

TECHNICAL REPORT



**Information technology – Home electronic system (HES) application model –
Part 3-8: GridWise transactive energy framework**

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ISO/IEC TR 15067-3-8:2020

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 35.200

ISBN 978-2-8322-8851-1

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CONTENTS

FOREWORD	5
INTRODUCTION	7
1 Scope	10
2 Normative references	10
3 Terms and definitions	10
4 Abbreviated terms	14
5 Context setting	15
5.1 Context for transactive issues	15
5.2 Report contents and organization	16
5.3 The problem	16
5.4 Time scales	18
5.5 Economic/market context	19
5.6 Grid control systems context	20
6 Transactive energy	22
6.1 Transition from central power generation	22
6.2 Transactive energy definition	23
6.3 Transactive energy attributes	23
6.4 Transactive energy principles	24
6.5 Evolution of the grid and its effects on transactive energy	25
6.6 Strata of transactive energy	26
7 Framework	27
7.1 The elements of transactive energy	27
7.2 Policy and market design	28
7.3 Business models and value realization	32
7.3.1 Overview	32
7.3.2 Overview of DER services and technical capabilities	33
7.3.3 DER services and values recognized today	35
7.3.4 DER values not yet recognized and quantified	39
7.3.5 Transactive markets and peer-to-peer transactions	42
7.3.6 Distribution system operator	42
7.3.7 Distribution system operator models	42
7.3.8 Summary: redefining the value of the grid	44
7.4 Conceptual architecture guidelines	44
7.4.1 Creating a conceptual architecture	44
7.4.2 Guiding architectural principles	45
7.4.3 Scope of the conceptual architecture for transactive energy	46
7.4.4 Organizing paradigms	47
7.5 Cyber-physical infrastructure	50
7.5.1 Two cyber-physical networks	50
7.5.2 Understanding the electricity grid	50
7.5.3 Hierarchy of node levels	53
7.5.4 Node characteristics and responsibilities	54
7.5.5 Transaction train	55
Annex A (informative) Case studies	58
A.1 Use of case study template	58

A.2	Case study template	58
A.2.1	Title of the case study	58
A.2.2	Case study characteristics and objectives	58
A.2.3	Transactive energy attributes	58
A.2.4	Participating agencies and organizations	60
A.2.5	References for case study	60
Annex B (informative)	Pacific Northwest Smart Grid Demonstration	61
B.1	Project characteristics and objectives	61
B.2	Transactive energy attributes	61
B.2.1	Architecture	61
B.2.2	Extent	62
B.2.3	Transacting parties	62
B.2.4	Transaction	62
B.2.5	Transacted commodities	62
B.2.6	Temporal variability	63
B.2.7	Interoperability	63
B.2.8	Value discovery mechanisms	63
B.2.9	Value assignment	63
B.2.10	Alignment of objectives	64
B.2.11	Stability assurance	64
B.3	Participating agencies and organizations	64
B.4	References for case study	64
Annex C (informative)	American Electric Power gridSMART® smart grid demonstration	65
C.1	Project characteristics and objectives	65
C.2	Transactive energy attributes	65
C.2.1	Architecture	65
C.2.2	Extent	65
C.2.3	Transacting parties	65
C.2.4	Transactions	65
C.2.5	Transacted commodities	66
C.2.6	Temporal variability	66
C.2.7	Interoperability	66
C.2.8	Value discovery mechanisms	66
C.2.9	Value assignment	67
C.2.10	Alignment of objectives	67
C.2.11	Stability assurance	67
C.3	Participating agencies and organizations	67
C.4	References for case study	68
Bibliography	69
Figure 1	– Overview of GWAC transactive energy reference documents	9
Figure 2	– A framework provides high-level perspective	16
Figure 3	– Electric power system timelines	19
Figure 4	– Growing complexity of electric power system control	21
Figure 5	– Stages of adoption of DER	25
Figure 6	– GWAC Stack with strata of transactive energy	26
Figure 7	– Transactive energy stakeholders	30

Figure 8 – Services available from DERs 33
Figure 9 – Architecture layers and iteration levels 45
Figure 10 – The GridWise Architecture Council's interoperability framework 47
Figure 11 – NIST Smart Grid Conceptual Model..... 48
Figure 12 – Grid Vision 2050 transactive energy abstraction model 49
Figure 13 – Integrated Control Abstraction Stack/GWAC Stack model..... 49
Figure 14 – Transaction train model..... 56

Table 1 – Characteristics of transactive energy 23
Table 2 – Challenges faced from interoperability and transactive perspectives 27
Table 3 – Summary of node characteristics and responsibilities 55

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) APPLICATION MODEL –

Part 3-8: GridWise transactive energy framework

FOREWORD

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ISO/IEC TR 15067-3-8, which is a Technical Report, has been prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

The text of this Technical Report is based on the following documents:

Enquiry draft	Report on voting
JTC1-SC25/2944/DTR	JTC1-SC25/2965/RVDTR

Full information on the voting for the approval of this Technical Report can be found in the report on voting indicated in the above table.

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

A list of all parts in the ISO/IEC 15067 series, published under the general title *Information technology – Home electronic system (HES) application model*, can be found on the IEC and ISO websites.

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INTRODUCTION

Over the past two decades, the use of demand response and other flexible distributed resources for electricity market efficiency and grid reliability has grown dramatically. Customers' loads, generation, and storage will impact the management of an increasingly unpredictable power system. Because of this growth in flexible distributed energy resources deployment, attention is being devoted to addressing not only the economics of the electricity grid, but also the control system implications for grid reliability. This has led to a focus on an area of activity called "transactive energy". Transactive energy (TE) refers to the use of a combination of economic and control techniques to improve grid reliability and efficiency. These techniques can also be used to optimize operations within a customer's facility.

The motivations for employing TE systems come from the increasing diversity of resources and components in the electric power system and the inability of existing practices to accommodate these changes. Expanded deployment of variable generation on the bulk power side, distributed energy resources throughout the system, and new intelligent load devices and appliances on the consumption side necessitate new approaches to how electric power is managed and delivered, and the associated economic and business models. Conventional wisdom is that once variable generation resources reach 30 %, the current control systems for the grid will be simply inadequate [1]¹.

Transactive energy systems provide a way to maintain the reliability and security of the power system while increasing efficiency by coordinating the activity of the growing number of distributed energy resources. These multiple goals pose a multi-objective control and optimization challenge. This is one reason why TE embraces both the economics and the engineering of the power system. The same considerations outlined for the electricity grid apply to building energy systems and other local energy systems such as microgrids [2].

In the past, these systems could be considered simply end nodes on the physical power grid that act as simple "dumb" loads. But they are becoming increasingly more interactive with the grid, providing intelligent load, storage, and generation sources. They now need to be considered integral and active components of the grid as a whole. Building energy systems account for a majority of the electric power consumed in the United States. For example, the U.S. Energy Information Administration (EIA) estimated that buildings (residential and commercial) would account for around 70 % of electricity consumption in the United States in 2014 [3]. Recent EIA data shows that this projection was correct and electricity use in buildings is currently just over 70 % each year [4]. From the grid perspective, buildings are examples of loads that will be integral, active components of the end-to-end electric power system. Within buildings, the same need exists to achieve similar economic and reliably optimized solutions to manage energy and potentially to realize new revenue streams through participation in markets related to electric power systems. The growing adoption of electric vehicles presents a new class of controllable loads, and possibly even generating loads, that can interact with the grid.

Asset owners, system operators, and other economic entities involved in the generation, transmission, and use of electric power all have a stake in a reliably efficient power system envisioned with the use of TE. There is a clear need to align value streams for all of these parties by using incentives for participation in an actively managed system. This document describes the considerations and basic elements for all stakeholders. This provides an opportunity for discussing how various approaches can enable alignment of value streams and the creation of sustainable business models.

¹ Numbers in square brackets refer to the Bibliography.

Regulatory, policy, and business issues frame the discussion about the functional characteristics of TE systems. From these characteristics, this document also presents a conceptual or reference architecture illustrating the principal functional entities and relationships. The intent of this material is not to define a specific solution, but to describe the TE environment and to enable comparisons among various approaches.

This document further examines the practical dimensions of implementing TE systems by considering the cyber-physical system aspects. Here, too, this document avoids prescribing specific solutions, but rather identifies gaps and technology challenges that need to be addressed.

There have also been several new TE pilots proposed and implemented, and panels on TE can be found at most conferences, including technology-focused conferences such as Institute of Electrical and Electronics Engineers (IEEE) Innovative Smart Grid Technologies and industry conferences such as DistribuTECH, showing considerable interest in this topic. TE is also a frequent topic in technical journals, magazines, and blogs. These varied platforms for discussing TE indicate a broad acceptance of the possibilities offered and interest in ways to apply TE by service providers, utilities, and regulators.

The intent of the TE framework is to promote discussion at the conceptual level of common features or elements of specific models, designs, or implementations of TE systems. At this conceptual level, the framework is intended to be broad and overarching.

In promoting broader discussion, multiple diverse stakeholders need to be considered. Consequently, TE involves contributions from multiple disciplines spanning both economics and engineering. The implications of the potential new approaches for managing and controlling electric power systems call for a broad involvement of economists, regulators, policy makers, vendors, integrators, utilities, researchers, end-consumers such as building owner-operators, and other stakeholders. The diversity of thought provided by multiple viewpoints is important to achieving a framework that addresses the variety of perspectives and needs these stakeholders bring to the table.

A framework is a method and a set of supporting tools that can be used for developing an architecture. The TE framework is a tool that can be used for developing a broad range of different architectures for implementing transactive techniques. This document discusses approaches for designing a transactive system in terms of a set of building blocks, and for showing how the building blocks fit together.

The United States Department of Energy has supported the GridWise®² Architecture Council (GWAC) in specifying a conceptual framework for developing architectures and designing solutions related to TE. The goal of this effort is to encourage and facilitate collaboration among the many stakeholders involved in the transformation of the power system and thereby advance the practical implementation of TE. The GWAC developed this document to provide definitions of terms, architectural principles and guidelines, and other descriptive elements that present a common ground for all interested parties to discuss and advance TE.

In creating the TE framework (this document), the authors presume an audience with a good understanding of interoperability, familiarity with ISO/IEC TR 15067-3-2 [5], and knowledge of energy markets and associated business models. People with this level of background should be reasonably able to understand the proposed ideas, critically review them, and participate in reworking or refining the framework so that it becomes a shared creation with tools that propagate and that serve the diverse smart grid community. This document covers the topic of TE at an abstract, conceptual level without prescribing specific implementations. The audience for this document includes policy makers, regulators, vendors, utilities, researchers, practitioners, and end-use asset owners.

² GridWise is a registered trademark of Gridwise, Inc. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC or ISO.

In addition to this document, the GWAC produced a TE Decision Maker's Checklist [6] and a TE Roadmap (ISO/IEC 15067-3-7) [7]. Each document is designed for a different audience and each provides a different perspective on what transactive systems are, how they will evolve, and necessary policy considerations (see Figure 1). In addition, the Smart Grid Interoperability Panel (now Smart Electric Power Alliance) produced a TE Landscape Scenarios white paper presenting six high-level operational scenarios [8]. Collectively, these explore TE interactions and provide examples where TE systems produce value.

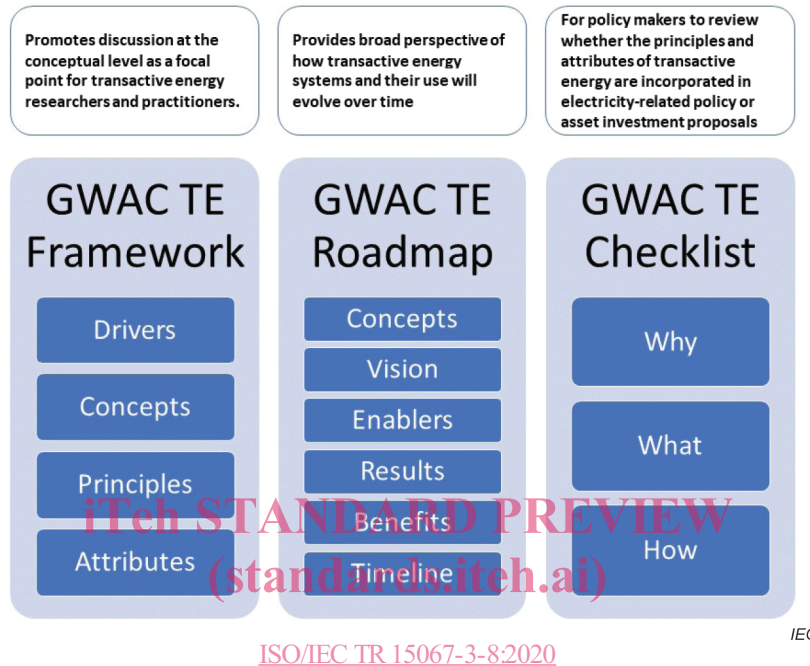


Figure 1 – Overview of GWAC transactive energy reference documents

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) APPLICATION MODEL –

Part 3-8: GridWise transactive energy framework

1 Scope

This part of ISO/IEC 15067, which is a Technical Report, provides a conceptual framework for developing architectures and designing solutions related to transactive energy (TE). Transactive energy allows electricity generated locally by consumers using wind, solar, storage, etc., at homes or buildings to be sold into a competitive market. This document provides guidance for enhancing interoperability among distributed energy resources involved in energy management systems at homes and buildings. It addresses gaps identified as problematic for the industry by providing definitions of terms, architectural principles and guidelines, and other descriptive elements that present a common ground for all interested parties to discuss and advance TE.

This document builds upon ISO/IEC 15067-3 [9], with technology to accommodate a market for buying and selling electricity generated centrally or locally by consumers. The energy management agent (EMA) specified in ISO/IEC 15067-3 can represent the customer as a participant in TE. Transactive energy is important for achieving electric grid stability as power from renewable sources such as wind and solar fluctuates with time and weather.

2 Normative references

ISO/IEC TR 15067-3-8:2020
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There are no normative references in this document.

3 Terms and definitions

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

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

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

3.1

ancillary services

services necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation of the transmission service provider's transmission system in accordance with good utility practice

Note 1 to entry: Ancillary services can include synchronized reserves, regulation and operating reserve, energy imbalance (using market-based pricing), and the cost-based services of scheduling, system control and dispatch, voltage control, and black start.

3.2

architecture

fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution

Note 1 to entry: ISO/IEC/IEEE 42010:2011 describes architecture viewpoints, architecture frameworks and architecture description languages for codifying conventions and common practices of architecture description.

3.3
area control error
ACE

instantaneous difference between a balancing authority's net actual and scheduled interchange, taking into account the effects of frequency bias and correction for meter error

3.4
automatic generation control
AGC

equipment that automatically adjusts generation in a balancing authority area from a central location to maintain the balancing authority's interchange schedule plus frequency bias

Note 1 to entry: AGC can also accommodate automatic inadvertent payback and time error correction.

3.5
boundary deference

respect for ownership or system boundaries during interactions

3.6
congestion

characteristic of the transmission system produced by a constraint on the optimum economic operation of the power system, such that the marginal price of energy to serve the next increment of load, exclusive of losses, at different locations on the transmission system is unequal

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3.7
customer

anyone taking (using) electric energy

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3.8
cyber-physical system

smart system that includes engineered interacting networks of physical and computational components

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3.9
demand response
DR

changes in electricity use by end-use customers (including automatic responses) from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized

3.10
distributed energy resource
DER

device that produces electricity and is connected to the electrical system, either "behind the meter" in the customer's premises, or on the utility's primary distribution system

Note 1 to entry: A DER can use a variety of energy inputs including, but not limited to, liquid petroleum fuels, biofuels, natural gas, solar, wind, and geothermal. Electricity storage devices can also be classified as DERs. Some definitions also include DR as a form of DER.

3.11
distributed generation
DG

generation that is located close to the particular load that it is intended to serve

Note 1 to entry: General, but nonexclusive, characteristics of distributed generation include an operating strategy that supports the served load, and interconnection to a distribution or sub-transmission system.

3.12
distribution system operator
DSO

entity responsible for planning and operational functions associated with a distribution system that is modernized for high levels of distributed energy resources (DERs) and handles the interface to the bulk system transmission system operator (TSO) at a locational marginal price (LMP) node or transmission-distribution substation

Note 1 to entry: A range of other DSO models are under consideration in the industry.

3.13
framework

description of a system at a high organizational or conceptual level that provides neutral ground upon which a community of stakeholders can discuss issues and concerns related to a large, complex system

3.14
hedge

protection against financial loss due to price fluctuation by prearranged purchase or sale for future delivery at an agreed-upon price

3.15
home energy management system
HEMS

system that regulates the energy within a household, controlling devices with the goal of achieving optimal energy use and providing consumers with important information about their energy consumption

3.16
interoperability

capability of two or more networks, systems, devices, applications, or components to exchange and readily use information securely, effectively, and without intervention by the user or operator

Note 1 to entry: In the context of the smart grid, systems are interoperable if they can exchange meaningful, actionable information. They share a common meaning of the exchanged information, and that the information can elicit agreed-upon types of responses.

3.17
market

area of economic activity in which buyers and sellers come together and the forces of supply and demand affect prices

3.18
microgrid

electrical system that includes multiple loads and DERs that can be operated in parallel with the broader utility grid or as an electrical island

3.19
photovoltaic power
PV

technology that turns sunlight directly into electricity

3.20
prosumer

person or entity who both consumes and produces

Note 1 to entry: This term was coined by Alvin Toffler. From a smart grid perspective, "prosumer" would apply to DER situations in which the owner of electricity production or storage assets can also have a consumer relationship with a utility, aggregator, or other energy services provider [10].

3.21
regional transmission organization
RTO

entity that is responsible for managing all transmission facilities under its control, maintaining grid stability, and matching electricity demand to supply

Note 1 to entry: RTO can be a regulated independent entity. An RTO performs the same functions as an ISO but has added responsibilities for the transmission network.

3.22
reliability

measure of the ability of the system to continue operation while some lines or generators are out of service

Note 1 to entry: Reliability deals with the performance of the system under stress.

3.23
renewable energy resources

energy resources that are naturally replenished.

Note 1 to entry: Renewable energy resources include biomass, hydroelectric, geothermal, solar, wind, ocean thermal, wave action, and tidal action.

3.24
resilience

ability to resist failure and rapidly recover from a breakdown

Note 1 to entry: See [10].

3.25
supervisory control and data acquisition
SCADA

highly distributed systems used to control geographically dispersed assets, often scattered over thousands of square kilometres, where centralized data acquisition and control are critical to system operation

3.26
smart grid

utility power distribution grid enabled with information technology and two-way digital communications networking

Note 1 to entry: A smart grid enables enhanced and automated monitoring and control of electricity distribution networks for added reliability, efficiency, and cost-effective operations.

3.27
transaction

exchange or transfer of exchangeable products, services, rights, or funds

3.28
transactive energy

system of economic and control mechanisms that allows the dynamic balance of supply and demand across the entire electrical infrastructure using value as a key operational parameter

3.29
transmission system operator
TSO

independent entity that coordinates regional transmission in a manner that is not discriminatory against any transmission owners, operators, or users, and ensures a safe and reliable electric system

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