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July 29, 2013

Via e-mail: docket@energy.ca.gov

California Energy Commission
Dockets Office, MS-4
1516 Ninth Street
Sacramento, CA 95814-5512

Re: Docket No. 12-AAER-2A 2012: Consumer Electronics

The Consumer Electronics Association hereby submits the attached document pursuant to the Invitation to Submit Proposals released in the above-referenced docket on June 13, 2013.

Sincerely,

/s/ Douglas K. Johnson

Douglas K. Johnson
Vice President, Technology Policy
Consumer Electronics Association
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Attachment

Before the

CALIFORNIA ENERGY COMMISSION

Sacramento, California

In the Matter of

Invitation to Submit Proposals in the 2012-2013 Appliance Efficiency Rulemaking	)	Title 20 CCR §§1601 – 1608
Docket No. 12-AAER-2A	)	

COMMENTS OF THE CONSUMER ELECTRONICS ASSOCIATION

The Consumer Electronics Association (CEA) appreciates the opportunity as an interested stakeholder to submit comments with respect to set-top boxes as requested in the June 13, 2013, Invitation to Submit Proposals in Docket 12-AAER-2A. CEA strongly urges the Energy Commission to take advantage of this historic opportunity and the authority invested in it under the Warren-Alquist Act to embrace the cutting-edge voluntary agreement entered into by all the key purchasers and manufacturers of set top boxes sold and used in the United States. Working closely with the parties to the voluntary agreement and other stakeholders, the Energy Commission can best support for California significant improvements in the energy consumption of set-top boxes and related networks and systems.

CEA is the preeminent trade association promoting growth in the $209 billion U.S. consumer electronics industry. CEA represents more than 2,000 companies across the consumer electronics industry, including a wide range of set-top box manufacturers, component manufacturers and service providers in a number of sectors.

For many years, CEA has been on the vanguard of energy efficiency initiatives related to the consumer electronics industry and has supported and advanced energy efficiency as part of the industry's broader commitment to environmental sustainability. CEA's comprehensive approach to energy efficiency includes initiatives relating to public policy, consumer education, research and analysis, and

industry standards. CEA supports the U.S. Environmental Protection Agency's (EPA's) ENERGY STAR program, and our members' cooperation and participation in this successful program goes back more than 20 years.

CEA also is the supporting organization for the consensus test procedure for set-top boxes, CEA-2043, which properly constitutes the United States testing standard for measuring energy consumption of set-top boxes. Leading national energy efficiency policy makers, including the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA), as well as their contractors and energy advocates, have been fully represented in the development of CEA-2043.

It is understandable that the Energy Commission is interested in programs to improve the energy efficiency and reduce energy consumption of set-top boxes. This cannot be done through conventional regulatory means, however, as has been amply demonstrated in industry submissions to the CEC and DOE. Moreover, a fundamental question has been raised by the cable industry as to whether state regulation of set-top boxes is preempted by federal law.

Fortunately, the Energy Commission has options available to support continued improvements in this important sector. The Warren -Alquist Act, section 25402(c)(1), appropriately requires the CEC to consider alternative approaches, measures and costs before setting standards. In this case, the more than adequate alternative already well under implementation is a voluntary agreement between all the leading firms buying, building and using set-top boxes across the U.S. economy. These firms have joined together in an aggressive and progressive voluntary agreement. Both in its immediate goals and as it evolves over time, this industry agreement will save enormous amounts of energy in California in a flexible manner allowing continued competition, innovation, technology and consumer benefits to flourish in the rapidly evolving market for multichannel video delivery.

The December 2012 "Set -Top Box Energy Conservation Agreement" ("Voluntary Agreement" or "VA") entered into by the key purchasers and manufacturers of set top boxes ensures enormous short-term and long-term energy savings while allowing set-top boxes and related technology and networks to innovate and drive toward system-wide efficiencies.[1] There is an opportunity for a close, working relationship between the Energy Commission and the VA. The CEC is encouraged to provide technical

[1] http://www.ce.org/News/News-Releases/Press-Releases/2012-Press-Releases/Set-Top-Box-Energy-Conservation-Agreement-Expected.aspx.

and policy input, particularly with respect to ensuring compliance with the commitments and developing future commitments.

The essence of the Voluntary Agreement is that 90 percent of all new set-top boxes that a service provider signatory purchases and deploys after December 31, 2013, shall meet the energy efficiency requirements established in the Version 3.0 ENERGY STAR specification for set-top boxes. The agreement effectively takes ENERGY STAR Version 3.0 efficiency levels designed for the top 25 percent of set-top boxes and makes it the norm across the industry. Partially attributable to the VA, and as part of its general technological progress, the cable sector is employing "light sleep" to 12 million set-top boxes already in homes, reducing power when the boxes are not being used to do recording, and doing so without disrupting the consumer experience. Telecommunications company service providers are making progress in light sleep capabilities as well, and satellite service providers are deploying "automatic power down." Energy-efficient home digital video recorder (DVR) solutions are now available as an alternative to multiple in-home DVRs for subscribers of satellite and some telecommunications company service providers.

In addition, the relevant sectors –cable, satellite and telecommunications company video service providers– have made their own specific, additional undertakings. Critically, the VA allows for the commitments to be extended and revised as additional goals are established over time in order to keep pace with the technological capabilities and architectural evolutions occurring within the subscription video delivery sector. The agreement covers 90 million American households and 90 percent of multi-channel video providers' consumers.

There are multiple and robust mechanisms for reporting, verification and compliance checks, including in-home evaluations, in order to ensure compliance with the agreement by all parties. An independent administrator as well as independent verification firms will be chosen to undertake these tasks. The VA is similar to an agreement already underway in Europe which was entered into unilaterally by industry with active European Commission participation and support.

The key difference between the VA and command-and-control regulation is that the agreement has been shaped with specific intent not only to save energy but to ensure there are no restrictions in future innovation, technology or competition to the detriment of California or the United States economy or consumers. This is not inconsistent with reasonable transparency, reporting and verified compliance. Indeed, the implementation of this full initiative, including laboratory and home environment testing, is

being accomplished in a shorter period of time than any state or federal standard could be developed, implemented and monitored. Yet it is designed to be sufficiently agile to adjust to market and technological realities and changes.

In light of these meaningful industry efforts, the Energy Commission's pursuit of a standard is unnecessary and counterproductive. Addressing set-top box energy efficiency through an appliance efficiency standards process, such as a CEC or DOE rulemaking, is not rational, practical or desirable. Firstly, for all practical purposes, there is no "product" or "appliance." Set-top boxes are not a stand-alone product for which it is meaningful to measure energy use *per se* and to regulate such equipment in a detached state. Set-top boxes are integral part of a larger and often-evolving delivery network for video and related services. The actual energy use related to set-top boxes is heavily dependent on the software which is deployed, and that software cannot be fully known initially when the product is produced or even initially deployed. As the services of the video provider change and as consumers' desires change, the software-hardware interface also changes with significant impacts on energy use. Therefore, the usual evaluation of the cost of designing and manufacturing a more efficient product, and relating and comparing that to potential energy savings –the paradigm of traditional appliance standards regulatory analysis– does not make sense.

Secondly, who is the regulated party? In the traditional appliance standards regulatory scheme, the manufacturer of the product is regulated, and the retailers have a fairly passive conduit role. In the case of set-top boxes, the situation is dramatically different. Although obviously the set-top box manufacturers play vital roles in the design, manufacturing and innovation involving set-top boxes, the pay TV service providers in the variety of sectors play an equally vital role which cannot be known or predicted by either the set-top box manufacturers or the putative regulator. Thus, for example, an analysis of the costs and benefits, which usually looks at the impact on the manufacturer, is only a small part of the story because it does not take into account the impact on software, software developers, service providers and others. The analytical structures that have been created by the CEC and DOE over the years simply are not applicable in this differently-structured and dynamic high-tech environment.

These issues have been explored in detail and in the context of an initial DOE analysis for set-top boxes by Everett Shorey, a consultant for CEA and the National Cable & Telecommunications Association (NCTA).[2] His comments are in the DOE record are attached as an appendix and incorporated

[2] "Analyzing Potential Impacts of Energy Efficiency Standards for Set-top Boxes," Everett Shorey, Shorey Consulting, Inc., June 2013. A copy of this report is attached as an appendix to these comments.

thereby in these comments. Mr. Shorey demonstrates that the economic and market-structure assumptions that underpin traditional appliance standards analyses are inapplicable to the system, network and market represented by set-top boxes.

In contrast, in working with the parties to the VA, the Energy Commission can ensure that it is receiving all the energy savings promised both for the benefit of California consumers and for utility power generation planning. If the VA falls short, the CEC can reconsider its stance (although we note again the cable industry's well-founded argument that there is federal preemption of the CEC with respect to set-top boxes which may limit a CEC regulatory action in any event). Certainly, the Energy Commission should allow time to monitor and evaluate the achievements and credibility of the VA before proceeding with any measures in this category.

Similarly, neither a California-specific test procedure nor California-specific labels are necessary or helpful. The ENERGY STAR program identifies the most energy-efficient set-top boxes in the marketplace. In addition, as part of the VA, energy use information for each model will be readily available to consumers online with more meaningful information than is likely in any state-level labeling program. With respect to energy use disclosures, it should be recognized that only a miniscule number of set-top boxes are purchased directly by consumers who might benefit from a comparative label. Consumers purchase services of a system, not a set-top box (and this is one of the fundamental reasons, as noted above, why regulation of set-top boxes does not make sense since it is a system of hardware and rapidly-evolving software.)

Further, it would be a serious mistake for California to adopt a test procedure when a consensus test method, CEA-2043, has been adopted. As of June 2013, CEA-2043 ("Set-top Box [STB] Power Measurement") is approved and published as a CEA standard and is presently undergoing review by the American National Standards Institute (ANSI). This consensus standard development process has engaged a number of stakeholders including DOE, EPA and energy efficiency advocates. The consensus process has the capability of making necessary revisions quickly as technology inevitably evolves in ways that could impact portions of the test procedure. No government-mandated test procedure locked into regulation could ever keep pace with innovation in the consumer electronics industry. A California-specific test procedure promulgated today and tied down in regulation will soon be outmoded, not covering future and unanticipated applications and design changes. An outmoded test procedure could stifle innovation to the detriment of the California economy and California firms' technological competitiveness.

The nature of the set-top box, its evolving design and technology, and its place in a networked content delivery system in the home would set a rigid state-mandated, or federally-mandated, test procedure on a collision course with the changing market and technology. Adopting test methods and energy efficiency standards through regulation would hinder, slow or even stifle innovation, resulting in inaccurate and unrepresentative energy disclosures, and also creating perverse incentives not to innovate.

With respect to annual energy savings for California under the VA, we estimate 1.5 terawatt hours per year with just the ENERGY STAR Version 3.0 commitments of the VA. Assuming that California's population is approximately 12 percent of the national population and proportionally representative for set-top box users, and referencing California's cost of electricity at $0.16 per kilowatt hour as cited by the CEC, we estimate the value of annual savings for California at $233 million. Unlike any regulation, the VA is creating energy savings immediately, and under the VA, industry already is ahead of its schedule.

CEA's proposal for the Energy Commission to recognize and rely upon the Voluntary Agreement meets all the criteria set forth in the CEC's invitation to submit proposals. Energy efficiency improvements in technology that will be adopted in compliance with the VA are technologically feasible and attainable and will significantly reduce energy consumption growth rates within this product category. The measures are more likely to be cost-effective for consumers than across-the-board, uniform, inflexible, traditional appliance efficiency regulations. The Energy Commission's interest in data to measure and evaluate the impact of VA compliance can be arranged in communications between the parties and under the terms of the VA.

Respectfully submitted,

CONSUMER ELECTRONICS ASSOCIATION

By: _____/s/_____

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July 29, 2013

Analyzing Potential Impacts of Energy Efficiency Standards for Set-top Boxes
June 2013

A Report to:
Consumer Electronics Association
National Cable & Telecommunications Association

Prepared by:
Everett Shorey
Shorey Consulting, Inc.

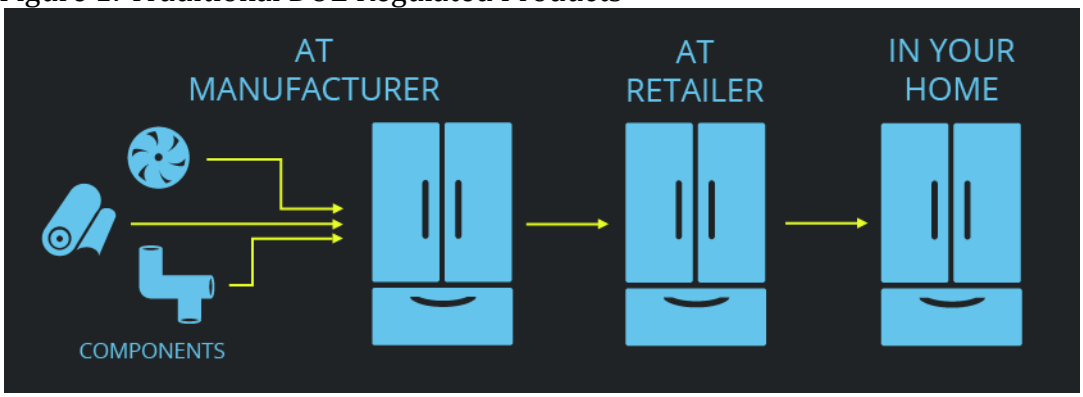
Analyzing Potential Impacts of Energy Efficiency Standards for Set-top Boxes
June 2013

EXECUTIVE SUMMARY

The US Department of Energy (DOE) is considering efficiency standards for set-top boxes used in cable, satellite and other television systems. However, the analytical approaches and models traditionally used by DOE do not apply to multichannel video services and the associated Multichannel Video Programming Distributors (MVPDs). It will not be possible to evaluate standards with respect to the factors required by statute in any meaningful way using DOE's current models and approaches. At its core, DOE's traditional concepts are based around static physical objects, such as a refrigerator, and not around dynamic reconfigurable networks.

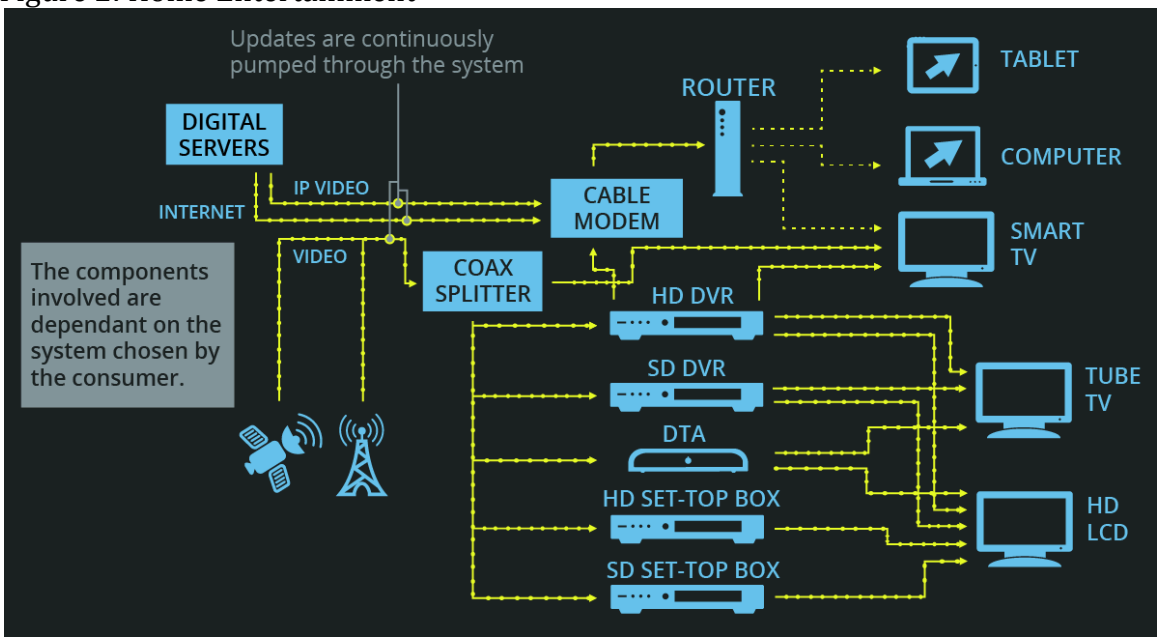
A refrigerator is a single, standalone, static object that consumers own, rarely replace; one that operates under stable operating conditions (Figure 1). It performs basically one function, design changes are infrequent, and it remains static in the consumer's house over its long lifetime. It can be analyzed with a limited number of models, projected and counted.

Figure 1: Traditional DOE Regulated Products



Home entertainment is an evolving service delivered by rapidly changing networks, equipment, software, programming and other services, all of which operate as integrated components for delivering those services. This situation is totally unlike appliances for which the regulatory system was developed. Set-top boxes are elements of complex systems providing programming and information services that change dynamically with changes in software, changes in the network, and changes in network services (Figure 2).

Figure 2: Home Entertainment



Set-top boxes have a short lifetime, are bundled and modified with changing service subscriptions and are returned to the service provider/owner when subscribers change services or service provider, or when the service provider upgrades its delivery infrastructure. Set-top boxes operate as highly specialized and variable components adjusted to each specialized MVPD network and service offering. Components of the network are reconfigurable in the field so their function and use change over time. Changes in one component affect all other components, and not just the cost of set-top box production. Set-top boxes change rapidly as services and market competition changes, making it impossible to develop meaningful projections within the DOE analytical process.

Efficiency standards of the type traditionally developed by DOE apply to static "*things*" that can be touched and measured. The home entertainment network cannot. While there are *things* involved, such as set-top boxes, servers, television sets, those *things* are changing rapidly. It is not possible to project how the network will evolve, what *things* will be in use, how those *things* will be configured and how consumers will use them. The DOE regulatory and analytical structure is fatally flawed with respect to home entertainment and can neither be used nor adapted to be used for set-top boxes.

I. SITUATION

The US Department of Energy (DOE) is considering whether and how to set minimum energy efficiency standards for set-top boxes used in cable and satellite television systems[1]. By statute[2], DOE is required to consider seven factors when deciding whether and how to establish energy conservation standards and it has developed a series of models and/or analytic tools to support its consideration of those factors[3]:

EPCA Factors	DOE Analysis
1. Economic impact on consumers and manufacturers	Life-Cycle Cost Analysis Manufacturer Impact Analysis
2. Lifetime operating cost savings compared to increased cost for the product	Life-Cycle Cost Analysis
3. Total projected energy savings	National Impact Analysis
4. Impact on utility or performance	Engineering Analysis Screening Analysis
5. Impact of any lessening of competition	Manufacturer Impact Analysis
6. Need for national energy conservation	National Impact Analysis
7. Other factors the Secretary considers relevant	Environmental Assessment Utility Impact Analysis Employment Impact Analysis

The Life-Cycle Cost Analysis, Manufacturer Impact Analysis and the National Impact Analysis depend upon inputs from the Engineering Analysis, Life-Cycle Cost Analysis, Government Regulatory Impact Model (GRIM), and National Impact Analysis spreadsheet models. DOE is proposing to use these models in its consideration of the *EPCA Factors* for set-top boxes. However, these models and their intellectual underpinnings were built around household appliances such as washing machines and refrigerators. Neither the models themselves nor the fundamental concepts of the *DOE Analysis* approaches are appropriate for assessing set-top boxes.

[1] Docket # EERE–2010–BT–NOA-0067

[2] 42 U.S.C. 6295(o)(2)(B)(i)

[3] Slide 17, 2012-01-26 Framework Meeting Presentation Slides, January 26, 2012, EERE-2011-BT-NOA-0067

II. CONCEPTS UNDERLYING STANDARD DOE APPROACH

A. The DOE Analysis was designed for standalone, static hardware appliances that operate under stable operating conditions

The basic underpinning of the standard DOE approach was developed for home appliances and similar products. This can be understood by thinking about a typical home appliance, such as a refrigerator. First, there is a physical object (i.e. the refrigerator) with definable components that affect energy use (e.g., insulation thickness, compressor efficiency, etc.). The refrigerator is ultimately sold to a user who will own and operate the refrigerator, essentially unchanged, for the refrigerator's lifetime. This situation remains static for some reasonably long period of time.

B. The DOE Analysis was designed for long-lived appliances that consumers own and rarely replace.

The standard DOE approach is also premised on relatively infrequent design changes in home appliances and similar products. The cost of changing the design of a refrigerator is substantial relative to the cost of the refrigerator, so manufacturers change designs infrequently. The cost of the refrigerator to the consumer is also high, so the consumer rarely replaces the refrigerator before the end of its useful life. Again, each element of this situation remains static for some reasonably long period of time.

C. The DOE Analysis was designed for products with relatively few variables that, if changed, would directly affect only hardware production costs.

The DOE modeling process flows from this situation of defined objects and static conditions. Even though the absolute numbers of products and consumers are large, the actual variations are relatively few. The number of design options for changing energy consumption is limited. The number of different product variations (i. e. refrigerator models) is constrained by manufacturing requirements. The most recent refrigerator National Impact Analysis covered 12 refrigerator types with 5-6 design options each for fewer than seventy-five situations.[4] The anticipated life of a refrigerator is over 15 years and standards are anticipated only every 7 years, allowing a lengthy period where the projected designs will be in place. The differences in distinctly different consumer use patterns are also limited. As a result, the situation is both countable and projectable.

[4] 2011-03-16 National Impact Analysis Spreadsheet: Refrigerator-Freezers from EERE-2008-BT-STD-0012

D. The DOE Analysis was designed for products in which design changes are infrequent and predictions could be relatively reliable.

From these basic underpinnings, DOE models can count and project within certain constrained cases developed for appliances and the appliance market. The models analyze example cases (a refrigerator of a defined size used in a certain fashion in a geographic area with a specified cost of energy and expected to last for a period of years). The models then calculate the economics to consumers of that case (the Life Cycle Cost Analysis) and add up all of the various options to estimate the total effects (the National Impact Analysis). The Government Regulatory Impact Model (GRIM) performs a similar function for manufacturers. The GRIM defines a specific set of cost assumptions and adds up the aggregate change in industry cash flows. There have, of course, been refinements to the models over time to account for certain types of variations (such as the expected lifetime of a product), which are then covered through probability analyses. But the core assumption of stable objects and situations remains intact, and that assumption serves an essential prerequisite for the model to work.

Because of the relative stability of appliances, it is possible to make reasonable determinations of consumer economics and to estimate national impacts. The economic situation for consumers can be calculated around a limited set of refrigerator design options and standardized conditions of use (i. e. hours of operation) leading to an estimate of payback periods for lower energy use. The national situation is an aggregation of energy and consumer savings from the various design options. There are specific things to count in a manageable number of variations. The actual mathematics of calculating the energy and economic effects can become intricate, but the essential situation is quite straightforward and manageable. In the case of a refrigerator, 12 refrigerator types with 5-6 design options and changes expected only after 7 years, the DOE models count seventy or so scenarios for multiple years.

III. SYSTEM REQUIREMENTS ON SET-TOP BOXES

A. Set-top boxes are elements of complex systems providing programming and information services that change dynamically with changes in software, changes in the network, and changes in network services

None of the fundamental assumptions underlying the DOE modeling process apply in the case of set-top boxes. A refrigerator stands alone – it sits in the kitchen and keeps things cold – for a long period of time. While the set-top box is a physical object, it is not standalone, static piece of hardware with stable operating conditions. Instead, the set-top box is a component part of a system or network that provides entertainment, programming, and information services to the home. It operates as part of a system that changes dynamically with changes in software, changes in the network, and changes in network services. Even as a device, the set-top box is the product of multiple vendors – of hardware, firmware, middleware,

guides, on-demand services and other applications – many elements of which continue to change over the life of the device. As the system changes, so does the role and functionality of the set-top box and where, when and how electricity is used in providing the home with programming and information services.

B. Set-top boxes have a short lifetime, are bundled and modified with changing service subscriptions and are returned to the service provider/owner as subscribers change services or service provider

A cable, satellite, or telephone multichannel video programming service accomplishes six principal functions:

1. It acquires and aggregates content and information services for retail service offerings. Content and services change during the service period.

2. It deploys, maintains and changes its distribution network as services evolve.

3. It encodes and protects content for distribution to subscribers who subscribe to a variety of retail offerings.

4. It delivers and decodes authorized content for presentation at the subscriber premises. This may also include recording of programming for later subscriber playback, and transcribing, re-encoding, or otherwise processing content for distribution to additional devices.

5. It uses one or more home networking and other technologies to distribute content to additional devices (typically in the home).

6. It enables the display of content.

The multichannel video program distributor (MVPD) conventionally performs the first four functions and may perform the fifth. Subscribers conventionally own their own television sets for the sixth function: display. Although the set-top box is often a component in delivering these services, the subscriber purchases this package of functionalities, not a specific piece of hardware. In fact, the set-top box is frequently bundled with the monthly service rate for the MVPD subscription service. Almost all set-top boxes are leased, rather than owned, as part of this service. In sharp contrast to appliances that are rarely replaced over a long lifetime, set-top boxes are frequently returned to the MVPD as customers change services, order additional features, or change residence or service provider.

C. Set-top boxes operate as highly specialized and variable components adjusted to each specialized MVPD network and service offering. Changes in one component of the network affect all other components, and not just the cost or performance of set-top boxes.

Set-top boxes do not operate as individual products but as integrated parts of very specialized MVPD networks and services. They are components of a complex network of electronics, software, and distribution infrastructure that varies not just from provider to provider, but often from local cable system to local cable system owned by a single MVPD. There are more than 1100 cable operators operating more than 7000 headends. Though six cable operators now provide service to approximately 85% of cable subscribers, they operate systems with often substantial diversity in their networks and with different set-top box configurations. For example, cable operators have chosen different video-on-demand approaches and vendors. Some operators have deployed switched digital video, which delivers certain channels only when consumers tune them, while others have not. While these cable systems share some common features, such as MPEG-2 compression and QAM modulation, they have many more distinct proprietary elements: different conditional access, out-of-band communications channels used for command and control of the set-top box, operating system (OS) and processor instruction sets, network control architecture in support of interactivity, and electronic program guide applications and guide metadata formats.

There is not only substantial variation among these six operators, but also within their companies as well. Due to consolidation in the cable industry, there is considerable variation among systems owned by the same company. Cable operators that were once among the ten largest – TCI, MediaOne, Adelphia, Century and Marcus – have been acquired (sometimes in parts) by other operators, leaving the owners today with a wide variety of system architectures and technologies within single companies. Today's cable systems thus encompass "a set of legacy digital video delivery systems that have a huge installed base of tens of millions of digital cable set top boxes," and system technology that "spans over a decade of technology advances resulting in a broad range of set-top capability and performance. "[5] Variation is even greater when other types of video service providers are considered. Four of the eight largest MVPDs are telephone companies and DBS providers, with varying implementations. Verizon's FiOS is very different from the IPTV network of AT&T and CenturyLink, and DISH and DIRECTV operate satellite systems that are very different from one another. And each of these separate ecosystems is far from static. System architectures and networks are constantly in flux.

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[5] Ralph W. Brown, *Tackling the US Cable Set-top Legacy: Middleware in a Sea of Proprietary Systems* at 1.

Among appliances for which the DOE model was developed, there are few variables in commodities—for example, 12 refrigerator types with 5-6 design options each, a 15-year anticipated life, and infrequent changes in production that affect only production costs. With set-top boxes, there are a high number of variables, a large number of models, frequent changes and a change in hardware affects not only set-top box production but also the network and services supported. The number of variations cannot be analyzed, assessed or counted in any reasonable process.

D. Set-top boxes change rapidly as services and market competition changes, making it impossible to make meaningful projections within the DOE appliance model

As component parts of MVPD services, set-top boxes change rapidly as services change. Set-top boxes initially just offered an expanded channel tuning range, a remote control, or descrambling of secured and optional channels. Set-top boxes have added new and innovative features to meet new consumer demands: HD resolution; simultaneous watching and recording of different channels; on-demand movies; digital video recording capability, and then more and more storage capacity for all those recorded shows; more advanced applications and more processing power and memory to run them. They have evolved also to support other devices, with multi-room playback of recorded shows on the main DVR, and home networking to other set-top boxes in the home, and to devices that travel with subscribers. They are now incorporating social networking into the viewing experience, and efforts are now underway to make the set-top box a hub for home energy management, home security or home automation. Competing service providers deliver their services in different ways. One MVPD has moved the DVR itself back into the network; another uses the primary set-top box to "sling" recorded content to additional, remote devices. Many MVPDs are delivering service using Internet Protocol (IP) directly to iPads, Android tablets, Roku devices, and other customer-owned devices.

Among appliances for which the DOE model was developed, design changes were infrequent. With set-top boxes, the only certainty is that designs will change rapidly. The means for performing each of the six functions performed by MVPDs, the technologies in use, and the location and type of hardware involved are virtually certain to continue to evolve at a rapid rate. For example, where storage takes place is a matter of system design, not an inherent characteristic of the service. How content is encoded, transmitted decoded and distributed changed as systems have moved from analog to digital, from Standard Definition to HD programming, from DVRs to network DVRs and home networking. The system, service, and set-top boxes will continue to evolve with ultra-HD, IP delivery or IP transcoding, and cloud delivery to tablets or other non-traditional displays. The very nature of service delivery may change with the evolution of streaming video from broadcaster websites, YouTube, and "over-the-top" (OTT) video service providers like Netflix and Hulu. The nature of the home entertainment service is in flux, and the role and

physical structure of a "set-top box" has continued to evolve so as to adapt to these changes in technology.

It is impossible for DOE models to project how the future of home entertainment will continue to evolve. History shows that home entertainment can and does take unpredictable paths. For example, over the past five years home entertainment has incorporated:

- The emergence of consumers watching programs on tablet computers, such as the iPad, using streaming video over home wireless networks. The emergence and growth of tablets was completely unpredicted prior to Apple's introduction of the iPad in 2010.

- The advent of TV Everywhere services to computers where the computer has replaced the television set and the Internet is the distribution network. In the early 2000s, the efforts and expectations were for computer functions to migrate to the television, not the reverse.

- The decline of "appointment viewing" of television programming where consumers watched programming as a set time. Increasingly, consumers store programming to watch at their convenience. The approaches consumers take to manage time shifting are still evolving.

- The introduction of products like AppleTV and GoogleTV to support OTT IP video services to the home by players that are traditionally not considered MVPDs.

- The potential for viewing of audio/video content on alternative platforms such as gaming devices.

Each of these changes was either unforeseen or lost in the sea of other alternative futures that did not occur. There is no reason to believe that the future from today onwards will be more predictable than the past several years. Attempting to predict which of a virtually infinite set of future situations will emerge is an impossible task. Trying to do so in order to add an appearance of rigor or accuracy to a set of projections obscures, but does not eliminate, the inherent unpredictability of the situation, providing a veneer of accuracy where none exists.

The only likely constant in this process is the requirement to change and adapt. The likelihood that the functionality and design of a set-top box being deployed a year or two from now will be what is in a box today is approaching zero unless artificially constrained by regulation. Even then, non-regulated systems may encroach in the regulated arena and entirely alter the market.

IV. IMPLICATIONS FOR THE USE OF DOE'S TRADITIONAL MODELS

The actual in-use situation for home entertainment and the corresponding outlook for on-premises hardware (the set-top box or alternatives) could hardly be more different from that of a static home appliance. There is no physical object with stable operating characteristics. There is no stable operating environment from which to project electricity usage. There is a continually evolving "product" with the potential for thousands of variations depending on the overall system choices of the MVPDs and on the need to adapt to the thousands of legacy system combinations of technologies in place across the country. The variations and options are, for all practical purposes, uncountable and are unstable. A modeling process based on counting stable objects is, thus, unsuitable for analyzing the dynamic situation of the home entertainment industry.

The temptation may be to try and force-fit the home entertainment industry and its component hardware into the traditional DOE modeling approach. This might entail treating the set-top box as a product, the set-top box manufacturer as a manufacturer, the MVPDs as a distribution channel and a homeowner as the end customer. However, this structure is unwieldy and not capable of capturing the dynamics of the home entertainment situation.

1. The set-top box is not a physical article of commerce where individual energy savings options can be added through hardware, measured, counted and costed. The set-top box is part of an evolving system with multiple opportunities to provide the same function either locally or remotely, through hardware or through software/firmware. In addition, the set-top box must fit within a broader system interacting with the headend and other systems. For example:

    a. A recent feature change at DIRECTV was the introduction of addressable TV advertising. All DIRECTV branded DVRs in the field have been upgraded with the capability to seamlessly insert advertisements that are targeted to a desired audience into live and recorded programs. The many changes to DVRs included capabilities to receive targeting attributes, record and store the relevant ads, choose ads for playback based on broadcast announcements and insert the chosen ads into in-progress programs with frame-accurate timing. Each of these changes required intensive modifications throughout the DIRECTV broadcast infrastructure adding new work flow, bitstream conditioning and trigger handling functions, as well as integrating new systems designed to manage profiles, schedule the ads, and perform audience measurement. The impact to headend and business systems to implement this new capability was an order of magnitude greater than the impact on the receivers themselves, and it took months of comprehensive testing to get all of these parts working in concert to deliver the desired result.

b. Likewise, satellite television did not convert from MPEG-2 to MPEG-4 set-top boxes for HD programming services with only a box change. The satellite industry's HD transition was accomplished with changes throughout the network, including new receiver dishes, DIRECTV's increase in satellite capacity through the launch of new satellites into new Ka-Band orbital slots, and new compression and other equipment installed in uplink centers. All told, billions of dollars were spent in effecting this transition.

c. As set-top boxes operate with more intelligence and functions moved into the network (such as program guides) and move to entirely IP operations, they can reach lower wattage states. Some of these offerings are available today to serve tablets and personal computers. But to support IP set-top boxes at scale requires far more than purchasing and deploying IP client set-top boxes. A cable operator would need to invest in additional network servers and encoders, additional distributed CDN (content delivery network) resources, clear additional distribution bandwidth for IP transport, and add more CMTS (cable modem termination system) resources to support such set-top boxes. Current estimates add well over a billion dollars in network costs to execute such a change across the cable industry, without even accounting for set-top box costs. These network, operational and other costs are not readily captured in the DOE modeling process.

2. The rapidly evolving nature of the MVPD and home entertainment industries makes projecting a "Base Case" virtually impossible. The traditional DOE approach is to project shipments of products and adjust those shipments for expected changes in product mix and efficiency to establish a Base Case without standards. The proliferation of potential future scenarios for home entertainment services renders this approach useless. Participants in the industry adjust flexibly to changing conditions, not to static forecasts. Developing and assessing alternative futures is a futile exercise that adds uncertainty rather than insight. There is no basis for determining the probability of any potential future scenario. The expected value and/or distribution of consumer or national impact results are not calculable.

3. Set-top boxes are part of a service and are changed out regularly by consumers or by the MVPDs. Therefore the expected life is short -- depreciable lives for set-top boxes range from 2-6 years.[6] This complicates an analysis of consumer payback for two reasons. First, the lifespan at the consumer for any set-top box will be short and often shorter than even the presumptive 5-year payback period considered in DOE consumer analyses.

[6] Annual reports for Comcast, Cablevision, DIRECTV and Dish Network

Second, the Base Case for any consumer analysis would need to evolve continually to reflect the fact that consumers get different set-top boxes with different characteristics many times over the course of a complete analytic cycle.

4. Even if it were possible to determine Base Case scenarios, they would need to incorporate the effects of any voluntary agreements or other situations that will affect future energy consumption for home entertainment services. These will reduce the potential gains that would accrue from any possible standards or other regulations.[7]

5. In addition, the lifetimes can be highly variable due to changes in feature sets and technologies. This is not well captured in the DOE models and the DOE approach of Monte Carlo simulations for equipment life does not reflect the high level of uncertainty and the potential for disruptive innovation. Monte Carlo simulations used by DOE are based on continuous probability functions that, in themselves, need to be derived from data. In the absence of a continuous function, the Monte Carlo simulation would need some sort of discrete but defined set of outcomes and probabilities, for which there is, by definition, no foundation for projection in the case of disruptive innovation that characterizes the set-top box market.

6. The proliferation of technologies and technological variations will strain any accumulation process past the breaking point. The range and variability of the imbedded assumptions on installed mix, operating conditions, product lifecycle, etc., will introduce error factors into the calculations. In 2013, MVPDs have myriad choices for the future: network and cloud-based delivery; conversion to HEVC; Ultra-HD; wired or wireless home networking; gateways or standalone devices; limited functionality devices like DTAs or switched digital video; and delivery to current and to-be-invented customer-owned devices. It is not possible to predict which technologies will be implemented or in what mix. Trying to address this problem with Monte Carlo simulations will only demonstrate that the confidence level in the ultimate results is very low. It will likely not be possible to distinguish between the energy and economic consequences of the post and the pre-regulatory scenarios with any confidence.[8]

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[7] Voluntary Agreement for Ongoing Improvement to the Energy Efficiency of Set-Top Boxes (Dec., 2012), available at http://www.ce.org/CorporateSite/media/ce_news/FINAL-PUBLIC-VOLUNTARY-AGREEMENT-(12-6-2012).pdf

[8] DOE has already seen this problem in the error bands introduced by its use of experience curves such that there is often a substantial overlap in the distribution of outcomes between base and standards cases: US Department of Energy, Preliminary Technical Support Document: Energy Efficiency Program For Consumer Products: Refrigerators, Refrigerator-Freezers, And Freezers, November, 2009, Table 5.9.1, p. 5-54.

7. The MVPD is not a manufacturer who creates a static appliance, places it into commerce, and leaves continuing responsibility to the end-user consumer. Nor is it a channel of distribution for such appliances. It owns, maintains, and changes the set-top boxes with changes in its network and services.[9] The current DOE notion of an incremental markup through a distribution channel does not and cannot be adapted to the case of an MVPD.[10]

8. While not explicitly a part of the DOE regulatory analysis, any DOE standard requires a testing and reporting structure. DOE is already finding limitations in its testing and reporting process for products with a wide variation in features and with either customization or rapid evolution. The concept of basic models and related testing and performance is proving unwieldy for commercial air conditioners and computer simulation programs are not proving to be a full answer. This same or greater complexity will be present in set-top boxes.[11]

These are examples of the issues DOE will face if it attempts to shoehorn set-top boxes into the existing regulatory analytical framework. That framework is simply designed around a completely different factual situation. DOE should abandon any attempt to apply its traditional analytical approaches and models to set-top boxes.

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[9] DOE and others have noted that the MVPD ownership of the set-top boxes creates an "agency problem" where the MVPDs own the boxes but the homeowners pay for the energy. While this is too complex a topic for full discussion here, MVPDs do have an incentive to use energy efficient set-top boxes. Set-top boxes that offer more features and services require increased processing power and memory. Pay TV providers own and maintain tens of millions of devices in consumer homes. If these devices fail, it means customer dissatisfaction, expensive customer service calls, and additional truck rolls. Lower power consumption generally means less heat and lower operating temperatures for devices, which can increase reliability, reduce service calls, and improve performance and device longevity. Energy efficiency helps meet customer expectations in a highly competitive environment. This is why the industry has devoted substantial resources that have already resulted in dramatic improvements in energy efficiency even as set-top boxes are being called upon to deliver more and more functionality.

[10] First, the notion of incremental variable costs would be hard to compute in this situation and would need to accommodate a wide range of software, firmware, hardware and other costs at the MVPD as well as installation and other costs. Second, the incremental margin concept requires the existence of "perfect competition" in the marketplace between the MVPD and the consumer. Again, a full discussion of this topic is too complex for this paper, but regulatory agencies have not concluded that perfect competition applies to the multichannel video marketplace and there are a variety of reasons why these assumptions and conclusions will not apply.

[11] As of late 2012, DOE has proposed extending the compliance date for new commercial air conditioner certification programs and has organized a convening to negotiate a new approach in the face of strong criticism from commercial air conditioner manufacturers: EERE-2012-BT-CE-0048.