Future Cooling Needs of Buildings
The Role of Ventilation

Mat Santamouris – UNSW Sydney Australia

The Air Conditioning Market

PENETRATION OF AIR CONDITIONING

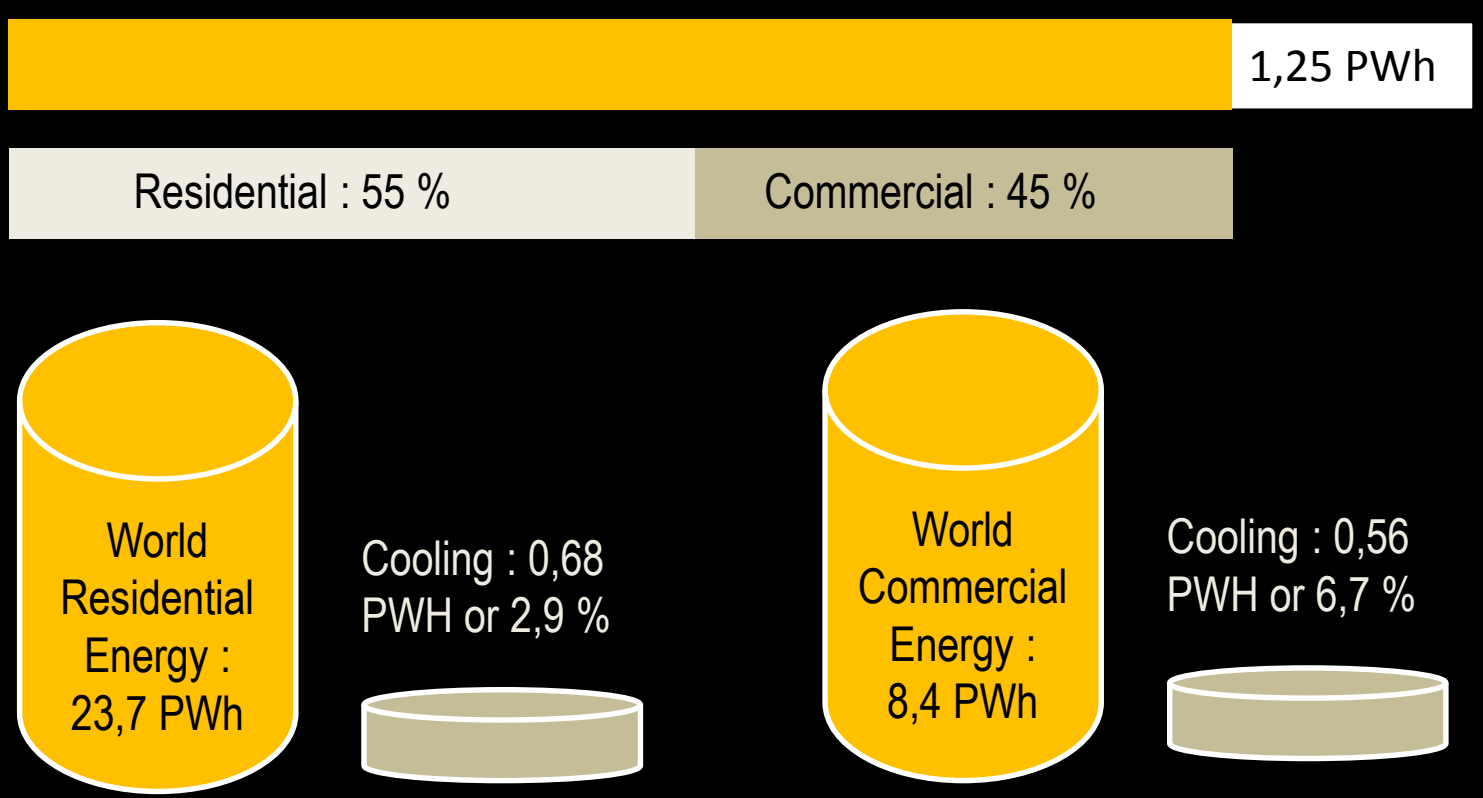
The world air conditioning market has exceeded 100 billion US$ presenting a total increase close to 7 % compared to the previous year.

Almost 128,5 million units have been sold worldwide.

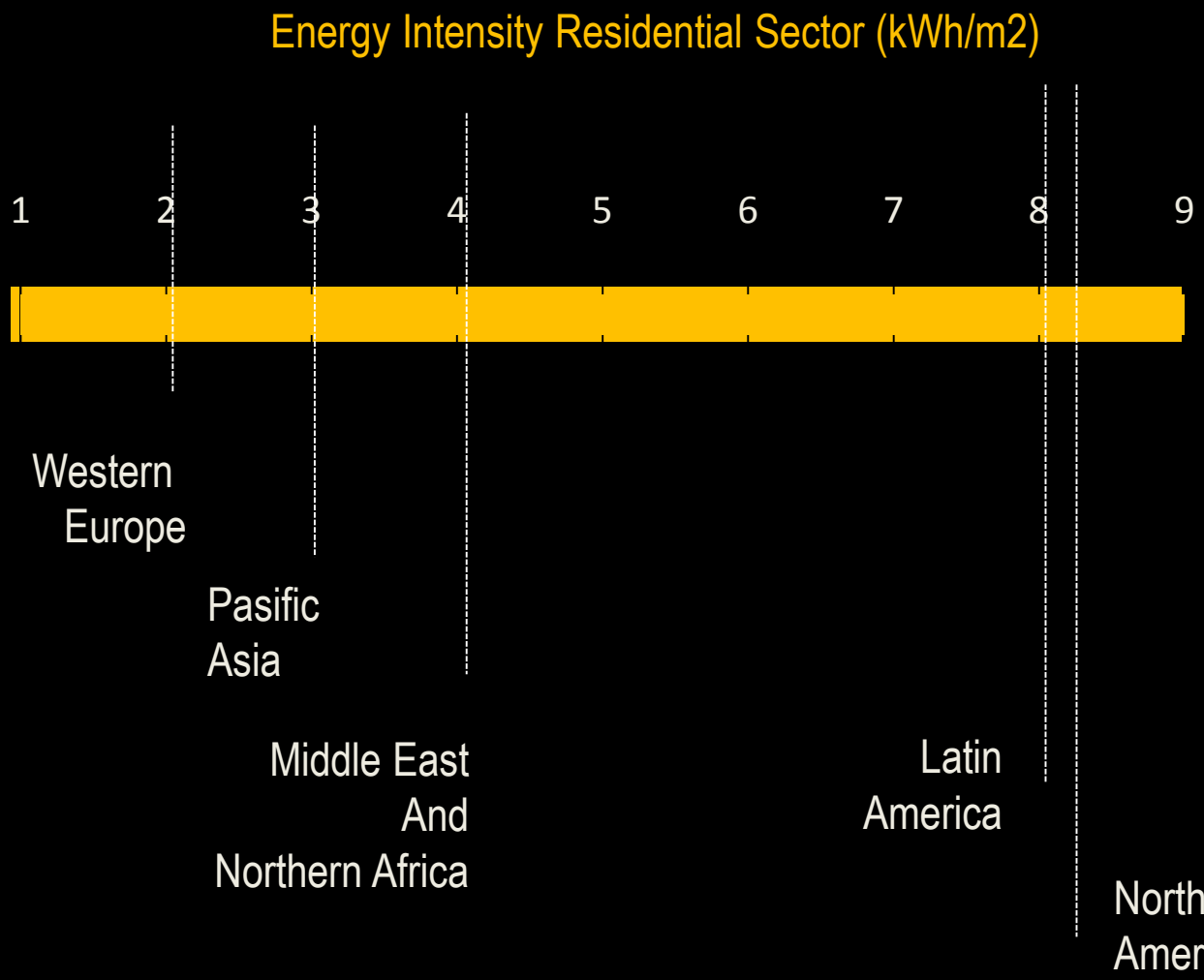
Most of the increase occurred in China and the Asia - Pacific zone where the global sales of air conditioning correspond almost 58 % of the world market.

China and Japan represent almost 83% of the total market in this area while important growth rates are observed in Myanmar, Vietnam, Hong Kong and Malaysia.

Cooling Energy Consumption

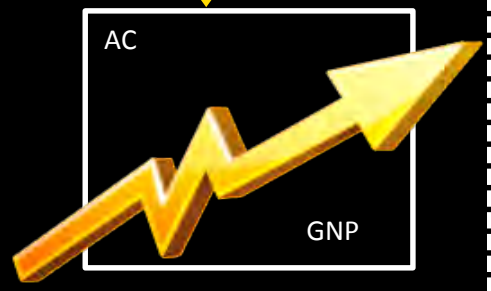


Cooling Energy Consumption

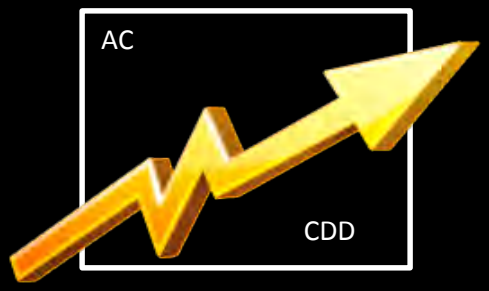


Drivers Affecting Air Conditioning

FAMILY INCOME

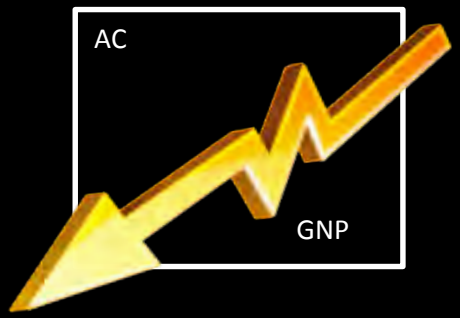


CLIMATE



POPULATION SIZE

ENERGY EFFICIENCY

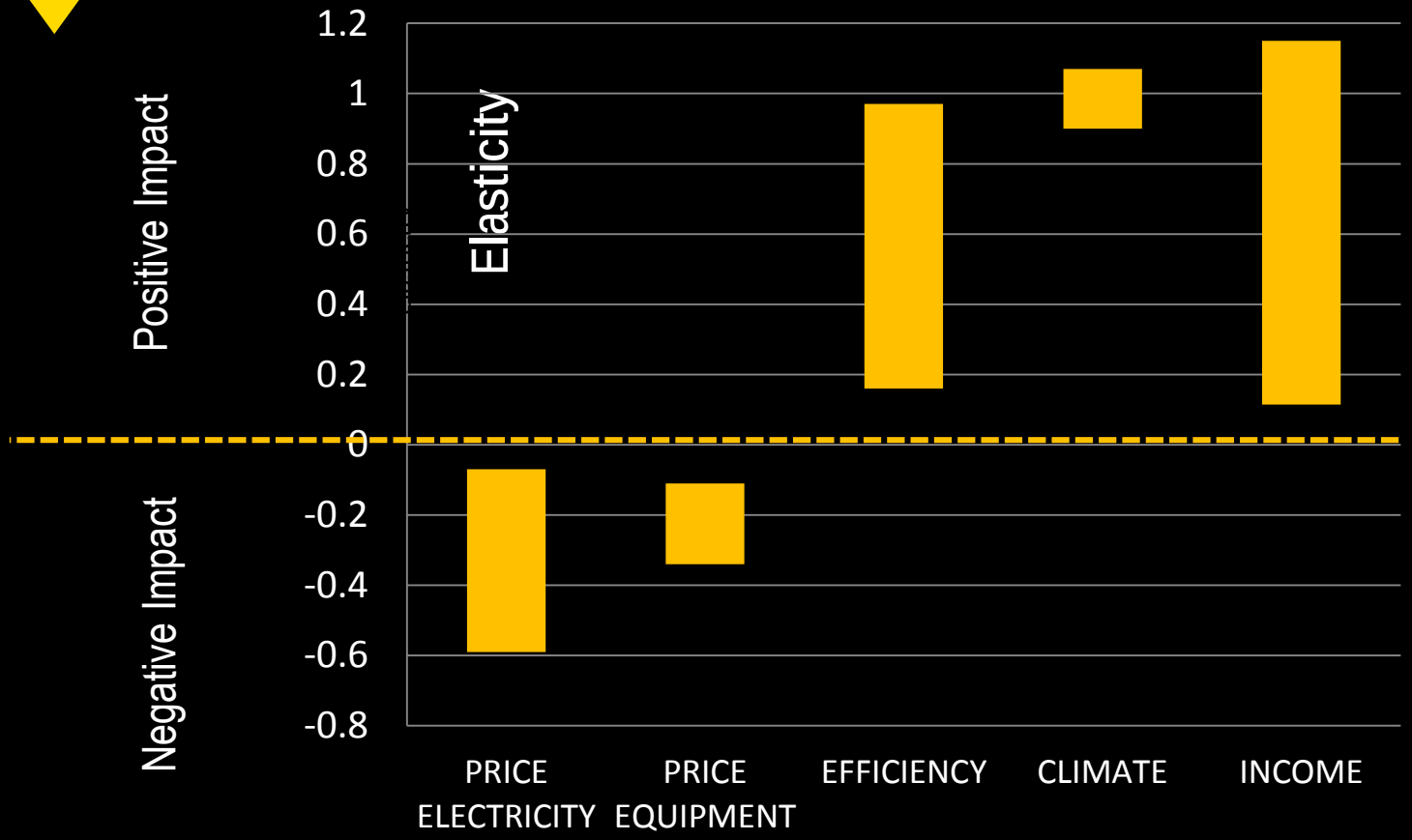


EQUIPMENT PRICE

COST ELECTRICITY

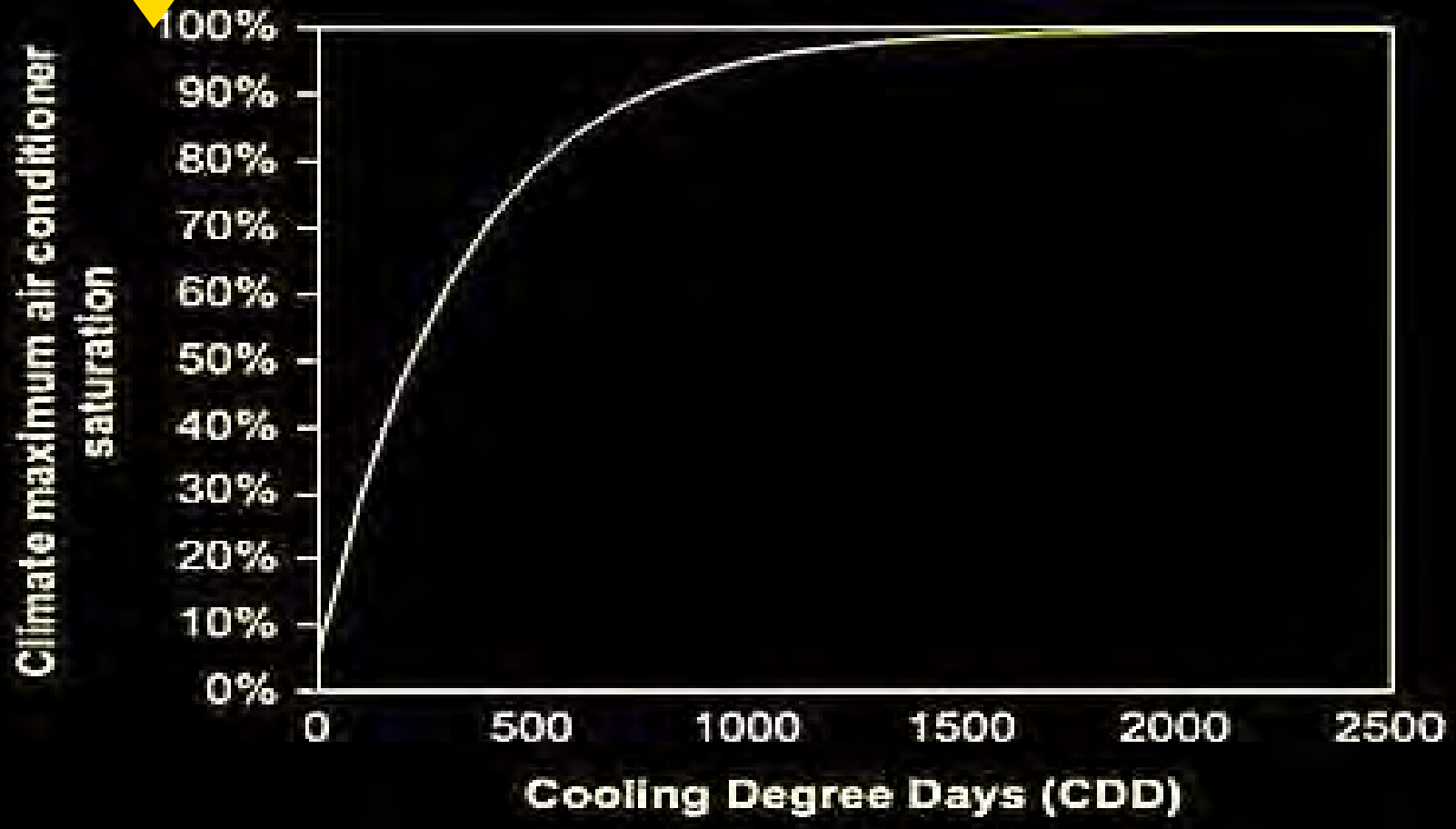
Drivers Affecting Air Conditioning

Range of Air Conditioning Elasticities



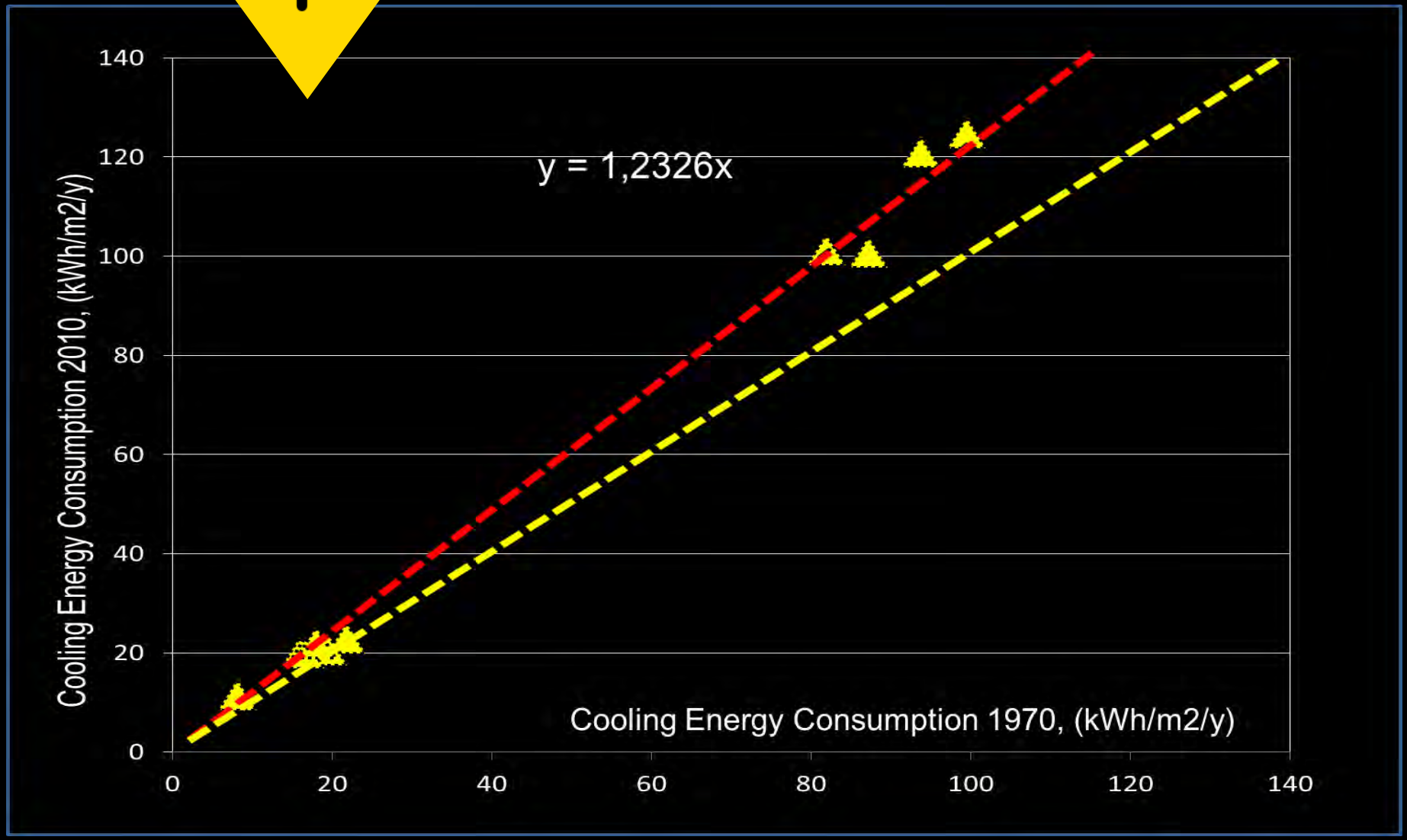
The Potential Impact of Climate Change

Air Conditioning Penetration depends on the Cooling Degree Days



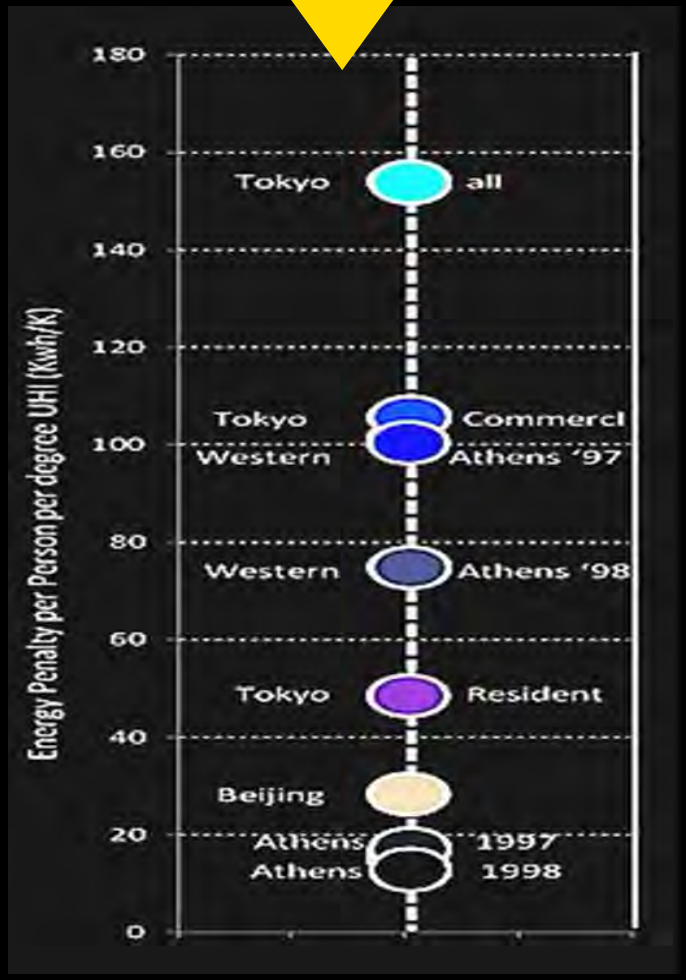
The Potential Impact of Climate Change

Existing Increase of the Cooling Load of Individual Buildings



The Potential Impact of Climate Change

Existing Increase of the Cooling Load of Buildings because of the Urban Heat Island



Global Energy Penalty per Person and per degree of the UHI intensity, GEPPI

It has the same characteristics as the GEPP index while it includes the local UHI intensity as additional information.

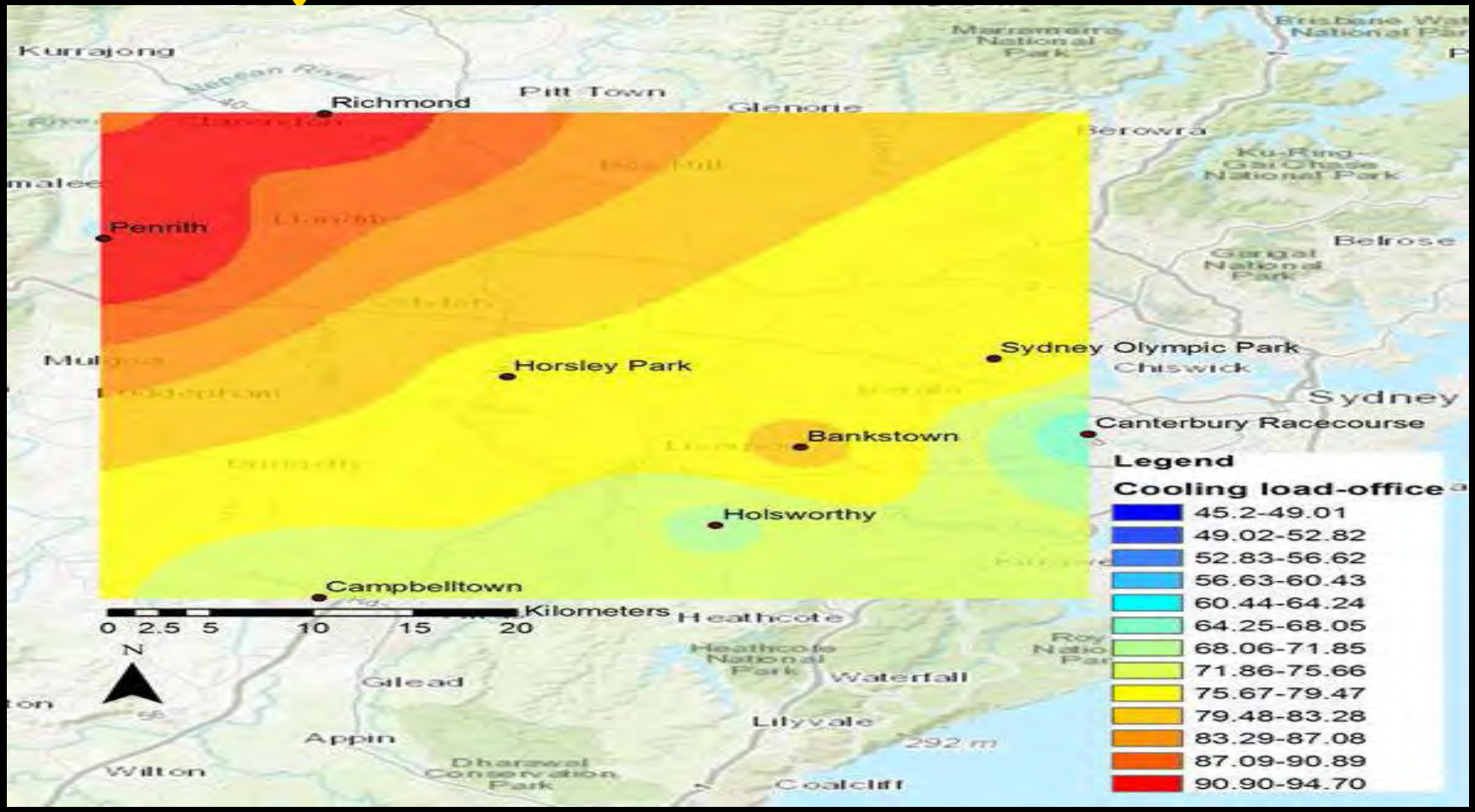
Values of GEPPI varied between 15 kWh/k for the Municipality of Athens to 154 kWh/K for Tokyo.

UHI triggers an average Global Energy Penalty per Person and per degree of the UHI intensity, GEPPI, close to

68 kWh/p/K.

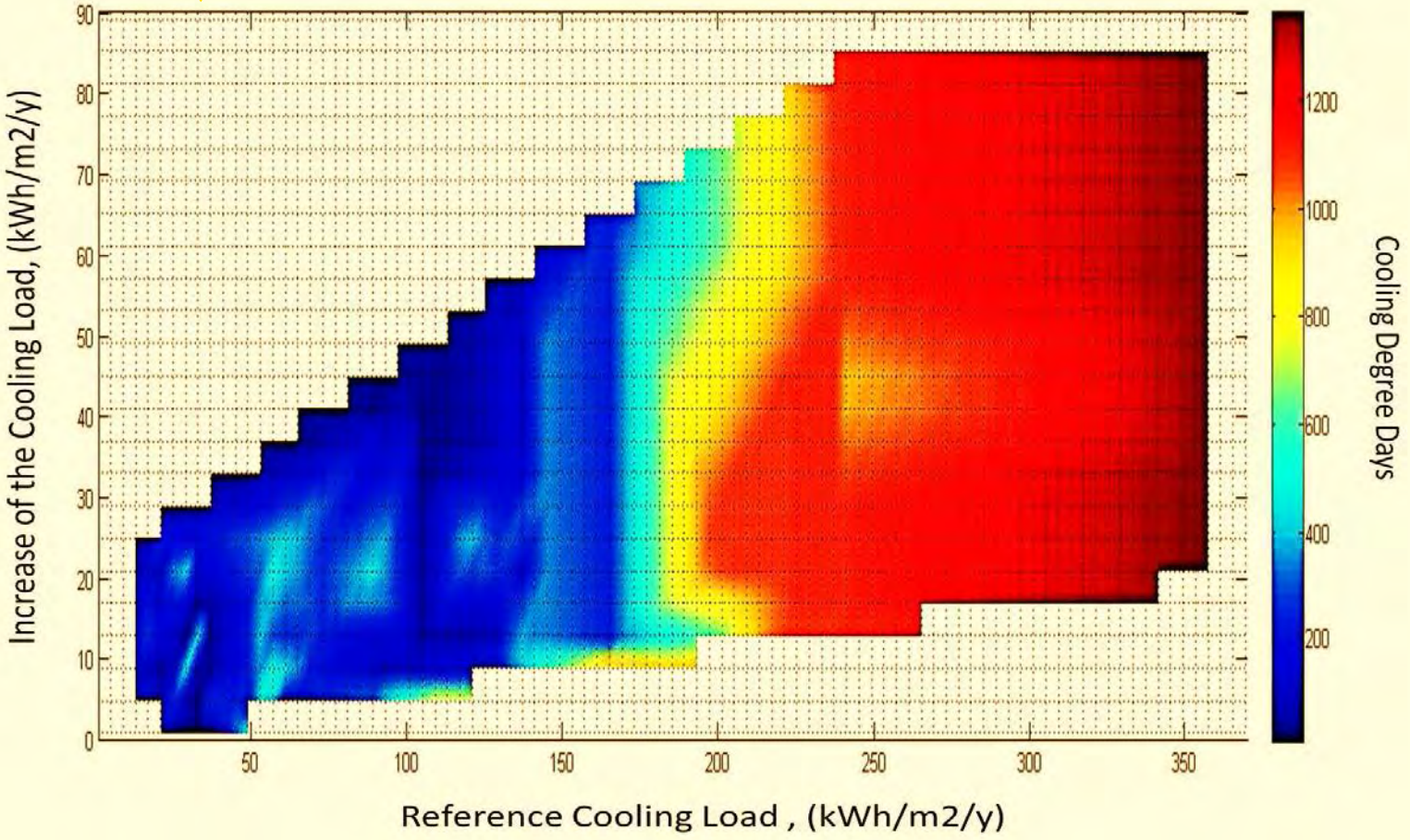
The Impact of Climate Change

Future Increase of the Cooling Degree Days



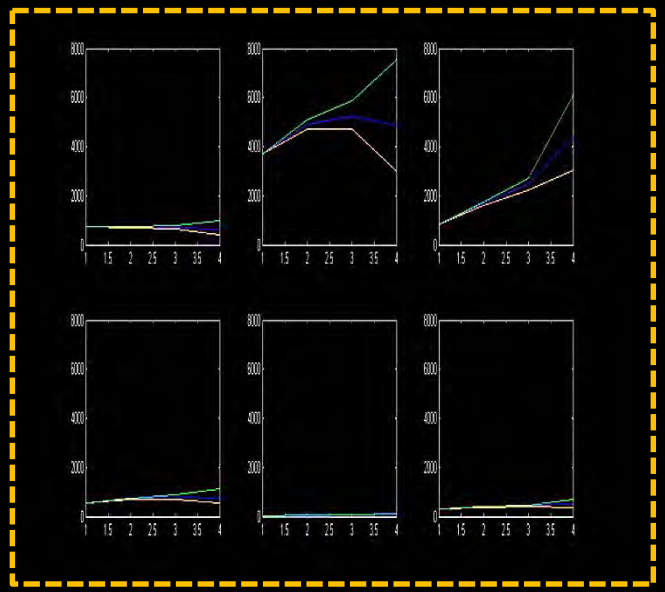
The Potential Impact of Climate Change

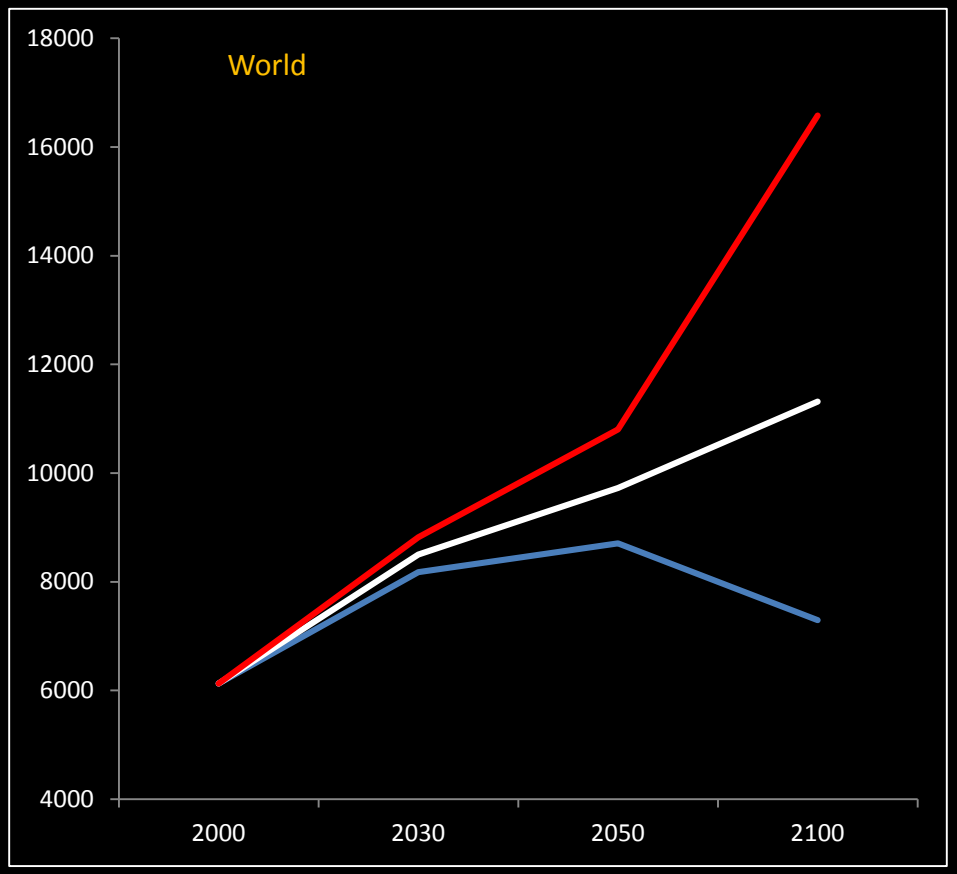
Existing Increase of the Cooling Load of Individual Buildings from 144 Case studies around the World



The Potential Impact of Population Increase

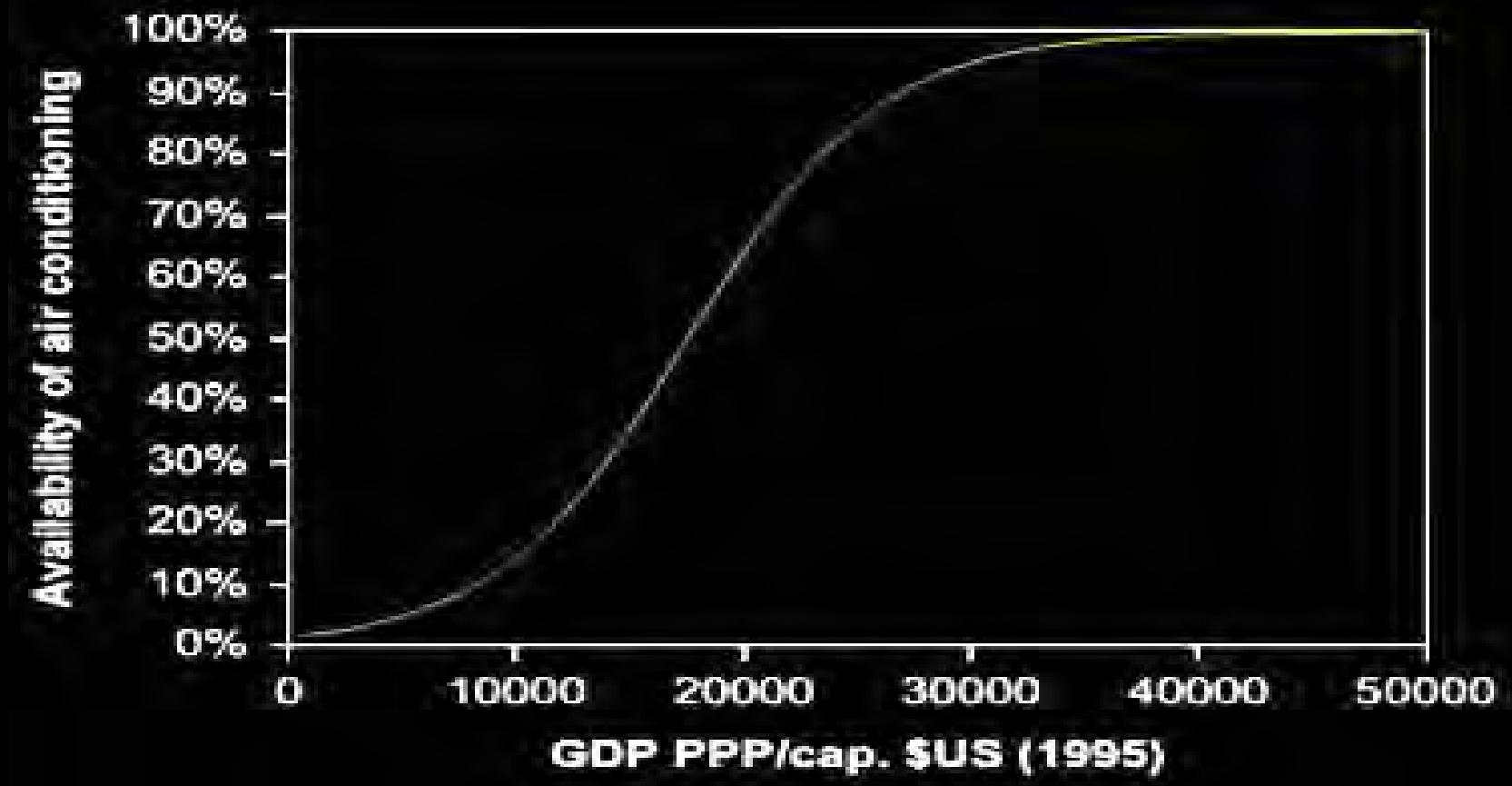
Forecasts of the United Nations about the Future Population





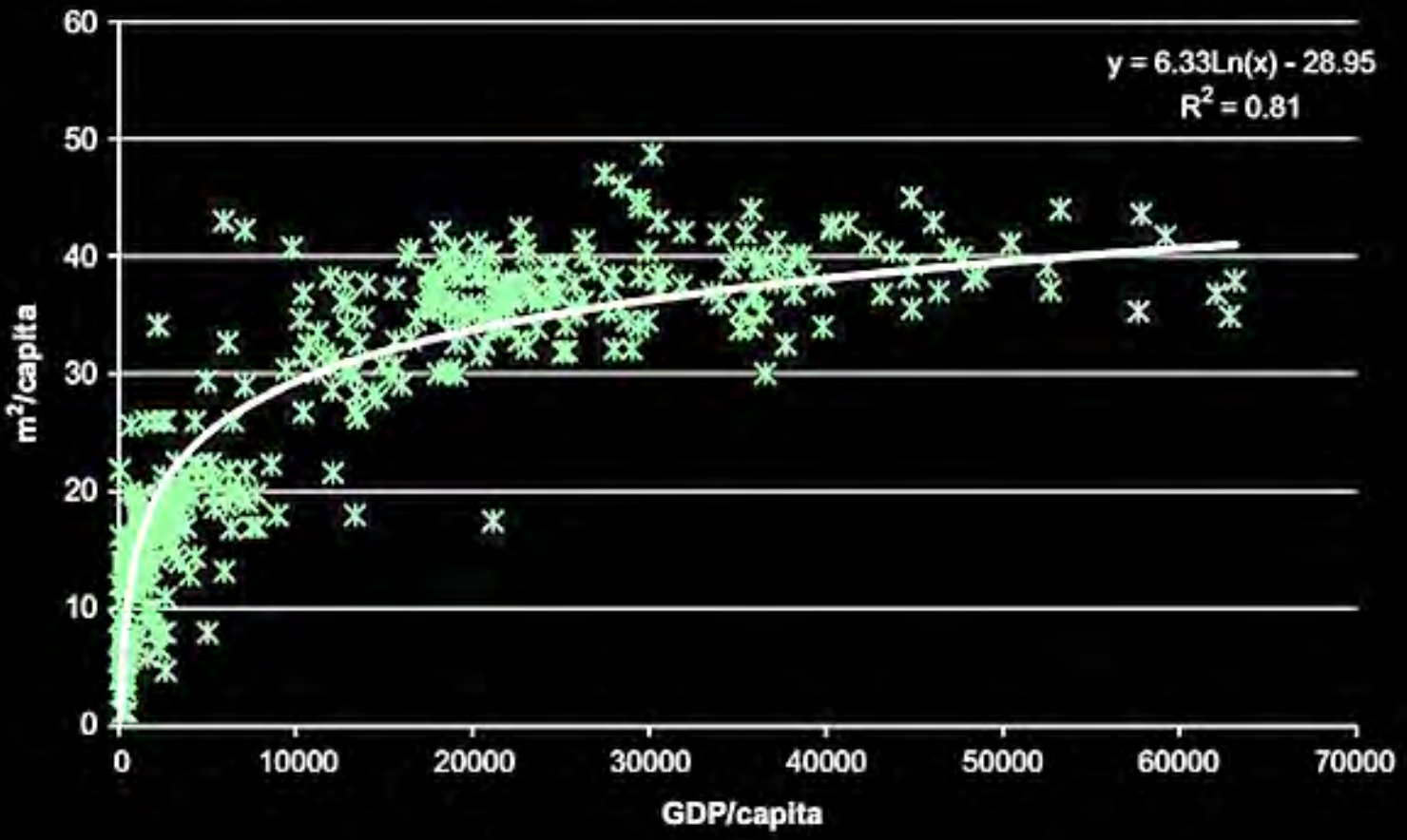
The Potential Impact of Increased Income

Air Conditioning Penetration depends on the Income Levels



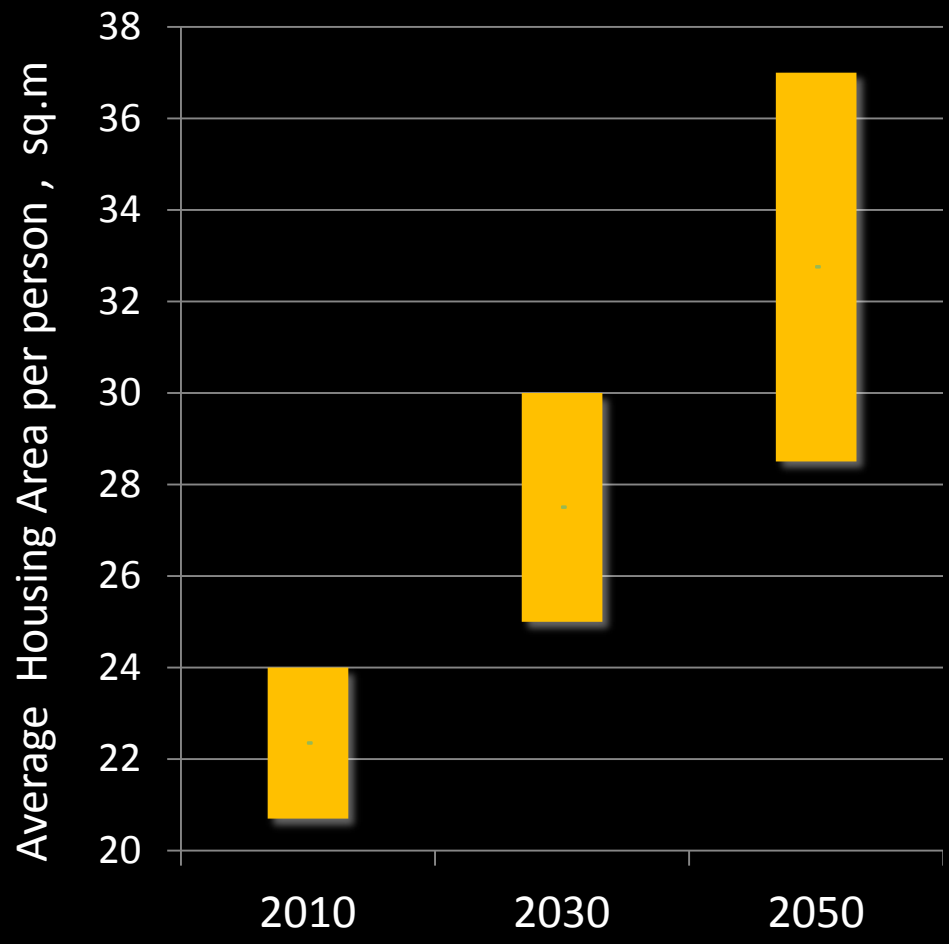
The Potential Impact of Increased Income

Air Conditioning Penetration depends on the Income Levels



The Potential Impact of Housing Size

How much the Future Size of Houses will be ?



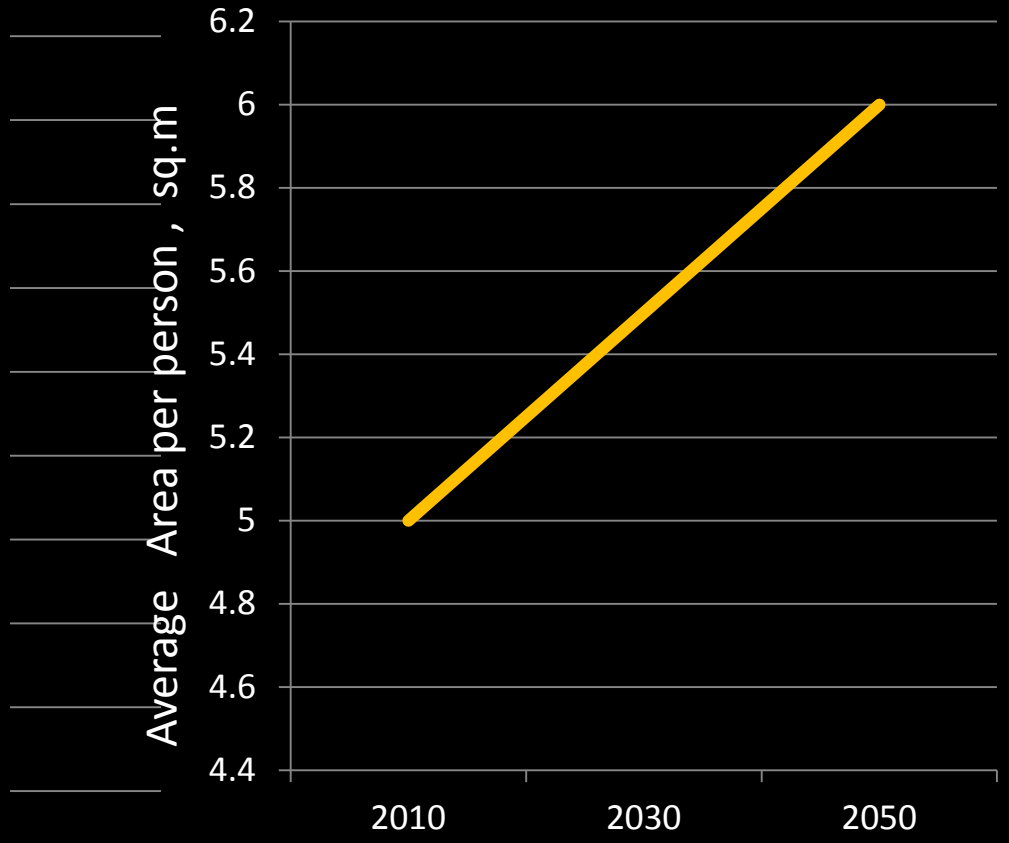
The expected increase of the total residential area between 2005 and 2050 is close to 500%

The Potential Impact of Building Size

How much the Future Size of Commercial buildings will be ?

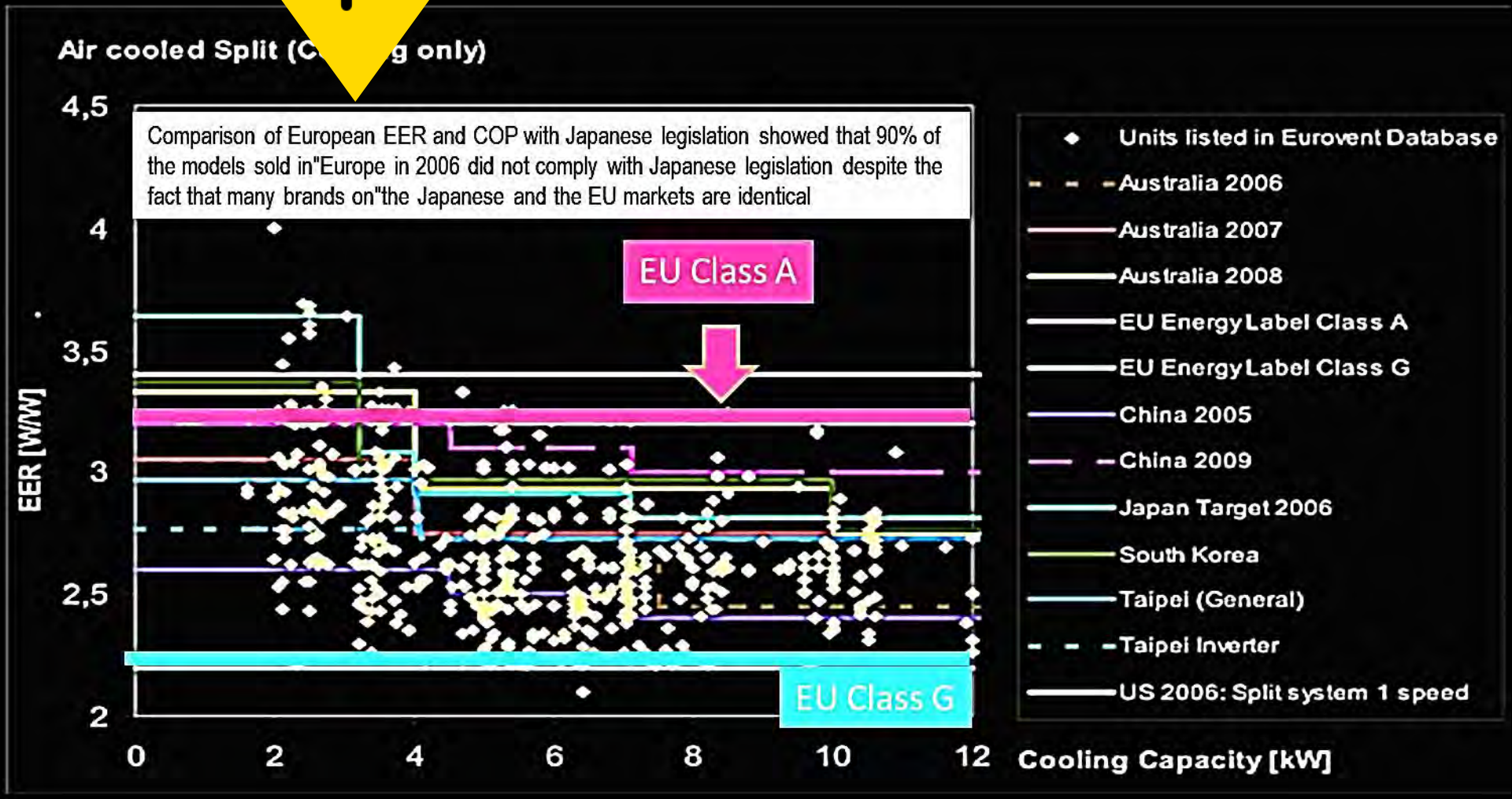
The highest increase rate of the commercial floor area between 2005 and 2050, is expected in North Africa and Middle East area, (549 %), the Central and Eastern Europe, (483 %), and South Asia, (471 %).

The smaller increase is expected in North America, (51 %).



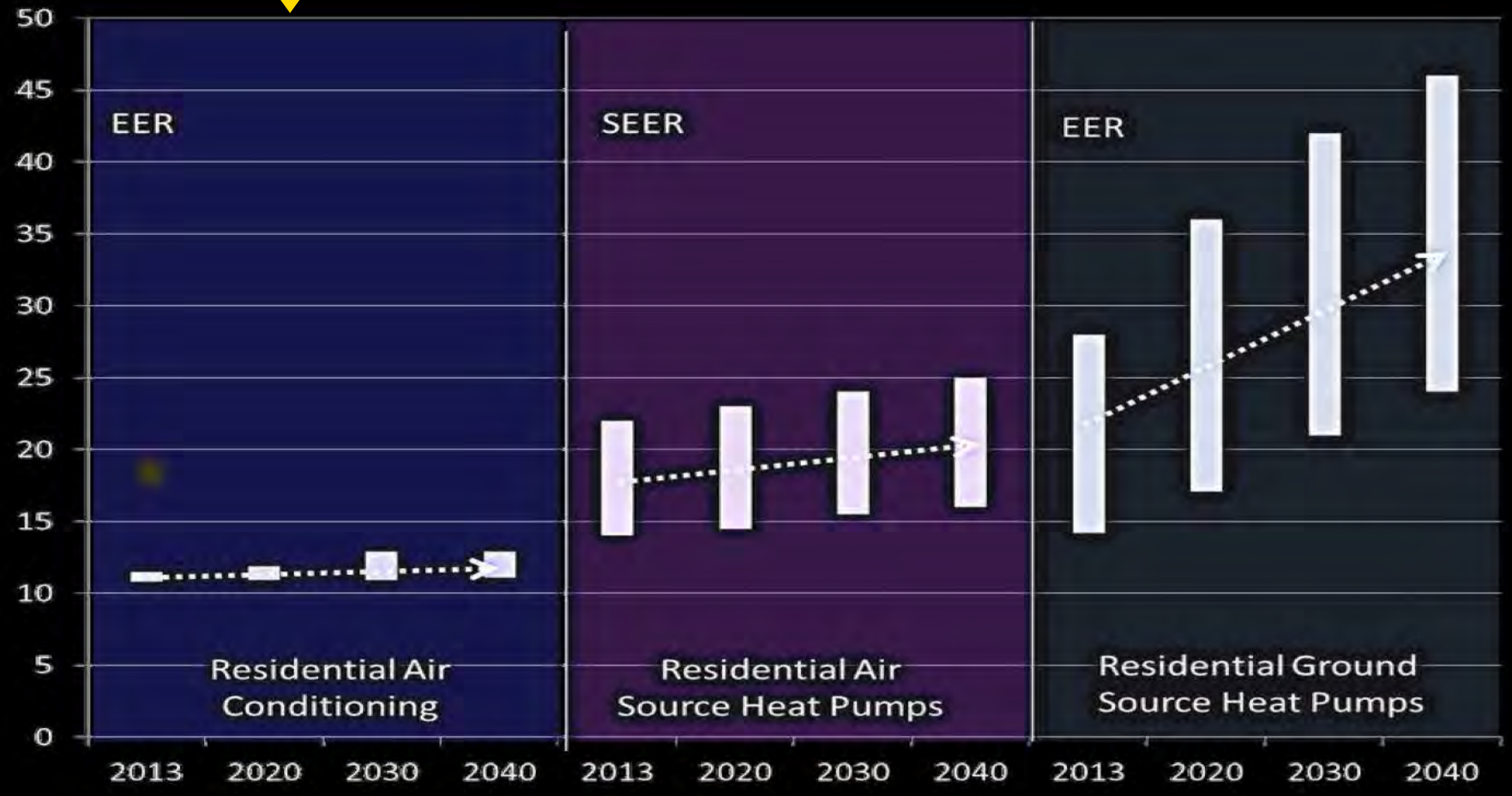
The Impact of Advanced AC Technology

The Actual Efficiency of Air Conditioning



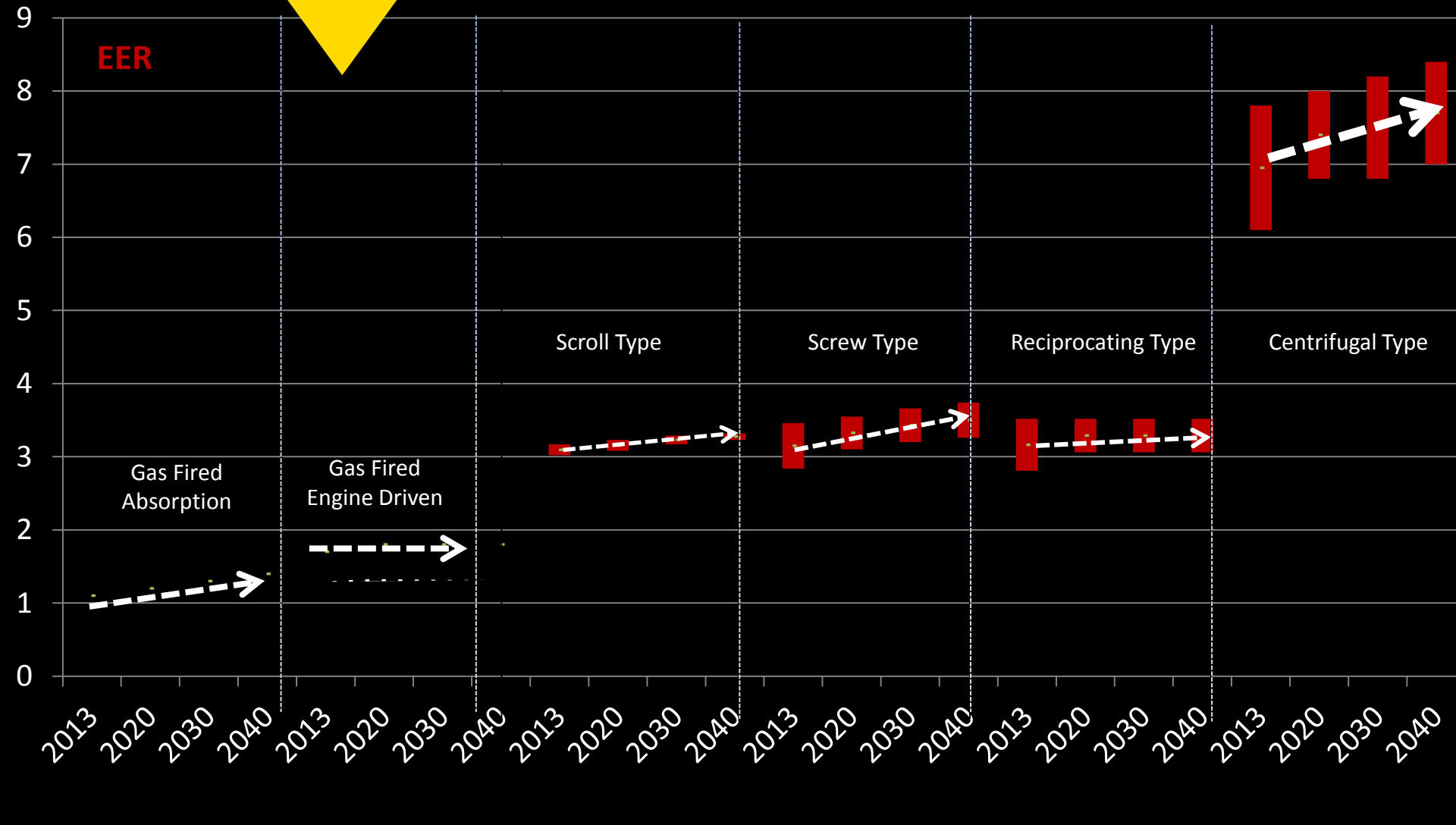
The Impact of Advanced AC Technology

The Future Efficiency of Air Conditioning



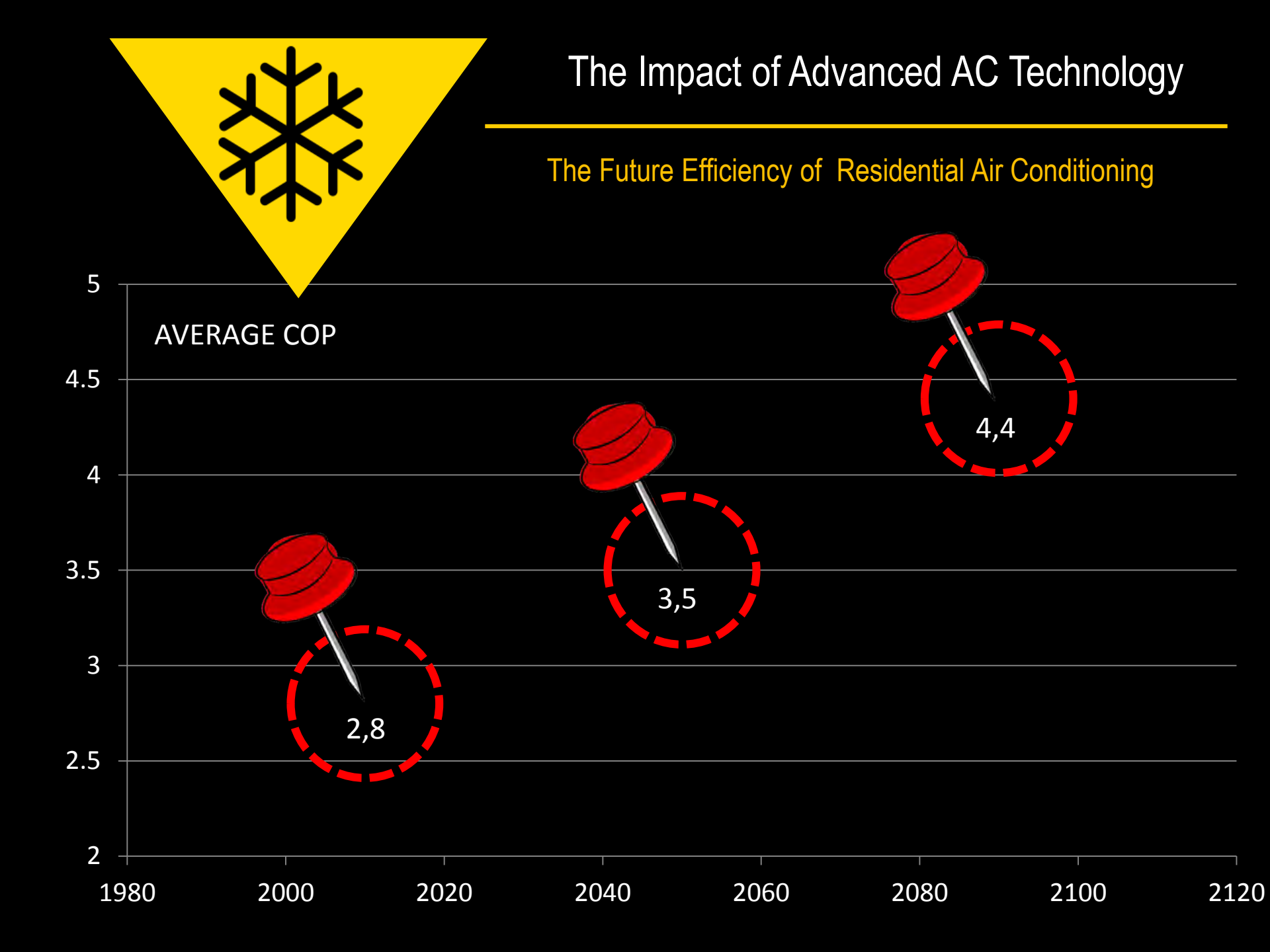
The Impact of Advanced AC Technology

The Future Efficiency of Air Conditioning



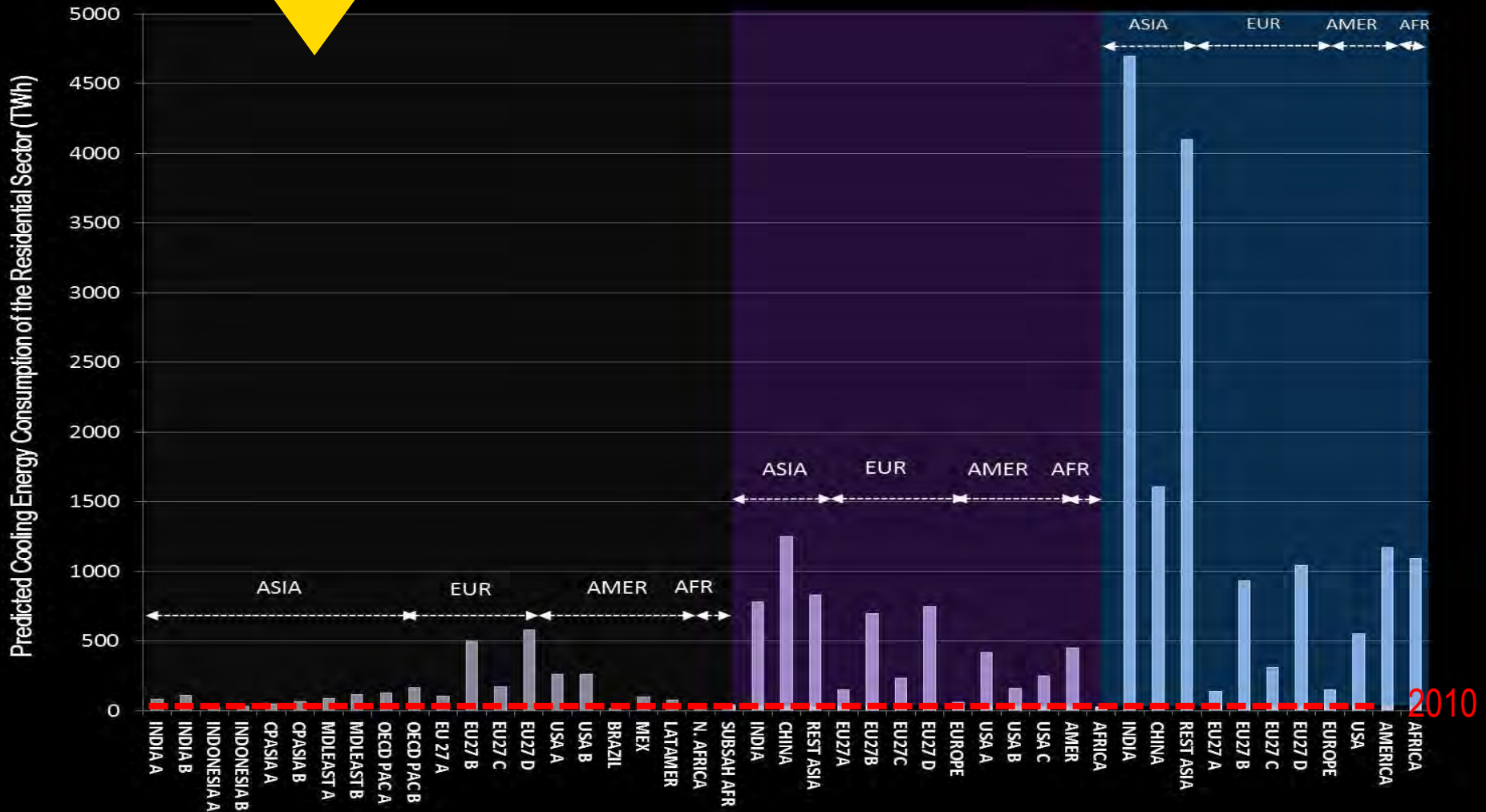
The Impact of Advanced AC Technology

The Future Efficiency of Residential Air Conditioning



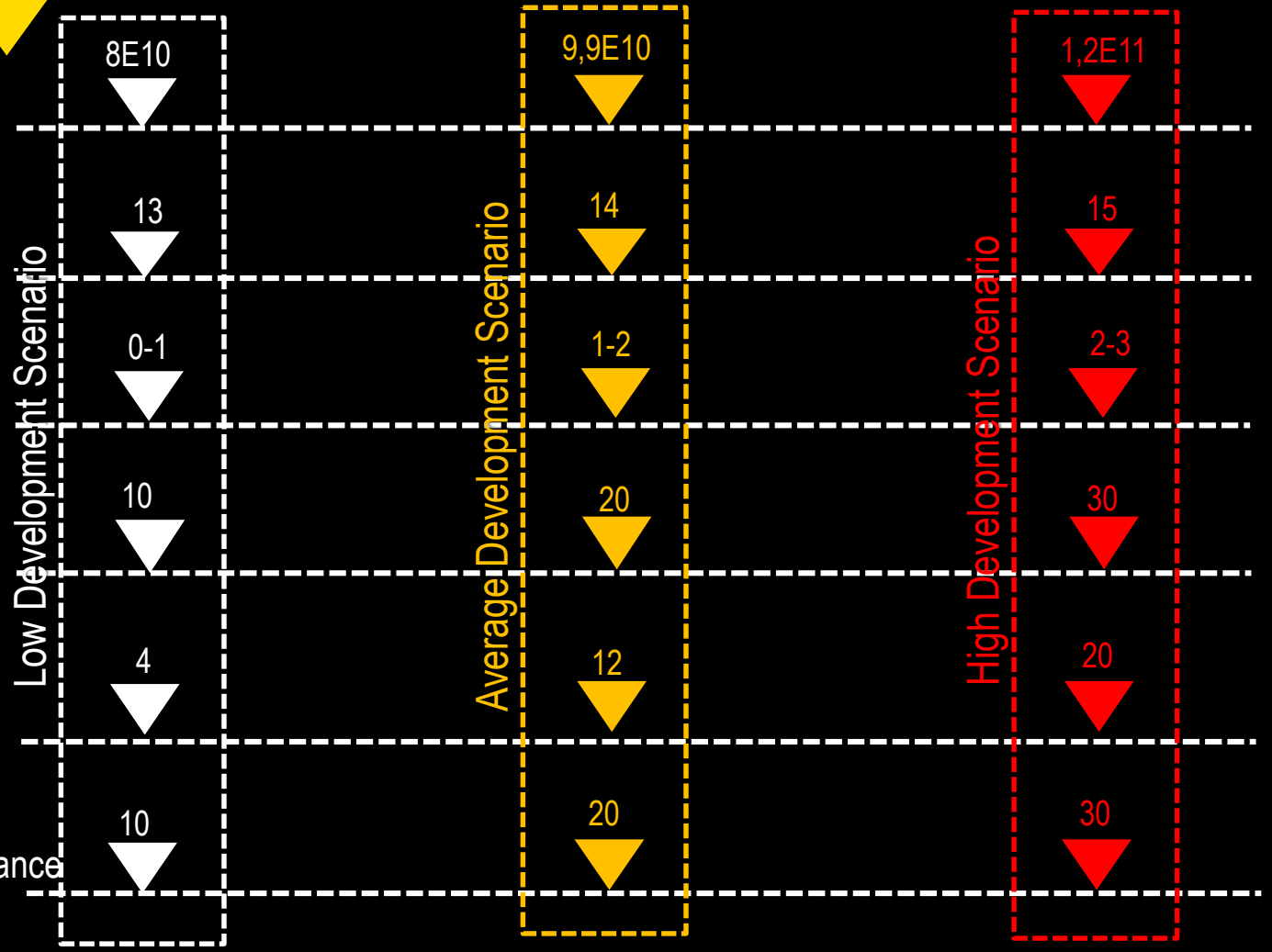
The Impact of Advanced AC Technology

The Future Consumption of Residential Air Conditioning



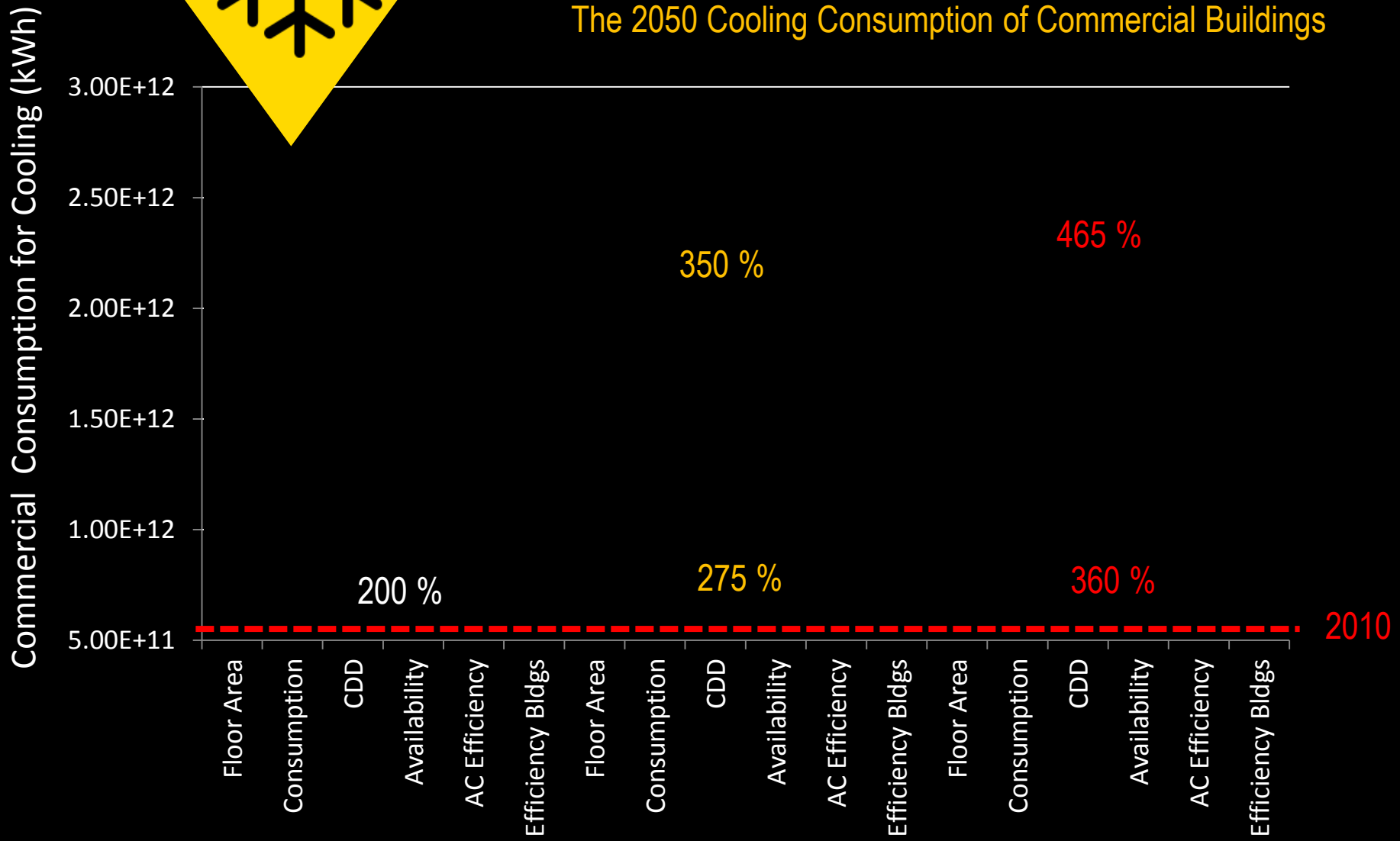
The Future Consumption of Air Conditioning

The 2050 Cooling Consumption of Commercial Buildings



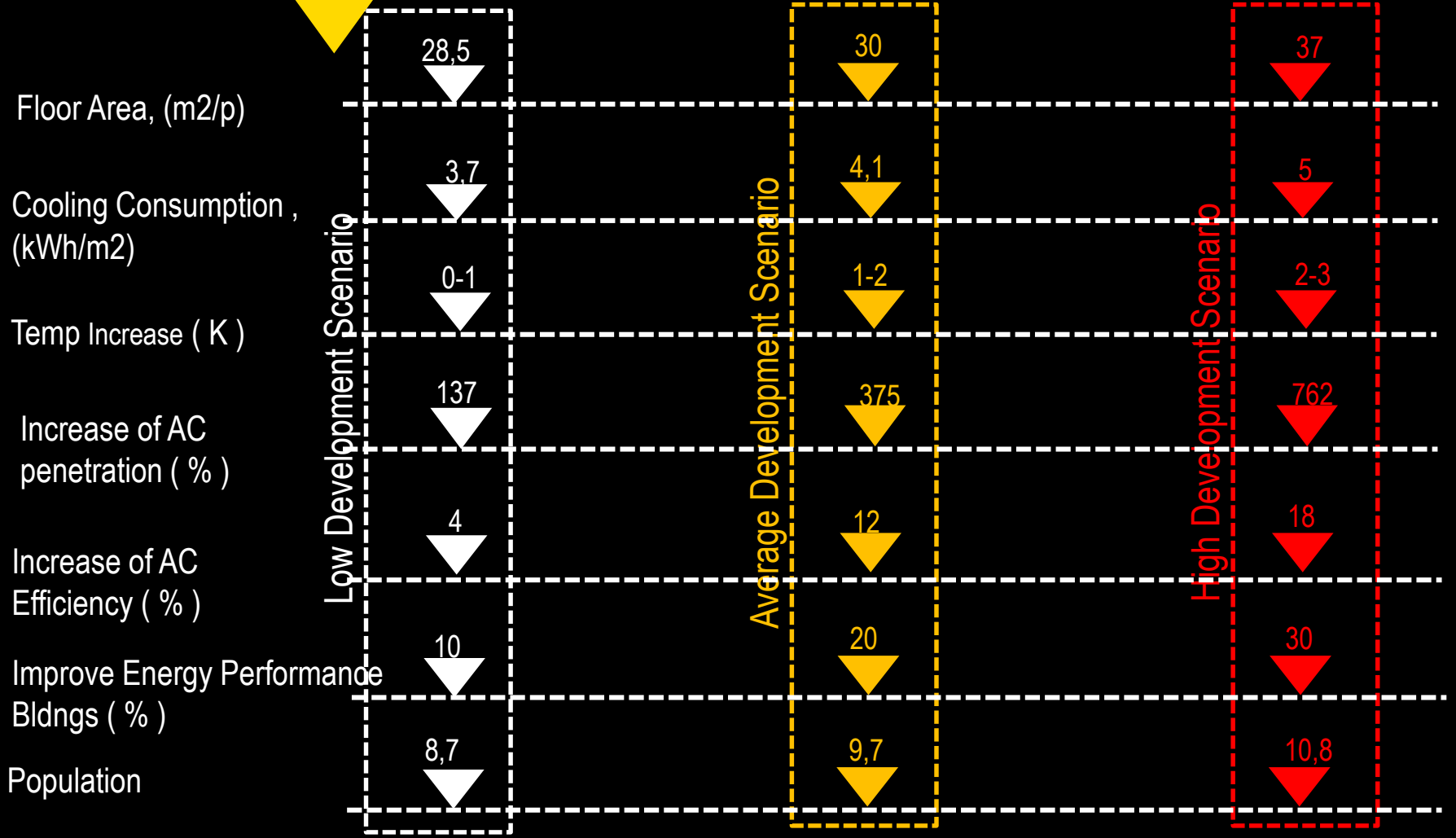
The Future Consumption of Air Conditioning

The 2050 Cooling Consumption of Commercial Buildings



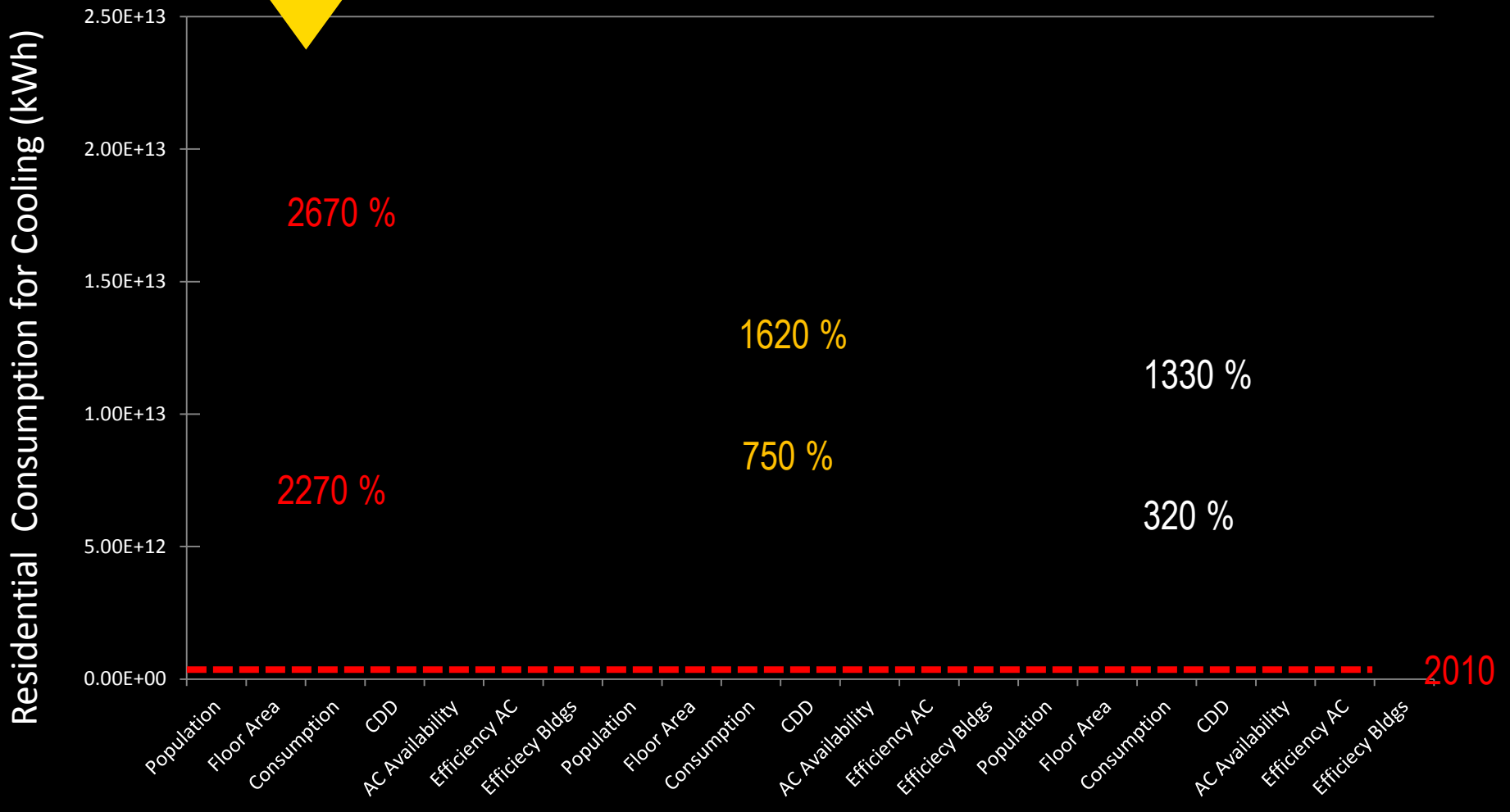
The Future Consumption of Air Conditioning

The 2050 Cooling Consumption of Residential Buildings



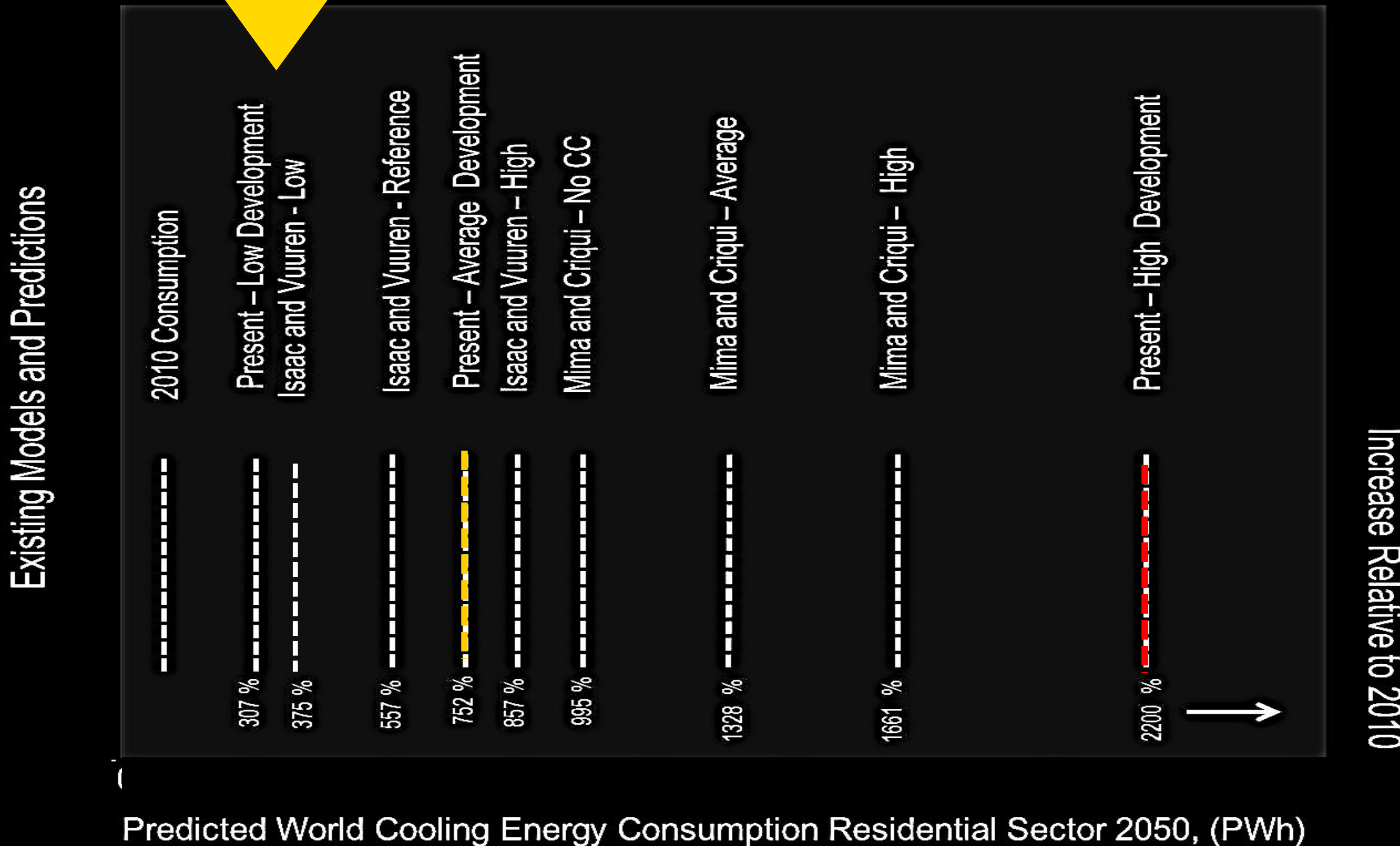
The Future Consumption of Air Conditioning

The 2050 Cooling Consumption of Residential Buildings



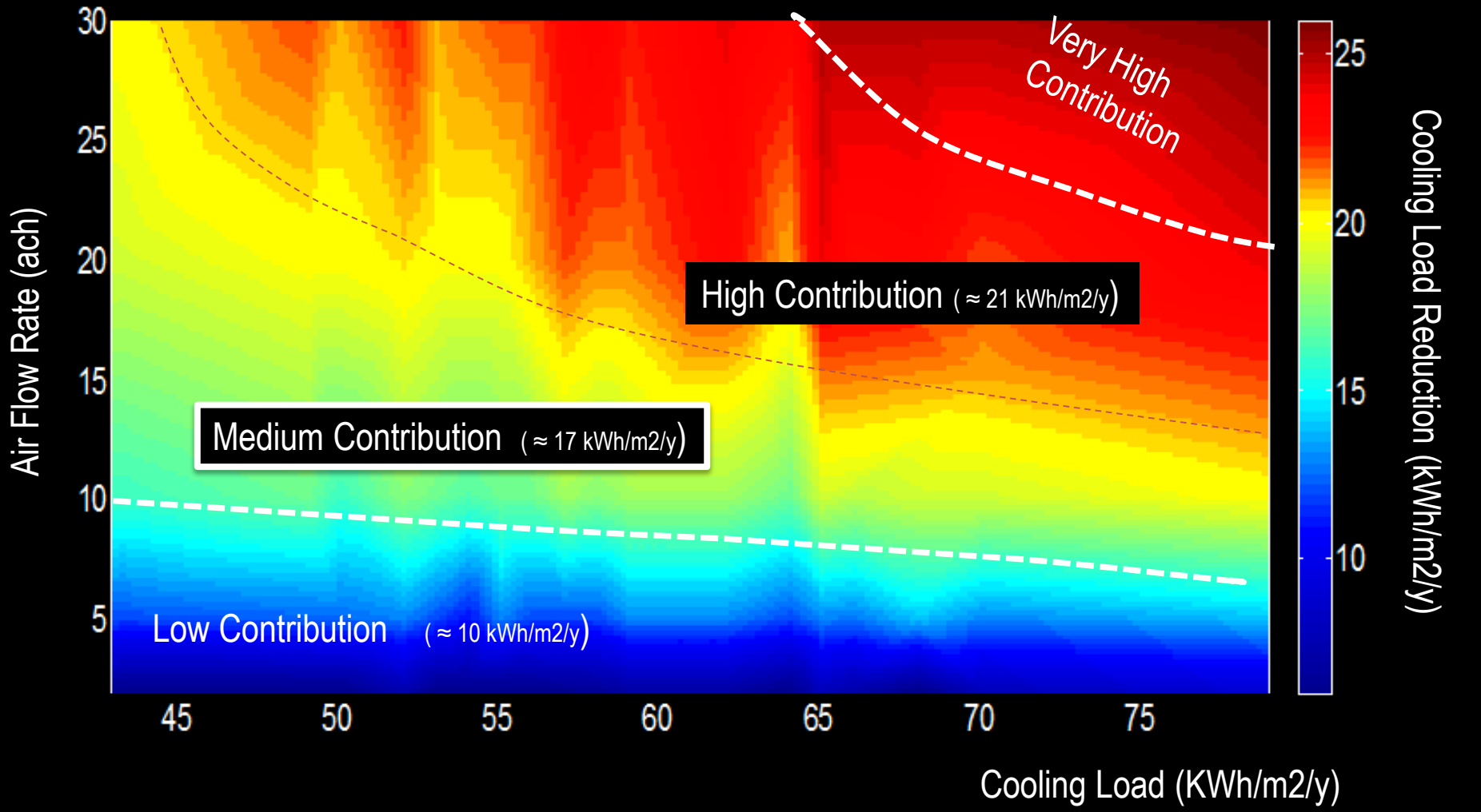
The Future Consumption of Air Conditioning

The 2050 Cooling Consumption of Residential Buildings

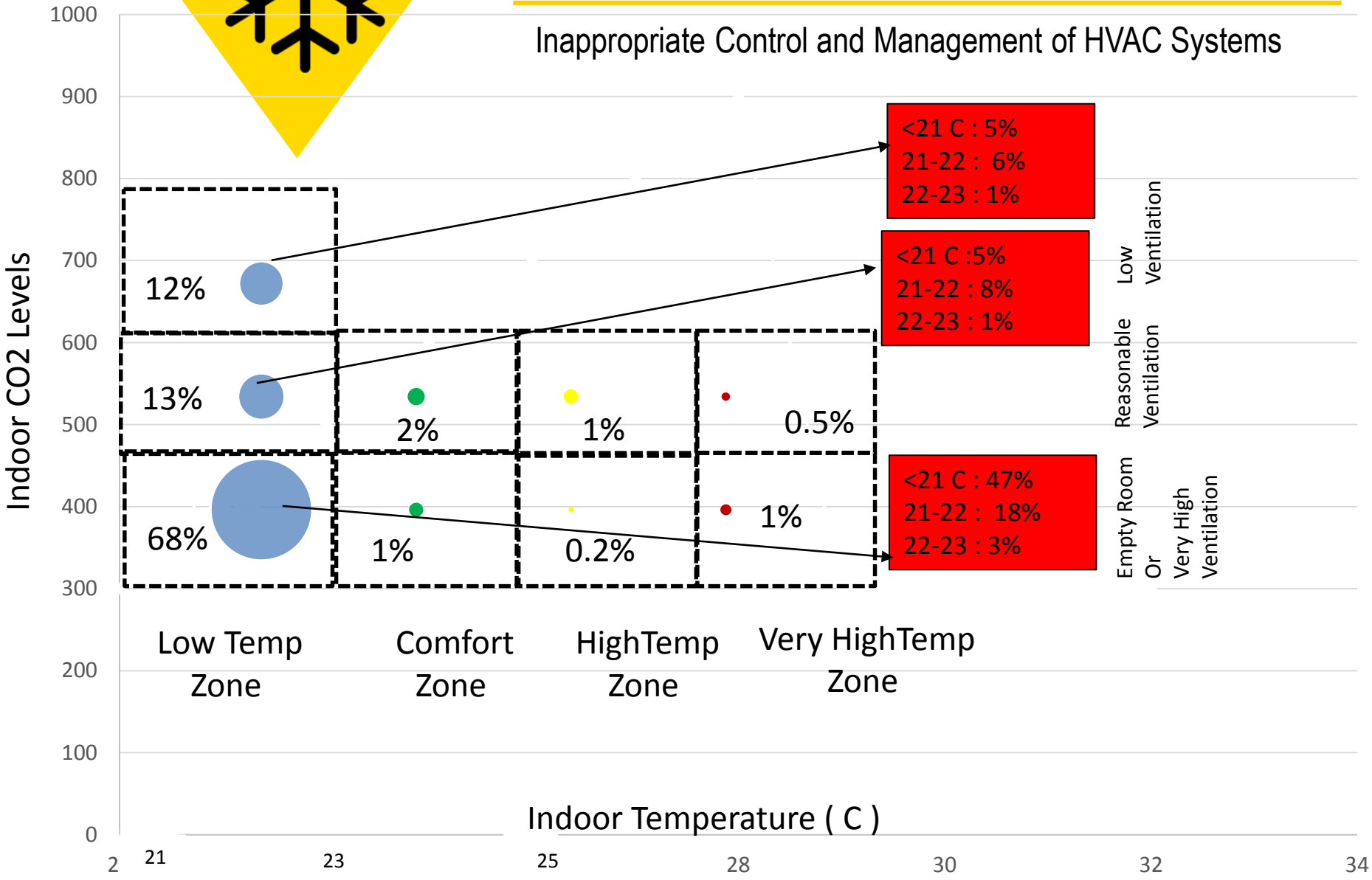


The Potential Contribution of Ventilation

The Theoretical Contribution of Night Ventilation



The Potential Contribution of Ventilation



The Air Conditioning Market

CONCLUSIONS

Local and Global Climate Change, increase of the world's population and potential economic growth result in significant increase of the energy demand for cooling.

While, in 2010, the global cooling consumption of the residential sector represented almost 4,4 % of the total heating and cooling needs of buildings, it is expected to increase up to 35 % in 2050 and 62 % in 2100.

In parallel, although the heating energy demand is expected to remain constant or slightly decrease in the future, the total heating and cooling consumption of residential buildings may increase up to 67 % in 2050 and 166 % in 2100 compared to the 2010 levels intensifying the global energy and environmental problems

The Air Conditioning Market

CONCLUSIONS

Higher energy consumption for cooling is strongly associated with a very significant increase of the peak electricity demand that oblige utilities to build additional power plants to satisfy the extra needs for electricity.

Significant future investments to increase the power capacity may raise the cost of electricity and put in strength the health and the quality of life of the low income and vulnerable population

Cooling the Future

CONCLUSIONS

To face the problem of the future growth of the cooling energy needs and of the associated increase of climatic vulnerability, three major clusters of policy actions may be identified and proposed:

Actions Aiming to Mitigate the Global and Local Climate Change. Decrease of the greenhouse gas emissions and counterbalance of the urban heat island may significantly limit the amplitude of the temperature increase and the strength of the energy impact of the climatic change.

Policies aiming to reduce the sources and enhance the sinks of temperature anomaly, like the use of clean fuels and mainly of renewable sources for power generation, higher energy efficiency, rationalization of the energy demand, intelligent and efficient use of energy, smart and resilient technologies for cities, green energy distribution systems, in association with urban mitigation technologies like cool and green materials and reduction of the anthropogenic heat, could seriously reduce the future demand for cooling, and protect the vulnerable population during the extreme climatic events.

Cooling the Future

CONCLUSIONS

Actions aiming to adapt the Building Sector and improve its Energy Performance.

A massive energy rehabilitation of the existing building stock requires a further reduction of the cost of the energy efficient building technologies.

Given the actual technological status, the necessary investments to reduce drastically the global building energy consumption in the world, are tremendous.

It is characteristic that only in Europe, the necessary investments to achieve an almost 80 % reduction of the building energy needs by 2050 are between 16-24 trillion Euros.

In parallel, the unprecedented urbanization and the increase of the population asks for the construction of billions of new buildings mainly in less developed, quite poor zones of the planet that unfortunately suffer the more the consequences of the climate change.

It is very crucial all these new buildings present significantly low energy consumption through the use of reduced cost energy efficiency technologies.

Cooling The Future

CONCLUSIONS

Actions aiming to Improve the Efficiency of Mechanical Air Conditioning and Alternative Cooling Technologies.

Although, the efficiency of the mechanical air conditioning systems has improved impressively, it is not sufficient to counterbalance the tremendous increase of the future cooling demand.

Breakthrough cutting edge technologies have to be developed through intensive scientific and industrial research.

In parallel, the performance of the alternative cooling dissipation technologies associated with the use of low temperature environmental sinks has to improve further in order to provide low cost and reliable coverage of a fraction of the cooling needs.