BUILDINGS & DESIGN
INFRASTRUCTURE & TRANSPORT
ENERGY & CLIMATE
ENVIRONMENT & NATURE
INDUSTRY & OIL/GAS
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MEETING TODAY'S CHALLENGES WITH TOMORROW IN MIND

ENERGY & CLIMATE

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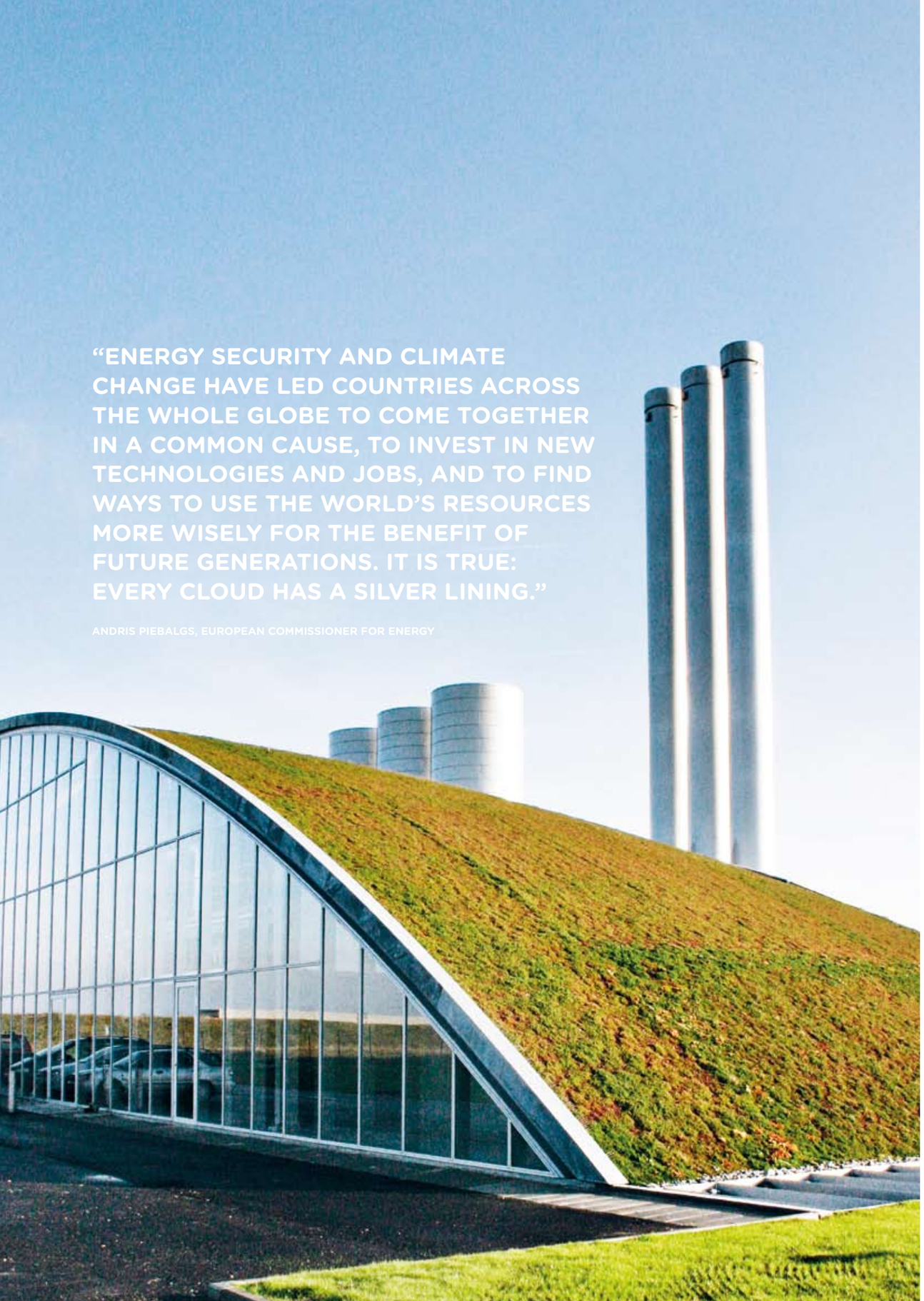


“ENERGY SECURITY AND CLIMATE CHANGE HAVE LED COUNTRIES ACROSS THE WHOLE GLOBE TO COME TOGETHER IN A COMMON CAUSE, TO INVEST IN NEW TECHNOLOGIES AND JOBS, AND TO FIND WAYS TO USE THE WORLD’S RESOURCES MORE WISELY FOR THE BENEFIT OF FUTURE GENERATIONS. IT IS TRUE: EVERY CLOUD HAS A SILVER LINING.”

ANDRIS PIEBALGS, EUROPEAN COMMISSIONER FOR ENERGY

WHAT WE CAN DO FOR YOU

As the skilful management of energy becomes an ever more pressing global priority, our full-range services enable our customers to plan and implement strategies and systems that are far sighted, cost conscious and practical. Energy and climate projects are at the heart of the Ramboll tradition – creating sustainable societies and minimising reliance on fossil fuels.

In addition to energy and climate strategies and planning at business, local, regional and national level, our services also encompass energy production facilities as well as systems designed to transmit energy to consumers.

Our consulting services cover the entire project cycle:

- Project management;
- Concept development and feasibility studies;
- Technical and financial analyses;
- Environmental impact assessments;
- Project definition;
- Authority liaison;
- Conceptual and detailed design;
- Tendering and procurement;
- Construction management and supervision;
- Testing and commissioning;
- Follow-up on operation and maintenance.

Ramboll is a major international engineering and design consultancy founded in Denmark in 1945 by two young Danish engineers, B.J. Rambøll and J.G. Hannemann. Today, we employ close to 9,000 experts and have a significant presence in northern Europe, India, Russia and the Middle East. With more than 180 offices in 24 countries, we emphasise local expertise combined with a global knowledge base. Our multidisciplinary activities range from sustainable energy to structural engineering.

Energy sources	Conversion technologies	Energy carriers	End users
Waste	Combined Heat and Power	District heating transmission	Heating installations
Biomass	Compressor heat pumps	District heating distribution	Cooling installations
Wind	Absorption heat pumps	Thermal storage	Thermal capacity
Solar	Large-scale solar	District cooling	Passive solar
Geothermal	Waste-to-energy	Cooling storage	Industrial processes
Oil	Biomass boilers	Electricity grid	
Natural gas	Flue gas condensation	Biogas grid	
Coal	Offshore wind farms		
	Solar cells		

ENERGY AND CLIMATE STRATEGY AND PLANNING

Like many other countries Romania faces numerous institutional and sociological barriers to improving the efficiency of the energy sector. Ramboll assisted the Ministry of Finance in developing a financial incentives mechanism for energy efficiency in Romania.

The making of a strategy and plan for the production and use of energy is the starting point for efficient energy management at all levels – from company to local authority and government.

At company level, we work in close cooperation with our customers to assess and reduce their energy consumption and carbon emissions. We help them optimise their energy mix and increase their energy efficiency. We also carry out due diligence studies of energy facilities evaluating potential liability costs as part of mergers and acquisitions.

We work with a range of private companies and local authorities on the development of climate action plans to reduce greenhouse gases and prepare for climate change. We do this by analysing present emissions and developing scenarios.

At national level, we assist governments and energy sector regulators in developing energy and climate action plans, strategies and policies. We assist them in the implementation of policies, for example by providing recommendations for the development of specific regulations. Our activities also include energy sector analysis and energy efficiency strategies in which we consider the technical, institutional, financial and social aspects of improving energy production, transmission, distribution and use.

Ramboll provided support to energy market integration and sustainable energy in Azerbaijan (photo), Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

The second largest city in Denmark, Aarhus, has analysed three scenarios to determine the most attractive renewable energy mix, both economically and environmentally. A key objective is to be able to maintain security of supply, reduce CO_2 emissions and integrate more renewable energy into the energy production of the city.

Tremendous efforts are being made around the world to reduce our carbon footprint. The "Heat Plan Denmark" study concludes that the Danish heating sector can become practically CO_2 neutral by 2030. This can be achieved by supplementing district heating based on combined heat and power and renewable energy with investments on the demand side to improve the performance of building envelopes and heating installations.

CO_2 neutrality is also the aim of Copenhagen. The Danish capital enjoys special conditions making this aim feasible: district heating is an integral part of the urban energy infrastructure, the city's layout favours public transportation, short distances encourage cycling, and houses have low energy consumption thanks to a long tradition of energy efficiency initiatives.

The Mayor of London has set a target to supply no less than 25 per cent of London's energy from decentralised sources by 2025. Ramboll has been commissioned with the detailed mapping of heat demands and supplies in six London Boroughs, supporting them in identifying the best opportunities for developing decentralised energy schemes.

DISTRICT HEATING AND COOLING

District heating is one of the most flexible ways of distributing thermal energy.

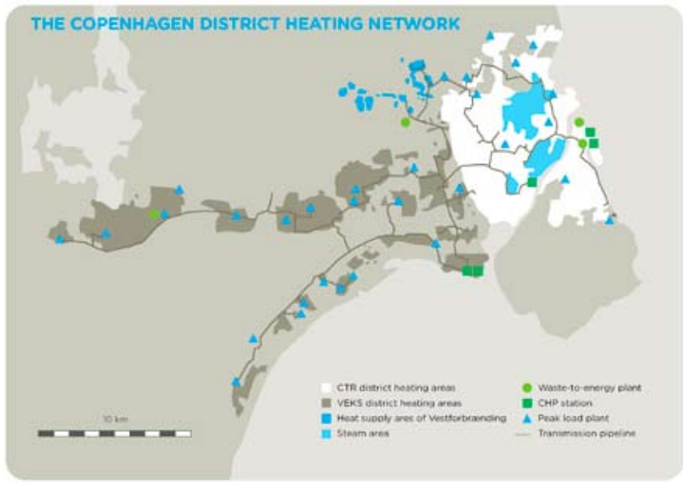
To transport energy instead of fuel has always had obvious advantages. Over the last century we have seen electricity become the most common energy carrier in the world. Although electrical power has many advantages, its generation has inherent inefficiencies.

In comparison, district heating makes it possible to use energy that would otherwise be wasted. The thermal energy can be stored in heat accumulators for days and even months in large seasonal stores, and it can be transmitted over long distances. Thermal energy often constitutes 50 per cent of the energy demand in a community, and district heating makes it possible to utilise a wide range of heat sources.

The flexibility provided by a district heating network allows it to be combined with large power stations, boiler plants using a variety of fuels, waste-to-energy, industrial heat recovery and a range of renewable energy sources such as solar thermal, biomass and geothermal. In fact, district heating and cooling is a precondition for efficient large-scale implementation of Combined Heat and Power (CHP) and renewable energy sources, including wind, where output fluctuates. Therefore, district heating and cooling is likely to be a natural part of the infrastructure in any modern sustainable city.

It is essential that the design, construction and operation of district heating systems should be founded on professional knowledge and experience. Ramboll has an unparalleled history of working internationally with city-wide and small-scale district heating systems.

Ramboll has carried out several studies for the Korean District Heating Engineering Company, including an analysis of a new district heating transmission line between two power stations.



The Copenhagen district heating network is one of the largest and most sophisticated in the world, supplying heat to a city with a population of more than one million people. The network extends over 50 km from east to west and covers a heated floor area of 50 million square metres, corresponding to 425,000 households. Ramboll has carried out a large number of projects on the Copenhagen district heating network, including planning, transient hydraulic analysis, detailed design, supervision and commissioning of new transmission mains, boiler plants, heat exchanger stations and other installations.

ENERGY PRODUCTION

Energy efficiency, cost effectiveness and environmental sustainability are key issues to be addressed when designing, building and upgrading energy production facilities.

Ramboll has experience of a wide range of production facilities, from small-scale plants for single-family houses to large-scale plants for city-wide district heating.

We offer our customers all the services necessary for establishing the most efficient production of heating and cooling, e.g. optimised CHP plants in combination with heat pumps, flue gas condensation facilities, heat only boilers and heat accumulators as well as district heating systems – from planning, design and procurement to implementation.

We have vast experience with district heating transmission systems, low-temperature district heating systems and building installations. Combined with our work with biomass and other renewable energy sources, this helps us maximise the environmental, social and economic benefits for both investors and customers.

Due to our long-term experience in energy planning and strategies we can give independent advice on the optimal solutions for energy facilities. Many production facilities are more cost-effective and environmentally friendly on a large scale. Ramboll's services include city-wide heating and cooling infrastructure, which enables us to optimise integrated production and thermal storage facilities.

Ramboll was the Client's Engineer in connection with the planning, organisation and follow-up on the design, procurement and construction of a new GE-frame 6-based 57 MW power/56 MW heat natural gas-fired combined cycle power plant in Viborg, Denmark. The introduction of the CHP plant necessitated a complete reorganisation of the district heating system in Viborg.

For Stadtwerke Lübeck, Germany, Ramboll carried out the planning and design of a completely new district heating system, which has subsequently been further developed. The system consists of two oil and gas fuelled peak load boiler plants.

Akershus, Norway, is establishing a wood chip fuelled boiler plant, bio oil fuelled peak load boilers and a landfill gas fuelled boiler with a capacity of 2 x 8 MW heat, 3 x 13 MW heat and 1.5 MW heat, respectively.

Sysav's CHP producing waste-to-energy facility in Malmö, Sweden, is one of the largest of its kind in Northern Europe. The facility has the capacity to produce 1.6 TWh heat and 0.3 TWh power from 650,000 tonnes of waste annually. Flue gas condensation has been installed in the plant, increasing the energy efficiency by 10 per cent.

ENERGY FROM WASTE AND BIOMASS

Europe does not have many dedicated sewage sludge incinerators. This one is located in Avedøre on the outskirts of Copenhagen and is based on fluidized bed technology. Ramboll was the lead consultant for the project, responsible for the planning, tendering, procurement, installation and commissioning of the plant. Ramboll is also the Client's Engineer in connection with the procurement of another sewage sludge incinerator in Copenhagen owned by Lynettefællesskabet I/S.

Waste and biomass are used for the production of a significant and increasing part of the energy consumed in modern society.

A waste-to-energy facility may generate a range of outputs: electricity, district heating, steam for industrial purposes, desalinated seawater or even district cooling. In this way, residual waste that cannot be recycled in an economic or environmentally beneficial way becomes a valuable local source of energy. Additionally, in most configurations, waste-to-energy facilities outperform alternative waste treatment processes in terms of their carbon footprint and other impacts on the environment.

Biomass is a renewable energy source and an energy solution that is innovative, cost-efficient and carbon neutral. A large variety of biomass may be used including liquid and solid agricultural biomass, wood chips, wastewater treatment residuals, energy crops, industrial biomass and even algae. Biomass facilities produce biogas, heat and electricity in an environmentally sustainable manner.

It is a multidisciplinary engineering exercise to successfully plan, design, procure, implement, commission and operate waste-to-energy and biomass facilities. Ramboll combines all the expertise required to do this.

Over the years we have been consultants to more than 70 new waste-to-energy units and retrofits of existing waste-to-energy facilities in 28 countries around the world.

We are presently involved in 35 waste-to-energy projects in different phases and are planning and procuring 10 Scandinavian biomass facilities. Many more are in the pipeline and are expected to emerge as projects to be implemented in the near future.

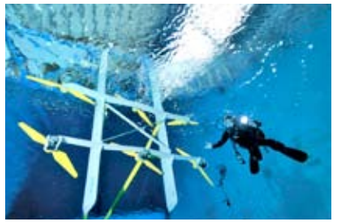
It is our knowledge and experience of how to best plan, procure and manage the implementation of waste-to-energy and biomass projects, in combination with our technical knowledge of mechanical and electrical equipment that is our unique set of capabilities.

The largest biogas facility in the world, Maabjerg BioEnergy, will be located in Holstebro, Denmark. Degasified and separated liquid manure from pigs and other biomass resources will be produced and utilized in an adjacent biomass facility. This will increase the production of CO_2 neutral heat and power by approx. 50 per cent. The plant is expected to produce approximately 20 million m^3 of biogas annually.

Ramboll was the Client's Representative at the waste-to-energy facility in the Isle of Man and is now assisting the Isle of Man government during its 25-year operation contract with the operator.

In Fusine, northeast of Milan, Italy, a new biomass power plant is installed at a cement factory. The plant has been designed to treat 55,000 tonnes of wood chips annually.

ENERGY FROM OTHER RENEWABLES



The UK has by far the best tidal current resource in Europe, estimated at between 18 and 60 TWh or 5 to 16 per cent of UK electricity demand. Ramboll is working with TidalStream to develop a range of turbines harvesting energy from tidal currents.

Like biomass; wind, geothermal heat, sunlight and tides are all renewable energy sources. Some of the technologies that can convert these sources to exploitable energy have not yet reached a commercially viable level. Nevertheless, the market for renewable energy as a whole continues to grow.

Wind is typically included in strategies for growth in renewable energy, and its usage as an energy source keeps growing steadily at 20-30 per cent annually. The large-scale and cost-effective use of wind energy requires offshore wind farms and the integration of wind energy into the power grid. Our energy planning experience includes developing the heating and electricity infrastructure to absorb fluctuating wind energy efficiently.

It is becoming more common for geothermal and solar energy to be considered as efficient solutions, particularly when integrated within larger energy systems.

There are three main factors determining the success of a geothermal energy project: a large heat market, demand for low-temperature heat, and favourable seismic conditions. We provide consultancy services for all three and have all the skills to successfully plan, implement and operate energy projects based on geothermal heat.

Thermal solar heating is a well-developed technology, which can be utilized for housing developments, large buildings and integrated district heating systems. Reduced production costs for solar heating systems combined with increasing costs of fossil fuels now make solar heating systems commercially viable, and many new projects have emerged in recent years. Ramboll has been involved in the development of large-scale solar heating systems that supply local district heating networks through heat accumulators, and we have planned and designed some of the largest solar heating systems in the world.

Viborg is planning a CO_2 neutral district heating supply based on renewable energy and local resources, including geothermal heat.

Further south in Denmark, Marstal is home to the world's largest solar power complex. Ramboll has planned, designed, tendered and procured the facility and subsequently managed and supervised its construction and operation.

Ramboll is involved in some of the largest wind farms in the world. We have designed more offshore wind turbine foundations than any other company. Our wind energy projects include the British Greater Gabbard offshore wind farm now in progress. Breaking waves and breaking records, it will be the first in wind power history with monopile foundations in water depths of more than 30 metres. "From an engineering standpoint it is an incredibly challenging and interesting project," says Henrik Carstens, lead engineer on the Ramboll team.

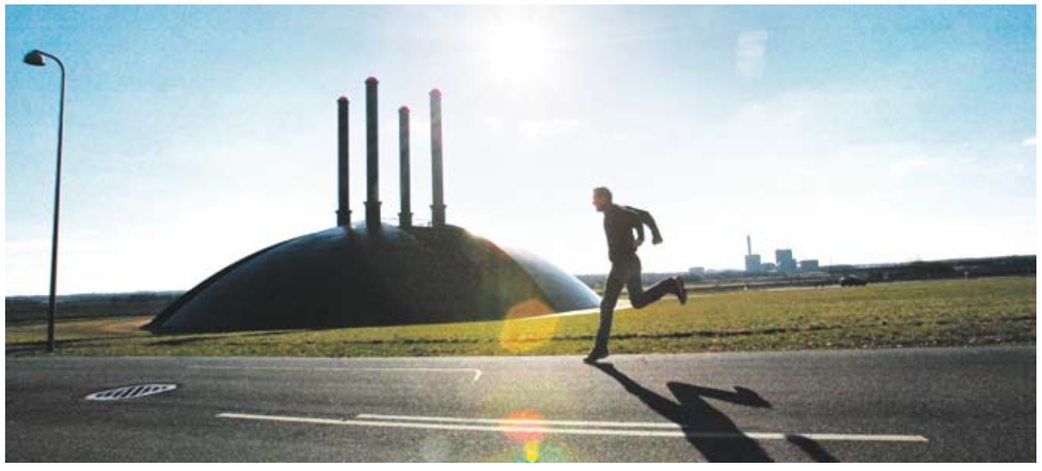
LOOKING BACK: ENERGY IN A HISTORICAL PERSPECTIVE

"Until the end of the 18th Century, power was generated with wind, water and muscles ..."

By Morris A. Pierce, PhD, Assistant Professor of History, University of Rochester, Rochester, New York

Until the end of the 18th Century, power was generated with wind, water, and muscles (both animal and human). Heating was primarily done with wood, although coal came into use in many locations where local wood supplies were depleted, including England and Italy. The earliest connection between heat and power was a Tibetan prayer wheel that was powered by heat turning a small turbine in a chimney. This device was adopted in European and American kitchens and generally called a smoke jack or roasting jack. The ancient Greeks had used steam power for small engines, but the first successful application of steam power was to pump water out of coal mines in Britain early in the 18th Century. These low-pressure systems were gradually improved, and by the 1780s mill owners were using steam heating in their factories and mansions. In 1784, a brewer in Oxford, England received a patent that covered the basic elements of combined heat and power, and the introduction of high pressure steam turbines by Richard Trevithick and Oliver Evans in the early 19th Century was soon followed by the wider use of exhaust steam for heating purposes as well as driving compound steam engines. The introduction of commercial electric service in the 1880s resulted in a rapid growth in the size of steam engines, but these were overtaken by steam turbines in the early 20th Century. Steam turbines and their close cousins the gas turbine and hydroelectric turbine today provide the majority of electrical power generated in the world.

Although large electric generating plants have certain advantages, they reject enormous amounts of heat and require long transmission lines to deliver power to customers. Recent trends have shifted towards a return to smaller distributed generation plants, which can be embedded in the electric power network and sited close to end users who can use the heat from the plant rather than rejecting it into the atmosphere. Another recent trend is waste heat electric generators that can produce electricity from heat below 100°C, making them ideal for geothermal and district heating applications. Solar thermal and photovoltaic technology is also improving rapidly, as are wind turbines and fuel cells. Wider use of renewable and more efficient energy generation technologies will mark the future of energy.



OUR REFERENCES

Ramboll has carried out energy projects in
Denmark, Sweden, Norway, Finland, Faroe Islands, Iceland, United Kingdom, Ireland, Germany, Netherlands, Spain, Portugal, Gibraltar, Italy, Austria, Kosovo, Serbia, Montenegro, Macedonia, Bulgaria, Romania, Hungary, Czech Republic, Poland, Estonia, Latvia, Lithuania, Belarus, Ukraine, Moldova, Russia, Georgia, Armenia, Azerbaijan, Kazakhstan. Turkmenistan, Uzbekistan, Tajikistan, Kyrgyzstan, Mongolia, China, South Korea, Taiwan, Hong Kong, Nepal, Thailand, Malaysia, Philippines, Indonesia, Canada, USA, Bermuda, Egypt, Burkina Faso, Ghana, Tanzania, Mauritius, Namibia, Swaziland, Lesotho, South Africa

1. Heat transmission from Barking Power Station, London, UK 2. Bioenergy plant producing biogas, bioethanol, biomethanol and hydrogen, Nakskov, Denmark 3. Sludge incineration plant in St. Petersburg, Russia.
4. District heating in New York, USA.
5. Strategic assistance to the power company RAO UES of Russia as part of its reorganisation.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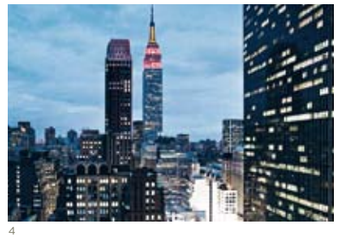
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