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Moezzi, Lutzenhiser,& Ingle Comments on EPIC 2018-2020 Triennial Research Plan draft

Additional submitted attachment is included below.

23 March 2017

RE: California Energy Commission Electric Program Investment Charge 2018-2020 Triennial Investment Plan

Dear Commissioners and California Energy Commission Staff:

We are truly excited about the directions that the California Energy Commission research initiatives are headed, and about the new topics, types of collaboration, data collection, data analysis, and insights that we hope and expect to see. We particularly support the focus on applied social science research (e.g., Initiative 7.1.2), in line with past and ongoing Commission funding of cutting-edge research on applications of social science insights and research methods in the residential sector.[1] This work has also identified research gaps, inventoried available data, and explored opportunities for applying a broader array of knowledge about energy users, technology adoptions, supply chain dynamics, and forecasting and planning for residential sector energy demand. It has begun to explore ways that this knowledge can be applied to climate modeling and the development of GHG reduction goal-setting and implementation policy.

But there is even a greater need to develop and apply social science—on its own or in the context of interdisciplinary and multidisciplinary teams and projects— to inform technology RD&D, deep decarbonization of the energy system, and broad as well as specific forms of sustainability and socio-technical resilience. Addressing these modern problems *well* begs for new forms of research, new perspectives on evidence, and collaboration across disciplines and among different types of contributors, be they academics, non-academy researchers, industry, or civil society. Most of the past 30+ years of energy efficiency research has been directed to narrower problems and contexts limited by specific regulatory constraints. The approaches established in that work provide partial pictures of energy supply and demand, but generally do not tackle the complexity of these systems with their multiple interconnections, nor the current realities of environmental, social, economic, organizational, political, and governance systems. They are not well-adapted to climate policy, deep decarbonization goals, and resilience concerns required for the coming decades.

As illustration of the types of changes that we think are needed, we submit the following possible topics for social sciences RD&D, along with comments on developing and improving research formats supporting social sciences and interdisciplinary knowledge production.

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[1] This social sciences research includes our work for the Commission through the Advanced Residential Energy and Behavior project (Contract 500-08-02), Historical Insights for Technology Adoption Scenarios in California and Flexible Demand Modeling for Residential Air Conditioning with Improved Behavioral Specificity (HITS/WARM, EPC-15-081), Understanding and Improving Solar Thermal Water Heating Effectiveness for California Households (PON-14-507), and contributions to several PON 14-306 "Analysis of Social, Cultural, and Behavioral Aspects of Energy Efficiency Potential" awards.

Making smart buildings intelligent

[S1.4: Enable Integration of Building and Equipment Controls and Automation]

Integrating smart technologies and systems into buildings promises many benefits, but if these technologies are not developed and tested in the context of buildings as *human* systems, buildings may become worse rather than better. Attention to how occupants provide feedback and control within buildings is surely important, but the building systems issues invited by 'smartness' go well beyond interface design oriented to individual comfort services, and cover questions such as: What are the roles of building operators and facilities staff in running and maintaining smart buildings, and how are these roles established? How well will smart buildings work under normal operating conditions, conditions of stress (e.g., extreme weather, failed components) and in emergencies (e.g., power outages), and how can potential problems be anticipated? How are routine building faults actually managed, and what does the other data provided by smart technologies inform? What are the roles of smart buildings as a nexus of other interconnected large infrastructures including power, water, information technology, and communications services? How to evaluate the actual performance of smart buildings in terms of occupant health and satisfaction, energy efficiency, resource use, costs, and own-building and community resilience? The increasingly integrated nature of 'smart' requires increasingly integrated approaches to research, development, and evaluation.

Addressing the social nature of diffusion success and enhancing the performance of technology-centered initiatives

[Initiative 7.1.2: Applied Social Science to Inform Technology Development and Adoption for Deep Decarbonization of the Energy System; also Theme 2: Accelerate Widespread Customer Adoption of Distributed Energy Resources and Theme 3: Increase System Flexibility from Low-Carbon Resources]

The diffusion of new technologies requires acceptance, but also requires fitting into existing socio-technical systems and sometimes even the reconfiguration of those systems. The social aspects of energy supply-demand systems include institutions (such as laws, engineering standards, codes, regulatory arrangements), as well as networks of firms and contracts that are assembled as 'supply chains' or 'value chains' which are often highly resistant to change. These institutions, networks, and chains are often under stresses from competition, various technical and market 'disrupters,' and changing macroeconomic and demand-side conditions.

Promising technology innovations that are a key part of EPIC portfolios include distributed generation, community solar, ZNE buildings, microgrids, distributed storage, demand response, and others. These all involve integration with, and changes to, existing socio-technical systems. And all will be strongly influenced by the dynamics of institutions, markets, consumer cultural tastes and values, and even community-level pressures. So the success of EPIC investments in these areas may well hinge on phenomena and processes that only a social science approach can analyze and communicate.

Smart grids as socio-technical systems

[Initiative 7.1.2: Applied Social Science to Inform Technology Development and Adoption for Deep Decarbonization of the Energy System; also Theme 5: Create a Statewide Ecosystem for Incubating New Energy Innovations]

The cluster of innovations identified above are sometimes called 'smart grids' and/or 'smart cities.' There have been a number of initiatives to create 'smart' systems and infrastructures by local governments, DOE, leading engineering and manufacturing firms, and Silicon Valley 'tech' firms (information, search, internet, social networks, B2B, systems, real-time geo-commercial, etc.). But their efforts have been quite uneven in approach and uptake. This is a good thing, since it offers an opportunity for California to learn from a range of pilot experiments. And better flows of information and control of more distributed/dispersed/decentralized sources of energy supply and storage will be a necessary part of California's response to climate change and continual growth in population with constrained resources. However much of the work on realizing smart grids and smart cities has been exclusively hardware-focused. At the same time, the problems that will be encountered in realizing these innovations will be rooted in social dynamics that need to be better understood through systematic research that can feed insights into system-reconfiguring policies, technologies and market arrangements. This more holistic approach to understanding and intervening in energy and environmental systems calls for 'transitions research' to support what the Europeans often refer to as 'transitions management'—where the goal is that socio-technical transitions that will inevitably come in the future are better anticipated, alternatives are more thoroughly explored and preferred alternatives are more effectively encouraged by policy and RD&D.

Socio-technical capacity and resiliency

[Initiative 7.2: Increase the Resiliency of the Electricity System to Climate Change and Extreme Weather Events, especially 7.2.2: Advance Climate Readiness into Electricity System Operations and Ratepayer Readiness]

The electricity system, and the energy system overall (covering fuel transport, natural gas, stored energy services, emergency reserves, etc.), is an immense critical infrastructure interconnected with other critical infrastructures. Its resilience is clearly much more than a matter of technology performance and economic costs. Individuals, groups, and institutions are not only affected by the energy system, they also help deliver this resilience during both normal and extreme circumstances. These contributions may be made through the relatively obvious methods of formal demand response instruments and coordinating grid resources, or through more hidden and local efforts creatively and collaboratively resolving or adapting to social and physical problems (e.g., emergency cooling centers, building and plant operators who identify and address risks, resource sharing). These efforts (including the people and resources that comprise them) are a form of distributed resource impacting not only the resilience of the grid itself, but also the resilience and performance of the myriad services and conditions that rely on the grid. They provide critical adaptation capabilities, even where other plans and procedures fail.

In short, we suggest that research on energy systems resilience take a *socio-technical perspective*, leading to physical designs and other results that deliberately support, as well as do not impede, the ability of individuals and organizations to deliver this "natural" resilience and to help build capacity to do so through sharing knowledge and experience.

Social sciences as an essential component of technology RD&D

[Initiative 7.1.2: Applied Social Science to Inform Technology Development and Adoption for Deep Decarbonization of the Energy System]

Social sciences can make important, even crucial, contributions to energy technology-focused RD&D and improve its outcomes. These contributions range across design, planning, performance, marketing, evaluation, and coordination with other transitions, whether planned and unplanned. Adding this expertise is not very easy and certainly not yet natural within current research environments, within and outside energy research. However, the Commission has a long-standing reputation for innovation. Given the increasingly broad and 'systems' nature of the technologies and research initiatives the Commission supports (e.g., Distributed Energy Resources, smart buildings, the food-energy-water nexus, and energy systems and infrastructure resilience), there are excellent opportunities to hone methods to deliver and integrate contributions from social sciences in realistic and useful ways, supporting a more holistic, more integrated approach to research and its results.

The situation thus itself poses a set of practical and research questions as to how to most usefully add social science expertise to EPIC technology RD&D investments toward more fully accounting for human factors in technology development and use, supporting dissemination of actionable findings, and increasing benefits to the people of California. There are more and less effective ways to think about and implement multidisciplinary and interdisciplinary work that involves effective collaboration between social scientists and physical scientists; different social sciences are suited to providing the most useful insights in different topic areas. For example, cognitive psychology can contribute to device interface design; sociology can contribute to supply chain research and, community and lifestyle studies, and anthropology can contribute to studies of cultural practices, beliefs and technology use in various groups, including marginalized or disadvantaged groups. Pilot projects can study and compare different ways to integrate social science insights with the knowledge and practices of technologists and experts from other disciplines to support proposed future integration strategies for EPIC investments and other California climate change and energy research involving complex socio-technical systems. A few specific ideas for developing and refining interdisciplinary methods, structures, and epistemologies are summarized below.

Technical Advisory Committees

EPIC projects now routinely have Technical Advisory Committees (TACs). These TACS are one of the innovative ways that the Commission has developed to elicit and integrate knowledge from industry and academia into EPIC projects. Given this experience, it may be valuable to examine the use of TACs in EPIC projects in more detail, focusing on committee composition, roles played in the research, how expertise is delivered and utilized by PIs and collaborators, how external stakeholders and stakeholder concerns (whether these are industries, NGOs, local governments, communities, or professions) are incorporated in the projects, cases of TAC 'success' (defining 'success') and 'not-success' across the population of EPIC project, identifying opportunities to enhance TAC contributions, and proposing pilot studies of TAC 'best practices' that might improve the quality of RD&D process, results and dissemination outcomes. For example, it might be useful to devise and test master TAC agreements allocating experts that could more routinely provide particular perspectives (e.g., sociology, anthropology, psychology, politics, economics, etc.) to projects and even coordinate across emerging findings.

Revised views of evidence

One of the challenges that social scientists face in conducting research and communicating insights across social sciences disciplines and to physical scientists and evaluators are others' expectations of what constitutes proper evidence. These expectations can lead to research approaches that do not suit real conditions and constraints (e.g., practical difficulties of statistical sampling, statistical methods that are not adapted to provide useful insights, data restrictions and limitations) even as they superficially appear to be defensibly scientific. To begin, more open conversations on these dilemmas of knowledge and evidence could help surface methodological expectations and limitations, leading to evolution in how research and policy communities view and interpret evidence.

Different management structures

Coordinating research across multiple types of expertise and multiple institutions, often conceptually and geographically distant from each other, is not an easy problem. Specialized research centers are one approach to coordination, but not the only one. Other possibilities include modular research that is centrally coordinated, staff experts, specific trainings, and local pilot studies.

Diversity, distributions, data, and planning

[Theme 8: Catalyze Clean Energy Investments in California's Disadvantaged Communities; also a general perspective for socio-technical research]

Especially with the advent of bigger data and the increasing salience of physical diversity and dynamics (e.g., weather extremes, perfect storms, myriad configurations, etc.), there is increasing need and increasing ability to explicitly incorporate distributions and complex relationships into analytic procedures and the planning that these procedures inform. For example, demand forecasting practice and potentially its accuracy can be improved through incorporation of more realistic characterizations of behavior, social variation in energy use, estimation of uncertainty, and the use of "what-if" scenario modeling at the sub-state scale (e.g., community scale, climate zones, utility territories).

In addition, empirical studies using existing data and new data collection and opportunities (e.g., especially the resources being developed at the Commission) can focus on variable patterns of technology and energy use among different income, ethnic, cultural, and regional groups in all sectors (residential buildings, commercial buildings, industrial contexts, etc.). Such analyses can improve the understanding of how energy is being used and how it might change, as well as examine the equity impacts and issues involved in the differential distribution of both benefits and negative outcomes from past, current and proposed policies focused on energy conservation, energy pricing, energy education, environmental improvement, climate change adaptation, greenhouse gas emissions reductions and deep decarbonization.

We are grateful for this opportunity to comment on the Research Plan and for the ability to participate in the preceding staff workshops.

Sincerely,

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