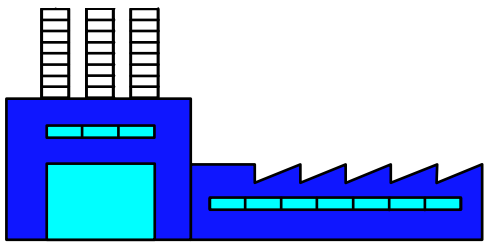
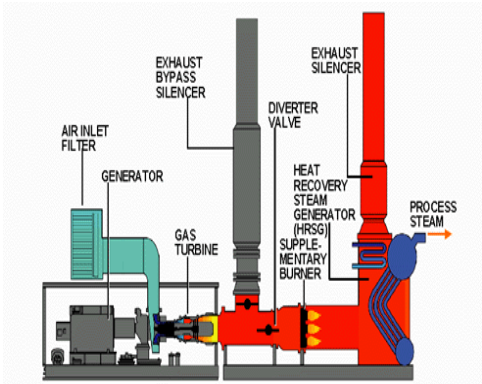
Introduction to Combined Heat and Power (CHP) and District Energy (DE)

Twinning project:
Improvement of energy efficiency in Turkey



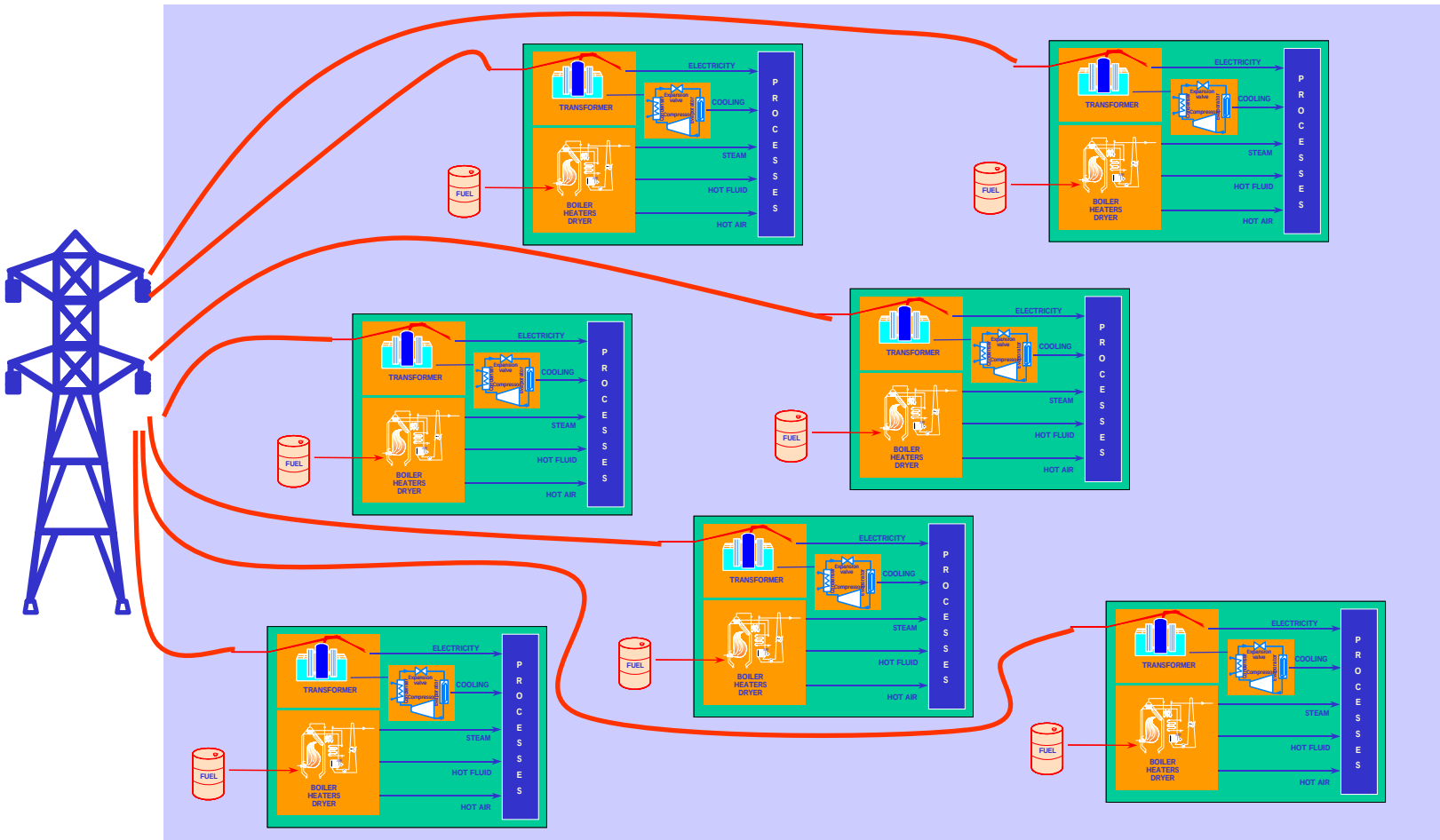


Brahmanand Mohanty, Ph.D.

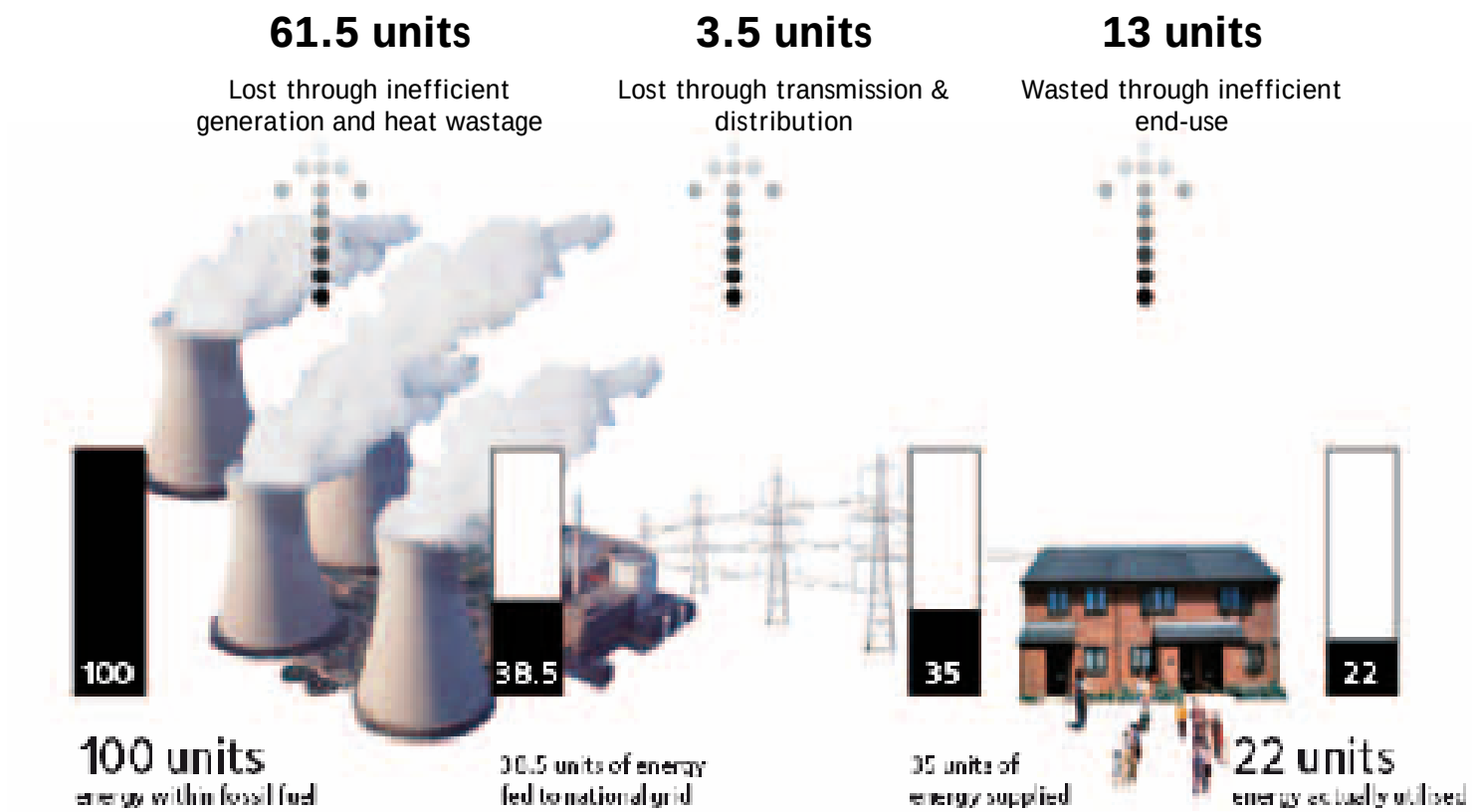
Regional Adviser for Asia, French Agency for the Environment and Energy Management (ADEME)
Visiting Faculty, Asian Institute of Technology (AIT)

Ankara
21-22 March 2007

Energy supply in individual buildings



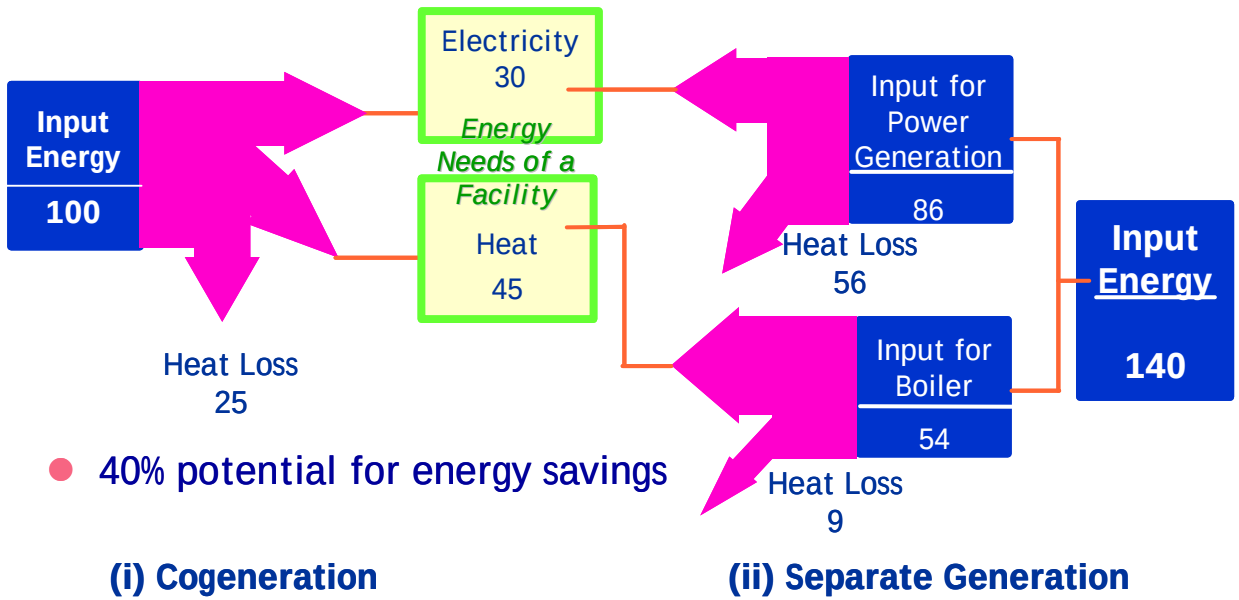
Electricity supply chain efficiency



Bron: Decentralising Energy, Greenpeace UK, 2005

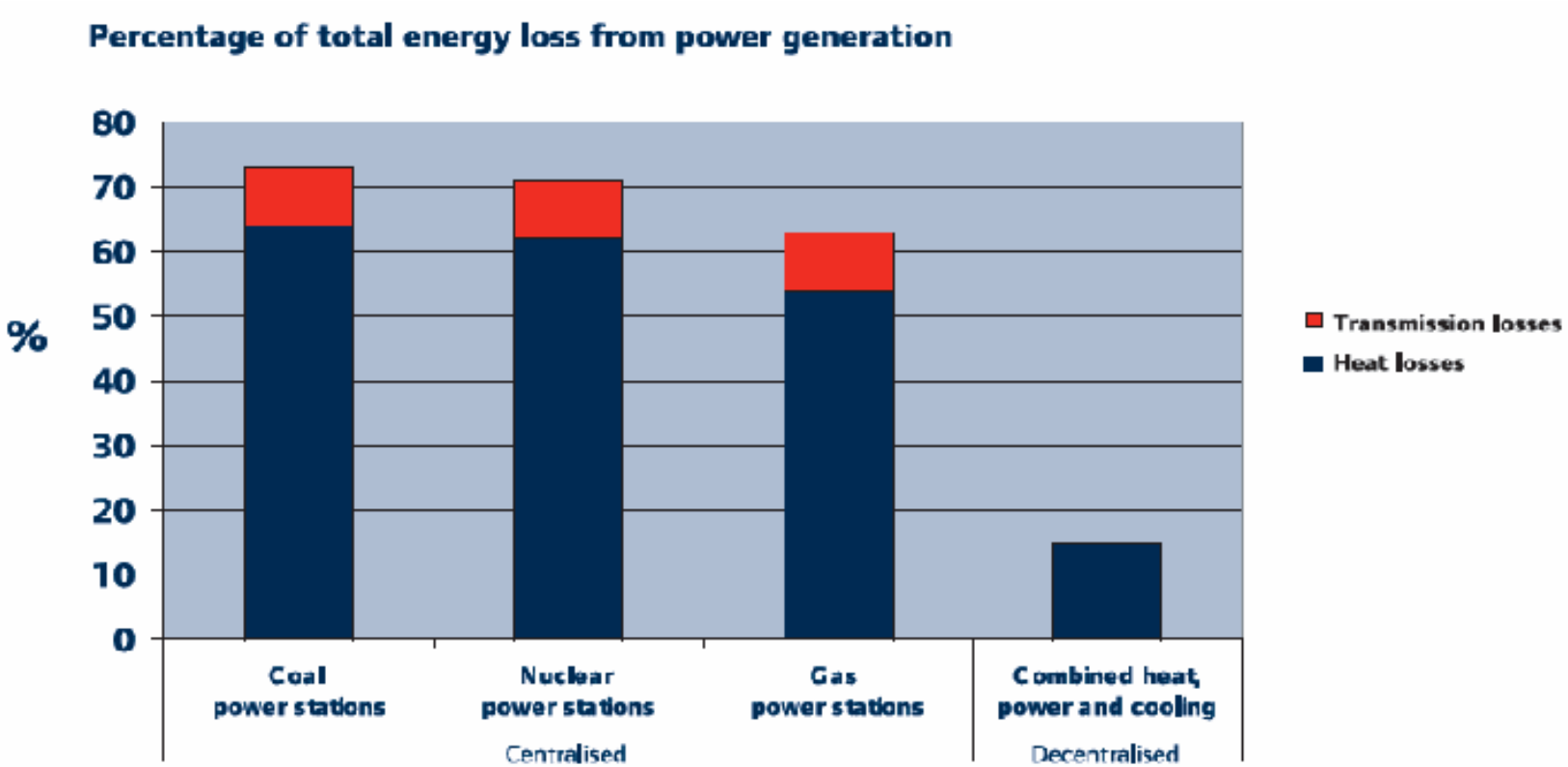
What is CHP or cogeneration

- **CHP or cogeneration**
  - *Combined heat and power generation*
  - *Achieve greater efficiency than by separately buying power from an electric utility and heat from natural gas supplied by a natural gas utility*
  - *Way to provide energy services much more efficiently*
  - *Plays a key role in the transition to a sustainable energy future*



- 40% potential for energy savings

Importance of decentralized energy



Who cogenerates

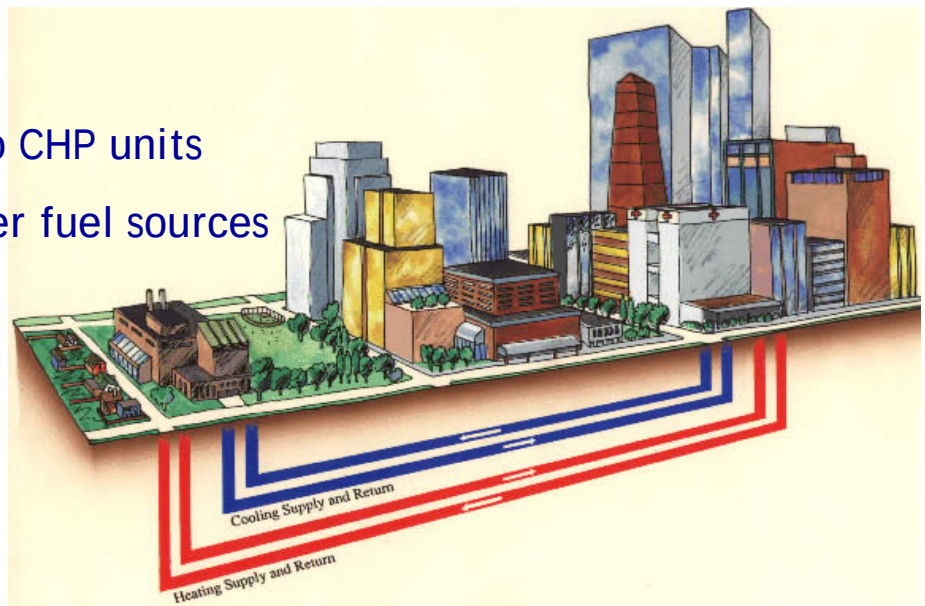
- **Main players**
  - *Mainly industries*
  - *Growing interest for use in residential, commercial and institutional buildings*

What is district energy

- **District energy systems**
  - *Provide heating and cooling to buildings from centrally located equipment, such as boilers, furnaces and chillers, rather than from separate equipment in each building*
  - *Energy is carried to the buildings through an underground network of insulated hot water or steam pipes*
  - *Municipal cogeneration involves a district energy system based on combined heat and power*

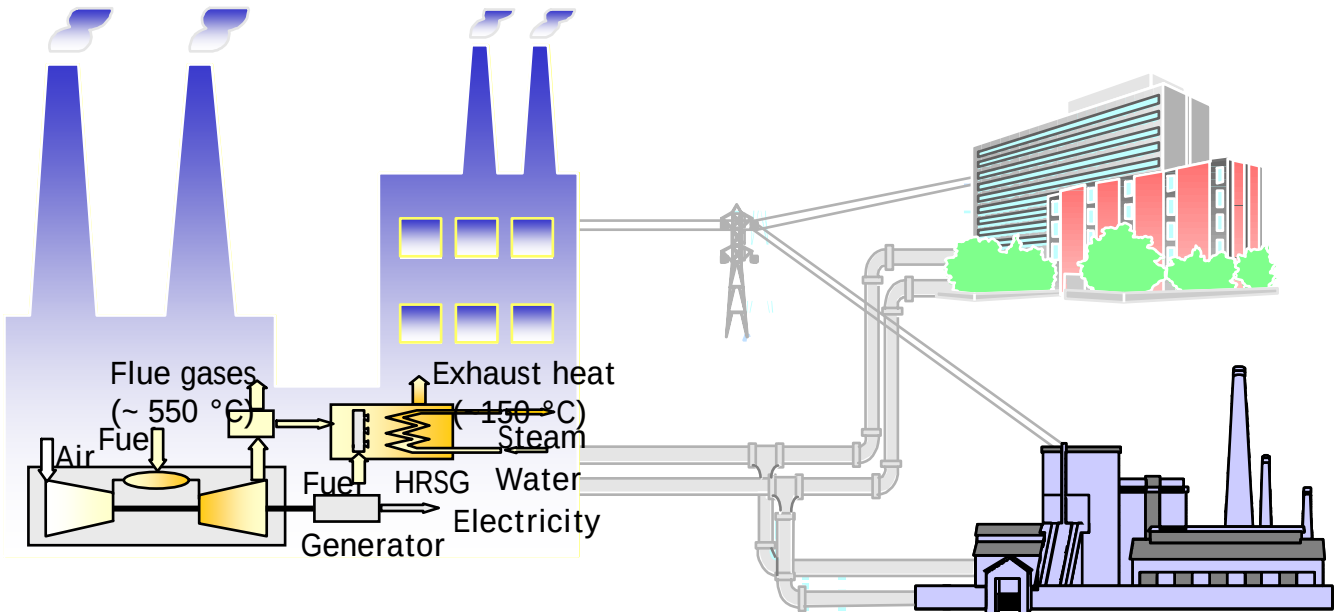
District energy applications

- **Suitable for adoption in**
  - *Urban and rural communities*
  - *New areas*
    - Buildings can be constructed appropriately, with central heating equipment
    - Energy system can be planned along with other services, such as water, sewer and roads
  - *Existing urban centres*
    - Converting old plants into CHP units
    - Using fossil fuels and other fuel sources



Economics of district energy systems

- **District energy systems in areas where energy costs are higher**
- **Economical in high-density areas**
  - *Well-proven and established*
  - *Hot water systems with temperatures below 90ºC allow the use of waste heat and cogeneration with low power losses*
  - *New plastic pipes and insulating materials enable greater cost-effectiveness*

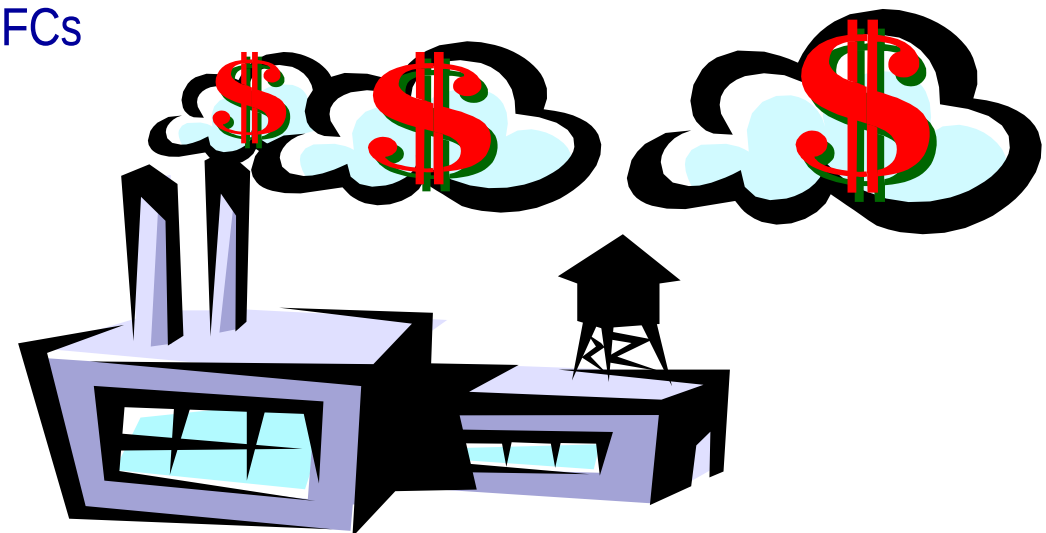


Benefits of CHP and district energy

- **CHP and DE offer benefits to**
  - *Local communities*
  - *Energy utilities*
  - *Building owners*
  - *Building tenants*
- **Benefits in high-density areas**
  - *reducing or limiting air emissions, thereby improving local and global air quality*
  - *contributing to a greenhouse gas reduction strategy for the energy sector*
  - *providing flexible infrastructure on which to base a sustainable energy future*
  - *benefiting the local economy*
  - *postponing utilities' need for new energy facilities, thus their costs and environmental impacts*
  - *providing service cost reductions to building owners*

Benefits for the building owners

- **Achieve lower cost of service**
  - Less capital, operating and maintenance expenditures on on-site boilers
  - Increased usable, and leasable, floor space
  - Greater safety and reduced insurance costs
  - Improved comfort and reliability
  - Less need to retrofit cooling equipment to get rid of ozone-depleting CFCs



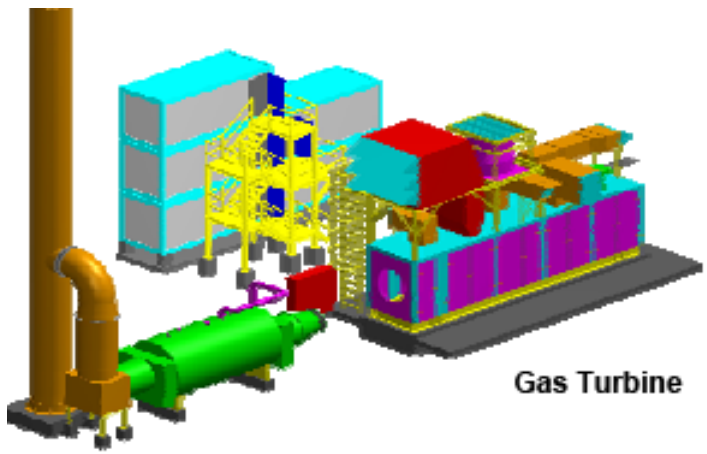
Small versus large CHP Systems

- Small-scale CHP
  - *Lower network costs for DH*
  - *More energy to adapt in local schemes*
  - *More suitable for novel CHP technologies*

  But
  - *Lower energy efficiency*
  - *Lower fuel flexibility*
  - *Higher CO_2 emissions*

- Large-scale CHP
  - *Higher energy efficiency*
  - *Lower CO_2 emissions*
  - *Higher fuel flexibility*
  - *Better local air quality*

  But
  - *Network costs are higher*
  - *Large customer based needs establishing early*



Barriers to DE and municipal CHP

- **Some typical barriers**
  - *District energy and municipal cogeneration are unfamiliar to community planners, engineers, architects, builders, developers, government officials and the public*
    - Stakeholders are not convinced that it will be technically feasible, reliable and cost-effective
  - *District energy means a large initial investment, with returns spread over a long time*
    - Time needed to recover initial investment is longer or the rate of return on the investment is lower than what private sector normally expects
  - *Developers of district energy system & municipal cogeneration face an uncertain market for their energy service*
    - Signing up customers initially may be difficult as builders and building owners may question the cost and reliability of future energy supply

Barriers to DE and municipal CHP

- **Some typical barriers**
  - *As potential customers of a district energy system, builders and developers are more concerned with keeping start-up costs low and turning a profit*
    - Builders tend to install electric-based heaters because of its low capital cost and the ease of metering
  - *Municipalities and communities may see district energy as an added complexity in their planning and development work*
    - District energy system may have to compete with other utilities (water, gas, sewage…) for rights-of-way
  - *Siting requirements, environmental standards and other municipal regulations can limit district energy and municipal cogeneration development near urban centres*
    - This creates a bias against central energy systems

Barriers to DE and municipal CHP

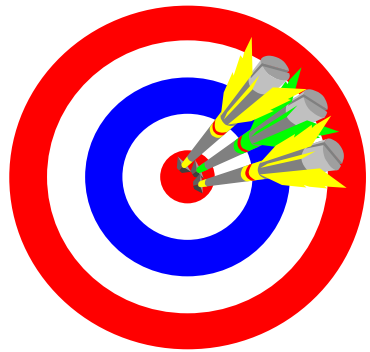
- **Some typical barriers**
  - *DE and municipal CHP projects require a high degree of planning and coordination among various interest groups*
    - DE and CHP may take 3 to 5 years to install and operate
  - *The stakeholders in district energy and municipal cogeneration development are fragmented*
    - Different stakeholders have varying levels of interest in energy efficiency and combining this interest can be challenging

Recent advances in district energy

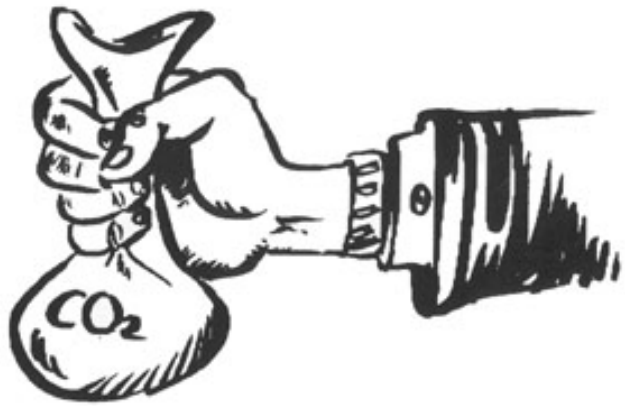
- **Recent advanced made in this domain**
  - *Accurate metering of hot or cold supplies to customers' premises is now cost-effective*
  - *Pre-insulated pipes are available. Cheap and easy to lay, they are virtually leak and corrosion-proof*
  - *Highly-efficient combined heat and power (CHP) systems have been designed*
  - *Restructuring of the utility industries favours more efficient, less centralised power generation and urban gas technology*
  - *Centralised installations with efficient combustion can meet today's stricter emission controls*
  - *CHP plants can operate on a variety of fuels, even household waste*

Factors for successful DE schemes

- **Key success factors**
  - *A ready local market*
  - *Good technical design*
  - *Favorable project economics*



- **Main questions to be answered**
  - *How to investigate your market*
  - *Selecting the right plant*
  - *Designing efficient distribution systems*
  - *Achieving energy efficiency*
  - *The economics of installing CHP plant*
  - *Selecting the right fuel*
  - *Managing Demand Fluctuations*



Potential DE stakeholders

- **Some of the stakeholders**
  - *National and Local Government Policy Makers*
  - *Energy Marketing Companies*
  - *Gas & Power Utilities*
  - *Relevant Trade Associations*
  - *Equipment and Services Suppliers*
  - *Plant Builders & Constructors*
  - *Energy Environmentalists*
  - *Any decision-maker not looking at district heating and cooling as an option*

District energy development tool

- **Typical software to plan, analyze and operate district energy systems for cities, towns, residential, commercial and institutional establishments**
  - *Analyze feasibility*
  - *Track performance*
  - *Help utilities plan electric and gas deregulation strategies;*
  - *Assess upgrades and expansions*
  - *Evaluate hot-water, steam, and chilled-water distribution*
  - *Determine viability of steam-to-hot water conversion*
  - *Evaluate strategies for district energy pipe replacement*
  - *Estimate system costs*
  - *Establish valuation of systems for sale*
  - *Determine the environmental and energy benefits of proposed or existing district energy systems alone or in combination with cogeneration facilities*

District energy solutions

- **Economic**
  - *Heated homes require less remedial work and the annual costs of servicing individual domestic boilers are eliminated.*
  - *Affordably heated homes have lower rent arrears and fewer changes in tenancy.*
  - *Homes with full heating attract higher rents.*
  - *Annual gas boiler safety checks are eliminated.*
- **Social**
  - *Savings from bulk fuel purchasing and higher efficiency plant such as CHP, can be passed on through lower charges.*
  - *Low cost electricity*
  - *Individual room control, as well as programmable heating and hot water, are standard features on modern community schemes.*
  - *Community Energy schemes provide instant availability of unlimited hot water at high pressure.*
  - *Modern metering ensures that residents only pay for the heat they use.*

District energy success stories

- **Some success stories around the world**
  - *On Prince Edward Island, two hot water systems using wood waste residue provide heat to about one-third of the large commercial and institutional buildings in downtown Charlottetown.*
  - *In northern Quebec, a Cree village has installed the first native community-wide district heating system in North America. It also uses wood residue and hot water technology.*
  - *A private company, Central Heat Distribution, supplies high-pressure steam to heat over 100 buildings in downtown Vancouver. It has plans to extend the system to serve new development on the former Expo '86 site.*
  - *Helsinki, Finland was awarded the United Nations Environmental Prize in 1990 for its cogenerated district heating, which serves more than 90% of the city's heat requirements.*