TRANSPORTING THERMAL ENERGY

DISTRICT ENERGY
ENGINEERING AND CONSULTANCY SERVICES

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WHAT IS A DISTRICT ENERGY SYSTEM?
District energy is the thermal energy infrastructure in cities. District energy is hot water district heating and/or chilled water district cooling based systems, all depending on the local conditions. The entire district energy system includes production, long-distance transmission, distribution, large thermal storages, building substations and HVAC installations in buildings. By interacting with the power system, a district energy system is a precondition for energy efficient use of low quality renewable energy in a cost effective and environmental friendly way. Thus district energy is an important infrastructure in liveable cities.

RAMBOLL DISTRICT ENERGY REFERENCES:
Armenia, Australia, Belgium, Bulgaria, Canada, China, Czech Republic, Denmark, Estonia, Faroe Islands, Georgia, Germany, Greenland, Ireland, Italy, Kazakhstan, Kosovo, Kyrgyzstan, Latvia, Lithuania, Netherlands, Norway, Poland, Romania, Russia, Saudi Arabia, South Korea, Sweden, Turkmenistan, UK, Ukraine, US, Uzbekistan
WHAT WE CAN DO FOR YOU

Ramboll offers a full range of services on district energy projects from strategic planning and feasibility studies to follow-up on operation and maintenance and business support.

Our specialists in district energy, waste-to-energy, combined heat and power (CHP), renewable energy, heat pumps, thermal storage and building installations work closely together to provide optimal use of heating and cooling sources.

Projects from A to Z
Our project references cover all aspects of district energy schemes with sizes ranging from the heat supply of smaller communities, new urban developments and villages to city-wide CHP and large scale district energy systems.

As engineering consultants we understand the plethora of issues associated with district energy ranging from policy, planning, technical and economic feasibility, design, construction and commissioning to operation, maintenance, network extension and decarbonisation.

We consider the role of service provision a closed and evolving loop. The development of district energy systems rarely stands still, so the need for continuous assistance will deliver continuous improvement.

Tailor-made services
Of course, we can offer any of our services, in isolation or out of sequence, where specific requirements are needed. Our experience is such that we can very quickly assimilate the needs of the client and of the particular requirements of the system.

As cities aim to become carbon neutral, district energy systems become more important than ever. They have a number of benefits, including improved energy efficiency and environmental conditions.

OUR SERVICES
Ramboll offers a full range of services on district energy projects.
STRATEGY AND PLANNING

In our cost-benefit analysis and design we simulate the system combining a number of automatic interacting models, mainly: CBA model, consumer database, GIS, load simulation models and hydraulic models. Our hydraulic model SR2 has been created to assist in the design of fluid based pipe systems and is used for district energy systems. It comprises a number of modules calculating stationary flow, pressure and temperature, and it can also simulate pressure and temperature transients.

The critical factors in the development of any district energy system is an understanding in the cost benefit analysis of how much energy is required, where it is required and from what sources it can be delivered.

This strategic triangular approach to any system means we can provide innovative solutions to any system size.

Careful assessment of the energy demands is of particular importance since this will set the framework around which the district energy system will be developed. Mapping of such energy demands requires an understanding of the energy needs of different buildings and an emphasis on the verification of the data gathered. Planning the delivery of energy must be undertaken mindful of the technical and financial drivers.

Optimum solution
District energy systems have particular technical aspects that must be employed to ensure that an optimum solution is delivered, and this in turn will impact on its financial health. Having developed many district energy systems throughout Europe and around the world, we have amassed unrivalled experience.

We employ specialist in-house developed software - SR2 - specifically designed for use in district energy network modelling and optimisation, to help find the ideal solution.

In order to identify the most optimal location of a new district cooling plant within a certain area, Ramboll has developed an automated mapping tool called DCmapper. This tool uses the estimated cooling requirements and geographical location of each building in an area to calculate the economic difference between traditional cooling and a district cooling system.

A holistic approach
In our holistic approach and optimisation we take into account the interaction between the district energy system and the rest of the energy system and buildings. We analyse the impact of the optimised district energy system on the society as well the local community. A stakeholder analysis will moreover give us an indication of how the benefit for the local community can be shared among local stakeholders – producers and consumers. Finally, a risk analysis will focus on the most important factors.

Wembley Regeneration Area, London
London Borough of Brent commissioned Ramboll to develop a decentralised energy masterplan for the Wembley Regeneration Area. Through detailed strategic planning, the work demonstrated the economic viability of the district heating and cooling solution and the benefits it would bring to developers.
“I HAVE ALWAYS ENJOYED WORKING WITH RAMBOLL, THEY ARE PROFESSIONAL AND APPROACHABLE TO WORK WITH.”

TOBY HEYSHAM, DIRECTOR, PINNACLE POWER (GREENWICH PENINSULAR PROJECT, UK)
FEASIBILITY

District energy systems can require the deployment of significant capital investment, and it is important to recognise that any return on such investment should be considered over a long term.

Assessing the viability of a district energy system requires a sensitive understanding of all the parameters that form part of the capital and operating costs. Our extensive project list provides us with the information required to continually refresh our cost database.

Capital costs
The development of the capital costs needs to be undertaken with great care, particularly when considering the network. A network can represent as much as 70% of the total capital outlay of a district energy system, so it is important to be able to understand all the aspects that may affect its installation.

Our engineers regularly work closely with installation contractors to ensure that we update our capital cost database to help provide accurate cost estimates for all work.

Operating costs
Understanding the operating costs of a district energy system requires an understanding of its operation. A simple principle, but one that cannot always be put into practice. We, however, have engineers that work alongside our clients on a daily basis, continuously building our knowledge base.

We also manage the operation and maintenance strategies for our clients. This work requires accurate cost management, which further increases our knowledge base. This continuous refreshing of operational knowledge helps us to develop realistic operating cost information which we can use in future work.

It is important to emphasise that district energy systems may not always be viable. We ensure that we identify this at an early stage in the development process. We will, however, always seek out ways that may help the client to deliver an alternative and viable solution.

Bunhill 2, London, UK
The results of a ground breaking feasibility study carried out by Ramboll for Islington Borough Council showed that the 850 dwellings already connected to the district energy system in central London could be extended to 1350 by adding two low-carbon heat sources. The first heat source was a London Underground ventilation shaft where 18-28°C air is exhausted to the atmosphere. The second heat source was a nearby UKPN transformer sub-station where heat is rejected at approximately 40°C. The study confirmed that both of these sources of waste heat could be exploited by heat pumps, which can capture the waste heat, upgrade it to approximately 80°C and then feed it directly into the district energy system.
The extensive portfolio of work Ramboll has amassed, has given us the understanding of using the most appropriate technologies in each situation.

In many cases, a district energysystem design can be overengineered. This can be from the use of incorrect pipe sizes to the inappropriate use of energy centre technologies. In such cases the capital and operating costs rise, and this can lead to a design that is both financially prohibitive and technically inferior.

The design of a district energy system should be considered in three parts:

- Energy production
- Distribution
- Delivery

Production
Energy production facilities can include CHP, biomass boilers, solar thermal, waste-to-energy, heat recovery or conventional gas-fired boilers, for example. Our in-house designed software - EPEM - provides us with a tool to determine what technologies would be best employed and at what sizes in terms of energy output.

Distribution
The design of the distribution system requires significant care to avoid creating an asset that could be grossly oversized and economically prohibitive. This can be a complex iterative procedure but through the use of our in-house software - SR2 - we can develop the most cost-effective design. In many cases district energy systems will require to be designed for future connected load that cannot yet be identified. Our extensive experience of strategic planning will allow us to determine the optimum solution.

Delivery
The delivery of the energy to buildings can be achieved through a direct or indirect connection - often through the use of a heat exchanger or heat interface unit. Careful design of this element is crucial to ensure sufficient energy is delivered in the most efficient way. Not only can we provide this experience, but we are also able to advise on how existing systems can be improved through efficiency measures to help reduce customer costs. It is important that these assessments should be undertaken with the prospective customer in the early stages of discussion.
COPENHAGEN DISTRICT HEATING NETWORK

Consultant to one of the largest city-wide district heating systems in the world
Ramboll has since 1970 provided a wide range of consultancy services to most of the energy companies and authorities in the region, e.g.:

- Heat supply planning for most of the municipalities
- Planning, design and implementation of the heat transmission networks of CTR and Vestforbrænding and more than 10 distribution networks
- Design of three waste-to-energy plants, Vestforbrænding, Amagerforbrænding and KARA/NOVEREN, and the sludge incineration plant of Lynettefællesskabet
- Design of CHP plants and heat accumulators for DONG Energy and Vattenfall
- Refurbishment of old district heating networks for several of the district heating companies
- Stationary and pressure transient hydraulic analysis of the whole transmission system

THE SYSTEM IN BRIEF
160 km heat transmission network
30,000 TJ/p.a. sale of heat to end user
60 million m² heated floor area
110 kg CO₂/MWh sale to end user
25% waste-to-energy
97% CHP
MILAN DISTRICT HEATING NETWORK

THE SYSTEM IN BRIEF

60 km heat transmission network
9,500 TJ/p.a. sale of heat to end user
35 million m² heated floor area
115 kg CO₂/MWh sale to end user
21% waste-to-energy
52% CHP

Consultant to Milan’s district heating network
Ramboll has prepared a strategic plan for the development of a heat transmission network in Milan to utilise heat from a large power plant and additional heat from waste-to-energy plants. The client is the Italian multi-utility company A2A. Ramboll’s services included:

• Heat mapping of potential district heating demand
• Identification and location of future heat production plants
• Production simulation
• Layout and dimensioning of the district heating pipe network
• Hydraulic analysis
• Description of the operation strategy of the integrated system
• Environmental analysis
• Profitability analysis

In addition to the Milan network, A2A owns and operates the largest Italian network in Brescia where Ramboll has assisted with a network leakage investigation and a heat storage study.
The procurement of a district energy system is a particularly specialist service offering and requires a detailed understanding of the issues involved in its design and installation.

Once the client has decided to procure specialist contractors to install a district energy system, it is important that the process is managed to avoid significant changes to both design and capital cost.

**Tender documents**
We can support the client in this process in a number of ways. Following the development of a detailed design, we can assist in producing and issuing the procurement documentation. This can be in the form of detailed design specifications and drawings or a design brief.

**Tender evaluation**
It is important to ensure that suitably experienced and qualified installation contractors are chosen. We can assist the client in selecting the appropriate contractors throughout the procurement process, including pre-selection and candidate interviews.

It is important to maintain the procurement process during the tender period. We can assist the client throughout this period helping to respond to technical questions as they arise.

Once the tenders have been received we can provide the client with the technical and financial expertise necessary to interrogate the bids to ensure that they comply with the requirements of the detailed design.

**Design review**
In instances where the client requires the contractor to undertake the design and construction of a district energy system through a design brief, we can offer the client the technical support to ensure that the offered design is rigorously checked for robustness and is of the most appropriate design.

**Contract negotiation**
Following the tender evaluation process we can be on hand to help the client in the appointment process, ensuring that the transition to the implementation phase is simplified.

Eandis, Belgium
Ramboll worked with Eandis, an electricity and natural gas mains and distribution company, to support the planning, design and execution of pilot district energy projects and helped establish district energy craftsmanship within the company. Eandis was looking to enter the market of district energy and chose Ramboll to support them in this new market. Ramboll’s support covered all aspects from early planning and mapping of heat demand to technical concept, detailed design of network, energy centres, procurement, advice on heat agreements and setting up a business plan.
IMPLEMENTATION

Following the appointment of the district energy contractor, it is critical that the installation of the network and energy centre proceeds on time, within budget and maintaining the highest technical specification.

Ensuring the network and energy centre are completed on time is always considered an important factor. In larger systems that may take more than 12 months to complete, it is especially critical that the system should be available to buildings requiring energy. We have the experience of managing the construction of many networks to understand the importance of this critical factor.

Handling of variations
All construction projects are sensitive to capital spend and the networks can be particularly capital intensive. Variations to an already significant investment will be most unwelcome. We will apply our extensive technical knowledge and installation experience to eliminate the situations that might give rise to variations, through practical design techniques to on-site management.

On-site management
Our significant experience of network and energy centre design has allowed us to amass an unrivalled understanding of the most appropriate technical solutions. Our experience of on-site management will ensure the client’s assets are installed to the highest quality, helping to ensure the longevity of the asset.

Once fully installed, the district energy network will need to be monitored to identify operational defects. We can help our client by assisting in this process, ensuring that the required corrections are undertaken to the highest standard. We can remain on hand during, what can be, an extended period of time.

Performance tests
To ensure that the network meets the contractual conditions before being handed over, we can also ensure that performance tests are properly carried out and assist our client in administering any contractual guarantees.

Hill of Banchory, Aberdeenshire, Scotland
A small district energy system, based on woody biomass, was developed to cater for the heating needs of a new development of houses and community buildings. Although Ramboll did not design the district energy system, we initially provided crucial input into the suitability of the system offered, and our initial work helped reduce the complexity and cost of the original design. During the commissioning period we were able to identify installed design errors which would have otherwise created delay in completion or a sub-optimal solution. Our daily site presence and knowledge of similar systems helped both the client and the contractor resolve design and operational issues.
Once a district energy network has been handed over to the client, it marks the start of a long relationship with an asset of considerable value.

It is very important that systems and procedures are in place to ensure the networks are operated and maintained to the highest standards. We are ideally placed to help the client to define and implement such systems.

We have a number of specialists who have many years’ experience of providing operation and maintenance advice to owners of district energy systems.

We are able to provide this advice at all levels of involvement from full-time assistance to a single annual review. Often the size and complexity of a network will be the determining factor of the required level of input.

**Maintenance activity plan**

As an example, if a network has been in place for some years, we are able to undertake a detailed asset survey and system assessment, to first provide an expert opinion of the condition of the system in place. We can then work with the client to improve and streamline system operation and create a targeted maintenance activity plan.

**Strategies and business models**

We can also provide business support. This can include providing strategy for the future growth of a network through analysing opportunities and undertaking a financial assessment of their worth. It can also include looking at minimising operating costs through a careful review of the network requirements.

We can review the business model to help improve the balance sheet by identifying operating costs.
“RAMBOLL COVERS ALL DISCIPLINES RELEVANT TO OUR PROJECT. THIS GIVES US PEACE OF MIND.”

PETER JESPERSEN, MAINTENANCE ENGINEER
METROPOLITAN COPENHAGEN, HEATING TRANSMISSION COMPANY - CTR
01 Chicago Lakeside, US
Chicago is taking urban development in the US in a brand new direction. The Chicago Lakeside project is based on the assumption that future generations picture themselves living in a city focused on liveability and sustainability. In the future, residents will be able to use sustainable cooling, heating and electricity and invest in energy from local wind turbines. When realised, the master plan will provide a new way of living based on the most advanced 21st-century infrastructure and technology.

Ramboll has proposed a design concept for sustainable energy, including a district-wide infrastructure for supply of heating and cooling; combined generation of cooling, heating and power based on natural gas and local renewable energy; near-shore wind turbines to produce electricity; and a green code for efficient design of buildings. The concept will reduce the use of fossil energy by 90%.

The Chicago Lakeside masterplan, which also includes concepts for water and waste management, won the Sustainia Community Award - the solution that received the most votes from the general public. The award is given annually to a solution, technology or project with a significant potential to help build a more sustainable future.

02 Manchester, Leeds and London heat mapping, UK
Ramboll was commissioned to carry out city level heat mapping and masterplanning for the Association of Greater Manchester Authorities and the Leeds City region. These projects involved heat mapping and opportunity mapping on the basis of economic, carbon and development risk criteria and initial de-risking of shortlisted priority schemes to enable them to be taken forward for feasibility stage appraisal. Ramboll also conducted heat mapping studies for nine London Boroughs and assembled heat demand data for priority buildings. Using real energy consumption data, the heat maps identified areas with the potential for delivering future district heating networks.
03 District energy to Køge, Denmark
The heat transmission company VEKS and the Municipality of Køge are developing district heating in Køge to replace gas boilers, in total 200 GWh plus transmission to VEKS based on a biomass fuelled industrial CHP plant. Moreover, district cooling to a new hospital is in progress. Ramboll has as the owner’s engineer developed the business plans and overall design for the district energy system and reconstruction of the CHP.

04 Carlsberg new urban area, Copenhagen, Denmark
The urban area includes 600,000 m² of which 50% needs cooling. Ramboll has assisted Carlsberg in the planning and design of the infrastructure. Ramboll proved that district heating from the integrated system in Greater Copenhagen was better than individual heat pumps, that district cooling based on a chilled water storage and compressors was better than individual chillers and transmission of cooling, and that electricity from offshore wind was better than building level wind and solar photovoltaics.

05 The UK’s largest district heating system
Greenwich Peninsula is a new mixed use development consisting of over 10,000 new homes, approximately 320,000 m² of commercial space and around 18,000 m² of retail space. The development has a build programme of around 20 years. Ramboll was commissioned to do the feasibility study and provide consultancy services in connection with the design and implementation of a low carbon, site wide energy infrastructure, including a central energy centre and a site wide district heating network.

06 Bridgeport, Connecticut, US
NuPower Thermal LLC is developing a modern district energy network for the City of Bridgeport, intended to provide an economical and environmentally sustainable source of heating and cooling for buildings throughout the city. The thermal network is based around a low temperature hot water distribution system. NuPower has hired Ramboll as lead consultant to design the network as well as the heat extraction at the local waste-to-energy plant and fuel cell plant. Ramboll has teamed up with Smith Engineering of New York City and Milone & MacBroom, Connecticut.

07 South Korea
Ramboll has for a number of years carried out several district heating studies for Korean District Heating Corporation (KDHC). The general background to the studies is that KDHC is looking to supply new developments as well as existing urban areas with district heating from a mix of new CCGT plants and existing plants. Also, the system has to meet an increasing heat demand. Finally, KDHC has a wish to ensure that the systems are designed and operated in accordance with best practise.
RAMBOLL IN BRIEF

- Independent engineering and design consultancy and provider of management consultancy
- Founded in 1945 in Denmark
- 12,300 experts across 35 countries and 300 offices
- Significant presence in the Nordics, North America, the UK, Continental Europe, Middle East, Asia, Australia, South America and Sub-Saharan Africa
- EUR 1.1 billion revenue
- Owned by the Ramboll Foundation