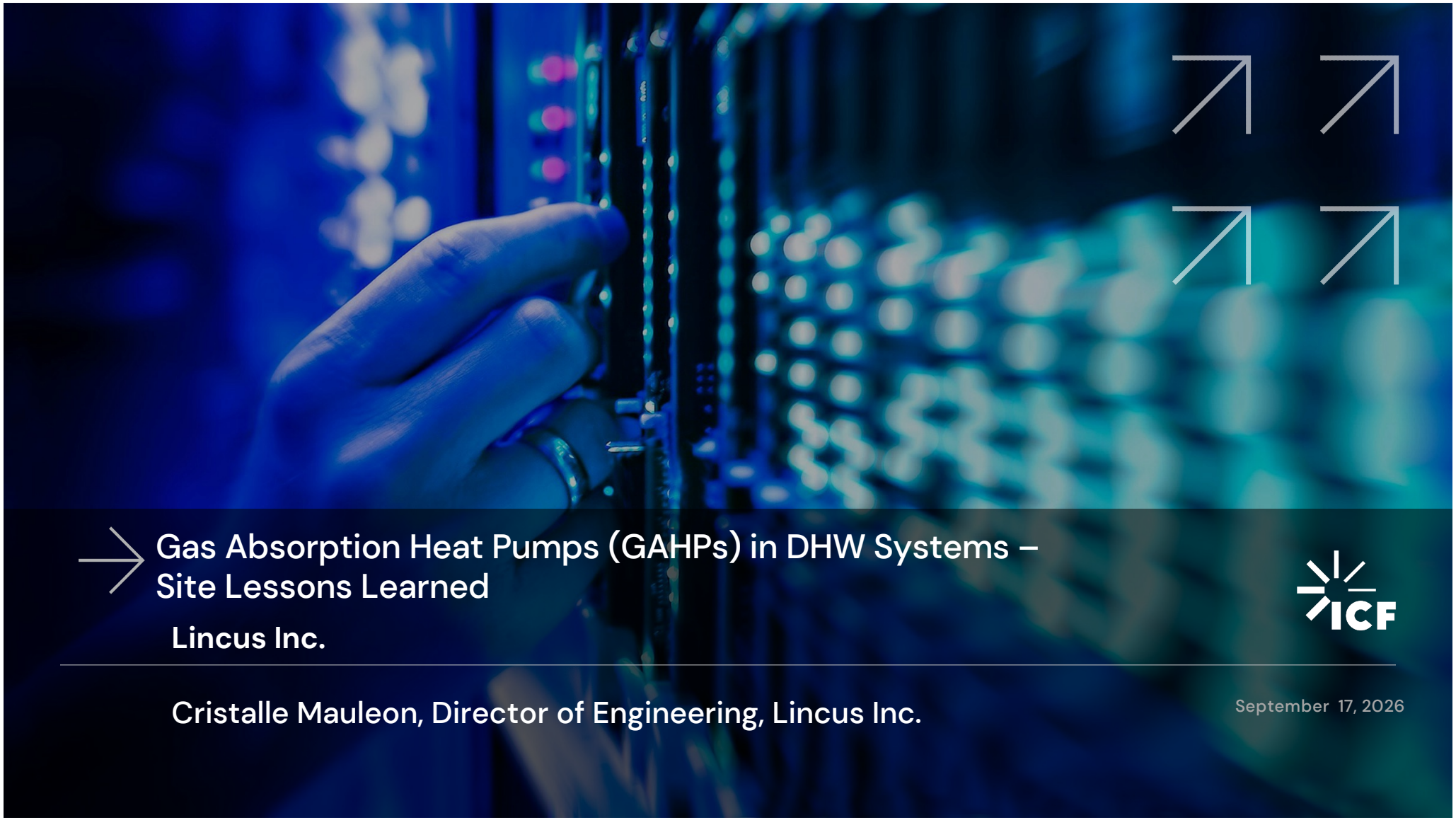

Gas Absorption Heat Pumps (GAHPs) in DHW Systems – Site Lessons Learned

Lincus Inc.

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Agenda

- Introduction & Background
- Pilot Objectives
- M&V Plan
- Baseline Data Analysis
- Results
- Additional Work
- Conclusions

Gas Absorption Heat Pump Water Heater (GAHP) Benefits

- Lower Emissions
  - High efficiency cuts gas use and emissions—consistently, day and night.
- Lower Utility Bills
  - Saves gas without increasing electric load.
- Retrofit-Friendly
  - No electric panel upgrades needed.
- Equity Impact
  - Supports cost savings and decarbonization in underserved communities.

Market Barriers and Field Pilot Objectives

Current State of GAHP EE Incentive

- SoCalGas incentive for GAHPs in **multifamily** buildings exists—but wasn't used

Barriers

- Low awareness of GAHPs and their carbon reduction potential
- Limited contractor & engineer sizing expertise
- Uncertainty around system operation and maintenance
- Lack of performance and cost data
- No incentives for other building types

Answer

- Field pilot study launched to address these gaps

Pilot Objectives

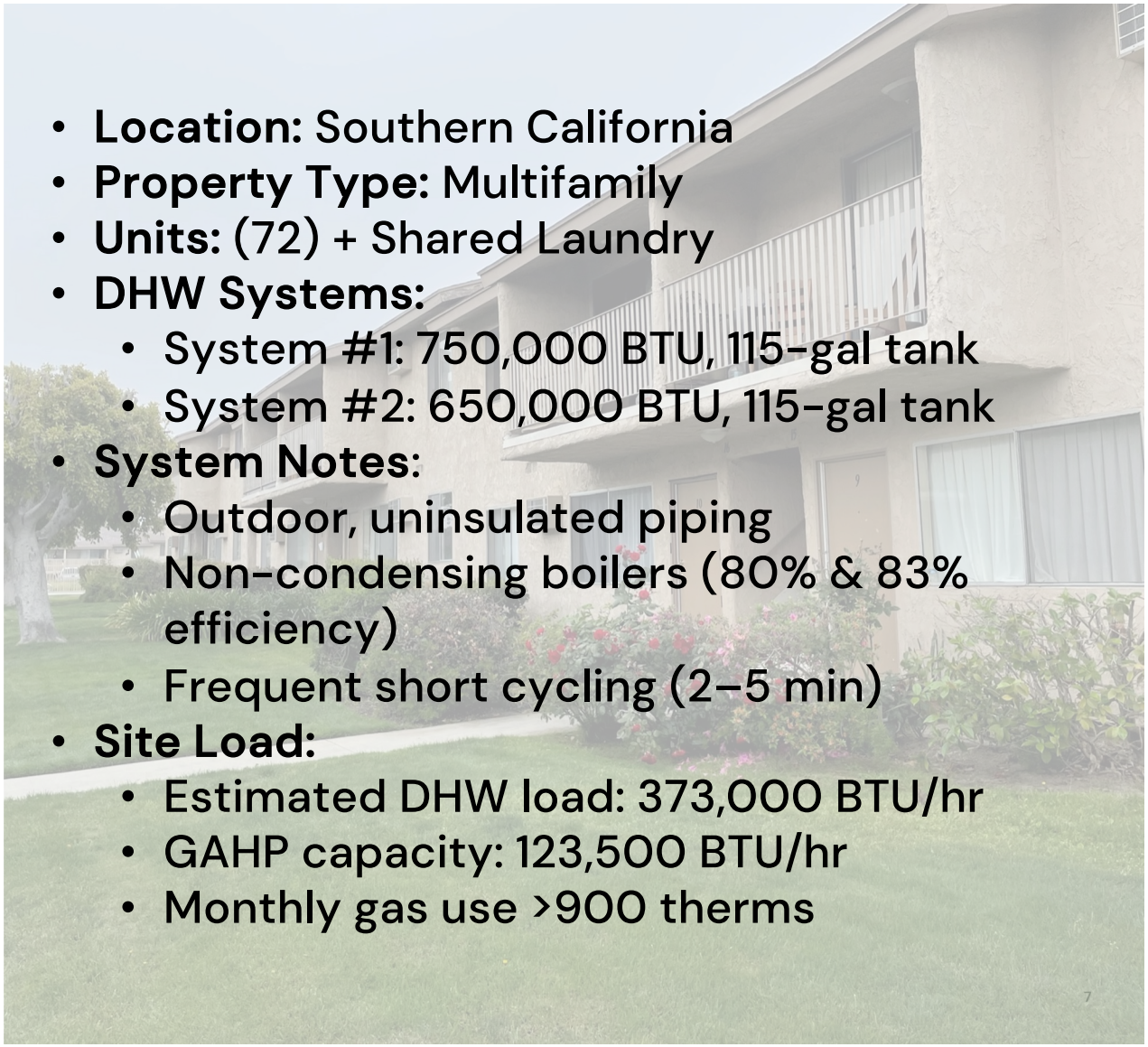
- Key Objectives:

1. Determine Energy Savings
2. Determine Carbon Emissions Reduction
3. Performance Validation
4. Market Barrier Mitigation

- Approach:

1. Field technology assessment at customer sites with high DHW loads

Site Characteristics



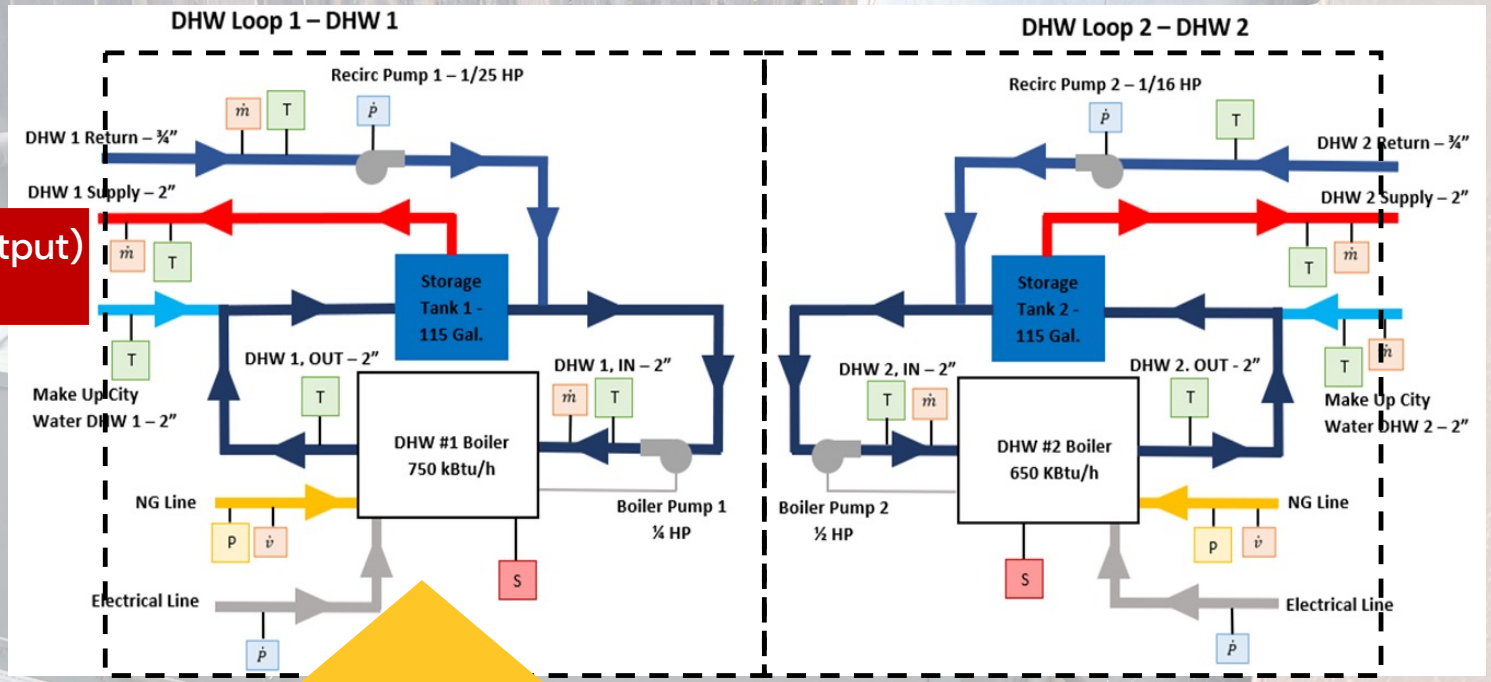
- **Location:** Southern California
- **Property Type:** Multifamily
- **Units:** (72) + Shared Laundry
- **DHW Systems:**
  - System #1: 750,000 BTU, 115-gal tank
  - System #2: 650,000 BTU, 115-gal tank
- **System Notes**:
  - Outdoor, uninsulated piping
  - Non-condensing boilers (80% & 83% efficiency)
  - Frequent short cycling (2–5 min)
- **Site Load:**
  - Estimated DHW load: 373,000 BTU/hr
  - GAHP capacity: 123,500 BTU/hr
  - Monthly gas use >900 therms

Baseline Measurement & Verification

Q_Out (aka Net Heat Output)
Supply – Return - City

System COP =

Q_Out/Q_In



Q_In
Boiler NG

Installation Pictures

- Upper Left: New Concrete Pad
- Upper Right: Piping to and from HX (insulated per T24)
- Lower Left: GAHP DDC control
- Lower Right: Installed GAHP Unit

Challenges

- Design:
  - No design support provided by mfg
  - Contractor struggled with HX size and buffer tank size
- Controls
  - Mfg has two controls
  - Contractor struggled to set up

Post-Installation GAHP COP Analysis

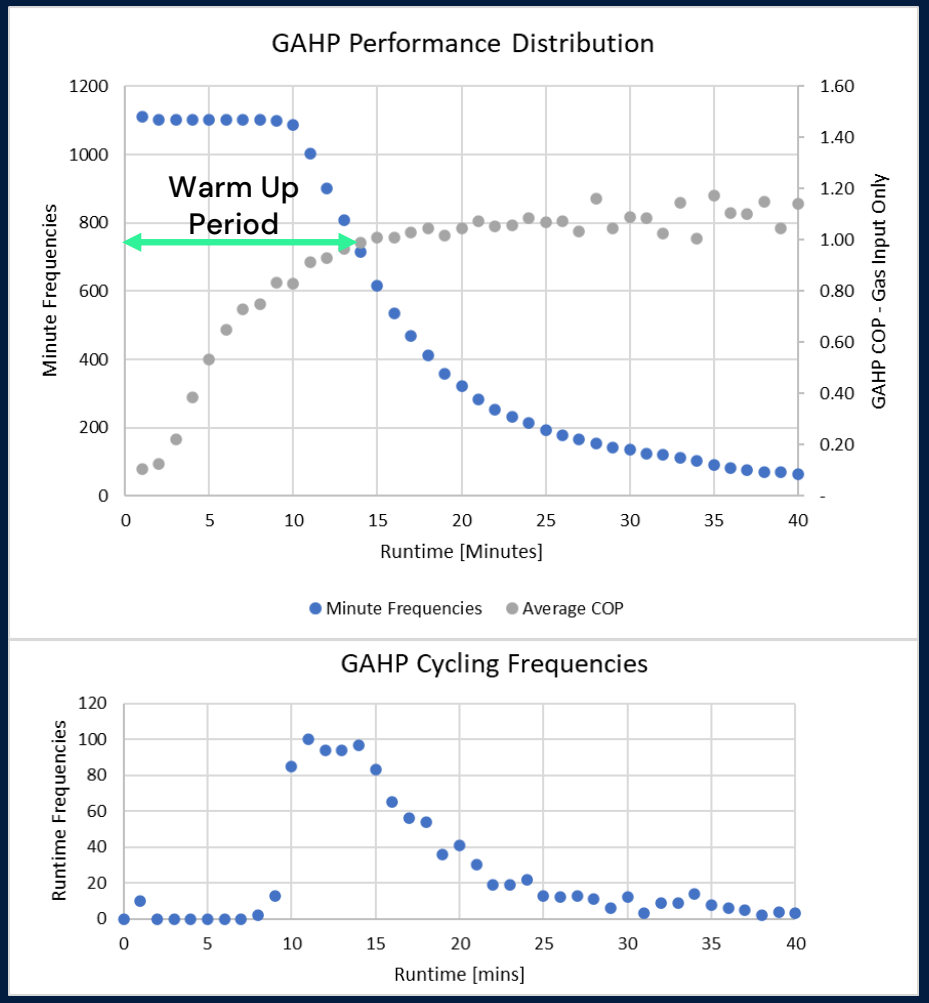
- Objective:
  - Determine the best-fitting model for GAHP COP.
- Key Findings
  - GAHP COP correlation with OAT or OAT^2 alone was **insufficient.**
  - Needed to use OAT AND NHO to get GAHP COP
  - Best-fit equation: GAHP COP = 0.000109 * NHO + 0.0046797 * OAT - 0.02489
  - Meets R2, CV(RSME) & NMBE Criteria

Metric Name	Metric Number	Goodess of Fit Requirement
R^2	0.78	>0.70
CV(RMSE)	19%	<25%
NMBE	0.00%	-0.05%<NMBE<0.05%

Post-Installation GAHP Performance Time Distribution

Key Insights

- **Steady-State COP:** ~1.14 after 20 minutes
- **Average Runtime:** 17.9 minutes
- **Weighted Average COP:** 0.75
- **Short Cycles = Lower Efficiency**
- **Energy Savings Depend on Runtime**



Energy Savings

- Key Metrics:
  - System COP 0.70 (0.67 in Baseline)
  - Net Heat Output: 233M Btu
  - Baseline Gas Use: 347M Btu
  - Actual Gas Use: 334M Btu
  - Savings: 134 therms (4%)
- Why Savings Fell Short:
  - Site screening missed low DHW loads
  - Recirculation not served by GAHP
  - Short GAHP runtimes (avg. 17.9 min)
  - Under-sized HXs
  - Oversized Boilers

Site #1 Follow Up Work

- **System Improvements:**
  - Incorporate recirculation load into GAHP system.
  - Add IST
  - Revise GAHP control settings.
- **Goals:**
  - Increase GAHP run-times for higher efficiency.
  - Validate lab data against field conditions.
- **Status:**
  - System redesign completed
  - HXs removed and replaced with 119 gallon ISTs
  - Submitted to Plan Check

Other Pilot Sites

Site #2

- Type: Hotel
- Existing System: (2) Tankless 751kbtuh boilers, 94% efficient
- Status: GAHP Installation Complete

Site #3

- Type: Multifamily
- Existing System: (2) 119kbtu 100 gal water heaters, 82% efficient
- Status: Design Complete

Site #4

- Type: Hotel
- Existing System: (2) 1,500 Mbtu Boilers & (2) 600 gallon storage tanks
- Status: Signed Customer Agreement

Conclusion

- **Key Findings:**
  - Post-installation COP increased to 0.70 (from 0.67).
  - Gas consumption reduced by 134 therms (4% savings).
- **Challenges:**
  - Contractor expertise gaps in design and installation.
  - Insufficient manufacturer support for design.
  - Short run-times limiting steady-state efficiency.
- **Next Steps:**
  - Enhance DHW system design and controls.
  - Install new design at Site #1
  - Install designs at Sites #2 through #4
  - Leverage findings to improve GAHP adoption in utility portfolios

Funding

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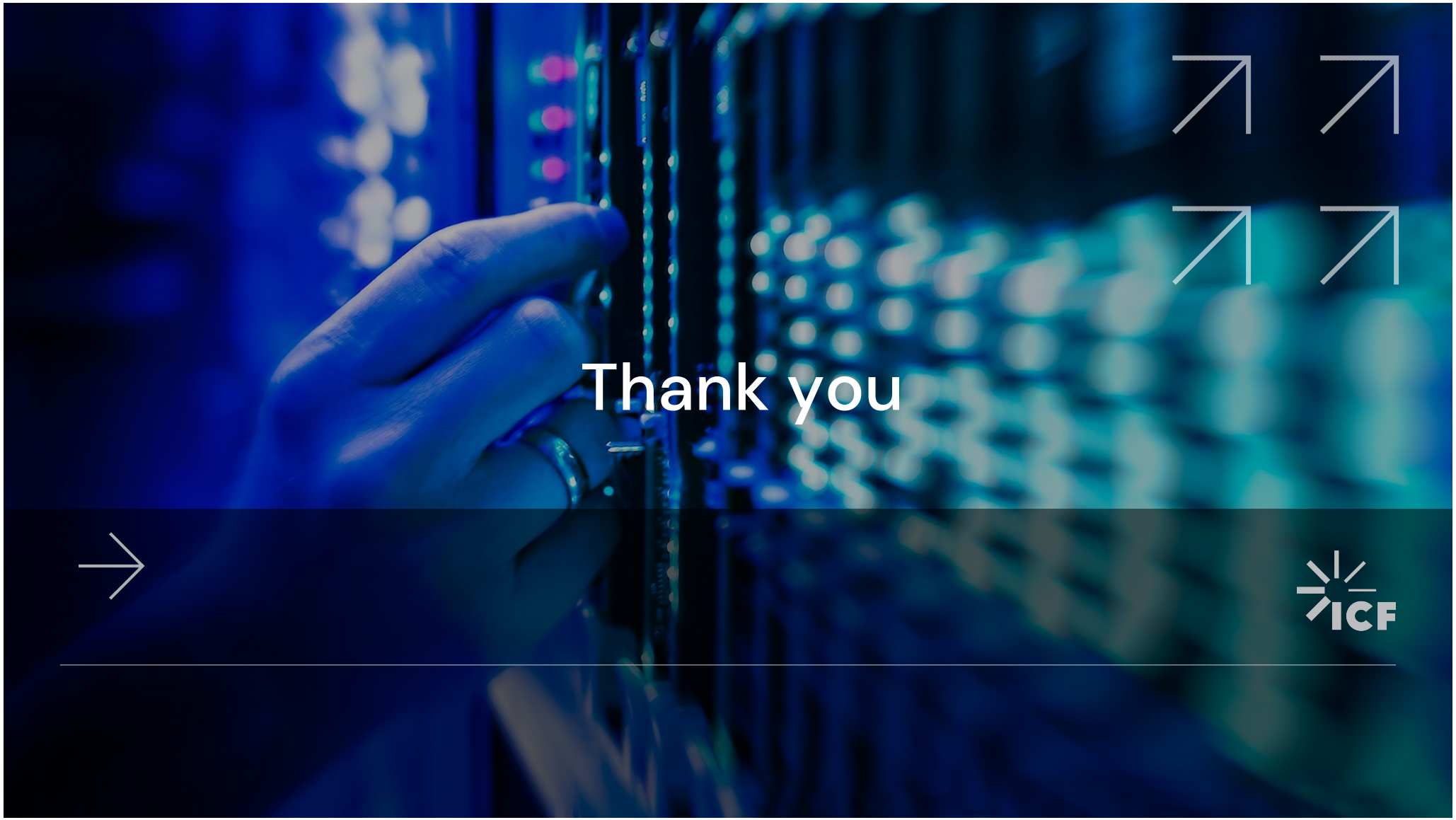
Thank you