CHP and District Energy : Evaluation as a Means to Achieve Transformative Reductions in Energy Usage/GHG Emissions

Presented by

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Chief Public Utilities Branch

Department of Cable and Consumer Services

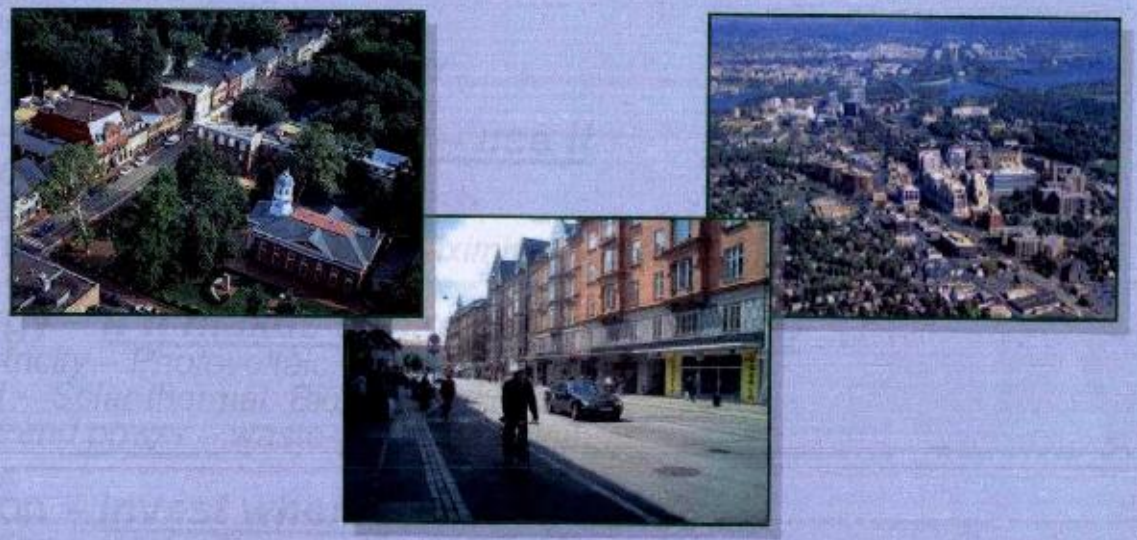
Discussion Overview

- Review P. Gorforth CEP Framework
- Overview of District Energy Industry: Denmark, US and Regionally
- Business Case, Economics, Project Viability Issues
- Impediments and Constraints
- State Legislative and Regulatory Framework – Susan Hafeli

Garforth CEP Framework

Community Energy Planning

Creating Globally Competitive Communities



Peter Garforth
Principal – Garforth International llc

MWCOG Workshop – Integrated Community Energy Solutions
January 26th, 2011 - Washington DC

Overall Efficiency Examples
Greenhouse Gas Indicators

- 70% of manmade GHG comes from energy use
- GHG good surrogate for overall energy productivity
- National GHG per capita per year (metric tons CO_2)
  - *USA* — *22.8*
  - *Canada* — *22.6*
  - *Denmark* — *14.1*
  - *Germany* — *11.7*
  - *European Union* — *10.5*
- Municipal GHG per capita per year (metric tons CO_2)
  - *Arlington County VA* — *14.6 with 4.5 goal*
  - *Loudoun County VA* — *14.2 with 6.0 goal*
  - *Guelph - Ontario* — *12.2 with 5.0 goal*
  - *Mannheim - Germany* — *6.0 with 4.5 goal*
  - *Copenhagen - Denmark* — *3.0 with zero goal*

Communities Embracing Breakthrough Targets

CEP Framework
Loading Order / Trias Energetica

- Energy efficiency – ***If you don't need it don't use it***
  - *Efficient buildings, vehicles*
  - *Urban design for transport efficiency*
  - *Local employment for commuting efficiency*
- Heat Recovery – ***It it's already there – use it***
  - *Distributed combined heat and power*
  - *Use existing "waste" heat*
  - *Structure commercial/industrial sites to maximize "waste" heat use*
- Renewable energy – ***If it makes sense, go carbon free***
  - *Renewable electricity – Photovoltaic, Wind, Run-of-river Hydro*
  - *Renewable heat - Solar thermal, Biomass, geothermal*
  - *Renewable heat and power – waste-to-energy, biomass*
- Energy distribution – ***Invest where it makes sense***
  - *Flexible distribution – electricity, gas, district heating, cooling…*
  - *Accepts multiple fuels and energy conversion technologies*
  - *Optimize local / regional investment choices*

Integrated Solution – Tailored for Community

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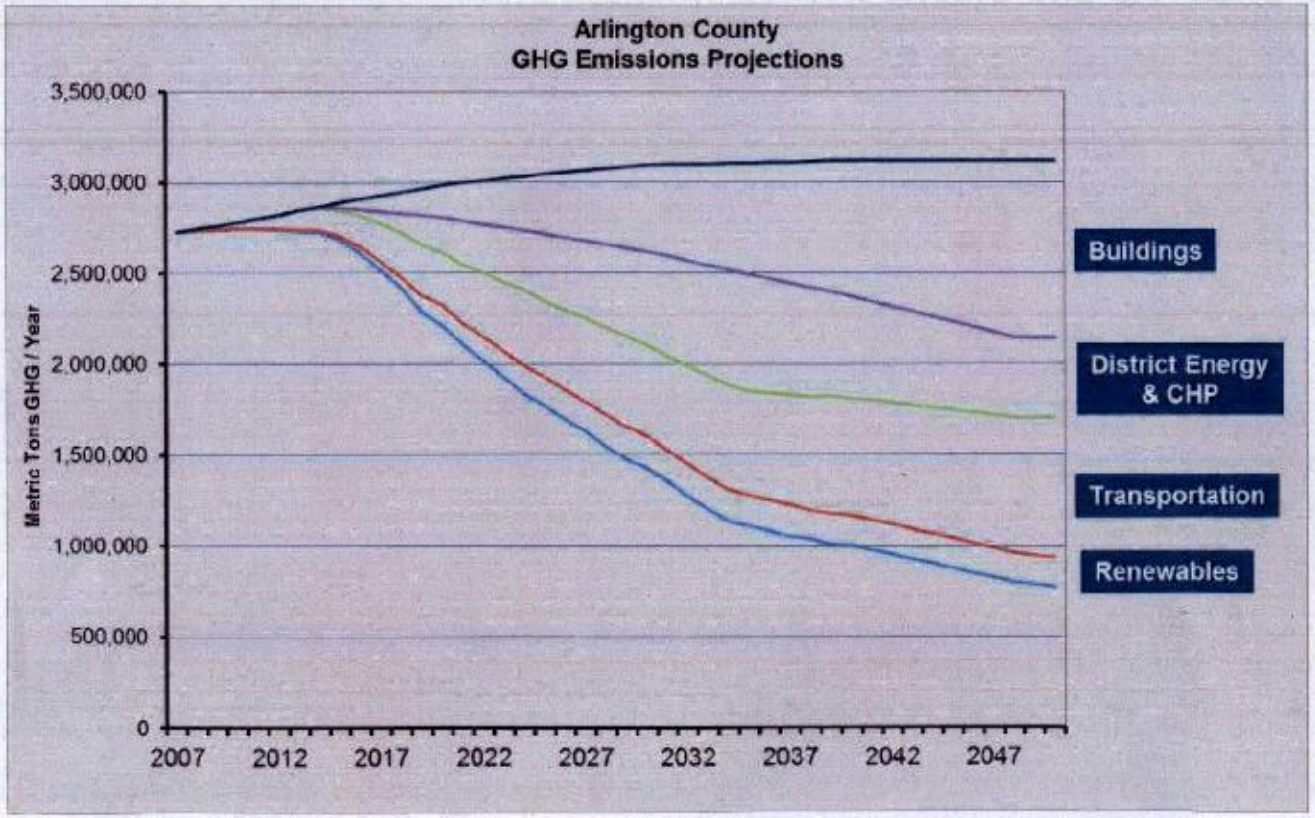
Create Clear Year-on-Year Goals
GHG Targets – Arlington Example



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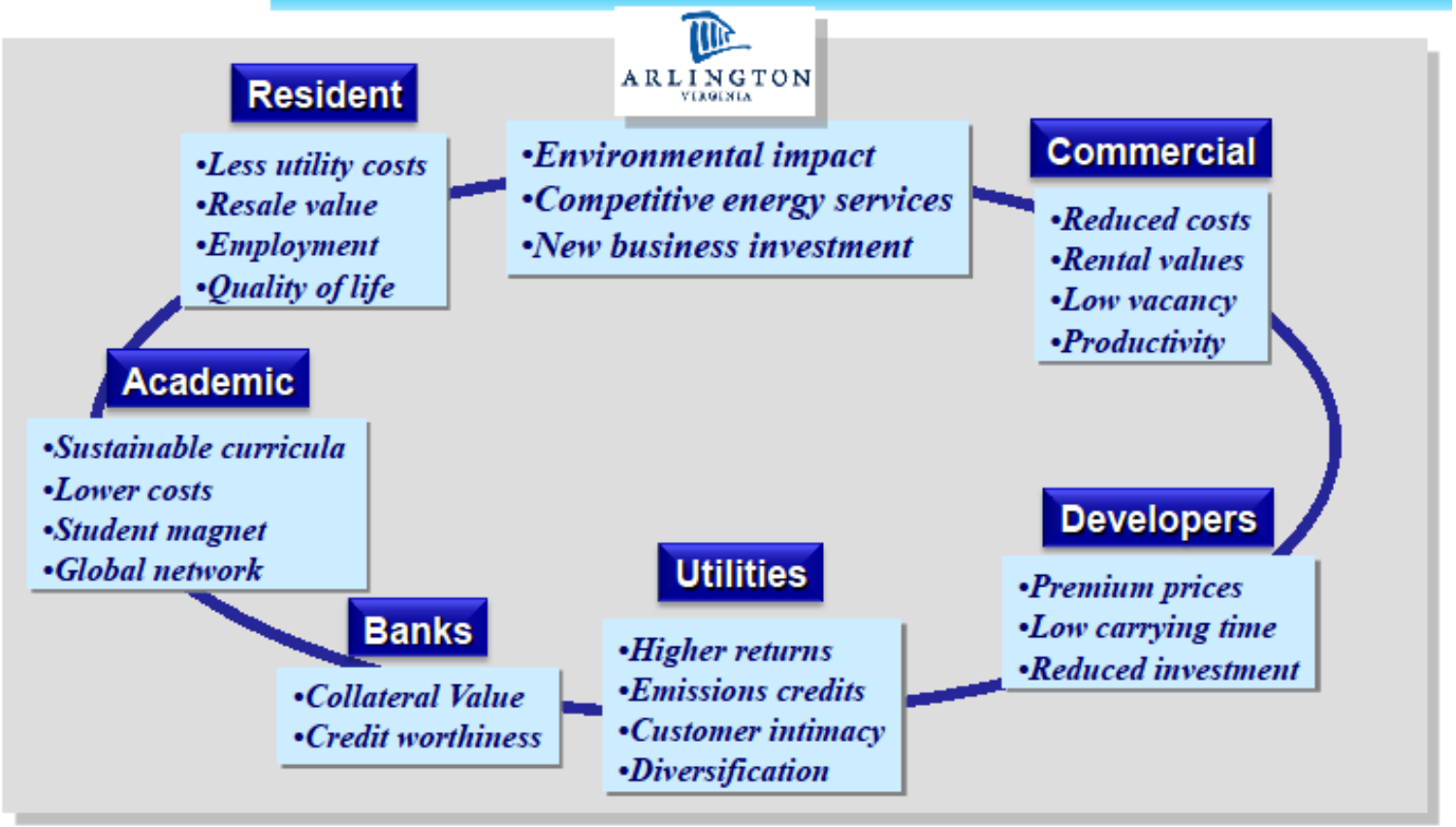
Benefits of Success!



New Relationships – New Rules

MWCOG

Metropolitan Washington Council of Governments

- Climate, Energy and Environment Policy Committee

(Why?) Denmark's District Energy Planning

Washington, DC, January 26th, 2011

Jes B. Christensen
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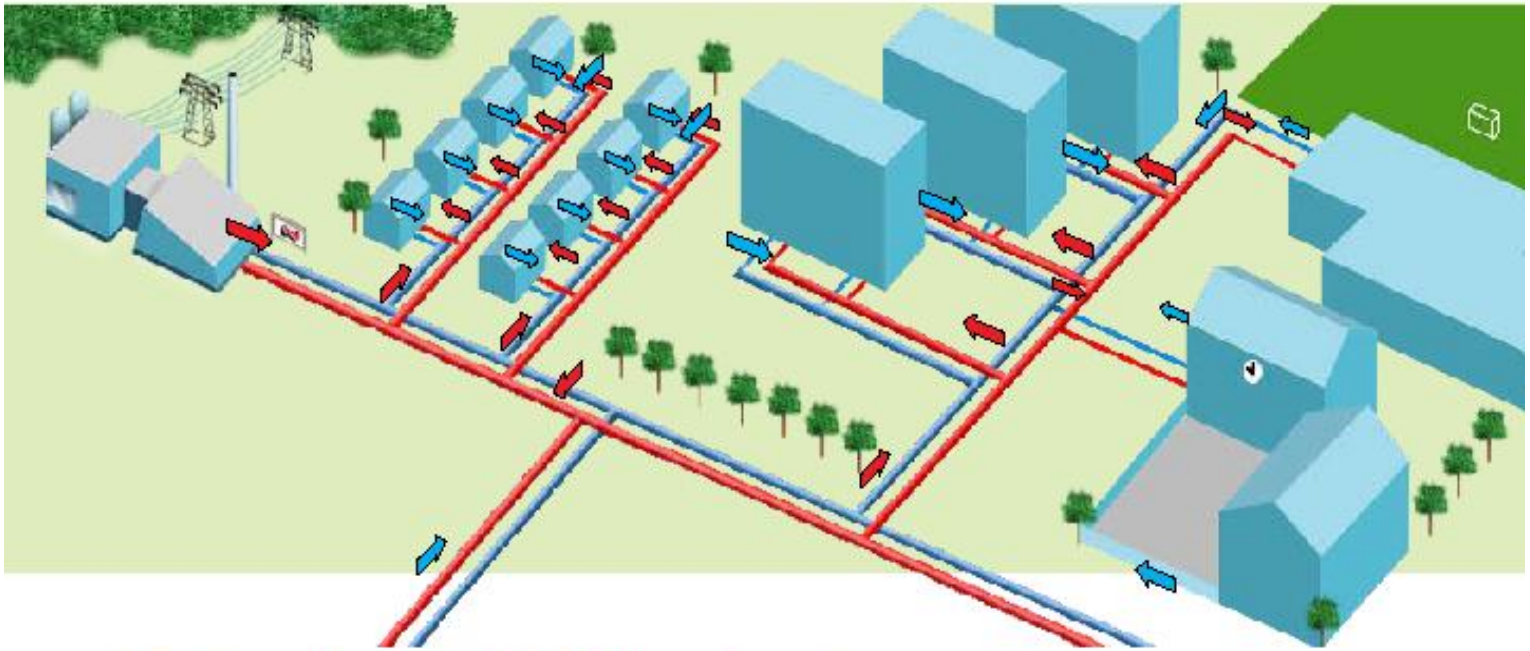
DBDH

- District Heating is under ground



- Nationally exists 30.000 km pipe system
- 62 % of all homes have District Heating
- This is equivalent to approx 50% of the total heat demand

DBDH

What triggered the energy revolution?

- 1973-74 oil crisis
- 2 countries were 98% dependent on imported energy: Japan and Denmark (oil and coal)
- Supply situation exacerbated by inefficient energy use
- Sharply rising oil prices caused severe economic crisis and high unemployment.

↓

A matter of national security and top economic priority to embark on new sustainable solutions

Show car free Sundays in Denmark as a result of the oil crisis in 1973

DBDH

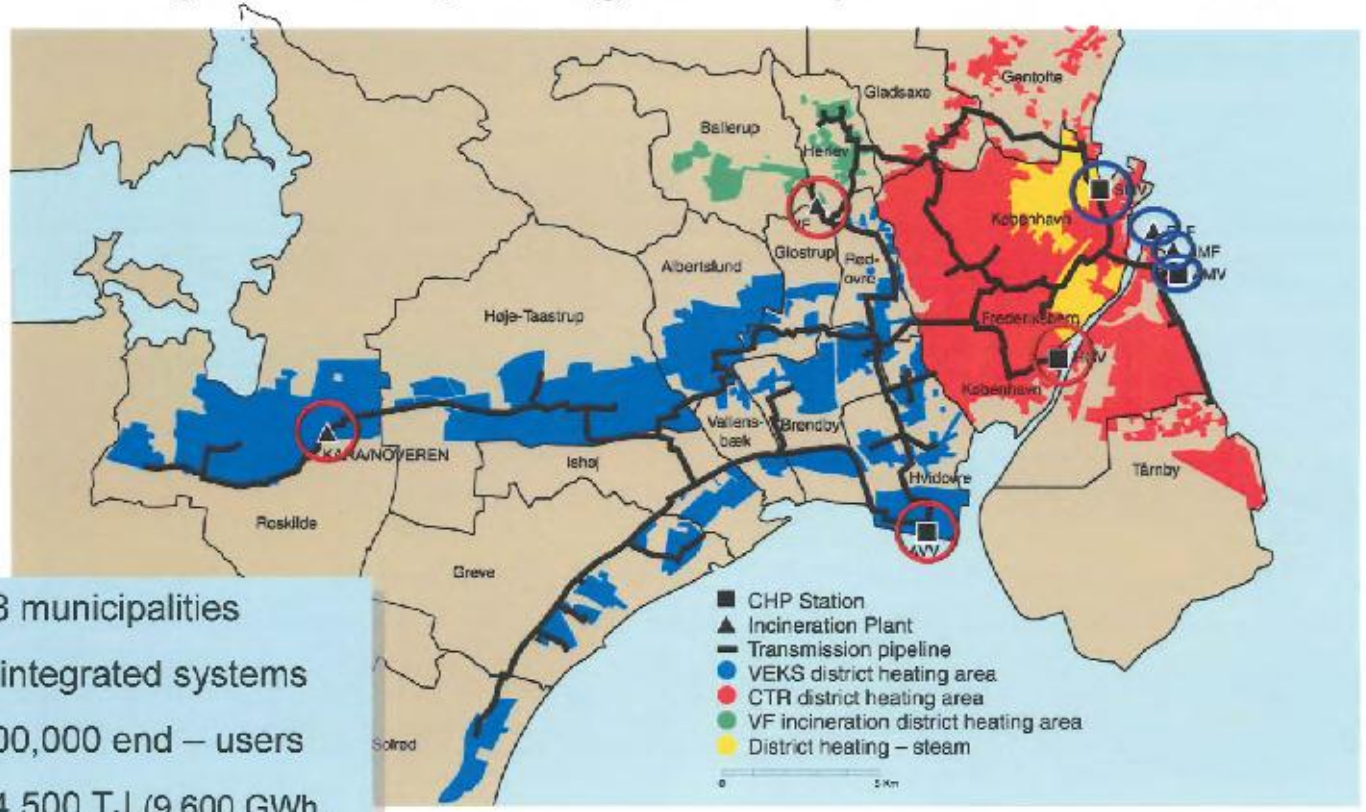
- Political Leadership before anything else

DECIDED THAT WASTED ENERGY IS BAD AND REACTED!

- **Energy Legislation**
  - **1976 – Electricity Supply Act**
  - **1979 – Heat supply act**
  - 1986 – decentralized CHP to promote domestic fuels, e.g. biomass
  - 1990 – increase use of biomass by building new CHP and converting existing coal and oil fired CHP's to e.g. biomass
  - 1993 – Concrete measures to increase use of biomass to 20 PJ/Year
  - 2008 – Further increase use of biomass by 700.000 tons
  - **2011 – Fossil Free Society?**

DBDH

The greater Copenhagen DH system – 'real time'



18 municipalities

4 integrated systems

500,000 end – users

34,500 TJ (9,600 GWh, 32,700 GBtu)

DBDH

Consumer Prices for District Heating (2010/11)

District heating is significantly cheaper than alternative supply:

- 98% of all district heating consumers pay less for their heat compared to heat from individual household-based oil stoves
- Compared to the cost of heat from an individual natural gas boiler, 95% of DH customers pay less
- DH consumer price averages 2,650 USD (18.1 MWh/year) = about 4% of HH income.
- Natural Gas = 3,670 USD
- Oil Furnace = 4,590 USD

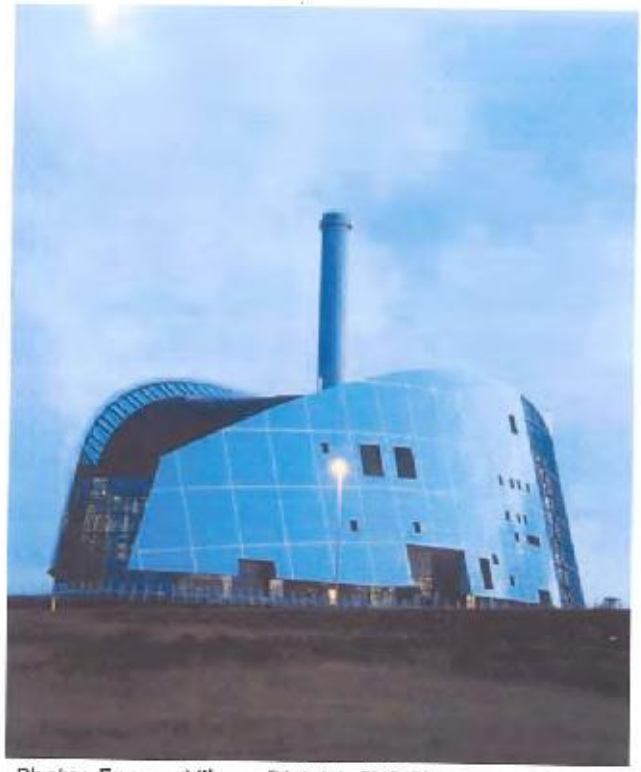


Photo: Energy Viborg District CHP Plant (Architectural Design Matters)

Source: Danish District Heating Association

DBDH

Arlington County

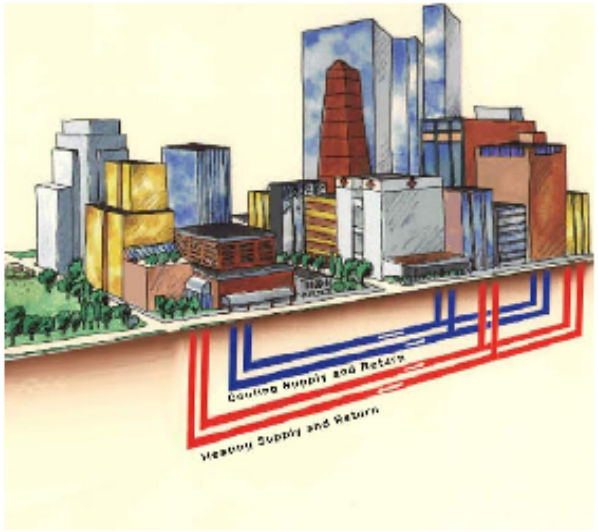
ARLINGTON
VIRGINIA

Arlington's Community Energy Project

Ensuring a Competitive and Sustainable Community

April 2011

Recommendation: District Energy Systems

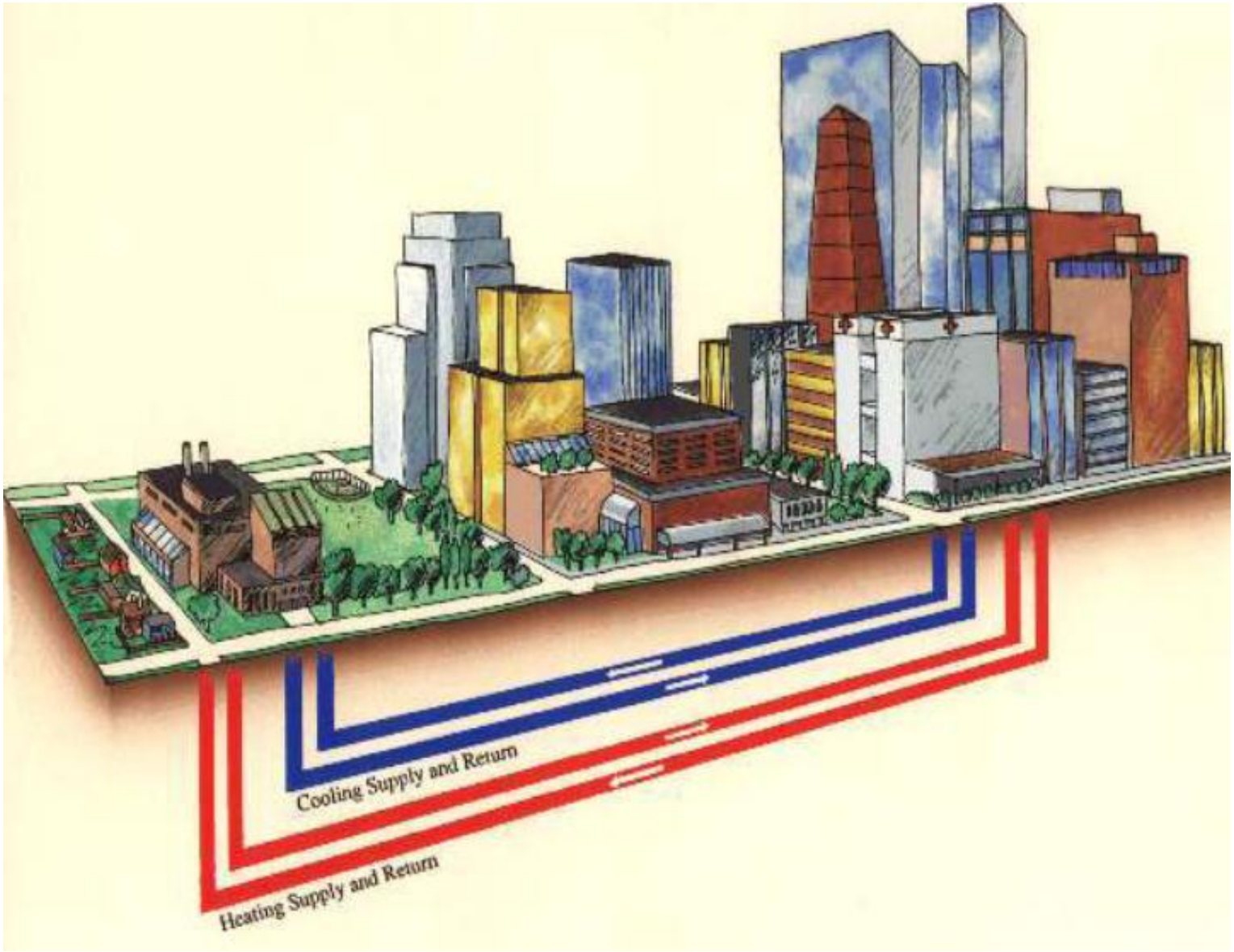


Centralized supply and delivery
- *Heating*
- *Cooling*
- *Domestic hot water*

- Distribution to many homes and buildings
- Closed network of highly insulated pipes
- Optimized energy supply from multiples sources
  - *Combined Heat & Power*
  - *Boilers/Furnaces*
  - *Absorption Chillers*
  - *Electric Chillers*
  - *Solar and Biomass*
  - *Waste heat recovery*
- Typically operated by dedicated DE-Utility

Widely deployed proven technology

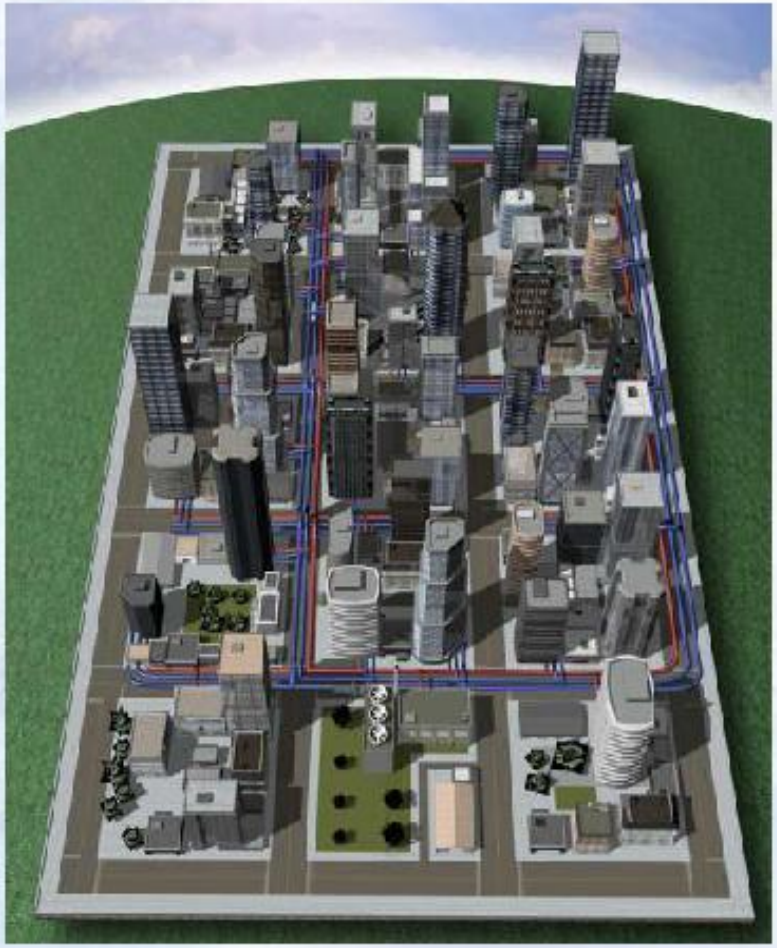
International District Energy


Cooling Supply and Return
Heating Supply and Return

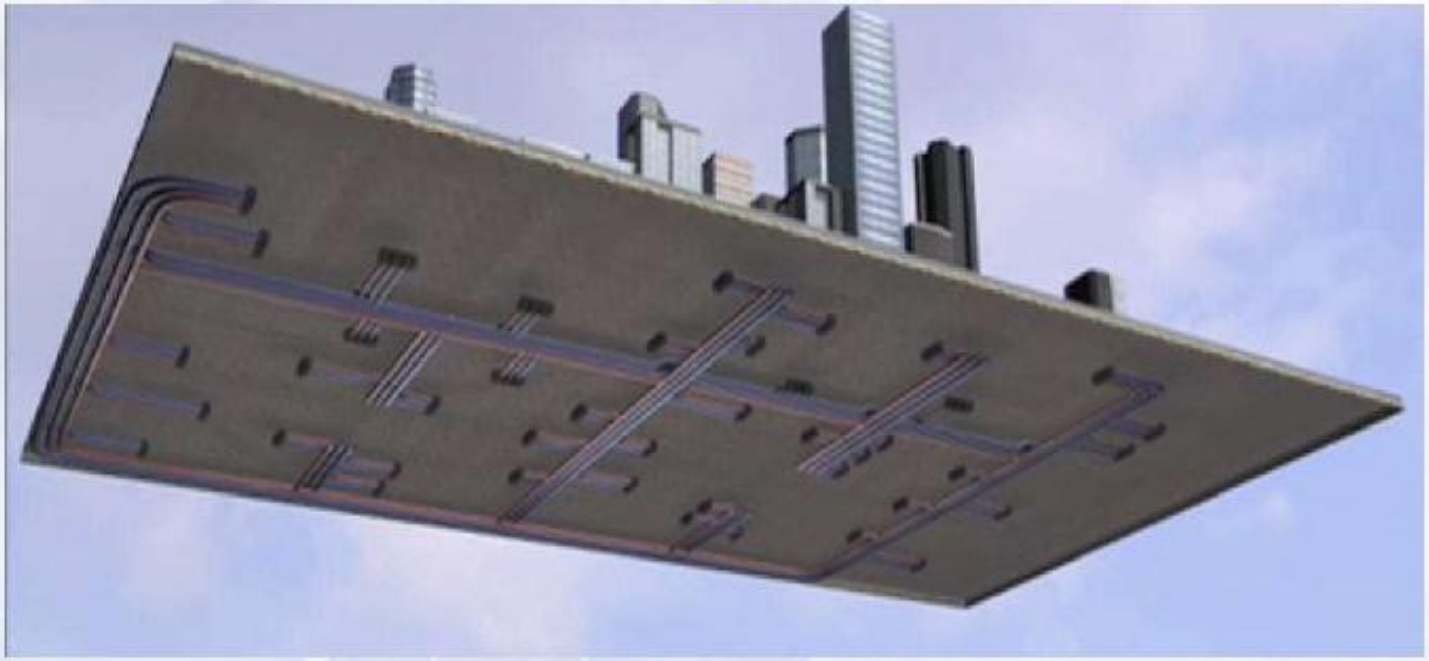
Opportunity – Use Surplus Heat

District Energy – Community Scale Heating and Cooling

- Underground network of pipes "combines" heating and cooling requirements of multiple buildings
- Creates a "market" for valuable thermal energy
- Aggregated thermal loads creates scale to apply fuels, technologies not feasible on single-building basis
- Fuel flexibility improves energy security, local economy

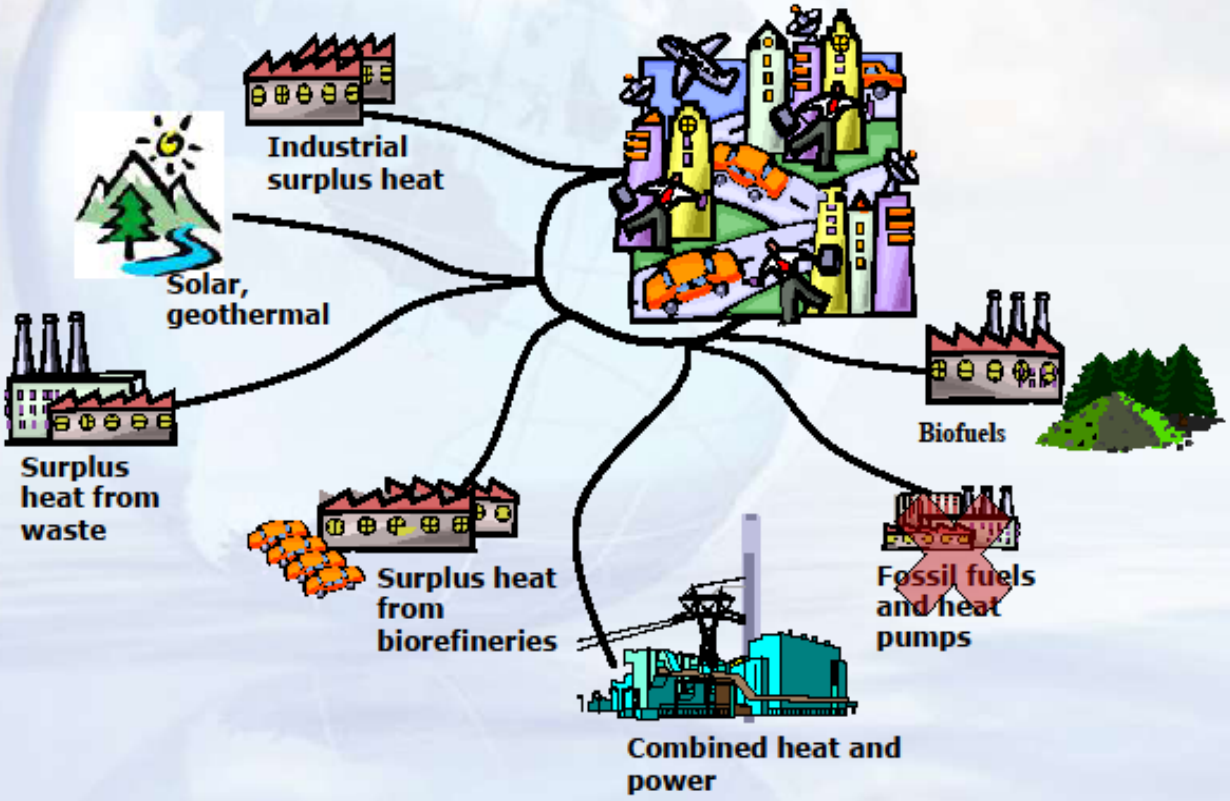


Infrastructure for Local Clean Energy Economy



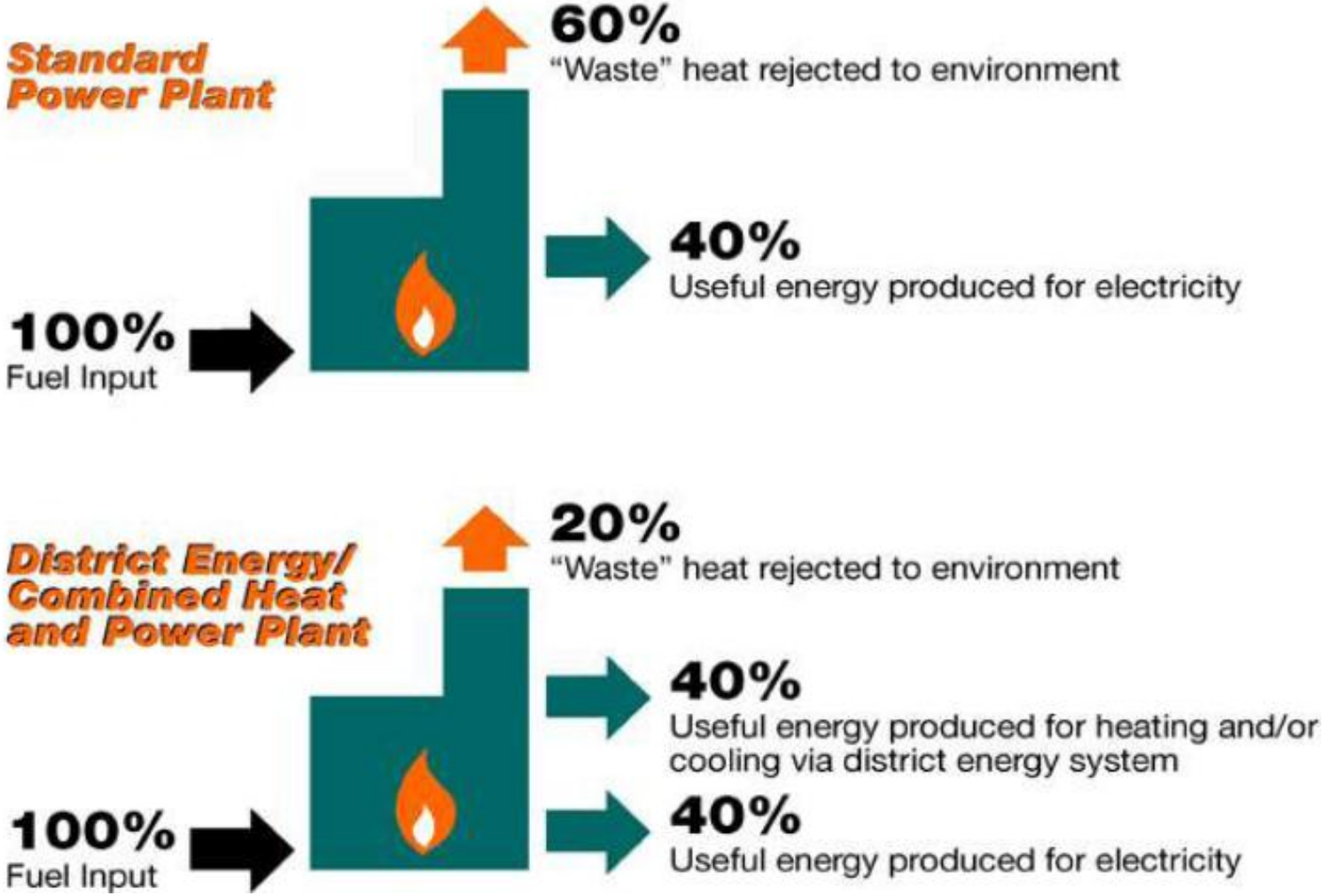
- Connects thermal energy sources with users
- Urban infrastructure – hidden community asset
- Energy dollars re-circulate in local economy
- Locate generation near the power & thermal load

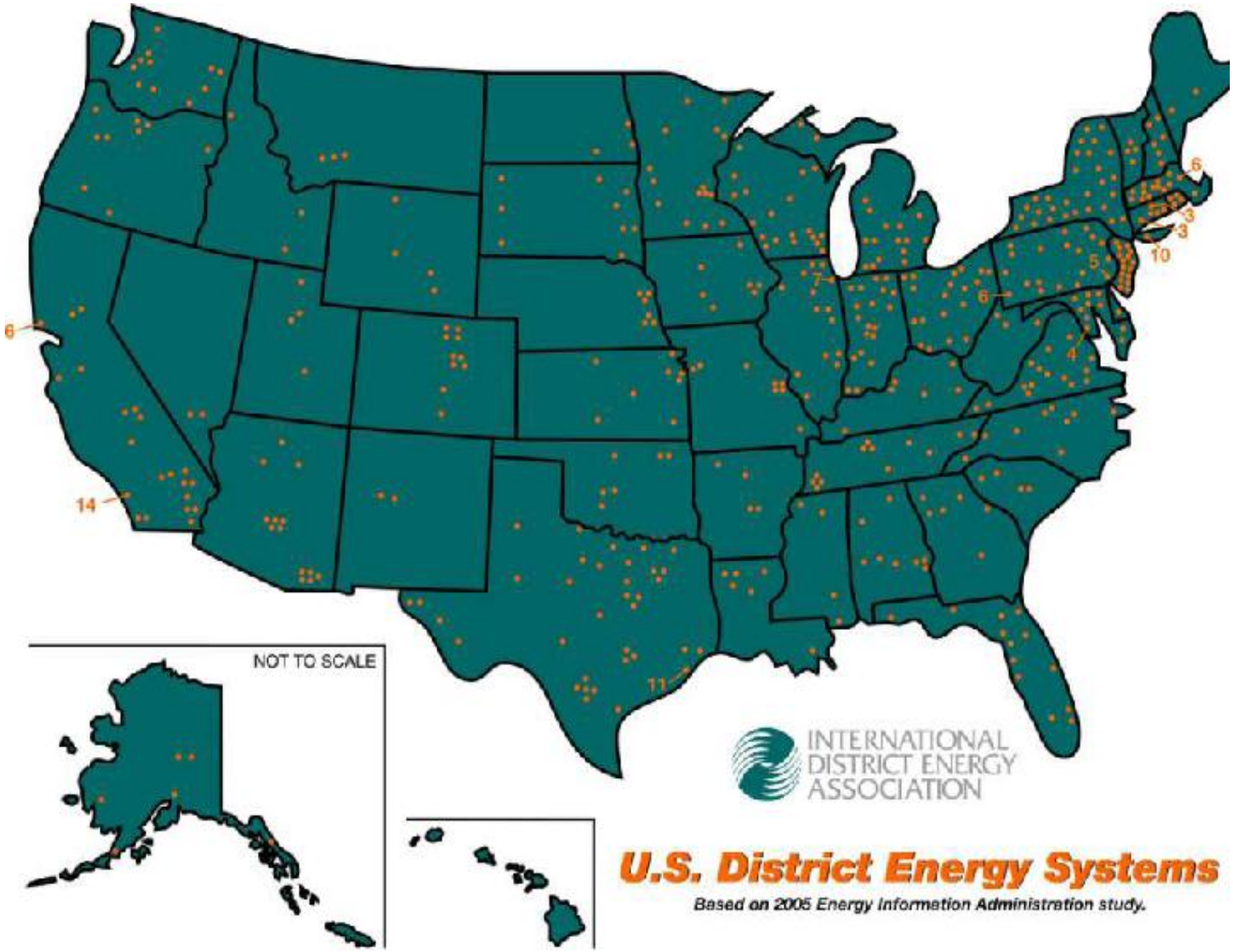
District Energy Networks Make Efficient Use of Local Renewable Energy Sources and Surplus Heat



INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Energy-Efficiency Comparisons

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NOT TO SCALE
INTERNATIONAL
DISTRICT ENERGY
ASSOCIATION
U.S. District Energy Systems
Based on 2005 Energy Information Administration study.

US District Energy Industry Capacity

	# Systems Reporting	Gross SF Customer Building Space Served	Heating Capacity (MMBtu/Hr)	Cooling Capacity (Tons)	Electricity Generation (CHP Mwe)
Downtown Utilities	85	1,898,037,560	49,239,000	1,082,355	950
Campus Energy Systems	330	2,489,216,071	82,107,191	1,855,546	2,197

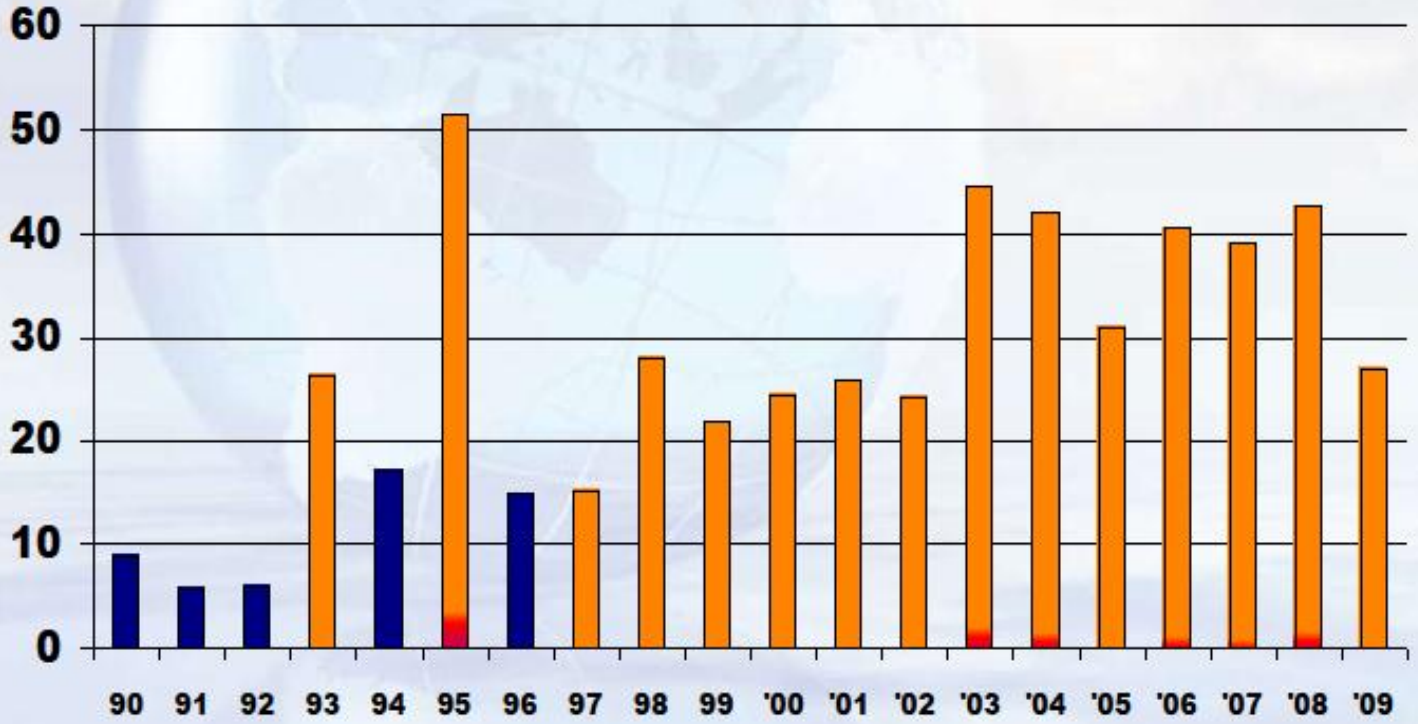
* Based on systems reporting 2005 data to EIA Survey

District Energy Industry Growth

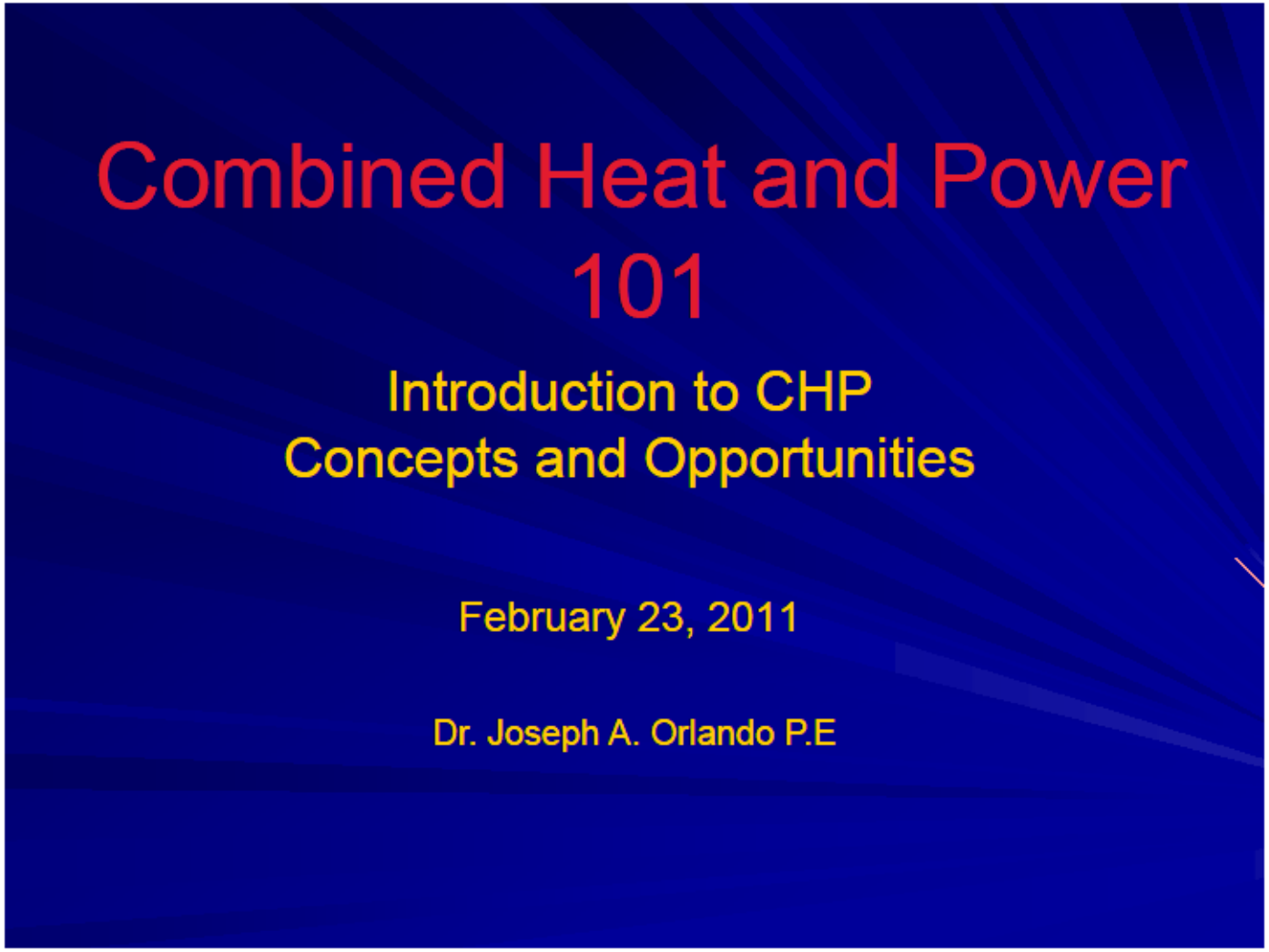
(Million sq ft customer bldg space connected/committed)

Aggregate SF reported since 1990 - 495,127,348 SF

(Annual average 24.7 Million SF/Yr – North America)



CHP Concepts



Characteristics of Good Applications

Good applications have at least one and preferably more than one of the following characteristics:

- High electric rates / low fuel costs – good "spark spread"
- Long operating hours
- Central heating and/or cooling plant – need thermal load
- Need to replace/upgrade existing boiler system
- Good coincidence between electric and thermal loads
- Nearby waste fuel or heat source available
- Larger facility size – yields lower first cost per kW
- Need or want more reliable power supply

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Walkthrough

The objective of the "walkthrough" is to identify those unacceptable sites, avoiding excessive analysis of a non-viable project opportunity:

- Economics
- Technical issues. Are site and building thermal systems capable of using recovered thermal energy?
- Existing conditions including infrastructure, zoning and environmental controls
- Space

Maximum walkthrough resource requirement is a few hours.

70

Garforth: District Energy can be the “Game Changer”: i.e.. the primary contributor to lower GHG emissions in Copenhagen

Other Factors To Consider

1. Copenhagen climate/no need for AC
2. Unique wind power/Scandinavian interconnect and subsidies
3. Denmark energy costs and unique energy taxation system
4. Commuter transportation
5. District Energy a “Niche” Industry – campus/govt.
6. Assumption that District Energy will beat local generation mix emissions
7. Assumption that District Energy is Green – RELAC

Business Case, Economics, Project Viability Issues

1. Combined Heat and Power/District Energy = Siting of Electric Generation Plant
2. District Energy “Lower Costs” in Denmark vs. Virginia
3. Ownership – public/private/public private partnership
4. Costs/Prices of old generation vs. new
5. Attraction of Customers to DE utility and sale of kWhs to Dominion
6. Financial Risk and Capital Attraction - Moody’s and case of State of MD electric utility industry
7. Start-up issues

Business Case, Economics, Project Viability Issues, cont.

8. Opportunity Costs Commercial vs. Industrial
9. Operational issues: reliability, 24/7 staffing/back-up systems and power
10. Technology Risk – 30 to 50 year project/techn. Δ
11. Few identifiable similar CHP/DE commercial model in US
12. Little attention in press
13. Poor track record of public officials directing energy industry organizational changes – electricity deregulation
14. Wide spread deployment not embraced by energy professionals/old costly technology

Impediments

1. Siting issues – residential and business community opposition
2. Air Quality/VA DEQ – non-attainment
3. Water access and cost
4. Security
5. Zoning – commercial vs. industrial
6. Building codes (Denmark vs. Virginia)
7. Financial attraction to unproven model
8. State of Virginia Statutes and Regulations

Final Thoughts

- Garforth hypothesis: hot water/steam the "Game Changer" for GHG emissions
- Staff recognized early-on issues
- Notable lack of attention in industry literature
- Discussions/negative feedback from energy industry experts