**Work Paper WPSDGEREHE0004**

**Revision 1.1**

**San Diego Gas & Electric**

**Energy Efficiency Engineering**

**Tier 2 Audio Visual (AV) Advanced Power Strip**

**At-a-Glance Summary**

|  |  |
| --- | --- |
| **Measure Codes** | PG&E: PG023  SCE: CE- 56727  SDG&E: TBD |
| **Measure Description** | Tier 2 Audio Visual (AV) Advanced Power Strip |
| **Base Case Description** | Standard power strip |
| **Units** | Each |
| **Energy Savings** | Refer to Ex-Ante Database |
| **Full Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Incremental Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Effective Useful Life** | Res-Plug-AdvPwrStrip |
| **Measure Installation Type** | Retrofit Add-On (REA) |
| **Net-to-Gross Ratio** | All-Default<=2yrs  ET-Default |
| **Important Comments** | This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). |

**Revision History**

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| 0 | 04/21/2015 | Martin Vu/RMS Energy Consulting, LLC | Original work paper template for 2015 |
| 0 Dot Rev1 | 4/28/2015 | Peter Ford, SDG&E | Minor language changes to WP per meeting on 4/21/2015 (Reynoso, Madison, Ford, Smith, and Vu). WP Revision to remain as “0” and the 0.1 designation is provided to denote a minor change only and is disregarded in ex-ante data. |
| 0 Dot Rev 2 | 7/22/2015 | Martin Vu/RMS Energy Consulting, LLC | WP Revision to remain as “0” and the 0.2 designation is provided to denote a minor change only and is disregarded in ex-ante data.   * Added 2013 California Fire Code (605.4) to measure requirements * Additional detail on EUL * Updated the Net-to-Gross section   Updated measure cost for downstream, midstream, and upstream delivery channels |
| 0 Dot Rev 3 | 8/25/2015 | Martin Vu/RMS Energy Consulting, LLC | WP Revision to remain as “0” and the 0.3 designation is provided to denote a minor change only and is disregarded in ex-ante data.   * EUL was revised from 8 years down to 5 years based on analysis performed by CALTF staff. * Energy savings was revised from 246 kWh down to 212 kWh using a weighted average approach to consider the 9 operational mode samples with the 33 log mode samples. * Peak demand reduction was proportional reduced from 34.6W down to 31.3W based on the inclusion of the 9 operational samples.   Reference to ongoing measurement and verification during program deployment is included. |
| 1 | 09/21/2016  10/03/2016 | Martin Vu/RMS Energy Consulting, LLC  QC SDGE | WP Includes June 10, 2016 Disposition on averaging savings for infrared and infrared/occupancy sensor based on the final results of the PG&E ET Phase 2 Study (Report ET13PGE1441) |
| 1 Dot Rev 1 | 08/10/2017 | Jia Huang, PG&E  Kelvin Valenzuela, SDG&E | WP Revision to remain as “1” and the 1.1 designation is provided to denote a minor change only and is disregarded in ex-ante data.   * Removed requirement for Tier 2 APS products to undergo field trials. * Revised active mode power consumption requirement to average power draw of 1 watt and 2 watts for products with wireless connectivity. |

**Commission Staff and Cal TF Comments**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
| 0 | CS | 6/2/15 | 8/27/15 |  | * Adopted CPUC Staff Approved Ex Ante Values |
| 0 | CS | 6/2/15 | 6/15/15 |  | * Adopted CPUC Staff Response to Early Opinion Request on Proposed Revisions to WPSDGEREHE0004 Revision 0.3. |

# Section 1. General Measure & Baseline Data

## 1.1 Measure & Delivery Description

This work paper details the replacement of a standard power strip with a new Tier 2 Advanced Power Strip (APS) in residential audio visual (AV) home entertainment environments. **Table 1** describes the measure name and associated product or solution code for each of the program administrators.

Table 1 Measure Names

|  |  |  |
| --- | --- | --- |
| Program Administrator | Product/Solution Code | Measure Name |
| PG&E | PG023 | Tier 2 AV Advanced Power Strip |
| SCE | CE- 56727 | Tier 2 Advanced Power Strip |
| SDG&E | TBD | Tier 2 AV Advanced Power Strip |

### 1.1a Measure Description

This work paper documents the cost-effectiveness parameters for a Tier 2 AV APS that can monitor and control the energy use of various plug load devices in residential home entertainment systems, which consist of equipment such as televisions, stereo systems, and DVD players without requiring any user interference to achieve energy efficiency gains.

Although it is recognized that game consoles represent a significant amount of energy consumption for plug devices found in residential AV environments, this workpaper does not account for game consoles in its energy savings calculations. However, when more field trials and studies are made available, the workpaper may be updated at that time to consider game consoles into the energy savings estimates.

**1.1b Measure Eligibility Requirements**

Tier 2 AV APS Minimum Product Specifications:

* + Feature a resettable circuit breaker;
  + Incorporate power switching electromechanical relays rated for 100,000 switching cycles at full 15 amp load (equivalent to over 10 years of use);
  + Average active/ON mode power consumption must not exceed 1.0 watt for Tier 2 APS devices without external communication capability via a wireless networked connectivity system\* when controlled devices are active. Average active/ON mode power consumption must not exceed 2.0 watts for devices with external communication capability via a wireless networked connectivity system\* when controlled devices are active.

\*External communication capability includes the incorporation of wireless network communication elements into the Tier 2 APS, including, but not limited to WiFi, IrDA, GPRS/cell modem, Z-wave, Zigbee, and Bluetooth/BLE communication interface capabilities which are provided to the end user and intended for typical Tier 2 APS device usage.

* + Sense total power being consumed by all controlled devices or sense total power consumed by the device plugged into the controlled outlet;
  + Sense IR or IR and Motion;
  + Sense true RMS power to determine device usage of AV equipment;
  + Hardware and/or software IR filtering technology and firmware to filter out rogue non AV equipment IR interference from compact fluorescent lights and sunlight;
  + Provide adjustable Idle Mode capability with a potential minimum setting of 1 hour;
  + Deliver a minimum ten minute count down Idle Mode warning to avoid nuisance switching;
  + Use an automatically adjustable power switching threshold
  + Must comply with the 2016 California Fire Code (605.4)

### 1.1c Program Implementation and Installation Requirements

To ensure energy savings are achieved for each installation, utility Tier 2 AV APS direct install programs should require that a valid installation control at least 2 AV devices with one being the television. Given this requirement, an AV environment consisting of a television and DVD player would be eligible for a Tier 2 AV APS installation.

## 1.2 Technical Description

Tier 2 APS use an external sensor paired with a configurable countdown timer to manage both active and standby power loads for controlled devices in a complete system. Tier 2 APS may operate either with or without a master control socket. Those without a master control socket sense power of all devices connected to the controlled sockets. Those with a master control socket sense power for the device connected to the control socket.

The external sensor of a Tier 2 APS may utilize an infrared-only sensor, or it may utilize a “multi-sensor” which detects both infrared (IR) remote control signals and motion to determine device inactivity and deliver additional savings as compared to a Tier 1 APS device. Both versions of external sensor use IR filtering to prevent inappropriate switching events which may have otherwise resulted from natural interference such as sunlight or CFL light bulbs.

## 1.3 Installation Types and Delivery Mechanisms

The installation type for this measure is retrofit add-on (REA).

**Installation Type Descriptions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Retrofit Add-on (REA) | Above Customer Existing | N/A | EUL | N/A |

A delivery mechanism is a delivery method paired with an incentive method. Delivery mechanisms are used by programs to obtain program participation and energy savings. The applicable incentive delivery methods are as follows:

* Financial Support / Direct Install

**Delivery Method Descriptions**

|  |  |
| --- | --- |
| **Delivery Method** | **Description** |
| Financial Support | The program motivates customers, through financial incentives such as rebates or low interest loans, to implement energy efficient measures or projects. |

**Incentive Method Descriptions**

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| Direct Install | The program implements energy efficiency measures for qualifying customers, at no cost to the customer. |

**1.4 Measure Parameters**

**1.4.1 DEER Data**

**DEER Difference Summary**

|  |  |
| --- | --- |
| **DEER Item** | **Used for Workpaper?** |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | No |
| DEER Measure Case | No |
| DEER Building Types | Yes |
| DEER Operating Hours | No |
| DEER eQUEST Prototypes | No |
| DEER Version | DEER 2016 READi v 2.4.6 |
| Reason for Deviation from DEER | DEER does not contain this home office or home entertainment center power strip measure. |
| DEER Measure IDs Used | N/A |

**Net-to-Gross Ratio**

The NTG values were obtained using the DEER READI tool. Due to the timing of the workpaper submittal, the measures in this workpaper are still considered emerging and are eligible for the ET NTG values from 1/1/2017 to 12/31/2017. Beginning 1/1/2018, the NTG will be changed to Res-Default>2 years. See table below the NTG values through 2017 and thereafter.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| Default>2yrs | All other EEM with no evaluated NTGR; existing EEM with same delivery mechanism for more than 2 years | Any | Any | Any | 0.55 |
| ET-Default | Emerging Technologies approved by ED through work paper review | Any | Any | Any | 0.85 |

**Spillage Rate**

Spillage rates are not tracked in work papers; they are tracked in an external document which will be supplied to the Commission Staff.

**Installation Rate**

The IR values were obtained using the DEER 2016 READI tool version 2.4.6. The relevant IR values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| Def-GSIA | Default GSIA values | Any | Any | Any | 1 |

**Effective and Remaining Useful Life**

The EUL and RUL values were obtained using the DEER 2016 READI tool version 2.4.6. DEER defines the RUL as 1/3 of the EUL value. The RUL value is only applicable to the first baseline period for an RET measure with an applicable code baseline. The relevant EUL and RUL values for the measures in this work paper are in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** |
| Res-Plug-AdvPwrStrip | Tier 2 Advance Power Strip | Res | AppPlug |

**1.4.2 Codes and Standards Analysis**

There are no federal, state, or regional code requirements that apply to this measure.

**Code Summary**

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 24 (2013) | N/A | July 1, 2014 |
| Title 20 (2014) | N/A | July 1, 2014 |
| Federal Standards | N/A | N/A |

# Section 2. Energy Savings & Demand Reduction Calculations

## 2.1 Energy Savings & Demand Reduction Calculations

### Energy Savings Calculation Methodology

#### June 10, 2016 CPUC Staff Response to Early Opinion Request on Proposed Revisions to WPSDGEREHE0004 Revision 0.3 Tier 2 Advanced Power Strips

The IOUs have completed two phases of research on Tier 2 Advanced Power Strips (T2APS) where they investigated two types of devices, one that uses an utilizes remote control infrared signals only (IR-T2APS) and one that uses infrared remote control and occupancy sensor signals (IROS-T2APS). The investigations show that the savings from each technology may be different for similar types and quantities of controlled audio and video equipment. SDG&E has proposed to use a single average savings value for both devices and has asked CPUC staff for an opinion on this approach. CPUC staff recommends that SDG&E revise the savings values for T2APS to be the average of the approved values for the two available technologies, resulting in savings values of 130 kWh and 0.018 kW.

1. **Final Approved Savings Values for Tier 2 Advanced Power Strips Using Infrared Signal Control**

There is currently an approved workpaper for Tier 2 Advanced Power Strips (T2APS) which includes approved savings and other cost-effectiveness values for devices that utilize infrared (IR) signals from audio video (AV) remote control units as the primary input signal to determine if AV equipment is in use or left on while not being used. The initial research used to estimate savings for these IR T2APS performed by AESC included two types of field monitoring: a savings “simulation” approach and a pre-post evaluation. The simulation approach included 56 installations, while the pre-post was performed on a subset of 9 installations in the simulation approach.

The pre-post results showed significantly lower savings than the simulation approach. The AESC study included analysis that showed if the simulated savings were reduced uniformly by the same amount indicated for the 9 pre-post sites, simulated savings would drop from 246 to 149 kWh per APS. The EAR team acknowledged that 9 data points was a small number to use for a uniform adjustment to the simulated savings. In consideration, the EAR team allowed a lower downward adjustment from 246 to 212 kWh per APS. However, the EAR team also directed SDG&E to perform additional pre-post research on the IR T2APS understanding that savings values would be adjusted again once that research was completed.

SDG&E and PG&E engaged AESC for a second round of field research. The work plan presented to CPUC staff covered research on another type of T2APS that included both IR and occupancy sensor (OS) signals to determine if AV equipment is in use or left on while not being used. The critical items to be investigated in this second round of research included:

Continued savings simulation on IR T2APS

* Pre-post data collection and savings analysis on additional IR T2APS
* Simulation and pre-post data collection and savings analysis on IR OS T2APS.

When the draft report was made available in late 2015, it became apparent to CPUC staff and the EAR team that the second phase of research had not performed any pre-post data collection (and therefore no savings analysis) on the IR T2APS which was a specific condition for the approval of the value of 212 kWh per installation for the originally submitted workpaper. Since this research was not performed, CPUC staff directs the savings value for IR T2APS to be revised from the currently approved value of 212 kWh per installation down to 149 kWh per installation, which is the value developed in the first phase AESC report when applying the results of the pre-post analysis to the entire number of sites in the investigation. The first AESC report did not include an analysis of the pre-post demand savings, however the phase 2 report estimates that simulated and pre-post demand savings are nearly identical. Therefore CPUC staff directs the demand savings for IR T2APS to be 0.025 kW, which is the result published in the phase 2 report based on the pre-post analysis.

1. **Final Approved Savings Values for Tier 2 Advanced Power Strips Using Infrared Plus Occupancy Sensor Signal Control**

As described above, the second phase of research performed by AESC included both simulation and pre-post data collection and savings analysis. The simulated savings values were 118 kWh and 0.016 kW while the pre-post study resulted in 110 kWh and 0.010 kW per installation. To be consistent with direction for IR T2APS, CPUC staff directs that savings for IR OS T2APS to be set at 110 kWh and 0.010 kW.

1. **Use of Technology Specific Savings Values Versus a Single Value**

At this time SDG&E only offers incentives on IR T2APS. SDG&E plans to add IR OS T2APS to its programs. SDG&E recently proposed to the CPUC to use a single set of average savings values that would apply to both product types even though the phase 1 and 2 AESC research yielded different savings values for each product. SDG&E solicited input from the California Technical Forum (CalTF) on the question of claiming different savings values for each technology or a single average value for all technologies.

Based on a review of the published CalTF meeting notes, there were diverse opinions with many CalTF members advocating for separate savings values for each technology. It does not appear from the meeting notes that the CalTF reached a consensus on which approach to recommend.

As discussed above, CPUC staff is concerned that the AESC phase 2 research did not include a pre-post investigation of IR T2APS even though the phase 1 investigation indicated significantly lower savings than the simulation mode. CPUC staff is reluctant to direct higher savings values for one technology type over another for measures that serve fundamentally the same purpose. For example, HVAC manufacturers incorporate different technologies to achieve high SEER ratings for air conditioners, but there is only one set of approved savings values that apply to all air conditioners of one particular SEER rating. For these reasons, CPUC staff recommends that SDG&E revise the savings values for T2APS to be the average of the approved values, discussed above, for the two available technologies. This will result in savings values of 130 kWh and 0.018 kW.

1. **Summary**

The IOUs have completed two phases of research on Tier 2 Advanced Power Strips (T2APS) where they investigated two types of devices, one that uses an utilizes remote control infrared signals only (IR-T2APS) and one that uses infrared remote control and occupancy sensor signals (IROS-T2APS). The investigations show that the savings from each technology may be different for similar types and quantities of controlled audio and video equipment. SDG&E has proposed to use a single average savings value for both devices and has asked CPUC staff for an opinion on this approach. CPUC staff recommends that SDG&E revise the savings values for T2APS to be the average of the approved values for the two available technologies, resulting in savings values of 130 kWh and 0.018 kW.

1. **Final Approved Savings Values for Tier 2 Advanced Power Strips Using Infrared Signal Control**

There is currently an approved workpaper for Tier 2 Advanced Power Strips (T2APS) which includes approved savings and other cost-effectiveness values for devices that utilize infrared (IR) signals from audio video (AV) remote control units as the primary input signal to determine if AV equipment is in use or left on while not being used. The initial research used to estimate savings for these IR T2APS performed by AESC included two types of field monitoring: a savings “simulation” approach and a pre-post evaluation. The simulation approach included 56 installations, while the pre-post was performed on a subset of 9 installations in the simulation approach. The pre-post results showed significantly lower savings than the simulation approach.

The AESC study included analysis that showed if the simulated savings were reduced uniformly by the same amount indicated for the 9 pre-post sites, simulated savings would drop from 246 to 149 kWh per APS. The EAR team acknowledged that 9 data points was a small number to use for a uniform adjustment to the simulated savings. In consideration, the EAR team allowed a lower downward adjustment from 246 to 212 kWh per APS. However, the EAR team also directed SDG&E to perform additional pre-post research on the IR T2APS understanding that savings values would be adjusted again once that research was completed.

SDG&E and PG&E engaged AESC for a second round of field research. The work plan presented to CPUC staff covered research on another type of T2APS that included both IR and occupancy sensor (OS) signals to determine if AV equipment is in use or left on while not being used. The critical items to be investigated in this second round of research included:

* Continued savings simulation on IR T2APS
* Pre-post data collection and savings analysis on additional IR T2APS
* Simulation and pre-post data collection and savings analysis on IR OS T2APS.

When the draft report was made available in late 2015, it became apparent to CPUC staff and the EAR team that the second phase of research had not performed any pre-post data collection (and therefore no savings analysis) on the IR T2APS which was a specific condition for the approval of the value of 212 kWh per installation for the originally submitted workpaper.

Since this research was not performed, CPUC staff directs the savings value for IR T2APS to be revised from the currently approved value of 212 kWh per installation down to 149 kWh per installation, which is the value developed in the first phase AESC report when applying the results of the pre-post analysis to the entire number of sites in the investigation. The first AESC report did not include an analysis of the pre-post demand savings, however the phase 2 report estimates that simulated and pre-post demand savings are nearly identical. Therefore CPUC staff directs the demand savings for IR T2APS to be 0.025 kW, which is the result published in the phase 2 report based on the pre-post analysis.

1. **Final Approved Savings Values for Tier 2 Advanced Power Strips Using Infrared Plus Occupancy Sensor Signal Control**

As described above, the second phase of research performed by AESC included both simulation and pre-post data collection and savings analysis. The simulated savings values were 118 kWh and 0.016 kW while the pre-post study resulted in 110 kWh and 0.010 kW per installation. To be consistent with direction for IR T2APS, CPUC staff directs that savings for IR OS T2APS to be set at 110 kWh and 0.010 kW.

1. **Use of Technology Specific Savings Values Versus a Single Value**

At this time SDG&E only offers incentives on IR T2APS. SDG&E plans to add IR OS T2APS to its programs. SDG&E recently proposed to the CPUC to use a single set of average savings values that would apply to both product types even though the phase 1 and 2 AESC research yielded different savings values for each product. SDG&E solicited input from the California Technical Forum (CalTF) on the question of claiming different savings values for each technology or a single average value for all technologies. Based on a review of the published CalTF meeting notes, there were diverse opinions with many CalTF members advocating for separate savings values for each technology. It does not appear from the meeting notes that the CalTF reached a consensus on which approach to recommend.

As discussed above, CPUC staff is concerned that the AESC phase 2 research did not include a pre-post investigation of IR T2APS even though the phase 1 investigation indicated significantly lower savings than the simulation mode. CPUC staff is reluctant to direct higher savings values for one technology type over another for measures that serve fundamentally the same purpose. For example, HVAC manufacturers incorporate different technologies to achieve high SEER ratings for air conditioners, but there is only one set of approved savings values that apply to all air conditioners of one particular SEER rating. For these reasons, CPUC staff recommends that SDG&E revise the savings values for T2APS to be the average of the approved values, discussed above, for the two available technologies. This will result in savings values of 130 kWh and 0.018 kW.

***Energy Interactive Effects***

Tier 2 AV APS measures do have HVAC interactive effects, but DEER does not include energy interactive effects specifically for Tier 2 AV APS measures at this time. Thus, Tier 2 AV APS measures will use the DEER HVAC interactive effects values used in lighting power applications. Please refer to the ex-ante database for actual energy savings values.

***Peak Demand Reduction***

CPUC staff recommends that SDG&E revise the savings values for T2APS to be the average of the approved values, discussed above, for the two available technologies. This will result in savings values of 130 kWh and 0.018 kW. Interactive effects for 2017 were provided ahead of time by the EAR team to help estimate the savings values in specific locations and building types statewide for the upcoming year. The savings are included in a support table in the attachments.

#### Demand Interactive Effects and Diversity Factors

Tier 2 AV APS measures do have HVAC demand interactive effects, but DEER does not include demand interactive effects specifically for Tier 2 AV APS measures at this time. Thus, Tier 2 AV APS measures will use the DEER HVAC demand interactive effects and coincident diversity factors used in lighting power applications. Please refer to the ex-ante database for actual peak demand reduction values.

## 2.2 Gas Energy Savings Estimation Methodologies

## Tier 2 AV APS measures do have HVAC negative therm interactive effects, but DEER does not include factors specifically for Tier 2 AV APS measures at this time. Thus, Tier 2 AV APS measures will use the DEER HVAC negative therm values used in lighting power applications. Please refer to the ex-ante database for actual negative therm interactive effect values.

# Section 3. Load Shapes

The ideal load shape for net benefits estimates would represent the difference between the base case and measure case. The CFL load shape was reviewed but because of the 24/7 operation of the equipment the closest load shapes that are applicable to the measures in this work paper are listed in the table below.

**Building Types and Load Shapes**

|  |  |
| --- | --- |
| **Building Type** | **Load Shape** |
| Residential | DEER:RefrgFrzr\_HighEff |
| Residential Mobile Home | DEER:RefrgFrzr\_HighEff |
| Residential Multi-family | DEER:RefrgFrzr\_HighEff |
| Residential Single Family | DEER:RefrgFrzr\_HighEff |

# Section 4. Base Case & Measure Costs

## 4.1 Base Case Cost

The assumed base case is a standard power strip. Therefore, for this measure category, the base case cost is assumed to be zero because these are discretionary modifications (retrofit add-on) to the customers’ existing equipment. The alternative is to make no changes to their existing system.

## 4.2 Gross Measure Cost

For retrofit add-on (REA) measures, the gross measure cost (GMC) is the full measure cost including the measure equipment cost and the measure labor cost. Per manufacturer cost quotes, the measure equipment cost for a Tier 2 AV APS is approximately $45. For the direct install delivery channel, labor rates may vary across different implementers. Please refer to the ex-ante tables for actual labor costs.

GMC is represented by the equation: GMC = Measure Equipment Cost

**Table 12 Measure Cost**

|  |  |
| --- | --- |
| **Measure** | **GMC ($/unit)** |
| Tier 2 AV APS Measure Equipment Cost | $45.00 |
| Labor Cost | See ex-ante database |
| Gross Measure Costs | $45.00 + DI labor cost |

## 4.3 Incremental Measure Cost

Incremental Measure Cost (IMC) is the premium cost to install an energy efficient measure over a standard efficiency measure or code baseline measure. For retrofit add-on measures, the IMC is equal to the gross measure cost, as there exists no base case from which to compare the measure.

# Attachments

