## Ideas for Innovation in Energy and Climate

Prof. Mike Mauel and students Applied Physics Lunch-Time Seminar Fall 2015

## Current Events (11/25/2015)

- (11/10) IEA Releases World Energy Outlook 2015 (http://www.worldenergyoutlook.org)

| ABOUT US TOPICS COUNTRIES | NEWSROOM \& EVENTS | PUBLICATIONS | STATISTICS |
| :--- | :---: | :---: | :---: | :---: | :---: |
| Publications $>$ World Energy Outlook |  |  |  |

## World Energy Outlook

| World Energy Outlook |  |
| :--- | :--- |
| Home | World Energ |
| About WEO |  |
| Publications |  |
| Factsheets |  |
| Resources |  |
| WEO Model |  |
| Press \& Media |  |

## Press Release

Factsheets
See video from the international press launch
$\qquad$

## Upcoming WEO Events

Upcoming Events

10 November: WEO 2015 launch | London

11th November: World Energy Council Deutschland Presentation to the Bundesministerium für Wirtschaft und Energy | Berlin

11th November: Ministry of Economic Affairs Clingendael International Energy Program The Hague

12th November: Friends of Europe | Brussels

19th \& 20th November: Atlantic INTERNATIONAL STUDIES

## EVENT INVITATIOI

## IEA World Energy Outlook 2015



Tuesday, December 1, 2015
9:00 am to 10:30 am
International Affairs Building, Room 1501
420 West 118th Street
New York, NY 10027

## RSVP Here

Please join the Center on Global Energy Policy for a presentation and discussion of the International Energy Agency's (IEA) World Energy Outlook 2015 featuring Dr. Fatih Birol, Executive Director, IEA.

The World Energy Outlook 2015 (to be released November 10) presents updated

International Energy Agency's World Energy Outlook 2
featuring

## Dr. Fatih Birol

Executive Director, International Energy Agency

## Moderated by:

Sarah Ladislaw
Director and Senior Fellow, Energy and National Security

> 1:00 PM - 2:30 PM

Monday, November 30, 2015
2nd Floor Conference Room
1616 Rhode Island Avenue NW

The CSIS Energy and National Security Program is pleased to host Dr. Director at the International Energy Agency to present the IEA's World presentation will include updated projections for the evolution of the gl based on the latest data and market developments, as well as detailed in fossil fuels, renewables, the power sector and energy efficiency and ana emissions and fossil-fuel and renewable energy subsidies.

In addition, the WEO 2015 includes in-depth analysis on several key is implications of a lower oil price future, India's energy sector, on the co growing renewable energy technologies in different markets, new analy policies, and unconventional gas with a particular focus on China. We h us for this important event.

Registration required to attend.
Please email your registration to energy@csis.org by COB Fr

## WORLD ENERGY OUTLOOK 2015 FACTSHEET

Global energy trends to 2040

- World energy demand grows in all WEO scenarios, but government policies play a powerful role in dictating the pace of the growth and the degree to which greenhouse-gas emissions follow the same path. In the New Policies Scenario (the central scenario), energy demand grows by nearly one-third between 2013 and 2040, with all of the net growth coming from non-OECD countries and OECD demand ending $3 \%$ lower. The links between global economic growth, energy demand and energy-related emissions weaken: some markets (such as China) undergo structural change in their economies, others reach a saturation point in demand for energy services, and all adopt more energy efficient technologies. As the largest source of global GHG emissions, the energy sector must be central to efforts to tackle climate change but, despite signs that a low-carbon transition is underway, energy-related $\mathrm{CO}_{2}$ emissions are projected to be $16 \%$ higher by 2040.
- The single largest energy demand growth story of recent decades is near its end; coal use in China reaches a plateau, close to today's levels, as the country's economy rebalances and industrial coal demand falls. The largest oil consumer - the United States - experiences one of the world's largest reductions in demand from 2013 to 2040 (along with the European Union), declining by around 4 million barrels per day ( $\mathrm{mb} / \mathrm{d}$ ), and returning to levels last observed in the 1960s. Broad-based growth in global natural gas demand (up 47\%) is led by China and the Middle East. By 2040, oil and coal collectively relinquish $9 \%$ of the global energy mix, with renewables growing by five percentage points and gas and nuclear each growing by two.
- The world's appetite for electricity lifts demand by more than $\mathbf{7 0 \%}$ by $\mathbf{2 0 4 0}$, and there is a concerted effort to reduce the environmental consequences of power generation. Renewables overtake coal as the largest source of electricity by the early-2030s and account for more than half of all growth over the period to 2040. Renewables-based generation reaches 50\% in the European Union by 2040, around 30\% in China



## Current Events (11/25/2015)

- (11/10) IEA Releases World Energy Outlook 2015 (http://www.worldenergyoutlook.org)
- (11/23) Moroccan Solar Thermal Plant to open next month (150 MW peak/9.7 sq miles) (http://www.bbc.com/news/science-environment-34883224)


## NEWS

## Science \& Environment

## Moroccan solar plant to bring energy to a million people

By Roger Harrabin
BBC environment analyst
(1) 23 November 2015 Science \& Environment

Morocco is poised to make history soon - when the first phase of one of the world's largest concentrated solar power plants starts generating electricity. When fully operational, it will produce enough energy for more than one million Moroccans, with possibly extra power to export to Europe. (\$2.2B at 500 MW peak in 2020)

## http://www.worldbank.org/projects/P131256?lang=en



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- $(11 / 23)$ Nature-News: Climate optimism builds ahead of Paris talks: Emission pledges raise hopes for an international treaty. (http://www.nature.com/news/climate-optimism-builds-ahead-of-paris-talks-1.18863)


## Talks begin Monday $(11 / 30)$ Agreement signed (12/11)?

- $(11 / 20)$ Hill: "Republicans vow to deny Obama climate funds to derail Paris talks"
(11/23) Hill: "GOP wants to block \$3B
 global climate aid"


# Secretary Moniz Awards \$125 Million for 41 Transformational Energy Technology Projects Ahead of COP21 in Paris 

November 23, 2015-3:36pm

- f Tweet G+1

NEWS MEDIA CONTACT<br>- 202-586-4940<br>- DOENews@hq.doe.gov

WASHINGTON - U.S. Energy Secretary Ernest Moniz today announced $\$ 125$ million across 41 cutting-edge energy technologies awarded by the Department of Energy's (DOE) Advanced Research Projects Agency-Energy (ARPA-E). These new projects are funded under ARPA-E's OPEN 2015 program and come in advance of the COP21 U.N. Climate Negotiations in Paris next week. The announcement was made at D.C. technology incubator 1776 at an event that focused on leveraging America's top innovators to find technological solutions to combat climate change, enhance security and solve pressing energy challenges around the globe.

Open solicitations - also issued in 2009 and 2012 - serve as an open call to scientists and engineers for transformational technologies across the entire scope of ARPA-E's energy mission. Through both open and focused solicitations, ARPA-E funds innovative technologies that display promise for both technical and commercial impact, but are too early for privatesector investment. The OPEN 2015 projects come from 21 states and encompass 10 technical categories, including transportation, electricity generation and delivery and energy efficiency.
"The ARPA-E projects selected today highlight how American ingenuity can spur innovation and generate a wide range of technology options to address our nation's most pressing energy issues," said U.S. Energy Secretary Ernest Moniz. "As we look beyond COP21, the energy technologies the Department of Energy invests in today will provide the solutions needed to combat climate change and develop a global low-carbon economy in the future."

## RELATED ARTICLES

Secretary Moniz Announces $\$ 125$ Million OPEN Solicitation for Transformational Energy Projects

Statement from U.S. Energy Secretary Moniz on Mexico's Greenhouse Gas Emissions Targets


Secretary Moniz Announces Clean Energy Technologies are Accelerating in the U.S.
Marketplace
According to
New
Revolution...
Now Report

## Innovation Teams

| Clever <br> NanoTech | Smart <br> Infrastructure | Good <br> Data-Info | Advanced <br> Nuclear | CCS |
| :---: | :---: | :---: | :---: | :---: |
| Seth Olsen | Omar Mahmood | Joshua Cohen | Sean Ballinger | Richard Cresswell |
| Jonathan Fletcher | Tyler Cowan | Lucas Zeppetello | Farrah Simpson | Aton Baleato- <br> Lizancos |
| Kevin Murphy | Drew Feldman | Jason Williams | Michael Wang | Lauren Riddiford |
| Chen Zhang | Derek Tropf |  | Ben Israeli | James Page |
| Alex Battery | Yumou Wei |  |  |  |
|  | Edwin Vargas |  |  |  |

## Clever Nano-Tech

## High Speed Diode and Rectenna for Waste Heat to Electricity Harvesting

RedWave Energy, Inc. | Glen Ellyn, IL | \$3,381,448
RedWave Energy, Inc. will develop a rectenna-based device that can convert waste heat to electricity. The technology will incorporate special metamaterial structures, multiple nanoantennas, compensation circuit structures, and proprietary rectifiers. The proposed device will be demonstrated in large-area arrays, fabricated using nanoimprint lithography, thus enabling cost-effective roll-to-roll fabrication.

## Ultrahigh Efficiency Photovoltaics at Ultralow Costs

National Renewable Energy Laboratory | Golden, CO | \$5,160,000
Researchers at National Renewable Energy Laboratory will develop an HVPE (hydride vapor phase epitaxy) deposition process for producing high quality, photovoltaic cells with the potential to achieve up to a $30 \%$ efficiency target. This manufacturing technology has the potential to be an order of magnitude lower cost than current state-of-the-art technologies, thus enabling larger scale deployment of efficient solar cells.

## Smart Infrastructure

## Resilient Information Architecture Platform for the Smart Grid

Vanderbilt University | Nashville, TN | \$3,500,000
Vanderbilt University will develop an open-source standard platform that could simplify the development and deployment of Smart Grid software applications by facilitating integration, interoperability, common system services, as well as model-based design tools. Their platform could allow Smart Grid embedded software to move from hard-coded functionality to plug-andplay architecture. This provides the technological underpinning for resilient distributed software apps for improved and effective energy management.

## Good Data-Info

## Data Analytics for Virtual Energy Audits and Value Capture Assessments of Buildings

Case Western Reserve University | Cleveland, OH | \$1,433,281
Case Western Reserve University will develop open-source software to collect data for virtual building energy audits, energy-efficiency assessments, and improvement advisories. Analysis of multiple data streams will identify correlations among different variables, diagnose building and equipment efficiency, and prescribe the highest return on investment solutions. The software could enable cost-effective audits for smaller commercial buildings and help spur energy improvements.

## Advanced Nuclear

IOME • BRIEFING ROOM - STATEMENTS \& RELEASES

The White House
Office of the Press Secretary

November 06, 2015

## FACTSHEET: Obama

Administration Announces Actions to Ensure that Nuclear Energy Remains a Vibrant Component of the United States' Clean Energy
Strategy
our Weekly Address
peeches \& Remarks
ress Briefings
tatements \& Releases
Vhite House Schedule
residential Actions
Executive Orders
Presidential Memoranda
Proclamations
egislation

## Briefing Room

As detailed in the Climate Action Plan, President Obama is committed to using every appropriate tool to combat climate change. Nuclear power, which in 2014 generated about 60 percent of carbon-free electricity in the United States, continues to play a major role in efforts to reduce carbon emissions from the power sector. (\$0.9B research \& \$12B loan guarantees)

THE

## Developing Ground Penetrating Radar (GPR) for Enhanced Root and Soil Organic Carbon Imaging: Optimizing Bioenergy Crop Adaptation and Agro-ecosystem Services

Texas A\&M AgriLife Research | College Station, TX | \$4,600,000
Texas A\&M AgriLife Research will develop ground penetrating radar antenna arrays for 3D root and soil organic carbon imaging and quantification. Visualization of root traits with one mm resolution in soils could enable breeders to select climate-resilient bioenergy crops that provide higher yields, require fewer inputs, improve soil health, and promote carbon sequestration.

## Task for Next Week

- Team oral presentations begin
- Team leaders (Seniors): Two slide summary
- What technical goals/motivations drive your innovation?
- Introduce/describe the element(s) of your tech/implementation
- Everyone: Three slide summary
- Slide 1: Description; what are you discussing/describing
- Slide 2: Present a technical summary of work/research to be done
- Slide 3: Present at least one why your idea shows promise


## Send by email to mauel@columbia.edu before Monday, November 30

## Task for Next Week

- Team oral presentations begin

|  | Monday | Wednesday |
| :---: | :---: | :---: |
| $11 / 30$ | Every Team | Blue $(20 \mathrm{~min})$ |
| $12 / 2$ | $(5 \mathrm{~min}$ each $)$ | Green $(20 \mathrm{~min})$ |
| $12 / 7$ | Yellow $(20 \mathrm{~min})$ | Red 2 min$)$ |
| $12 / 9$ | Orange $(20 \mathrm{~min})$ | (Pizza mity) |

## ARPA-E OPEN 2015 Outline

## OPEN 2015



ACROSS 21 STATES


10 TECHNICAL AREASS


Funding Archive

## Login

Register
Manuals

## FAQs

Funding Agreements

## SBIR/STTR

Teaming Partners

## ARPA-E FUNDING OPPORTUNITY ANNOUNCEMENTS

(ब) Jump to a FOA:

| FOA Number | FOA Title | Announcement Type | NOI Deadline | CP Deadlline | FA Deadiline |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ |
| DE-FOA-0001002 | INNOVATIVE DEVELOPMENT IN ENERGY-RELATED APPLIED SCIENCE (IDEAS) | Funding Opportunity Announcement (FOA) |  | $\begin{aligned} & \text { 9/28/2015 05:00 } \\ & \text { PM ET } \end{aligned}$ | TBD |
| DE-FOA-0001261 | OPEN 2015 | Funding Opportunity Announcement (FOA) | $\begin{aligned} & \text { 2/20/2015 05:00 } \\ & \text { PM ET } \end{aligned}$ | $\begin{aligned} & \text { 2/27/2015 05:00 } \\ & \text { PM ET } \end{aligned}$ | $\begin{aligned} & \text { 6/29/2015 05:00 } \\ & \text { PM ET } \end{aligned}$ |
| DE-FOA-0001289 | NETWORK OPTIMIZED DISTRIBUTED ENERGY SYSTEMS (NODES) | Funding Opportunity Announcement (FOA) |  | $\begin{aligned} & \text { 3/20/2015 05:00 } \\ & \text { PM ET } \end{aligned}$ | $\begin{aligned} & \text { 7/27/2015 05:00 } \\ & \text { PM ET } \end{aligned}$ |
| DE-FOA-0001357 | Generating Reallstic Information for the Development of Distribution and Transmission Algorithms (GRID DATA) | Funding Opportunity Announcement (FOA) |  | $\begin{aligned} & \text { 7/20/2015 05:00 } \\ & \text { PM ET } \end{aligned}$ | $\begin{aligned} & \text { 10/19/2015 } \\ & \text { 05:00 PM ET } \end{aligned}$ |
| DE-FOA-0001425 | SINGLE-PANE HIGHLY INSULATING EFFICIENT LUCID DESIGNS (SHIELD) | Funding Opportunity Announcement (FOA) |  | $\begin{aligned} & \text { 11/18/2015 } \\ & \text { 05:00 PM ET } \end{aligned}$ | TBD |
| DE-FOA-0001428 | INNOVATIVE DEVELOPMENT IN ENERGY-RELATED APPLIED SCIENCE (IDEAS) | Funding Opportunity Announcement (FOA) |  | $\begin{aligned} & \text { 9/30/2016 05:00 } \\ & \text { PM ET } \end{aligned}$ | TBD |
| DE-FOA-0001429 | SINGLE-PANE HIGHLY INSULATING EFFICIENT LUCID DESIGNS (SHIELD) (SBIR/STTR) | Funding Opportunity Announcement (FOA) |  | $\begin{aligned} & \text { 11/18/2015 } \\ & \text { 05:00 PM ET } \end{aligned}$ | TBD |
| RFI-0000018 | Announcement of Teaming Partner List for an upcoming Funding Opportunity Announcement: Single pane Highly Insulating Efficient Lucid Designs (SHIELD) | Teaming Partner List |  | TBD | TBD |

## DE-FOA-0001002: INNOVATIVE DEVELOPMENT IN ENERGY-RELATED APPLIED SCIENCE (IDEAS)

***The Concept Paper deadline for DE-FOA-0001002 was on 9/28/2015. All Concept Papers submitted to this FOA prior to the deadline and all Full Applications submitted under this FOA will be reviewed, however ARPA-E expects a prolonged review period due to the large volume of applications received. If you wish to submit a new IDEAS Concept Paper to ARPA-E, you must submit through DE-FOA0001428.***

This Funding Opportunity Announcement (FOA) is intended to provide rapid support to revolutionary applied energy research (Studies) that may lead to new ARPA-E programs to develop transformational and disruptive energy technologies. Studies are defined as single-phase efforts of durations less


Printable Version

## ARPA-E FUNDING OPPORTUNITY ANNOUNCEMENTS

## DE-FOA-0001261: OPEN 2015

The Full Application submission window is now closed.
The objective of an ARPA-E OPEN FOA is simple, yet comprehensive: to support the development of potentially disruptive new technologies across the full spectrum of energy applications. ARPA-E seeks to support transformational research in all areas of energy R\&D, covering transportation and stationary applications. Areas of research responsive to this FOA include (but are not limited to) electricity generation by both renewable and nonrenewable means; electricity transmission, storage, and distribution; energy efficiency for buildings, manufacturing and commerce, and personal use; and all aspects of transportation, including the production and distribution of both renewable and non-renewable fuels, electrification, and energy efficiency in transportation.

Because of the enormous breadth of energy technologies solicited under an OPEN FOA, it is impossible to provide the well-defined technical targets contained in an ARPA-E FOA for a focused technology program. Rather, ARPA-E asks applicants to address the potential impact of the proposed technology on the agency's Mission Areas: reducing imported energy, reducing energy-related emissions, and improving energy efficiency. The critical question for applicants to consider in assessing potential impact is: "If it works, will it matter?" In a FOA for a focused technology program, this question has already been answered by ARPA-E. If an applicant can demonstrate that the proposed technology can achieve the technical targets specified in the FOA for a focused program, the agency believes that the technology can have significant impact on the agency's missions. In an OPEN FOA, the burden of demonstrating potential impact lies solely upon the applicant, who must make the strongest possible case for why the proposed technology will matter - that it has the potential to change our energy future.

## FOA DOCUMENTS

- OPEN FOA 2015 - Full Application - MOD 02 - 05.14.2015


## View Previous Versions

## REQUIRED APPLICATION DOCUMENTS

Pursuant to the FOA, Applicants are required to submit the "Required Application Documents" with their Application. Incomplete applications will not be reviewed or considered.

View Template Application Documents

## CONTACT INFORMATION

- ExchangeHelp@hq.doe.gov

Please contact the email address above for questions regarding ARPA-E's online application portal, ARPA-E eXCHANGE

# Report Format <br> \section*{PROJECT TITLE} 

Estimated Total Project Cost (\$1-10M)
Project Duration (3-5 years)

## 1. CONCEPT SUMMARY

- Describe the proposed concept with minimal jargon, and explain how it addresses sustainable energy the Program Objectives of the FOA.


## 2. INNOVATION AND IMPACT

- Clearly identify the problem to be solved with the proposed technology concept.
- Describe how the proposed effort represents an innovative and potentially transformational solution to the technical challenges of sustainable energy posed by the FOA.
- Explain the concept's potential to be disruptive compared to existing or emerging technologies.
- Describe how the concept will have a positive impact on your technology area ARPA E mission areas in Section 1.A of the FOA
- To the extent possible, provide quantitative metrics in a table that compares the proposed technology concept to current and emerging technologies-and to the technical performance targets in Section I.E of the FOA for the appropriate Technology Category in Section I.D of the FOA.


## 3. PROPOSED WORK

- Describe the final deliverable(s) for the project and the overall technical approach used to achieve project objectives.
- Discuss alternative approaches considered, if any, and why the proposed approach is most appropriate for the project objectives.
- Describe the background, theory, simulation, modeling, experimental data, or other sound engineering and scientific practices or principles that support the proposed approach. Provide specific examples of supporting data and/or appropriate citations to the scientific and technical literature.
- Describe why the proposed effort is a significant technical challenge and the key technical risks to the project. Does the approach require one or more entirely new technical developments to succeed? How will technical risk be mitigated?
- Identify techno-economic challenges to be overcome for the proposed technology to be commercially relevant.


## Monday Reports

- Each Team prepares one (approx) 3 slide report, based your team discussions
- Three points:
- Concept Summary
- Innovation and Impact
- Proposed Work
- Be pro-active, positive, and persuasive
- 5 minute presentation/5 minute discussion


## Final Reports

- Each Team prepares one ppt report, based your team discussions. Seniors may (or may not) share presentation.
- Three points:
- Concept Summary
- Innovation and Impact
- Proposed Work
- Be pro-active, positive, and persuasive
- 15 minute presentation/5 minute discussion

