

Contents

List of Tables	ix
List of Figures	xi
1 Introduction	1
1.1 Motivation	1
1.2 Proposed Hypothesis	2
1.2.1 General Objective	2
1.2.2 Specific Objectives	2
1.3 Contributions	3
1.4 Structure of the Document	3
2 Literature Review	5
2.1 Network Investment with Distributionally Robust Security	5
2.2 Resilient Network Design with Decision Dependent Ambiguity	6
3 Network Investment with Distributionally Robust Security	9
3.1 Mathematical Formulation	9
3.1.1 Overview	9
3.1.2 Model	11
3.1.3 Ambiguity Sets	15
3.2 Solution Methodology	17
3.2.1 Problem reformulation	18
3.2.2 Subproblem	19
3.2.3 Master problem	19
3.2.4 Solution algorithm	20
3.3 IEEE RTS Case Study	20
3.3.1 Input data	20
3.3.2 Case studies	21
3.3.3 Results and discussion	23
3.3.4 Overall costs and risks: out-of-sample analysis	25
3.4 118-busbar System Case Study	26
3.4.1 Input data	26
3.4.2 Results and discussion	26
4 Resilient Network Design with Decision Dependent Ambiguity	29
4.1 Resilient grid planning	32

4.1.1	Earthquake effects on the grid	32
4.1.2	Resilience enhancing strategies	33
4.2	Mathematical model	34
4.2.1	Overview	34
4.2.2	Ambiguity set	34
4.2.3	Complete formulation	36
4.2.4	Operation under contingency	37
4.3	Solution methodology	39
4.3.1	Compact formulation	39
4.3.2	Problem reformulation	40
4.3.3	Subproblem	41
4.3.4	Master problem	42
4.3.5	Solution methodology	42
4.4	Illustrative 3-bus Study Case	43
4.4.1	Description	43
4.4.2	Results and analysis	45
4.5	Real-Scale Study Case	47
4.5.1	Description	47
4.5.2	Results and analysis	49
5	Conclusions and Further Work	53
5.1	Conclusions	53
5.2	Further Work	54
6	Bibliography	55