




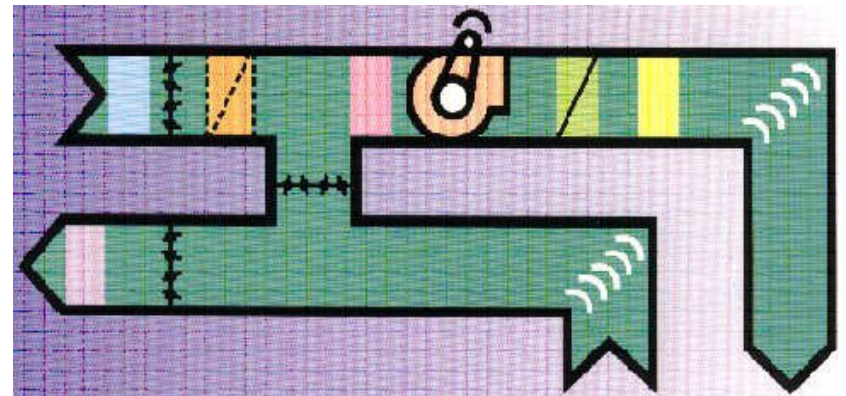
Latest Trends and Challenges in the HVAC Industry

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1. Introduction

HVAC (heating, ventilation & air-conditioning)

- It is the biggest energy consumers in buildings
- Growing demand for space cooling in the world

Driving factors

- Increasing energy costs & government regulations
- Sustainable & environmentally friendly buildings

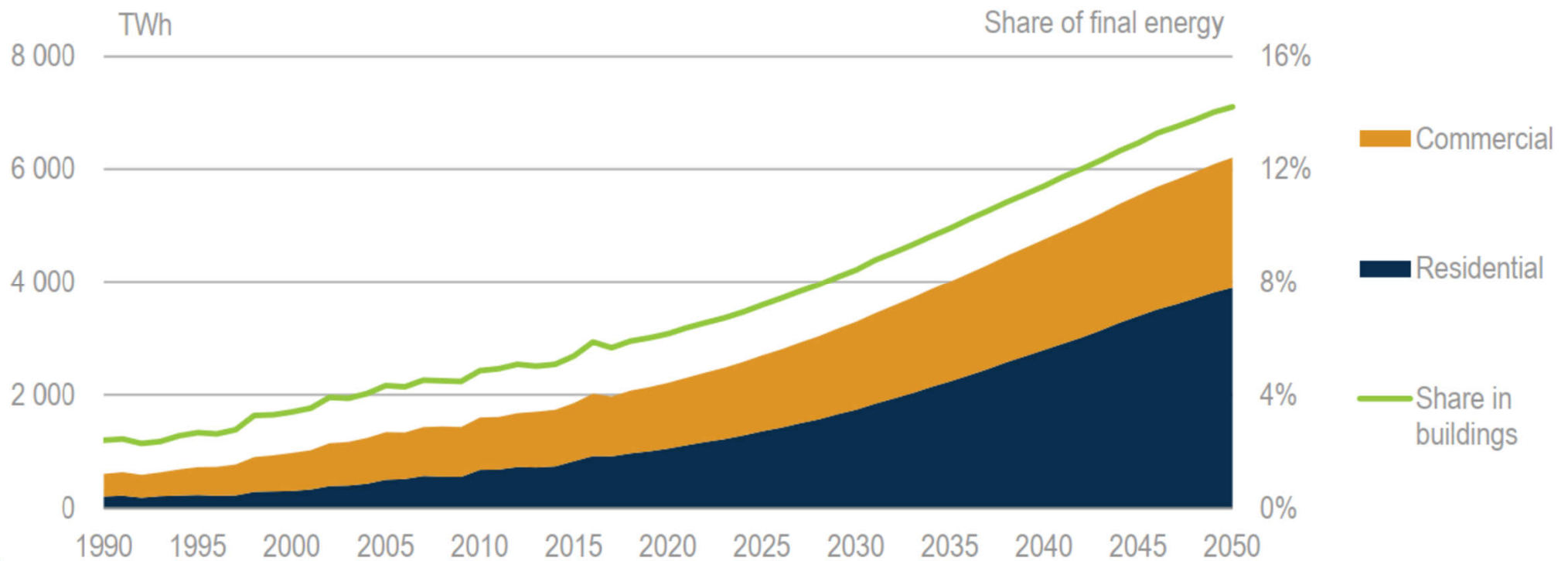
HVAC industry

- Respond to market changes & technology advancements
 - Electronic, information & communication technology (ICT)
- Need to optimise HVAC systems & building operation



暖通空調

World energy use for space cooling by subsector



(Source: The Future of Cooling <https://www.iea.org/reports/the-future-of-cooling>)

2. Latest Trends in HVAC

Many industry trends & technology innovations

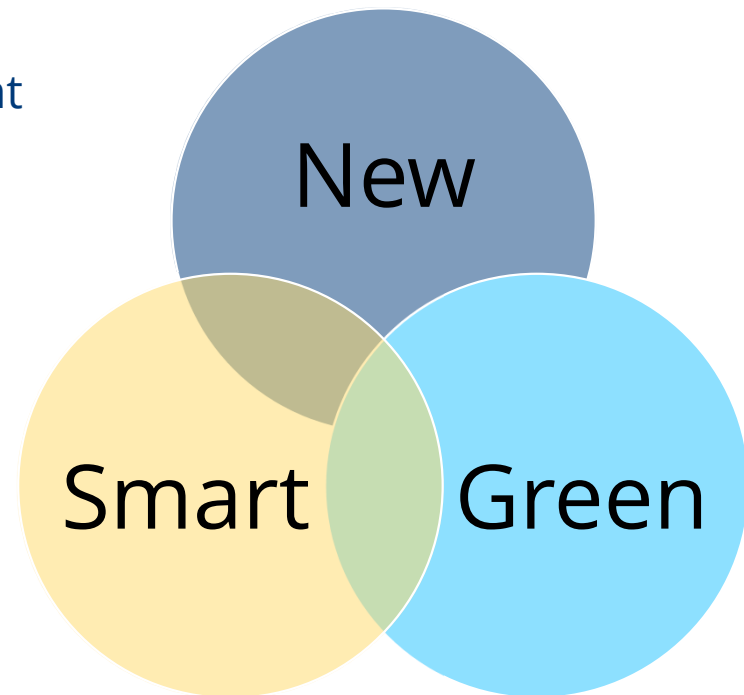
- Reduce energy consumption & carbon footprint
- Markets for new & existing buildings

Latest trends can be summarised as:

- New HVAC technologies
- Smart HVAC systems
- Green power sources

Global COVID-19 pandemic

- Greater safety precautions
- Remote work



2. Latest Trends in HVAC

New HVAC technologies

(a) Zoning systems e.g. variable refrigerant flow (VRF)

- Flexible, adaptable & ductless
- New developments in inverter technology

(b) More efficient heat pumps

- Multistage cycles, hybrid systems (e.g. solar, desiccant), ground source

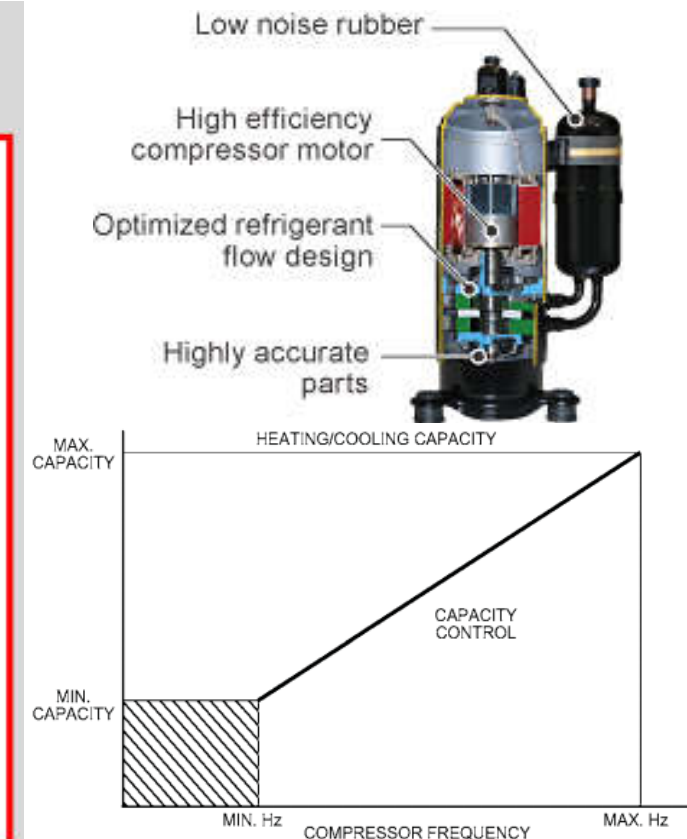
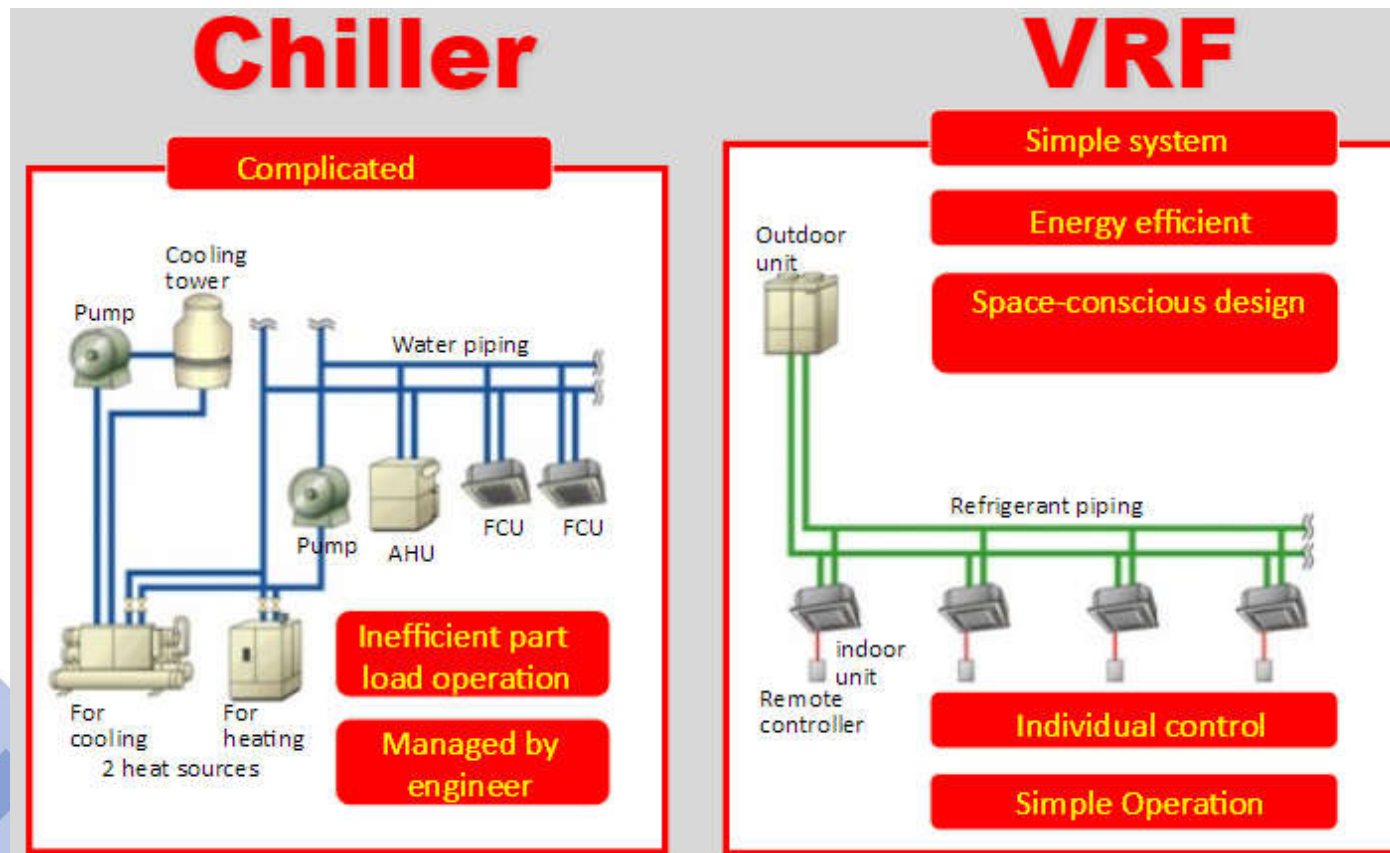
(c) Environmentally friendly refrigerants

- Ozone depletion potential (ODP) & global warming potential (GWP)



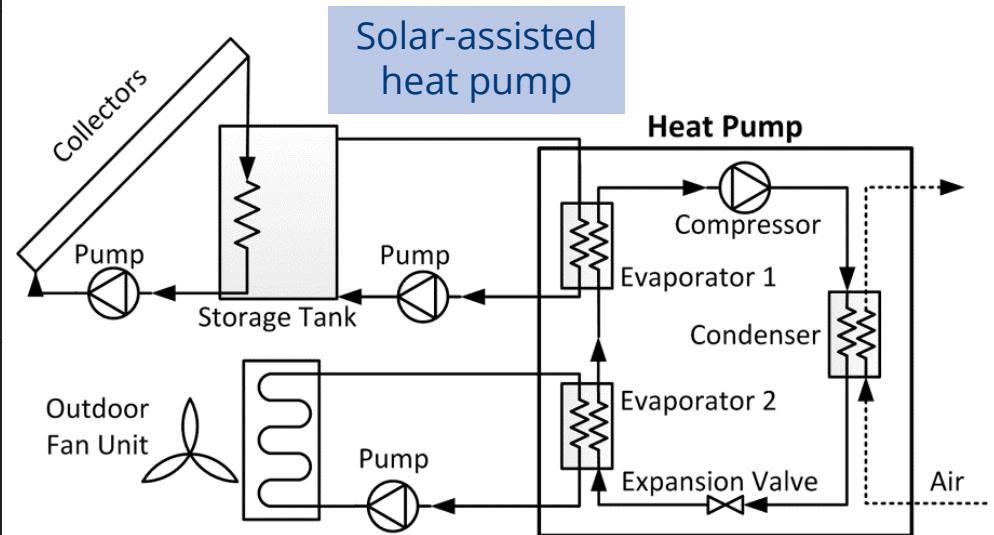
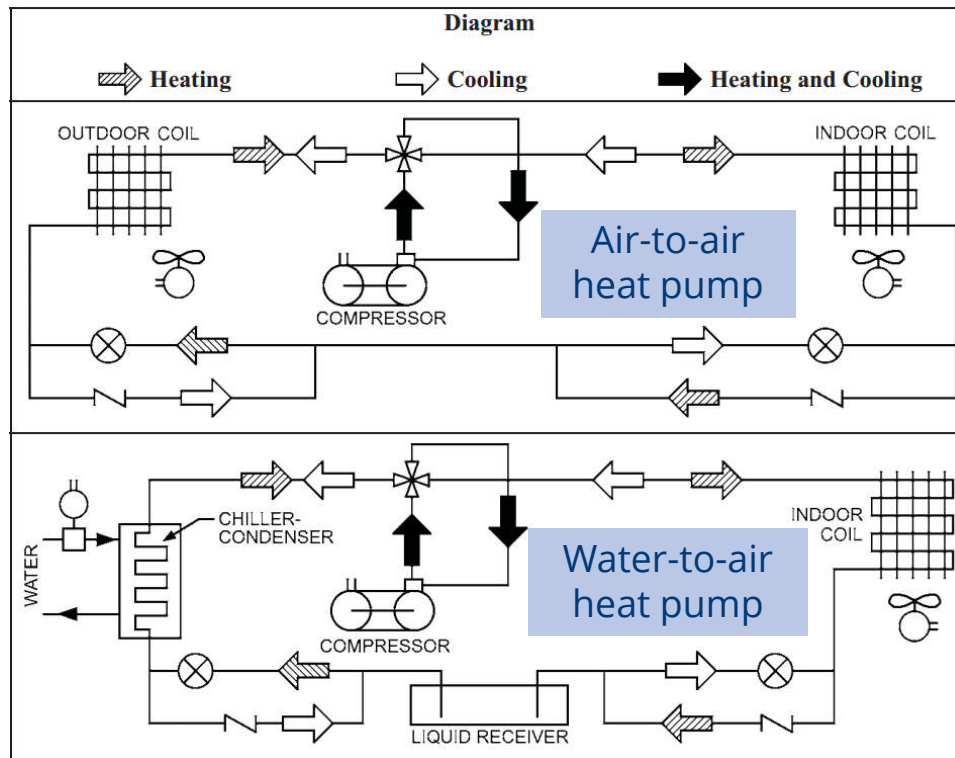
New

Zoning systems e.g. variable refrigerant flow (VRF) and inverter-driven compressor



(Source: Allen Anaya, W M Carroll LLC and Fujitsu)

More efficient heat pumps



(Source: 2016 ASHRAE Handbook—HVAC Systems and Equipment, Chapter 9 & J. Sol. Energy Eng 136(4), 041013 (Jun 17, 2014))

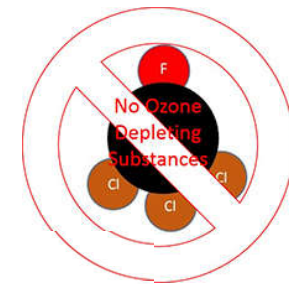
Environmentally friendly refrigerants

Refrigeration	Type ¹	ODP ²	GWP ³
R-744 (CO ₂)	Natural	0	1
R-134A	HFC	0	1,430
R-410A	HFC	0	2,088
R-407C	HFC	0	1,774
R-404A	HFC	0	3,922
R-22	HCFC	0.055	1,810
R-12	CFC	1	10,900
R-717 (Ammonia)	Natural	0	0

¹ Natural = Naturally occurring; HFC = hydrofluorocarbon;
HCFC = hydrochlorofluorocarbons; CFC = chlorofluorocarbon

² ODP = Ozone depletion potential, 0 to 1 scale with R-12 = 1

³ GWP = Global warming potential, scale based on CO₂ = 1



CFC's

- High ODP
- High GWP

HFC/HCFC's

- No ODP
- High GWP

HFO's

- No ODP
- Lower GWP

HC's

- No ODP
- No GWP

CFC = chlorofluorocarbon
HFC = hydrofluorocarbon
HCFC = hydrochlorofluorocarbon
HFO = Hydrofluoroolefin
HC = hydrocarbons

2. Latest Trends in HVAC

Smart HVAC systems

(a) Smart meters, thermostats & sensors

- Network connectivity & systems integration
- Automation & data analytics

(b) IoT (Internet of Things) enabled HVAC controls

- Self-regulation, remote access & integration with smart building controls
- Connecting HVAC to building management system (BMS)

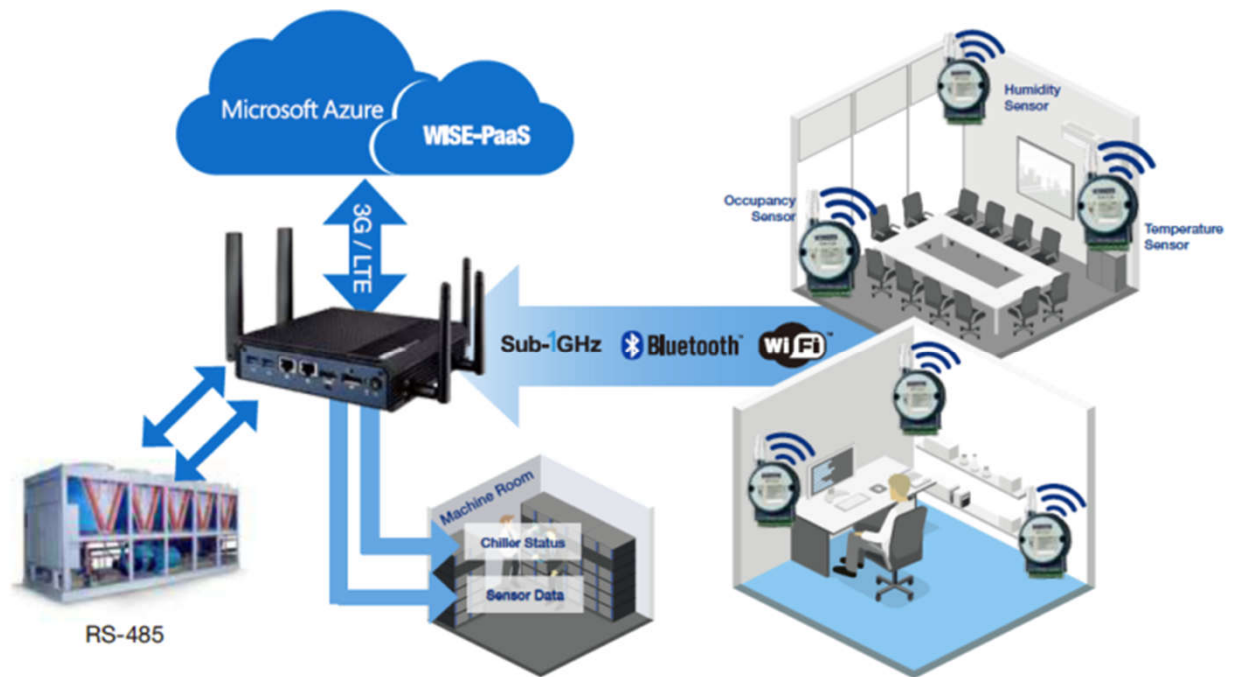
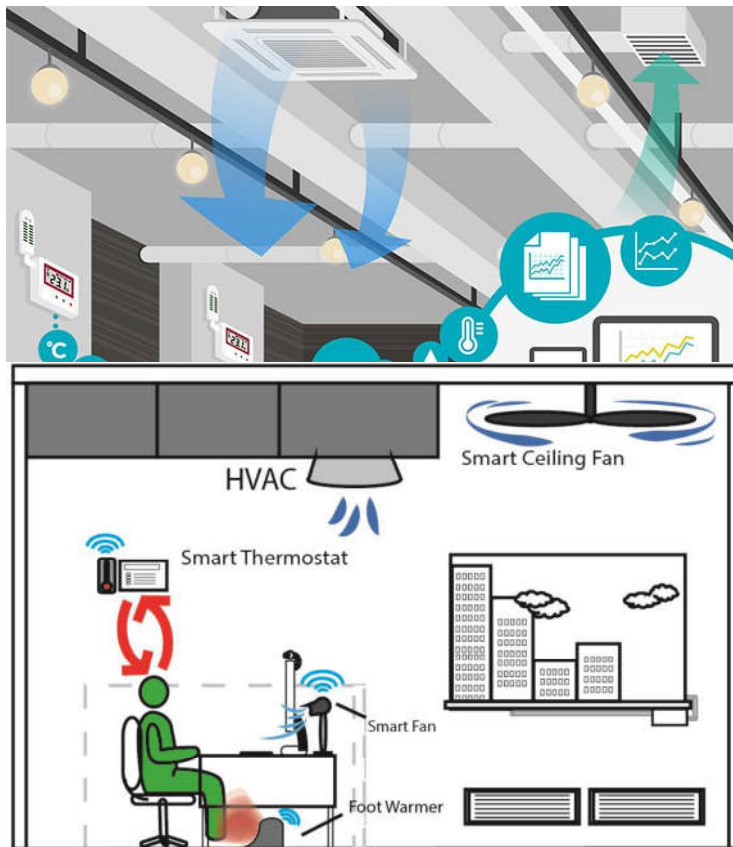
(c) AI (artificial intelligence) analytics for HVAC controls

- Increased level of intelligence, predictive control & optimisation



Smart

Smart meters, thermostats & sensors



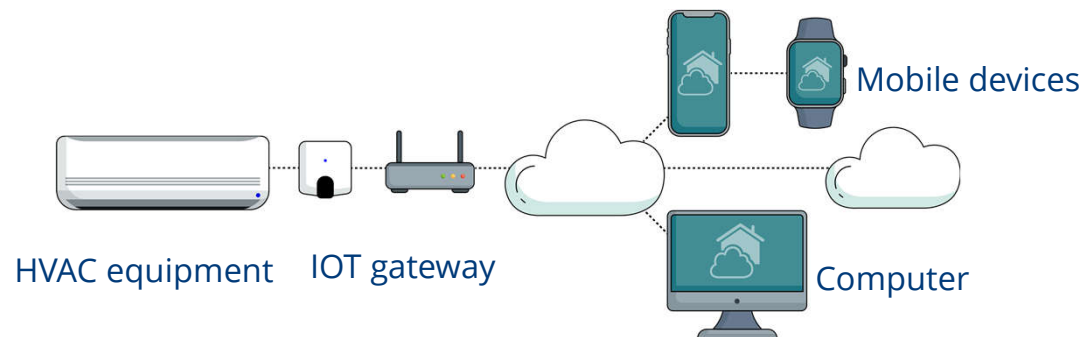
(Source: <https://www.adriasecuritysummit.com/smart-hvac-systems-on-cybersecurity-and-connection-protocols/>, <http://www.air-tempmech.com/2019/05/09/future-artificial-intelligence-hvacr/> & <https://doi.org/10.3389/fbuil.2020.00049>)

IoT (Internet of Things) enabled HVAC controls

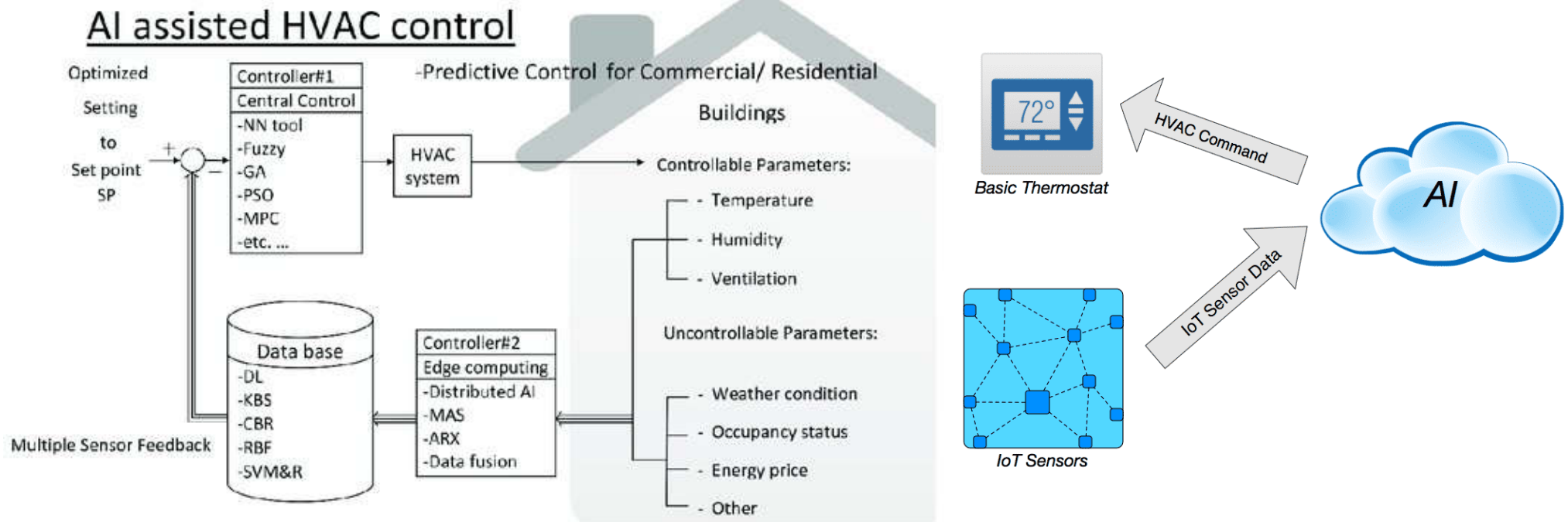


IoT enabled HVAC functions:

1. Predictive maintenance
2. Air quality measurement
3. Measurement & verification
4. Real-time data accessibility
5. Prefabricated building components
6. Efficient construction management
7. Energy efficiency
8. Better asset optimization



AI (artificial intelligence) analytics for HVAC controls



(Source: https://www.researchgate.net/publication/331608687_Artificial_Intelligence-Assisted_Heating_Ventilation_and_Air_Conditioning_Control_and_the_Unmet_Demand_for_Sensors_Part_1_Problem_Formulation_and_the_Hypothesis)

2. Latest Trends in HVAC

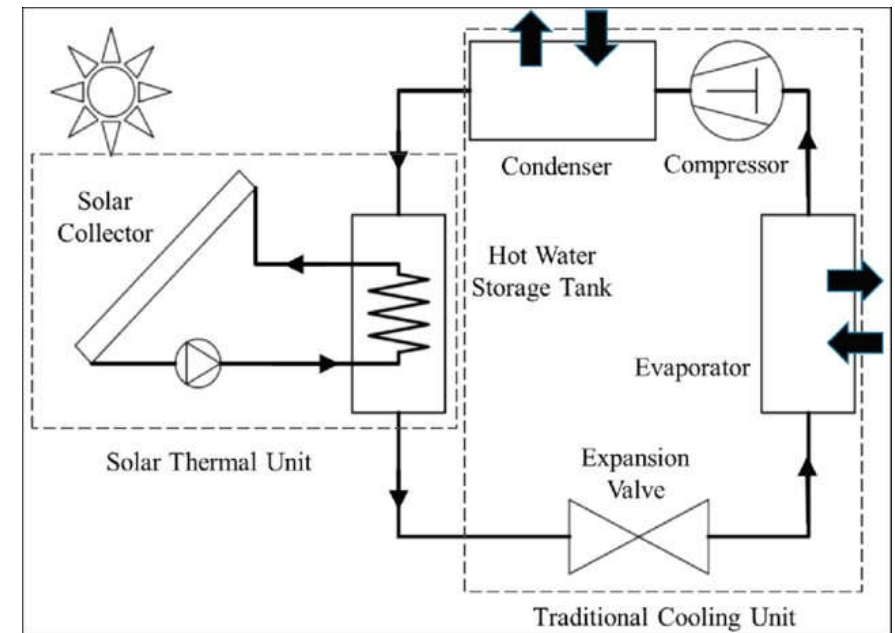
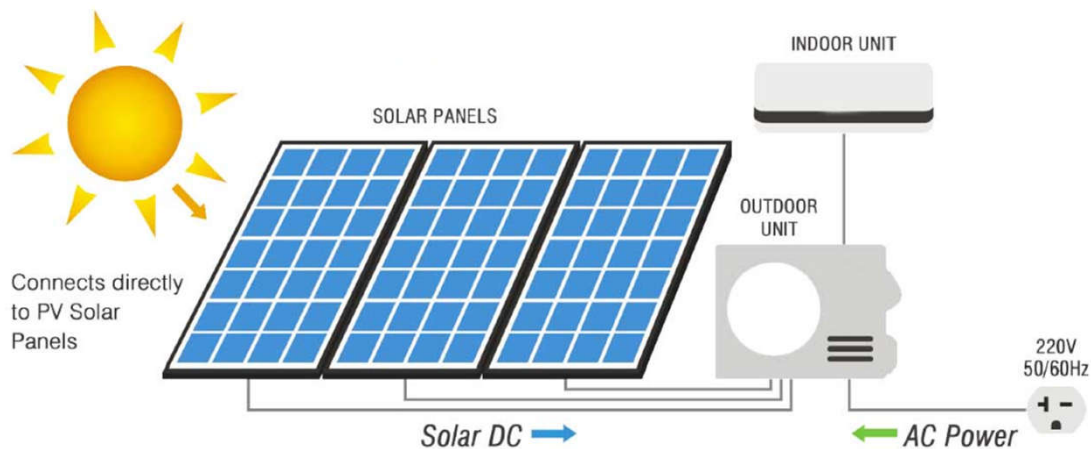
Green power sources for HVAC systems

- (a) Solar photovoltaic (PV) & solar thermal
 - Renewable energy applications
 - Solar powered & solar assisted HVAC
- (b) Geothermal heating & cooling system
 - Geothermal or ground source heat pump
 - High energy efficiency ratio (EER)
- (c) Desiccant enhanced evaporative (DEVap) air conditioning
 - Use desiccant to dehumidify the air before cooling it



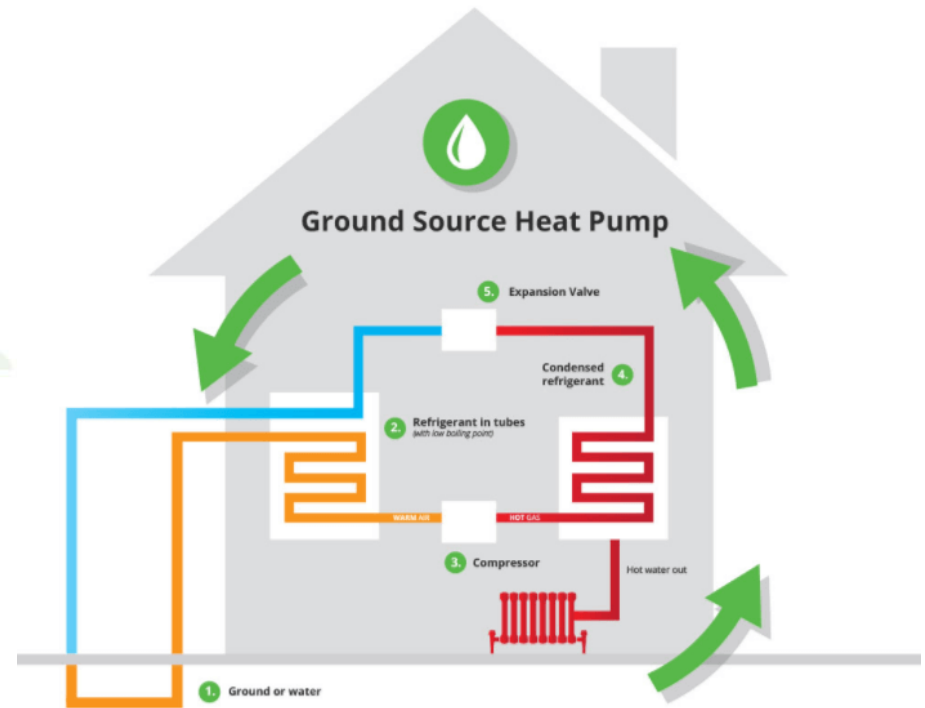
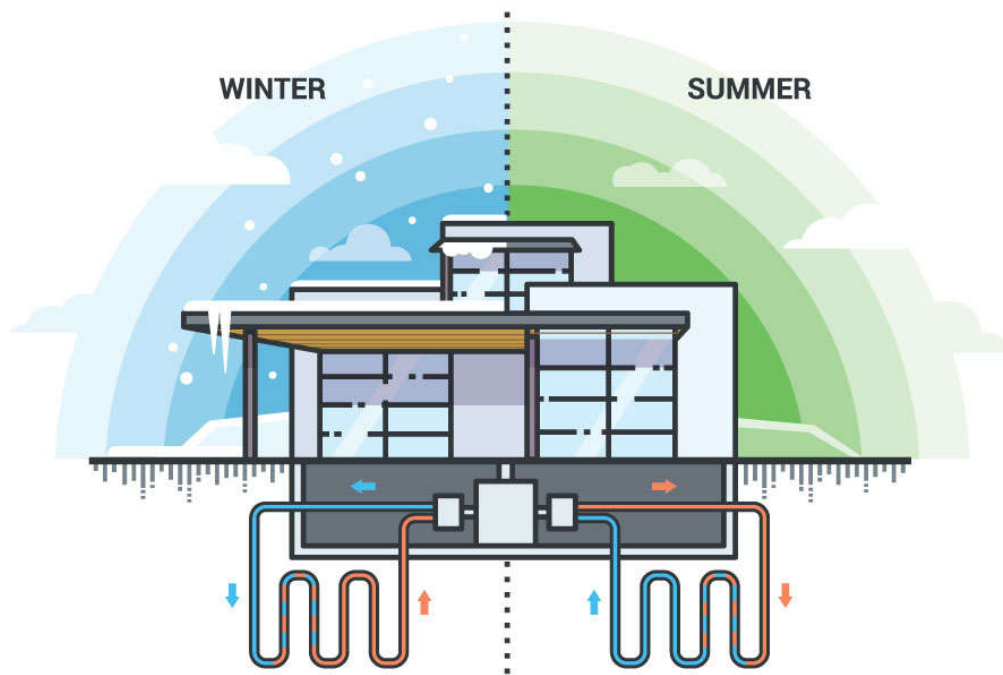
Green

Solar photovoltaic (PV) & solar thermal assisted air conditioning systems



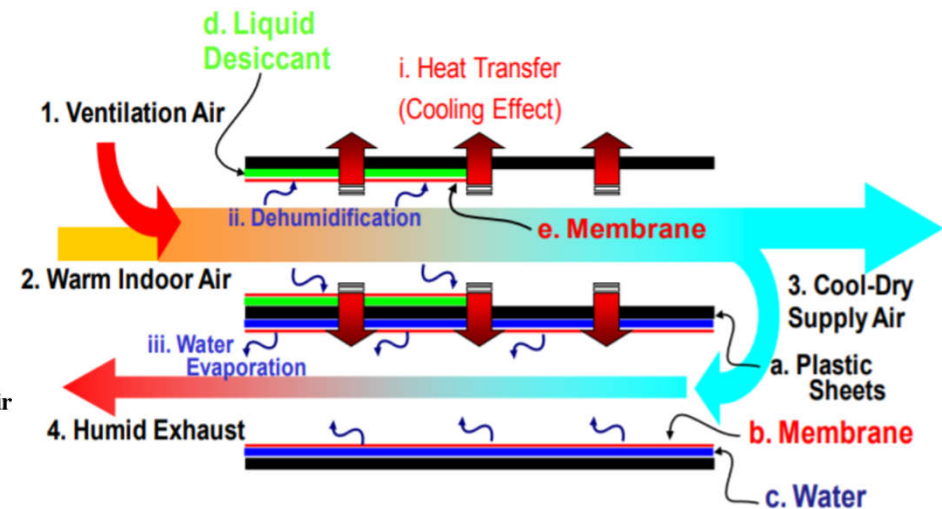
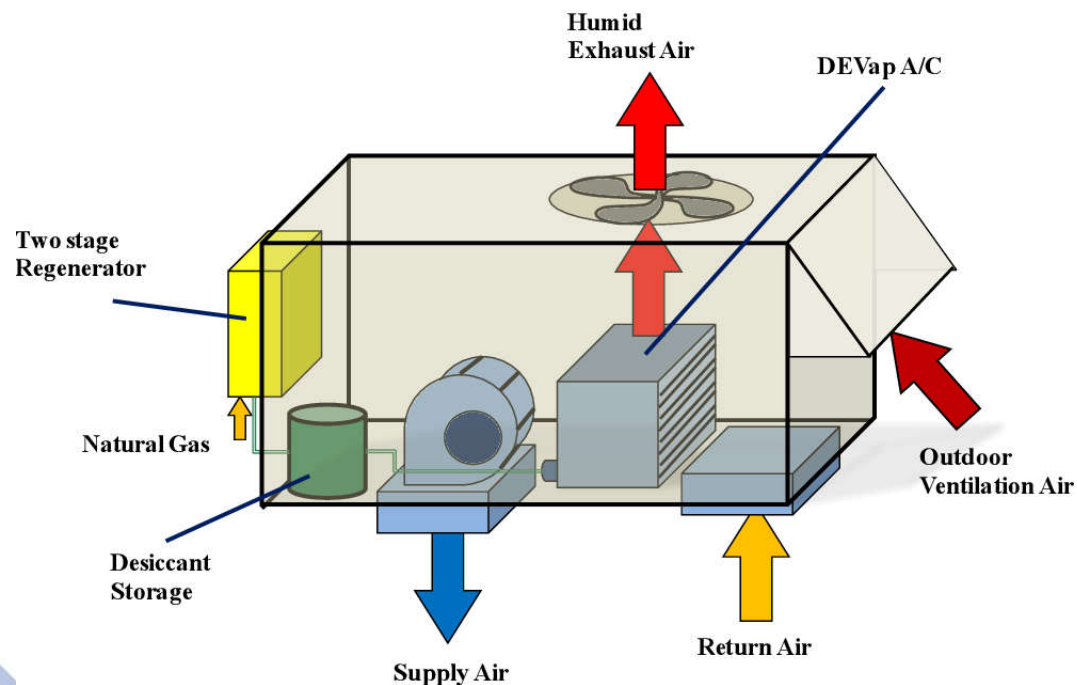
(Source: <https://www.solairworld.com/solar-hybrid-air-conditioner> & <https://doi.org/10.3390/su71114710>)

Geothermal heating & cooling system



(Source: <https://earthrivergeothermal.com/advantages-geothermal-heating-cooling-systems/> & <https://www.remodelingcalculator.org/geothermal-heating-cooling-costs/ground-source-heat-pump-diagram/>)

Desiccant enhanced evaporative (DEVap) air conditioning



(Source: Kozubal E., Woods J., Burch J., Boranian A. & Merrigan T., 2011. Desiccant Enhanced Evaporative Air-Conditioning (DEVap): Evaluation of a New Concept in Ultra Efficient Air Conditioning, NREL/TP-5500-49722, National Renewable Energy Laboratory, Golden, Colorado. <https://www.nrel.gov/docs/fy11osti/49722.pdf>)

3. Major Challenges

Major challenges in the HVAC industry

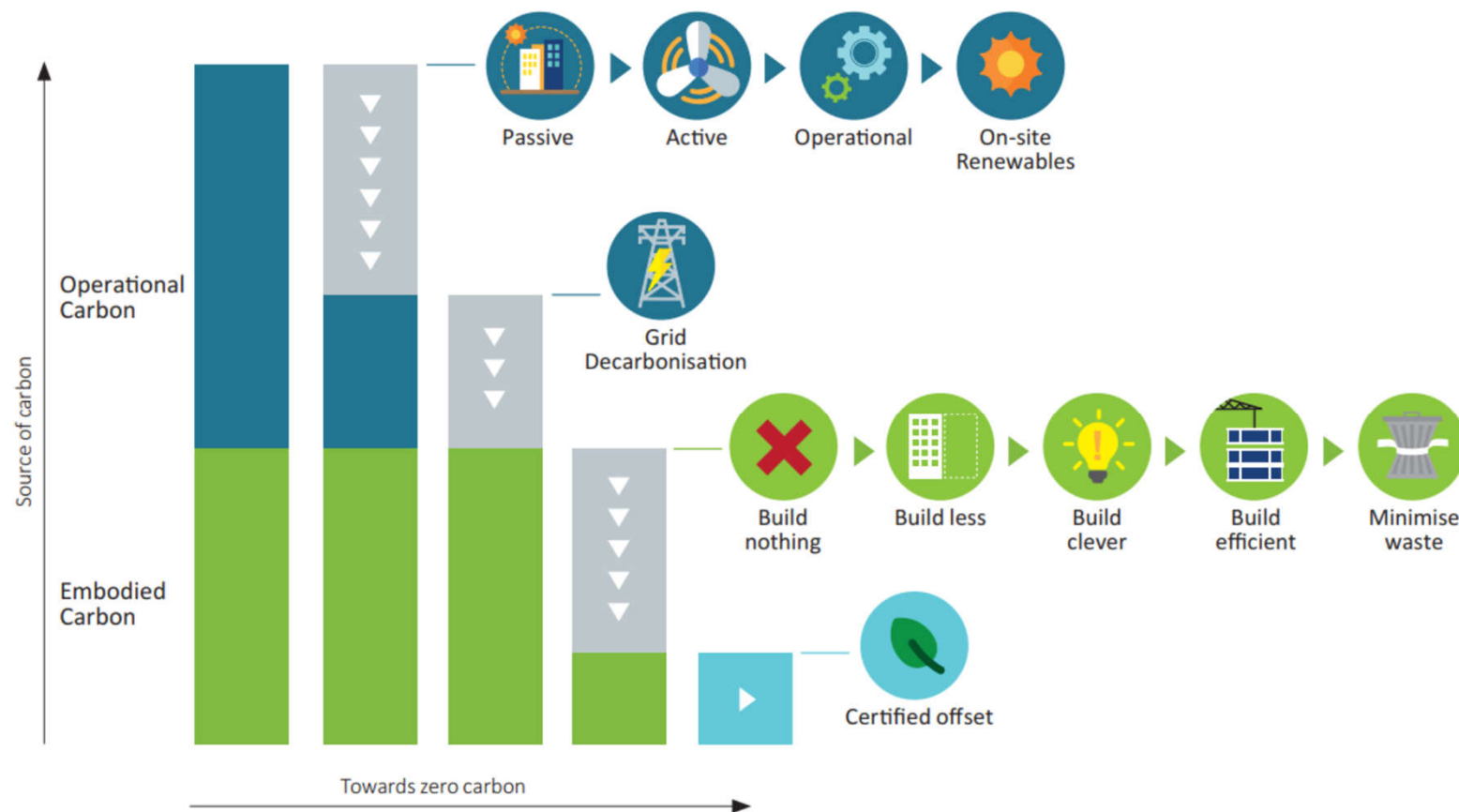
- Improve system & energy efficiency continuously
- Sustainable building design & HVAC operation
- Healthy building

Decarbonization & sustainability roadmap

- Hong Kong's net-zero target by 2050
- Reduce carbon emissions in buildings
- District-scale cooling & heating systems
- Smart electric grid



Route to zero carbon



(Source: CE & HKGFA, 2020. Decarbonising Hong Kong Buildings: Policy Recommendations and Next Steps, Civic Exchange (CE) & Hong Kong Green Finance Association (HKGFA), Hong Kong. <https://www.hkgreenfinance.org/wp-content/uploads/2020/12/Decarbonising-Hong-Kong-Buildings-Policy-Recommendations-and-Next-Steps-2.pdf>) 19

4. Impact of COVID-19

Transition to the “new normal”

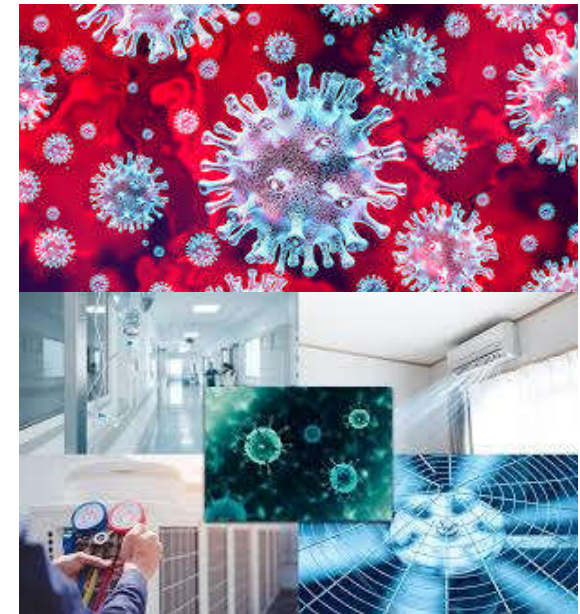
- Social distancing & remote work

Safety precautions in HVAC systems

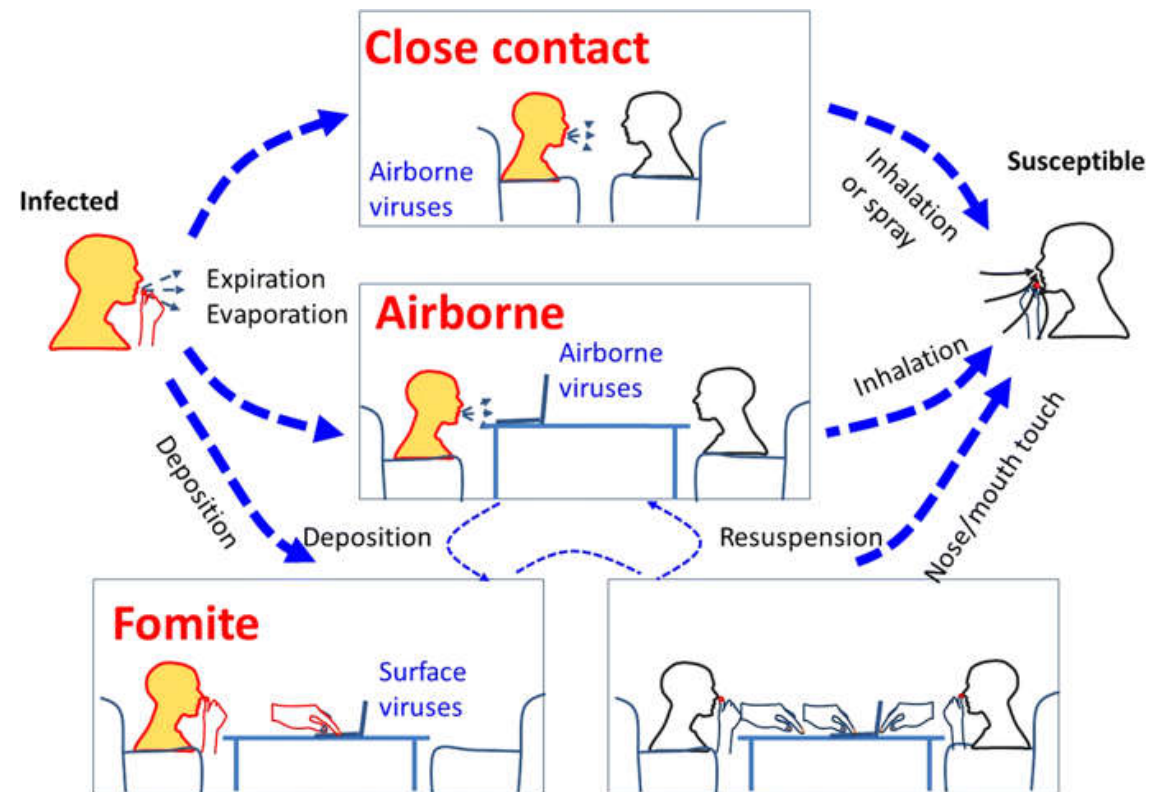
- Enhanced level of indoor air quality (IAQ)
- Cleaning & disinfecting
- Cloud-based AI system to capture & analyse the IAQ data

HVAC operation & maintenance

- Deal with varied load conditions depending on occupancy rate to maximize operational efficiency
- Remote technology for operation & inspection
- Remote supervisory & troubleshooting



Possible transmission routes of respiratory infection

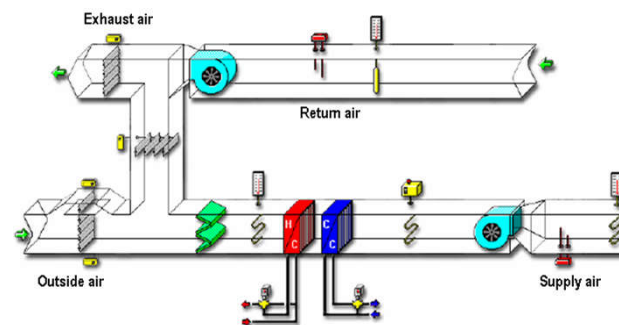
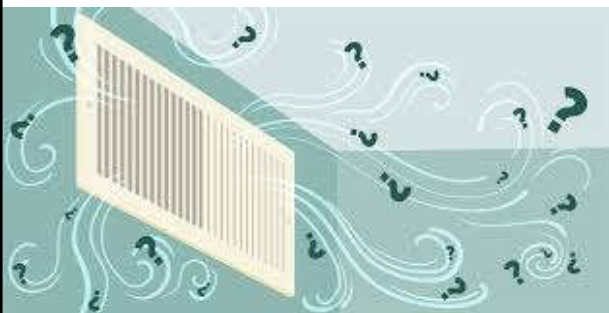


(Source: Recognition of aerosol transmission of infectious agents: a commentary <https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-019-3707-y>) 21

4. Impact of COVID-19

COVID-19 prevention strategies in HVAC

- Increase air changes
- Outdoor air intakes
- Exhaust air outlets
- Air filters
- Disinfection & decontamination in air distribution systems
 - Ultraviolet germicidal irradiation (UVGI)
 - Bipolar Ionization (plasma)
- Control of aerosols transmission in ventilation system



5. Conclusions

- HVAC demand in the world is growing fast & contributes to significant energy use + carbon emissions
- Latest trends in the HVAC industry focuses on “New, Smart & Green”
- Major challenges are to improve system & energy efficiency and satisfy the needs for sustainable & healthy buildings
- Requires strategic planning & right business mindset
- Should educate & advise the client on new HVAC technologies & decarbonization goals





Q&A