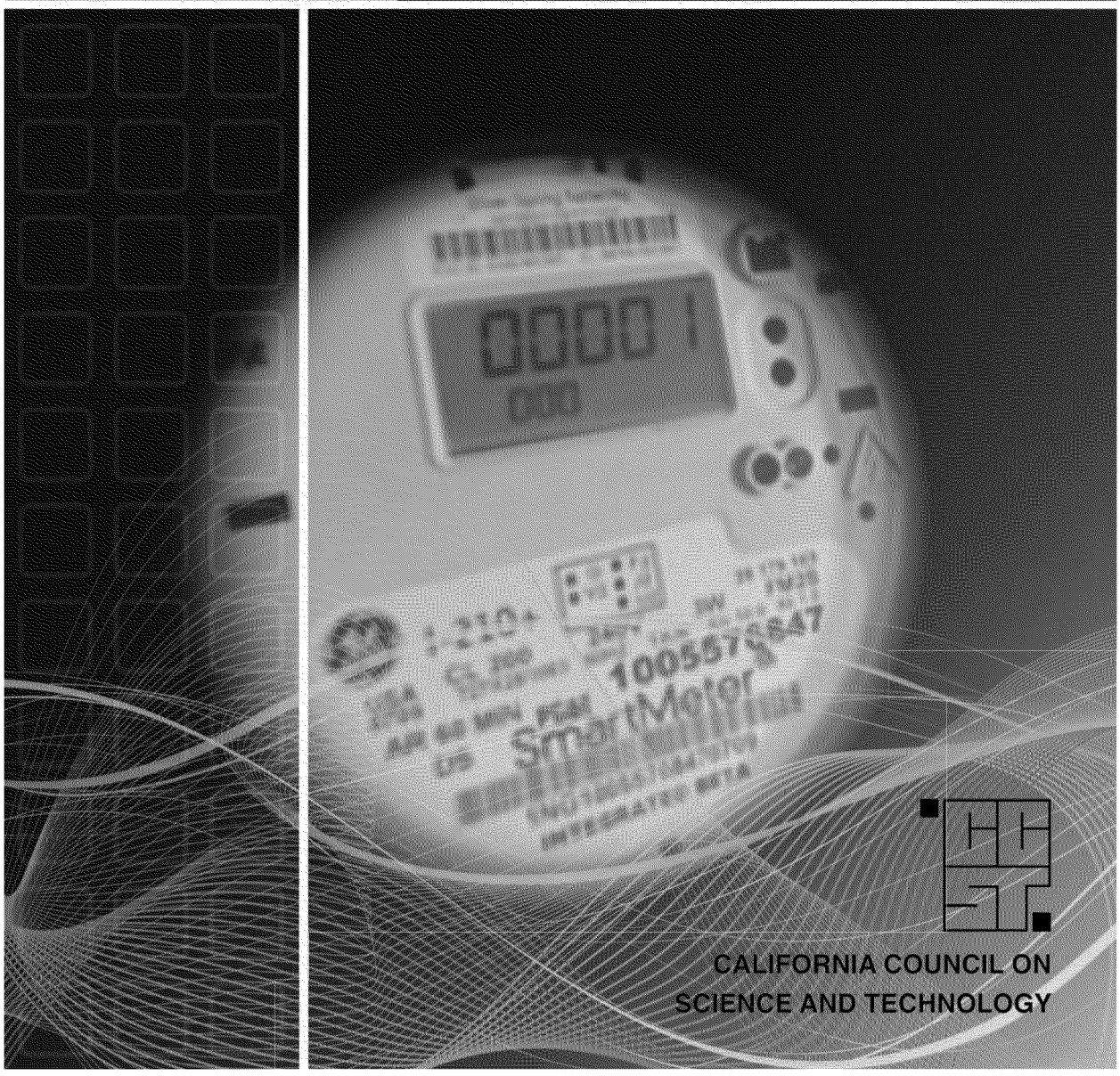
HEALTH IMPACTS OF RADIOFREQUENCY FROM SMART METERS

JANUARY 2011



CALIFORNIA COUNCIL ON
SCIENCE AND TECHNOLOGY

ACKNOWLEDGMENTS □ð

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

□ð

This □ð report □ð was □ð conducted □ð with □ð the □ð oversight □ð of □ð a □ð CCST □ð Sm members □ð include: □ð Rollin □ð Richmond □ð (Chair), □ð Emir □ð Macari, □ð Patrick □ð Man McCarthy, □ð Jane □ð Long, □ð David □ð Winickoff, □ð and □ð Warren □ð Papa. □ð We □ð also □ð thank □ð J.D. □ð Stack □ technical □ð contributions □ð and □ð Lora □ð Lee □ð Martin □ð for □ð the □ð overall □ð coor We □ð express □ð gratitude □ð to □ð CCST's □ð members □ð and □ð colleagues □ð for □ð their □ð comments □ð and □ð contributions □ð to □ð report. □ð

□ð

Cataloging □ð Number □ð in □ð Publications □ð Data □ð Main □ð Entry □ð Unde Health □ð Impacts □ð of □ð Radio □ð Frequency □ð From □ð Smart □ð Mete

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□ð

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CCST's □ð mission □ð is □ð to □ð improve □ð science □ð and □ð technology □ð policy □ð and proposing □ð programs, □ð conducting □ð analyses, □ð and □ð recommending □ð public □ð polic that □ð will □ð maintain California's □ð technological □ð leadership □ð and □ð foster □ð vigorous □ð eco

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□ð

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Letter from the CCST

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

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

The electricity issues of 2000 and 2001 helped fore the issue he significant urgency to the need for better management of powe In 2006, the California Public Utilities Commission authorized the Company to implement a relatively new technology, smart meters, precise information about power usage throughout the state. T meters throughout the state is still underway.

As with any new technology, there are unknowns involved. transmitting information wirelessly. Some people have expressed c effects of wireless signals, particularly as they become virtually have recently been brought to the attention of state legislators, opting to ban further installation of the meters in their con

We are pleased that Assembly Members Huffman and Monning on this issue. It is CCST's charge to take an independent and to recommend solutions to issues. In this have assembled a succinct but comprehensive overview of what exposure to wireless signals and they standards for these signals do so, we assembled a project team that consulted with ov through over a hundred articles and reports, providing a thorou relatively rapid manner.

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

Susan Hackwood Rollin C. Richmond

Susan Hackwood Rollin Richmond
Executive Director, CCST Project Team Chair, CCST

Health □ð Impacts □ð of □ð Radio □ð Frequency □ð from □ð Smart □ð Met
Response □ð to □ð Assembly □ð Members □ð Huffman □ð and □ð Monning
□ð
California □ð Council □ð on □ð Science □ð and □ð Technology
January 2011 □ð
□ð

KEY □ð REPORT □ð FINDINGS
1. Wireless □ð smart □ð meters □ð installed □ð and □ð maintained, □ð result □ð in □ð much □ð smalle levels □ð of □ð radio □ð frequency □ð (RF) □ð exposure □ð than □ð many □ð existing electronic □ð devices, □ð particularly □ð and □ð microwave □ð ovens.
2. The □ð current □ð FCC □ð standard □ð provides □ð adequate □ð protection □ð against □ð RF induced □ð health □ð impacts □ð of □ð existing □ð common □ð household □ð electronic meters. □ð
3. To □ð date, □ð scientific □ð studies □ð have □ð not □ð identified □ð or □ð confirmed □ *potential non-thermal* □ð health impacts □ð of □ð RF □ð emissions □ð such □ð as □ð those □ð produ common □ð household □ð electronic □ð devices □ð and □ð smart □ð meters.
4. Not □ð enough □ð is □ð currently □ð known □ð about □ð potential □ð non-thermal □ð radio □ð frec emissions □ð to □ð identify □ð or □ð recommend □ð additional □ð standards □ð f

□ð

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

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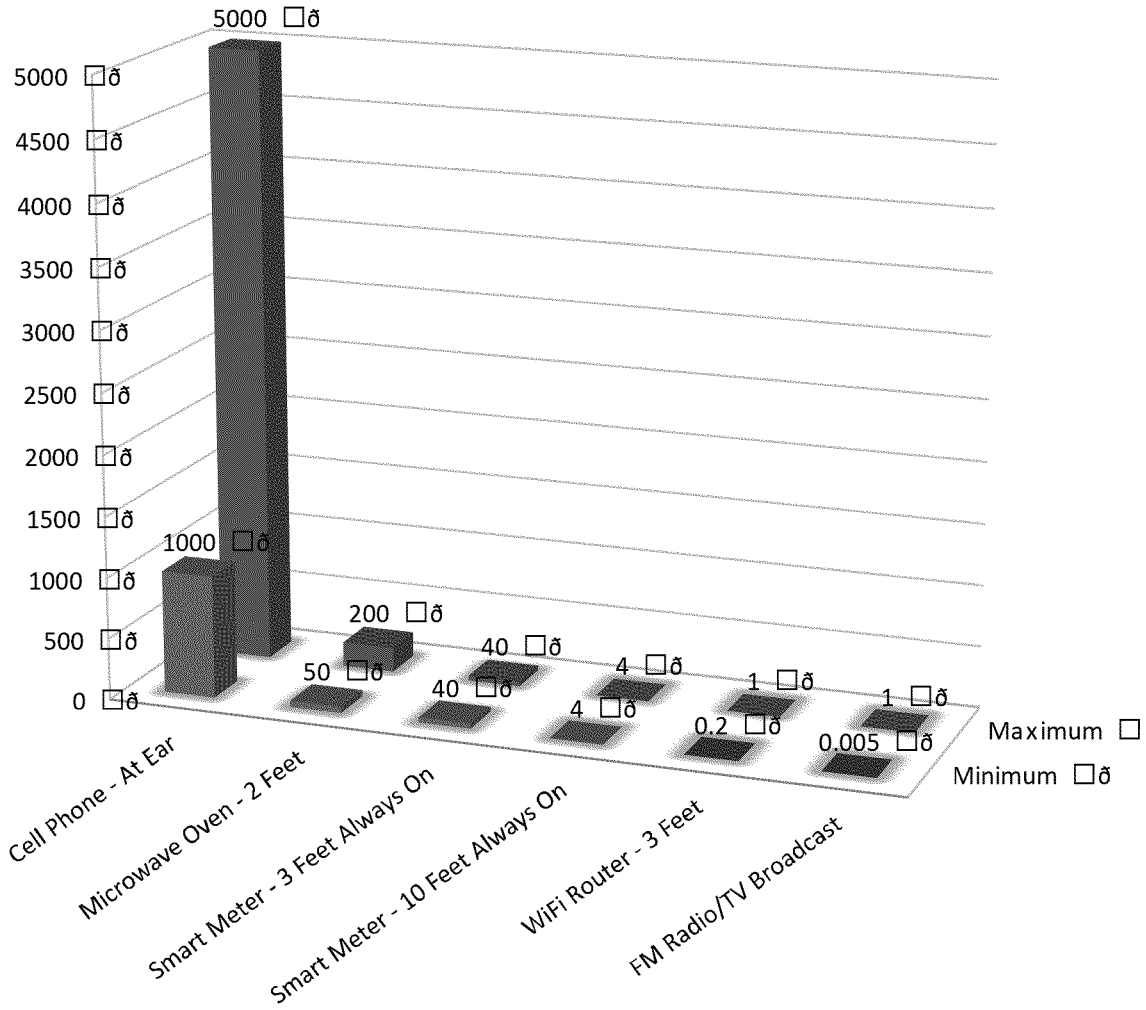

□ð

□ð

Figure □ð Comparison □ð of □ð Radio □ð Frequency □ð Levels □ð from □ð Various □ð Sources □ð in □ð

□ð

Note: □ð Exposure □ð levels □ð in □ð μW/cm□ð from □ð Table □ð 2 □ð and □ð converted □ð from □ð meter □ð figures □ð represent □ð 100% □ð duty □ð cycle □ð (i.e., □ð always □ð on) □ð as □ð

□ð

Legislative Request

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

Approach

Reflecting the requests of the Assembly Members, and CCST assessed the evidence available to address:

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

2. **Whether additional or different standards are needed for smart meters and other devices that are commonly found in and around homes to protect from adverse health effects.**

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

It is important to note that CCST has not undertaken a primary study of these issues. This response is limited to soliciting input from CCST members and evaluating available information from past and current research on emissions emitted from electric appliances generally, and smart meters specifically contacted provided written input on the issues extensively CCST. This report was reviewed by the Project Team, some experts who has related subject to CCST review process (see Appendix B). It has also been made

Two Types of Radio Frequency Effects: Thermal and Non-Thermal

Household electronic devices, such as cellular and cordless telephone wireless routers, and wireless smart meters produce RF emissions. [may lead to thermal and non-thermal effects. Thermal effects on humans extensively studied and appear to be well understood. The Fede Commission (FCC) has established guidelines to protect public health associated with the thermal impacts of RF: tissue heating from with radiofrequency emissions. Non-thermal effects, however, including cumulative prolonged exposure to lower levels of RF emissions, are not have suggested that non-thermal effects may include fatigue, headache, even cancer. *But these findings have not scientifically established, and the mechanisms to thermal effects remain unknown. Additional research and monitoring is needed better identify and understand the potential effects no*

Findings

Given the body *generally exists to the scientific knowledge* smart meters are similar electronic devices, CCST finds that:

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

   The potential for behavioral disruption from increased body to only biological health impact that has been consistently demo proven to result from absorbing RF within the band of (EMF) that smart meters use. The Federal Communications limit on the Standard Absorption Rate (SAR), from electromagnetic the level that has been demonstrated to affect behavior meters, including those being installed by Pacific Gas and 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 but safety a occur at the power levels and within the RF band us scientific knowledge, the FCC guideline incorporates a margin of safety against the known thermal effects.

2. **At this time the evidence is not sufficient to establish additional standards are needed to protect the public from smart meters or other common household**

No clear causal relationship between exposure to RF emissions and health impacts has been scientifically established the mechanisms that may cause such a biological impact been clearly identified. Additional research is needed to understand and verify these potential mechanisms.

Given the existing significant scientific uncertainty regarding the effects, and the currently no generally accepted dose-response indication that additional standards are needed. Because of the lack of generally accepted basis from which to understand what could be a appropriate threshold a clearer understanding of the biological identifying additional standards or evaluating the relative costs and standards cannot be determined at this time.

CCST notes that in some of the studies reviewed, contributors questions from some in the medical and biological fields biological impacts other than the thermal impact that the report of the National Academies identifies research needs and gaps areas of research to be undertaken to improve exposure understanding RF emissions from communication devices, particularly mechanisms that are not addressed by FCC guidelines.[1] our increasingly wireless society, smart meters very small power emissions to which exposed. Concerns about human health impacts of RF should be considered this broader context.

> "Scientifically established", "generally accepted scientific knowledge" and other throughout this document are referencing information obtained through the scientific method consists of collecting data through observation and experimentation, and the formulation and testing of These steps must be repeatable in order Scientific inquiry is generally objective as possible, to reduce biased interpretation results. Another basic expectation is that documentation, and methodology so they are available for careful scrutiny by other scientists, giving them the opportunity attempting to reproduce them. This practice, also allows statistical measures the reliability of these data to be established.

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

[1] National Research Council (2008) *Identification of Research Needs Relating to Potential Biological Health Effects of Wireless Telecommunication*, National Academies Press, Washington, D.C.

What are Smart Meters?

Smart meters measure electricity, natural 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 that utilities, customers, and regulators expected to reduce operating costs for utilities (see Figure 2).

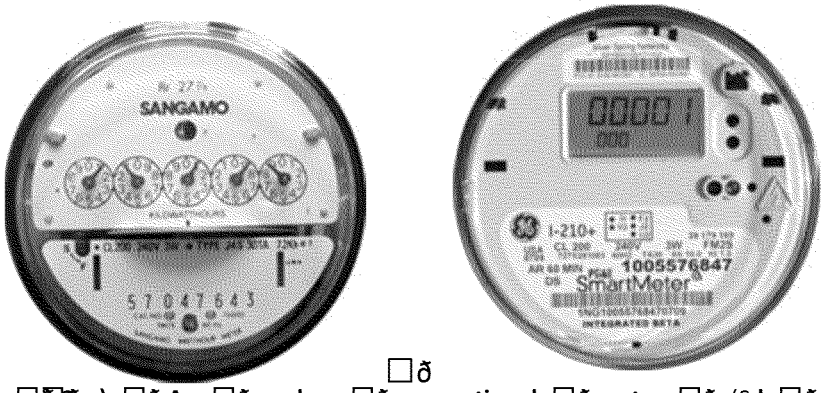

Figure 2: a) An analog, conventional meter and b) a digital smart meter

Each of California's major electricity utilities has begun deploying

There are many kinds of smart meters manufactured by a variety including sensors and the housing and casing for the communications device (installed within the meter) is manufactured upon the internal communications device employed, meters are configured wired or in wireless environment. The PG&E smart meters used by Gen and Landis + Gyr and use a wireless communications technology Each of these PG&E meters has two transmitters to provide data from these meters to provide for the "automatic meter reading" of the meter (and for real-time monitoring of the characteristics of electrical energy delivered to the consumer) and sends this data collected along with data from many other customers and transmitted area network (WAN) (similar to the way cell phone communicat

[2] Teli, R. (2008) "Supplemental Report on An Analysis of Radiofrequency Fields PG&E Smart Meter Program Upgrade System," Prepared for Pacific Gas & El Associates, Inc., October 27

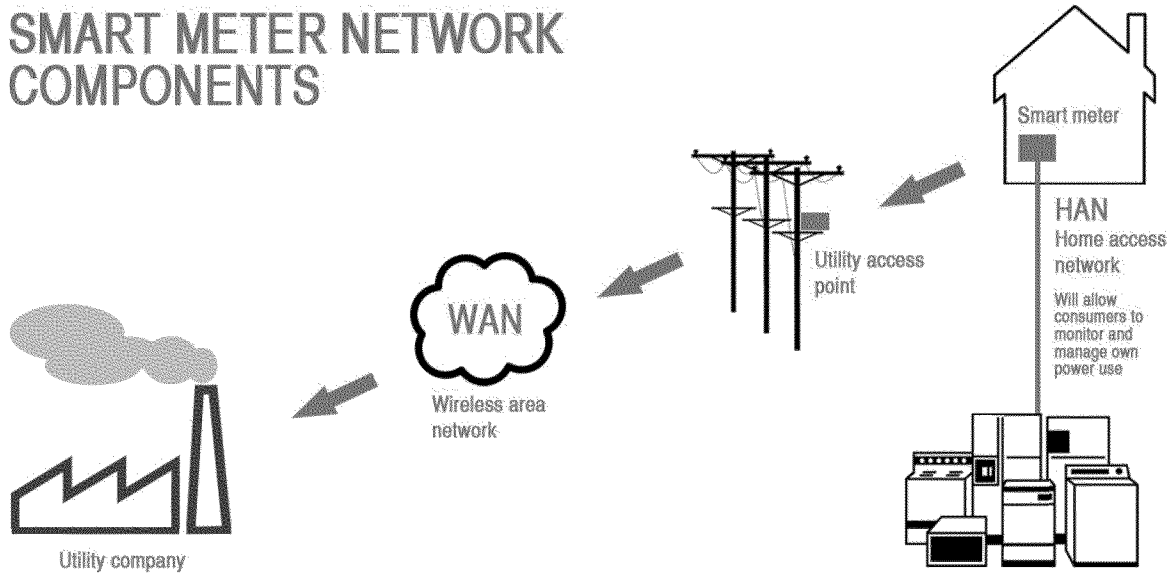

Figure 1: Simplified depiction of Smart Meter system network. Arrows show signals for automated meter reading, communications among electric power met company's enterprise management systems. The future home access network wi

Smart meters have evolved from automatic meter reading (AMR), replacing meter readers to a real time monitoring of power as delivered to the obtained from PG&E and Richard Tell Associates, which reports describes the operation of smart meters from the perspective of , deployed real time smart The Richard Tell Associates report used of the smart meters radios by PG&E and by the FCC for a maximum power output of 928 MHz frequency band. In its initial deployment of PG&E configure the radios to transmit data from the meters hours, for about 50 milliseconds[3] during for this, the current duty cycle meter transmitter (that is, the percent of time that the me 1 percent, or in some cases entire used as meter relay fre m percent. This means that the typical smart meter would in both instances transmit *any RF signal the percent of the time.*

It is important to note that any one smart meter and its compa act as a relay among other smart meters and utility access grid is fully functional the smart meters would be connected once every four hours, providing data in a much highe

[3] Tell, R. (2008) "Supplemental Report on An Analysis of Radiofrequency Fields PG&E Smart Meter Program Upgrade System," Prepared for Pacific Gas & El 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 this hypothetical scenario where the smart meter is continually transmitting. Even in this 100% duty cycle situation below the limits

Smart meters are designed to transmit data to a utility access point on a utility or light pole. These access points are connected to a similar AMR smart meters, as well as communicates with utilities and to wireless cards used in typically operate at 0.25 W in the 900 MHz band.

In some cases, the meter relaying the data meters to the access point. This may occur when the transmission of data from a smart meter to the relaying of data may occur between one smart meter and to the utility access point (e.g., hops along a meter's data to relays will also exist in order to connect 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 communi and the future smart grid. This functionality is important to t smart grid. This second internal transmitter, for delivery of reportedly will operate at a 2.4 similar to that of cell phones and wireless phones). The depend on the design and operation of network.

Why are Smart Meters Being Installed T

It is anticipated, when fully operational, that smart meters are a key technology for a "smart grid" that is expected to become and safe (see Figure 3) at a potential lower cost to the used for reading 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 the end-user adjustments can help to protect the overall reliability of utility customers, and improve the operation and efficiency of th grid will enable grid operators to supply and demand in re which becomes increasingly important as more intermittent wind an resources are added to the grid.

Figure depicts the potential operation of a smart grid.

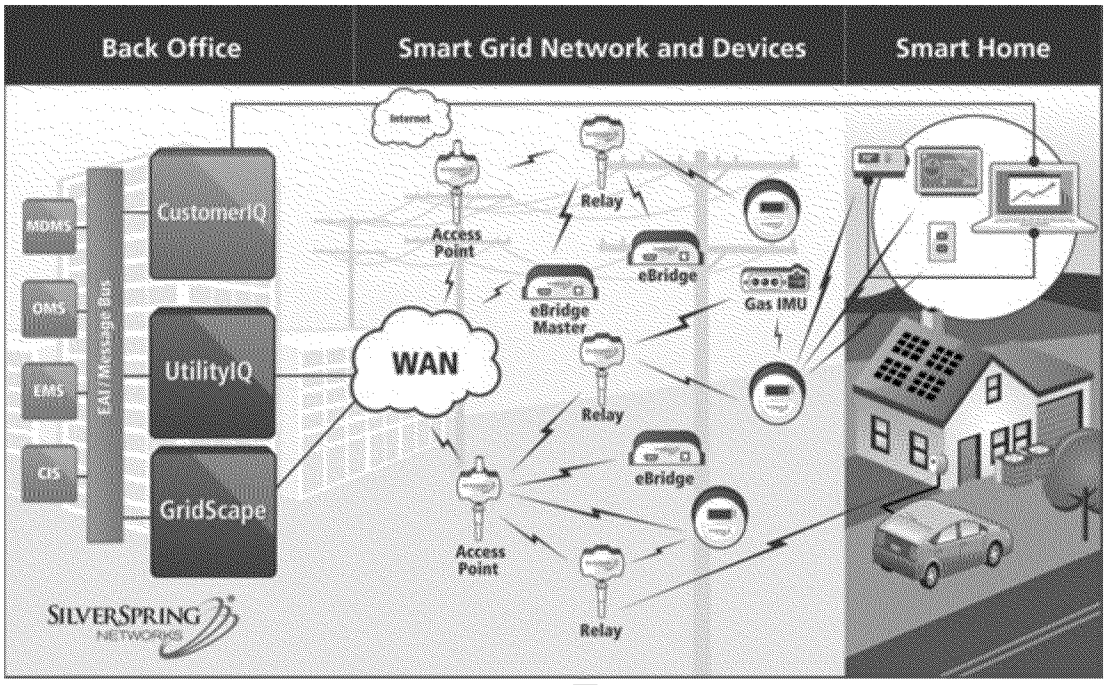

Figure 1: Illustration of components of the PG&E Smart Meter Program Upgrade radiofrequency (RF) signals for communications among electric power meters, and ultimately, the company's enterprise management systems. Source: Silver Spring Networks[4]

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

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

[illegible]

[4] See http://www.silverspringnet.com/products/index.html for component descriptions. The infrastructure includes the Silver Spring Access Points and Relays that forward data from endpoints the utility's backhaul or WAN infrastructure into the back office.

The UtilityIQ application incorporates both utility applications such as Meter and Outage Detection as well as administrative programs for managing and upgrading the network management for DA communications networks.

The CustomerIQ web enables utilities to directly communicate usage, pricing, and reconsumers. Silver Spring software each utility to customize the information portrayed specific information such as rate schedules.

grid □ð networks, □ð including □ð the □ð use[5] □ð of □ð advanced □ð smart □ð meters. □ð In □ð addition □ð to California □ð Public □ð Utilities □ð Commission[6] □ð in □ð California □ð have □ð begun □ð to □ð instal throughout □ð the □ð state. □ð □ð Some □ð California □ð utilities □ð (such □ð as □ð Sacrame have □ð received □ð significant □ð federal □ð funding □ð to □ð help □ð support □ð from □ð the □ð Ame Recovery □ð and □ð Reinvestment □ð Act □ð (federal □ð stimulus □ð package). □ð Many □ð co are □ð actively □ð deploying □ð smart □ð meters □ð as □ð well. □ð Digital □ð smart □ð meter the □ð fundamental □ð technology □ð to □ð enable □ð widespread □ð integration □ð of □ð info technology □ð (IT) □ð into □ð the □ð power □ð grid □ð (i.e., □ð the □ð smart □ð grid). □ð Th summarizes □ð some □ð potential □ð societal □ð benefits □ð expected □ð to □ð result □ð from

□ð

Table □ð 1: □ð Smart □ð Grid □ð Benefits □ð

Consumers □ð □ð	**Environment** □ð □ð
1. Cost □ð Savings □ð Resulting □ð from □ð Reduced □ð Electricity □ð Consumption □ð 2. Increased □ð Consumer □ð Choice □ð and □ð Control □ð 3. □ð More □ð Transparent □ð Time-Based □ð Information □ð and □ð Control □ð for □ð Consumers	1. Widespread □ð Deployment □ð of □ð Renewable □ð Energy □ð (Solar, □ð Wind, □ð Biofuels) □ð and □ð Electric □ð Vehicles □ð (EVs) □ð 2. Reduced □ð Need □ð to □ð Build □ð More □ð Power □ð plants □ð 3. □ð Reduced □ð Carbon □ð Footprint □ð and □ð Pollution □ð (via □ð Renewables, □ð Energy □ð Efficiency, □ð Electric □ð Vehicles) □ð
Utilities □ð □ð	**Economy** □ð □ð
1. □ð Reduced □ð Cost □ð Due □ð to □ð Increased □ð Efficiency □ð in □ð Delivering □ð Electricity □ð and □ð Reduction □ð in □ð Manpower □ð to □ð Read □ð and □ð Meters. 2. Improved □ð Reliability □ð and □ð More □ð Rapid □ð Outage □ð Response □ð 3. Increased □ð Customer □ð Satisfaction □ð Due □ð to □ð Increased □ð Savings □ð and □ð Control □ð	1. Creates □ð New □ð Market □ð for □ð Goods □ð and □ð Services □ð (e.g., □ð New □ð Companies, □ð New □ð Jobs) 2. □ð Building □ð Workforce □ð to □ð be □ð Prepared □ð for □ð Jobs □ð 3. □ð Reduced □ð Dependence □ð on □ð Foreign □ð Oil □ð Dollars □ð at □ð Home

Source: □ð □ð California □ð Smart □ð Grid □

□ð

What □ð Health □ð Concerns □ð are □ð Associated □ð with □ð Smart □ð Meters?

□ð

Human □ð health □ð impacts □ð from □ð exposure □ð to □ð electromagnetic □ð frequency □ð depending □ð on □ð the □ð frequency □ð and □ð power □ð of □ð the □ð fields. □ð □ð Smar in □ð the □ð RF □ð portion □ð of □ð the □ð electromagnetic □ð spectrum □ð from □ð smart □ð At □ð thes

[5] The □ð federal □ð Energy □ð Independence □ð and □ð Security □ð Act □ð of □ð 2007 □ð directs □ð states □ð t grid □ð program □ð allows □ð recovery □ð of □ð smart □ð grid □ð investments □ð through □ð utility □ð rates, □ð ar smart □ð grid □ð investments. □ð □ð The □ð American □ð Recovery □ð and □ð Reinvestment □ð Act □ð of □ð 2 smart □ð grid □ð infrastructure □ð and □ð information. □ð For □ð more □ð information □ð on □ð U.S. □ð see: □ð □ð Congressional □ð Research □ð Service □ð (2007) Independence □ð and □ð Security □ð Act □ð of □ð 2007: □ð A □ð Summary □ð of □ð Major □ð Provisions," □ð CRS RL34294, □ð December 21, □ð 2007 (http://energy.senate.gov/public/_files/RL342941.pdf) □ð

[6] California □ð Public □ð Utilities □ð Commission □ð decision □ð C12-09-012 (Application □ð 12-08-009, □ð 2009). □ð Decision □ð on and □ð Electric □ð Company's □ð Proposed □ð Upgrade □ð to □ð the □ð Smartmeter □ð Program.

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

Thermal Effects □ð

Electromagnetic □ð waves □ð carry □ð energy, □ð and □ð EMF □ð absorbed □ð by □ð the □ð body □ð increases □ð the □ð temperature □ð of □ð human □ð tissue. □ð The □ð intensity □ð of □ð the □ð body □ð temperature □ð must □ð increase □ð at □ð least □ð 1°C □ð to □ð lead □ð to □ð potential □ð biological □ð impacts □ð from □ð the □ð effect □ð that □ð has □ð been □ð shown □ð to □ð occur □ð in □ð the □ð power □ð meters □ð are □ð designed □ð to □ð not □ð exceed □ð an □ð increase □ð of □ð 1°C □ð in □ð order □ð to □ð avoid □ð behavior □ð at □ð energy □ð levels □ð of □ð 4 □ð W/kg □ð and □ð with □ð an □ð accompanying □ð increased □ð body □ð exposure □ð levels □ð from □ð smart □ð meters □ð have □ð been □ð shown □ð to □ð be □ð thousands □ð of □ð times □ð lower □ð than □ð those □ð that □ð has □ð set □ð limits □ð on □ð power □ð densities □ð from □ð electronic □ð devices □ð that □ð where □ð demonstrated □ð biological □ð impacts □ð occur, □ð and □ð the □ð limits □ð are □ð tens □ð of □ð times □ð more □ð likely □ð exposure □ð from □ð smart □ð meters.

□ð

Non-thermal Effects □ð

There □ð are □ð emerging □ð issues □ð in □ð the □ð medical □ð and □ð biological □ð fields □ð about □ð effects □ð caused □ð by □ð non-thermal □ð mechanisms □ð of □ð absorbed □ð RF □ð energy □ð on □ð health □ð impacts □ð from □ð “electromagnetic □ð stress” □ð have □ð been □ð reported, □ð with □ð symptoms □ð of headache, and □ð irritability. □ð Some □ð studies □ð have □ð suggested □ð that □ð RF □ð exposure □ð from cell phones □ð may □ð disrupt □ð communication □ð between human, □ð which □ð may □ð lead □ð to □ð other impacts □ð on □ð human □ð biology. □ð Some □ð of □ð the □ð concerns □ð of □ð brain □ð cancer □ð associated □ð with mobile □ð phone usage □ð persist, □ð there □ð is □ð currently □ð no □ð definitive □ð evidence □ð linking □ð cell phone use to an increased incidence □ð of □ð brain □ð cancer □ð due □ð to □ð the □ð recent □ð nature □ð of □ð the □ð technology □ð and □ð the □ð low exposure □ð are □ð not □ð known. □ð Ongoing □ð scientific □ð studies □ð are □ð trying □ð to □ð understand □ð the □ð long-term thermal □ð effects □ð from □ð exposure □ð to □ð cell phones □ð and □ð smart □ð meters, □ð especially □ð

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[7] D’Andrea, □ð J.A., □ð Adair, □ð E.R., □ð and □ð J.O. □ð de □ð Lorge □ð (2003) □ð Behavioral □ð and □ð cognitive *Bioelectromagnetics* Suppl □ð 6 □ð 62 □ð (2003).

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

[9] Markova, □ð E., □ð Malmgren □ð and □ð I.Y. □ð Belyaev □ð (2009) □ð Microwave □ð mobile □ð phones □ð inhibit □ð 53PB1 □ð focus formation □ð in □ð human □ð stem □ð cells □ð stronger □ð than □ð in □ð differentiated □ð cells: □ð Possible □ð Environmental □ð Health □ð Perspectives, □ð doi:10.1289/ehp.0900781.

[10] Nittby, □ð H., □ð Grafstrom, □ð G., □ð Eberhardt, □ð J.L., □ð Malmgren, □ð L., □ð Brun, □ð A., □ð Persson □ð Radiofrequency □ð and □ð Extremely □ð Low □ð Electromagnetic □ð Field □ð Effects □ð on □ð the Blood Electromagnetic □ð Biology □ð and □ð Medicine, □ð 27:103-126, □ð 2008 □ð

[11] Elliott, □ð A., □ð Feychting, □ð M., □ð Green, □ð A., □ð Kheifets, □ð L., □ð Savitz, □ð D. □ð A., □ð and □ð Ahlbom on □ð mobile □ð phones □ð and □ð tumours. *Epidemiology* 20(3): 316-22; □ð (2009).

the cumulative impact of emissions from all sources, including that of a network operating throughout a community.[12]

There currently is no conclusive scientific evidence to establish a definitive link between human exposure to RF and negative health impacts. For this reason, regulators and policymakers be prudent to call for more research before acceptable human exposure limits on currently proven scientific and effects, known thermal effects, rather than on general concerns or speculation and as yet unproven effects. It will likely take considerable time to resolve these questions. While data that are available strongly suggest that thermal effects of RF absorption on human health, such effects are not so profound

FCC Guidelines Address Known Effects Only, Not Potential Effects

In 1985, the FCC first established guidelines to limit human exposure to thermal effects of RF emissions. The guidelines were based on American National Standards Institute (ANSI) that were issued by the FCC in 1986,[13] and modified its guidelines in 1992 on a rulemaking process that began in 1990.[14] The revision to the ANSI guidelines was based on findings by the National Council on Radiation Protection and Measurements (NCRP).[15] The 1996 guidelines are still in place.[16][17]

In its rulemaking process to set SAR and MPE limits, the FCC safety agencies, including the U.S. Environmental Protection Agency and Administration. While the FCC guidelines appear to provide a known thermal effects of exposure to radiofrequency energy, they do not potential athermal effects, nor do they address additional to understanding of these effects, there is inadequate basis to develop additional gu

[12] National Research Council (2008). *Identifying Future Research Needs Relating to Potential Biological and Health Effects of Wireless Telecommunications*. 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 C95.2-1982, Institute of Electrical and Electronics Engineers, Inc.

[14] FCC (1997) "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields," OET Bulletin 65, Edition 97-01, 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 Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," previously ANSI C95.1-1991, ANSI/IEEE C95.1-1992, Institute of Electrical and Electronics Engineers, Inc.

[16] American National Standards Institute (1992) "Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave," ANSI/IEEE C95.3-1991, Institute of Electrical and Electronics Engineers, Inc.

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

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

The FCC guidelines measure exposure to RF emissions in two ways. Specific absorption (SAR) measures the rate of energy absorption per unit mass measured body weight (W/kg). It accounts for the thermal effects on human heating body tissue and is the measurement used for devices, such as mobile phones, that are used in close proximity to the human body.[19] The FCC limits, as well as underlying ANSI and NCRP limits, are based on the SAR. Data from the three FCC rulemakings and still today, behavioral disruption in laboratory animals human primates) at this absorption rate is the only adverse effect linked to RF at levels similar to those emitted by smart meters.[20, 21] scientific literature and by the World Health Organization and many Europe.[22, 23] The FCC limit of 1.6 W/kg provides a significant safety threshold.

Limits on SAR provide a measurement for localized exposure, the maximum permissible exposure (MPE) limits average exposure over a given time period general exposure) from a device and is often used for exposure human exposure likely to occur at a distance of more than 20 (10^6) watts per square centimeter ($\mu W/cm^2$), and accounts for the fact that absorbs energy more efficiently at some radiofrequencies than other absorbs energy most efficiently in the 30 MHz range and of the 30 corresponding for RF emissions are in this range the most stringent. In the where smart meters operate, including 902 MHz and 2.4 GHz range, the human body absorbs energy less efficiently, and the

The FCC limits are summarized in Figure 5 appropriate for of the AMR transmitter of the smart meter, the FCC

[19] FCC (2001) "Additional Information for Evaluating Compliance of Mobile and P Human Exposure to Radiofrequency Emissions," Supplement C to OET Bulletin 65 (Edition Federal Communications Commission, June. (http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65c.pdf)

[20] D'Andrea, J.A., Adair, and E.J.O. de Lorge (2003) Behavioral and cognitive effects *Bioelectromagnetics Suppl* (2003)

[21] Sheppard, A.R, Swicord, M. L., and Q. Balzano (2008) Quantitative evaluations interactions between biological molecules and *Health Physics* (2008)

[22] The World Health Organization has reviewed international guidelines for limiting scientific studies related to human health impacts below guidelines limits exposure to have health consequences. (http://www.who.int/peh-emf/standards/en/)

[23] Committee on Man and Radiation (COMAR) (2009) "Technical review information Statement potential health effects of radiofrequency electromagnetic fields and comments on Health Physics (2009)

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

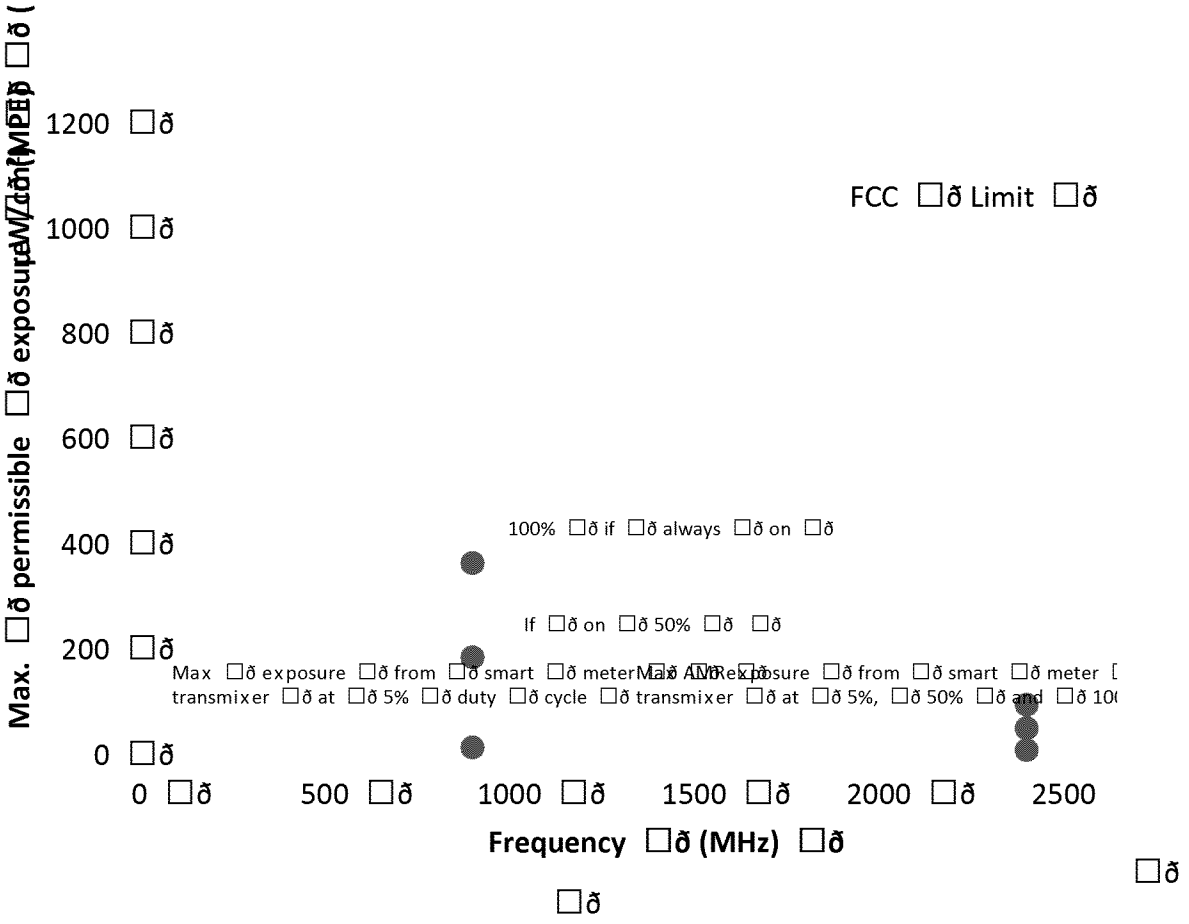
[25] FCC (1999) "Questions and Answers about Biological Effects and Potential Haz Electromagnetic Fields," OET Bulletin 56 (Fourth Edition), Federal Communications Co (http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet56/oet56e4.pdf)

the human body even at its energy, and the threshold for the 2.4
home area network communications is consequently higher, 1000 μW/cm²
PG&E commissioned a study by Richard Tell Associates, Inc. titled "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 for safety, and found that the perceived hazardous exposure times higher than the FCC limits.[26] The study estimates that the highest exposure meters, if an individual were standing directly in front of an μW/cm² transmitting at full time. The study notes that this than the FCC 100% limit and less than the demonstrated hazard level individuals will be away from smart meters (within the structure) where power density will be much lower. The smart meter system would occur immediately adjacent to an that an individual would be immediately adjacent to the and are located 25 feet above the ground on a telephone or electric power density from an access point is, estimated to be 24.4 than the FCC limit. Exposure to the power density from access estimated to be 15,000 times less than the FCC limit in device.

The PG&E commissioned by Richard Tell Associates, Inc. is based on an AMR duty cycle of smart data once every four hours. In this very low estimate However, we are not aware of the justification for using a duty do know that FCC allows averaging of exposure over 30 minutes. truly be a smart grid the data will be transmitted at a this report we look at a worst meter that is stuck in constantly relaying, at a 100% duty cycle. In RF emissions measurably below the FCC limits for thermal effects.

[26] Tell, R. (2008) "Supplemental Report on An Analysis of Radiofrequency Fields PG&E Smart Meter Program Upgrade System," Prepared for Pacific Gas & 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



□ð

Figure □ð 5. □ð □ð FCC □ð maximum □ð permissible □ð exposure □ð limits □ð on □ð power □ð density □ð r
body □ð can □ð safely □ð absorb □ð more □ð energy □ð at □ð the □ð highest □ð maximum □ð exposure □ð f
AMR □ð transmitter □ð at □ð 5% □ð duty □ð cycle □ð (ie, □ð 7 □ð minutes/day) □ð and □ð 100% □ð of □ð the
limit. □ð Even □ð if □ð a □ð meter □ð malfunctioned □ð and □ð was □ð transmitting □ð 24 □ð hours □ð a □ð day, □ð always
exposure □ð levels □ð would □ð be □ð far □ð below □ð the □ð FCC □ð limit □ð if □ð the □ð transmitt
Exposure □ð figures □ð from □ð November □ð 2010 □ð Electric □ð Power □ð Research □ð Institute □ð (EPRI)
entitled □ð "Radio □ð Frequency □ð Exposure □ð Levels □ð from □ð Smart □ð Meters"[28]

□ð

Power □ð Density □ð (and □ð Exposure □ð Level) □ð Decreases □ð Rapidly □ð with □ð D

□ð

The □ð power □ð density □ð from □ð smart □ð meter □ð devices □ð that □ð emit □ð RF, □ð falls distance. □ð □ð □ð this □ð affect □ð for □ð an □ð example □ð smart □ð meter. □ð maximum □ð exposure □ð level □ð at □ð 1 □ð foot □ð from □ð the □ð meter □ð is □ð below □ð the □ð FCC □ð guidelines □ð of □ð the □ð exposure □ð approaches □ð zero. □ð □ð

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

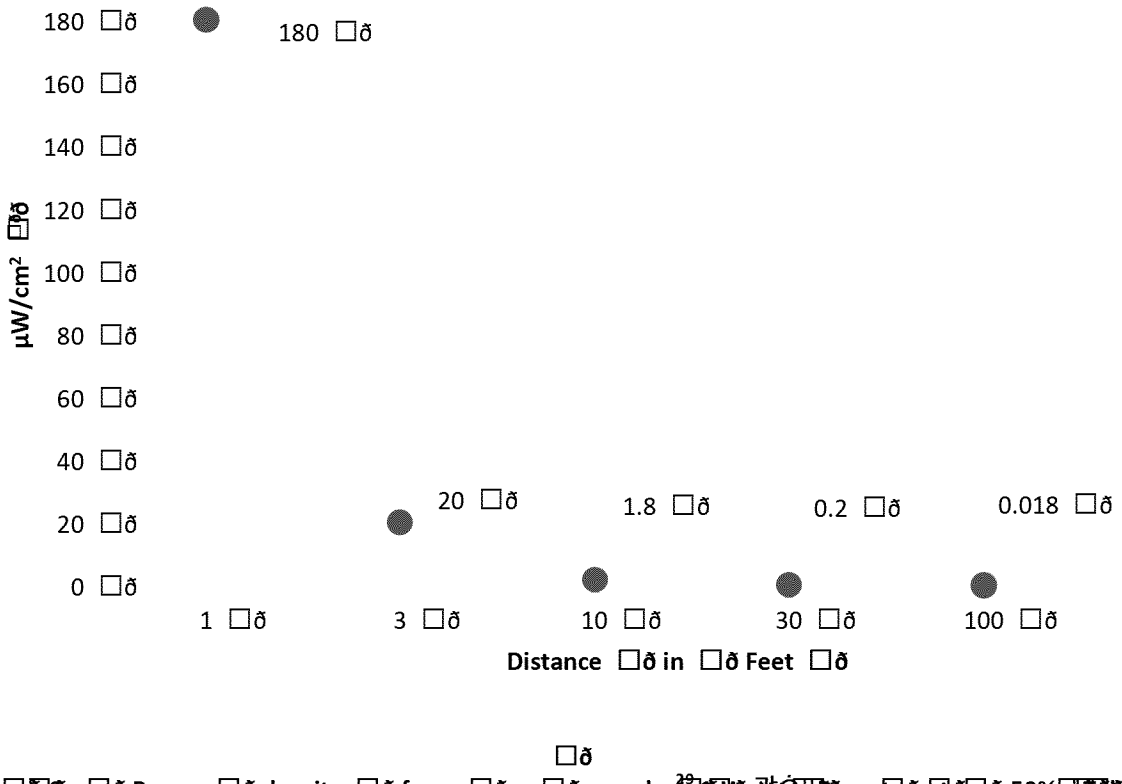


Figure 1. Power density from a sample; 1 watt meter at 50% duty cycle. smart meter AMR transmitter power density with distance drop of power with distance (inverse law) is similar for various duty cycles and differe

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 microwaves and ovens, wireless routers, hair dryers, and laptop wireless routers.

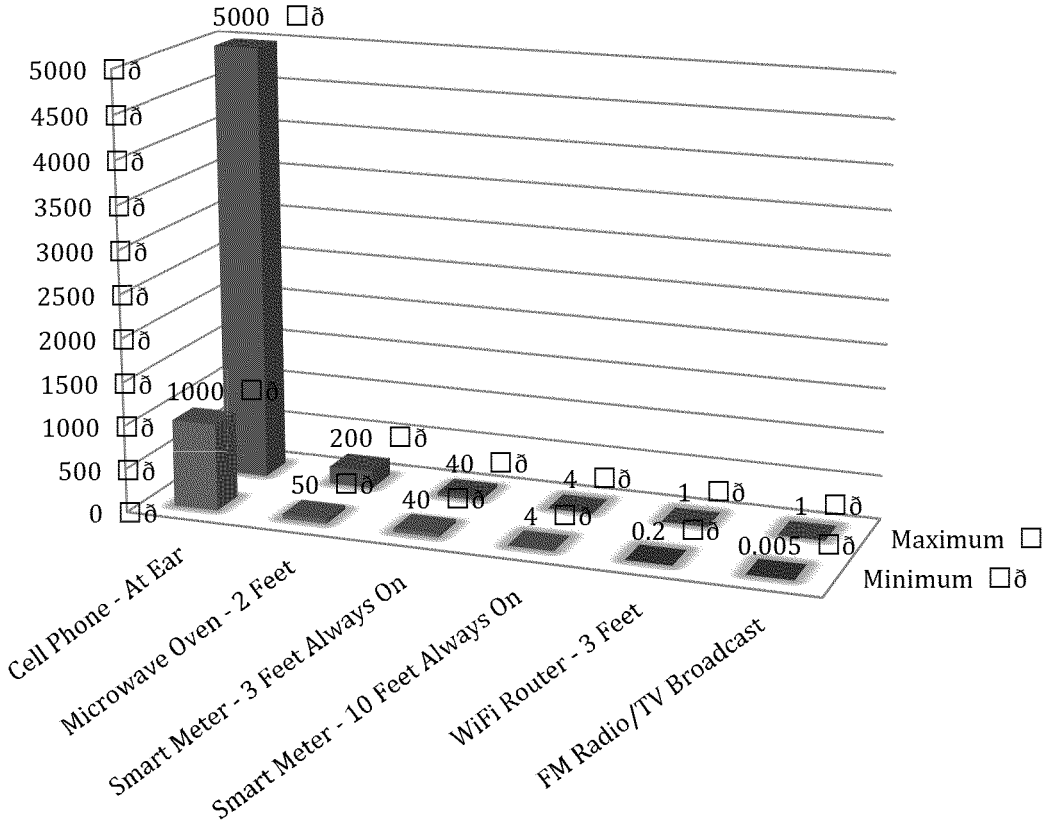
In addition to slight differences in frequency and power levels, of RF from these devices, the primary difference among them phones, for example, are often used for many minutes a day, and held directly next to one's head.

For perspective, microwave ovens operate at a similar frequency smart meters (2.45 GHz), and the U.S. Food and Drug Admi levels are five thousand times (5 the FCC limit for smart devices operating at 2.4 GHz routers and equipment produce radiofrequency

[29] EPRI (2010). Frequency Exposure Levels from Electric Power Research Institute, 2010.

[30] FDA, "Summary of the Electronic Product Radiation Control Provisions of the Act," U.S. Food and Drug Administration (http://www.fda.gov/RadiationEmittingProducts/ElectronicProductRadiationControlProgram/LawsandRegulations/ucm118156.htm)

fields □ð of □ð about □ð 1,000 □ð μW/cm[2][31][32][33] □ð /cm[2] □ð in □ð metropolitan □ð areas □ð are □ð exposed radiofrequency □ð from □ð radio □ð and □ð television □ð antennas, □ð as □ð well, □ð although population, □ð exposure □ð is □ð quite □ð low, □ð around □ð 0.005 □ð μW □ð /cm[2][34] □ð



□ð

□ð

Figure □ð Comparison □ð of □ð Radiofrequency □ð Levels □ð from □ð Various □ð Sources

□ð

Note: □ð Exposure □ð levels[2] □ð obtained □ð in □ð μW/cm[2] □ð Table □ð 2 □ð and □ð converted □ð to □ð V/m □ð from □ð meter □ð figures □ð represent □ð 100% □ð duty □ð cycle □ð (i.e., □ð always □ð on) □ð as □ð

□ð

[31] "Radio-Frequency □ð Exposure □ð Levels □ð from □ð White □ð Spaces □ð Devices," □ð Rob □ð Kavet □ð and □ð Gabor □ð *Electric □ð Power □ð Research □ð Institute* □ð (EPRI), □ð November □ð 20[illegible] □ð

[32] Foster, □ð K.R. □ð (2007) □ð Radiofrequency □ð exposure □ð from □ð wireless □ð LANs □ð utilizing □ð WI *Physics*, □ð Vol. □ð 92, □ð No. □ð 2, □ð March, □ð pp. □ð 280

[33] Schmidt, □ð G. □ð et □ð al. □ð (2007) □ð Exposure □ð of □ð the □ð general □ð public □ð due □ð to □ð wirel Places, *Radiation □ð Protection □ð Dosimetry* □ð Vol. □ð 123, □ð No. □ð 1, □ð June □ð 11, □ð pp. □ð 48

[34] EPA □ð (1986) □ð The □ð Radiofrequency □ð Radiation □ð Environment: □ð Environmental □ð Exposure □ð Levels Emitting □ð Sources, □ð EPA □ð U.S. □ð Environmental □ð Protection □ð Agency, □ð July.

□ð

Table □ð 2: □ð Frequency □ð Levels □ð from □ð Various □ð Sources

□ð

Source □ð	Frequency □ð	Exposure □ð Level (mW/cm^2) □ð	Distance □ð	Time □ð	Spatial □ð Characteristic □ð
Mobile phone □ð	900 □ð MHz, □ð 18	1—5 □ð	At □ð head	During □ð call	Highly □ð localized
Mobile phone □ð base station □ð	900 □ð MHz, □ð 18	0.000005—0.002 □	10s □ð to □ð a thousand □ð feet	Constant □ð	Relatively uniform □ð
Microwave □ð oven	2450 □ð MHz	~50.05 0.2	2 □ð inches2 □ð	During □ð use	Localized, □ð nonuniform □ð
Local □ð area □ð net	2.4—5 □ð GHz	0.0002—0.001 □ð 0.000005—0.0002	3 □ð feet	Constant □ð when nearby □ð	Localized, □ð nonuniform □ð
Radio/TV □ð broadcast	Wide □ð spectrum	0.001 □ð (highest □ population) □ð 0.000005 □ð (50% population) □ð	Far □ð from □ð source most □ð cases	Constant □ð	Relatively □ð uniform
Smart □ð meter	900 □ð MHz, □ð 24	0.0001 □ð (250 □ð duty □ð cycle) 0.002 □ð (1 □ð W, cycle) 0.000009 □ð (250 1% □ð duty 0.0002 □ð (1 □ð W, duty □ð cycle)	3 □ð feet □ð □ð □ð 10 □ð feet	When □ð in □ð pr during □ð transmiss	Localized, □ð nonuniform □ð

□ð

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

What is Duty Cycle, How Does it Affect Human Health?

Duty cycle refers to the fraction of time a device is transmitting. A transmits RF energy 1% of a given time period. One hundred percent of the day. The lower duty cycle, or signal modulation, the more comparing exposures from kinds of devices, Wi-Fi routers, smart meters, microwave ovens, FM signals).

Duty cycle of devices vary considerably. The duty cycle of AM/FM radio words, they are transmitting continuously. Mobile phone usage varies widely from user to However, the national average is about 45 This usage equates to “average” user.

From information that the CCST was able to obtain we understand that the PG&E operates with a maximum power output of 1 W (30 dBm) in the 902-928 MHz band. Each smart meter is part of a broader “mesh” network and 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 use of the communications paths in the mesh network.

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

Typical Smart Meter Operation With Repeater Activity	Scaled Hypothetical Maximum Use (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 Research Institute reported Radio Frequency Exposure Levels from Smart Meters, column hypothetical maximum derived through extrapolation of first column exposure levels at 1 foot distance.

In summary, the duty cycles of smart meters, typical operation, operation result in exposures of the FCC exposure guidelines, a hypothetical always scenario the maximum exposure would be about of the FCC limit, which provides a with known thermal effects of RF emissions.

What Abo exposure E Levels of Meters Bank and from Just Behind the Meter?

In a November 2010 study Electric Power Research Institute (EPRI)[35] measured exposure levels from bank of 10 to 250 mW power level at one foot distance bank of smart meters located at a multifamily building, such as a exposure level was equivalent to 0.5% of the FCC standard.

In the same study EPRI measured exposure levels from meter panel box is similar to proximity on the opposite side of the wall cycle it yielded an exposure of only 0.3% to 10% of the FCC cycle always transmitting), exposure at eight inches behind the meter

Is the FCC Standard Sufficient to Protect the Public H

The FCC guidelines do provide a significant factor of safety currently understood human health impact that occurs at the frequency bands that smart meters use. In addition to the factor guidelines, at worst, human exposure to RF operating smart meter 50% duty cycle is significantly lower than the guidelines. While to understand potential non-thermal 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 N

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

Given the scientific uncertainty of all RF emitting equipment time there is no clear indication of what, if any, additional is there a basis from which to understand could be he appropriate. Without a clear understanding of the biological mechanisms benefits of additional standards emitting devices including smart meters determined at this time.

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

Public Information and Education

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 in a variety of strengths and distances from commonly found in our world.

Equipped with this information, people can make knowledgeable jud prudently minimize possible exposure to their family by standards compliant devices at known safe distances will be better able to field strengths of various RF sources in everyday electronic blankets, clock radios, TV and radio towers, computer lines, microwave etc.). An ongoing regularly updated source of unbiased information research, both proven and possible effects being studied, if pres independent entity, provided consumers a credible and transparent sour obtain facts about RF in our environment.

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

Alternatives to Wireless?

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 company. These a power line or wired through phone lines, cable Each m tradeoffs among cost and performance (e.g., how much data ca The ability to have a protocol alternative to wireless depends upon the configuration of the meter used. Some existing smart meters c would have to be modified or replaced. The communications The current PG&E meters use communications board that only suppo protocol. SilverSpring or another vendor could provide an alter such were and cost effective. The costs of an alternative ap need to be factored into the decision making process related to

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

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

□ð

Key □ð Factors □ð to □ð Consider □ð When □ð Evaluating □ð Exposure □ð to □ð Radiofreque

□ð

1. □ð □ð Signal □ð Frequency	Compare □ð to □ð devices □ð in 900 □ð MHz □ð band □ð and	Frequency □ð similar mobile □ð phones, □ð laptop □ð com walkie-talkies, □ð baby □ð monit microwave □ð ovens
2. □ð □ð Signal □ð Strength □ð (or □ð Power □ð Density)	Microwatts/square □ð centimeter □ð ($\mu W/cm^2$) □ð	Meter □ð signal □ð strength □ð compared □ð to □ð other □ð d above □ð
3. □ð □ð Distance □ð from □ð Sig	Signal □ð strength □ð drops □ð ra (doubling distance □ð cuts □ð pow density □ð by □ð four)	Example: □ð 1 □ð ft □ð □ð $\mu W/cm^2$ □ð 3 □ð ft □ð □ð $\mu W/cm^2$ □ð 10 □ð ft □ð □ð $\mu W/cm^2$ □ð
4. □ð □ð Signal □ð Duration	┐ Extremely □ð short □ð amount □ (2.0-5.0%, □ð max), □ð ┐ Normal RF □ð signal □ð 95 □ð the (over □ð 23 □ð hours/day)	┐ often □ð overlooked □ð when comparing □ð devices □ð ┐ Short □ð duration □ð combined weak □ð signal □ð strength □ exposures □ð
5. □ð □ð Thermal □ð Effects	┐ Scientific □ð consensus □ð on □ effects □ð from □ð heat □ð at □	┐ FCC □ð “maximum” □ð limits times □ð lower □ð than □ð exposure □ð level ┐ Typical □ð meter □ð operates times □ð less □ð than □ð FC 3,500 □ð times □ð less □ð th demonstrated □ð hazard □ð le
6. □ð □ð Non-Thermal □ð Effects	┐ Inconclusive □ð research □ð to □ ┐ No □ð established □ð and □ð pointing □ð to □ð negative □ð h impacts □ð	Continuing □ð research □ð need

□ð

Conclusion □ð

□ð

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

□ð

1. **The** □ð **FCC** □ð **standard** □ð **currently** □ð **accepted** □ð **factor** □ð **of** □ð **safety** □ð **against** □ð **kn thermally** □ð **induced** □ð **health** □ð **impacts** □ð **of** □ð **smart** □ð **meters** □ð **and** □ð **othe same** □ð **range** □ð **of** □ð **RF** □ð **emissions.** □ð □ð **Exposure** □ð **levels** □ð **below** □ð **the thresholds** □ð **for** □ð **such** □ð **effects.**

□ð

2. **There** □ð **is** □ð **evidence** □ð **that** □ð **additional** □ð **standards** □ð **are** □ð **needed** □ð **to** □ **smart** □ð **meters**

□ð

The □ð topic □ð of □ð potential □ð health □ð impacts □ð in □ð general, □ð including □ð the □ð sm exposure □ð levels □ð of □ð meters, □ð continues □ð to □ð be □ð a □ð concern. □ð been □ð develo provide □ð readers □ð and □ð consumers □ð with □ð factual, □ð relevant □ð information □ð ab

□ð

- Scientific □ð basis □ð underpinning □ð current □ð RF □ð limits
- Need □ð for □ð further □ð research □ð into □ð RF □ð effects
- Relative □ð to □ð the □ð of □ð RF □ð emissions □ð from □ð a □ð wide □ð array □ð of □ð dev world □ð (e.g., □ð cellular □ð and □ð cordless □ð phones, □ð laptop □ð computers, □ð baby monitors, □ð microwave □ð ovens).

□ð

CCST □ð encourages □ð the □ð ongoing □ð development □ð of □ð a □ð and □ð □ð facts □ð for □ð public □ð information □ð and □ð □ð A □ð written □ð reports, frequently □ð asked □ð questions □ð and □ð answers, □ð graphics, □ð and □ð video □ð demon consumers □ð with □ð factual, □ð relevant □ð information □ð to □ð effects □ð environment. □ð

STATE CAPITOL
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3501 CIVIC CENTER DRIVE, SUITE 412
SAN RAFAEL, CA 94903
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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 devises, 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.

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 devises 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
CHAIR, HEALTH
ARTS, ENTERTAINMENT, SPORTS, TOURISM & INTERNET MEDIA
ENVIRONMENTAL SAFETY & TOXIC MATERIALS
JOINT LEGISLATIVE AUDIT COMMITTEE
JUDICIARY
LABOR AND EMPLOYMENT
WEBSITE: www.assembly.ca.gov/monning

Assembly
California Legislature

WILLIAM W. MONNING
ASSEMBLYMEMBER, TWENTY-SEVENTH DISTRICT

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99 PACIFIC STREET, SUITE 555-D
MONTEREY, CA 93940
(831) 649-2832
(831) 649-2935

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

WWM:rog

MILL VALLEY

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

City of Mill Valley, 26 Corte Madera Avenue, Mill Valley, California 94941 • 415-388-4033

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,

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

CCST Smart Meter Project Approach

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

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

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

In addition to those on the [illegible] project team, CCST appointed technical experts to contribute their opinion to inform CCST's response. [illegible] from a variety of sources and were vetted by the Smart [illegible] were made to include both biological and engineering sciences to help provide broad context and perspective to the response. Many indicated they did not time to provide a written response [illegible] references to additional experts and/or literature for the reviewers to ide[illegible] were not asked to contribute due to affiliations that were [illegible] Experts were asked to provide written comment on two issues other experts, and to suggest literature reviewed. [illegible] Appendix D [illegible] list of those experts who provided written comment.

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

In addition to written and oral input from technical experts, reports and other sources of information to inform the final found listed in Appendix D and at http://ccst.us/projects/smart/.

□ð

Peer □ð Review: □ð □ð After □ð the □ð draft □ð report □ð was □ð vetted □ð in □ð great

Team, □ð it □ð was □ð forwarded □ð to □ð the □ð CSTA □ð Board □ð for □ð review. □ð □ð

□ð

Public □ð Comment: □ð □ð The □ð report □ð was □ð posted □ð on □ð the □ð CSTA □ð website □ð for □ð the □ð general □ð public □ð to □ð comment. □ð

Appendix C – Project Team

The California Council on Science and Technology adheres to a rigorous process to provide independent, objective, and respected advice. Members review all work that bears the 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 targeted and sound manner.

In all, this report reflects the input of people with expertise in one or more project team Reviewers include experts from academia, industry, national and non-profit organizations.

We wish to extend our sincere appreciation to members who helped produce this report. Their expertise and diligence has been invaluable rigorously honing the accuracy and focus of the work and perspectives of their respective areas of expertise and institutional account. Without the insightful and expert guidance 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 in 2005, he had a distinguished career as a faculty member, researcher in academic administrator. Richmond received a Ph.D. in genetics Rockefeller University and a bachelor's degree in zoology University. Dr. Richmond's career has included at UC Berkeley and as Chancellor of University, founding Dean of the College of Arts and South Florida, Provost at the State University of New Provost and Professor of Zoology and Genetics at Iowa State named the sixth President of Humboldt State University i Richmond is a fellow of the American Association for and a member of Phi Beta Kappa. His evolutionary genetics.

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

Dr. Long is the Principal Associate Director at Large for National Laboratory working on energy and climate. She is LLNL Center for Global Strategic Research. Her current interest of the 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

□ð

Patrick □ð Mantey □ð

Director, □ð UC □ð Center □ð for □ð Information □ð Technology □ð Research □ð in □ð the □ð Interes
@ □ð Santa □ð Cruz, □ð University □ð of □ð California, □ð Santa □ð Cruz

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

□ð

Emir □ð José □ð Macari

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

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

□ð

Larry □ð Papay □ð CCST □ð Board □ð Member

CEO, □ð PQR, □ð LLC □ð Mgmt □ð consulting □ð firm

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

Vice □ð President □ð at □ð Southern □ð California □ð Edison. □ð □ð Papay □ð receiv
from □ð Fordham □ð University, □ð a □ð M.S. □ð in □ð Nuclear □ð Engineering □ð from □ð M
Nuclear □ð Engineering □ð from □ð MIT. □ð He □ð is □ð a □ð member □ð of □ð th
Engineering □ð and □ð served □ð on □ð its □ð Board □ð on □ð Energy □ð and □ð Environmental
CCST □ð Council □ð Chair □ð from □ð 2005 □ð through □ð 2010 □ð he □ð was □ð appointe
Board. □ð

□ð

David □ð E. □ð Winickoff

*Associate □ð Professor □ð of □ð Bioethics □ð and □ð Society, □ð Department □ð of □ð Envir
and □ð Management, □ð UC □ð Berkeley*

David □ð Winickoff □ð (JD, □ð MA) □ð is □ð an □ð Associate □ð Professor □ð of □ð Society
Berkeley, □ð where □ð he □ð co-leads □ð the □ð UC □ð Science, □ð Technology □ð and □ð Socie
Center. □ð Trained □ð at □ð Yale, □ð Harvard □ð Law □ð School, □ð and □ð Cambrid
published □ð over □ð 30 □ð articles □ð in □ð leading □ð bioethics, □ð biomedical, □ð
studies □ð journals □ð such □ð as □ð New □ð England □ð Journal □ð of □ð Medicine, □ð
International □ð Law, □ð Science, □ð Technology □ð & □ð Human □ð Values. □ð His □ð academic □ð and □
policy □ð work □ð spans □ð topics □ð of □ð biotechnology, □ð engineering, □ð intellectual □ð property
risk-based □ð regulation, □ð and □ð subjects □ð research.

□ð

Paul □ð Wright

Director, □ð UC □ð Center □ð for □ð Information □ð Technology □ð Research □ð in □ð the □

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

□ð

Ryan □ð McCarthy

Science □ð and □ð Technology □ð Policy □ð Fellow, □ð California □ð Council □ð on □ð Scien

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

Appendix D – Written Submission of Authors

Written Input Received from:

Physical Sciences/Engineers

Kenneth Foster, Professor, Department of Bioengineering, University of

Rob Kavet, Physiologist/Engineer, Electric Power Research Institute (E

Biologists/medical

Kun Li, MD, Ph.D., Senior Principal Epidemiologist, Division of Research, Kaiser Foundation Research Institute, Kaiser Permanente

Asher Sheppard, Ph.D., Asher Sheppard Consulting, trained in physics, medicine, and neuroscience

Magda Havas, B.Sc., Ph.D., Environmental & Resource Studies, Trent Peterborough, Canada

Cindy Sage, MA, Department of Ecological Health, Santa Barbara, Editor, BioInitiative Report

Ray Neutra, MD, Ph.D., Epidemiologist, retired Chief of the Occupational Disease Control, California Department of Public Hea

Appendix – Additional Materials Consulted

All sources can be accessed through the CCST website at http://cost...

American Academy of Pediatrics

- The Sensitivity of Children to Environmental Agents Fields of the American Academy of Pediatrics (August 3, 2005)

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)

- www.arpansa.gov.au Australian Radiation Protection and Nuclear Safety (ARPANSA)
- Radiation Protection Committee on Electromagnetic Energy Public Hea (Fact Sheet)
  Australian Radiation Protection Nuclear and Safety Agency (ARPANSA) (May 2010)
- Radiation Protection Mobile Telephones and Health Effects
  Australian Radiation Protection and Nuclear Safety Agency (AR 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 Study
  Oxford University Press (March 8, 2010)
- Mobile Phones and Health
  U.K. Department of Health
- Late Lessons from Early Warnings: Towards Realism and
  David Gee, European Environment (January 30, 2009)
- Statement of Finnish Radiation and Nuclear Safety Authority
  Mobile Phones and Health
  Radiation and Nuclear Safety Authority (January 7, 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,
- AFSSE Statement on Mobile Phones and Health
  French Environmental Health and Safety Agency (April 16, 2003)

Committee on Man and Radiation (COMAR)

- IEEE Engineering in Medicine and Biology Society Committee
  Radiation (COMAR)
- COMAR Technical Information Statement the Limits IEEE for Expos

Radiofrequency □ð and □ð Microwave□ð Energy □ð
IEEE □ð Engineering □ð in □ð Medicine □ð and □ð Biology□ð Magazine □ð (April □ð

Commonwealth □ð Club □ð of □ð California

- Commonwealth □ð Club□ð of □ð California□ð Health □ð Effects □ð of □ð Electromagnetic □ð (Video) □ð (November □ð 18,□ð 2010)

Electric □ð Power □ð Research □ð Institute □ð (EPRI)

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

Environmental □ð Protection □ð Agency

- United □ð States □ð Environmental □ð Protection □ð Agency's □ð Response □ð to □ð (March □ð 8, □ð 2002)
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Epidemiology □ð

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

European □ð Journal □ð of □ð Radiology □ð (Elsevier)

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

Federal □ð Communications □ð Commission

- Radio □ð Frequency □ð Safety□ð□ð FAQ's
- RF □ð Safety □□ðPage
- Federal □ð Communications □ð Commission □ð Response □□ð to □ð Cindy □ð Sage □ð (August □ð 6, □□ð2010)
- FCC □ð Certification□ð
  - FCC Certification □ð for □ð the □ð Silver □ð Spring Networks□ð 2□ð Devices □ð 2009 □ð
  - FCC □ð Certification □ð for □ð the □ð Silver □ð Spring Networks, □ð Devices 2009 □ð
  - FCC □ð Certification □ð for □ð the □ð Silver □ð Spring Networks, □ð Devices 2007 □ð
  - FCC □ð Certification □ð for □ð the □ð Silver □ð Spring Networks, 2007
- Questions □ð and □ð Answers □ð about □ð Biological □ð Effects □ð and □ð Potential Radiofrequency □ð Electromagnetic □□ðFields
  Federal □ð Communications □ð Commission □ð Office □ð of □ð Engineering □ð & □ð Techn 1999) □ð
- Evaluating □ð Compliance □ð with □ð FCC □ð Guidelines □ð for □ð Human □ð Exposu Radiofrequency □ð Electromagnetic □ð Fields□ð □ð
  Federal □ð Communications □ð Commission □ð Office □ð of □ð Engineering □ð & □ð 1997) □ð

Food □ð and □ð Drug □ð Administration

- No □ð Evidence □ð Linking □ð Cell □ð Phone □ð Use □□ð to □ð Risk □ð of □ð Brain
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Health □ð Protection □ð Agency

- Wi-Fi
  Health □ð Protection □ð Agency □ð (Last □ð reviewed:□□ð October □ð 26, □ð 2009)
- Cordless □ð Telephones□ð □ð Enhanced □ð Cordless □ð Telecommunications □ð (DECT) other □ð Cordless □ð
  Health □ð Protection □ð Agency □ð (Last □ð reviewed: □□ð September □ð 4, □ð 2008)

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  International □ð Commission □ð on Non-Ionizing □ð Radiation □ð Protection □ð (September □ð 2
- Epidemiologic □ð Evidence □ð on □ð Mobile □ð Phones□ð □ð and □ð Tumor □ð Risk
  International □ð Commission □ð on Non-Ionizing □ð Radiation □ð Protection □ð (September □ð 2
- Exposure □ð to □ð High □ð Frequency □ð Electromagnetic □ð Fields, □ð Biological □ð Consequences □ð (100 □□ð GHz)□ð □ð

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  Swedish □ð State □ð Radiation □ð Protection □ð Authority

University □ð of □ð Ottawa

- Wireless □ð Communication □ð and □ð Health □ð Energy □ð and □ð Radiofrequency □ð Radiation □ð FAQ's □ð
  University □ð of □ð Ottawa, □ð RFcom

World □ð Health □ð Organization

- Database □ð of □ð Worldwide □ð EMF □ð Standards
- WHO □ð Electromagnetic □ð Fields □ð
- Electromagnetic □ð Fields □ð and □ð Public □ð Health □ð and □ð Wireless □ð Networ (Fact □ð Sheet □ð N°304) □ð
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Unsolicited □ð Submissions

Documents □ð Provided □ð by □ð Alexander □ð Blink, □ð Executive □ð Director □ð o Institute, □ð Fairfax □ð CA

- Points □ð and □ð Sources □ð Submitted □ð for □ð Consideration □ð by □ð Ale
- Points □ð and □ð Sources □ð Submitted □ð for □ð Consideration □ð by □ð Ale
- Public □ð Health □ð Implications □ð of □ð Wireless □ð Technologies, □ð Cindy
- Memory □ð and □ð Behavior, □ð Jay, □ð Bioelectromagnetics □ð Research □ð Laboratory, □ð University □ð of □ð Washington

Sage □ð Consulting

- Assessment □ð of □ð Radiofrequency □ð Microwave □ð Radiation □ð Emissions Smart □ð Meters
  Sage □ð Associates □ð (January □ð 2011)
- Cindy □ð Sage □ð Letter □ð to □ð Julius □ð Knapp □ð (FCC)
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- Response □ð Letter □ð Cindy □ð Sage □ð from □ð Julius □ð Knapp □ð (FCC)
  (August □ð 6, □ð 2010)
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  (March □ð 15, □ð 2010)
- Bioinitiative □ð Report: □ð A □ð Rationale □ð for □ð a □ð Biologically-based □ð Public □ð Exposure Standard □ð for □ð Electromagnetic □ð Fields □ð (ELF □ð and □ð RF)
- Bioinitiative □ð Report: □ð What □ð is □ð the □ð BioInitiative □ð Report? □ð
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- Radio ☐ð Frequency ☐ð RF ☐ð Safety ☐ð and ☐ð Antenna ☐ð FAQs
- Smart ☐ð Grid ☐ð Information ☐ð Clearinghouse ☐ð (SGIC)
- stopsmartmeters.org ☐ð

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 part

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

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

Federal Communications Commission (FCC) – The Federal Communications Commission (FCC) is an independent agency of the US Federal Government that reports to Congress. The FCC was established by the Communications Act of 1934 and is charged with regulating interstate and international communications by radio, television, wire, satellite, and cable. The FCC also allocates portions of the frequency spectrum for non-government communications services (the NTIA allocates government frequencies). The FCC rules for human exposure to radiofrequency electromagnetic fields, as set by the FCC, are contained in the Office of Engineering and Technology (OET) Bulletin 65 (August 1997). Additional information is contained in OET Bulletin 65 Supplements A (radio and television broadcast stations), B (amateur radio stations), and Supplement C (mobile and portable devices).

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

Hertz – The unit for expressing frequency, one cycle per second (1 Hz) equals

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

Mesh network – A network providing a means for routing data, via nodes. A mesh network allows connection for and reconfiguration around broken or blocked data paths by "hopping" from node to destination is reached.

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

Microwatt per square centimeter (μW/cm²) A unit of measure of the power density through an area of space, 1 of one of a millionth of a watt passing through a l centimeter.

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

Repeater A device that can simultaneously receive a radio s the signal. Repeated units are used to extend the range of lo geographical area.

Router An electronic computer device that is used to route d typically between various computers within a local different area network local area networks.

Smart meter A digital device for measuring consumption, such as natural gas, and sending the measurement to a utility comp reading (AMR) meters send information by wireless to a meter infrastructure (AMI) meters are a communications

Specific absorption rate (SAR) The incremental energy absorbed by a mas density. SAR is expressed in units of watts per kilogram

Transmitter An electronic device that produces RF energy that antenna. The transmitted energy is typically referred to a ra

Wide area network (WAN) A network that covers a broad area whole community, town, or city. Commonly, WANs are implemen connection using radio signals. Internet connections can be provide customers by wireless WANs.

Wi-Fi The name given to the wireless technology mobile in ho phones, and other wireless electronic devices that employ the (a standard that defines specific characteristics of wireless local

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Appendix I – Report Credits

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Sandra Valdez La Torre, Coordinator, Layout