DOE Quadrennial Technology Review

Clean Electricity Workshop

Boulder, CO

7 June 2011

Welcome

FACA Guidelines

- Participants attending this Workshop are not members of a Federal Advisory Committee, nor do we intend to use this group as a Federal Advisory Committee.
- We are not seeking a group decision or consensus view with respect to the issues before you, or as to any action the Federal government should take.
- We welcome your individual recommendations and advice, and are looking forward to a productive workshop.

Transparency and Outreach

PCAST Recommendation: *"The [process] needs strong external input from many sources, including other levels of government, large and small businesses, academia, national laboratories, Congress, nongovernmental organizations, consumers, and other Federal agencies. …"*

We are committed to engaging our stakeholders consistent with the President's commitment to transparency, public participation, and collaboration. To meet these goals, the DOE will pursue a variety of mechanisms, including:

- A publicly accessible web site
- Release of ex parte communications
- Request For Information (RFI) and Framing Document (published mid-March)
- Public comment
- Focus groups & workshops through mid June

Notes and attendee list from this workshop will be published on the project webpage. Individuals' names will be redacted from comments.

Outreach: Workshops

TRANSPORT

- Alternative Fuels
  - April 26
  - Chicago, IL
- Vehicles Efficiency and Electrification
  - May 4
  - Knoxville, TN

Capstone
July 13 in Washington, DC

STATIONARY

- Stationary Efficiency
  - May 17
  - Pittsburgh, PA
- Grid
  - May 23
  - Scottsdale, AZ
- Clean Electricity
  - June 7
  - Denver, CO

Agenda and Logistics

Time	Agenda Item
8:30-9:00 AM	Welcome and framing remarks from Dr. Koonin
9:00-9:30 AM	Panel discussion of cross-cutting questions
9:30-10:00 AM	Full-workshop open discussion with the panel on cross-cutting questions
10:00-10:15 AM	Break
10:15-11:30 AM	Breakout sessions on the cross-cutting questions
11:30-1:00 PM	Lunch (non-working)
1:00-2:30 PM	Technology roadmap presentations from QTR Technology Teams
2:30-3:30 PM	Technology-specific breakout sessions
3:30-3:45 PM	Break
3:45-4:00 PM	Report-backs from technology breakout sessions
4:00- 4:15 PM	Report-back from the morning's cross-cutting breakout sessions
4:15-4:45 PM	Full group discussion on cross-cutting questions
4:45-5:00 PM	Closing Remarks

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Wireless access

- Network: UCB Wireless
- Login name: confrasi
- Password: RASEI6/7-8

DOE Quadrennial Technology Review

Steven E. Koonin

Under Secretary for Science

U.S. Department of Energy

7 June 2011

Scope

- The DOE-QTR will provide a context and robust framework for the Department's energy programs, as well as principles by which to establish multiyear programs plans and budgets. It will also offer high-level views of the technical status and potential of various energy technologies.

- The primary focus of the DOE-QTR process and document will be on the following:
  - Framing the energy challenges
  - A discussion of the roles of government, industry, national laboratories, and universities in energy system transformation
  - Summary roadmaps for advancing key energy technologies, systems, and sectors
  - Principles by which the Department can judge the priority of various technology efforts
  - A discussion of support for demonstration projects
  - The connections of energy technology innovation to energy policy

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Timeline

Nov 2010

PCAST made recommendations for DOE to do QER

3/14 – 4/15

Public comment period for DOE-QTR Framing Document

4/20

First batch of public comments released on project website

Through mid-July

Hold workshops and discussions of each of the Six Strategies

End July/Aug

Submit DOE-QTR to White House for approval

Before Dec 2011

Release DOE-QTR

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DOE-QTR Logic Flow

Energy context
- Supply/demand
- Energy essentials

Energy challenges
- Oil security
- US competitiveness
- Environmental Impact

Players and Roles
- Private/Gov't
- Within gov't
- Econ/Policy/Tech
- Acad/Lab/Private

Technology Assessments
- History
- Status
- Potential

Six strategies

DOE portfolio principles

Technology Roadmaps
- Milestones
- Cost
- Schedule
- Performers

DOE priorities and portfolio
Balanced within and across strategies

Program plans and budgets

DOE-QTR Logic Flow (Transport Example)

Energy context

- Supply/demand
- Energy essentials

Energy challenges

- Oil security
- US competitiveness
- Environmental Impact

Six strategies

- Oil imports: $1 billion/day; create geopolitical distortions
- Oil is a commodity: domestic prices are coupled to the global market and subject to global supply/demand balance
- Fuels that are fungible with oil products will sell at the global price

- Primary goal in transportation sector: reduce oil consumption without impacting transportation services
- Economic competitiveness and environmental impacts are secondary drivers

3 Transport Strategies

- Increasing vehicle efficiency
- Progressively electrifying the vehicle fleet
- Deploying alternative fuels

Six Strategies

	Supply		Demand
Stationary	Deploy Clean Electricity	Modernize the Grid	Increase Building and Industrial Efficiency
Transport	Deploy Alternative Fuels	Progressively Electrify the Fleet	Increase Vehicle Efficiency

DOE-QTR Logic Flow (Transport Example)

Internal Combustion Engines

- Significant headroom in both gasoline and diesel engines
- Dramatic increases in efficiency over the last few decades have mostly gone to performance rather than fuel economy
- Effective private-public consortia
- ICE improvements have wide-spread benefits (benefit all vehicles except for all-electrics and fuel cell vehicles)

Lightweighting and Aerodynamics

- Lightweighting:
  - More potential impact on light duty vehicles (LDVs) than heavy duty (HDVs) due to freight weight
- Aerodynamics:
  - More headroom in HDVs due to greater frontal area and more highway travel than LDVs

Vehicle Electrification

- Degrees of electrification for EDVs: HEVs → PHEVs → BEVs + FCEVs
- The electric grid can handle PHEVs
- Electricity and H_2 are not fungible with oil
- Opportunity to build a competitive US industry while reducing oil consumption and emissions
- Battery and electronics costs can fall significantly, driven by new technologies

Alternative Fuels

- Biofuels
  - Starch-based ethanol is well established
  - Other feedstocks, fuel molecules, and processes show promise and have some private sector investment
- Alternative fossil fuels:
  - CTL/GTL/CBTL: known, capital-intensive technology
  - CNG: Used in fleets; infrastructure is a challenge

Technology Assessments

- History
- Status
- Potential

Technology Roadmaps

- Milestones
- Cost
- Schedule
- Performers

A QTR Technology Discussion Includes

- Why this technology is included
- Headroom
  Resource
- Current industry
  Actors and their roles
- Roadmap
- DOE history and accomplishments
- Policy context
  Barriers
- Tech-specific items needed for prioritization

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DOE-QTR Logic Flow (Transport Example)

DOE in context

- CAFE standards drive vehicle efficiency and R&D investments in the private sector
- RFS2 standards mandate biofuel production; tax credits and tariffs shape this market
- DOE/ARRA investments in biofuels and batteries
- Successful consortia for pre-competitive vehicle R&D
- DOE has materials, biology, and computing expertise

Players and Roles

- Private/Gov't
- Within gov't
- Econ/Policy/Tech
- Acad/Lab/Private

DOE portfolio principles

OE priorities and portfolio
ced within and across strategies

rogram plans and budgets

Portfolio Principles

- DOE can be a source of credible techno-economic information and analysis
- Innovation can lower the cost of compliance with standards and other polices
- Infrastructure compatibility matters

Performers

www.energy.gov/QTR

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We will require input on:

- Roles of government, industry, national laboratories, and universities in energy system transformation
- Principles by which the Department can evaluate and prioritize various technology efforts
- Connections of energy technology innovation to energy policy

Tidbits of what we've read and heard

DOE-QTR Workshop	Public Comments (direct quotes)	Workshop Comments
Alternative Fuels	"Some continuing support from DOE to supplement the extensive private capital is worthwhile."	The value proposition of the department is technology assessment, not technology invention.
Vehicle Efficiency and Electrification	"Electrification of the vehicle fleet means both light-weighting vehicles and better batteries and energy systems."	Industry doesn't separate demonstration and deployment. We're entering a decade of experimentation.
Building and Stationary Efficiency	"[I]nvest substantial resources into research and development to better understand the energy flows of buildings to stimulate the development and deployment of lower-cost building and equipment monitoring technologies."	We need better data on how energy is actually used in buildings and industrial processes. Skilled workforce matters.
Grid	"Other experts saw the task of modernizing the grid as one of deployment not development, and thus questioned the need for much DOE investment."	DOE's most important role is as a convener of the different grid stakeholders–helping to build a shared vision of the future of the grid both regionally and nationally.

A Few Comment Excerpts Specific to Clean Electricity

Organization	Comments Specific to Clean Electricity (direct quotes)
Linde	"…we also encourage the development and deployment of advanced well completion techniques that can help economically expand natural gas production while meeting other societal needs such as managing impacts on people and the surrounding environment."
Natel Energy, Inc.	"We suggest creating a new taxonomy which demonstrates awareness of and interest in the separate scientific discourses around hydroelectric, marine, and geothermal technologies equal to the awareness and interest demonstrated in the discussions of nuclear, wind, and solar power."
UTC Power	"The Department has limited the discussion of distributed generation technologies and has made fuel cell technology conspicuous by its absence in the framing document. The United States has the technology leadership in the commercial application of fuel cell technology. Three fuel cell technologies are currently in limited production and commercial deployment for large stationary power applications."
Terry Arthur Ring, Dept of Chemical Engineering, Univ of Utah	DoE's present approach is not selective enough when it comes to technologies that will stand the test of market viability. As an example of what I mean, the 2010 ARPA-E funding has spent multiple tens of millions of dollars on "mineralization" as a means to sequester carbon dioxide from fossil fuel fired power plants.

Comments can be found at: http://energy.gov/qtr/10091.htm

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Cross Cutting Questions

- What problem should DOE be trying to solve in electricity supply, beyond GHG emissions?
- There are a wide variety of electricity generation technologies. How should DOE balance:
  - Depth vs. breadth of investment?
  - Technological R&D vs. addressing non-technical barriers in deployment?
  - Different timescales of impact?
  - Widgets vs. systems?
  - Distributed vs. centralized generation?
- How should DOE take regional variability of resources into account in building its electricity supply portfolio? How should DOE take water requirements into account?
- Should technologies "exit" from DOE's portfolio? As a technology becomes more mature, how should DOE's posture change? What metrics should DOE use to measure progress and to compare technologies? LCOE + GHG + …
- What do you think will happen in this field if natural gas prices drop, or skyrocket? How would you alter your priorities? How should DOE's portfolio differ if gas prices change?
- What and how can we learn from the vigorous deployments abroad?
- What is the relative value of innovation investment to develop technologies vs. other polices that support deployment?
- A "Clean Electricity Advisory Committee"?
- What are the criteria for entertaining a demonstration project?

Panel Discussion

- John Tombari
  - President, Schlumberger Carbon Service
- Per Peterson
  - Professor, Department of Nuclear Engineering, University of California-Berkeley
- Joseph Armstrong, PhD
  - Vice President and CTO, Ascent Solar Technologies, Inc.
- Carsten Hein Westergaard, PhD
  - Global Technology Director, Vestas Technology R&D

Breakout: Cross-cutting questions

- Groups have been assigned

Technology Roadmaps Presentation

- CCS – Jarad Daniels (15 mins)
- Nuclear – Matthew Crozat (15 mins)
- Wind – Jim Ahlgrimm (10 mins)
- Water – Jim Ahlgrimm (10 mins)
- Geothermal – JoAnn Milliken (10 mins)
- Fuel cell – Tien Nguyen (10 mins)
- Solar PV – Kathleen Bolcar (10 mins)
- Solar CSP – Kathleen Bolcar (10 mins)

Breakout: Technology-specific

- Solar (PV and CSP)
- Nuclear
- Fuel Cells
- Water
- Wind
- Fossil (including CCS) & Geothermal

Report-back from AM's cross-cutting breakout sessions

- DOE's primary value is through its informational role (info clearinghouse, test facilities, be a referee), assessing technology headroom, market potential, validation of technology (or component) performance.
- Lab expertise allows technologies to ride over fluctuations in money or policy (a "capability mode").
- DOE brings deep technical knowledge and capability and is perceived to own the national energy strategy. Should recognize, maintain, and leverage that.
- Roadmaps are important, and DOE should both shepherd their development and drive technologies along them.
- DOE endorsement (or lack thereof) has enormous signaling power.
- DOE should work with industries to ID technology needs; sharing these needs help direct private (small company) R&D. "Opportunistic within a vision."

Report-back from AM's cross-cutting breakout sessions

- DOE should do pre-competitive R&D, and for more mature tech. DOE should focus on reducing non-technical barriers. Industry can do the rest.
- DOE should take more risks, as there is still real value of a "failed" effort (e.g, FutureGen and SynFuels Corp). DOE should make negative outcomes – and their reasons – more available.
- Appropriate role of government: [1] invest in/support anything that is not available commercially, [2] identify what industry is not doing (and why) to determine what we should do, and [3] to pick winners all the way through commercial scale demonstration, but it must justify decisions.
- Portfolio: [1] DOE should focus attention on tech 2 generations out. Can't count on impacts more near term than 3 years, ***vs.*** [2] DOE should focus on pre-competitive R&D and knocking down non-technical barriers.
- The user facilities, test facilities, and technical workforce at the national labs are great national assets, but establishing common rules for partnering is critical. Variability in requirements is a barrier.

Public Talk Tonight

America's Energy Challenges

Tuesday, June 7, 6:30 pm

University of Colorado Boulder

Old Main Chapel

Look for event parking signs on University Avenue

The U.S. Department of Energy´s goals for meeting America's energy challenges involve energy security; reduction in greenhouse-gas emissions; and promoting changes in energy supply, transmission, storage, and use. And even within those challenges lies another: energy change can be slow. Dr. Koonin will discuss the technology, policy, and economic levers we can use to transform the energy system while enhancing U.S. competitiveness in the global economy.

NREL NATIONAL RENEWABLE ENERGY LABORATORY rasei University of Colorado Boulder U.S. DEPARTMENT OF ENERGY

THANK YOU!

Project Website

http://www.energy.gov/qtr

Questions/Feedback

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Official (Public) Comments

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Proposed Mission Statement for DOE Energy Research

To facilitate the invention, refinement, and early deployment of meaningful technologies that enable options for scaling by the private sector toward national energy goals.

The words in this statement are carefully chosen:

- to facilitate – we convene and fund various entities – as well as support the basic research that underpins invention and refinement
- invention, refinement – we work on both revolutionary and evolutionary technologies
- early deployment – we support some activities beyond first commercial demonstration
- meaningful technologies – we pursue technologies that could have a material impact when deployed; accordingly, scale, economics, and timeliness are important criteria
- enable options – we do not pick commercial winners and losers; the markets make those choices
- scaling by the private sector – we support commercialization as an essential part of what we do
- toward national energy goals – we cannot and will not pursue all technologies; only those that enhance energy and national security, reduce environmental impacts, and increase U.S. competitiveness

Questions

- **Mission**: What do you think of the following mission statement for DOE energy research?
- **Clean Energy Leadership**: How can DOE activities best support U.S. leadership in clean energy innovation? In clean energy manufacturing? In clean energy deployment? How do we balance international competitiveness against international cooperation?
- **Program Definition and Management**: What principles should the Department follow for allocating resources among technologies of disparate maturity and potential time to impact?

  a) What should be the criteria for including a technology in the DOE portfolio? What should be the criteria for removing a technology from the DOE portfolio? How should programs be structured and managed to accommodate entry and exit of technologies within the DOE portfolio?

  b) How do we balance the diversity of technology options the Department could provide for the private sector against timeliness, scale, and cost-effectiveness?

  c) How can DOE be more effective at each stage of the innovation chain?

  d) What are useful metrics to guide DOE technology activities?

Questions

- **Private Sector Partnership**: What are the optimal roles for the private sector, government laboratories, citizens and academia in accelerating technology innovation?

  a) How can DOE best coordinate activities between and among these types of organizations (including the wide variety of institutions within each class)? How should we gauge the effectiveness of this coordination? How can the basic-applied coupling be optimized? Are there examples in other sectors or other countries that can serve as models?

  b) What are the design principles for an effective 'technology user facility'?

  c) How can the Department best gather technology market information? How can information on private sector innovation be captured without compromising competitive advantage?

Questions

- **Technology Demonstrations**: What are principles and best practices in performing large-scale demonstration projects?

  a) How close to commercial viability does a demonstration have to be? What are the optimal cost sharing arrangements? How might demonstrations be coordinated with DOE financing activities?

  b) How can demonstration projects better benefit all stakeholders beyond the immediate participants? How are lessons-learned best captured and promoted, and how is intellectual property best handled?

  c) How should DOE determine whether demonstrations adequately address technical and operation risks?

  d) What defines failure or success in the demonstration phase?

- **Non-technical Barriers**: A number of non-technical barriers—including federal, state, and local regulations, market failures, and non-technical risks—impact the rate of deployment of energy technologies. What, if any, role should the Department have in addressing these barriers?
- **Six Strategies**: Have we correctly identified and structured these six strategies?
- **Technology discussion**: Current selection of technologies and sources? Suggestions of alternate technologies and sources? Updated technology, cost, or forecast data, particularly in rapidly-moving fields?