



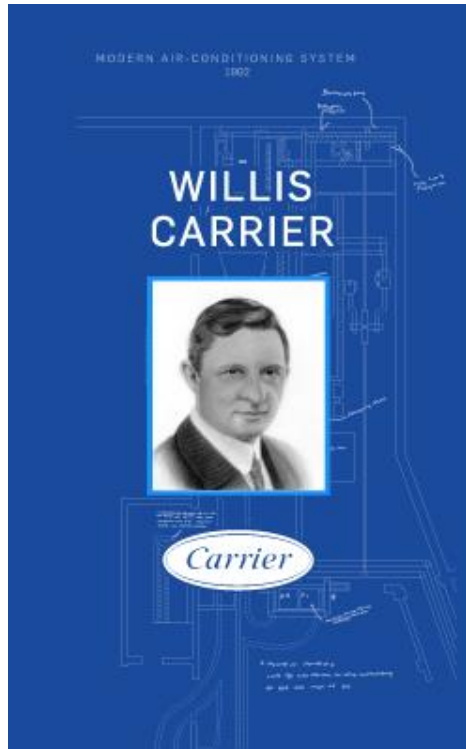
A brief introduction to

CARRIER

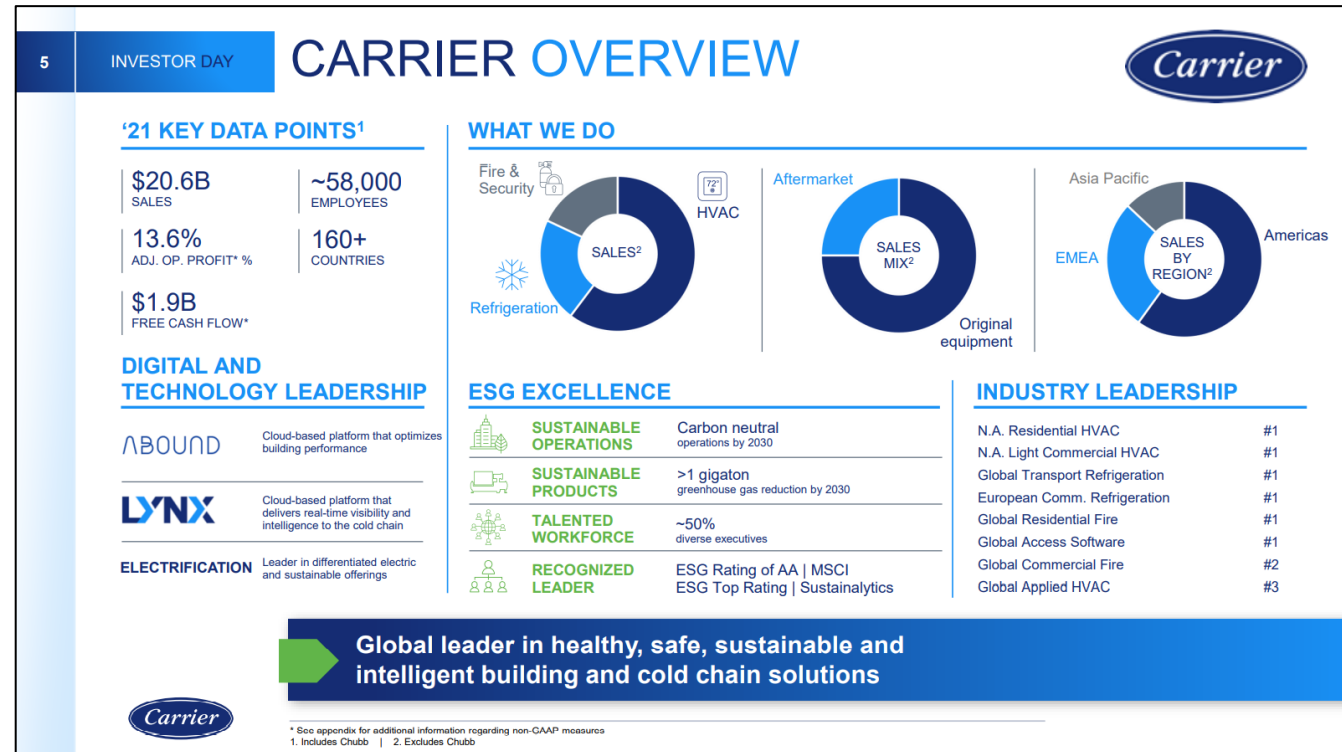
Master thesis opportunities

Magdalena Atlevi, Johan Åkesson, Clas Jacobson

Carrier – Then and Now



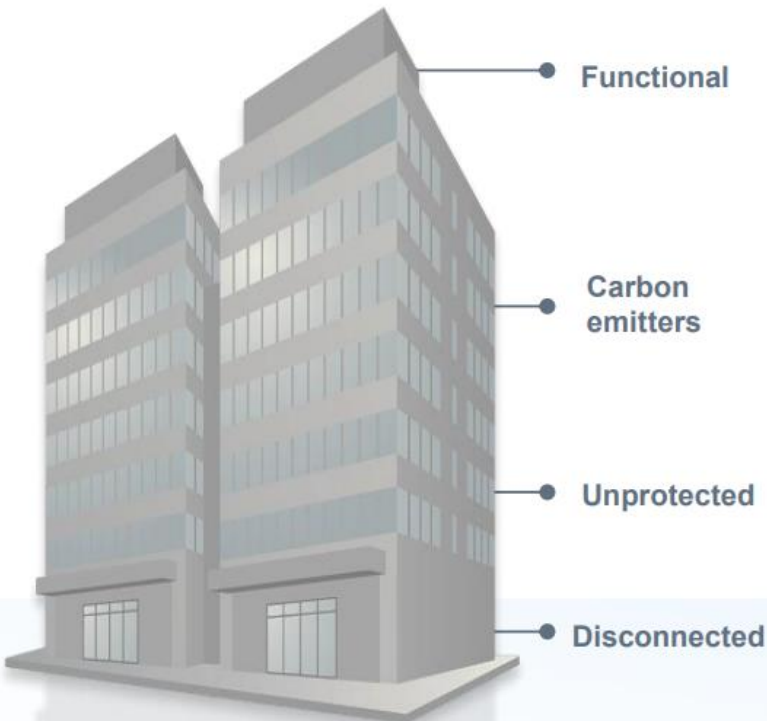
- 1902: Invents the modern air-conditioning system
- 1915: Founds Carrier Corporation



- Today: A world leader in healthy, safe, sustainable and intelligent building and cold chain solutions
- 2022: Opened small engineering office in Lund

Environmental Trendsetter

BUILDINGS OF YESTERDAY



BUILDINGS OF TOMORROW



People spend
~90%
of our time
indoors¹

Indoor air can be
3-5x
more polluted than
outdoor air¹

Buildings account
for **~40%**
of greenhouse gas
emissions²

1 in 5 existing
buildings retrofitted to
meet net-zero
emissions by 2050²

Effective filtration can
eliminate **99%**
of airborne pathogens³

<30% of U.S.
homes protected to
National Fire Protection
Association standards⁴

>4 billion
connected IoT devices
in commercial
buildings by 2028⁵

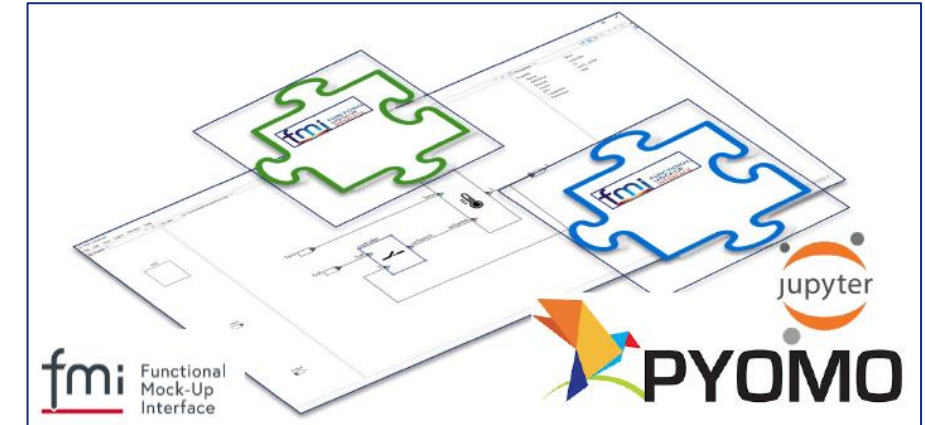
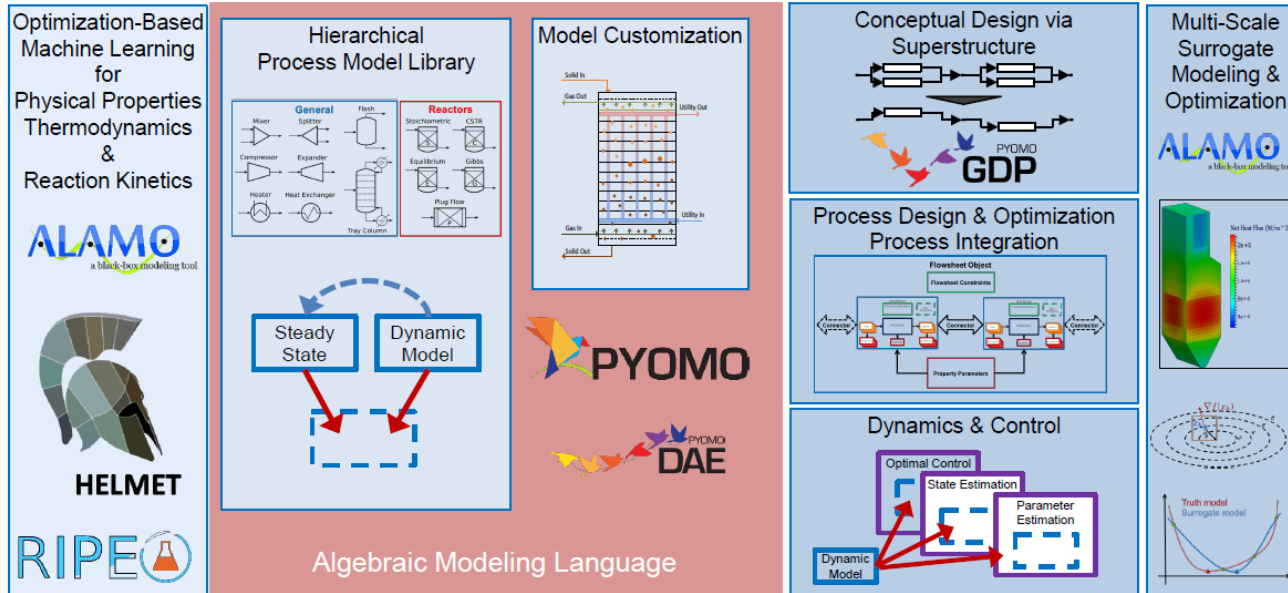
Integrated smart
building systems can
reduce energy use
~10%-20%⁶



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



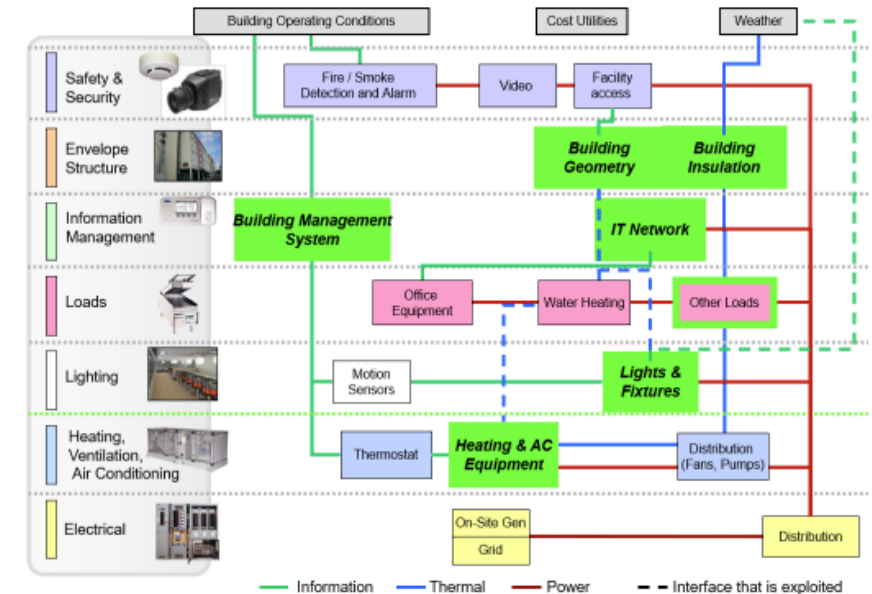
Optimization Based Workflows in EBolt



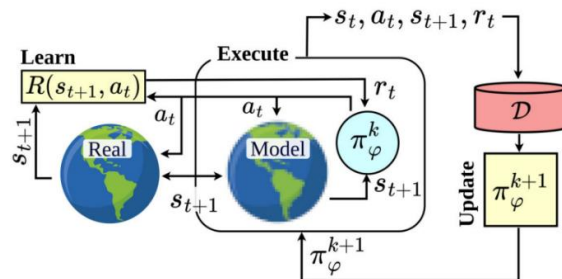
Reinforcement Learning for Building Energy Optimization

- Buildings are complex: heterogeneous physical domains, large scale, span a large range of time constants
- Tuning building controls for energy efficient operation is time consuming and require skilled experts
- Reinforcement learning is a promising approach to adaptively and autonomously optimize energy consumption during operation

Scaling of RL to complex systems is non-trivial!

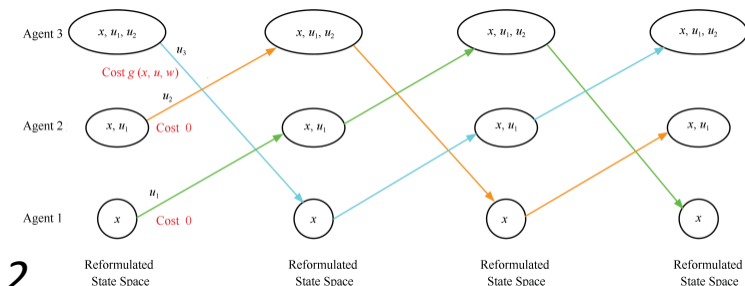


Physics-Informed Reinforcement Learning for Building Energy Optimization



Project 1

Distributed Reinforcement Learning for Building Energy Optimization



Project 2

Master Thesis Projects - Logistics



- Supervisors:
 - Magdalena Atlevi (magdalena.atlevi1@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



LUND UNIVERSITY



- 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

