



ORDEM
DOS ENGENHEIROS

Tecnologias Emergentes nos Sistemas AVAC

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ESPECIALIZAÇÃO EM ENGENHARIA DE CLIMATIZAÇÃO
RENOVAÇÃO ENERGETICAMENTE EFICIENTE
DE EDIFÍCIOS EXISTENTES

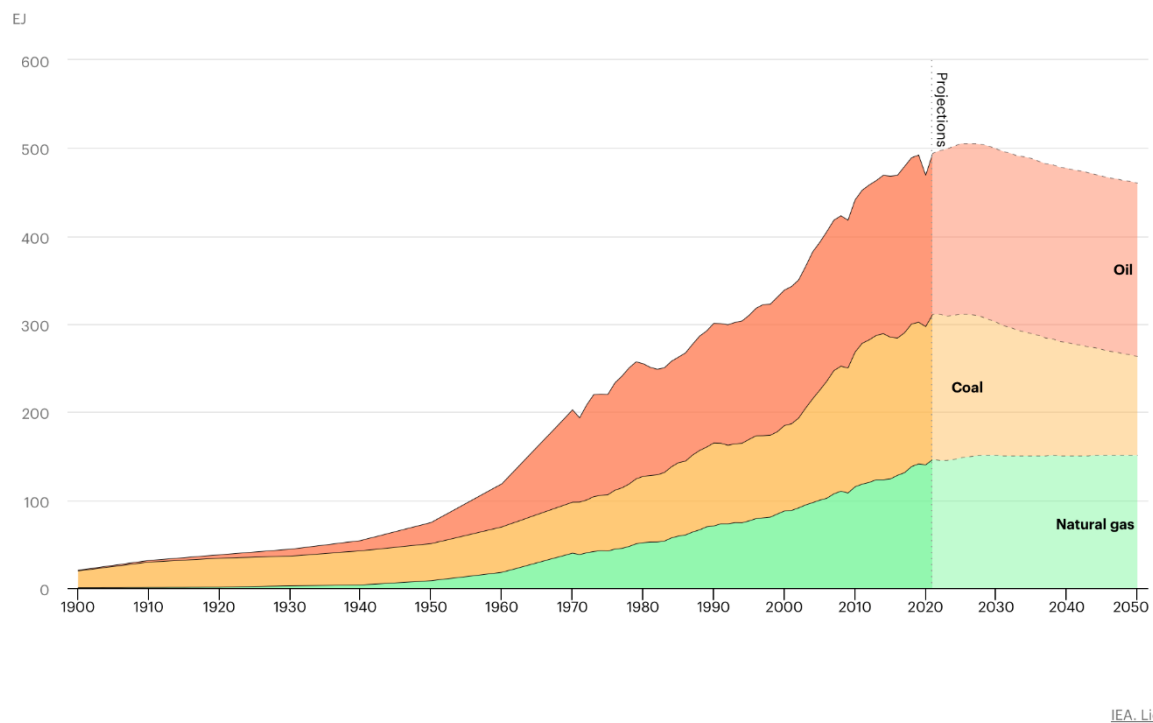


- * **Impacto energético e ecológico no sector dos Edifícios**
- * **A mudança de paradigma**
- * **As principais soluções e tendências**
- * **Massificação das bombas de calor**
- * **Soluções de armazenamento térmico**
- * **Eficiência e manutenção**
- * **Outras soluções**



Energia vs. AVAC - Contexto internacional

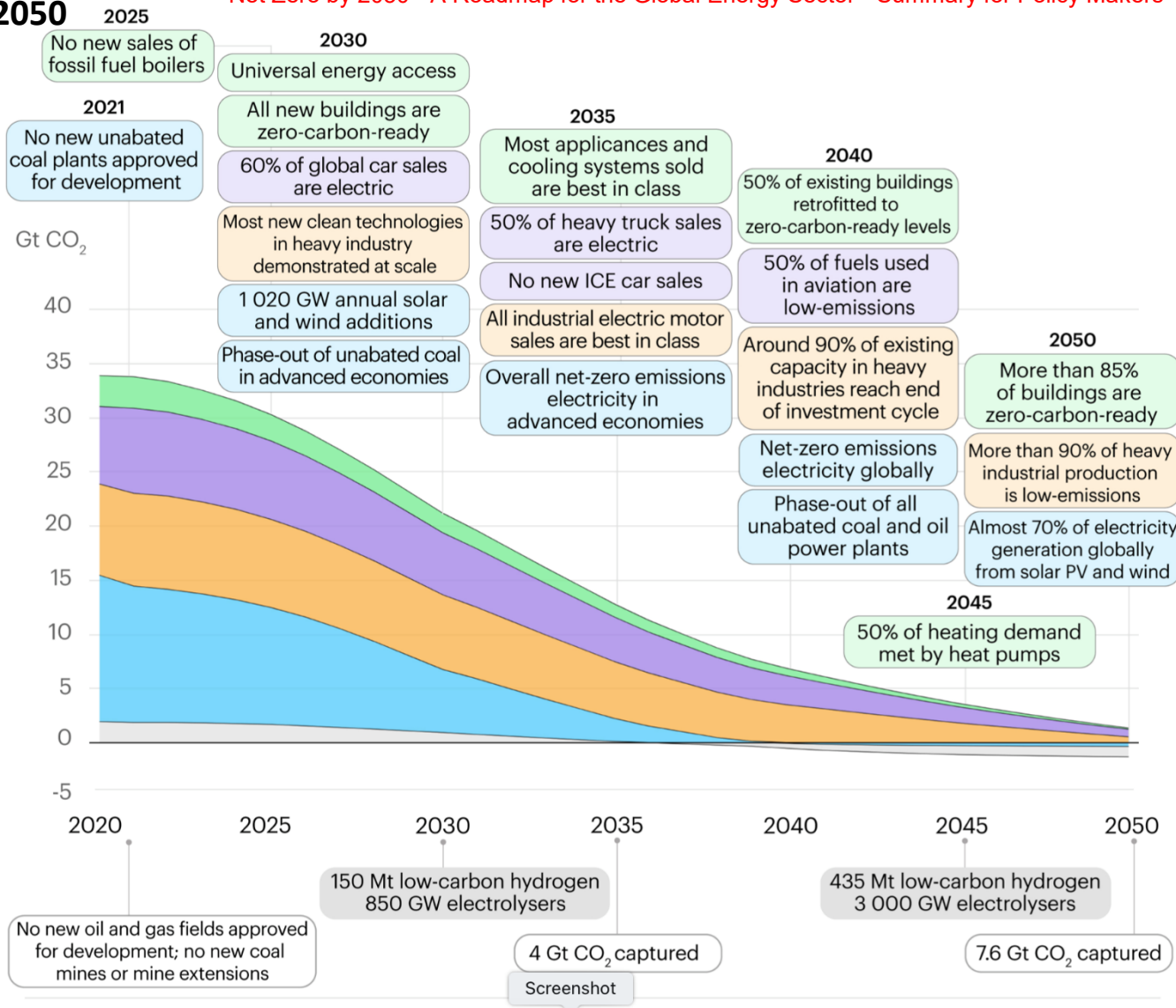
Fossil fuel demand in the Stated Policies Scenario (STOS, 1900-2050) (políticas previamente estabelecidas)



● Natural gas ● Coal ● Oil

Key milestones in the pathway to net zero

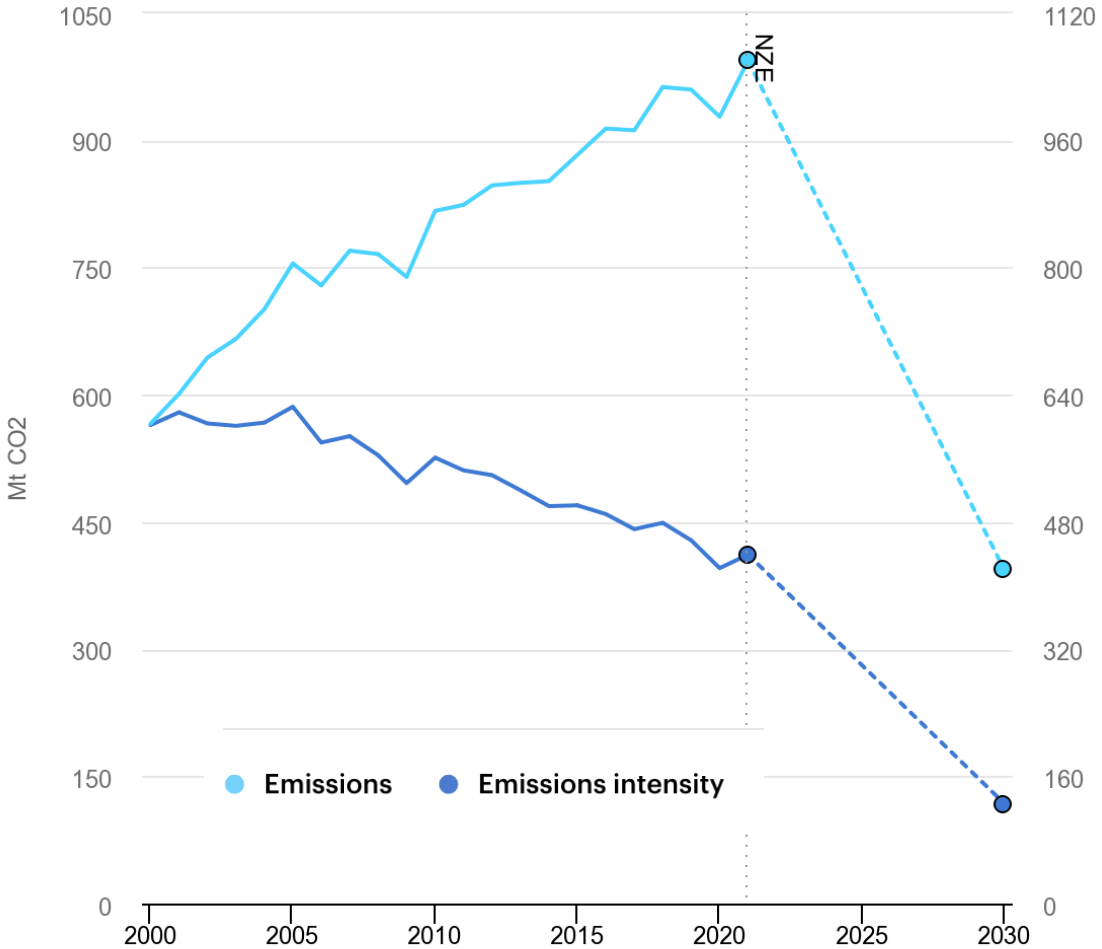
Net Zero by 2050 - A Roadmap for the Global Energy Sector - Summary for Policy Makers





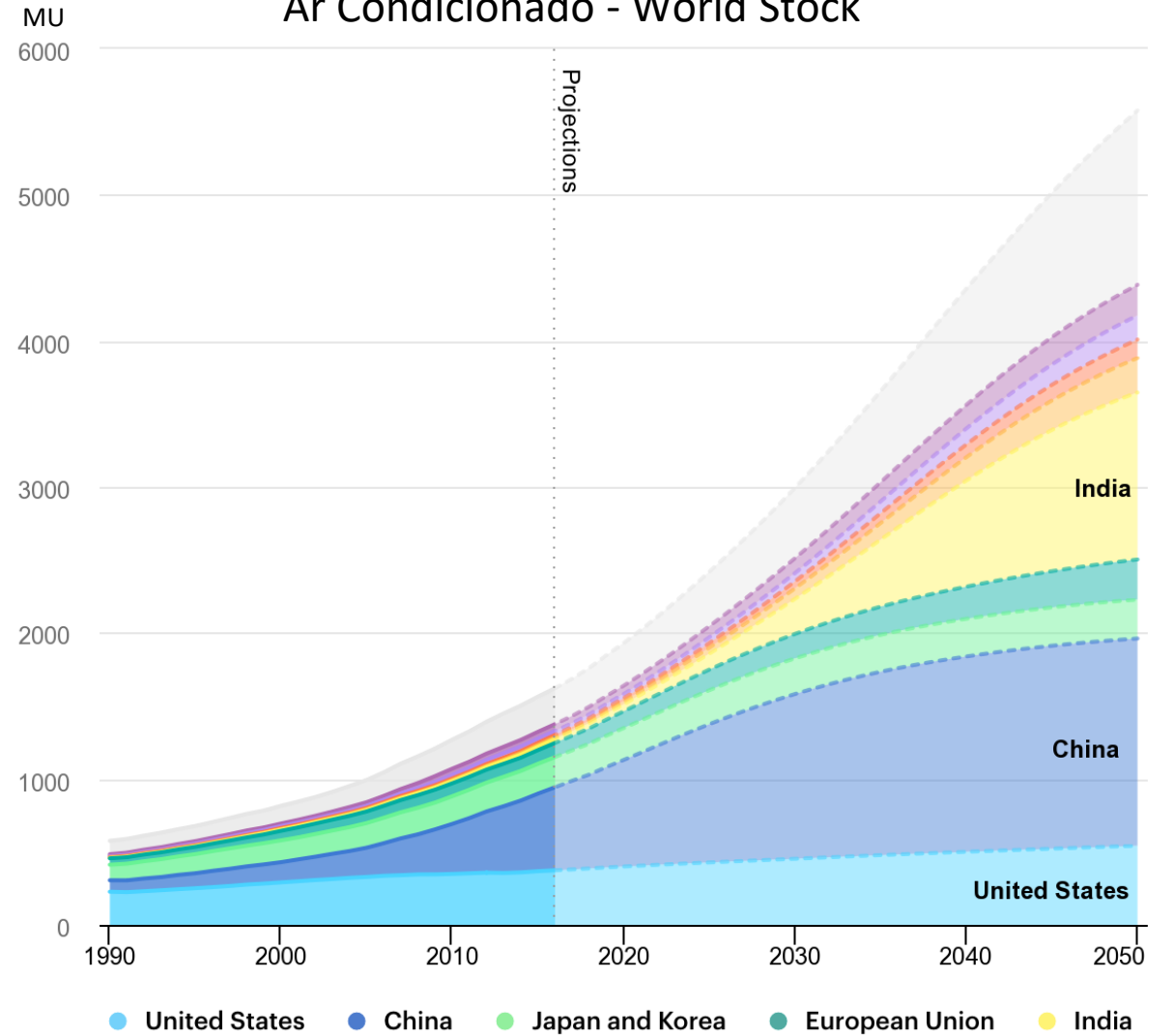
Energia & CO₂ vs. AVAC - Contexto internacional

Emissões de CO₂ do Ar condicionado no NZS.



Fonte: IEA©2022

Ar Condicionado - World Stock



Fonte: IEA©2022

United States, China, Japan and Korea, European Union, India, Indonesia, Mexico, Brazil, Middle East, Rest of world



Mudança de paradigma nos sistemas AVAC

Eficiência
Optimizar Custo Benefício



Maximizar Sustentabilidade



Conforto



Foco na Sustentabilidade



Aumento da Eficiência e Suficiência energética



Automação

Data mining





Quais as soluções que permitem :

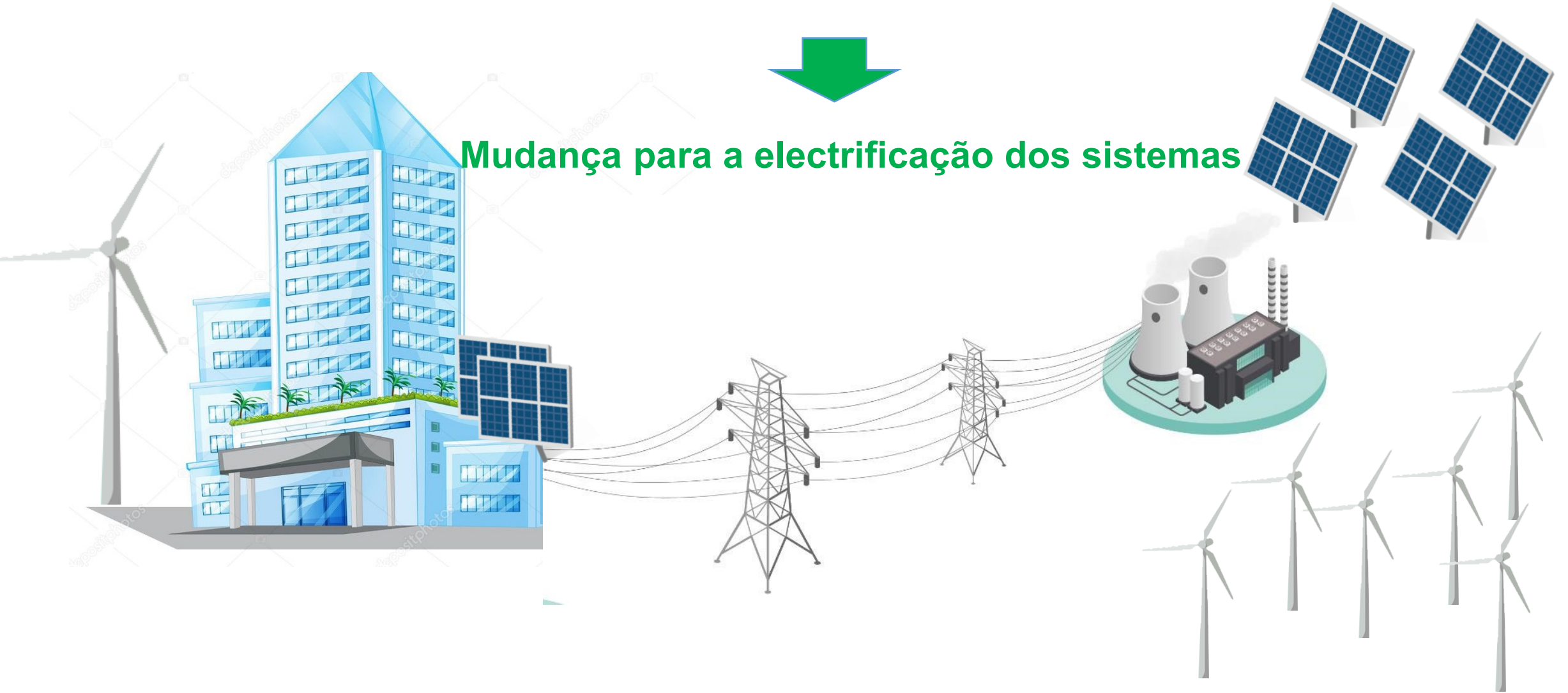
- a neutralidade carbónica até 2050?
- cumprir a eficiência e **suficiência** energética?



Soluções que permitam progressivamente a Descarbonização



Mudança para a electrificação dos sistemas





Trajeto para Descarbonização dos sistemas AVAC



Aumentar a eficiência

Suficiência energética

Fluidos frigorigénios



Combustíveis sintéticos e/ou H₂



Electrificação

Novas tecnologias de Aquecimento

Reformulação/adaptação das soluções clássicas





Soluções aplicadas aos sistemas AVAC na direcção do NZE

Soluções passivas

- Soluções passivas integradas com outras soluções de CO₂ ↘

Sistemas de CHP – Trigeriação (inclusão progressiva de novas tecnologias)

Armazenamento energético e térmico

Massificação da utilização das bombas de calor (simples, em cascata e com sistemas auxiliares)

Escolha de fluidos frigorigéneos de baixo GWP .

Utilização de torres evaporativas nos sistemas de arrefecimento

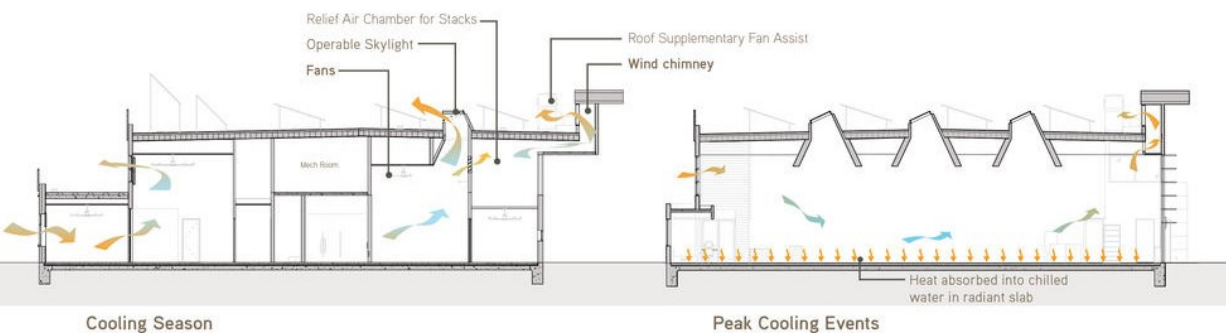
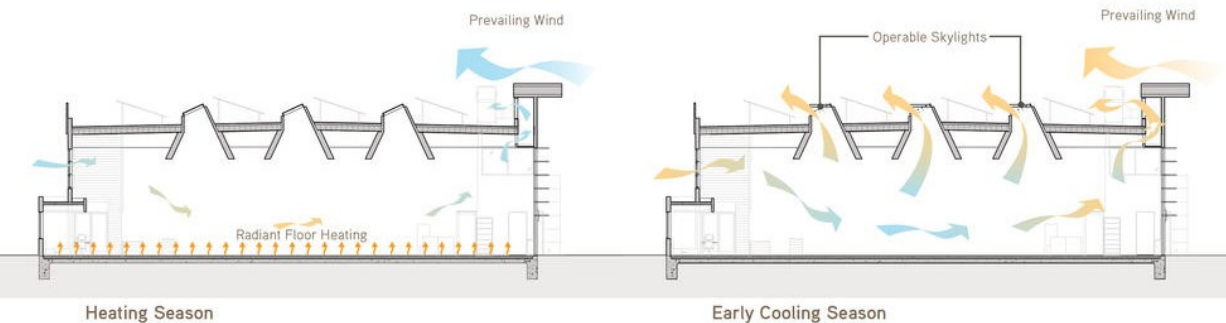
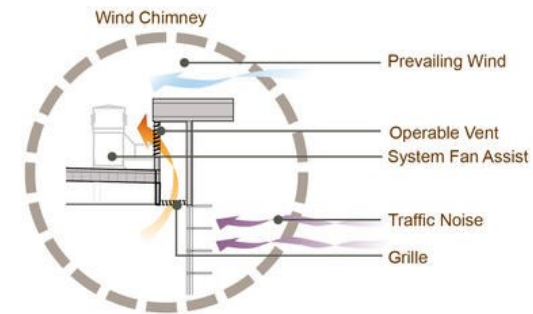
Manutenção associada às IoT e IA



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- 1 Site Selection Urban Site, No Onsite Parking, Promotes Public Transportation
- 2 Storm Water Technology Gardens and Low Flow Planters
- 3 Native Trees and Planting Ecological Education Opportunities
- 4 Building Material Thermal Efficient High Performance Rain Screen - R31
- 5 Building Material Thermal Efficient Cool Roof - R40
- 6 Building Material FSC Certified Wood - 97%
- 7 Natural Ventilation Operable Windows for Air Intake
- 8 Natural Ventilation Venting Skylights for Air Exhaust
- 9 Natural Ventilation Wind Chimney for Air Exhaust - Stack Ventilation/Bernoulli Concepts
- 10 Daylighting Operable Skylights
- 11 Daylighting Sunshading for Direct Southern Light Over Triple Glaze Low-e Curtain Wall
- 12 Solar Thermal Radiant Floor
- 13 Solar Thermal Runtal Radiators
- 14 Solar Thermal Hot Water Panels
- 15 Energy Generation PV Panels - Feed back to Grid
- 16 Prevailing Ocean Breeze Creates Negative Pressure at Backside of Front Facade - Pulls Air out of the Building



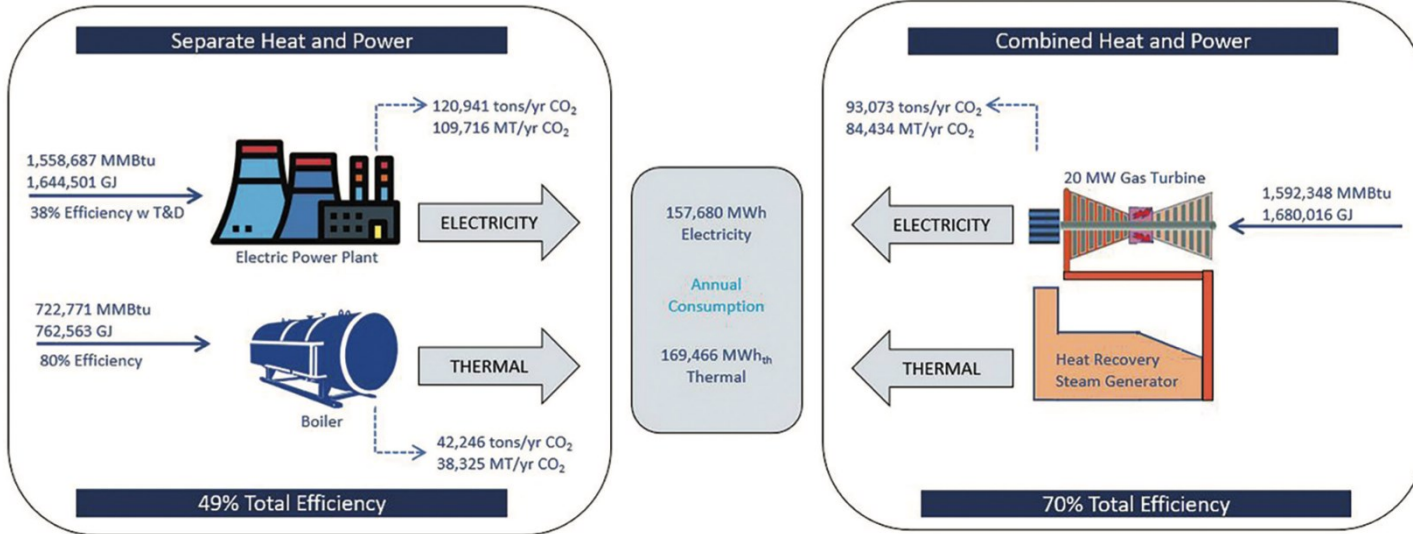
West Branch of the Berkeley Public Library

Berkeley, California

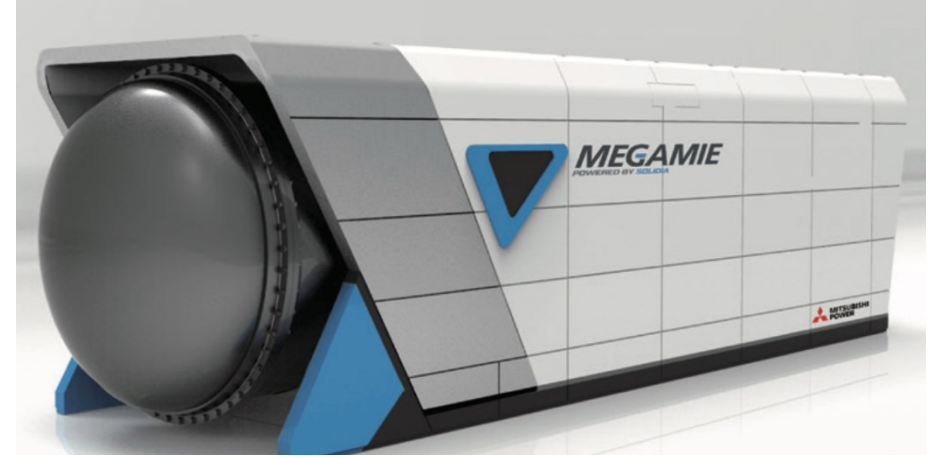
Integração de sistemas passivos
Com sistemas alimentados por FRE



CHP/ Trigeração (velha e nova geração de sistemas CHP)



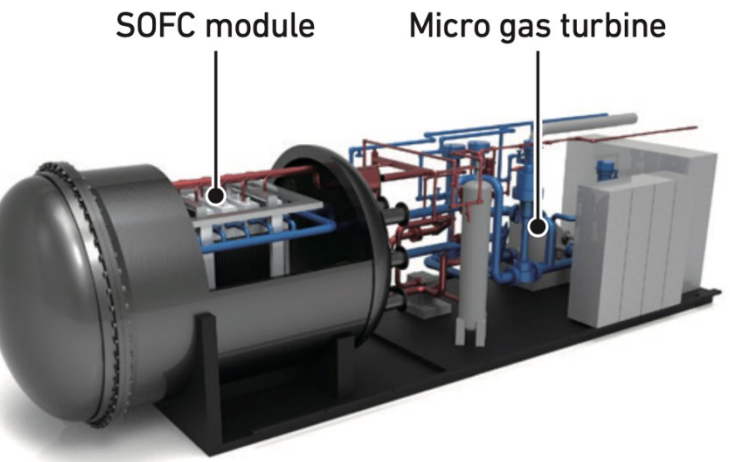
Energy savings: 689,110 MMBtu/yr (727,049 GJ/yr) CO₂ Savings: 70,114 tons/yr (63,606 MT/yr)



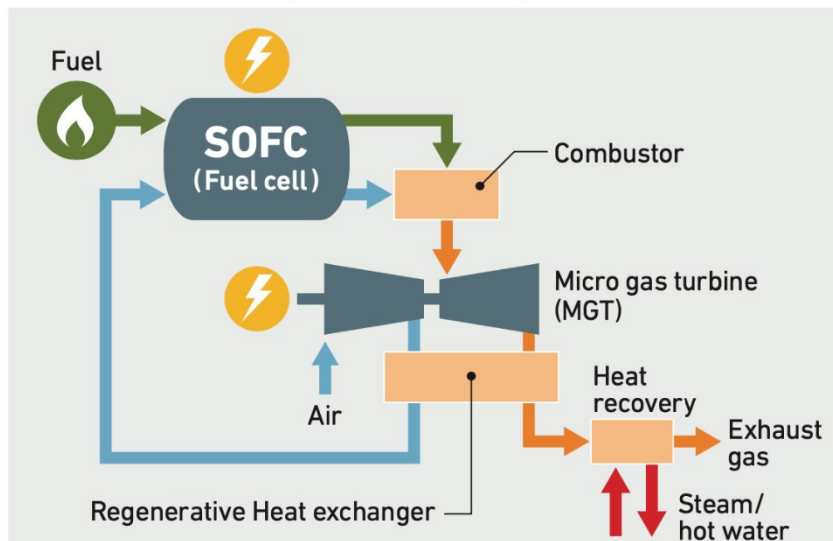
Células Combustíveis de Alta Temperatura Solid Oxid Fuel Cell + Micro Turbinas

- Multi-combustíveis (biogás, GN, H₂ blend, etc)

SOFC



System Diagram



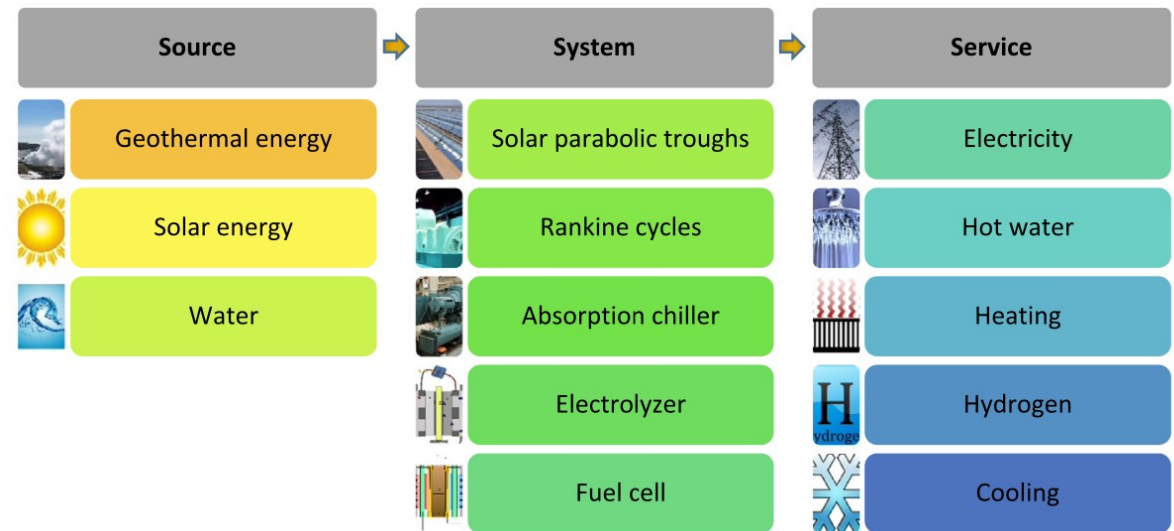
Rated output	210 kW
Frequency, Phase	50/60 Hz, 3 phases
Voltage	200 V/220 V
Thermal output	86 kW (hot-water recovery) 54 kW (steam recovery)
Hot-water/steam flow rate	15 t/h (hot water from 83°C to 88°C) 80 kg/h (0.78 MPa steam ² /water-sup)
Electrical efficiency	53% LHV
Total efficiency (Electrical + Thermal)	73% LHV (hot-water recovery) 65% LHV (steam recovery)

CHP/ Trigeriação (velha e nova geração de sistemas CHP)

Integração de FRE na multigeração

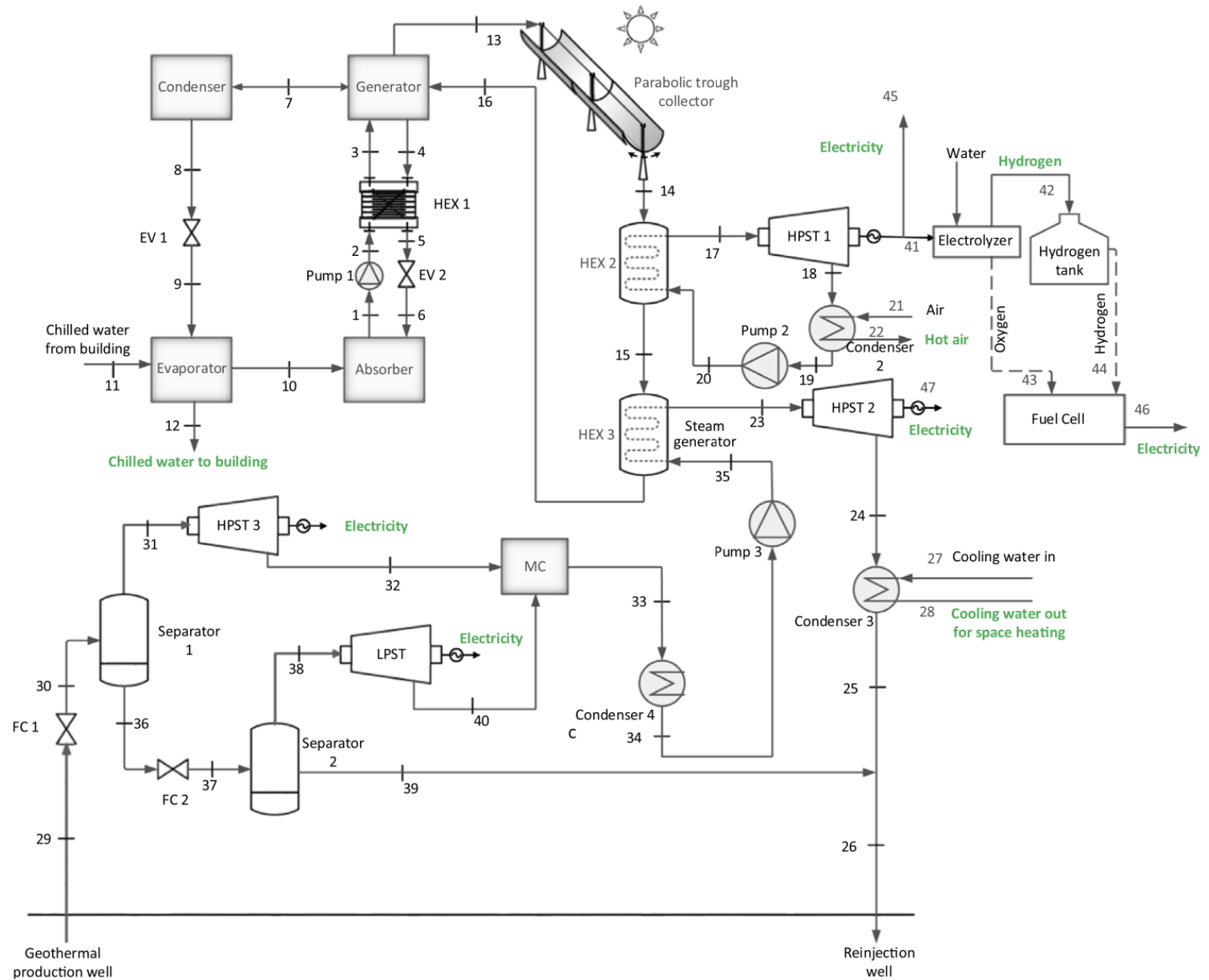
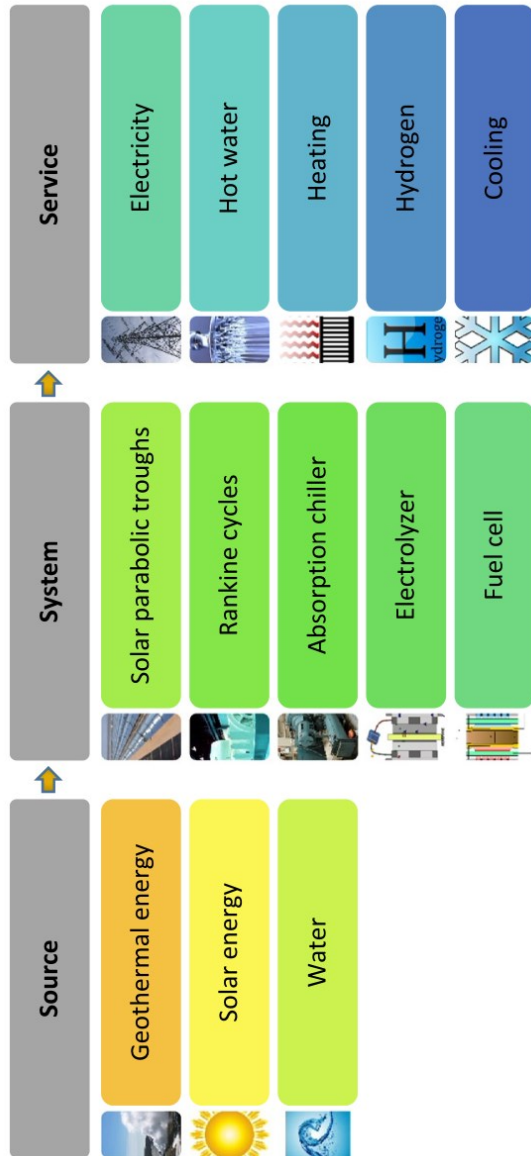


Exemplo de integração FRE em multi-sistema de energia





CHP/ Trigeriação (velha e nova geração de sistemas CHP)





Armazenamento energético



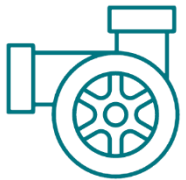
❖ Baterias



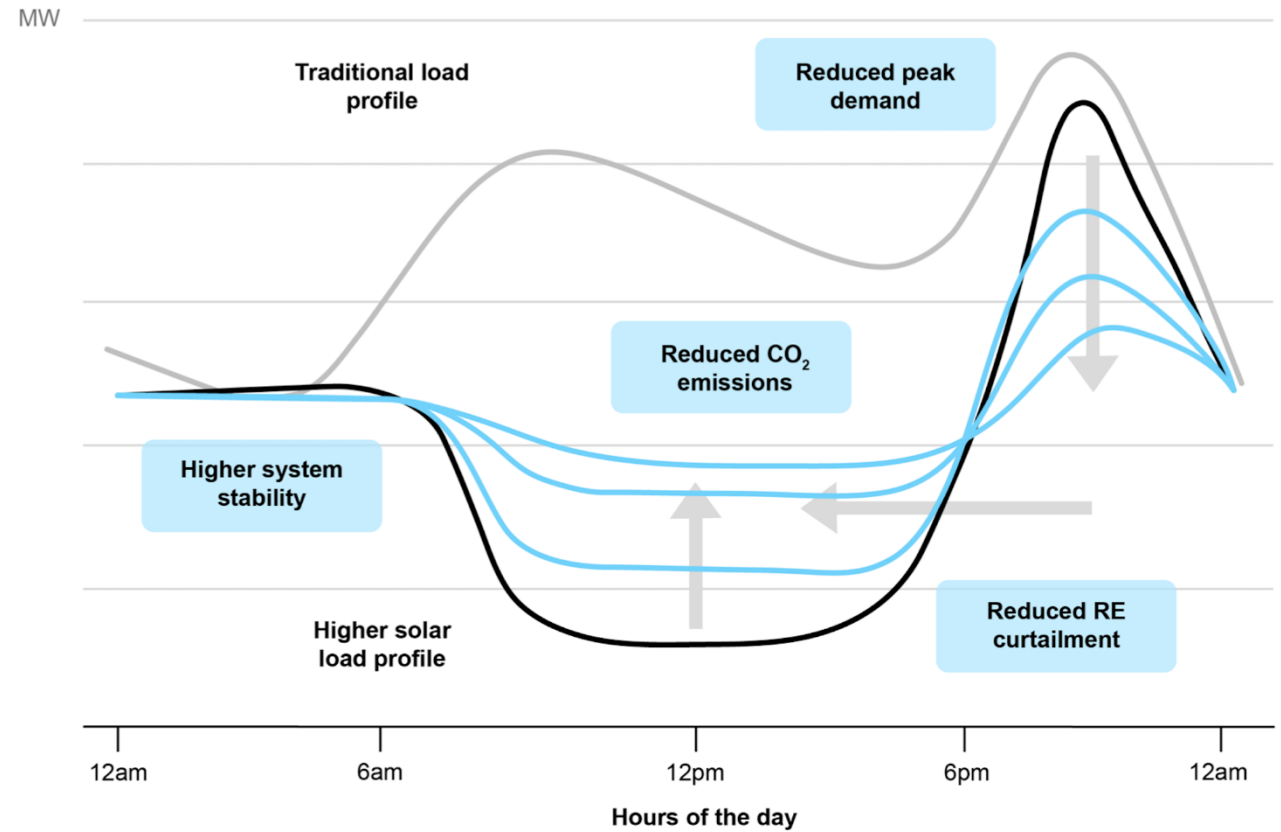
❖ Hidrogénio



❖ Térmico (Calor e Frio)



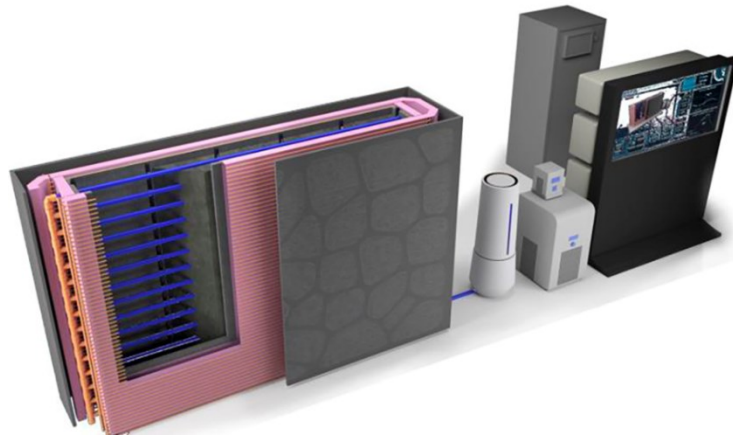
❖ Ar comprimido(minas) e bombagem (barragens)



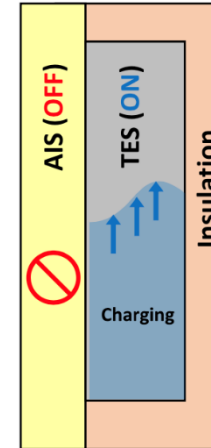


Armazenamento Térmico

❖ PCM

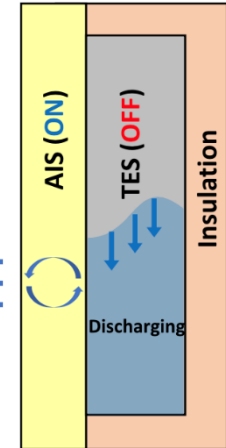


- **AIS (OFF):** Lower the thermal conductivity to trap the cold in the TES
- **TES (ON):** Store the cold in the TES during off-peak periods



(b) Charging operation (section view)

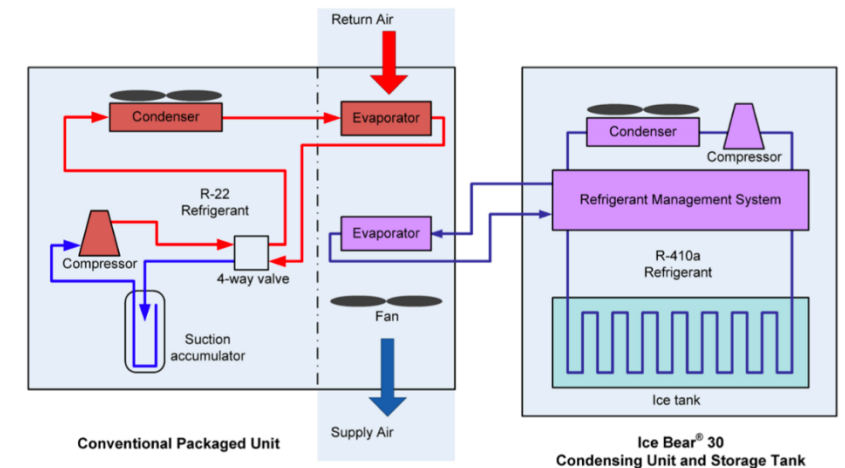
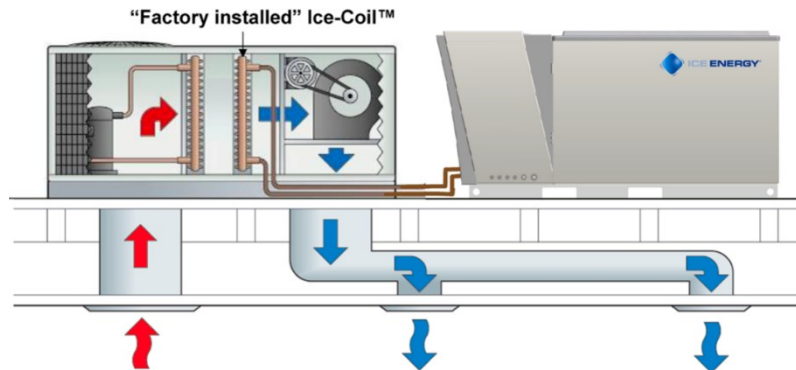
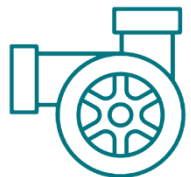
- **AIS (ON):** Increase the thermal conductivity to discharge the cold in the TES
- **TES (OFF):** By stopping the storage of cold in the TES, reduce cooling energy usage during on-peak periods



(c) Discharging operation (section view)



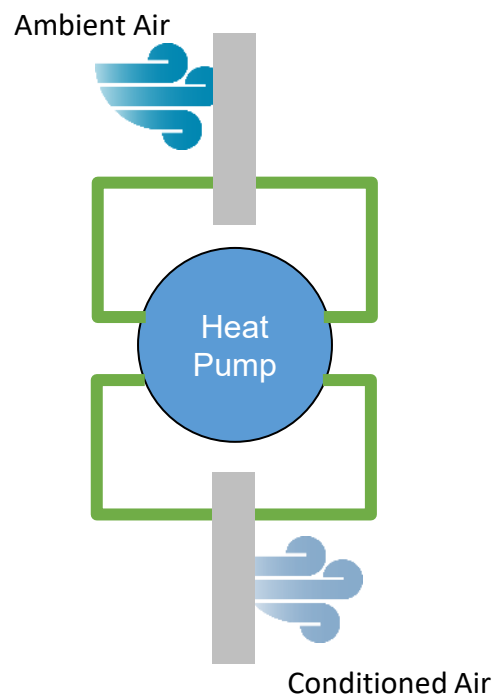
❖ “Ice Bear” (bancos de gelo)





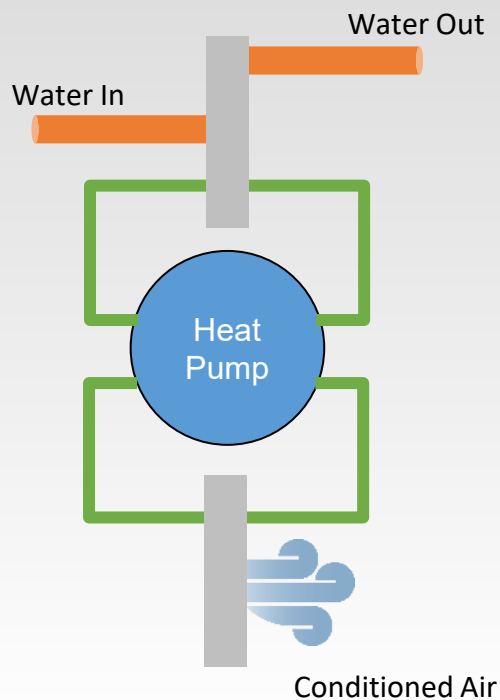
Massificação da utilização das Bomba de Calor

Ar/Ar



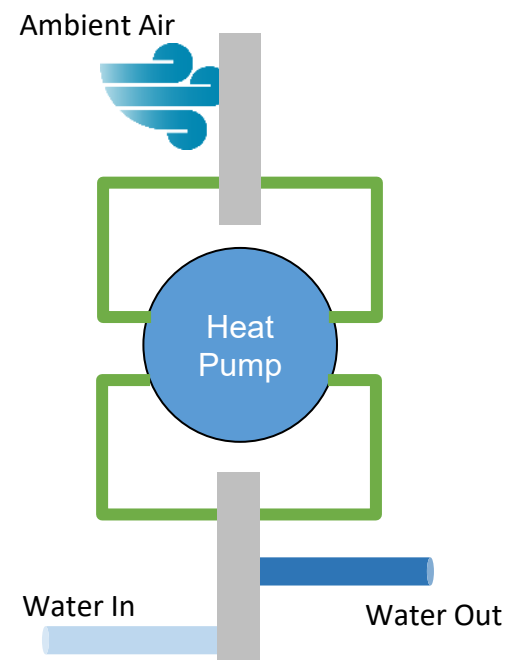
Exempl:
Rooftop Units
VRF

Água /ar



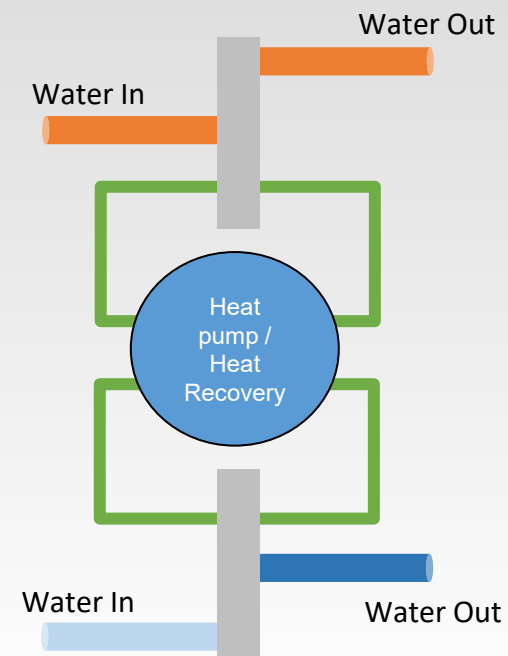
Exemplos:
WSHP

Ar /água



Example:
Ar – fonte térmica
Heat Pump

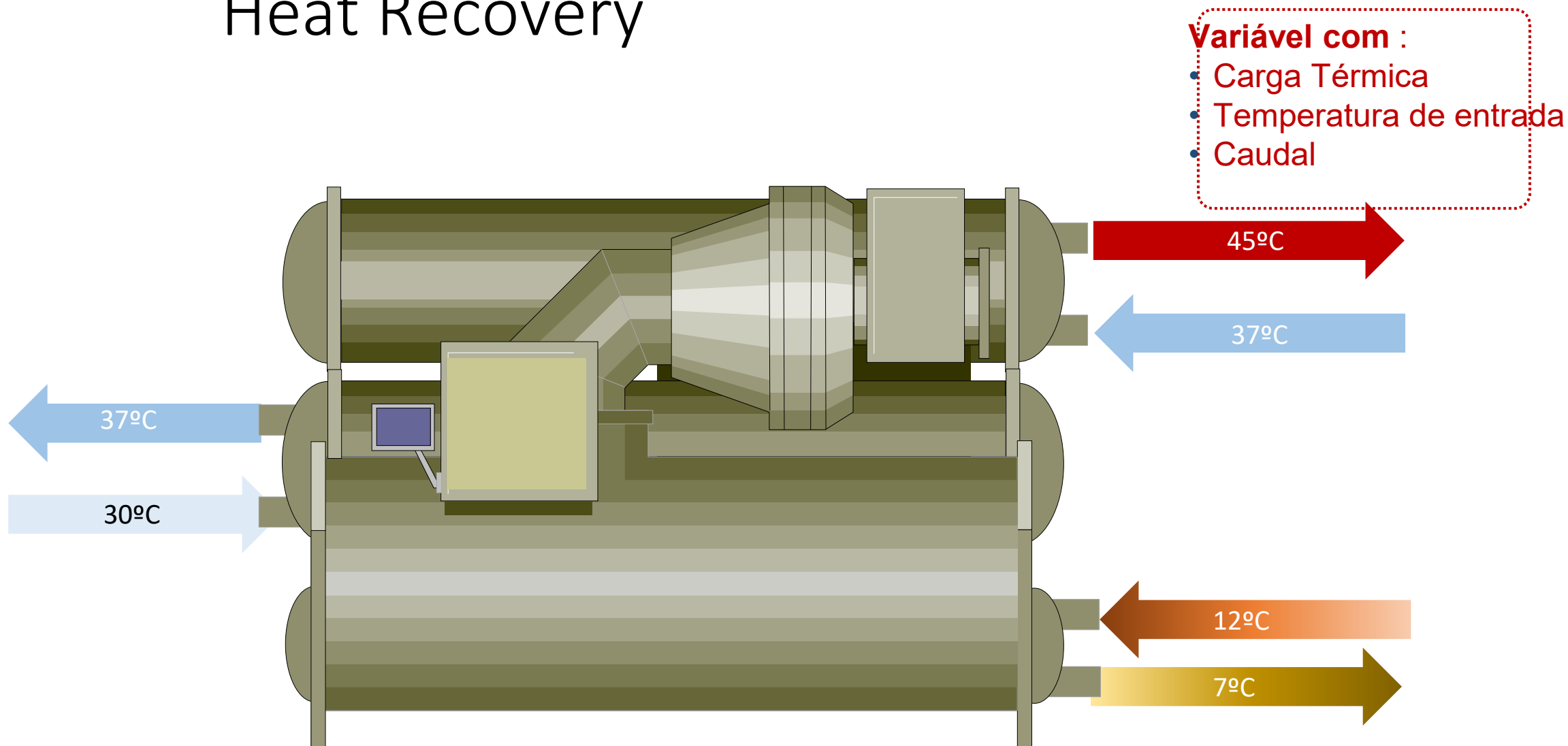
Água/água



Example:
Água – fonte térmica
Chiller/Heater

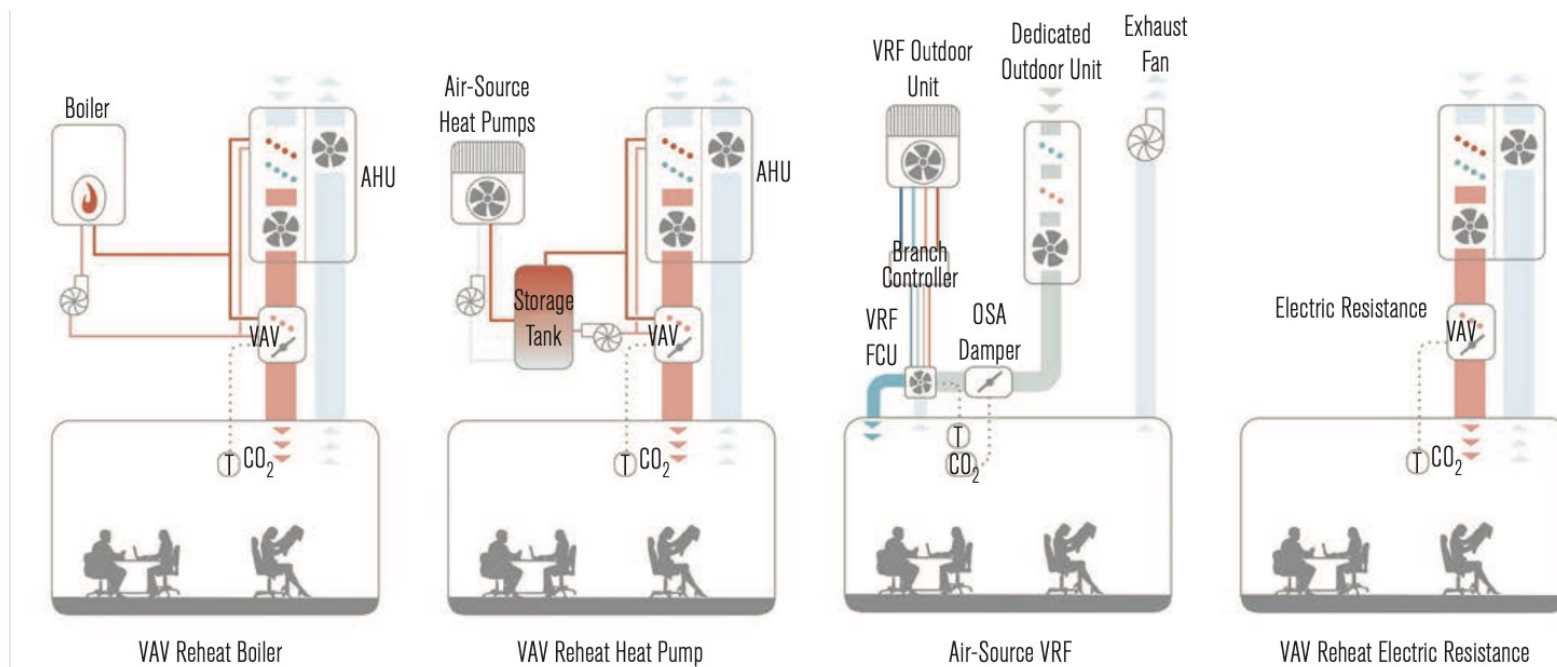


Heat Recovery

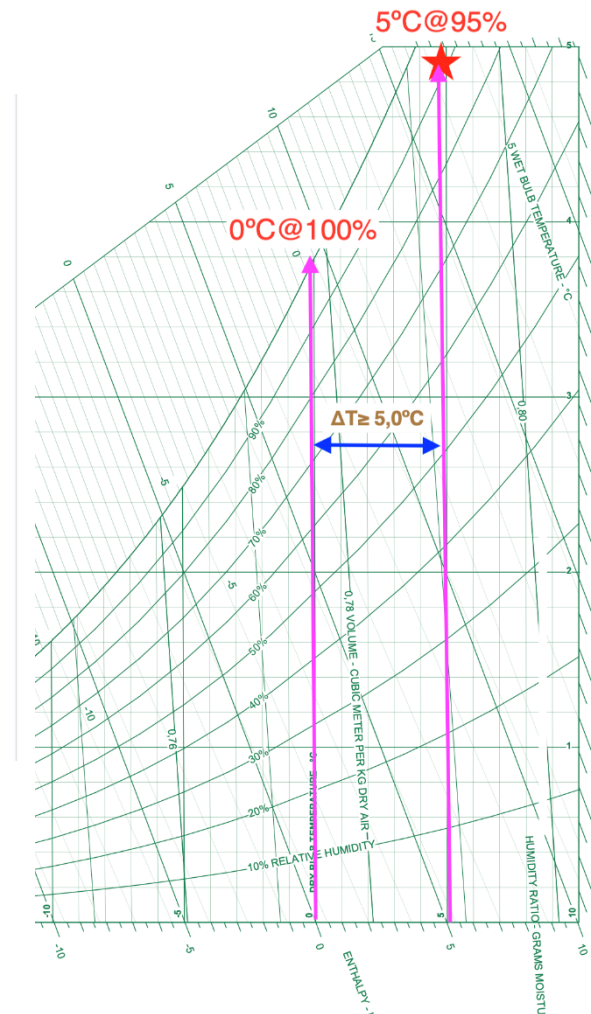




Dual-Fuel Heat Pumps

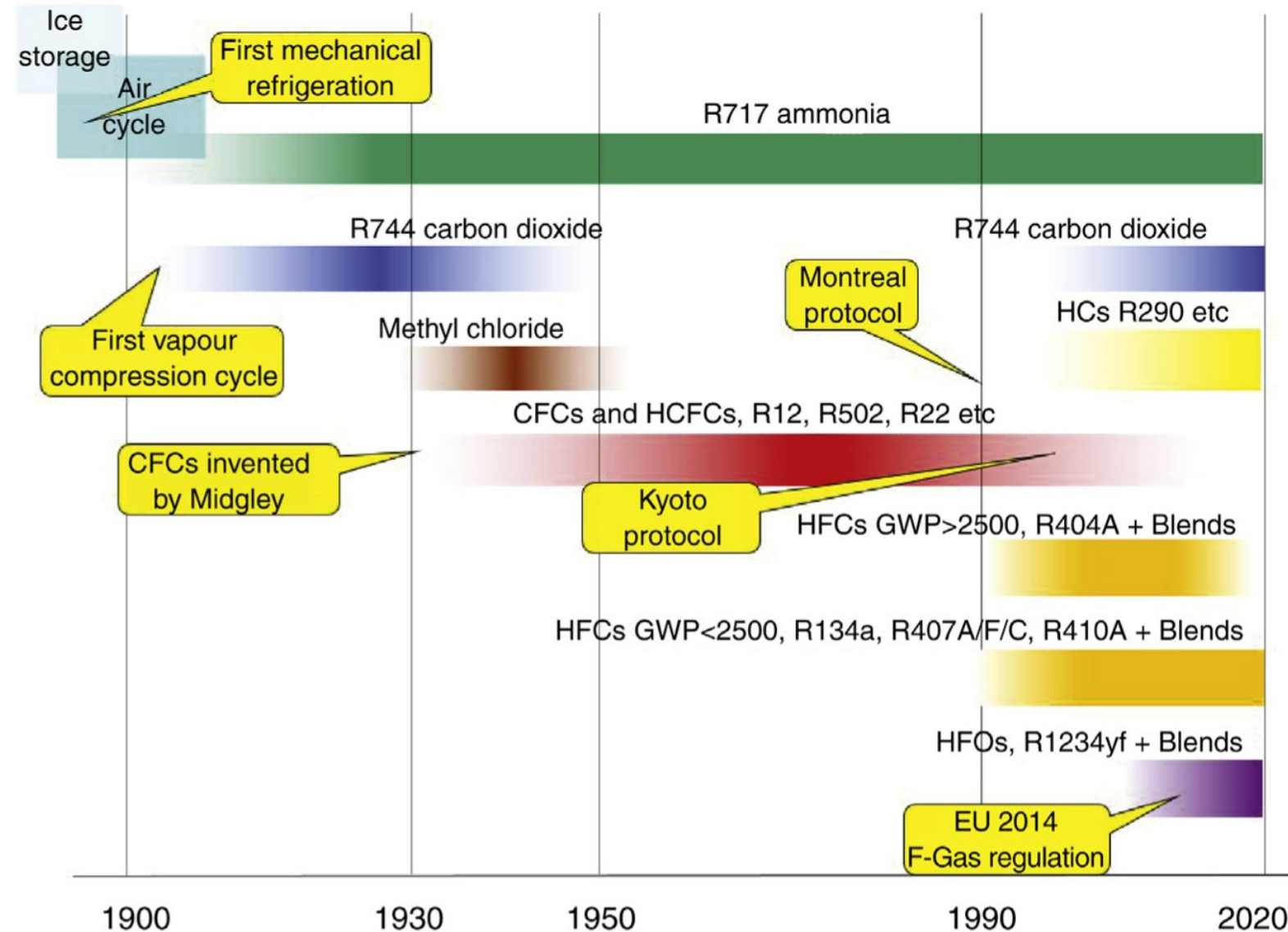


Apoio de uma caldeira de condensação para otimizar o seu comportamento global





Utilização de FF de CO₂ ↘



- ✓ **Utilização de NH₃ de uma forma consistente**
- ✓ **Reaparecimento do CO₂ (problemas com ciclos transcriticos $\Delta P \nearrow \nearrow - P_{\max} = 110 \text{ bar}$)**
- ✓ **Redução gradual dos “blends” alternativos**

Exemplo:

R32 → GWP = 675 kg_{eq}CO₂

R410A → GWP = 2088 kg_{eq}CO₂

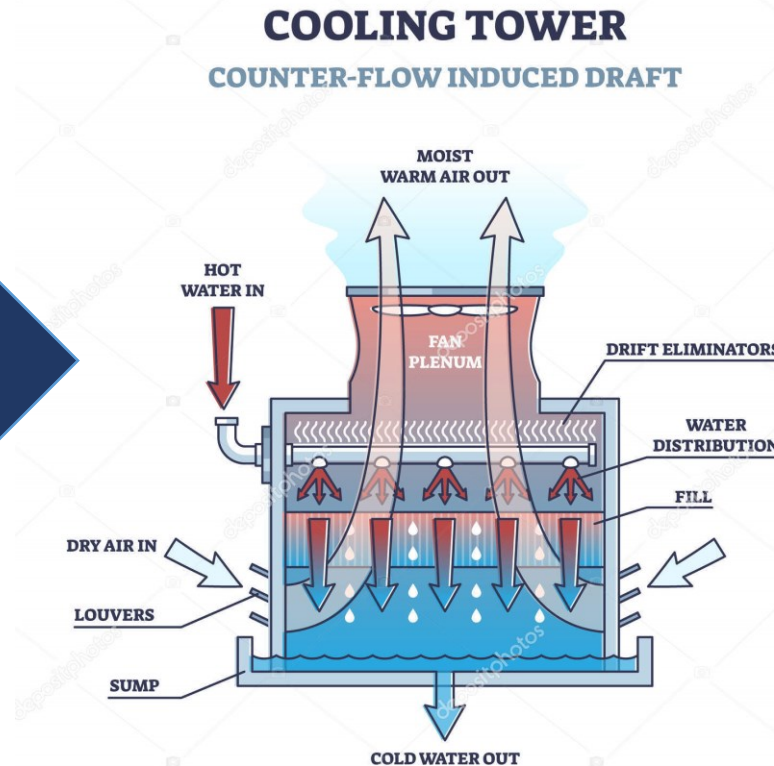
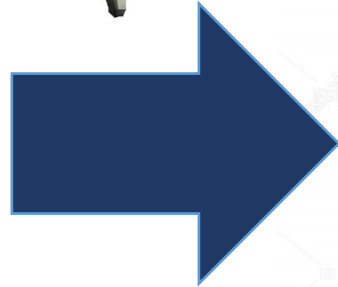
R744 → GWP = 1 kg_{eq}CO₂

R717 → GWP = 0 kg_{eq}CO₂

CO₂ T_{cr} = 31°C



❖ Diminuir a temperatura do fluido no condensador/evaporador



Manutenção preventiva – base em Data Mining & IoT



➤ Utiliza sobretudo informação digital

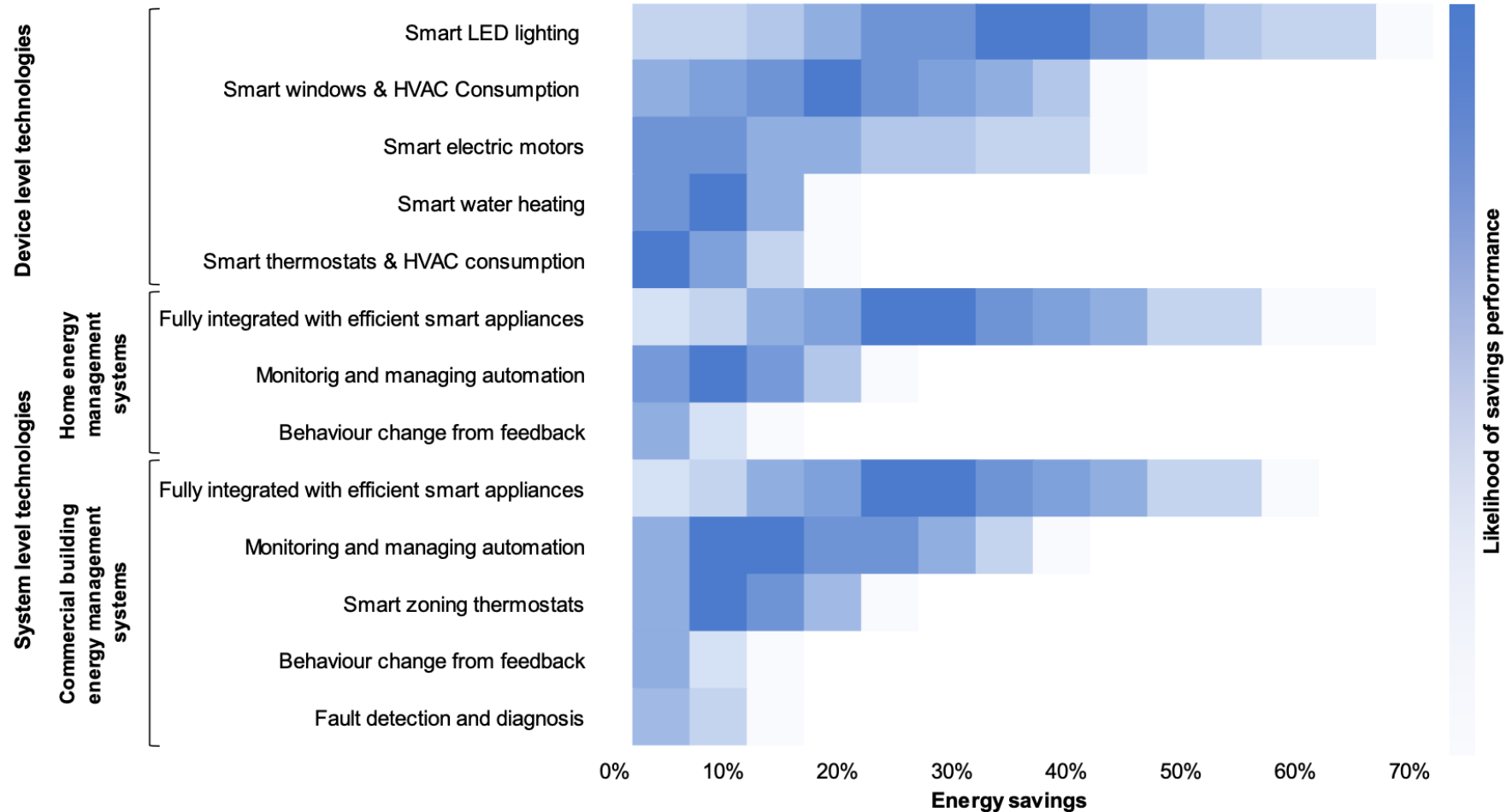
- Plataformas digitais com alertas
- Usa metodologias de diagnóstico de falhas
- Métodos de previsão - simples (Fuzzy) ou mais complexos (IA e Machine Learning)





Efeito da Eficiência associado Data mining (& IoT)

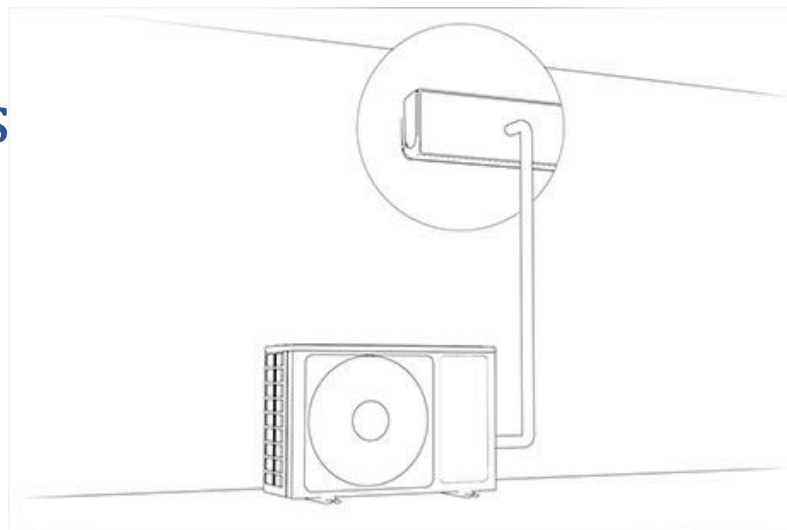
Expanding the scale of energy efficiency with digital devices





Outras soluções a implementar

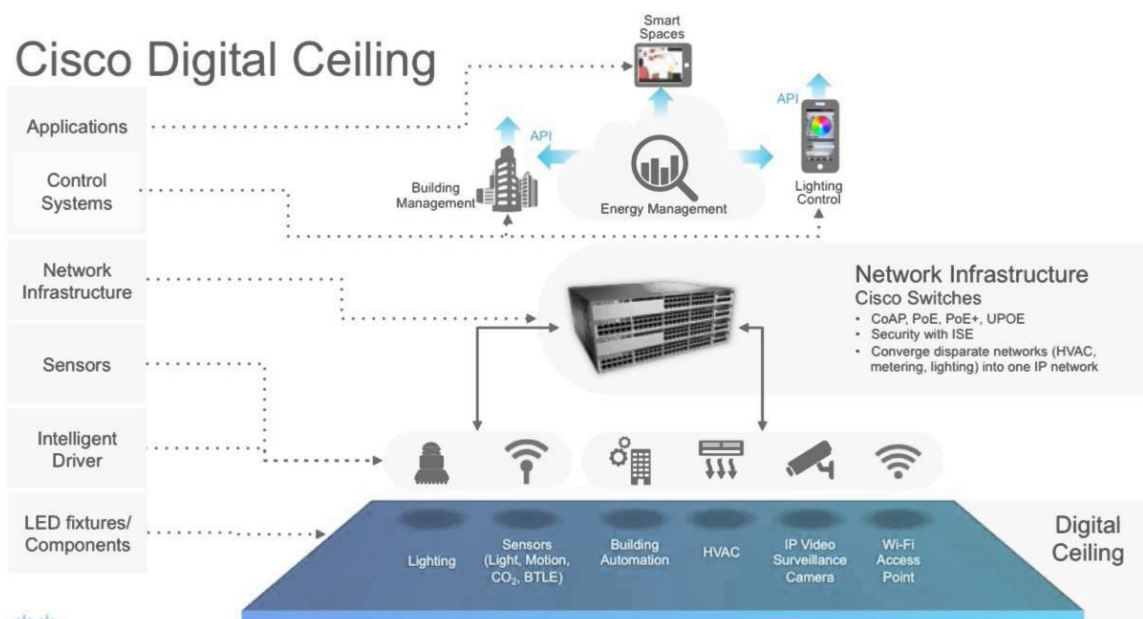
❖ Ductless HVAC Systems



❖ Smart Thermostats



❖ Digital Ceilings



Obrigado !

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Ordem dos Engenheiros
Lisboa

