A brief introduction to

CARRIER

Master thesis opportunities

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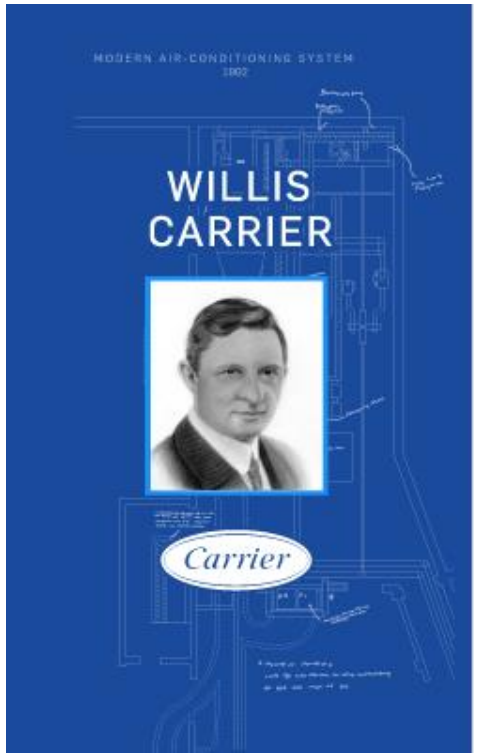
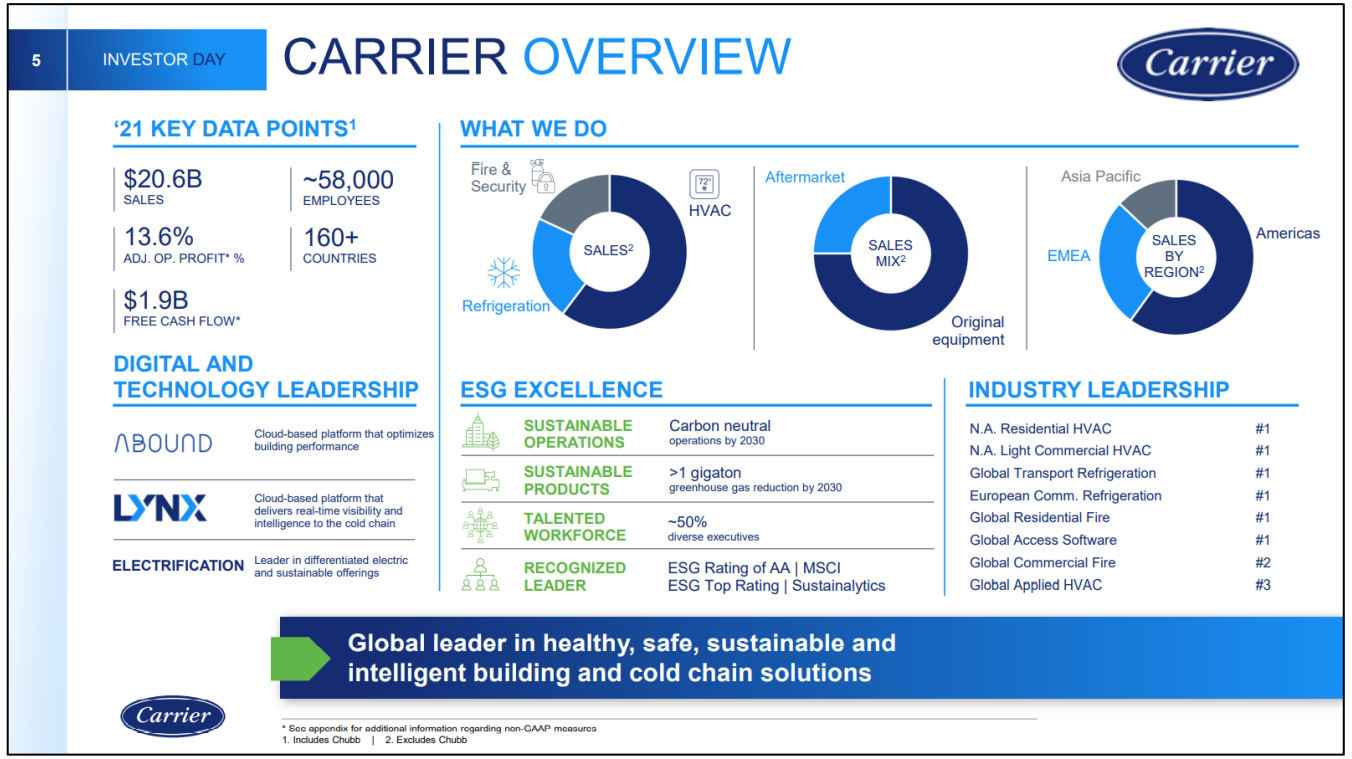
Carrier – Then and Now



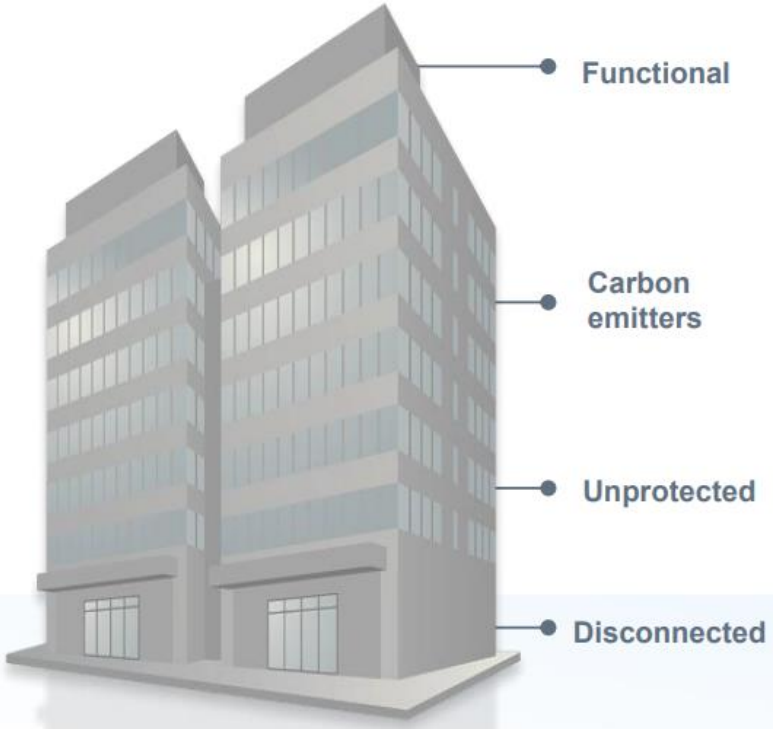
- 1902: Invents the modern air-conditioning system
- 1915: Founds Carrier Corporation



- Today: A world leader in commercial and residential HVAC and refrigeration
- 2022: Open engineering office in Lund

Environmental Trendsetter

BUILDINGS OF YESTERDAY



BUILDINGS OF TOMORROW

People spend **~90%** of our time indoors[1]

Indoor air can be **3-5x** more polluted than outdoor air[1]

Buildings account for **~40%** of greenhouse gas emissions[2]

1 in 5 existing buildings retrofitted to meet net-zero emissions by 2050[2]

Effective filtration can eliminate **99%** of airborne pathogens[3]

<30% of U.S. homes protected to National Fire Protection Association standards[4]

>4 billion connected IoT devices in commercial buildings by 2028[5]

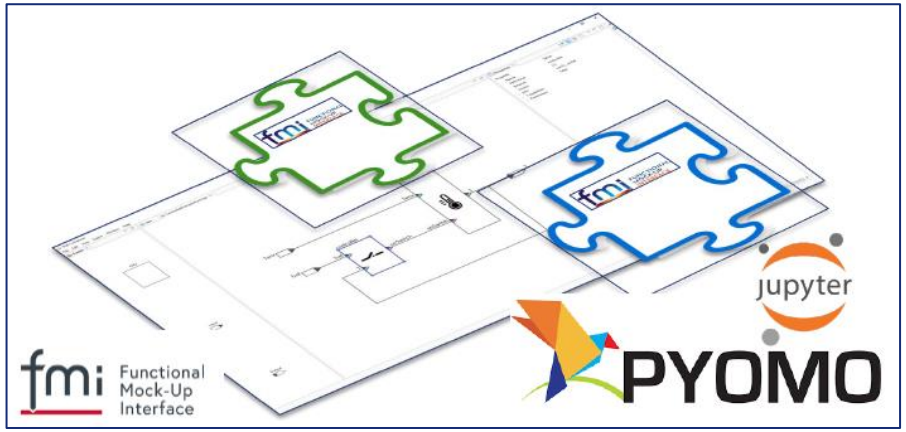
Integrated smart building systems can reduce energy use **~10%-20%**[6]

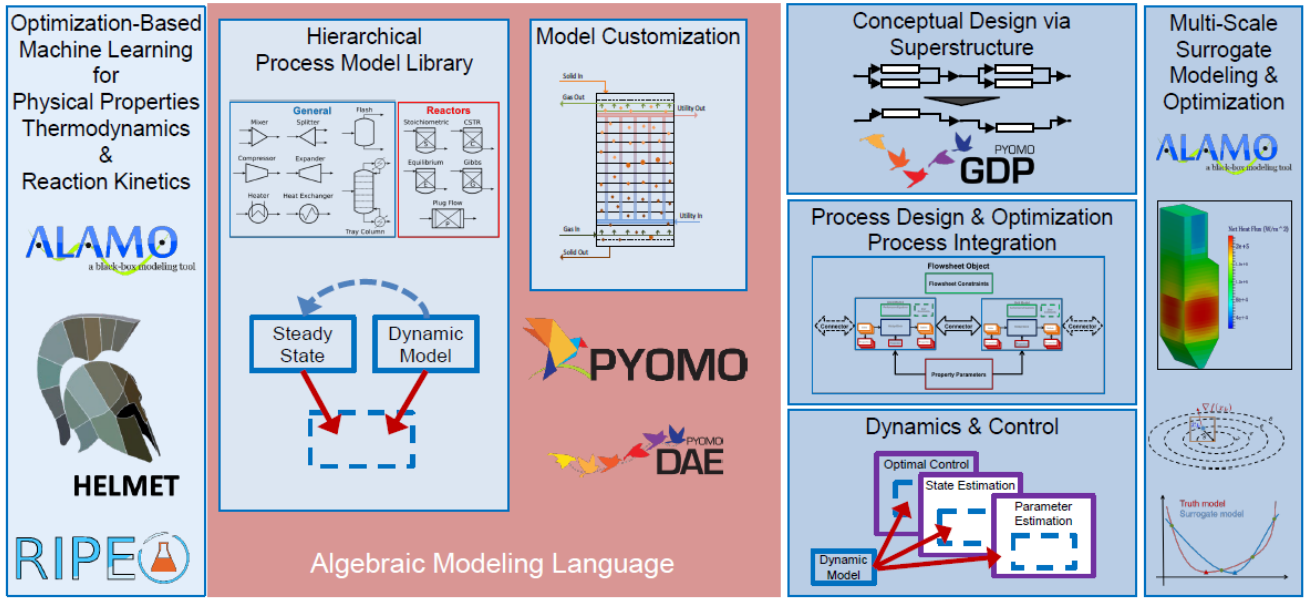
Carrier

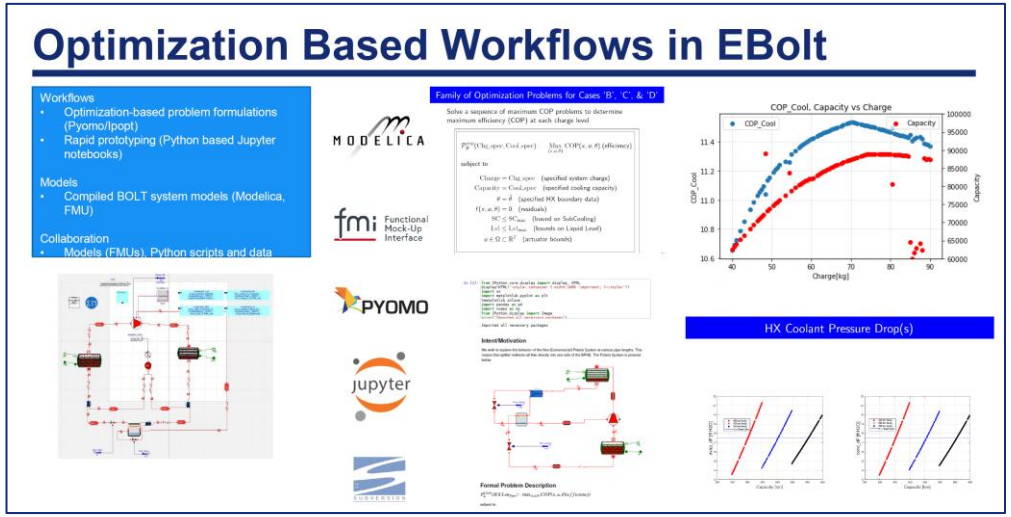
1. Harvard School of Public Health | 2. IEA | 3. Carrier product legal claim, based on third-party testing (2020)
4. NFPA | 5. Deloitte, Gartner | 6. The Nesler Group, National University of Singapore

Technology Trendsetter

- 20 years of Modelica modeling maturity
- Python, Jupyter notebooks, computations
- On-going collaboration with open-source state-of-art computational tool development (experts & their tools)
- Labs & facilities to test new ideas







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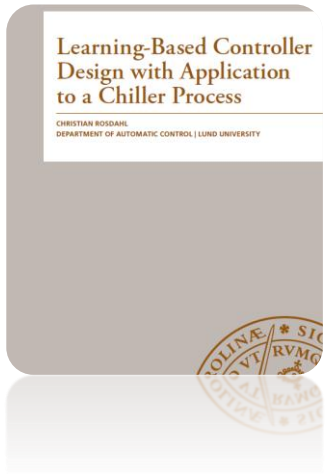
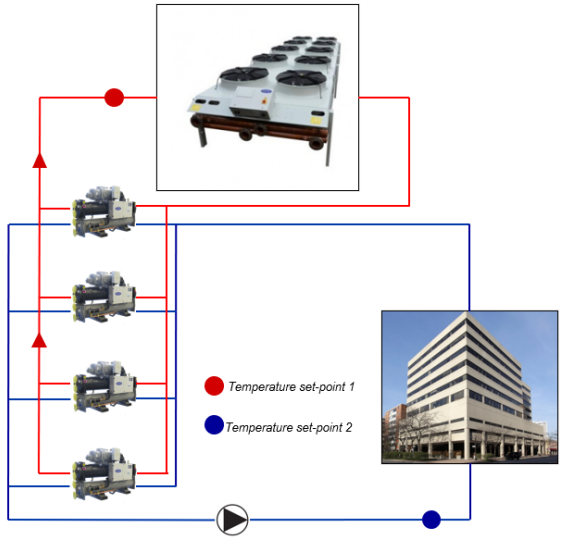
Master Thesis Projects - Suggestions

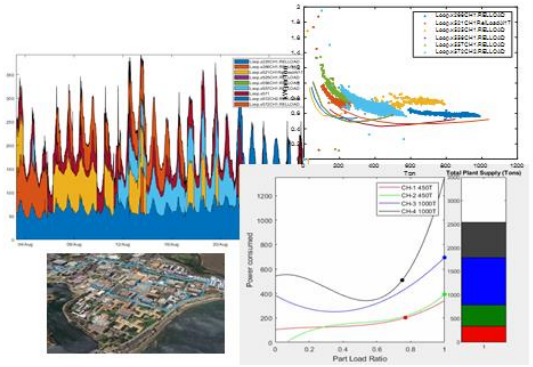
Reinforcement Learning in Chiller Controls

- Develop chiller controls that can adapt to new chiller designs, field implementation, and aging using AI and Learning
- Expand on techniques worked on in the graduate department (2022 thesis) to speed up and enhance robustness of learning method

2022 Thesis

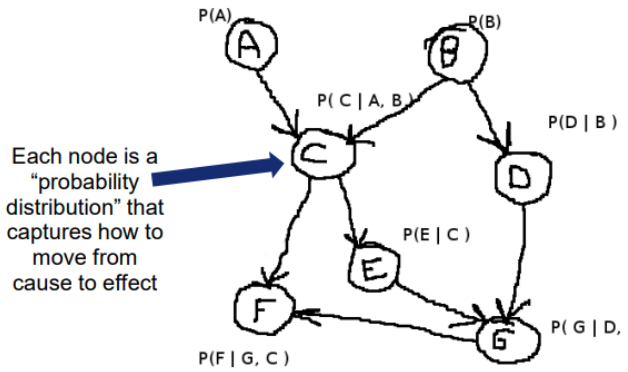






Diagnostics of Chiller Systems

- Monitor degraded performance and diagnose faults in chiller systems to proactively prevent energy waste and operating down-time
- Use machine learning methods, measurement data and models to develop diagnostic algorithms that can be run in real-time



Master Thesis Projects - Logistics



- Supervisors:
  - Bryan Eisenhower (bryan.eisenhower1@carrier.com)
  - Johan Åkesson (johan.akesson1@carrier.com)
  - Clas Jacobson (clas.jacobson2@Carrier.com)
- Local office location:
  - Ideon Gateway office hotel, 4th floor: desks & coffee available
- Opportunity: Learn from Carrier engineers to solve relevant problems



- Long-standing collaboration with the Department of Automatic Control
- Control design methods and architectures, machine learning…
- Joint advising of Master's students and PhD students