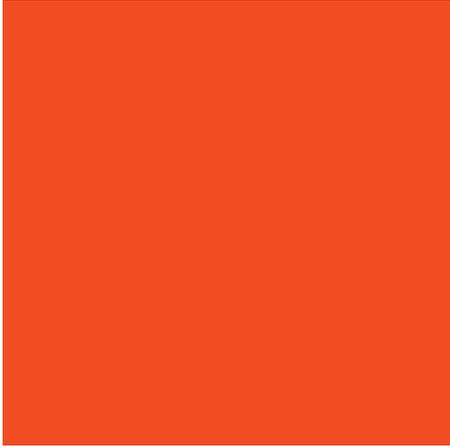


CAPABILITY STATEMENT

WASTE MANAGEMENT AND ENERGY FROM WASTE AND BIOMASS



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WHO ARE WE?

'ENERGY FROM WASTE AND BIOMASS' are the people, skills, and experience in the COWI Group dedicated to the most energy efficient and optimum environmental handling and treatment of secondary energy sources, such as biomass and solid wastes.

We have a strong background. COWI has consistently been among the largest international consultants within handling and treatment of solid waste and the international 'ENR Source Book' (Engineering News Record) places COWI at the very top of the list for Year 2016.

SOLID WASTE		
Rank	Firm	Revenue (\$ Mil.)
1	COWI A/S	29.5
2	TETRA TECH INC.	25.0
3	MOTT MACDONALD	9.4
4	DORSCH GRUPPE	8.7
5	RAMBOLL GROUP A/S	8.2
6	STANTEC INC.	7.0
7	DAR AL-HANDASAH CONSULTANTS (SHAIR & PARTNERS)	6.3
8	FICHTNER GMBH & CO. KG	5.3
9	HDR	5.3
10	AMEC FOSTER WHEELER (U.S.)	4.2

Engineering News Record 2016

COWI has been an active consultant in energy-from-waste since the 1960s, using energy recovered from municipal solid waste (MSW) and sewage sludge to generate electricity and heating.

We are a pioneer in the use of biomass for energy generation and have recently completed 'Converting Biomass to Energy - A Guide for Developers and Investors', produced for the World Bank /IFC. The Guide is available for free download at www.IFC.org.

We combine our technical skills, gained from the development of several energy projects with the no-nonsense attitude of our in-house economy and finance colleagues to secure that the final project is both technically and financially viable. We will work with international or local architects to ensure that the project blends with the local environment.

WHAT IS OUR BACKGROUND?

BIOMASS AND WASTE TO ENERGY is a part of the COWI Group with 6,600 consultants worldwide.



COWI has over 85 years of experience as an international consultant. In addition to our activities in BIOENERGY AND THERMAL POWER, COWI is a major force in bridge, tunnel, and marine design, and in many other areas. Group turnover in 2017 reached €826 million.

Section 4 of this document offers a full and detailed description of the COWI Group and its background.

WHAT WE DO IN BIOENERGY AND THERMAL POWER

This Capability Statement describes COWI's experience in the field of Biomass and Waste fired Heat and Power plants, including related experience within waste management, waste-to-energy, district heating, economic calculations, financing etc.

The increasing focus on climate change calls for new sustainable solutions. Bioenergy is one of them. Energy production based on straw, wood chips, rice husks, wood pellets or other biomass reduces the CO₂-emission to the atmosphere, compared to the use of fossil fuels.

Our experience with thermal conversion of biomass includes both combustion in traditional boilers and the most advanced systems for biomass gasification. We have assisted in projects for heat production plants supplying district heating networks, for boiler plants producing steam for industrial purposes, and for combined heat and power plants. These plants use a large variety of feedstocks, such as wood chips, wood pellets, and straw.

COWI has been involved in Energy from Biomass and Municipal Solid Waste (MSW) projects in Denmark and worldwide for decades.

The beginning was in Herning in Denmark. COWI in 1964 designed and developed a solid waste fired boiler station, disposing of the town's solid waste and in return producing district heating for the town's extensive district heating system. This project marked COWI's entrance into Waste-to-Energy (WtE). COWI was earlier involved in the start of the municipal district heating system in Herning in 1956, originally based on heavy oil-fired boilers.

Many waste to energy (WtE) projects followed in Denmark and internationally.

In 1999, we upgraded the existing district heating system in Assens, Denmark with a combined heat and power plant using wood chips made from tree logs imported from the Baltic area. Once again, several similar projects succeeded this first Bioenergy plant, in Denmark and abroad.

From this beginning, COWI has developed extensive regional and international competence and experience in Biomass and Waste fired Heat and Power projects. COWI can add considerable value to the development and realisation of such projects and COWI will therefore be a sound and dependable partner for a Client, who may rely on COWI to successfully deliver and exceed the expected result.

Our extensive knowledge in the use of Bioenergy, municipal solid waste (MSW) and other non-fossil fuels for the production of electricity and heat originated in Denmark, but has for several years been requested and used outside of our home country.

From an early beginning, we have continually developed the technology for recovering energy from this renewable energy source. Today, it meets high technical and environmental standards.

COWI has the interdisciplinary skills to assess the local conditions and the biomass market and provide the Client with sound advice on all the aspects for a constructive solution.

COWI's BIOENERGY AND THERMAL POWER section has about 100 staff, but COWI globally employs up to 300 specialists in bioenergy and waste related projects.

Several COWI specialists have wide international background, including working experience from a number of countries and regions in Europe, Asia, Africa and the Americas.

COWI's advisory and design services in the production of energy from non-fossil fuels, such as biomass and municipal solid waste are today being used in several countries worldwide – both developing and industrial.

SERVICES OFFERED

PROJECT DEVELOPMENT

- › Pre-feasibility study
- › Conceptual design and specification
- › Bankable feasibility study
- › Technical, environmental and economic due diligence
- › Environmental Impact Assessment (EIA)
- › Technology evaluation
- › BAT (Best Available Technology) assessment
- › Procurement plan
- › Technology, economy, finance and organisational set-up
- › Statutory process
- › Economy, finance and organisational set-up
- › Transaction advisor for PPP projects

DESIGN AND IMPLEMENTATION

- › Design of mechanical, electrical, and civil work – at turnkey or detail level
- › Pre-qualification
- › Planning permission and licensing
- › Procurement, including technical specification to FIDIC and other international standards
- › Bid evaluation and contract negotiation
- › Progress monitoring
- › Quality control, including shop inspections
- › Construction management and supervision
- › Commissioning, including start-up, performance testing and handover

OPERATION AND MAINTENANCE

- › Support during the guarantee period
- › Optimisation and upgrading of existing plants
- › Operation and maintenance support
- › Education and training of operation and maintenance staff
- › Planning of scheduled maintenance
- › Assistance in diagnosis and remediation of operational problems
- › Thermoflex/TURABS
- › Applied tribology

SPECIAL CONSULTING SERVICES

- › Handling, treatment and disposal of residual products
- › Optimisation and improvement of monitoring and control instruments and systems (DCS/SCADA)
- › Environmental management including “Green Reports”
- › Life cycle and climate analyses
- › Energy planning
- › District heating and cooling systems
- › Connection to the electricity grid
- › Waste management
- › Health, Safety and Environment (HSE)
- › Value-for-money analyses
- › Architectural competitions
- › Benchmarking of facilities

The following pages show a few examples of services offered and their applicability for different conditions. Later, we describe some spectacular projects (case stories).



PROJECT DEVELOPMENT

Pre-feasibility study

A small group of specialists can often outline a useful frame for a potential project during a short visit to the proposed location for the project. A pre-feasibility study will look at the overall background for the proposed project; hereunder assess availability of suitable (biomass) fuels, access to energy market, relevant technology, labour availability, and potential legal or environmental obstacles. If the outcome of the pre-feasibility study is favourable, the Client may decide to continue to the next step of the project development.



EXAMPLE:

ANGOLA WTE – PRE-FEASIBILITY STUDY

Angola Environmental Serviços (AES) is an Angolan registered company, which offers Waste Management services to the Angolan oil and gas industry. This includes all aspects related to the handling, cleaning, collection, treatment and disposal of restricted and non-restricted wastes generated as part of the country's onshore and offshore oil-activities.

COWI conducted a technical and financial analysis for AES of a proposal for an Engineering, Procurement and Construction contract for a new waste-to-energy (WtE) plant.

The financial analysis provides estimates of the net profit and the net present value of the cash flow during the period analysed (2019–2038). The financial analysis uses data provided by AES and its potential technical partner /plant supplier (capital cost), supplemented by background data provided by COWI.

Rough budget information from suppliers, combined with COWI's general experience formed the basis for the pre-feasibility analysis. AES provided the background from existing documents and information given during meetings with AES.

COWI's pre-feasibility analysis included capital costs and operational and maintenance costs.

A complete technical review and risk assessment will be possible when firm detailed information is available (including list of sub-suppliers, main components sizing, etc.). COWI's assessment used the general principles compiled from numerous waste-to-energy plants throughout the world, and applied a conservative approach for waste handling, combustion technology, boiler design, electricity yield, and flue gas treatment to meet environmental requirements.

The capacity of the proposed WtE plant was 36,000 tons of waste per year.

COWI assessed three scenarios:

SCENARIO 1	Incineration (WtE) plant with energy recovery
SCENARIO 2	Incineration plant with no energy recovery
SCENARIO 3	A smaller incineration plant than for Scenario 2, and landfilling of remaining waste



Conceptual design and specification

This will be required to provide a solid basis for a *Bankable feasibility study*, which in turn will determine whether the project is technically, environmentally, and economically feasible and – not least, whether the necessary financing can be obtained on acceptable terms. As above, at this point the Client may decide on the next phase of the project.

The size of the project and its location will influence the complication of the *Statutory Process*. National and local environmental standards may require different levels of data, often including an EIA (environment impact statement), perhaps demand BAT (best available technology) for the project, and it may prescribe a procurement plan with fair competition, if public financing is involved.

EXAMPLE:

BIOMASS (STRAW-FIRED) COMBINED HEAT AND POWER PLANT IN KASUR, PAKISTAN

Establishment of a new CHP biomass plant based on local wheat straw, corn stover, and cotton stalks.

The packaging materials producer, Packages Ltd. in Lahore, Pakistan in 2011 asked COWI to explore alternative energy sources for its paper mill in Kasur in Punjab, Pakistan. The existing boiler plant generated process steam and electricity for the mill using natural gas and heavy fuel oil. The paper mill has an annual production of 300,000 tons of paper and cardboard, but production suffered from both escalating fuel costs and unreliable supplies.

COWI carried out a conceptual design and a 'bankable feasibility study'

The conclusion was to integrate a new 120 MW biomass boiler plant with the existing facilities. This would provide a dependable energy source and cut operation costs, using locally grown biomass for fuel.

COWI examined potential fuel sources for the biomass plant, based on a study of the feedstock in the region. With focus on availability, flexibility and environmental sustainability, the optimal solution was the use of surplus biomass residues from the local farmers.

The conclusion of the feasibility study resulted in Packages Ltd. giving COWI the order to proceed with the project.

Tender specifications were according to FIDIC, with procurement as a turnkey contract.

COWI acted as Owner's Engineer during plant construction. Plant operation started in 2016.

Technical, environmental and economic due diligence

COWI recently prepared a Guide for World Bank/IFC, aimed mainly at developers and investors in developing countries to assist them in developing biomass-to-energy projects using local fuels. World Bank/IFC published the Guide 'Converting Biomass to Energy' in June 2017.

EXAMPLE:

SRI LANKA WTE – DUE DILIGENCE – 2016–2017

Fairway Waste Management Group (FWM) in Colombo, Sri Lanka in December 2016 entered into an agreement with COWI to prepare an independent technical and financial assessment of an integrated waste management plant consisting of:

- › A Sorting plant for 500 tonnes waste per day to separate the waste into an organic and a combustible waste fraction
- › An Anaerobic Digestion plant to handle the organic waste
- › A Waste to Energy plant to handle the combustible waste fraction

COWI's role in the project was to advise FWM on:

- › Procurement strategies, technical as well as commercial
- › Review contract proposals between the Waste Authorities and FWM
- › Other reviews based on COWI's extensive experience in establishing waste treatment technologies all over the world.
- › Establish a financial model for the entire integrated waste management facility

FWM used a 1-week workshop in Colombo in December 2016 to introduce COWI to the background and details of project.

COWI's assignment was to prepare an objective and independent initial assessment of the financial and technical aspects of establishing a proposed waste treatment facility at the Karadiyana Landfill Site.

The assessment concludes that establishing the plant would be technically and financially feasible when balanced against the desired financial rate of return for the project.

COWI used its international technical experience and standard best industry practice in preparing its recommendations and conclusions.

COWI handed over the final report to FWM in July 2017.

Transaction advisor for PPP projects

Very large projects may be relevant for a PPP (Public Private Partnership) contract, which involves the close cooperation between the project owner and a service provider that will undertake plant design, construction, and project financing in return for a long term operating agreement.

EXAMPLE:

DUBLIN WASTE-TO-ENERGY PROJECT/IRELAND – CLIENT’S REPRESENTATIVE

Dublin City established its new plant in the port of Dublin as a PPP project with a major international operator of WtE plants. The plant has a waste treatment capacity of 600,000 t/year, to be incinerated in two lines, each of 35 t/hour. The plant will cogenerate heat and power. Due to the high degree of process optimisation, the plant’s net electrical output exceeds 60 MW, when operating in power-only mode (electrical efficiency of approx. 29% is among the highest in the world for WtE). COWI, in collaboration with an Irish consultant served the City of Dublin as Client’s Representative. Responsibilities included assessment of alternative technologies, PPP procurement, contracting, complete Authority applications, and close monitoring of operator’s choice of technology, acceptance of operator’s basic design, tendering and contract process equipment etc.

Throughout the project development, Client’s Representative had focus on ‘Value for Money’ in comparison with an agreed ‘Public Sector Benchmark’. Community involvement and acceptance was another important part of the assignment. – Plant operation started in 2017.

DESIGN AND IMPLEMENTATION

Design of mechanical, electrical, and civil work – at turnkey or detail level

COWI can offer design and procurement of a new plant at turnkey or detail level as requested by the Client.

EXAMPLE:

LISBJERG BIOMASS POWER PLANT, AARHUS/DENMARK – DESIGN, PERMITTING AND PROCUREMENT IN LOTS

Lisbjerg Biomass Power Plant is located in the northern part of Aarhus, Denmark’s Second City. The owner is AffaldVarme Aarhus, which is a City department.

The plant was commissioned in 2017 and is an important part of the City’s long-term green strategy.

Wheat straw is the main fuel for the power plant, with wood chips as 50% alternative and backup fuel. The plant has a fired capacity of 110 MW and produces 37 MW of electricity and approx. 77 MW of district heat. The plant can thus supply around 35,000 homes with heat and 62,000 homes with electricity.

COWI was Owner’s Engineer for the total project.

OPERATION AND MAINTENANCE

Operation and maintenance support including plant upgrading and optimisation

COWI offers to assist our clients in all matters related to Operation and Maintenance including plant upgrading and optimisation.

EXAMPLE:

I/S VESTFORBRÆNDING (COPENHAGEN WEST MSW-FIRED HEAT AND POWER PLANT) – MAINTENANCE AND UPGRADING

I/S Vestforbrænding produces power and district heating to the Copenhagen Area using municipal solid waste (MSW) as fuel.

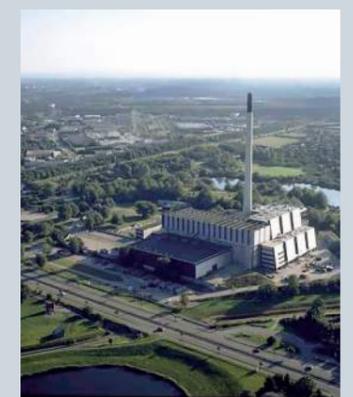
Nineteen local authorities own the plant that is the largest WtE plant in Denmark, treating approx. 600,000 tons annually.

Vestforbrænding has produced district heating using MSW since 1970, but was converted to heat and power generation with new plant equipment in 1998–2004. One of the four original furnace lines was removed while three were kept for special duties and as stand-by reserve.

In 2013 and 2014, COWI assisted Vestforbrænding as general consultant for scheduled maintenance and upgrading of the plant. This involved planning of the maintenance/ refurbishment work, specification and procurement under EU rules, evaluation and negotiation of the bids received, and preparation of the final contracts.

Unit 5 was installed in a new building in 1998. It was supplied by Babcock & Wilcox Vølund and has a fired capacity of 100 MW. Annual throughput is approx. 280,000 tons MSW. – Major work in the 2010–2013 refurbishment included new Inconel-panels in the second boiler wall pass, new transport systems for fly ash and bottom ash, partial replacement of the flue gas bag filter system, and new gas/gas heat exchanger.

Unit 6 was supplied in 2004 by FISIA Babcock Environment. It has a fired capacity of 114 MW and an annual throughput of approx. 320,000 tons MSW. – Major refurbishment/maintenance took place in 2014 and involved mainly replacement of 280 m² corroded boiler walls with new Inconel-panels.



**EXAMPLE:****FYNSVÆRKET (FYN HEAT & POWER STATION) – LIFESPAN EXTENSION AND EFFICIENCY IMPROVEMENT**

Since 1953, Fynsværket has been an important part of the electricity grid in West Denmark with effect 442 MW power and 650 MW heat for district heating. The two main boilers originally used coal, oil and/or gas for fuel, but today one uses straw as its fuel, whereas the coal-burning unit is in use only during the heating season.

In 1995, Fynsværket installed two waste-to-energy units, each 8 t/h. Four years later, an additional 16 t/h waste-to-energy unit increased the MSW-based effect to 26 MW power and 70 MW district heating.

In 2006, Fynsværket was privatised and bought by Vattenfall of Sweden.

In 2014, Vattenfall sold the plant to Fjernvarme Fyn – the Local Authority-owned utility that supplies district heating to a large part of the Funen Island.

COWI assisted Fjernvarme Fyn, first by analysing and evaluating the potential for upgrading the plant and extending its lifespan. Subsequently, COWI was responsible for implementing the agreed project by undertaking the design and procurement for the planned refurbishment.

The work included:

- › Replacing approx. 1000 m² boiler wall with new corrosion-resistant Inconel-welded wall panels
- › Water cooled wear zones at the grates
- › Flue gas condensation
- › Enhanced waste water treatment
- › Ash transport systems improved
- › Turbine/generator protection installed
- › Baghouse filters for the two oldest WtE units supplementing the existing ESP's

Achievements:

- › Lifespan of the plant extended beyond 2030
- › Annual waste treatment capacity increased from 270,000 to 290,000 tons (the two oldest lines each improved throughput from 8 t/h to 9 t/h)
- › Energy output increased from 26 MW power/70 MW heat to 22 MW power/108 MW district heating (district heating production is the main interest of Fjernvarme Fyn)
- › The plant is better suited to handle today's changed waste composition resulting from source separation and recycling
- › The plant is more competitive in a commercial waste treatment market

Careful planning enabled Fjernvarme Fyn to accomplish maintenance, refurbishment, and upgrading without disruption of daily service. The project was completed in October 2017.

1. SERVICES PERFORMED – DETAILS

1.1 BIOMASS AND WASTE TO ENERGY

From a background of conventional combined heat and power (CHP) stations, COWI has today developed skills, expertise and experience in energy from biomass and municipal solid waste.

COWI has developed comprehensive knowledge and experience within the engineering, procurement and construction management (EPCM) approach and is a leading European consultant within this field. Turnkey tendering is another speciality and we are used to tendering and contracting according to FIDIC.

We have recently been involved in biomass heat-only-boiler (HOB) projects in Helsingør (Elsinore)/Denmark (woodchips/heat capacity 5 MW); Ringsted/Denmark (straw/heat capacity 2 × 9 MW); Skanderborg/ Denmark (woodchips/heat capacity 2 × 10 MW); and Purmerend/Netherlands (wood chips/44 MW).

In addition, a number of other biomass projects are at the planning or implementing stage in Denmark and abroad.

Below a few examples of CHP plants are shown:

HELISINGØR BIOMASS FIRED CHP PLANT

The existing plant is a gas fired, combined cycle CHP plant. The hot gases from the gas turbine generates steam in a boiler to feed a steam turbine. The two turbines drive a common generator.

The new biomass plant is under construction in an adjacent building, but uses some of the equipment and controls in the existing plant. This includes the steam condensers that converts low-pressure steam from the back-end of the turbine to district heating water.

A hot water storage tank (energy accumulator) serves as a back-up for the district heating system.

The operating permit for the plant limits power output, so either the gas fired plant or the biomass plant may be in use at any time.

Helsingør Local Authority appointed COWI to be its overall consultant for the new project.

COWI is responsible for building and process plant design and construction, EIA (environmental impact assessment), permitting, technical specifications (civil, mechanical and electrical), procurement incl. negotiations with suppliers and contractors, construction management and supervision, testing and hand-over to the Client.

The new plant will start operation in 2018. Construction budget: €94 million

PLANT DATA

FUEL:
wood chips

FIRED CAPACITY:
63 MW

BOILER:
BFB Fluidized bed

STEAM DATA:
74.9 t/h; 65 bar/500 °C

OUTPUT:
16 MW power;
47 MW district heating

FLUE GAS CONDENSATION:
Condensation and reheating by use of heat pump increases heat output by approx. 15 MW

HEAT STORAGE TANK:
38 high/ 25 m diameter; 18,000 m³;
700 MWh heat capacity

AARHUS NORD WASTE-TO-ENERGY PLANT

In 1977, the City of Aarhus, Denmark's Second City commissioned the Aarhus Nord Waste-to-Energy (WtE) plant, for which COWI was the designer and overall consultant. COWI has subsequently been engaged in the WtE plant's expansion and upgrading from supplying district heating, only, to generating both electricity and heat in a CHP process (combined heat and power). During that time, the WtE plant's waste treatment capacity has also been expanded from 130,000 tons per annum (tpa) to 260,000 tpa with its latest expansion in 2004.

In 2013, the City of Aarhus following an open tender under EU rules appointed COWI as its general consultant for the new Lisbjerg Biomass Power Plant.

This straw fired CHP plant will generate approx. 37 MW power and 77 MW district heating for the City. For maximum fuel flexibility, the plant can use wood chips as an alternative fuel.

This plant is located adjacent to the existing WtE plant and the two plants share a common chimneystack.

The new Biomass Power plant started commercial operation in November 2017.

1.2 WASTE MANAGEMENT

COWI'S MUNICIPAL SOLID WASTE MANAGEMENT (SWM) ADVISORY SERVICES

COWI provides solutions for handling and disposal of municipal, hazardous, and other types of wastes. For more than 30 years, COWI has developed sustainable and cost-effective solutions and has carried out projects in more than 35 countries.

Our consulting and engineering services cover the whole range from organizational, institutional, legislative issues over economic and technical planning analyses to design, tendering, construction supervision and optimisation of facility operations. Environmental and climate considerations are an integral part of all projects, and we perform environmental and risk assessments for both individual facilities and regional schemes. Training and capacity building of the Client's personnel are important aspects in many projects.

COWI has over 100 key personnel permanently working with waste issues and waste-related projects. Large international projects may require multidisciplinary project groups, consisting of engineers, institutional experts, economists, chemists, biologists, sociologists, geologists, hydrogeologists, environmental lawyers and training experts. In this case, COWI can draw on up to 300 specialists worldwide.

In 2016, ENR (Engineering News Record) ranked COWI as number 1 among the world's Top International Design Firms in Solid Waste.

COWI's Solid Waste Management Unit is currently working on waste projects in Asia, the Caucasus, Africa and Europe, ranging from rehabilitation of a waste dump in Calcutta, India, over the development of hospital waste handling systems in Lesotho and Serbia, to the establishment of recycling solutions for the Saint Helena Island in the South Atlantic Ocean.

COWI's experience covers all aspects of waste management as described hereunder.

WASTE MANAGEMENT PLANNING

COWI's experience in waste management planning ranges from policy-making and institutional development to technical planning and design and financial evaluation of integrated solutions for the handling and disposal of waste. We adopt a strategic planning approach, where the waste strategy is based on a thorough analysis of the existing situation, identification of goals and targets, and evaluation of feasible development options and scenarios.

PRIVATE SECTOR PARTICIPATION (PSP)

During the last decade, the private sector has become increasingly involved in the delivery of waste services. COWI assists in identifying advantages and disadvantages and in establishing well-designed and transparent PSP schemes including Public-Private Partnerships (PPP). On several IFC transaction projects, we have been acting as the Technical Consultant. Furthermore, COWI has been involved in the establishment of Inter-municipal Solid Waste Management Companies in Denmark and in Bulgaria, Estonia and Lithuania. The assistance has included an analysis of the National legislative requirements governing the establishment of legal entities as well as the financing requirements.

FINANCING AND ECONOMIC INSTRUMENTS

Investment finance, financial viability, cost recovery and affordability are important aspects in all waste management strategies. COWI's experience in this field ranges from environmental financing strategies for the SWM sector, over detailed financial feasibility studies and willingness-to-pay studies to tariff policies. COWI has also been responsible for planning and implementation of economic instruments in the SWM sector and implementation of micro-enterprise based waste collection schemes in informal settlements.

WASTE COLLECTION, RECYCLING AND TREATMENT

COWI has taken part in developing the waste collection and treatment sector in a number of European countries. We have hands-on experience from all steps of the handling and disposal route gained via direct involvement in planning and design of full-scale solutions. We possess extensive experience in planning and establishing source separation schemes and in the establishment of civic amenity sites for disposal of recyclable waste and other waste fractions. Our expertise covers treatment technologies, such as biological treatment (composting, anaerobic digestion), thermal treatment (incineration with energy recovery), materials recovery facilities and recycling plants, construction and demolition waste.

WASTE TO ENERGY

The large amounts of combustible waste that cannot be recycled due to contamination, cost or handling problems can serve as fuel for thermal treatment facilities with energy utilisation. This offers great benefit in an environmentally sound way. COWI can assist in all aspects of the establishment of modern thermal treatment facilities. We provide all services from environmental and economic assessments through procurement to construction supervision and commissioning as well as project management.

LANDFILLING OF WASTE

During the last 30 years, COWI has been involved in numerous landfill facility projects and has gained extensive experience in the development of technologies and concepts for environmentally safe ("sanitary") landfills. Specific services include:

- › Planning and design of landfill facilities for different types of waste;
- › Environmental Impact Assessments;

- › Training of landfill staff;
- › Rehabilitation of old dump sites;
- › Establishment of landfill gas utilization schemes (JI/CDM).

HAZARDOUS WASTE

COWI has the experience needed to assist with all aspects of hazardous waste and health care waste (HCW) management. Our experience includes the devising of strategies and planning and implementing solutions. We perform all services ranging from assessments and surveys through procurement to construction supervision and management for collection, treatment, transport, storage and disposal.

TRAINING AND CAPACITY BUILDING

Provision of training and capacity building puts decision makers and practitioners in a better position to meet present SWM challenges. It is thus a cost-efficient way to propel the development in a sustainable direction. COWI training modules cover all relevant aspects of solid and hazardous waste management and we can combine basic course modules according to need. Through a number of projects, COWI has provided practical training of operational staff of waste management companies within landfill operation and maintenance, environmental monitoring, management reports etc.

1.3 FINANCIAL MANAGEMENT SUPPORT

COWI prepares bankable feasibility studies that assist public or private investors in developing a solid basis for decision-making on major investments. This comprises technical, financial, economic, and social and environmental studies and analyses, all comprised in a comprehensive bankable feasibility study.

MODELLING

A financial model can produce reliable financial ratios to illustrate the consequences of the project risks. A financial analysis provides and reviews the baseline scenario (current situation) and forecasts the future growth. This can serve as a basis for implementation of major investments and for other strategic decisions.

COWI has solid in-house expertise in developing financial models presenting income statement, balance sheet, cash flows and economic key figures, sensitivity analysis, risk assessment and financing plan. The results of the financial analysis in the bankable feasibility study provide a solid basis for decision-making for financial institutions in their project assessment. An economic analysis supplements the financial analysis.

COMBINING SKILLS

A multidisciplinary team with technical and financial expertise will perform the bankable feasibility study, tailored to meet the special requirements from investors and hosting governments.

The technical and financial assessments are essential parts of the decision process.

The technical assessment shall provide an analysis of the feasibility of the project, along with input data for the financial analysis in form of capital and operational expenditures.

The financial analysis follows the incremental method. The project is analysed based on the difference in costs and benefits between the baseline situation and the investment.

BANKABLE FEASIBILITY STUDY

The financial analysis covers several areas customised to the specific project. The financial model is always developed according to the same structure. The financial analysis may also include an affordability and creditworthiness analysis.

The product is a clear financial evaluation of the project, providing stakeholders and potential external investors with a decision basis for their involvement in the project.

STRUCTURED APPROACH

COWI uses a structured approach when carrying out feasibility studies. The specific financial model for a business case/project enables the Client to assess the consequences of new information on the project's sustainability etc. The model's overview of editable input data allows the Client to work with the model itself, reviewing consequences of different changes in input data.

WORLDWIDE ACTIVITIES

COWI is working for private companies, development banks (the World Bank, EBRD, EIB, Fad, ADB etc.), and bilateral donors (the European Union, DANIDA, NORAD, SIDA etc.). Our customers also include governments in Europe, Middle East, Asia and Africa.

1.4 SPECIALIST AREAS

ASSISTANCE IN DIAGNOSIS AND REMEDIATION OF OPERATIONAL PROBLEMS

Thermoflex/TURABS and Applied Tribology are two areas, where COWI specialists have unique skills to help Clients maximise their operation and maintenance efficiency.

Process optimisation

The TURABS programme is a COWI tool for online Performance Monitoring of the overall energy efficiency of a power and heat plant. The online continuous supervision of key instruments at the plant enables early process adjustments and this in turn can maximise the efficient use of the fuel. The resulting data from the TURABS online calculations may be used in cooperation with the Client as a basis for further process corrections with the purpose of further optimising plant performance and efficiency.

COWI assists three Danish Heat and Power plants with online Performance Monitoring and this has resulted in annual fuel savings of approx. € 3 million.

Chemistry and materials

COWI specialists in materials and chemistry have more than 30 years of experience in materials, water chemistry, and applied tribology (the science of friction, lubrication and wear). We have developed our knowledge in close collaboration with the power industry in Scandinavia, which has been our main client. Our in-depth knowledge comprises lubricants used in advanced gas and steam turbines, all kinds

of hydraulic oils used in power and process industries, and gear oils used in power plants and wind turbines.

An analysis of lubricants in mechanical component may warn about a bearing at risk of collapsing.

The testing of the general properties of transformer oils and using dissolved gas analysis will serve as a tool for monitoring the condition of transformers and other liquid-filled, high-voltage components.

Turbines/generators

Our background enables COWI to assess the conditions of boiler, turbine, steam pipes, heat exchangers and other ancillary equipment and plant. This may serve as the basis for a decision about refurbishing or replacement of an existing plant.

In the event of a sudden plant breakdown, we can carry out a root cause analysis to provide a basis for repair options and to minimise the risk of a recurrence.

COWI has the experience and competence to take the results of the oil analysis and translate them into tailor-made recommendations for how to optimize operation of your plant. The key point is here to use oil analysis as a tool for monitoring the condition of your advanced machinery.

1.5 COMBINED HEAT AND POWER

COWI assists with planning, designing, upgrading and rehabilitation of thermal power and heating plants for all kinds of fuels. We have focus on the environment, technique, operation and economy, using the best available technology.

Combined Heat and Power increases total energy recovery efficiency from around 40% to as much as 90%+ by enabling the use of the energy in the cooling water from a thermal electricity generating process. This applies not only to the well-known steam cycle process, where superheated steam from boiler drives a turbine/generator. It has also a use in diesel driven power production and for combined cycle plants using gas turbines in combination with steam turbines to generate electricity.

The energy recovered in the form of heat has a natural market in cold climates for district heating. Globally, it can be used for desalination of seawater or by absorption chillers use heat to produce cooling for air condition or cold stores.

COWI provides consultancy services in all project phases of the project cycle, i.e. feasibility studies, conceptual design, tendering and supervision.

1.6 DISTRICT HEATING AND COOLING

COWI is a leading international specialist for optimisation and rehabilitation of district heating and cooling systems.

COWI deals with all questions related to the planning and establishment of district heating and cooling systems. We design new systems and handle optimisation and extension of existing networks, and renewal and replacement of worn-out or outmoded pipeline systems.

Combined Heat and Power plants is a typical heat source for district heating systems and COWI's involvement in district heating goes back nearly one hundred years to the first diesel driven power plants that used the energy in the cooling water and in the engine exhaust to produce heat for the surrounding community. Today, large steam CHP plants supply cities and towns with both electricity and heat in many countries in the northern hemisphere. Other sources of 'free' heat are surplus heat from industrial production plants, which is available in several areas.

Finally, several district heating systems were developed around a central gas or oil fired boiler plant, simply because of better economy and less environmental impact.

In cold and temperate climates, district cooling from seawater can be used to cool a city's business district, sometimes supplemented by absorption chillers during peak demand.

COWI has calculation programs and proven expertise and experience for optimising both the design and the economic operation of district heating and cooling systems.

1.7 ENVIRONMENTAL ISSUES

EU regulations require environmental impact assessments before making decisions that may have a significant effect on the environment. An EIA (environmental impact assessment) is an analysis that looks into the consequences that projects may have on the present situation.

COWI has provided EIA consultancy services since the EU Directive mandating this became part of Danish law in the mid-1980s. In 2004, Denmark passed the Environmental Analysis Act, and COWI incorporated the new regulations into its consultancy. With staff specialising in environment, transport, law, communication and public hearing, COWI can offer consultancy throughout the entire environmental analysis process, either as a comprehensive or as a specialised service.

COWI emphasises a close collaboration between our environmental specialists, the Client, and the project designers during the EIA study. In this way, it is possible to adjust the design when potentially undesirable impacts are identified, thereby minimising the impacts and the need for mitigation measures. In accordance with international guidelines, we place emphasis on a participatory approach in carrying out EIAs. Contributions from stakeholders and the public are often mandatory and are likely to result in a smooth process favourable to all parties.

COWI carries out EIAs all over the world and for a multitude of project types, including major bridges, causeways, roads, railways, power plants, waste treatment plants, water irrigation and solid waste landfills.



2. REFERENCES

2.1 SELECTED BIOMASS PROJECTS

COWI has been involved in several Heat-only Boiler plants (HOB) and Combined Heat and Power plants (CHP) based on biomass in Denmark and abroad. COWI is the leading consultant within Energy from Biomass in Denmark.

The following names some relevant references and describes some spectacular projects in more detail.



PLANT DATA

FUELS:
Biomass (wheat straw, wood chips)

YEARLY CONSUMPTION:
~230,000 tons of straw

STORAGE CAPACITY:
3,168 straw bales equal to 67 hours consumption

THERMAL INPUT:
110 MW

STEAM DATA:
110 bar / 540 °C

ELECTRICAL EFFICIENCY:
~35%

GRATE TYPE:
Vibrating grate

FILTER TYPE:
Bag house with lime injection. SCR deNOx

PROJECT VALUE:
€ 120 million

STRAW FIRED CHP IN AARHUS/DENMARK

Denmark's Second City, Aarhus in 2013 entrusted COWI as its general consultant for its new Lisbjerg Biomass Power Plant. This straw fired CHP plant has a fired capacity of 110 MW and will generate approx. 37 MW power and 77 MW district heating for the City. For maximum fuel flexibility, the plant can use wood chips as an alternative fuel up to 50% of fuel input capacity.

Following a pre-conceptual design study, COWI prepared the application for environmental permit and completed the environmental impact assessment. COWI performed the final design and procurement in several large packages, each one under a separate turnkey contract. COWI used Friis & Moltke as architects for the building design. COWI also acted as Owner's Engineer during the construction and commissioning phase.

The process plant contractor went into bankruptcy during the construction phase, but on behalf of the City of Aarhus, COWI undertook to manage the completion of plant construction and testing. COWI achieved this within the budget and the agreed time schedule.

District heating for the City is the most important energy supply from the plant.

Flue gas condensation provides additional low temperature heat for district heating that heat pumps upgrade to the desired flow temperature.

This further improves the thermal efficiency of the plant.

Lisbjerg Biomass Power Plant started operation in 2017.

BIOMASS (STRAW-FIRED) COMBINED HEAT AND POWER PLANT IN KASUR, PAKISTAN

Locally grown biomass produces energy for Pakistan paper mill.

The packaging materials producer, Packages Ltd. in Lahore, Pakistan in 2011 asked COWI to explore alternative energy sources for its paper mill in Kasur in Punjab, Pakistan. The existing boiler plant generates process steam and electricity for the mill using natural gas and heavy fuel oil. The paper mill has an annual production of 300,000 tons of paper and cardboard, but production suffers from both escalating fuel costs and unreliable supplies.

NEW BIOMASS BOILER

COWI carried out a conceptual design and a 'bankable feasibility study', and the conclusion was to integrate a new biomass boiler plant with the existing facilities. This will provide a dependable energy source and cut operation costs, using locally grown biomass for fuel.

BIOMASS RESIDUES

COWI examined potential fuel sources for the biomass plant, based on a study of the feedstock in the region. With focus on availability, flexibility and environmental sustainability, the optimal solution is the use of surplus biomass residues from the local farmers. Biomass residues such as wheat straw, corn stover and cotton stalks are available in large quantities in the adjacent area and will form the basis of the feedstock.

COWI SERVICES

COWI's assessment of available residue fuels included the collection and transport from the fields as baled and loose biomass, and the subsequent storing and handling at the plant. COWI services also comprised the conceptual design of the complete plant, including systems for preparation of the biomass fuel and its feeding to the boiler. COWI next examined and calculated the integration between the new biomass boiler and the existing power plant, using the thermodynamic simulation tool Thermoflex. This resulted in the optimum design and size of the new boiler plant and its integration with the existing steam turbine and gas boilers.

Based on the conceptual design, COWI assessed several scenarios, prepared a 'bankable feasibility study' for external financing, followed by overall plant design, preparation of tender documents based on FIDIC, and procurement on a turnkey basis of a new biomass fired power plant.

The new power plant will notably reduce Packages operating costs. It will also contribute to the region's economic development because it will use locally grown biomass residues as its fuel. Finally, the new biomass fired power plant will significantly cut CO₂ emissions from the plant.

A turnkey contract was signed in 2013 with Chinese Runh Power Ltd, using combustion technology and process engineering from Babcock & Wilcox Vølund in Denmark. As Owner's Engineer, COWI supervised this phase on site in Pakistan and at fabrication locations in China.

The new plant started operation in 2016.



PLANT DATA

FUELS:
Biomass (wheat straw, cotton stalks, corn stover, other)

YEARLY CONSUMPTION:
~250,000 tons

THERMAL INPUT:
120-150MW

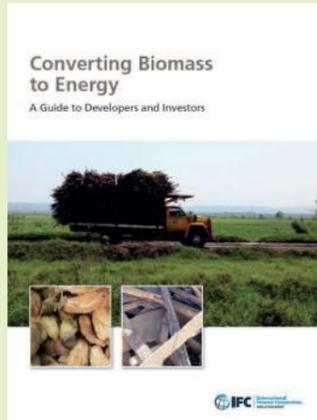
STEAM DATA:
95 bar / 525 °C

ELECTRICAL EFFICIENCY:
~33%

GRATE TYPE:
Vibrating grate

FILTER TYPE:
Bag house

PROJECT VALUE:
USD 60 million



CONVERTING BIOMASS TO ENERGY: A GUIDE TO DEVELOPERS AND INVESTORS

The International Finance Corporation (IFC) – a World Bank Company – in 2016 appointed COWI to create and produce an International Guide for the use of biomass as an energy source. In June 2017, IFC presented the 190-page Guide as a practical tool for developers and investors in biomass to energy projects. The guide can help them assess the technical and financial feasibility of the different Biomass to Energy options available to their businesses and industry.

The guide describes and discusses various sources and types of biomass and their use from a technical, financial, environmental, and regulatory aspect.

It introduces modern Biomass to Energy technologies generating electricity and steam/heat from combustion of solid, liquid, and gaseous biomass fuels in high-efficiency conversion systems. The guide also includes production of biogas through anaerobic digestion of organic matter, such as agricultural residues, animal wastes and food industry wastes.

The Guide furthermore describes:

- › Project development process
- › Securing the biomass supply
- › Plant design, permitting, procurement, construction, and commissioning
- › Operation and maintenance of biomass plants
- › Regulatory framework
- › Commercial aspects, typical investment and O&M costs, financial and economic analyses
- › Financing biomass projects
- › Environmental and social considerations
- › Lessons learned from biomass projects

The Guide book is free available for download at www.IFC.org.

STRAW FIRED CHP IN NIKOPOL/BULGARIA

COWI has assisted the Bulgarian company, Enemona in their plans to establish a straw fired combined heat and power plant in Nikopol on the banks of River Danube.

It is designed for a fuel input of 50 MW and will be able of co-firing other fuels such as wood chips up to 20%. The plant was designed for 33% electrical conversion efficiency.

COWI was acting as Client's Representative and as such prepared tender specification, evaluated proposals and assisted in drafting the contracts.

BIOMASS GASIFICATION PLANT IN SKIVE/DENMARK

COWI assisted Skive District Heating Company in the implementation of a 10 MW biomass gasification plant based on gasification of wood pellets. Included were also three gas engine installations and two peak load and stand-by boilers.

FYNSVÆRKET 8 – STRAW FIRED POWER STATION (FYV 8)

A Danish Act of 1993 formed the background for the biomass fired Unit 8 at the Fynsværket Electric Utility. The Act ruled that the Danish Power sector for fuel should use 1.2 million tonnes of straw and 200,000 tonnes of wood chips per year. 'Vattenfall' was established in Denmark in 2006 and inherited part of this commitment. As an early result, Fynsværket's Unit 8 (FYV8) started operation in 2009.

FYV8 is a self-contained unit, connected to, but able to operate independently of the common facilities at Fynsværket. The boiler is designed for burning biomass, such as straw and wood chips. Initially, FYV8 was equipped for straw burning only, but was in 2012 outfitted for wood chips handling. Today, FYV8 can trade between the different fuel types in the market.

Trucks deliver the straw to the plant in the form of large bales, so-called Heston bales. Each bale weighs approximately 550 kg and a truck can carry 24 bales with a total weight of approx. 13 tonnes.

The enclosed storage area has a 2,300 bales capacity, sufficient for meeting fuel demand when no straw is delivered between Saturday afternoon and Monday morning. The storage provides fully automatic off-loading of the trucks, using cranes to fill up the storage and supply straw when needed to the chain conveyors feeding the boiler.

The bales are shredded immediately, before a screw conveyor meters the straw into the boiler, where it is ignited and burns. The steam raised in the boiler flows into the turbine, which generates electricity and heat. The flue gas from the boiler releases its remaining heat in a series of heat exchangers, before a bag house filter collects the fly ash. Subsequent condensation of the flue gas ensures complete recovery of the thermal energy and absorbs some of the sulphur and hydrochloric acids produced during combustion. This reduces emissions from the stack.

As general consultant, COWI was in charge of the FYV8-project, beginning with the initial analysis that determined the design of the plant. COWI subsequently carried out detail design of piping systems including stress analyses, electrical systems, computer programs, and building structures. Next followed the preparation of specifications and tender documents, EU advertisement, prequalification of suppliers and contractors, contract negotiations and contract signing, construction supervision, start-up and commissioning. Finally, COWI reviewed all plant documentation before hand-over to the client. COWI was also responsible for all Authority liaison and documentation.

Shortly after the commissioning of FYV8, the Danish government introduced a substantial levy on NO_x-emissions and lowered the emission limit. Therefore, Vattenfall decided to install NO_x-emission control equipment and again appointed COWI as general consultant for the project. An analysis demonstrated that SCR technology offered the optimal solution on technical, environmental and economic grounds. The new deNO_x (SCR) plant started operation ultimo 2014.



PLANT DATA

FYV8 has an annual straw consumption of 170,000 tonnes or approx. 28.4 t/h, equal to a thermal input of 117.5 MW.

STEAM DATA:
110 bar / 540 °C

ELECTRICITY:
35.2 MW (net)

DISTRICT HEATING:
86.7 MW

FYV8 substitutes approx. 100,000 tonnes of coal and reduces CO₂ emission by approx. 245,000 tonnes per year.



BIOMASS POWER PLANT IN LINZ, AUSTRIA

Aalborg Energie Technik A/S was the turnkey supplier of a biomass power plant for Linz AG in Austria and selected COWI as its structural engineer for the plant expansion. This included design and construction of buildings for boiler, turbine and power plant.

The power plant has a boiler capacity of 31 MW and generates 7.5 MW electricity. The new facility was built in connection with "Linz-Mitte" – the existing heat and power plant.

The boiler building is a steel building with insulated steel panels and exterior corrugated steel sheet cladding. The main floor plan is 350 m² and the plant reaches a height of 26 metres.

The turbine and power building is an insulated pre-cast concrete building with exterior corrugated steel sheets cladding. The main floor plan is 220 m² and the building is 12 metres high.

COWI used 3-D design for the technical construction drawings for the boiler building. These integrated structural calculations and steel drawings and included 3-D images of the boiler, equipment and mechanical and electrical pipes. 3-D design has optimised coordination between the process plant and the buildings, thus eliminating spatial conflicts in the design phase.

COWI was responsible for engineering services and technical construction drawings for all steel and concrete structures, including boiler, turbine, and power buildings.

COWI services also included liaison and negotiations with the local authorities.

Project completed: 2007



Woodchip fired Combined Heat and Power plant in Assens/Denmark

WOODCHIP FIRED COMBINED HEAT AND POWER PLANT IN ASSENS/DENMARK

COWI was involved in the planning of the woodchip fired CHP plant in Assens. The plant produces steam at 525 °C and 77 bar. Maximum electrical output is approx. 5 MW and a maximum heat output of 14 MW with flue gas condensation in operation. Assens District Heating Company uses logs imported from the Baltic countries, which are chipped when arriving at the facility.

RISKULLA CHP, MÖLNDAL, SWEDEN

Möln dal Energi AB constructed a biomass fired Combined Heat and Power plant with an electricity production of 23 MW and a heat production of 90 MW at Riskulla in Möln dal. COWI assisted with design of civil construction, electrical and DCS and coordination of civil, electrical and mechanical works, hereunder a 3D model for the entire facility.

2.2 SELECTED WASTE-TO-ENERGY PROJECTS

COWI has been involved in a substantial number of Waste-to-Energy projects in Denmark and abroad. COWI is one of the leading consultants within Waste-to-Energy in Denmark and Scandinavia.

The following names some relevant references and describes some spectacular projects in more detail.

167 MW RDF AND BIOMASS CFB PLANT FOR MÄLARENERGI AB, VÄSTERÅS/SWEDEN

Since 1963, the 'MälärEnergi' Utility has supplied the Västerås region of Sweden, some 100 km west of Stockholm, with district heating, district cooling and electricity. – Heating is the most important product with power generation as a lucrative side business.

The 40 years old boiler units 1, 2 and 3 were decommissioned and a new Unit 6 has replaced them. Better fuel flexibility and better power generation were important factors in the choice of technology.

MälärEnergi AB in 2010 appointed COWI as its project manager for the new Unit 6 project.

Residential and commercial solid waste, pre-treated as RDF, is the main fuel for the unit, but supplemented by biomass when needed. A CFB boiler (circulating fluidised bed) uses approximately 400,000 tonnes of MSW (municipal solid waste) annually as fuel and recovers approximately 135 MW energy as 75 bar/470°C high pressure steam. The steam drives a 48 MW turbine/ generator, with extraction of low pressure steam to produce 100 MW hot water district heating via a heat exchanger. Flue gas condensation with heat pumps provides an additional 30 MW district heating.

The CFB boiler is the world's largest circulating fluidised bed boiler for municipal solid waste.

COWI was the overall consultant for the project with responsibility for project management and detailed design and procurement of buildings, boiler, turbine/ generator, and flue gas cleaning process plant. COWI also headed MälärEnergi's logistics project for fuel transport, preparation and storage. Finally, COWI carried out 3D integration between buildings and process plant.

The new plant started operation in 2015.



FORUS WASTE-TO-ENERGY, STAVANGER/NORWAY

COWI in 2009 signed a contract with Forus Energigjenvinning for total consultancy for the establishment of a new 9 tons per hour incineration line, which is erected parallel to the existing line at 6 tonnes per hour from 2002. The new line is a combined heat and power line. COWI was responsible for design, tendering and contracting of electrical and mechanical equipment. COWI was furthermore responsible for the follow up of the turnkey contractor during the construction period. Following commission, take-over of the new line was in November 2012.



Forus Waste-to-Energy, Stavanger/Norway

BIR WASTE-TO-ENERGY, BERGEN/NORWAY

Establishment of a new WtE line with electricity and district heat production. The updated plant capacity is 15 tons per hour, generating approx. 9.2 MW of electricity and 30 MW of heat. COWI, represented by both COWI Denmark and COWI Norway, was consultant for the owner BIR AS in the entire process. The new line was commissioned in 2010. COWI was responsible for all process-related planning, turnkey tendering, contracting and monitoring. COWI was also heavily involved in the commissioning of the plant with a WtE expert stationed in Bergen for 1 year. In March 2012, the plant successfully passed the warranty period.



BIR Waste-to-Energy, Bergen/Norway



PLANT DATA

- › Grate type incinerator/boiler
- › Semi-dry flue gas cleaning
- › Cooling of turbine/generator condensate to River Liffey, but with take-off for a hot water district heating system

PLANT THROUGHPUT:
is limited to 600,000 t/a by EPA Waste Licence

RATED CAPACITY:
2 x 32 t/hr. at 11.5 MJ/kg

NOMINAL CAPACITY:
2 x 35 t/hr. at 10.5 MJ/kg LHV equal to 550,000 t/a

POWER EFFECT:
58.5 MW (net) when in electricity-only mode

INITIAL DISTRICT HEATING OUTPUT:
55 MW at 950C, but prepared for a future expansion to 110 MW

ENVIRONMENTAL IMPACT:
limited as prescribed by Irish EPA (air emission contracted at 10% below EU Directive 2010/75)

CAPITAL COST:
approx. €460 million

DUBLIN WASTE-TO-ENERGY PROJECT/IRELAND PROCURED UNDER A PUBLIC-PRIVATE-PARTNERSHIP (PPP) AGREEMENT

Combined Heat and Power (CHP) plant using municipal solid waste (MSW) for fuel.

In 2001 the City of Dublin, following an open tender appointed the Joint Venture of COWI, Denmark and RPS, Ireland as 'Client's Representative' for the Dublin Region's Waste-to Energy Project.

The tasks for the Client's Representative were to explore and manage the development of a PPP project for a waste-to-energy plant for the Dublin Region. This included the entire process from Expression of Interest through to Financial Close, evaluating alternative technologies, contractors, operating, and financing companies. Client's Representative should also undertake procurement, hereunder negotiation and contract agreement with the preferred service provider, and was responsible for the administration of the Project Agreement.

An important task was the development of a strategy for the involvement of the Public.

In November 2003, Dublin issued an 'Invitation to Negotiate' to four pre-qualified bidders, and received two compliant bids in April 2004. Parallel clarifications and negotiations with the two bidders proceeded during 2004, and in April 2005, the City of Dublin signed an Agreement in Principle (Memorandum of Understanding) with Elsam of Denmark (a major power utility company).

In 2005-06 Elsam was acquired by DONG Energy (Danish Oil and Natural Gas – a state owned company) and with the approval of City of Dublin, Covanta Energy (a US waste-to-energy operator) joined DONG Energy as a partner in the project. In September 2007, the City of Dublin signed a contract with the Covanta-DONG consortium.

The statutory process was initiated in 2006, and following Oral Hearings, Planning permission was granted in November 2007 and an EPA Waste Licence issued in December 2008.

Worldwide fiscal constraints, political and public opposition, including complaints to EU by opposing waste handling and waste treatment companies, postponed the progress of the project. The Client's Representative has assisted City of Dublin in its justification against these complaints.

On 7th May 2014, EU rejected the last of these complaints and in September 2014 Covanta closed its financing agreements with its banks and financing partners and executed a restated Project Agreement with Dublin City, following which plant construction commenced.

The plant started operation in mid-2017.

BAKU WASTE-TO-ENERGY / AZERBAIJAN

Establishment of a Waste-to-Energy plant in the capital Baku. The plant will be the first of its kind in Azerbaijan and will have a capacity of 500,000 tonnes of waste per year. COWI has assisted in the procurement of turnkey service, tender evaluation and turnkey contracting according to FIDIC, in cooperation with other international consultancies.

UDDEVALLA WASTE-TO-ENERGY/SWEDEN

Establishment of a new WtE plant in Lillesjö in Uddevalla. The plant can annually incinerate 100,000 tons of waste to produce both electricity and heat. COWI assisted with complete civil, architectural, geotechnical, electrical and hydraulic engineering. Additionally, COWI has coordinated 3D model for all lots, including the process plant (boiler, flue gas cleaning and steam turbine).

RENOVA AB, WASTE-TO-ENERGY, GÖTEBORG/SWEDEN

Expansion of the existing WtE plant in Sävenås with a fourth line of 14 tonnes of waste per hour. Simultaneously with the establishment of the new line, the three existing flue gas treatment lines were upgraded. COWI was responsible for the complete design from initial sketches to the delivery of all building structures for the new incineration line and upgrading of the flue gas cleaning.

AARHUS WASTE-TO-ENERGY/DENMARK

The City of Aarhus appointed COWI as Owner's Engineer for the new Waste-to-Energy line 4, in consortium with Friis & Moltke Architects.

As general consultant, COWI conducted the complete engineering from planning, design, authority approvals, procurement, and follow up, to commissioning and hand over. The main equipment was procured in lots (boiler, turbine and PAC) and in close co-operation with Friis & Moltke Architects COWI performed detailed design of the civil constructions.

The plant has a waste capacity of 16 ton/hour and generates 10 MW electricity and 30 MW district heat.

L90 WASTE-TO-ENERGY, ESBJERG/DENMARK

"Leverandørsammenslutningen af 1990" (L90) appointed COWI as Owner's Engineer for the entire planning and design of the green field Waste-to-Energy plant in Esbjerg. L90 is a partnership between a group of municipalities in the western part of Denmark.

As general consultant, COWI conducted the complete engineering from planning, design, Authority approvals, procurement, construction supervision, follow up, to commissioning and hand over. The main equipment was procured in lots (boiler, turbine and PAC) and COWI performed detailed design of the civil constructions in close co-operation with Friis & Moltke Architects.

The plant has a capacity of 24 ton/hour equivalent to 180.000-200.000 tons of MSW per year, dependent on the heating value. The plant generates approx. 18 MW of electricity and 55 MW district heat.



Aarhus Waste-to-Energy/Denmark



L90 Waste-to-Energy, Esbjerg/Denmark



3. PROJECT EXECUTION METHODOLOGY AND EXPERIENCE

3.1 TURNKEY APPROACH

A number of countries around the world favour the turnkey contract including civil constructions or just a mechanical/electrical turnkey package. COWI has experience in both, but have procured most of our projects as turnkey, but divided into a mechanical/electrical and a civil contract. In some projects, the mechanical/electrical is further divided into two packages, e.g. having the major process equipment (the boiler part) in one package, with the other packages covering balance of plant equipment.

COWI e.g. used the mechanical/electrical turnkey approach for projects in Lahore, Pakistan, Bergen, Norway and Stavanger, Norway.

3.2 SPLIT PACKAGE APPROACH

COWI and our key personnel are very experienced using the “Scandinavian model”, tendering the facility in a number of precisely defined lots. This is as an alternative to our experience in a full turnkey or mechanical/electrical turnkey approach.

Using the “Scandinavian model”, COWI together with the Client defines a number of appropriate lots, as far as possible tailored to the potential suppliers’ core competence area. A quite normal approach for a new Biomass Heat and Power facility would be to divide the scope into the following packages:

- › Furnace/boiler including auxiliaries such as steam pipes, bottom ash handling etc.
- › Turbine/generator including condensate system, DH condensing system, lube oil system, turbine control etc.
- › Air pollution control equipment including ducts, ID fan, stack, flue gas condensation etc.

In addition to these major and most important process packages, a number of smaller packages such as fuel transport system may be purchased separately.

Electrical equipment including DCS/SCADA is often incorporated in the three major packages, but can also be split into separate lots. If DCS were incorporated, the overall DCS would be included in the boiler lot.

This approach offers a unique flexibility in terms of getting the best equipment available in the market. On the other hand, it requires a strong and experienced consultant, able to control the supply interfaces and administer the overall coordination in terms of time, quality and costs.

COWI is normally the general consultant and responsible for the overall design of the facility and the development of all important process data and design criteria. We will manage the supply limits, and together with the main suppliers develop the supply limit list during the final contract negotiation. This list will serve as the firm and detailed agreement with all suppliers with respect to location, design data, etc. for all supply limits. During the contract negotiations, we develop a time schedule based on COWI’s overall project time schedule, in order to have the suppliers agree on the same construction and commissioning milestones. The supply limit list and time schedule are incorporated in all contracts. This approach limits the associated risks substantially.

We have a number of references using the split package approach, such as the L90 Waste-to-Energy in Esbjerg, Denmark.

The most suitable approach – turnkey or split package - will depend on the Client’s needs and specific interests. The split package approach enables the Client to go into more detail of the specific technical solution, but it also carries a risk as regards coordination and dependencies.

COWI has experience in both approaches and has in-depth knowledge of all technologies and suppliers. COWI has gained the experience from our handling of several contracts and has thus the knowledge to identify and focus on the potential areas of conflict.

COWI further offers detailed design in a wide range of areas within electrical/DCS, civil constructions, district heating and piping design. Using the “Scandinavian model”, we often include detailed design for the civil construction and procure the civil part in small lots, such as steel structure, concrete structure, roof and wall panels, etc.

3.3 PPP CONTRACT

Some Local Authorities may prefer to outsource their waste management or waste-to-energy project.

A Public-Private-Partnership (PPP) contract is a proven model for this and COWI has the experience to assist the Local Authority with the development and contract for the project.

- Local Authorities and Governments already use the PPP-model for many other purposes – the design/ construction/ maintenance of a school or institution; the design/ construction/ maintenance/ operation of a bridge, road or railway; etc.
- › COWI will assist the Client with the evaluation of the legal, economic, and technical conditions for a PPP-project. This will determine the optimum procurement route for the project.
 - › COWI will explore and recommend reputable service providers with the necessary financial strength, proven technology, and documented operation capability for a long-term contract. COWI will thus manage the entire procurement process from Expression of Interest to Financial Close.
 - › COWI will develop comprehensive 'Invitation to Negotiate' documents, including prequalification criteria and final tender evaluation criteria, hereunder evaluate alternative technologies. COWI will evaluate the received bids, nominate the preferred Bidder, and assist the Client in the negotiations with the preferred Bidder.
 - › If applicable, assist the Client with site selection and with the development of a strategy for involvement of the Public.
 - › On behalf of the Client, COWI will review and certify the PPP Company's detailed design and ensure that this is in accordance with the contract.
 - › On behalf of the Client, COWI will follow the PPP Company's plant construction and testing.
 - › Assist the Client with the Administration of Project Agreement

3.4 TENDER SPECIFICATION AND CONDITIONS

COWI normally structures the tender specifications in "Particular Conditions" and a number of "Technical Conditions" describing demands on equipment, documentation, commissioning etc.

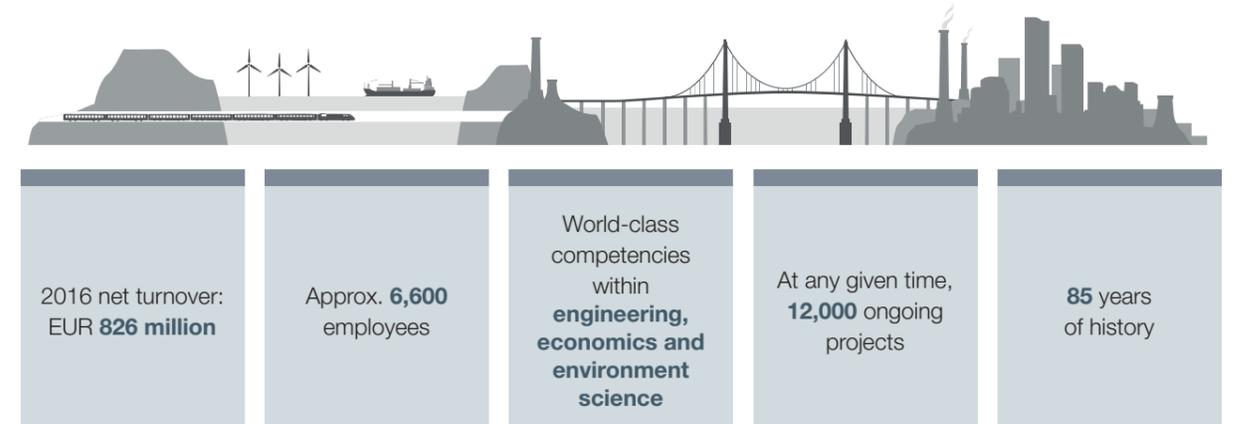
We are used to working according to FIDIC on projects abroad.



4. COWI GROUP – CORPORATE DETAILS

COWI A/S is a private limited company registered under the laws of the Kingdom of Denmark. COWI A/S is wholly owned by COWI Holding A/S, whose majority shareholder is COWIfonden (the COWI Foundation), an independent commercial foundation, the purpose of which is to support research and development. COWI employees own the remaining shares, thus securing the financial independence of the company.

COWI A/S is registered in the Central Business Register of Denmark under the number 44 62 35 28.



For the past 85 years, COWI has carried out more than 85,000 projects in over 124 countries, mainly in Europe, Asia, the Middle East, Africa and the Americas. The company is currently engaged in some 12,000 projects within a wide range of disciplines.

COWI A/S is the parent company of the COWI Group.

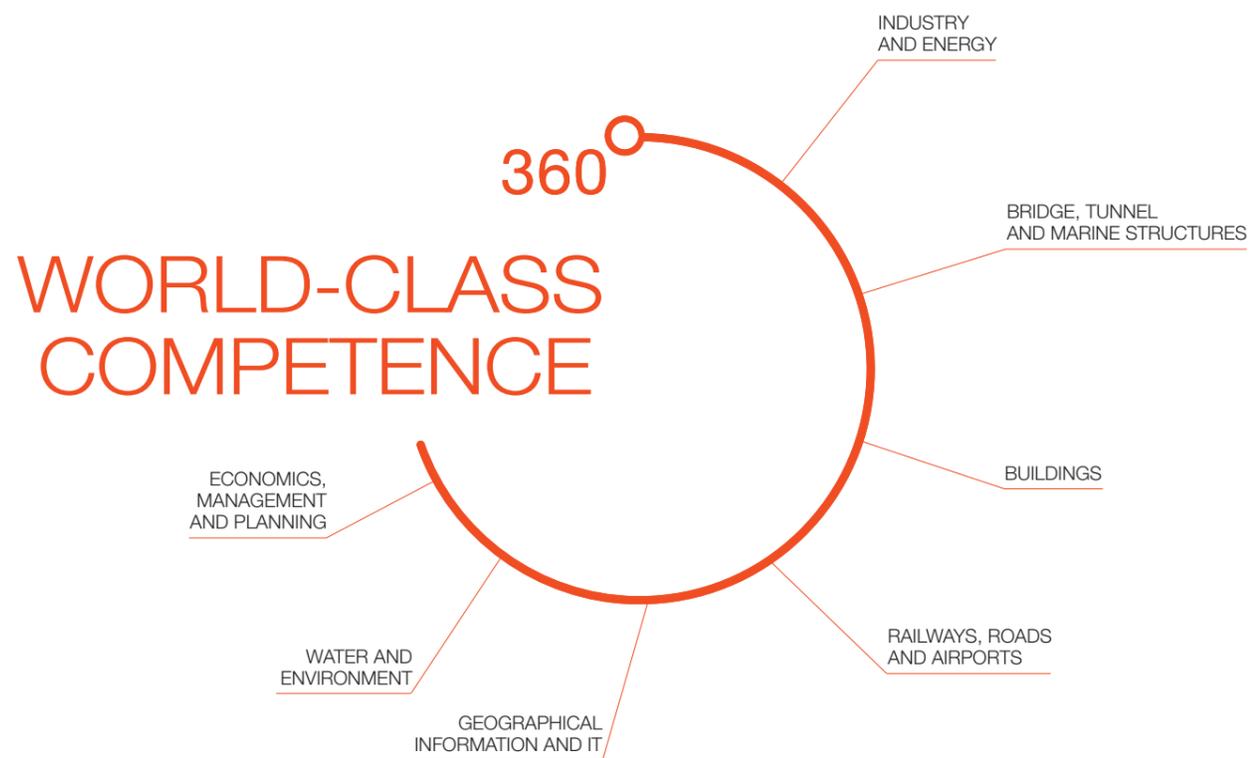
With a turnover in 2017 of approximately EUR 400 million COWI A/S maintains its position as one of the leading consulting companies in Northern Europe. In the same period, the COWI Group turnover was approx. EUR 826 million.

In COWI, we concentrate on the added value that our consultancy gives to our customers and society in general. Health, safety, social conditions and the environment are natural elements of our consultancy all over the world.

4.1 SERVICES

The basis of the COWI Group strategy is the provision of a combination of multidisciplinary services to local markets and specialist services to the global market.

COWI's core business lies within the three service lines ranging from the classic art of engineering through environmental science to modern social and economic analyses.



ENR RANKING 2016 (ENGINEERING NEWS RECORD)

World-class knowledge secures top ENR rankings:



4.2 EMPLOYEES

The COWI Group has approximately 6,600 employees. Seven out of ten employees are academic professionals, holding PhD, Master or Bachelor degrees in engineering, economics, environmental science, urban planning, mapping, agronomy, biology, chemistry, geology, hydrology, social and political science, etc.

More than half of the employees are experienced project managers while every fifth employee has been responsible for international projects.

Furthermore, COWI maintains a well-developed network of contacts with national and international organisations, consultants, research and development institutes and databanks, thus facilitating easy access to an additional resource base, information and expertise.

The directors and leading professionals of COWI are all members of the Danish Society of Consulting Engineers (FRI), affiliated to the International Federation of Consulting Engineers (FIDIC).

4.3 LANGUAGES

As an international consultant with multinational staffing, COWI carries out projects in all major languages.

4.4 FACILITIES

In COWI, we have at our disposal up-to-date computer hardware and software including powerful CAD, BIM and GIS facilities. The basic software platform has a high degree of standardization, and COWI uses a wide range of specialized software for solving specific engineering problems.

Other technical facilities include data acquisition equipment for structural monitoring, laboratories for geotechnical and environmental investigations including equipment for soil and water sampling, noise measurements, water quality analyses, and biological tests.

COWI pays special attention to IT security and reliable protection of the company's IT environment as a means to securing the confidentiality of customer data.

4.5 PROJECT SITES

Well-functioning lines of communication are fundamental for the success of our projects. This calls for a well-defined organization with unequivocal roles and responsibilities and for continuous dialogue between the project parties.

COWI offers to make use of our project sites, which may function as the hub for communication and sharing of project information between COWI and other project parties.

COWI project sites are integrated web-based sites accessible from any Internet computer. Advanced security measures including password protection provide data safety and limits access to only project parties invited to participate.

Created in Microsoft's SharePoint technology, COWI project sites meet the international standards of portal solutions and thereby offer all users a globally recognized and future-oriented user interface and terminology.

4.6 INDEPENDENCE

COWI retains absolute independence from contractors, manufacturers and suppliers and is not associated with any interests, which may interfere with its work as consultant.

4.7 SUSTAINABILITY

To COWI, sustainability is more than a sound business area. It also represents our focus on innovation and creating projects that are inspiring, aesthetically pleasing, safe and socially and financially responsible.

4.8 BUSINESS INTEGRITY

Credibility and integrity have always been the backbone of COWI's values and any action that might call this in question is unacceptable.

In order to make our business integrity clear we have formulated a Business Integrity Management Programme for the entire COWI Group. The programme is laid down in a Code of Conduct that outlines COWI's basic values for conducting our business, and in a Corporate Practice in Business Integrity that contains the business integrity policy of the company.

The COWI Group Business Integrity Policy is formulated as follows:

- COWI wishes to maintain its impartiality and independence and contribute globally to a fair conduct of business, avoiding extraneous influence on selection, execution or compensation procedures.
- We will not in our services or in any other activity, directly or indirectly, accept bribery, extortion, fraud, collusion or any other undue business activity.

The Business Integrity Management programme meets the guidelines issued by ICC (International Chamber of Commerce) and FIDIC (International Federation of Consulting Engineers).

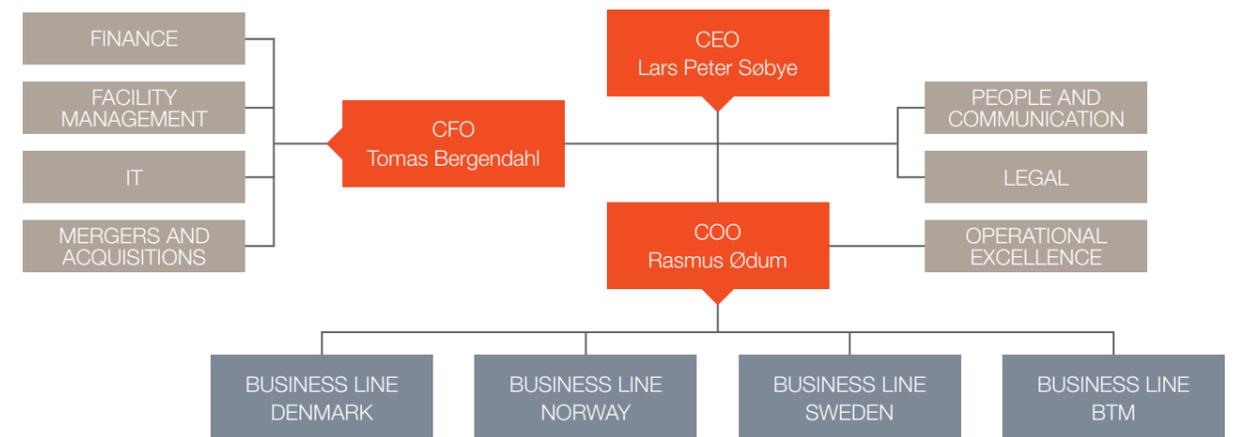
4.9 COMPANY ORGANISATION

The COWI Group is organised in four business lines: Denmark, Norway, Sweden and the international Bridge, Tunnel and Marine Structures (BTM).

In addition to our four regional business lines and the international BTM, COWI also consists of COWI CMC (emerging markets in China, Middle East, Central and Eastern Europe). COWI Africa is organised under COWI Denmark.

A regional vice president, who refers to the Group's Executive Board, manage each of COWI's three regional business lines – Denmark, Sweden and Norway. The Group's Executive Board consists of a president/CEO and two executive vice presidents (COO and CFO). At the top of the organisation is the Board of Directors with nine members. In addition to the three regional business lines, COWI also covers the international business line BTM (Bridge, Tunnel and Marine Structures).

These business networks operate as a One Company Network across geographies and cultures to the benefit of our customers, employees and services provided. This ensures that all business units can draw on the entire Group's vast international expertise while working in close dialogue with the local/regional/global customers.



4.10 GEOGRAPHICAL COVERAGE OF THE COWI GROUP

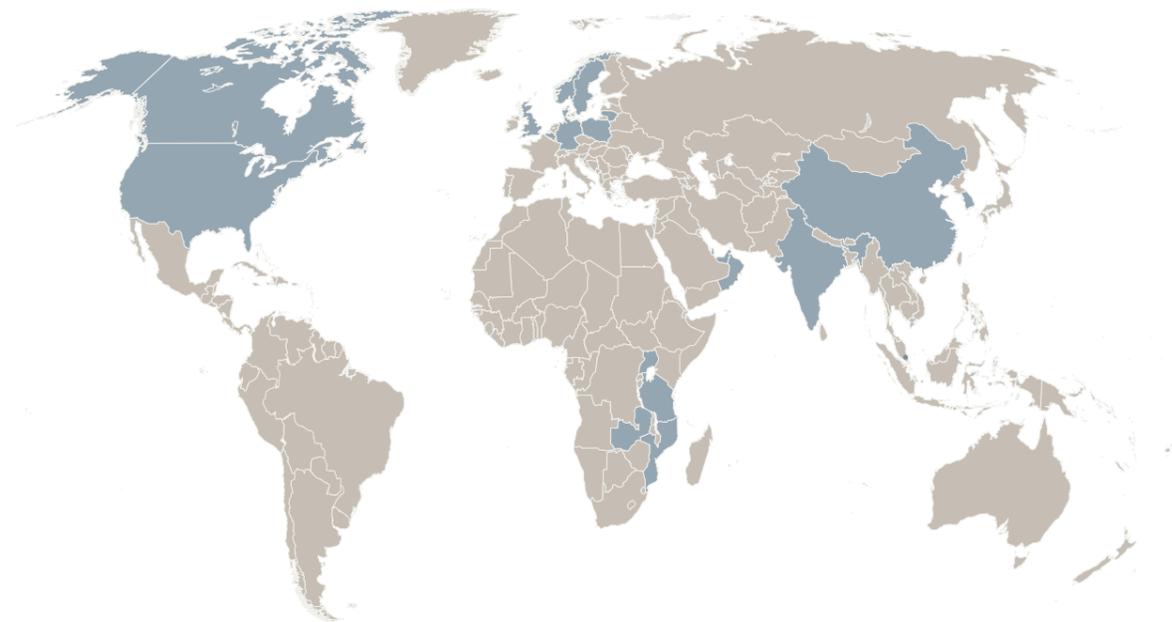
The head office of the COWI Group is in Kongens Lyngby, north of Copenhagen, Denmark and COWI maintains 77 branch offices and affiliated offices in Asia, Europe, the Middle East, Africa and the Americas.

Project offices in a large number of countries supplement the permanent offices. These offices are established, staffed and operated in accordance with the requirements of the individual projects.

COWI Denmark numbers 2,607 consultants, who carry out projects internationally, nationally, regionally and locally. In addition to COWI's head office in Kongens Lyngby; we have offices across Denmark, allowing us to be close to the projects that we carry out in the local community.

Region Denmark is organised in six business units: Planning and Economics; Water and Environment; Mapping; Railways, Metros, Roads and Airports; Buildings; and Industry and Energy (including Bioenergy and Thermal Power).

The business units are independent units with strong links to the other disciplines across the organisation. The business units plan and implement Interdisciplinary Projects through an integrated approach that encompasses not only the traditional engineering services, but also environmental science, economy, sociology, institution building, training, and transfer of technology.



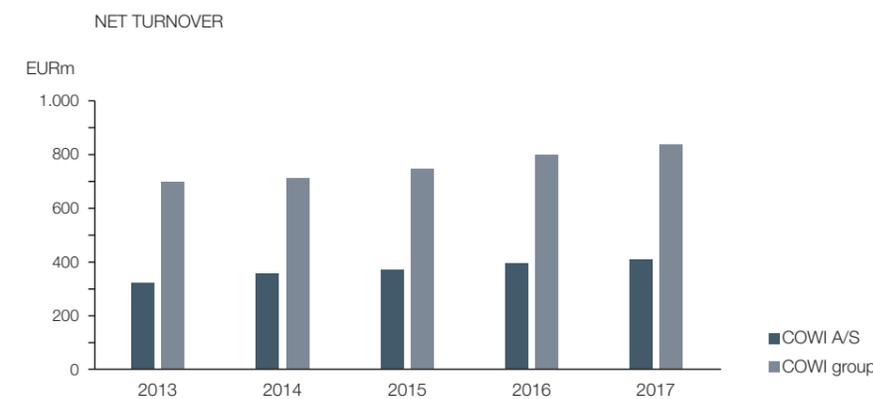
CANADA 3 offices	BELGIUM 1 office	POLAND 2 offices	SINGAPORE 1 office	TANZANIA 1 office	OMAN 1 office
USA 6 offices	DENMARK 9 offices	LITHUANIA 1 office	SOUTH KOREA 1 office	UGANDA 1 office	QATAR 1 office
SWEDEN 15 offices	GERMANY 1 office	HONG KONG 1 office	CHINA 1 office	ZAMBIA 1 office	UAE 2 offices
UNITED KINGDOM 6 offices	NORWAY 17 offices	INDIA 3 offices	MOZAMBIQUE 1 office	BAHRAIN 1 office	



4.11 FINANCIAL POSITION

The figures below offer an overview of key figures from the last five financial years for COWI A/S and the COWI Group, respectively. COWI's financial year follows the calendar year. The annual result is approved at COWI's annual general meeting.

	2013 EURm		2014 EURm		2015 EURm		2016 EURm		2017 EURm	
NET TURNOVER	324.9	707.8	356.0	713.8	368.7	747.4	392.5	798.8	409.0	826.3
PROFIT AFTER TAX	14.3	18.8	19.5	23.3	21.4	17.6	22.8	21.8	22.7	19.3
BALANCE	300.0	402.1	293.5	422.5	293.8	402.9	316.0	448.0	315.4	464.3
EQUITY EXCL. MINORITY INTERESTS	83.6	109.1	73.2	120.7	94.0	135.7	97.5	153.0	90.6	164.1
EQUITY/SOLVENCY RATIO	27.9%	27.1%	25.0%	28.6%	32.0%	33.7%	31.0%	34.1%	28.7%	35.4%
OPERATING MARGIN	3.7%	4.0%	5.0%	4.2%	6.0%	3.3%	7.1%	3.9%	7.5%	4.0%
LIQUIDITY RATIO (CURRENT RATIO)	0.92	1.35	0.93	1.17	1.38	1.28	1.29	1.29	1.30	1.30





4.12 QUALITY MANAGEMENT

COWI has a strong tradition for good quality management, and COWI's quality director refers directly to the Executive Board.

COWI's key resource is its employees. COWI creates quality through its committed and motivated employees, who understand the customer's expectations and needs for consultancy. COWI's impartiality and our employees' ability to enter into interdisciplinary cooperation contribute to creating quality.

COWI A/S has a fully implemented ISO 9001:2008 quality management system, certified by DNV.

COWI has defined the responsibilities, duties and rights for all its managerial employees. A special quality organisation ensures that the system is developed and maintained. This includes an annual assessment of the system's usability and effectiveness within each business unit and by the company's management.

Quality management takes place in all project phases, based on the quality plan prepared for each project.

COWI's ISO 9001:2008 Certificate is presented in 4.15.

4.13 LEGAL OFFICIAL CERTIFICATE

COWI A/S is registered in the Central Business Register of Denmark under the number 44 62 35 28. We present a certificate of conformity in 0.

4.14 LEGAL DOCUMENTS

OFFICIAL CERTIFICATE

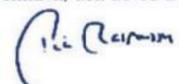
for
COWI A/S

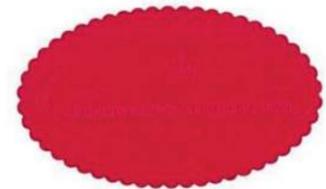
CVR-nr:44623528, Parallevej 2, 2800 Kgs.Lyngby, Danmark (DK)

In our capacity as the competent authorities pursuant to directive 2014/24/EU of the European parliament and of the council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC, Erhvervsstyrelsen (the Danish Business Authority), Skifteretten (The Bankruptcy Court), Politi (the Danish National Police), ATP (the Danish Labour Market Supplementary Pension Fund) and SKAT (the Danish Customs and Tax Administration) do hereby declare, certify and attest as follows regarding COWI A/S pursuant to the above-mentioned Council Directives 2014/24/EC:

	that the business has been registered in accordance with Danish legislation and has the status of being in normal operation mode ("normal") or "active" in the Central Business Register (CVR).
	that the business has not been declared bankrupt, is under restructuring or liquidation as a result of prior compulsory dissolution before this court.
	that the business and/or one or more members of/representatives of the business' board of directors, executive board or supervisory board have not been convicted by final judgment or accepted a fixed-penalty notice in respect of one or more offences falling within the scope of section 135(1) of the Danish Public Procurement Act pursuant to Danish legislation. In addition, a solemn declaration, see section 153(2) of the Danish Public Procurement Act, has been issued to the effect that within the last four years the business and/or one or more members of/representatives of the business' board of directors, executive board or supervisory board have not been convicted by final judgment or accepted a fixed-penalty notice in respect of one or more offences falling within the scope of section 135(1) that are not comprised by the criminal record certificate for public use, see section 22(1), para. 1 of the Executive Order on the Processing of Personal Data in the Central Criminal Register, (Ministry of Justice Executive Order no. 881 of 4 July 2014, as subsequently amended).
	that the business has complied with its obligations with respect to payment of social security contributions pursuant to Danish legislation.
	that the business has complied with its obligations with respect to payment of taxes and duties pursuant to Danish legislation.

København, den 25-08-2017


 Pia Rasmussen

4.15 ISO CERTIFICATES



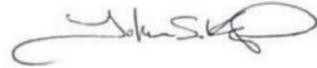
Certificate of Insurance

To whom it may concern

This is to certify that following insurance cover has been arranged to the insured named herein, subject to the insuring agreements, exclusions, conditions and declarations contained therein and during its effective period, coverage as described below.

Carrier:	AIG Europe (UK) Ltd.
Coverage:	Professional Indemnity Insurance
Policy Holder:	COWI Holding A/S
Insured:	COWI A/S
Activities insured:	Consulting Engineering Services
Limits of liability:	DKK 25,000,000 any one claim costs inclusive
Policy number:	34028142
Geographical area:	World Wide excl. USA/Canada
Policy period:	April 1 st 2017 to March 31 st 2018
Certificate holder:	TO WHOM IT MAY CONCERN
Date issued:	November 16 th 2017
Issued by:	Marsh A/S Teknikerbyen 1 2830 Virum

This certificate is issued as a matter of information only and confers no rights upon the certificate holder. This certificate does not amend, extend or alter the coverage afforded by the policy.



Signature

Mia Munk
Client Support

Marsh A/S
Teknikerbyen 1 | DK-2830 Virum
T +45 45 95 95 95
D +45 45 95 95 14
mia.munk@marsh.com
www.marsh.com (global website)

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MANAGEMENT SYSTEM CERTIFICATE

Certificate No: 05660-2000-AQ-DEN-DANAK	Initial certification date: 19, September, 2000	Valid: 24, January, 2017 - 15, September, 2018
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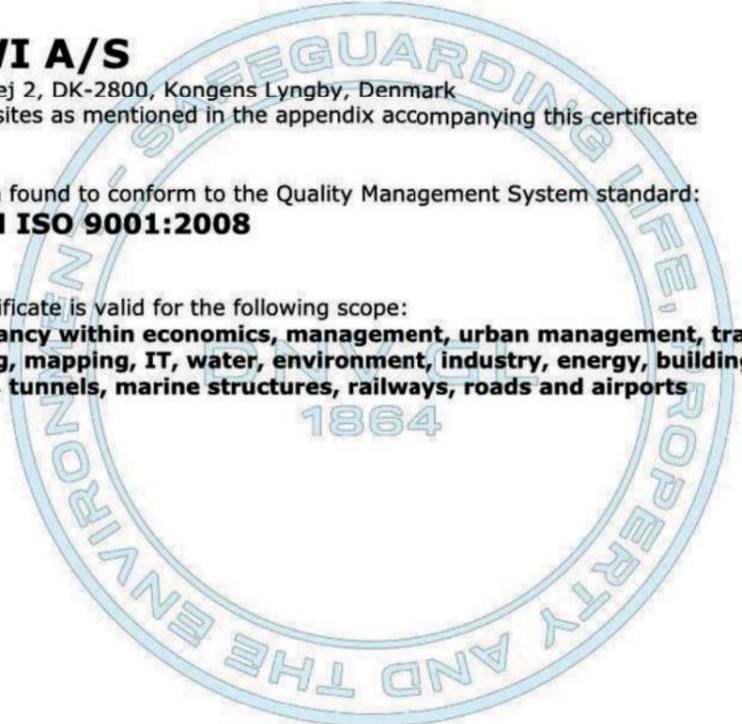
This is to certify that the management system of

COWI A/S

Parallevej 2, DK-2800, Kongens Lyngby, Denmark
and the sites as mentioned in the appendix accompanying this certificate

has been found to conform to the Quality Management System standard:
DS/EN ISO 9001:2008

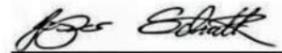
This certificate is valid for the following scope:
Consultancy within economics, management, urban management, transport planning, mapping, IT, water, environment, industry, energy, buildings, bridges, tunnels, marine structures, railways, roads and airports



Place and date:
Hellerup, 19, January, 2017



For the issuing office:
**DNV GL - Business Assurance
Tuborg Parkvej 8, 2., DK-2900, Hellerup,
Denmark**



Jesper Schultz
Management Representative

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.
ACCREDITED UNIT: DNV GL Business Assurance Denmark A/S, Tuborg Parkvej 8, DK-2900 Hellerup, Denmark. TEL: +45 39 45 48 00.
<http://assurance.dnvgl.com>

DNV·GL

Certificate No: 05660-2000-AQ-DEN-DANAK
Place and date: Hellerup, 19, January, 2017

Appendix to Certificate

COWI A/S

Locations included in the certification are as follows:

Site Name	Site Address	Site Scope
Buckland & Taylor International Inc.	276 5th Avenue, Suite 1006, New York, New York, 10001, USA	Consultancy within bridges, tunnels and marine structures
COWI (Aalborg)	Visionsvej 53, DK-9000, Aalborg, Denmark	Economics. Management. Urban management. Transport planning. Mapping. IT. Water. Environment. Energy. Buildings. Bridges. Marine structures. Roads.
COWI (Aarhus)	Jens Chr. Skous Vej 9, DK-8000, Århus, Denmark	Economics. Management. Urban management. Transport planning. IT. Water. Environment. Industry. Energy. Buildings. Bridges. Tunnels. Marine structures. Railways. Roads. Airports.
COWI (Esbjerg)	Stormgade 2, DK-6700, Esbjerg, Denmark	Environment. Buildings. Bridges. Roads.
COWI (Holstebro)	Nupark 51, DK-7500, Holstebro, Denmark	Water. Environment. Roads.
COWI (Lyngby) HQ	Parallelvej 2, DK-2800, Kongens Lyngby, Denmark	Consultancy within economics, management, urban management, transport planning, mapping, IT, water, environment, industry, energy, buildings, bridges, tunnels, marine structures, railways, roads and airports
COWI (Odense)	Vestre Stationsvej 7, DK-5000, Odense, Denmark	Mapping. IT. Water. Environment. Industry. Energy. Buildings. Bridges. Railways. Roads.
COWI (Ringsted)	Nørretorv 14, DK-4100, Ringsted, Denmark	Urban management. Water. Environment. Bridges. Railways. Roads. Airports.
COWI (Roskilde)	Lufthavnsvej 48, DK-4000, Roskilde, Denmark	Mapping
COWI (Silkeborg)	Vejlsøvej 51, Bygning O, 1. sal, DK-8600, Silkeborg, Denmark	Consultancy within economics, management, urban management, transport planning, mapping, IT, water, environment, industry, energy, buildings, bridges, tunnels, marine structures, railways, roads and airports
COWI (Vejle)	Havneparken 1, DK-7100, Vejle, Denmark	Urban management. Transport planning. IT. Water. Environment. Industry. Energy. Buildings. Bridges. Railways. Roads.
COWI (Viborg)	Asmildklostervej 11, DK-8800, Viborg, Denmark	Water. Environment. Buildings.

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.
ACCREDITED UNIT: DNV GL Business Assurance Denmark A/S, Tuborg Parkvej 8, DK-2900 Hellerup, Denmark. TEL: +45 39 45 48 00.
<http://assurance.dnvgl.com>

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Certificate No: 05660-2000-AQ-DEN-DANAK
Place and date: Hellerup, 19, January, 2017

COWI A/S (COWI Middle East)	P.C. 112, Fl. 2 - Bait Mahmiyat Al Qurum, Way 2601 Qurum, OM, Muscat, Oman	Consultancy within economics, management, urban management, transport planning, mapping, IT, water, environment, industry, energy, buildings, bridges, tunnels, marine structures, railways, roads and airports
COWI A/S (COWI Middle East)	PO.Box 23800, Al Mana Tower 8th & 9th fl, Suhaim Bin Hamad St, C-Ring Road, Doha, QT, Qatar	Consultancy within economics, management, urban management, transport planning, mapping, IT, water, environment, industry, energy, buildings, bridges, tunnels, marine structures, railways, roads and airports
COWI Gulf A/S	P.O. Box 5486, Offsice No. 82, 8th fl. - Al Zamil Tower, Block 305, Manama, BH, Bahrain	Consultancy within economics, management, urban management, transport planning, mapping, IT, water, environment, industry, energy, buildings, bridges, tunnels, marine structures, railways, roads and airports
COWI Gulf A/S	P.O.Box 52978, Reemas Bldg, Office MF-10, Land No.592, Al Quoz-1, UA, Dubai, United Arab Emirates	Consultancy within economics, management, urban management, transport planning, mapping, IT, water, environment, industry, energy, buildings, bridges, tunnels, marine structures, railways, roads and airports
COWI Gulf A/S	P.O.Box 130078, Ground Floor, Store No. 181, Mina Store Area, UA, Abu Dhabi, United Arab Emirates	Consultancy within economics, management, urban management, transport planning, mapping, IT, water, environment, industry, energy, buildings, bridges, tunnels, marine structures, railways, roads and airports
COWI Mozambique Lda.	Ave. Zedequias Manganhela 95, 1st floor, P.O.Box 2242, MZ, Maputo, Mozambique	Consultancy within economics, management, urban management, transport planning, mapping, water, environment, industry, energy, buildings, bridges, marine structures, railways, roads and airports
COWI NA Inc.	1191 2nd Avenue, Suite 1110, Seattle, Washington, 98101, USA	Consultancy within bridges, tunnels and marine structures
COWI NA Inc.	1300 Clay Street, 7th Floor, Oakland, California, 94612, USA	Consultancy within bridges, tunnels and marine structures
COWI NA Inc.	35 Corporate Drive, Suite 1200, Trumbull, Connecticut, 06611, USA	Consultancy within bridges, tunnels and marine structures
COWI NA Inc.	2 Edison Place, Springfield, New Jersey, 07081, USA	Consultancy within bridges, tunnels and marine structures

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.
ACCREDITED UNIT: DNV GL Business Assurance Denmark A/S, Tuborg Parkvej 8, DK-2900 Hellerup, Denmark. TEL: +45 39 45 48 00.
<http://assurance.dnvgl.com>

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4.16 FINANCIAL KEY FIGURES

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Key figures and financial ratios for COWI A/S
Hoved- og nøgletal for COWI A/S

	2012		2013		2014		2015		2016	
	EURm	DKKm	EURm	DKKm	EURm	DKKm	EURm	DKKm	EURm	DKKm
Exchange rate DKK/EUR, 31 December		746.04		746.03		744.36		746.25		743.44
PROFIT & LOSS:										
RESULTATOPGØRELSE:										
Net turnover	349.6	2,672.9	324.9	2,424.1	356.0	2,649.7	369.7	2,751.6	392.5	2,918.2
Net income	249.8	1,862.6	256.7	1,914.8	273.7	2,037.5	279.4	2,085.1	293.9	2,185.1
Own production	277.3	2,069.0	236.8	1,768.8	249.3	1,855.7	249.2	1,859.5	255.2	1,897.1
Salary and other operating expenses	(27.5)	(205.3)	19.8	147.9	24.4	181.8	30.2	225.6	38.7	288.0
Operating profit before amortisation, depreciation and impairment losses	9.0	67.0	7.7	57.4	8.3	61.9	8.0	60.0	11.0	81.5
Amortisation, depreciation and impairment losses on fixed assets	(96.5)	(725.3)	12.1	96.5	16.1	119.9	22.2	165.6	27.7	206.5
Operating profit	(87.5)	(658.3)	(9.4)	(38.1)	(7.8)	(58.0)	(14.2)	(105.6)	(16.7)	(124.5)
Profit before tax	(30.9)	(230.4)	15.8	116.1	23.2	172.7	28.2	210.8	31.2	231.8
Profit on ordinary activities after tax in subsidiaries and associates	4.0	29.7	2.7	19.8	3.1	23.4	1.6	11.7	1.1	8.0
Goodwill and group goodwill amortisation	1.9	14.5	1.3	10.0	1.9	14.4	2.0	15.1	2.7	20.3
Net financials	1.7	12.3	1.0	7.8	3.9	29.4	4.5	33.5	2.3	17.3
Profit on ordinary activities after tax	(23.0)	(171.7)	14.3	107.0	19.5	145.2	21.4	159.4	22.8	169.2
FINANCIAL RATIOS:										
Operating margin (EBIT margin)	-10.4%		3.7%		4.5%		6.0%		7.1%	
Equity ratio	27.9%		27.9%		25.0%		32.0%		31.0%	
ASSETS:										
AKTIVER:										
Group goodwill	7.9									
Other fixed assets	159.0		134.6		117.7		63.8		81.3	
Cash and cash equivalents	62.4		55.8		68.3		46.7		49.6	
Other current assets	120.1		109.6		107.4		183.2		185.1	
Total current assets	182.6		165.4		175.8		229.9		234.7	
Total assets	349.4		300.0		293.5		293.8		316.0	
LIABILITIES AND EQUITY:										
PASSIVER:										
Equity excl. minority interests	97.6		83.6		73.2		94.0		97.5	
Provisions	41.0		32.5		31.3		32.9		36.9	
Long-term debt	25.1		4.6		0.3		0.3		0.1	
Short-term debt (current liabilities)	185.8		179.3		188.7		166.6		181.5	
Total liabilities and shareholders' funds	349.4		300.0		293.5		293.8		316.0	
NUMBER OF EMPLOYEES										
ANTAL ANSATTE										
Average number of employees	2,545		2,461		2,474		2,545		2,607	
Number of employees at 31 December	2,487		2,435		2,512		2,578		2,636	

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Management's Report

The listed COWI A/S figures are derived from the audited Annual Reports of COWI A/S for the year ended 31 December 2016, and the last four previous years. In my opinion the summarised COWI A/S figures are consistent in all material respect with the Annual Reports of COWI A/S from which they were derived. The complete Annual Report of COWI A/S can be obtained at the company address, Parallelvej 2, DK-2800 Lyngby or e-mail: heon@cowi.dk.

Kgs. Lyngby, 31 March 2017
COWI A/S



Rasmus Ødum
President, CEO



Independent Auditor's Report on Summary Financial Statements

To the Board of Directors of COWI A/S

Opinion

In our opinion, the accompanying Summary Financial Statements, which have been extracted from the audited financial statements of COWI A/S for the financial years 2012, 2013, 2014, 2015 and 2016, are, in all material respects, consistent with the audited financial statements of COWI A/S.

The Summary Financial Statements comprise the summary balance sheet at 31 December 2012, 2013, 2014, 2015 and 2016 as well as the summary income statement for the financial years 2012, 2013, 2014, 2015 and 2016 and related notes.

The Summary Financial Statements

The Summary Financial Statements do not contain all the disclosures required under the Danish Financial Statements Act applied in the preparation of the audited financial statements of COWI A/S. Therefore, the Summary Financial Statements and our auditor's report thereon cannot be read as a substitute for the audited financial statements and auditor's reports thereon.

The Summary Financial Statements and the audited financial statements do not reflect the effects of events that occurred subsequent to the dates of our reports on the audited financial statements.

The audited financial statements and our report thereon

We have expressed unmodified opinions in our reports dated 27 February 2013, 27 February 2014, 27 February 2015, 26 February 2016 and 27 February 2017, respectively, on the audited financial statements.

Management's responsibility for the Summary Financial Statements

Management is responsible for the preparation of the Summary Financial Statements of COWI A/S.

Auditor's responsibility

Our responsibility is to express an opinion on whether the Summary Financial Statements are, in all material respects, consistent with the audited financial statements based on our procedures, which were conducted in accordance with International Standard on Auditing (ISA) 810 (Revised), Engagements to Report on Summary Financial Statements.

Copenhagen, 31 March 2017

PricewaterhouseCoopers

Statsautoriseret Revisionspartnerselskab

CVR No 33 77 12 31


Hans Jørgen Andersen

State Authorised Public Accountant



ADDRESS COWI A/S
Parallevej 2
DK-2800 Kongens
Lyngby
Denmark

PHONE +45 56 40 00 00

FAX +45 56 40 99 99

EMAIL cowi@cowi.com

WWW cowi.com