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INITIAL STATEMENT OF REASONS

Computers, Computer Monitors, and Signage Displays Appliance Efficiency Rulemaking

California Energy Commission
Docket No. 16-AAER-02
September 2016

I. STATEMENT OF SPECIFIC PURPOSE AND RATIONALE - Government Code §11346.2(b)(1)

PROBLEM STATEMENT

The problem the Energy Commission is trying to solve with these regulations is energy wasted through the use of inefficient computers and computer monitors. Section 25402(c)(1) of the California Public Resources Code mandates that the California Energy Commission reduce the inefficient consumption of energy and water by prescribing efficiency standards and other cost-effective measures for appliances that require a significant amount of energy or water to operate on a statewide basis. Such standards must be technologically feasible and attainable and must not result in any added total cost to the consumer over the designed life of the appliance.

In determining cost-effectiveness, the Energy Commission considers the value of the water or energy saved, the effect on product efficacy for the consumer, and the life-cycle cost to the consumer of complying with the standard. The Commission also considers other relevant factors including, but not limited to, the effect on housing costs, the total statewide costs and benefits of the standard over the lifetime of the standard, the economic effect on California businesses, and alternative approaches and the associated costs.

The Appliance Efficiency Regulations (Title 20, Sections 1601-1609 of the California Code of Regulations (CCR)) contain definitions, test procedures, labeling requirements, and efficiency standards for state- and federally regulated appliances. Appliance manufacturers are required to certify to the California Energy Commission that their products meet all applicable state and federal regulations pertaining to efficiency before their products can be included in the Commission's database of approved appliances to be sold or offered for sale within California. Appliance energy efficiency is identified as a key to achieving the greenhouse gas (GHG) emission reduction goals of Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006) (AB 32), as well as the recommendations contained in the California Air Resources Board's Climate Change Scoping Plan.

Energy efficiency regulations are also identified as key components in reducing electrical energy consumption in the Energy Commission's 2013 Integrated Energy Policy Report (IEPR) and the California Public Utilities Commission's (CPUC) 2011 update to its Energy Efficiency Strategic Plan. Finally, Governor Brown identified reduced energy consumption through efficiency standards as a key strategy for achieving his 2030 GHG reduction goals.

Neither computers nor computer monitors have previously been subject to any California appliance efficiency standard. Computers consume a significant amount of energy and have one of the largest plug loads of any appliance. The most common computer form factors in homes are desktops and notebooks. While there are more notebooks than desktops in California, the energy consumption of a desktop is more than double that of a notebook. This consumption increases when computer monitor energy use is included, which is necessary for functionality. Estimates of computer energy consumption range between 2.5 percent and 4.4 percent of all residential electricity use, not accounting for computer monitor consumption. More than 25.2 million computer monitors are installed in residential and commercial settings in California. Statewide, computer monitors consume about 1,527 gigawatt hours (GWh) of electricity per year. Computer monitors contribute to a peak demand of almost 206 megawatts (MW).

The problem the Energy Commission is trying to solve with regard to signage displays is that there appears to be some confusion among manufacturers and retailers over whether signage displays currently fall under the appliance efficiency standard for televisions. If this confusion continues, manufacturers may not ensure that these products comply with the applicable standard when they become effective in 2018, potentially resulting in increased emissions as a result of non-compliant products being sold in California.

Lastly, the problem the Energy Commission is trying to solve with regard to battery charger systems is that the Energy Commission's 2009 rulemaking for battery chargers inadvertently resulted in the regulation of certain non-consumer products that would qualify as rechargeable batteries or battery charger systems, but were not intended to be covered. These products are not capable of complying with the battery charger systems regulations and if no change were proposed, they would be prohibited from being sold in California, an outcome not anticipated in the original rulemaking.

BENEFITS

The California Energy Commission proposes to modify existing appliance efficiency regulations located at title 20, California Code of Regulations, sections 1601(v) and (w), 1602(a) and (v), 1604(v), 1605.3(v), and 1606(v) to place efficiency standards on computers, computer monitors. The analysis shows that these proposed standards are technically feasible and cost-effective to consumers and would save a significant amount of energy statewide. The proposed changes would also clarify that certain rechargeable batteries and battery charger systems were not intended to be regulated by the previously completed battery charger rulemaking, thus allowing for their continued sale in the state.

Since 1975, California's building and appliance energy efficiency standards have saved Californians an estimated $75 billion in reduced electricity bills. The state's appliance efficiency regulations saved an estimated 22,923 gigawatt hours (GWh) of electricity and 1,626 million therms of natural gas in 2012 alone, resulting in about $5.24 billion in savings to California consumers from these regulations. The proposed standards represent the next step in California's long history of resource efficiency and economic savings.

The proposed computer standards will save about 1,636 GWh/y, calculated using the Energy Star dataset as a baseline, resulting in greenhouse gas emission reductions of 0.513 million metric tons of carbon dioxide equivalent (MMTCO2e) per year and will save consumers about $262 million in electricity bills, calculated using the Energy Star dataset as a baseline, after the stock turnover. Regulating computer monitors will save about 696 GWh/y statewide, will result in greenhouse gas emission reductions of 0.218 million metric ton of carbon dioxide equivalent, and will save about $111 million after existing stock is replaced. These regulations combined will benefit businesses and consumers by reducing electricity bills by $400 million per year. In California, computers and computer monitors, use an estimated 5,610 GWh of electricity and account for 1.7 to 2.9 percent of electricity consumption in the residential sector and 7 percent of electricity consumption in the commercial sector. In the commercial sector, these appliances are concentrated in offices and educational facilities. Energy savings from the proposed monitor standard are about 27.75 kWh a year per unit. At a cost of $0.16 per kWh, the proposed standard will generate $4.44 in electricity savings per unit per year and $31.08 over the lifetime of the unit to the consumer. Subtracting the incremental cost of $5 per unit from the total energy savings of $31.08 per unit over the product life provides life cycle savings of $26.08 to the consumer. Based on the iSuppli and the investor-owned utilities (IOUs') incremental cost data, staff estimates the payback period for the improvement is less than 1.2 years. Therefore, the proposed standard for each unit and model is cost-effective and will save energy.

These regulations will benefit individuals and businesses in California by reducing the energy needed to run the targeted appliances. Any initial increase in purchase price will be offset by reduced operational costs. Additionally, under the proposed standard emissions of greenhouse gases, CO, SOx, NOx, VOC, and PM2.5 decline in the electric power sector due to the decreased demand for electricity from computers and computer monitors. The proposed standards will lead to improved environmental quality in California. Saved energy translates to fewer power plants built and less pressure on the limited energy resources, land, and water use associated with them. Lower electricity consumption results in reduced GHG and criteria pollutant emissions, primarily from lower generation in hydrocarbon burning power plants, such as natural gas power plants. The energy saved by the computer standard would reduce GHG emissions by 0.513 MMTCO2e. The energy saved by the computer monitor standard would reduce GHG emissions by about 0.218 MMTCO2e.

The changes regarding signage displays would provide clarity by confirming that these products are subject to the television standard and ensure that all products sold in California are compliant with the standard. The addition of a new exemption to the battery charger systems regulation would ensure that products that were not intended to be covered by the standard are not unnecessarily prohibited from being sold in California.

PURPOSE AND NECESSITY

1601 Scope

Subdivision (v)

Purpose: To expand the scope of the existing appliance efficiency regulations to include computers and computer monitors. Computers and computer monitors have not previously been regulated for efficiency in California. Because they are new to these regulations, the scope must be expanded to include them.

Necessity: To ensure clarity as to which products are covered under the Commission's regulations, it is necessary to add identifiers for computers and computer monitors to the regulations. The Energy Commission has chosen to establish appliance efficiency regulations for computers and computer monitors because these appliances have a large potential for energy efficiency savings and such savings can be obtained in a cost-effective manner, as required by Public Resources Code section 25402(c).

Subdivision (w)

Purpose: To exempt from the battery charger system standard those appliances that were not intended to be covered by the standard. These appliances consist of non-consumer products with battery chargers or battery charger systems that do not support the primary function of the product when not plugged in. This includes servers and storage controllers.

Necessity: This change is necessary to ensure that products not intended to be covered in the Energy Commission's 2012 battery charger rulemaking are not inadvertently required to comply. At the time of the rulemaking, the Energy Commission was not aware of a battery charger subsystem, and as a result, the Commission did not look at these products for cost-effectiveness, technical feasibility, or potential energy savings. The effective date for these non-consumer products is not until January 1, 2017, so these products are not currently required to comply with the battery charger standard. This change will ensure that these particular products are exempted from the efficiency standard and can continue to be sold in California. These products cannot be tested as required under the battery charger system regulations and, therefore, are incapable of complying with the battery charger system regulations. Failing to exempt them from the standard would mean they could not be sold in California, a result that was never intended in the original rulemaking.

1602 Definitions

Purpose, generally: Definitions are being added to the regulations to address new terms that have been incorporated into the regulatory language. Precise technical language helps to ensure regulatory clarity and common understanding of requirements for computers and computer monitors.

Necessity, generally: The technical nature of the regulations generally requires corresponding definitions to be added to the regulations when the scope expands to cover new product classes, in this case, computers and computer monitors. Terms to define a specific product, a product's part, or a product's feature are also needed to ensure the regulations' applicability and effect are clearly identified. Without the definitions, there would be ambiguity as to what products are covered, what product features are subject to the standards, or what metrics are being used to assess compliance.

Subdivision (a)
Basic Model
Purpose: To define what a basic model of a computer is so that this term can be used in the regulations.

Necessity: This definition is necessary to specify when a computer is different enough from other computers manufactured by the same manufacturer to warrant separate testing and reporting in the database.

Subdivision (v)

Add-in Card
Purpose: An add-in card is a type of expansion card that can be added to a desktop to increase its functionality. All add-in cards consume some amount of additional energy. Add-in cards receive adders for calculating the computer's compliance with the standard. This definition differentiates add-in cards from other types of computer components.

Necessity: Because the amount of energy a computer uses is dependent upon its components, the regulations establish a total energy consumption target and then allow applicable adders to increase the total annual energy consumption that the computer may consume. As a component of computers, add-in cards are assigned an adder amount. The add-in card definition is based on a common industry understanding of the meaning of the word. These definitions are based on the work of expert technical staff as discussed on page 47 in Harinder Singh, Soheila Pasha, Ken Rider. *2016. Final Analysis of Computer, Computer Monitors, and Signage Displays.* California Energy Commission. (Hereinafter referred to as the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.)

Computer
Purpose: This definition defines what types of appliances are considered computers for purposes of these regulations and differentiates computers from other similar types of appliances not intended to be covered under these regulations.

Necessity: In order to ensure the scope of these regulations is precisely limited to those appliances warranting regulation pursuant to Public Resources Code section 25402(c), it is necessary to specifically define what is and is not considered a computer for purposes of these regulations. In a broad sense, computers are everywhere and consist of both specialized and generic systems. These regulations focus on computers that constitute significant loads in buildings and targets energy-efficiency opportunities in five broad computer form factors: desktops, notebooks, small-scale servers, thin-clients, and workstations. The definition of computer is based on a description of common characteristics in a computer. The definition is based on the work of expert technical staff as discussed on page 9 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Computer monitor

Purpose: This definition defines what types of appliances are considered computer monitors for purposes of the scope of these regulations. This definition distinguishes computer monitors from other appliances not intended to be covered by the computer monitor regulations, including televisions and signage displays. This definition excludes computer monitors that are less than 17 inches because sales volumes of these displays are low and estimated to decrease, thus limiting the cost-effectiveness justification of including them. Computer monitors greater than 61 inches are also excluded because there are none available or expected to be available in the market.

Necessity: In order to ensure the scope of these regulations is precisely limited to those appliances warranting regulation pursuant to Public Resources Code section 25402(c), it is necessary to specifically define what is and is not considered a computer monitor for purposes of these regulations. This definition is necessary to specify when a computer monitor is different from televisions, signage displays, electronic readers, mobile phones, portable tablets, and battery-powered digital picture frames, as not all of these products are intended to be covered by the regulations. The computer monitor definition is based on a common industry understanding of the meaning of the word, and was developed by expert technical staff, as described on pages 59-65 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Computer monitor off mode

Purpose: This term defines when a computer monitor is off for purposes of determining power consumption. It is the lowest power mode of a computer monitor and is one of the states that must be tested to determine compliance with the computer monitor efficiency standard.

Necessity: The term computer monitor off mode is used to identify one of the three states a computer monitor must be tested in. The results of the test are used to determine whether the computer monitor meets the energy efficiency requirements contained in this rulemaking. The computer monitor off mode definition is based on a common industry understanding of the meaning of the word and was developed by expert technical staff, as described on page 67 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Computer monitor sleep mode

Purpose: This term establishes when a computer monitor enters a period of inactivity, usually triggered by a signal from a connected device or an internal stimulus. While a product is in sleep mode, it is not producing a picture, and is one of the states that must be tested to determine compliance with the computer monitor efficiency standard.

Necessity: The term computer monitor sleep mode is used to identify one of the three states a computer monitor must be tested in. The results of the test are used to determine whether the computer monitor meets the energy efficiency requirements contained in this rulemaking. The computer monitor sleep mode definition is based on a common industry understanding of the meaning of the word and was developed by expert technical staff, as described on pages 66 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Desktop computer

Purpose: This definition defines desktop computer and differentiates it from other types of computer to allow for different standards to apply as necessary under these regulations.

Necessity: Different regulatory approaches are needed for different types of computers. To differentiate between the efficiency standards that apply to each computer type, it is necessary to specifically define each type of computer so that manufacturers are not confused about which efficiency standard applies to their product. The regulations address efficiency opportunities in five form factors (computer types): desktops, notebooks, small-scale servers, thin-clients, and workstations. The regulations then establish three different standards, and group the form factors according to the appropriate efficiency level. Desktops are subject to one set of performance requirements, whereas notebooks are subject to a different set of performance requirements and workstations are subject to a design requirement. The desktop computer definition is based on industry-accepted terminology for describing a desktop computer. The definition is based on the work of expert technical staff as discussed on pages 27 and 35 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Digital Cinema Initiative (DCI)-P3

Purpose: DCI-P3 is one of three criteria for determining whether a computer monitor is a very high performance monitor, which are exempted from the standards.

Necessity: This definition is necessary to specify a specific type of computer monitor producing Red-Green-Blue (RGB) color space that features the widest color gamut of all of the emulated color spaces. This term is necessary to establish the scope of the coverage of the computer monitor regulations. The digital cinema initiative (DCI)-P3 definition is based on a common industry understanding of the meaning of the word.

Discrete graphics or Discrete Graphics GPU

Purpose: Discrete graphics GPU is a component of computers that consume energy and present opportunities to reduce energy consumption. This term differentiates these components from integrated graphics and hybrid graphics, which consume different amounts of energy.

Necessity: Because the amount of energy a computer uses is dependent upon its components, the regulations establish a total energy consumption target and then allow applicable adders to increase the total annual energy consumption that the computer may consume. The regulations limit the energy consumption attributable to discrete graphics GPU. Discrete graphics GPU is also part of the criteria for defining high expandability computers. This definition is based on industry-accepted terminology for describing a graphics processing units. The definition is based on the work of expert technical staff as discussed on page 40 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Energy-Efficient Ethernet capability
Purpose: Ethernet is one of computer interfaces that allows a computer to connect to the internet and it consumes energy. The term Energy-Efficient Ethernet is defined to differentiate between regular Ethernet and Energy-Efficient Ethernet.

Necessity: Energy-Efficient Ethernet is one of the requirements for desktop and mobile workstations, small-scale servers, and high expandability computers. It is necessary to define this in order to avoid ambiguity as to what type of Ethernets meets the requirement. Also, because the amount of energy a computer uses is dependent upon its components, the regulations establish a total energy consumption target and then allow applicable adders to increase the total annual energy consumption that the computer may consume. The regulations limit the energy consumption attributable to Energy-Efficient Ethernets. The "Energy-Efficient Ethernet" definition is based on industry-accepted terminology for describing an Ethernet. The definition is based on the work of expert technical staff as discussed on page 46 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Enhanced-performance display (EPD)
Purpose: This definition defines a type of specialty computer monitor that requires more power than a standard computer monitor to produce a higher quality picture. The definition distinguishes an enhanced-performance display from a standard computer monitor or other types of specialty computer monitors.

Necessity: The amount of energy a computer monitor requires when being actively used depends in part on the quality of the picture that the computer monitor is producing. Higher-quality computer monitors use more power than standard computer monitors. Because of this, the regulations establish adders to allow higher-quality products, such as enhanced-performance displays, to consume more power in active mode. Enhanced-performance displays have different color gamuts, which require different adders as well. These color gamuts are referred to as percentages of CIELUV color space, and are described in the International Commission on Illumination (CIE) color space adopted in 1976 (called CIE 1976 (L*, u*, v*) color space), which is a calculation from the earlier 1931 CIE XYZ color space. The enhanced-performance display definition is based on a common industry understanding of the meaning of the word and was developed by expert technical staff, as described on pages 62 to 65 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Expandability score

Purpose: Definitions are being added to the regulations to address new terms that have been incorporated into the regulatory language. The term is being used when dividing computers into four different categories. Precise technical language helps to ensure regulatory clarity and common understanding of requirements for computers.

Necessity: Expandability score of a computer is a number that is calculated based on computer's features and capabilities, and is closely correlated with the amount of actual energy that it consumes. This is a new term that is not commonly used in the industry. It is necessary to define this term in order to remove any confusion when it is used to describe the base model categories. The "expandability score" definition is based on the work of expert technical staff as discussed on page 24 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Frame buffer bandwidth

Purpose: This term is added to the definitions to define what "frame buffer bandwidth" means so that the term can be used to identify the appropriate adders for computers.

Necessity: "Frame buffer bandwidth" is a term used to describe the rate at which data moves between a video display and a memory buffer, and is distinct from system memory bandwidth. Faster (higher) rates consume more energy than lower rates. As a result, this term is necessary for identifying the rates that require more energy, and therefore merit an adder under the computer efficiency standards. This definition is based on a common industry understanding and measure of the term.

Game console

Purpose: Game console is a system that meets the definition of a desktop computer. Game console is incorporated into the regulatory language and this definition is added to differentiate it from regular computers.

Necessity: Game consoles are exempted from the proposed standards. Since they are a type of computer, they need to be defined to avoid ambiguity as to what products are covered and what products are exempted from the proposed regulations.

Gaming monitor

Purpose: This definition describes a type of specialty computer monitor that requires more power than a standard computer monitor to produce a high refresh rate that displays images that can keep up with user-interaction, as for gaming. The definition distinguishes gaming monitors from standard computer monitors, and from other types of specialty computer monitors.

Necessity: The amount of energy a computer monitor requires when being actively used depends in part on the vertical refresh rate of the computer monitor. Computer monitors that can rapidly update their images in response to user input require more power than standard computer monitors. These types of computer monitors are used primarily for gaming and film production. The regulations establish adders to allow these types of computer monitors to use more power in active mode so as to provide this additional functionality. Gaming monitors with incremental hardware-based assistance typically use more energy than those without incremental hardware-based assistance, so the definition necessarily distinguishes these two types. Incremental hardware-based assistance is an industry term to refer to physical technology improvements to a monitor that allow it to sync to the graphics card to achieve the high refresh rate for a gaming monitor. An example of a gaming monitor with this type of improvement is a "G-Sync" monitor. This is contrasted to monitors using software improvements (that is, without incremental hardware-based assistance) that perform this syncing function. An example of this is a "Freesync" monitor. The gaming monitor definition is based on a common industry understanding of the meaning of the word and was developed by expert technical staff, as described on pages 65 and 66 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Graphical user interface (GUI)
Purpose: Graphical user interface (GUI) is part of a computer's operating system and is a type of interface that facilitates interactions between the user and the computer through visual indicators and icons. This term is added to differentiate GUI from text based and typed command interfaces.

Necessity: "Graphical user interface" is part of the criteria used in differentiating conventional operating systems from limited capability operating systems. "Limited capability operating systems" do not support "graphical user interface" and computers with such operating systems are exempted from part of the proposed regulations. It is necessary to define this term in order to have a clear determination as to what kind of operation system a computer has and therefore what standards apply to it. The "graphical user interface" definition is based on industry-accepted terminology for describing a GUI.

Graphics processing unit (GPU)
Purpose: GPU is a component of discrete and integrated graphics which consumes energy and presents opportunities to reduce energy consumption. This term differentiates these components from Central Processing Units (CPUs).

Necessity: The "graphics processing unit" definition is based on industry-accepted terminology. The Graphics Processing Unit's (GPU's) function is very similar to the Central Processing Unit (CPU) of the computer with the exception that it only handles graphic related processes. This term is used to describe discrete and integrated graphics and is necessary to define it in order to draw distinction between GPU and CPU.

High expandability computer
Purpose: "High expandability computer" describes computers that have many high-end features. Desktops that meet certain criteria are considered "high expandability" computers and this term is added to distinguish them from regular desktop computers.

Necessity: "High expandability computer" is incorporated into the regulations. They are required to comply with a different set of standards than other desktop computers. This is a new term that is not commonly used in the industry. It is necessary to define it in order to remove any ambiguity as to what products are high expandability computers. The "high expandability computer" definition is based on the work of expert technical staff as discussed on page 28 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Hybrid graphics
Purpose: Hybrid graphics is a component of computers that consume energy and present opportunities to reduce energy consumption. This term differentiates these components from integrated and discrete graphics, which consume different amounts of energy.

Necessity: The amount of energy a computer uses is dependent upon its components and how they are setup. Computers with hybrid graphics have the opportunity to save energy if this function is enabled by allowing Discrete Graphics to enter a low-power state when not required in favor of Integrated Graphics. Since the regulations consider different limits for the energy consumption attributable to hybrid graphics and discrete graphics, it is necessary to define the term "hybrid graphics." It is also used to describe the test procedure to collect the energy consumption data.

Idle condition
Purpose: Idle condition describes the state of a computer where no user interaction is occurring and where no user-prescribed task is underway. This term is used in the definition of the short-idle and long-idle modes.

Necessity: A definition for idle condition is being added to address short-idle and long-idle terms that have been incorporated into the regulatory language. It is necessary to adequately describe these modes since they are measured in the test procedures and represent the majority of energy saving opportunities and therefore regulations heavily target them.

Industrial computer
Purpose: The Industrial computer definition describes computers that are designed specifically to automate an industrial, medical, or laboratory process. It differentiates industrial computers from other types of computers.

Necessity: The "industrial computer" definition is based on the work of expert technical staff. Industrial computers are exempted from the computer regulations. It is necessary to define them in order to remove any ambiguity as to what products are covered and what products are exempted from the regulations.

Integrated desktop computer
Purpose: The integrated desktop computer definition is used to describe a computer where the computing hardware and display are integrated into a single housing. This

definition distinguishes integrated desktop computers from other types of desktop computers.

Necessity: Because the amount of energy a computer uses is dependent upon its components, the regulations establish a total energy consumption target and then allow applicable adders to increase the total annual energy consumption that the computer may consume. Integrated desktop computers contain an integrated display which consumes energy in addition to that which the computer uses. The regulations limit the energy consumption attributable to an integrated display. The "integrated desktop computer" definition is based on industry-accepted terminology for describing an integrated desktop computer. The definition is based on the work of expert technical staff as discussed on page 15 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Integrated Graphics

Purpose: Integrated graphics are a component of computers that consume energy and present opportunities to reduce energy consumption. This term differentiates these components from discrete graphics and hybrid graphics, which consume different amounts of energy.

Necessity: Because the amount of energy a computer uses is dependent upon its components, the regulations establish a total energy consumption target and then allow applicable adders to increase the total annual energy consumption that the computer may consume. The regulations limit the energy consumption attributable to integrated graphics. This definition is based on industry-accepted terminology for describing integrated graphics. The definition is based on the work of expert technical staff as discussed on page 40 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Keyboard, video, and mouse (KVM) or keyboard, mouse, and monitor (KMM)

Purpose: A keyboard, video, and mouse (KVM) or keyboard, mouse, and monitor (KMM) is a type of device that allows a user to control multiple computers at once, and is typically used in server rooms. These devices are defined here to distinguish them from standard computer monitors. KVM and KMM devices are exempted from the standards because of their unique application and low sales volume.

Necessity: This definition is necessary to specify a specific type of computer monitor that allows a user to control multiple computers at once, and is typically used in server rooms. This term is necessary to establish the scope of the coverage of the computer monitor regulations. The definition of a KVM, also known as a KMM, is based on a common industry understanding of the meaning of the word.

Limited capability operating system

Purpose: One of the requirements of the regulations is that computers be shipped with operating systems that have certain power management settings. However, some computers are shipped with only minimally functional operating systems that do not have power management. This definition is added to describe these types of operating systems for the purpose of exempting them from the power management requirements in the regulations.

Necessity: Power management is a feature of operating systems, and a key requirement in the regulations. However, some consumers do not need a fully functional operating system, as, for example, when the consumer already has the license to an operating system and only needs the computer to have enough functionality to boot up so that the licensed system can be uploaded. These limited capability operating systems therefore do not have power management settings, as they are not designed for long or continuous use by a computer user, making it necessary to exempt them from the power management requirements. To do otherwise would effectively ban these types of systems in California. The definition is based on the work of expert technical staff as discussed on page 28 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Long-idle mode
Purpose: Long-idle mode is one of five modes of operation for a computer. Four of these five modes, including long-idle mode, are tested and regulated under the efficiency standards for computers. A definition for long-idle mode is added to differentiate it from active/on mode, short-idle mode, sleep mode, and off-mode so that manufacturers can properly test the efficiency of the computer in that mode. The modes are then added together (with weighting factors determined by the test procedure) to determine the total energy consumption of the computer.

Necessity: Long-idle mode is a state based on time – it represents a longer time since a user last interacted with the computer or the computer last conducted a process. The key efficiency opportunities in the regulations are in reducing the energy consumption in short- and long-idle modes. This term is used throughout the regulations to differentiate it from other operating modes of a computer and to identify efficiency opportunities in each mode. The definition is based on the work of expert technical staff as discussed on pages 34 and 41 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Mobile gaming system
Purpose: Mobile gaming systems are a type of very high-performing portable computer. Because of their high performance, the energy consumption profile and opportunities for mobile gaming systems better resembles desktops than notebooks. The definition is added to differentiate this type of product from workstations and notebooks.

Necessity: Mobile gaming systems resemble notebooks, but because they are high performing and have a lot of functionality, they more closely resemble desktops in terms of energy use and efficiency opportunities. As a result, it is necessary to differentiate mobile gaming systems from notebooks in order to provide different efficiency standards for the two products. The "mobile gaming system" definition is based on the work of expert technical staff as discussed on page 25 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Mobile thin client

Purpose: A mobile thin client is a type of thin client that is designed for portability. As a result, its energy consumption is more like a notebook computer than a conventional thin-client or desktop computer. The definition is added to differentiate mobile thin clients from conventional thin clients and desktops so that different efficiency standards can apply to it.

Necessity: To differentiate between the efficiency standards that apply to each computer type, it is necessary to specifically define each type of computer so that manufacturers are not confused about which efficiency standard applies to their product. The regulations apply the same efficiency standards to thin-clients and desktops. However, because of its portability and functionality, a mobile thin-client uses significantly less energy than a conventional thin-client. Therefore, it is treated as a notebook, with lower energy consumption requirements, instead of a thin-client or desktop. The "mobile thin client" definition is based on industry-standard language and the ENERGY STAR categorization for this product.

Mobile workstation

Purpose: Mobile workstations are a type of very high-performing portable computer. Because of their high performance, the energy consumption profile and opportunities for mobile workstations better resembles workstations than notebooks or even desktops. The definition is added to differentiate this type of product from desktops and notebooks.

Necessity: Mobile workstations resemble notebooks, but because they are high performing and have a lot of functionality, they more closely resemble workstations in terms of energy use and efficiency opportunities. As a result, it is necessary to differentiate mobile workstations from notebooks in order to provide different efficiency standards for the two products. The "mobile workstation" definition is based on the work of expert technical staff as discussed on page 25 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Monitor screen area

Purpose: The computer monitor standards are based on three components of a computer monitor: diagonal length (for purposes of determining the appropriate "bin"), screen area, and resolution. This definition is being added to the regulations to determine how to measure the viewable screen area of a computer monitor, as distinguished from the total area of a computer monitor (including any border around the edge). The definition also explains how to measure the screen area of curved monitors, as curved monitors can have two distinct areas, depending on whether you measure along the curvature or straight across from corner to corner.

Necessity: Defining how to measure the monitor screen area is necessary to ensure consistency in how manufacturers determine the efficiency levels that apply to their products. Monitor screen area can be measured by counting only the viewable screen or by counting any border around the monitor. Similarly, curved monitors can be measured along the curvature of the monitor or along a chord (from corner to corner). Therefore, it is necessary to define the appropriate measurements for screen area to ensure a level playing field. The monitor screen area definition is based on the ENERGY STAR approach and was developed by expert technical staff, as described on pages 84 to 89 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Native resolution

Purpose: The computer monitor standards are based on three components of a computer monitor: diagonal length (for purposes of determining the appropriate "bin"), screen area, and resolution (or native resolution). This definition is being added to the regulations to determine how to measure the native resolution of the monitor so that manufacturers can properly calculate the efficiency level that applies to their product.

Necessity: Defining native resolution is necessary to ensure consistency in how manufacturers determine the efficiency levels that apply to their products. Native resolution is distinguished in the definitions from other measures of resolution, such as scaled resolution or varied resolution. Because the efficiency standards scale with the native resolution of the computer monitor, it is necessary to define native resolution to ensure a level playing field among manufacturers and products. The native resolution definition is based on a common industry understanding of the meaning of the term.

Notebook computer

Purpose: This definition defines what types of appliances are considered notebook computers for purposes of these regulations and differentiates notebooks from other types of computers, such as desktops and workstations, as different efficiency standards apply to each product under the regulations.

Necessity: To differentiate between the efficiency standards that apply to each computer type, it is necessary to specifically define each type of computer so that manufacturers are not confused about which efficiency standard applies to their product. The regulations address efficiency opportunities in five form factors (computer types): desktops, notebooks, small-scale servers, thin-clients, and workstations. The regulations then establish three different standards, and group the form factors according to the appropriate efficiency level. Notebooks, along with a few specialized products, like portable all-in-ones, are subject to one set of performance requirements, whereas desktops are subject to a different performance requirement, and workstations are subject to a design requirement. The "notebook computer" definition is based on industry-accepted terminology for describing a notebook computer and based on the work of expert technical staff as discussed on page 29 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Off mode

Purpose: Off mode is one of five modes of operation for a computer. Four of these five modes, including off mode, are tested and regulated under the efficiency standards for computers. A definition for off mode is added to differentiate it from active/on mode, short-idle mode, long-idle mode, and sleep mode so that manufacturers can properly test the efficiency of the computer in that mode. The modes are then added together (with weighting factors determined by the test procedure) to determine the total energy consumption of the computer.

Necessity: Off mode is defined based on the processing state of the central processing unit. Off mode is the lowest power-consuming state for a computer. This term is used throughout the regulations to differentiate it from other operating modes of a computer and to identify efficiency opportunities in each mode. The definition is based on the work of expert technical staff as discussed on pages 33 and 34 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Organic light emitting diode (OLED) monitor
Purpose: This definition defines a type of specialty computer monitor that requires more power than a standard computer monitor to produce a higher quality picture. The definition distinguishes an OLED monitor from a standard computer monitor. Standard computer monitors, in contrast, typically use either LEDs or cold cathode fluorescent lamp technologies.

Necessity: The amount of energy a computer monitor requires when being actively used depends in part on the quality of the picture that the computer monitor is producing. Higher-quality computer monitors use more power than standard computer monitors. Because of this, the regulations establish adders to allow higher-quality products, such as OLED monitors, to consume more power in active mode. The OLED monitor definition is based on a common industry understanding of the meaning of the word and was developed by expert technical staff, as described on page 59 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Portable all-in-one
Purpose: This definition is added to define a sub-type of computers for the purpose of clarifying that portable all-in-ones are a type of notebook computer. The definition differentiates this type of product from other computers with built in screens, such as integrated desktops, and from exempted products, such as tablets.

Necessity: Portable all-in-ones resemble tablets, but they are in fact a type of a notebook computer and therefore subject to the regulations. Unlike notebooks, however, a portable all-in-one often has a detached keyboard and mouse, making it necessary to define these separately from notebook computers. This definition is necessary to differentiate portable all-in-ones from exempted tablets, and from integrated desktops, which are desktops with built-in displays. Different efficiency standards apply to each product type: integrated desktops are treated as desktops; portable all-in-ones are treated as notebooks; and tablets are exempted entirely. The "portable all-in-one" definition is based on the work of expert technical staff as discussed on page 25 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Primary Storage
Purpose: Primary storage is a component of computers that consumes energy and presents opportunities to reduce energy consumption. This term differentiates primary storage from other types of storage for the purposes of enabling the determination of what adders to apply to the energy consumption calculation.

Necessity: Because the amount of energy a computer uses is dependent upon its components, the regulations establish a total energy consumption target and then allow applicable adders to increase the total annual energy consumption that the computer may consume. The regulations use primary storage as a factor in the Expandability Score to determine which Total Energy Consumption levels apply to the computer. The definition is based on the work of expert technical staff.

Professional signage display

Purpose: A professional signage display is a type of signage display that is designed for viewing by a large number of people, typically in stadium or arena settings. These displays typically are connected to each other with limited inputs, making their energy consumption different than typical signage displays. The definition is added here for the purpose of exempting these devices from the standards so that more studies can be done on their energy consumption.

Necessity: This definition is necessary to specify a specific type of signage display that is larger than a signage display, connected with multiple display panels with limited inputs, and designed for viewing by a large audience. This term is necessary to establish the scope of the coverage of the signage display regulations. The professional signage display definition is based on a common industry understanding of the meaning of the word and was developed by expert technical staff, as described on page 74 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Rack-mounted workstation

Purpose: This definition defines what types of appliances are considered rack-mounted workstations for purposes of these regulations and differentiates rack-mounted workstations from other types of workstations, as different power management requirements apply to each.

Necessity: To differentiate between the power management requirements that apply to workstations versus rack-mounted workstations, it is necessary to define specifically each type so that manufacturers are not confused about which efficiency standard applies to their product. The regulations address efficiency opportunities in five form factors (computer types): desktops, notebooks, small-scale servers, thin-clients, and workstations. Rack-mounted workstations are a type of workstation, but unlike typical workstations, they are always in active mode and therefore do not have a sleep state. As a result, it is necessary to define this sub-type so that they can be exempted from the power management requirements of the regulations. The "rack-mounted workstation" definition is based on the work of expert technical staff as discussed on page 25 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Short-idle mode

Purpose: Short-idle mode is one of five modes of operation for a computer. Four of these five modes, including short-idle mode, are tested and regulated under the efficiency standards for computers. A definition for short-idle mode is added to differentiate short-idle mode from active/on mode, long-idle mode, sleep mode, and off-mode so that manufacturers can properly test the efficiency of the computer in that mode. The modes are then added together (with weighting factors determined by the test procedure) to determine the total energy consumption of the computer.

Necessity: Short-idle mode is a state based on time – it represents a short time since a user last interacted with the computer or the computer last conducted a process. The key efficiency opportunities in the regulations are in reducing the energy consumption in short- and long-idle modes. This term is used throughout the regulations to differentiate it from other operating modes of a computer and to identify efficiency opportunities in each mode. The "short-idle mode" definition, including the timeframe for determining when the computer is in short-idle mode, is based on industry-accepted terminology and based on the work of expert technical staff as discussed on pages 33 and 34 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Signage display

Purpose: The signage display definition is being added to the regulations to clarify an existing term (televisions) that was previously incorporated into the regulatory language. Some stakeholders had previously expressed confusion about whether the definition of televisions encompassed signage displays. Adding a definition here clarifies the scope of coverage of the television regulations.

Necessity: The technical nature of the regulations requires the signage display definition to be added to the regulations to ensure that signage displays comply with the existing television standard stated in Table V-2. Without the definition, stakeholders had expressed ambiguity about whether signage displays were considered "televisions." This ambiguity arose because although signage displays met the regulatory definition of a "television," manufacturers did not consider them "televisions" because they were marketed for a different purpose and audience, such as arrival/departure screens or hotel event displays. Adding a definition for this term is necessary to clarify that the standards for televisions also apply to signage displays. The signage display definition is based on a common industry understanding of the meaning of the word and was developed by expert technical staff, as described on page 66 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Sleep mode

Purpose: Sleep mode is one of five modes of operation for a computer. Four of these five modes, including sleep mode, are tested and regulated under the efficiency standards for computers. A definition for sleep mode is added to differentiate sleep mode from active/on mode, short-idle mode, long-idle mode, and off-mode so that manufacturers can properly test the efficiency of the computer in that mode. The modes are then added together (with weighting factors determined by the test procedure) to determine the total energy consumption of the computer.

Necessity: Sleep mode is a lower energy state than short-idle and long-idle modes. A computer can enter sleep mode either manually (when a user tells the computer to go to sleep) or automatically after a set period of time. Unlike off mode, a computer can "wake" relatively quickly from sleep mode. The term is used throughout the regulations to differentiate it from other operating modes of a computer and to identify efficiency opportunities in each mode. The sleep mode definition requires manufacturers to test after the computer has been idle for at least 30 minutes (called long-idle). This is because the efficiency standards in section 1605.3 require a computer to enter into sleep mode within 30 minutes, so the definition ensures that the test is conducted both to determine whether the computer has entered into sleep mode and to determine the energy consumption of that sleep state for purposes of complying with the standards. The definition also acknowledges alternative sleep modes for operating systems that do not have a traditional sleep mode. The definition is based on the work of expert technical staff as discussed on pages 33 and 34 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Small computer device

Purpose: A small computer device is a type of computer in a broad sense. However, small-computer devices, such as calculators, smartphones, and handheld video games, are not being covered as computers for purposes of this regulation. This definition is added to define small computer devices for purposes of excluding them from the regulation for computers.

Necessity: To differentiate between products that are covered under the scope of the regulations and products that are exempted, it is necessary to define each type of product under the regulation that could be considered a computer in the broad sense. Small computer devices contain many of the same components as the computers being regulated, but the regulations exclude small computer devices, as no analysis was done on these products to determine what efficiency standards would be cost-effective or technically feasible. This definition differentiates small-computer devices from computers generally. The "small computer device" definition is based on the work of expert technical staff as discussed on page 25 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Small-scale server

Purpose: This definition defines what types of appliances are considered small-scale servers for purposes of these regulations and differentiates small-scale servers from other types of computers, as different efficiency standards apply to each product under the regulations.

Necessity: To differentiate between the efficiency standards that apply to each computer type, it is necessary to define specifically each type of computer so that manufacturers are not confused about which efficiency standard applies to their product. The regulations address efficiency opportunities in five form factors (computer types): desktops, notebooks, small-scale servers, thin-clients, and workstations. The regulations then establish three different standards, and group the form factors according to the appropriate efficiency level. Workstations and small-scale servers, along with a few specialized products, like high expandability computers, are subject to specific design requirements, whereas desktops and notebooks are each subject to general performance requirements. The "small-scale server" definition is based on the work of expert technical staff as discussed on page 29 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Small volume manufacturer

Purpose: Unlike many industries, computers are manufactured by both large and small businesses, and can be made in large or small quantities. Small volume manufacturers are small businesses that do not make a large volume of computers, making compliance with the regulations potentially cost-prohibitive. This definition provides clear criteria for determining whether a manufacturer is a small volume manufacturer. Manufacturers that meet the criteria are exempt from complying with the more costly parts of the regulations for any basic model for which they produce 40 units or fewer.

Necessity: This definition is necessary to specify when a specific type of computer manufacturer is exempted from the computer regulations. The criteria developed are designed to focus the exemption on small businesses (having gross annual receipts of less than $2,000,000) and that manufacture and sell the product in one location. The criteria were developed based on the U.S. Department of Energy's criteria for small business exemptions from their appliance efficiency regulations and based on an analysis of the "break-even" point for cost recovery to comply with the regulations. The definition is further discussed on page 30 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

System memory bandwidth

Purpose: This term is added to the definitions to define what "system memory bandwidth" means so that the term can be used to identify the appropriate adders for computers.

Necessity: "System memory bandwidth" is a term used to describe the rate at which data moves in the memory of a computer. Faster (higher) rates consume more energy than lower rates. As a result, this term is necessary for identifying the rates that require more energy, and therefore merit an adder under the computer efficiency standards. This definition is based on a common industry understanding and measure of the term.

Tablet

Purpose: Tablets are a type of computer in a broad sense. However, tablets are not being covered as computers for purposes of this regulation. This definition is added to define tablets for purposes of excluding them from the regulation for computers.

Necessity: To differentiate between products that are covered under the scope of the regulations and products that are exempted, it is necessary to define each type of product under the regulation that could be considered a computer in the broad sense. The regulations explicitly exclude tablets from the definition of a computer. This definition is added to describe what a tablet is, as distinguished from, for example, a two-in-one notebook (not excluded). The "tablet" definition is based on industry-accepted terminology for describing a computer's operating modes and based on the work of expert technical staff as discussed on page 25 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Thin client

Purpose: This definition defines what types of appliances are considered thin-clients for purposes of these regulations and differentiates thin-clients from other types of computers, as different efficiency standards apply to each product under the regulations.

Necessity: To differentiate between the efficiency standards that apply to each computer type, it is necessary to specifically define each type of computer so that manufacturers are not confused about which efficiency standard applies to their product. The regulations address efficiency opportunities in five broad form factors (computer types): desktops, notebooks, small-scale servers, thin-clients, and workstations. The regulations then establish three different standards, and group the form factors according to the appropriate efficiency level. Thin-clients and desktops, along with a few specialized products, like mobile gaming systems, are subject to general performance standards, whereas notebooks are subject to different performance standards and workstations are subject to specific design requirements. The "thin client" definition is based on the work of expert technical staff as discussed on page 15 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Two-in-one notebook

Purpose: This definition is added to define a sub-type of computers for the purpose of clarifying that two-in-one notebooks are a type of notebook computer. The definition differentiates this type of product from other computers with built in screens, such as integrated desktops, and from exempted products, such as tablets.

Necessity: Two-in-one notebooks resemble tablets, but they are in fact a type of a notebook computer and therefore subject to the regulations. This definition is necessary to differentiate two-in-one notebooks from exempted tablets, and it also differentiates these products from integrated desktops, which are desktops with built-in displays. Different efficiency standards apply to each product type: integrated desktops are treated as desktops; two-in-one notebooks are treated as notebooks; and tablets are exempted entirely. The "two-in-one notebook" definition is based on the work of expert technical staff as discussed on page 25 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Very high performance monitors

Purpose: This definition is added for the purpose of exempting very high performance monitors from the computer monitor standards. Very high performance monitors represent a very small share of the computer monitor market and consumers of these products, typically engineering and film industries, require high performance, and therefore high energy consumption. However, because the sales volume of these products is so low, and because their cost prevents them from becoming mainstream, the energy consumption expected from these products is not significant.

Necessity: This definition is necessary to specify a specific type of computer monitor that is the highest end of computer monitors, having a very wide color gamut (DCI-P3 or Adobe RGB), a large diagonal screen size, and a very high resolution (greater than 4K). This term is necessary to establish the scope of the coverage of the computer monitor regulations. The "very high performance monitor" definition is based on conversations with industry representatives who described the types of very high-end computer monitors that, while very energy intensive, are used in only niche areas of the market.

Workstation
Purpose: This definition defines what types of appliances are considered workstations for purposes of these regulations and differentiates workstations from other types of computers, as different efficiency standards apply to each product under the regulations.

Necessity: To differentiate between the efficiency standards that apply to each computer type, it is necessary to specifically define each type of computer so that manufacturers are not confused about which efficiency standard applies to their product. The regulations address efficiency opportunities in five form factors (computer types): desktops, notebooks, small-scale servers, thin-clients, and workstations. The regulations then establish three different standards, and group the form factors according to the appropriate efficiency level. Workstations and small-scale servers, along with a few specialized products, like high expandability computers, are subject to specific design requirements, whereas desktops and notebooks are each subject to general performance requirements. The "workstation" definition is based on industry-accepted terminology for workstation and on the work of expert technical staff, as discussed on page 46 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

1604, subdivision (v) Test Methods for Specific Appliances

(v)(2) Test method for Televisions

Purpose: Adds the term signage displays to clarify that signage displays are regulated under the televisions energy efficiency regulations and are subject to the test methods established for these appliances.

Necessity: This addition is necessary to address some confusion expressed by a few stakeholders that were uncertain whether the original television standard rulemaking was intended to encompass signage displays. It clarifies that the scope of the energy efficiency regulations for televisions includes signage displays.

(v)(4) Test method for computer monitors

Purpose: This section identifies the test methods related to computer monitors that will allow manufacturers to show product compliance. This test method is developed and used by ENERGY STAR specification Version 7.0. This test method includes standardized International Electrotechnical Commission (IEC) developed procedures that describe the testing method and protocol. Test methodology and directions provided in this section clarify additional steps that are needed to test the computer monitors.

Necessity: In order to have energy efficiency standards there must be corresponding standardized test methods identified that manufacturers can use to assess product performance. The test procedures were modified from the original ENERGY STAR version 7.0 test procedure to provide clarity and consistency in how manufacturers are required to test their products so that test results are comparable between products and manufacturers and consistent within product lines. Specifically, the Energy Commission made the following modifications:

Testing in on-, sleep-, and off-modes. Under the ENERGY STAR version 7.0 test procedure, manufacturers test in on-, sleep-, and off-modes, which are then calculated together to report a "total energy consumption" for the product. Because the Energy Commission is proposing modal standards for computer monitors, and not a total energy consumption standard, it is necessary to have manufacturers test and report the power consumption in each mode. Subdivisions (v)(4)(A) and (v)(4)(B) are added to clarify this modal testing and reporting requirement.

Turning off features not addressed by ENERGY STAR. The ENERGY STAR version 7.0 test procedure specifies features that should be turned off during the test, but it does not address all features. Because this is a mandatory standard rather than a voluntary standard like ENERGY STAR, it is necessary to specify that any feature not addressed by ENERGY STAR must be turned off.

Turning off features unrelated to the display of images. The ENERGY STAR version 7.0 test procedure requires some features, like speakers, webcams and LAN connections, to be tested in their "as-shipped" mode, whether on or off. The Energy Commission modified this for two reasons. First, because computer monitors may be shipped in different configurations, it is necessary to specify whether features should be on or off in order to compare efficiency levels between computer monitor models. Second, the energy efficiency standards focus on efficiency improvements in the display and power supply, not on energy efficiency in other features of a computer monitor, so the test procedure was modified to focus on energy efficiency improvements to the display, with other features disabled or turned off.

Additional information about the necessity of modifications is provided on page 70 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

(v)(5) Test method for computers

Purpose: This section specifies the testing protocols related to computers that will allow manufacturers to show product compliance with the standards. Test procedures are standardized methods that describe the testing protocol to create consistency and replicability between tests and products.

Necessity: In order to have energy efficiency standards, there must be corresponding standardized test methods identified that manufacturers can use to assess product performance. Test procedures must be replicable, yield consistent results, and indicate the real-world energy consumption and behavior of an appliance. The test procedure for computers is based on the test procedure developed by the U.S. Environmental Protection Agency in its ENERGY STAR program specification for computers. The ENERGY STAR test method is well understood by industry and provides most of the testing protocols necessary to verify compliance with the proposed standards.

However, it was necessary to modify the ENERGY STAR test procedure to account for specific situations raised by computer manufacturers and to minimize potential loopholes. These modifications include the following:
Specifying the settings for when the hard-disk should be spinning. The hard-disk, when active (spinning), can consume a significant amount of energy. To ensure that test results indicate the actual energy consumption of the product and the consistency of the test results between computers, hard-disk spinning must be at its as-shipped setting.

Identifying which weighting mode or "duty cycle" a manufacturer must use to calculate the annual energy consumption of their product. ENERGY STAR offers several different duty cycles that manufacturers may choose between. However, in order to easily compare the energy consumption of two different products, it is necessary to specify a single duty cycle and the conditions under which any alternate duty cycle may be used.

The regulations allow the alternate duty cycle (called "full capability mode weighting") to be used for systems that instantly and intelligently wake up upon receiving a command. These systems transition from idle into sleep mode faster than conventional systems, but they also are constantly connected to a network, making their idle time longer. Although full capability mode weighting is a logical process, the weightings given for each mode are not scientifically or empirically studied. Therefore, the regulations sunset the use of full capability mode weighting on July 1, 2021, consistent with the effective date for the Tier 2 computer standards.

Providing an expandability score that manufacturers will use to categorize their products in order to determine which efficiency metric applies. The expandability score is based on potential interfaces that may be included in a computer model, and their actual energy consumption. This is necessary to determine which standards apply to a computer configuration.

Specifying the settings for attached and integrated monitors or displays so that testing is consistent between products. This is necessary so that variations in the default modes for a monitor or display is not a relevant factor in a computer's energy consumption.

Specifying the configuration for testing compliance with the standards. This is necessary to provide an indication of whether other configurations of that product would also meet the standards. If the most energy-consumptive model meets the standards, then other configurations are also likely to meet the standards.

Providing a point in time for conducting the sleep-mode power measurement to between 30 and 31 minutes of user inactivity. This is necessary to provide a consistent and replicable test procedure for computers with a manual sleep mode and computers without a manual sleep mode. The time limit for this test ensures that computers are entering the sleep mode as required after 30 minutes of user inactivity as well as verifying that both the sleep mode energy consumption limit and the total energy consumption limit are met.

Specifying a test procedure for power factor. This is necessary because the ENERGY STAR test procedure does not include a test procedure for power factor, and the regulations contain standards for power factor.

1605.1 Federal and State Standards for Federally-Regulated Appliances, subdivision (v)
Purpose: The purpose of this change is to add computers and computer monitors to the reference in section 1605.1 on where efficiency standards are located for these products and directs the reader to section 1605.3(v).

Necessity: Adding computers and computer monitors to the list of products for which there are efficiency standards is necessary for consistency and to provide a single location for manufacturers who seek to identify which standards are applicable to their products.

1605.2 State Standards for Federally-Regulated Appliances, subdivision (v)
Purpose: The purpose of this change is to add computers and computer monitors to the reference in section 1605.2. This section describes where efficiency standards are located for these products and directs the reader to section 1605.3(v).

Necessity: Adding computers and computer monitors to the list of products for which there are efficiency standards is necessary for consistency and to provide a single location for manufacturers who seek to identify which standards are applicable to their products.

1605.3 State Standards for Non-Federally Regulated Appliances, subdivision (v)

(1) Consumer Audio and Video Equipment.
Purpose: This section is changed to modify the table numbers only.

Necessity: Table numbers are modified due to the addition of a table earlier in the regulations. This is a non-substantive change in the regulations.

(2) Televisions and Signage Displays
Purpose: This change adds the term “signage displays” to the regulatory language establishing standards for televisions to clarify that signage displays are covered under this standard. The signage display clarification will ensure that all signage displays align with the requirements of 1605.3(v)(2).

Necessity: This clarification is necessary to address confusion among stakeholders over whether signage displays are intended to be covered by the television standards. This change is necessary to ensure that signage displays meet the applicable requirements of televisions as was intended in the original television standards rulemaking.

(3) Televisions and Signage Display and Table V-3
Purpose: This section is changed to modify the table numbers only.

Necessity: Table numbers are modified due to the addition of a table earlier in the regulations. This is a non-substantive change in the regulations.

(3)(D) Exceptions to Section 1605.3(V)(2) and 1605.3(V)(3)
Purpose: Existing law requires televisions and signage displays to comply with the requirements stated in section 1605.3(v)(3). The purpose of this exception is to clearly exempt "professional signage displays," as defined in the definitions, from the scope of the standards.

Necessity: It is necessary to exempt professional signage displays from these regulations because although they would generally meet the definition of a "signage display," there was no intent to include them when the television standard was originally developed. As a result, no determination has been made about whether the efficiency standards as applied to these appliances would be technically feasible or cost-effective, as required under the Energy Commission's enabling statute at Public Resources Code section 25402(c).

(4) Computer monitors – effective date of standards
Purpose: An effective date is added to the standards to specify when computer monitors must comply with the applicable efficiency standards.

Necessity: The effective date of July 1, 2019 was selected to provide manufacturers sufficient time to redesign products to meet the standards, based on manufacturer input on the number of products that could be redesigned and the timing of redesign and manufacturing cycles.

(4)(A) Maximum on-mode standards (Table V-4)
Purpose: The language identifies the energy efficiency standards that computer monitors must meet in order to be sold or offered for sale in California.

Necessity: In order for the state to meet its energy efficiency goals and for the commission to meet its mandate under Public Resources Code section 25402 to reduce wasteful energy use in the state, the Energy Commission is proposing on-mode efficiency standards for computer monitors. The standards are based on the diagonal screen size of the computer monitor, with several bins, consistent with the ENERGY STAR specification for computer monitors. For monitors between 20 inches up to 30 inches, the standards are based on the ENERGY STAR version 7.0 efficiency levels and represent the maximum cost-effective and technically feasible levels in on-mode. For computer monitors between 17 inches up to 20 inches, and from 30 inches to 61 inches, the on-mode levels are based on ENERGY STAR version 6.0 levels as the market for these sizes is small, making it less likely that manufacturers would redesign the products to meet higher efficiency levels. The formulas themselves are based on ENERGY STAR and scale by both the area of the screen and the resolution of the screen.

The standards are also divided by resolution at 5 megapixels. This is because power scales by resolution for computer monitors less than 5 megapixels, but stays relatively constant above 5 megapixels. The Energy Commission therefore specifies a constant for monitors above 5 megapixels rather than have it continue to scale by resolution, ensuring that these products limit energy consumption. Detailed analysis of the standards, including a discussion of the various efficiency levels and adders for specific computer types, is provided on pages 78 and 79 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*. The proposed efficiency standards will require computer monitors sold or offered for sale in California to be more efficient than baseline computer monitors, thereby saving energy.

(4)(B) Maximum sleep- and off-mode standards
Purpose: The language identifies the sleep- and off-mode energy efficiency standards that computer monitors must meet in order to be sold or offered for sale in California. Manufacturers may either demonstrate compliance by meeting a 0.7 watt sleep and 0.5 watt off requirement, or by combining sleep- and off-mode to be less than 1.2 watts combined.

Necessity: Sleep- and off-modes present additional opportunities to improve the energy efficiency of a computer monitor, making it necessary to set specific targets for these modes in order for the commission to meet its mandate under Public Resources Code section 25402 to reduce wasteful energy use in the state. Energy Commission staff proposed these levels based on an analysis of computer monitors that would meet the proposed efficiency levels. The Energy Commission also considered manufacturer input that indicated that for higher-end computer monitors, such as EPDs, if sleep- and off-mode requirements were too low, manufacturers would have to remove products from the market rather than redesign them, as there were no technical solutions to achieve very low sleep- and off-mode levels. In addition to the modal limits, the Energy Commission proposed an alternative calculation to provide additional flexibility to manufacturers seeking to comply with the regulation.

Detailed analysis of the sleep- and off-mode efficiency levels is provided on pages 78 and 87 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*. The proposed efficiency standards will require computer monitors sold or offered for sale in the state to be more efficient than baseline computer monitors, thereby saving energy.

(4)(C) Screen luminance shipped at 200 cd/m^2 ± 35%.
Purpose: This language identifies the brightness at which a computer monitor may be shipped, and exempts EPDs from the requirement.

Necessity: The test procedures for computer monitors require them to be tested at a specified brightness – 200 cd/m^2 – in order to have results be comparable between computer monitor models. This is consistent with the ENERGY STAR version 7.0 test procedure. In order to ensure that customers receive a computer monitor that would yield similar energy consumption levels "out of the box," and because customers are unlikely to change their screen brightness as long as it is minimally sufficient, it is necessary to specify the brightness level for shipping a computer monitor to achieve the expected energy savings. Some flexibility is provided (± 35%) so that manufacturers can market monitors according to customer needs.

EPDs are exempted from the screen luminance shipment requirement because customers of these high-performance monitors will adjust the screen brightness to meet their needs, without regard to the energy consumed at brighter levels. As a result, having a limit on what is shipped has no effect, making it unnecessary for EPDs. Detailed analysis of these requirements is provided on page 77 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

(4)(D) Touch screen adder

Purpose: The language identifies a 1 watt adder in each of on-, sleep-, and off-modes for computer monitors with touch screens. This adder increases the total energy that a touch-screen monitor may consume under the efficiency standards.

Necessity: Touch screen computer monitors use more power for the touch sensors in the display, necessary for users to interact with the display in on-mode, and to "wake up" or turn on the display when in sleep- or off-mode. Because these touch sensors must always draw some power to provide this functionality, a 1 watt adder is necessary to accommodate this innovation. More information is provided on page 79 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

(4)(E) Adders

Purpose: This language identifies additional power consumption ("adders") for enhanced performance displays with a color gamut that is 99 percent or more of sRGB, enhanced performance displays with a color gamut of 99 percent or more of Adobe RGB, variable refresh-rate monitors, curved monitors, and OLED monitors. The adders are reduced after a year and a half to drive additional energy efficiency improvements.

Necessity: The purpose of an adder is to allow the product or component to use more energy than the base efficiency level because of some additional functionality that the product or component provides that also requires more energy. Table V-5 presents a list of adders to accommodate specific computer monitor types that require greater energy use in order to provide higher performing displays. Each adder is set at a level of consumption expected through some energy efficiency improvements over time for that computer monitor type. Only one adder is applicable to a computer monitor model, as the additional energy consumption is based solely on the consumption of the display, and not additive. (For example, an OLED monitor that is also an EPD would still only need a 1.30 multiplier to meet the efficiency standards.) Each of these products represent a very small part of the market, so allowing them to consume additional energy is unlikely to affect overall expected energy savings, but it does ensure that these products can continue to provide the functionality that their consumers demand.

The January 1, 2021 date on which several of the adders are reduced is based on providing an additional design cycle of 18 months to make efficiency improvements to these products.

Detailed analysis of the adders is provided on pages 79 and 80 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

(4)(F) Exceptions to section 1605.3(v)(4)

Purpose: This provision identifies those types of computer monitors that are exempted from the computer monitor standard. Products that are exempted are KVMs and KMMs (monitors used only in data centers), computer monitors designated as medical devices, and very high performance monitors. Manufacturers of these products must still, however, test and certify them to the Energy Commission's Appliance Efficiency Database in order to sell or offer them for sale in California.

Necessity: The Commission proposes to exempt these products from compliance with the computer monitor standards because these products have low energy use and, due to low sales volume, not enough information is currently available about the use of these products to determine whether regulating them is cost-effective or technically feasible under Public Resources Code section 25402(c). Most notably, data on which to do an evaluation of the cost-effectiveness and feasibility of applying the computer monitor standards to these products is lacking. This exception would still require manufacturers of these products to test and certify them to the Energy Commission's Appliance Efficiency Database, allowing the Energy Commission to collect data on their energy usage. Collecting information on the energy use of these products will help to determine whether future standards are appropriate.

(v)(5), Desktop computers, thin-clients, mobile gaming systems, portable all-in-ones, and notebooks

Purpose: The proposed standards limit the energy consumption of desktop computers, thin-clients, mobile gaming systems, portable all-in-ones, and notebooks through cost-effective and technologically feasible energy efficiency standards, ensuring that California saves energy and consumers save money. This provision requires that these products comply with the applicable energy consumption standards located in Table V-6 and requires that these products be shipped with power management settings that transition the computer into either sleep mode or off mode within 30 minutes of user inactivity and transitions connected displays into sleep mode within 15 minutes of user inactivity.

This provision also specifies that models that use an alternative operating system that does not have a conventional sleep mode (ACPI S3) can comply with an alternative sleep mode power limit in Table V-6. Additionally, this provision exempts desktop and thin-client computers assembled prior to July 1, 2021 from parts manufactured before

September 1, 2018, from compliance with the energy consumption standards contained in Table V-7.

Necessity: The specific efficiency levels, effective dates, adders, and power management requirements established in these regulations are the result of technical input during the preliminary rulemaking proceeding from industry stakeholders and energy efficiency advocates on the highest cost-effective levels of efficiency that could be achieved over the time period identified for these technologies.

For notebooks and portable all-in-ones, the January 1, 2019, effective date is two years from the anticipated adoption date of the standards, a sufficient amount of time to allow the industry to prepare to manufacture compliant products. For desktops, thin-clients, and mobile gaming systems, the two-tier effective date of January 1, 2019 for Tier 1 and July 1, 2021 for Tier 2 represents the expected timeframe for achieving the efficiency levels identified in each Tier in a cost-effective manner. The rationale behind these effective dates is described further on page 25 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

The standards in Table V-7, the applicable adders in Table V-8, and the power management requirements for desktops, thin-clients, mobile gaming systems, notebooks and portable all-in-ones are designed to improve the energy efficiency of these products in idle mode and will lead to significant energy savings, as described in pages 24 to 47 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*. The expandability score of a computer is a number that correlates closely with the amount of actual energy that it consumes. This metric is used to categorize desktop, mobile gaming, and thin client computers into four groups. Each category has a maximum total energy consumption limit that is directly related to its expandability score. The expandability score range for each category is chosen based on staff's evaluation of a database provided by the computer industry and provides a reasonable grouping of computers. Maximum annual energy consumption was chosen as a metric for driving energy efficiency based on the ENERGY STAR framework, which is widely accepted in the industry. Each specific adder in Table V-8 represents a functionality in the computer that requires some energy consumption. Each adder is set at a level of consumption expected through continued energy efficiency improvements over time. Standards and adders for notebooks and portable all-in-ones are lower than standards and adders for desktops, thin-clients, and mobile gaming systems, because notebooks and portable all-in-ones are designed for portability and are already designed to use less energy than their fixed-location counterparts.

Power management is required in all of these products to shift the computer into lower power modes when idle, thereby reducing energy consumption. Products that are shipped with limited or no operating system are not required to comply with power management because without a fully functioning operating system, the computer does not have a sleep mode and so cannot comply with the power management requirements.

Alternative sleep mode limits are established for operating systems that do not have a traditional sleep mode, such as Chrome OS and Android systems. These alternative sleep mode limits ensure that systems with these alternative sleeps mode achieve the same efficiencies as systems with conventional sleep modes, while retaining incentives for power management. The power consumption levels in Table V-6 are based on what these operating systems are able to achieve today after incorporating the same efficiency improvements expected of computers that use traditional sleep mode. For more information on the energy and cost benefits of power management, see pages 28, 39, and 43 of the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Power factor is a ratio of true power to apparent power in an electrical system. In a perfect system, the power factor is 1. A higher power factor means that the system is working more effectively. As power factor decreases, the system works less effectively, causing losses both on the consumer side and the utility side. A minimum power factor is established for the power supply used in desktop and notebook computers to ensure that these products work effectively, especially in a large system.

The exemption for desktop and thin-client computers assembled prior to July 1, 2021, from parts manufactured prior to September 1, 2018, is necessary to enable manufacturers to be able to sell computers that are assembled entirely from their stockpiled parts. This enables manufacturers to ship orders to their customers who ask for computers that are the exact same models as their previously ordered computers. This exemption is limited in scope and time and would not significantly affect the energy efficiency gains resulting from these regulations.

(v)(6) Small-scale servers, high-expandability computers, mobile workstations, and workstations

Purpose: The proposed standards limit the energy consumption of small-scale servers, high-expandability computers, mobile workstations, and workstations through cost-effective and technologically feasible energy efficiency standards, ensuring that California saves energy and consumers save money. These provisions require these types of computers to be powered by an efficient power supply, incorporate energy-efficient Ethernet functionality, transition connected displays into sleep mode within 15 minutes of user inactivity, and transition the computer into either sleep mode or off mode within 30 minutes of user inactivity. Small scale servers and rack mounted workstations are not required to comply with this last requirement.

Necessity: The prescriptive design requirements, power management requirements, and effective dates were the result of technical input during the preliminary rulemaking proceeding from industry stakeholders and energy efficiency advocates on the highest cost-effective levels of efficiency that could be achieved by January 1, 2018. The January 1, 2018, effective date is one year from the anticipated adoption date of the standards, the minimum required by Public Resources Code § 25402(c)(1). Additional information explaining the selected effective date is described further on page 29 in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

The design standards for small-scale servers, high expandability computers, mobile workstations, and work stations would improve the energy efficiency of these products by requiring more efficient component parts that are available for purchase today and will lead to significant energy savings, as described on pages 46 and 47, and 48 to 51in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*.

Small-scale servers and rack-mounted workstations are exempted from the power management requirements of the standards because they are always "on," and therefore power management, which transitions computers into lower power modes during idle activity, would provide no energy-related benefit.

(v)(7) Small volume manufacturers
Purpose: Computers manufactured by small volume manufacturers are exempted from the energy efficiency standards, the testing requirement, and the certification requirement, but must still meet the power management setting requirements specified in sections 1605.3(v)(5)(B) and 1605.3(v)(6)(C) and (v)(6)(D).

Necessity: Small businesses have less capital and produce much smaller volumes of a family of products, which means that the testing costs and costs of compliance may have a larger impact on these small businesses. The testing cost alone could put such entities at a competitive cost disadvantage to larger manufacturers in competing for small information-technology bids and ultimately place them at risk of failing. Therefore, this exemption is necessary to ensure that the proposed regulations do not have the unintended consequence of damaging small businesses. However, they would still be required to comply with power management requirements, which bears no cost and ensures that some energy efficiency improvements are made to these products.

1606 Filing by Manufacturers; Listing of Appliances in Database, Table X, subdivision (v)
Purpose: This provision requires manufacturers of computers and computer monitors who want to sell their products in California to submit specified information about those products into the Energy Commission's Appliance Efficiency Database. For those products not exempted from the computer or computer monitor energy efficiency standard, this information enables the Energy Commission to verify that these computers and computer monitors meet the applicable efficiency standards. For those products that are exempted from the computer or computer monitor energy efficiency standard, this data provides the Energy Commission sufficient information to monitor market activity and technologies for the purpose of developing or amending standards for these products in the future, or to provide consumer-users of the Appliance Efficiency Database sufficient information to compare products.

Necessity: The data submittal requirements for computers were determined based on the need for the information to confirm that the product meets the efficiency standard. Each type of required information for computers is directly linked to either the expandability score in section 1604, the annual energy consumption standards in Table V-6 of Section 1605.3, or the potential adders in Table V-7 of Section 1605.3.

The data submittal requirements for computer monitors were based on a combination of the need for the information to confirm that the products meet the efficiency standard and requiring information to monitor future efficiency trends. Specifically, monitor type, viewable screen area, screen size, screen luminance, native resolution, power consumed (on, sleep, and off), touch-screen, and color gamut are directly linked to either the test procedure requirements in section 1604, the on-, sleep-, and off-mode requirements in section 1605.3, whether an adder applies from Table V-5, whether a touch-screen adder applies, or whether the computer monitor is an exempted type. Technology type, automatic brightness control, and automatic brightness control enabled when shipped are information that the Energy Commission needs in order to monitor these features in future product offerings to determine whether more stringent efficiency standards are appropriate.

(e)(3) Modified and Discontinued Appliances

Purpose: This provision requires that a manufacturer of a computer must remove the appliance from the database, or certify it as a different computer type, if it fails to obtain two independent software vendor (ISV) certifications within 60 days of certifying a computer model or subsequently loses its ISV certifications so that the computer no longer meets the definition of a workstation or mobile workstation.

Necessity: One of the criteria for determining whether a computer is a workstation or a mobile workstation (and therefore exempt from the total energy consumption targets) is whether they have qualified or are currently being reviewed for qualification by two or more ISVs. Independent software vendors are companies that specialize in making and selling software designed for mass or niche markets, and are separate from the company manufacturing the computer. In order to ensure the validity and consistency of the test, certifications from at least two ISVs is required. Sixty days is the expected average time it takes for ISVs to test and certify computers. If a computer manufacturer fails to obtain such certificate within that time, they must remove their products from the database as a workstation or mobile workstation and instead comply with the standards applicable to desktops or notebooks, respectively.

(k) Small Volume Manufacturers

Purpose: This provision specifies that for entities to be exempted from some of the regulatory provisions as a small volume manufacturer, they must certify as such in the database and qualify by showing their annual gross revenue for the preceding 12-month period is less than $2 million, and that they manufacture 40 or fewer units of a basic model each year. This provision also specifies that if at any time a small volume manufacturer ceases to meet either of these criteria, it must comply with all of the energy efficiency, testing, and certification requirements specified in these regulations.

Necessity: The incremental cost of testing and compliance is more significant for small businesses since they have less capital and lower sales volume. In order to balance the cost of testing with the average net energy savings benefits, the manufacturer needs to sell at least 40 units of the same basic model each year. At this level, the incremental costs of testing are outweighed by the expected savings from the efficiency standard. The revenue cap is modeled after the U.S. Department of Energy exemption for small businesses and is based on a combination of assumed overhead costs, comments received from small businesses, and net revenue for a small business, as defined in California Government Code § 11342.610.

II. DOCUMENTS AND REPORTS RELIED UPON - Government Code §11346.2(b)(3)

The Commission has relied upon the following technical, theoretical, or empirical studies, reports, or similar documents in drafting the proposed regulations:

California Energy Commission. 2016. Dataset of computer models submitted by Information Technology Industry Council.

Singh, Harinder, Ken Rider, and Soheila Pasha. 2016. *Final Analysis of Computers, Computer Monitors, and Signage Displays*. California Energy Commission. CEC-400-2016-016.

Singh, Harinder, Ken Rider, and Soheila Pasha. 2016. *Revised Analysis of Computers, Computer Monitors, and Signage Displays*. California Energy Commission. CEC-400-2015-009-SD-REV

Roland-Holst, David, Samuel Evans, Cecilia Han Springer, Tessa Emmer. 2016. *Standardized Regulatory Impact Assessment: Computers, Computer Monitors, and Signage Displays*. California Energy Commission: CEC-400-2016-008

Roland-Holst, David, Samuel Evans, Cecilia Han Springer, Tessa Emmer. 2016. *Revised Standardized Regulatory Impact Assessment: Computers, Computer Monitors, and Signage Displays*. California Energy Commission: CEC-400-2016-008.

Pasha, Soheila. *Form DF-131 – Standardized Regulatory Impact Assessment Summary*. July 1, 2016.

Information Technology Industry Council. *ITI Recommendation CEC Battery Charger Regulation.* April 7, 2015.

Information Technology Industry Council. *CEC Battery Charger Regulation: Battery Subsystems.* October 2, 2015.

Final Statement of Reasons -Amendments Adopted Into Appliance Efficiency Regulations. California Energy Commission. Docket 09-AAER-1C. July 2010.

III. CONSIDERATION OF REASONABLE ALTERNATIVES, INCLUDING THOSE THAT WOULD LESSEN ANY ADVERSE IMPACT ON SMALL BUSINESS - Government Code §11346.2(b)(4)

No reasonable alternatives to the proposed regulations have been proposed that would lessen any adverse impact on small business or that would be less burdensome and equally effective in achieving the purposes of the regulation in a manner that achieves the purposes of the statute being implemented.

During the public participation that led up to this rulemaking, the Energy Commission received many comments suggesting modifications to the proposed standards and worked closely with stakeholders to accommodate concerns, all of which resulted in changes to what was originally proposed in the draft staff report. These changes were intended to improve the effectiveness of the standards or decrease the burden on the affected industry. In addition to this iterative process of modifying the original proposal, the Energy Commission analyzed several variations of the proposed regulations. These included the proposal contained in the *Revised Analysis of Computers, Computer Monitors, and Signage Displays* published in March 2016, a high stringency alternative and a lower stringency alternative analyzed in the Standardized Regulatory Impact Assessment, and alternatives raised by stakeholders in comments on the *Revised Analysis of Computers, Computer Monitors, and Signage Displays* published in March 2016.

Revised Analysis of Computers, Computer Monitors, and Signage Displays. In its March 2016 staff report, Energy Commission staff proposed an efficiency standard for computers that would have taken effect on January 1, 2018 for all computer types and that would have required desktops to meet "total energy consumption" targets based on their expandability score and applicable adders. While the standard for workstations and notebooks was substantially the same, the overall standard was more stringent than these standards for computers. The proposed computer monitor standards in the March 2016 staff report were also somewhat more stringent because the proposed adders for specialty computer monitors were significantly smaller and the effective date was on January 1, 2018. Although this proposal was both cost-effective and technically feasible, staff rejected the proposal because of the substantial burden on industry, resulting in higher costs, thereby decreasing the cost-effectiveness of the standards.

High Stringency: Standardized Regulatory Impact Assessment. In its *Standardized Regulatory Impact Assessment* for this rulemaking, staff considered a higher stringency alternative. This alternative would have delivered greater energy savings from desktops and monitors. It was rejected because it would have resulted in only modest additional energy savings at significantly higher compliance costs, particularly as applied to monitors. This would have resulted in fewer cost-savings to consumers.

Low Stringency: Standardized Regulatory Impact Assessment. Staff also considered a lower stringency alternative in its *Standardized Regulatory Impact Assessment* for the rulemaking. The lower stringency alternative aligned with ENERGY STAR levels for computers and monitors. Under this alternative, the costs of compliance were lower, but the energy savings were much lower. The Energy Commission rejected this alternative because it did not yield energy savings that were consistent with the Energy Commission's objectives to set cost-effective and technically feasible standards that save a significant amount of energy.

Stakeholder Proposals. During workshops and in written comments before the formal rulemaking, stakeholders presented alternatives to the staff analysis. As part of forming its rule, staff considered these proposals and combined suggestions to create a regulation that would minimize the burden on industry while maximizing the energy savings to consumers and the state. A detailed discussion of these stakeholder proposals, and the reasons for accepting or rejecting pieces of those proposals, is provided at pages 20-23 (computers) and 74-75 (computer monitors) in the *Final Analysis of Computer, Computer Monitors, and Signage Displays*. Each proposal as a whole was rejected because it would not be more effective, or as effective and less burdensome, or more cost-effective and equally effective at reducing energy consumption through energy efficiency as required under Public Resources Code, section 25402(c)(1).

However, the Energy Commission did take pieces of each proposal to create an alternative proposal from what was analyzed in the SRIA in order to lessen the burden on manufacturers. These changes included providing a full design cycle to make short-term efficiency improvements, and a second design cycle to make deeper efficiency improvements; included adders where necessary to accommodate an important functionality for computers or computer monitors; and extending the effective dates to comply with the standards. Working within the manufacturer design cycles will ease manufacturer burden and increase the number of competitive component parts, reducing overall costs of complying with the standard. This alternative would not have lessened any adverse impact on small business.

To date, based on the information available to the Energy Commission and identified by stakeholders, the Energy Commission has not received or identified an alternative that would be less burdensome and equally effective in achieving the purposes of the regulations in a manner that ensures full compliance with Public Resources Code, section 25402(c)(1). Commission staff closely considered various levels of stringency for the efficiency standards. The Energy Commission ultimately chose a level of efficiency that, based on the best available information, was feasible and maximized energy savings while minimizing costs.

To address impacts on small businesses that manufacture computers, the Energy Commission has included a provision that exempts small volume manufacturers from complying with most manufacturing aspects of the proposed computer standards, with the exception of no-cost power management requirements.

Unlike most appliance types for which the Energy Commission has proposed regulations, computer manufacturing of desktop computers is feasible even at a very small scale. This results in a significant number of manufacturers producing small volumes of the appliance. However, small businesses have less capital and produce smaller volumes of a family of products, which means that the testing and compliance costs may have a larger effect on small businesses. The incremental cost of testing is more significant for smaller volume sales. While not extreme—approximately $600 per test—the cost could be prohibitive for a small entity to perform. According to comments received during the pre-rulemaking proceeding, the testing could put such entities at a competitive cost disadvantage when competing for small information technology bids and could ultimately place them at risk of failing. Without significant volume, testing costs can outweigh the benefit of improved energy efficiency. Therefore, staff proposes to exempt small businesses from complying with most manufacturing aspects of the proposed computer standards, with the exception of no-cost power management requirements.

To develop the exemption, staff investigated revenue caps, location of assembly and sale, and minimum number of sold systems as the main considerations for exemption. Manufacturers qualify to apply for the exemption if annual gross operations revenues are $2 million or less, if the manufacturer assembles and sells the computers at the same location, and if no more than 40 units of a basic model are sold. These requirements were modeled after the U.S. Department of Energy exemptions and based on 1) IOUs' estimates of testing costs through outreach to ENERGY STAR-certified laboratories (approximately $600 for a single test); 2) a combination of assumed overhead costs and net revenue for a small business; and 3) the number of units that would need to be sold for the costs of testing to justify the estimated energy savings to the consumer from the proposed standards. Preassembled products that are repackaged or offered for resale through small businesses are not eligible for this exemption. This provision ensures that the proposed regulations will not adversely impact small businesses.

The Energy Commission has not been presented with any other alternative that would lessen any adverse impact on small business; overall the proposed regulations are anticipated to benefit small business due to the resultant energy savings.

IV. SPECIFIC TECHNOLOGIES OR EQUIPMENT– Government Code §§11340.1(a), 11346.2(b)(1), and 11346.2(b)(4)(A)

The proposed regulations do not mandate a specific technology, and instead establish performance and design standards related to computers and computer monitors that can be met with multiple types of equipment or technology.

The proposed regulations also clarify that signage displays are subject to the television standard, which is also a performance standard. The regulation change exempting certain appliances from the battery charger standard is an exemption from a standard, and thus does not require a specific technology or equipment.

V. DUPLICATION OR CONFLICTS WITH FEDERAL REGULATIONS– Government Code §11346.2(b)(6)

These proposed regulations do not duplicate or conflict with any federal regulations contained in the Code of Federal Regulations. The Energy Commission has reviewed the applicable federal statutes and regulations and confirmed that there are no federal energy efficiency standards for computers, computer monitors, or signage displays. There are comparable federal regulations applicable to battery charger systems that will take effect June 13, 2018. These standards will preempt California's standards at that time, so there would be no overlap in applicability between the Energy Commission's battery charger systems regulations and those of DOE, and, thus, no duplication or conflict. Additionally, the proposed change to the battery charger systems regulations would better align these regulations with DOE's regulations. To the extent this change would be seen as duplicative with the federal regulations even though the timing of effectiveness would not overlap, the Energy Commission has determined that these regulations are authorized by law and the cost of implementing them prior to the effectiveness of the federal regulations is justified by the benefit to human health and the environment of having energy efficiency standards for battery charger systems in place for several extra years.

VI. SIGNIFICANT ADVERSE ECONOMIC IMPACT ON BUSINESS – Government Code §11346.2(b)(5)(A)

The Energy Commission has determined that the proposed regulation will not have a significant adverse economic impact on business.

The Energy Commission's proposed standard would increase gross state product by 0.014% in 2030 and create slightly more than 12,000 jobs from 2018 to 2030. California businesses are expected to accrue both costs and benefits from the proposed regulation. For businesses that are consumers of the regulated products, costs are expected to be approximately $58 million to $62 million per year (assuming that businesses account for approximately 60 percent of computer and monitor purchases). Expected benefits from reduced electricity consumption are expected to be approximately $280 million to $290 million per year, once the stock has turned over. The bulk of these savings come from lower energy use in desktops and monitors, with the remainder of savings coming from notebooks, small-scale servers, and workstations.

Some businesses in California are involved in the manufacture and distribution of products covered by the proposal. The performance standards are set in a way that gives the industry compliance flexibility. A number of technically feasible options currently exist for all product categories to achieve the proposed efficiency levels. It is possible that certain individual businesses may experience higher or lower compliance costs for their products, affecting their competitive position in the market. However, the flexibility in compliance options is designed to avoid this outcome by allowing manufacturers to choose the least-cost compliance pathway.

Small businesses, like other businesses that use computers and monitors, are expected to benefit from the anticipated electricity savings resulting from the efficiency standards. Like other business enterprises, small businesses will also incur an additional cost when purchasing products covered under the standard. The net effect is expected to be an overall savings in electricity spending. The proposal is not expected to result in savings or costs that disproportionately impact small businesses.

The Energy Commission included an exemption in the proposed regulation for small businesses that manufacture products covered by the proposal. The small business definition in the proposed standard is different than the official California small business definition

(California Government Code § 11342.610). The proposed exemption is based on a company's gross revenue and the volume of sales of regulated products, whereas the state definition for manufacturing enterprises is based on number of employees. There is still likely to be some overlap in the two definitions, in which case those businesses would not be subject to any of the costs likely to be incurred by other manufacturers. Small businesses, using the state's definition, that are not covered by the proposed exemption are expected to follow the same manufacturing standards as other business enterprises. For more detail concerning this analysis and the basis for the Energy Commission's determination, please see the Standardized Regulatory Impact Assessment, which is provided in full below.

The clarification regarding signage displays would not result in any significant adverse impact on business as it simply clarifies existing law.

Similarly, the exemption for battery charger subsystems from the battery charger system standards would not result in any significant adverse impacts on business because these appliances were not intended to be covered under the original proceeding, and their coverage would not have occurred until January 1, 2017. Clarifying that these appliances are exempt would ensure that they may continue to be sold in California. Manufacturers who make these products would not be required to conduct any testing, reporting, or redesigning for compliance pursuant to the battery charger system standards, thus eliminating any potential compliance costs the businesses would otherwise incur.

VII. STANDARDIZED REGULATORY IMPACT ANALYSIS - Government Code §11346.2(b)(2) and §11346.3

EXECUTIVE SUMMARY

This report was prepared by researchers at the University of California, Berkeley in compliance with the rulemaking requirements for major regulations set forth in Senate Bill 617 (Chapter 496, Statutes of 2011). The analysis presented here evaluates the economic impacts of new efficiency standards for computers, computer monitors, and signage displays proposed by the California Energy. The standards would require manufacturers of notebooks, desktops, small-scale servers, workstations, and monitors to comply with minimum product energy efficiency levels.

The direct costs and savings calculations that serve as the inputs into the macroeconomic analysis were prepared in consultation with Energy Commission staff. Staff prepared the engineering and market data based on several rounds of stakeholder engagement. Detailed background information on the proposed regulation, including regulated products and details on market and engineering data sources, is available in the March 30, 2016, Final Draft Staff report.[1]

[1] Final staff report available at http://www.energy.ca.gov/appliances/2014-AAER-2/prerulemaking/

The macroeconomic impacts of the Energy Commission's proposal were evaluated using the BEAR computable general equilibrium (CGE) model. The BEAR model is a dynamic forecasting model of the California economy. The model generates estimates for a wide range of macroeconomic variables, including gross state product (GSP), employment, enterprise output, household income, and investment.

Model results show that, relative to a baseline, the Energy Commission's proposed standard would increase GSP by 0.014 percent in 2030 and create slightly more than 12,000 jobs from 2018-2030. The proposal is also expected to result in modest increases in household income of 0.016 percent to 0.044 percent. Lower-income households that spend a higher proportion of their income on electricity are expected to benefit slightly more than other household groups.

In addition to the proposed standard, this economic analysis evaluated two regulatory alternatives. One alternative was more stringent, providing greater benefits to the proposed standard. The other standard was less stringent, but the lower benefits were provided at a lower cost. Both alternatives were rejected in favor of the proposed standard. In addition to these two alternatives, the analysis also considered three sets of sensitivity analysis (six total scenarios) to explore the impacts of potential uncertainty around key assumptions. None of the sensitivity scenarios suggested major differences in the conclusions of the assessment.

CHAPTER 1: Introduction

Statement of Need for Proposed Regulation

The Warren-Alquist Act establishes the California Energy Commission (CEC) as California's primary energy policy and planning agency and mandates the Commission to reduce the wasteful and inefficient consumption of energy and water in the state by prescribing standards for the minimum levels of operating efficiency for appliances that consume a significant amount of energy or water statewide.

This Standardized Regulatory Impact Assessment (SRIA) analyzed the economic impact of introducing new efficiency standards for computers, computer monitors, and signage displays. The proposed performance standards would amend the Appliance Efficiency Standards (Title 20, Code of Regulations, Sections 1601-1609). The proposed regulation covers desktops, notebooks, workstations, small-scale servers, thin clients, computer monitors, and signage displays.

The proposed efficiency standards require compliance beginning January 1, 2018. This SRIA assesses the economic impacts of the proposal from 2018 through 2030. Using 2030 as a final year for analysis allows for consistency in comparing the Energy Commission's proposal to other state planning objectives, such as the Governor's 2030 goals for reducing greenhouse gas emissions through increasing renewable energy, reducing petroleum consumption, and doubling expected savings from energy efficiency. Both compliance costs and benefits of the proposal accrue for the duration of the assessment period.

Results from this SRIA suggest that Energy Commission's proposed regulations are cost-effective and deliver a moderate stimulus to the California economy. Gross State Product (GSP) is anticipated to increase by approximately 0.014 percent in 2030 relative to the baseline, and other macro indicators, such as job creation, are also anticipated to increase slightly. The policy is expected to have a moderate positive impact on household income, with slightly greater benefits accruing to lower income households. This is due to the higher expenditure shares towards electricity in lower income households.

The Energy Commission's proposal results in a 0.06 percent reduction in greenhouse gas emissions from the electric power sector in 2030 due to lower demand for regulated products.

Major Regulation Determination

The proposed regulation is expected to result in electricity savings and incremental product costs to both California consumers and businesses that exceed the $50 million threshold over a 12-month period that requires the completion of a SRIA. Total electricity savings are expected to exceed 2 terawatt hours per year once the existing stock of computers and monitors is replaced, which valued at projected electricity prices results in an aggregate gross savings of over $440 million per year. Gross direct costs to California consumers and businesses are expected to be approximately $100 million per year.

Baseline Information

Currently, none of the product categories included in the proposed regulation is required to comply with other state or federal energy efficiency standards. However, a percentage of the products covered by the proposal are already compliant with the Energy Commission's proposed standards. The baseline assumes that the current compliance rate for each product category remains fixed at current levels over the 2018-2030 analysis period.

California recently committed to increasing the percentage consumption of electricity from renewable resources from 33 percent to 50 percent between 2020 and 2030 (SB 350, DeLeón; Chapter 547, Statutes of 2015). The environmental benefits and electricity expenditure savings expected from the proposed regulation are directly related to the

State's electricity portfolio. The baseline scenario for this SRIA assumes that the State's electricity portfolio is compliant with the RPS requirements outlined in SB350, assuming a linear phase-in of additional renewable generation from 2020 to 2030. Uncertainty surrounding the future price of electricity is analyzed in a sensitivity analysis.

Public Outreach and Input

The Energy Commission requested input from stakeholders and the public on multiple occasions for this rulemaking. The Energy Commission first published a draft staff report and on April 15, 2015, held a public workshop to receive input on the draft proposed regulations. After publishing a revised staff report incorporating stakeholder feedback, the Energy Commission held a second staff workshop on April 26, 2016, to solicit another round of stakeholder and public comments. All documents associated with these staff workshops are available to the public on the Energy Commission's website, under docket number 14-AAER-02.[2]

Chapter 2: Direct Costs and Benefits

The proposed appliance standards are anticipated to deliver considerable electricity savings to individuals and businesses in California. The initial incremental costs of manufacturing compliant computer and monitor products are expected to be considerably less than the anticipated lifetime benefits, resulting in a highly cost-effective energy efficiency proposal.

This section outlines the anticipated direct costs and benefits to Californians from the proposed regulation. Costs and benefits are presented separately for individuals and businesses. Indirect impacts and macroeconomic effects are presented in Section 3.

Methodology and Assumptions

Both the projected costs and electricity savings are a function of the market trajectory for the regulated products. **Table 1** shows the assumptions for initial product stock levels, initial annual shipments of new products to California consumers, the growth rate of new product purchases, and the expected product life cycle. Market and product assumptions are based on industry data provided to Energy Commission staff during the stakeholder engagement process. It is assumed that the costs and savings of the proposed regulations begin in 2018, consistent with the Energy Commission's target implementation date for the proposed standard.

Table 1: Assumptions for Regulated Product Market Growth

Product Category	Initial Stock (millions)	Shipments (millions)	Growth Rate	Product Life (years)

[2] https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=14-AAER-02

Desktops	23.40	4.62	-0.7%	5
Notebooks	21.00	5.30	0.6%	4
Small-Scale Servers	0.30	0.06	0.0%	5
Workstations	0.53	0.11	0.0%	5
Monitors	21.20	3.60	0.0%	6.6

Source: Energy Commission staff

Based on these assumptions, a market trajectory was estimated for each regulated product (**Table 2**). As a sensitivity analysis, alternative product growth rate assumptions were analyzed (described in detail below).

Table 2: Product Stock Forecasts (million units)

	Desktops	Notebooks	Small-Scale Servers	Workstations	Monitors
2018	22.3	21.9	0.3	0.5	21.2
2019	22.1	22.0	0.3	0.5	21.2
2020	22.0	22.2	0.3	0.5	21.2
2021	21.8	22.3	0.3	0.5	21.2
2022	21.7	22.4	0.3	0.5	21.2
2023	21.5	22.6	0.3	0.5	21.2
2024	21.4	22.7	0.3	0.5	21.2
2025	21.2	22.8	0.3	0.5	21.2
2026	21.1	23.0	0.3	0.5	21.2
2027	20.9	23.1	0.3	0.5	21.2
2028	20.8	23.2	0.3	0.5	21.2
2029	20.6	23.4	0.3	0.5	21.2
2030	20.5	23.5	0.3	0.5	21.2

Source: Energy Commission staff

Electricity savings and incremental costs of compliance for each product category were estimated by Energy Commission staff (**Table 3**). The statewide annual energy savings from the proposed regulation are estimated as the anticipated unit energy savings multiplied by the product stock, adjusting for stock that already complies with the proposed standards (and therefore would not be expected to benefit from any energy savings). Average unit energy consumption was calculated from a large database of computer models. This formed the baseline unit energy consumption. Then the energy consumption was altered for units that did not comply to a level where they would just barely comply. For models that already complied, no modifications were made. The resulting average produces the unit energy consumption after the standard. The inclusion of models that comply in the average unit consumption calculation accounts for compliance in existing products even though a specific compliance rate is not used in the calculation.

As an example, consider average energy usage of desktop computers. Assume that there are 5 models with different levels of baseline energy usage (**Table 3**). Also assume that the regulation requires desktops to meet a 50kWh/year energy standard. Models 1, 2, and 4 are not compliant with the standard and will be required to make adjustments to reduce energy usage to 50 kWh/year. Models 3 and 5 are over-compliant in the baseline and are assumed to maintain their baseline performance after the regulation goes into effect. The difference ("delta") in average baseline energy usage (50.8 kWh/year) and average energy usage after all models comply with, or exceed, the standard (49.4 kWh/year) is then multiplied by the projected desktop shipments (**Table 2**) in order to provide an estimated average energy savings in a given year.

Table 3: Example for Energy Usage Calculation

Model #	**Energy Usage (kWh/year)**	
	Baseline	**Regulation**
1	52	50
2	53	50
3	48	48
4	52	50
5	49	49
Average	**50.8**	**49.4**

The energy savings is monetized using Energy Commission forecasted electricity rates. Statewide annual costs are the incremental unit costs multiplied by new product purchases. Costs are assumed to pass-through to consumers of the regulated products and manufacturing is expected to occur outside of California. Some aspects of the engineering design process could occur within California for certain companies; however, the incremental costs incurred from the proposed standard are not expected to affect these operations.

Table 4: Savings and Costs from Proposed Performance Standard

Product Category	Annual Energy Savings (kWh/unit)			Incremental Cost ($/unit)		
	Proposed	**More Stringent**	**Less Stringent**	**Proposed**	**More Stringent**	**Less Stringent**
Desktops	77.4	78.6	44.1	$18	$20	$6
Notebooks	3.6	3.6	3.6	$1	$1	$1
Small-Scale Servers	24.0	24.0	24.0	$13	$13	$13
Workstations	37.4	37.4	37.4	$13	$13	$13
Monitors	27.75	32.9	18.6	$5	$10	$0

Source: Energy Commission staff

The total direct costs and savings to Californians are shown in **Table 4**. The proposal is cost effective, with a benefit-cost ratio of 4.2-4.5 (total benefits/total costs) once the stock has fully turned over. Benefit-cost ratios are lower in the first few years after the standard is implemented (0.8-3.3), due to lower electricity savings from the existing stock of computers and monitors. This benefit-cost ratio excludes any environmental and public health impacts, which are assessed in Chapter 3.

Table 5: Aggregate Cost and Savings (million 2013$)

	Proposed		**More Stringent**		**Less Stringent**	
Year	**Reduced Electricity Cost**	**Compliance Cost**	**Reduced Electricity Cost**	**Compliance Cost**	**Reduced Electricity Cost**	**Compliance Cost**
2018	$82	$105	$86	$132	$50	$34
2019	$167	$104	$176	$131	$103	$34
2020	$257	$104	$270	$130	$158	$34
2021	$344	$103	$361	$130	$211	$34
2022	$428	$103	$450	$129	$262	$33
2023	$445	$102	$471	$129	$274	$33
2024	$446	$102	$472	$128	$274	$33
2025	$447	$101	$473	$128	$275	$33
2026	$448	$101	$474	$127	$276	$33
2027	$449	$100	$475	$126	$276	$33
2028	$450	$100	$476	$126	$277	$33
2029	$451	$99	$477	$125	$278	$32
2030	$452	$99	$478	$125	$278	$32

Source: Energy Commission Staff

Direct Costs and Benefits to Individuals

Individuals in California are expected to incur both costs and benefits from the proposed efficiency standards. The assumed incremental unit cost to improve the efficiency of each product is assumed to pass through to consumer purchases of these goods. Based on industry data, approximately 40 percent of total computer and monitor purchases are by residential consumers. Based on the total direct cost results presented in **Table 4**, this translates into an approximate cost to residential consumers of $40-$43 million per year.

For an individual consumer, the net benefit of the proposed regulation is the difference between additional cost incurred when purchasing a regulated product and the savings on electricity spending over the lifetime of that product. For example, a desktop computer consumer would pay approximately $18 more for the computer upon purchase, and then save approximately 77.4 kWh/year for the life of the product. If the consumer pays

19¢/kWh for electricity (based on the Energy Commission's 2018 projected price for residential consumers), then the consumer would save $14.91 per year. Assuming that the product has a useful life of 5 years, the consumer saves $73.53 in electricity spending. The net benefit to the consumer over the lifetime of the product is $55.53 ($73.53-$18), excluding any net present value adjustment. The bulk of the savings comes from reduced electricity consumption from desktops, and a smaller portion of savings come from monitor use. Aggregate savings to consumers are shown in **Table 5**.

Table 6: Statewide Consumer Savings on Electricity Consumption (million $2013)

	Desktops	**Notebooks**	**Small-Scale Servers**	**Workstations**	**Monitors**	**Total**
2018	26	1.6	0.1	0.3	7.6	36
2019	54	3.2	0.2	0.6	15.6	74
2020	83	4.9	0.4	1.0	23.9	113
2021	111	6.6	0.5	1.3	32.2	152
2022	139	6.7	0.6	1.6	40.5	189
2023	139	6.8	0.6	1.7	48.0	196
2024	139	6.9	0.6	1.7	48.3	197
2025	139	7.0	0.6	1.7	48.6	197
2026	139	7.1	0.6	1.7	49.0	197
2027	139	7.1	0.6	1.7	49.3	198
2028	139	7.2	0.6	1.7	49.6	198
2029	139	7.3	0.6	1.7	50.0	199
2030	139	7.4	0.6	1.7	50.3	199

Source: Energy Commission Staff

Distributional economic costs and savings will be addressed in Chapter 3.

Direct Costs and Benefits to California Businesses

As with individuals, California businesses are also expected to accrue both costs and benefits from the proposed regulation. For businesses that are consumers of the regulated products, costs are expected to be approximately $58-$62 million per year (assuming that businesses account for approximately 60 percent of computer and monitor purchases). Expected benefits from reduced electricity consumption are expected to be approximately $280-$290 million per year, once the stock has turned over (**Table 6**). As with individuals, the bulk of these savings come from lower energy use in desktops and monitors, with the remainder of savings coming from notebooks, small-scale servers, and workstations.

Table 7: Statewide Business Savings on Electricity Consumption (million 2013$)

	Desktops	Notebooks	Small-Scale Servers	Workstations	Monitors	Total
2018	33	1.9	0.1	0.4	9.9	46
2019	68	4.0	0.3	0.8	20.4	94
2020	104	6.2	0.4	1.2	31.4	144
2021	140	8.3	0.6	1.6	42.1	192
2022	175	8.4	0.8	2.1	53.0	239
2023	175	8.5	0.8	2.1	62.9	249
2024	175	8.6	0.8	2.1	63.3	250
2025	175	8.8	0.8	2.1	63.7	250
2026	175	8.9	0.8	2.1	64.1	251
2027	175	9.0	0.8	2.1	64.6	251
2028	175	9.1	0.8	2.2	65.0	252
2029	175	9.2	0.8	2.2	65.4	252
2030	175	9.3	0.8	2.2	65.9	253

Source: Energy Commission Staff

Some businesses in California are involved in the manufacture and distribution of products covered by the proposal. The performance standards are set in a way that gives the industry compliance flexibility. A number of technically feasible options currently exist for all product categories to achieve the proposed efficiency levels (**Table 7**).[3] It is possible that certain individual businesses may experience higher or lower compliance costs for their products, affecting their competitive position in the market. However, the flexibility in compliance options is designed to avoid this outcome by allowing manufacturers to choose the least-cost compliance pathway.

[3] Detailed descriptions of the various compliance options are available in the March 2016, Energy Commission Staff Report, "Revised Analysis of Computers, Computer Monitors, and Signage Displays" (California Energy Commission 2016) http://docketpublic.energy.ca.gov/PublicDocuments/14-AAER-02/TN210913_20160330T161602_Final_Draft_Staff_Report_for_Computers_Computer_Monitors_and_Si.pdf.

Table 8: Technically Feasible Compliance Options

Product Category	Description	Availability
Desktops and Notebooks	Improved hard disk subcomponents	Currently available
	Improved power supplies	Currently available
	Introduction of deeper "C" state	Currently available
	Improved optical disk drive power management modes	Currently available
	Volatile memory (RAM)	Currently available
	Motherboard	Currently available
	Improved discrete graphics card	Currently available
	Improved software management and organization of system resources	Currently available
	Power management enabled	Currently available
	More efficient display (for integrated displays)	Currently available
Small-scale servers and Workstations	Efficient power supplies	Currently available
	Energy Efficient Ethernet	Currently available
Monitors	Higher efficiency light-emitting diode (LED) backlights	Currently available
	Improved optical film	Currently available
	High transmittance screen technologies	Currently available
	Efficient power supplies	Currently available
	Automatic brightness control	Currently available
	Quantum dots technology	Emerging
	Organic LEDs that do not require backlight of light filters	Emerging

Source: Energy Commission staff

Small businesses, like other businesses that use computers and monitors, are expected to benefit from the anticipated electricity savings resulting from the efficiency standards. Like other business enterprises, small businesses will also incur an additional cost when purchasing products covered under the standard. The net effect is expected to be an overall savings in electricity spending. The proposal is not expected to result in savings or costs that disproportionately impact small businesses.

The Energy Commission included an exemption in the proposed regulation for small businesses that manufacture products covered by the proposal. The small business definition in the proposed standard is different than the official California small business definition (California Government Code § 11342.610). The proposed exemption is based on a company's gross revenue and the volume of sales of regulated products, whereas the State definition for manufacturing enterprises is based on number of employees. There is still likely to be some overlap in the two definitions, in which case those businesses would not be subject to any of the costs likely to be incurred by other manufacturers. Small businesses, using the State's definition, that are not covered by the proposed exemption are expected to follow the same manufacturing standards as other businesses enterprises.

Chapter 3: Economic Impacts
Methodology for Determining Economic Impact

The economy-wide results of the proposed regulations are assessed using the Berkeley Energy and Resources (BEAR) model. The BEAR model is a dynamic economic forecasting model for evaluating long-term growth prospects for California. The model is an advanced policy simulation tool that models demand, supply, and resource allocation across the California economy, estimating economic outcomes annually over the period 2015–2030. This kind of Computable General Equilibrium (CGE) model is a state-of-the-art economic forecasting tool, using a system of equations and detailed economic data that simulate price-directed interactions between firms and households in commodity and factor markets. The role of government, capital markets, and other trading partners are also included, with varying degrees of detail, to close the model and account for economy-wide resource allocation, production, & income determination.

BEAR is calibrated to 2013 economic activity data of the California economy and includes highly disaggregated representation of firm, household, employment, government, and trade behavior (see Table A.2 in Annex A). For this SRIA, the model is aggregated to 60 sectors that are of particular relevance to the economic activities most likely impacted by the proposed regulation (see Table A.3 in Annex A). The model's 2015-2030 baseline is calibrated to California Department of Finance economic and demographic projections.[4]

Policy Scenarios

This SRIA considers the economic impacts of the proposed regulation, two regulatory alternatives, and three sensitivity scenarios. The two regulatory alternatives include a more stringent alternative with higher benefits and a less stringent alternative with lower benefits. The more stringent alternative includes a slightly higher annual energy savings for desktops (78.6 versus 77.4 kWh/year) and monitors (32.9 versus 27.75 kWh/year). The savings come at a higher incremental cost of $20 versus $18 per unit and $10 versus

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[4] A baseline comparison of BEAR and DOF forecasts for key economic variables is available upon request.

$5 per unit for desktops and monitors, respectively. This alternative is meant to represent the maximum efficiency possible through existing technologies, whether or not it is cost-effective. The less stringent alternative is similar to the existing EnergyStar standard. The energy savings is lower for desktops and monitors (44.1 kWh/year and 18.6 kWh/year, respectively) but the incremental compliance costs are also expected to be lower ($6/unit and $0/unit, respectively). This alternative is based on efficiency levels proposed by stakeholders in comments following the first Energy Commission staff analysis.

The anticipated costs and benefits of the proposed regulation are subject to several areas of uncertainty, which are considered in three sensitivity analyses. First, the anticipated reduction in electricity expenditures is based on the projected price of electricity for residential and commercial users. A high and low electricity price sensitivity is considered. The ranges for electricity prices are taken from the Energy Commission's California Energy Demand 2016-2026, Revised Electricity Forecast, Table 6 (CEC-200-2016-001-V1, p. 35). An electricity price forecast that includes implementation of SB 350 was not available at the time of this assessment. The high and low price scenarios of the Revised Electricity Forecast are used as proxies for sensitivity analysis of electricity rate uncertainty.

A second sensitivity analysis considers possible variation in anticipated compliance costs, which include high and low value assumptions for the incremental cost of manufacturing desktops and monitors that comply with the proposed performance standards. The high cost scenario reflects concern amongst several industry stakeholders that the Energy Commission has underestimated the cost of producing compliant products. The low cost scenario reflects the possibility that technological improvements will decrease the compliance costs over time.

A third sensitivity analysis considers alternative market growth rates for the regulated products. Since both savings and costs are a function of market stock and new product purchases, these alternate market growth scenarios are likely to affect both the cost and the electricity savings of the proposed regulation.

Additional details on the assumptions used for each sensitivity analysis are available in Annex B.

Inputs of the Assessment

For the macroeconomic assessment, the direct cost and electricity savings data presented in Table 4 are used as an input into the BEAR model. Electricity savings is apportioned to households and businesses separately based on the total savings shown in Table 5 and 6. This induces expenditure shifting away from direct electricity consumption towards other activities.

Total costs of compliance, shown in Table 4, are allocated to the two impacted sectors in the BEAR model. The costs for desktops, notebooks, small-scale servers, and workstations are attributed to the model's dedicated computer and related products sector, while additional monitor costs are attributed to the model's dedicated monitor sector.

Assumptions and Limitations of the Model

The following assumptions were made for the macroeconomic analysis:

- The baseline economy grows at the long-term rate projected by the California Department of Finance. The labor force is also projected to change according to the Department of Finance's demographic forecast.

- The energy efficiency of regulated products is fixed at current levels in the baseline. There is some evidence that energy efficiency improves over time even without regulatory standards. Exogenous improvements in baseline efficiency would reduce the benefits from lower electricity consumption in the proposal. However, in this case, it is also likely that the assumed compliance costs would be overstated.

- An average compliance cost across a wide range of technically feasible compliance options was assumed. Actual compliance costs for individual manufacturers could be higher or lower.

- Additional compliance costs are assumed to pass through to consumers of regulated computer and monitor products.

- The analysis assumes that users do not change the power management setting on regulated products. Actual energy savings may be different if users change the default power management settings.

- The compliance rate is assumed to be 100 percent for the purposed of this economic analysis. Other appliance regulations typically have a 60 to 90 percent compliance rate.

Results of the Assessment

Results from the macroeconomic assessment are shown below. In compliance with the SRIA requirements, results from the BEAR model are presented for Gross State Product (GSP), employment, business impacts, statewide investment, household income, and environmental impacts. Qualitative discussions on incentives for innovation and competitive advantages and disadvantages are also presented.

Impacts on Gross State Product

Table 8 shows the impact of the proposed standards and various sensitivity scenarios on Gross State Product (GSP). The standard has an overall positive effect on economic activity in the state once the current stock has fully turned over. The lower energy savings in the first few years of the standards results in a very slight decline in GSP. Both effects are small and expected due to the size of the economic stimulus. Because the electricity savings accumulate over time at a faster rate than the incremental costs, the growth effects expand in later years of the analysis period. The increasing rate of growth over time, relative to the baseline, is also due to the multiplier effects that begin accruing as soon as the policy begins. The positive impact of expenditure shifting due to lower electricity spending is compounded over time.

None of the sensitivities have a dramatic effect on statewide economic activity. As would be expected, scenarios that increase savings relative to costs have a slightly larger positive impact on GSP than scenarios that have increased costs relative to savings. The former include higher projected electricity prices, lower expected compliance costs, and higher expected market growth rates.

Table 9: Change in Gross State Product from Baseline (2013 $M and %)

		2020		**2025**		**2030**	
Proposal		**-87**	**-0.003%**	**374**	**0.011 %**	**636**	**0.014%**
Sensitivity: Electricity Price	High	-79	-0.003%	398	0.011%	674	0.015%
	Low	-98	-0.003%	347	0.010%	596	0.014%
Sensitivity: Compliance Cost	High	-99	-0.004%	347	0.010%	592	0.013%
	Low	-84	-0.003%	394	0.011%	685	0.016%
Sensitivity: Market Growth	High	-84	-0.003%	386	0.011%	655	0.015%
	Low	-90	-0.003%	362	0.010%	619	0.014%

Source: BEAR model

California Employment Impacts

The proposed efficiency standards are expected to have a moderate positive impact on overall job creation (**Table 9**). Approximately 5,500 additional jobs (FTE annual) are expected to be created relative to the baseline in 2030. The cumulative change over the analysis period, 2018-2030, is expected to be slightly greater than 12,000 jobs created. Most of the jobs are created towards the end of the analysis period due to the fact that there is a lag of several years in enterprise expansion as consumers spend their additional electricity bill savings on alternative goods and services, and because there is a phase-in period for more efficient products to replace existing stock.

The proposal is not expected to result in the elimination of jobs in the economy. Expenditure shifting by households may result in some short-term employment adjustments, although the aggregate effect, as measured by the model, is positive across sectors. The short-term adjustments are not captured in the general equilibrium model. Employment *growth* in the electricity sector may be slighter lower than in the baseline due to lower electricity demand.

Variation based on the sensitivity scenarios is small. The largest increase in jobs relative to the proposal comes from the high electricity price scenario (~6.4 percent increase). The low electricity price scenario creates the fewest additional jobs (~6.6 percent decline) as a result of the lower savings levels for individuals and businesses.

Table 10: Change in Employment from Baseline (FTE annual jobs)

		2030	Cumulative Change (2018-2030)
Proposal		**5,525**	**12,158**
Sensitivity: Electricity Price	High	5,878	12,471
	Low	5,162	11,833
Sensitivity: Compliance Cost	High	5,325	12,011
	Low	5,769	12,401
Sensitivity: Market Growth	High	5,812	12,430
	Low	5,272	11,919

Source: BEAR model

<u>California Business Impacts</u>

In addition to the direct net benefits that energy efficiency standards have for California businesses, the proposal also improves overall business activity in the state (**Table 10**). The net savings are redistributed as a general stimulus throughout the economy. The results suggest that the policy will have very modest positive impact on aggregate business creation.

Table 11: Change in Real Enterprise Output from Baseline (2013 $M and %)

		2020		2025		2030	
Proposal		**-20**	**0.000%**	**750**	**0.013%**	**1,189**	**0.017 %**
Sensitivity: Electricity Price	High	-13	0.000%	773	0.013%	1,227	0.017%
	Low	-28	-0.001%	726	0.013%	1,148	0.016%
Sensitivity: Compliance Cost	High	-42	-0.001%	705	0.012%	1,118	0.016%
	Low	-14	0.000%	786	0.014%	1,273	0.018%
Sensitivity: Market Growth	High	-21	0.000%	753	0.013%	1,195	0.017%
	Low	-13	0.000%	773	0.013%	1,227	0.017%

Source: BEAR model

Lower electricity expenditures resulting from the efficiency standards are expected to have a modest adverse impact on the electricity sector. Sectoral results confirm this (**Table 11**), showing a less than 2 percent reduction in electric power sector output in 2030, relative to the baseline. This result would be expected with any large-scale energy efficiency policy affecting the electric power sector. The slower growth in the electric power sector is partially muted by an overall increase in economic activity resulting from the policy; however, the net sectoral impact is still slightly negative. Nonetheless, there is no expectation that this would eliminate businesses in California.

Table 12: Percent Change in Sector Output from Baseline in 2030

		Electric Power	**Refined Petroleum**	**Manufacturing**	**Services**	**Other**
Proposal		**-1.7%**	**0.031%**	**0.06%**	**0.033%**	**-0.05%**
Sensitivity: Electricity Price	High	-2.0%	0.032%	0.06%	0.034%	-0.05%
	Low	-1.5%	0.030%	0.06%	0.031%	-0.05%
Sensitivity: Compliance Cost	High	-1.7%	0.031%	0.05%	0.032%	-0.05%
	Low	-1.7%	0.030%	0.06%	0.033%	-0.05%
Sensitivity: Market Growth	High	-2.0%	0.032%	0.06%	0.033%	-0.05%
	Low	-1.5%	0.030%	0.06%	0.032%	-0.05%

Source: BEAR model

<u>Impacts on Investments in California</u>

The BEAR model predicts a modest increase in investment as a result of the proposed regulation (**Table 12**). This result is consistent with the expected increase in economic activity resulting from the large electricity savings. Investment impact decreases over time as the incremental net savings from the proposed standard level off. This is different than GSP and employment, which grows over time relative to the baseline, due to economy-wide multiplier effects.

Table 13: Change in Real Investment from Baseline (2013 $M and %)

		2020		**2025**		**2030**	
Proposal		**175**	**0.038%**	**170**	**0.029%**	**124**	**0.017%**
Sensitivity: Electricity Price	High	179	0.039%	180	0.031%	137	0.019%
	Low	170	0.037%	159	0.027%	111	0.016%
Sensitivity: Compliance Cost	High	167	0.036%	160	0.028%	113	0.016%
	Low	177	0.039%	180	0.031%	141	0.020%
Sensitivity: Market Growth	High	176	0.038%	176	0.030%	132	0.018%
	Low	174	0.038%	165	0.028%	117	0.016%

Source: BEAR model

Impacts on Individuals in California

The Energy Commission staff proposal is expected to provide electricity savings to all California consumers of regulated computer and monitor products. However, results suggest that electricity savings are distributed differently across household income deciles (**Table 13**). Model results suggest that households at the very low and high ends of the income spectrum will benefit disproportionately from lower electricity bills. For low-income households, electricity is a necessary good which consumes a larger percentage of total household expenditures, so reducing the electricity spending provides a greater benefit. Higher income households consume a larger fraction of energy intensive products and are therefore also expected to benefit more than other income deciles. It should be noted that these disproportionate impacts for high and low income households are very modest.

The sensitivity scenarios have a negligible impact on the results. Results vary by less than one basis point (a hundredth of a percentage point) across the scenarios, and the same distributive theme emerges. Household income increases for all income deciles, and low and high-income households continue to have a modestly higher benefit from the proposal.

Table 14: Change in Household Relative Real Income by Decile in 2030 (% change from baseline)

Household Decile (HH1=low)	**Proposal**	**Sensitivity Analysis**					
		Electricity Price		**Compliance Cost**		**Market Growth**	
		High	**Low**	**High**	**Low**	**High**	**Low**
HH1	**0.044%**	0.045%	0.043%	0.044%	0.044%	0.044%	0.044%
HH2	**0.044%**	0.045%	0.044%	0.044%	0.044%	0.045%	0.044%
HH3	**0.028%**	0.029%	0.026%	0.027%	0.029%	0.029%	0.027%
HH4	**0.027%**	0.028%	0.025%	0.026%	0.028%	0.028%	0.025%
HH5	**0.018%**	0.020%	0.016%	0.017%	0.020%	0.020%	0.017%
HH6	**0.018%**	0.020%	0.016%	0.017%	0.020%	0.019%	0.017%
HH7	**0.026%**	0.028%	0.024%	0.024%	0.028%	0.027%	0.025%
HH8	**0.016%**	0.018%	0.013%	0.014%	0.018%	0.017%	0.014%
HH9	**0.036%**	0.038%	0.034%	0.034%	0.038%	0.037%	0.035%
HH10	**0.030%**	0.032%	0.028%	0.028%	0.032%	0.031%	0.029%

Source: BEAR model

Incentives for Innovation

The proposed efficiency standard is by design meant to promote innovation for the regulated product categories. While a number of technically feasible compliance options are currently available, the standard is also likely to incentivize manufacturers to consider other lower cost options for delivering energy efficiency benefits.

Due to the state's large market share of regulated products, there is the possibility that the Energy Commission's proposed standards would compel manufacturers to incorporate the higher efficiency technologies into similar products sold outside of the state. It is also possible that the state's proposal could serve as a template for federal computer efficiency standards, especially because it is not expected that the Energy Commission's proposal will be preempted by the federal government with an equal or less stringent appliance efficiency standard.

Competitive Advantage or Disadvantage

The regulation would apply to all businesses manufacturing the regulated products inside and outside of the state, and selling computers and monitors to California customers. It is therefore not anticipated that the regulation will have an adverse effect on the competitiveness of California businesses. In fact, the BEAR model results suggest that the macroeconomic stimulus effect from the proposal will induce a modest increase in the state's aggregate export volume.

Other Benefits and Impacts of the Regulations

The BEAR model predicts levels of greenhouse gas emissions and criteria air pollutants resulting from the proposed efficiency standards. These estimates are based on emissions factors linked to sectoral output from polluting sectors. Base year emissions levels are calibrated to the California Air Resources Board emissions inventory.

Benefits from reduced GHG emissions in the electric power sector are shown in Table 14. Under the proposed standard and all six sensitivity scenarios, emissions decline in the electric power sector due to the decreased demand for electricity from computers, monitors, and displays. Emissions reductions are greater in later years, relative to the baseline, as the stock of products turns over and cumulative energy savings are realized. For example, expected emissions reductions in 2030 are approximately 2.5 times larger than in 2020. The high electricity price and high market growth sensitivities yielded the greatest emissions reductions of the six sensitivities. Model results suggest that alternative compliance cost scenarios are unlikely to affect the emissions outcome.

The emission reduction benefits are monetized using estimates from the U.S. Environmental Protection Agency for global damages due to GHG emissions.[5] Using a

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[5] For social cost of carbon, see http://www.epa.gov/climatechange/EPAactivities/economics/scc.html

low range estimate of \$13/mtCO_2e and a high range of \$47/mtCO_2e, the proposed standard would result in avoided damages of \$11.4-\$41.1 million from 2018-2030.

Table 15: Change in Electric Power Sector GHG Emissions
(million tCO_2e, difference from baseline)

		2020	2025	2030
Proposal		-0.0376	-0.0810	-0.0938
Sensitivity: Electricity Price	High	-0.0421	-0.0933	-0.1122
	Low	-0.0322	-0.0677	-0.0752
Sensitivity: Compliance Cost	High	-0.0368	-0.0808	-0.0944
	Low	-0.0380	-0.0818	-0.0944
Sensitivity: Market Growth	High	-0.0405	-0.0927	-0.1144
	Low	-0.0348	-0.0703	-0.0757

Source: BEAR Model

The BEAR model also reports emissions from other sectors of the economy. The model results suggest that the economic stimulus created by the proposed standard could potentially increase emissions outside of the electric power sector (**Table 15**). This would be due to consumption shifting away from electricity towards other GHG-intensive activities, such as transportation and manufacturing. This possibility of increases in indirect and induced emissions highlights the importance of an economy-wide approach to GHG mitigation.

Table 16: Change in Sector GHG Emissions
(million tCO_2e, difference from baseline)

Sector	**2020**	**2025**	**2030**
Electricity	-0.038	-0.081	-0.094
Refined Petroleum	0.061	0.096	0.119
Manufacturing	0.079	0.122	0.147
Services	-0.017	-0.006	0.003
Other	-0.047	-0.066	-0.074

Source: BEAR model

The reduction in electricity demand due to the proposed standard is also expected to reduce the amount of other air pollutants. Model results for five common pollutants known to have adverse human health impacts are shown in **Table 16**. These emissions reductions were monetized using the COBRA model, developed by the US Environmental Protection Agency.[6] The COBRA model results, which report a low and high range for health impacts, suggest a cumulative health benefit from 2018-2030 of

[6] The COBRA Model is available at https://www.epa.gov/statelocalclimate/co-benefits-risk-assessment-cobra-screening-model.

$4.7 million to $10.6 million.[7] This valuation result is driven almost entirely by reductions in premature adult mortality.

Table 17: Cumulative Change (2018-2030) in Electric Power Sector Criteria Pollutants (thousand metric tons, difference from baseline)

		CO	NOx	SOx	$PM_{2.5}$	VOC
Proposal		**-0.298**	**-0.152**	**-0.024**	**-0.030**	**-0.018**
Sensitivity: Electricity Price	High	-0.346	-0.176	-0.028	-0.035	-0.021
	Low	-0.248	-0.126	-0.020	-0.025	-0.015
Sensitivity: Compliance Cost	High	-0.297	-0.152	-0.024	-0.030	-0.018
	Low	-0.301	-0.154	-0.025	-0.030	-0.018
Sensitivity: Market Growth	High	-0.343	-0.175	-0.028	-0.035	-0.021
	Low	-0.257	-0.012	-0.021	-0.026	-0.015

Source: BEAR Model

Summary and Interpretation of the Results of the Economic Impact Assessment

The Energy Commission's computer and monitor efficiency proposal is expected to provide substantial energy savings to California consumers. Net direct savings to individuals and businesses in the state are expected to be approximately $3.5 billion cumulatively from 2018 to 2030, or $350 million per year once the product stock has fully turned over.

The macroeconomic impact results show that, relative to the baseline, economic growth, employment, enterprise output, and investment all increase due to the electricity savings associated with the proposed efficiency standards. Employment and enterprise output increase at a slightly faster rate than GSP due to the fact that expenditure shifting occurs from relatively low employment electricity sectors to higher employment service sectors. All macroeconomic effects are modest, relative to the size of the California economy, which is consistent with the magnitude of the stimulus generated by the standards. The proposed standards are also expected to modestly reduce greenhouse gas and criteria air pollutant emissions in the electric power sector.

Based on three sets of sensitivity analyses, the direction and magnitude of the results are not significantly affected by reasonable variation in future electricity price projections, compliance costs, or assumed product market growth rates. These results suggest that the intended benefits of proposal are likely to be delivered under a range of relevant economic and policy conditions.

[7] The COBRA model does not consider the health impact of lower carbon monoxide emissions. The other four pollutants are included in the model.

Two regulatory alternatives were evaluated, including a higher stringency alternative that delivered greater energy savings and a less stringent standard that delivered lower energy savings but at a lower compliance cost. Each of these alternatives was rejected by the Energy Commission. The higher stringency alternative delivered only modest additional direct gross savings but at a significantly higher compliance cost, yielding a significantly lower benefit to the consumer. The lower stringency option did not deliver energy savings that were consistent with the Energy Commission's objectives to set cost-effective and technically feasible standards that maximize reduction of the wasteful consumption of energy from appliances that consume a significant amount of energy statewide.

Chapter 4: ALTERNATIVES

The SRIA requires the consideration of two regulatory alternatives to the proposed regulation. One alternative would deliver greater benefits ("more stringent") and the other ("less stringent") would deliver fewer benefits but at a lower compliance cost. A description of each alternative, its economic impact, and the reason for rejection is outlined below.

The primary difference between the alternatives and the proposal are the aggregate costs and savings assumptions. The timing and distribution of these costs and savings is not expected to deviate from the proposed regulation.

Alternative 1: High Stringency

The first alternative considers a more stringent efficiency standard that requires greater energy savings from desktops and monitors (higher efficiency requirements for the other product categories were considered to be technically infeasible). The electricity savings by product category and assumed costs are reported in Table 3 in Chapter 2.

Economic Impacts

Based on the assumed direct costs and electricity savings presented in Table 4, the more stringent alternative has a considerably lower benefit-cost ratio than the proposed standard. The benefit-cost ratio for the more stringent alternative ranges from 4.3 to 4.9, whereas the benefit cost-ratio for the proposal ranges from 5.3 to 6.0. This is due primarily to a doubling in the incremental compliance costs for regulated monitors that would in turn deliver only a modest level of electricity savings. The additional savings for desktops from the higher stringency standard is also very modest, although the incremental cost for desktops is also small ($2/unit).

The macroeconomic results, shown in **Tables 17** and **18**, also suggest that the more stringent alternative delivers lower economy-wide benefits than the proposed standard.

However, it is worth noting that this alternative still provides net direct and economy-wide benefits relative to the baseline.

Table 18: Economic Impact Summary, More Stringent Alternative

		2020	2025	2030
Gross State Product (2013 M$)	**Proposal**	-87.4	373.6	636.0
	More Stringent	-94.2	359.8	610.5
	Percent Difference	7.8%	-3.7%	-4.0%
Real Investment (2013 M$)	**Proposal**	175	170	124
	More Stringent	170	166	119
	Percent Difference	-2.9%	-2.6%	-4.5%

Source: BEAR Model

Table 19: Employment Impacts, More Stringent Alternative

	2030	Cumulative Change (2018-2030)
Proposal	5,525	12,158
More Stringent	5,490	12,149
Percent Difference	-0.64%	-0.07%

Source: BEAR Model

Reason for Rejection

The higher stringency alternative was rejected because of its significantly lower cost-effectiveness. The additional energy savings from a stricter standard would have been very modest, but the costs incurred, especially for monitor compliance, are much higher, resulting in fewer savings to consumers and a lesser economic benefit to the state.

Alternative 2: Low Stringency

The second alternative considers an efficiency standard that provides considerably lower energy savings for desktops and monitors. The incremental cost for these two product categories is also substantially lower.

Economic Impacts

The benefit-cost ratio of the low stringency alternative (8.4-9.5) is substantially higher than the proposal. However, the aggregate net benefits are much smaller. The macroeconomic impacts of the less stringent proposal suggest that this regulatory option would generate considerably less aggregate economic activity than the proposed regulatory standard (**Table 19**). The cumulative impact on jobs is a negligible increase over the analysis period (**Table 20**).

Table 20: Economic Impact Summary, Less Stringent Alternative

		2020	2025	2030
Gross State Product (2013 M$)	**Proposal**	-87.4	373.6	636.0
	Less Stringent	-94.4	357.8	633.9
	Percent Difference	7.9%	-4.2%	-0.3%
Real Investment (2013 M$)	**Proposal**	175	170	124
	Less Stringent	175	160	116
	Percent Difference	0.1%	-6.2%	-6.8%

Source: BEAR Model

Table 21: Employment Impacts, Less Stringent Alternative

	2030	Cumulative Change (2018-2030)
Proposal	5,525	12,158
More Stringent	5,490	12,149
Percent Difference	-0.64%	-0.07%

Source: BEAR Model

Reason for Rejection

The lower stringency alternative was rejected because the energy savings are unacceptably low given the Energy Commission's mandate to reduce the wasteful consumption of energy statewide through cost-effective and technically feasible standards. Even though the benefit-cost ratio was higher than the proposed standard, the Energy Commission's objectives of significantly reducing energy consumption would not have been met.

Chapter 5: FISCAL IMPACTS

The California state government is a large consumer of computers and monitors. The proposed regulation is expected to affect state agencies in much the same way as individuals and businesses. Based on procurement data from the Department of General Services (DGS), the state purchased an average of approximately 31,000 desktops, 15,000 notebooks, and 41,500 monitors in 2014-2015. This data was used to quantify the impact of the proposed regulation on the state government. This approach excludes procurement of regulated products from a number of other state institutions, such as the University of California system, and local governments. Therefore, this estimate should be considered a lower bound for the statewide fiscal impact.

It is assumed that the State electricity rate is similar to other commercial users. The proposed regulation is expected to provide $592,000 to $3,361,000 in reduced electricity costs at an additional cost to procuring compliant products of $771,000 to $728,000

(**Table 21**). In all years, except the first year of implementation, the proposed standard is expected to result in a benefit-cost ratio greater than 1.

Table 22: Direct Impact on State Agencies (million $)

	Reduced Electricity Cost	**Increased Procurement Cost**
2018	0.592	0.771
2019	1.211	0.768
2020	1.858	0.764
2021	2.488	0.760
2022	3.115	0.756
2023	3.304	0.753
2024	3.312	0.749
2025	3.320	0.746
2026	3.328	0.742
2027	3.336	0.739
2028	3.344	0.735
2029	3.353	0.732
2030	3.361	0.728

The proposed regulation is not expected to incur an enforcement or compliance cost for the state government. Enforcement of appliance efficiency standards is self-funded through fines levied against entities that violate the standards, pursuant to Public Resources Code section 25402.11. The additional cost to enforce compliance is estimated to be negligible since enforcement resources for other products are expected to be shifted to computers.

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Appendix A: Technical Summary of the BEAR Model

The Berkeley Energy and Resources (BEAR) model is a constellation of research tools designed to elucidate linkages across the California economy. The schematics in **Figures A.1 and A.2** describe the four generic components of the modeling facility and their interactions. This section provides a brief summary of the formal structure of the BEAR model. For the purposes of this report, the 2013 California Social Accounting Matrix (SAM) was aggregated along certain dimensions. The current version of the model includes 195 activity sectors, 22 occupations, and ten households aggregated from the original California SAM. The equations of the model are completely documented elsewhere (Roland-Holst 2008), and for the present we only review its salient structural components.

Structure of the CGE Model

Technically, a CGE model is a system of simultaneous equations that simulate price-directed interactions between firms and households in commodity and factor markets. The role of government, capital markets, and other trading partners are also specified, with varying degrees of detail and passivity, to close the model and account for economy-wide resource allocation, production, and income determination.

The role of markets is to mediate exchange, usually with a flexible system of prices, the most important endogenous variables in a typical CGE model. As in a real market economy, commodity and factor price changes induce changes in the level and composition of supply and demand, production and income, and the remaining endogenous variables in the system. In CGE models, an equation system is solved for prices that correspond to equilibrium in markets and satisfy the accounting identities governing economic behavior. If such a system is precisely specified, equilibrium always exists and such a consistent model can be calibrated to a base period data set. The resulting calibrated general equilibrium model is then used to simulate the economy-wide (and regional) effects of alternative policies or external events.

The distinguishing feature of a general equilibrium model, applied or theoretical, is its closed-form specification of all activities in the economic system under study. This can be contrasted with more traditional partial equilibrium analysis, where linkages to other domestic markets and agents are deliberately excluded from consideration. A large and growing body of evidence suggests that indirect effects (e.g., upstream and downstream production linkages) arising from policy changes are not only substantial, but may in some cases even outweigh direct effects. Only a model that consistently specifies economy-wide interactions can fully assess the implications of economic policies or business strategies. In a multi-regional model like the one used in this study, indirect effects include the trade linkages between countries and regions which themselves can have policy implications.

The model we use for this work has been constructed according to generally accepted specification standards, implemented in the GAMS programming language, and calibrated to the new California SAM estimated for the year 2013. The result is a single economy model calibrated over the thirty-five year time path from 2015 to 2050. Using the very detailed accounts of the California SAM, we include the following assumptions in the present model.

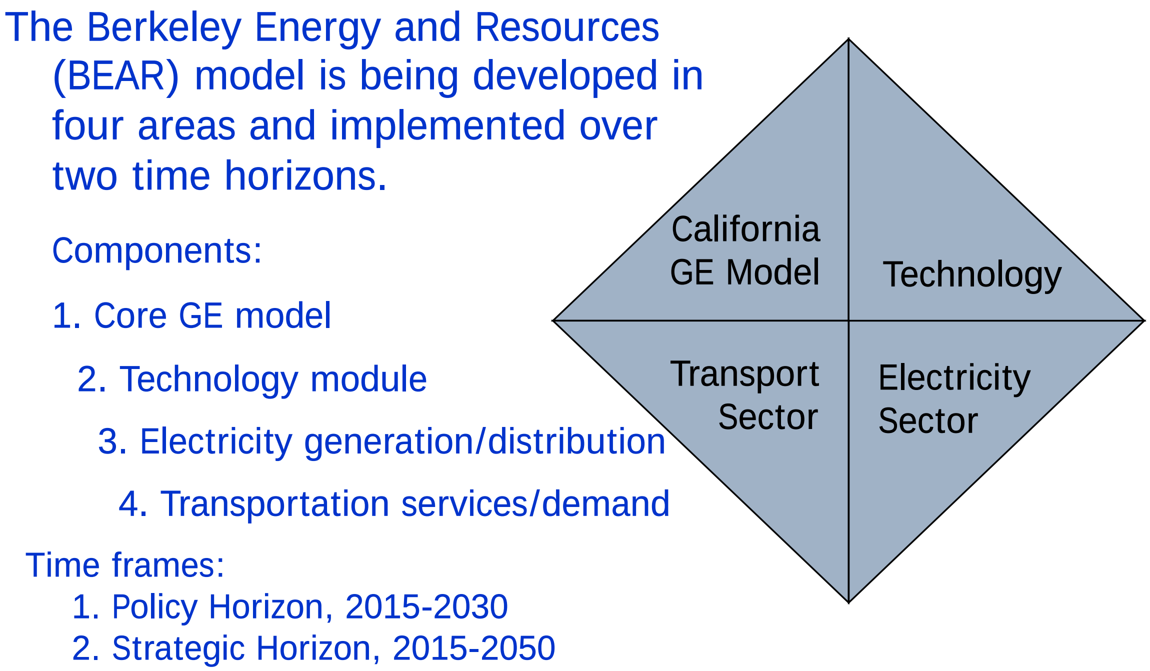
Production

All sectors are assumed to operate under constant returns to scale and cost optimization. Production technology is modeled by a nested constant-elasticity-of-substitution (CES) function.

In each period, the supply of primary factors — capital, land, and labor — is usually predetermined.[8] The model includes adjustment rigidities. An important feature is the distinction between old and new capital goods. In addition, capital is assumed to be partially mobile, reflecting differences in the marketability of capital goods across sectors.[9] Once the optimal combination of inputs is determined, sectoral output prices are calculated assuming competitive supply conditions in all markets.

[8] Capital supply is to some extent influenced by the current period's level of investment.
[9] For simplicity, it is assumed that old capital goods supplied in second-hand markets and new capital goods are homogeneous. This formulation makes it possible to introduce downward rigidities in the adjustment of capital without increasing excessively the number of equilibrium prices to be determined by the model.

Figure A.1: Component Structure of the Modeling Facility



Consumption and Closure Rule

All income generated by economic activity is assumed to be distributed to consumers. Each representative consumer allocates optimally his/her disposable income among the different commodities and saving. The consumption/saving decision is completely static: saving is treated as a "good" and its amount is determined simultaneously with the demand for the other commodities, the price of saving being set arbitrarily equal to the average price of consumer goods.

The government collects income taxes and indirect taxes on intermediate inputs, outputs, and consumer expenditures. The default closure of the model assumes that the government deficit/saving is exogenously specified.[10] The indirect tax schedule will shift to accommodate any changes in the balance between government revenues and government expenditures.

The current account surplus (deficit) is fixed in nominal terms. The counterpart of this imbalance is a net outflow (inflow) of capital, which is subtracted (added to) the domestic flow of saving. In each period, the model equates gross investment to net saving (equal to the sum of saving by households, the net budget position of the government and

[10] In the reference simulation, the real government fiscal balance converges (linearly) towards 0 by the final period of the simulation.

foreign capital inflows). This particular closure rule implies that investment is driven by saving.

Trade

Goods are assumed to be differentiated by region of origin. In other words, goods classified in the same sector are different according to whether they are produced domestically or imported. This assumption is frequently known as the *Armington* assumption. The degree of substitutability, as well as the import penetration shares are allowed to vary across commodities. The model assumes a single Armington agent. This strong assumption implies that the propensity to import and the degree of substitutability between domestic and imported goods is uniform across economic agents. This assumption reduces tremendously the dimensionality of the model. In many cases this assumption is imposed by the data. A symmetric assumption is made on the export side where domestic producers are assumed to differentiate the domestic market and the export market. This is modeled using a *Constant-Elasticity-of-Transformation* (CET) function.

Dynamic Features and Calibration

The current version of the model has a simple recursive dynamic structure as agents are assumed to be myopic and to base their decisions on static expectations about prices and quantities. Dynamics in the model originate in three sources: i) accumulation of productive capital and labor growth; ii) shifts in production technology; and iii) the putty/semi-putty specification of technology.

Capital Accumulation

In the aggregate, the basic capital accumulation function equates the current capital stock to the depreciated stock inherited from the previous period plus gross investment. However, at the sectoral level, the specific accumulation functions may differ because the demand for (old and new) capital can be less than the depreciated stock of old capital. In this case, the sector contracts over time by releasing old capital goods. Consequently, in each period, the new capital vintage available to expanding industries is equal to the sum of disinvested capital in contracting industries plus total saving generated by the economy, consistent with the closure rule of the model.

The Putty/Semi-Putty Specification

The substitution possibilities among production factors are assumed to be higher with the new than the old capital vintages — technology has a putty/semi-putty specification. Hence, when a shock to relative prices occurs (e.g. the imposition of an emissions fee), the demands for production factors adjust gradually to the long-run optimum because the substitution effects are delayed over time. The adjustment path depends on the values of the short-run elasticities of substitution and the replacement rate of capital. As the latter determines the pace at which new vintages are installed, the larger is the volume of new investment, the greater the possibility to achieve the long-run total amount of substitution among production factors.

Profits, Adjustment Costs, and Expectations

Firms' output and investment decisions are modeled in accordance with the innovative approach of Goulder and co-authors (see Goulder, Hafstead, and Dworsky 2010 for technical details). In particular, we allow for the possibility that firms reap windfall profits from events such as free permit distribution. Absent more detailed information on ownership patterns, we assume that these profits accrue to US and foreign residents in proportion to equity shares of publically traded US corporations (16 percent in 2009, Swartz and Tillman, 2010). Between California and other US residents, the shares are assumed to be proportional to GSP in GDP (11 percent in 2009).

Dynamic Calibration

The model is calibrated on exogenous growth rates of population, labor force, and GDP. In the baseline scenario, the dynamics are calibrated in each region by imposing the assumption of a balanced growth path. This implies that the ratio between labor and capital (in efficiency units) is held constant over time.[11] When alternative scenarios around the baseline are simulated, the technical efficiency parameter is held constant, and the growth of capital is endogenously determined by the saving/investment relation.

Modelling Emissions

The BEAR model captures emissions from production activities in agriculture, industry, and services, as well as in final demand and use of final goods (e.g. appliances and autos). This is done by calibrating emission functions to each of these activities that vary depending upon the emission intensity of the inputs used for the activity in question. We model both CO_2 and the other primary greenhouse gases, which are converted to CO_2 equivalents. Following standards set in the research literature, emissions in production are modeled as factors inputs. The base version of the model does not have a full representation of emissions reduction or abatement. Emissions abatement occurs by substituting additional labor or capital for emissions when an emissions tax is applied. This is an accepted modeling practice, although in specific instances it may either understate or overstate actual emissions reduction potential.[12] In this framework, emission levels have an underlying monotonic relationship with production levels, but

[11] This involves computing in each period a measure of Harrod-neutral technical progress in the capital-labor bundle as a residual. This is a standard calibration procedure in dynamic CGE modeling.
[12] See e.g. Babiker et al. (2001) for details on a standard implementation of this approach.

can be reduced by increasing use of other productive factors such as capital and labor. The latter represent investments in lower intensity technologies, process cleaning activities, etc. An overall calibration procedure fits observed intensity levels to baseline activity and other factor/resource use levels. The BEAR model has the capacity to track 13 categories of individual pollutants and consolidated emission indexes, each of which is listed in Table A.1 below. For more detail, please consult the full model documentation.

An essential characteristic of the BEAR approach to emissions modeling is endogeneity. Contrary to assertions made elsewhere (Stavins 2008), the BEAR model permits emission rates by sector and input to be exogenous or endogenous, and in either case the level of emissions from the sector in question is endogenous unless a cap is imposed. This feature is essential to capture structural adjustments arising from market-based climate policies, as well as the effects of technological change.

Table A.1: BEAR Emissions Categories

Variable Description	**Variable Name**
Greenhouse Gas Emissions	
Carbon Dioxide	CO2
Methane	CH4
Nitrous Oxide	N2O
Air Pollutants	
Suspended Particulates	PART
Sulfur Dioxide	SO2
Nitrogen Dioxide	NO2
Volatile organic compounds	VOC
Carbon monoxide	CO
Toxic air index	TOXAIR
Biological air index	BIOAIR
Water Pollutants	
Biochemical oxygen demand	BOD
Total suspended solids	TSS
Toxic water index	TOXWAT
Biological water index	BIOWAT
Land Pollutants	
Toxic land index	TOXSOL
Biological land index	BIOSOL

Figure A.2: Schematic Linkage Between Model Components

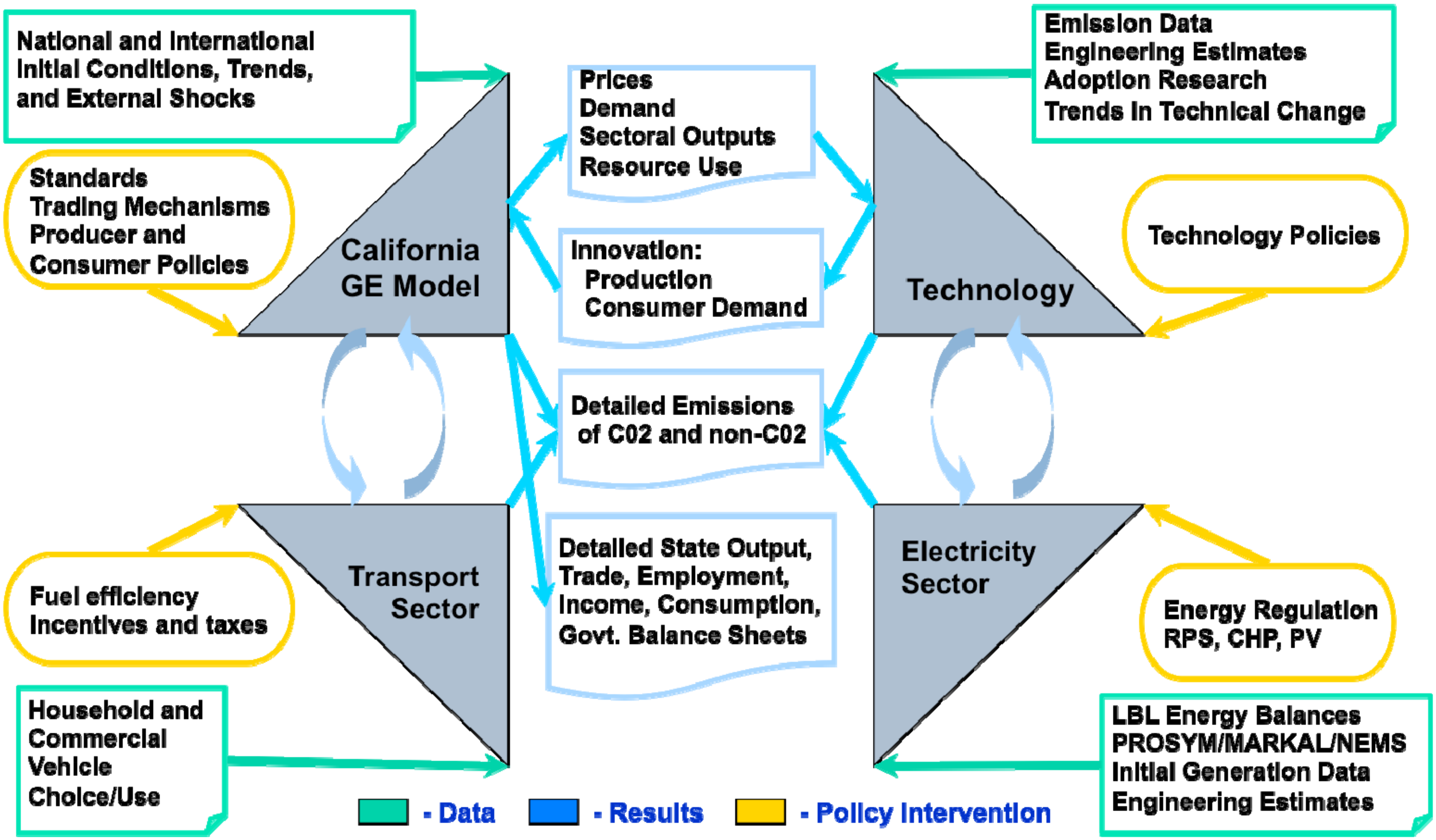


Table A2: California SAM for 2013 - Structural Characteristics

SAM Category
195 commodities (includes trade and transport margins)
24 factors of production
22 labor categories
Capital
Land
10 Household types, defined by income tax bracket
Enterprises
Federal Government (7 fiscal accounts)
State Government (27 fiscal accounts)
Local Government (11 fiscal accounts)
Consolidated capital account
External Trade Account

The 60 production sectors and commodity groups used in this analysis are shown in **Table A.3**. This aggregates based on the original 195 sectors in the BEAR model.

Table A.3: Aggregate Accounts for CEC California CGE Model

Label	**Description**	**Label**	**Description**
A01Agric	Agriculture	A31Aluminm	Aluminum
A02Cattle	Cattle and Feedlots	A32Machnry	General Machinery
A03Dairy	Dairy Cattle and Milk Production	A33MfgMon	Monitor and Displays Manufacturing
A04Forest	Forestry, Fishery, Mining, Quarrying	A34MfgComp	Computer Manufacturing
A05OilGas	Oil and Gas Extraction	A35SemiCon	Semi-Conductor Manufacturing
A06OthPrim	Other Primary Products	A36ElecApp	Electrical Appliances
A07EleHyd	Electricity Generation-Hydro	A37Autos	Automobiles and Light Trucks
A08EleFF	Electricity Generation-Fossil Fuels	A38OthVeh	Other Vehicle Manufacturing
A09EleNuc	Electricity Generation-Nuclear	A39AeroMfg	Aeroplane and Aerospace Manufacturing
A10EleSol	Electricity Generation-Solar	A40OthInd	Other Industry
A11EleWind	Electricity Generation-Wind	A41WhlTrad	Wholesale Trade
A12EleGeo	Electricity Generation-Geothermal	A42RetVeh	Retail Vehicle Sales and Service
A13EleBio	Electricity Generation-Biomass	A43AirTrns	Air Transport Services
A14EleOth	Electricity Generation-Other	A44GndTrns	Ground Transport Services
A15DistElec	Electricity Distribution	A45WatTrns	Water Transport Services

A16DistGas	Natural Gas Distribution	A46TrkTrns	Truck Transport Services
A17DistOth	Water, Sewage, Steam	A47PubTrns	Public Transport Services
A18ConRes	Residential Construction	A48RetAppl	Retail - Electronics and Appliances
A19ConNRes	Non-Residential Construction	A49RetGen	Retail- General Merchandise
A20ConPow	Power Sector Construction	A50InfCom	Information and Communication Services
A21ConRd	Other Infrastructure Construction	A51FinServ	Financial Services
A22FoodPrc	Food Processing	A52OthProf	Other Professional Services
A23TxtAprl	Textiles and Apparel	A53BusServ	Business Services
A24WoodPlp	Wood, Pulp, and Paper	A54WstServ	Landfill Services
A25PapPrnt	Printing and Publishing	A55Educatn	Educational Services
A26OilRef	Oil Refining	A56Medicin	Medical Services
A27Chemicl	Chemicals	A57Recratn	Recreation Services
A28Pharma	Pharmaceutical Manufacturing	A58HotRest	Hotel and Restaurant Services
A29Cement	Cement	A59OthPrSv	Other Private Services
A30Metal	Metal Manufacture and Fabrication	A60GovtSv	Government Services

These data enable us to trace the effects of responses to climate change and other policies at unprecedented levels of detail, tracing linkages across the economy and clearly indicating the indirect benefits and tradeoffs that might result from comprehensive policies, pollution taxes, or trading systems. The effects of climate policy can be quite complex. In particular, cumulative indirect effects may outweigh direct consequences, and affected groups are often far from the policy target group.

It should be noted that the SAM used with BEAR departs in a few substantive respects from the original 2013 California SAM. The two main differences have to do with the structure of production, as reflected in the input-output accounts, and with consumption good aggregation. To specify production technology in the BEAR model, we rely on both activity and commodity accounting, while the original SAM has consolidated activity accounts. We chose to maintain separate activity and commodity accounts to maintain transparency in the technology of emissions and patterns of tax incidence. The difference is non-trivial and considerable additional effort was needed to reconcile use and make tables separately. This also facilitated the second SAM extension, however, where we maintained final demand at the full 119 commodity level of aggregation, rather than adopting six aggregate commodities like the original SAM.

Emissions Data

Emissions data were obtained from California's own detailed emissions inventory. In most of the primary pollution databases like this, measured emissions are directly associated with the volume of output. This has several consequences. First, from a behavioral perspective, the only way to reduce emissions, with a given technology, is to reduce output. This obviously biases results by exaggerating the abatement-growth tradeoff.

Second, output-based pollution modeling imperfectly captures the observed pattern of abatement behavior. Generally, firms respond to abatement incentives and penalties in much more complex and sophisticated ways by varying internal conditions of production. These responses include varying the sources, quality, and composition of inputs, choice of technology, etc.

The third shortcoming of the output approach is that it does not provide guidance about other important pollution sources outside the production process, especially pollution in use of final goods. The most important example of this category is household consumption. BEAR estimates emissions from both intermediate and (in-state) final demand.

Emissions impacts were evaluated using the U.S. EPA COBRA Model. The U.S. EPA has developed the Co-Benefits Risk Assessment (COBRA) Model to help state and local governments assess the health and economic impacts of policies that affect criteria air pollutant levels. The COBRA Model provides a high and low estimate of avoided public health impacts due to reductions in criteria emissions. It also provides estimates of economic impacts resulting from changes in criteria air pollutant emissions.

The COBRA Model uses U.S. EPA emissions estimates for criteria air pollutants in the year 2017 as a baseline. Users specify a discount rate and scenarios for emissions levels at different geographic scales. The COBRA Model employs a reduced form air quality model, the Source-Receptor Matrix, for assessing changes in ambient particulate matter. The model then uses concentration response functions to link the changes in particulate matter to health and economic impacts, based on data from epidemiological studies. Outputs are expressed with multiple metrics such as willingness-to-pay, value of a statistical life and direct medical costs for economic impacts, and incidences of mortality, hospital admissions, and work loss days for health impacts.[13]

[13] The COBRA Model is available at https://www.epa.gov/statelocalclimate/co-benefits-risk-assessment-cobra-screening-model. Prior SRIAs on LED lights and appliance efficiency have used the COBRA model.

Appendix B: Sensitivity Analysis Assumptions

Electricity Price

Projected electricity price assumptions for the proposed standards, as well as the high and low electricity price sensitivity scenarios are shown in Table B.1. Prices were averaged across the various planning areas reported in the Energy Commission forecast. Residential rates are used for calculating individual consumer savings and the commercial rates are used for the calculated business savings.

Table B.1: Electricity Price Assumptions (2013 cents/kWh)

	Baseline		**Low Price Forecast**		**High Price Forecast**	
Year	**Residential**	**Commercial**	**Residential**	**Commercial**	**Residential**	**Commercial**
2013	16.91	14.77	16.91	14.77	16.91	14.77
2014	17.23	15.05	16.95	14.81	17.78	15.53
2015	17.54	15.32	16.99	14.85	18.64	16.28
2016	18.03	15.75	17.18	15.02	19.25	16.81
2017	18.52	16.17	17.38	15.19	19.86	17.34
2018	19.00	16.60	17.57	15.35	20.46	17.87
2019	19.49	17.02	17.76	15.52	21.07	18.40
2020	19.98	17.45	17.96	15.69	21.67	18.93
2021	20.12	17.57	18.01	15.74	21.92	19.14
2022	20.25	17.69	18.07	15.79	22.17	19.36
2023	20.39	17.81	18.12	15.84	22.42	19.58
2024	20.53	17.93	18.18	15.89	22.67	19.79
2025	20.67	18.05	18.23	15.94	22.92	20.01
2026	20.81	18.17	18.29	15.98	23.17	20.23
2027	20.95	18.29	18.35	16.03	23.42	20.45
2028	21.09	18.41	18.40	16.08	23.68	20.67
2029	21.23	18.54	18.46	16.13	23.94	20.90
2030	21.38	18.66	18.51	16.18	24.20	21.12

Source: Energy Commission's California Energy Demand 2016-2026, Revised Electricity Forecast, Table 6 (CEC-200-2016-001-V1, p. 35)

Compliance Cost

The compliance cost sensitivity analysis considers a high and low incremental cost to manufacturers of regulated products. The high compliance cost scenario assumes the same incremental cost as the more stringent alternative (Table 3). The low compliance cost scenario assumes that the incremental cost declines by 5 percent per year from the assumed proposal cost in 2018.

Market Growth

Market growth rates for new products are subject to a great deal of uncertainty based on consumer preferences, changing technologies, and macroeconomic conditions. We assess the possibility that growth rates might deviate from the base assumption for the proposed regulation. A high and low growth rate adder of +/- 0.75 percentage points is applied for new purchases in each product category.

Appendix C: Annual Macro Results

The following tables show variables reported as differences from the baseline scenario.

Table C.1 Gross State Product at Factor Cost (2013 M$, difference from baseline)

		2018	2019	2020	2021	2022	2023	2024	2025	2030
Proposal		-326	-207	-87	25	139	226	303	374	636
Sensitivity: Electricity Price	High	-324	-201	-79	38	156	246	325	398	674
	Low	-328	-212	-98	11	120	204	279	347	596
Sensitivity: Compliance Cost	High	-333	-216	-99	10	121	205	279	347	592
	Low	-326	-205	-84	31	147	238	318	394	685
Sensitivity: Market Growth	High	-326	-205	-84	30	146	236	314	386	655
	Low	-326	-208	-90	21	132	217	292	362	619
More Stringent Alternative		-331	-213	-94	18	130	217	291	360	611
Less Stringent Alternative		-320	-207	-94	11	117	205	284	358	634

Source: BEAR Model

Table C.2 Employment (FTE Jobs, difference from baseline)

-	-	2018	2019	2020	2021	2022	2023	2024	2025	2030
Proposal		-6633	-4926	-3261	-1769	-273	776	1662	2478	5525
Sensitivity: Electricity Price	High	-6593	-4842	-3127	-1582	-32	1039	1939	2769	5878
	Low	-6672	-5019	-3420	-1985	-547	481	1357	2163	5162
Sensitivity: Compliance Cost	High	-6686	-4994	-3342	-1863	-380	655	1529	2333	5325
	Low	-6633	-4915	-3237	-1729	-215	852	1760	2598	5769
Sensitivity: Market Growth	High	-6619	-4886	-3190	-1664	-131	966	1868	2699	5812
	Low	-6646	-4965	-3329	-1868	-407	599	1473	2278	5272
More Stringent Alternative		-6660	-4940	-3261	-1755	-247	807	1684	2489	5490
Less Stringent Alternative		-6684	-5142	-3644	-2309	-969	77	991	1834	4998

Source: BEAR Model

Table C.3 Real Output (2013 M$, difference from baseline)

-	-	2018	2019	2020	2021	2022	2023	2024	2025	2030
Proposal		-398	-207	-20	159	334	486	624	750	1189
Sensitivity: Electricity Price	High	-396	-203	-13	169	347	502	643	773	1227
	Low	-400	-212	-28	148	318	467	603	726	1148
Sensitivity: Compliance Cost	High	-411	-224	-42	133	303	450	583	705	1118
	Low	-398	-204	-14	170	349	508	652	786	1273
Sensitivity: Market Growth	High	-400	-208	-21	159	334	488	626	753	1195
	Low	-397	-206	-19	159	333	484	622	748	1184
More Stringent Alternative		-410	-221	-37	139	310	460	594	717	1138
Less Stringent Alternative		-372	-179	8	188	362	518	661	792	1254

Source: BEAR Model

Table C.4 Real Investment (2013 M$, difference from baseline)

-	-	2018	2019	2020	2021	2022	2023	2024	2025	2030
Proposal		161	167	175	185	192	187	179	170	124
Sensitivity: Electricity Price	High	162	170	179	191	200	196	188	180	137
	Low	159	165	170	178	183	177	168	159	111
Sensitivity: Compliance Cost	High	154	160	167	177	183	178	169	160	113
	Low	161	169	177	189	197	194	187	180	141
Sensitivity: Market Growth	High	160	168	176	187	195	192	184	176	132
	Low	161	167	174	183	189	182	174	165	117
More Stringent Alternative		155	162	170	180	188	183	175	166	119
Less Stringent Alternative		171	173	175	180	181	175	168	160	116

Source: BEAR Model

Table C.5 Household Relative Real Income (2013 M$, difference from baseline)

_	_	2018	2019	2020	2021	2022	2023	2024	2025	2030
Proposal		-367	-209	-56	87	225	317	391	457	652
Sensitivity: Electricity Price	High	-363	-201	-42	106	250	345	422	489	697
	Low	-371	-218	-71	65	196	286	358	422	606
Sensitivity: Compliance Cost	High	-378	-223	-71	70	205	296	368	431	616
	Low	-367	-207	-51	95	236	332	410	479	699
Sensitivity: Market Growth	High	-367	-207	-50	95	237	334	410	478	683
	Low	-367	-211	-60	79	213	301	374	438	625
More Stringent Alternative		-376	-218	-63	81	219	312	385	449	637
Less Stringent Alternative		-354	-212	-74	53	174	265	341	408	613

Source: BEAR Model

Table C.6 Electric Power Sector GHG Emissions (million tCO2e, difference from baseline)

-	-	2018	2019	2020	2021	2022	2023	2024	2025	2030
Proposal		-0.0066	-0.0210	-0.0376	-0.0552	-0.0739	-0.0785	-0.0796	-0.0810	-0.0938
Sensitivity: Electricity Price	High	-0.0078	-0.0237	-0.0421	-0.0619	-0.0831	-0.0889	-0.0909	-0.0933	-0.1122
	Low	-0.0054	-0.0180	-0.0322	-0.0474	-0.0635	-0.0669	-0.0672	-0.0677	-0.0752
Sensitivity: Compliance Cost	High	-0.0056	-0.0201	-0.0368	-0.0545	-0.0734	-0.0782	-0.0793	-0.0808	-0.0944
	Low	-0.0066	-0.0212	-0.0380	-0.0557	-0.0746	-0.0793	-0.0804	-0.0818	-0.0944
Sensitivity: Market Growth	High	-0.0071	-0.0225	-0.0405	-0.0597	-0.0804	-0.0876	-0.0899	-0.0927	-0.1144
	Low	-0.0060	-0.0194	-0.0348	-0.0509	-0.0679	-0.0702	-0.0701	-0.0703	-0.0757
More Stringent Alternative		-0.0064	-0.0218	-0.0396	-0.0584	-0.0785	-0.0841	-0.0856	-0.0873	-0.1025
Less Stringent Alternative		-0.0033	-0.0105	-0.0192	-0.0283	-0.0379	-0.0395	-0.0386	-0.0380	-0.0392

Source: BEAR Model

Table C.7: Electric Power Sector SOx Emissions (thousand metric tons, difference from baseline)

-	-	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2030**
Proposal		-0.0002	-0.0006	-0.0010	-0.0015	-0.0021	-0.0022	-0.0022	-0.0023	-0.0026
Sensitivity: Electricity Price	High	-0.0002	-0.0007	-0.0012	-0.0017	-0.0023	-0.0025	-0.0025	-0.0026	-0.0031
	Low	-0.0001	-0.0005	-0.0009	-0.0013	-0.0018	-0.0019	-0.0019	-0.0019	-0.0021
Sensitivity: Compliance Cost	High	-0.0001	-0.0006	-0.0010	-0.0015	-0.0020	-0.0022	-0.0022	-0.0022	-0.0026
	Low	-0.0002	-0.0006	-0.0011	-0.0015	-0.0021	-0.0022	-0.0022	-0.0023	-0.0026
Sensitivity: Market Growth	High	-0.0002	-0.0006	-0.0011	-0.0017	-0.0022	-0.0024	-0.0025	-0.0026	-0.0032
	Low	-0.0002	-0.0005	-0.0010	-0.0014	-0.0019	-0.0020	-0.0019	-0.0020	-0.0021
More Stringent Alternative		-0.0002	-0.0006	-0.0011	-0.0016	-0.0022	-0.0023	-0.0024	-0.0024	-0.0029
Less Stringent Alternative		-0.0001	-0.0003	-0.0005	-0.0008	-0.0010	-0.0011	-0.0011	-0.0010	-0.0011

Source: BEAR Model

Table C.8: Electric Power Sector NOx Emissions (thousand metric tons, difference from baseline)

-	-	2018	2019	2020	2021	2022	2023	2024	2025	2030
Proposal		-0.0011	-0.0036	-0.0065	-0.0096	-0.0129	-0.0137	-0.0139	-0.0141	-0.0164
Sensitivity: Electricity Price	High	-0.0013	-0.0041	-0.0073	-0.0108	-0.0145	-0.0155	-0.0159	-0.0163	-0.0196
	Low	-0.0009	-0.0031	-0.0056	-0.0082	-0.0111	-0.0117	-0.0117	-0.0118	-0.0131
Sensitivity: Compliance Cost	High	-0.0009	-0.0035	-0.0064	-0.0095	-0.0128	-0.0136	-0.0138	-0.0141	-0.0165
	Low	-0.0011	-0.0037	-0.0066	-0.0097	-0.0130	-0.0138	-0.0140	-0.0143	-0.0165
Sensitivity: Market Growth	High	-0.0012	-0.0039	-0.0070	-0.0104	-0.0140	-0.0153	-0.0157	-0.0162	-0.0200
	Low	-0.0010	-0.0034	-0.0060	-0.0089	-0.0118	-0.0122	-0.0122	-0.0122	-0.0132
More Stringent Alternative		-0.0011	-0.0038	-0.0069	-0.0102	-0.0137	-0.0147	-0.0149	-0.0152	-0.0179
Less Stringent Alternative		-0.0005	-0.0018	-0.0033	-0.0049	-0.0066	-0.0068	-0.0067	-0.0066	-0.0067

Source: BEAR Model

Table C.9: Electric Power Sector VOC Emissions (thousand metric tons, difference from baseline)

_	_	2018	2019	2020	2021	2022	2023	2024	2025	2030
Proposal		-0.0001	-0.0004	-0.0008	-0.0011	-0.0015	-0.0016	-0.0016	-0.0017	-0.0019
Sensitivity: Electricity Price	High	-0.0002	-0.0005	-0.0009	-0.0013	-0.0017	-0.0018	-0.0019	-0.0019	-0.0023
	Low	-0.0001	-0.0004	-0.0007	-0.0010	-0.0013	-0.0014	-0.0014	-0.0014	-0.0015
Sensitivity: Compliance Cost	High	-0.0001	-0.0004	-0.0008	-0.0011	-0.0015	-0.0016	-0.0016	-0.0017	-0.0019
	Low	-0.0001	-0.0004	-0.0008	-0.0011	-0.0015	-0.0016	-0.0017	-0.0017	-0.0019
Sensitivity: Market Growth	High	-0.0001	-0.0005	-0.0008	-0.0012	-0.0017	-0.0018	-0.0018	-0.0019	-0.0024
	Low	-0.0001	-0.0004	-0.0007	-0.0010	-0.0014	-0.0014	-0.0014	-0.0014	-0.0016
More Stringent Alternative		-0.0001	-0.0004	-0.0008	-0.0012	-0.0016	-0.0017	-0.0018	-0.0018	-0.0021
Less Stringent Alternative		-0.0001	-0.0002	-0.0004	-0.0006	-0.0008	-0.0008	-0.0008	-0.0008	-0.0008

Source: BEAR Model

Table C.10: Electric Power Sector CO Emissions (thousand metric tons, difference from baseline)

-	-	2018	2019	2020	2021	2022	2023	2024	2025	2030
Proposal		-0.0022	-0.0071	-0.0128	-0.0188	-0.0253	-0.0268	-0.0272	-0.0276	-0.0320
Sensitivity: Electricity Price	High	-0.0026	-0.0080	-0.0143	-0.0211	-0.0284	-0.0304	-0.0311	-0.0319	-0.0384
	Low	-0.0018	-0.0061	-0.0109	-0.0161	-0.0217	-0.0228	-0.0229	-0.0231	-0.0256
Sensitivity: Compliance Cost	High	-0.0018	-0.0068	-0.0125	-0.0186	-0.0251	-0.0267	-0.0271	-0.0276	-0.0322
	Low	-0.0022	-0.0072	-0.0129	-0.0190	-0.0255	-0.0271	-0.0275	-0.0279	-0.0323
Sensitivity: Market Growth	High	-0.0024	-0.0076	-0.0138	-0.0203	-0.0275	-0.0299	-0.0307	-0.0317	-0.0392
	Low	-0.0020	-0.0066	-0.0118	-0.0173	-0.0232	-0.0239	-0.0239	-0.0240	-0.0258
More Stringent Alternative		-0.0021	-0.0074	-0.0135	-0.0199	-0.0268	-0.0287	-0.0292	-0.0298	-0.0350
Less Stringent Alternative		-0.0011	-0.0035	-0.0065	-0.0096	-0.0129	-0.0134	-0.0131	-0.0128	-0.0132

Source: BEAR Model

Table C.11: Electric Power Sector PM 2.5 Emissions (thousand metric tons, difference from baseline)

-	-	2018	2019	2020	2021	2022	2023	2024	2025	2030
Proposal		-0.0002	-0.0007	-0.0013	-0.0019	-0.0026	-0.0027	-0.0027	-0.0028	-0.0032
Sensitivity: Electricity Price	High	-0.0003	-0.0008	-0.0014	-0.0021	-0.0029	-0.0031	-0.0031	-0.0032	-0.0039
	Low	-0.0002	-0.0006	-0.0011	-0.0016	-0.0022	-0.0023	-0.0023	-0.0023	-0.0026
Sensitivity: Compliance Cost	High	-0.0002	-0.0007	-0.0013	-0.0019	-0.0025	-0.0027	-0.0027	-0.0028	-0.0033
	Low	-0.0002	-0.0007	-0.0013	-0.0019	-0.0026	-0.0027	-0.0028	-0.0028	-0.0033
Sensitivity: Market Growth	High	-0.0002	-0.0008	-0.0014	-0.0021	-0.0028	-0.0030	-0.0031	-0.0032	-0.0040
	Low	-0.0002	-0.0007	-0.0012	-0.0018	-0.0023	-0.0024	-0.0024	-0.0024	-0.0026
More Stringent Alternative		-0.0002	-0.0007	-0.0014	-0.0020	-0.0027	-0.0029	-0.0030	-0.0030	-0.0035
Less Stringent Alternative		-0.0001	-0.0004	-0.0007	-0.0010	-0.0013	-0.0014	-0.0013	-0.0013	-0.0013

Source: BEAR Model

The following tables show levels of the baseline, proposal and alternate scenarios.

Table C.12: Real GDP at Factor Cost (2013 M$)

-	-	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2030**
Baseline		2,590,770	2,707,691	2,829,537	2,956,866	3,089,925	3,228,972	3,374,276	3,526,118	4,394,185
Proposal		2,590,444	2,707,484	2,829,450	2,956,892	3,090,064	3,229,198	3,374,578	3,526,492	4,394,821
Sensitivity: Electricity Price	High	2,590,446	2,707,490	2,829,458	2,956,904	3,090,081	3,229,217	3,374,600	3,526,516	4,394,858
	Low	2,590,441	2,707,479	2,829,439	2,956,877	3,090,045	3,229,176	3,374,554	3,526,465	4,394,781
Sensitivity: Compliance Cost	High	2,590,437	2,707,475	2,829,438	2,956,877	3,090,046	3,229,177	3,374,555	3,526,465	4,394,777
	Low	2,590,444	2,707,486	2,829,453	2,956,897	3,090,072	3,229,210	3,374,594	3,526,512	4,394,870
Sensitivity: Market Growth	High	2,590,444	2,707,486	2,829,453	2,956,896	3,090,071	3,229,208	3,374,590	3,526,504	4,394,840
	Low	2,590,443	2,707,483	2,829,447	2,956,887	3,090,057	3,229,189	3,374,568	3,526,480	4,394,803
More Stringent Alternative		2,590,438	2,707,478	2,829,443	2,956,884	3,090,056	3,229,189	3,374,567	3,526,478	4,394,795
Less Stringent Alternative -		2,590,449	2,707,484	2,829,443	2,956,878	3,090,042	3,229,177	3,374,560	3,526,476	4,394,818

Source: BEAR Model

Table C.13: Employment (FTE Jobs)

-	-	2018	2019	2020	2021	2022	2023	2024	2025	2030
Baseline		18,818,315	19,312,734	19,822,601	20,348,181	20,889,318	21,445,663	22,016,876	22,602,616	25,738,625
Proposal		18,811,683	19,307,807	19,819,339	20,346,412	20,889,045	21,446,439	22,018,538	22,605,095	25,744,150
Sensitivity: Electricity Price	High	18,811,723	19,307,892	19,819,473	20,346,599	20,889,286	21,446,702	22,018,815	22,605,385	25,744,504
	Low	18,811,644	19,307,715	19,819,181	20,346,195	20,888,770	21,446,144	22,018,233	22,604,780	25,743,787
Sensitivity: Compliance Cost	High	18,811,629	19,307,740	19,819,258	20,346,318	20,888,937	21,446,318	22,018,405	22,604,950	25,743,950
	Low	18,811,683	19,307,818	19,819,364	20,346,452	20,889,102	21,446,515	22,018,636	22,605,214	25,744,394
Sensitivity: Market Growth	High	18,811,697	19,307,847	19,819,410	20,346,516	20,889,187	21,446,630	22,018,744	22,605,315	25,744,437
	Low	18,811,669	19,307,769	19,819,272	20,346,313	20,888,911	21,446,262	22,018,349	22,604,894	25,743,898
More Stringent Alternative		18,811,656	19,307,794	19,819,340	20,346,425	20,889,071	21,446,471	22,018,560	22,605,106	25,744,115
Less Stringent Alternative		18,811,632	19,307,592	19,818,957	20,345,871	20,888,348	21,445,741	22,017,867	22,604,450	25,743,623

Source: BEAR Model

Table C.14: Real GDP at Factor Cost (2013 M$) - Level Change from pervious year

_	_	2018	2019	2020	2021	2022	2023	2024	2025	2030
Baseline		_	116,921	121,846	127,329	133,059	139,047	145,304	151,842	173,613
Proposal		_	117,041	121,965	127,442	133,172	139,134	145,380	151,913	173,666
Sensitivity: Electricity Price	High	_	117,044	121,969	127,446	133,177	139,137	145,383	151,916	173,669
	Low	_	117,037	121,961	127,438	133,168	139,131	145,378	151,911	173,663
Sensitivity: Compliance Cost	High	_	117,038	121,963	127,439	133,170	139,131	145,377	151,910	173,662
	Low	_	117,042	121,967	127,444	133,175	139,137	145,384	151,918	173,672
Sensitivity: Market Growth	High	_	117,042	121,967	127,444	133,175	139,137	145,382	151,915	173,667
	Low	_	117,040	121,964	127,440	133,170	139,131	145,379	151,912	173,665
More Stringent Alternative		_	117,040	121,965	127,441	133,172	139,133	145,378	151,911	173,663
Less Stringent Alternative		_	117,035	121,959	127,435	133,165	139,135	145,383	151,916	173,669

Source: BEAR Model

Table C.15: Employment (FTE Jobs) - Change in total employment from previous year

_	_	2018	2019	2020	2021	2022	2023	2024	2025	2030
Baseline		_	494,418	509,867	525,580	541,137	556,346	571,213	585,741	627,202
Proposal		_	496,125	511,532	527,073	542,633	557,394	572,100	586,557	627,811
Sensitivity: Electricity Price	High	_	496,169	511,581	527,125	542,688	557,416	572,113	586,570	627,824
	Low	_	496,071	511,466	527,015	542,575	557,374	572,089	586,546	627,801
Sensitivity: Compliance Cost	High	_	496,111	511,518	527,059	542,620	557,381	572,087	586,544	627,800
	Low	_	496,136	511,545	527,088	542,650	557,413	572,120	586,579	627,836
Sensitivity: Market Growth	High	_	496,151	511,563	527,106	542,670	557,443	572,115	586,571	627,824
	Low	_	496,100	511,503	527,041	542,598	557,351	572,087	586,545	627,801
More Stringent Alternative		_	496,138	511,546	527,085	542,646	557,400	572,089	586,546	627,802
Less Stringent Alternative		_	495,961	511,365	526,915	542,477	557,392	572,127	586,583	627,834

Source: BEAR Model