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SOUTHERN CALIFORNIA GAS COMPANY

ADVANCED METERING INFRASTRUCTURE

CHAPTER V

ESTIMATED CONSERVATION IMPACT OF PROVIDING DAILY GAS INFORMATION TO CUSTOMERS

Prepared Direct Testimony

of

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BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

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I. INTRODUCTION

The purpose of my testimony is to present evidence for the potential conservation impact of using AMI technology and making timely usage information available to customers. The focus is on how customers change their behaviour in relation to information feedback.

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II. SUMMARY

The Southern California Gas Company (SoCalGas) proposes communication
technologies and supporting systems to provide online next-day gas usage information for their
customers. The total conservation impact from these information presentation tools will depend
on the scope for conservation in customers' homes, the quality of feedback and the level of
customer participation in a feedback programme.

On the basis of the research literature regarding the impact of feedback on heating- and cooling-related behaviour, I estimate an average conservation impact of approximately 5% per participating household from the adoption of AMI and regular use of next-day feedback on the SoCalGas website. This saving would result from changes in routine behaviour and resetting of controls.

A second option under consideration by SoCalGas is a dedicated in-home display. My
estimate of the conservation effect from adoption of AMI with display-based feedback is 10%.
The higher figure results from the information being more easily accessible than it is when
online: the consumer does not have to go and seek it out.¹

Over 75% of households in southern California are estimated to have Internet access²; the display-based feedback would be the default option for those who are not online. In-premise displays and web-based feedback are not mutually exclusive and can be complementary.

 <sup>25
 &</sup>lt;sup>1</sup> SoCalGas witness Mr. Olmsted discusses the capabilities of the available AMI technologies, including responses to SoCalGas AMI technology RFP. Several gas AMI technology vendors propose communications capabilities that will communicate with home information gateway devices or home area network (HAN) display devices.
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^{27 &}lt;sup>2</sup> Nielsen figures for local internet penetration, Q4 2006

I have estimated the overall conservation impact of web-based and display-based
feedback on the assumption that initial participation levels will be 6.5% of the customer base for
each. This gives a total conservation impact of just under 1% in the first year for those
customers with the arrangements in place for next-day feedback. If participation were then to
increase at a rate of an additional 1% per year, this total would rise to approximately 1.6% of
total gas consumption 5 years after the start of the rollout, averaged over the customer base.

7 There are potential further savings from investment in energy efficiency measures and
8 low-carbon technologies, once customers' interest and commitment are engaged more fully, but
9 these are likely to be accounted for elsewhere.

Approximately 40% of gas consumption in homes in the SoCalGas territory is used for
 space heating and 47% for water heating. These two end-uses offer the main potential for
 conservation.

Estimates for the conservation effect of web-based and display-based feedback are based on the studies summarised in the Attachments. They can only be a guide to what is possible. The outcome for SoCalGas customers will depend to some extent on how the feedback is implemented and supported, and on the overall drive towards fuel conservation in California. However, the trend over recent years has been for domestic energy users to show increased concern about their usage and about its environmental impact, and to expect greater access to timely information.

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III. BACKGROUND

The California Energy Efficiency Strategic Plan sets targets for deep energy reduction and envisages a 'rapid evolution in both technology and customer behaviour to make energy efficiency "a way of life" among Californians by 2020' (pp.2-3). Visual displays of real-time or near-real-time energy use are seen as part of this evolution (p.17), enabling households to manage their energy use more effectively and to reduce emissions through changes in behaviour and adoption of low-carbon technologies and efficiency measures.

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This testimony deals with the potential for energy conservation resulting from adoption
 of AMI by the Southern California Gas Company. It relates to the likely impact of improved
 feedback on customer behaviour.

AMI can provide energy usage information to both customer and utility on a defined,
regular basis. By doing so, it can improve the quality of feedback to both, which can lead to
better understanding of how to manage and to conserve fuel. Data from an AMI also provides a
shared point of reference in the event of complaints or requests for advice.

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IV. THE RESEARCH LITERATURE ON ENERGY FEEDBACK

Several of the studies on energy information feedback that were reviewed for this
 testimony were conducted before advanced metering was available. However, they are still
 relevant because these studies involved changes in the energy user's information environment of
 the type proposed by SoCalGas, i.e., more timely, accurate information, comparisons of energy
 usage with previous periods, and identification of consumption goals or benchmarks.

In 2006 I carried out a review of some 35 papers and reports in the literature on energy
 feedback in the residential sector for the UK Department of Environment, Food and Rural
 Affairs³. I concluded that

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Indirect feedback [that is, feedback that is processed in some way before reaching the energy user]... is usually more suitable than direct feedback [immediately available to the user] for demonstrating any effect on consumption of changes in space heating, household composition and ...investments in efficiency measures...

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 ²⁵ ³ Darby S (2006) The effectiveness of feedback on energy consumption. A review for DEFRA of the literature on metering, billing and direct displays. Environmental Change Institute, University of Oxford

http://www.defra.gov.uk/environment/climatechange/uk/energy/research/pdf/energyconsump-feedback.pdf and
 http://www.defra.gov.uk/environment/climatechange/uk/energy/research/pdf/energyconsump-feedback appendix.pdf

Savings have ranged from 0-10%, but they vary according to context and the quality of information given. Historic feedback (comparing with previous recorded periods of consumption) appears to be more effective than comparative or normative (comparing with other households, or with a target figure)...

Persistence of savings will happen when feedback has supported 'intrinsic' behaviour controls – when individuals develop new habits – and when it has acted as a spur to investment in efficiency measures...As a rule of thumb, a new type of behaviour formed over a three-month period or longer seems likely to persist – but continued feedback is needed to help maintain the change and, in time, encourage other changes.

Dr. Corinna Fischer, a psychologist working at the Free University of Berlin, recently reviewed the same literature and also some German-language studies.⁴ She found that feedback stimulates energy savings that are usually between 5-12%, provided that there is some motivation to conserve. She concludes that

With all due care because of data restraints, there are reasons to identify some likely features for successful feedback (meaning, both effective in stimulating conservation and satisfying to households). Such feedback

- is based on actual consumption
- is given frequently (ideally, daily or more)
- involves interaction and choice for households
- involves appliance-specific breakdown [the review relates to electricity]
- is given over a longer period [prolonged period]

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 ²⁶ Fischer C (2008) Feedback on household electricity consumption: a tool for saving energy?. *Energy Efficiency* 1 (1), 79-104

may involve historical or normative comparisons (although these are appreciated by households, the effects are less clear)

is presented in an understandable and appealing way.'

I concur with Dr. Fischer's conclusions. For the SoCalGas situation, the most important characteristics are actual, frequent consumption feedback information over a long (continuing) period of time, interactivity, comparisons with consumption in previous periods and presentation in a user-friendly format. I would also argue that more than one option for mode of feedback is desirable, in order to engage as many customers as possible; and more than one metric for feedback (for example, allowing customers to choose between cost or energy units, and to select time periods for comparison and goals or benchmarks).

V. **RESEARCH DIRECTLY RELEVANT TO THIS TESTIMONY**

There are not many fully-documented trials of feedback carried out with large numbers of people in 'normal' conditions, and those that exist have shown a range of conservation impacts, as indicated above. For this testimony, I selected four case studies of 'indirect' feedback that seemed most relevant to the SoCalGas situation, in that they relate to gas usage and use a computer-based interface with the customer. These case studies are summarized in Attachment SD-1.

I also selected eight studies and reports that deal with more direct feedback modes (where 20 the end-user has instant access to the consumption data), where space- and water heating are 21 included among the end-uses. These are summarized in Attachment SD-2. The main point is 22 that the feedback in these trials included relatively high energy loads, which do not change 23 rapidly from moment to moment and which lend themselves to next-day feedback more than to 24 real-time feedback. 25

26 The only instance in the English-language literature of a trial of next-day feedback on domestic gas consumption alone, given via a dedicated display rather than online, produced 12% 27

savings against a baseline and 10% against a control group for the duration of the experiment⁵.
The feedback was given for the previous day's consumption in relation to a 10% conservation
target. However, a year after the displays had been removed, consumption had reverted to the
same level as that in the control groups: feedback needs to be integrated into the energy system,
not offered as a temporary expedient.

We have evidence of durable or sustainable change – that is, changed habits – in the
available studies, and we have evidence that people who monitor their energy usage also tend to
have a more active interest in installing long-lasting efficiency measures and low-carbon
technologies.⁶

Some of the selected research shows the combined effect of feedback and advice. 10 Feedback information may prompt energy users to seek advice and it can also be used to check 11 that the advice is productive. A study of low-income households in West Lothian in Scotland 12 demonstrated that basic feedback from self-meter-reading gave average savings of 11% within 13 three months from behaviour change when it was combined with personalised advice; there were 14 further savings from energy efficiency measures which were installed later⁷. In Germany, 15 participants in the Home Resource Account programme have averaged 5% gas savings per year 16 over a period of four years when given graphical online feedback on their meter readings in 17 combination with online or phone advice, including advice on improving the efficiency with 18 which their central heating pumps work⁸. This indicates something of what is possible with 19 motivated participants over an extended period. The participants in this scheme do not have 20 smart meters but record their meter readings on the HRA website whenever they wish. A third 21

²³
 ⁶ Darby 2006 as in footnote 1; Darby S (2006) Social learning and public policy: lessons from an energy-conscious village. *Energy Policy* 34, 2929-2940; CO2 Online, a German website offering personal energy advice in

²²

⁵ Van Houwelingen, JH and van Raaij, WF (1989) The effect of goal-setting and daily electronic feedback on inhome energy use. *Journal of consumer research* **16**, 98-105.

conjunction with meter readings; Harrigan MS and Gregory JM (1994) Do savings from energy education persist?
 Alliance to Save Energy, Washington DC; Staats H, Harland P and Wilke HAM (2004) Effecting durable change:
 a team approach to improve environmental behaviour in the Netherlands. Environment and Behaviour 36 (3), 341-367

⁷ Annual reports of the West Lothian Energy Advice Project; referred to in Darby S (1999) *Energy advice – what is it worth?* Proceedings, European Council for an Energy-Efficient Economy, III.05

^{27 8} CO2online.de, accessed July 2008. Home Resources Account

example, that of the 'Ecoteams' in the Netherlands, shows what is possible with neighbourhood
groups of motivated individuals: weather-adjusted gas savings of 20% against baseline were
achieved during the first year of the programme and three years after the programme began,
savings were still at 16% against the baseline⁹. There is more information on these three
programmes in Attachment SD-2.

Attachment SD-2 includes summaries of the conservation impact of three pay-as-you-go
systems. This payment method intrinsically involves a degree of feedback to the customer, but
these programmes also included in-premise displays. They systems produced substantial
conservation effects of up to 20%, though it is not known whether some of this was due to selfdisconnection by customers from their electricity supply.

In summary, the evidence from these selected studies is that gas conservation and electric space- and water-heating conservation have resulted from both 'indirect' and 'direct' feedback; that durable effects have been measured, and that the effect of feedback can be enhanced by combining it with advice and/or community initiatives.

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VI. SCOPE FOR SAVINGS AMONG SOCALGAS CUSTOMERS

The scope for savings will be affected by factors such as initial consumption levels (how much scope is there for reductions in usage without sacrificing comfort?); ability and willingness to invest in energy efficiency measures or low-carbon technologies; and tenure (is the customer in a position to make alterations to the property or the gas appliances?).

21 SoCalGas workpapers¹⁰ give eight principal end-uses for natural gas in dwellings, with 22 varying scope for demand reduction. They are:

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⁹ Staats, Harland and Wilke as in footnote 4.

¹⁰ 2006 California Gas Report workpapers, redacted. Prepared by the Gas Company. P117.

1	1. Space heating (39% of residential gas consumption in California) ¹¹ . This will vary
2	according to location but conservation gains can be made in the short- and long-term
3	through behavioural and physical changes such as
4	 improving furnace efficiency or replacing old, inefficient furnaces;
5	• turning the central heating thermostat down in winter: a rule of thumb is that a
6	reduction of 1°C (1.8°F) leads to a reduction in consumption of around 10%;
7	• heating less of the building – turning off heaters or shutting vents in unused
8	rooms;
9	• heating it for less time, e.g. use of timer to switch off and setback at night and
10	during absences from home;
11	• using area-specific thermostats to control heating better in different areas of the
12	building;
13	• improving the insulation of the home (this would also have the effect of keeping
14	the building cooler in summer and reducing air-conditioning loads);
15	• building and refurbishing for solar gain in winter.
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17	There appears to be a price-response effect at work in conservation of space heating.
18	When comparable trials of feedback via an in-premise display were carried out in Newfoundland
19	and British Columbia ¹² , the Newfoundland householders with electric space heating reduced
20	their demand by 20% compared with the control group. In British Columbia, where electricity is
21	much less expensive than in Newfoundland, comparable figures were 3% and 2%. This could be
22	relevant at a time of rapidly rising gas prices.
23	2. Water heating (47% of residential gas use). Potential conservation measures include
24	• insulating the water tank;
25	• installing low-flow taps and shower heads
26	¹¹ California Statewide Residential Appliance Saturation Study. Final Report, June 2004 ¹² Mountain, DC (2007) real time feedback and residential electricity consumption. British Columbia and
27	¹² Mountain, DC (2007) real-time feedback and residential electricity consumption: British Columbia and Newfoundland and Labrador pilots. Mountain Economic Consulting and Associates Inc., Ontario
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1	• using less hot water day by day, e.g. shorter showers
2	• turning down the water tank thermostat to 140°F/ 60°C
3	• replacing the water heating system either with solar water heating or with a more
4	efficient tank-less system. It is estimated that installing solar water heating could
5	reduce natural gas demand in homes for water heating by 50-75%. ¹³
6	
7	3. Cooking (10% of residential use). We have no research data on use of feedback
8	specifically for gas cooking; only for the real-time displays that were tried with
9	electric cookers, where the volunteer users saved an average of 14%. ¹⁴ There is no
10	suggestion that this would be separately available to SoCalGas customers, so any
11	savings here would come from increased general awareness of consumption.
12	Cooking would be likely to show up in the feedback if data were available three or
13	four times a day, as proposed by SoCalGas, but might otherwise be 'lost in the noise'
14	of daily data.
15	
16	4. Drying (4%). There is scope for reducing this consumption through line-drying.
17	Again, data three or four times daily would be likely to show the impact of dryers.
18	
19	5-8. Pool heating, spa heating, fireplaces and barbecues (very small proportions of overall
20	consumption, but may be significant for the customers who use them). The first two
21	of these lend themselves to solar heating technologies – a step involving investment
22	but one that is becoming more likely in the light of recent policy on solar water
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24	¹³ Del Chiaro B and Telleen-Lawton T (2007) Solar water heating: how California can reduce its dependance on
25	natural gas. Environment California Research and Policy Center http://www.arb.ca.gov/cc/ccea/comments/jan/environment california swh.pdf
26	¹⁴ Wood, G. and Newborough, M. (2003) Dynamic energy-consumption indicators for domestic appliances: environment, behaviour and design. <i>Energy and Buildings</i> 35, 821-841
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heating and the California Energy Efficiency Strategic Plan. Fireplaces and barbecues offer some prospect of incremental savings.

From the above, there is clearly substantial scope for gas conservation in the SoCalGas area. The question is how much of it can be realised through provision of gas usage and bill information feedback to customers, using AMI.

Table 1 summarises the findings from the most relevant research literature, dealing with feedback on gas consumption and/or space heating and cooling. Findings from the studies from which Table 1 is drawn are set out in more detail in the Attachments, as noted above.

	Number of studies from which a figure for savings is derived	Indicative figure for savings per participant	Range
Indirect feedback, PC /	4	5%	4 - 9%*
web-based			
Direct feedback through	9	10%	1 - 20%
a moveable in-premise			
display monitor or self-			
meter-reading			
Pay-as-you-go metering			
with feedback	3	12%	5 - 20%

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*The data for German homes show 5% savings year-on-year over a period of four years for a combination 25 of self-monitoring, website use and availability of targeted advice.

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¹⁵ with the exception of the Carbon Trust trial of web-based feedback to SMEs.

The 5% and 10% indicative figures relate to savings in the short- to medium-term, mostly 1 from behavioural change (change of habits) arising from increased awareness. They do not 2 include any further conservation effects that may come about as householders become more 3 knowledgeable about the options open to them and more likely to invest in energy efficiency and low-carbon technologies.¹⁶ (These may be accounted for elsewhere, for example as a result of 5 specific marketing programmes.) 6

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VII. LIKELY PARTICIPATION IN A FEEDBACK PROGRAMME

Evidence on the effectiveness of feedback is mostly drawn from samples that are unlikely 9 to be representative of the whole (especially in the early studies), and I had to make a judgement 10 as to how much we could expect customers to take an interest in feedback. Participation in a 11 utility-led, feedback-based conservation programme will depend to a large extent on customer 12 motivation to conserve, and on the extent to which the utility engages them. The research 13 literature shows that feedback is effective in two main ways. First, it builds awareness in people 14 who have had a more or less fatalistic attitude to their energy bills, seeing them as something 15 over which they have little or no control. This mindset is summarised in a recent study of 16 householders in London: 17

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Energy and power are not terms within the natural language of mainstream householders. Gas and electricity operate at the level of the subconscious within the home ... there appeared to be virtually no sense of being able to actively and significantly reduce energy consumption in the household.¹⁷

²⁵ ¹⁶ Darby S (2006) Social learning and public policy: lessons from an energy-conscious village. Energy Policy 34, 2929-2940

²⁶ Dobbyn, J and Thomas, J (2005) Seeing the light: the impact of micro-generation on our use of energy. Report to the UK Sustainable Development Commission. http://www.sd-commission.org.uk/publications/downloads/Micro-27 generationreport.pdf

For this group of people, response depends in the first instance on the extent to which the feedback seizes their attention. Once they are more aware of their consumption, they are in a position to start doing something about altering it. Once they have started experimenting, the feedback then tells them which actions and measures are most worthwhile.

Second, feedback acts as a tool for people who are already motivated to save energy. A psychologist evaluating a community trial of digital electricity real-time monitors in Wales noted that

The [monitors] had the most effect in households where discretionary electricity use was fairly high and they were motivated to reduce it for either environmental or cost reasons.¹⁸

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Something similar could be expected for those SoCalGas customers who are motivated 13 by environmental and/or financial concerns, frequently online and comfortable with web-based 14 interactive tools. Research carried out with 563 members of the SoCalGas online customer 15 insight panel (a 51% response rate) showed 68% agreeing (38% strongly and 30% somewhat) 16 that if their daily gas usage and cost were made available, it would influence their usage, with 17 only 13% disagreeing. 47% of the panel said that they would prefer to have daily information on 18 the SoCalGas website. This fits with the finding by a recent Pew Centre study that 41% of ICT 19 users are either 'elite' or 'middle of the road' users who are at ease with the technology and 20 value it¹⁹. On the combined SoCalGas and Pew figures, we could expect nearly 15% of all 21 SoCalGas customers (51% response rate x 68% interest x 41% highly computer-literate) to show 22 some interest in online feedback information at the outset of an AMI-related programme. 23

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26 ¹⁸ Kidd and Williams, 2008

¹⁹ Pew (2007) A Typology of Information and Communication Technology Users. Pew Internet and American Life Project, Washing DC, May 7 2007.

29% of the SoCalGas customer panel said that they would prefer daily feedback on an in home display; however, this was an *online* panel. For those customers who are not online, a
 standalone display would be the default option.

I have estimated 13% participation in a feedback programme for the early days – a little
lower than the 15% suggested by the customer insight panel and Pew data, but still a substantial
level of interest. This 13% is divided into 6.5% of customers opting for online feedback and
6.5% for display-based feedback.

13% is higher than the Southern California Edison estimates of initial uptake of webbased feedback at 1% (with growth of 1% per year), and uptake of display-device-based
feedback at 1% initially (with growth of 0.1% per year).²⁰ I believe the higher estimate is
justified, based on the reasoning given above and on recent experience in northern Ontario,
where Hydro One were recently able to roll out real-time electricity displays to 30,000 (20%) of
their customers over a period of nine months, charging them \$9 for postage and handling.²¹

SoCalGas is proposing measures as detailed in Chapter VI to encourage participation and
 conservation. All of these proposals could assist recruitment and effectiveness. It is worth
 noting that they would be introduced at a time when customers would be growing accustomed to
 real-time feedback on electricity consumption, and at a time when energy prices, environmental
 concern and expectations for high-quality information are rising.

Table 2 gives estimates of the initial conservation potential of an online feedback service,
applying estimates of savings potential and participation (as discussed above) across the
customer base.

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 ²⁵ ²⁰ Rebuttal testimony supporting Edison SmartconnectTM deployment funding and cost recovery. February 19, 2008.
 ²⁶ ²¹ Provide Landau Content of the Directory Devices Transformed and t

 ²¹ Personal communication from the Director, Business Transformation, Hydro One. The conservation outcome is not established yet but is estimated to be in line with the findings of the pilot studies carried out by Mountain Consulting: that is, around 6-7%.

customers 2 Feedback type % of Savings **Initial total** Conservation 3 conservation customers potential (%) estimate in Y5, 4 participating estimate (% of assuming 1% 5 participants with participation growth 6 'smarted' meters) rate per year 7 Web-based 6.5 5 8 0.325 0.525 Display-based 9 6.5 10 0.65 1.05 Total 10 conservation 11 12 effect 0.975 1.575

Table 2: Estimates of conservation potential from daily online feedback to SoCalGas

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14 VIII. WITNESS QUALIFICATIONS

My name is Sarah J Darby. I am a Research Fellow at the Environmental Change
Institute, University of Oxford. The fellowship was awarded for the study of domestic energy
feedback, with reference to the introduction of advanced metering, and is funded by the UK
Research Councils' Energy Programme. I am a member of the evaluation team for the UK
Demand Reduction Trials. I also contribute to the ECRIS project, part-funded by the
Department of Business, Enterprise and Regulatory Reform, to develop tools to help people
manage their energy usage better. This has led to the launch of the company ONZO.

I hold a BSc in Ecological Science from the University of Edinburgh, a postgraduate
diploma in urban and regional planning from Oxford Polytechnic, and a doctorate from Oxford
University. I began researching energy issues at the ECI in 1997, evaluating the effectiveness of
energy advice programmes for low-income householders. In 2000 I wrote a paper that has been
widely cited, '*Making it obvious: designing feedback into energy consumption*', in which I

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1	reviewed the evidence on how feedback affects energy consumption. In 2003 I completed a
2	doctoral thesis on the topic of 'Awareness, action and feedback in domestic energy use'.
3	Between 2003 and 2007 I contributed to research on policy and practice for low-energy housing
4	and non-domestic buildings, including the ECI report 40% House and background research for
5	the Royal Commission on Environmental Pollution's 2007 report on the urban environment. In
6	2006 I carried out a further literature review on the effectiveness of feedback for the UK
7	Department of Environment, Food and Rural Affairs.
8	This is my first testimony before the California Public Utilities Commission.
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IX. NOTICE

This report was commissioned by Southern California Gas Company on terms
specifically limiting Isis Innovation Limited trading as Oxford University Consulting's liability.
Our conclusions are the result of our professional judgment, based in part upon the material and
information provided to us by Southern California Gas Company and others. Use of this
report by any third party for whatever purpose should not, and does not, absolve such third party
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Attachment

						Attachment SD-1	ut SD-1		
		Findings from selected 'indirect'		eedback studi	es (data pri	ocessed and s	feedback studies (data processed and supplied by the utility) involving gas and/or space heating/cooling	vr space heating/cooling	
Strude.	Suit-2-							0.44	Construction of the second
		reraistence	Sample size	Control	Location	Energy source Feedback type			Comments
Brandon G & Levis A (1999) Reducing Household 4% total carcry reduction <i>Bergy Consemption: a Qualitative and</i> again backing (12% for <i>Quantitative Fad.</i> Sung', Journal of Envrorance and who made surges 3% Psychology19, 75.45. Psychology19, 75.45.	on or 12 e 3 iction	Project ran for 9 months	98 households in 6 groups (15 with PC- based feedback)	3	ы М	Gas and electricity	Via PC and showing current and previous year's weather- the structure documention as a graph, formalised to a <i>nonship</i> , in Why. Other modes included paper-based an introduct, comparative against other boaseholds, cost, anvironmental values, with advice).	the PC-based feedback was accompanied by a questionnaire on aspects of energy savings a questionnaire on aspects of energy saving and a directory of information and advice.	Via PC and showing current and previous year's weather- the PC-based feedback was accompanied by High users reduced consumption. Iow users increased it. Frout groups showed accompanied by the previous one applie of the previous year's weather accompanied bout accompanies of the previous strained paper-based and a directory of information and advice. It he take of personalised information the only feedback mode the athorns are usedby, in WND, Other modes included paper-based and a directory of information and advice. It he take of personalised information the only feedback mode the athorns are taken of comparative against other households, cost, and a directory of information and advice.
Uson T. Inder, R. Saeci O. D. Haji K. (2005) Effectiveness of displaying energy: communities data in residential bases. <i>Interpreta Council Versidents respond</i> . Proceedings, European Council for an Energy-Efficient Economy, 6, 100	9% gas reduction against baseline and against controls	Data were collected for 28 weekdays (5.5 weeks)	10 households	o.	Japan G	Gas, electricity W and kerosence C C C 4 w w	We based, via PC, <i>Hind/Faury</i> to communicate data over Rk mark Aury, verpresend in out terms: also 10-day perioda. Si Comparisons with pase data (dai) data averaged over Comparisons with pase data (dai) data averaged over data rearrant month, provisions month, pous and with other households. No weather contection (note thin to data were collected for the coldest month). Data from appliances was dissigninged and.	Room temperatures shown, also caregy- saving tipa.	Complex and expensive system, required a meters + like hase computer to send feedback displays to the homes. 7 of the homes' paird attention to their speec heating consumption, reducing learning times? can be fol patter attention of the backness of the participants were especially interested in the <i>dash</i> date; taken thererested in comparisons with other homeschilds, which induced competitive spirit;
Curbon Trust (2007) Advanced metering for SMEs 4% against baseline force and cost savings. The Carbon Trust, London, UK jutts//www.entbourtast.co.uk/technologe vaccelerator/advanced_metering.html	4% against baseline	Project ran over 2 years	108 SMEs		аланан алана Аланан аланан аланан аланан аланан аланан алана алан	Gas	Faif-bourb data, communicated next day.	Some participants had additional information advice, eg emails, face to face advice.	Greatest strings were achieved with consumption profiles and carery strong recommendations sets the reault. Suvings of Tr's were identified on average for each outstoner. Estimated projvated time for advanced metering + feedback in single-to SUFS was a years; for multi-site SMEs, 2 years. Over 80% of SMEs apped to continuer with the advanced metering service, on a full commercial basis, at the end of the trial.
CODatiline.de. accessed July 2008. Home Resources Account	5% per year (21% in all), continuing, weather- adjusted, against baseline	Dataset for 4 years	1247 households		Germany	Gas	Soff-reaching of maters and reporting to a weaking the action wataling the Participana get (http://www.mergiesparkono.de/274.0.html.), whencert regulate camils to remind them to carter data; the unervision. The site relevant superior display of consumption. The other cheford any recent means of whether the function average HRA measures Given projections of future energy, onsite incorporating users, expectations of prace microases.		No published report of this as yet, but the figures come from the CO20nine database of family houses, at deviation database of hum http://www.emergiesynthouto.de/zahlenundfakten 0 huml

						V	Attachment SD-2		
		Findings fro	m selected	direct' feedb	ack studies	(data imm	es from selected 'direct' feedback studies (data immediately accessible to customer) involving gas and/or space heating/cooling	d/or space heating/cooling	
Study McChelland I and Cost SW (1970) Ensent			mple size	Control? [A	Location			Other Interventions / changes to normal bractice	Comments
conversion Level - Oce and (r.y.) Cartery conversion efficient of communum in-home feedback in all electric homea. Journal of Environmental Systems 9 (2), 166-173		In-got your around I	a	·		Electricity in new, insulated, all-electric fromes	Fields mengy transitions with display of controlin.		Design they have every time to have midden with a choice consume the near angre than annually the annual variance and the choice commends and a choice commendation of the choice of annual and the choice commendation that controls in all 11 meanits to the choice of the
Hutton, R.J., Maner, G.K., Kataraki P. ed. Aland, OT (1980) Effests of construction forehous on commune tasowholge and construction behaviour: a faid tasowholge and construction behaviour. a faid Research 13, 327-336.	Up to % over controls, depending on context	, Chine Itemer	3x,25 (1 city in 3x US and 2 cities on in Canada): ex EC1 + co education co	3x75: education U only. (Q experimental B: control, blind C control	USA + Canada ge (Queboc and Brùish Columbia)	gas + electricity E		Education materials for 2 groups	The spin structure of
Van Honweingen, Ha act van Basij, WF (1989) The effert of gautsetting and datify elektratic feebleck on this house energy use. <i>Journal of</i> consumer research 14, 94:105.	12% against baseline. 10% against control	 year experiment. 1 year after end of experiment. differences between groups cessed to be significant 	9 5 E	4 x 55 and one N group of 52 self- monitors	Netherlands	1	hairearn choosing duity gar use sinng with comervation geal of 10% arving (ograed norm), sajaned for wether, Signal light to show when hading was on.		Supports the view data commitment 4 feedback leads to genere weings than external feedback or welf smeaturing, data. Committee of the other structure and a supply market check in their barrens and the external Weeple scars to each a permutation remainder and a trapping check in their barrens to a new event of energy use meased what the information and a menuform of the indicator, particular permeta permetary and and singly defined and a structure of the and a menuform of the indicator, particular permeta permetary and before a structure of the and a menuform of the indicator, particular permetary neurons of energy use before an work and an end an end an endition of the and data permetary permetary permetary and between workhor related change and other change. All bonnes were major family matuk
Dobus IK and Griffin JDA (1992). Conservation Office of Jammakine electrology case feedbacks restrictuate consumption behaviour. Proceedings American Counsul for an Energy-Elifectuat Economy, 1992, 10.3.3 – 10.3.5	13% compared with controls and compared with weather-skipstod baachine	A penatence of conservation behaviour? with shortness consurptions dorining by a spore 3% over the 60 days ffor the households with displays?	25, random sampie	75, randomly Ca solocted	Canada	electric homes a	Residential Electricity Clear Speedenneer, dinoving cost on hourly, duity, monthly and annual band, also breaks down by end-une		A cost will interview a checken the function with the RECS of the linking about desirefully mage to ways and possible websiture specific (editors). They constrained that angular first dimensions on their possible Praticipant reported that they increased their use of the RECS over the presid of the test.
Annual reports of the West Lothun Energy Advice Froject: reference to in Durry (1999) Energy advice - what is it work? Proceedings Energy Gourcil for an Energy-Efficient Economy, III.05	Approx 11% against baseline, from behavioural change only	Mananeman somaly spanned 3-4 1	1,000+	2	10 -10 -	Ges and It let the let	1 flouwholder read their melere	Distrumion of progress with energy advisers, as needed	There are the induced householder who difficulty as polying their fault the maine activation does one constrained and any discretistic devices and the second does are activated as a second does are not justice wrong following installation of every efficiency summer or on documentals.
States H. Harland P. and Wiles FLAM (2004) Elibering and sche changes ranks proved ho more environmental behaviour in the Mederland, Environment and Eduction 36 (1), 41-567	20%, against baseline after 9 months and 3 17% after three years, weather-adjusted	1.134	130	2	Vether lands G		Householdern read their mediern und compared reading, with others in R their Book and the second of O months	Regular meetings of the eco-team (sprear menth)y).	Social factors nad commitment a log demote in the Eos teams. A datable analysis of our behavior, means of memory and the second and and a performance should be participation, and the depend of behavior and induces on the Eos of team along periophram.
Mountain, DC (2006) The Impact of real-time feedback on residential deterrities contamptions the tyshor One pilot. Mountain Economic Consulting and Associates Inc., Ortario	1% aguint control for homes with electric space heating; 17% for home with el water heating but not space heating.	 Year study inc 1.5 years of beseline data. Response was persistent across the study period. 	382 42		Cenada, cic	decurcity P	For this monitor with international feedback, showing contamption (extrapolated from current $k\Psi$), is a WA, 5 and CO3, per bour, in total and predicted. Also show temperature		
Mountain, DC (2007) Read-time feedback and readomat detroity consumption: British Colonizio and Newfoundand and Lanualer plate. Mountain Economic Consulting and Associates Inc., Outerio	20% against control for homes with electric space heating; 22% for those with el water boating but not space , heating.	3.5 year study, including up to 2.5 year of beactine date. Remonse was pertistent across the study period.	58 in 6 localitics, after data-cleaning		Canada, ck Newfoundiand	efectivity F	Porteble monther with instantaneous feedback, consumption its VM, 7 and CO2, per base, in total and predicted. Also shown temperature.		This are small as the second manual of media of mediate, and age affinish approach to be meanine. (Seminer data of constraints, meanine around a symmetry prophy, pediago because days over enser (fugal a the cance). Approx 37 of participants checked distr monitors regularly.
Mounstein, DC (2007)	 19% against control for homes with electric space heating; 2% for those with elevene heating but not space heating. 	3.1% against control for homen with 3.5.year study, actualing up to 2.3 yrs of 4 electric space leading. The for those with basedine data. Response was permanned of electric space heating. across the study period.	43. after data- 17 cleaning	00	Canada, British el Columbia	electricity k k	Portable monitor with instantaneous feedback, showing consumption in kWh, 5 and CO2, per hour, in total and predicted. Also shows temperature.		Bertischy mucht cheuper is BC than in Nowfoundhuch Response was higher during winter menthe than during the annuer, prenumely boesaus the impact of space boulding was analosed: thin fiscaling fair with those from Onstran Level of education also effected responsiveesaus. Approx 37 of participants checked shert mention regularly.
Parsus rese recenter with dispings Woodsock Hyder. Woodsock Hyder. Woodsock Hyder.				opprex 12,000 Ca	Canada, Onterio	cleatricity d d 7	The alify restance a 'han't mach to solve cauded home. The candinger high the alify restance a 'han't mach to solve cauded home. The candinger high highly unit a barry a mar can be any some units the end in profile an end highly unit a barry and the system cauded the constance will gue the means the solution. The constance and how the solution of the off-phy the source of energy are in chilars and could home.		Re sin Shin ad Eicha. 2006 Al who commercian tha the XVCC cubracen us (3-20% km Bur, traditionally more contacted with the single and single and single and solution of shorts. We are not goes housing. From prevent communications with Woodneed Shipon, a mean that its programme was introduced for psymmetric-build customerar but has been taken up by many others.
King J (2007) M geomer: a better way to keep construction in power. Everyo P hilds. Amany 19th construction in power. Everyo Puke, Amany 19th bits.//www.energypute.and/construction/everyor hist.//www.energypute.and/construction/everyor in cfm?s_id=1406 (Sah River Project)	13% (14% nammer, 11% withor) quaine began in 1999 baciline				USA, Arizona el	electricity P + C	in the second	Reminder to customer if they need to buy more credit using smart cards.	The pair of appoinds process controls that can pair the population streads also used for pairwises. There is a second to be all cancers of the second stream static transmission of the second stream
Northern Ireland Electricity, http://www.ukerc.ac.uk/DownloadsPDF/Meeting%2 OPaceEvent2008/03UKcanadademandred/Boyd,	3% against controls	2002-2007	up to 200,000 ap	approx 600,000 Ne	Northern ele Ireland	electricity	Statistar to Sait Rowe Project above.		The programme began units proment-translated containmer who user also given advices to be use the moment. (They area given 11%). These with bighets containmer who user also given advices to be used the moment. Properties of a Disoutabolish with deciric space hading (peptus %) of these in 21% have device sented heading).