



SLOVENSKI STANDARD
oSIST prEN IEC 62872-2:2020
01-julij-2020

Internet stvari (IoT) - Aplikacijski okvir uporabe za upravljanje porabe energije v industrijskih objektih

Internet of Things (IoT) - Application framework for industrial facility demand response energy management

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ICS:

25.040.01	Sistemi za avtomatizacijo v industriji na splošno	Industrial automation systems in general
35.100.05	Večslojne uporabniške rešitve	Multilayer applications

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65/794/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER:

IEC 62872-2 ED1

DATE OF CIRCULATION:

2020-05-08

CLOSING DATE FOR VOTING:

2020-07-31

SUPERSEDES DOCUMENTS:

65/777/CD, 65/789A/CC

IEC TC 65 : INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION	
SECRETARIAT: France	SECRETARY: Mr Rudy BELLIARDI
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 13, TC 57, ISO/IEC JTC 1/SC 41	PROPOSED HORIZONTAL STANDARD: <input type="checkbox"/> Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: <input type="checkbox"/> EMC <input type="checkbox"/> ENVIRONMENT <input type="checkbox"/> QUALITY ASSURANCE <input type="checkbox"/> SAFETY	
<input checked="" type="checkbox"/> Submitted for CENELEC parallel voting IEC the -CENELEC parallel voting	<input type="checkbox"/> NOT SUBMITTED FOR CENELEC PARALLEL VOTING
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TITLE:

Internet of Things (IoT) – Application framework for industrial facility demand response energy management

PROPOSED STABILITY DATE: 2023

NOTE FROM TC/SC OFFICERS:

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117 INTERNATIONAL ELECTROTECHNICAL COMMISSION

118

119

120 **INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION –**

121

122 **Part 2: Internet of Things (IoT) – Application framework for industrial**
123 **facility demand response energy management**

124

125

FOREWORD

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158 Industrial-process measurement, control and automation.

159 The text of this document is based on the following documents:

FDIS	Report on voting
65/xxx/FDIS	65/xxx/RVD

160

161 Full information on the voting for the approval of this document can be found in the report on
162 voting indicated in the above table.

163 This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

164 The committee has decided that the contents of this publication will remain unchanged until the
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166 the specific publication. At this date, the publication will be

- 167 • transformed into an International standard,

- 168 • reconfirmed,
169 • withdrawn,
170 • replaced by a revised edition, or
171 • amended.

172

173 The National Committees are requested to note that for this publication the stability date
174 is ??? (TBD)

175 THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED
176 AT THE PUBLICATION STAGE.

177

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INTRODUCTION

181 The World Energy Outlook 2017 [1]¹ reported that industry consumed over 40 % of world
182 electricity generation in 2015. Furthermore, industry itself is a significant generator of internal
183 power, with many facilities increasingly implementing their own generation, co-generation and
184 energy storage resources. As a major energy consumer, the ability of some industries to
185 schedule their consumption can be used to minimize peak demands on the electrical grid. As
186 an energy supplier, industries with in-house generation or storage resources can also assist in
187 grid load management. For example, in-house generation can supply energy to the smart grid
188 and to the facility. Furthermore, storage resources can assist in smart grid load management.
189 While some larger industrial facilities already manage their use and supply of electric power,
190 more widespread deployment, especially by smaller facilities, will depend upon the availability
191 of a readily available standard interface between industrial automation equipment and the
192 “smart grid”.

193 NOTE In this document “smart grid” is used to refer to the external-to-industry entity with which industry interacts
194 for the purpose of energy management. In other documents this term can be used to refer to all of the elements,
195 including internal industrial energy elements, which work together to optimize energy generation and use.

196 Standards are already being developed for home and building automation interfaces to the
197 smart grid; however, the requirements of industry differ significantly and are addressed in this
198 document. For industry, the planning of energy resources and production processes are under
199 the responsibility of the facility energy planner and production planner while operations are
200 under the responsibility of the facility energy operator and production operator.

201 Incorrect operation of a resource could impact the safety of personnel, the facility, the
202 environment or lead to production failure and equipment damage. In addition, larger facilities
203 may have in-house production planning capabilities which could be coordinated with smart grid
204 planning, to allow longer term energy planning.

205 IEC TS 62872-1:2019 Industrial-process measurement, control and automation - Part 1: System
206 interface between industrial facilities and the smart grid defines the interface, in terms of
207 information flow, between industrial facilities and the “smart grid”. It identifies, profiles and
208 extends where required, the standards needed to allow the exchange of the information needed
209 to support the planning, management and control of electric energy flow between the industrial
210 facility and the smart grid.

211 “Internet of Things” (IoT) is being applied into different domains to facilitate the application.
212 Building on the system interface between industrial facilities and the smart grid defined in IEC
213 TS 62872-1:2019, this document addresses IoT application for industrial facility demand
214 response energy management (FDREM). The smart grid is a modern electric power grid
215 infrastructure system, whereby advanced information and communication technologies (ICTs)
216 are integrated with the power grid. Industry is the largest consumer of electricity among all end
217 user sectors. This has led to significant interest in the development of industrial energy
218 management around the world in recent years. Interconnectivity and interoperability are very
219 important features in the development of integrated energy management systems for industrial
220 facilities. Therefore, IoT technologies are needed and suitable for exchanging energy-related
221 information in FDREM. By using the IoT for communication, it enables real-time data-acquisition
222 (In this standard, it means acquisition of real time data, not data in real time.) and efficient data-
223 analysis, which can make industrial energy management more intelligent and cost-saving.
224 Currently, there may exist different implementation of IoT-based FDREM. Thus, a standard
225 specification is urgently needed to guide different kinds of IoT application to data-exchange in
226 industrial energy management.

227 The proposed IoT application framework is divided into the utility side and industrial electricity
228 demand side, with the utility meter as the boundary between the two. Functional components
229 that are essential for building the automatic demand response energy management are
230 described clearly in this framework. the IoT application framework is compliant with the IoT
231 Reference Architecture (IoT RA) standardized in ISO/IEC 30141, therefore, functional
232 components of the IoT application framework can be mapped to the IoT RA appropriately.

1 Numbers in square brackets refer to the Bibliography.

233 This document will also describe the functionality of each IoT protocol stack layers in regard to
234 communication of the IoT application framework, aiming to provide related information
235 exchange services for functional components. Identification of existing IoT protocols will be
236 executed to support this kind of information exchange. Non-functional communication
237 requirements will also be analysed to ensure comprehensive performance of the information
238 exchange.

239 Presently no standard covers industrial facility energy management with IoT technologies;
240 therefore this standard not only fills the gap to support such an IoT framework, but also can
241 guide the deployment of IoT into different energy management applications. For this purpose,
242 this standard will specify a general IoT-based communication framework for industrial FDREM.

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244 **INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION –**

245 **Part 2: Internet of Things (IoT) – Application framework for industrial**

246 **facility demand response energy management**

248 **1. Scope**

249 This document presents an IoT application framework for industrial facility demand response
250 energy management (FDREM) for the smart grid, enabling efficient information exchange
251 between industrial facilities using IoT related communication technologies. This document
252 specifies:

- 253 - Overview of price-based demand response program that serves as basic knowledge
254 backbone of the IoT application framework;
- 255 - An IoT-based energy management framework which describes involved functional
256 components, as well as their relationships;
- 257 - Detailed information exchange flows that are indispensable between functional
258 components;
- 259 - Existing IoT protocols that need to be identified for each protocol layer to support this kind
260 of information exchange;
- 261 - Communication requirements that guarantee reliable data exchange services for the
262 application framework.

263 **2. Normative references (standards.iteh.ai)**

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

268 ISO/IEC 30141:2018, Internet of Things – Internet of Things Reference Architecture (IoT RA)

269 ISO/IEC TR 22417:2017, Information technology - Internet of things (IoT) use cases

270 IEC TS 62872-1:2019, *Industrial-process measurement, control and automation - Part 1:*
271 *System interface between industrial facilities and the smart grid.*

272 **3. Terms and definitions**

273 For the purposes of this document, the following terms and definitions apply.

274 ISO and IEC maintain terminological databases for use in standardization at the following
275 addresses:

- 276 • IEC Electropedia: available at <http://www.electropedia.org/>
- 277 • ISO Online browsing platform: available at <http://www.iso.org/obp>

278 **3.1 General**

279 **3.1.1**

280 **facility**

281 **industrial facility**

282 site, or area within a site, that includes the resources within the site or area and includes the
283 activities associated with the use of the resources

284 [SOURCE: IEC 62264-1:2013, 3.1.20, modified – The preferred term facility and the admitted
285 term industrial facility have been replaced by facility.]

286 **3.1.2**
287 **profile**

288 set of one or more base standards, where applicable, the identification of chosen classes,
289 conforming subsets, options and parameters of those base standards, necessary to accomplish
290 a particular function

291 [SOURCE: IEC/ISO TR 10000-1:1998, 3.1.4, modified – "ISPs" has been removed.]

292 **3.1.3**
293 **enterprise**

294 one or more organizations sharing a definite mission, goals and objectives which provides an
295 output such as a product or service

296 [SOURCE: IEC 62264-1:2013, 3.1.10]

297 **3.1.4**
298 **area**

299 physical, geographical or logical grouping of resources determined by the site

300 [SOURCE: IEC 62264-1:2013, 3.1.2, modified – The example has been removed.]

301 **3.1.5**
302 **site**

303 identified physical, geographical, and/or logical component grouping of a manufacturing
304 enterprise

305 [SOURCE: IEC 62264-1:2013, 3.1.39]

306 **3.1.6**
307 **planner**
308 **facility energy planner**
309 **FEP**

310 entity responsible for the advanced planning of facility energy use, storage and generation,
311 taking into account the requirements of future production and the overall operation of the facility

312 Note 1 to entry: The facility energy planner is responsible for defining the overall future energy plan for the facility,
313 to include both the energy requirements of production and the overall needs and capabilities of the facility to generate,
314 store, and consume energy.

315 Note 2 to entry: Plans developed by the facility energy planner will typically be made at least a day prior to intended
316 use.

317 Note 3 to entry: The facility energy planner will assemble the overall energy plan based on the individual plans
318 developed by production planners and the non-production requirements and capabilities of the facility.

319 **3.1.7**
320 **production planner**
321 **PP**

322 entity responsible for developing, monitoring and modifying the production plan based on facility
323 requirements and the availability of inputs

324 Note 1 to entry: Example of inputs are equipment, labour, raw materials and energy.

325 **3.1.8**
326 **facility energy operator**

327 entity responsible for the minute by minute supply of energy to support current production and
328 current facility operation

329 Note 1 to entry: The facility energy operator monitors facility energy use, generation and storage, and makes
330 adjustments in response to changes related to shifting energy supplies, material disruptions, and equipment
331 breakdowns.

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332 **3.1.9**333 **production operator**

334 entity responsible for the minute by minute use of energy to carry out production plans, and
 335 authorized to respond to real-time changes based on feed-back from the process and other
 336 internal or external event

337 Note 1 to entry: The production plan is given from production planner.

338 **3.2 Models in automation**339 **3.2.1**340 **asset**

341 physical or logical object owned by or under the custodial duties of an organization, having
 342 either a perceived or actual value to the organization

343 Note 1 to entry: In the case of industrial automation and control systems the physical assets that have the largest
 344 directly measurable value may be the equipment under control.

345 [SOURCE: IEC TS 62443-1-1:2009, 3.2.6]

346 **3.2.2**347 **automation asset**

348 asset with a defined automation role in a manufacturing or process plant

349 Note 1 to entry: It would include structural, mechanical, electrical, electronics and software elements (e.g.
 350 controllers, switches, network, drives, motors, pumps). These elements cover components, devices but not the plant
 351 itself (machine, systems). It would not include human resources, process materials (e.g. raw, in-process, finished),
 352 or financial assets.

353 **3.2.3**354 **process**

355 set of interrelated or interacting activities that transform inputs into outputs

356 [SOURCE: ISO 14040:2006, 3.11]

357 **3.2.4**358 **product**

359 result of labour or of a natural or industrial process

360 Note 1 to entry: This term is defined by "any goods or service" in IEC 62430 and ISO 20140-1. The European
 361 Commission adopts a similar understanding in the directive "Ecodesign requirements for energy-related products".
 362 In the context of this document, the term "product" does not cover the automation assets but only the output of the
 363 manufacturing or process plant.

364 [SOURCE: IEC TR 62837:2013, 3.7.7]

365 **3.3 Models in energy management system and smart grid**366 **3.3.1**367 **smart grid**368 **SG**

369 electric power system that utilizes information exchange and control technologies, distributed
 370 computing and associated sensors and actuators, for purposes such as to integrate the
 371 behaviour and actions of the network users and other stakeholders, and to efficiently deliver
 372 sustainable, economic and secure electricity supplies

373 Note 1 to entry: In this document, smart grid is the counterpart system to which FEMS is connected.

374 [SOURCE: IEC 60050-617:2009, 617-04-13, modified by adding abbreviation and Note 1 to
 375 entry]

376 **3.3.2**377 **smart meter**378 **SM**

379 embedded-computer-based energy meter with a communication link

380 Note 1 to entry: In this document smart meters are used to measure both the consumption and supply of energy by
 381 the facility. They may also be deployed within the facility to measure internal energy flows.

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382 **3.3.3**
 383 **utility smart meter**
 384 **USM**
 385 smart meter deployed by the utility company to measure energy consumption and supply by the
 386 facility

387 Note 1 to entry: This meter typically forms part of the advanced metering infrastructure of smart grid.

388 **3.3.4**
 389 **facility smart meter**
 390 **FSM**
 391 smart meter deployed and used by the facility to measure energy flows

392 **3.3.5**
 393 **energy resource**
 394 electricity, fuels, steam, heat, compressed air, and other like identifiable entity whose use and
 395 state at any time can be unambiguously determined to provide external activity or perform work

396 [SOURCE: ISO/TR 19815:2018 (en) and IEC 60050-715-02-01:1992]

397 **3.3.6**
 398 **distributed energy resource**
 399 **DER**
 400 energy resource, often of a small size, operated by the utility to augment the local supply of
 401 energy

402 Note 1 to entry: In this document, DER, in contrast to FER, is used to refer to resources under the direct control of
 403 the utility. Such resources may include generation and/or storage capabilities.

404 **3.3.7**
 405 **facility energy resource** (standards.iteh.ai)
 406 **FER**
 407 energy resource, operated by the facility, which is used to supply energy to the facility and
 408 which may also be used to provide energy to the grid

409 Note 1 to entry: This terminology, rather than distributed energy resource (DER) terminology, is used to emphasize
 410 that the FER is operated by the facility and not under the direct control of the utility. Such resources may include
 411 generation and/or storage capabilities.

412 **3.3.8**
 413 **demand response**
 414 **DR**
 415 mechanism to manage customer load demand in response to supply conditions, such as prices
 416 or availability signals

417 **3.3.9**
 418 **price-based demand response**
 419 **PBDR**
 420 mechanism that give customers time-varying rates that reflect the value and cost of electricity
 421 in different time periods. Armed with this information, customers tend to use less electricity at
 422 times when electricity prices are high

423 **3.3.10**
 424 **time of use**
 425 **TOU**
 426 rate with different unit prices for usage during different blocks of time, usually defined for a 24-
 427 hour day. TOU rates reflect the average cost of generating and delivering power during those
 428 time periods

429 **3.3.11**
 430 **day-ahead price**
 431 **DAP**
 432 rate notified on a day-ahead basis, in which the price for electricity fluctuates hourly reflecting
 433 changes in the wholesale price of electricity

- 434 **3.3.12**
 435 **real-time price**
 436 **RTP**
 437 rate notified on hourly-ahead basis, in which the price for electricity fluctuates hourly reflecting
 438 changes in the wholesale price of electricity
- 439 **3.3.13**
 440 **incentive-based demand response**
 441 **IBDR**
 442 mechanism supported by soliciting demand response behaviour, commitment to agreed
 443 demand response and programs that pay participating customers to reduce their loads at times
 444 requested by the program sponsor
- 445 Note 1 to entry: The no participation in solicited demand response behaviour does not incur any penalty; examples
 446 are DLC and EDRP.
- 447 Note 2 to entry: The no participation in committed agreed demand response behaviour entails a penalty; examples
 448 are I/C, DB, CMP and ASM.
- 449 **3.3.14**
 450 **direct load control**
 451 **DLC**
 452 one of the IBDR programs, in which the SG operator remotely shuts down the load of a facility
 453 to address system reliability contingencies, in exchange for paying the facility participation
 454 payment in advance
- 455 **3.3.15**
 456 **interruptible/curtailable load**
 457 **I/C**
 458 one of the IBDR programs, in which the SG operator issues "incentive" to a facility for agreeing
 459 to reduce load during system contingencies, a facility will be penalized if it does not reduce load
- 460 **3.3.16**
 461 **emergency demand response program**
 462 **EDRP**
 463 one of the IBDR programs, in which the SG operator provides incentive payment to a facility for
 464 measured load reduction during a reliability-triggered event, no penalty is imposed if the facility
 465 does not respond
- 466 **3.3.17**
 467 **demand bidding**
 468 **DB**
 469 one of the IBDR programs, in which the SG operator allows a facility to bid load reduction into
 470 the energy market, a facility with accepted bid shall reduce load as contracted, otherwise it
 471 faces a penalty
- 472 **3.3.18**
 473 **capacity market program**
 474 **CMP**
 475 one of the IBDR programs, in which the SG operator provides a facility with guaranteed payment
 476 for committing to provide predefined load reduction as the system reaches capacity, a facility
 477 will face a penalty if it does not reduce load during a DR event
- 478 **3.3.19**
 479 **ancillary service market**
 480 **ASM**
 481 one of the IBDR programs, in which the SG operator allows a qualified facility to bid load
 482 reduction into the ancillary market as operating reserves, a facility with accepted bid shall curtail
 483 load when called by the SG operator, otherwise it faces a penalty