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welcome! välkommen!

Thermal Energy Networks: Lessons Across the Atlantic

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global solutions for global challenges

Thermal Energy Networks in Sweden & NY

Agenda

Welcome

The Policy Landscape & Outlook

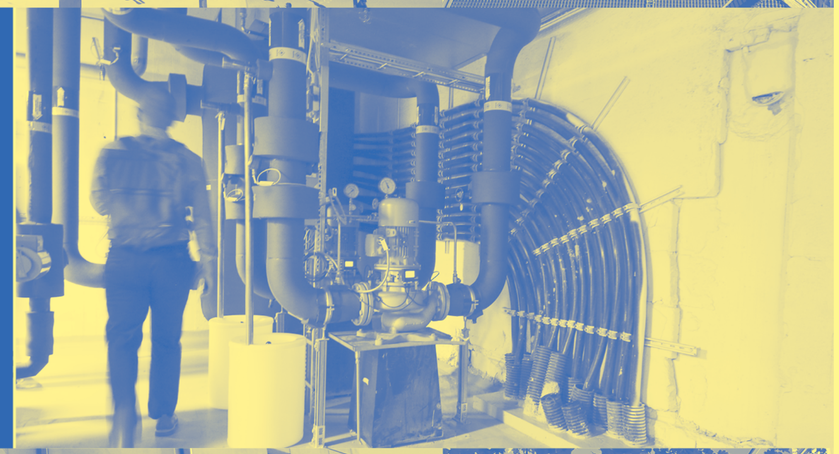
Advanced Technical Solutions & the Business Case

Panel Discussion

Q&A

Solutions for Low-Carbon Building: Stockholm

June 3-6, 2023



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US Delegation to Stockholm

Seeing is believing...

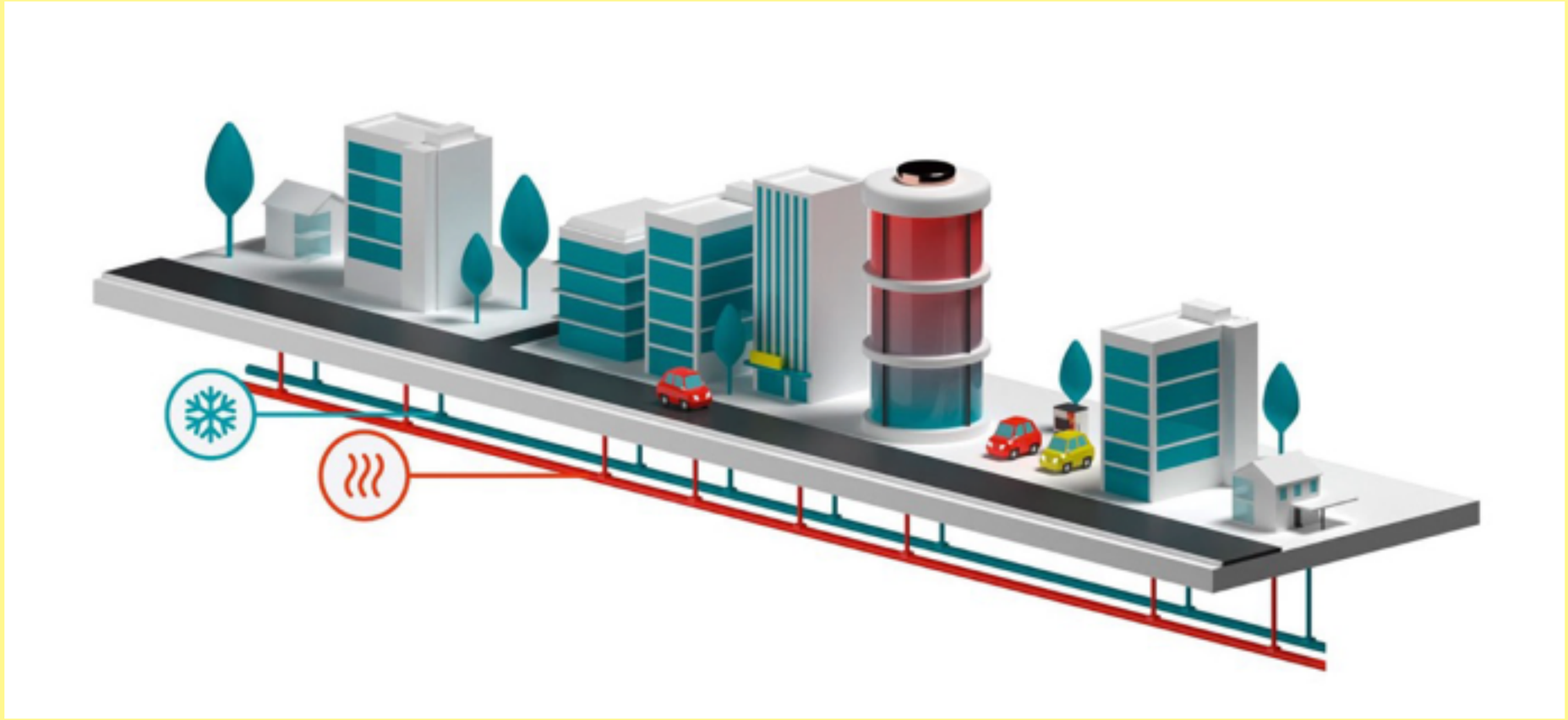
Stockholm Study Trip

June 3-6, 2023

Read:
Solutions for Low-Carbon Buildings: Stockholm

What is a “Thermal Energy Network” (TEN)?

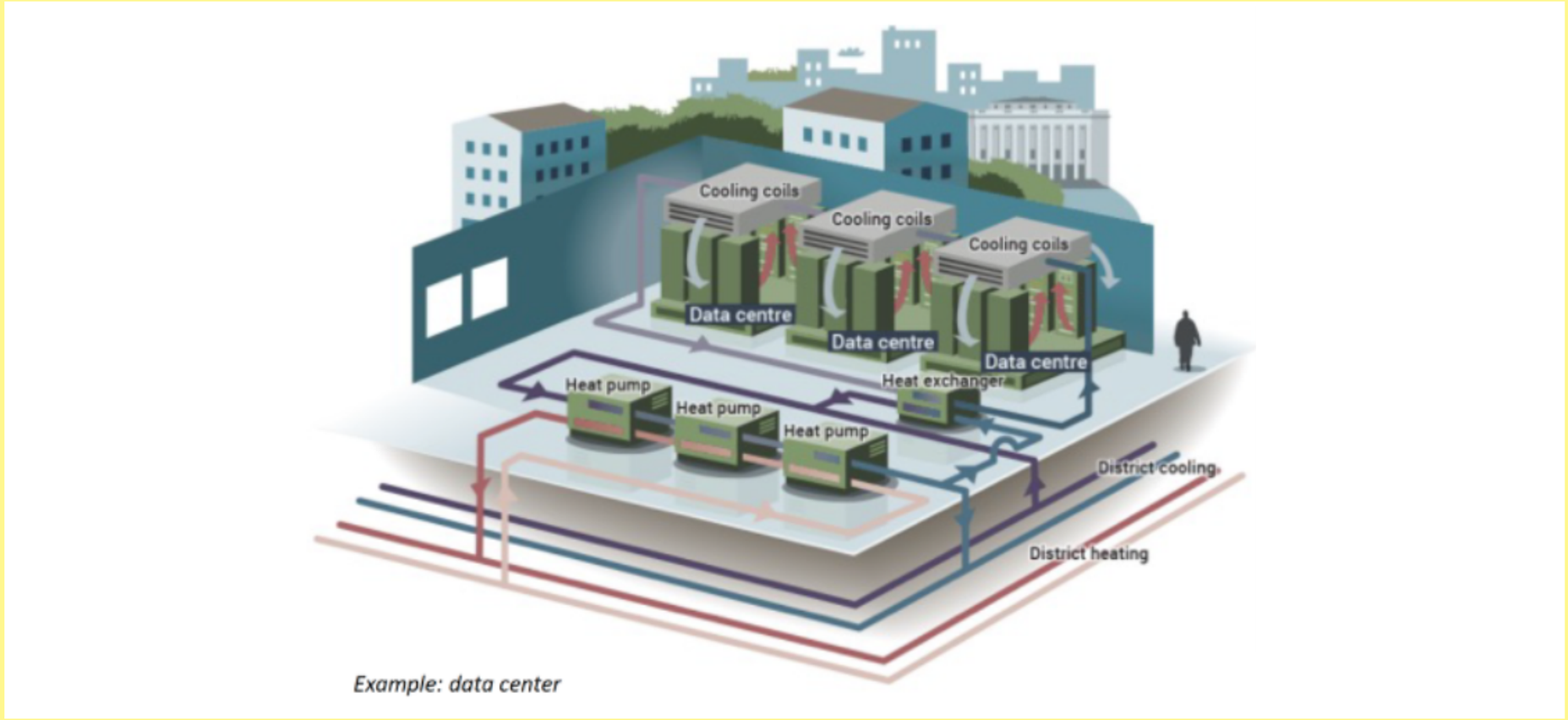
Example Thermal Network: E-ON Ectogrid



From E.ON Ectogrid presentation at 5/30/2024 | BEEx Dist Energy Policy Exchange

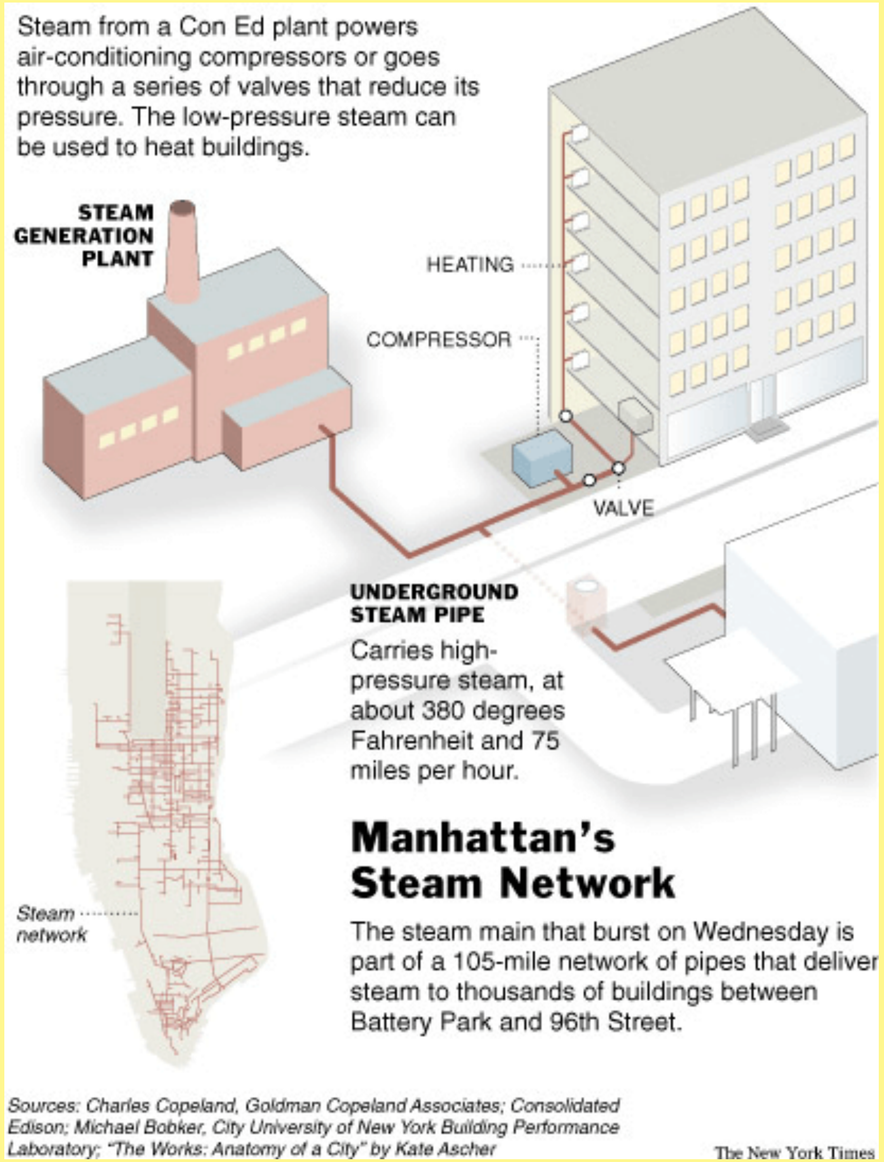
TEN & District Energy System can be synonymous

Example 2-way district system: Stockholm Exergi “Open District Heating”



From Stockholm Exergi presentation at 5/30/2024 | BEEx Dist Energy Policy Exchange

Con Edison District Energy System - Steam



142 Years Old

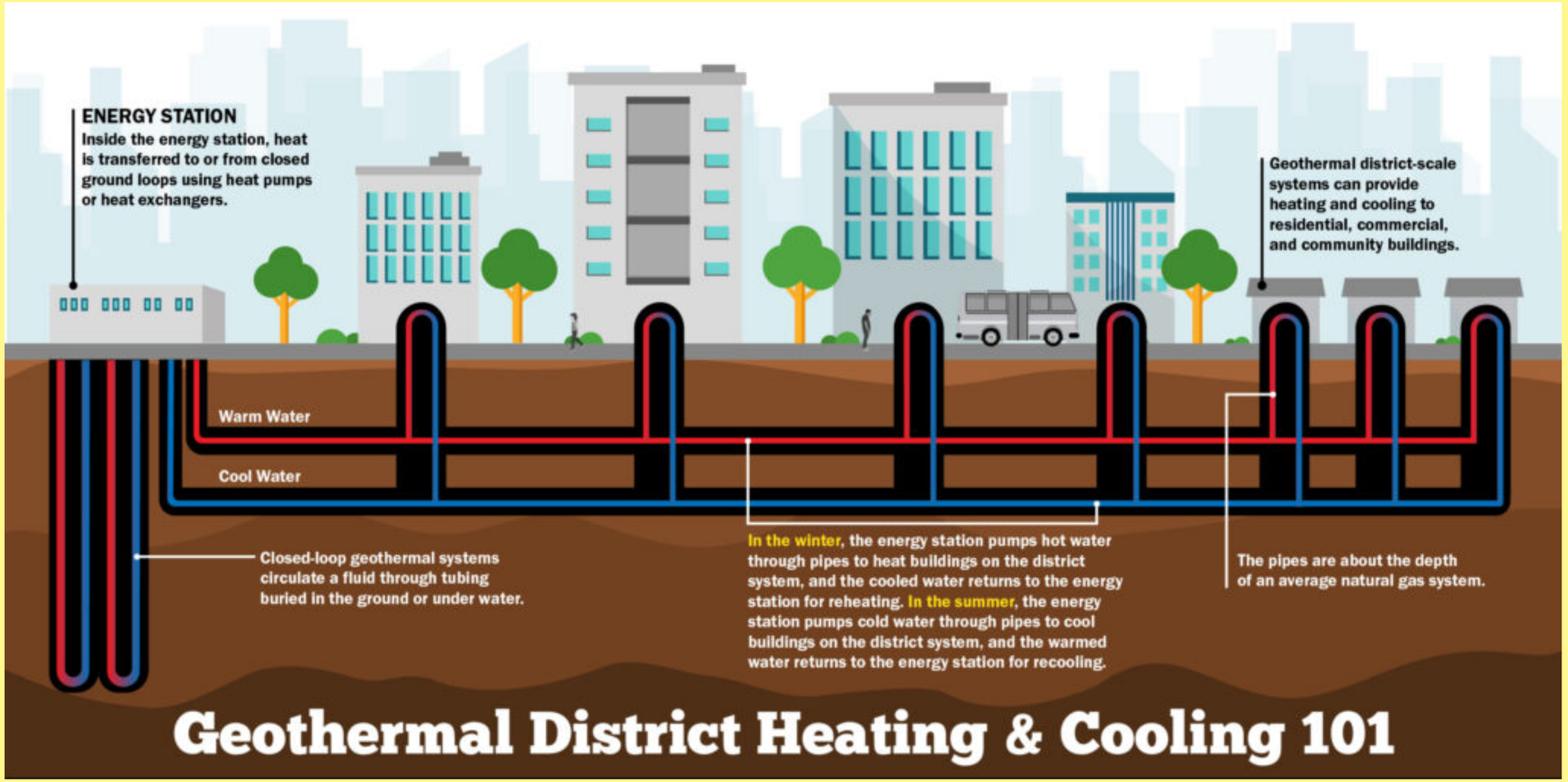
1500 Customers (±3 million people)

105 Miles of Piping

10,800 Mlbs/hr of steam capacity

From New York Times 2007

Geothermal District Energy



Configuration of a geothermal district heating and cooling system using geothermal heat pumps | source: US Department of Energy

https://www.thinkgeoenergy.com/us-doe-study-shows-decarbonization-potential-of-geothermal-heat-pumps/

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thank you! tack själv!

global solutions for global challenges

NEW YORK STATE | Department of Public Service

Thermal Energy Networks (TENs) – New York State Policy Landscape and Outlook

Peggie Neville, Deputy Director
Efficiency, Equity & Innovation
NYS Department of Public Service
Peggie.Neville@dps.ny.gov

September 30, 2025

Policy Context

- NYS Climate Leadership and Communities Protection Act (CLCPA)
  - Aggressive climate goals
  - Requirements for benefits to accrue to Disadvantaged Communities
- Buildings are the largest source of GHG emissions in New York State
  - 6 million residential buildings
  - 5 billion square feet of commercial/institutional space
- Significant reduction or elimination of GHG emissions from combustion of fossil fuels in buildings is needed to achieve the goals of the CLCPA
  - 8 out of 10 housing units use fossil fuels as main source of space heating
  - 85% of commercial square footage uses fossil fuels for space conditioning
- NYS All Electric Building Code
- More than $1 billion per year supporting energy efficiency/buildings electrification efforts

Where do TENs fit in?

Utility Thermal Energy Network and Jobs Act (UTENJA)

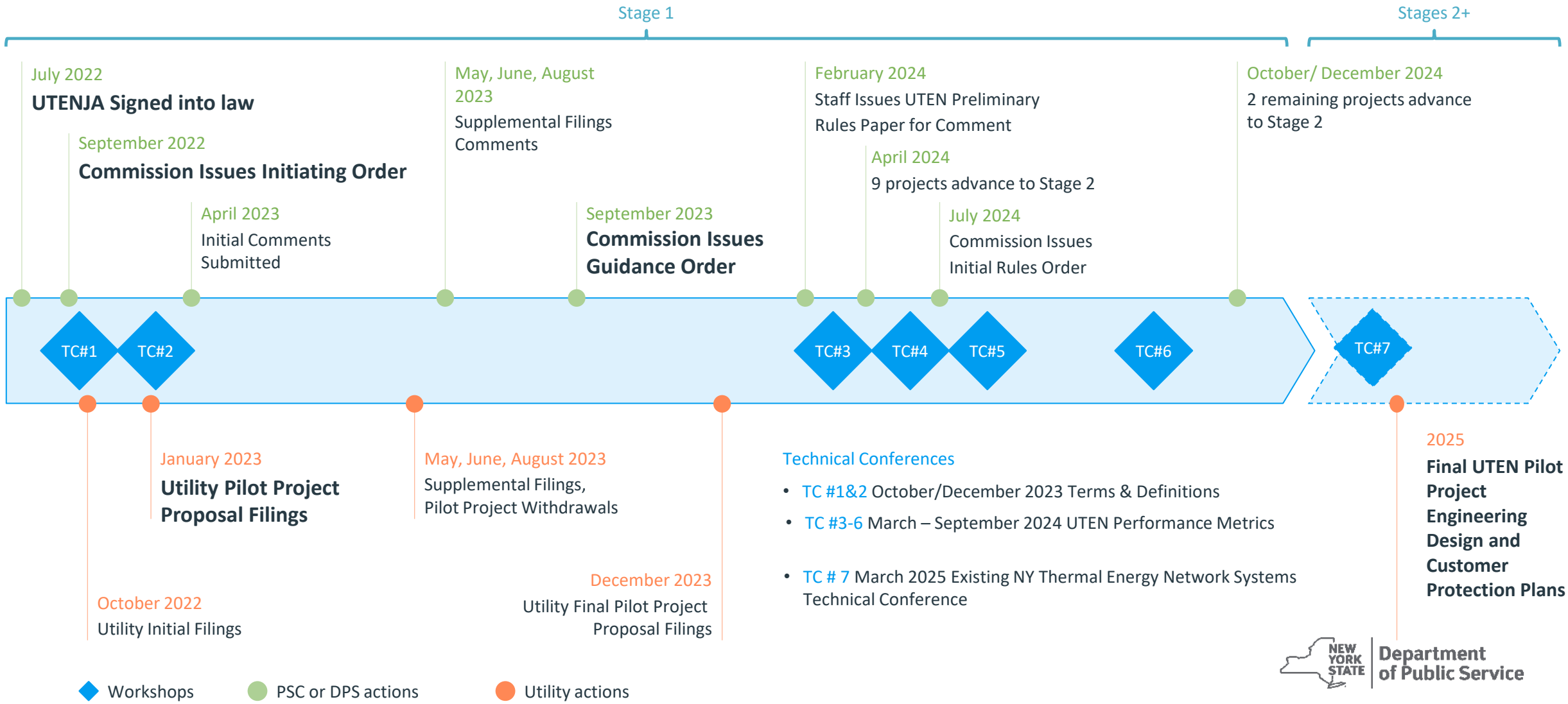
- Limited support prior to UTENJA for TENS related work (feasibility studies, small pilots)
- Commission led efforts limited in scope and bound by limitations in Public Service Law and provisions in place at the time
- UTENJA enacted in 2022
  - Emphasis on equitable electrification and benefits to Disadvantaged Communities, and UTENs as an avenue to aid in the transition of utility workers
  - Directs Commission proceeding to create a new regulatory framework to guide the development of UTENs
  - Requires the seven largest utilities to propose 1-5 UTEN Pilot Projects for consideration

UTENJA continued

Amends several provisions of New York's Public Service Law:

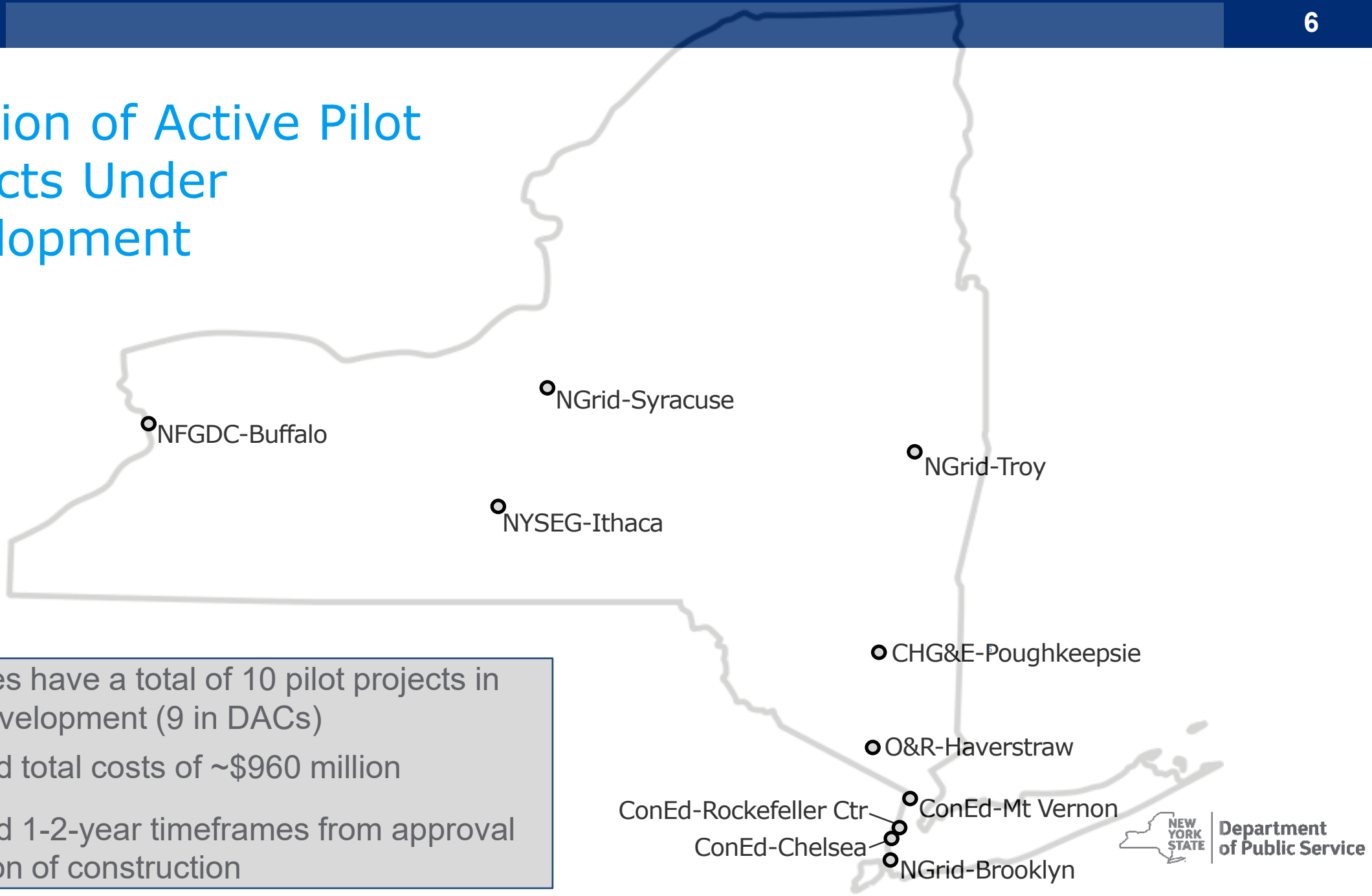
- Allows utilities to provide "thermal energy" not just electric and gas service
- Defines thermal energy as follows –
  - *"Thermal energy," when used in this chapter, shall mean piped non-combustible fluids used for transferring heat into and out of buildings for the purpose of eliminating any resultant on-site greenhouse gas emissions of all types of heating and cooling processes, including, but not limited to, comfort heating and cooling, domestic hot water, and refrigeration."*

Case 22-M-0429: Timeline-To-Date



NEW YORK STATE | Department of Public Service

Location of Active Pilot Projects Under Development



- Six utilities have a total of 10 pilot projects in active development (9 in DACs)
- Estimated total costs of ~$960 million
- Estimated 1-2-year timeframes from approval to initiation of construction

NEW YORK STATE | Department of Public Service

Summary of Proposals

Pilot Project (+ = DAC)	Description	Current Pilot Budget ($M)
Con Ed – Chelsea+	Dense urban; utilization of waste heat recovery as thermal resource; serving public housing (NYCHA); 2-pipe ambient configuration	95.5
Con Ed - Mt. Vernon+	Geothermal borefield-centric system; leak prone pipe retirement; mixed use inc. City-owned fire station & rec center; 2-pipe ambient configuration	191.7
Con Ed – Rockefeller	Dense urban including three existing high rise commercial buildings; waste heat from excess heat from server loads, recovered steam condensate heat, chiller plants and cooling towers; commoditizing waste heat	128.2
CHGE – Poughkeepsie+	Geothermal borefield-centric system; large community support; utility lease agreement for borefield site; 1-pipe ambient configuration	24.9
KEDNY – Brooklyn+	Geothermal borefield-centric system to serve public housing (NYCHA) and comm buildings; ww recovery facility and/or subway dewatering possible source/sink for future TEN; 1-pipe ambient configuration	125.5
NiMo – Troy+	Two single-pipe ambient loops supplied from boreholes; located in center of the City (including several older buildings); strong support from City who views TEN as a part of their long-term City planning	52.7
NiMo – Syracuse+	Wastewater treatment outfall as thermal resource, mixed use new construction, UTEN identified as a non-pipe alternative (NPA) due to the avoidance of the new development from connecting to the gas system; 2-pipe ambient configuration	143.5
NFG – Buffalo+	Urban area; two thermal resources: geothermal borefield serving apartments and wastewater heat recovery serving three municipal buildings; distribution system is hybrid, includes a central GSHP system (4-loop) and existing hot water district heating system	43.4
NYSEG – Ithaca+	Suburban area; open-loop ground water system; company ownership of customer equip; three interconnected loops; 1-pipe ambient configuration	42.5
O&R – Haverstraw+	Geothermal borefield-centric system to serve new construction and existing buildings of mixed use; new construction will eliminate new gas; 2 separate ambient loops, each loop is a 1-pipe ambient configuration	112.0
Total		959.9

UTENJA continued

- Rules & Regulations to support TENS, intended to:
  - Create fair market access rules for utility-owned TENS
  - Exempt “small scale” TENS not owned by utilities
  - Promote training and transition of utility workers
  - Encourage 3rd party participation and competition where it will maximize benefits to customers

- Initial Rules Order (issued July 2024, Case 22-M-0429)
  - Recognized more research and analysis needed to advance this work

Other TENS-Related Efforts

NYS TENS Investment and Support

- Sustainable Futures Fund - $200 million for TENs (municipal and state-owned facilities)
- NYSERDA technical assistance and support for the design and construction of new networks

New York State Energy Plan (Comments due Oct 6th)

- TENs highlighted within the Buildings Chapter
- TENS Road Map
  - Analysis on density of thermal demand and resources
  - Data to de-risk projects and catalyze private investment
  - Business model and policy approaches for customer acquisition
- Integration of building decarbonization plans with gas and electric system planning

Links of Interest

Utility Thermal Energy Networks and Jobs Act

https://www.nysenate.gov/legislation/bills/2021/A10493

https://assembly.state.ny.us/leg/?default_fld=&leg_video=&bn=A10493&term=2021&Summary=Y&Actions=Y&Memo=Y&Text=Y

Proceeding on Motion of the Commission to Implement the Requirements of the Utility Thermal Energy Network and Jobs Act, Case 22-M-0429

https://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=22-m-0429&CaseSearch=Search

- **How to subscribe to a Case**
- **Link to Notice Soliciting Comments**

New York State Energy Plan (Comments due Oct 6th) (TENS in Buildings Chapter)

https://energyplan.ny.gov/?gad_source=1&gad_campaignid=23026235472&gbraid=0AAAABBatbqkUEL4STvFOcAncOAGQ3654m&gclid=CjwKCAjwlt7GBhAvEiwAKal0csvTTHvoF1VecArwRafcJqIaTl2SpvnD1sS40wSZ-EDLjfW_qEI3yRoC-JEQAvD_BwE

NEW YORK STATE | Department of Public Service

DPS, Policy Analyst & UTEN Project Manager - Laurie.Kokkinides@dps.ny.gov

Thank you

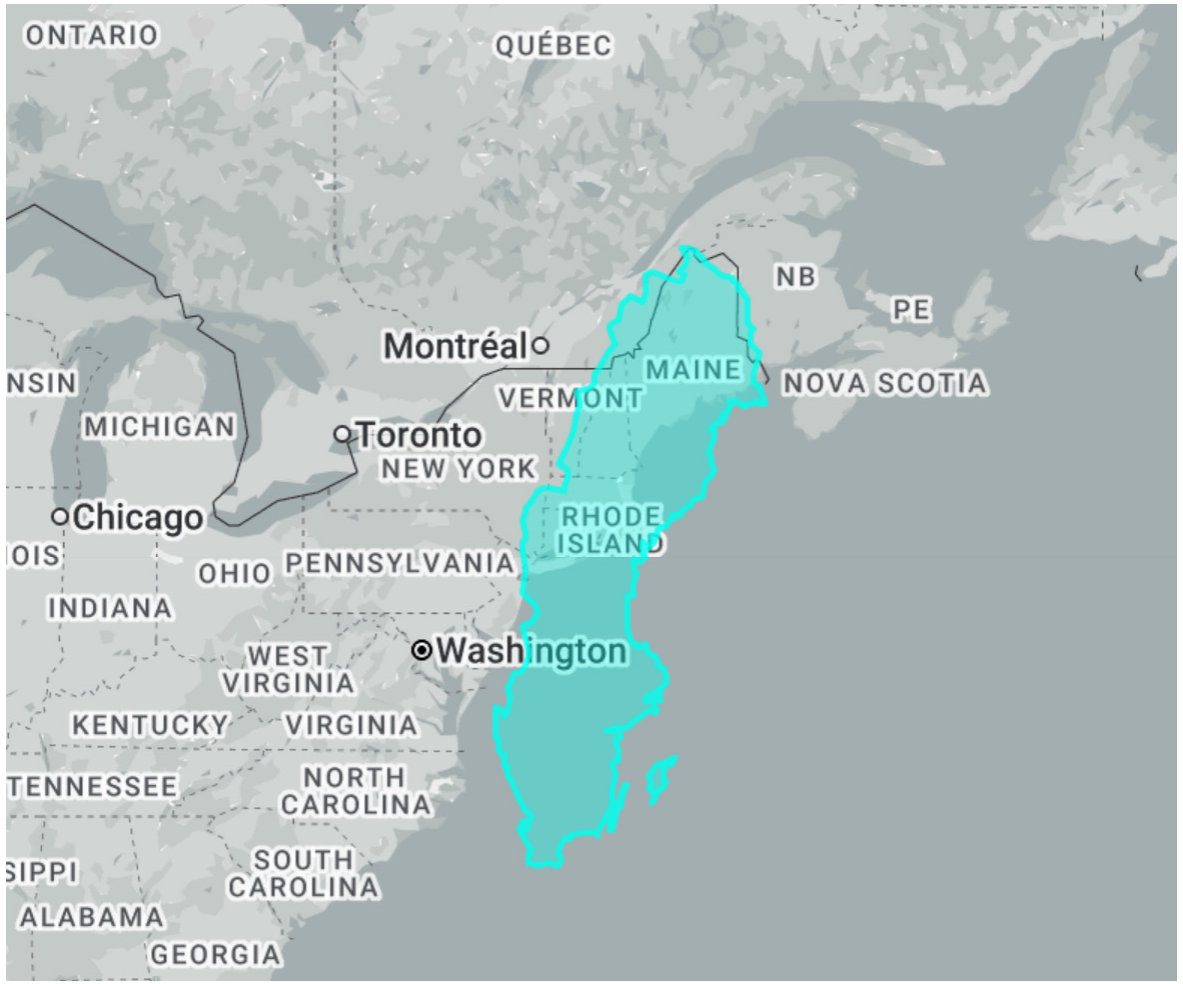
Swedish Energy Agency

Swedish District Heating

A pathway to carbon neutrality

Paul Westin, Senior Business Developer, SEA

Sweden, true size, slightly larger than CA.



- Sweden, 10 million population, NY state 20, and NY City 11.
- NY City is the 8th largest economy of the world, Sweden is the 23rd.
- Sweden achieved rankings:
  - # 1 - Energy Policy (WEC)
  - # 2 - Global Innovation Index
  - # 2 - Global Sustainabiltiy Goals
  - # 2 - Happiness
  - # 4 - Freedom of Press
  - # 8 - Anti-Corruption

Swedish Energy Agency

Definition of District Heating in DH Act

§ 1. District heating operations in this Act refer to the distribution in pipelines of hot water or other heat carrier for heating, if an unspecified group within a certain geographical area may be connected to the operation.

A district heating operation also includes the production and sale of the heat distributed in the pipelines, if the person carrying out the distribution also carries out the production and sale of the heat.

- Distribution in pipes/pipelines
- Heat carrier
- If an unspecified group may connect
  - Instutional systems (e.g. campus with own operation) is not affected by the Act.
- Within a certain geographical area
  - Municipalities may operate ”near-by”.
- Production, Sales and Distribution are included in definition if the operation is vertically integrated.

The Greater Stockholm interconnected network for DH.

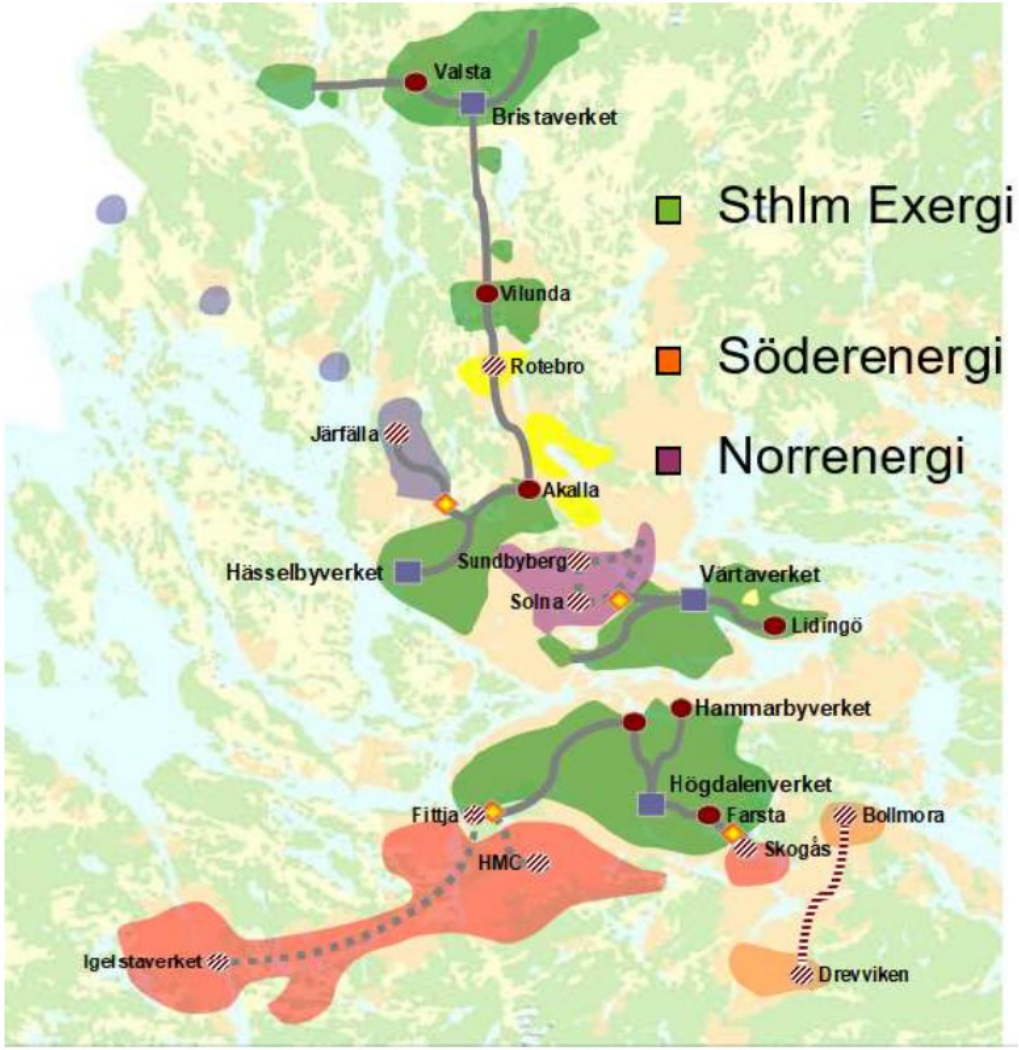


Figure 4. Main DH networks and heat production plants in the Stockholm region (image from Dalgren, 2018).

- Population: ~2.5 million
- With access to district heating: ~1.7 million (≈70%)
- Very high coverage in central Stockholm, Solna, Sundbyberg, Södertälje, Sollentuna, Huddinge
- Lower coverage in outer suburbs with detached houses
- One of the largest interconnected district heating networks in Europe
- 90 km (55 miles) from North to South

Region	Network length (km)	Population served	Coverage (%)	Notes
Moscow	>70,000	~12 M	~95%	World's largest DH system, mainly gas-fired CHP
Beijing / North China	>20,000	>10 M	~90%	Enormous systems, rapid growth, coal-heavy but shifting
Greater Stockholm	~4,000	~1.7 M	~70%	Largest interconnected DH network in Western Europe (by length)
Seoul (metro area)	~2,500	~5–6 M	~20–25%	KDHC system, fragmented across metro and satellite cities
Western Scania	~1,900	~0.5 M	~60–70%	Regional cluster (Kraftringen + Öresundskraft + Landskrona)
Greater Warsaw	~1,800	~1.5 M	~80%	EU's largest DH system by heat delivered (TWh/year)
Greater Berlin	~1,700	~1.3 M	30–40%	Large CHP-based system, fossil-heavy
Greater Copenhagen	~1,500	~1.0 M	~98%	Near-universal coverage, highly integrated
Greater Helsinki	~1,300	~0.9 M	~90%	Very high penetration, moving away from coal
Greater Vienna	~1,100	~0.8 M	40–50%	CHP + waste heat, ambitious decarbonization
Greater Paris	~500	~1.3 M	~20%	Smaller relative to population, strong WtE
Tokyo (fragmented)	<500	Few 100k	<5%	Several small DHC systems, not integrated
New York (steam)	~169	~3 M (practical use)	N/A	Largest commercial steam system, ~1,600 buildings
Vicinity (Baltimore, Philadelphia, Boston, Kansas City, …)	?	< 0.2 M?	N/A	Largest multi-city operator in the U.S.
S:t Paul	~100	<0,1 M?	N/A	Largest Scandinavian inspired system in the U.S.

District heating in Sweden facts

- Developed since the 1950's and even into the 2020's in smaller communities
- Now available in 285 of 290 cities/municipalities
- Market share
  - 90 % for multi-family buildings
  - 70 % for hospitals, offices, malls, etc.
  - 20 % for detached houses.

    Heat pumps are most common for detached houses
- The share of renewables is approximately 90% with biomass dominating
  - Waste heat from industry and large heat pumps are also common
- Total network length 25 000 km (ca 15 000 miles)
- Total DH deliveries to customers 53 TWh (ca 180 million MMBtu)

  Ca 8 x ConEdison's steam production

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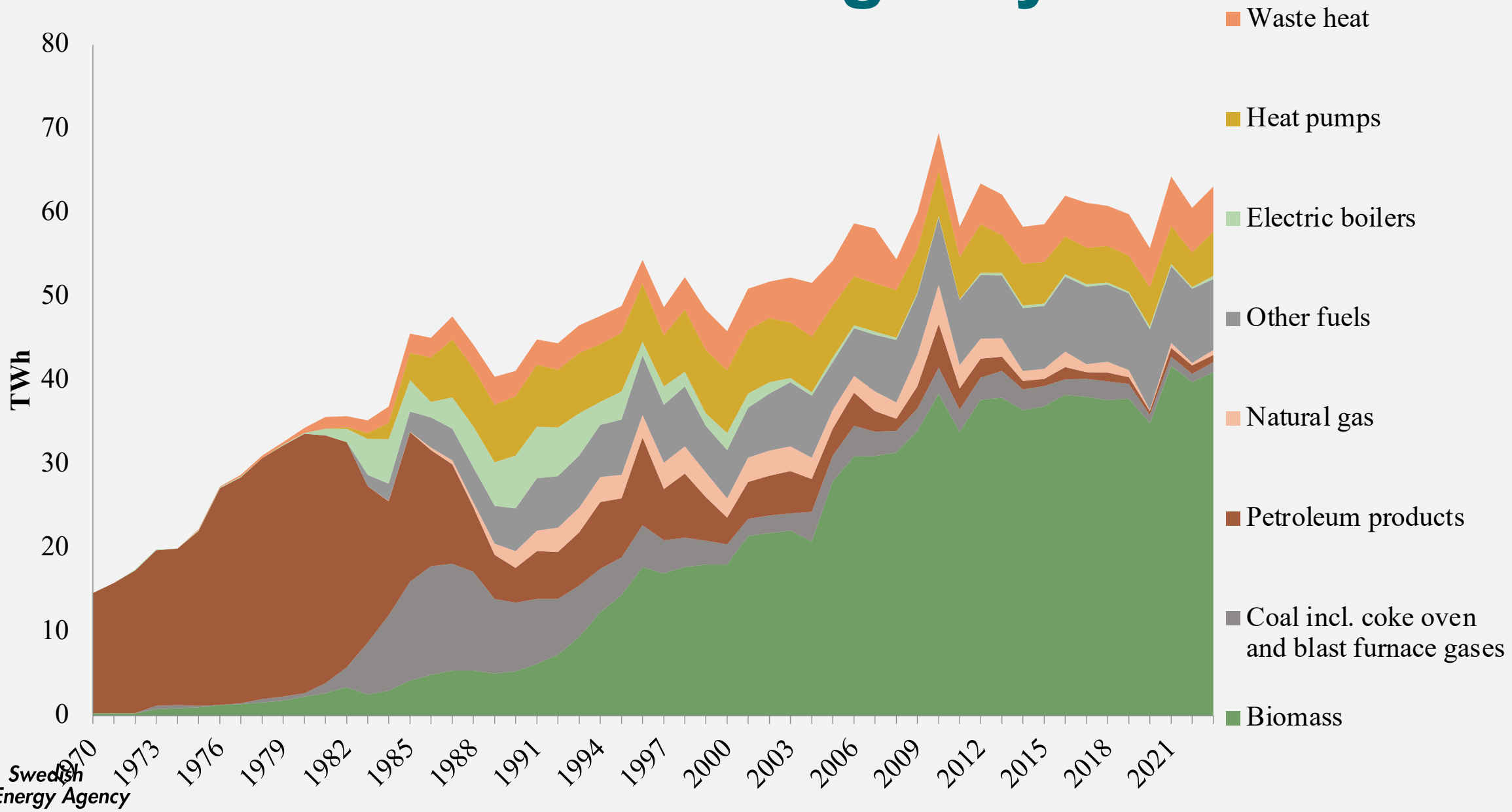
The evolution during 55 years



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Ownership, pricing strategies etc

- Ownership mix: ~60% municipal, the remaining state-owned, joint ventures, or private firms
- Free establishment, District Heating Act applies
- Municipal owners: typical return targets ~5–6%
  - But, profit margins modest: often 2–5% (recent years)
  - Private owners, non disclosed, probable targets 6-10 % ROCE.
- Pricing strategies:
  - Cost-plus (cover costs + margin)
  - Competitive vs. alternatives (heat pumps, electricity)
  - Return-based (target %, ROCE or similar)
  - Municipal social or environmental targets may also apply
- Billing: fixed fee + variable fee (per kWh) + 25% VAT

Billing DH in Sweden

- Fixed annual fee – covers infrastructure, metering, admin
- Variable energy fee – per kWh consumed (~$/MMBtu)
- Value-added tax (VAT, 25%) – applied on the subtotal
  - Note: No separate 'energy tax' on the customer bill (taxes are upstream at production).

Example: A Single-family house

20,000 kWh ≈ 68 MMBtu/year

Fixed fee: 4,500 SEK/year (~$400)

Energy: 0.95 SEK/kWh → 19,000 SEK (~$1,750)

Subtotal before VAT: 23,500 SEK (~$2,150)

VAT (25%): 5,875 SEK (~$540)

Total annual bill ≈ 29,400 SEK (~$2,700)

Equivalent to ≈ $40 per MMBtu

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Key aspects of DH in Sweden

- District heating is key to Sweden's energy & climate policy
- Energy sources: Biomass (forestry residues), MSW incineration, Industrial Waste heat, Heat pumps (waste water treatment e.g.), Electrical boilers, Bio-oils (biodiesel), increasingly looking for customer cooperations with e.g. Data Centers.
- Customers sensitive to price increases → trust & transparency important
- Seen as stable, climate-friendly, urban heating solution
- Most consumers don't even know they are connected, rare with individual billing to appartements
- Highly competitive market on heating between incumbents and heat pump providers

Future challenges for DH in Sweden

Heat pumps and energy efficiency will reduce district heating demand

- Climate change also reduces needs for heat, but increases needs for cooling.

Large reinvestments needed in aging networks and plants

Profitability is modest – requires transparent pricing and customer trust

Climate policy and fossil-free transition demand flexibility and innovation

- Sector coupling with electrification, transport, industry is crucial to stay relevant, energy storage both thermal and electrical is interesting, as well as CCS/CCU and Hydrogen production.

Over-invested in biomass and waste incineration

- Combustion is increasingly seen as old-fashioned, and the climate neutrality of biomass is truly questionable
- Recent year increases in price of wood fuels have shown the vulnerability of DH competitiveness in Sweden.

District Cooling is an opportunity

Facts

~40 systems in Sweden

Volume: ~1.2–1.5 TWh/year

Usually 5-10 % of sales in a combined DH/DC-company

Sources: lake/sea ”free” cooling, heat pumps (combined DHC), absorption chillers (heat-driven), thermal storage technologies

Customers: hospitals, offices, shopping centers, data centers

Strategic Value for Operators

Balance the system: use summer heat surplus for cooling

Increase revenues: offer both heating & cooling to same customers, compete with HP

Reduce risks: diversify income streams

Future-proofing rising cooling demand from climate change & data centers

Alleviates bottle-necks in electricity grids (even more true for DH in climates with peak load in winter)

SHC BY SWEDEN | SUSTAINABLE HEATING & COOLING BY SWEDEN

A program for DHC by the Swedish Energy Agency

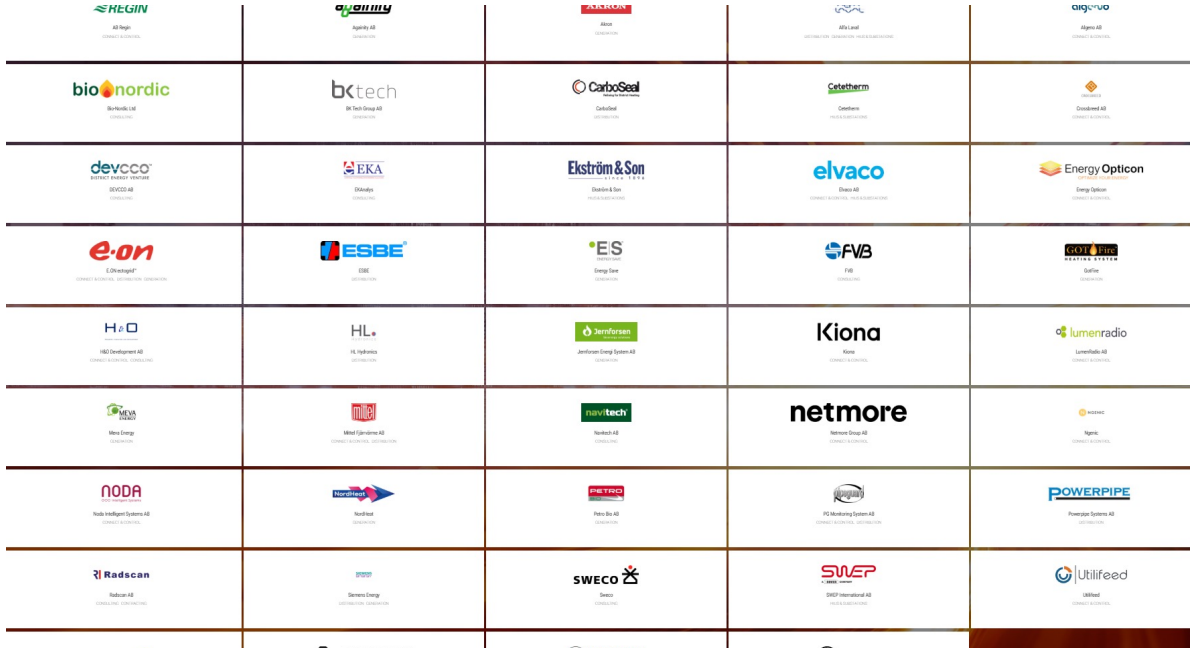
Some 40+ tech suppliers to the DHC industry

Check it out at:

[Sustainable Heating & Cooling by Sweden]

Sign up for newsletter, engage.

Paul Westin & Sofie Fjellgren



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Visit us on
www.energimyndigheten.se/en

Final push Sweden vs Denmark ☺

- Copenhagen and Denmark may have the highest coverage of DH but Stockholm and West Scania have the largest interconnected systems in Western Europe, serving more customers.
- Sweden's more varied ownership and market model has fostered innovation that goes beyond the Danish top-down regulated approach.
- Price to consumers are not that different either.
- Check out the innovative Swedish Supplier base for DHC at
  - Sustainable Heating & Cooling by Sweden, a Swedish Energy Agency program led by Paul Westin and Sofie Fjellgren

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SHC BY SWEDEN | SUSTAINABLE HEATING & COOLING BY SWEDEN

Kraftringen
Energy for future generations

Patrik Schneider, Production manager

kraftringen

Kraftringen – a leading regional player in the south of Sweden

#5
largest DSO in Sweden

#11
largest DH Grid operator in Sweden

~AT $450 M

~600 employees

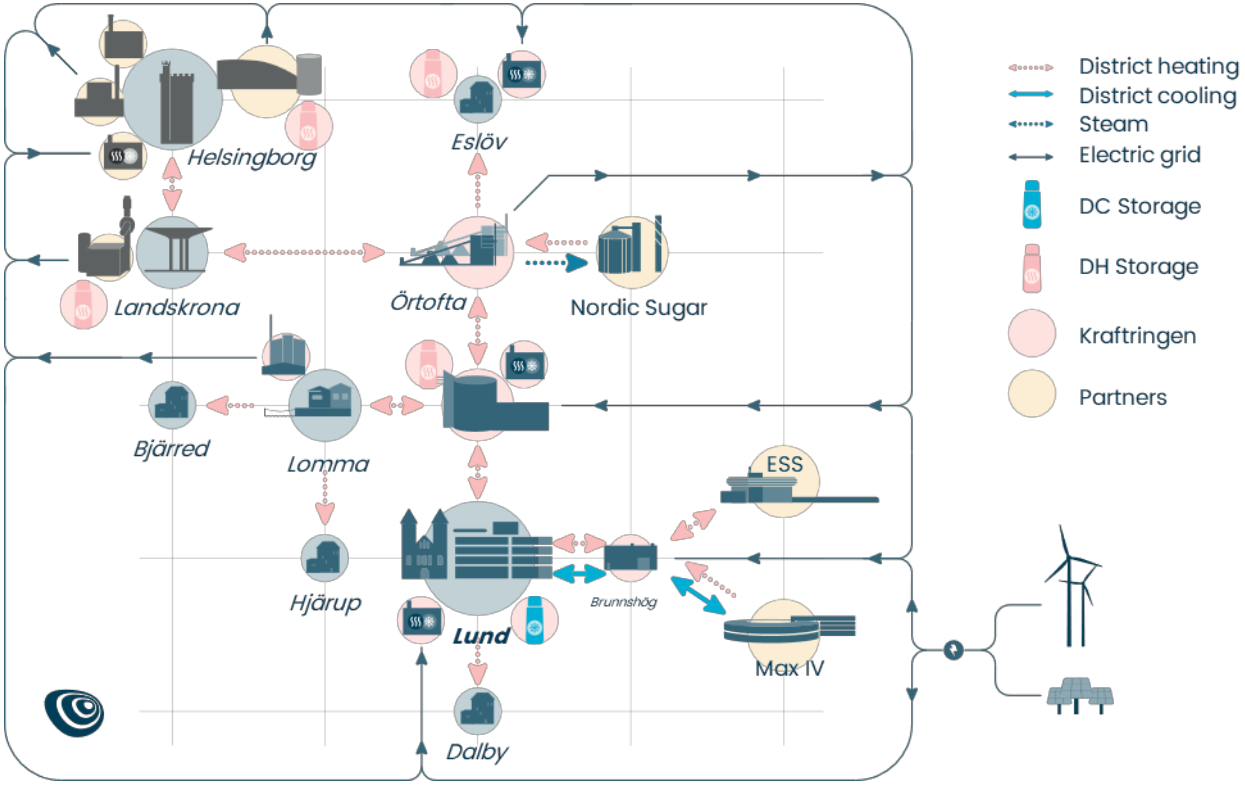
~280 000 customers

Electricity & gasdistribution	District heat/cool	Electricity and gas trading	Data comm.

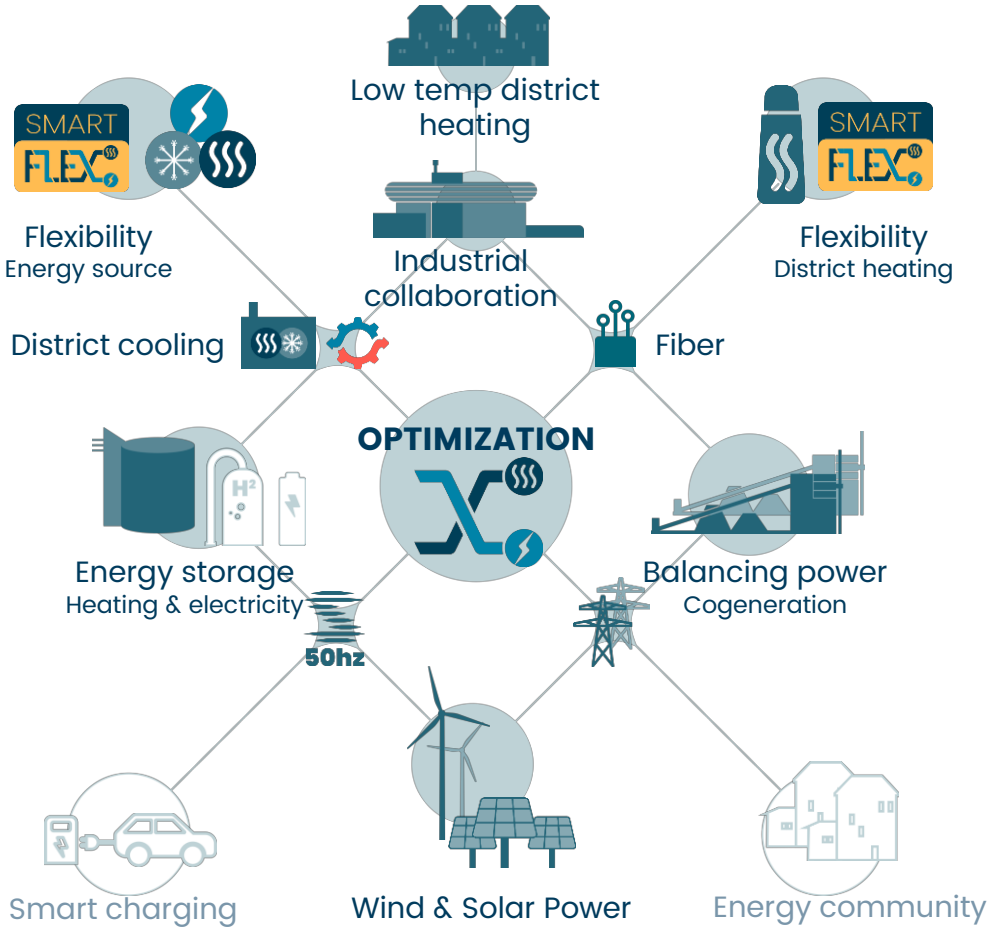
Products: electricity distribution, electricity sales, district heating & cooling, gas distribution, gas sales, mobility solutions, Data communication.

Lund *82,4%*	*Eslöv* *12%*	*Hörby* *3,5%*	*Lomma* *2,1%*

Our Energy system – it's all connected!



The energy system of the future



NetZero 2030

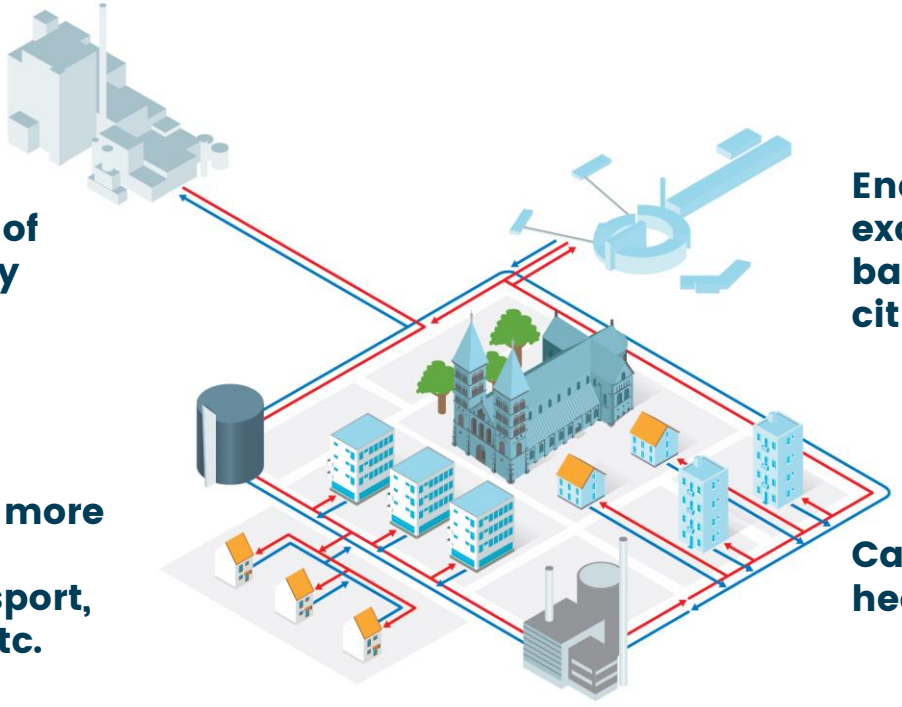
Large-scale energy sharing

Industrial symbiosis

Low temp DH

District heating enables a climate neutral city and circularity!

Facilitates resource efficient generation of renewable electricity (cogeneration/CHP)



Enables recovery of excess heat and balancing of entire cities and regions

Saves electricity for more sophisticated applications – transport, research, industry etc.

Can provide both heating and cooling

Kraftringen's energy cluster in Örtofta, outside Lund

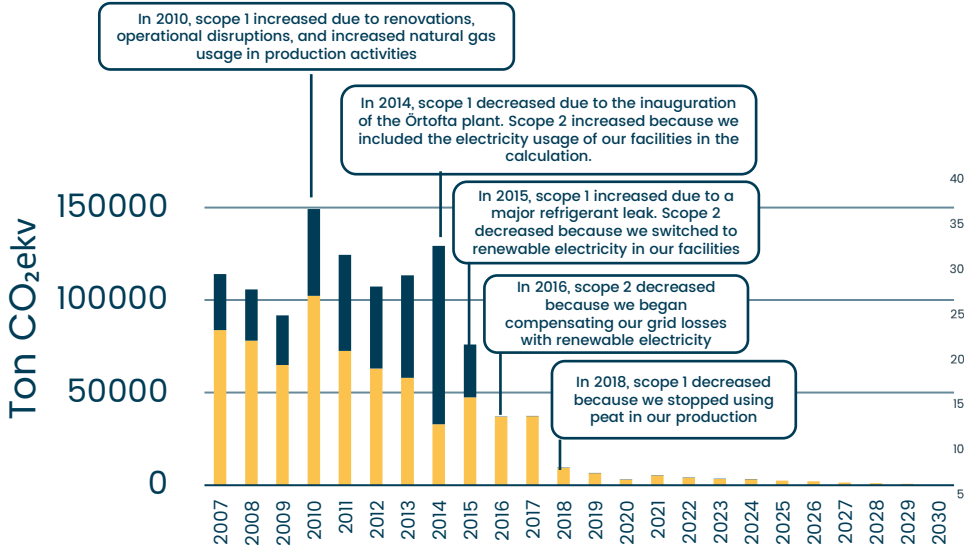
What we have done

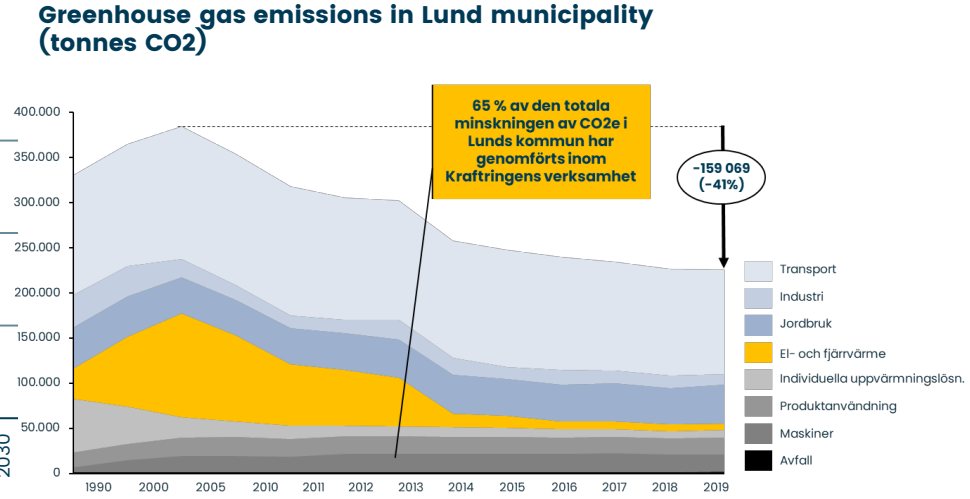
- In 2014; Kraftringen commissioned a biomass CHP in Örtofta that supplies heat to Lund, Lomma, Eslöv, etc
- The plant also produces electricity and deliver steam to the sugar refinery next door (reducing gas demand, 100 GWh/y)

Still to come; an additional biomass CHP in 2028

- The new plant will replace older, less efficient, heat production capacity in Lund and Lomma…
- … and produce more electricity and steam to the sugar refinery…
- … and it will be prepared for CCS

Kraftringen's CO2 emissions will be Net Zero by 2030 and help others to be the same





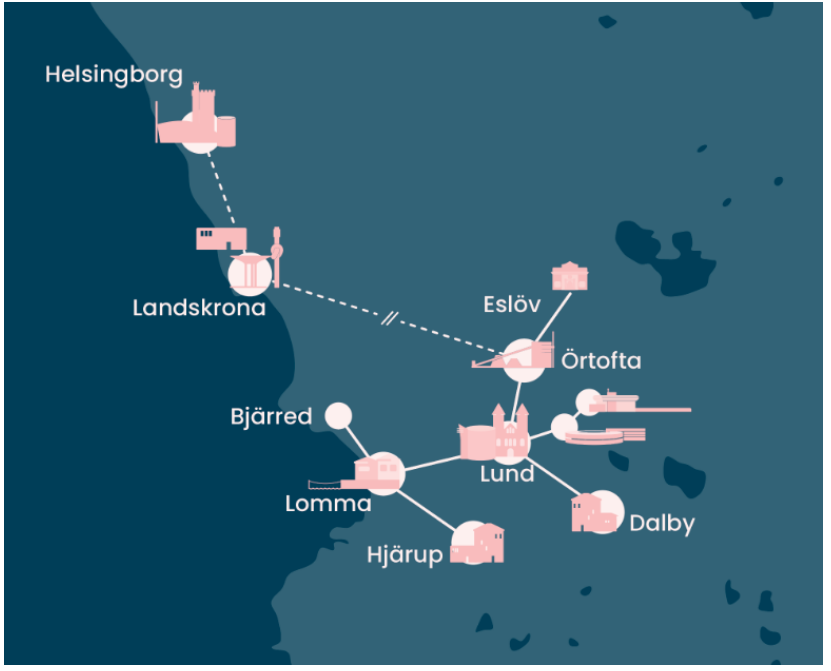
Kraftringen has reduced emissions in scope 1–2 by 97% since 2007

Large-scale energy sharing

Southern Sweden's largest energy-sharing collaboration

Energy companies, industry, research and freight

- Actors: Kraftringen, Landskrona energi and Öresundskraft
- Energy sharing
  - 2500 GWh district heating
  - 500 GWh of electricity
  - 100 GWh of steam
  - Residual heat from industry, research and freight
- Joint production optimisation with open book principle
  - Improved profitability
  - Increased production reliability & redundancy
  - Reduced capex
- Recycled heat and biofuels replace natural gas in industry leading to reduced CO2 emissions in the region



The Mayor of Lund, Anders Almgren, and Kraftringen's CEO, Sezgin Kadir, welcome you to Lund to learn more about our energy system.

Thank you!

Patrik Schneider, Production manager Kraftringen
Mobile: +46 101 227 383
Mail: patrik.schneider@kraftringen.se

Extras

Industrial symbiosis

Steam pipeline Nordic Sugar

- Investment: ROI<4 years
- Length 1.1 km
- 25% CO2 reduction
- Delivery since commissioning 2022:
  226 GWh of steam
  - 50,000 tons of CO2

Low temp DH and district cooling

Brunnshög

Science heats and cools the city

Kraftringen is building the world's largest low temperature district heating network that will use this residual heat and distribute all this energy to accommodate the city´s need of heating and cooling.

Recycled heat

- ESS: 160 GWh p.a. (>80 °C)
- Max IV 28 GWh p.a. (65 ° C)

Needs Brunnshög

- 23 GWh p.a. (65 °C)

Brunnshög, a part of the city of Lund that makes space for 40 000 people to live and work here

Thermal Energy Networks (TEN)

BE-Exchange

Current Market Perspective – Fall 2025

9/29/2025

Smith Engineering

SMITH ENGINEERING

MARKET CONDITIONS PERSPECTIVE | FALL 2025

Traditional Drivers (Pre-2025)

- Net Zero pledges and ESG commitments drove decision-making
- Infrastructure projects justified on environmental impact
- Long-term planning with less emphasis on first cost

Current Market Conditions

- **First cost is paramount** – Focus on $/MTon carbon reduction ($1,000-$10,000 range)
- Customers delaying detailed net-zero planning to leverage future technology advancements

Strategic Response for Universities & Fortune 500 Campuses

Brownfield Projects

- Position TEN components as cost-effective alternatives to planned infrastructure upgrades

Greenfield Projects

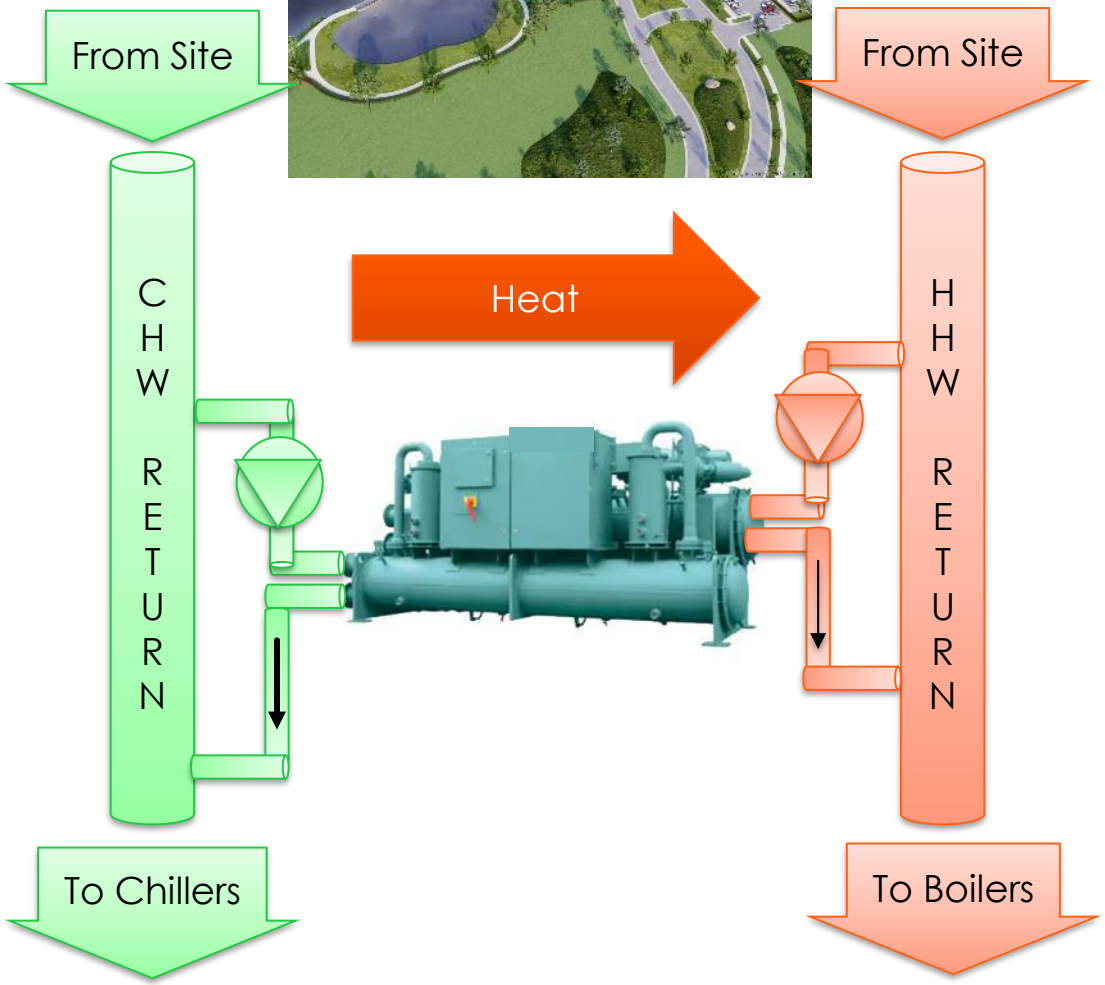
- Position TEN components on incremental cost only

Project Structuring

- Break down into subcomponents with independent economic justification
- Accept minor electrical efficiency losses to achieve lower first cost. Especially when leveraging virtual power purchase agreements.
- Phased implementations that deliver near-term value
- Defer deeper carbon reduction to later years of Decarb Masterplan

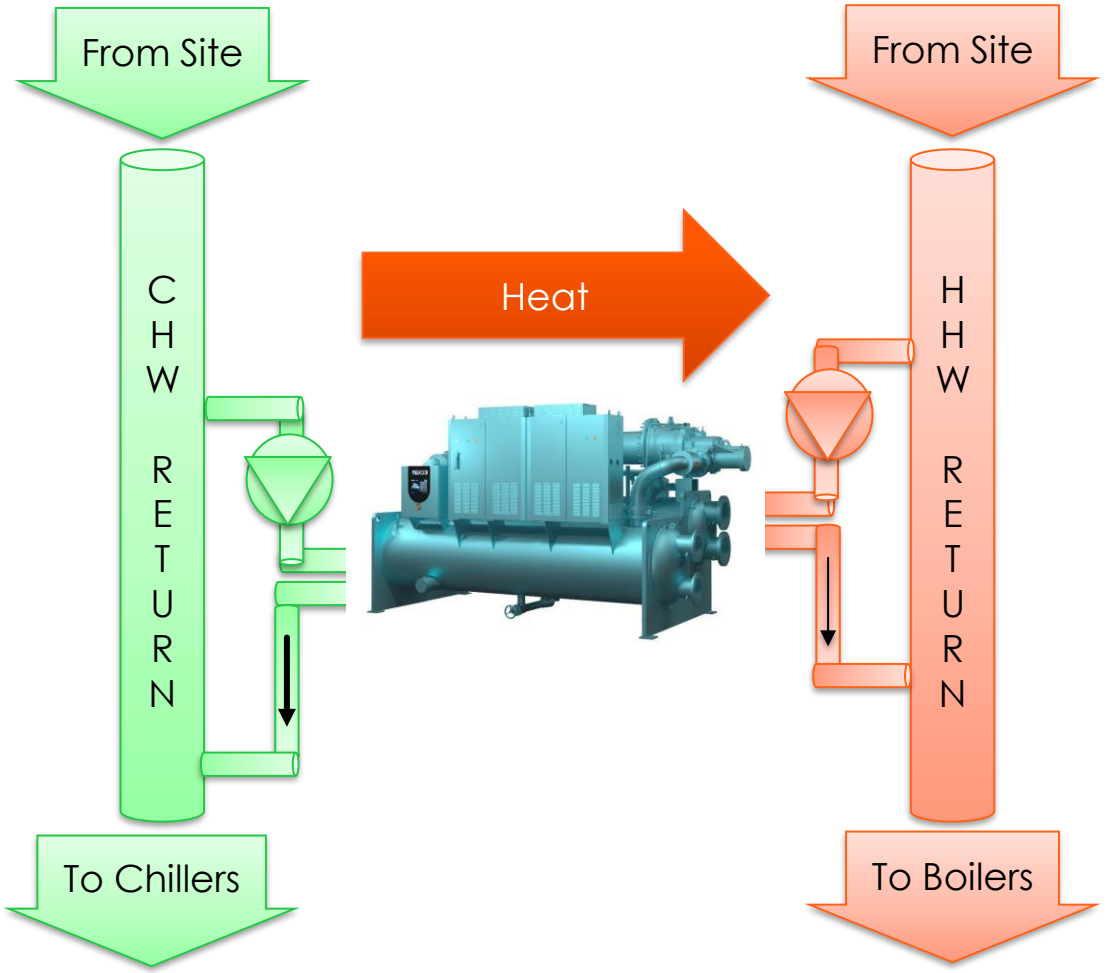
INSTALLATION | PHARMACUITICAL SITE | NORTH CAROLINA | GREENFIELD

- Heat pump Tech
  - (1) YORK YVWA
  - 130F HHW
- Arrangement
  - Sidecar
  - Simultaneous Heating and Cooling
- Important Notes
  - North Carolina
  - **Greenfield**
  - Smaller Application
- Dealing with Load Mismatch
  - Sizing - Small relative to CHW and HHW loads
  - Storage: None
  - Geo-exchange: None
- Other Notes
  - Heating: Gas Condensing Boilers
  - Heat Rejection: Cooling Towers
  - Controls are Ultra Critical



INSTALLATION | PHARMACUITICAL SITE | IRELAND | GREENFIELD

- Heat pump Tech
  - (5) YORK YVWH
  - 150F HHW
- Arrangement
  - Sidecar
  - Simultaneous Heating and Cooling
- Important Notes
  - Ireland
  - **Greenfield**
  - Medium to Large Application
- Dealing with Load Mismatch
  - Sizing - Large relative to CHW and HHW loads
  - Storage: None
  - Geo-exchange: None
- Other Notes
  - Heating: Gas Condensing Boilers
  - Heat Rejection: Cooling Towers
  - Controls are Ultra Critical



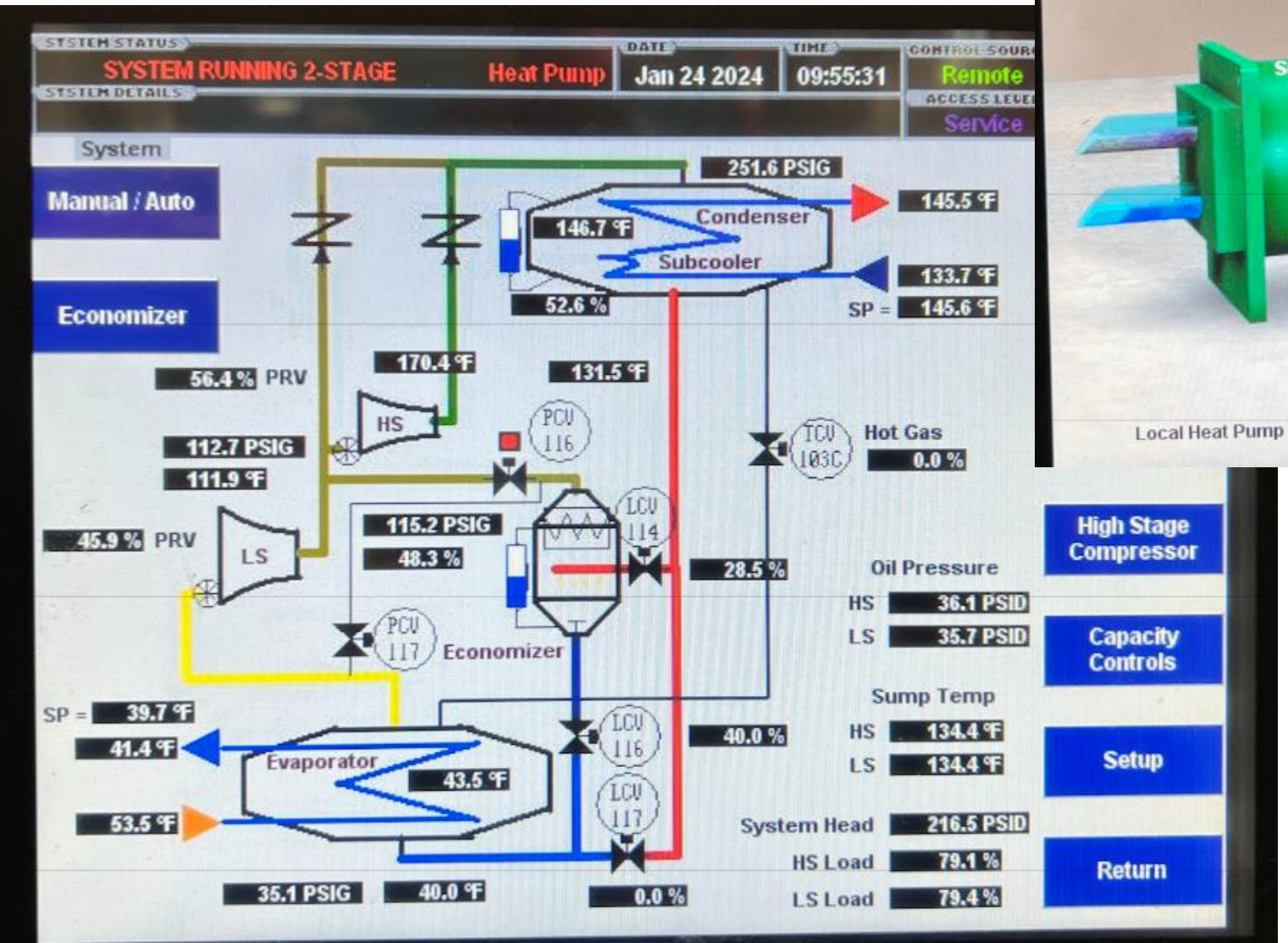
INSTALLATION | PHARMACUITICAL SITES | NEW JERSEY | BROWNFIELD

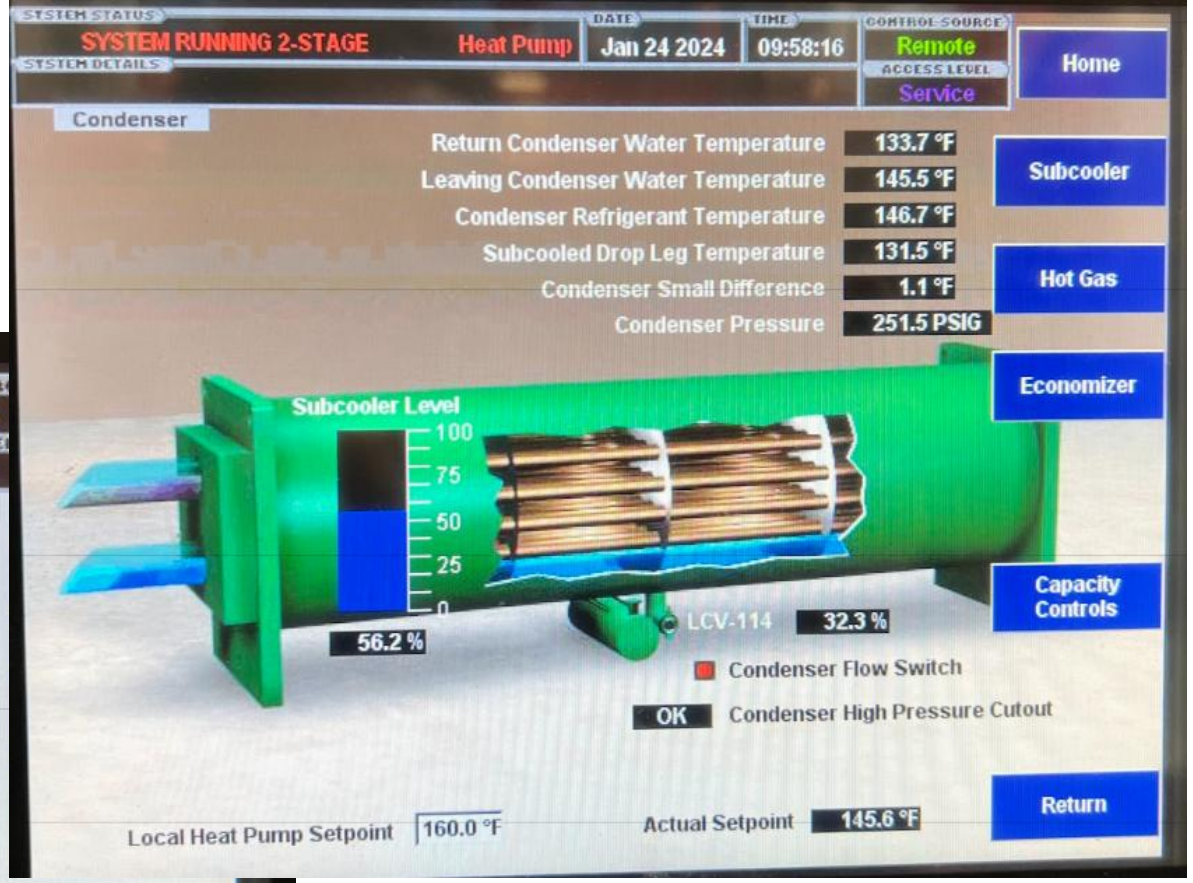
- Heat pump Tech
  - Combination of CYKs and YVWH
  - 170F HHW
- Arrangement
  - Sidecar
  - Simultaneous Heating and Cooling
- Important Notes
  - New Jersey
  - **Brownfield**
  - Large Application
- Dealing with Load Mismatch
  - Sizing - Large relative to CHW and HHW loads
  - Storage: Planned Storage
  - Geo-exchange: Later Stages
- Other Notes
  - Heating: Cogen
  - Heat Rejection: Cooling Towers
  - Controls are Ultra Critical

INSTALLATION | PRINCETON | TIGER PLANT

- Heat pump Tech
  - 165F HHW
- Arrangement
  - Simultaneous Heating and Cooling with Geo-Exchange
- Important Notes
  - New Jersey
  - Gets very cold
- Dealing with Load Mismatch
  - Geo-exchange
  - HHW Storage
  - CHW Storage
- Other Notes
  - Heating: Cogen and Steam Boilers at West Plant
  - Heat rejection: Cooling Towers at West Plant
  - Controls are Ultra Critical

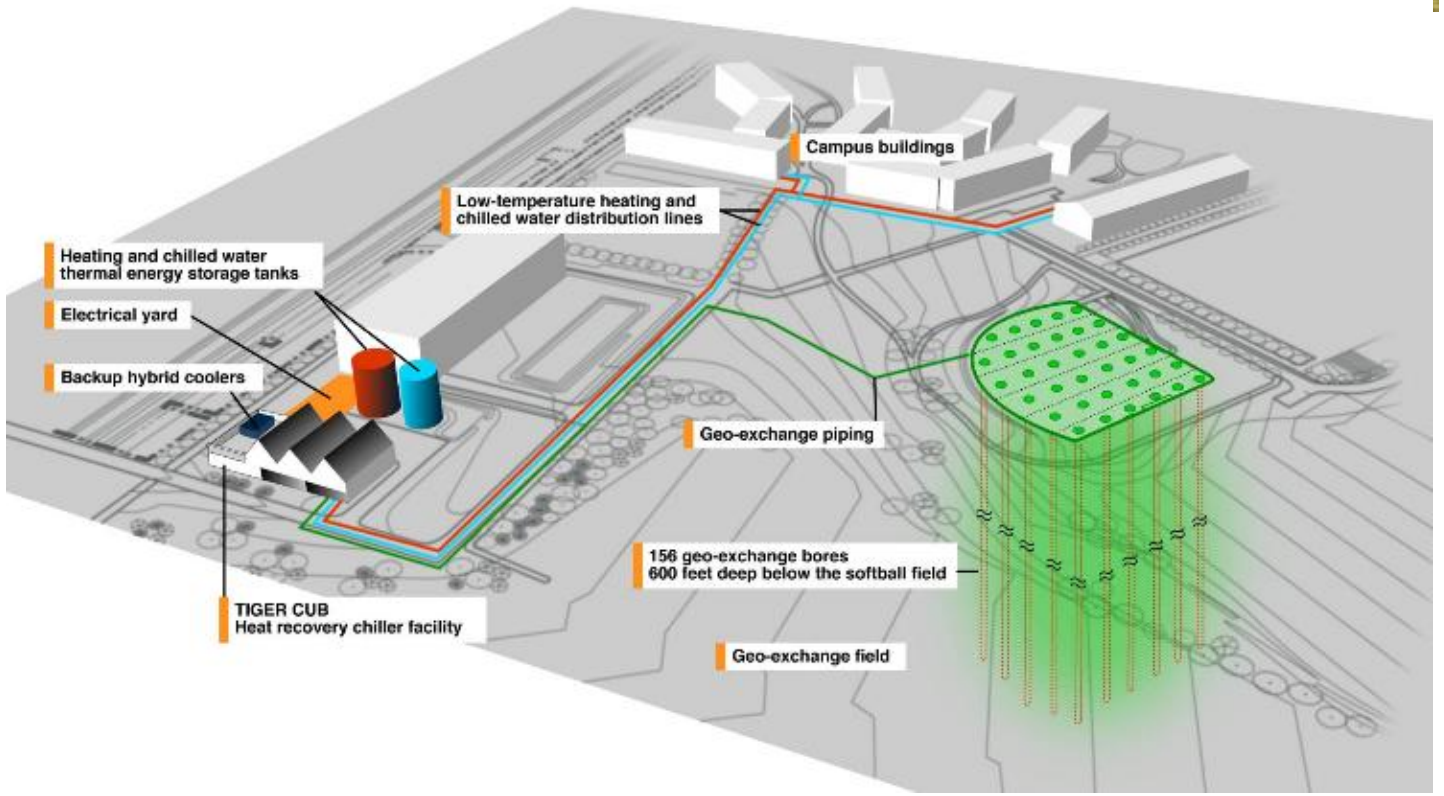
INSTALLATION | PRINCETON | TIGER PLANT



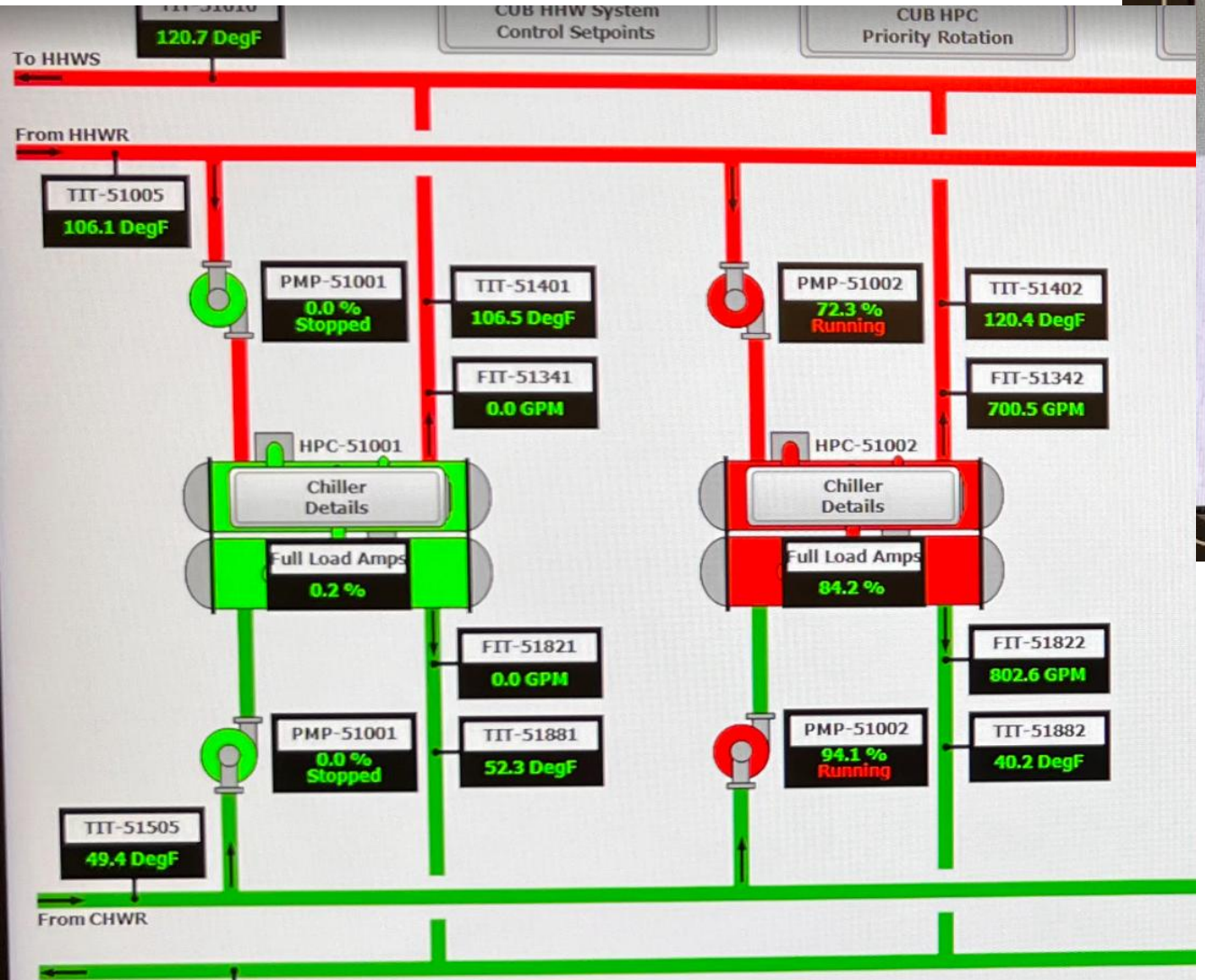


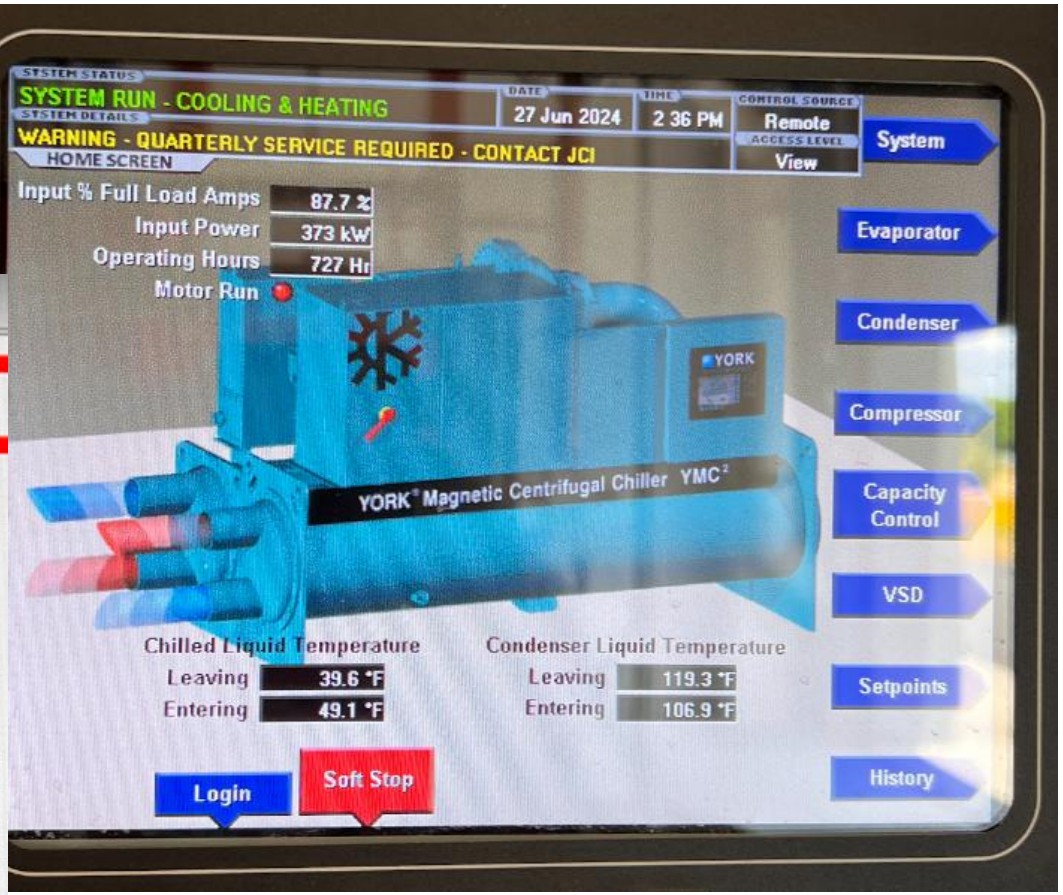
INSTALLATION | PRINCETON CUB

- Heat pump Tech
  - 120F HHW
- Arrangement
  - Simultaneous Heating and Cooling with Geo-Exchange
- Important Notes
  - New Jersey
    - Gets very cold
- Dealing with Load Mismatch
  - Geo-exchange
  - HHW Storage
  - CHW Storage
- Other Notes
  - Heating: Back-up Condensing Boilers
  - Heat rejection: Evaporative Coolers
  - Controls are Ultra Critical



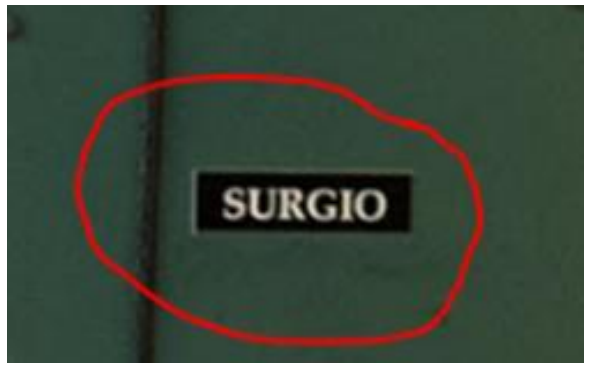
INSTALLATION | PRINCETON CUB

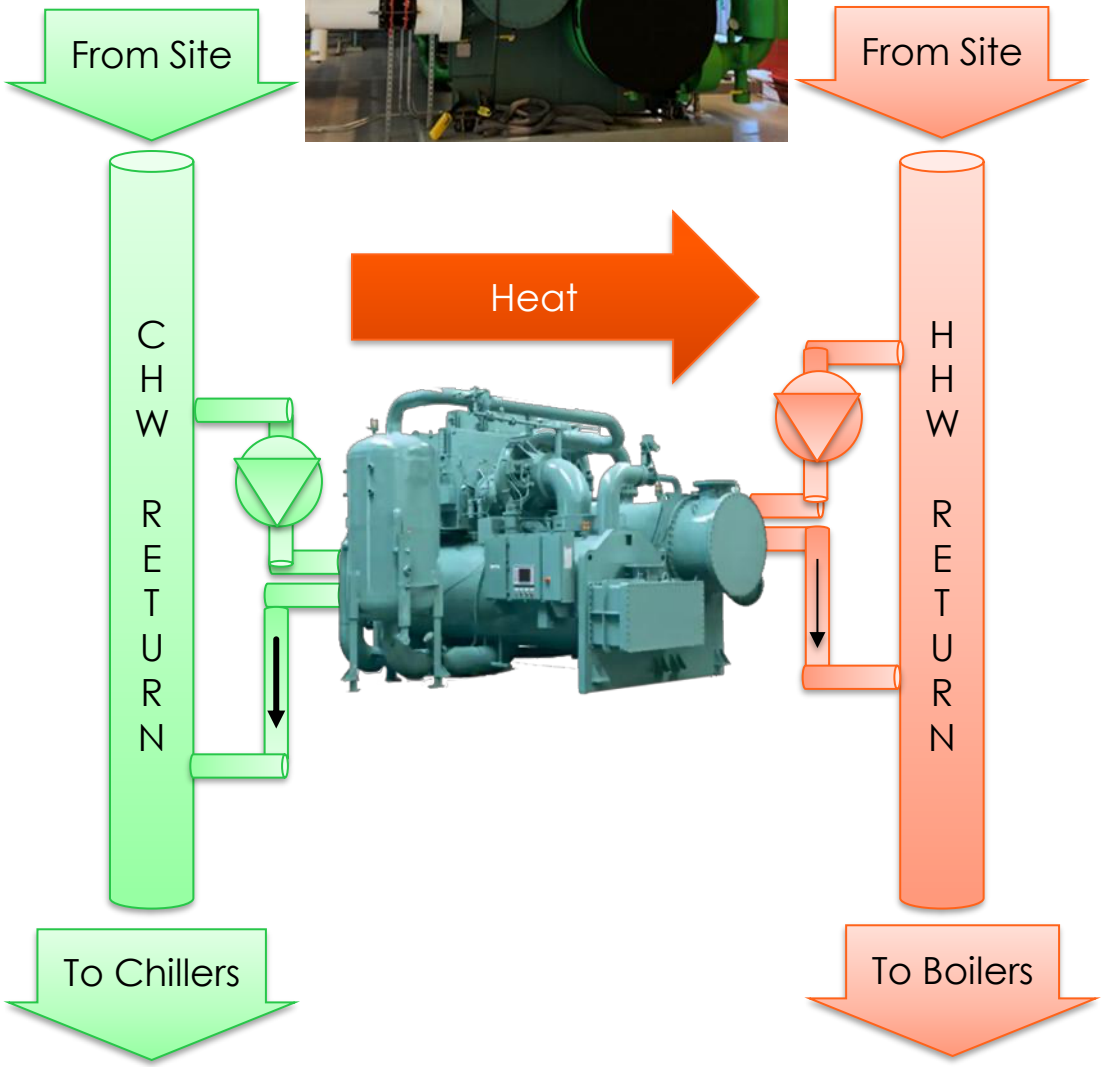




INSTALLATION | UD

- Heat pump Tech
  - YORK CYK
  - 150F HHW
- Arrangement
  - Sidecar
  - Simultaneous Heating and Cooling
- Important Notes
  - Delaware
  - Gets cold but not as cold of NYC
- Dealing with Load Mismatch
  - Sizing – Oversized, has issues
  - Storage: None
  - Geo-exchange: None
- Other Notes
  - Heating: Steam to Hot Water
  - Heat rejection: Cooling Towers
  - Controls are Ultra Critical

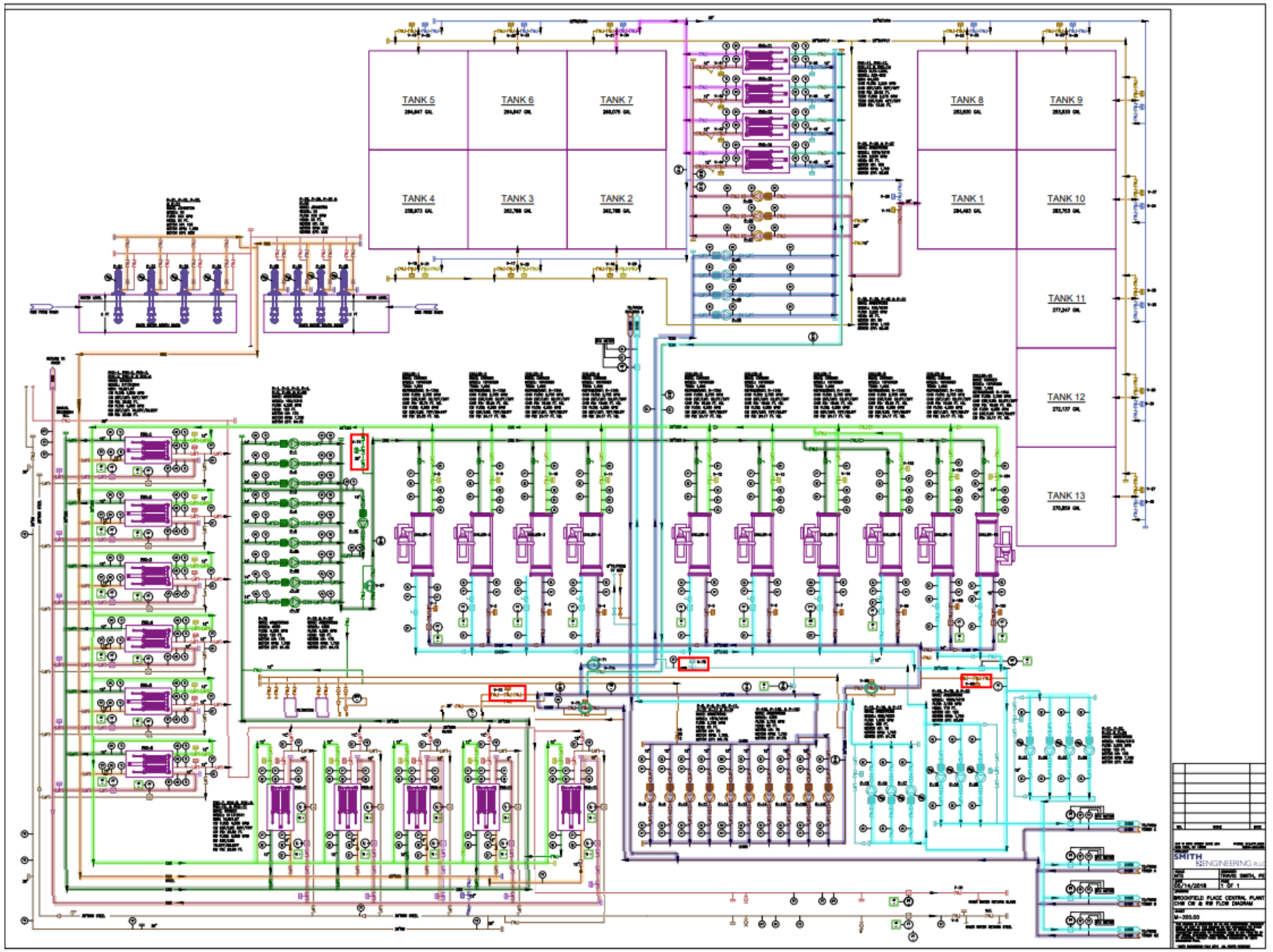




INSTALLATION | BROOKFIELD PLACE

- Heat pump Tech
  - 130F HHW – Chiller Rebuild
- Arrangement
  - Parallel to Existing Chillers
  - Series with existing STM to HHW HXs
  - Simultaneous Heating and Cooling
- Important Notes
  - NYC - Gets cold
- Dealing with Load Mismatch
  - Sizing - Small relative to CHW and HHW loads
  - Storage: CHW Existing
  - Geo-exchange: River
- Other Notes
  - Heating – Coned Steam
  - Heat rejection – River
  - HPs and Traditional chiller
  - Controls are Ultra Critical
  - LL97 – Carbon Tax

INSTALLATION | BROOKFIELD PLACE



TAKE AWAYS FROM SWEEDEN TRIP

1. **Skilled Labor Advantage**

- Sweden demonstrates a significant edge in skilled workforce development compared to the US, which faces critical shortages across multiple sectors:
  - **Trades**: The US is projected to be 400,000+ workers short in 2025
  - **Operations**: Building operators average 48 years old (vs. 42 for overall US workforce, and mid-30s in the 1980s) — signaling an aging workforce without sufficient replacement pipeline
  - **Professional Services**: One-third of all positions remain unfilled
- Despite Sweden also experiencing labor shortages, their education system appears more effective at producing skilled technical workers.

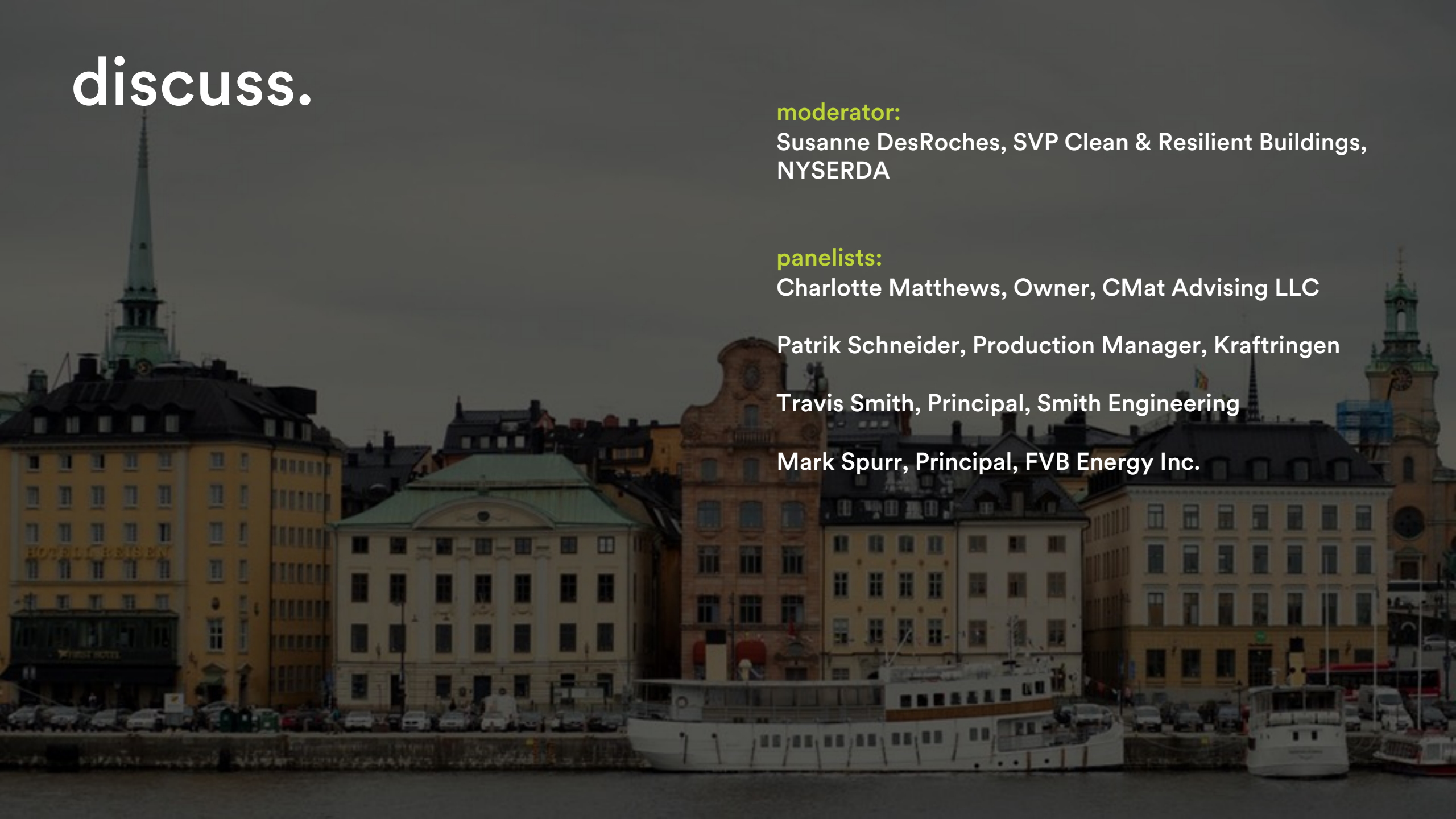
2. **TENs Mature Technology**

- District System with simultaneous heating and cooling over 30 years old

3. **Progressive Policy Approach**

- Sweden takes a collaborative stance on data centers:
- **Incentivizes** urban data center development by treating waste heat as a valuable resource
  - Integrates data centers into district heating systems
  - Contrasts sharply with US tendency to penalize data centers
  - This approach transforms what's often viewed as an environmental burden into a community asset, creating win-win scenarios for infrastructure providers and municipalities.

discuss.



moderator:
Susanne DesRoches, SVP Clean & Resilient Buildings, NYSERDA

panelists:
Charlotte Matthews, Owner, CMat Advising LLC

Patrik Schneider, Production Manager, Kraftringen

Travis Smith, Principal, Smith Engineering

Mark Spurr, Principal, FVB Energy Inc.

thank you!