

Contents

List of Figures	xiii
List of Tables	xv
Abbreviations	xvii
Preface	xix
1 Introduction	1
1.1 Problem Formulation	3
1.2 Scope of the work	4
1.3 Objective	5
1.4 Methodology	6
1.5 Significant Contribution	8
1.6 Organization of the Thesis	9
1.7 Proposed model Novelty	13
2 Literature Review	15
2.1 Related Work on EF	16
2.1.1 LTEF	16
2.2 Related Work on predicting energy usage based on occupancy pat- terns.	19
2.2.1 Challenges in Energy Prediction: A Review of Modern Ap- proaches	19
2.2.2 Exploring Energy Prediction Models: Strengths, Drawbacks, and Future Directions	21
2.3 Current research in LT and occupancy-based energy prediction for SBs	24
2.4 Research Gap	29
2.4.1 Energy Optimization	29
2.4.2 LTEF in SBs using AI, ML, and DL	30
2.4.3 Occupancy based LTEF in SBs	30
2.4.4 Federated and XAI in role in LTEF in SBs	31
2.5 Research Plan	32
2.5.1 LTEF Framework	32

2.5.2	TCN-GRU Hybrid Model for Energy Storage Optimization . . .	32
2.5.3	TCN-Bi-LSTM Hybrid Approach for Occupancy-Based Forecasting	33
2.6	Summary: Overall Observations	33
3	Data Acquisition and Processing	35
3.1	Introduction	36
3.2	Dataset Description -1	36
3.3	Dataset Description-2	36
3.3.1	Preliminary Analysis	40
3.3.2	Data Preprocessing	43
3.3.3	Feature Extraction	45
3.4	Experimental and Simulation setup	47
3.4.1	Performance Measures	47
3.4.2	Simulation setup	49
4	Modern Machine Learning Solution for Electricity Consumption Management in Smart Buildings	51
4.1	Introduction	51
4.2	Theoretical Background	53
4.2.1	Temporal Convolutional Network (TCN)	53
4.2.2	Gated Recurrent Unit (GRU)	55
4.3	Proposed Methodology	57
4.4	Experimental Setup and Result Discussion	58
4.4.1	Results Evaluation	58
4.4.2	Managerial Implications	61
4.5	Summary	63
5	Energy Consumption Prediction of Smart Buildings: A Federated Learning and XAI from Consumer Endpoint	65
5.1	Introduction	66
5.2	Theoretical Background	67
5.2.1	Problems and Motivations	67
5.3	Explainable AI (XAI)	68
5.3.1	Model Overview	69
5.4	Proposed Methodology	71
5.5	Experimental Setup and Result Discussion	74
5.5.0.1	Univariate ML model	74
5.5.0.2	Univariate DL model	75
5.5.0.3	Univariate HDL model	77
5.5.1	Multivariate ML model	78
5.5.1.1	Multivariate DL model	78
5.5.1.2	Multivariate HDL model	81
5.5.1.3	Federated learning model	82
5.5.2	Explainable artificial intelligence (XAI) analysis	84

5.6	Summary and Conclusion	84
6	Self-Attention-Driven DL for accurate electricity forecasting in smart building environments	87
6.1	Introduction	87
6.2	Theoretical Background	88
6.2.1	Attention Mechanism	89
6.2.2	Model Overview	90
6.3	Proposed Methodology	91
6.4	Experimental Setup and Result Discussion	91
6.4.1	Results Evaluation	93
6.4.1.1	Performance Evaluation	95
6.4.1.2	Visualization and Analysis	95
6.5	Summary	96
7	Self-Attention-Based Neural Architectures for Energy Forecasting in Intelligent Building Environments	99
7.1	Introduction	99
7.2	Theoretical Background	100
7.3	Proposed Methodology	101
7.4	Experimental Setup and Result Discussion	103
7.5	Summary	107
8	Conclusion and Future Work	109
8.1	Conclusions	109
8.2	Future Directions	111
A	List of Publications	113
	Bibliography	115