INVESTIGATION ON STRATERGIES TO MINIMIZE IMPACTS OF GLOBAL TEMPERATURE RISE ON AIR CONDITIONING COOLING LOAD DEMAND OF EXISTING BUILDINGS

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DECLARATION

I declare that this is my own work, and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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ABSTRACT

Energy demand for building air conditioning and heating account for a significant fraction of the global electricity demand. With global average temperatures projected to increase throughout the 21st century, building energy demand and consumption are slated to also increase. Even though climate resilient building energy management has been identified as a key research area to date, there have been a very little studies conducted to estimate the sensitivity of electricity demand for air conditioning to the climate variability. Most of the energy efficient building codes are mainly focused on new buildings, while the existing buildings pose a significant threat to the building air conditioning energy loads. The localized studies are important in this regard, as the air conditioning loads significantly vary with the local ambient conditions. The impacts of climate change on building air conditioning energy demand for existing buildings can be reduced by establishing future energy demand patterns and by effective usage of passive cooling strategies. Hence, this study focused on investigating the current demand for building air conditioning in selected existing buildings and forecast energy demand for predicted future climate scenarios to establish the electricity demand patterns and investigate effectiveness of passive cooling strategies to counteract the effects of climate change on cooling energy usage of existing buildings. The study used data driven black box and hybrid grey box models to predict the indoor temperature using RCP emission scenarios. The model results were then used to predict the cooling demand increase for the selected building zones. It was observed that cooling demand can increase on average by 20% and 50% by 2035 and 2090 respectively while the suggested mitigation tactics are able to reduce the demand increase by approximately 30%. The knowledge gained by the investigation will have a significant importance in terms of mitigating climate change challenges and identifying counteracting measures in neutralizing climate effect in building cooling energy in different climate environments.

Keywords: Climate change, Building energy, Cooling energy demand mitigation, Energy demand prediction, Global warming

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LIST OF ABBREVIATIONS

Abbreviation	Description
ACCA	Air Conditioning Contractors of America
ACH	Air Changes per Hour
ANN	Artificial Neural Networks
ARI	Air conditioning and Refrigeration Institute
ARX	Autoregressive with Exogenous Input
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CDD	Cooling Degree Days
CEA	Central Environmental Authority
CFD	Computational Fluid Dynamics
CIBSE	Chartered Institute of Building Services Engineers
CLTD/CLF	Cooling Load Temperature Difference/Cooling Load Factor
COP	Coefficient of Performance
EPW	EnergyPlus Weather
FAR	First Assessment Report
GAST	Global Average Surface Temperatures
GDP	Gross Domestic Product
GHG	Greenhouse Gasses
HB	Heat Balance
HDD	Heating Degree Days
HDKR	Hay-Davies-Klucher-Reindall
HVAC	Heating Ventilation and Air Conditioning

IES VE	Integrated Environmental Solutions Virtual Environment
IPCC	Intergovernmental Panel on climate Change
LPD	Lighting Power Density
MAE	Mean Absolute Error
MPC	Model Predictive Control
MSE	Mean Squared Error
NARX	Nonlinear Autoregressive with exogenous input
NRMSE	Net Root Mean Squared Error
PMV	Predictive Mean Vote
RCP	Representative Concentration Pathways
RH	Relative Humidity
SCLF	Solar Cooling Load Factor
RMSE	Root Mean Squared Error
RNG	Re-Normalization Group
RTS	Radiant Time Series
SC	Shading Coefficient
SCLF	Solar Cooling Load Factor
TAR	Third Assessment Report
TETD/TA	Total Equivalent Temperature Difference/Time Average
Toe	Ton of oil equivalent
UHI	Urban Heat Island
WFR	Wall to Floor Ratio
W-L-R	Wall to Length Ratio
WWR	Wall to Window Ratio

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