

HEALTH
IMPACTS OF RADIOFREQUENCY
FROM SMART METERS

JANUARY 2011



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ACKNOWLEDGMENTS

We would like to thank the many people who provided input and completion of this report. Without the insight and feedback that provided, this report could not have been completed. We thank the California Smart Grid Center, College of Engineering and Computer Science, Sacramento State University, and California Center for Information Technology Research in the Interest of Society (CITRIS).

This report was conducted with the oversight of a CCST Steering Committee members include: Rollin Richmond (Chair), Emir Wright, Patrick McCarthy, Jang, David Winickoff, and Barry Papay. We also thank J.D. Stack for technical contributions and Lora Lee Martin for the overall coordination. We express gratitude to CCST's members and colleagues for their report.

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ISBN 13: 978-0-981447-42-6

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Table of Contents

Letter from the CCST..... 3

Key report findings..... 4

Other considerations..... 4

Legislative request..... 6

Approach..... 6

Two types of radio frequency effects: Thermal and Non-Thermal..... 7

Findings..... 7

What are smart meters..... 9

Why are smart meters being deployed in California?..... 11

What health concerns are associated with smart meters?..... 13

FCC guidelines address known and potential effects..... 15

Power density (and exposure level) decreases rapidly..... 18

Comparison of electromagnetic frequencies from smart meters to other devices..... 19

What is the duty cycle and how does it affect human health?..... 22

What about exposure back to front meters and from just behind the wall of a single meter?..... 23

Is the FCC standard sufficient to protect public health?..... 23

Are additional standards needed?..... 23

Public information and education..... 24

Alternatives to wireless?..... 24

Key factors to consider when evaluating exposure from smart meters..... 25

Conclusion..... 26

Appendix A: Letters requesting assistance..... 27

- Assembly Member Huffmann's Letter..... 27
- Assembly Member Monning's Letter..... 29
- City of Merced Valley..... 30

Appendix B: Project Process..... 32

Appendix C: Project Team..... 34

Appendix D: Written Submission Authors..... 37

Appendix E: Witnesses Consulted..... 38

Appendix F: Glossary..... 45

Appendix G: 2010 Board Members..... 47

Appendix H: 2010 Council Members..... 48

Appendix I: Report Credits..... 49

Letter from CCST

With rapidly emerging and evolving technologies, lawmakers at this time to make policy decisions on complex technologies. Smart meters

Smart meters are being deployed in the world in an effort generation of utility service based on the concepts of a smart and cost effective.

The electric utility industry of 2000 and 2001 helped fund the issue of the significant urgency to the need for better management of power. In 2006, the California Public Utilities Commission authorized the Company to implement a relatively new technology, smart meters, to provide precise information about power usage throughout the state. Smart meters throughout the state is still underway.

As with any new technology, there are unknowns involved. Some people have expressed concerns of wireless signals, particularly as they become virtually invisible. have recently been brought to the attention of state legislators, opting to ban further installation of the smart meters in their communities.

We are pleased that Assembly Members Huffman and Monning on this issue. It is CCST's charge to state for government and to recommend solutions to state and industry. In this have assembled a succinct but comprehensive overview of what is exposure to wireless signals and the effects of these signals. do so, we assembled a project team that consulted with over through over a hundred articles and reports, providing a thorough relatively rapid manner.

In situations where public sentiment urges policy makers to make potentially long-term consequences, access to the best information possible the role that CCST was created to fulfill.

Susan Hackwood

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Health Impacts of Radio Frequency from Smart Meter Response to Assembly Members Huffman and Monning

California Council on Science and Technology
January 2011

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KEY REPORT FINDINGS
<p>1. Wireless smart meters installed per household, result in much smaller levels of radio frequency (RF) exposure than many existing electronic devices, particularly cell phones and microwaves ovens.</p> <p>2. The current FCC standard provides an adequate margin of safety for induced health impacts of existing common household electronic meters.</p> <p>3. To date, scientific studies have not identified or confirmed potential non-thermal impacts of RF emissions such as those produced by common household electronic devices and smart meters.</p> <p>4. Not enough is currently known about the potential of radio frequency emissions to identify or recommend additional standards.</p>

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OTHER CONSIDERATIONS
<p>Smart electricity meters are a key enabling technology for a become increasingly clean, efficient, reliable, and safe at a price consumer. The CCST Smart Meter offers the following for further consideration by policy makers, regulators, and utilities each of these considerations would likely require an analysis. However, we feel should be considered as cumulative exposure to RF emissions in environment continues to expand.</p> <p>1. As wireless technologies of all types increase in usage, it continue to quantitatively assess the levels of RF emissions from devices and smart meters to which the public may be investigate potential thermal and non-thermal impacts of such RF emissions health.</p> <p>2. Consumers should be provided with clearly understood information radiofrequency emissions of all devices that emit RF including information should include intensity of output, duration and in the cases of the smart meter, pattern of sending from all devices.</p> <p>3. The California Public Utilities Commission should undertake a review of the deployment of smart meters to determine if they consistent with the information provided to the consumer.</p> <p>4. Consideration could be given to alternative smart meter configurations in those cases where wireless meters continue to be cor</p>

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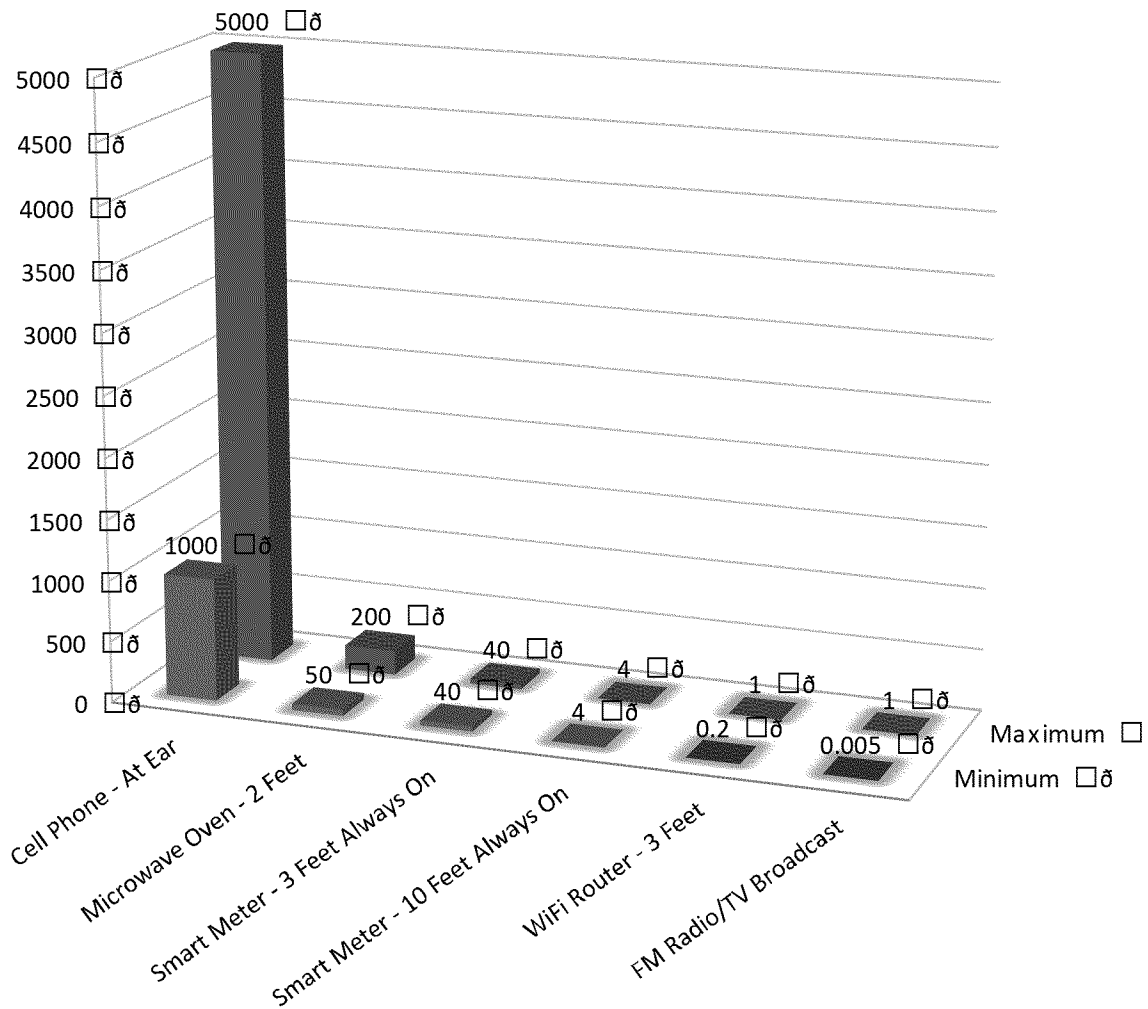


Figure 1. Comparison of Radio Frequency Levels from Various Sources in the Environment

Note: Exposure levels are based on a 100% duty cycle (i.e., always on) as indicated in the table. The values are converted from meter figures to represent 100% duty cycle (i.e., always on) as indicated in the table.

Legislative Request

On July 30, 2010, California Assembly Member Jared Huffman with Science and Technology (CCST) to request that the Council perform a study...[that] would help policy makers and the general public whether smart meters present a significant risk. Of course, Assembly Member Bill Monning signed onto the request with his own name in 2010. The City of Mill Valley also supporting the Assembly Member Huffman's request for the study.

Approach

Reflecting the requests of the Assembly members, and CCST assess the evidence available to address:

1. Whether Federal Communications Commission (FCC) standards sufficiently protective of public health, taking into account current exposure to radiofrequency and electromagnetic fields.

2. Whether additional specific technology standards are needed for smart other devices that are commonly found in and around protection from adverse health effects.

CCST convened a Smart Meter Project Team composed of CCST supplemented with additional experts in relevant fields (see Appendix members). The Project Team identified 100 publications and positions smart meters and other devices in the same range of emissions cell phone RF emissions, and contacted over two dozen experts emissions and related fields seek their opinion on the two identified

It is important to note that CCST has not undertaken a prima these issues. This response is limited to soliciting input from and available information from past and current research emitted from electric appliances generally, and smart meters specific contacted provided written input on the issues exclusively CCST. This reviewed by the Project Team, experts has related subject to review process (see Appendix B). It has also been made

Two Types of Radio Effects: Thermal and Non-Thermal

Household electronic devices, such as cellular and cordless telephones, wireless routers, and wireless smart meters produce RF emissions. They may lead to thermal effects on humans extensively studied and appear to be well understood. The FCC has established guidelines to protect public health associated with the thermal impacts of RF: tissue heating from with radiofrequency emissions. However, including cumulative or prolonged exposure to lower levels of RF emissions, are not have suggested that effects may include fatigue, headache, and cancer. But these findings have not been established, and the mechanisms of thermal effects remain unknown. Additional research and monitoring is needed to better identify and understand the potential effects.

Findings

Given the body of generally accepted scientific knowledge, smart meters are similar to other electronic devices, and the Commission finds that:

- 1. The FCC standard provides an adequate margin of safety for induced health impacts of smart meters and other electronic range of RF emissions.

The potential for behavioral disruption from increased body temperature is not only a biological health impact that has been consistently demonstrated to result from absorbing RF within the band of (EMF) that smart meters use. The Federal Communications Commission limit on the Standard Absorption Rate (SAR) is derived from the level that has been demonstrated to affect behavior of smart meters, including those being installed by Pacific Gas and Electric in the Assembly Members' districts, if installed according to the instructions and consistent with the FCC certification, emit RF fraction of the exposure level established as safe by the

The FCC guidelines provide a significant factor in safety: occur at the power levels and within the RF band used in scientific knowledge, the FCC guidelines provide a margin of safety against the known thermal effects.

2. At this time the evidence is that additional standards are needed to protect the public from smart meters or other common household devices. No clear causal relationship between these devices and health or non-health impacts has been scientifically established. The mechanisms that may result in such a biological impact have not been clearly identified. Additional research is needed to understand and verify these potential mechanisms.

Given the existing significant scientific uncertainty about the effects of these devices, it is currently not generally accepted based on the available evidence that additional standards are needed. Because of the lack of generally accepted scientific knowledge or an existing basis from which standards could be developed, or appropriate methods for a clearer understanding of the biological mechanisms, identifying additional standards or evaluating the relative costs and benefits of standards cannot be determined at this time.

CCST notes that in some of the studies reviewed, contributors raised questions from some in the medical and biological fields about biological impacts other than the thermal impact that the report of the National Academies identifies. Research needs and gaps in areas of research to be undertaken to better understand the health effects of RF emissions from communication devices, particularly mobile phones, that are not addressed by CCST guidelines are increasing in our society, smart meters vary in size and power and emit RF emissions to which we are exposed. Concerns about human health impacts of RF emissions should be considered in this broader context.

“Scientifically established”, “generally accepted scientific knowledge” and other terms throughout this document are referencing information obtained through the scientific method consisting of observation and experimentation and the formulation and testing of hypotheses. These steps must be repeatable in order for scientific inquiry to be generally accepted as possible. It is not possible to reduce biased interpretations. Another basic expectation of science is that all data are available for careful scrutiny by other scientists, giving them the opportunity to attempt to reproduce them. This practice of disclosure, also allows statistical measurement of the reliability of these data to be established.

Health concerns surrounding RF from smart meters are similar to those from devices that we use in our daily lives, including cordless phones, ovens, wireless routers, cell phones, laptops, and other wireless devices. As the report shows, a comparison of electromagnetic frequencies from smart meters shows that the exposure level is very low.

¹ National Research Council (2008) *Use of Research to Assess Potential Biological Health Effects of Wireless Technologies*, National Academies Press, Washington, D.C.

What are smart meters?

Smart meters measure electricity, gas, or water as delivered and transmit that information digitally to utility companies. Some are also designed to transmit information to the consumer. These replace traditional, analog meters and meter readers with an automated system expected to reduce operating costs for utilities and potentially, Figure 2).

a. Analog Meter and Digital Meter

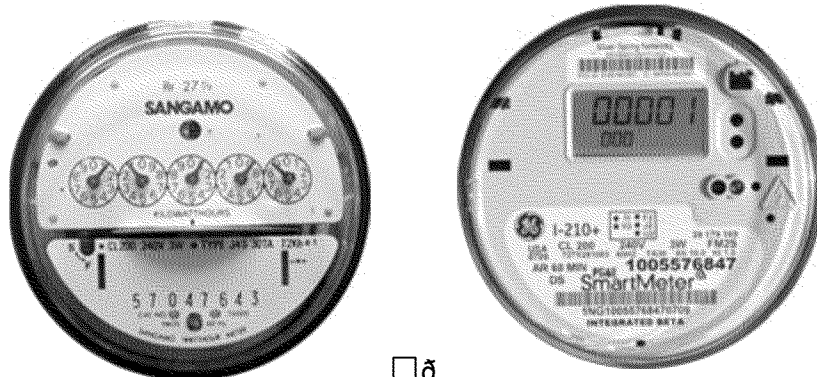


Figure 2 a) An analog, conventional meter and a digital smart meter

Each of California's major electricity utilities has begun deploying smart meters.

There are many kinds of smart meters manufactured by a variety of companies including sensors and the communications device (installed within the meter) is manufactured upon the internal communications device employed, meters are either wired or in a wireless environment. The PG&E smart meters made use of Gyr and Landis + Gyr and use a wireless communications technology. Each of these PG&E meters has two transmitters to provide data from these meters for the "automatic meter reading" of the meter (and for other applications) and sends this data collected along with data from many other customers and transmits it over an area network (WAN) (similar to the way cell phone communicate

² R. (2008) "Supplemental Report on an Analysis of Radiofrequency Fields [PG&E Smart Meter Program Upgrade System," Prepared for Pacific Gas & Electric Associates, Interim Report 27

SMART METER NETWORK COMPONENTS

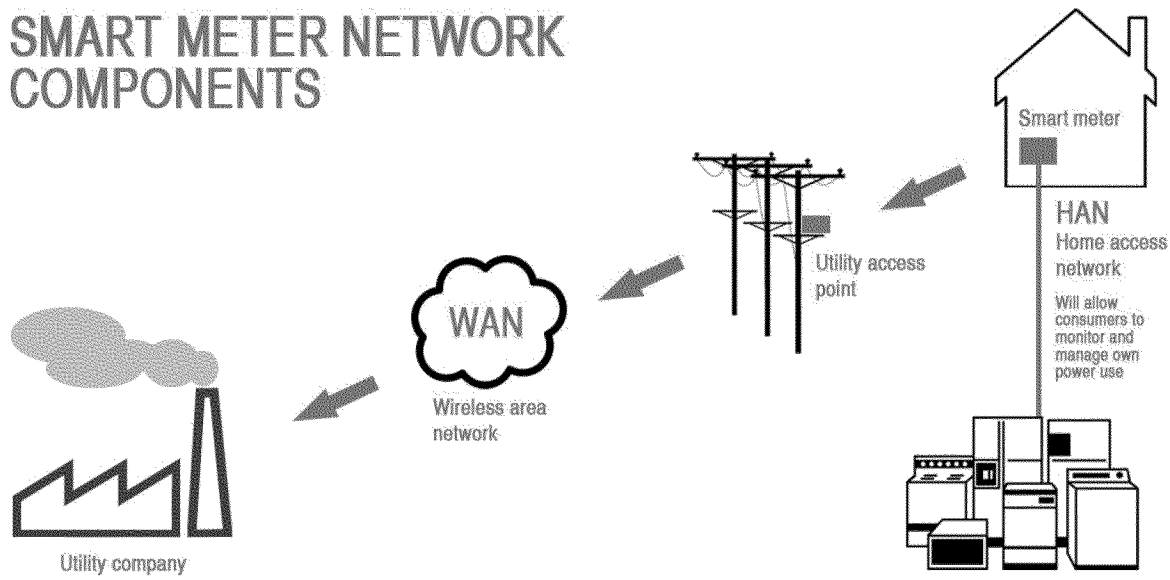


Figure 5.3 Simplified depiction of Smart Meter system network. The diagram shows signals for automated meter reading, communications among electric power meter company's enterprise management systems. The future home access network will

Smart meters have evolved from meter analog replacing meter readers to a real time monitoring of power as delivered. To obtain the real time data, the Richard Tell Associates report describes the operation of smart meter from the perspective of, time. The Richard Tell Associates report use of the smart meters deployed radios by the FCC for a maximum power output of 928 MHz. In its initial deployment, PG&E configure the radios to transmit data from the meter about every 50 milliseconds. Additionally, the current duty cycle meter transmitter (that is, the percent of time that the meter transmits) is 1 percent, or in some cases, as low as 0.1 percent. This means that the typical smart meter would be in this initial any RF signal for 1 percent of the time.

It is important to note that any one smart meter does not act as a relay among other smart meters and utility access grid is fully functional the smart meters would be expected once every four hours, providing data to the utility in a much higher

³ R. (2008) "Supplemental Report on An Analysis of Radiofrequency Fields [PG&E Smart Meter Program Upgrade System," Prepared for Pacific Gas & Electric Associates, Inc., October 27. http://www.pge.com/includes/docs/pdfs/shared/edusafety/systemworks/rfsafety/rf_fields_supplemental_report_2008.pdf

cycle. For purposes of including hypothetical scenario where the smart meters are continuously transmitting. Even in this 100% duty cycle situation below are the limits.

Smart meters are designed to transmit data to a utility access point, on utility or light poles. These access points are 5,000 smart meters to the access utility point. A similar AMR smart meters, as well as well as wireless cards, which communicate with utilities and to wireless cards used in wireless devices. A typical computer operates at 0.25 GHz or 900 MHz. The range is 600 ft.

In some cases, the data is relayed through a network, relaying the data from meters to the access point. This may occur when the top interferes with the transmission of data. The relay may occur between one smart meter and the utility access point (e.g., hops along a network). Some relays will also exist between some smart meters to utility.

Many smart meters, including those from PG&E, also have a future point in time, will allow customers to enable a home allow increased consumer monitoring of electricity use and the future smart grid. This functionality is important to smart grid. This second internal transmitter, used for delivery of data, reportedly will operate at a 2.4 GHz power frequency of about 2.4 (similar to that of cell phones and wireless phones). The depend on the design of the network.

Why are Smart Meters Being Installed?

It is anticipated, when fully operational, smart meters are a key technology for a "smart grid" that is expected to become safe and (see Figure 3) at a potential lower cost to the used for reducing natural gas and water consumption). Smart electrical two-way communication between utilities and customers, which is e adjust their demand to price changes that reflect these conditions. user adjustments can help to protect the overall reliability of utility customers, and improve the operation and efficiency of the grid will enable grid operators to better manage demand in real time, which becomes increasingly important as more intermittent wind and resources are added to the grid.

Figure 3 depicts the potential operation of a smart grid.

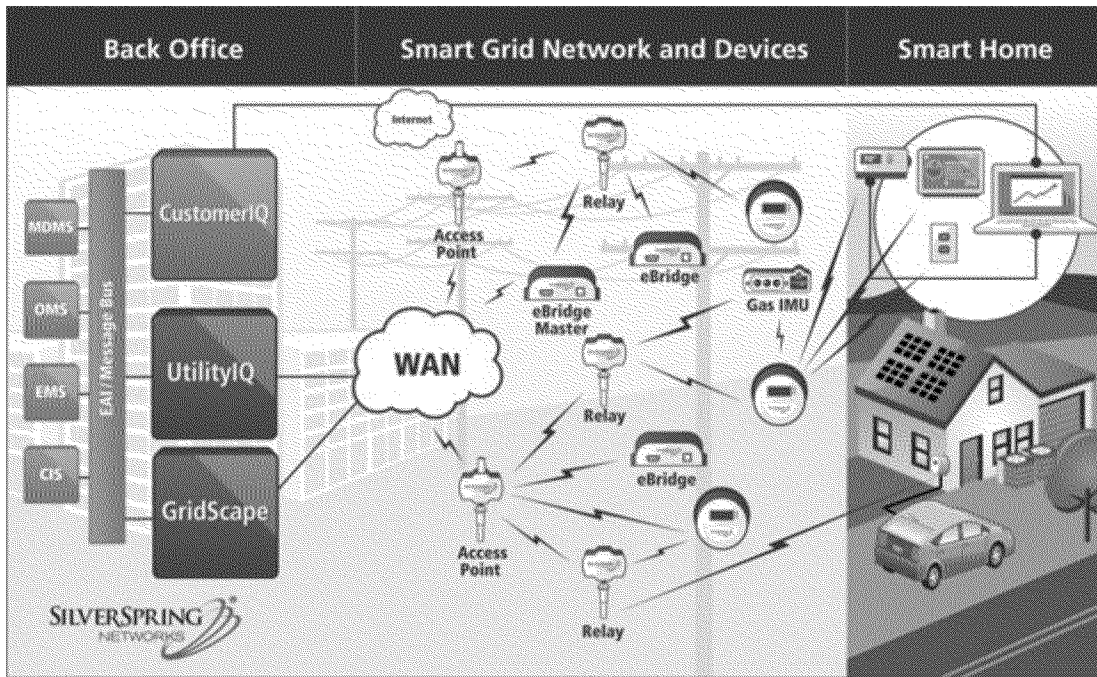


Figure 1-16 Illustration of the PG&E Smart Meter Program Upgrade: radiofrequency (RF) signals for communications among electric power meters, ultimately, the company's enterprise management systems. (Source: Silver Sp

Smart meters will also allow utilities to communicate grid conditions price signals, so that consumers, via time-of-use rates, can avoid delays (such as clothes drying) to a time when electricity is cheapest to use. In some cases wireless signals interior to the automatically adjust the heating and ventilation systems and to units. This adaptation to real-time price signals could reduce overall electric customers, improve the utilization of renewable power plants, and costs associated with adding intermittent wind and solar resources.

While such benefits of smart meters will take years to fully [promising that the federal government has required utilities to

⁴ See <http://www.silverspringnet.com/products/index.html> for component descriptions. Infrastructure includes the Silver Spring points and says that forward data from endpoints to the utility's backhaul or WAN infrastructure into the back office. The UtilityIQ application incorporates both utility applications such as Metering, Outage Detection as well as administrative programs for managing GridScape provides the management for DA communications networks. The CustomerIQ web enables utilities to directly communicate usage, pricing, and re consumers. Silver Spring will enable each utility to customize the information portrayed specific information such as rate schedules.

grid networks, including the use of smart meters and the authorization of California Public Utilities Commission in California have begun to install throughout the state. Some California utilities (such as Sacramento) have received significant federal funding to help pay smart meters from the American Recovery and Reinvestment Act (federal stimulus package). Many companies are actively deploying smart meters as well. Digital smart meter technology is the fundamental technology that will enable widespread integration of information technology (IT) into the power grid (i.e., the smart grid). This summarizes some potential societal benefits expected to result from

Table 1: Smart Grid Benefits

<p>Consumers</p> <ol style="list-style-type: none"> Cost Savings Resulting from: Increased Consumer Choice and More Transparency and Control for Consumers 	<p>Environment</p> <ol style="list-style-type: none"> Widespread Deployment of Renewable (Solar, Wind, Fuel Cells) Electric Vehicles (EVs) Reduced Need to Build More plants Reduced Carbon Footprint and (via Renewables, Energy Efficiency Vehicles)
<p>Utilities</p> <ol style="list-style-type: none"> Reduced Cost Due to Improved Delivering Electricity and Reducing Manpower to Read Meters. Improved Reliability and More Response Increased Customer Satisfaction Due to Savings and Control <p>Source: California Smart Grid</p>	<p>Economy</p> <ol style="list-style-type: none"> Creates New Market for Goods and New Companies, New Jobs Supports Workforce to be Productive Reduces Dependence on Foreign Dollars at Home

What Health Concerns are Associated with Smart Meters?

Human health impacts from exposure to electromagnetic frequency fields depending on the frequency and power of the fields. Smart meters in the RF portion of the electromagnetic spectrum from smart meters

⁵ The federal Energy Independence and Security Act of 2007 directs states to implement smart grid programs that allow recovery of smart grid investments through utility rates, or smart grid investments. The American Recovery and Reinvestment Act of 2009 provides smart grid infrastructure funding. See: Congressional Research Service (2007, Independence and Security Act of 2007: A Summary of Major Provisions," CRS RL34294, December 21, 2007, http://energy.senate.gov/public_files/RL342941.pdf)

⁶ California Public Utilities Commission decision 12-03-006 (Application 12-07-2009). Decision on and Electric Company's Proposed Upgrade to the Smartmeter Program.

meters are unlikely to produce effects; however, it is not scientifically whether or what the effects on organisms and potentially, human health might be. These same concerns over potential impacts should apply to devices that operate with similar frequency and power levels, including cordless phones, televisions, and wireless routers. Impacts from these devices is likely to be a result of differences in usage patterns.

Thermal Effects

Electromagnetic waves carry energy, and EMF absorbed by the temperature of human tissue. The consistency of body temperatures must increase at least to lead to potential biological impacts from the verified effect that has been shown to occur in the power meters are designed to report occupancy in animal feeding behavior at environmental levels of 4 W/kg and with an accompanying increase in body temperature exposure levels from smart meters. Even below the threshold range, there has been set on limits for power densities from electronic devices that have demonstrated biological impacts occur, and the limits are tens of likely exposure from smart meters.

Non-thermal Effects

There are emerging questions about the medical and biological fields about effects caused by mechanisms of absorption of RF of health impacts from "electromagnetic stress" have been reported, with symptoms such as headache, and irritability. Some studies have suggested that RF phones may disrupt cellular communication in human cells, which may have negative effects on other impacts on human health. Concerns of brain cancer have been associated with usage persist, there is currently no definitive evidence linking cell phone incidence of cancer due to the recent nature of cell phone technology exposure are not known. Ongoing scientific study is currently being conducted on thermal effects from long-term exposure to mobile and smart meters, especially

7. Andrea, J.A., Adair, E.R., and J.O. de Lorge (2003) Behavioral and cognitive Bioelectromagnetics Supplement (2003)

8. Taylor, R. (2008) "Supplemental Report on An Analysis of of Radiofrequency Fields [PG&E Smart Meter Program Upgrade System]," Prepared for Pacific Gas & Electric Associates, Inc., October 27. (http://www.pge.com/includes/docs/pdfs/shared/edusafety/systemworks/rfsafety/rf_fields_supplemental_report_2008.pdf)

9. Markova, E., Malinger, and I.Y. Mikheyeva (2009) mobile phones inhibit 53PB1 formation in human stem cells stronger than in differentiated cells: Possible Environmental Health Perspectives, doi:10.1289/ehp.0900781.

10. Niimi, H., Grafstrom, G., Eberhardt, J.L., Malmgren, L., Brun, A., Persson Radiofrequency and Extremely Low Frequency Electromagnetic Field Effects on Blood Electromagnetic Biology and Medicine, 2008, 27: 103

11. Bloom, A., Feychting, M., Green, A., Kheifets, L., Savitz, D. A., and A on mobile phones and tumor risk. Epidemiology 2009, 20: 538-546

the cumulative impact of the emissions, including that of a network operating throughout a community.

There is no conclusive scientific evidence pointing to a causal link between human exposure to and negative health impacts. For this reason, regulators should make it prudent to call for more research on acceptable human exposure limits on currently proven scientific and known thermal effects, rather than on general concerns or speculation as yet unproven effects. It is not prudent to take considerable time to resolve the data that are available strongly suggest effects of thermal absorption on human health, such effects are not so profound.

FCC Guidelines Address Known Effects Only, Not Potential Non-thermal Effects

In 1985, the FCC first established guidelines to limit human thermal effects of radio frequency emissions. The guidelines were based on American National Standards Institute (ANSI) standards. In 1996, the FCC modified its guidelines on a rulemaking process that began in 1992 revision of the ANSI guidelines. The findings by the National Council on Protection and Measurements (NCP) in 1996 guidelines are still in place.

In its rulemaking process to set SAR and MPE limits, the safety agencies, including the U.S. Environmental Protection Agency Administration. While the FCC guidelines appear to provide a [known thermal effects of exposure to radio frequency, but they do not address potential non-thermal effects, nor do they add to our understanding of these effects, there is inadequate basis to develop additional guidelines.

¹² National Research Council (2008) *Identifying Research Needs Relating to Potential Biological and Health Effects of Wireless Technologies*. National Academies Press, Washington, D.C. (<http://www.nap.edu/catalog/12036.html>)

¹³ American National Standards Institute (1982) "American National Standard Radio Frequency Warning Symbol," ANSI Z39.1-1982, Institute of Electrical and Electronics Engineers, Inc.

¹⁴ FCC (1997) "Evaluating Compliance with FCC Guidelines for Radio Frequency and Electromagnetic Fields," OET Bulletin 65, Federal Communications Commission, August. (http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf)

¹⁵ American National Standards Institute (1992) "Safety Levels with Respect to Human Frequency Electromagnetic Fields, 3 kHz to 100 GHz," ANSI/IEEE Std C95.1-1992, Institute of Electrical and Electronics Engineers, Inc.

¹⁶ American National Standards Institute (1992) "Recommended Practice for the Measurement of Electromagnetic Fields and Waves," ANSI/IEEE Std C101.1-1992, Institute of Electrical and Electronics Engineers, Inc.

¹⁷ NCP (1986) "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Radiation," National Council on Radiation Protection and Measurements, Report No. 86 (1986).

¹⁸ The U.S. EPA confirmed this in a letter to The Electromagnetic Radiation (http://www.emrpolicy.org/litigation/case_law/docs/noi_epa_response.pdf)

The FCC guidelines measure exposure to waves RF in a specific absorption (SAR) measures the rate of energy absorption per unit mass of the measured body weight (W/kg). It accounts for the thermal effects on human heating body tissue and limiting is measured in various devices, such as mobile phones, that are used in close proximity to limit human exposure. The underlying ANSI and NCRP limits, are being. For the FCC rulemaking and still today, behavioral disruption in laboratory a human primates) at this absorption rate is the only adverse linked to RF at levels similar to those emitted by smart scientific literature^{20, 21} by the World Health Organization and many Europe.^{22, 23} The FCC limit of 1.6 W/kg provides a significant fact threshold.

Limits on SAR provide the maximum exposure limits (MPE) average exposure over a given time per general exposure from a device and is often used for exposure human exposure is to occur at a distance of more than 20 (10⁶) watts per square centimeter (μW/cm²) and accounts for the fact that absorbs energy more efficiently at some radiofrequencies than other absorbs energy most efficiently in 300 kHz to 10 MHz range and of the corresponding for RF emissions in this range. In the most stringent. In the where smart meters operate, including 928.5 MHz, namely 100 and 102.2 range, the human body absorbs energy more efficiently and structure.

The FCC limits are summarized in Figure 5 of the AMR transmitter of the 928.5 MHz.

Figure 5 of the AMR transmitter of the 928.5 MHz.

¹⁹ FCC (2001) "Additional Information for Evaluating Compliance of Mobile and P Human Exposure to Radiofrequency Emissions," OET Bulletin 65 (Edition Federal Communications Commission, June).

²⁰ Andrea, J.A., A. Adami, and E.J.O. de Lorge (2003) Behavioral and cognitive effects [*Bioelectromagnetics Suppl* 16:52-60 (2003)

²¹ Sheppard, A.R., Swicord, M. L., and Q. Balzano (2008) Quantitative evaluations interactions with biological molecules and health processes, *IEEE* (2008)

²² The World Health Organization has reviewed international guidelines for limiting scientific studies related to human health impacts and guidelines that do not to have health consequences. <http://www.who.int/emf/standards/en/>

²³ Committee on Man and Radiation (COMAR) (2009) "Technical Review of the potential health effects of radiofrequency electromagnetic fields and comments on Health Physics 97(4):38 (2009)

²⁴ FCC (1997) "Evaluating Compliance with FCC Guidelines for Electromagnetic Exposure to Fields," OET Bulletin 65, *Federal Communications Commission*, August. http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf

²⁵ FCC (1999) "Questions and Answers about Biological Effects and Potential Hazards of Electromagnetic Fields," OET Bulletin 56 (Fourth Edition), *Federal Communications Commission* (http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet56/oet56e4.pdf)

the human body absorbs energy, and the threshold for the 2.4 GHz home area network communications is consequently higher, 1000 μW/cm².

PG&E commissioned a study by Risk Associates, Supplemental Report on An Analysis of Radiofrequency Fields Associated with Operation of the Upgrade System. In this study of PG&E's proposed smart meter FCC limits on MPE, it is concluded that the perceived hazardous exposure times are higher than the FCC limits. The study estimates that the highest exposures, if an individual were standing directly in front of a 100 μW/cm² transmitting antenna for 4% of the time. The study notes that this is less than the FCC 500 limit and less than the demonstrated hazard level for individuals who are further away from smart meters (likely in a building structure) where power density will be much lower. The smart meter system would occur immediately adjacent to an access point that an individual would be immediately adjacent to if they are not located 25 feet above the ground on a telephone or electric power line. The power density from an access point is estimated to be 25 times higher than the FCC limit. The exposure to the power density from access points is estimated to be 15,000 times less than the FCC limit in a device.

The PG&E commissioned Report on the Safety of the Smart Meter Duty Cycle of transmitting data once every 15 minutes in this very low estimate. However, we are not aware of the justification for the 15-minute averaging period. We do know that averaging of exposure over (30-minute) periods truly be a smart grid the data will be transmitted at a this report we looked at scenarios, where a smart meter that is stuck in constantly relaying, at a 100% duty cycle scenario, the RF emissions measurably below the FCC limits for thermal effects.

²⁶ See R. (2008) "Supplemental Report on An Analysis of Radiofrequency Fields PG&E Smart Meter Program Upgrade System," Prepared for Pacific Gas & Electric Associates, Inc., October 27.

(http://www.pge.com/includes/docs/pdfs/shared/edusafety/systemworks/rfsafety/rf_fields_supplemental_report_2008.pdf)

²⁷ http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet56/oet56e4.pdf

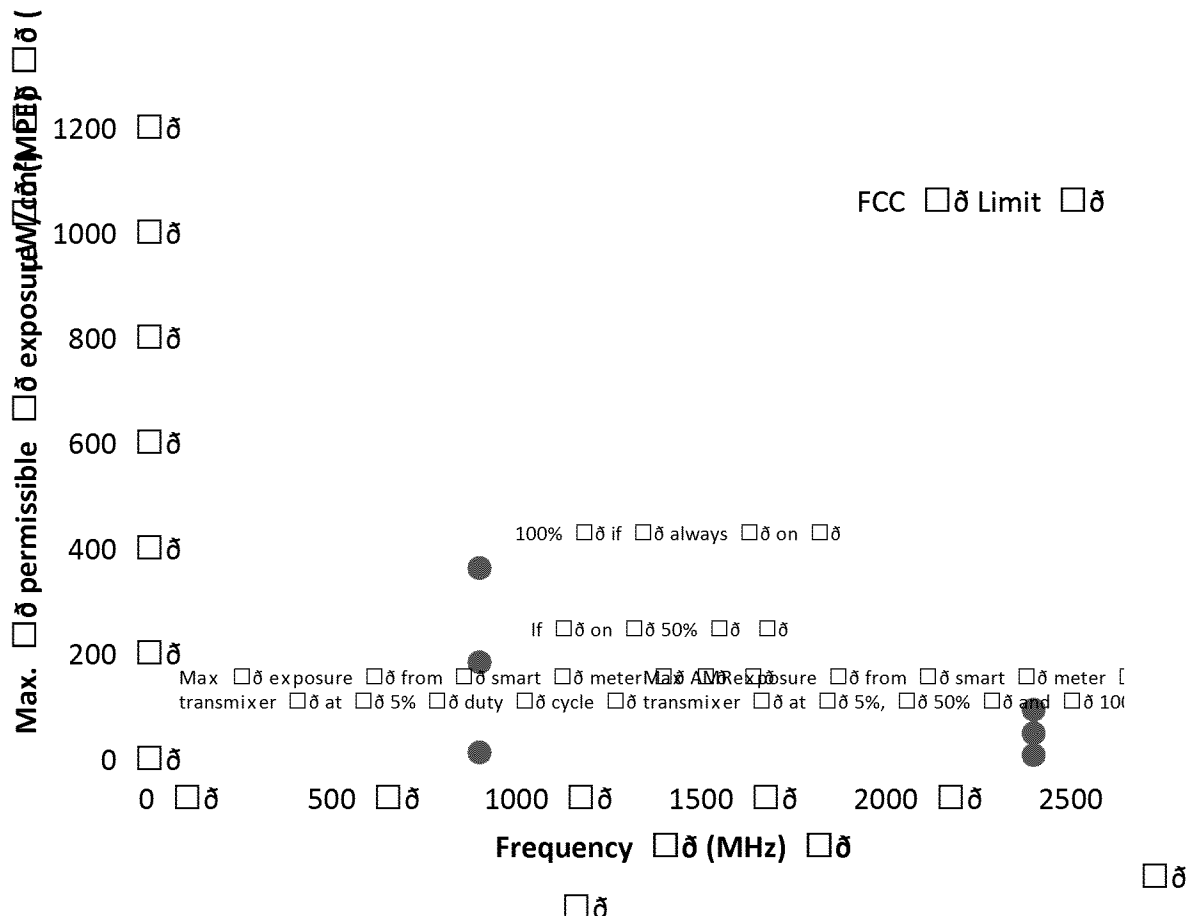


Figure 5. FCC maximum permissible exposure limits on power density. The body can safely absorb more energy at the highest estimated maximum exposure of AMR transmitter at 5% duty cycle (if on 50% of time/day) than at any other of the limit. Even if a meter malfunctioned and it was stuck on, it would always exposure levels would be below the FCC limit. AMR transmitter at a 5% duty cycle would be the 15% of FCC limit and FCC limit if the transmitter Exposure figure is from November 2010 Electric Power Research Institute (EPRI) entitled "Radio Frequency Exposure Levels from Smart Meters"

Power Density (and Exposure Level) Decreases Rapidly with Distance

The power density from smart meter devices that emit RF, falls distance. As Figure 5 shows, this affects for an example smart meter. Maximum exposure level at 1 with a duty cycle of 5% is 1000, which is below the FCC guidelines a distance of 10 the upper end of exposure approaches zero.

²⁸ EPRI (2010) Radio Frequency Exposure Levels from Smart Meters. Electric Power Research Institute, November 2010.

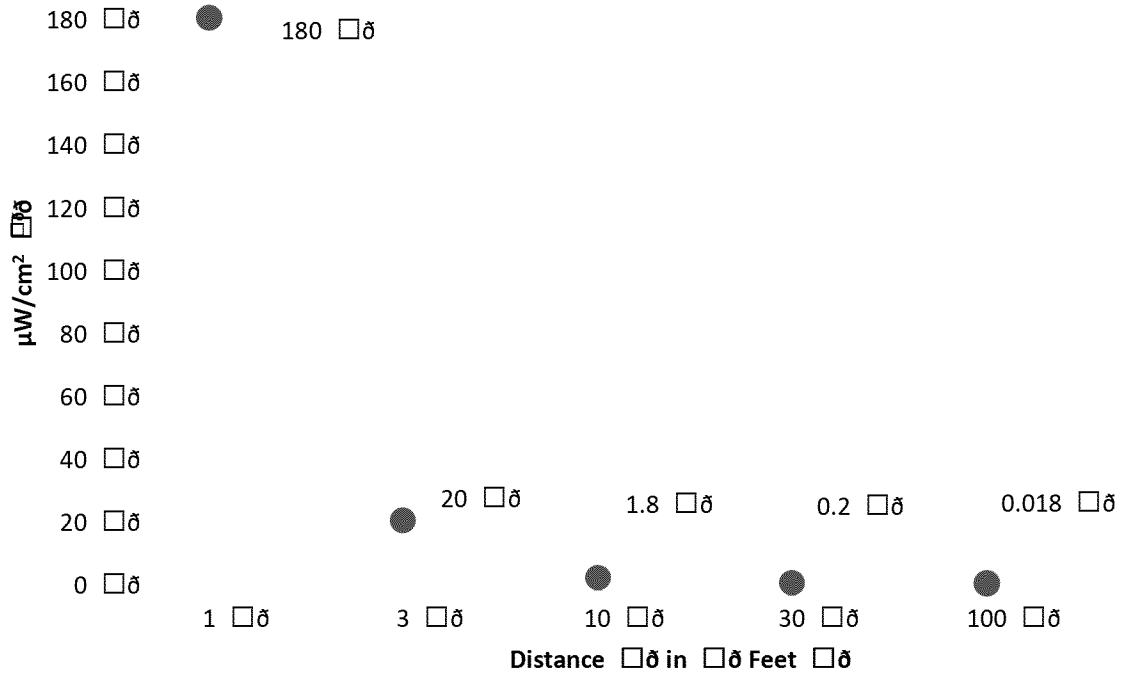


Figure 5. Power density from a sample; ²⁹ The power density from a smart meter AMR transmitter decreases rapidly with distance (inverse square law) is similar for various duty cycles and different

Comparison of Electromagnetic Frequencies from Smart Meters and Other [

Health concerns surrounding RF from smart meters are similar to devices that we use in our daily lives, including microwave ovens, wireless routers, hair curlers, and laptop computers. In addition to slight differences in frequency and power levels, of RF from these devices, the primary difference among them [phones, for example, are often used for many hours a day, and held directly next to one's head. For perspective, microwave ovens operate at a similar frequency smart meters (2.45 GHz), and the U.S. Food and Drug Administration levels are five times higher than the FCC limit for smart devices operating at wireless routers and equipment produce radiofrequency

²⁹ EPA (2008) Radio Frequency Exposure Levels from Electric Power Research Institute, 2010.

³⁰ EPA, "Summary of the Electronic Product Radiation Control Provisions of the Act," U.S. Food and Drug Administration (2011). <http://www.fda.gov/oc/ohrt/EmittingProducts/ElectronicProductRadiationControlProgram/LawsandRegulations/ucm118156.htm>

fields of about 0.02 to 0.1 $\mu\text{W}/\text{cm}^2$ in metropolitan areas are exposed to radiofrequency from radio and television antennas, as well, although population exposure is quite low, and about 0.005 $\mu\text{W}/\text{cm}^2$.

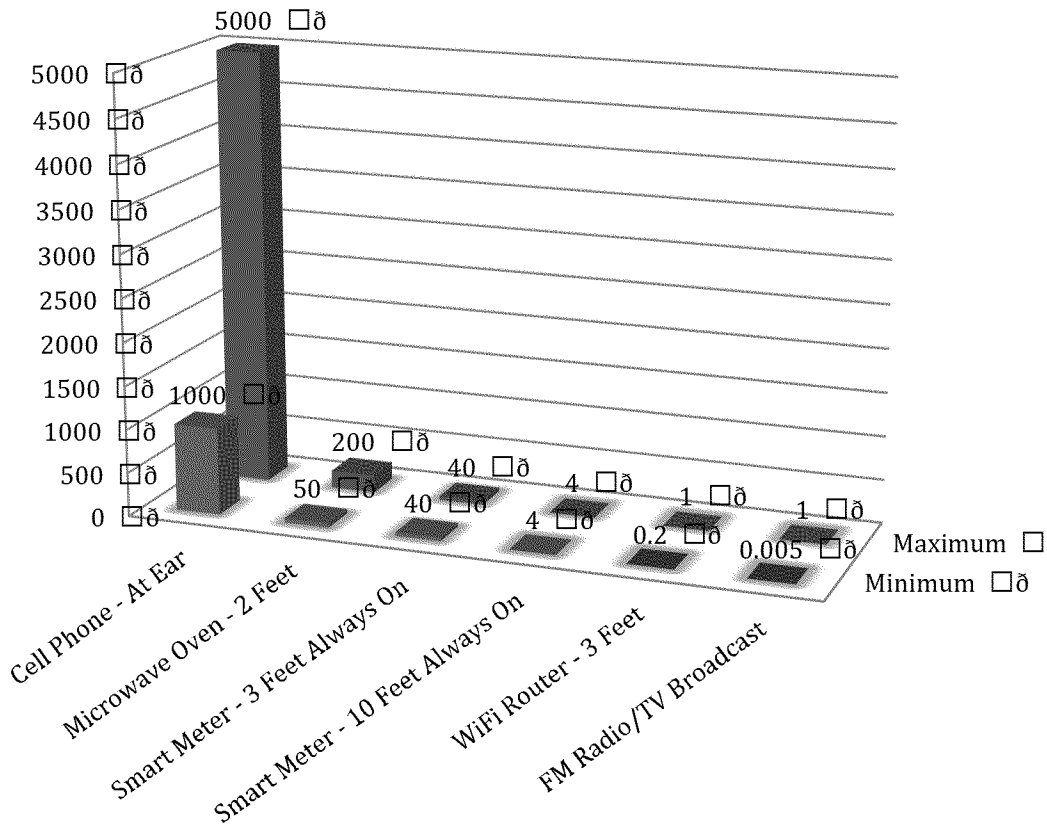


Figure 1. Comparison of Radiofrequency Levels from Various Sources

Note: Exposure levels are based on $\mu\text{W}/\text{cm}^2$ Table 2 and converted from meter figures represent 100% duty cycle (i.e., always on) as indicated.

³¹ "Radio-Frequency Exposure Levels from Various Sources" by Rob Kavet and Gabor Elek, *Electric Power Research Institute*, 2010.

³² Foster, K.R. (2007) Radiofrequency exposure from mobile phones utilizing WI Physics, Vol. 92, No. 2, pp. 280.

³³ Schmidt, G. et al. (2007) Exposure of the general public due to wireless Places, *Radiation Protection Dosimetry*, 123, No. 1, pp. 48.

³⁴ EPA (1986) The Radiofrequency Radiation Environment: Environmental Exposure Levels Emitting Sources, EPA-600/3-86-010, U.S. Environmental Protection Agency, July.

Table 2: Electromagnetic Interference Levels from Various Sources

Source	Frequency	Exposure Level (mW/cm ²)	Distance	Time	Spatial Characteristic
Mobile phone	900 MHz, 1.8 GHz	1–5	At least	During call	Highly localized
Mobile phone base station	900 MHz, 1.8 GHz	0.000005–0.002	10s to a thousand feet	Constant	Relatively uniform
Microwave oven	2450 MHz	~50.05–0.25	2 inches	During use	Localized, non-uniform
Local area network	2.4–5 GHz	0.0002–0.001 0.000005–0.0002	3 feet	Constant when nearby	Localized, non-uniform
Radio/TV broadcast	Wide spectrum	0.001 (highest population) 0.000005 (50% population)	Far from source (most cases)	Constant	Relatively uniform
Smart meter	900 MHz, 2.4 GHz	0.0001 (250 r duty cycle) 0.002 (1 W, cycle) 0.000009 (250 W, 1% duty cycle) 0.0002 (1 W, duty cycle)	3 feet	When in proximity during transmission	Localized, non-uniform

Source: Electric Power Research Institute (EPRI), Radio Frequency Exposure Levels from

What is Duty Cycle and it Affect Human Health?

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Duty cycle refers to the fraction of time a device is transmitting. It transmits RF energy 1% of a given time period. One liter per day. The duty cycle, or signal modulation, is to be compared from kinds of devices (cell phones, Wi-Fi routers, smart meters, microwave ovens, FM radio/ signals).

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Duty cycles of devices vary considerably. The duty cycle of AM/FM radio words, they are transmitting continuously. Usage varies widely from user to user. However, the national average is 100 minutes per hour. This usage equates to "average" use.

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Information that CCST was able to obtain we understand that the smart PG&E operates with a maximum power output of 20 MHz. The signal is within band. Each smart meter is part of a broader "mesh" network and utility access points. The transmitter at each smart meter will be time idle (not transmitting) depending on the amount and schedule of data the relaying of data from other meters that an individual meter does, a manages control of the communications path in the mesh network.

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Theoretically the transmit time could increase substantially beyond today's actual applications and functionality are added to the meter's communication network. In "worst case" scenario, if a meter malfunctioned and was stuck in the transmit mode duty cycle 100%, where the transmitter is always on. The table below different duty cycles against the FCC guidelines for human exposure limits.

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Typical Smart Meter Operation With Repeater Activity	Scaled Hypothetical Maximum Usage (i.e., always on)
5% Duty Cycle	100% Duty Cycle
72 minutes/day	24 hours/day
3% of FCC limit	60% of FCC limit

Source data on operating duty cycles (i.e., first column) from Electric Power Meter Report. Radio Frequency Exposure Levels from National Institute for Environmental Health Sciences. Hypothetical maximum derived through extrapolation of first column exposure levels at 100 foot distance.

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In summary, the duty cycles of smart meters are not expected to be a health concern. In operation result in exposure that is 60% of the FCC exposure guideline. A hypothetical always scenario the maximum exposure would be the FCC limit, which provides a known thermal effects of RF emissions.

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What is the Absorbance Level of the Meter Bank and is it from Just Behind the Meter?

In a November 2010 study of Electric Power field research exposure (EPRI) from a bank of 10 250 mW power level at one foot distance bank meter meters located at a multifamily building, such as exposure level was equivalent to 33% of the FCC standard.

In the same study EPRI measured meter level exposure at 10 inches behind the meter panel box in a utility proximity on the opposite side of the cycle it yielded an exposure of only 10% of the duty cycle (always transmitting), exposure at eight inches behind the meter

Is the FCC Standard Sufficient to Protect Public Health?

The FCC guidelines do not provide a significant factor of safety currently understood human health impact that occurs at the frequency bands that meters use. In addition to the factor of safety guidelines, at worst, human exposure to RF from smart meters at 50% duty cycle will be significantly lower than the guidelines. While to understand potential effects of exposure to RF and effect prolonged exposure to several devices emitting RF, given current guideline provides an adequate margin of safety against known

Are Additional Technology Standards Needed?

The FCC guidelines protect against thermal effects of RF exposure have been suggested, and additional research is needed to validate them.

Given the scientific uncertainty about the effects of all RF emitting equipment time there is no clear indication of a health risk. Neither additional is there a basis from which to set a standard could be appropriate. Without a clear understanding of the biological mechanisms benefits of additional standards for emitting devices including smart meters determined at this time.

³⁵ EPRI (2010) "A perspective on the exposure associated with residential automatic meter technology," Electric Power Research Institute, February.

Public Information and Education

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It is important that consumers have clear and easily understood emissions as well as readily available access to clear, factual, known effects of RF emissions fields strengths and distances from commonly found in our world.

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Equipped with this information, people can make knowledgeable judgments prudently minimize possible risks and the more familiarizing standards compliant devices at known safe exposure levels will be better able to field strengths of various RF sources in mobile phones, laptop computers, blankets, clock radios, TV and radio meters, computers, lines, microwave etc.). An ongoing regularly updated source of unbiased information research, both proven and causal effects being studied, if pre-independent entity, provide consumers a credible and transparent source obtain facts about RF in our environment.

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CCST is currently aware of a single source of information which are able to endorse as impartial

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Alternatives to Wireless

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Assembly Member Huffman has inquired about potential alternatives to v communication with smart meters. There are currently several data from some smart meters to the utility and smart meters. These a power line or wired through phone cables, etc. Each n tradeoffs among cost and performance (e.g., how much data ca The ability to transmit data over a wireless depends upon the c configuration of the meter used. Some existing smart meters would have to be modified or replaced. The communications [The current PG&E smart meters board that only support protocol. SilverSpring or another vendor could provide an alter such as wireless and cost effectiveness costs of an alternative ap need to be factored into the decision making process related to

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If future research were to establish a causal relationship between human health impacts, industries and governments worldwide may choices about practical alternatives to avoid and mitigate such effects the widespread use of cordless phones, smart meters, walkie-talkies, microwave ovens, and many other everyday appliances. If such a hypothetical scenario were to occur, smart meters c non-wireless transmission of data. However, retrofitting millions of smart c wired technology could be difficult and costly. Perhaps more [

meters would not address the significantly greater challenge present phones in use globally.

Key Factors to Consider When Evaluating Exposure to Radiofrequency

1. <input type="checkbox"/> <input type="checkbox"/> Signal <input type="checkbox"/> Frequency	Compare <input type="checkbox"/> to <input type="checkbox"/> devices <input type="checkbox"/> in 900 <input type="checkbox"/> MHz <input type="checkbox"/> band <input type="checkbox"/> and <input type="checkbox"/>	Frequency <input type="checkbox"/> similar <input type="checkbox"/> to <input type="checkbox"/> phones, <input type="checkbox"/> laptop <input type="checkbox"/> walkie-talkies <input type="checkbox"/> baby <input type="checkbox"/> microwave <input type="checkbox"/>
2. <input type="checkbox"/> <input type="checkbox"/> Signal <input type="checkbox"/> Strength <input type="checkbox"/> (or <input type="checkbox"/> Power <input type="checkbox"/> Density)	Microwatts/square <input type="checkbox"/> centimeter <input type="checkbox"/> ($\mu\text{W}/\text{cm}^2$) <input type="checkbox"/>	Meter <input type="checkbox"/> signal <input type="checkbox"/> strength <input type="checkbox"/> compared <input type="checkbox"/> to <input type="checkbox"/> other <input type="checkbox"/> above <input type="checkbox"/>
3. <input type="checkbox"/> <input type="checkbox"/> Distance <input type="checkbox"/> from <input type="checkbox"/> Sig	Signal <input type="checkbox"/> strength <input type="checkbox"/> drops <input type="checkbox"/> (doubling distance <input type="checkbox"/> cuts <input type="checkbox"/> power density <input type="checkbox"/> by <input type="checkbox"/> four)	Example: <input type="checkbox"/> 1 <input type="checkbox"/> $\mu\text{W}/\text{cm}^2$ 3 <input type="checkbox"/> $\mu\text{W}/\text{cm}^2$ 10 <input type="checkbox"/> $\mu\text{W}/\text{cm}^2$
4. <input type="checkbox"/> <input type="checkbox"/> Signal <input type="checkbox"/> Duration	Exposure <input type="checkbox"/> short <input type="checkbox"/> amount <input type="checkbox"/> (2.0-5.0% <input type="checkbox"/> max <input type="checkbox"/> Note: RF <input type="checkbox"/> 95% <input type="checkbox"/> the (over <input type="checkbox"/> 23 <input type="checkbox"/> hours/day)	Overload <input type="checkbox"/> when comparing <input type="checkbox"/> devices <input type="checkbox"/> duration <input type="checkbox"/> combined weak <input type="checkbox"/> signal <input type="checkbox"/> strength <input type="checkbox"/> exposures <input type="checkbox"/>
5. <input type="checkbox"/> <input type="checkbox"/> Thermal <input type="checkbox"/> Effects	Scientific <input type="checkbox"/> consensus <input type="checkbox"/> on <input type="checkbox"/> effects <input type="checkbox"/> from <input type="checkbox"/> heat <input type="checkbox"/> at <input type="checkbox"/>	FCC <input type="checkbox"/> "marginally" <input type="checkbox"/> limits times <input type="checkbox"/> lower <input type="checkbox"/> than <input type="checkbox"/> exposure <input type="checkbox"/> level Typical <input type="checkbox"/> meter <input type="checkbox"/> operates times <input type="checkbox"/> less <input type="checkbox"/> than <input type="checkbox"/> FCC 3,500 <input type="checkbox"/> times <input type="checkbox"/> less <input type="checkbox"/> than demonstrated <input type="checkbox"/> hazard <input type="checkbox"/> level
6. <input type="checkbox"/> <input type="checkbox"/> Non-thermal <input type="checkbox"/> Effects	Inclusive <input type="checkbox"/> research <input type="checkbox"/> to <input type="checkbox"/> established <input type="checkbox"/> pointing <input type="checkbox"/> to <input type="checkbox"/> negative <input type="checkbox"/> impacts <input type="checkbox"/>	Continuing <input type="checkbox"/> research <input type="checkbox"/>

Conclusion

The CCST Project Team, after carefully reviewing the available li science on health impacts of radiofrequency from smart meters subject matter, concludes that:

1. The FCC standard currently in place is a factor of safety against known thermally induced health impacts of smart meters and other same range of RF emissions. Exposure levels are well below established thresholds for such effects.

2. There is no evidence that additional standards are needed to smart meters.

The topic of potential health impacts in general, including the smart exposure levels of smart meters, continues to be a topic of interest. This report has been developed to provide readers and consumers with factual, relevant information at

- Scientific basis underpinning current RF limits
- Need for further research into RF effects
- Relative magnitude of RF emissions from a wide array of devices world (e.g., cellular and cordless phones, laptops, baby monitors, microwave ovens).

CCST encourages the ongoing development of available sources of facts for public information and education. This information is written reports, frequently asked questions and answers, graphics, and video demonstrate consumers with factual, relevant information to understand the effects of environment.

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Assembly
California Legislature



JARED HUFFMAN
ASSEMBLYMEMBER, SIXTH DISTRICT

COMMITTEES
CHAIR, WATER, PARKS AND
WILDLIFE
NATURAL RESOURCES
UTILITIES AND COMMERCE

SUBCOMMITTEE NO.3
ON RESOURCES

July 30, 2010

Karl Pister, Chair
Susan Hackwood, Executive Director
California Council on Science and Technology
1130 K Street, Suite 280
Sacramento, CA 95814-3965

Dear Chair Pister and Ms. Hackwood:

I am writing to request a study by the California Council on Science and Technology in response to the many concerns and questions that have been raised by constituents in my Assembly District including the Marin County Board of Supervisors, City of Sebastopol, City of Fairfax, and Marin Association of Realtors relating to potential negative health effects from SmartMeters, the electronic monitoring devices that Pacific Gas and Electric Company (PG&E) is installing statewide to continuously measure the electricity output from each household and business.

SmartMeters are currently being installed throughout the state under the authority of the California Public Utilities Commission (CPUC) pursuant to a series of decisions that span from 2006 through 2009. The authority for PG&E to deploy SmartMeters in its territory is embodied in two decisions: D.06-07-027 (the initial deployment) and D.09-03-026 (the upgrade). On the question of health effects of radiation from the devices, PG&E and CPUC maintain that electromagnetic fields emitted from these SmartMeters and the radio frequency power associated with the wireless radios fall within the Federal Communications Commission's (FCC) regulations, pointing out that SmartMeters emit fewer radio frequencies than the amount allowable for cellular telephones, microwave ovens, and wireless Internet Services.

Critics claim, among other things, that FCC standards are not sufficiently protective of public health and do not take into account the cumulative effect of radiation exposure from a growing number of sources and devices, including continuous exposure from some sources. For example, they cite a letter from the Radiation Protection Division of the Environmental Protection Agency (attached), they argue, ..."these standards were thermally based and do not apply to chronic, nonthermal exposure situations, ... and that ... the current exposure guidelines are based on the effects resulting from whole-body heating, not exposure of and effect on critical organs including the brain and the eyes." Therefore, they argue the "safety" standards were not designed to protect the public from health problems under the circumstances which the meters are being used.



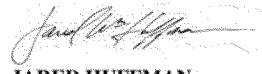
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Letter to Karl Pister and Susan Hackwood
July 30, 2010
Page 2

An independent, science-based study by the California Council on Science and Technology would help policy makers and the general public resolve the debate over whether SmartMeters present a significant risk of adverse health effects. Toward that end, I request that the Council specifically determine whether FCC standards for SmartMeters are sufficiently protective of public health taking into account current exposure levels to radiofrequency and electromagnetic fields, and further to assess whether additional technology specific standards are needed for SmartMeters and other devices that are commonly found in and around homes, to ensure adequate protection from adverse health effects.

Thank you for your serious consideration of this important and time-sensitive request. Please do not hesitate to contact me if I can be of assistance going forward

Sincerely,



JARED HUFFMAN
Assemblymember, 6th District

COMMITTEES
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ENVIRONMENTAL SAFETY &
TOXIC MATERIALS
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WILLIAM W. MONNING
ASSEMBLYMEMBER, TWENTY-SEVENTH DISTRICT

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SANTA CLARA COUNTY DIRECT LINE
(408) 782-0647

September 15, 2010

Karl Pister, Chair
California Council on Science and Technology
1130 K Street, Suite 280
Sacramento, CA 95814-3965

Dear Chair Pister:

This letter is to formally request that I be included in the response from the California Council on Science and Technology (CCST) regarding the health safety evaluation of the new electronic metering devices, otherwise known as Smart Meters, currently being installed by Pacific Gas and Electric Company (PG&E) which will be available by October 15, 2010.

Numerous concerns and questions have been raised by PG&E customers throughout the state, as well as local government entities such as the County of Santa Cruz, the City of Capitola, City of Santa Cruz, City of Scotts Valley, and the City of Watsonville, relating to potential health effects of the radio frequency (RF) emitted from Smart Meters.

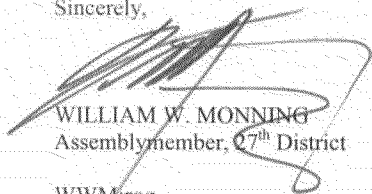
As you know, the federal Energy Independence and Security Act of 2007 required each state to initiate a smart grid system. In response to this federal mandate, the State of California enacted Senate Bill 17, Chapter 327, Statutes of 2009, granting the California Public Utilities Commission (CPUC) smart grid oversight authority. While the CPUC has authorized PG&E to install their current Smart Meter system, CPUC has not addressed the question of whether the RF emissions from Smart Meter devices have potential health impacts.

While PG&E maintains that Smart Meters comply with the Federal Communications Commission (FCC) safety standards, there is still public concern that the FCC standards do not sufficiently protect the public's health and do not take into account the cumulative effect of radiation exposure from the growing number of sources and devices emitting RF.

The scientific evaluation by the California Council on Science and Technology will help to inform both elected officials and the public about the safety of PG&E's Smart Meters and I appreciate the Council taking the time to assess this very important issue.

Thank you for your time and assistance on this issue.

Sincerely,



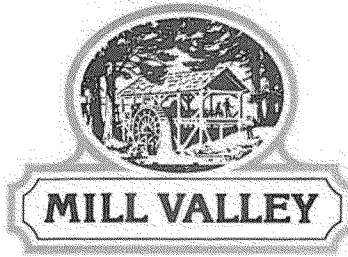
WILLIAM W. MONNING
Assemblymember, 27th District

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Stephanie Moulton-Peters
Mayor
Ken Wachtel
Vice-Mayor
Garry Lion
Councilmember



Shawn Marshall
Councilmember
Andrew Berman
Councilmember
James C. McCann
City Manager

September 20, 2010

Karl Pister, Chair
Susan Hackwood, Executive Director
California Council on Science and Technology
1130 K Street, Suite 280
Sacramento, CA 95814-3965

Dear Chair Pister and Ms. Hackwood:

On behalf of the Mill Valley City Council, I am writing to support Assemblymember Jared Huffman's request for a study by the California Council on Science and Technology (CCST) to specifically determine whether Federal Communications Commission (FCC) standards for Pacific Gas and Electric (PG&E) SmartMeters are sufficiently protective of public health.

This request is in response to the many concerns and questions that have been raised by Mill Valley residents relating to potential negative health effects from SmartMeters. Mill Valley residents have expressed their concerns that these devices, which are regulated by the California Public Utilities Commission (CPUC), emit levels of radiation that may be harmful to public health, especially with consideration to the long-term and cumulative impacts of the devices. The CPUC maintains that SmartMeters emit radiation well below the FCC-established safety standards, and have therefore not ordered PG&E to halt the installation of the advanced metering devices.

Critics argue that the safety standards determined by the FCC are not sufficient and specifically not designed to protect the public from health problems under the circumstances which the meters will be used. The FCC standards, they claim, do not take into consideration long-term and cumulative exposures to these devices.

The City of Mill Valley City Council therefore join Assemblymember Huffman in requesting the CCST undertake a study to specifically determine whether FCC standards for SmartMeters are sufficiently protective of public health, taking into account current exposure levels to radiofrequency and electromagnetic fields, and further to assess whether additional technology

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specific standards are needed for SmartMeters and other devices that are commonly found in and around homes, to ensure adequate protection from adverse health effects.

Thank you for your consideration.

Sincerely,

A handwritten signature in cursive script that reads "Stephanie Moulton-Peters".

Stephanie Moulton-Peters, Mayor
City of Mill Valley

Cc: Mill Valley City Council
Assemblymember Jared Huffman
Joshua Townsend, PG&E Public Affairs Manager
Marzia Zafar, CPUC Business and Community Outreach Division Manager

Appendix B – Project Process

1

CCST Smart Meter Project Approach

Assembly Member Huffman (Marin) (July 30, 2010 letter) and Monning (Santa Cruz) (September 17, 2010 letter) requested CCST’s determining if there are health safety issues regarding the n installed by the utilities. In addition, the City of Mill Valley (September, 2010) in support of Mr. Huffman’s request. (Appendix C)

The CCST Executive Committee appointed a **Smart Meter Project** development of a response on the issue (Appendix C):

- Rollin Richmond (Chair); Humboldt University, CS
- Jane Loscalzo Director at Large, Global Security Directorate for Global Security Research Lawrence Livermore National Lab
- Emir Mariani, Dean of Engineering and Computer Science, California State University, Sacramento and Director of the California Smart Grid
- Patrick Maroney, Director CITRIS @ Santa Cruz
- Ryan McCarthy, 2009 CCST Science and Technology Policy
- Larry Papay, PQR, LLC, mgmt consulting firm
- David Winickoff, Assistant Professor of Bioethics and Society, Department of Environmental Science, Policy and Management, UC Berkeley
- Paul Wright, Director, UC Center for Information Technology Research in the Interest of Society (CITRIS)

2

In addition to those on the project team, two CCST appointed technical experts to contribute their opinion to inform CCST’s response. From a variety of sources and were vetted by the Smart Meter Team were made to include both biological and physical science help provide broad context and perspective to the response. Many indicated they did not have time to provide a written response. References to additional experts and/or literature for reviews were not asked to contribute due to affiliations that were Experts were asked to provide written comment on two issues other experts, and to suggest literature review. See Appendix D list of those experts who provided written comment.

3

Smart Meter Project Team members and the experts providing completed a conflict of interest disclosure form to create a the potential perception of a conflict.

4

In addition to written and oral input from technical experts, reports and other sources of information to inform the final found listed in Appendix B on a <http://CCST.us/projects/smart/>.

Peer Review: After the draft report was vetted in great Team, it was forwarded to the Board for final review.

Public Comment: The report is being posted to the website. This will allow the general public to comment.

Appendix C – Object of Test

The California Council on Science and Technology adheres to the principle of providing independent, objective, and respectful scientific review of all work that bears CCST's name. In addition, CCST seeks technical experts. The request for rigorous peer review results in the specific issue being addressed is done so in a target and sound

In all, this report reflects the input of people with expertise in the project team. Reviewers include experts from academia, industry, national and international organizations

We wish to extend our sincere appreciation to the members who helped produce this report. Their expertise and diligence has been invaluable in rigorously honing the accuracy and focus of the work and perspectives of their respective areas of expertise and institutional account. Without the leadership that has been provided, this report could not have been completed.

**Rollin Richmond, Smart Meter Project Chair, CCST Board Member
President Humboldt State University, CSU**

Prior to Richmond's appointment at Humboldt State University, he distinguished career as a faculty member, researcher in academic administrator. Richmond received a Ph.D. in genetics from Rockefeller University and a bachelor's degree in zoology from University. Dr. Richmond's career has included at the University of California, founding Dean of the College of Arts and South Florida, Provost at the State University of New York, Provost and Professor of Zoology and Genetics at Iowa State University. He named the sixth President of Humboldt State University in Richmond is a fellow of the American Association for Evolution and a member of the Phi Kappa Phi Honor Society. He is an evolutionary geneticist.

Jane Long, CCST's California's Energy Future Project Director, LLNL Fellow Associate Director at Large, Global Security Directorate Fellow, Center for Research Lawrence Livermore National Laboratory

Dr. Long is the Principal Associate Director at Large for the National Laboratory working on energy and climate. She is in LLNL Center for Global Strategic Research. Her current interests include energy system in light of climate change, national stress, and ecological breakdown. She holds a bachelor's degree from Brown University and Masters and Ph.D. from UC

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Patrick □đ Mantey

Director, □đ UC □đ Center for □đ Information □đ Technology □đ Research □đ in □đ the □đ Inter: @ □đ Santa □đ Cruz, □đ University □đ of □đ California, □đ Santa □đ Cruz

Mantey □đ holds □đ the □đ Jack □đ Baskin □đ Chair □đ in □đ Computer □đ Engineer founding □đ Dean □đ of □đ the □đ Jack □đ Baskin □đ School □đ of □đ the □đ Engineering □đ CITRIS □đ at □đ UC □đ Santa □đ Cruz □đ and □đ of □đ ITI, □đ the □đ Information [Baskin □đ School □đ of □đ Engineering. □đ He □đ joined □đ the □đ UCSC □đ faculty [engineering □đ programs, □đ coming □đ from □đ IBM □đ where □đ he □đ was □đ a Almaden □đ Research □đ center. □đ His research □đ interests □đ include □đ system □đ architecture, [and □đ performance, □đ simulation □đ and □đ modeling □đ of □đ complex □đ system networks □đ and □đ multimedia □đ data □đ acquisition, □đ and □đ control □đ system Mantey □đ is □đ a □đ Fellow □đ of □đ IEEE □đ and □đ Electronics □đ Engineers current □đ projects □đ at □đ CITRIS □đ include □đ Load □đ Monitoring □đ and □đ Project work □đ on □đ power □đ distribution □đ monitoring □đ and □đ control. □đ He □đ received □đ his □đ B.S. □đ (magna □đ cum □đ laude) □đ from □đ the □đ University □đ of □đ Nc University □đ of □đ Wisconsin, □đ and □đ his □đ Ph.D. □đ from □đ Stanford □đ Unive electrical □đ engineer. □đ He □đ is □đ a □đ Fellow □đ of □đ IEEE □đ and □đ Electron Engineers □đ (IEEE)

□đ

Emir □đ José □đ Macari

Dean □đ of □đ Engineering □đ and □đ Computer □đ Science, □đ California □đ State □đ Univ. Director □đ of □đ the □đ California □đ Smart □đ Grid □đ Center

Prior □đ to □đ his □đ appointment □đ as □đ dean □đ at □đ CSU □đ Sacramento, □đ College □đ of □đ Science, □đ Mathematics □đ and □đ Technology □đ at □đ the □đ U Brownsville. □đ Prior □đ to □đ that, □đ he □đ served □đ as □đ the □đ program □đ Research □đ Excellence □đ in □đ Engineering □đ and □đ Technology □đ at □đ the □đ National □đ Sci Foundation. □đ He □đ spent □đ five □đ years □đ as □đ a □đ Distinguished □đ Professor □đ in □đ the □đ Department □đ of □đ Civil □đ and □đ En at □đ Louisiana □đ State □đ University. □đ At □đ the □đ University □đ of □đ Georgia □đ he □đ was □đ both □đ engineering □đ and □đ public □đ policy □đ and □đ at □đ the □đ University | professor □đ and □đ director □đ of □đ Civil □đ Infrastructure □đ Research □đ Center. as □đ a □đ civil □đ engineer □đ in □đ private □đ industry □đ he □đ has □đ been [both □đ a □đ doctorate □đ and □đ a □đ master's □đ degree □đ in □đ civil □đ engin the □đ University □đ of □đ Colorado. □đ He □đ has □đ a □đ bachelor's □đ degree [geomechanics □đ from □đ Virginia □đ Tech □đ University.

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Larry □đ Papay □đ CCST □đ Board □đ Member

CEO, □đ PQR, □đ a □đ consulting □đ firm

Papay □đ is □đ currently □đ CEO □đ and □đ Principal □đ of □đ PQR, □đ LLC, □đ a [specializing □đ in □đ managerial, □đ financial, □đ and □đ technical □đ strategies □đ fo clients □đ in □đ electric □đ power □đ and □đ other □đ energy □đ industries. □đ His □đ Sector □đ Vice □đ President □đ for □đ the □đ Integrated □đ Solutions □đ Sector, □đ President □đ and □đ General □đ Manager □đ of □đ Bechtel □đ Technology □đ & □đ

Vice President at Southern California Edison. Papay received a M.S. in Nuclear Engineering from MIT. He is a member of the Engineering and served on its Board of Directors from 2005 to 2006. He also served on the CCST Council Chair from 2005 to 2006 after which he was appointed Board.

David E. Winickoff

Associate Professor of Bioethics and Society, Department of Environmental and Management, UC Berkeley

David Winickoff (JD, MA) is an Associate Professor of Bioethics and Society Berkeley, where he directs the Center for Science, Technology and Society Center. Trained at Yale, Harvard Law School, and Cambridge published over 30 articles in leading bioethics, biomedical, and studies journals such as The New England Journal of Medicine, International Law Science, Technology & Humanism, and Academic and policy work spans topics of biotechnology, genetic engineering, property risk-based regulation, and subjects research.

Paul Wright

Director, UC Center for Information Technology Research

As Director of CITRIS Wright oversees projects on large energy and the environment and for intelligent infrastructures such as: public safety, water management and sustainability. In the mechanical engineering department, and holds the He is director of the Berkeley Institute of Manufacturing and co-director of the Berkeley Wireless Research Center (BWRC). He obtained his degrees from the University of Birmingham, the United States in 1979 following appointments at the New Zealand and Cambridge University England. He is also National Academy of Engineering.

Ryan McCarthy

Science and Technology Policy Fellow, California Council on Science

McCarthy recently completed the UC Technology Policy Fellowship in the office of California Assembly Member Wilmer Amin advised on issues associated with energy, utilities, and the others. McCarthy holds a master and doctorate degree in environmental engineering from UC Davis, and a bachelor's degree in UC San Diego. His expertise lies in transportation and energy specifically regarding the electricity grid in California and vehicles on energy use and emissions in the state.

Appendix D - Written Submission Authors

Written Input Received from:

Physical Sciences/Engineers

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Biologists/medical

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Asher Sheppard, Ph.D., Asher Sheppard Consulting, trained in physics, medicine, and neuroscience
Magda Havas, B.Sc., Ph.D., Environmental & Resource Studies, Trent University, Peterborough, Canada
Cindy Sage, MA, Department of One Health, Umeå University, Sweden
Ray Neutra, MD, Ph.D., Epidemiologist, retired Chief of the California Department of Public Health

Appendix Additional Materials Consulted

All sources can be accessed through the IARC website at

American Academy of Pediatrics

- The Sensitivity of Children to American Academy of Pediatrics (August 13, 2005)

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)

- www.arpansa.gov.au Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)
- [Radiation Protection Committee on Electromagnetic Energy Public Health \(Fact Sheet\)](#) Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) (May 2010)
- [Radiation Protection Committee on Mobile Telephones and Health Effects](#) Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) (2010)

Documents from the California Department of Public Health (CDPH)

- Mixed Signals About Cellphones' Health Risks Hang Up Re The Chronicle (September 26, 2010)
- Summary of the Literature: What do we Know About (July 20, 2010)
- Brain Tumor Risk in Relation to Mobile Telephone Use: INTERPHONE International Cohort Study Oxford University Press (March 8, 2010)
- Mobile Phones and Health U.K. Department of Health
- Late Lessons from Early Warnings: Towards Realism and F David Gee, European Environment Agency (January 30, 2009)
- Statement of Finnish Radiation and Nuclear Safety Authority [Mobile Phones and Health Radiation and Nuclear Safety Authority (July 2009)
- Fact Sheet: Children and Safe Cell Phone Use Toronto Public Health (July 2008)
- Children and Mobile phones: The Health of the Following Russian National Committee on Radiation Protection (April 14, 2003)
- AFSSE Statement on Mobile Phones and Health French Environmental Health Agency (April 16, 2003)

Committee on Man and Radiation (COMAR)

- IEEE Engineering in Medicine and Biology Society Committee on Radiation (COMAR)
- COMAR Technical Information Statement on the Limits of Exposure

Radiofrequency and Microwave Energy

IEEE Engineering in Medicine and Biology Magazine (April)

Commonwealth Club of California

- Commonwealth Club of California - Title: Health Effects of Electromagnetic (Video) (November 18, 2010)

Electric Power Research Institute (EPRI)

- emf.epri.com EMF/RF Program at EPRI
Radio-Frequency Exposure Levels from SmartMeters
Electric Power Research Institute (EPRI) (November 10, 2010)
Perspective on Frequency Exposure Associated With Residential A Meter Reading Technology
Electric Power Research Institute (EPRI) (February 22, 2010)
Testing and Performance Assessment for Field Applications of Electric Power Research Institute (EPRI) (December 4, 2009)
Overview of Personal Radio Frequency Communication Technologies
Electric Power Research Institute (EPRI) (September 9, 2008)
Characterizing and Quantifying the Societal Benefits Attributable Metering Investment
Electric Power Research Institute (EPRI) (July 2008)
Metering Technology
Electric Power Research Institute (EPRI) (June 20, 2008)
The BioInitiative Working Group Report
Electric Power Research Institute (EPRI) (November 23, 2007)
An Overview of Common Sources of Environmental Levels in Fields
Electric Power Research Institute (EPRI) (September 2002)

Environmental Protection Agency

- United States Environmental Protection Agency's Response to (March 8, 2002)
United States Environmental Protection Agency's Response to (September 16, 2002)

Epidemiology

- Prenatal and Postnatal Exposure to Cell Phone Use and Children
Epidemiology July 2006

European Journal of Neurobiology Institute

- Non-Thermal Effects and Mechanisms of Interaction between Fields and Living Matter (2010)

Federal Communications Commission

- [Radio Frequency Safety FAQ's](#)
- [RF Safety Page](#)
- [Federal Communications Commission Response to Cindy Sage \(August 6, 2010\)](#)
- [FCC Certification](#)
 - [FCC Certification for the Silver Spring Networks Devices 2009](#)
 - [FCC Certification for the Silver Spring Networks Devices 2009](#)
 - [FCC Certification for the Silver Spring Networks Devices 2007](#)
 - [FCC Certification for the Silver Spring Networks 2007](#)
- [Questions and Answers about Biological Effects and Potential Radiofrequency Electromagnetic Fields](#)
Federal Communications Commission Office of Engineering & Tech (1999)
- [Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields](#)
Federal Communications Commission Office of Engineering & Tech (1997)

Food and Drug Administration

- [No Evidence Linking Cell Phone Use to Risk of Brain Cancer](#)
U.S. Food and Drug Administration (May 2010)

Health Protection Agency

- [WiFi](#)
Health Protection Agency (Last reviewed: October 26, 2009)
- [Cordless Telephones Enhanced Cordless Telecommunications \(DECT\) other Cordless](#)
Health Protection Agency (Last reviewed: September 4, 2008)

International Commission on Non-Ionizing Radiation Protection (ICNIRP)

- [www.icnirp.de](#) International Commission on Non-Ionizing Radiation Protection (ICNIRP)
- [International Commission on Non-Ionizing Radiation Protection \(ICNIRP\) on Interphone Publication](#)
International Commission on Non-Ionizing Radiation Protection (May 18, 2008)
- [ICNIRP Statement on the "Guidelines for Limiting Exposure to Electric, Magnetic, and Electromagnetic \(up to 300 GHz\)"](#)
International Commission on Non-Ionizing Radiation Protection (September 2008)
- [Epidemiologic Evidence on Mobile Phones and Tumor Risk](#)
International Commission on Non-Ionizing Radiation Protection (September 2008)
- [Exposure to High Frequency Electromagnetic Fields, Biological Consequences \(100-300 GHz\)](#)

International Commission on Radiological Protection (2009)

National Academies Press

- Identification of Research Needs Relating to Potential Biological Effects of Wireless Communication National Academies Press (2008)
- An Assessment of Potential Health Effects Exposure to PAWS Level 1 Phasors Radiofrequency (RF) National Academies Press (2005)

National Cancer Institute

- Cell Phones and Cancer Risk National Cancer Institute
- Cell Phones and Brain Cancer: What We Know (and Don't Know) National Cancer Institute (September 23, 2008)

National Institute of Environmental Health Sciences

- Electric and Magnetic Fields National Institute of Environmental Health Sciences

PG&E

- Understanding Radio Frequency (RF) PG&E
- Supplemental Report on An Analysis of Radiofrequency Fields Operation of PG&E SmartMeter Program Upgrade System Richard A. Tell, Richard Tell Associates, Inc. (October 27, 2009)
- Smart Grid: Utility Challenges (Z. M. Tang) 21st Century Andrew Tang, Smart Energy Web, Pacific Gas and Electric 18, 2009
- Summary Discussion of RF Fields SmartMeter System PG&E Richard A. Tell, Richard Tell Associates, Inc. (2005 Report)
- Analysis of Associated Fields with Operation of PG&E Automatic Reading Systems Richard A. Tell, Richard Tell Associates, Inc. and J. Mi Consultants (April 5, 2005)

Provided by Raymond Neutra

- www.ehib.org/emf The California Electric and Magnetic Fields (EMF)
- Should the World Organization (WHO) Apply the Precautionary Principle Low and High Frequency Fields Raymond Richard Neutra

Society for Risk Analysis

- Risk Governance for Mobile Phones, Power Lines and Other Society for Risk Analysis (2007)

Swedish State Radiation Protection Authority (SSI)

- [The Nordic Radiation Safety Authorities See no Need to Generated by Mobile Bas Stations and Wireless Networks](#)
Swedish State Radiation Protection Authority

University of Ottawa

- [Wireless Communication and Electromagnetic Energy and Radiofrequency Radiation](#) FAQ's
University of Ottawa RFcom

World Health Organization

- [Database of Worldwide EMF Standards](#)
- [WHO Electromagnetic Fields](#)
- [Electromagnetic Fields and Public Health Standards and Wireless Network \(Fact Sheet N°304\)](#)
World Health Organization (May 2006)
- [Electromagnetic Fields and Public Health Implications of Electromagnetic Hypersensitivity \(Fact Sheet N°298\)](#)
World Health Organization (December 2005)
- [Electromagnetic Fields and Public Health Implications of Wireless Technologies \(Fact Sheet N°198\)](#)
World Health Organization (May 2010)

Unsolicited Submissions

Documents Provided by Alexander Blink, Executive Director of Institute, Fairfax VA

- [Points and Sources Submitted for Consideration by Ale:](#)
- [Points and Sources Submitted for Consideration by Ale:](#)
- [Public Health Implications of Wireless Technologies, Cindy](#)
- [Memory and Behavior, Raj, Bioelectromagnetics Research Laboratory, University of Washington](#)

Sage Consulting

- [Assessment of Radiofrequency Microwave Radiation Emissions Smart Meters](#)
Sage Associates (January 2011)
- [Cindy Sage Letter to Julius Knapp \(FCC\) \(September 22, 2010\)](#)
- [Response Letter Cindy Sage from Julius Knapp \(FCC\) \(August 6, 2010\)](#)
- [Cindy Sage Letter to Edwin D. Mantiply \(FCC\) \(March 15, 2010\)](#)
- [Bioinitiative Report: A Rational Basis for Public Exposure Standard for Electromagnetic Fields \(EMF\) and RF](#) (SAGE PDF)
- [Bioinitiative Report: What is the Bioinitiative Report?](#)
- [Bioinitiative Report: Myocardial Function Improved by Elect Field Induction of Stress \(LAVB PDF\) hsp70](#)

- o [Bioinitiative Report: The Interphone Study](#) (1.1MB PDF) Study by Cindy Sage, Editorial Perspective
- o [Bioinitiative Report: Steps to the Mobile Phone with ELF EM](#) (1.0MB PDF)
- o [Mobile Phone Base Station Wellbeing and Health Pathophysiology](#) (August 2009)
- o [Increased Blood-Brain Barrier Permeability in Mammalian Brain after Exposure to the Radiation from Mobile Phones](#) Pathophysiology (August 2009)
- o [Public Health Implications of Wireless Technologies Pathophysiology](#) (August 2009)
- o [Genotoxic Effects of Radiofrequency Electromagnetic Fields Pathophysiology](#) (August 2009)
- o [Epidemiological Evidence for an Association Between Use of Phones and Tumor Diseases Pathophysiology](#) (August 2009)
- o [Public Health Risks from Wireless Technologies: The Critical Biologically-based Public Exposure Standards for Electromagnetic](#) (2.9MB PDF)
- o [BioInitiative Briefing for President Obama Transition Team](#)
- o [The BioInitiative Report: A Rational Basis for Public Biologically Exposure Standard for Electromagnetic](#) (1.6MB PDF) and Cindy Sage PowerPoint Presentation (November 2007)

Wilner & Associates

- o [SmartMeters and Existing Electromagnetic Pollution](#) Wilner & Associates (January 2011) **was not commissioned by CCSB**
- o [Application for Modification of the California Public Utilities Commission](#) (3.5MB PDF)

Other Documents

- [Health Canada Safety Code 6 and City of Toronto's Policy](#) (2010)
- [Transmitting Smart Meters Pose A Serious Threat To Public](#) (2010)
- [RF Safety and WiMax FAQs](#) (Addressing Perceived Health Eff) (April 2008)

Relevant Websites

- [EMF Facts](#)
- [emfacts.com](#)
- [emfsafetynetwork.org](#)
- [lbagroup.com](#)

- [NIOSH Program Centers for Disease Control and Prevention](#)
- [Radio Frequency RF Safety and Antenna FAQs](#)
- [Smart Grid Information Clearinghouse \(SGIC\)](#)
- stopsmartmeters.org

Appendix F Glossary

Access point A term typically used to describe an electronic device that provides wireless connectivity via a WAN to the Internet or a pair

Duty cycle A measure of the percentage of time that a transmitter or receiver device is in operation. A duty cycle of 100% corresponds to continuous operation (24 hours/day). A duty cycle of 1% corresponds to a transmitter that is on for 14.4 minutes/day.

Electromagnetic field (EMF) The composition of both an electric field and a magnetic field that are related in a fixed way that can convey electromagnetic energy. Electromagnetic fields are produced when electric charges are used to transmit information.

Federal Communications Commission (FCC) The Federal Communications Commission (FCC) is an independent agency of the US Federal Government that regulates interstate and international communications by radio, television, satellite, and cable. The FCC also allocates government frequencies for various communications services (the NTIA allocates non-federal frequencies). The FCC also sets limits on human exposure to radio frequency fields as set by the FCC's Office of Engineering and Technology (OET) (August 1997). Additional information is contained in OET's Bulletin (radio and television broadcast stations), (amateur radio stations), and Supplement C (mobile and portable devices).

Gigahertz (GHz) One billion Hertz, or one billion cycles per second frequency.

Hertz (Hz) The unit for expressing frequency, one Hertz (Hz) equals one cycle per second.

Megahertz (MHz) One million Hertz, or one million cycles per second frequency.

Mesh network A network providing a means for routing data, via multiple paths, between nodes. A mesh network allows for self-healing and reconfiguration around broken or blocked data paths by "hopping" from node to node until the destination is reached.

Milliwatt per square centimeter (mW/cm²) A unit of the power density through an area of one square centimeter of a watt passing through one square centimeter.

Microwatt **estimate** **(μW)** **measure** **of** **the** **power** **density** **through** **an** **area** **of** **space**, **one** **millionth** **of** **a** **watt** **passing** **through** **a** **1** **centimeter**.

Radiofrequency **(RF)** **spectrum** **is** **formally** **defined** **in** **terms** **of** **extending** **from** **0** **to** **3000** **GHz**, **the** **frequency** **range** **of**

Repeater **device** **that** **can** **simultaneously** **receive** **a** **radio** **signal** **and** **retransmit** **it** **to** **extend** **the** **range** **of** **radio** **signals**. **Repeater** **units** **are** **used** **to** **extend** **the** **range** **of** **local** **geographical** **area**.

Router **electronic** **computer** **device** **that** **is** **used** **to** **route** **data** **between** **various** **computers** **within** **a** **local** **area** **network** **or** **between** **local** **area** **networks**.

Smart **meter** **digital** **device** **for** **measuring** **consumption**, **such** **as** **natural** **gas**, **and** **sending** **the** **measurement** **to** **a** **utility** **computer** **reading** **(AMR)** **meters** **send** **usage** **information** **to** **the** **utility** **company** **via** **radio** **frequency** **communication** **infrastructure** **(AMI)** **meters** **are** **used** **to** **provide** **remote** **meter** **readings**.

Specific **absorption** **rate** **(SAR)** **measure** **of** **the** **rate** **at** **which** **radio** **frequency** **energy** **is** **absorbed** **by** **a** **mass** **of** **material**. **SAR** **is** **expressed** **in** **units** **of** **watts** **per** **kilogram** **of** **material**.

Transmitter **electronic** **device** **that** **produces** **RF** **energy** **that** **is** **transmitted** **to** **an** **antenna**. **The** **transmitted** **energy** **is** **typically** **referred** **to** **a** **radio** **transmitter**.

Wide **area** **network** **(WAN)** **network** **that** **covers** **a** **broad** **area** **such** **as** **an** **entire** **community**, **town**, **or** **city**. **Commonly**, **WANs** **are** **implemented** **using** **radio** **frequency** **connections** **and** **fiber** **optic** **connections** **can** **be** **provided** **to** **customers** **by** **wireless** **WANs**.

Wi-Fi **name** **given** **to** **the** **wireless** **technology** **used** **in** **home** **phones**, **and** **other** **wireless** **electronic** **devices** **that** **employ** **the** **IEEE** **802.11** **standard** **that** **defines** **specific** **characteristics** **of** **wireless** **local** **area** **networks**.

Appendix G - BOARD MEMBERS

- Karl S. Bitter, Chancellor Emeritus, UC Santa Cruz; and Dean Carlson Professor of Emergent UC Berkeley
- Bruce M. Alberts, Department of Biochemistry & Biophysics, UC
- Ann Aron, Provost and Dean of the School of Public Health, Professor of Pediatrics and Professor of Microbiology and Immunology, Stanford
- Warren J. Bowers, President, California Polytechnic State University, San Obispo
- Peter Cowhey, Vice-Chair, Dean, School of International Relations and Pacific Studies, UC San Diego
- Bruce B. Dealing, Vice President, University of California
- Susan Hackworth, Executive Director, California Council on Science and Technology
- Randolph H. Hale, Provost for Research Advancement of Southern California
- Charles E. Hampner, Chairman, Sierra Monolithics, Inc.
- Miriam E. Johnson, and Emeritus Vice President, Sandia National California
- Mory Ghannem, Provost, California Institute of Technology
- Bruce Margolis, Chancellor of, University of California Santa Cruz
- Tina Nares, President, CEO, and Director, Genoptix, Inc.
- Lawrence T. O'Byrne, and Principal, PQR, LLC
- Patrick P. O'Neil, Chancellor of Technology, Research Systems, of California Community Colleges
- Rollin Richmond, President, Humboldt State University
- Sam Trautman, Chancellor of, University of California, Merced

Appendix H – 2016 COUNCIL MEMBERS

- Miriam E. Cochran, Emeritus Vice President, Sandia National Laboratories, California
- Peter Cowham, Vice Chair, School of International Relations and UC San Diego
- Wanda Austin, President and CEO, The Aerospace Corporation
- Julian Bell, Professor of Economics, UC San Diego
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- Charles Kennedy, President for Health Information Technology, WellPoint, Inc
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- William Madhwar, Senior Executive Vice President of Laboratory Operation
- David W. Martin, Chairman and CEO, AvidBiotics Corporation
- Fariborz Masheghi, and Managing Principal Picoco LLC
- George H. Miller, Director, Lawrence Livermore National Laboratory
- Michael Nachreiner, Dean, Goldman School of Public Policy, UC Berkeley
- Stephen D. Rabinowitz, Vice President, Science Applications International Corp
- Jeffrey Rudolph, President and Director, California Science Center
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- James L. Sullivan, Lead, Pradour Institute for Energy Efficiency, and Professor of Management Science and Engineering, Stanford University
- S. Pete Worden, NASA Ames Research Center
- Julie Meier Wright, and CEO, San Diego Economic Development Corp
- Kathy Yelick, Director, National Energy Research Scientific Computing Center (NBS-C) Berkeley National Laboratory

Appendix I - Report Credits

□

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