DISTRICT ENERGY Development & Deployment

March 18, 2015 |

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

ABOUT IDEA

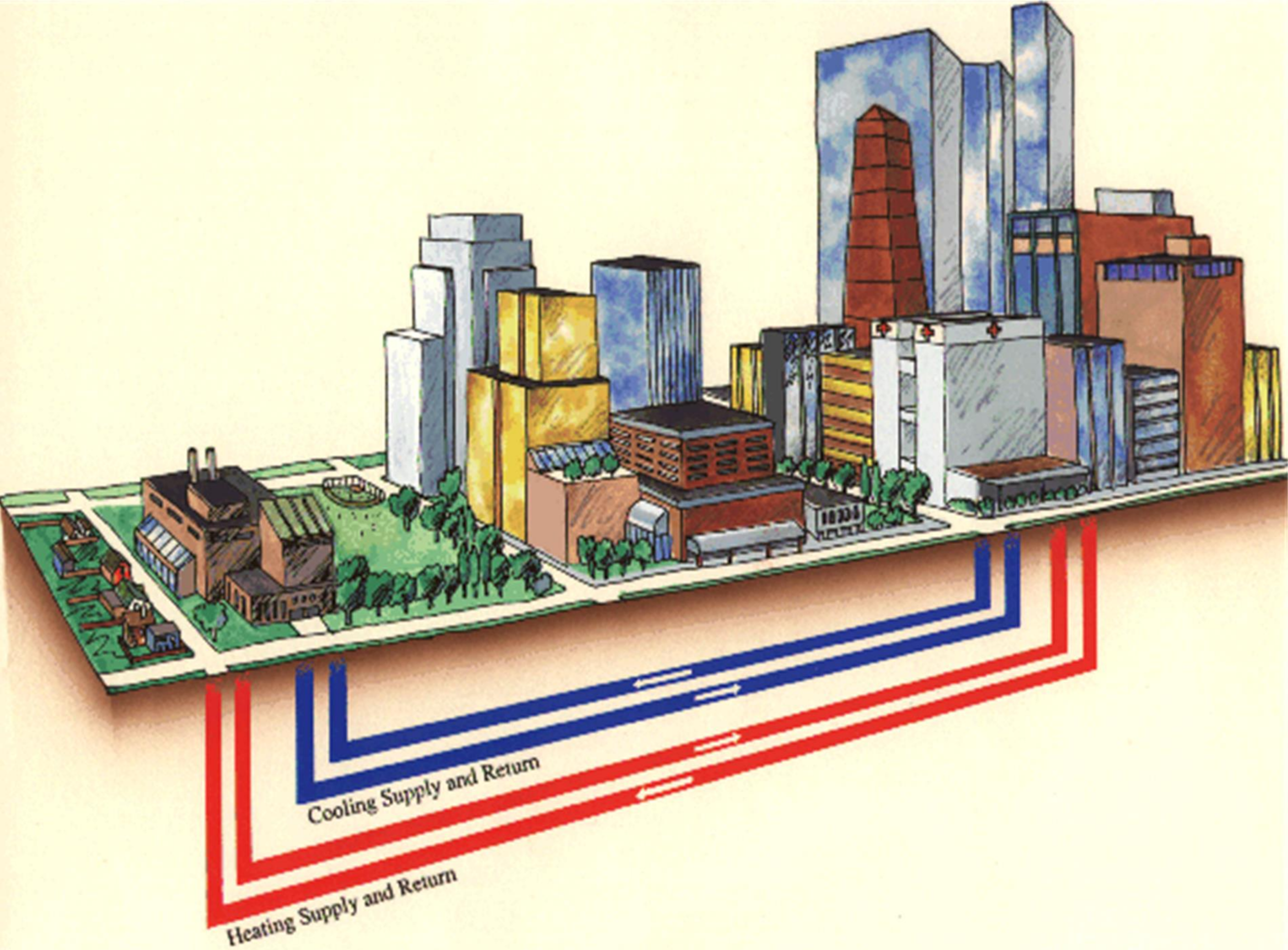
INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Formed in 1909: 106th year

501 (c) 6 industry association

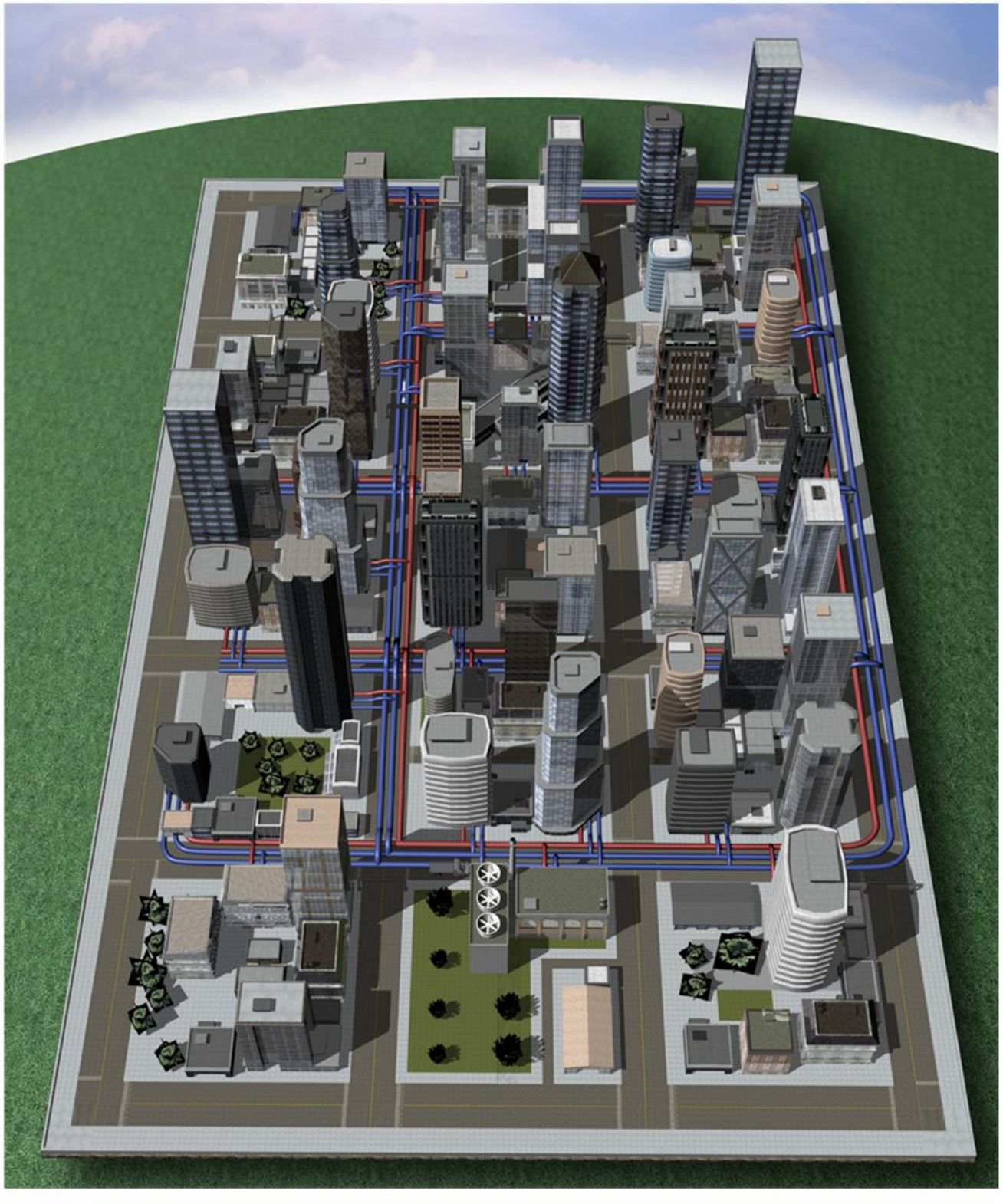
2000+ members – 25 nations
56% end-user systems, majority in North America: 6 provinces; 44 states

Major urban utilities, public and private universities & colleges, healthcare, pharma, airports, industrial, etc.

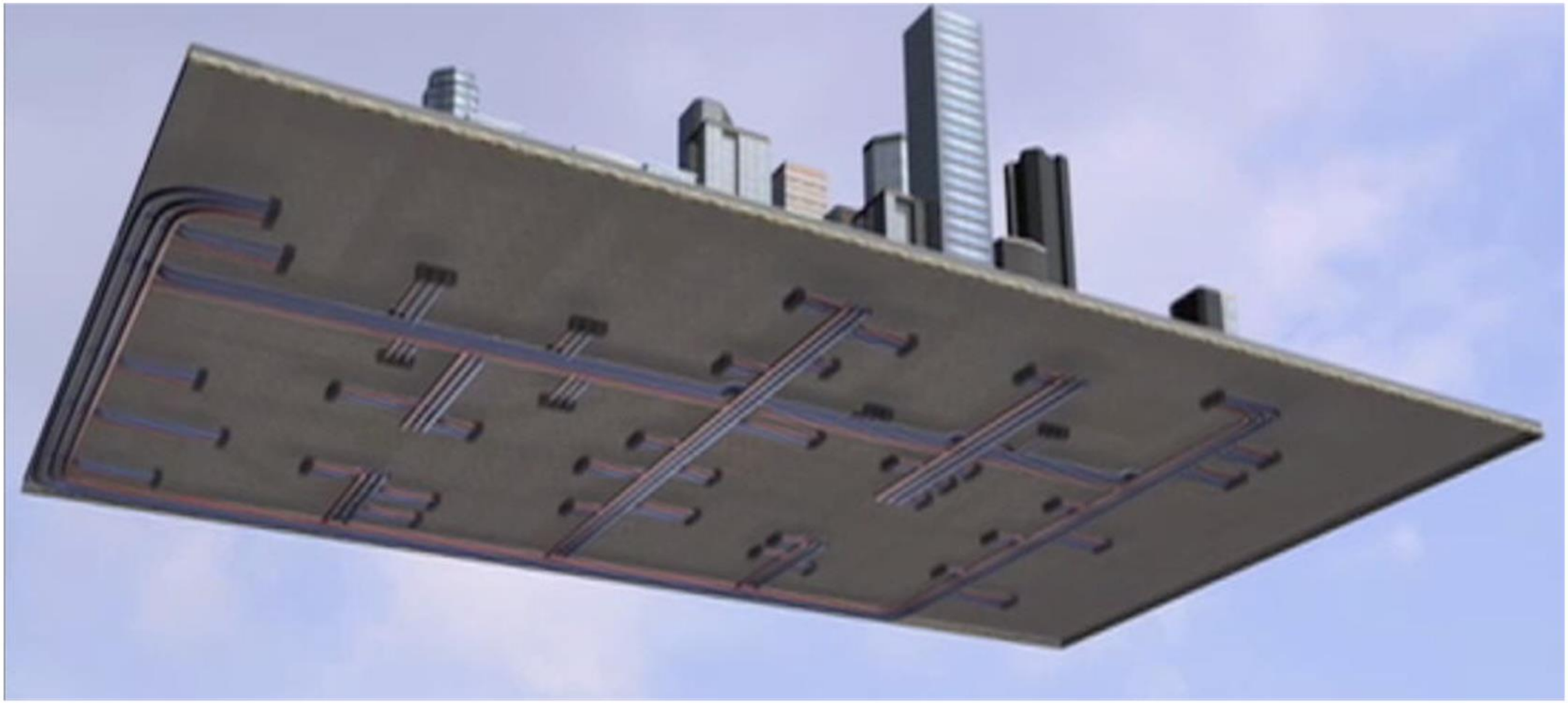

Cooling Supply and Return
Heating Supply and Return

District Energy/CHP/Microgrid – Community Scale Energy Solution

- 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 and technologies not feasible on single-building basis
- Fuel flexibility & distributed generation improves energy security, strengthens local economy

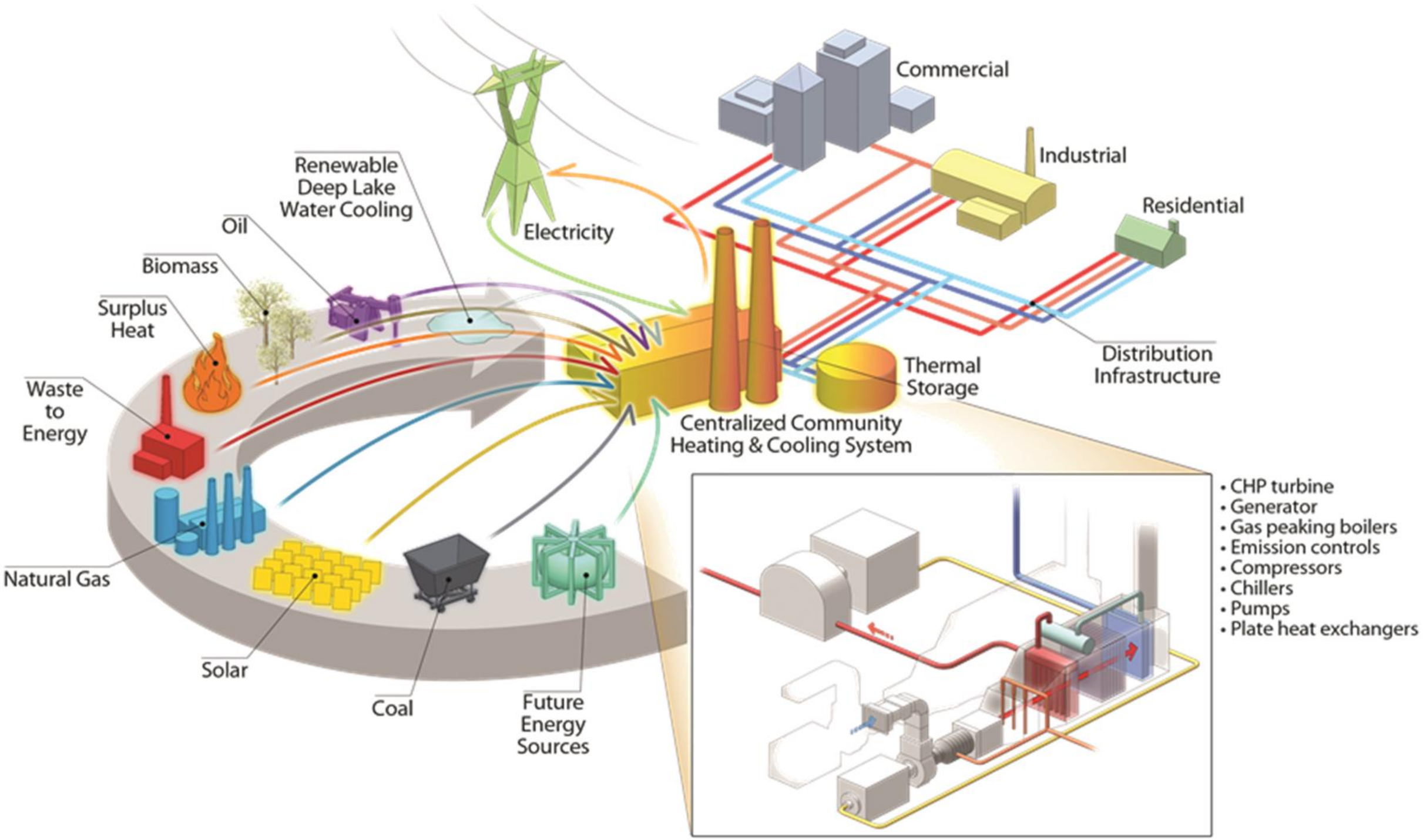


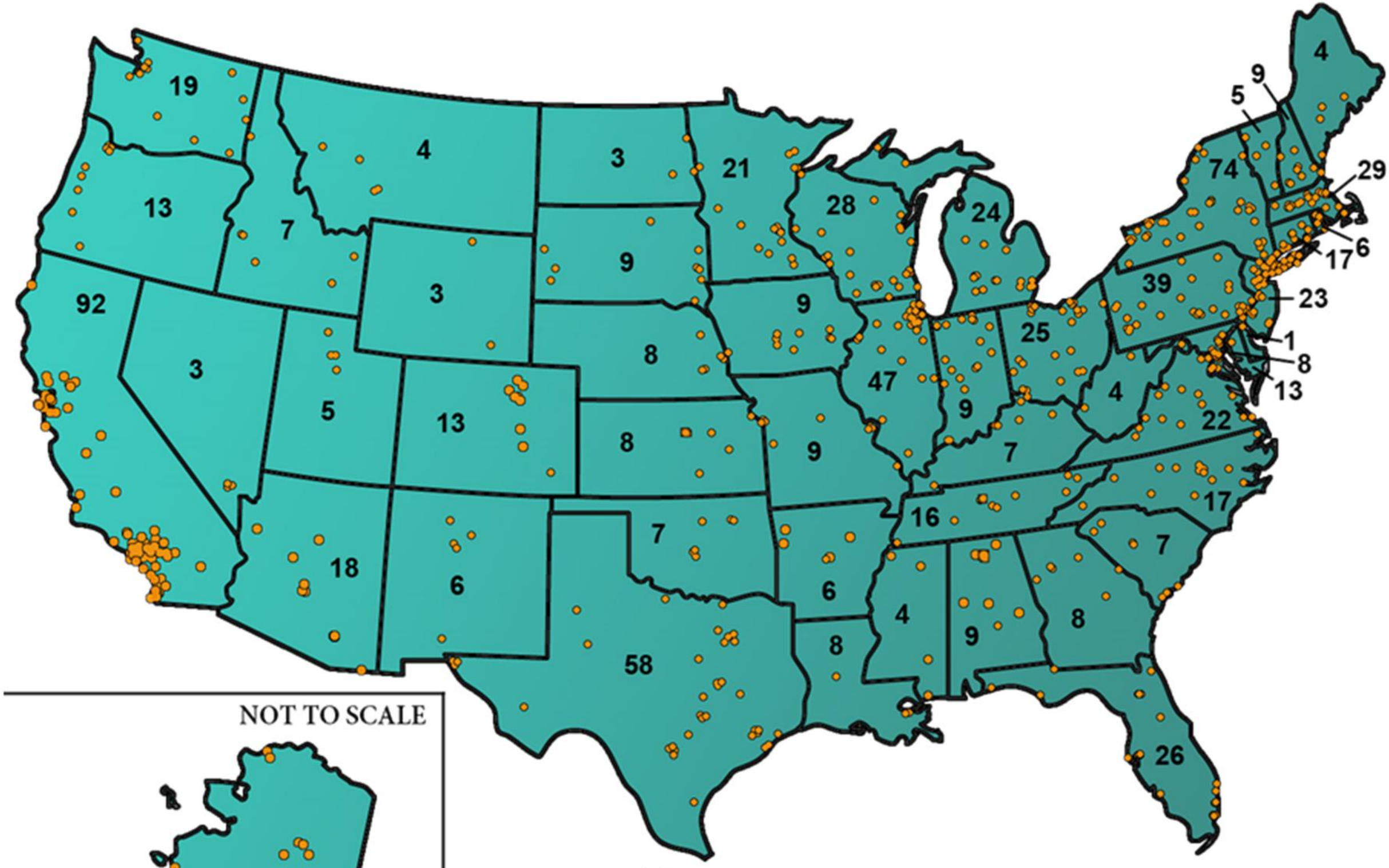
Infrastructure for Local Clean Energy Economy



- Connects thermal energy sources with users
- Urban infrastructure – hidden community asset
- Robust and reliable utility services
- Energy dollars re-circulate in local economy

Future Proofing a More Resilient City





U.S. District Energy Systems 2009

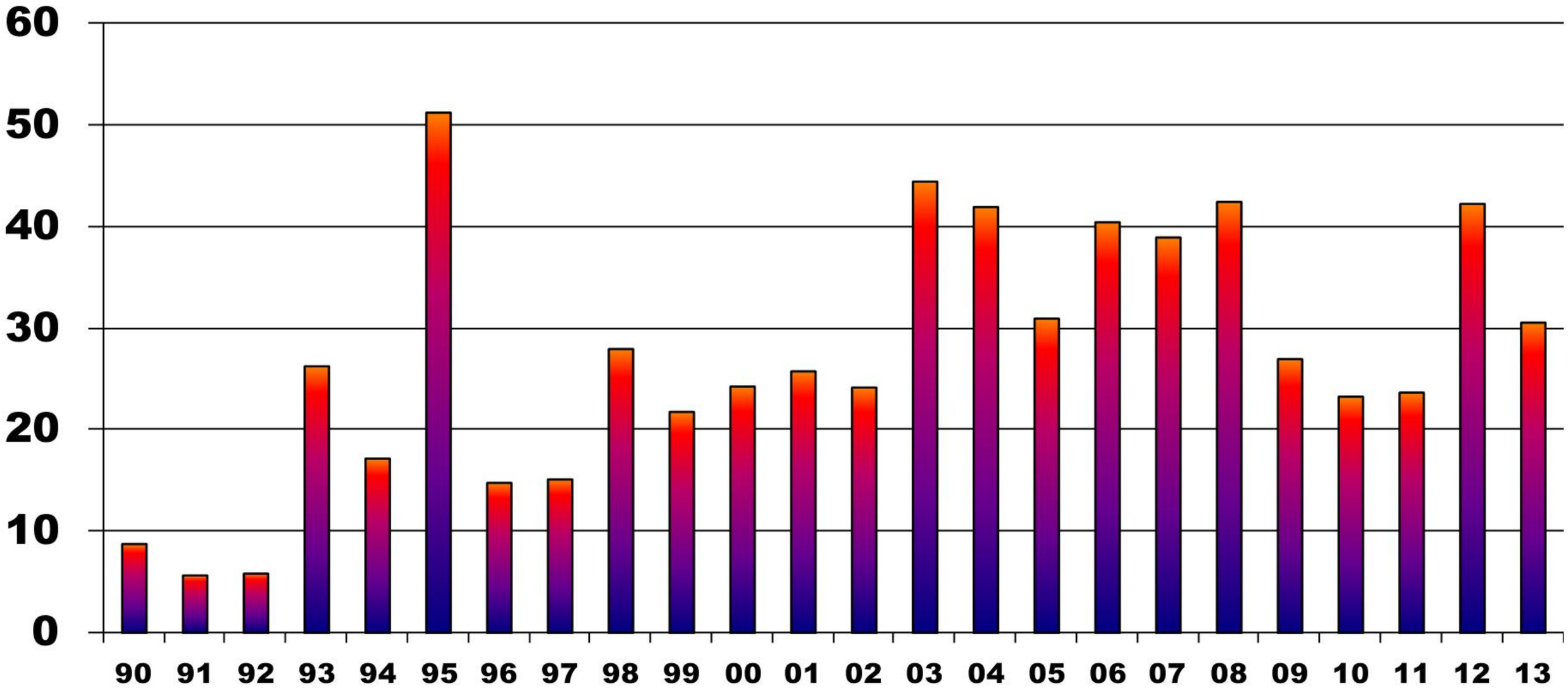
INTERNATIONAL DISTRICT ENERGY ASSOCIATION

District Energy Industry Growth

(Million sq ft customer bldg space connected/committed)

Aggregate SF reported since 1990 – 572,853,166 SF

(Annual average 23.8 Million SF/Yr – North America)



QTR

REPORT ON THE FIRST
QUADRENNIAL TECHNOLOGY REVIEW

"For the average coal plant, only 32% of the energy is converted to electricity; the rest is lost as heat."

-Page VI, Executive Summary

U.S. DEPARTMENT OF ENERGY

NATIONAL GEOGRAPHIC

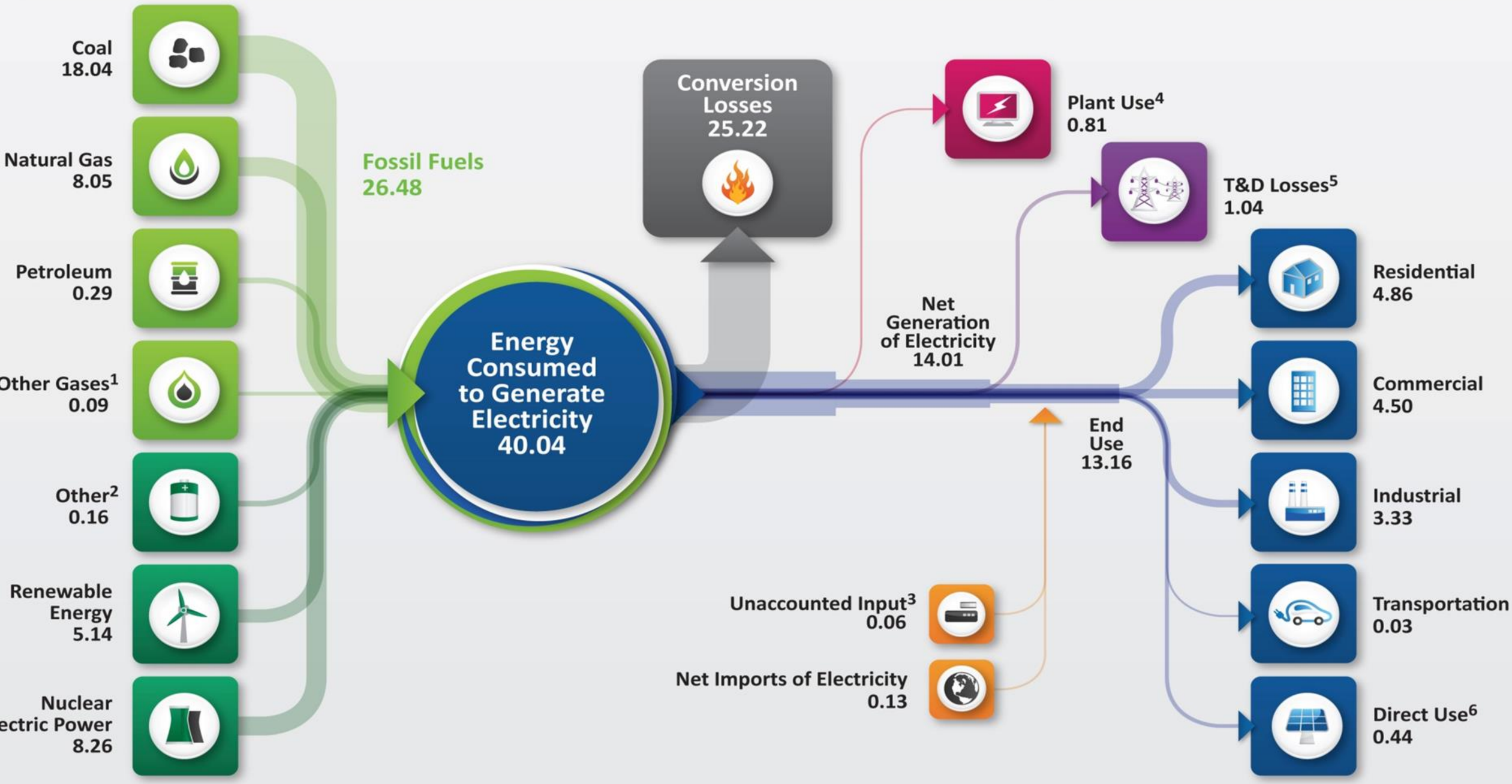
Photograph by Jason Hawkes

HOTHOUSE EARTH. OCTOBER 2011

U.S. Electricity Flow from Source to Use, 2011

Quadrillion Btu

enerdynamics
The Energy Education Experts



1 Blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuels.

2 Batteries, chemicals, hydrogen, pitch, purchased steam, sulfur, miscellaneous technologies, and non-renewable waste (municipal solid waste from non-biogenic sources and tire-derived fuels).

3 Data collection differences and non-sampling error.

4 Electric energy used in the operation of power plants.

5 Transmission and distribution losses (electricity losses that occur between the point of generation and delivery to the customer) are estimated as 7 percent of gross generation.

6 Use of electricity that is 1) self-generated, 2) produced by either the same entity that consumes the power or an affiliate, and 3) used in direct support of a service or industrial process located within the same facility or group of facilities that house the generating equipment. Direct use is exclusive of station use.

Notes: • Net generation of electricity includes pumped storage facility production minus energy used for pumping. • Values are derived from source data prior to rounding for publication. • Totals may not equal sum of components due to independent rounding.

Source: U.S. Energy Information Administration Annual Energy Review 2011

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Energy-Efficiency Comparisons

Standard Power Plant

60%
"Waste" heat rejected to environment

40%
Useful energy produced for electricity

100%
Fuel Input

District Energy/ Combined Heat and Power Plant

20%
"Waste" heat rejected to environment

40%
Useful energy produced for heating and/or cooling via district energy system

40%
Useful energy produced for electricity

100%
Fuel Input

MOVING FORWARD

more efficient use of resources

community-based economic engine

safe, secure, and reliable energy

affordable, high-quality thermal services

attractive local environments +
livable towns and cities

LOCAL OPPORTUNITIES

Communities want to become energy producers

Challenges:

- volatile costs of traditional energy and trade balance
- national and local energy security and supply
- local resiliency, growing weather risk
- reducing greenhouse gas emissions
- replacing coal generation & integrating renewables

Local energy infrastructure maximizes resource efficiency and exploits local opportunities

LOCAL ECONOMIC ENGINE

Improved energy security and resilience attracts businesses, residents who value cleaner, competitive and secure energy supply

Economic multiplier: cash that would pay for outside energy supplies stays local

Compact communities with mix of uses and density of buildings reduce sprawl and support public transit systems

District energy enables high-quality and attractive place to live and work

PLANNING FOR (THERMAL) ENERGY:

PLANNING FOR (THERMAL)ENERGY:

- **Project champions: Community energy, economic development and sustainability staff, elected officials, planners**
- **Consider energy in comprehensive planning, brownfield/revitalization projects, Climate Action Plans**
- **Variety of project developers: opportunities for collaboration and public/private partnerships**
  - **Local governments**
  - **Private sector developers**
  - **Communities**
  - **Institutions**
  - **Property developers, landowners and building operators**

SPHERE OF ENERGY INFLUENCE:

BUILDINGS

URBAN FORM

LAND USE

TRANSPORTATION

LEGISLATION

FEDERAL LEGISLATION

(CLEAN POWER PLAN; CLIMATE ACTION PLAN)

STATE/PROVINCIAL LEGISLATION

(PLANNING ACT; PPS)

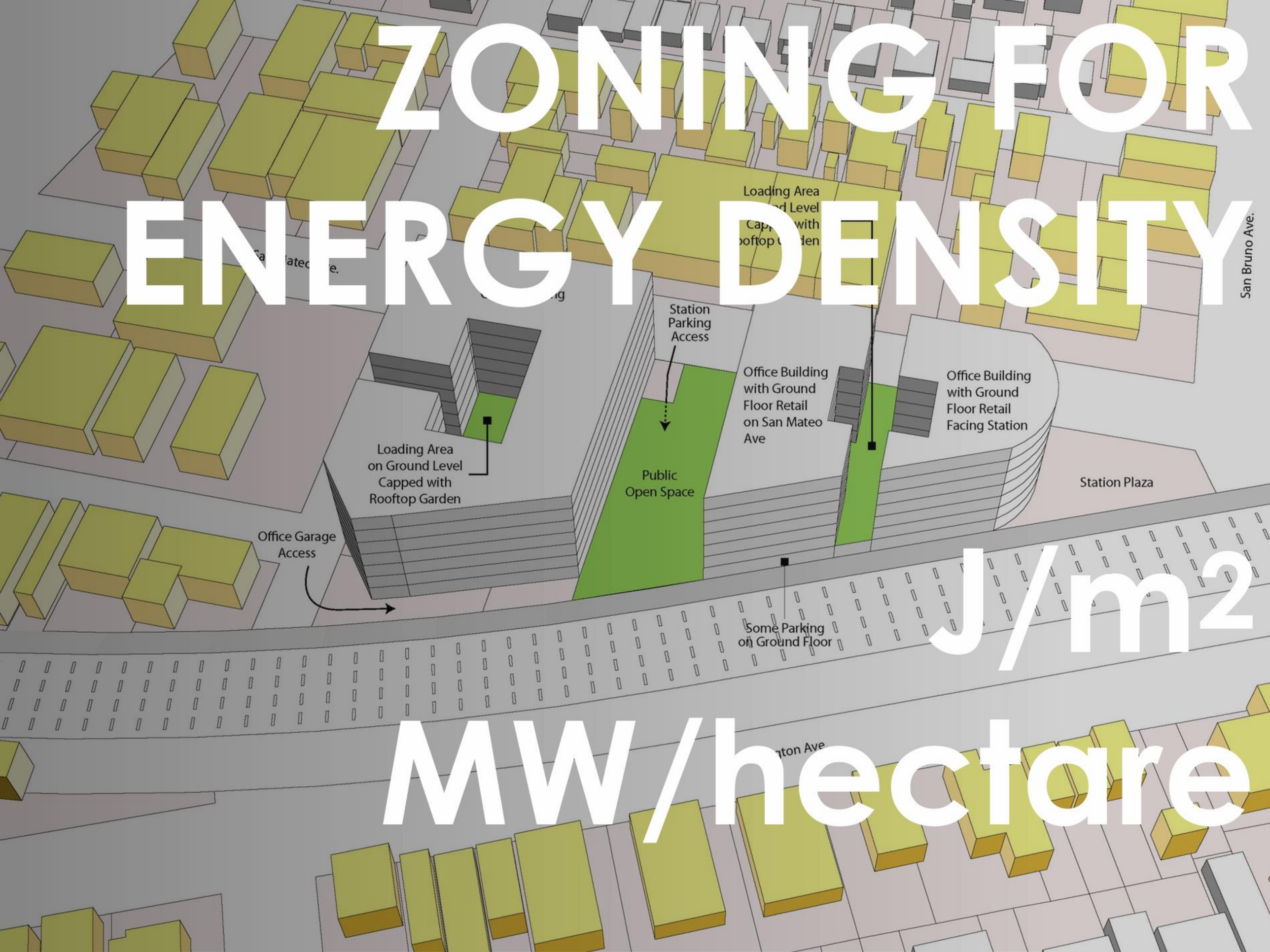
IMPLEMENTATION

OFFICIAL PLAN

COMMUNITY ENERGY PLAN

ZONING BYLAWS

ZONING FOR ENERGY DENSITY



J/m²

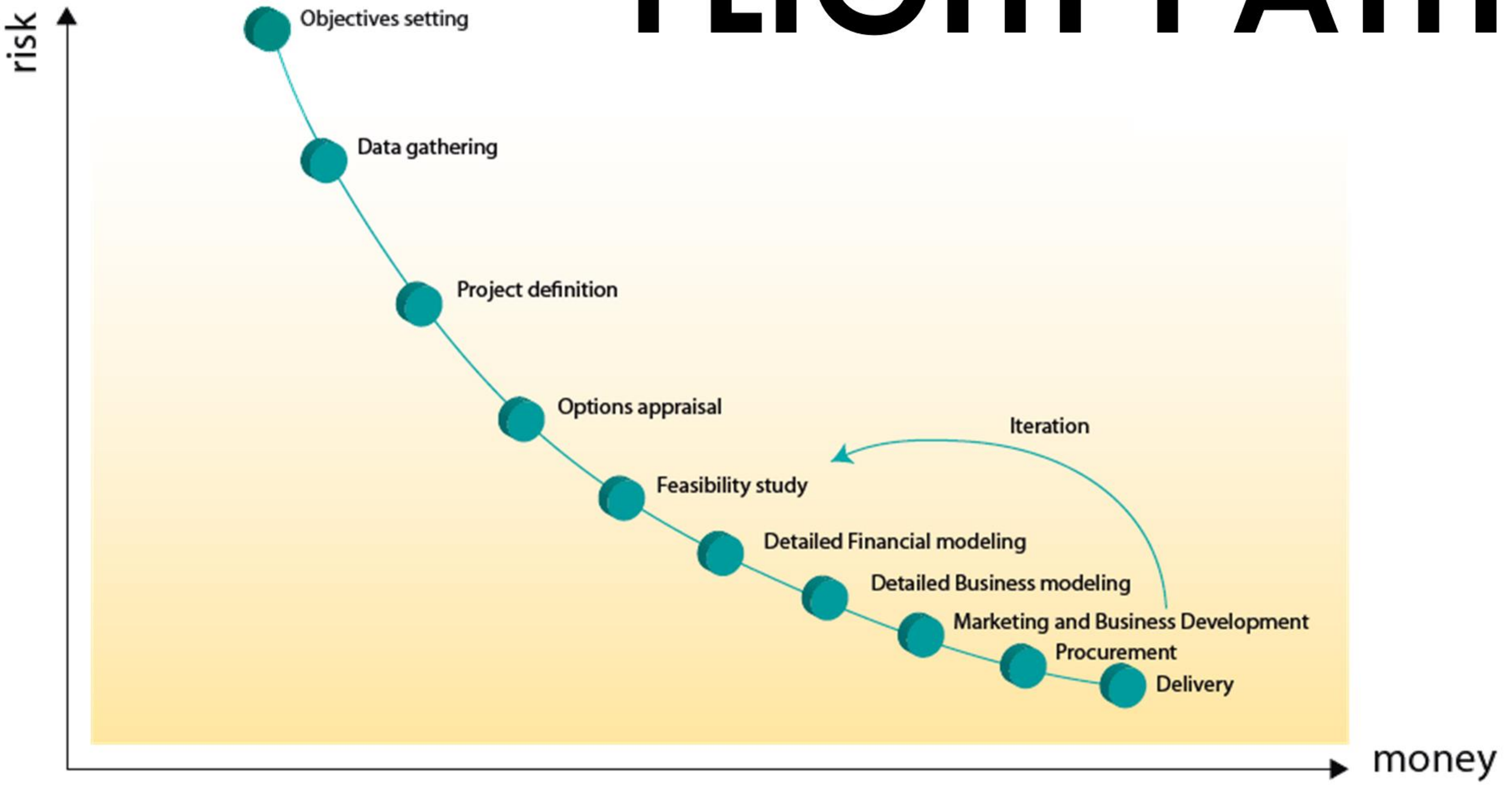
MW/hectare

1. Consistent interpretation of planning legislation with supporting policy prompting municipal energy reduction
2. Consistent metric for energy density factors for development approval in conjunction with State/Province
3. Develop Community Energy Plan/ Municipal GHG Reduction Targets
4. Template for OP amendments with energy density factors
5. Zoning bylaws incorporating energy density factors
6. Utility agencies incorporated at initiation of development process

STAGES OF DEVELOPMENT:

Stage 1: Objectives setting
Stage 2: Data gathering
Stage 3: Project definition
Stage 4: Options appraisal
Stage 5: Feasibility study
Stage 6: Financial modeling
Stage 7: Business modeling
Stages 8, 9 & 10: Marketing and business development; Project procurement; and Delivery

PROJECT FLIGHT PATH



STAGE 1: Objective Setting

ECONOMIC

Reduce reliance on imported energy

Strengthen local economy, retain energy dollars, stable high-quality jobs

Develop infrastructure to exploit locally sustainable energy supplies

Stable, predictable energy rates

Reduce first cost of new development space

ENERGY SECURITY

Reduce reliance on imported energy and lessen impact of market volatility

Flatten or re-shape peak demand on grid

Enable fuel flexibility and multi-fuel strategies

Enhance reliability and resilience

EMISSION REDUCTIONS

Reduce energy intensity

Cut primary energy consumption

Improve end-use energy efficiency

Aggregated scale enables shift toward lower carbon solutions

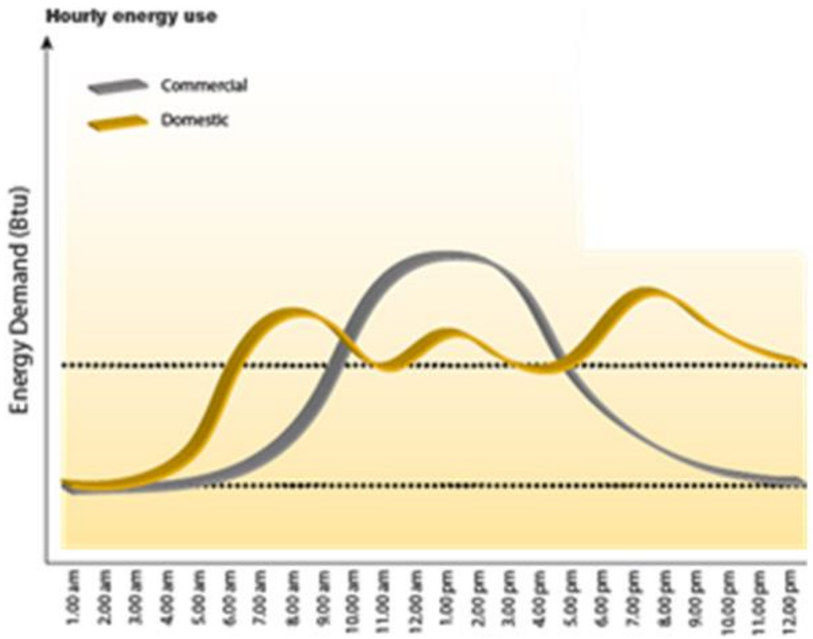
STAGE 2: Data Gathering

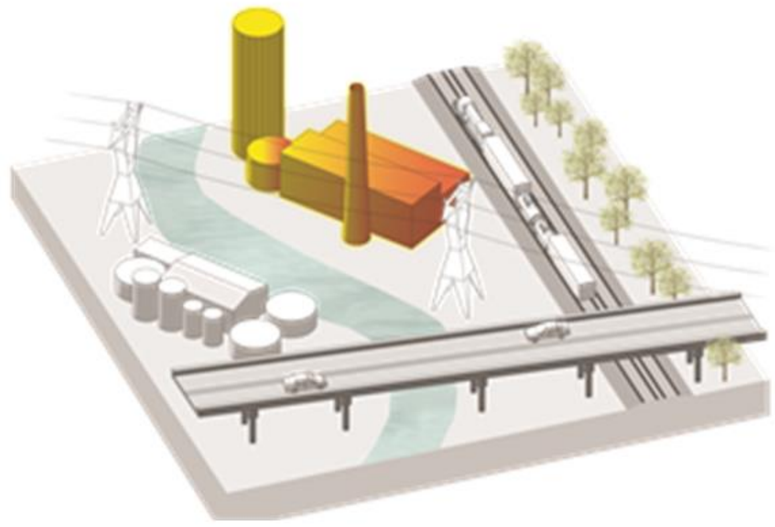
Benchmarking data: high-level understanding of the opportunity

Consider local factors:

- existing and likely future energy consumption of new and existing buildings
- rate of construction/occupancy for new buildings
- fuel and power sources and how the energy will be delivered or transported
- Pros and cons of location in terms of energy sources, distribution, transport, land use, form, and character

DATA COLLECTION





01 **DEVELOPMENT DENSITY**

02 **LOAD DIVERSITY**

03 **ANCHOR LOADS**

DEVELOPMENT DENSITY

Age of buildings

LOAD DIVERSITY

Demand loads

Mix of uses

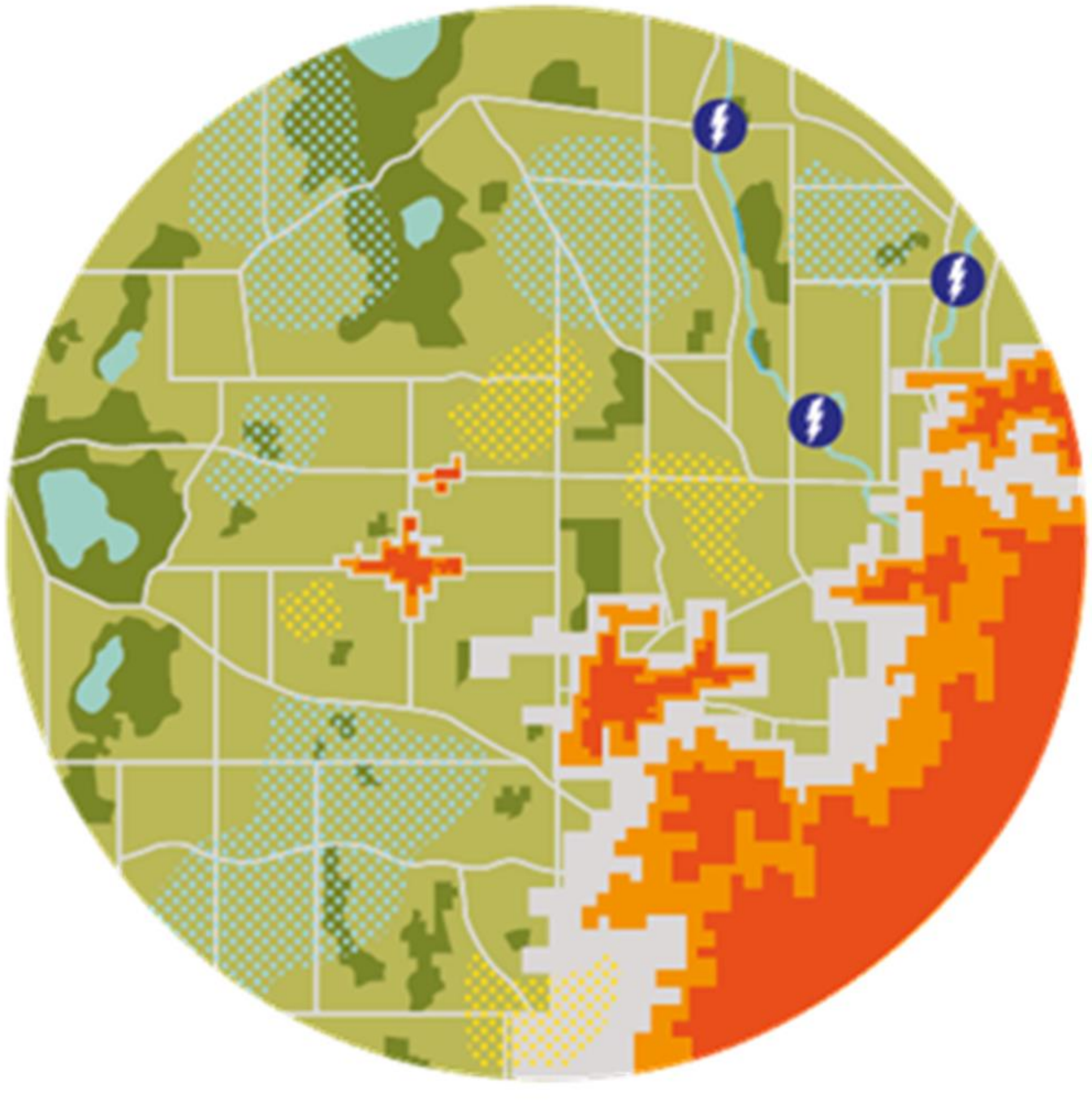
Heating/cooling

ANCHOR LOADS

Physical barriers

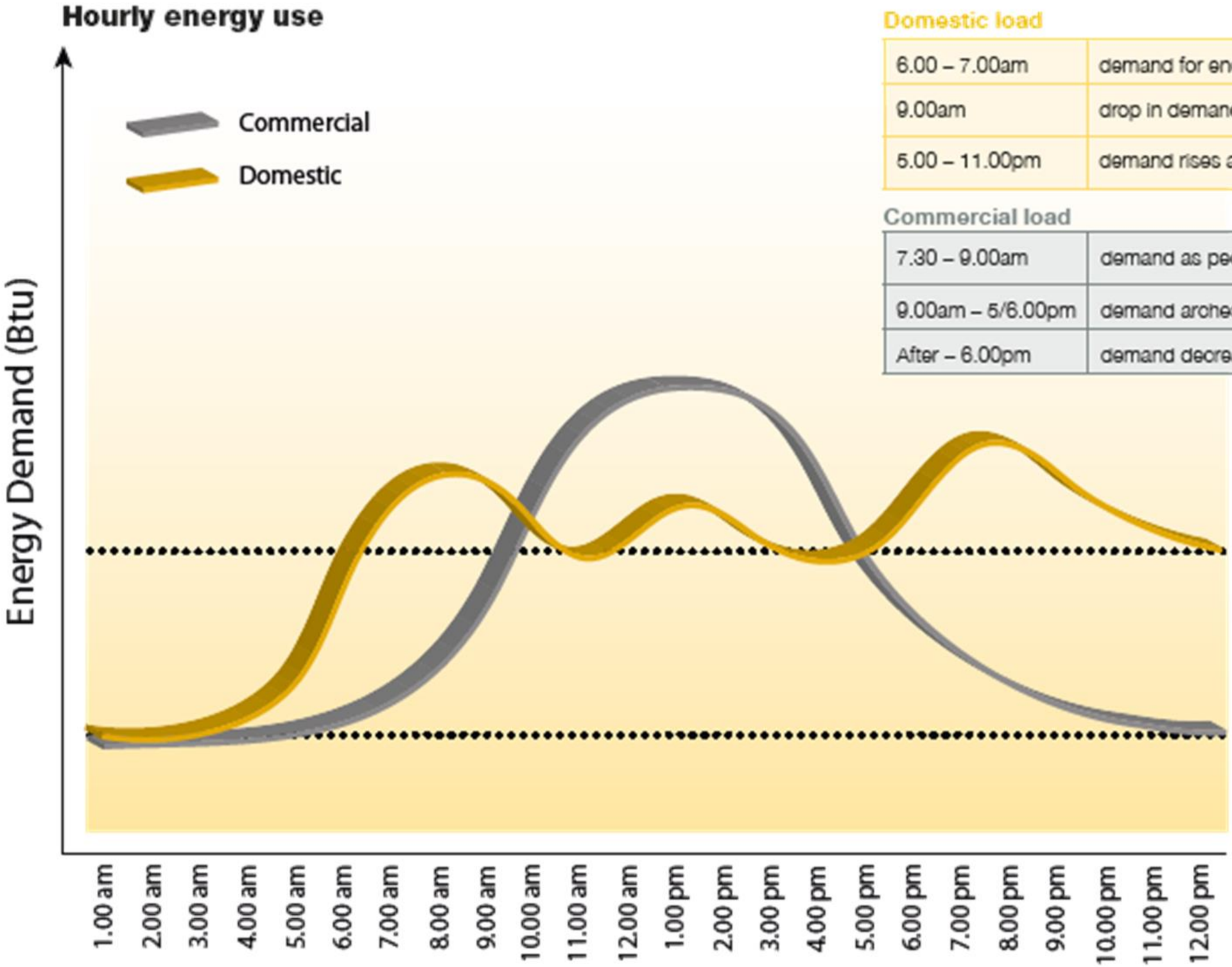
Other existing infrastructure: gas and heat networks and electricity sub-stations; existing power plants, power stations, waste-to-energy plants, industrial processes that dump heat; transport infrastructure for bulky fuels such as biomass

ENERGY MAPPING



- Rural Areas
- Urban Areas
- Lake / Reservoir
- Woodland - Biomass Potential
- Wind Turbines - Large Scale
- Wind Turbines - Small Scale
- District Heating
- Hydroelectric Potencial

DEMAND LOADS



Domestic load

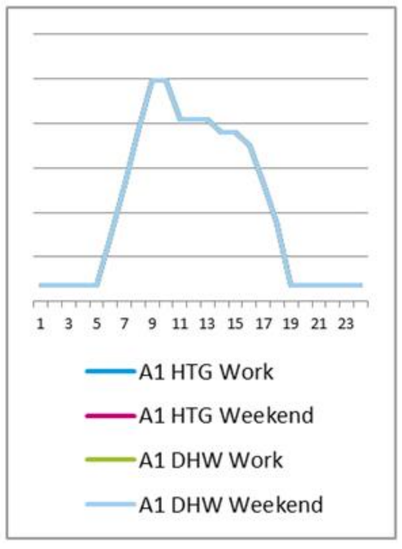
6.00 – 7.00am	demand for energy as the household gets up
9.00am	drop in demand as occupants leave for school/work
5.00 – 11.00pm	demand rises as people come home from work

Commercial load

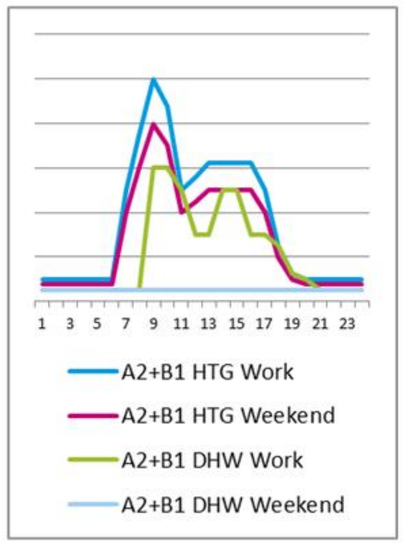
7.30 – 9.00am	demand as people arrive at work
9.00am – 5/6.00pm	demand arches
After – 6.00pm	demand decreases as people leave work

CONSIDER BUILDING TYPE PROFILES

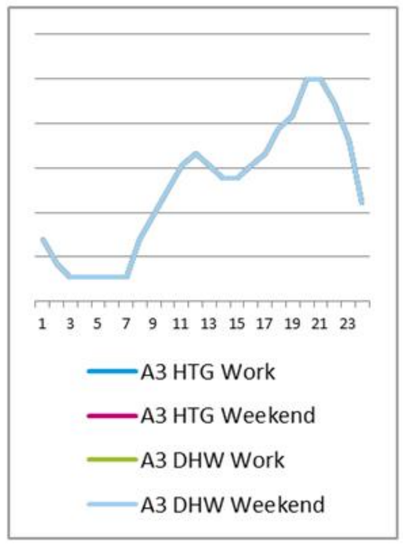
A1 Retail



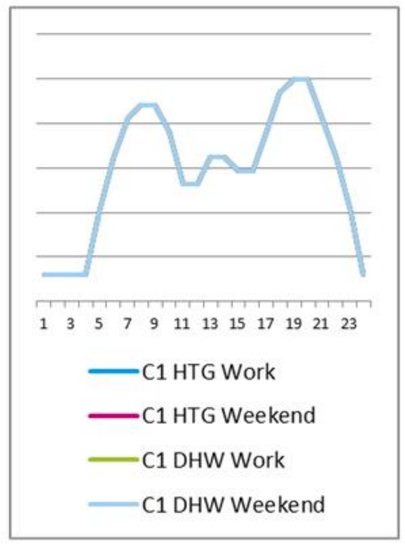
A2+B1 Commercial



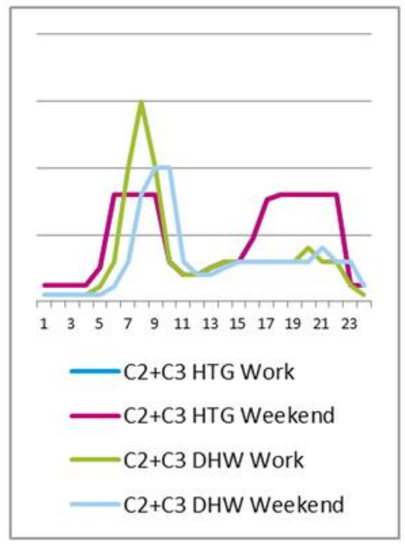
A3 Food and Drink



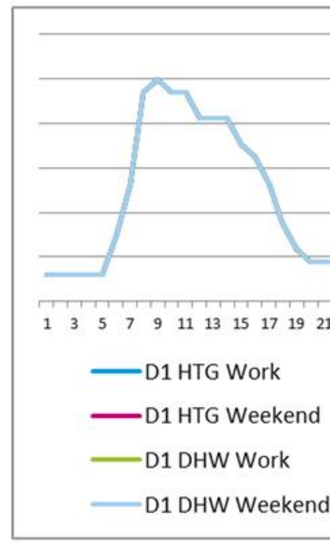
C1 Hotels



C2+C3 Residential



D1 Non-residential institutions



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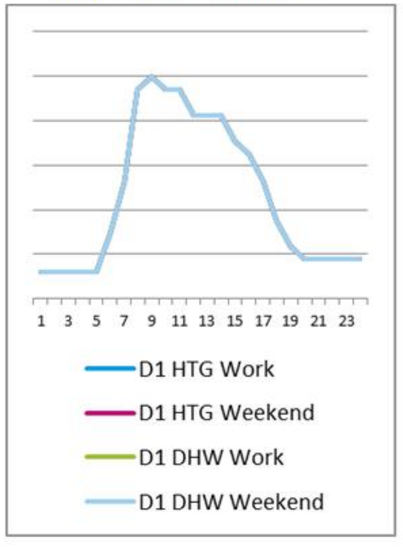
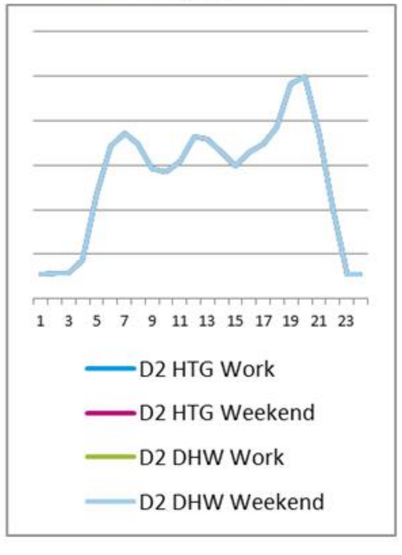
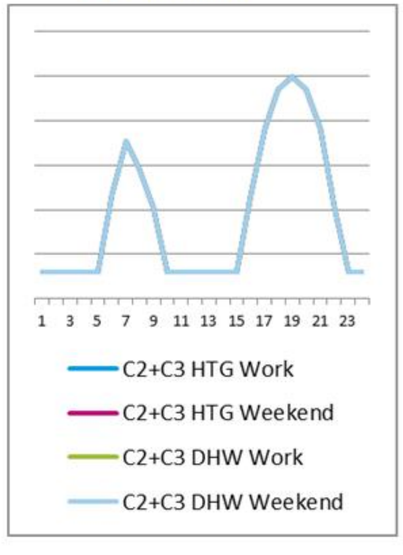


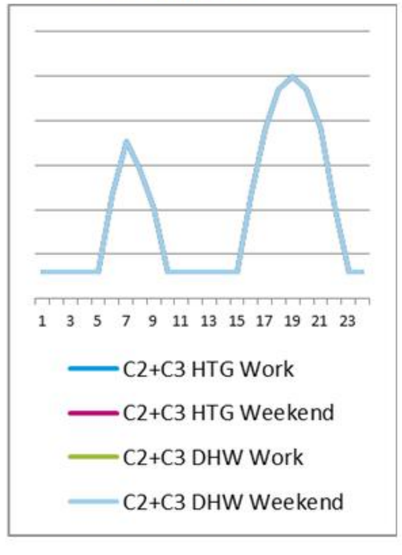
D2 Assembly and Leisure



C2+C3 Custom1



C2+C3 Custom2

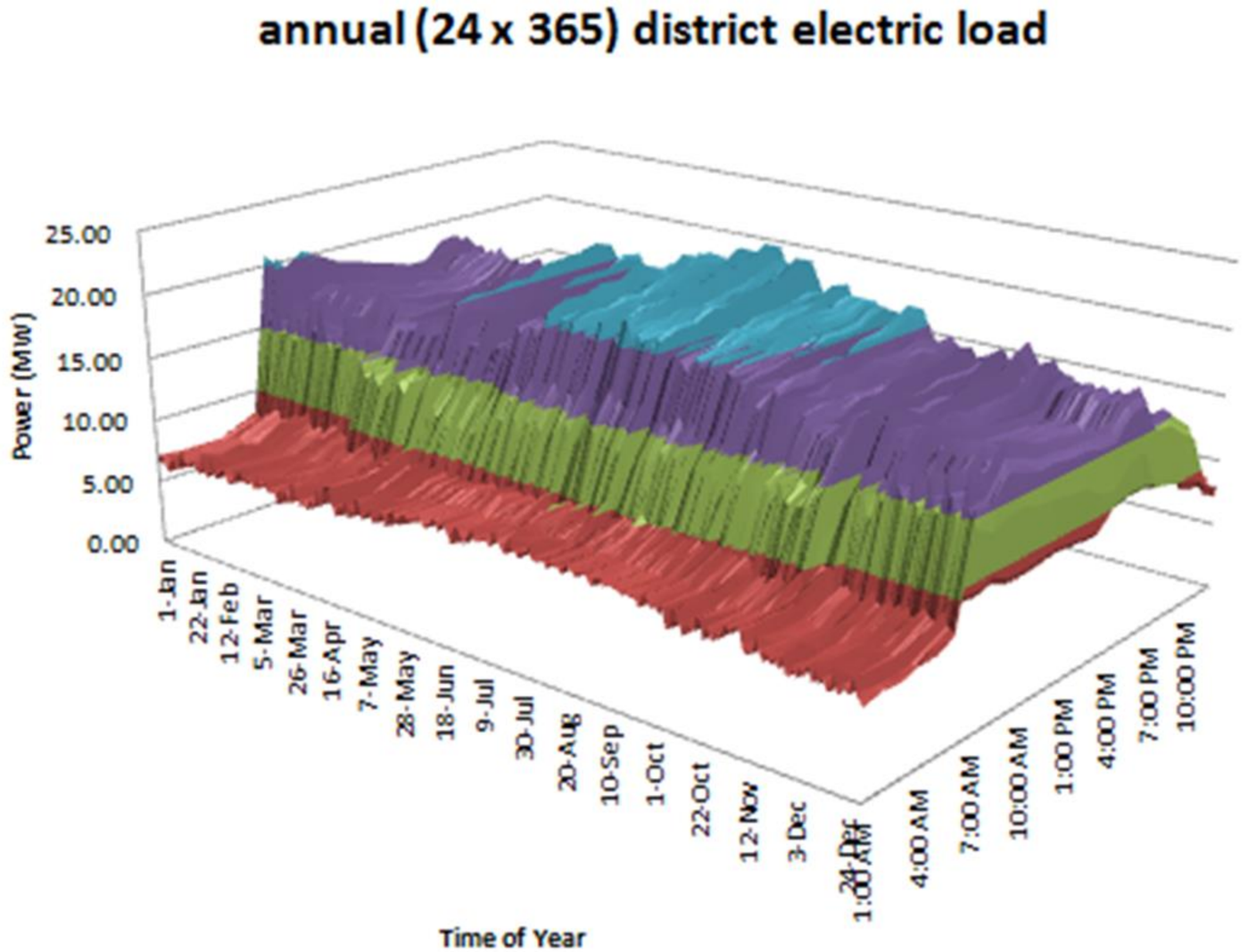


What is Composite Energy Demand?

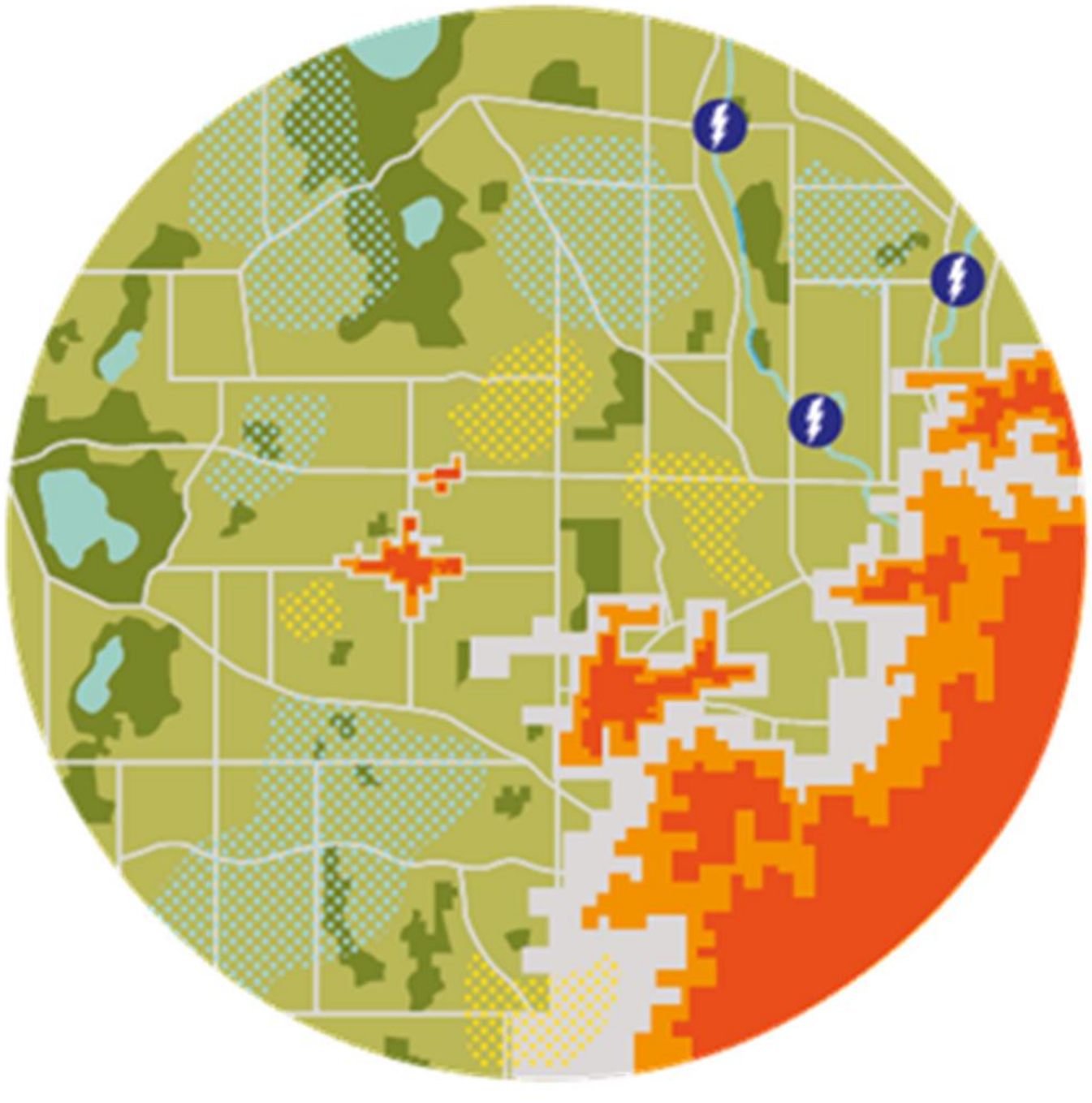
- Load Profiles by Functional End Use
- Composite Load Profile for the District
- Base Load
- Peak Load

Occupancy Type	*input values here*	*input values here*	
	SF	# Bldg	
Large Office	1,000,000	***3***	
Medium Office	1,500,000	***10***	
Small Office	300,000	***20***	
Warehouse	-	-	
Stand Alone Retail	500,000	***4***	
Strip Mall	-	-	
Primary School	-	-	
Secondary School	-	-	
Supermarket	-	-	
Quick Service Restaurant	30,000	***4***	
Full Service Restaurant	30,000	***4***	
Hospital	1,200,000	***1***	
Outpatient Health Clinic	-	-	
Small Hotel	250,000	***2***	
Large Hotel	500,000	***1***	
Midrise Apt	1,000,000	***10***	
Total	***6,310,000***	***59***	

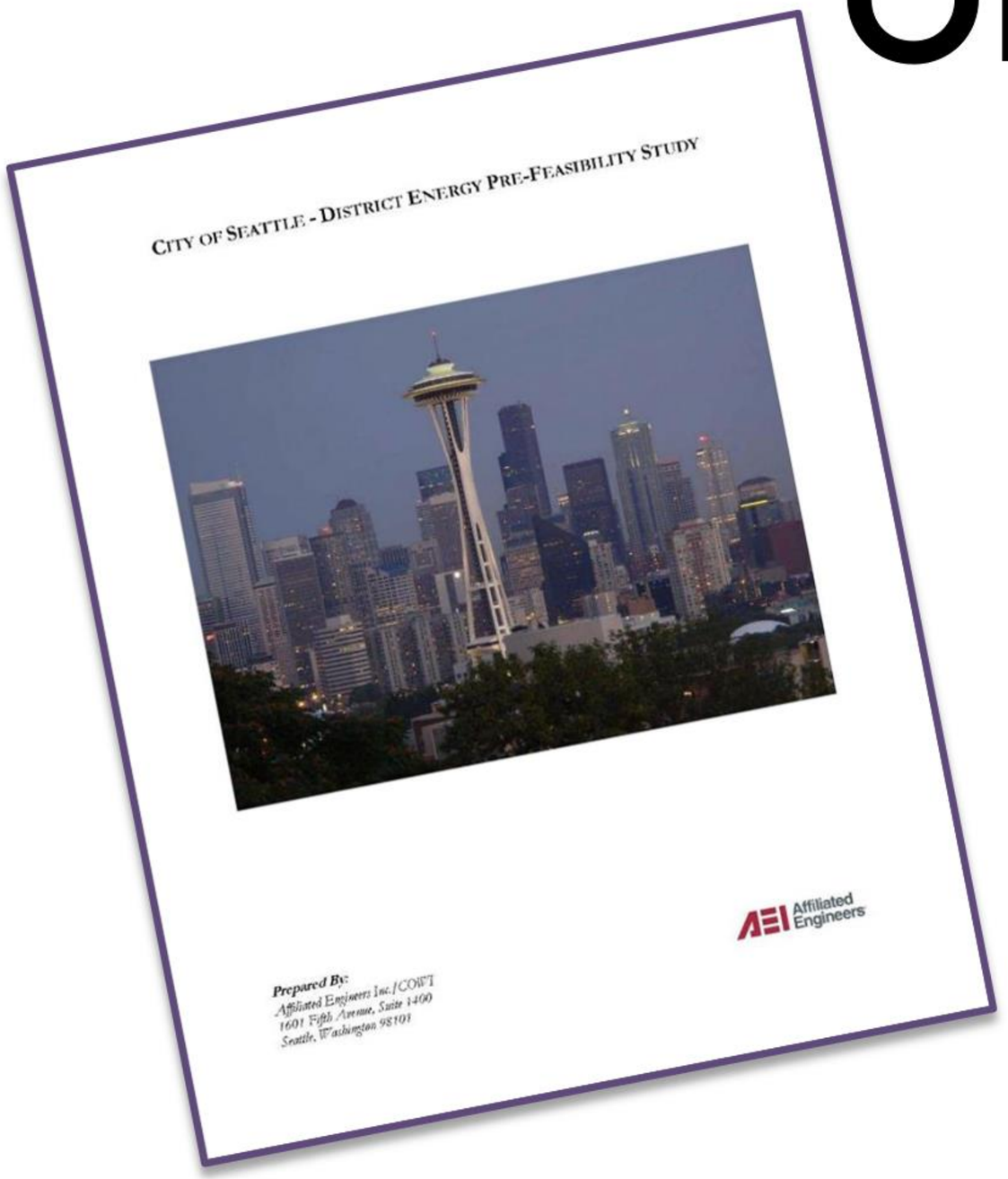
annual (24 x 365) district electric load



CITY OF SEATTLE DISTRICT ENERGY PRECINCT STUDY

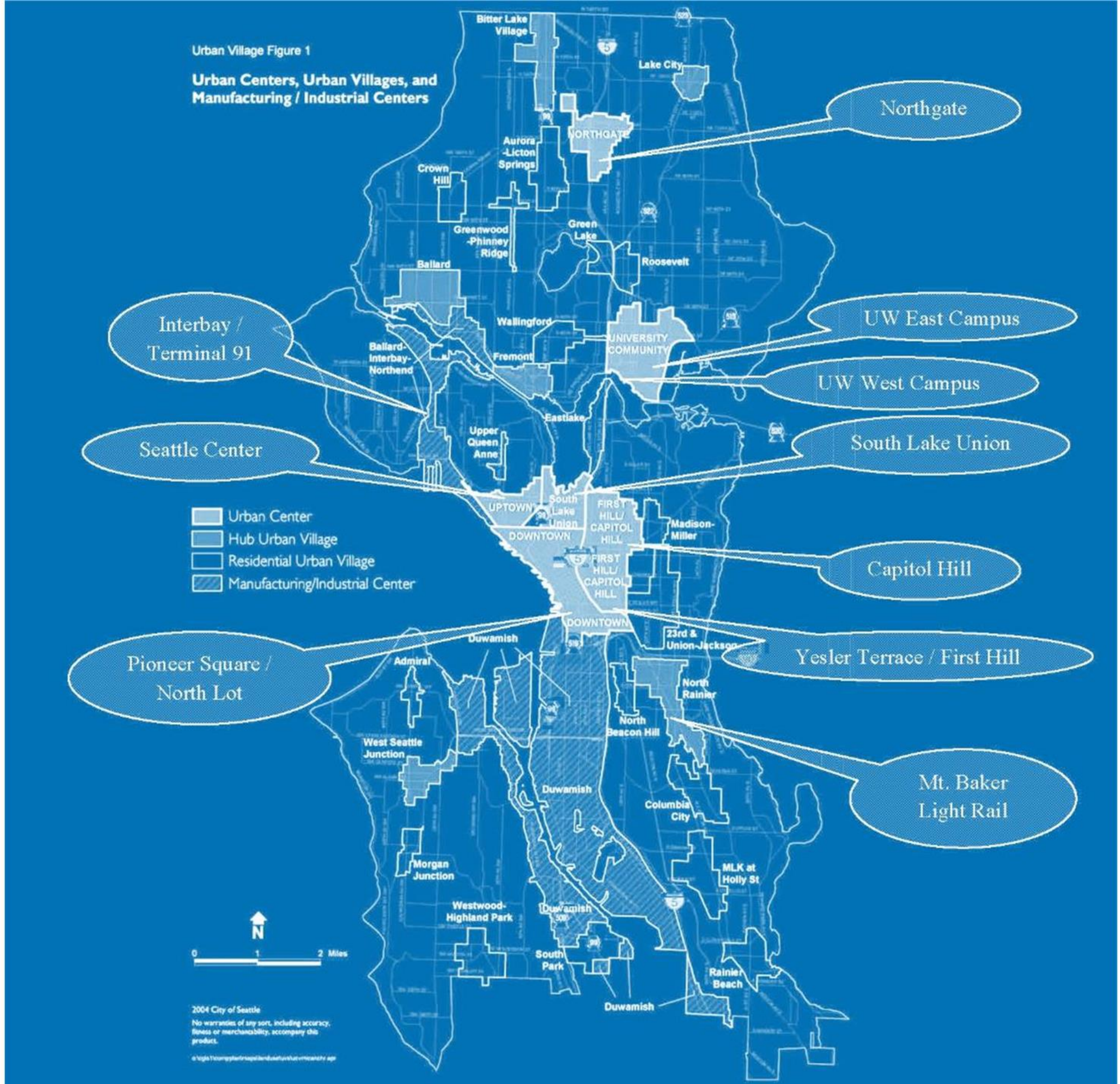


GOAL: HIGH-LEVEL SCREENING ANALYSIS OF 10 POTENTIAL DISTRICTS



Urban Village Figure 1

Urban Centers, Urban Villages, and Manufacturing / Industrial Centers



KEY ASSESSMENT ACTIVITIES

Current Building Stock
Type/Size/Age/Heating System

Future Growth

Load Projections – Occupancy/Absorption

Existing Energy Sources

First Cost

Operating Cost

Carbon Impacts

KEY ASSESSMENT ACTIVITIES

Current Building Stock
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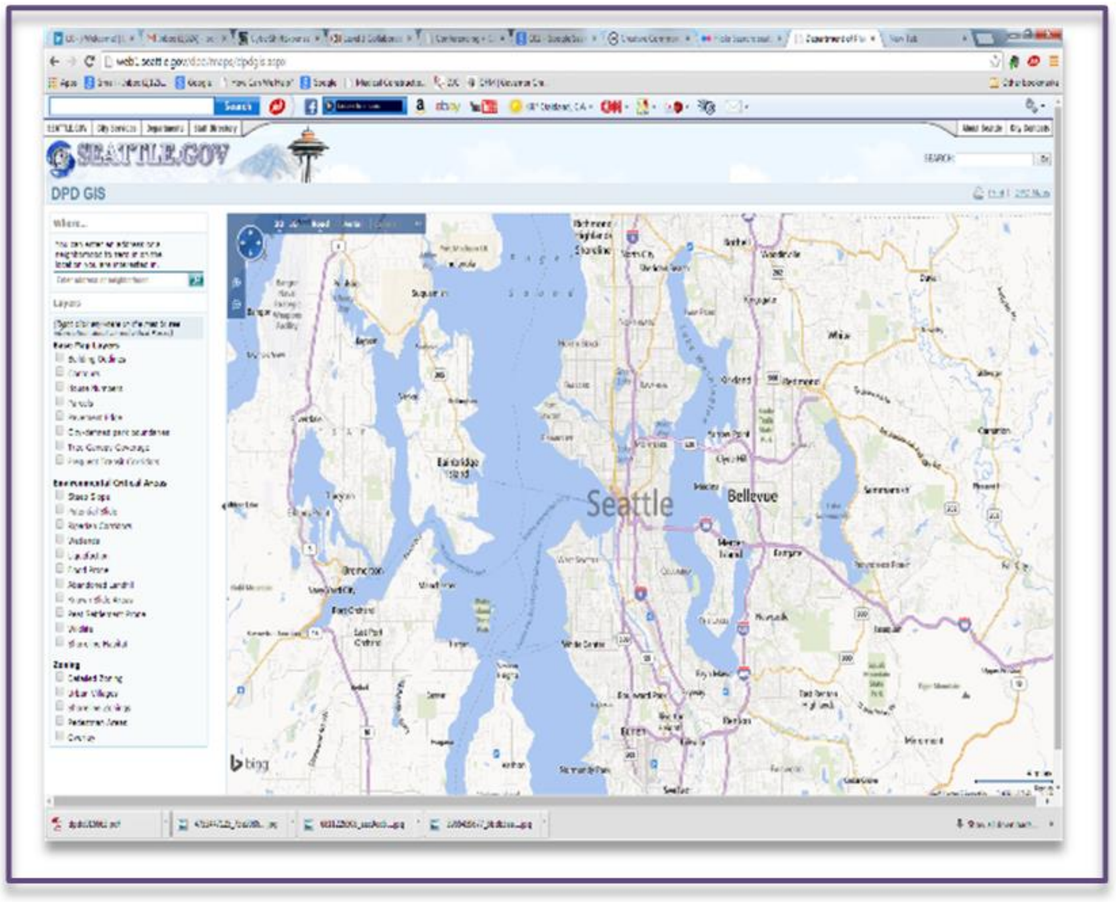
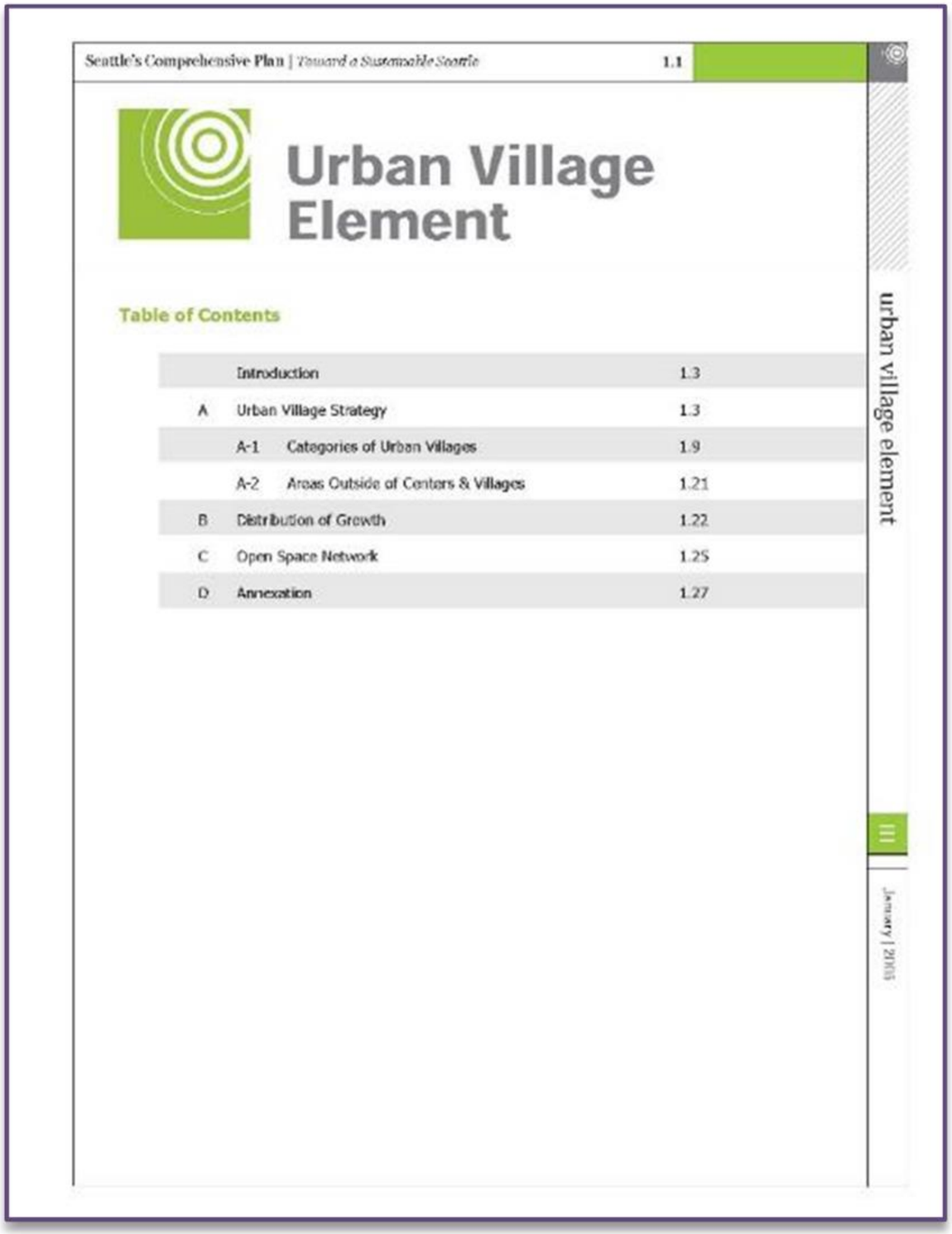
DATA

City of Seattle – DPD GIS

King County Tax Records

Seattle Comprehensive Growth Plan





BUILDING TYPES

Apartment/Condo	Single Family	Restaurant	Institutional
APARTMENT	4 PLEX	RESTAURANT (FAST FOOD)	GOVT SERVICE
APARTMENT (CO-OP)	DUPLEX	RESTAURANT/LOUNGE	SCHOOL (PRIVATE)
APARTMENT (MIXED USE)	SINGLE FAMILY (C/I USE)		SCHOOL (PUBLIC)
CONDO (MIXED USE)	SINGLE FAMILY (C/I ZONE)		
CONDO (RESIDENTIAL)	SINGLE FAMILY (RES USE/ZONE)		
GROUP HOME	TOWNHOUSE PLAT		
HOTEL/MOTEL	TRIPLEX		
Industrial	**Office**	**Public Gathering**	**Unknown**
INDUSTRIAL (HEAVY)	MED/DENTAL OFFICE	MOVIE THEATER	MORTUARY/CEMETERY/CREMATORY
INDUSTRIAL (LIGHT)	OFFICE BLDG	BOWLING ALLEY	SERVICE BLDG
MINI WAREHOUSE		CHURCH	VACANT (COMMERCIAL)
WAREHOUSE		CLUB	VACANT (MULTI-FAMILY)
		TAVERN/LOUNGE	
		AUTO SHOWROOM AND LOT	
Retail/Commercial			
GROCERY STORE			
POST OFFICE			
RETAIL STORE			
BANK			
CONV STORE W GAS			

TOTAL AREA OF HEATED SPACE

Heated Area (1000 SF)										
Space Usage Type	District									
	1st Hill	Cap Hill	S Lk Union	UW West	Pioneer Sq	Interbay	Mt Baker	Northgate	Seattle Ctr	UW East
Office	2,610	600	710	0	3,154	95	62	80	2,729	1,200
Industrial	91	189	708	0	275	148	53	39	386	19
Institutional	333	318	43	0	88	76	4	10	80	91
Retail	44	860	807	13,421	977	80	317	810	236	863
Church	16	10	48	0	81	0	13	0	34	281
Grocery Store	0	8	0	0	0	0	0	0	0	34
Health/Fitness	0	0	6	0	0	0	54	0	301	13
Hospital	6,589	0	0	0	0	0	0	0	0	0
Restaurant	10	125	47	0	342	11	18	15	87	80
Theater	0	19	0	0	54	0	0	0	768	17
Single Family	108	641	0	0	71	20	496	78	215	357
Apartment/Condo/ Extended Stay Hotel	2,720	7,837	49	1,107	1,231	192	756	1,160	2,148	3,041
Hotel/Motel	936	0	96	0	461	0	59	170	445	92

TOTAL AREA OF HEATED SPACE

Heated Area (1000 SF)										
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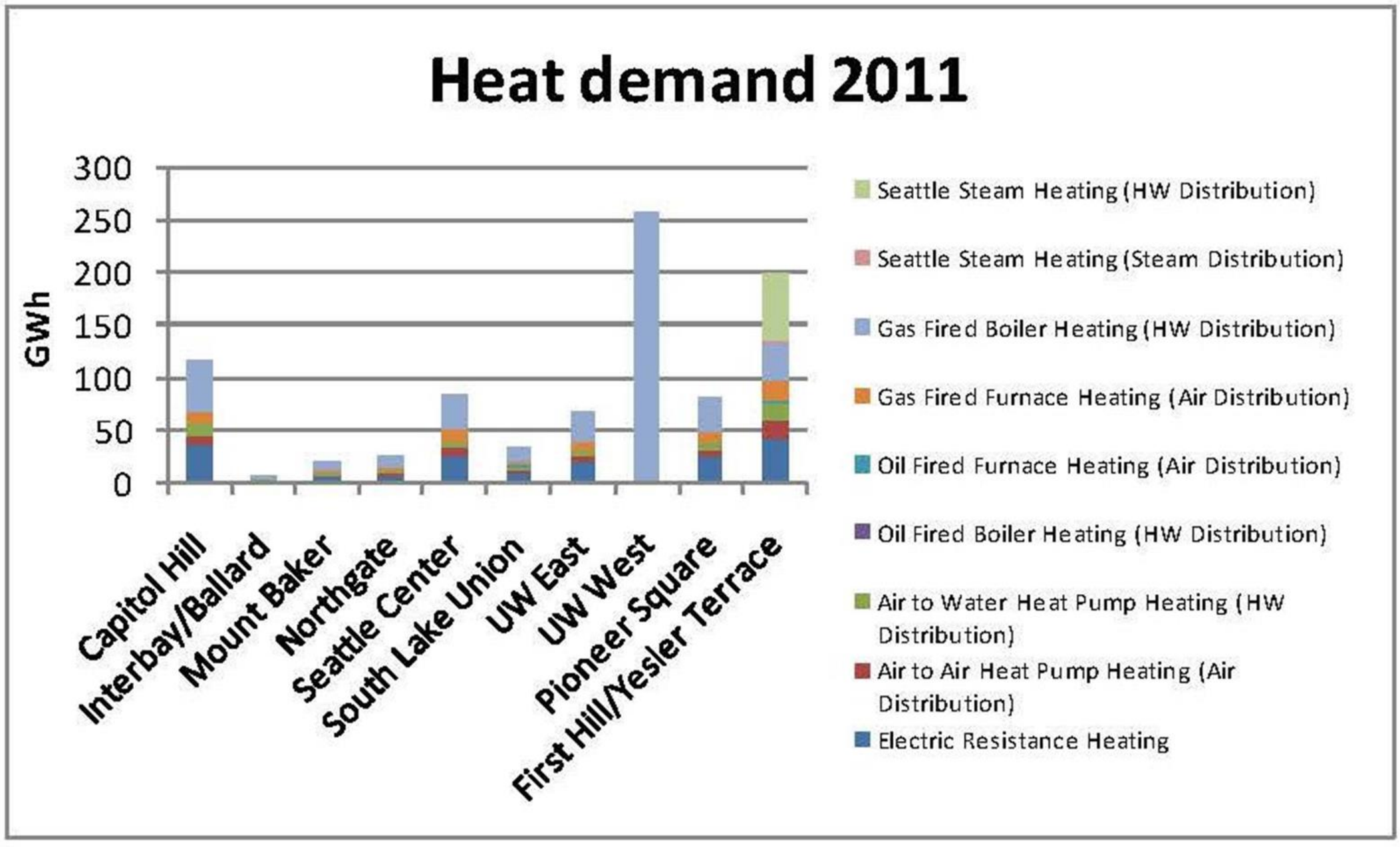
GROWTH FACTORS

Building Usage	Growth Factor by District (%)									
	1st Hill	Cap Hill	S Lk Union	UW West	Pioneer Sq	Interbay	Mt Baker	Northgate	Seattle Ctr	UW East
Office	15	16	45	10	17	59	30	15	11	11
Industrial	15	16	45	10	17	0	0	15	11	11
Institutional	15	16	45	10	17	59	30	15	11	11
Retail	15	16	45	44	17	59	30	15	11	11
Church	15	16	45	10	17	0	30	0	11	11
Grocery Store	15	16	0	10	0	0	0	0	0	11
Health/Fitness	15	0	45	10	0	0	30	0	11	113
Hospital	15	0	0	0	0	0	0	0	0	0
Restaurant	15	16	45	10	17	59	30	15	11	11
Theater	15	16	0	10	17	0	0	0	11	11
Single Family	163	21	0	10	42	83	69	37	17	22
Appartment/ Condo/ Extended Stay	163	21	182	44	42	83	69	37	17	22
Hotel/Motel	163	0	45	10	17	0	30	15	11	22

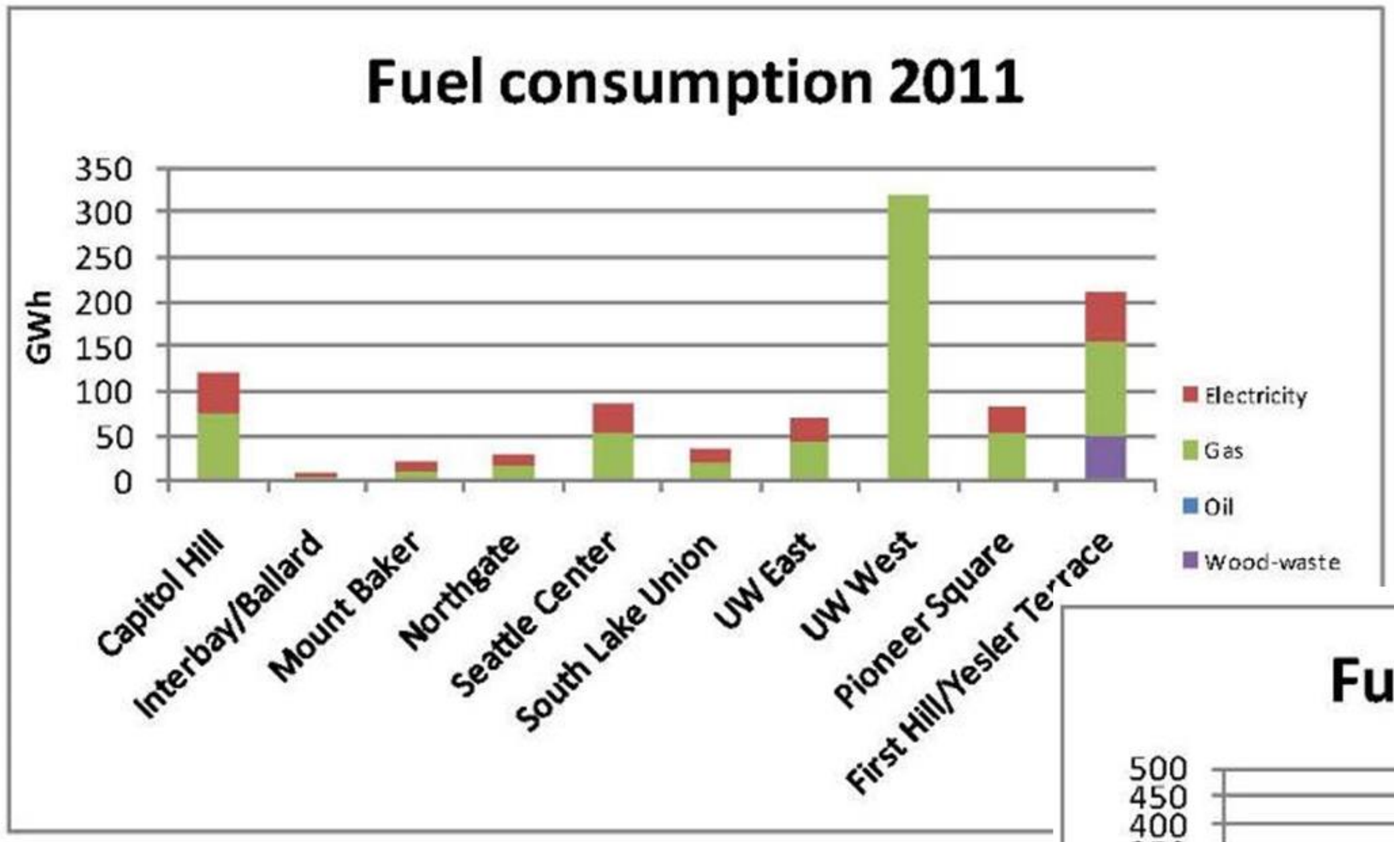
ENERGY USE ASSUMPTIONS

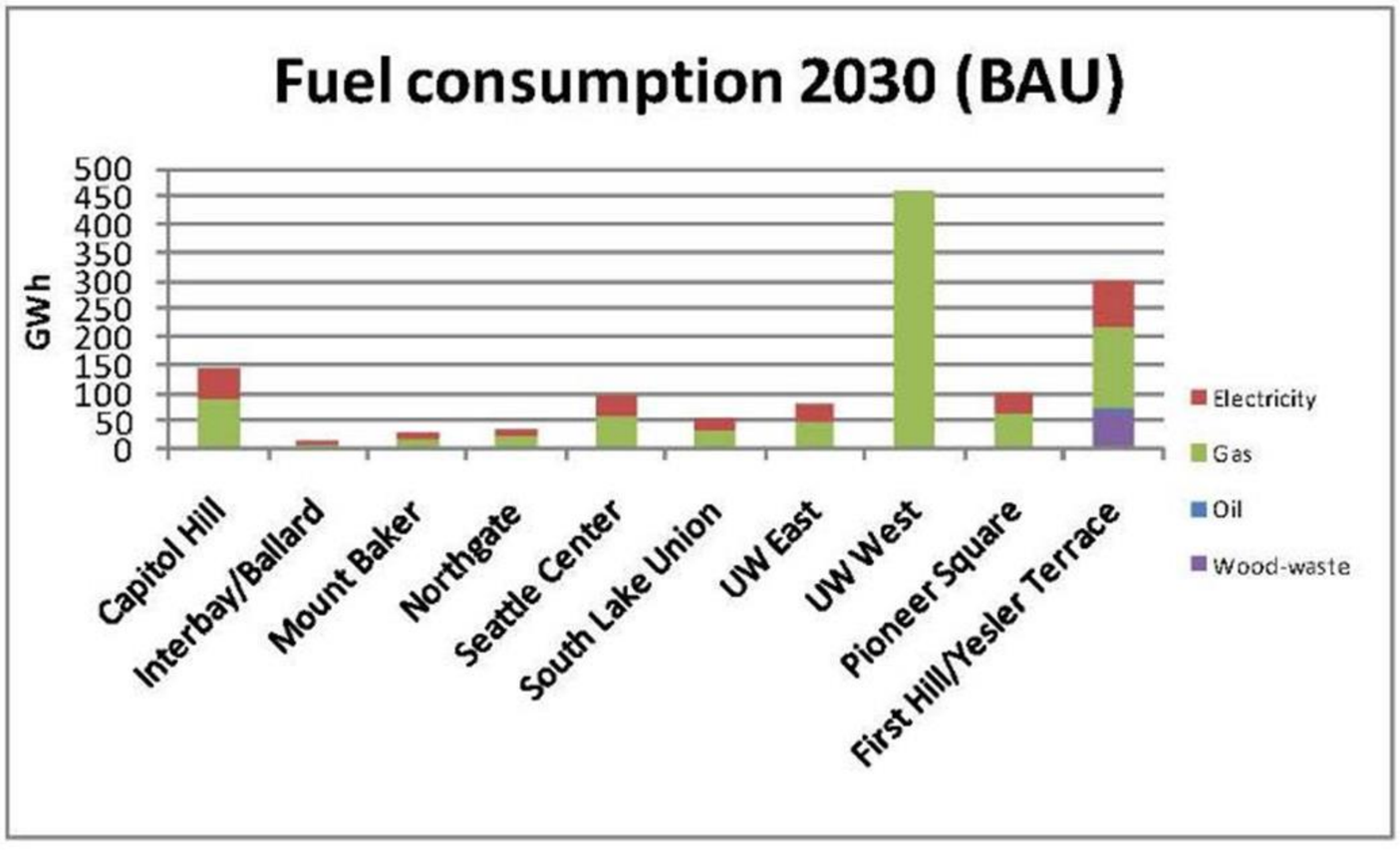
Energy Usage Assumptions							
FVB Energy Inc. (South Lake Union)			Compass (Vancouver BC)			Seattle
Space Usage Type	Peak Heating Demand Factor (Btu/hr/sf)	Peak Cooling Demand Factor (sf/ton)	Space Usage Type	Peak Heating Demand Factor (Btu/hr/sf)	Peak Cooling Demand Factor (sf/ton)	Space Types
High Tech Office	11.4	450				
Conventional Office	12.0	615				
Average	**11.7**	**533**	Office	17.4	630	Office/Med/Dental/Office
Research Lab	20.4	350				
Institutional	21.0	450				
Average	**20.7**	**400**	Community/Institutional	17.4	675	School/Institutional
Retail	16.1	550				
Grocery Store	16.1	550				
Average	**16.1**	**550**	Commercial	9.5	1,351	Retail/Commercial
Hotel/Motel	11.6	779				
Apartment/Condo/Extended Stay Hotel	11.6	779				
Average	**11.6**	**779**	Low Rise	15.2	788	Apartment/Condo
Restaurant	33.0	420				Restaurant
			Row	11.4	1,576	Single Family/Townhouse/Triplex/Duplex
			Mid Rise	17.4	485	
			Artisan/Industrial	17.4	1,351	
Health/Fitness	11.6	779				
Theater	16.1	550				
Data Center	7.2	58				

WHAT DID WE LEARN?

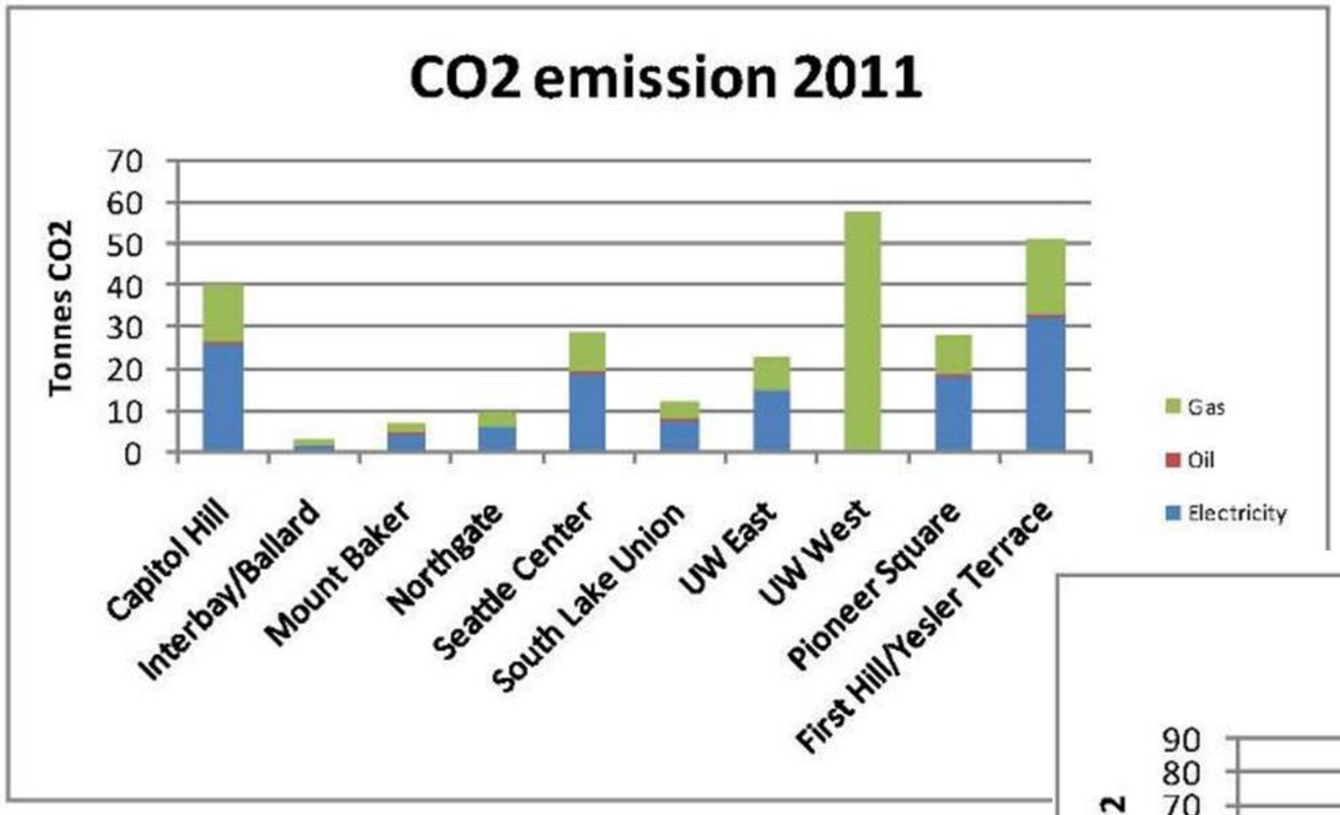


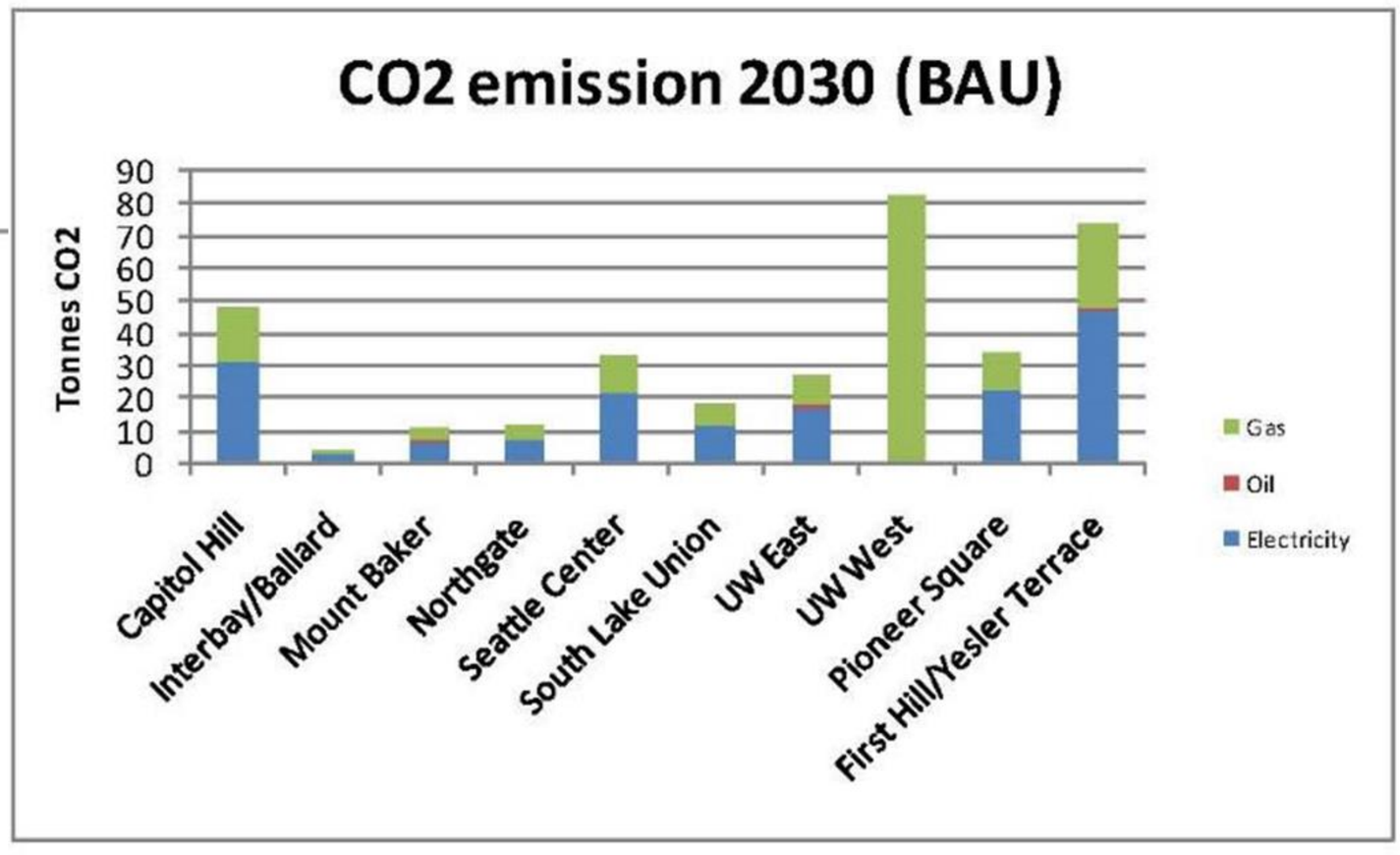
FUEL CONSUMPTION



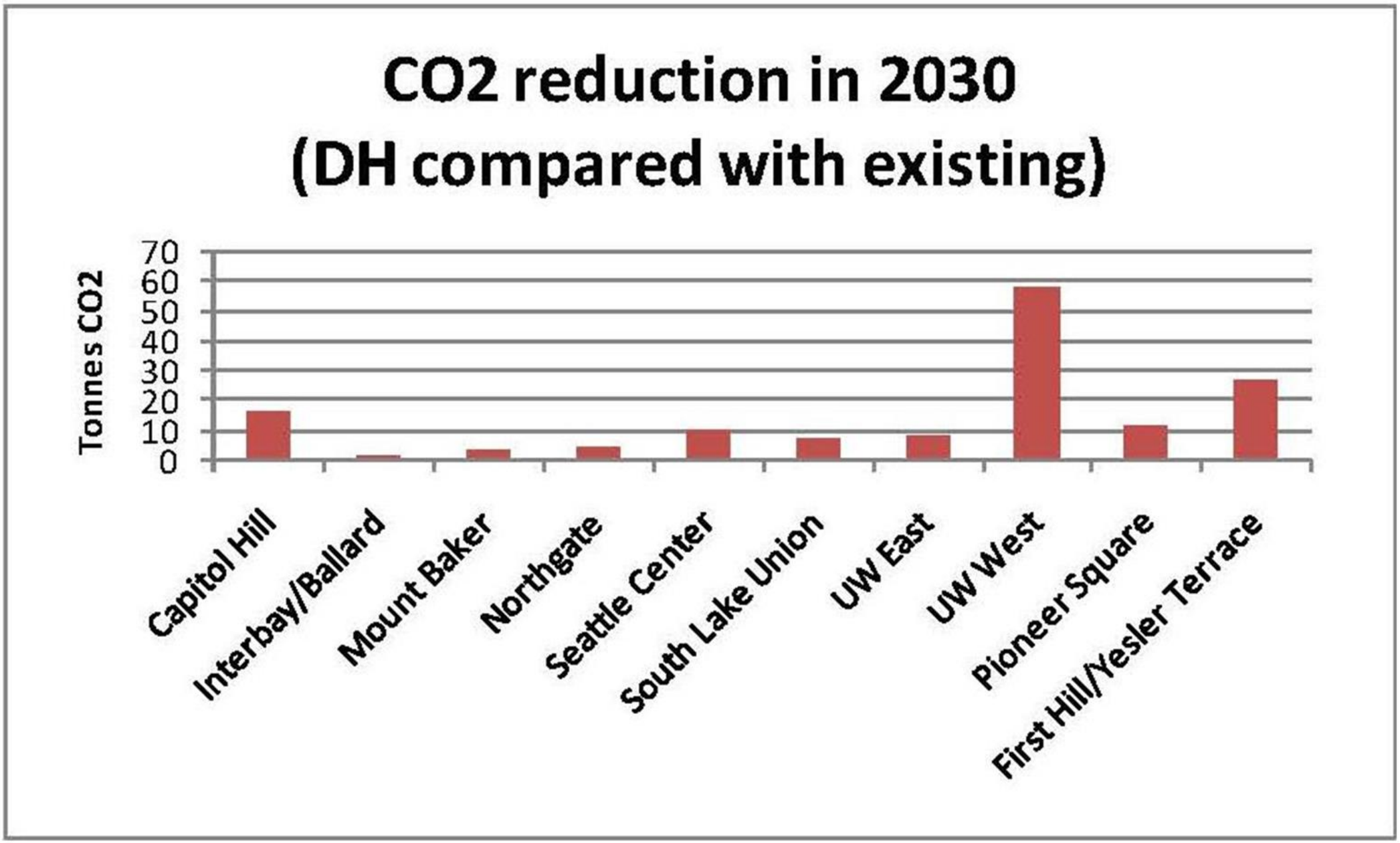


CO_2 EMISSIONS

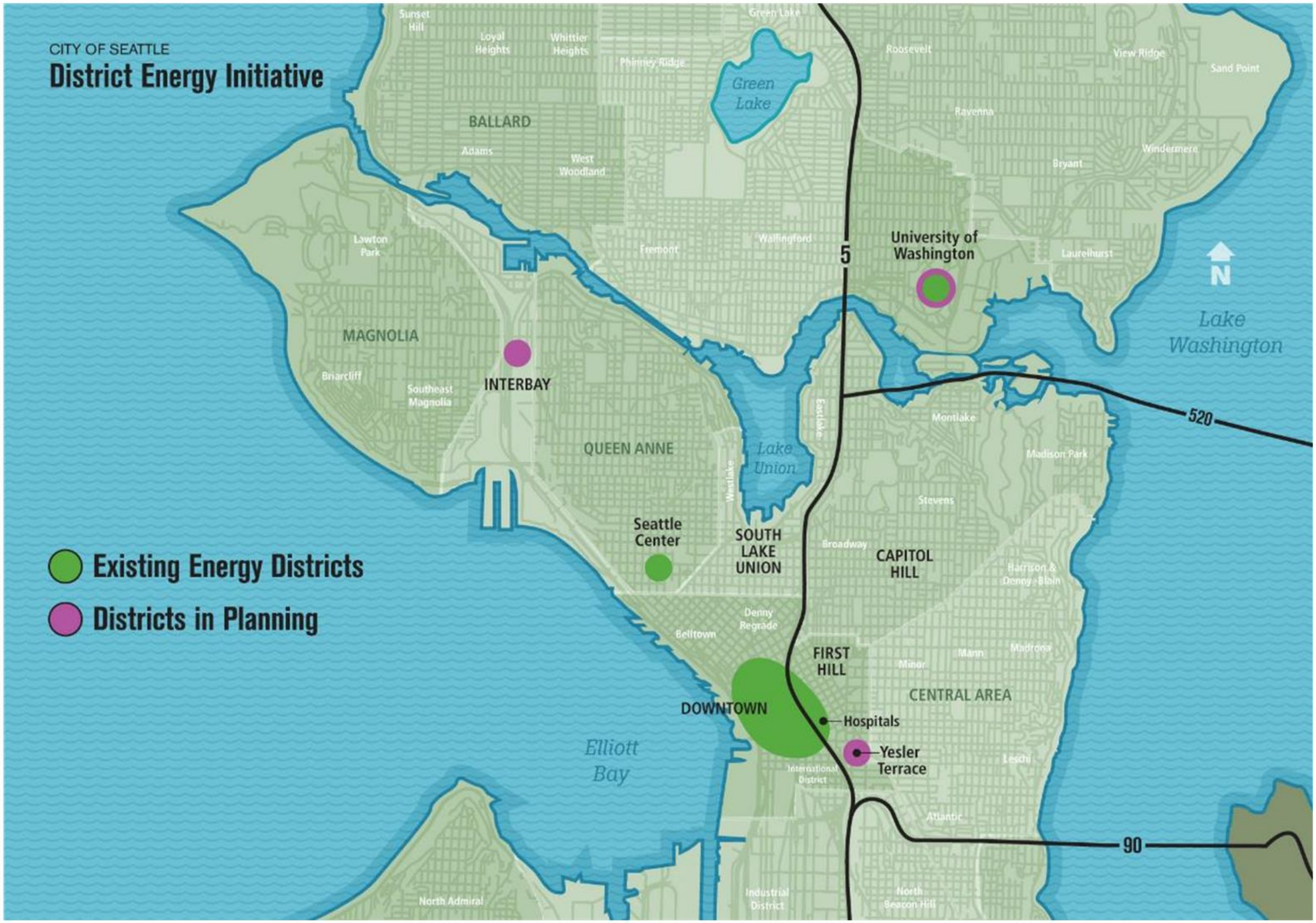




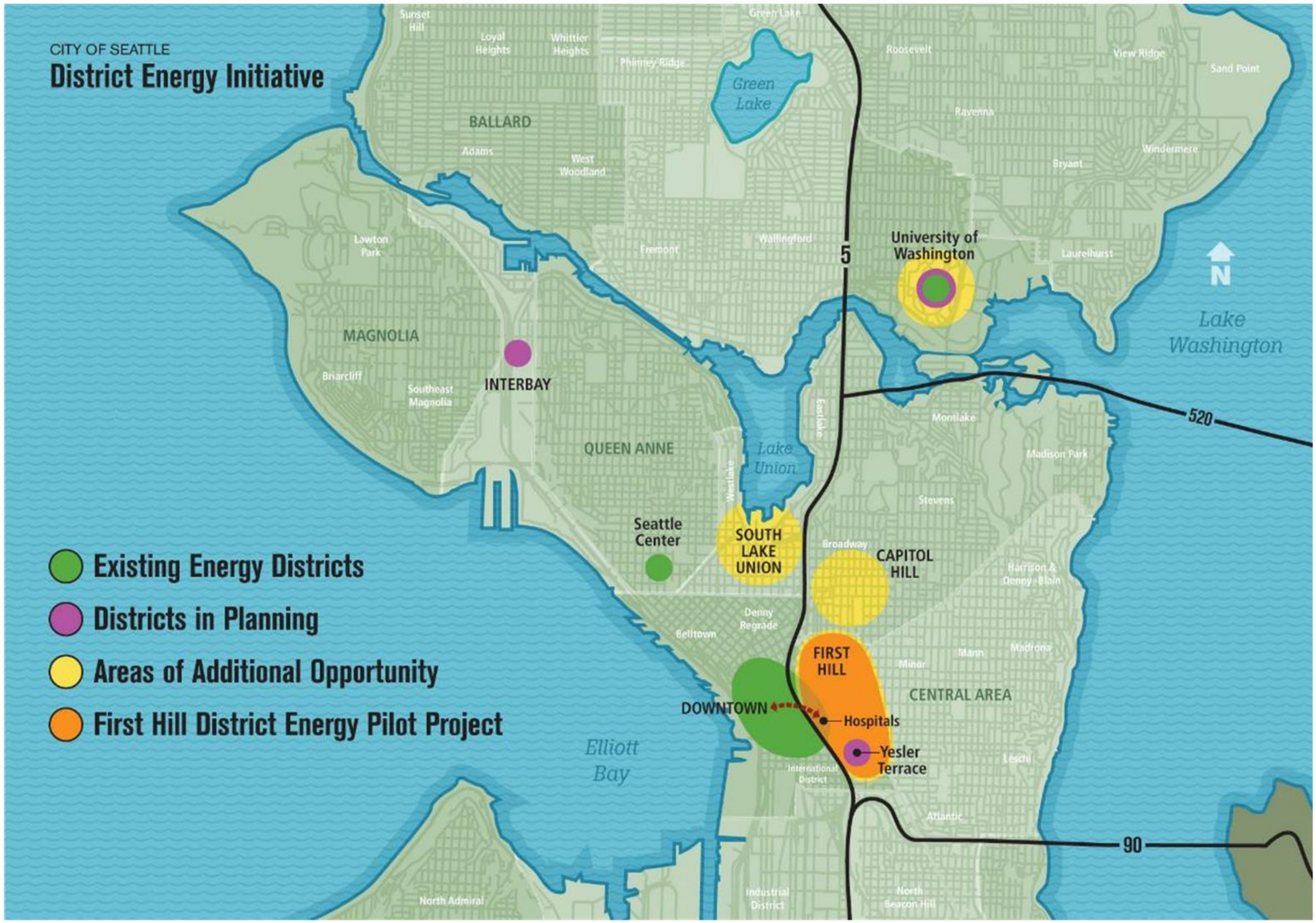
CO_2 REDUCTION IN 2030



NEXT STEPS


CITY OF SEATTLE
District Energy Initiative
Existing Energy Districts
Districts in Planning
Sunset Hill
Loyal Heights
Whittier Heights
Phinney Ridge
Green Lake
Roosevelt
View Ridge
Sand Point
Ravenna
BALLARD
Adams
West Woodland
Windermere
Bryant
Lawton Park
Fremont
Wallingford
University of Washington
Laurelhurst
5
N
Lake Washington
MAGNOLIA
Briarcliff
Southeast Magnolia
INTERBAY
520
Montlake
Madison Park
QUEEN ANNE
Lake Union
Eastlake
Westlake
Stevens
Seattle Center
SOUTH LAKE UNION
Broadway
CAPITOL HILL
Harrison & Denny-Blaine
Denny Regrade
Belltown
FIRST HILL
Minor
Mann
Madrona
CENTRAL AREA
DOWNTOWN
Hospitals
Yesler Terrace
Elliott Bay
International District
Leschi
Atlantic
90
North Admiral
Industrial District
North Beacon Hill

NEXT STEPS


CITY OF SEATTLE
District Energy Initiative
Existing Energy Districts
Districts in Planning
Areas of Additional Opportunity
First Hill District Energy Pilot Project
BALLARD
MAGNOLIA
QUEEN ANNE
CENTRAL AREA
DOWNTOWN
INTERBAY
SOUTH LAKE UNION
CAPITOL HILL
FIRST HILL
Seattle Center
University of Washington
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Mann
Madrona
Leschi
International District
Atlantic
Industrial District
North Beacon Hill
North Admiral
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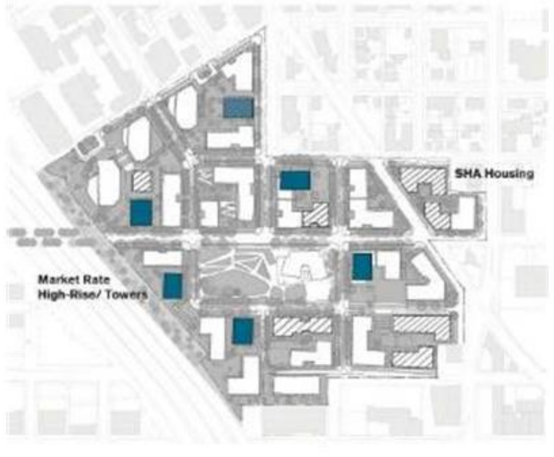
520
90
N

FIRST HILL OPPORTUNITY

Three Hospitals

Yesler Terrace Redevelopment



ADDITIONAL NEAR-TERM PRIORITIES

Capitol Hill

South Lake Union

University District

STAGE 3:
Project Definition

Selling the idea – different drivers for different audiences

Collect commitments from partners/potential customers to investigate the opportunity further

Securing the commitment of key anchor load: similar to retail development securing anchor tenant

Viability of a project improves with size and diversity of loads: partnerships between multiple building owners in private and public sectors are beneficial

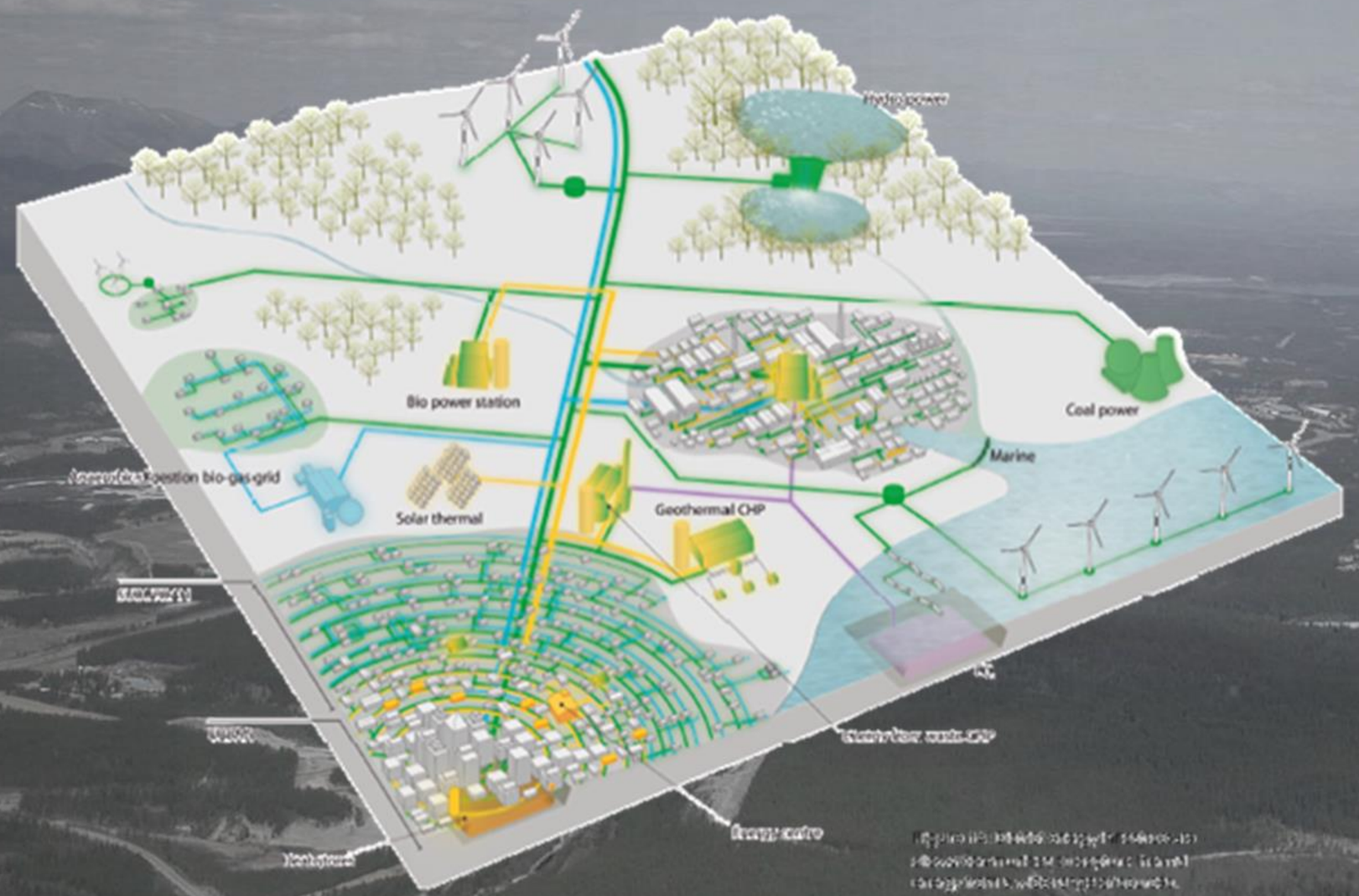
Varied priorities: commercial developments, community developments

STAGE 4: Options Appraisal

Analyze data and examine energy technology options

High-level feasibility study: compare the energy solutions available, evaluate payback periods and cost-effectiveness

Compare a limited number of typical solutions, including business-as-usual case



ASSESSING FINANCIAL VIABILITY

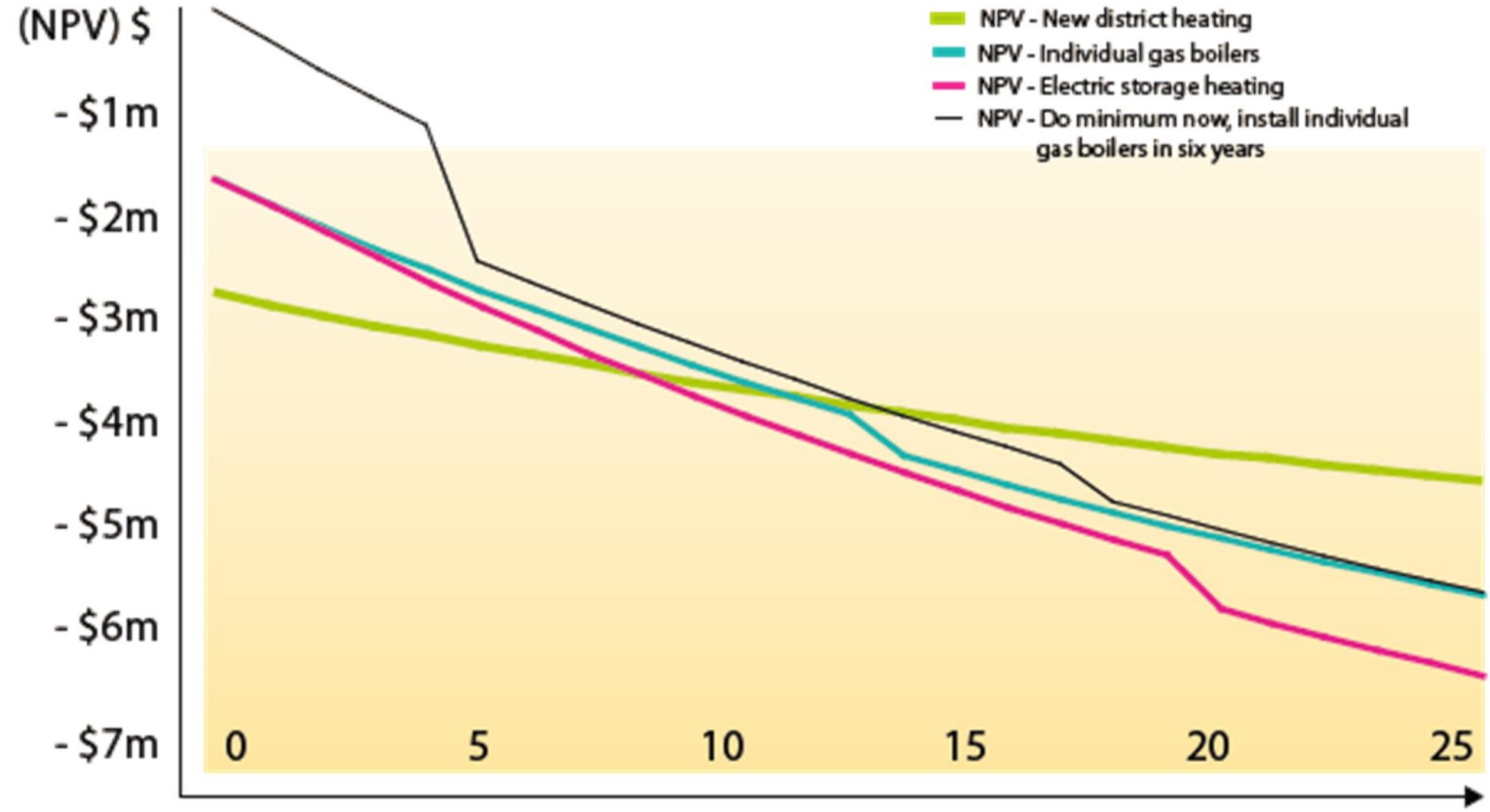
Compare Simple Payback and Net Present Value (NPV)

Consider rate of return requirements

Life-cycle costing: 25-year term, considers the capital costs of each option as well as other costs

Operational costs: fuel, maintenance, replacement costs

Community energy : life-cycle cost analysis



STAGE 5:

Feasibility Study

DETAILED TECHNICAL ANALYSIS

Age of buildings and existing energy systems | Routing and network measurements | Phasing | Network heat losses |Connections | Heat production | Cooling | Thermal storage | Land availability | CHP

ANALYZING HEATING LOADS

Existing

Heating parameters:

Electric resistance; heat pump;

Steam,

Hot water,

Temperatures and pressure

ANALYZING COOLING LOADS

Existing Buildings

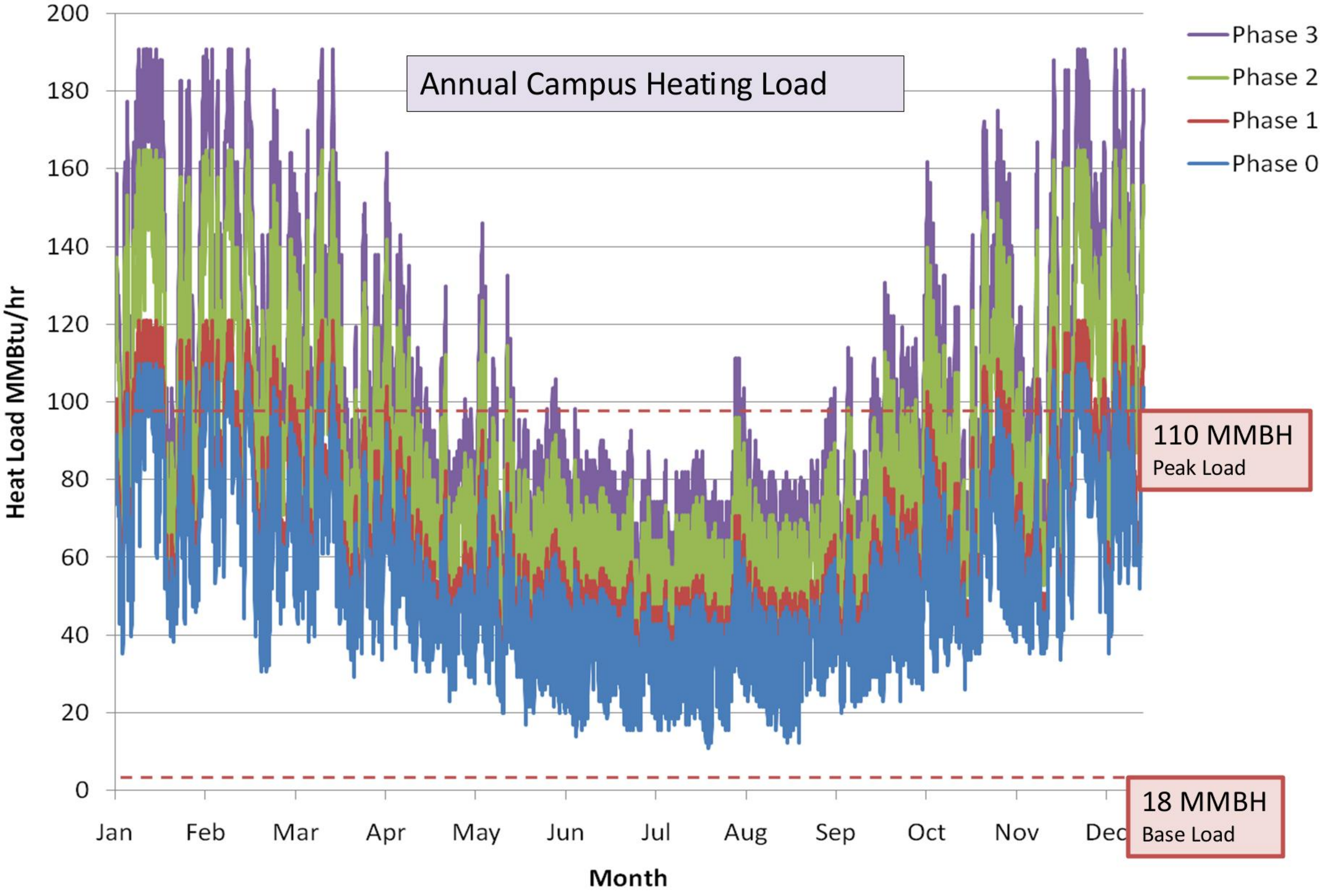
Cooling parameters:

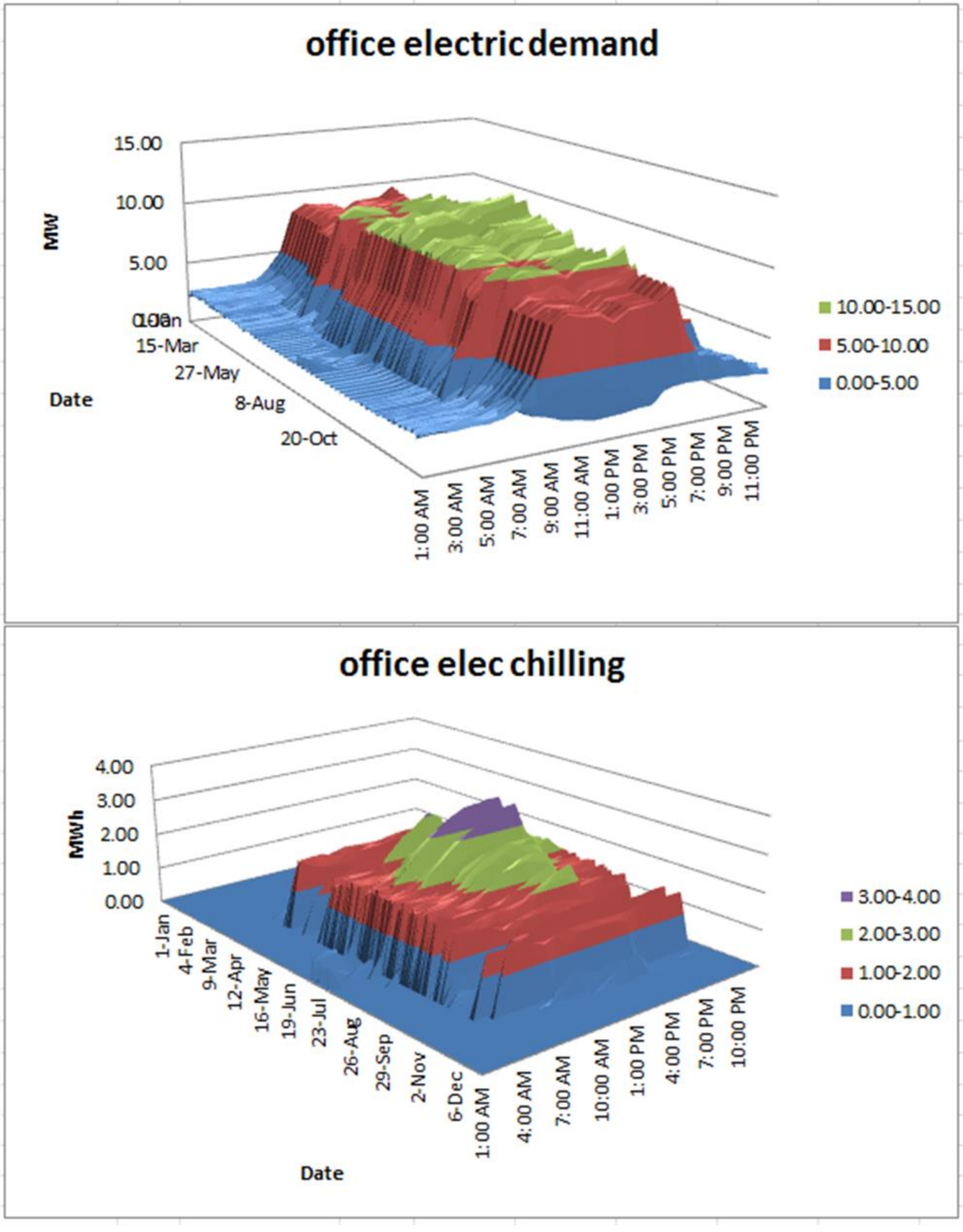
Installed capacity vs contract demand

Central chilled water; AHU's; VAV, etc

DX; split systems; VFR?

Temperatures – supply, return, delta T, coil selections


Annual Campus Heating Load
Heat Load MMBtu/hr
200
180
160
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
Phase 3
Phase 2
Phase 1
Phase 0
110 MMBH
Peak Load
18 MMBH
Base Load


office electric demand
MW
15.00
10.00
5.00
0.00
Date
15-Mar
27-May
8-Aug
20-Oct
1:00 AM
3:00 AM
5:00 AM
7:00 AM
9:00 AM
11:00 AM
1:00 PM
3:00 PM
5:00 PM
7:00 PM
9:00 PM
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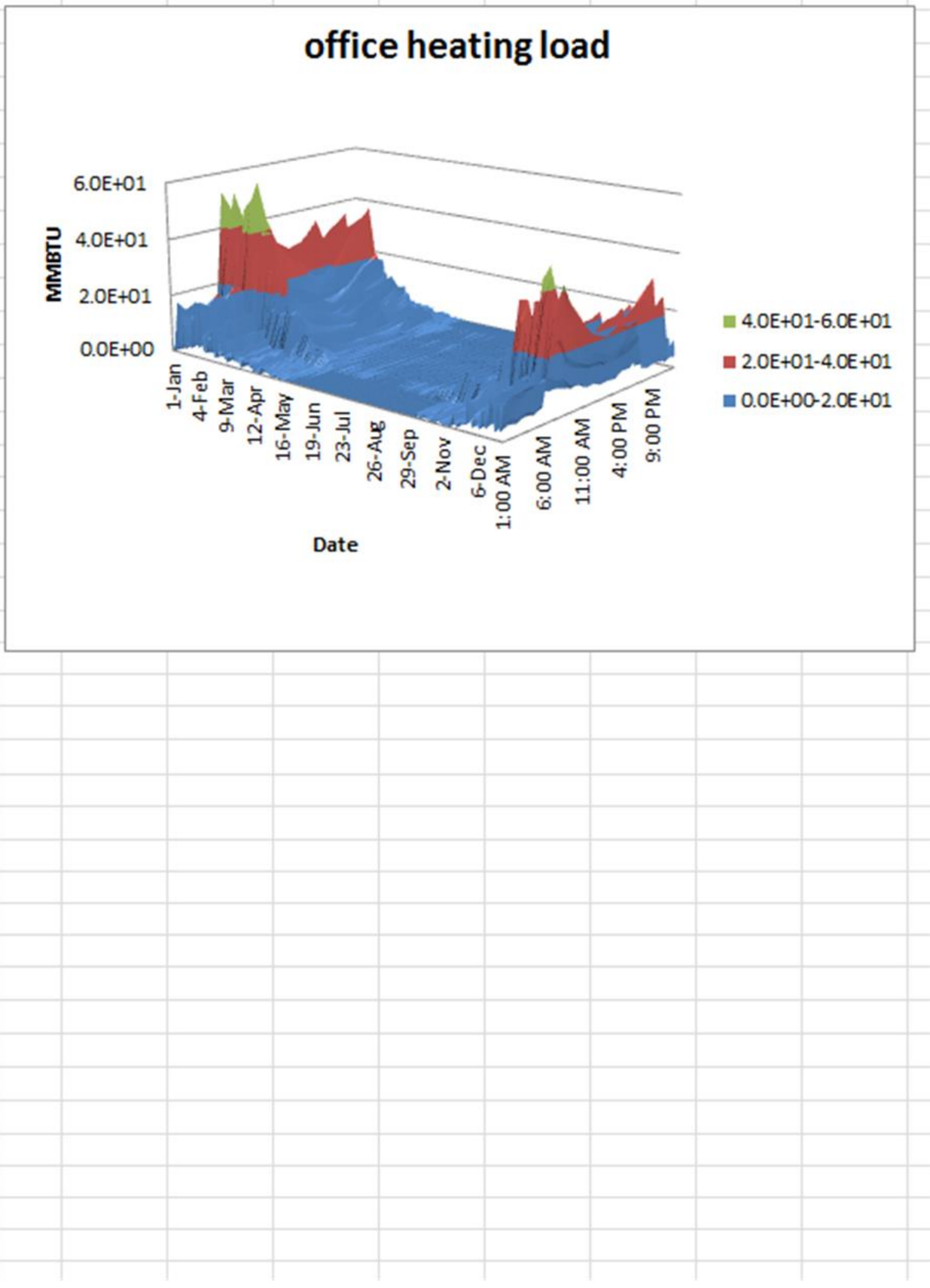
5.00-10.00
0.00-5.00


office heating load
MMBTU
6.0E+01
4.0E+01
2.0E+01
0.0E+00
Date
1-Jan
4-Feb
9-Mar
12-Apr
16-May
19-Jun
23-Jul
26-Aug
29-Sep
2-Nov
6-Dec
1:00 AM
6:00 AM
11:00 AM
4:00 PM
9:00 PM
4.0E+01-6.0E+01
2.0E+01-4.0E+01
0.0E+00-2.0E+01

office elec chilling
MWh
4.00
3.00
2.00
1.00
0.00
Date
1-Jan
4-Feb
9-Mar
12-Apr
16-May
19-Jun
23-Jul
26-Aug
29-Sep
2-Nov
6-Dec
1:00 AM
4:00 AM
7:00 AM
10:00 AM
1:00 PM
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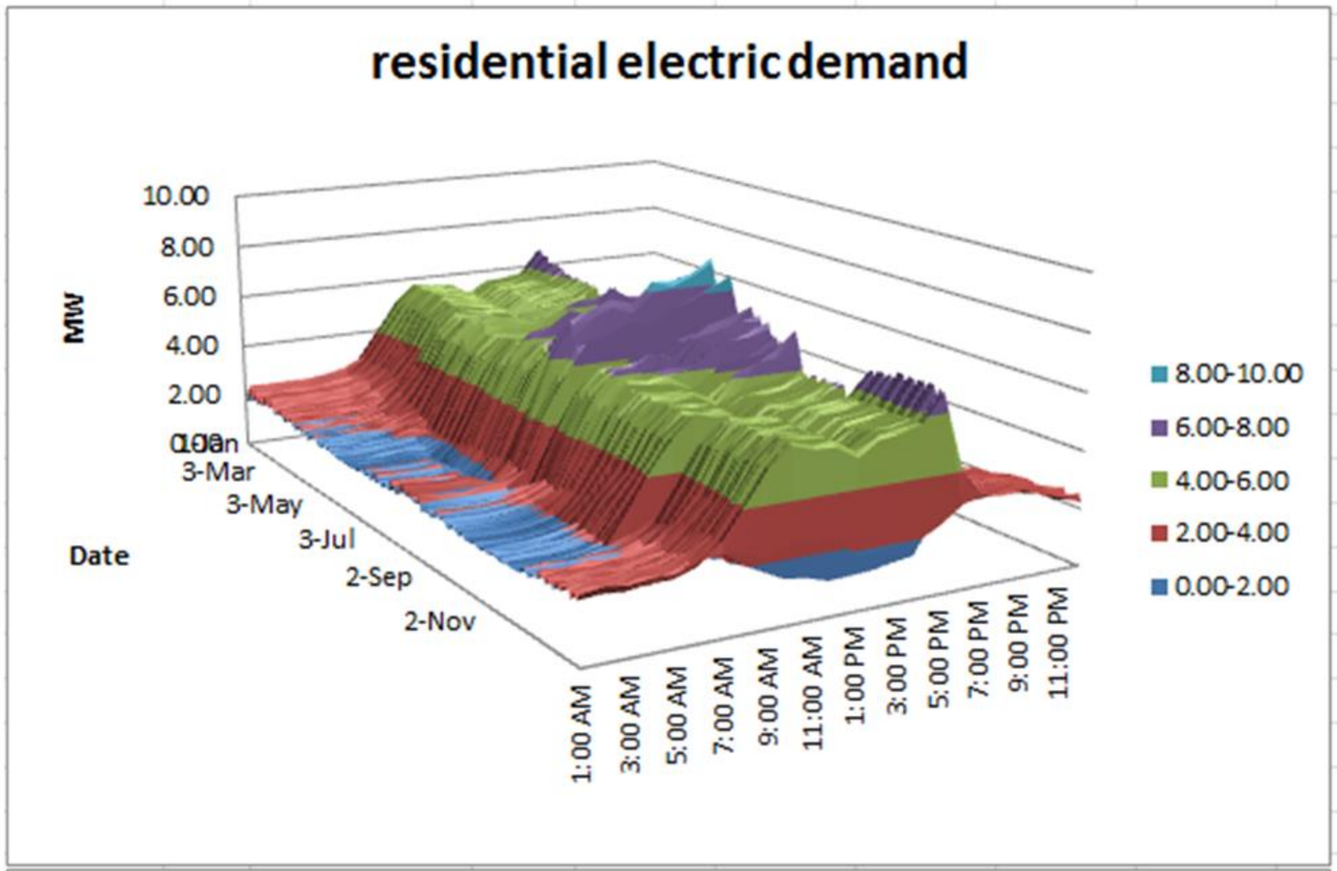
7:00 PM
10:00 PM
3.00-4.00
2.00-3.00
1.00-2.00
0.00-1.00


residential electric demand
MW
10.00
8.00
6.00
4.00
2.00
0.00
Date
1-Jan
3-Mar
3-May
3-Jul
2-Sep
2-Nov
1:00 AM
3:00 AM
5:00 AM
7:00 AM
9:00 AM
11:00 AM
1:00 PM
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5:00 PM
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8.00-10.00
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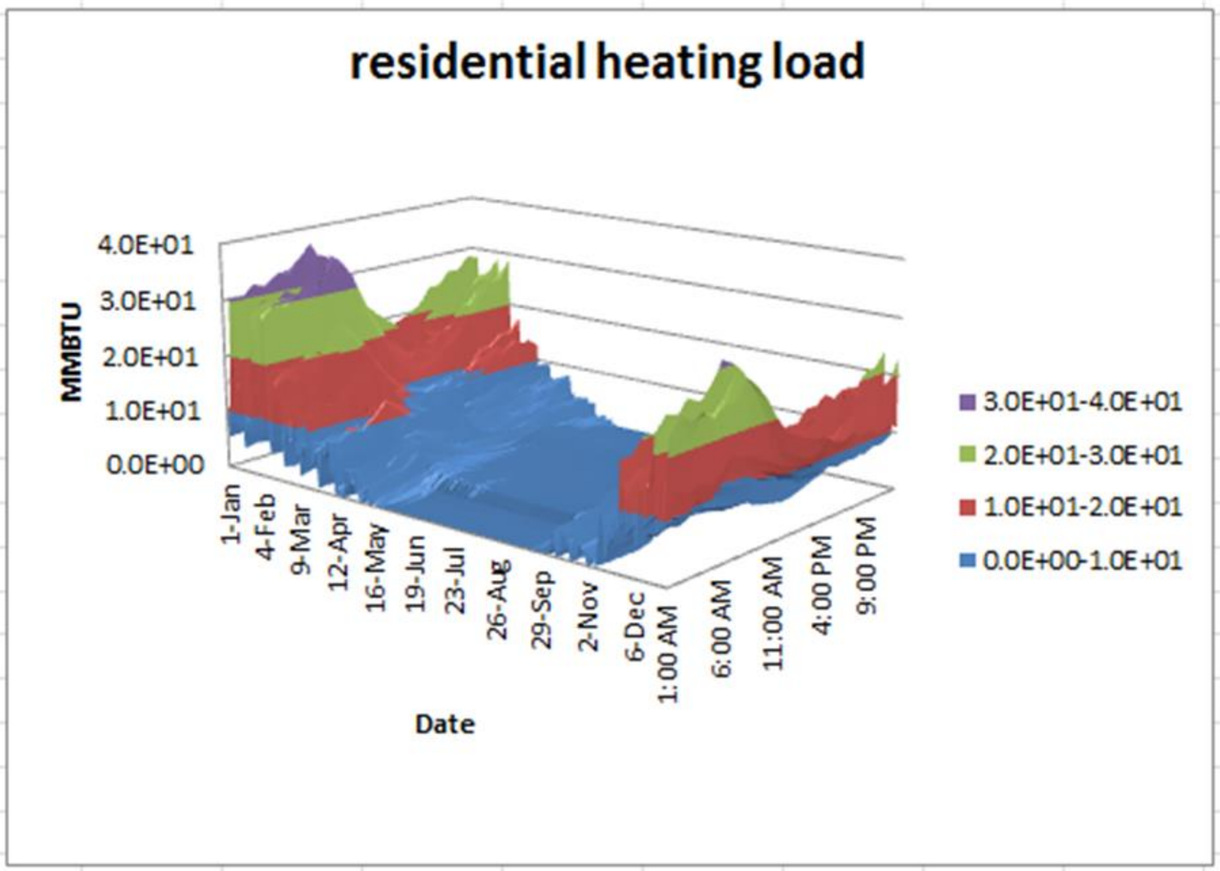
4.00-6.00
2.00-4.00
0.00-2.00


residential heating load
MMBTU
4.0E+01
3.0E+01
2.0E+01
1.0E+01
0.0E+00
Date
1-Jan
4-Feb
9-Mar
12-Apr
16-May
19-Jun
23-Jul
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29-Sep
2-Nov
6-Dec
1:00 AM
6:00 AM
11:00 AM
4:00 PM
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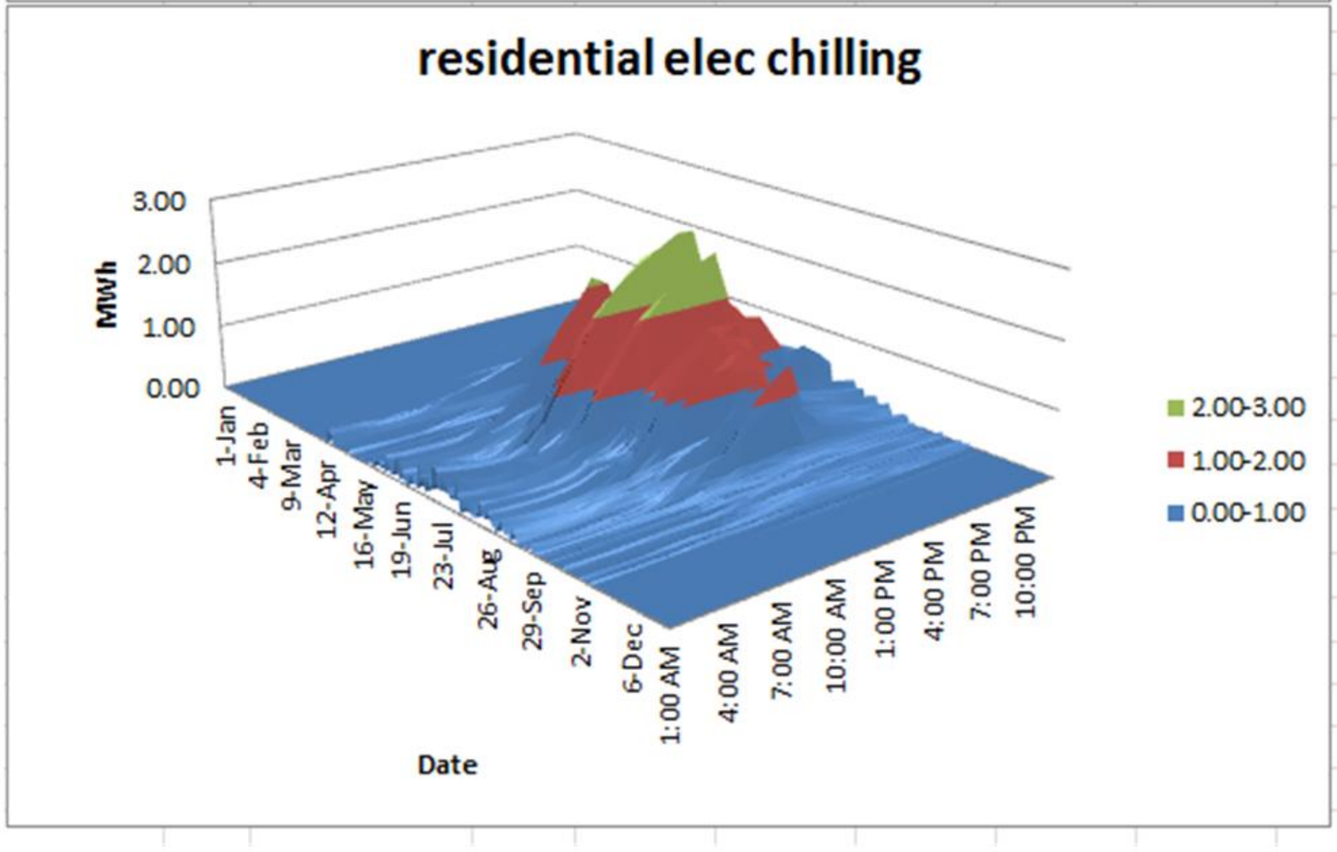
3.0E+01-4.0E+01
2.0E+01-3.0E+01
1.0E+01-2.0E+01
0.0E+00-1.0E+01


residential elec chilling
MWh
3.00
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Date
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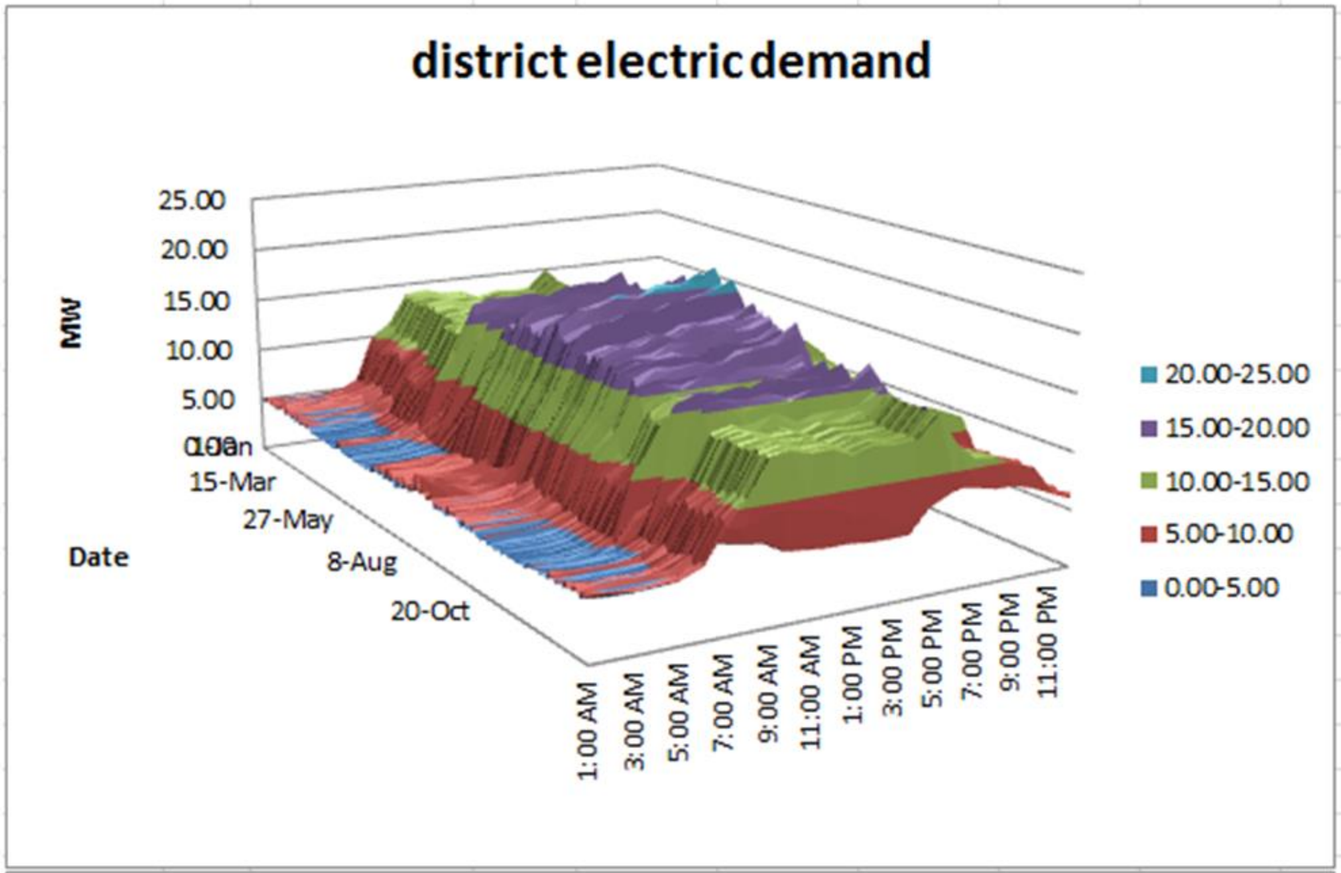
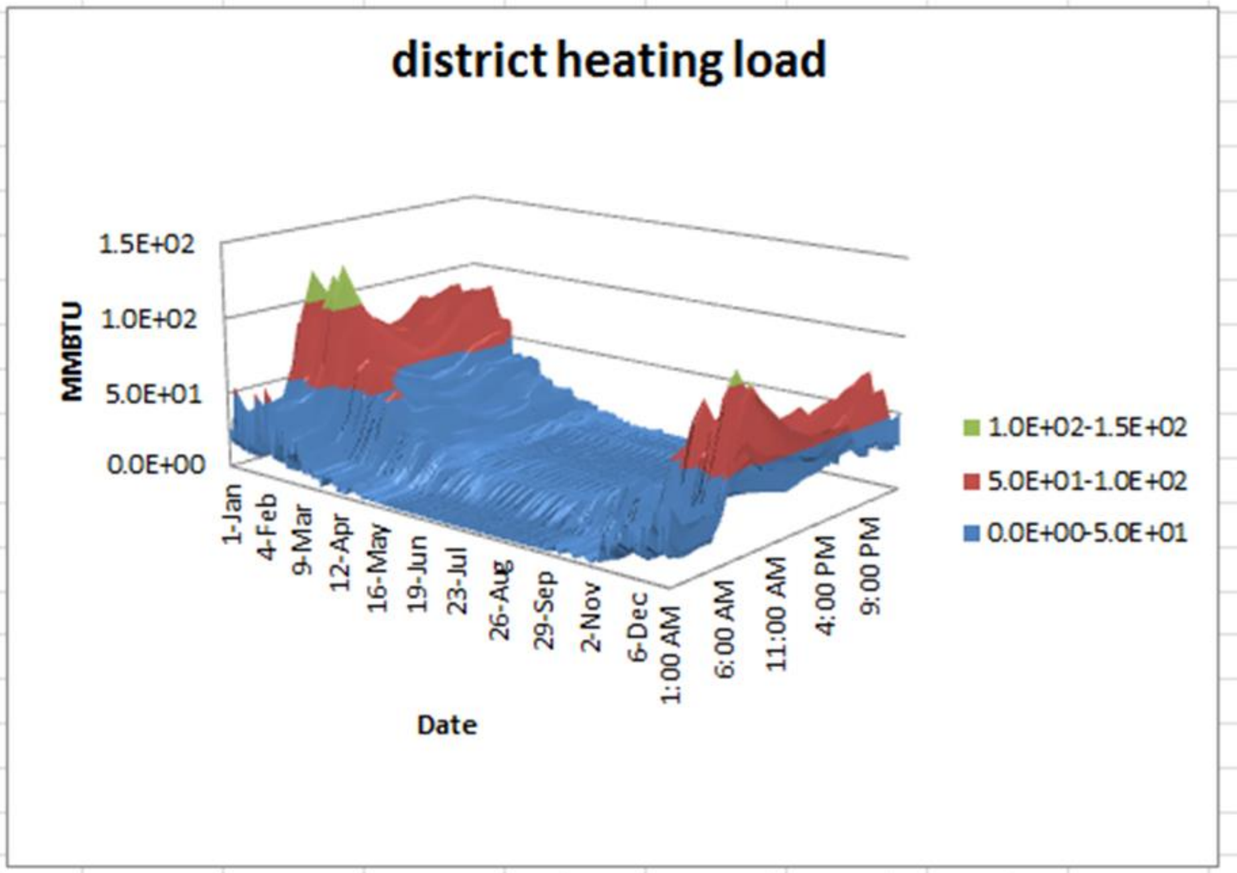
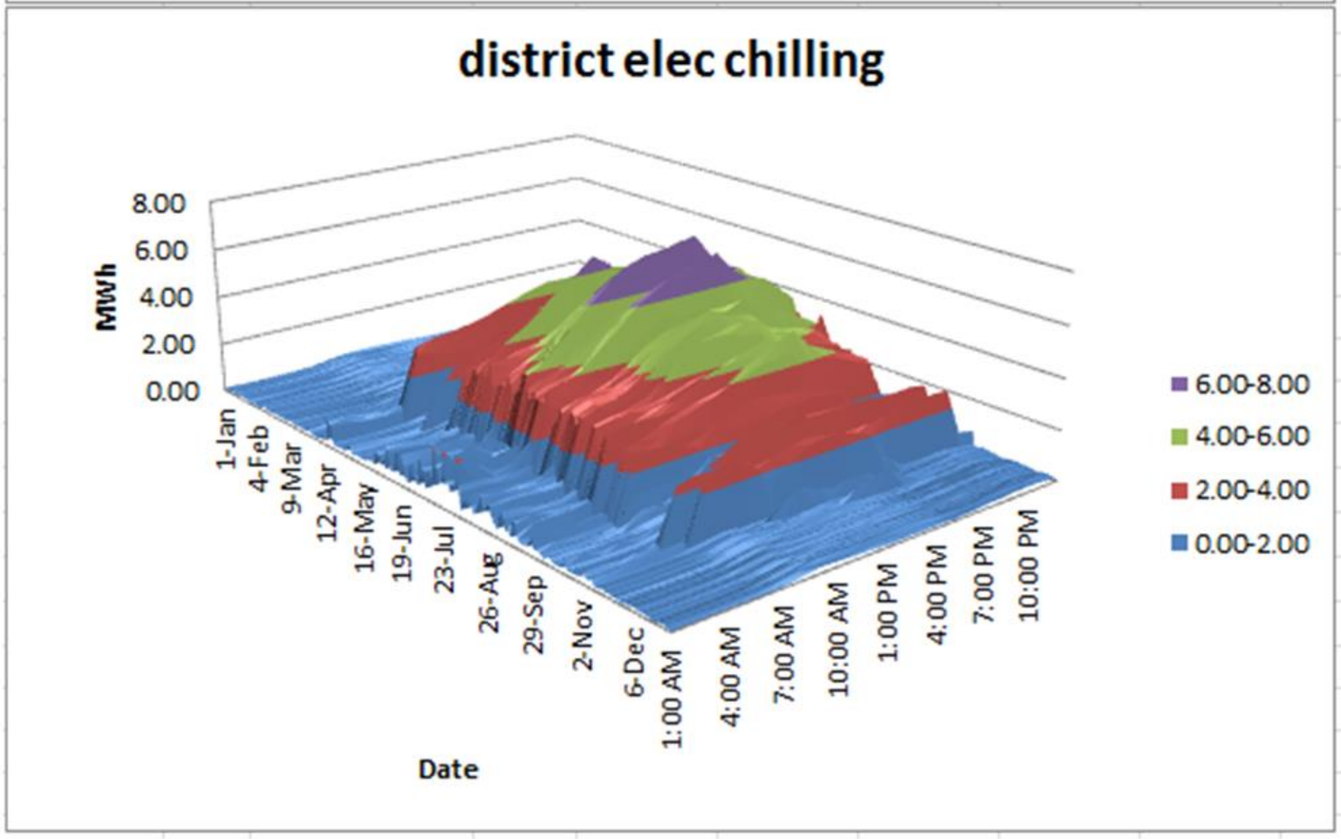
0.00-1.00

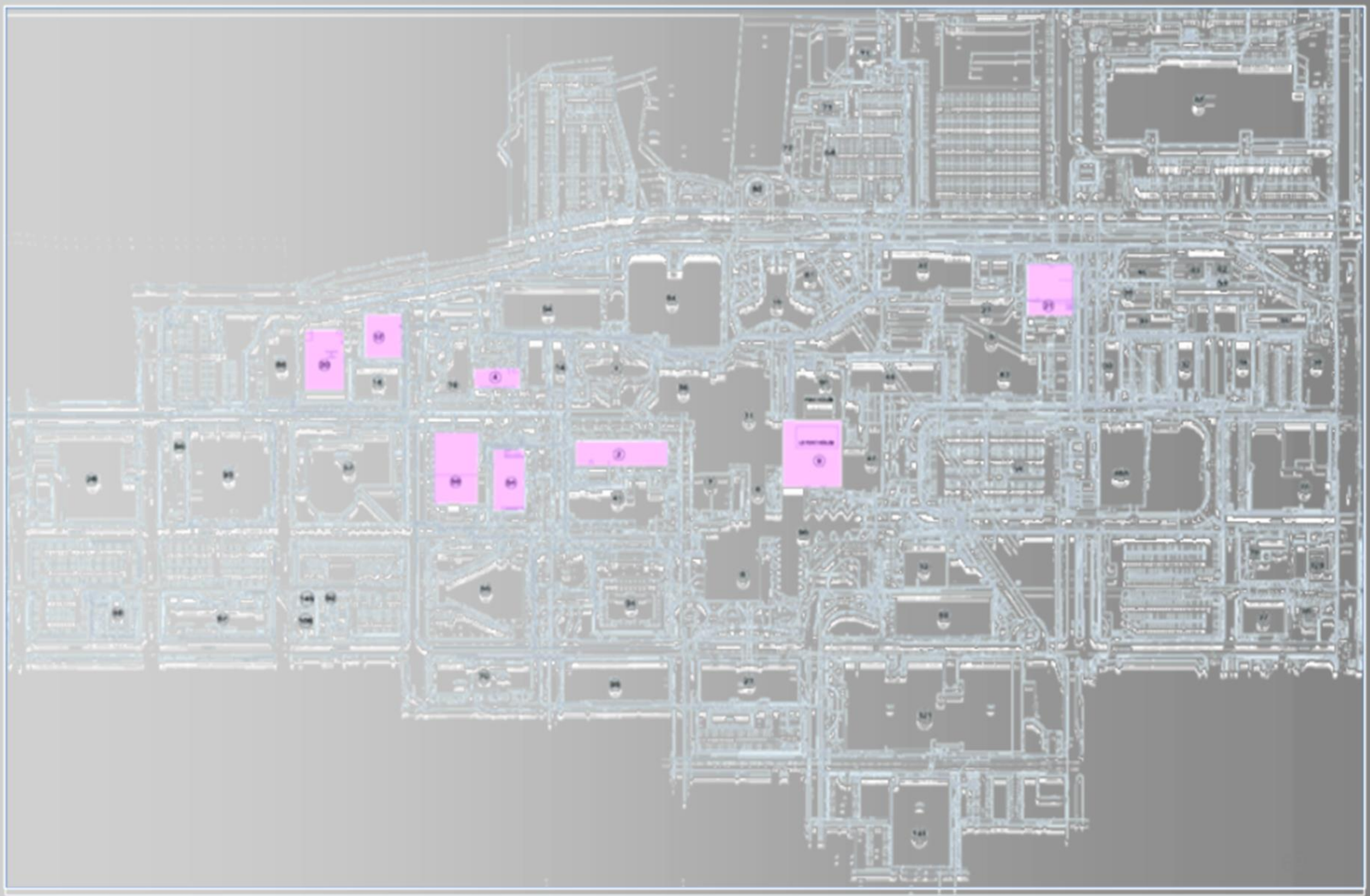




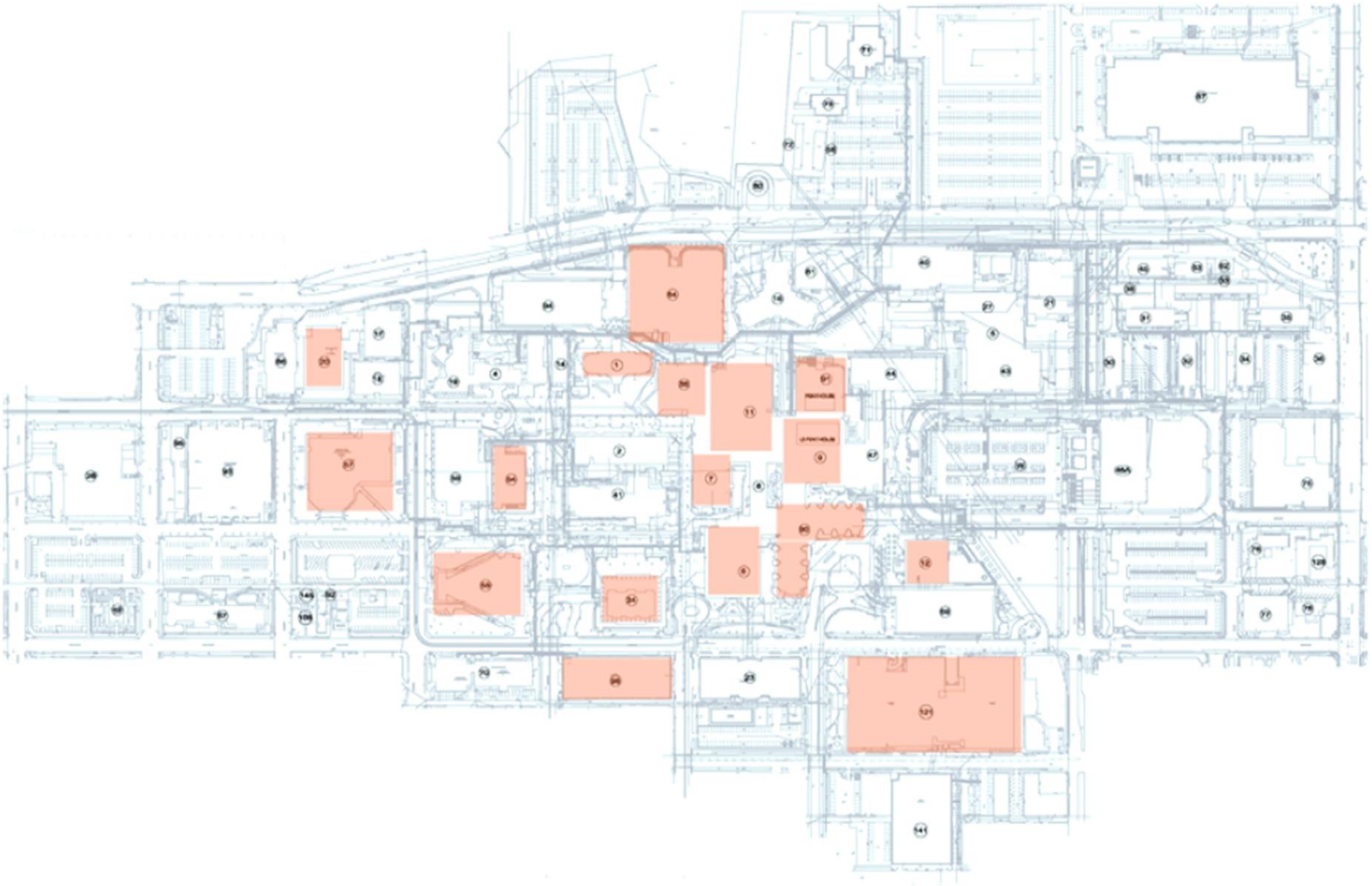


Occupancy Type	*input values here*	*input values here*	
	SF	# Bldg	
Large Office	1,986,000	***11***	
Medium Office	277,920	***4***	
Small Office	-	**-**	
Warehouse	-	**-**	
Stand Alone Retail	122,850	***20***	
Strip Mall	-	**-**	
Primary School	-	**-**	
Secondary School	36,000	***3***	
Supermarket	75,140	***2***	
Quick Service Restaurant	75,140	***3***	
Full Service Restaurant	75,140	***4***	
Hospital	-	**-**	
Outpatient Health Clinic	-	**-**	
Small Hotel	234,000	***8***	
Large Hotel	420,600	***2***	
Midrise Apt	1,329,400	***405***	
Light Industrial	685,645	***11***	
User Building 2	-	**-**	
User Building 3	-	**-**	
User Building 4	-	**-**	
User Building 5	-	**-**	
Total	***5,317,835***	***30***	

STEAM PRE-HEAT COILS



THREE-WAY VALVES



ANALYZING LOADS

New Buildings:

Establish design parameters (delta T carrot/stick)

How enforced?

Critical to assess installed vs peak capacity

Future regulations and codes (LEED; ASHRAE; etc)

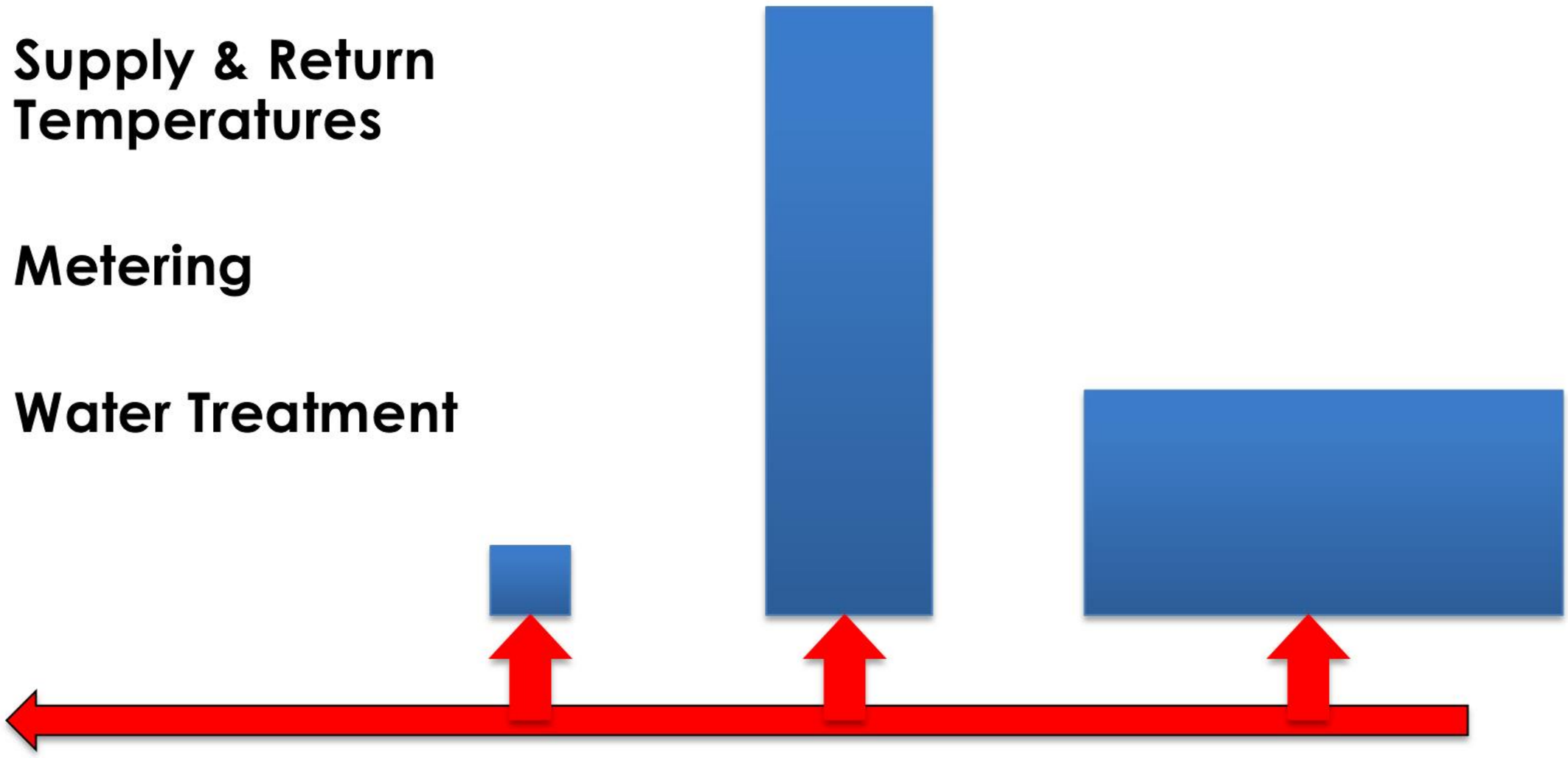
CUSTOMER INTERFACE

Differential Pressures

Supply & Return Temperatures

Metering

Water Treatment



NETWORK +ROUTING

Phasing of mains and services – rights of way

Distances; street crossings; congested underground

Customer Interface – point of entry; vaults; rights of way; clearances; garage; vertical routes;

Losses; design flow rates; pressure control

Plant locations and hydraulic model

NODAL DEVELOPMENT

Development
Distribution pipeline
Heat source
Anchor heat loads

Heat loads
Transmission pipeline
Power station

HEAT(ING)

HW or Steam (Temperature; PSIG)

Heat Recovery – Seasonality; Longevity; Risk of Supply

Fuel Source: Solid, Liquid, Gas

Quantity/Configuration: Base/Peak, Equal Size

Redundancy (N + 1)

Maintainability - Accessibility

$ per MMBtu Range – Risk tolerance

COOL(ING)

Chilled Water or Thermal Fluid -

Motivator: Electric, Turbine, Absorption

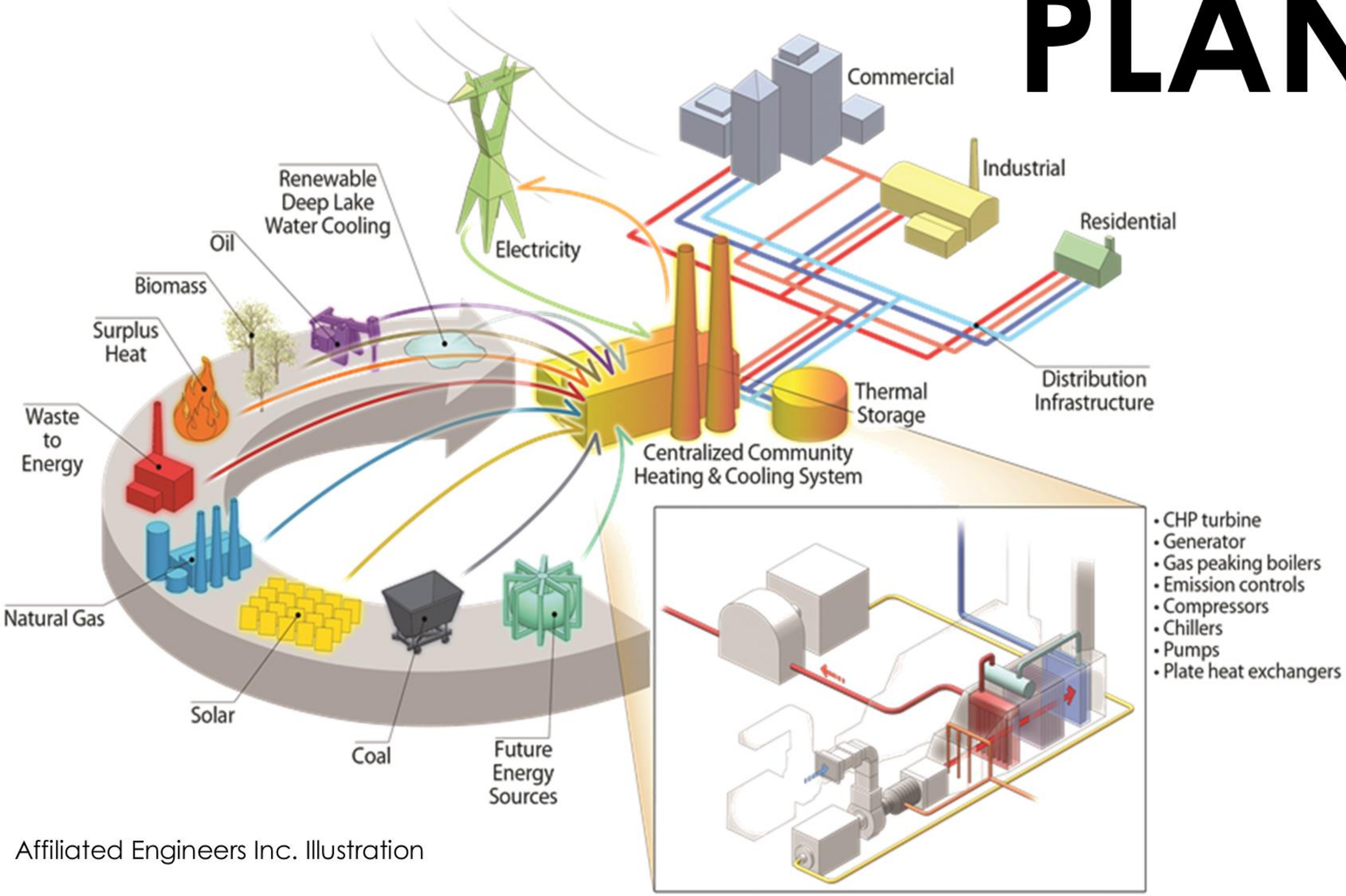
Quantity/Configuration: Base/Peak, Size Ratio to peaks

Redundancy

Maintainability

Future Thermal Storage

CENTRAL PLANT



Affiliated Engineers Inc. Illustration

OPTIMUM SOLUTION

Financial viability determines technology

Feasibility study may produce a range of scenarios with different permutations of technologies and design arrangements

Project developer must calculate rates of return based on a variety of sensitivity analyses

Conservatively project revenue amount and timing, include reasonable capital costs and contingencies to capture risk

Depending on whether the project principals are private investors, public entities, or partnerships, this may alter the rate of interest targets and financial viability of the project

STRATEGIES FOR RISK MITIGATION

Risks	Mitigation
Thermal Load	Take or Pay Contract; Capacity Payment
Equipment Failure	Proven Technology Equipment Guarantees O/M Contract
Project Cost Overrun	Contingencies - EPC Site Control
Gas Price Hedging: Match of Purchases to Consumption	Contract With Marketer

STAGE 6: Financial Modeling

FINANCIAL MODELING

Time value of money (discount rate)

Weighted average cost of capital

Risk assessment and mitigation

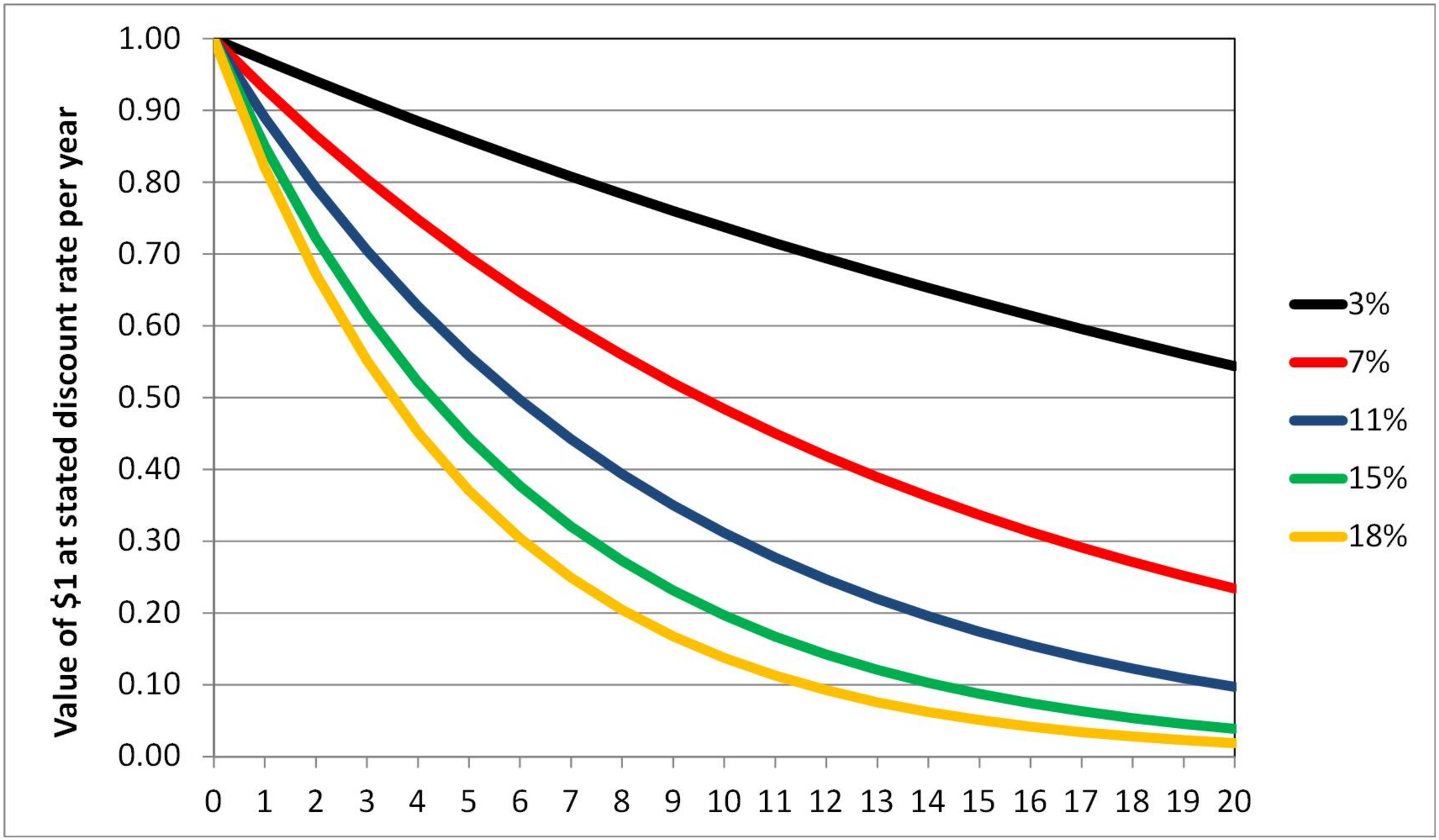
Measures of financial viability

Inputs to financial analysis

Example financial analysis

TIME VALUE OF MONEY

(DISCOUNT RATE)



WEIGHTED AVERAGE COST OF CAPITAL (WACC)

Debt interest rate = IR

Equity rate of return = ER

Debt ratio = DR

Weighted average cost of capital =

$$[IR \times DR] + [ER \times (1-DR)]$$

MEASURES OF FINANCIAL VIABILITY

Net Present Value (NPV)

Internal Rate of Return (IRR)

Return on Equity (ROE)

Simple Payback – not always relevant

FINANCIAL ANALYSIS

Capital Costs

Land for central plant
Central plant components

Pipes and units that bring energy into the building

Soft costs, i.e. engineering, permitting, land-use approvals, and rights of way

Construction and installation costs

Capital Contributions

Debt

Equity

Grants; Program

Connection charges

FINANCIAL ANALYSIS

Operational Costs

Fuel/ Power

Electricity for lighting, pumping

Labor -
Operations /Maintenance

Management (administration, billing, marketing etc.)

Capital interest and repayments

Insurance, taxes

Contributions to sinking fund

Consultant fees

Revenues

Thermal energy charges:
1. Consumption charge
2. Capacity charge

Electricity revenue

Other revenue – REC's' EEC's

SAMPLE FINANCIAL ANALYSIS

Hypothetical district heating and cooling system serving new mixed use development

Build-out: 60% by operating year 5; 100% by operating year 12

Phased plant, distribution and building connection capital costs

Initial plant natural gas boilers and electric centrifugal chillers

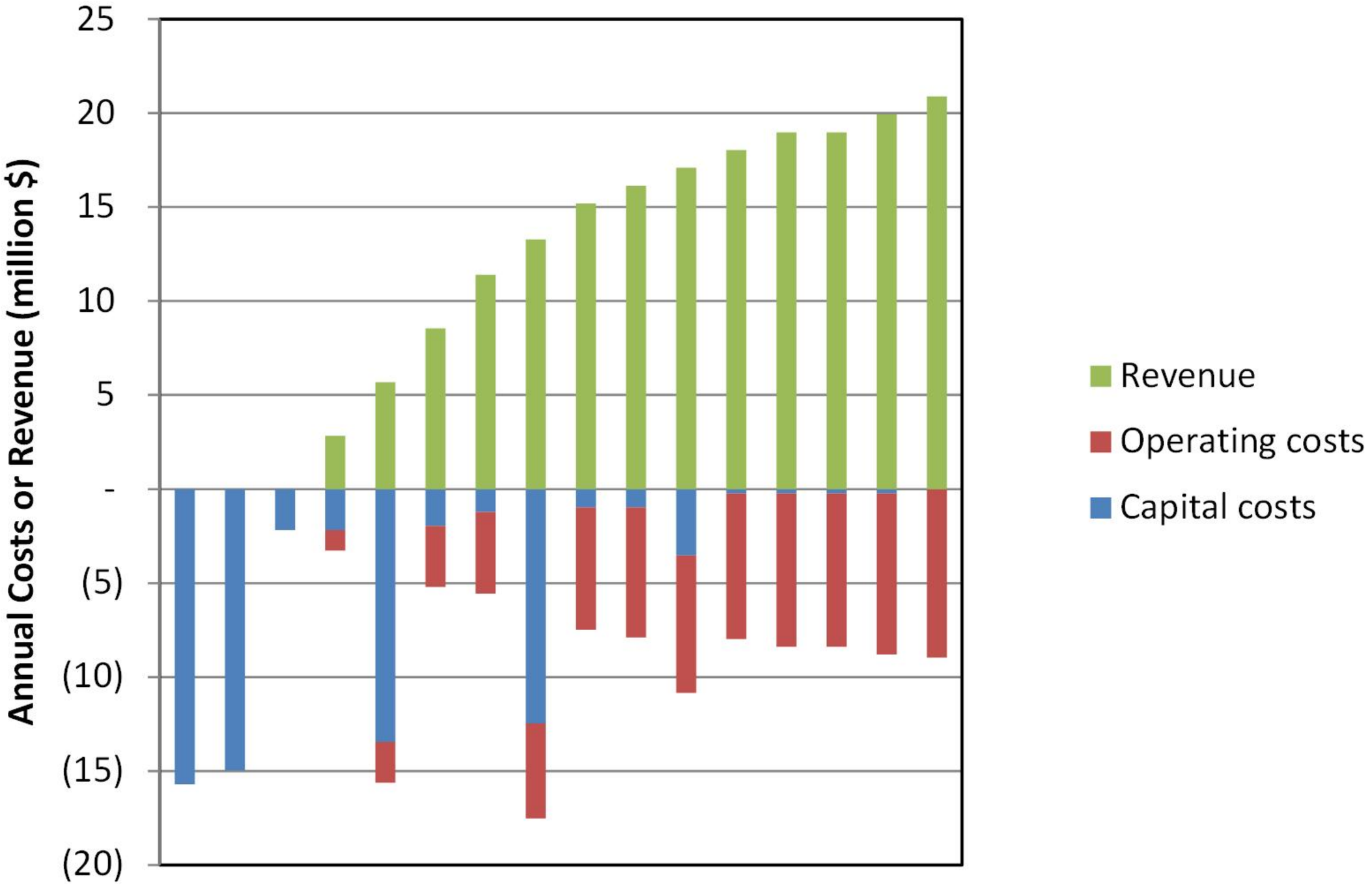
Add two 6.5 MW gas turbine CHP in operating years 2 and 5

Peak demands at full build-out

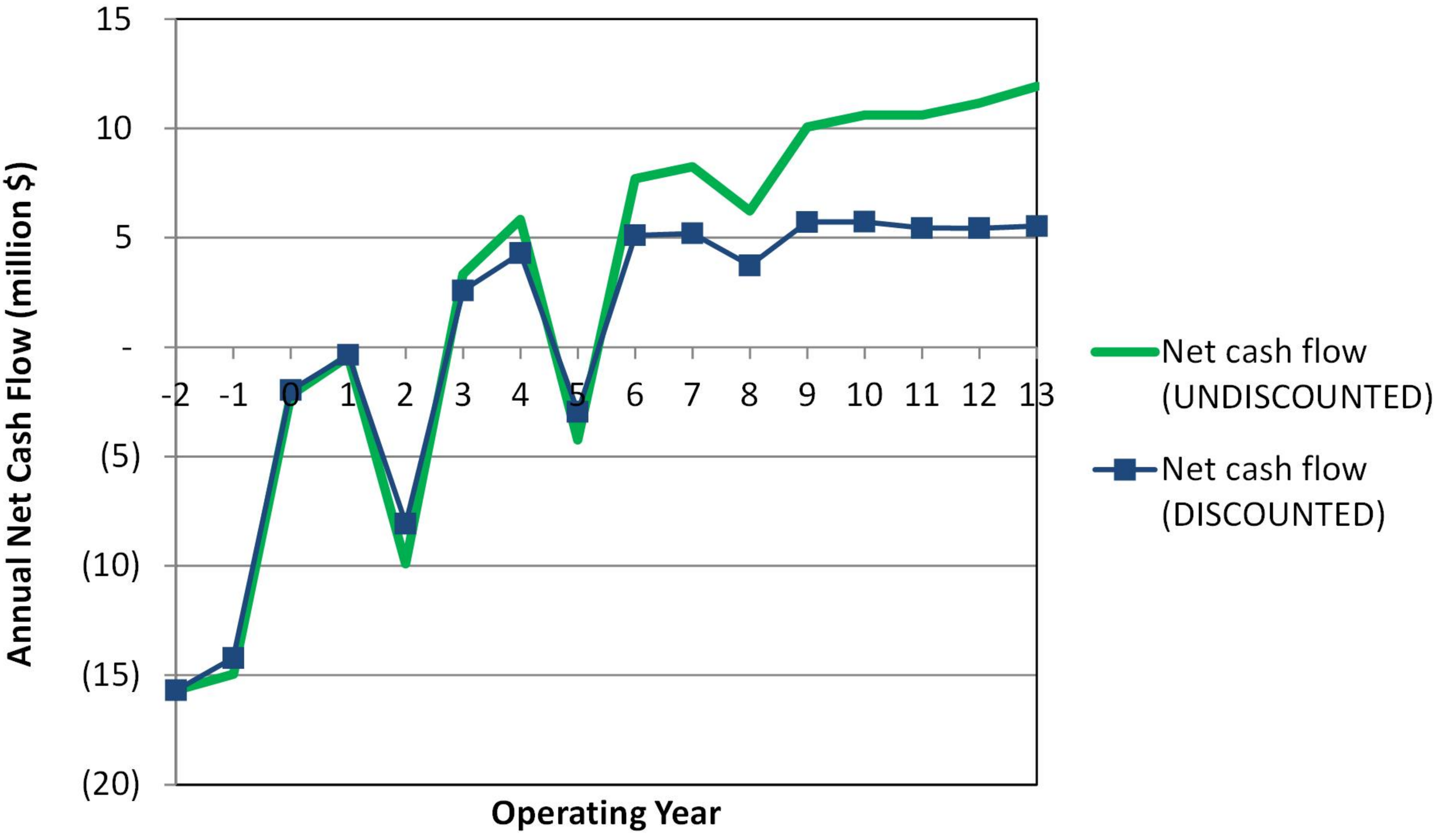
Heating 165 MMBtu/hr

Cooling 17,250 tons

ANNUAL COSTS + REVENUES



NET CASH FLOW



RISK

BALANCING RISK

Cost of capital varies with risk

Assign risk to appropriate parties

Sensitivity analysis to each risk

- Balancing generation and demand
- Permitting and regulatory risks of plant siting
- Cost over-run during construction
- Plant failure; or plant efficiencies failing to reach design specification
- Fuel price variation
- Non-payment by customers
- Delay in insurance payments for damage
- Lead/lag time on capital

RISK ASSESSMENT

	Risk Description	Risk Ownership	Impact Description	Impact Severity	Probability	Action Status	Mitigation Strategy	Revised Impact	Revised Probability	Action Status
Engineering design	Poor technical design	Technical Sub-Group	Project fails to achieve objective; project fails to achieve financial viability	High	Possible	Manage	Check track record of engineer; check references; peer review; check Professional Indemnity in place	Low	Low possibility	Review
Planning and permitting	Fail to secure permits	Planning Sub-Group	Project cannot proceed	Extreme	Possible	Actively manage	Early understanding of requirements; early engagement with officials; ongoing engagement, adjustment, and review	Low	Possible	Actively manage until secured
Construction	Poor construction and installation	Technical Sub-Group	Work requires correction and remediation; adverse impacts on project schedule and budget	High	Probable	Actively manage	Monitor and review; set standards in contractor agreements; obtain insurance cover	Off-set	Off-set	Monitor and review

POLICY DRIVERS

- IDEA Screening tool provides initial insight, next step is more rigorous evaluation of engineering, economics and environmental impact of options

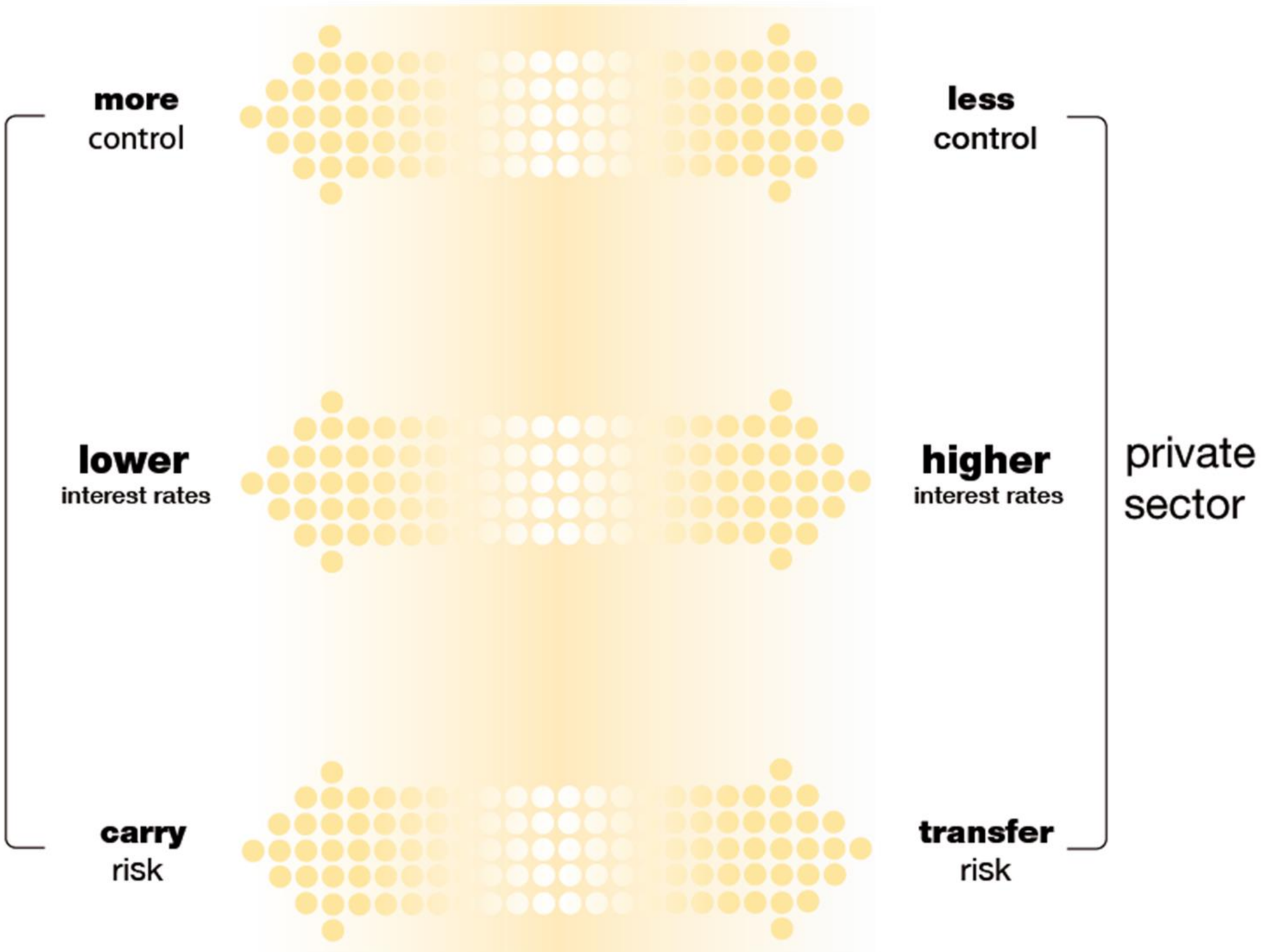
- Prudent to require buildings include "district readiness"

- Consider expanding the load base, connecting to the existing grid and alternative approaches to finance and implementation

- Consider risks - load base does not materialize, spark spread closes…

STAGE 7:
Business Modeling

BUSINESS MODELING



BUSINESS MODELS

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Private Project Development Companies
Private utility provider – private capital; IRR driven

Public Project Development Companies
Municipal utilities – public funding; ROE; asset value exit?

Hybrid public/private partnership arrangements
Joint venture or special purpose vehicles (SPV)

Stakeholder-owned special purpose vehicle (SPV)
Ownership by a variety of stakeholders (REIT; MLP's)

ROLES

Project champion: identify and define project, stakeholder buy-in, initiate technical feasibility studies and financial investment appraisals, fundraising, drive business

Regulation/Franchise: establish and monitor standards of performance and/or consumer protection; local right of way to construct/operate in city streets; etc

Governance: strategic guidance, stakeholder accountability, high-level relationships (legal structure; bond counsel; regulatory; etc)

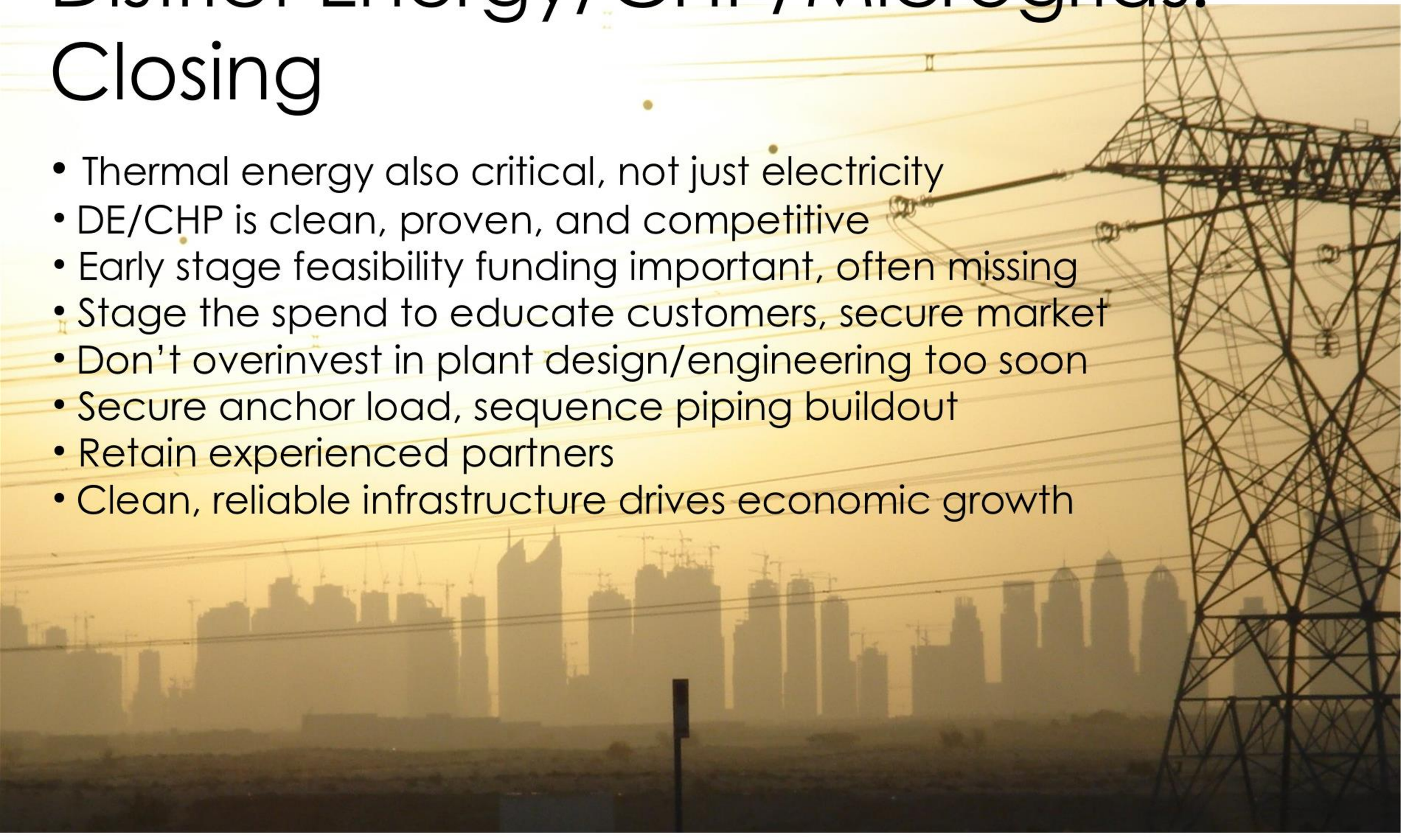
Developer: concerned with the physical delivery, including design/construction/commissioning; can continue to concession management

Asset owner: the party that owns the actual physical assets, could be a municipality; private; non-profit; partnership; or financial investor

Operator: technical operation of the asset; specific expertise; manpower; could be a long term concession arrangement (performance incentive)

District Energy/CHP/Microgrids: Closing

- Thermal energy also critical, not just electricity
- DE/CHP is clean, proven, and competitive
- Early stage feasibility funding important, often missing
- Stage the spend to educate customers, secure market
- Don't overinvest in plant design/engineering too soon
- Secure anchor load, sequence piping buildout
- Retain experienced partners
- Clean, reliable infrastructure drives economic growth



INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Thank you for your attention.

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