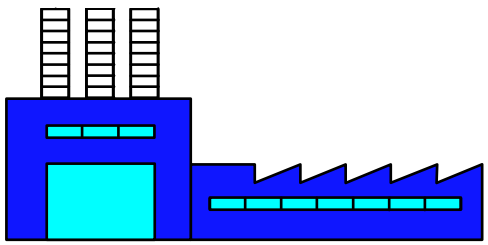
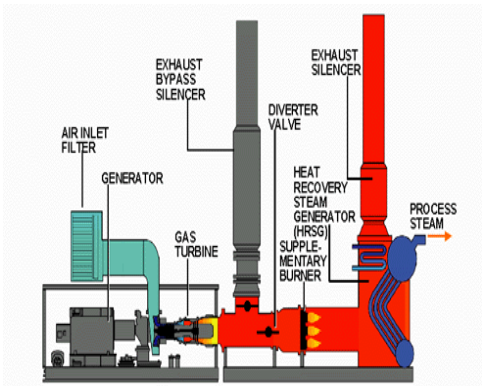
District Heating for Planners and Developers

Twinning project:
Improvement of energy efficiency in Turkey





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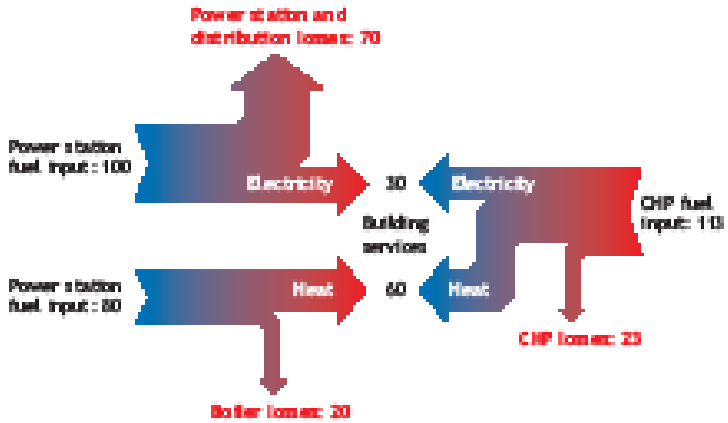
District heating or/& cooling: definition

- Provision of heating or/and cooling from a central source to more than one building or dwelling via a network of heat mains
- Heat generated in conventional boilers, renewable-fired boilers, or using waste heat from power generation
- DH system can encompass the whole of a city, or a group of residential and commercial buildings
- Often involves local production and distribution of electricity, ensuring essential security of supply
- Can be financially attractive and environmentally beneficial as an alternative to electric heating in buildings

Elements of district heating scheme

- An energy centre with
  - *a central heat source*
  - *a heat distribution network*
  - *end-user space heating and domestic hot water system within each building/dwelling*
- Heat sources
  - *Conventional fuels*
  - *Waste heat from power generation*
  - *Energy from waste or waste heat from industrial processes*
  - *Geothermal or solar energy*



Elements of district heating scheme

- Heat distribution
  - *A distribution network of flow and return pipes transferring heat from the energy centre to individual buildings/dwellings*
  - *For larger systems, high diameter flow and return pipes with variable speed pumping equipment and heat exchangers*
  - *Larger pipework may be installed above ground or buried within a trench (commonly preinsulated)*
  - *Preinsulated pipes incorporate automatic leak detection*

Elements of district heating scheme

- End user installations
  - *The use of a hydraulic interface unit (HIU) including a heat exchanger, flow and return pipework, control valves and a metering facility*
  - *Typically include a plate heat exchanger to provide hot water instantaneously, eliminating the need for a hot water storage calorifier*

Benefits of district heating

- Generic benefits include
  - *Economic*
    - If demand density is high
    - A diversity of building types with different (complimentary) heat demand profiles
    - Locally available heat that would otherwise be wasted (low running cost)
    - Opportunity to integrate other energy services (electricity from CHP plant, cooling using surplus summer heat)
  - *Social*
    - Reduced energy bills for residents and provision of affordable warmth and reducing condensation related illnesses
    - Increased floor area of buildings (no need for individual boilers and domestic hot water storage)
  - *Environmental*
    - Significant carbon reduction and option for using low or zero carbon emerging technologies

Regulatory benefits of district heating

- Regulatory benefits for considering and implementing DH
  - *For planners*
    - Assisting local authorities in achieving sustainable development, sustainable communities and adhering to their Agenda 21
  - *For developers*
    - EU Building Directive requires all planning proposals to consider community heating
    - Building design with large area of glazing commonly require energy intensive cooling and heating services to maintain comfort; DH can be an effective way to improve their carbon footprints
    - Environmental benefits appeal to some informed purchasers
    - Demonstration of corporate environmental responsibility adding to company profile
    - DH may provide the lowest whole life cycle cost
  - *For the community*
    - Promotion of sustainable regeneration within the community

Opportunities for district heating

- DH potential is generally high
- Technology cuts across sectors and can provide heat to both public and private sector buildings
- Main opportunities are the following
  - *Part of refurbishment of existing buildings, especially in dense urban areas with high/low rise housing*
  - *A large public sector development of new or refurbished project such as hospitals, universities, government buildings, etc.*
  - *Part of a wider regeneration agenda, at regional/town level which may include dense urban developments*
  - *Part of a small community currently off the gas network but having access to renewable energy sources*

Life cycle analysis of district heating

- **Life cycle analysis takes into account**
  - *All costs, benefits, income and expenditure, including energy, maintenance and replacement costs over a 25-year period*
  - *And discounted back to current values using a low discount rate*
- **Options for the provision of electricity and heat may include**
  - *DH with CHP and renewables, electric heating and gas boilers, with electricity purchased from the grid*
- **Scheme costs**
  - *Provision of heating services includes covering a number of options, while adhering to compliance with building regulations, health and safety standards*
  - *The cost of electric heating has to be considered*
  - *The cost of central heating system includes those of the radiators, internal pipes, controls and boilers; installation of a gas main to individual dwelling will be additional*
  - *Some costs may be met by a gas network operator who recovers the installation costs through a charge on gas use*

District heating option appraisal

- **Any potential development includes an option appraisal**
  - *Covering everything to the point where a decision can be recommended on which type of space heating and hot water system option should be implemented*
- **Life cycle costing as an important part of an option appraisal**
  - *Includes the total cost of the equipment or service from day zero of the project to its eventual termination or replacement*
  - *All capital costs, operating costs and revenue streams are calculated before discounting them back to the current values*
- **Key stages of life cycle costing for DH**
  - *Identify potential heating options for each scheme*
  - *Select an appropriate project life time and equipment life expectancy*
  - *List and identify the capital costs and operating costs with any revenues and ongoing expenditures to create the resultant cash flow forecasts*
  - *Calculate the net present value and annual cash flows*

Life cycle analysis of district heating

- **Some cost figures**
  - *Investment costs*
    - Cost of central heating system can be of the order of 4 500 to 6 000 euros per dwelling; the investment may be made by the gas operator or the DH service provider, to be recovered during the operation
    - A heat meter is more expensive than a gas meter
    - A HIU is cheaper than a boiler
    - Heat network is more expensive than the gas network because of the additional controls
    - Retrofitting heat mains to existing housing stock is more problematic than the new build, and hence more expensive.
  - *Running costs*
    - Important to maintain it low to achieve significant savings over system life
    - Life of the DH system is 25 years whereas individual gas and oil boilers last for 15 years and the life of the electric storage heating system is around 10 years
    - Energy savings are typically 25% compared to gas boilers and up to 50% compared to electric heating
    - Electricity supply with CHP is an additional benefit, also providing savings to users

Typical example of an option appraisal

- **Example of the outline content of an option appraisal report**
  - *Summary*
    - Financial and environmental benefits of each of the space heating, domestic hot water and electricity generation systems and recommendations based on the results
  - *Introduction*
    - An indication of the customer, the consultant engineer and the scope and objectives of the work
    - Provision of a map of the site and surrounding areas
    - Scope of work description
  - *The site, current heating, hot water and electrical systems, services and estimation of heat demand*
    - Description of the building and its current services, outlining the customers likely to be served in early or later phases
    - Adjacent sites and customers who may be considered for later phased connection

Typical example of an option appraisal

- **Example of the outline content of an option appraisal report**
  - *Heating, hot water and electricity options*
    - A description of all suitable options considered
    - Assessment procedures (including environmental benefits)
    - The proposed DH and embedded generation schemes
    - The alternative schemes such as electric storage heating, individual gas boilers, or no change to the existing provision of energy
  - *Life cycle costing of the main options*
    - An analysis showing the net present cost of each alternative at commercial rates of discount and project life to determine the attractiveness to the developer
    - An analysis including any government subsidy and incentive schemes
  - *Conclusions*
    - Which is the lowest life cycle heating option
    - Whether it is technically practical and feasible to pursue this option
    - In view of the above, stating which option is recommended to pursue

Business plan

- **Business plan is important: while DH can have least life cycle cost, it is certainly not the least first-cost solution**
  - *DH requires installation and management of the assets over a long period to recover the additional up-front costs*
  - *An ESCO (Energy Service Company) can develop an ongoing relationship with the residents, including billing, to cover management and maintenance of an asset*
  - *As financing DH can be difficult due to the high up-front costs, it is important to develop a partnership approach with an ESCO, or devolving all ownership, management and maintenance issues to an ESCO*
  - *The Business Plan needs to include arrangements for financing DH, including partnerships and ESCOs, and sources of funding, including bank finance, leasing, grants and other sources*

Typical example of a business plan

- **An example of an outline contents of a business plan report**
  - *Executive Summary*
    - Describing the aim of the study: Optimizing the life cycle costs in an option appraisal by exploring a range of issues relevant to delivery
  - *Organizational structure*
    - Examining and concluding an organizational structure considering an ESCO or partnership and a variety of tendering options
  - *Finance options*
    - Including evidence of having examined (either examined or ruled out)
      - *All funding sources and private investment, and associated costs of capital*
      - *Methods of reducing up-front capital needs such as leasing*
      - *Options for maximizing revenue generation (direct and indirect sales of heat and electricity)*

Typical example of a business plan

- **An example of an outline contents of a business plan report**
  - *Long term plans for future growth*
    - A timetable for the connection of additional public and non-public sector buildings to the proposed scheme or replication in other areas of the same financial or planning authority
  - *Approvals*
    - A process to achieve
      - *Planning consent approval*
      - *Committee approval*
      - *Appropriate tenant consultation*
  - *A project plan*
    - Including all proposed activities/tasks, deliverables, the time-scale and an indication of the capital expenditure profile

Key elements for DH viability

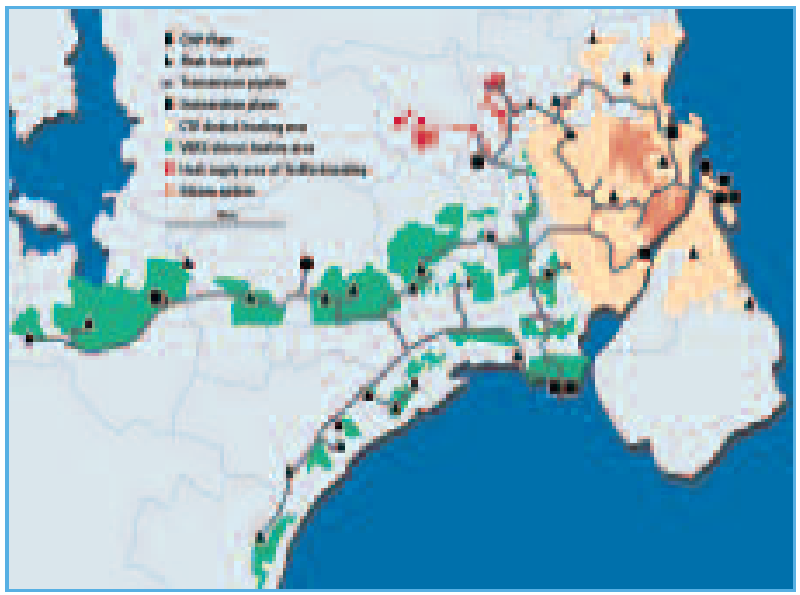
- **Successful schemes are generally based on the following**
  - *High heat demand and diversity*
    - The number of dwellings and the density of the development are important for residential developments
    - The hours of operation is also important for DH economic viability
  - *Availability of heat that would otherwise be wasted*
    - Heat is likely to be available at a low running cost (although the network itself will have a high capital cost)
    - Sources could include waste heat from power generation, industrial or municipal waste heat, use of renewable energy (probably biomass)
  - *A sound business case*
    - A combination of sources will be needed with public-private partnership
      - Involvement of private sector, especially in city centre schemes where commercial loads are likely to predominate
      - Commitment from the local authority and eventually availability of grant funding

Key elements for DH viability

- **Successful schemes are generally based on the following**
  - *A local Champion*
    - Who is in a position to influence and mobilize various local authority departments which need to be involved
    - Who has local political support
    - Who has a high knowledge of community heating and its benefits
    - Who has the ability to communicate and enthuse this to potential stakeholders
  - *Partnership*
    - Most schemes need to engage with the private sector
    - Cooperation agreement sets the foundation for the core scheme to secure new customers, allowing the connected heating and cooling load to grow

Examples of district heating in Europe

- **Modern DH in Europe: the case of Denmark**
  - *In Denmark, 55% of homes and up to 95% of buildings in urban areas are served by district heating with CHP*



A map of Copenhagen outlining the DH and CHP installation

Examples of district heating in Europe

- **Example of DH development in the UK**
  - *Greenwich Millennium Village (GMV)*
    - The landowner English Partnerships (EP) stipulates stringent environment design criteria, with 80% reduction in energy use
      - *30% reduction through measures defined in building regulations (improved insulation and airtightness)*
      - *35% reduction through installation of DH and CHP*
      - *The remaining percentage through solar photovoltaic cells, and education programme with residents*
    - The scheme is managed on behalf of the developer and the residents by an ESCO

Greenwich Millennium Village, Phase I

Examples of district heating in Europe

- **Example of DH development in the UK**
  - *The city of Southampton*
    - DH serving 40 major buildings and consumers
    - Initial catalyst for the scheme was a geothermal energy source
    - The Southampton city council committed its own buildings to the scheme and encouraged local commercial and public sector buildings to connect to the network
    - This has resulted in the provision of affordable energy services and avoidance of individual heating and chilling plants
    - Partnership between the city council and Utilicom Ltd

Examples of district heating in Europe

- **Example of DH development in the UK**
  - *New-build housing development*
    - Park View, a new private housing development of luxury apartments, connected to the Southampton District Energy Scheme
    - Reasons for project implementation
      - *Finance: gas was not required so that installation costs were avoided*
      - *Design: the absence of a boiler and no storage tank was used to enhance the design and give additional storage space*
      - *Marketability: popular with buyers due to the instant hot water availability, high water pressure for showers, no gas boiler to maintain and low running costs*

Park View – new residential complex connected to DH