**PAS 1878** **Classification of energy smart appliances**

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# Foreward

Publishing information

This is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on . It was prepared by Subcommittee , , under the authority of Technical Committee , . A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This supersedes , which is withdrawn.

Information about this document

Use of this document

As a guide, this takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice.

Presentational conventions

The guidance in this standard is presented in roman (i.e. upright) type. Any recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

*Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.*

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

**Compliance with a British Standard cannot confer immunity from legal obligations.**

# Introduction

To be completed

# Scope

This PAS specifies requirements and criteria that an electrical appliance needs to meet in order to perform and be classified as an energy smart appliance (ESA). It defines the attributes, the functionalities and performance criteria for an ESA, and specifies how compliance with these can be verified. The characteristics of an ESA are complementary with those of the DSR framework in the sense that an ESA is able to perform in a DSR environment, and enable DSR-based activities.

This PAS is intended to be used by manufacturers and maintainers of ESAs, by manufacturers and maintainers of interfacing products and by software developers and service providers.

This specification applies the following criteria in defining the requirements that shall be met by an ESA.

• Interoperability: the ability of an ESA to work seamlessly across any DSR service operated by any system player.

• Data privacy: the secure storing of data on the device or with any controlling party.

• Grid-stability: the prevention of outages on the grid caused by erroneous operation of an ESA.

• Cyber-security: the prevention of unauthorized access to an ESA by third-parties.

In relation to smart EV charge points, this PAS will build upon the European Network for Cyber Security EV charging security requirements and the smart meter HCALC security characteristics.

This specification does not cover the general safety or other aspects of the non-smart functionality of an ESA.

# Normative references

To be populated with a list of normative standards or specifications

# Terms and definitions

To be populated

# Architecture

* This section provides a description of the ESA relevant parts of the demand side flexibility systems architecture.
* A systems architecture diagram is followed by general descriptions of the main components and interfaces
* Details of the components and interfaces are considered in later sections
* As the content becomes more stable, references to any relevant standards/specifications will be added as required

## Top level systems architecture

* The DSR relevant components and interfaces will be included in the top level architectural diagram (perhaps in a simplified form) for completeness
* The interface(s) between the DSR side and ESA side will be clearly shown and described in the text
* GB smart metering components that are relevant to ESA operation will be explicitly included in this diagram
* The diagram will show high level functional blocks and interfaces
* The distinction will be made between logical entities and physical entities wherever possible
* The distinction will be made between control flow and energy flow (i.e. electrical wiring) – this may require the use of separate diagrams

An example logical systems architecture is shown below.

A screenshot of a video game

Description automatically generated

Figure 1 Example ESA/DSR system architecture

## Smart appliance

* A smart appliance may be considered to consist of a “smart controller” connected to a “dumb appliance”
* The distribution of functions between the smart controller and dumb appliance is manufacturer specific and therefore out of scope for this PAS
* The nature of the interface that the smart controller presents to the “outside world” and certain performance and operational aspects of the smart appliance as a whole are within the scope of this PAS and are covered in more detail in later sections

## Smart EV charger

* This may be considered as a special case of “smart appliance” due to particular use cases in GB
* Use cases include flexible use of smart EV charging and vehicle to grid (i.e. “storage battery”)
* Variations may include control by the CEM and/or directly by the smart metering system – this is TBD

## Gateway

* This may have two functions:
  1. Convert between the data model used by the ESA network (e.g. Zigbee) and the CEM data model
  2. Bridge between underlying communications protocols
* The requirement for each of these functions is TBD and is expected to be clarified by SAG/SG

## Customer Energy Manager (CEM)

* The CEM bridges between the ESA present within the home/building and the DSR/smart metering actors external to the home/building
* In general, a CEM consists of an interface to the DSR/smart metering actors (nominally termed “S1” here), control logic (“intelligence”) and an interface to the ESAs (nominally termed “S2” here)
* Both S1 and S2 are bi-directional
* The S2 data model is in the process of being standardized in CENELEC
* A third interface, S3, allows the CEM to connect directly to either a dedicated service provider (e.g. aggregator or energy services provider) or via the cloud to a service provider.
  + The requirement for this interface is TBD
* The functionality of the control logic is largely manufacturer specific, although it is expected that this PAS shall define some basic performance and operational requirements in order to define baseline functionality and performance (this will allow manufacturers to design in value-add features)
* The CEM is currently not well defined, although the general opinion is that it is a logical entity that may run on a range of hardware platforms including specific hardware, in a CAD, in an ESA, the cloud, be distributed etc.
* NOTE: Current expectations are that there will be only one CEM corresponding to a particular metering connection (or smart grid connection point – SGCP)
  + Otherwise communication and functional complexity increases drastically

## Energy Management Gateway (EMG)

* Not well defined currently
* Usually seen to act as a means of multiplexing/demultiplexing data flows between the grid-side/metering-side actors and the CEM
* As such, could also be seen to be acting as the SGCP

## Consumer Access Device (CAD)

* Part of the GB smart metering system (a type 2 device)
* Allows bridging/gateway from the secure smart metering HAN to the “outside world”
* Information flow is currently unidirectional (except for a few communications specific messages), from the SMHAN
* Information provided is similar to that of the in-home display (IHD) – tariff, consumption etc.
* This type of device could be used to pass tariff and consumption/generation information to the CEM (or directly to other ESAs)

## HAN Connected Auxiliary Load Control Switch (HCALCS)

* An electricity smart meter (ESME) is able to control several HCALCS
* HCALCS control signals may be sent to the ESME from the DCC
* The HCALCS is effectively an actuator (on/off switch) and so may be used for “coarse grain” control
* More fine grain control via updated HCALCS has been proposed in the SEC

# DSR/ESA interface

* From Figure 1, it may be seen that the DSR and ESA sub-systems connect at the
  + Energy Management Gateway,
  + WAN side of the GB smart metering communications hub and
  + (as yet undefined) S3 interface on the CEM.
* All communications between the DSR side and ESA shall occur over these interfaces.
* It is assumed that communication over these interfaces takes the form of building-level aggregated energy flexibility requests/controls rather than specific ESA control requests.
* For example, a request from DSR side could take the form “can load be reduced by 500W for a two hour period, beginning in 4 hours’ time” rather than “HVAC1 please increase temperature by 3 degrees; EV charger please delay charge cycle for 6 hours from now”
* The DSR-side includes several actors with interests in different types of energy management. These include:
  + Short term grid stability (equivalent to the “traffic light model” – green/amber/red state)
  + Longer term grid stability (forecast grid level load issues)
  + Energy flexibility trading (from a markets perspective) – both short term and longer term?
* In most cases, a bidirectional information flow is required

## Energy management gateway

* Most of the energy flexibility communication with the CEM will be routed through S1 via the EMG interface
* This will include most of the short term and long term requirements mentioned above

## Smart metering interface

* Although information between the smart metering system and the home/building enters via the communications hub, in effect this will be exposed to the home/building/CEM through the CAD or actuation of the HCALCS (as the other components are within the highly secure smart metering HAN).
* The exception here is any metrology or supply state information originating in the ESME and passed out to the WAN via the CH
* As such, information is able to flow in only one way and is limited to a given set of information (i.e. tariff, consumption, “on/off”). Nevertheless, this information is vital for efficient energy flexibility management

## CEM S3

* Included here as an “internet” connection, often mentioned when discussing the CEM
* This could be a connection out to the cloud, or it could be a more “private” connection
* The requirement for this interface is not clear and is still a moot point
* Incorporating this interface may significantly increase the cybersecurity attack surface of the system

# ESA classification

* In order to limit the type of appliances covered by this PAS, the general categories of
  + eHVAC
  + storage
  + wet
  + dry
  + smart EV charger (if different from “storage”)

are proposed

* There is some concern from workshop attendees that this is will limit the future proofing of this PAS, in that it is bounding the types of appliances
* Other more generic classification schemes are also available – viewing the appliance from a purely “energy flexibility” point of view
* Some workshop participants also raised the possibility of categorising ESAs according to the range of functionality/data available over its smart interface
* One possible approach here is to
  + define a (limited) set of “energy flexibility” types (such as defined by TNO in TC205 WG18)
    - each of these types has a particular set of fundamental properties and behaviours
  + Map the four selected equipment categories (HVAC/storage/wet/dry) onto these flexibility types
* Futureproofing is not required here, as long as the document structure allows new flexibility types and appliance categories to be added in later revisions/versions
* Using the equipment categories as the highest level of classification is useful as it allows specific requirements (e.g. security levels) to be separately applied to each
* “Energy flexibility” types should not be used as the highest level of classification as this PAS considers more aspects of the ESA than its energy flexibility
* NB: it may be necessary to add a fifth category, “energy manager” here.

# Generic requirements

* Horizontal type requirements – applicable to all types of devices
* Divide or classify into functional and non-functional?

## Interoperability

* Define what is meant by “interoperability” in this PAS. Examples include:
  + Data model
  + Communications protocols
  + Services connectivity
  + Installation procedures (including messages to grid-side actors)
  + Interface to smart metering system
* Provide generic requirements for interoperability between given parts of the architecture (e.g. for an ESA, it may be necessary to interoperate at the data model level in order to provide a common set of functions, but allowable for the manufacturer to provide additional, proprietary, “value add” capabilities)

## ESA security

* Define what is meant by “security”
* Introduce the concept of “security levels”?
* Specify core security functions/properties that should be exhibited by all ESA, including smart EV charger and CEM

## Data privacy

* The amount of operational and personal data stored on an ESA will depend upon the type of ESA and the nature of the ESA/CEM/Grid interfaces (which are determined by the distribution of functionality between different parts of the system)
* Specify common data privacy requirements (policies?) that are common to all ESA

## Grid security

* The operation of an ESA should not affect the stability or security of the (distribution) grid network
* It is unlikely that one household/building will be able to cause appreciable problems for the grid, hence this applies more to cohorts of ESA or households/buildings
* The impact of EV (especially higher power EV chargers) and storage batteries is higher than other types of ESA (TBD)
* If no particular aspects of ESA behaviour are identified as potential risks here, then provide a set of overarching requirements or policies
* It may be that this applies more to ESA specifics in later sections
* Possibly a link to CEM requirements and Grid Codes here?

## DSR/ESA operational aspects

Fundamental aspects of the interaction between DSR and ESA sub-systems e.g. timing synchronisation, non-repudiation mechanisms

## ESA operational aspects

Fundamental aspects of expected ESA behaviour e.g. behaviour under system fault conditions

# Specific ESA requirements

* Specify requirements that are particular to each equipment category
* Examples include security, response timing, self-metering, status information output on the smart interface
* Reference out to other sections where appropriate – allows entire requirements for appliance type to be included here
* This section may be used to define all mandatory and optional requirements for compliance of a given ESA category
* Include compliance matrix as summary or include in normative Annex?

## HVAC

* Aspects to consider include:
* Attributes
* Functionality
* Performance criteria
* Interoperability
* Data privacy
* ESA security
* Grid security
* Data model (including profiles)
* Communications interfaces
* Default configuration and operation
* Operation under error conditions
* Any other functional/non-functional requirements

## Storage

As above

## Wet appliance

As above

## Dry appliance

As above

## Smart EV charger

As above

* Separated out as requirements may be different to “storage”

## Energy manager

As above

# Communication interfaces

Points to consider here:

* Coarse requests from aggregators
* Specific (short term) requests from DSO wrt state of local grid
* Fine grain requests coming in from aggregators (direct control of appliances from grid-side)
* Tariff/consumption/generation information from SM side (CAD)
* Direct control from SM side (HCALCS – coarse, or new HCALCS – finer) BUT still no feedback path?
* Any case, if CEM then best that it knows about ALL energy activity behind meter point

Use a diagram to highlight the interfaces (but one that is more pleasing on the eye than the following!)

A screenshot of a video game

Description automatically generated

Figure 2 Interfaces and connections [example interface labels]

The following sub-sections provide more detail:

## Connections

* The connections between elements or actors on the architecture diagram
* May involve connection across several elements and interfaces
* Some of these may be optional

## “Interface 1”

Description and requirements of each interface

### Data models

* Definition of what kind of data and instructions should be passed over a given interface
* Reference or specification to existing data model representations or new format (don’t re-invent the wheel unless we have to. E.g. the S2 specification from prEN50491-12-2 is a good starting point for the CEM/smart controller data model)

### Communications protocols

* Underlying communications stack options for each interface
* Referencing existing application, network and physical communications stacks
* Provide a requirements framework and reference to existing protocols but do not necessarily mandate any particular protocol

## “Interface 2”

As above

Etc.

# Annex 1 (normative) ESA Compliance matrices

* Only include if compliance matrices are not included in §8
* For each ESA category

# Annex 2 (normative) Specification of EV smart charger

* [only insert if this does not fit into the main document]

# Annex 3 (informative) Use cases

* Summary of Use Cases used to generate requirements for this PAS
* Reference existing UCs
* Reference or include new UC descriptions if generated during the production of this PAS

# Annex 4 (informative) Key requirements

* Following on from Use Cases or SAG/SG/Public consultation
* These should be high level requirements rather than detailed requirements