

Climate Change 2 : Canadian Technology Development

District Energy Systems: A Technology to Reduce Greenhouse Gas Emissions

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2001**

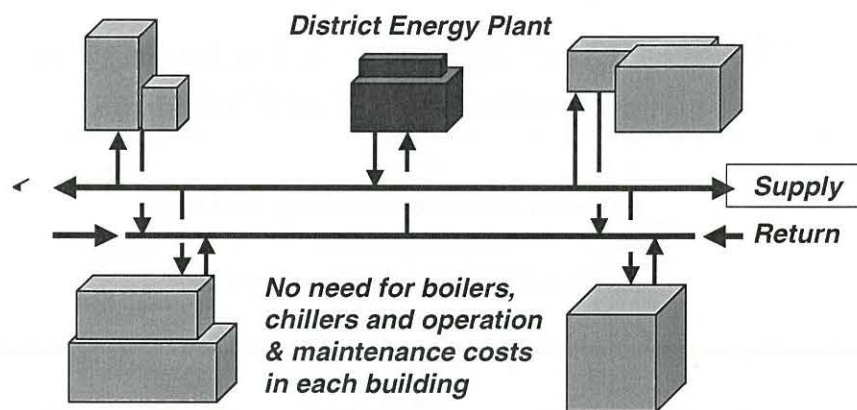
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What is District Energy?

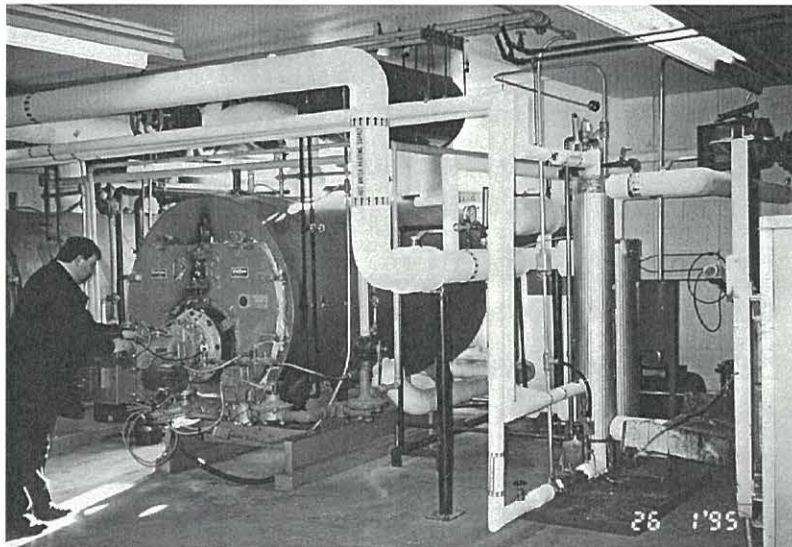
- **District Energy Systems distribute steam, hot water and/or chilled water from a central plant to individual buildings through a network of pipes**
- **Provide space heating, air conditioning, domestic hot water and process energy**
- **Serve downtowns, universities, military bases, hospital complexes, industrial areas**

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How Does District Energy Work?



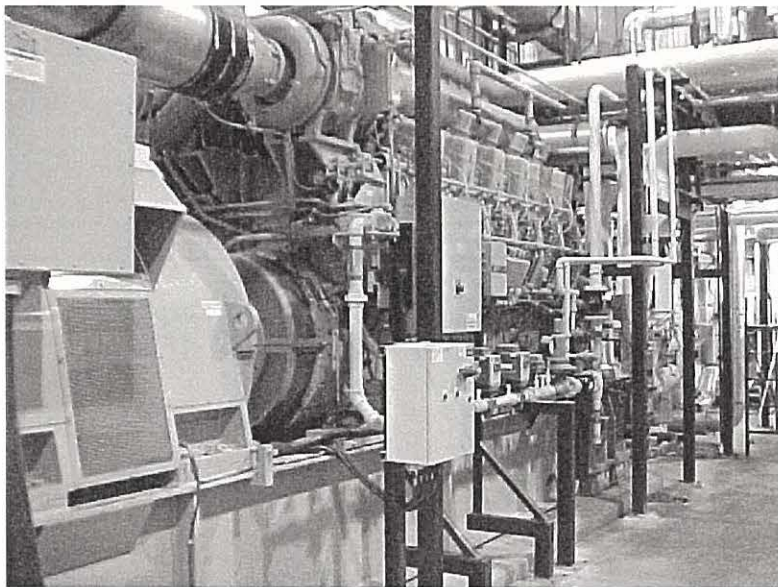
In The Building



In The Streets



The Plant

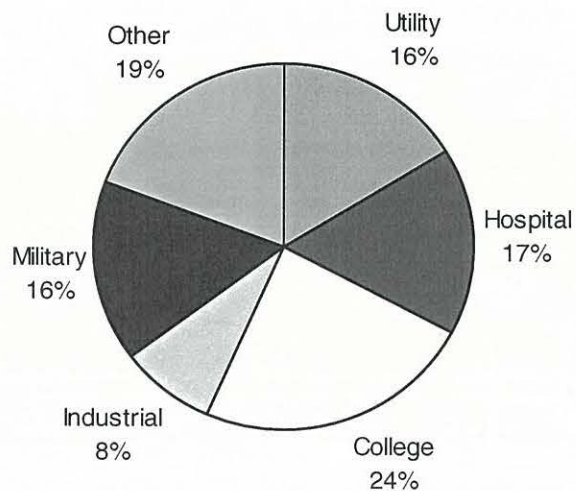


Size of District Energy Industry

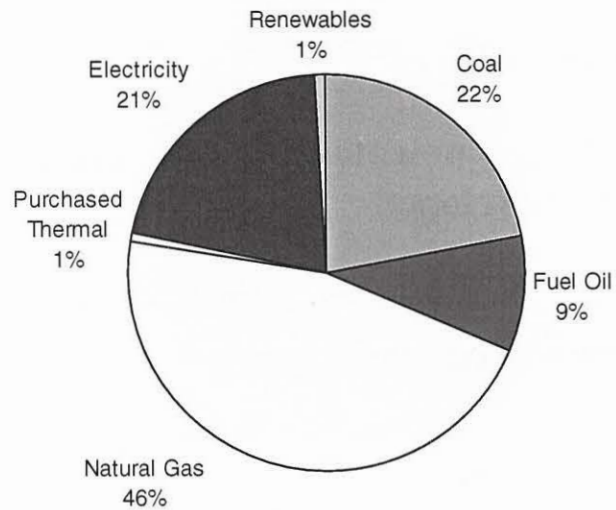
- 5,800 systems in North America
- Over 1 quad of end-use energy
- Over 10% of commercial floorspace served by district heating
- Over 4% of commercial floorspace served by district cooling

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District Energy Output by System Type



District Energy Fuel Use



Old Fashioned View of DES

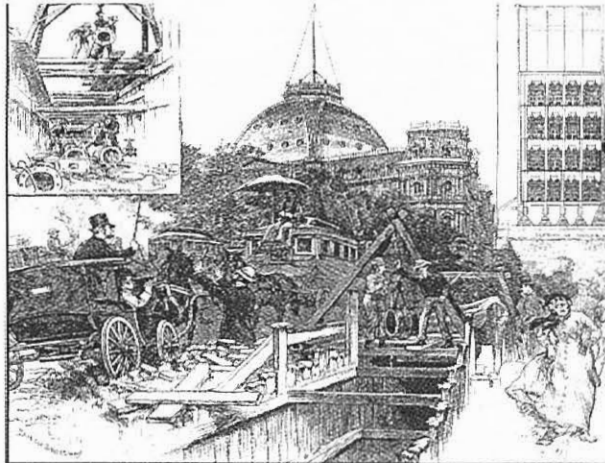


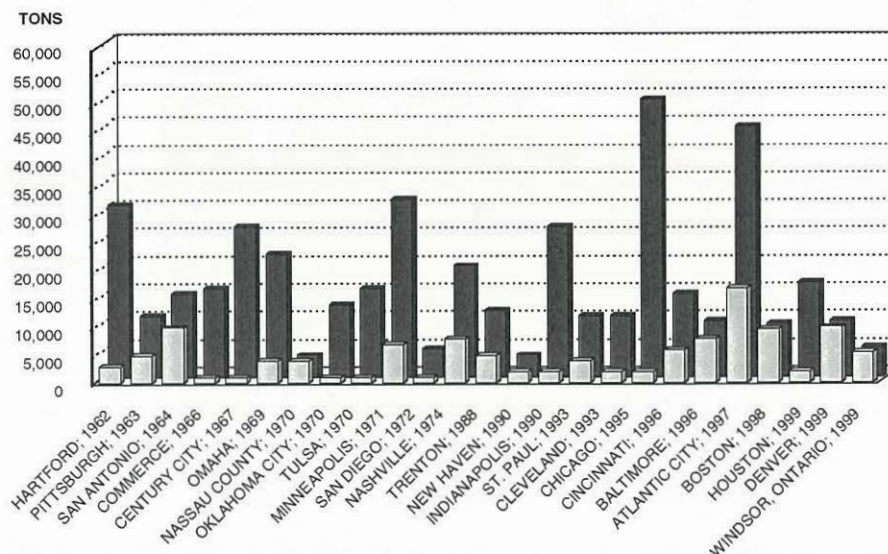
Illustration from Harper's Weekly (September 9, 1882) depicting installation of the New York steam district heating system

N.A. District Energy since 1990

- Over \$1.7 billion invested
- Over 20 new downtown district cooling systems developed
- Over 150 million square feet of new customer space connected

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Significant Growth in System Size



District Energy Technologies

- **Combined Heat and Power (CHP)**
- **Chiller Technologies**
- **Distribution Systems**
- **Thermal Energy Storage**

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Combined Heat & Power

- **Gas Turbine**
 - Simple Cycle
 - Combined Cycle
- **Steam Turbine**
- **Reciprocating Engine**
- **Fuel Cell**

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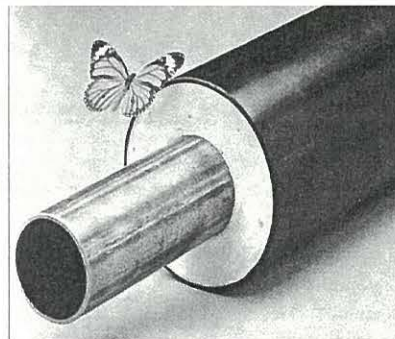
Chiller Technologies

- **Compression Chillers**
 - Electric Drive
 - Steam Turbine Drive
- **Absorption Chillers**
 - 1-Stage Steam
 - 2-Stage Steam
 - Hot Water

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Distribution Technologies

- **Pre-insulated pipe**
- **Plastic pipes**
- **Ice slurries and freeze point depressants**
- **Friction reduction additives**



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Thermal Energy Storage

- Economical with aggregated loads
- Flattened load more attractive in deregulated market
- Reduces costs and increases operational flexibility
- Ice storage
 - Densely developed areas
 - Reduce building costs
- Chilled water storage used where space available



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District Energy Roles

- Existing DES used as thermal sink for CHP
- New DES integrating loads to optimize CHP
- DES as community energy broker, distributing excess thermal output from:
 - building- and small-scale CHP
 - power plants
 - industrial waste heat
 - community biomass
 - natural sources of thermal energy

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Key Opportunities for CHP with District Energy Systems (DES)

✓ Heat Sinks R Us!

Install CHP to supply existing DES in university campuses, military bases, hospital complexes or downtown areas

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Key Opportunities

✓ Optimize CHP in new multi-building developments

Link buildings in a Power Park or other development, thereby achieving sufficient load to implement technically proven, economical, low-emissions CHP

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Key Opportunities

✓ Community Energy Broker

Use DES to link thermal energy users to multiple sources of waste heat and renewable energy sources

- building- and small-scale CHP
- power plants
- industrial waste heat
- community biomass
- natural sources of thermal energy

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Key Opportunities

✓ Power Grid Reliability

Reduce peak power demand and increase grid reliability by:

- Generating power at load centers through CHP
- Shifting demand to off-peak periods through Thermal Energy Storage
- Delivering cooling energy through DES rather than power grid

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District Energy Roles

- Competitive edge for office/industrial parks and downtown areas
- Energy and cost optimization in new building complexes through low temperature cooling
- Strategy for reducing peak power demand
 - optimize use of generating capacity
 - relieve transmission/distribution constraints
- Tool for reducing energy costs through CHP, thermal storage and new technologies

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Benefits of District Energy Systems

- | | |
|---|--|
| ● Tap waste energy | ● Emissions reductions |
| — Power plant waste heat | — SO ₂ , NO _x , particulates |
| — Industrial waste heat | — Carbon dioxide |
| — Biomass waste fuels | — Ozone-depleting refrigerants |
| — Environmental sources of heat or cool | |
| ● Electric load shift | ● Fuels |
| — Low cost peak capacity | — Flexibility |
| — Better baseload utilization | — Indigenous fuels |

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Energy Efficiency

- **Tap waste energy**
 - Power plant waste heat
 - Industrial waste heat
 - Biomass waste fuels
 - Environmental sources of heat or cool
- **Energy-efficiency equipment**
 - high-efficiency equipment
 - better equipment loading
 - sophisticated controls and professional staff

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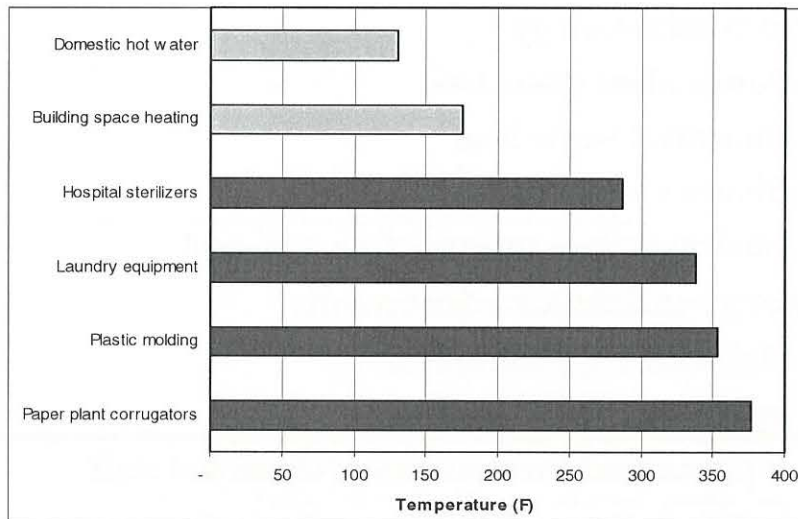
Environment



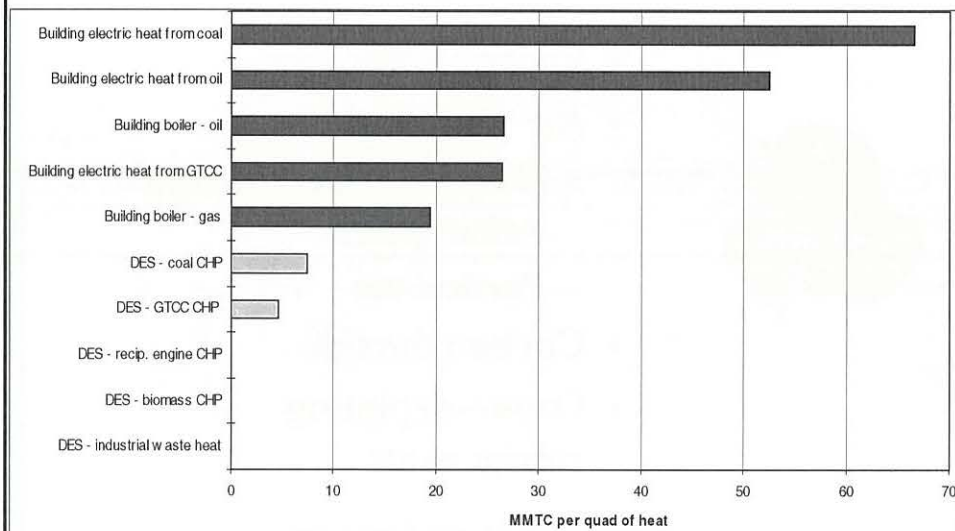
- **Energy Efficiency**
- **Air Pollution**
 - Nitrogen oxides --> smog
 - Sulfur dioxide
 - Particulates
- **Carbon dioxide**
- **Ozone-depleting refrigerants**

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End-use Temperature Requirements



Carbon Intensity of Building Heating Options



Economy



- **Economic Growth**
 - Labor-intensive development
 - Economic multiplier
- **Urban Revitalization**
 - Energy-efficient infrastructure
 - Lower cost for building development
 - Stable, cost-competitive operating costs
 - Better air quality

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Economy

- **Energy security**
 - Flexibility helps price and supply stability
 - Renewable sources
- **Improved reliability of electricity supply**
 - district energy CHP generates power near demand
 - thermal storage shifts power demand off-peak
 - cooling can be supplied with non-electric systems
 - transmission and distribution constraints reduced

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Customer Benefits

- **Elimination of capital costs for boiler and chiller systems**
- **Improved reliability**
- **Reduced risk**
- **Flexibility**
- **Convenience**
- **Compares favorably with costs for equipment, fuels, electricity, operation and maintenance**

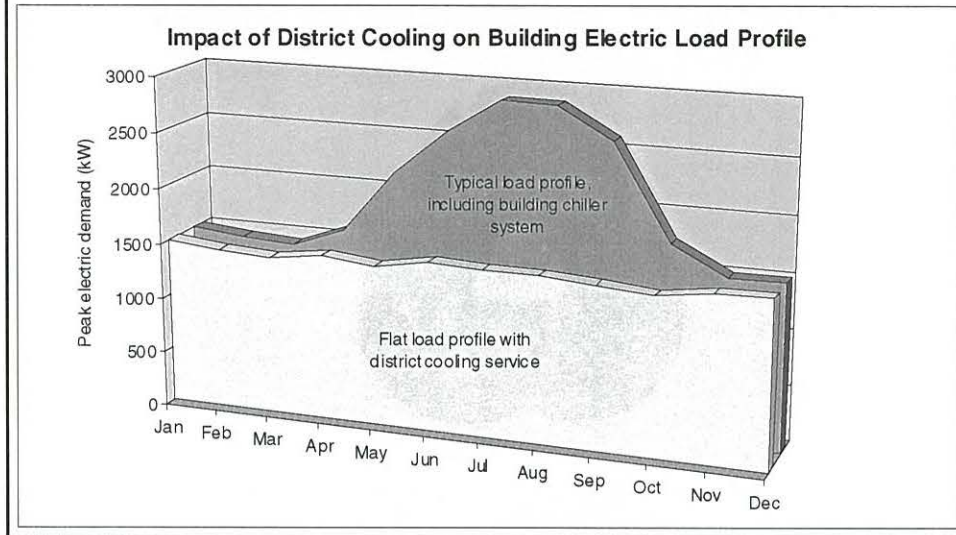
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District Cooling Helps Position Buildings for Competitive Power Market

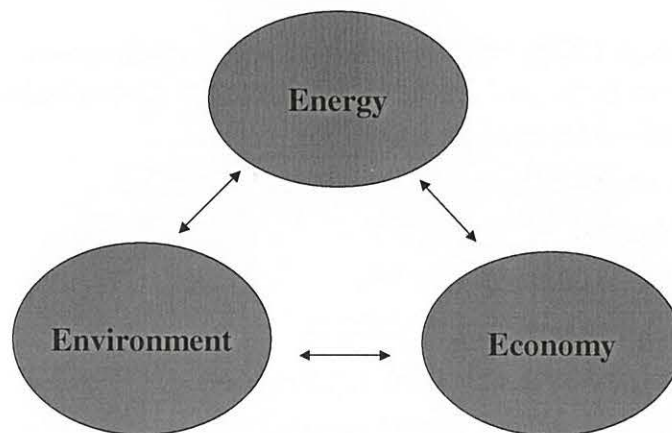
- **With restructuring, peak electricity will increase in cost**
- **Flat electric load will reduce electricity costs and improves purchasing power for base electricity requirements**
- **District cooling reduces peak electric demand and flattens the load profile**

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District Cooling Flattens the Building Electric Load Profile

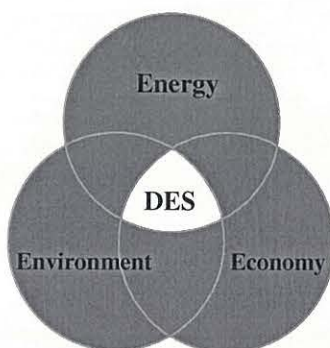


Historic Tensions



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Energy-Environment-Economy Synergy with District Energy



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Example of Denmark

- Since 1970, *total* space heating requirements have been *cut* by 40% while total space being heated *increased* by 48%
- Energy efficiency has almost *doubled*
- SO₂ reduction of 35%
- CO₂ reduction of 50%
- NO₂ reduction of 80-90%
- Major industry - jobs, jobs jobs
- Funded with private capital

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