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Management of distributed energy storage systems based on electrically chargeable vehicle batteries -
Part 1: Use cases and architectures

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CONTENTS

FOREWORD 5
INTRODUCTION 7
1 Scope 9
2 Normative references 11
3 Terms, definitions and abbreviated terms 11
3.1 Terms and definitions 11
3.2 Abbreviated terms 19
4 Electric vehicle charging stations (EVCS) – actors and station configurations 20
4.1 Actors and their interactions 20
4.2 Electric vehicle charging station (EVCS) configurations 23
5 Functional requirements 26
5.1 Data communication 26
5.1.1 General 26
5.1.2 Information model principles 27
5.1.3 Information model compatibility and mapping to other standards 27
5.1.4 Communication transport protocol 27
5.1.5 Message transport 27
5.1.6 Message payload encoding 28
5.1.7 Physical layer 28
5.2 Cybersecurity and privacy 28
5.2.1 General 28
5.2.2 Cybersecurity and privacy perimeter of the IEC 63382 series 28
5.2.3 Cybersecurity and privacy risks 28
5.2.4 Cybersecurity principles and requirements 31
5.2.5 Cybersecurity and privacy measures 32
5.3 Grid support functions and flexibility services 32
5.3.1 Grid support functions – General principles 32
5.3.2 Flexibility services 33
6 Use cases 34
6.1 Overview of use cases 34
6.2 Flexibility energy transfer use cases 35
6.2.1 Individual EVU recharge at home CS 35
6.2.2 EVU recharge at a visited charging station 45
6.2.3 EV fleet recharge at a private parking 56
6.2.4 Fleet EV recharge at a public parking 61
6.2.5 EV service station – EVSS 70
6.2.6 EV recharge and energy community – use case UC 1.6 78
6.2.7 Bidirectional inverter on board. use case UC 1.7 90
6.3 Flexibility service use cases 98
6.3.1 Flexibility service based on setpoint following – use case UC 2.1 98
6.3.2 Flexibility service based on demand response – use case UC 2.2 103
6.3.3 Flexibility service based on droop control – use case UC 2.3 109
6.3.4 Fast frequency response service – use case UC 2.4 114
6.3.5 V2G for tertiary control with reserve market – use case UC 2.5 119
6.3.6 V2X with dynamic pricing linked to wholesale market price – use case UC 2.6 130

6.3.7 Distribution grid congestion management by EV charging and discharging – Use case UC 2.7 140
6.4 Management of FO interface 151
6.4.1 Enrolment of CSO/CSP by flexibility operator – use case UC 3.1 151
6.4.2 Credentials handling – use case UC 3.2 155
6.4.3 Management of flexibility service contracts – use case UC 3.3 159
6.4.4 Proof of flexibility service – use case UC 3.4 163
6.4.5 Discover flexibility service contract holders – use case UC 3.5 168
6.4.6 flexibility service Phone App – use case UC 3.6 172
Annex A (informative) Energy flexibility service use cases and DER operational functions 177
Annex B (informative) Supplementary information from Japanese energy markets 186
B.1 UC 2.5: V2G for tertiary control with reserve market 186
B.2 UC 2.6: V2X with dynamic pricing linked to the wholesale market 188
B.3 UC 2.7: Distribution grid congestion management by EV charging and discharging 191
Annex C (informative) Energy flexibility services 193
Bibliography 195

Figure 1 – Primary actors and secondary actors of the EV infrastructure 20
Figure 2 – Overall diagram with actors of the EV infrastructure without roaming 21
Figure 3 – Overall diagram with actors of the EV infrastructure with roaming 21
Figure 4 – EVCS with multiple EVSE and DC bus, DC charge (diagram 1) 24
Figure 5 – EVCS with multiple EVSE and AC bus, DC charge (diagram 2) 24
Figure 6 – EVCS with multiple EVSE and AC bus, AC charge without off board power converter (diagram 3) 25
Figure 7 – EVCS with single EVSE, AC charge without off board power converter (diagram 4) 25
Figure 8 – EVCS with single EVSE, DC charge (diagram 5) 26
Figure 9 – IEC 63382 use case structure 29
Figure 10 – UC 1.2 structure 29
Figure 11 – UC 1.2 compromised communications 30
Figure 12 – AC–DC power conversion generic diagram 32
Figure 13 – Flexibility services by FO, basic principle of operation 34
Figure 14 – Sequence diagram of UC 1.1 scenario 1 – CSBE is present 41
Figure 15 – Sequence diagram of UC 1.1 scenario 2 – CSBE is not present 45
Figure 16 – Sequence diagram of UC 1.2 scenario 1 – FS session is controlled by V-CSO 52
Figure 17 – Sequence diagram of UC 1.2 scenario 2 – FS session is controlled by H-CSP 56
Figure 18 – Sequence diagram of UC 1.3 – EV fleet at private parking 61
Figure 19 – Sequence diagram of UC 1.4 – Fleet EV at public parking – Scenario 1 – FS controlled by visited-CSO 67
Figure 20 – Sequence diagram of UC 1.4 – Fleet EV at public parking – Scenario 2 – Execution of a flexibility service controlled by home-CSP 70
Figure 21 – Block diagram of an EV service station power system showing connections between DERs and actors 71

Figure 22 – Sequence diagram of UC 1.5 – EV service station 77
Figure 23 – Block diagram of a prosumer power system showing connections between DERs and actors 79
Figure 24 – Sequence diagram of UC1.6 Scenario 1 – Operation of EC in on grid mode 86
Figure 25 – Sequence diagram of UC1.6 Scenario 2 – Operation of EC in off grid mode 90
Figure 26 – Block diagram of bidirectional inverter onboard 91
Figure 27 – Sequence diagram of UC 1.7 – Bidirectional inverter onboard 97
Figure 28 – Flow chart of use case UC 2.1 102
Figure 29 – Sequence diagram of UC 2.1 – flexibility service based on setpoint following 103
Figure 30 – Sequence diagram of UC 2.2 – flexibility service based on demand response 109
Figure 31 – Sequence diagram of UC 2.3 – flexibility service based on droop control 114
Figure 32 – Interaction of actors in UC 2.4 114
Figure 33 – Sequence diagram of UC 2.4 – Fast frequency response service 119
Figure 34 – Use case diagram 122
Figure 35 – Sequence diagram of UC 2.5 – V2G for tertiary control with reserve market 129
Figure 36 – Use case diagram 133
Figure 37 – Sequence diagram of UC 2.6 – V2X with dynamic pricing linked to wholesale market price 140
Figure 38 – Use case diagram 143
Figure 39 – Sequence diagram of UC 2.7 – Distribution grid congestion management by EV charging and discharging 150
Figure 40 – Sequence diagram of UC 3.1 – Enrolment of CSO/CSP by flexibility operator 155
Figure 41 – Sequence diagram of UC 3.2 – credentials handling 159
Figure 42 – Sequence diagram of UC 3.3 – Management of flexibility service contracts 163
Figure 43 – Sequence diagram of UC 3.4 – Proof of flexibility service 168
Figure 44 – Sequence diagram of UC 3.5 – Discover flexibility service contract holders 172
Figure 45 – Sequence diagram of UC 3.6 – flexibility service phone APP 176
Figure B.1 – Tertiary control execution 186
Figure B.2 – "V2G for tertiary control with reserve market" System Configuration 187
Figure B.3 – Tertiary control result example 187
Figure B.4 – "V2G for tertiary control with reserve market" System Architecture model 188
Figure B.5 – System configuration of "V2X with dynamic pricing" 189
Figure B.6 – Shift of charging time by applying dynamic pricing 189
Figure B.7 – Induction of EV charging/discharging by electricity price 190
Figure B.8 – "V2H with dynamic pricing" system architecture model 190
Figure B.9 – System configuration of "distribution grid congestion management by EV charging and discharging" 191
Figure B.10 – Example of "distribution grid congestion management by EV charging" 191
Figure B.11 – "Distribution grid congestion management by EV charging and discharging" system architecture model 192

Table 1 – List of actors of use cases 22

Table 2 – EVCS Configurations 23
Table 3 – Application of SGAM within IEC the 63382 series 27
Table 4 – Information model mapping or compatibility 27
Table 5 – Business parameters 31
Table 6 – List of use cases and use case groups 35
Table 7 – Additional actors in the UC 2.5 122
Table 8 – Additional actors in the UC 2.6 134
Table 9 – Additional actors in the UC 2.7 143
Table A.1 – DER functions, roles and information exchanges. flexibility services that can be requested by FO to EVCS 178

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Management of distributed energy storage systems based on electrically chargeable vehicle batteries - Part 1: Use cases and architectures

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IEC 63382-1 has been prepared by IEC technical committee 69: Electrical power/energy transfer systems for electrically propelled road vehicles and industrial trucks. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
69/1073/FDIS	69/1093/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 63382 series, published under the general title *Management of distributed energy storage systems based on electrically chargeable vehicle batteries*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

– reconfirmed,

– withdrawn, or

– revised.

INTRODUCTION

The high share of renewable energy sources (RES) connected to the grid, because of their intermittent and not-programmable nature, imposes a change in the management of the electrical network.

The replacement of conventional generators with the RES static power converters reduces the total rotating inertia connected to grid.

An increasing number of distributed energy resources (DERs), consisting in small generators, energy storage systems and controllable loads, is connected to the distribution networks, which become "active", that is, capable not only of absorbing energy from the transmission network, but also of supplying energy in the opposite direction.

The transition to an "All Electric Society", which involves the use of electric energy in the transportation (e-mobility) and in the building heating and conditioning systems (heat pumps), increases the demand of electricity and imposes additional stress on the existing electrical power systems.

Power unbalances, network congestions and voltage fluctuations may happen more frequently.

A more suitable way to manage the electrical network and to dispatch the energy resources is unavoidable to meet these changes.

The energy flexibility, which is the ability to adjust power generation and/or demand, represents a solution and it is applicable to DERs.

The growth of electric vehicle (EV) circulation, associated with the expansion of the EV charging infrastructure and the advent of smart charging (V1G) and vehicle to grid (V2G) technologies are creating a large number of DERs in the mobility sector.

In fact, the pair EVSE-EV can be considered as a DER, since it can operate as a generator in V2G mode and as a controllable load in smart charging (V1G). Furthermore, the EV battery is a mobile energy storage system.

Distributed energy storage systems (DESS), based on electrically chargeable vehicle batteries (ECV-DESS), can be created by aggregating several EVs connected to the charging infrastructure and acting as DERs.

The ECV-DESS may provide energy flexibility services contributing to an improvement of the stable and reliable operation of the electrical network. See Annex C.

The power balancing will result from the coordinated efforts of conventional power systems in combination with the EV charging infrastructure, other DERs, microgrids and virtual power plants (VPPs), which may include DESS.

The energy flexibility services are aimed at achieving:

– power balancing;
– network congestion management;
– voltage control.

The specific nature of EV, which is mobile and capable to connect to the charging infrastructure in different locations, with different charging modes, sets new requirements on the control and communication interfaces.

The EV charging Stations may have different configurations and modes of operations.

They can operate by AC or DC charge, they can charge and discharge, with mono or bidirectional power transfer between EV and EVSE.

They can be composed by one or more EVSEs in one EV-charging station. In presence of multiple EVSEs, they can be arranged in AC or DC bus configurations.

Finally, the bidirectional inverter can be installed on-board of vehicle or off-board.

Appropriate standards are essential to manage the complexity of these systems.

These standards will sustain the growth of EV circulation, rule the V1G and V2G services, support the aggregation of multiple EV DERs, define how to specify the requirements between the aggregator /flexibility operator (FO) and the EV charging station operators.

NOTE Aggregator and flexibility operator have the same meaning in the context of this document.

The presence in the e-mobility market of products and services offered by several vendors calls for interoperability and interchangeability between solutions provided by different suppliers.

Furthermore, the standards have to meet the requirements of cybersecurity and privacy for a proper operation of ECV DESSs.

The IEC 63382 series is intended to cover all these aspects and to fills gaps in existing standards concerning communication between the aggregator/FO and the EV charging station backend system.

It is aimed at completing the communication and control chain which connect the EV with the charging infrastructure (EVSE and charging stations) and with the aggregator/FO at an upper hierarchical level. In this respect it represents a complement of the standardization work made on ISO 15118 series and IEC 63110 series.

The IEC 63382 series consists of three parts, each dedicated to a specific subject:

IEC 63382-1 is dedicated to EV charging station configurations, communication architecture, requirements, both functional and non-functional, use cases, with actors, roles and domains descriptions. Reference is made to CENELEC's SGAM (Smart Grid Architecture Model) and to UML model.

IEC 63382-2 is dedicated to communication protocol specifications. It includes layered model according to OSI model from ISO, list of requirements, data models, object model, messages and message formats, datatypes, message sequences, and security aspects.

IEC 63382-3 is dedicated to conformance testing. The tests will cover the interface between Aggregator/FO and the CS Backend system.

It includes test setup, test suite, test cases designed to verify behaviour of system with respect to specifications and requirements.

The IEC 63382 series is intended to be used by the many stakeholders of ECV-DESS:

Aggregators/FO, e-mobility service providers, car makers, utilities (e.g. energy supplier (reseller), transmission grid operator (TSO), distribution grid operator (DSO), measuring point operator), EV users, EV charging station operators and owners, manufacturers and maintainers of interfacing products, technology providers (HW, SW, certification testing), software developers and system engineers.

1 Scope

The IEC 63382 series specifies the management of distributed energy storage systems, composed of electrically chargeable vehicle batteries (ECV-DESS), which are handled by an aggregator/flexibility operator (FO) to provide energy flexibility services to grid operators.

Aggregator and flexibility operator have the same meaning in the context of this document and represent the entity which aggregates a number of other network users (e.g. energy consumers, prosumers, DERs) bundling energy consumption or generation assets into manageable sizes for the energy system.

The aggregator/FO communicates with the charging station (CS) backend system, which is typically the system platform (HW, SW and HMI) of either a charging station operator (CSO), or a charging service provider (CSP).

The purpose of the data exchange is to perform flexibility services, and it takes place between the aggregator/FO and a dedicated interface located in the CS backend system, which has been defined FCSBE, flexibility port at the charging station backend.

This part of IEC 63382 describes the technical characteristics and architectures of ECV-DESS, including:

– EV charging stations configurations, comprising several AC-EVSEs and/or DC-EVSEs;

– individual EVs connected to grid via an EVSE and managed by an aggregator/FO.

The focus of this document is on the interface between the FO and the FCSBE and the data exchange at this interface, necessary to perform energy flexibility services (FS).

The FO/aggregator converts grid services and/or grid support functions requested by the grid operators (DSOs or TSOs) into multiple flexibility services to be provided by a number of CSs, utilizing their own optimization and resource allocation algorithms.

Communication between FO and grid operators (DSO, TSO), optimization algorithms adopted by FO, flexibility service bidding procedures are out of scope of this document.

The data exchange between FO and FCSBE typically includes:

– flexibility service request and response;

– flexibility services parameters;

– EV charging station configuration and technical capabilities;

– credentials check of parties involved in the flexibility service;

– FS execution related notifications;

– event log, detailed service record, proof of work.

The exchange of credentials has the purpose to identify, authenticate and authorize the actors involved in the flexibility service transaction, to check the validity of a FS contract and to verify the technical capabilities of the system EV + CS, and conformity to applicable technical standards to provide the requested flexibility service.

This document also describes the technical requirements of ECV-DESS, the use cases, the information exchange between the EV charging station operator (CSO) and the aggregator/FO, including both technical and business data.

It covers many aspects associated to the operation of ECV-DESS, including:

– privacy issues consequent to GDPR application (general data protection regulation);
– cybersecurity issues;
– grid code requirements, as set in national guidelines, to include ancillary services, mandatory functions and remunerated services;
– grid functions associated to V2G operation, including new services, as fast frequency response;
– authentication/authorization/transactions relative to charging sessions, including roaming, pricing and metering information;
– management of energy transfers and reporting, including information interchange, related to power/energy exchange, contractual data, metering data;
– demand response, as smart charging (V1G).

It makes a distinction between mandatory grid functions and market driven services, taking into account the functions which are embedded in the FW control of DER smart inverters.

This document deals with use cases, requirements and architectures of the ECV-DESSs with the associated EV charging stations.

Some classes of energy flexibility services (FS) have been identified and illustrated in dedicated use cases:

– following a dynamic setpoint from FO;
– automatic execution of a droop curve provided by FO, according to local measurements of frequency, voltage and power;
– demand response tasks, stimulated by price signals from FO;
– fast frequency response.

Furthermore, some other more specific flexibility service use cases include:

– V2G for tertiary control with reserve market;
– V2H with dynamic pricing linked to the wholesale market price;
– distribution grid congestion by EV charging and discharging.

FS are performed under flexibility service contracts (FSC) which can be stipulated between:

– FO and EV owner (EVU or EV fleet manager);
– FO and CSP;
– FO and CSO.

Any flexibility service is requested by the aggregator/FO with a flexibility service request (FSR) communicated through the FCSBE interface to the available resources.

The actors EVU, CSO, CSP have always the right to choose opt-in or opt-out options in case of a FSR, unless it is mandatory for safety or grid stability reasons.

A use case shows how to discover flexibility service contract (FSC) holders.

This document describes many use cases, some of them are dedicated to special applications such as as: EV service station, energy community, fast frequency response, EV fleet, onboard bidirectional inverter, mobile app.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62351-3, *Power systems management and associated information exchange - Data and communications security - Part 3: Communication network and system security - Profiles including TCP/IP*

IEC 62351-9, *Power systems management and associated information exchange - Data and communications security - Part 9: Cyber security key management for power system equipment*

ISO 15118 (all parts), *Road vehicles - Vehicle to grid communication interface*