

TECHNICAL REPORT



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



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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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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.

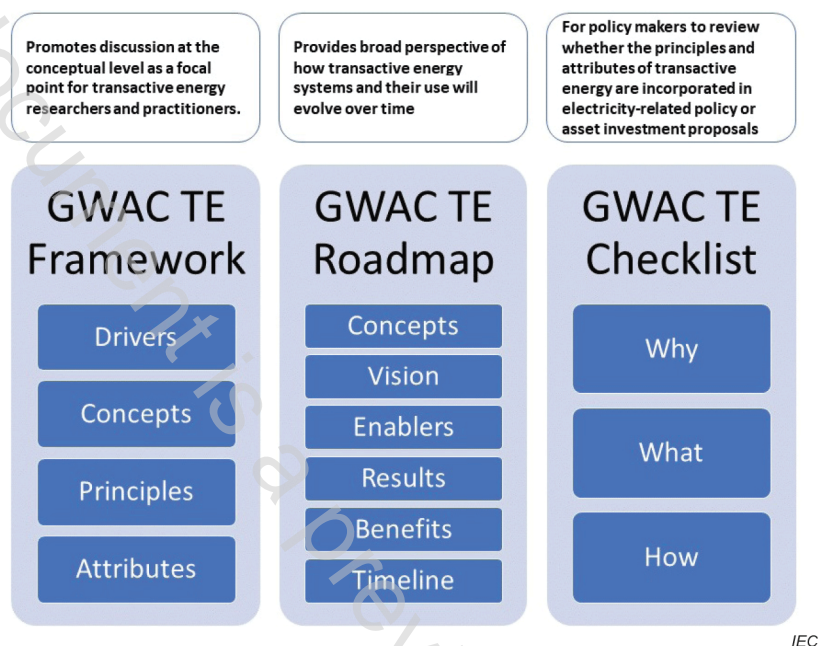


Figure 1 – Overview of GWAC transactive energy reference documents

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

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.