

Contents

I. Abstract	vii
II. List of Abbreviations	ix
III. List of Symbols	xiii
1. Motivation	1
1.1. Introduction	1
1.2. Objectives and Structure	5
2. Theory: Performance Assessment of PV Battery Systems	7
2.1. Performance in the Context of PV Battery Systems	7
2.2. Influences on the Performance of PV Battery Systems	8
2.2.1. Power conversions	9
2.2.2. Efficiency of PV inverters	11
2.2.3. Efficiency of battery systems	13
2.2.4. Standby operation and auxiliaries	15
2.2.5. Effectiveness	15
2.3. Requirements for Key Performance Indicators	16
3. Development of Performance Test Procedures	19
3.1. Fundamentals for Test Procedure Development	19
3.2. Application Test Procedures	22
3.2.1. Fundamentals for Application Tests	22
3.2.2. Test Profiles for Application Tests	23
3.3. Modular Test Procedures	29
3.3.1. Fundamentals of modular tests	29
3.3.2. Modular tests for combined performance assessment	31
3.3.3. Modular tests for application-independent performance assessment	34

4. Development of Key Performance Indicators	37
4.1. Hybrid Benchmark	37
4.2. SPI (System Performance Index)	41
4.3. Euro- η for PV Battery Systems	45
4.4. Conclusions of KPI development	47
5. Application of Test Procedures in Laboratory	49
5.1. Laboratory Equipment and Test Bench	49
5.2. Presentation of Devices Under Test	51
5.3. Measurements According to Modular Test Procedures	55
5.3.1. Conversion efficiencies	55
5.3.2. Battery efficiency	61
5.3.3. Standby consumption	62
5.3.4. Control deviations	63
5.4. Measurements According to the Application Test Procedure	67
5.4.1. Results of Four-day Application Test	68
5.4.2. Results of Three-day Application Test and Comparison to Four-day Test	72
5.4.3. Comparison with Results of Modular Tests	74
5.5. Conclusion of Laboratory Investigations	82
6. Application of Key Performance Indicators	85
6.1. KPI Calculation Applying Measurement Results	85
6.2. KPI Determination Applying Generic Performance Models	89
6.3. KPI Assessment	93
6.4. Conclusions of KPI application	99
7. Conclusions	101
7.1. Conclusions and Outlook	101
7.2. Contributions	102
Appendices	105
A. Derivation of Test Profiles for Application Tests	107
A.1. Related works	107
A.2. Database	108
A.3. First step - Profile Analysis	109
A.4. Second step - PV battery system operation analysis	114
B. Detailed Tables and Additional Figures of Measurement Results	119

C. Additional Table for KPI Calculation	125
D. Publications	127
List of Figures	131
List of Tables	135
Bibliography	137