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Energy
REPUBLIC OF SOUTH AFRICA

Toolkit: Energy efficient building system technologies

Buildings: Maxine Jordan, IEA and Ian Hamilton, UCL Energy Institute

Pretoria, Tuesday 15th October 2019

Buildings energy efficiency sessions in partnership with:

UCL ENERGY
INSTITUTE



Energy Efficiency Training Week: Buildings programme

1. Where to start: Energy use in buildings
2. Where to start: Energy efficiency potential in buildings
Special session: GlobalABC Regional Roadmaps
3. Toolkit: Energy efficient building design technologies
- 4. Toolkit: Energy efficient building system technologies**
Special session: Green Building in Africa – *Elizabeth Chege, KGBS*
Special session: The GlobalABC Africa Roadmap for buildings and construction
5. What are the steps? Determining the current status of policies
6. Toolkit: Energy efficiency policies and target setting *with guest speaker: Hlompho Vivian, GBC SA*
7. What are the steps? Implementing codes and standards
8. What are the steps? Building operations and procurement *with guest speaker: Christelle Van Vuuren, Carbon Trust*
Special session: The multiple benefits of energy efficiency
9. Did it work? Evaluation and energy efficiency indicators
Special session: Financing energy efficiency in buildings
10. Buildings quiz

Energy Efficiency Training Week: Buildings

4. Toolkit: Energy efficient building system technologies

Trainers: Ian Hamilton, UCL Energy Institute

Purpose: To teach the fundamentals of building technologies and energy efficiency products that can reduce energy use in buildings. This course will discuss building technologies including building envelope, HVAC systems, lighting and controls.

Scenario: Stakeholders are saying that more ambitious policies are not possible because the technology that enables increased energy efficiency is not available.

Discussion question: What building system of equipment do you think most needs to be addressed today to support low energy buildings?

- *which sector*
- *which part of the building*
- *why is it the most urgent*

Building equipment and systems



Space and water heating

Space cooling

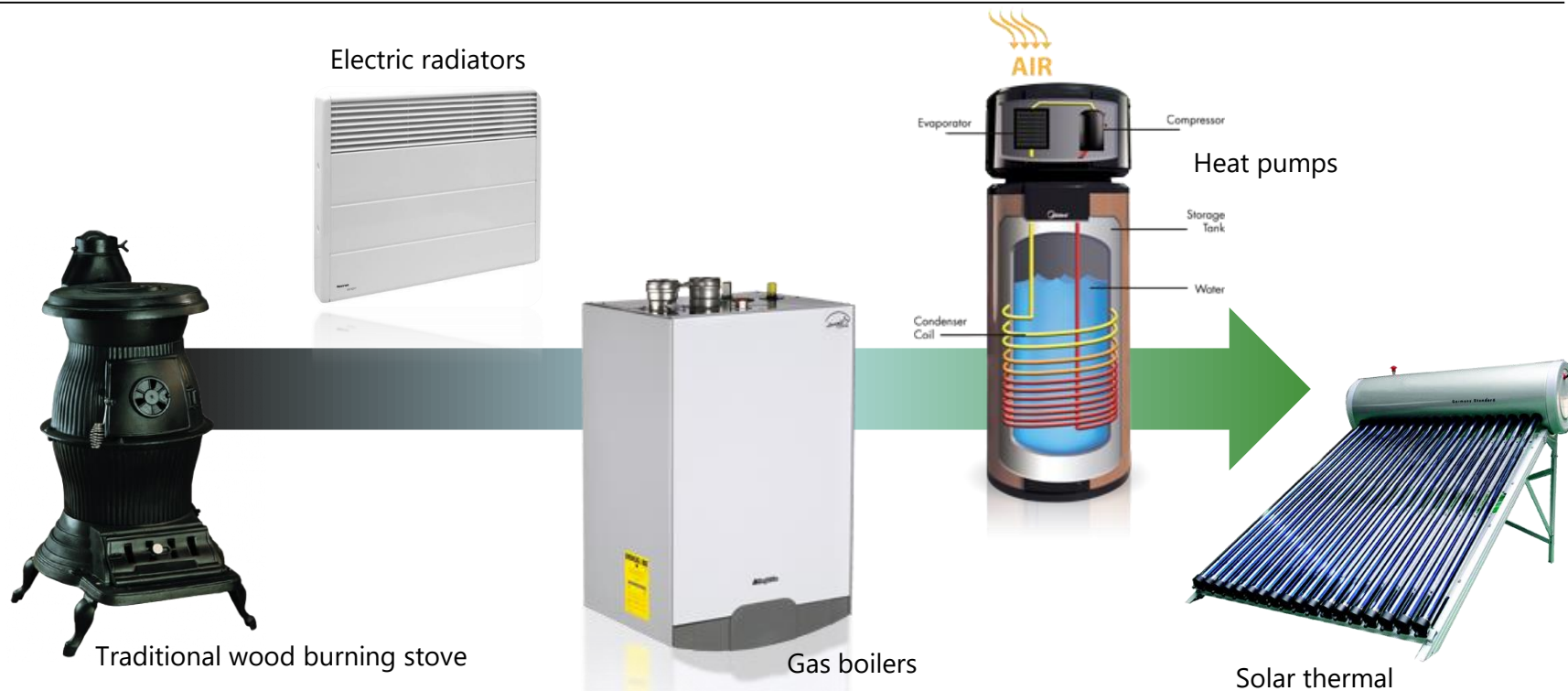
Ventilation

Lighting

Controls



Building equipment and systems: space and water heating



Shifting to more efficient and renewable integrated technologies.

Sources: wood-furnaces.net, asapburnerservice.com, altal.eu, redinfratech.com

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Building equipment and systems: space and water heating

Heat pump R&D

- Improve performance in cold climates

Standards

- Ban electric resistance heaters
- Require condensing gas boilers

Promote solar thermal systems

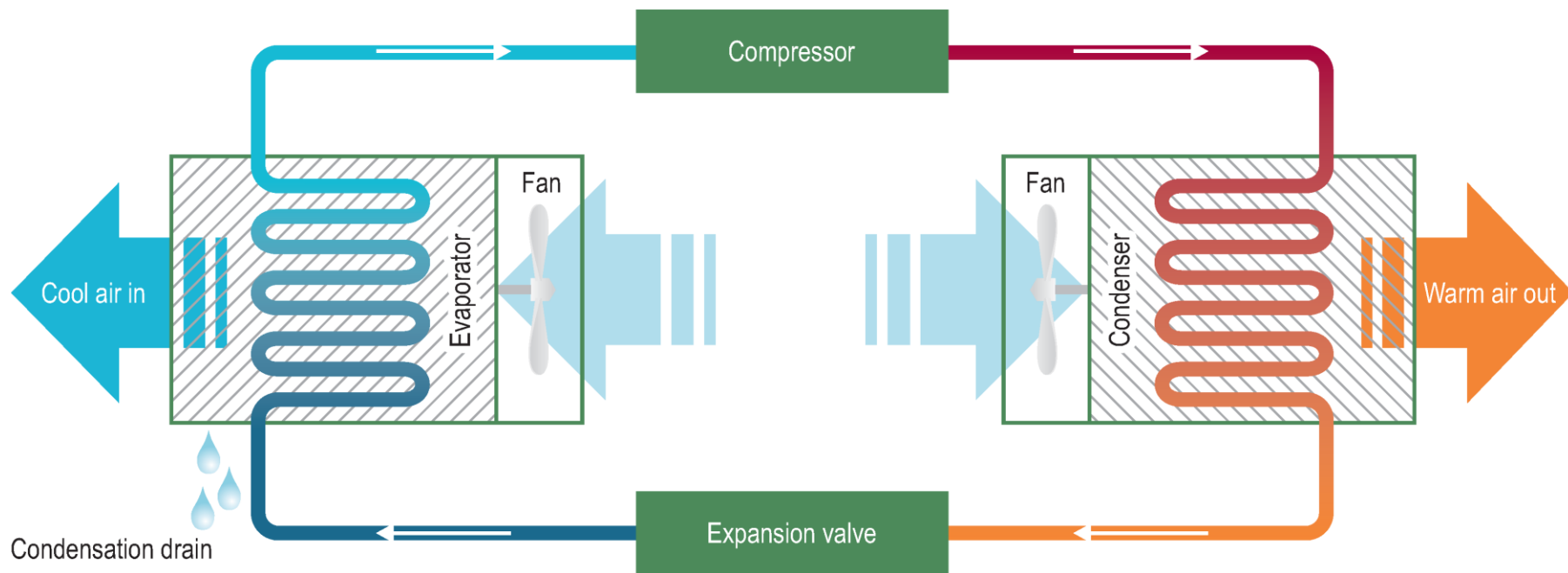
- Develop lower costs systems
- Invest R&D for cooling applications

Integrated district heating

- Focus on greater participation of renewables, waste heat & co-generation
- Develop model advanced district heating systems with efficient building envelopes



Building equipment and systems: cooling



ACs use a refrigerant and a vapour compression cycle to move heat from one space to another, providing comfort and the sensation of fresh, cool air

Building equipment and systems: cooling equipment types

Packaged ACs

- Window air conditioners
- Portable units
- Packaged rooftop units

Split System ACs

- Chilled water systems
- Rooftop and air handling units
- Variable Refrigerant Flow (VRF)

Chillers

- Water cooled chillers
- Air cooled chillers

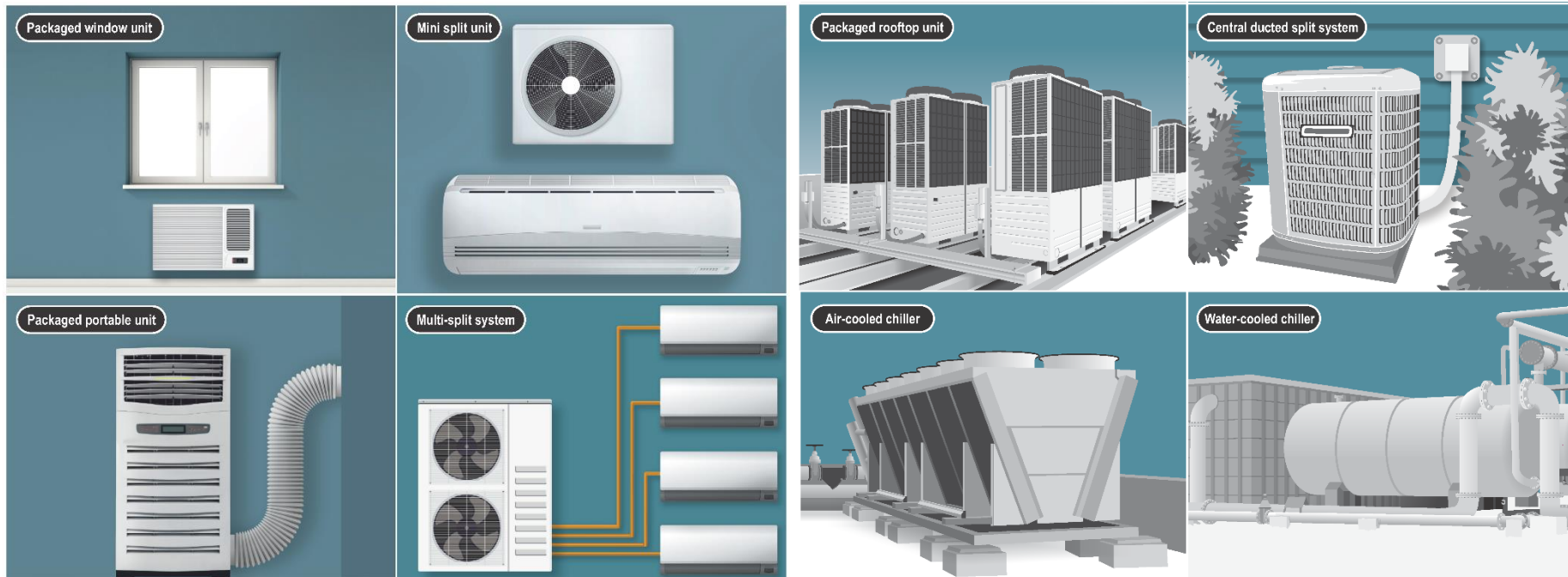
Other systems

- Evaporative coolers
- Absorption chillers
- Ground source or geothermal

What makes an Energy Efficient system?

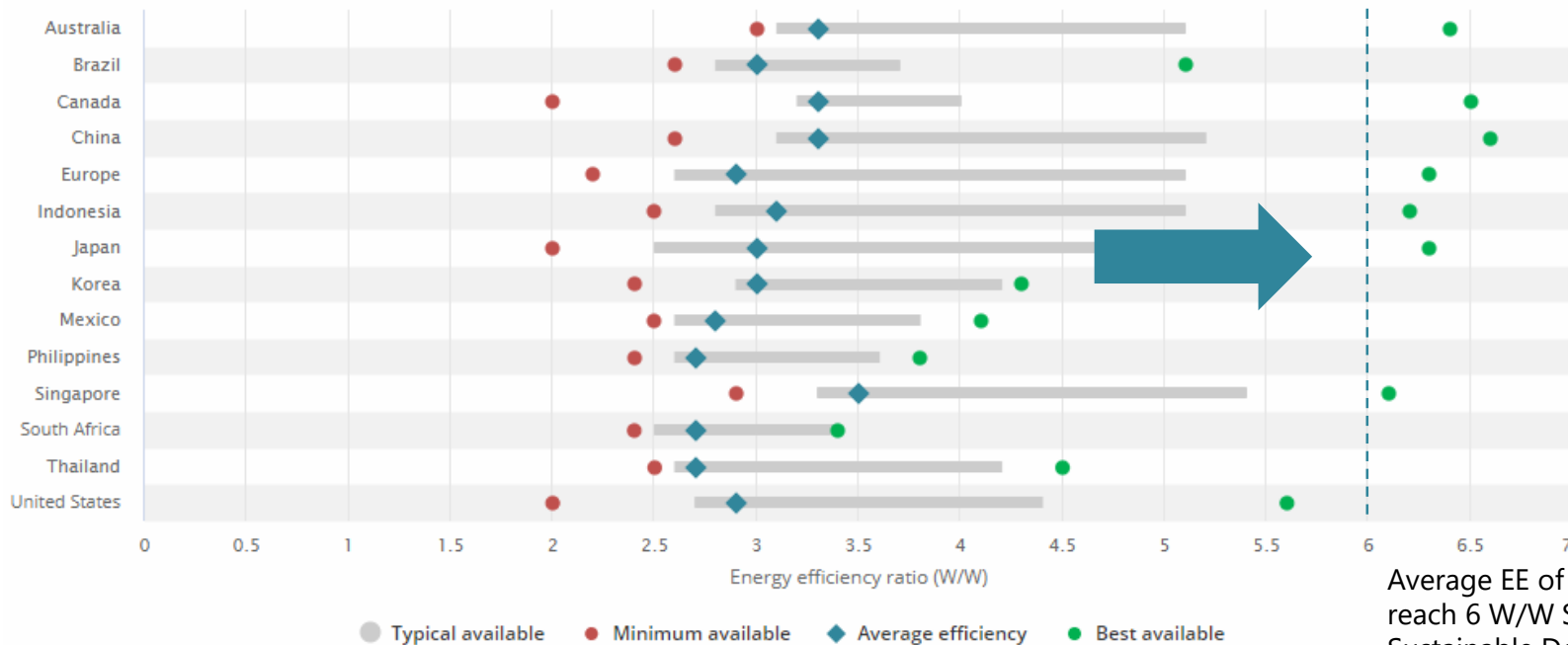
- ✓ Reduced energy used for same output of cooling
 - ✓ High COP or EER
 - ✓ High CSPF or SEER
- ✓ Correctly sized
- ✓ Ability to reduce output according to load
- ✓ Ability to integrate smart controls

Building equipment and systems: cooling equipment



Efficiency of air conditioners in W/W

Range of minimum available to best available efficiencies for residential air conditioners (EER)



Average EE of ACs for sale must reach 6 W/W SEER to meet Sustainable Development Scenario

<https://www.iea.org/tcep/buildings/cooling/>
<https://www.iea.org/topics/energyefficiency/buildings/cooling/>

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Building equipment and systems: cooling equipment features

Flexibility

- Variable speed compressors, “inverter”, variable speed fans, variable flow refrigerant.

Storage

- Ice or chilled water
- For peak demand control
- Integration with renewables

Thermal recovery

- Heat and/or enthalpy exchangers

Smart controls

- Pre-cooling, free-cooling
- Set point adjustment and demand-side management
- Integration with other building systems

Building equipment and systems: cooling considerations

- Refrigerant fluids used in air conditioning equipment are harmful to the environment, either because of their damage to the ozone layer, or for the Global Warming Potential of their emissions.
- Transitions to cleaner, alternative fluids are underway, as well as a gradual phase down of the most harmful fluids under the Kigali Amendment to the Montreal Protocol.
- This is an opportunity to also transition to more efficient compressor technologies.
- The K-CEP programme is available to support economies in this phase down.



Find out more:

<https://www.k-cep.org/>
<https://ozone.unep.org/>

Building equipment and systems: ventilation

Natural

- Cross ventilation
 - via wind
 - via temperature
- Stack ventilation
 - via air stratification
 - via temperature induced exhaust

Mechanical

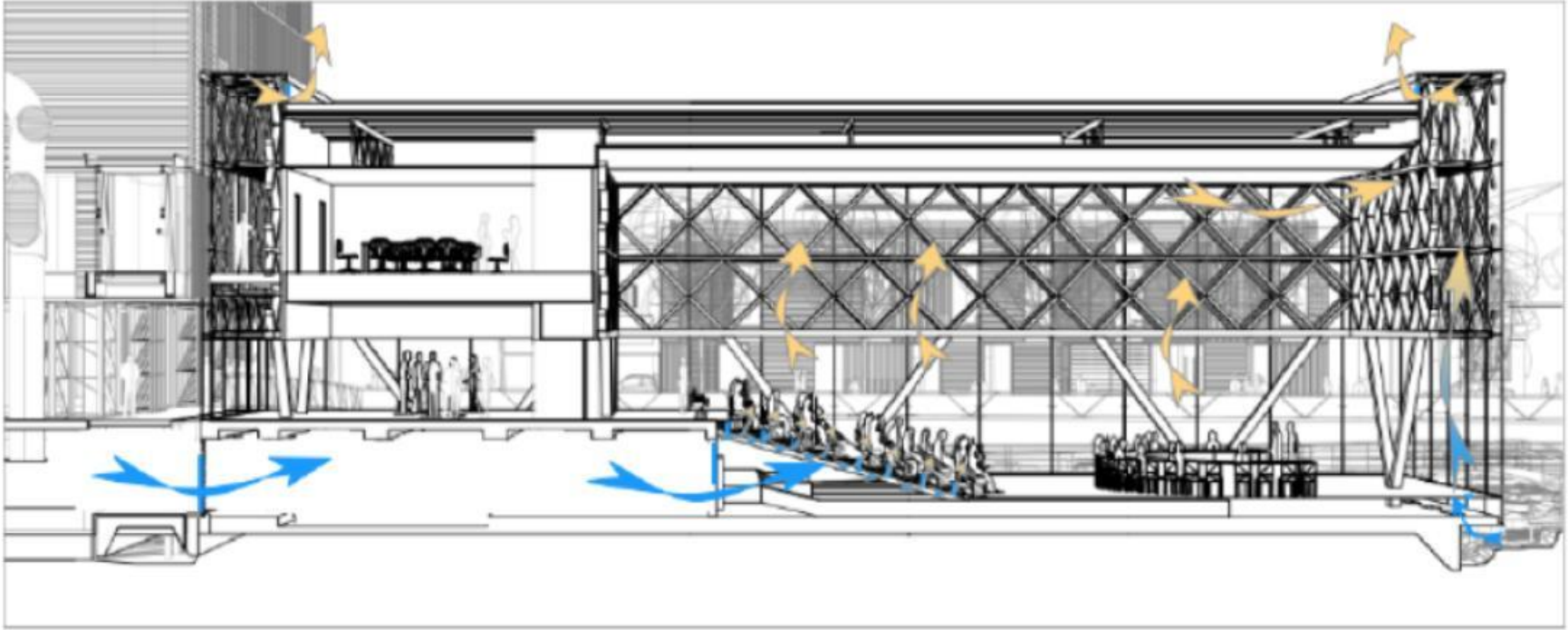
- Fan exhaust or supply
- Heat/energy recovery ventilation

Hybrid, or mixed-mode



Source: Bedzed, UK

Building equipment and systems: hybrid ventilation



Natural ventilation (stack/stratification) in combination with mechanical ventilation to enable comfort

Source: IEA EBC Annex 62 – Ventilative Cooling

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Building equipment and systems: lighting



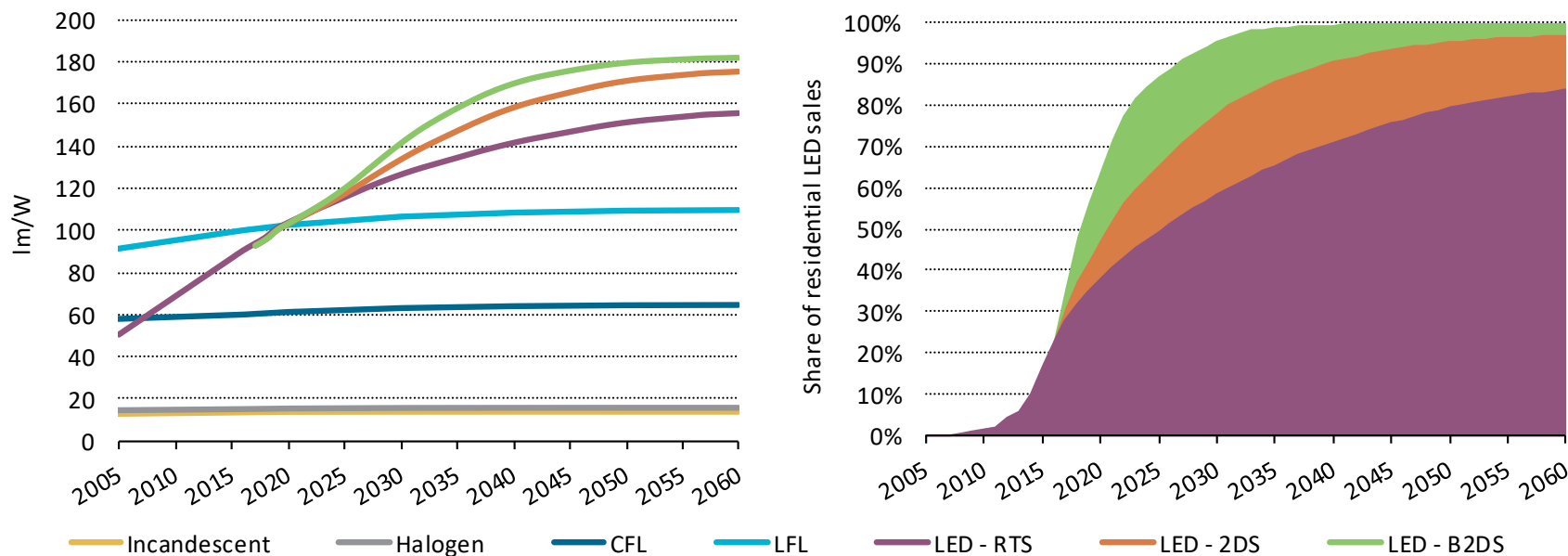
Shifting to high performance technologies

Source: premierlightbulbs.com

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Building equipment and systems: lighting

Lighting equipment performance and residential LED sales share to 2060



Rapid deployment of energy-efficient technologies will create critical mass in the market, helping to lower technology costs and drive R&D for greater energy performance.

Source: IEA Energy Technology Perspectives 2017

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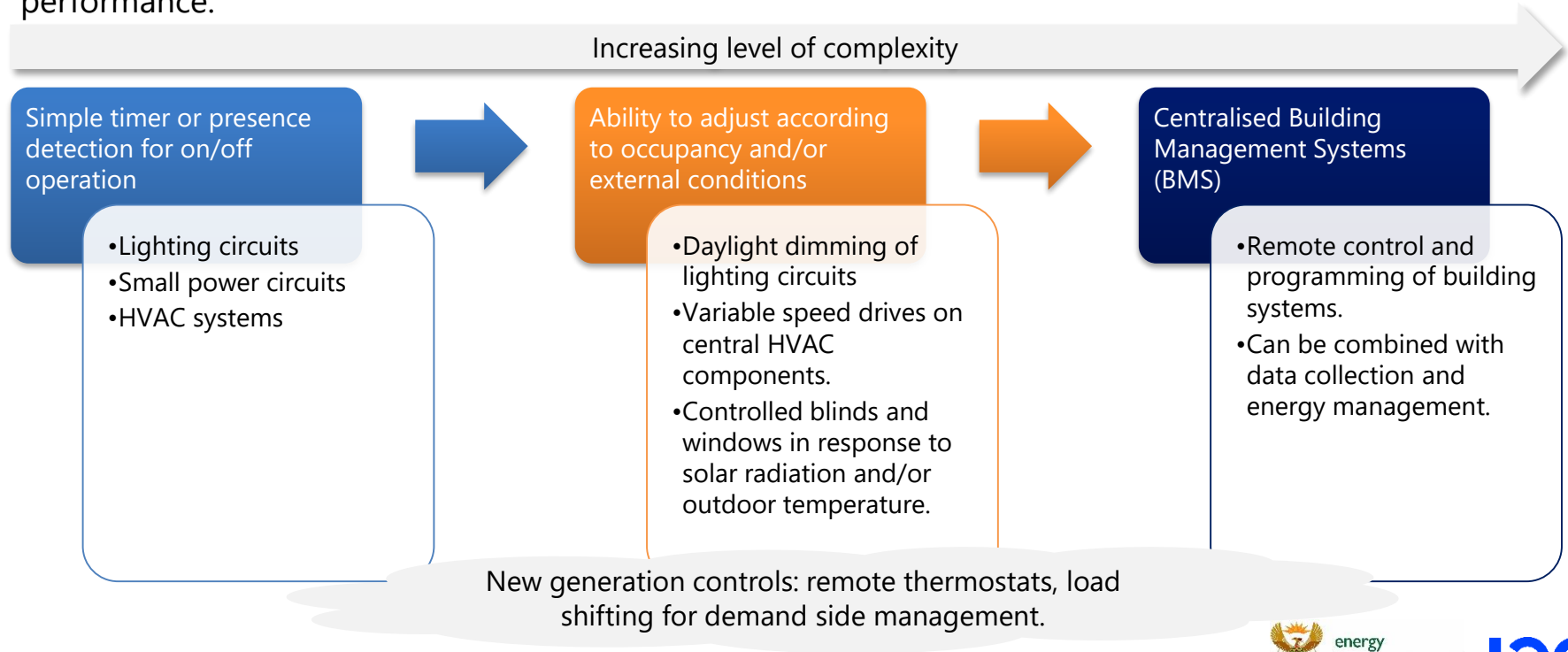


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Building equipment and systems: controls

- Controls can be used to regulate and/or automate the operation of building systems to optimise performance.



Advanced technologies: equipment and systems

Examples of some of the newest technologies

- **HVAC:**

- Natural gas heat pumps
- Cold climate heat pumps
- Modulating refrigerant to optimize EER/COP of HVAC systems
- Building control optimization
- Fault detection automation
- Seasonal thermal storage with heat pumps

- **Lighting:**

- Advanced LED lighting with sensors and controls

- **Data centers:**

- Immersion cooling
- Liquid cooling direct to computer chip

4. Toolkit: Energy efficient building system technologies

Scenario:

Stakeholders are saying that new policies are not possible because the technology that enables increased energy efficiency is not available.

Discussion question: What building system of equipment do you think most needs to be addressed today to support low energy buildings?



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