

IDEA 2023

114th International District Energy Association Annual Conference & Trade Show

Combined Heat and Power (CHP)



Acknowledgements

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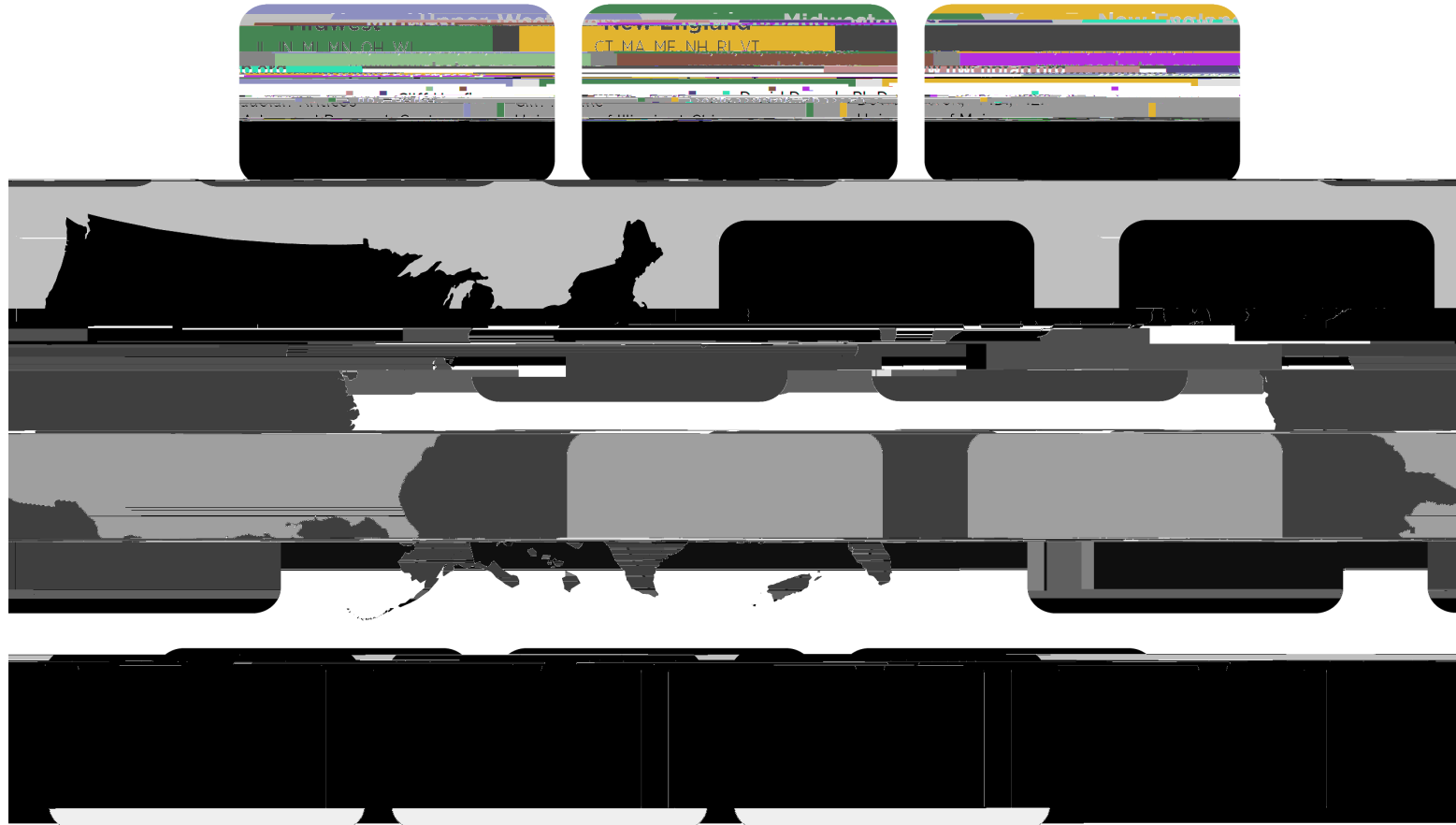
Supporting materials generously shared by:

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DOE CHP Technical Assistance Partnerships (CHP TAPs)



DOE CHP Deployment
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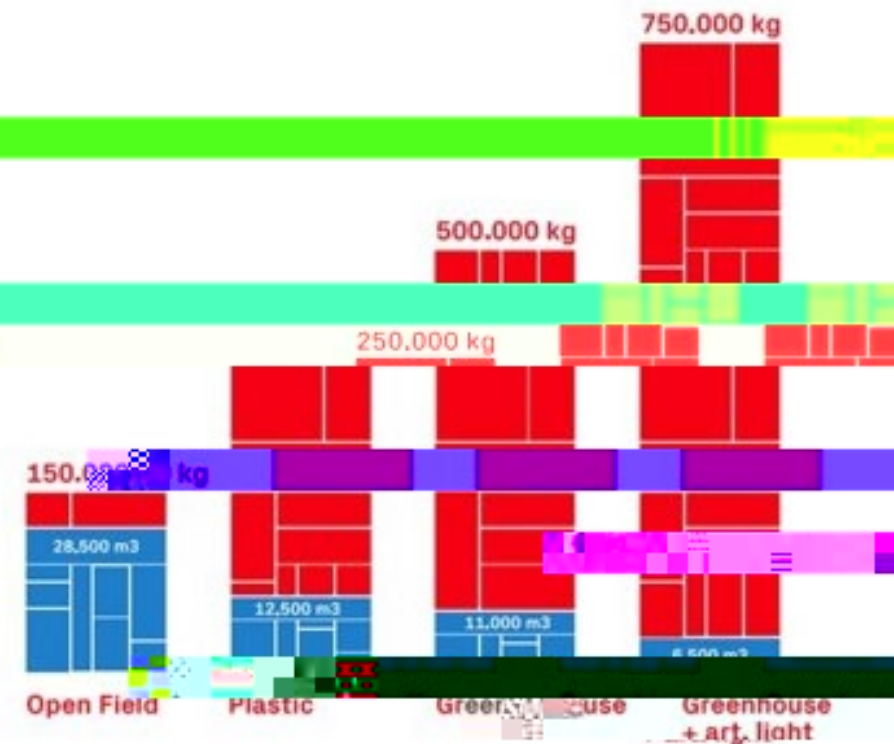
US DOE CHP Technical Assistance Partnership Services



Energy, Water, Food Nexus

It can be done,
it has been done!

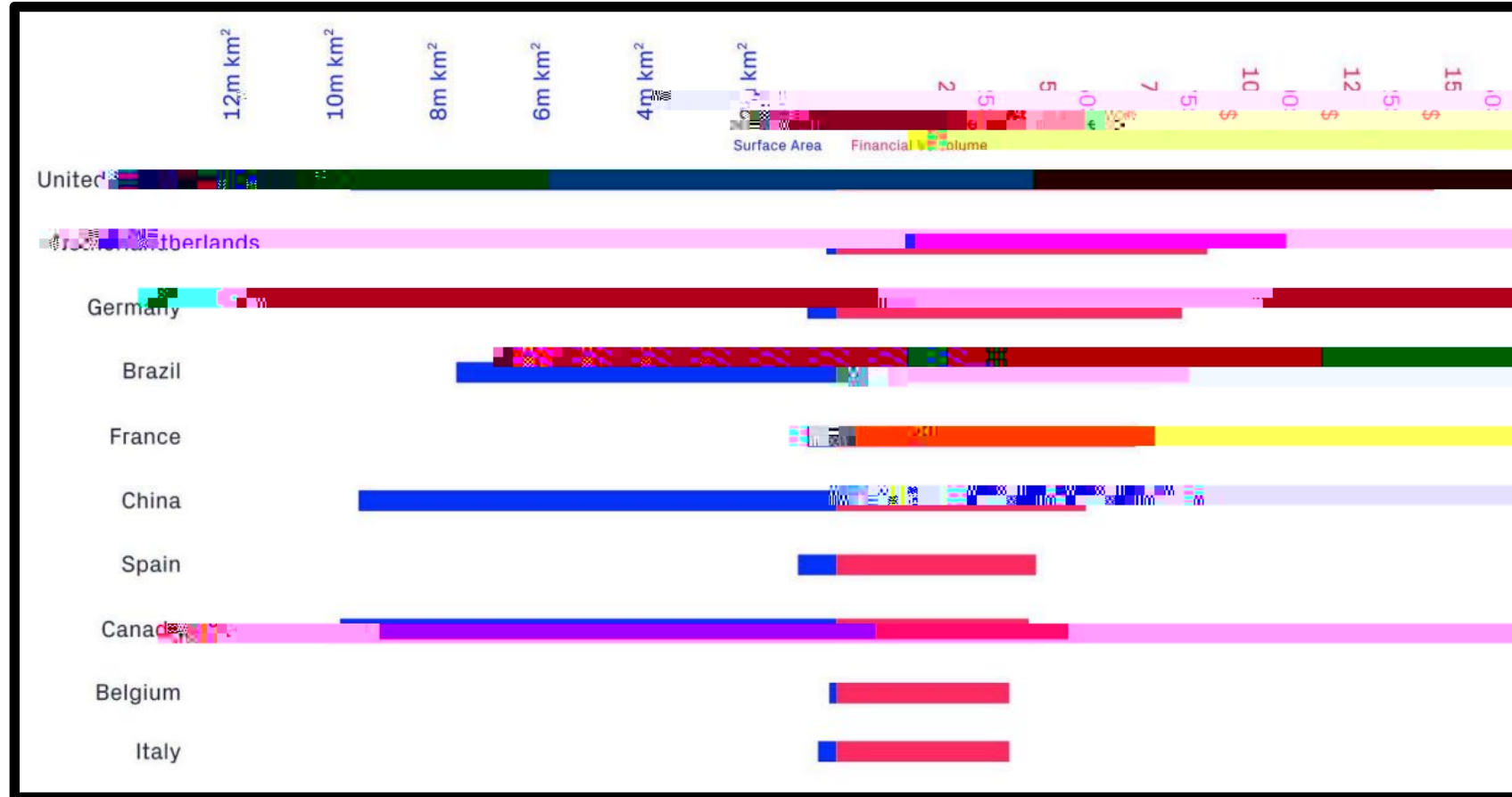
The high-tech greenhouse
delivers 5 times the output while
consuming nearly 78% less
water.



Tomato production on one hectare vs. water
consumption (Dutch Greenhouse Horticulture
2020).



Success of CEA in the Netherlands



Country Food Production in Dollars by Land Area. (Dutch Greenhouse Delta 2021)



CHP and CEA: Conjoining Food & Energy for Resilient Communities



- f* Locally grown healthy food
- f* CHP for site energy resiliency, redundancy, & reliability
- f* Thermal storage for peak shaving
- f* Heat recovery for greenhouse, carbon sequestration from engine feeds plants
- f* Goodwill toward community
- f* Educational program opportunities



CHP/CEA – Cost Savings

f Utility load data collected for 26-acre semi-



Why CHP at CEA

- f* CHP produces electricity, heat, cooling, and CO₂. Utilizing these energy streams results in increased efficiency (> 75%) of the fuel source (natural gas or low carbon fuel) reducing utility costs and providing several ancillary benefits.
- f* Cost Savings Utilities (lighting, dehumidification, space conditioning) represent the second largest cost associated with CEA behind labor



CEA – Flexible Loads

Lighting	LED lighting can be ramped more easily than HPS lighting. Plants can tolerate variations in lighting amount and schedule. Alternating red and blue light with tomatoes to reduce peak demand.
Ventilation and Fans	Horizontal and vertical fans are utilized to create different crop zones in the same greenhouse. The use of variable flow drive fans allows flexible usage. Vertical fans that provide boundary separation in lettuce crops can be flexibly timed.
Thermal Energy	Thermal batteries allow decoupling greenhouse thermal generation and utilization allowing flexible timing of cogenerated heat and power.

Source: Afzali et al. 2021; Bhuiyan and van Iersel 2021; Frijns 2022; Hao 2021; Nicholson et al. 2022.



Integration of CHP w/ CEA

f

HoSt's 2020 State-of-Art Biomass CHP Plant:
Produces 15 MW thermal + 3.4 MW electrical power







Many Applications Worldwide¹

Some Case Study Examples:

Netherlands - Has 25,000 MW of installed generatiTw 24 -0 (IC (,)0.6 (0)-TJ -0.1 12Tf -0.004 0.30.4161 0



CHP/CEA – Emissions

Dutch Greenhouses and On-Site Power

2020 production of electricity using natural gas fired CHP in greenhouse horticulture in the Netherlands was 10.3 billion kWh. Deploying CHP in greenhouse horticulture th2 uay red (e)3 (d)-5.4(u a)10ovnhouaal o



Benefits of District Energy (DE) & CEA / CHP

- f* Dispatchable generation resource and flexible load for microgrid balancing.
- f* Excess electric and thermal generation from serving greenhouse loads can be used to serve district energy loads.
 - C* Greenhouses have minimal electric and thermal loads during the summer so CHP can serve increased electric (air conditioning) loads and run absorption chillers.
 - C* Excess heat from CHP HW loop
- f* Food production located near population and load (electrical, thermal) centers.
 - C* Reduces emissions associated with food transportation.
- f* Close proximity to large food waste sources provides ability to produce low carbon fuels (biogas or renewable natural gas) to run CHP when anaerobic digestion is included in CEA / CHP system.



CEA Integration in Districts

- f* Q-Scale data center with Greenhouse utilizing residual Heat Lévis, Que. the company claims that it will “produce 2,800 tonnes of small fruit and more than 80,000 tonnes of tomatoes per year” in greenhouses to be constructed adjacent to the facility.¹
- f* Toundra Greenhouse, Resolute Paper Mill, CO2 Solutions Partnership – Phase one of a \$100 million, 34 hectare, agrothermic industrial park has been completed. Heat and CO₂ produced from the Resolute pulp mill are used to heat and supplement greenhouse CO₂ in a 8.5 hectare greenhouse. CHP is under consideration to serve electric loads and provide heating for upcoming industrial tenants.
- f* Sweden: An agreement between Agtira and Greenfood \$27.8 million (\$US) has been signed for a cucumber cultivation plant in Boden. The facility will be one of eventually a total of ten around the country.

"The potential to recover residual heat from data centers and other industries is a huge and often unus resource,"

- Pontus Lamberg, operations manager at Agtira (Data center) ²

¹ <https://www.greenhousecanada.com/water-tapped-by-major-quebec-grower-31899/>

² <https://www.hortidaily.com/article/9516261/sweden-cucumbers-grown-on-residual-data-facility-heat/> date: Mon 3 Apr 2023



Decarbonization / Energy Markets / Grid Reliability

- f* Short term reliability margin are “thinning” to 2026 ¹
- C* NYC reliability margin narrows to 50 MW in 2025
- C* “even the slightest deviations from expected conditions, load forecasts, or project delays could trigger future reliability needs”NYISO
- f* Total Installed Capacity must Triple (95 GWs) to meet the 2040 Goal²
- C* New York currently has 37 GWs of generating capacity
- C* Roughly 7 years from now, an estimated 20 GW’s of additional renewable generation needed
- C* 12.9 GWs of new generation have been developed since 1999

¹ 2022-RNA-Datasheet.Pdf

² NYISO 2021-2040-Outlook-Datasheet.Pdf



Ontario IESO Illustrates CEA & CHP As Grid Solution

Challenge:



Summary



Thank you. Questions?



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For more information about the TAPs:

https://betterbuildingsolutioncenter.energy.gov/chp/chp_taps

