

# Nanogrid and Microgrid Laboratory Testbeds

Tim Kingston, *Senior Director, R&D* MEEA MES Conference | February 1<sup>st</sup>, 2023

## Growing Demand for Energy Resilience





#### Demand for Electricity is Growing





## Nanogrid and Microgrid Testbed Goals



Maximize Efficiency
Minimize GHG
Maximize Resilience
Cost Effectively
Minimal Customer Impact



#### Nanogrids and Microgrids



Energy systems with multiple controllable energy sources and various controllable loads

#### "Nanogrids" Single building operates as energy system

#### "Microgrids" Multiple buildings operated by central system





#### **Relative Greenhouse Gas Scenarios**





#### Nanogrid Testbed on GTI Energy Campus





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#### Microgrid Testbed on GTI Energy Campus





## Simulated-Use (Virtual Test Home) Approach



Laboratory Test Rigs — Virtual Test Home — Models (or digital twin from field)



Simulated use testing is performance mapping is Advanced modeling is Quantify: GHG, EE, Cost savings

#### Forced-air/Hydronic Heating Performance





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#### Air-source Heat Pump Performance

![](_page_10_Picture_1.jpeg)

20%

18%

16%

14%

12% 10%

8%

4%

2%

0%

80

70

Humid/Region IV Load

Daily Heating Distribution

![](_page_10_Picture_2.jpeg)

![](_page_10_Figure_3.jpeg)

![](_page_10_Figure_4.jpeg)

5.0

4.5

4.0

U.S. Average Source Energy Conversion Factor for the grid is 2.63 based on eGrid 2020. (≥100% efficiency = ≥2.63 COP)

40

Daily Average OATdb, °F

50

ccASHP#2

60

Source: Center for Energy and Environment

#### Hybrid Hydronic/ASHP Performance

![](_page_11_Picture_1.jpeg)

![](_page_11_Figure_2.jpeg)

#### Nanogrid Performance

![](_page_12_Picture_1.jpeg)

![](_page_12_Picture_2.jpeg)

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#### Nanogrid Research Results

![](_page_13_Picture_1.jpeg)

![](_page_13_Figure_2.jpeg)

#### **Research Conclusions**

![](_page_14_Picture_1.jpeg)

![](_page_14_Figure_2.jpeg)

![](_page_15_Picture_0.jpeg)

![](_page_15_Picture_1.jpeg)

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