What Do We Know About Behavior and Energy?
Lessons Learned and Recommendations for Future Research, Improved Program Design and Implementation, and Creative Policymaking

Edward Vine

Lawrence Berkeley National Laboratory
&
California Institute for Energy and Environment

2009 Behavior, Energy and Climate Change (BECC) Conference
Washington, DC

November 16, 2009
1. Motivating program and policy personnel to help empower consumers
2. Encouraging greater advances in the production of energy-efficient technologies & services
3. Using experiments to foster innovation and improve the effectiveness of energy efficiency programs
4. Behavioral assumptions in energy efficiency potential studies
5. Behavioral assumptions underlying California residential energy efficiency programs
6. Behavioral assumptions underlying energy efficiency programs for businesses
7. Market segmentation and energy efficiency program design
8. Process evaluation’s insights for program implementation
9. Energy savings, net to gross, non-energy benefits, and retention from energy efficiency behavior
The findings, opinions, and conclusions expressed in this presentation are those of the presenter and do not represent the opinions or policies of the CPUC or CIEE.
White Papers’ Focus and Products

Focus of white papers:
- What has been learned about the topic?
- What additional work is needed (RD&D and policy guidance)?
  - Context: CPUC’s Long-term Strategic EE Plan

Final products:
- White paper
- Two-page summary
- Presentations to CPUC Energy Division staff & at public workshop
MOST IMPORTANT SLIDE OF TALK

White Papers, 2-page summaries, and workshop presentations available at:

http://uc-ciee.org/energyeff/energyeff.html
White Papers’ Methods & Caveats

Methods:
- Review of literature, program info, policy documents
- Interviews with energy efficiency program managers & evaluators, and, in some cases, interviews with national energy efficiency experts

Caveats:
- Authors indicate limits of study (time & resources => scope)
- This presentation focuses on a subset of their conclusions and recommendations and does not do justice to the rich amount of information in these papers - go read the papers!
Energy Efficiency Program Planning Cycle

- Utilization perspective
- Move “behavior” closer to its use (utilities, government)
- Focus on tools and methods
Fasten Seatbelts!
Energy Efficient Behavior in a Regulatory Environment: Motivating Program and Policy Personnel to Help Empower Consumers

Karen Ehrhardt-Martinez
(American Council for an Energy-Efficient Economy)
Behavioral Inputs to Planning

Motivating People to Pursue Behavioral Change Strategies

Planning

Program Design

Program Implementation

Program Evaluation
# Categories of Residential Energy Behavior

<table>
<thead>
<tr>
<th>Cost</th>
<th>Frequency of Action</th>
<th>Low-cost or No cost</th>
<th>Frequent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infrequent</strong></td>
<td></td>
<td>Energy Stocktaking Behavior and Lifestyle Choices</td>
<td>Frequent Behaviors and Lifestyle Choices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Install CFLs</td>
<td>Wash in Cold Water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pull fridge away from wall</td>
<td>Take Shorter Showers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Install Weather Stripping</td>
<td>Air Dry Laundry</td>
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<tr>
<td></td>
<td></td>
<td>Choose a Smaller Living Space</td>
<td>Turn Off Computer &amp; Other Devices</td>
</tr>
<tr>
<td><strong>Higher cost / Investment</strong></td>
<td></td>
<td>Consumer Behavior &amp; Technology Choices</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>New EE Windows</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>New EE Appliances</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Additional Insulation</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>New EE Car</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>New EE AC or Furnace</td>
<td></td>
</tr>
</tbody>
</table>
# Two Behavior Change Camps

<table>
<thead>
<tr>
<th></th>
<th>Traditional Techno-Economic</th>
<th>New Social and Behavioral</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target Behaviors</strong></td>
<td>Awareness and purchase of energy efficient products.</td>
<td>Technology choices, Energy stocktaking, Habits, and Lifestyles</td>
</tr>
<tr>
<td><strong>Change Strategies</strong></td>
<td>Information and Financial Incentives</td>
<td>Goals, competitions, modeling, commitment, tailored information, feedback, social norms, community-based social marketing.</td>
</tr>
</tbody>
</table>
Conclusions

- Behavior change strategies offer the potential of large-scale energy savings
- Many energy professionals are already motivated to pursue behavior change strategies
- A combination of major and minor barriers is constraining the pursuit of behavior strategies
  - Lack of interest in pursuing behavioral change strategies
  - Lack of money or financial resources
  - Inability to quantify energy savings
  - Lack of persistence of behavior-related savings
  - Incompatibility of existing measurement methodologies

[Image of Berkeley Lab logo]
Recommendations

☐ Encourage more research and experimentation to expand the base of reliable knowledge

☐ Revise evaluation and attribution methods to better account for energy savings from behavior change strategies

☐ Adjust existing accountability practices to allow program managers more leeway to incorporate behavior change strategies and apply qualitative measures of customer satisfaction

☐ Work to broaden the purview of utility regulators to enable greater investment in a broader range of cost-effective programs — particularly behavior change strategies — and to encourage more social scientists to join the staff at all levels
The Climate Imperative and Innovative Behavior:

Encouraging Greater Advances in the Production of Energy-Efficient Technologies and Services

John A. (Skip) Laitner
(American Council for an Energy-Efficient Economy)
Behavioral Inputs to Planning

Innovative Behavior

Planning

Program Design

Program Implementation

Program Evaluation
The Scale of the California Imperative

![Graph showing the scale of the California Imperative with and without expanded innovation. The graph shows a significant reduction in emissions by 2050 when expanded innovation is applied compared to Business As Usual (BAU) innovation.]
Conclusions (1)

- California is rightly seen as an innovator, and as a world leader in developing the energy efficiency resource.
- Yet, the “Climate Imperative” will require an equivalent “~17 Gigaton Throwdown” for California between now and the year 2050 – if the state is to respond successfully to that challenge.
- Beyond significant investments in the state’s infrastructure, and human and physical resources, new collaborations, new expectations and new institutional arrangements are essential if innovation is to meet that challenge.
Conclusions (2)

- None of the following recommendations is revolutionary, nor are they prescriptive; but taken together they provide a reasonable portfolio of next steps forward that might catalyze purposeful innovation at the scale sufficient to address California and the global climate imperative.

- These next steps forward can enable energy efficiency to evolve from its current status as a low-hanging fruit to the dynamic, long-term resource that it could provide.
Recommendations

- Boost innovation in the adoption phase of the energy-efficient technology pipeline by implementing efficiency-friendly smart grid policies.
- Energize the public sector and civil society with a compelling innovation narrative.
- Promote knowledge sharing and cooperation among all elements of the energy efficiency supply chain.
- Increase the use of swarm-type meetings in energy-related brainstorming sessions, possibly with a first experimental effort at the CPUC’s upcoming smart grid meetings.
- Make use of an innovation mandate to direct the actions of appropriate government agencies and personnel.
Using Experiments to Foster Innovation and Improve the Effectiveness of Energy Efficiency Programs

Michael Sullivan
(Freeman, Sullivan & Company)
Behavioral Inputs to Planning

Experiments & Innovation
Planning
Program Design
Program Implementation
Program Evaluation

ieren Lab
Conclusions

- Realization of much of remaining economic potential requires changing behavior of energy users.
- Significant R&D will be required to improve the performance of energy efficiency programs using behavior change strategies, taking advantage of knowledge from the behavioral sciences.
- Fostering innovation in the development of energy efficiency programs based on behavior change is key.
- Innovation in products and services requires highly managed and focused R&D effort based on experimentation.
- Significant institutional barriers stand in the way of progress and must be overcome.
Experiments or Pilots – what’s the difference?

Pilots can be experiments, but usually they are not

Pilots
- More or less full-scale test of program within a limited geographical area or for a short time
- Test of effectiveness of fully-developed prototype
- Integrated within utility production organization
- Headed for full-scale implementation unless fatal problem is discovered
- Evaluation of ex-post impacts and process evaluation

Experiments
- Small-scale tests designed to conclusively determine whether a given program design alternative works better than another
- Multiple program design alternatives tested
- Careful attention to research design to allow conclusive decision about how to proceed
- Often not integrated with production organization
- Full-scale implementation may or may not be contemplated - depends on outcome of test
Recommendations for Experimental Programs

☐ Feedback programs
  ☐ Test cost-effective approaches to combining information about price, consequences of action and information about decision alternatives that can achieve significant reductions in household energy use. Could be the holy grail!

☐ Community level interventions
  ☐ Conduct experimentation at the community level for studying effectiveness and new ideas

☐ Alternative marketing messages
  ☐ Conduct ongoing experimental work on market segments to discover effective messages
Recommendations for Overcoming Institutional Barriers to Innovation

- Provide utilities with funding specifically earmarked for R&D designed to develop energy efficiency program improvements based on behavior change.
- Develop a framework within which utilities and regulatory staff can come to agreement on reasonable short-term and long-term R&D objectives as well as appropriate research protocols to be applied to answer specific types of questions.
- Closely monitor utility performance in achieving R&D objectives including development of organizational capability to efficiently bring new products and services to market.
- Reorganize regulatory staff as necessary to allow them to oversee the work of utilities in designing and bringing new energy efficiency programs, based on behavior change, to market.
Behavioral Assumptions in Energy Efficiency Potential Studies

Mithra Moezzi
(Ghoulem Research)
Behavioral Inputs to Planning

Energy potential studies

Planning

Program Design

Program Implementation

Program Evaluation
<table>
<thead>
<tr>
<th>Turn thermostat down in winter</th>
<th>Defrost freezer more often</th>
<th>Take shorter showers</th>
<th>Run dishwasher only when full</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shut windows and doors</td>
<td>Reduce refrigerator temperature</td>
<td>Wash &amp; rinse clothes in cold water</td>
<td>Turn up air-conditioning temperature set-point</td>
</tr>
<tr>
<td>Turn off lights</td>
<td>Reduce water heater temperature</td>
<td>Line or hang-dry clothing</td>
<td>Turn off water heater when on vacation</td>
</tr>
<tr>
<td>Draft-proofing</td>
<td>Use microwave instead of oven</td>
<td>Put lids on pots</td>
<td>Unplug electronic devices</td>
</tr>
</tbody>
</table>
Conclusions (1)

- Energy efficiency potential studies explicitly consider *purchasing* behavior
  - Depictions reflect informed convention
  - Excellent forum for critically analyzing these conventions
  - May poorly represent individual, even aggregate, decision-making

- Improving *modeling* is costly, and elaborations are not necessarily desirable or reasonably possible

- Improving understanding and operations at the program and policy level may be far more important
  - Need data to collect, experiments to do, questions to ask
Conclusions (2)

- Energy efficiency potential studies consider only a limited aspect of energy efficiency and energy savings potential
  - Befits their “official” job and should not be misread as doing more
  - They provide a strong vantage point for seeing what is missed
  - Looking beyond is harder but crucial if the goal is finding convincing routes to long-term emissions reductions

- Need to consider:
  - Behavioral conservation
    - Growing interest in quantifying and motivating
    - Savings obviously possible but evidence on persistence is poor
    - Some promise but the lens is narrow and the logic shaky
  - Larger systems shape and constrain individual choice
    - Social and technological infrastructures
    - Rarely amenable to easy interventions
Scales of Energy Use and Change Potential

- Individual, Easier
  - Technical Efficiency
  - Behavioral Conservation
  - Lifestyle
  - Infrastructural
- Societal, Harder
  - Indirect Consumption
Recommendations

- Support work on more real **observations** of how people and groups use and decide about energy
  - Models can’t substitute
- Support more **collaboration**
  - Policy-makers & researchers, consulting & academics, etc.
- Recognize **limitations**
  - Of individual decision-making, whether for purchases or behavioral change
  - Of efficiency, information, programs, etc.
- Support **research** and better **communications** for understanding and transcending institutional and analytical constraints within the field
Behavioral Assumptions Underlying California Residential Energy Efficiency Programs

Loren Lutzenhiser
(Portland State University)
Behavioral Inputs to Program Design

- Behavioral assumptions
- Program Design
- Program Implementation
- Program Evaluation
- Planning
Physical, Technical, Economic Model (PTEM) - Current Paradigm

- Efficiency improvement comes from changing technology
- Adoption decision drives improvement
- Adoption decision is economically rational
- Programs concentrate on providing information to improve awareness and provide incentives to offset first cost, risk and other costs
Conclusions (1)

- Fundamental policy frames that made sense for energy efficiency don’t work for climate change

- Energy efficiency policy frame
  - Based on a device-centered view and PTEM
  - Weak for residential sector
  - Limited attention to behavioral goals and tools
  - Utilities constrained and reliant upon craft knowledge

- Climate change policy frame changes everything
  - Big, bold ideas needed to significantly reduce GHG emissions

- New policy imagery needed
Conclusions (2)

- Behavior change and consumer choice: new territory for energy policy
  - Particularly at large scale and rapid implementation

- Research is needed to better understand:
  - Consumption and choice
  - How to improve communications & influence
  - How to support joint private/public action
Conclusions (3)

☐ Social science research on energy and behavior has not focused on policies and interventions

☐ Need a significant commitment in this area

☐ Unprecedented policy goals require new ideas, approaches, transparency and collaboration

☐ We can begin to improve program assumptions, designs and implementation – incorporating targeted research
  ☐ Program Experiments
  ☐ Adaptive Theory-Based Pilot Programs
Recommendations (1)

- Program Experiments
  - Experimental designs
    - Sort out causes, effects, program design elements, population characteristics, consumer choice processes, household dynamics, etc.
  - Vary treatments, control variables and compare hypotheses based on observed outcomes
Adaptive Theory-Based Pilot Programs

- Incorporates formal theory, observation, real-time feedback, and corrective action
- Can embed experiments
- Must be closely observed in real time
Recommendations (3)

- **Theory-based market transformation approach**
  - Developed independently of adaptive theory-based pilot programs, but shares many attributes
  - Specifically applicable to energy efficiency change in market contexts
  - Incorporates evaluation
  - Links program design, implementation and evaluation with social science research
  - Serious commitments to program theory
Behavioral Assumptions Underlying Energy Efficiency Programs for Businesses

Michael Sullivan
(Freeman, Sullivan & Co.)
Behavioral Inputs to Program Design

- Behavioral assumptions
- Program Design
  - Planning
  - Program Evaluation
  - Program Implementation
Conclusions (1)

- The effectiveness of the PTEM-based energy efficiency programs is increasingly limited as the “low hanging fruit” are being picked.
- Recently approved energy efficiency programs have been designed to overcome many of the market barriers and behavioral factors that hinder program effectiveness. However, the success of some of the proposed improvements to programs will depend on R&D.
Conclusions (2)

- There is a need for more R&D, but there are three significant hurdles:
  - Historically, funds have not been allocated for front end R&D designed to improve program effectiveness.
  - Failure, which is normal and required in R&D, is sometimes punished or penalized in the current regulatory environment.
  - Failure results in costs without offsetting benefits at the program level.
Conclusions (3)

- Programs targeted at businesses and government tend to deliver information about alternatives and incentives at the bottom of the organizational hierarchies that make decisions about energy efficiency investment.
  - They are targeted at facilities managers and engineers.
Conclusions (4)

☐ Next generation of energy efficiency programs poses significant challenges to program evaluation paradigm:

☐ Program evaluation protocols are focused on measurement and verification of direct energy savings – not on indirect energy savings or non-energy impacts.

☐ Some aspects of programs pose extremely difficult technical problems for evaluation – particularly when net savings are considered.

☐ Program evaluation protocols are not focused on providing feedback to programs during startup and rollout about what is working and what is not.
Conclusions (5)

- The Elephant in the Room – the current emphasis on impacting the energy efficiency of buildings, equipment and processes misses much of the opportunity for improving the efficiency of energy use in businesses.

- Efficiency gains from improvements in building and process equipment efficiency are often the most capital intensive and difficult for businesses to achieve.

- Actual energy use associated with business goes far beyond what is used in buildings and processes.
  - We are missing the low hanging fruit.
Recommendations (1)

☐ Require substantial R&D on the **front end** of program implementation.

☐ Improve the effectiveness of programs through market segmentation and development of more effective messages.
  - Requires experimenting with different strategies & approaches.

☐ Develop new evaluation approaches for programs that do not fit well within the context of the existing evaluation framework.
Recommendations (2)

- Encourage corporate and government management to:
  - Establish annual energy efficiency goals for their organization
  - Set aside reserves and budgets to fund energy efficiency and other sustainability investments on an ongoing basis
  - Set reasonable economic tests for energy efficiency investments
  - Create a formal review process to evaluate energy efficiency investments
  - Assign responsibility to one of their direct reports for improving energy efficiency in the organization
Market Segmentation and Energy Efficiency Program Design

Steven Moss
(M.Cubed)
Behavioral Inputs to Program Design

Market segmentation

Planning

Program Design

Program Implementation

Program Evaluation
Conclusions

- Segmentation is actively used in consumer markets
- Several competing criteria need to be satisfied to apply segmentation techniques
- Need to question the integration of energy efficiency with demand response, renewables, self-generation:
  - Consumer products don’t typically take care of all your personal hygiene needs
  - Health maintenance organizations provide comprehensive care, but different institutional/financial model
  - Some populations will embrace integrated approaches; others won’t
Recommendations

☐ Provide same measures but to different segments:
   ☐ Technologies can be building blocks, with different marketing applications matched with specific segments
   ☐ Pay more attention to how target population is defined and delivered
   ☐ Limit broadcast information in favor of segment-based marketing coupled with incentives

☐ Conduct more applied research:
   ☐ Conduct active demonstration pilots focusing on different segments in each IOU service territory
   ☐ Incorporate academic research into the regulatory process
Process Evaluation Insights for Program Implementation

Jane Peters
(Research Into Action)
Behavioral Inputs to Program Design and Program Implementation

- Planning
- Program Design
- Process Evaluation Findings
- Program Implementation
Conclusions (1)

☐ Program design:
  ☐ More understanding of the market is needed AND it takes time to understand the market & work effectively
  ☐ Need to conduct market research on:
    - Customers
    - Market structures
    - Technologies

☐ Program implementation:
  ☐ There are real barriers to adoption of energy efficiency:
    - Lack of information, knowledge, access & availability, split incentives, and program-derived barriers
Conclusions (2)

- **Program administration:**
  - Greatest challenge is to balance regulatory requirements with the need for simplification in the market
  - Solutions must work with the market: the challenge is to insert the program into the business model of each market actor

- **Reaching market actors:**
  - Working with manufacturers, distributors, and retailers provides a larger return for lower cost, but there are significant data challenges

- **Reaching residential consumers:**
  - Transaction costs are high, barriers are high, interest is high
  - Need to leverage existing market relationships, regional and national efforts, and local groups
Conclusions (3)

☐ Reaching commercial & industrial consumers:
  □ The business of business is business
  □ Need to understand the business case for efficiency in the market segment and their unique needs
  □ Need to leverage existing organizational ties

☐ Process and market evaluations:
  □ Useful to improve programs and better understand the market
Recommendations (1)

- **Program design:**
  - Understand the roles of the different market actors
  - Understand customer needs and motivations

- **Program implementation:**
  - Targets should be very clear
  - Theory of change and logic model should be well defined
  - Communication should be an integral part of the program - not generic messages, but targeted information

- **Program administration:**
  - Reward systems for implementers should be clear and transparent
  - Program metrics should combine quantity, quality, and satisfaction with meeting the needs of regulators
Recommendations (2)

☐ Reaching market actors:
  - Understand different market channels
  - Engage trade allies through distributors

☐ Reaching residential consumers:
  - Take advantage of decision events
  - Help consumers know what is energy efficient

☐ Reaching commercial & industrial consumers:
  - Focus messaging on similar customers
  - Provide A&E help for measures in similar applications
  - Reach decision-makers at multiple levels of organizations - it usually takes a “champion” to make the case repeatedly
Recommendations (3)

- Process evaluation:
  - Conduct more formative process and market evaluation using a range of methods
  - Integrate social science theory into process and market evaluations
  - Encourage greater connection to the general evaluation community
  - Formative evaluations should be viewed as management tools not report cards
  - Formative evaluations should use process, market, or impact methods
Findings and Next Steps in Energy Efficiency Measurement and Attribution:

Energy Savings, Net to Gross, Non-Energy Benefits, and Retention from Energy Efficiency Behavior

Lisa Skumatz
(Skumatz Economic Research Associates)
Behavioral Inputs to Planning, Program Design and Program Implementation
Conclusions - Gross Energy Savings Measurement

- Impact evaluations apply at least one of following 5 methods:
  - Measurement and verification (M&V)
  - Deemed savings
  - Statistical analyses
  - Market progress / market share analysis
  - Surveys

- Education and behavioral programs have been evaluated but require tailored, rather than prescribed, evaluation methods.

- Direct and indirect impacts can be measured with up-front experimental design methods and sufficient sample sizes.

- Program attribution is challenging.
  - May only be possible to estimate market effects from a portfolio of programs.
Recommendations - Gross Energy Savings Measurement

- Conduct market assessments up front
- Conduct market and appliance / equipment saturation surveys
- Improve modeling and other approaches for assessing behavioral programs
Conclusions - Net Energy Savings Measurement

- Net-to-Gross (NTG, reflecting free ridership and spillover) apply at least one of following four calculations:
  - Deemed NTG
  - NTG adjusted by models with a dynamic baseline
  - Paired comparisons NTG
  - Survey-based NTG

- Spillover is more complicated than free ridership to measure

- Considerable, and growing, controversy regarding the use of NTG, especially in regulatory applications

- Evaluation of free ridership and spillover serves other purposes
  - Identify superior program designs
  - Identify program exit timing
Recommendations - Net Energy Savings Measurement

- Consider short-term (year 1 or 2) and long-term (year 3) deemed values
- Develop enhanced NTG, free ridership and spillover methods
- Conduct experimental designs for evaluation
- Encourage more real-time evaluation data collection for refining programs
- Develop enhanced modeling methods for improving estimates of attributable impacts
- Compile NTG results into a database and continuously update with new research and evaluations
Conclusions - Non-Energy Benefits (NEBs) (1)

- NEBs are often ignored in program evaluation
- NEBs are evaluated under three perspectives:
  - Utility
    - Indirect costs or savings to utility or ratepayers
    - Fairly small NEBs (bill payment improvements, infrastructure savings)
    - Not researched: line loss reductions, insurance impacts, time of day/capacity impacts
  - Society
    - Emissions, job creation/ economic development, health - increasing value
  - Participant
    - Operations and maintenance, comfort, productivity, etc.
    - Studies show large estimated NEBs, exceeding value of energy savings
- NEBs are important for behavioral and education programs and participants
Conclusions - Non-Energy Benefits (NEBs) (2)

- NEBs are real and measurable and represent important factors influencing program and measure adoption.
- Unclear on how and when regulators will incorporate NEBs into the program review process.
- By omitting these impacts, regulators may discourage adoption of programs - especially, behavioral and education programs.
Recommendations - Non-Energy Benefits (NEBs)

- Report program and portfolio metrics with various proportions of NEBs incorporated
Conclusions - Measure Lifetimes

- Measure lifetimes are a key element in the calculation of energy savings from energy efficiency programs.
- Measure lifetimes are fairly consistent for many measure-based programs in residential and commercial sectors.
- Shortage of primary research on technical degradation.
- Virtual absence of studies addressing retention or persistence of energy savings from behavioral and education programs.
- Identifying the measure lifetimes of behavioral and education programs is complicated as more media messages on behavior and education “bleed” across territories.
Recommendations - Measure Lifetimes

- Conduct measure lifetime studies on:
  - Process equipment, some shell measures, cooking, refrigeration, and air compressors
- Conduct technical degradation studies that account for mechanical and behavioral performance-related changes
- Conduct studies on retention or persistence of energy savings from behavioral and education programs
- Require new behavioral programs to conduct retention assessments every year or two
- Apply different evaluation methods to a variety of behavioral programs
Former DOE/EERE Assistant Secretary Worldview

Investment

Technology

Policy
Current DOE/EERE Assistant Secretary Worldview

We don’t have a technology problem!

We have a mobilization problem!
Time for Questions