

***Smart Grid Communications
Security Project, U.S.
Department of Energy***

Final Technical Report

Period Covered: September 2010- August 2012

September 2012

Professor Frank Barnes

University of Colorado Boulder

Boulder, Colorado

Smart Grid and Security

2010-2012

Frank Barnes

Introduction,

There were four groups that worked on this project in different areas related to Smart Grids and Security. They included faculty and students from electric computer and energy engineering, law, business and sociology. The results of the work are summarized in a verity of reports, papers and thesis.

A major report to the Governor of Colorado's energy office with contributions from all the groups working on this project is given below.

Smart Grid Deployment in Colorado: Challenges and Opportunities, Report to Colorado Governor's Energy Office and Colorado Smart Grid Task Force(2010) (Kevin Doran, Frank Barnes, and Puneet Pasrich, eds.)

This report includes information on the state of the grid cyber security, privacy, energy storage and grid stability, workforce development, consumer behavior with respect to the smart grid and safety issues.

From the group in electrical engineering the following documents were generated.

1. Chhabra, M., Harnesswalla, T., Lim, M.; Barnes, F. "Frequency regulation and economic dispatch using integrated storage in a hybrid renewable grid," 2011 International Conference on Energy, Automation, and Signal (ICEAS)
2. Pradhan, O., Awan, M., Newman, K., Barnes, F., "Trust and reputation approach to smart grid security," 2011 4th International Symposium on Resilient Control Systems (ISRCS)
3. Lim, M., Chhabra, M., Pasrich, P., Newman, K., Barnes, F., "Frequency variations in hybrid renewable energy network with integrated storage," 2011 IEEE International Conference on Smart Grid Communications(SmartGridComm)
4. Levine, J. F, Barnes. "Energy Variability and Produced Water: Two Challenges: one synergistic management approach utilizing pumped hydroelectric energy storage" *Journal of Energy Engineering*. ASCE Vol 136, No 1 pp 6-10, 2010
5. Chhabra, M., Lim, M., Barnes, F., "Frequency Stabilization Using Solar Smoothing, Leveling, and Time Shifting in a Hybrid Renewable Network", IEEE ISGT, December 2011, Kollam, Kerala, India

6. Barnes, F., Levine, J., "Applications of Energy Storage to Generation and Absorption of Electric Power" Chapter 1 CRC Large Energy Storage Systems, Handbook Edited by F.Barnes and J. Levine. March 2011
7. Chhabra, M., Mahadevan, R., Pasrich, P., Barnes, F., "A Review of Battery Technologies", Book Chapter, (*Transportation Technologies for Sustainability*) Springer 2013, New Delhi, India 2011
8. Chhabra, M., Harnesswalla, T., Lim, M., Barnes, F., "Arbitrage Operation of a Wind Farm in a Hybrid Renewable Network", IEEE ICEAS, December 2011, Bhubaneswar, Orissa, India
9. Lim, M., Chhabra, M., Barnes, F., "Use of Energy Storage to Mitigate Frequency Variations in a Load Frequency Model", Sandia EESAT, October 2011, San Diego, CA, USA
10. Lim, M., Chhabra, M., Pasrich, P., Newman, K., Barnes, F., "Frequency Variations in Hybrid Renewable Energy Network with Integrated Storage", IEEE Smart Grid Comm, October 2011, Brussels, Belgium
11. Large Energy Storage Systems Handbook Ed by Frank Barnes and Jonah Levine was translated into Chinese. 2014
12. Mohit Chhabra , Frank Barnes," Robust Current Controller Based Solar-Inverter System Used for Voltage Regulation at a Substation" IEEE-PVSC 2014
13. Mohit Chhabra , Frank Barnes "Robust Current Controller Design using Mu-Synthesis for Grid-Connected Three Phase Inverter"IEEE-PVSC 2014

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADOIN THE MATTER OF THE PROPOSED RULES)
RELATING TO SMART GRID DATA PRIVACY) DOCKET NO. 10R-799E
FOR ELECTRIC UTILITIES, 4 CODE OF)
COLORADO REGULATIONS 723-3.)

**INITIAL COMMENTS OF BARBARA C. FARHAR, PH.D, AND PROFESSOR KEVIN
L. DORAN OF THE RENEWABLE AND SUSTAINABLE ENERGY INSTITUTE
(RASEI) TO THE PROPOSED MARCH 17, 2011 SMART GRID PRIVACY RULES**

Pursuant to Decision No. R1 1-0157-I issued on February 10, 2011, Barbara C. Farhar, Ph.D., and Assistant Professor Kevin L. Doran (Research) of the Renewable and Sustainable Energy Institute (RASEI) at the University of Colorado at Boulder submit the following initial comments regarding the proposed March 17, 2011 smart grid data privacy rules.

COMMENTS**I. General Comments on the Rule and the Rulemaking Process****A. Privacy of CD as a Significant National Issue**

The privacy of customer energy use data is a serious local, state, national, and indeed international issue being addressed by a number of high-level organizations. Recent reports from federal agencies have addressed privacy issues related to the smart grid, including the National Institute for Standards and Technology (NIST), the Department of Energy and the Federal Trade Commission.¹ The Obama administration has just announced a “Privacy Bill of Rights” whose

¹ Smart Grid Interoperability Panel – Cyber Security Working Group. National Institute of Standards and Technology, U.S. Department of Commerce. 2010. Guidelines for Smart Grid Cyber Security: Vol. 2, Privacy and the Smart Grid. August. 42 pp. plus appendices; U.S. Department of Energy. 2010. *Data Access and Privacy Issues*

purpose is to protect Americans from intrusive data gathering by data tracking organizations. Although this bill of rights focuses legally enforceable standards for the collection and sale of personal data gathered from internet use, concern about the privacy of household energy use data collected in a smart grid context is increasing rapidly. Privacy advocates insist that federal agency stakeholder processes must include representation of consumers as well as corporate interests—now termed “multi-stakeholder processes.”

B. Risks to Residential Customers

In a report produced for the Colorado Governor’s Energy Office, Doran and Quinn (2010) have developed a part list of the risks that consumers face if their household energy is released.² The risk of sabotage of electricity bills, unwanted additions to tracking data bases, unwanted marketing contacts, legal monitoring of household behavior, tracking of household routines for a variety of business purposes (such as by insurance companies), law enforcement observation, criminal activity, and other activities makes release of household energy data dangerous for household members.

C. Policy Recommendations from GEO Report

Based on a social science literature review conducted for the Governor’s Energy Office, Farhar and Kemp concluded that “sufficient research and understanding of the long-term impacts of releasing identified energy data does not exist.”³ The authors recommended that consumers’ utility data and information must be safeguarded, and that identified data should not be released to companies, local governmental entities, or other third parties. These organizations may not

Related to Smart Grid Technologies. October; Edison Electric Institute, 2010. *Comments on DOE Request for Information – Implementing the National Broadband Plan by Empowering Consumers and the Smart Grid: Data Access, Third Party Use, and Privacy.* July.

² Doran, K.L. and Quinn, E. 2010. “Consumer Privacy,” Chapter 3, in *Smart Grid Deployment in Colorado: Challenges and Opportunities*, K. Doran, F. Barnes, and P. Pasrich, eds. University of Colorado at Boulder (see chart on p. 44).

³ Farhar, B.C. and R. J. Kemp. 2010. “Consumer Behavior,” Chapter 11, in *Smart Grid Deployment in Colorado: Challenges and Opportunities*, K. Doran, F. Barnes, and P. Pasrich, eds. University of Colorado at Boulder, p. 99.

understand the privacy implications and the risks to which customers may be put if these data are disclosed.

D. Lack of Customer Choice

Household customers had no choice when 23,000 smart meters were installed on their homes in Boulder, Colorado, even though the smart meters collect data on household electricity consumption in 15-minute increments. Therefore, requiring an affirmative informed consent form for the release of CD is a minimal requirement for privacy protection since the risks to households from the release of their household energy data are so serious and households were given no choice whatsoever about the collection of their household energy data.

The GEO report states that: “Third parties should be required to acknowledge in writing that the customer information is confidential and cannot be shared or utilized by any other person, corporation, or entity without the customer’s express written consent.” (p. 3)

The rule as it stands (version 5.0) provides no requirement that third parties must hold CD as confidential and private. Indeed, third parties may well have plans to market anonymized customer data to fourth parties, thereby profiting by putting customers who sign informed consent forms at risk for the kinds of activities cited by Doran and Quinn (2010). Evidence for this is H.B. 11-1191 (bill introduced to the Colorado legislature by Rep. Max Tyler and tabled indefinitely) which directs the PUC to certify that data aggregators, such as Symbiotic, can obtain customer data to sell to public and private entities. Customers will be at risk because their “anonymized” data can be swiftly re-identified, as has been demonstrated by the Federal Trade Commission in the Netflix case.⁴ The motivations to use personally-identifiable information are diverse, ranging from profit motives on the part of corporations to “name-and-shame”

⁴Federal Trade Commission. 2010. *Protecting Consumer Privacy in an Era of Rapid Change, A Proposed Framework for Businesses and Policymakers*. Preliminary FTC Staff Report. December; include citation from Texas study on re-identification of data as well.

approaches on the part of governments (e.g., Gainesville, Florida and activists in the Boulder area).

In addition, the authors recommended that the PUC should develop recourse for those wishing greater privacy and a system to handle short-term damages for those harmed by privacy invasions.

E. Working Group Process

Tony Munoz of the Colorado PUC staff, with Jeff Ackerman of the PUC staff also in attendance, convened a Working Group of stakeholders to consider the language of the Rule. Participating consistently in Working Group deliberations were five attorneys (three for Xcel Energy, Inc. and two for Black Hills) and a representative of the Office of Consumer Counsel (not an attorney) Participating occasionally were representatives of Tendril, Symbiotic, and Dr. Barbara Farhar and Kevin Doran (an attorney), both smart-grid researchers at the University of Colorado at Boulder. Both have been studied smart-grid privacy and security issues for at least two years. Dr. Farhar has collected primary data on household response to SmartGridCity in Boulder.

Version 5.0 of the rule was primarily written by the utility attorneys in the Working Group, and its content reflects that fact. Version 5.0 provides for protection of the utility companies from harm when they release customer data (CD), and although it does provide for affirmative informed consent, it does little to protect customers from the release of their data once they have signed a consent form. We recommend that from April 7th forward, the PUC staff alone should modify the rule.

F. Findings from the qualitative household interviews on perceptions of SGC.

Research on consumer perceptions of the smart grid is being conducted in Boulder, Colorado. Responses from qualitative household interviews suggests that electricity customers, even those who have volunteered to participate in the smart grid have concerns about the security, privacy, safety, reliability, and control of the smart grid (mentioned in 21% of 106 responses)—the most frequently mentioned area of concern.⁵

II. Comments on Specific Sections of the Rule 5.0

Section 3011(d)(IV). Here, and elsewhere (specifically, Section 3013 (b)(IX) and in the Customer completion section of the Informed Consent form), there is an overly broad statement protecting the Utility from responsibility for any harm or damages resulting from the disclosure of CD, including loss of profits or other damages. Indeed, one gets the impression from 5.0 that protecting the Utility is of greater concern than protecting customer privacy.

After Section 3011(e). Insert a provision that Utilities provide to the PUC an annual report, due by no later than January 31st of the subsequent year, that discloses the total number of requests for CD and identifying the entities who requested CD and how many requests each made.

After Section 3012(c)(VI)(b). Insert a provision that if the customer wishes to discontinue informed consent, the third parties must purge CD from their data bases and confirm that back to the Utility and the customer.

3013(b)(III). Insert the phrase “in detail” after the word “State” so that the passage reads: “State in detail the uses of the data for which the customer is allowing disclosure;”

⁵ Farhar, B.C., et al. 2011. *Household Perceptions of the Smart Grid* (manuscript in preparation).

3013(b)(V). Insert the phrase “beginning and ending” so that the passage reads: “State the beginning and ending dates of disclosure;”

3013(b)(IX). Once again, the rule reiterates that the Utility shall not be responsible for third parties maintaining CD in strict confidence. In fact the rule does not provide that third parties should so maintain their CD and this should be added. (See later comments on Sections 3014 and 3015).

3013(b)(IX). A standardized utility consent form authorized by the PUC should be required for use by third parties. Otherwise, the Utility is in the position of attempting to determine if third parties are in compliance with the Rule. Also, this would best serve the privacy interests of customers.

3013(e). This provision overshoots the mark. It would be highly burdensome for customers to require that they notarize their consent forms. Security safeguards can be employed, such as the Utility requesting email or other authentication for hardcopy forms.

3013(f). The word “required” should be substituted for the word “model” so that the passage reads: “The required Consent Form is found in rule 3017.”

3014. This section addresses “Utility-Related Third-Party Access to CD”; however, an operational definition of “Utility-Related” is not provided. It is unclear to what specifically the section refers.

3014(a)(III). The phrasing in 5.0 allows the data aggregator, social-norming organization, and other third-party entities with Utility contracts to obtain customer’s consent for the use of CD for a secondary commercial purpose. Language is needed to constrain use of CD. The rule should restrain third-party organizations from selling or otherwise providing CD to fourth

parties, and from seeking customer consent to do so. This provision also needs to deal with the scenario in which third-parties already possess CD.

3015. This section addresses “Non-Utility-Related Third-Party Access to CD”; however, an operational definition of “Non-Utility-Related” is not provided. It is unclear to what specifically the section refers. This provision also needs to deal with third parties who do not already possess CD.

3015(a). The phrase, “or a third party acting on behalf of a customer” should be clarified.

3015(b). The phrase “A request for the disclosure of a customer’s CD shall not be combined with an inducement . . .” must be clarified. What constitutes an “inducement?” How can such inducements be limited by the rule?

3015(c). The statement should be changed to read: “In order to be valid, the Consent Form must be the standard Utility consent form set forth in the rule, Section 3017.”

3016(b). The section refers to the “15/15” rule; however, the definition provided “(1) at least fifteen customers or premises, and (2) no single customer or premise’s energy usage may comprise 15 percent or more of the aggregated data amount” does not distinguish among customer classes. Thus, data could be aggregated for a mixture of C/I customers and residential customers in a given geographic area. The rule should specify that 15/15 applies separately to each customer class (residential, commercial and industrial).

The section does not define what the percent designation is in relation to—e.g., 15 percent of the total file size for the requested information (kilobytes, megabytes, etc.); or 15 percent of the total energy consumption data encompassed by the request. This needs to be defined.

Further, it is certain that anonymized data can swiftly and reliably be re-identified. The question for this rule is if aggregated data can be re-identified. This highly significant question can only be resolved by testing aggregated utility data through sophisticated data mining techniques. The Commission should ensure that this question is addressed before issuing rules allowing the release of aggregated CD.

3016(c). The section refers to the situation in which the Utility cannot honor a request for AD and requires the Utility to specify the reason that the request cannot be honored. This requirement, besides being burdensome to the Utility, potentially provides too much information to the requestor about the nature of the customer data included within the request. For example, if the requestor asks for data for 16 residential customers, and the request is denied, the requestor would thus be aware that one or more of the customers in the 16-customer group is consuming 15% or more of the data within that customer group. Or alternatively the requestor could be made aware that the request encompasses only 14 or fewer customers, which also provides data to the requestor about the nature of the customer group for which the requestor is seeking data. The recommendation is that the language should only require the Utility to deny requests that do not fall within the parameters without disclosing why those requests are denied.

3016(d). With respect to this section, it appears that the Commission intends the Utility to be the aggregator of CD. However, it is likely that the Utility will contract with data aggregation companies to aggregate CD, and will provide CD with PII to the data aggregator. The rule needs to go much further in specifying the role of the data aggregator than it currently does. For example, from the language in 5.0, it is unclear if the data aggregator, having received CD with PII, develops standard and non-standard AD reports and *provides them back to the utility company to sell to those buying such reports*, or if the *data aggregator is being allowed to sell*

reports directly to fourth parties. If the latter is the case, then the data aggregator is incentivized to develop and market its own products using CD for profit.

The rule should specify that data aggregators *may not sell CD* to fourth parties, and the rule should further specify that data aggregators must publish and adhere to strict CD privacy protections.

3016(d)(I)(c). The language states that the Utility must state how it “will support third-party recipients in translating their requests into the available selection parameters.” Will such assistance to third parties be carried out by Utility personnel or by data aggregators under contract to the Utility? If such technical assistance is performed by data aggregators under contract, data aggregators could be incentivized to develop products based on CD that they then would market independently of the Utility. The rule should specify limitations on data aggregator technical assistance to requestor entities until more is known about the kinds of requests, products, and requestor entities that come forward once the rule is published.

3016(e). This section’s language provides that data aggregators can merge CD from several different utilities and potentially with other data bases. This provision goes beyond the scope of current knowledge in terms of protecting CD from being recombined with other data bases to provide a means of identifying individual customers’ energy use data. Again, until more is understood about the potential harms that could come from such data-merging activities, the activities called out in the section should not be permitted, or, at a minimum, should be strictly limited.

After 3016(e). An additional section is needed that explicitly prohibits data aggregators from providing CD to any other entity.

3016(g). The language here is intended to hold the Utility harmless for any damages resulting from the disclosure of the AD report; however, this statement is overly broad. The Utility should get guarantees from data aggregators and other third-party contractors that they have privacy policies to guard CD in place. A key national and international privacy principle is to first do no harm. The Utility should be proactive in guarding the privacy of CD.

III. Comments on Informed Consent Form

A. General Comment

An affirmative informed consent form is essential to ensure that households retain the privacy of their household energy usage data (referred to as “CD” in the proceedings).

Is government authorized to receive data authorized by consent forms? This form only refers to “company.”

B. Specific Comments

- Title: Change “Consent to Disclose Energy Usage Data” to “Consent of Disclose Residential Energy Usage Data”
- Develop a different form for commercial and industrial accounts.
- On page 1, add the following bullet: “Statement of the privacy policy of the recipient organization”
- On page 2, under the section “To Be Completed by Customer:” Line 3, after the phrase . . . “I authorize disclosure.”: Add the sentence: “If I authorize such disclosure, I understand that I may give up all rights to the privacy of my household’s energy usage data.”
- Under the same section, 2nd paragraph: The statement absolving the Utility of any responsibility for protecting the data is overly broad. Also, add the sentence: “The company agrees to hold your household’s energy usage data in strict confidence.”

- Under the same section, 3rd paragraph: Delete the entire sentence that begins: “Should I refuse to agree to these terms of use consenting to release the data to Company my refusal will not affect the standard utility services I receive from Utility” and replace with the following sentence: “If I refuse to agree to these terms of use consenting to release the data to Company my utility services will not be affected.”
- Under the same section, add a provision that requires Company to purge CD upon request of the Customer.
- On the third page, under the section “For Electronic Form,” 2nd paragraph: Insert the word “electronically” after the word “Agreement” in the first sentence. At the end of the paragraph, add a sentence: “You may request the agreement in writing by contacting [insert name, address, phone number, and e-mail address].”

CONCLUDING COMMENT

We intend to have a representative available at the April 7, 2011 hearing to answer any questions which the Commission may have regarding our comments.

DATED this 24th day of March, 2011.

Respectfully Submitted,

KEVIN L. DORAN
Assistant Research Professor
Renewable and Sustainable Energy Institute (RASEI)
University of Colorado at Boulder

BY: Kevin Doran

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted DOE	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment) DE-SC0005225	Page of 1 1 pages
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3. Recipient Organization (Name and complete address including Zip code)

THE REGENTS OF THE UNIVERSITY OF COLORADO, 572 UCB, 3100 MARINE ST, BOULDER, CO 80309

4a. DUNS Number 00-743-1505	4b. EIN 846000555	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment) 1547366	6. Report Type <input type="checkbox"/> Quarterly <input type="checkbox"/> Semi-Annual <input type="checkbox"/> Annual <input checked="" type="checkbox"/> Final	7. Basis of Accounting <input checked="" type="checkbox"/> Cash <input type="checkbox"/> Accrual
8. Project/Grant Period (Month, Day, Year) From: 09/01/2010			9. Reporting Period End Date (Month, Day, Year) To: 08/31/2012 08/31/2012	

10. Transactions

(Use lines a-c for single or multiple grant reporting)

Federal Cash (To report multiple grants, also use FFR Attachment):

a. Cash Receipts	\$	972,000.00
b. Cash Disbursements	\$	972,000.00
c. Cash on Hand (line a minus b)	\$	-

(Use lines d-o for single grant reporting)

Federal Expenditures and Unobligated Balance:

d. Total Federal funds authorized	\$	972,000.00
e. Federal share of expenditures	\$	972,000.00
f. Federal share of unliquidated obligations		0.00
g. Total Federal share (sum of lines e and f)	\$	972,000.00
h. Unobligated balance of Federal funds (line d minus g)	\$	-

Recipient Share:

i. Total recipient share required		0.00
j. Recipient share of expenditures		0.00
k. Remaining recipient share to be provided (line i minus j)		0.00

Program Income:

l. Total Federal program income earned		0.00
m. Program income expended in accordance with the deduction alternative		0.00
n. Program income expended in accordance with the addition alternative		0.00
o. Unexpended program income (line l minus line m or line n)		0.00

11. Indirect Expense	a. Type Predetermined	b. Rate 26.00%	c. Period From 09/01/2010	Period To 08/31/2012	d. Base \$ 694,581.66	e. Amount Charged \$ 180,591.24	f. Federal Share \$ 180,591.24
							g. Totals: \$ 694,581.66
							\$ 180,591.24

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

a. Typed or Printed Name and Title of Authorized Certifying Official Elizabeth M. Smith, Grant Accountant	c. Telephone (Area code, number, and extension) 303-492-2617
b. Signature of Authorized Certifying Official 	d. Email Address elizabeth.m.smith@colorado.edu
e. Date Report Submitted (Month, Day, Year) 04/06/2013	14. Agency use only.

Standard Form 425 - Revised 6/28/2010

OMB Approval Number: 0348-0061

Expiration Date: 10/31/2011

Paperwork Burden Statement

According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

