrades. We can help to extend the plant life time or modify it to utilise new waste resources. By upgrading or adding new technologies to existing plants; or replacing outdated equipment we can help to maintain the highest possible efficiencies. As well as our expertise in biomass power plants, our partnership with leading service companies in Europe provides us with the relevant expertise to provide retrofits, servicing and support for biomass and waste to energy plants in Asia and China.

Optimisation of existing plant equipment can have a significant positive economic impact. Using expert diagnostic processes and our considerable experience we systematically assess, identify and eliminate malfunctions in the installation and operation of boiler island components - including those from other suppliers. We identify the best optimization or modifications. To support optimization recommendations, DP has partnered with European grate servicing experts TISKA GmbH. For automation, DP has partnered with DUBLIX Engineering to recommission and calibrate existing control systems.

Retrofits, upgrades and improvements are accompanied by training and maintenance schedules to ensure performance improvements are sustained.

Case Studies and References

China Everbright International, China

Background

China Everbright International is a Hong Kong Stock Exchange listed enterprise, and part of the Everbright Group. The company's business portfolio includes significant environmental protection and new energy investments in China's fast growing renewables industry. In 2009, and with over 50 waste-to-energy projects in China, Everbright identified Anhui province as the best location for its first biomass project. Everbright had only limited knowledge and experience of biomass, and DP was contracted to design and deliver the optimum solution.



DP Solution

In September 2011, a 130t/h customized mixed fuel boiler started operation in DangShan, Anhui province. The 30MWe plant was designed to consume 200,000 tons of fuel per year; and, to generate 2*10kWh of clean electricity annually. DangShan and 5 other DP projects have been the top performing plants in Anhui in recent years. The success of DangShan has led to the signing of a further 10 contracts and a formal commitment with Everbright International to pursue R&D of biomass and waste-to-energy technologies.

Mahachai, Thailand

Background

Mahachai Green Power Co., Ltd. is a Thai joint venture between TPC Power Holding Co., Ltd. (owned by Thai Polycons); EnBW (a German utility); and minority shareholders NC Coconut Co., Ltd. and Green Power Producer Group Co., Ltd. The project is located in Samut Sakhon Province, Thailand. An innovative solution was needed to efficiently turn all the waste residues from a coconut processing plant into clean energy. This required the ability to handle all the

herbaceous and woody biomass from a complex tropical fuel, for which there was no pre-existing solution. The project was delivered on an EPC turnkey basis.

DP Solution

In April 2016 DP delivered a state-of-the-art 9.5MWe high pressure, high temperature plant - including all electro-mechanical systems and ancillary plant. The plant is fueled by coconut waste residues, (husk, shell, fronds and leaves). The boiler is designed to operate at high steam parameters (92 bar and 540°C), producing 9.5MWe of electricity. The plant is fully automated to achieve an efficiency net heat rate of 13250 KJ/KWH, 27% with a design fuel at 44%. Emissions are lower than the regulatory standards. Full automation also ensures a stable operation and reliable performance, with minimal stoppages and reduced manpower requirements. This allows the plant to operate at full capacity for more than 7,900 hours per year.

Vattenfall, Denmark

Background

Vattenfall is a Swedish owned power company and one of Europe's largest generators of electricity and heat. In 2006, Vattenfall sought a cost effective way to diversify their energy portfolio and simultaneously improve their environmental credentials. Their requirement was for a flexible and fully automated state-of-the art straw-fired plant to utilize local agricultural waste at one of the company's large coal-fired facilities in Fynsvaerket, Denmark.

DP Solution

DP CleanTech designed a 35 MWe 85MW, fully automated thermal straw-fired plant which is still one of the most advanced in the world. It was provisioned to allow co-firing with wood chips, pellets and granulated fuels to preclude fuel supply disruptions. Since commissioning in 2009, the plant has been running at full load, requiring only 2 operators. It is one of the fastest regulating plants in Vattenfall's portfolio. In 2012, the plant was flawlessly recommissioned to co-fire wood chips and straw.





About DP CleanTech

- ✓ DP CleanTech designs, engineers, manufactures and commissions biomass and waste-to-energy power plants, providing complete solutions for turning waste materials into clean energy.
- ✓ DP CleanTech has over 100 biomass power plant references around the world using high pressure, high temperature technology originally developed in Denmark.
- ✓ DP CleanTech built the first biomass power plant in China and is responsible for over 30% of the biomass power plants operating in China today.
- ✓ DP CleanTech is recognized as a world leader in the biomass clean energy field.

