Alleyn Harned
Executive Director, Virginia Clean Cities

Alleyn Harned is the Executive Director of Virginia Clean Cities (VCC), a member of the U.S. Department of Energy-affiliated Clean Cities Coalitions program.

Alleyn joined Clean Cities in 2009, the same year Virginia Clean Cities, Inc., formed a partnership with James Madison University. That partnership allows Clean Cities and the university in Harrisonburg, Va., to work together to leverage resources, support alternative fuel initiatives and pursue opportunities to decrease pollution and reduce dependence on foreign oil.

Prior to be named Executive Director, Alleyn served as the VCC’s Business Development Director. He serves as the Virginia representative to the nine-state Southeast Natural Gas Vehicle Corridor Committee, and was coordinator for Virginia’s initial 2010 electric vehicle readiness effort. Harned was appointed to Virginia’s Energy Commission in 2014 and the State Advisory Board on Air Pollution in 2013. Harned serves on the Transportation Energy Partners board of directors and was elected to the Clean Cities Coordinator Council in 2014.

Alleyn has worked on transportation and energy related issues in Virginia since 2006. Before joining the VCC staff, Alleyn served as the Assistant Secretary of Commerce and Trade for the Commonwealth of Virginia where he assisted in drafting Virginia’s initial Energy Plan, and participated in the Virginia Commission on Climate Change and Governor’s Energy Policy Advisory Council. Harned is a graduate of Ohio Wesleyan University, and has his Masters degree in Public Administration from James Madison University.

With Virginia Clean Cities, Harned leads the Virginia Clean Cities coalition’s collaborative effort to assist stakeholders and the Commonwealth in programs to improve air quality, and increase American energy security and economic opportunity through the increased use of alternative fuels and vehicles. Operating since 1996, Virginia Clean Cities has successfully managed tens of millions of dollars of federal, state, and stakeholder programs from offices in Richmond VA, and on the James Madison campus in Harrisonburg VA. Examples of past projects were the nation’s largest propane autogas vehicle deployment project, which covered 13 states, the Richmond Electric Vehicle initiative, which facilitated vehicles, and a Virginia DC and Maryland ethanol deployment project which installed the first ethanol stations in the mid-Atlantic region.
Emerging Technologies – Electric Vehicles and Battery Storage
This panel will focus on new technologies in early practice. The panelists will provide overview and debate on the role that emerging technologies will play in our existing regulatory structures. Panelists will debate whether these early stage technologies will serve as disrupters to existing models and will try to predict the direction and regulatory issues pertaining to electric cars, energy storage, and others that are expected to deploy in the near future.

Intro
• Overview of all alternative fuels and of Virginia energy source production and why state and federal and local governments are engaged in alternative fuels including electric.

Environmental benefits of electric vehicles
• Emissions, particularly in urban environments

Economic benefits to Virginia of electric vehicles
• Energy sources
• Cost of fuel, maintenance differential
• Cost differential on infrastructure

External considerations
• New appliance change way we can use grid
• New first responder issues

Human consideration
• Consumer reports / consumer review
• Instant torque and acceleration

Challenges in Virginia as market barriers
• Low gasoline tax
• Annual vehicle property tax – EVs often have higher cost
• Additional Electric Vehicle fee – leading the nation
• Federal tax credits applies but no state leverage

Positive Electric Vehicle Deployment efforts (STATION SLIDE)
• DC Fast Chargers
• Diversity of level 2 charging
• Level 2 chargers at work and at destinations
• Localities supporting chargers & partnering with utilities
• Localities supporting reduced vehicle personal property tax rates (Loudoun low speed EVs)

Next phase
• Markets developing in Richmond, Tidewater, elsewhere
• Bus, heavy duty trucks

Formal flier for attendees -
Hybrid and Plug-In Electric Vehicles

Electric-drive vehicles use electricity as their primary fuel or to improve the efficiency of conventional vehicle designs. These vehicles can be divided into three categories:

- Hybrid electric vehicles (HEVs)
- Plug-in hybrid electric vehicles (PHEVs)
- All-electric vehicles (EVs).

Together, they have great potential to cut U.S. petroleum use and vehicle emissions.

**Hybrid Electric Vehicles**

HEVs are powered by an internal combustion engine (ICE) and by an electric motor that uses energy stored in a battery. The extra power provided by the electric motor allows for a smaller engine without sacrificing performance; the battery also powers auxiliary loads like audio systems and headlights and can reduce engine idling when the vehicle is stopped. Some HEVs can drive short distances at low speeds on electrical power alone. All these capabilities typically result in better fuel economy and lower emissions than comparable conventional vehicles.

HEVs cannot be plugged in to charge the battery. Instead, the battery is charged through regenerative braking and by the ICE. Regenerative braking allows HEVs to capture energy normally lost during braking by using the electric motor as a generator and storing that captured energy in the battery.

**Plug-In Hybrid Electric Vehicles**

PHEVs (sometimes called extended range electric vehicles, or EREVs) use batteries to power an electric motor and use another fuel, such as gasoline, to power an ICE. PHEVs can be plugged into the grid to charge their batteries; their batteries can also be charged by the ICE and through regenerative braking.

PHEVs have larger battery packs than HEVs do, providing an all-electric driving range of about 10 to 40-plus miles for today’s light-duty models. So long as the battery is charged, a PHEV can draw most of its power from electricity stored in the battery during typical urban driving. The ICE may power the vehicle when the battery is mostly depleted, during rapid acceleration, at high speeds, or when intensive heating or air conditioning is required.

When running on battery power alone, PHEVs produce no tailpipe emissions. Even when the ICE is operating, PHEVs consume less gasoline and typically produce lower emissions than similar conventional vehicles do. A PHEV’s gasoline consumption depends on the distance traveled between charges. If the vehicle is never plugged in, its gasoline-only fuel economy will be about the same as that of a similarly sized HEV. If the vehicle is plugged in to charge and driven a shorter distance than its all-electric range, it may be possible to use only electric power.
EVs, which are now widely available, must plug in to charge. Increasing numbers of fleets and consumers are turning to EVs to cut petroleum use, fuel costs, and emissions. Photo from City of Fort Collins, NREL 27238

All-Electric Vehicles
EVs (also called battery-electric vehicles, or BEVs) use batteries to store the electrical energy that powers one or more motors. The batteries are charged by plugging the vehicle into the grid. EVs can also be charged in part through regenerative braking. EVs do not have ICEs and, therefore, do not produce tailpipe emissions. However, there are “life cycle” emissions associated with the majority of electricity production in the United States.

Today’s EVs typically have shorter driving ranges per charge than conventional vehicles have per tank of gasoline. Most EVs have ranges of about 70 to 90 miles on a fully charged battery, although a few models have longer ranges. An EV’s range varies according to driving conditions and driving habits. Extreme ambient temperatures tend to reduce range, because energy from the battery must power climate control systems in addition to powering the motor. Speeding, aggressive driving, and heavy loads can also reduce range.

Vehicle Availability
Dozens of light-duty HEV, PHEV, and EV models are available from major auto manufacturers. A variety of medium- and heavy-duty options are also available. For up-to-date information on today’s models, use the Alternative Fuels Data Center’s (AFDC) Light-Duty and Heavy-Duty Vehicle Searches (afdc.energy.gov/tools) and the Find a Car tool on FuelEconomy.gov (fueleconomy.gov/feg/findacar.shtml).

Charging EV and PHEV Batteries
Charging stations, also known as electric vehicle supply equipment (EVSE), provide electricity to charge the batteries of EVs and PHEVs. The EVSE communicates with the vehicle to ensure that it supplies an appropriate and safe flow of electricity.

EVSE for plug-in vehicles is classified according to the rate at which the batteries are charged. Two types—AC Level 1 and AC Level 2—provide alternating current (AC) to the vehicle, with the vehicle’s onboard equipment (charger) converting AC to the direct current (DC) needed to charge the batteries. The other type—DC fast charging—provides DC electricity directly to the vehicle. DC fast charging is sometimes referred to as DC Level 2.

Hydrogen Fuel Cell Vehicles
A hydrogen fuel cell vehicle combines hydrogen gas with oxygen from the air to produce electricity, which drives an electric motor. Fuel cell vehicles produce no harmful tailpipe emissions. Limited numbers of fuel cell cars are currently leased to customers in select regions; some manufacturers are planning to introduce new models in the California market within the next two years.

HEVs work well for both light-duty and heavy-duty applications, particularly those that require frequent stops and starts. Photo by Pat Corkery, NREL 18142
<table>
<thead>
<tr>
<th>EVSE Options</th>
<th>Amperage</th>
<th>Voltage</th>
<th>Kilowatts</th>
<th>Charging Time</th>
<th>Primary Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Level 1</td>
<td>12 to 16 amps</td>
<td>120V</td>
<td>1.3 to 1.9 kW</td>
<td>2 to 5 miles of range per hour of charging</td>
<td>Residential and workplace charging</td>
</tr>
<tr>
<td>AC Level 2</td>
<td>Up to 80 amps</td>
<td>208V or 240V</td>
<td>Up to 19.2 kW</td>
<td>10 to 20 miles of range per hour of charging</td>
<td>Residential, workplace, and public charging</td>
</tr>
<tr>
<td>DC Fast Charging</td>
<td>Up to 200 amps</td>
<td>208 to 600V</td>
<td>50 to 150 kW</td>
<td>60 to 80 miles of range in less than 20 minutes</td>
<td>Public charging</td>
</tr>
</tbody>
</table>

Charging times range from less than 20 minutes to 20 hours or more, based on the type or level of EVSE; the type of battery, its capacity, and how depleted it is; and the size of the vehicle’s internal charger. EVs generally have more battery capacity than PHEVs, so charging a fully depleted EV takes longer than charging a fully depleted PHEV.

Charging units can be installed in residential, fleet, workplace, and public settings. As of January 2014, there were nearly 20,000 charging outlets across the country. To locate public charging stations, use the Alternative Fueling Station Locator (afdc.energy.gov/stations), also available as an iPhone app from the App Store (QR code on page 4).

Emissions Benefits
HEVs, PHEVs, and EVs typically produce lower levels of emissions than conventional vehicles do. HEV emissions benefits vary by vehicle model and type of hybrid power system. EVs produce zero tailpipe emissions, and PHEVs produce no tailpipe emissions when in electric-only mode. The life cycle emissions of an EV or PHEV depend on how that electricity is generated, and this varies by region. In geographic areas that use relatively low-polluting energy sources for electricity generation, PHEVs and EVs have substantial life cycle emissions advantages over similar conventional vehicles running on gasoline or diesel. In regions that depend heavily on conventional fossil fuels for electricity generation, plug-in vehicles may not demonstrate as strong a life cycle benefit. Even in these areas, however, consumers may have the option of purchasing renewable energy.

Vehicle Safety
HEVs, PHEVs, and EVs undergo the same rigorous safety testing as conventional vehicles sold in the United States and must meet Federal Motor Vehicle Safety Standards. Their battery packs meet testing standards that subject batteries to conditions such as overcharge, vibration, extreme temperatures, short circuit, humidity, fire, collision, and water immersion. Manufacturers design vehicles with insulated high-voltage lines and safety features that deactivate electric systems when they detect a collision or short circuit. For additional safety information, refer to the AFDC’s Maintenance and Safety of Hybrid and Plug-In Electric Vehicles page (afdc.energy.gov/vehicles/electric_maintenance.html).

Maintenance Requirements
Because HEVs and PHEVs have ICEs, their maintenance requirements are similar to those of conventional vehicles. The electrical system (battery, motor, and associated electronics) requires minimal scheduled maintenance. Brake systems on these vehicles typically last longer than those on conventional vehicles, because regenerative braking reduces wear.

EVs typically require less maintenance than conventional vehicles or even HEVs or PHEVs. Like their hybrid counterparts, their electrical systems require little to no regular maintenance and their brake systems benefit from regenerative braking. In addition, EVs often have far fewer moving parts and fewer fluids to change.
Fuel Costs

Fuel costs for HEVs, PHEVs, and EVs are generally lower than for similar conventional vehicles. Electric drivetrains are about four times more efficient than internal combustion engines, and electricity prices are less volatile than gasoline and diesel fuel prices. HEVs and PHEVs typically use significantly less gasoline/diesel than their conventional counterparts. Over the life of the vehicle, HEV, PHEV, and EV owners can expect to save thousands of dollars in fuel costs, relative to the average new vehicle.

To find fuel economy ratings and fuel cost comparisons among currently available vehicle models, visit FuelEconomy.gov.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Hybrid Electric Vehicles</th>
<th>Plug-In Hybrid Electric Vehicles</th>
<th>All-Electric Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Economy</td>
<td>Better than similar conventional vehicles</td>
<td>Better than similar HEVs and conventional vehicles</td>
<td>Better than similar HEVs and conventional vehicles</td>
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<td></td>
<td>The fuel savings of driving a Honda Civic Hybrid versus a conventional Civic is about 36%</td>
<td>Most PHEVs achieve combined fuel economy ratings higher than 90 miles per gasoline gallon equivalent*.</td>
<td>Most EVs achieve fuel economy ratings higher than 100 miles per gasoline gallon equivalent*.</td>
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<td>in the city and 11% on the highway</td>
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<tr>
<td>Emissions Reductions</td>
<td>Lower emissions than similar conventional vehicles</td>
<td>Lower emissions than HEVs and similar conventional vehicles</td>
<td>Zero tailpipe emissions</td>
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<td></td>
<td>HEV emissions vary by vehicle and type of hybrid power system. HEVs are often used to</td>
<td>PHEVs produce no tailpipe emissions when in electric-only mode. Life cycle</td>
<td>EVs produce no tailpipe emissions. Life cycle emissions depend on the sources of</td>
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<td>offset fleet emissions to meet local air quality improvement strategies and federal</td>
<td>emissions depend on the sources of electricity, which vary from region to</td>
<td>electricity, which vary from region to region. Emissions reductions are substantial in</td>
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<td></td>
<td>requirements.</td>
<td>region.</td>
<td>most regions of the United States.</td>
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<tr>
<td>Fuel Cost Savings</td>
<td>Less expensive to run than a conventional vehicle</td>
<td>Less expensive to run than an HEV or conventional vehicle</td>
<td>Less expensive to run than conventional vehicles</td>
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<tr>
<td></td>
<td>HEV fuel cost savings vary by vehicle model and type of hybrid power system. For many</td>
<td>In electric-only mode, PHEV fuel costs can range from about $0.02 to $0.04</td>
<td>EVs run on electricity only. Fuel costs for a typical EV range from $0.02 to $0.04 per</td>
</tr>
<tr>
<td></td>
<td>HEV models, annual fuel cost savings range from $400 to $1,000, relative to their</td>
<td>per mile. On gasoline only, fuel costs range from about $0.05 to $0.10 per</td>
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<td></td>
<td>conventional counterparts.</td>
<td>mile. For conventional sedans, costs range from about $0.10 to $0.15 per</td>
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<tr>
<td>Fuelling Flexibility</td>
<td>Can fuel at gas stations</td>
<td>mile.</td>
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</table>

Sources: Alternative Fuels Data Center (afdc.energy.gov), FuelEconomy.gov

* PHEVs and EVs are rated not in miles per gallon (mpg) but miles per gallon of gasoline equivalent (mpge). Similar to mpg, mpge represents the number of miles the vehicle can travel using a quantity of fuel (such as electricity) with the same energy content as a gallon of gasoline.
Dr. Damien Buie is the Director of Innovation for EDF Renewable Energy – a subsidiary of EDF Energies Nouvelles. In this role Dr. Buie’s primary responsibility is the integration of new products into the company’s North American development pipeline as both renewable energy markets and associated technologies mature.

His tenure began in 2011 working exclusively on solar technology, and in 2012 his role expanded to include all activities across North America including both mature and emerging renewable energies and storage technology.

Dr. Buie has worked in the renewable energy space since 1999 in both the commercial and academic arenas. He has held the position of associate lecturer in computational modelling at the University of Sydney and University College London, as well as the technical lead for Albuquerque-based Emcore Solar Power, responsible for the design of their third generation concentrating photovoltaic system.

He holds both a Bachelor’s degree with honors in science from The University of Sydney and a PhD in physics from that same institution.
Emerging Technologies – Electric Vehicles and Battery Storage
This panel will focus on new technologies in early practice. The panelists will provide overview and debate on the role that emerging technologies will play in our existing regulatory structures. Panelists will debate whether these early stage technologies will serve as disrupters to existing models and will try to predict the direction and regulatory issues pertaining to electric cars, energy storage, and others that are expected to deploy in the near future

Dr Damien Buie

4 key points I will be making:

I. The EDF Group is one of the largest operators of battery storage in the world with over 800 MWh deployed in the field across a range of applications:
   - 20 MW (8 MWh) frequency response in North America with a further 40 MW under construction.
   - 15 MW (25 MWh) deployed at the distribution level within Continental France and its overseas territories.
   - 300 MW (800 MWh) deployed for critical infrastructure at bulk generation plants.

II. Energy storage presently provides a more cost effective solution than conventional generation for short duration applications such frequency response, frequency regulation, synchronized reserve & ramp support),

III. The most critical piece of information required to design and price a storage facility is the details on the application.
   - Don’t define the technology, just the application – specifically what are you trying to achieve.
   - Think about the risks and who is best able to wear them when defining your revenue models.

IV. There are risks in pairing storage with an application and the experience of the developer is critical in managing those risks.
ENERGY STORAGE

Meeting the Growing Demand for Flexibility
The EDF Group meets demand for flexibility with energy storage

As a major global electricity operator, EDF manages a significant number of industrial assets to meet the needs of more than 38 million customers. Ensuring a supply-demand balance around the clock requires significant flexibility in the resources.

With major advances in storage technologies and cost reductions, primarily for batteries, EDF is proactively investigating and testing services and value streams that distributed storage can provide to interconnected or islanded/isolated grid power systems, and to various locations, such as behind the meter, distribution, and transmission level interconnections.
Energy storage is an attractive, cost-effective addition to intermittent energy generation projects. Batteries and other storage technologies instantaneously dispatch energy, dramatically increasing resiliency and stability in systems with high penetrations of renewables.

Battery Energy Storage Operational Capacity

EDF participates extensively in the distributed energy market, currently operating in excess of 316 megawatts (MW) / 824 megawatt-hours (MWh) of battery storage worldwide, including:

- French overseas territories
  - 11.7 MW / 21 MWh
- Distribution grids in continental France
  - 4.5 MW / 3.2 MWh
- Bulk generation power plants
  - 300 MW / 800 MWh

An additional 100 MW / 42 MWh of energy storage systems (ESS) is under construction or in development in the U.S. for frequency regulation in the PJM market.

McHENRY STORAGE PROJECT • ILLINOIS

- 20 MW stand-alone storage
- Balancing function on the PJM network
- Participating in primary control PJM market
- Reg-D resource in PJM's frequency response market
- Online December 2015
STORAGE APPLICATIONS

Stable Integration of Renewables

Islanded Power System

Fossil Fuel Generation

Smart Grids
**Strengths of a Battery Energy Storage System:**
- Rapid and flexible response
- Accurate and stable output
- High round trip efficiency
- Operation as both generator and load
- Easy and quick installation
- Low operating costs

**Rapidly Advancing Technology Delivers:**
- Decreasing capital cost
- Longer life
- Greater safety
- More recycling options

**Providing Valuable Services to Grids and Energy Markets:**
- Grid support during a frequency event like the loss of generation
- Power sources for frequency disturbance recovery and voltage support
- Absorbing and smoothing the fluctuations of renewables
- Energy shifting from peak production periods to peak consumption periods
- More accurate forecasting of renewables production
- Reliable back-up power for nuclear, fossil and hydro plants

**Resulting in:**
- Better frequency regulation
- Higher grid penetration of solar and wind plants
- Deferred upgrades to existing infrastructures
- Avoided activation of expensive generation units
- Avoided or deferred investment in expensive transmission lines or substations
- Increased reliability and lower cost of power supply
- Reduced CO₂ and less dependence on fossil fuel resources

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**Grid Services**

**UPS at Bulk Generation Power Plants**

**Investment Deferral**

**Frequency Regulation Market**

**Peak Load Management**
EDF DISTRIBUTED STORAGE PROJECTS

TOUCAN PROJECT
FRENCH GUYANA (SOUTH AMERICA)
• 5 MWp photovoltaic plant with
  2 MW/4 SMWh storage
• Yearly production 5900 MWh
  (4000 households in Guyana)
• 20-year project life
• Operational December 2014

Makes solar production grid friendly:
• Smooths intermittent production
  (no fluctuations due to the weather)
• Shifts energy to meet evening
  peak demand
• Provides ancillary services
  (frequency and voltage regulation)
• Forecasts production
  (day ahead and hour ahead)
FREQUENCY REGULATION MARKETS

- **McHENRY - ILLINOIS | UNITED STATES**
  Size: 20 MW / 8.5 MWh
  Status: Under construction
  Completion Date: Commercial operation in 2015

- **SUMMIT-WESTFALL - PENNSYLVANIA | UNITED STATES**
  Size: 20 MW / 8.5 MWh
  Status: In development
  Completion Date: Commercial operation in 2016

- **KENSINGTON/KANKAKEE 1 - ILLINOIS | UNITED STATES**
  Size: 20 MW / 8.5 MWh
  Status: In development
  Completion Date: Commercial operation in 2016

- **KENSINGTON/KANKAKEE 2 - ILLINOIS | UNITED STATES**
  Size: 20 MW / 8.5 MWh
  Status: In development
  Completion Date: Commercial operation in 2016

- **PICWAY 69KV - OHIO | UNITED STATES**
  Size: 20 MW / 8.5 MWh
  Status: In development
  Completion Date: Commercial operation in 2016

- **LES RENARDIERES - PARIS | FRANCE**
  Demonstration project for grid balancing and frequency regulation software and algorithms
  Size: 1 MW / 600 kWh
  Status: Operational
  Completion Date: 2014

GRID SERVICES FOR UTILITIES

- **VENTEEA - TROYES | FRANCE**
  Utility demonstration project for development of software and algorithms
  Size: 2 MW / 1.3 MWh
  Status: Operational
  Completion Date: 2015

RENEWABLES INTEGRATION

- **TOUCAN - FRENCH GUYANA**
  Size: 5 MW / 4.5 MWh
  Status: Operational
  Completion Date: 2014

- **REMIRE-MONTJOLY - FRENCH GUYANA**
  Size: 5 MW / 4 MWh
  Status: Under construction
  Completion Date: Commercial operation 2015

- **PEGASE PROJECT - REUNION ISLAND, INDIAN OCEAN**
  Demonstration of storage coupled with PV
  Size: 1 MW / 7 MWh
  Status: Operational
  Completion Date: 2011

ISLANDED POWER SYSTEMS

- **KAW - FRENCH GUYANA**
  Size: 1 MW / 1.25 MWh
  Status: Operational
  Completion Date: 2009

- **PROVIDENCE - FRENCH GUYANA**
  Size: 1 MW / 1.25 MWh
  Status: Operational
  Completion Date: 2015

- **TALUHEN - FRENCH GUYANA**
  Size: 1 MW / 1.25 MWh
  Status: Operational
  Completion Date: 2015

SMART GRIDS AND HYBRID APPLICATIONS

- **NICE GRID - NICE | FRANCE**
  Size: 1 MW / 600 kWh
  Status: Operational
  Completion Date: 2014

- **PREMIO - LAMBESC | FRANCE**
  Size: 100 kWh
  Status: Decommissioned
  Completion Date: 2009

UPS AT BULK GENERATION POWER PLANTS

- **VARIOUS PROJECTS | FRANCE**
  Size: 300 MW / 600 MWh
  Status: Operational
Over 30 EDF R&D researchers bring their advanced level of expertise to various aspects of energy storage. EDF researchers are dedicated to providing research and development, actionable results, and active support to EDF business units, including EDF Energies Nouvelles, EDF Renewable Energy and EDF Store & Forecast. EDF R&D capabilities have been applied to a wide range of projects in critical areas:

- **Basic research on electrochemistry and development of new battery technologies at lower costs and/or improved capabilities**, including groundbreaking zinc-air cells (14 patents, highest worldwide cycling performance).

- **Characterization of commercial electric vehicle (EV) and stationary storage technologies** at dedicated testing facilities (accelerated aging, harsh conditions, etc.).

- **Evaluation of large commercial systems in real-life conditions at Concept Grid**, a unique smart-grid demonstration platform and testing facility.

- **Development of simulation tools and models to support battery storage system design** as well as analysis of applications and single or multi-services provided by energy storage in current and future contexts.

- **Comprehensive assessment of storage use cases** including ancillary services, active power smoothing, grid investment deferral, self-consumption, islanding, electric vehicles, etc.

- **Development of battery storage scheduling and real-time control systems** for commercial projects.

- **Economic and regulatory evaluations** (Europe, Asia, North America) including cost-benefit analysis, vendors’ landscape and trends, stakeholders, business models evaluations, etc.

To support these efforts, EDF R&D has developed strong partnerships with numerous energy storage entities, including The Electric Power Research Institute, Inc. (EPRI), the Joint Research Center of the European Commission, storage manufacturers, leading universities, and others.

EDF researchers also contribute to storage standardization and industrial initiatives such as IEC's TC120 Electrical Energy Storage Systems and EPRI's Energy Storage Integration Council (ESIC).
COMMAND AND CONTROL

Wind and solar energy by nature are intermittent and unpredictable. Their rising penetration rate intensifies the imbalance between supply and demand and threatens electrical system stability.

EDF Renewable Services provides 24/7 remote monitoring and basic trouble shooting from its Operations Control Center (OCC). The facility is staffed around the clock, 365 days a year, with trained and experienced EDF Renewable Services operation technicians.

Our O&M team services over 10 GW of electricity in the United States, Canada, and Mexico.
As leaders in the global energy market, EDF Energies Nouvelles with EDF Renewable Energy, its North American subsidiary, develop, construct, own, and operate a diverse portfolio of energy projects in North America and Europe with projects in 25 states and 20 countries.
Bic Stevens is the Founder and Principal of Stevens Capital Advisors, a cleantech investment bank and advisory firm. Bic has advised a wide range of clean technology companies including five energy storage companies, three fuel cell companies, two solar companies, two frackwater companies, two hydrogen companies, and companies involved with advanced motors, smart grid and demand management, energy efficiency, energy services, geothermal energy, renewable energy certificates, renewable plastics, graphene, organic photovoltaics, autonomous and robotic systems, and clean air.

Bic was previously SVP of Business Development for Premium Power, a manufacturer of grid-scale flow batteries. He was previously a Managing Partner of Ardour Capital Investments, a cleantech investment bank, and a Managing Director at Zero Stage Capital, an early-stage venture capital firm, where he was in charge of the firm’s clean technology investing. Prior to Zero Stage Capital, Bic was the CEO and founder of Eastech, an early-stage venture capital firm, and a Vice President at Paine Webber, where he worked in its investment banking and venture capital operations.

Bic has a B.I.E. degree from Georgia Tech and an M.B.A. from the Harvard Business School.
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Outline of Subjects for Discussion:

• Batteries for transportation
  o Technologies...lithium, solid state, ultra caps, new technologies
  o Characteristics...energy density, weight, safety
  o Costs...current and projected

• EV’s
  o Past examples and penetration
  o Nissan Leaf
  o BMW i3
  o Other autos
  o Busses
  o Trucks

• New EV’s
  o Chevy Bolt
  o Tesla Model 3
  o Busses
  o Others

• EV’s vs HPV’s...current vs future
• EV Projections and predictions...costs, range, weight
• EV Issues...costs, payback, charging infrastructure, safety, grid integration,
• EV Charging
  o Charging Stations
  o Wireless Charging

• EV to Grid
  o Who controls...utilities, auto companies?, independents?
  o Economics?

• Demand Management
  o Buffering
  o Capacity capabilities
  o Frequency regulation

• Driverless Vehicles and their Implications
• Ride Sharing and its Implications
 Wyndham San Diego Bayside

Panel: Energy Storage Finance & Investment

Monday, January 25, 2016
4:30 – 5:30 pm

Moderator:  Rohit Sachdev
Senior Associate
Orrick, Herrington & Sutcliffe
office: 415-773-5813 mobile: 917-547-0494

Panel:

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<th>John May</th>
<th>Mark Perutz</th>
<th>Bic Stevens</th>
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<td>Managing Director</td>
<td>Partner</td>
<td>Principal</td>
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<td>Starwood Energy Group</td>
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<td>Global, LLC</td>
<td><a href="mailto:jmav@sternbrothers.com">jmav@sternbrothers.com</a></td>
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Discussion Outline

I. Introduction to Panel Topic and Panelist Biographies (Rohit)

II. Discussion on Panel Topic (followed by 15 minutes of audience Q&A)

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<td>1</td>
<td>Introductory Question&lt;br&gt;  • What is your role and experience with financing energy storage technology, companies or projects?</td>
<td>All [30 seconds each]</td>
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<td>2</td>
<td>Energy Storage Technology&lt;br&gt;  Any successful financing, whether venture financing, strategic investment, or equity or debt financing, will require a proven and dependable storage</td>
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Technology. Many in the developer and financing community in the United States are convinced that, as their costs continue to decline over the next decade, lithium-ion batteries will ultimately serve as the industry’s technology standard, despite potentially cheaper alternatives available, including flow batteries and thermal energy storage, and other historically proven technologies such as pumped hydropower.

- Which storage technologies are currently financeable, or do you expect will become financeable in the next several years?
- Do you believe any single technology (or any single type of battery) will ultimately become the industry’s preferred choice, and why?

### Venture Financing

The past couple of years have witnessed numerous venture capital investments into energy storage startups and technologies. On the other hand, non-recourse project financings of stand-alone energy storage projects are only a recent phenomenon (Rohit to provide examples).

- What is the current state of the venture financing market for energy storage? Which storage companies and technologies are most successful in securing venture and private equity investments in today’s market?

### Yieldcos

Over the past nine months, certain large yieldcos, including SunEdison’s yieldco TerraForm, have committed to investing significant sums into successful storage startup projects, such as those of Advanced Microgrid Solutions. However, yieldco prices have dropped precipitously in the same timeframe. As a result, Yieldco equity capital is now less accessible and more expensive, and yieldcos have delayed launches and changed...
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<td>Financing and acquisition plans as a result.</td>
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<td>• How will the yieldco contraction impact financing of storage? Does it mean less equity financing available for storage startups, and less development capital available for storage projects?</td>
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<td>5</td>
<td>Project Financing and Bankability</td>
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<td>Successfully project financing a stand-alone energy storage project on a non-recourse basis would seem to require the same elements necessary for financing any other conventional or renewable energy facility: a long-term offtake contract with predictable cash flows; proven technology; and performance guarantees and warranties to support the technology.</td>
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<td>• Few offtake contracts for stand-alone energy storage projects have been successfully financed to date. These are often structured as tolling arrangements with fixed capacity payments and variable O&amp;M payments. From a financeability perspective, are there issues unique to energy storage or batteries that you would evaluate differently in a storage contract from any other toll or offtake contract?</td>
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<td>• Large stand-alone storage projects do not yet have long-term operational records, and the long-term viability of most of these technologies has not been proven. How does an investor or lender become comfortable with this uncertainty, and which party is in the best position to provide and backstop the long term performance guarantees and warranties – the battery manufacturer, EPC contractor, etc.?</td>
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<td>Some in the industry believe that batteries will eventually replace any need for future (and even existing) gas-fired peaking plants. 30 GW of gas-fired power plants are completed installed each year, however recent studies have indicated that the levelized cost of storage is decreasing, and makes</td>
<td>Ali, John and others</td>
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|   | storage cost-competitive with conventional grid electricity in certain markets. In addition, peakers have an extremely low utilization factor of below 10% per year and a single battery-based storage project can be used for a variety of purposes beyond just capacity and spinning reserves.  
  
  • In your view, can storage really replace peakers, and what are the challenges to reaching that goal? |   |
| 6 | Utility Scale vs DG | All |
|   | The majority of the approximately 200 MW of energy storage capacity deployed in the US in 2015 was in front of the meter and connected to the transmission or distribution network. However, behind the meter storage — sited and connected at the customer’s site — grew at a much more rapid rate, buttressed by incentives provided by states across the country for behind the meter installations, including California, Texas and New York. Here in California, investor-owned utilities have awarded large contracts to cutting-edge storage companies such as Stem, Advanced Microgrid Solutions, and Ice Energy, some of which offer behind the meter storage solutions which can be aggregated and dispatched by the utility.  
  
  • Does the financing community view in-front-of-meter storage as more or less attractive than behind-the-meter-storage?  
  • How are behind-the-meter storage projects getting financed — are they too small for third-party investors or lenders to generate returns, or can aggregating these projects address the value proposition (e.g., AMS and Ice Energy)? |   |
<p>| 7 | Value of Energy Storage | All |
|   | In financing a gas-fired or solar powered facility, lenders generally understand what products are being provided by the facility and what the |   |</p>
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<td>revenue streams are. In contrast, certain value streams from a storage project cannot be monetized, or even evaluated, because a single storage asset can be used to provide different services to different people, and each of those services carry different risk. For instance, a customer-cited battery can be used for demand charge reductions for the customer today and potentially grid services such as frequency regulation in the future. A utility-scale battery can be utilized for capacity today, and demand response tomorrow.</td>
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<td>- How do you structure a financeable storage deal even though the storage asset may be providing multiple services to multiple stakeholders? How do you define, price and evaluate the risk of each product?</td>
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<td>8</td>
<td>Geographical Markets</td>
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<td>Certain international and national markets favor storage development more than others. For instance, China and Japan together have almost as many megawatts of energy storage installed as the next eight countries combined (including the US). In the United States, the markets with more sophisticated and developed pricing structures for storage products may help determine where storage projects are ultimately developed and to what uses those storage facilities are put. Although certain markets have used storage for frequency regulation, certain markets such as PJM are reevaluating this use. Some in the storage community believe that the long-term proposition for storage is its long-duration use and ability to provide capacity, as it serves in California, however the economics do not necessarily pencil out in other markets.</td>
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<td>- Which markets (both globally and nationally) offer the most attractive returns to storage? California, Island grids such as Hawaii, PJM?</td>
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<td>- Which markets have the most sophisticated product and pricing</td>
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<td>structures for energy storage?</td>
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<td>California's legislature recently passed SB350 which establishes a 50% Renewable Portfolio Standard goal by 2030. As a result, existing “duck curve” and resulting curtailment issues are expected to increase substantially the next decade, and energy storage is considered by many to be California’s most effective solution. At the end of 2014, California released the highest storage procurement goals in the world, requiring California’s three investor-owned utilities to procure 1.3 GW of storage by 2020. Since then, SCE has signed contracts for over 260 MW of storage resources (including the 100 MW AES/Long Beach project, which will be the largest battery the world) and PG&amp;E is now seeking approval for 75 MW storage projects.</td>
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<td>• How does the financing community view energy storage in the context of the opportunities and challenges presented by California’s energy markets and ambitious renewables goals?</td>
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<td>• Are investors and lenders interested and capable in providing sufficient equity and debt financing for the large number of additional storage projects expected to be developed in California over the next decade?</td>
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<td>9</td>
<td>Lessons from Solar</td>
<td>All</td>
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<td>Energy storage today is often compared to the status of the solar industry 10 years ago. Now, lenders are comfortable with assured revenue streams, predictable degradation rates and supplier warranties supported by strong balance sheets, and as a result, tens of thousands of megawatts of solar projects have been successfully financed.</td>
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<td>However, critical differences exist between solar and storage. For instance, in developing solar projects over the past few years, long permitting and construction timelines in PPAs allowed bidders to agree to</td>
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<td>Low PPA prices with the expectation that solar panel and equipment costs would have decreased by the time the equipment was ordered. However, permitting and construction timelines are shorter for batteries, so developers may not have the benefit of such a “harvest” period.</td>
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<td>• Do the last 15 years of developing and financing solar powered generation projects lend any useful insights or lessons as storage companies and storage projects begin to mature and require significant financing commitments?</td>
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<td>10</td>
<td>M&amp;A</td>
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<td>Over the past 12 months, M&amp;A activity has commenced in the storage sector, with one example being Sun Edison’s acquisition of Solar Grid Storage in March 2015.</td>
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<td>• Do you anticipate that large renewables sponsors will begin acquiring storage companies or storage projects this year? Will acquirors be more interested in new or established technologies? Do you anticipate project acquisitions to be financed on balance sheet or by third parties?</td>
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<td>11</td>
<td>Economics of Storage</td>
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<td>Batteries can constitute approximately ½ the cost of a storage project. Some battery storage systems are currently estimated to cost more than $500 per kilowatt hour installed, and it is estimated that the cost must fall to $100-$150 for financeability.</td>
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<td>• How do you evaluate capital costs when considering financing a storage technology or project, and do you expect falling costs to help determine which technologies prevail?</td>
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“Emerging Technologies – Electric Vehicles and Battery Storage”
Kate Staples, Dominion Virginia Power

Outline:

I. Electric Vehicle (EV) Types
   • EPRI description of vehicle types and acronyms:
     http://et.epri.com/ResearchAreas_IndustryTerms.html
   • Hybrid vs. Plug-in Electric Hybrid vs. Electric Vehicle

II. Electric Vehicle Supply Equipment
   • Characteristics of Level 1, Level 2, and Fast Charging

III. Electric Vehicle Legislation in Virginia
   • 2011 House Bill 2105
     https://lis.virginia.gov/cgi-bin/legp604.exe?111+ful+CHAP0408
     • Clarifies that third parties can offer EV charging service, but offering EV charging service does not render the third party a public utility/public service corporation/public service company
     • Legislation directed public utilities to evaluate options for off-peak charging rates

IV. Dominion Virginia Power (DVP) Electric Vehicle Pilot Program
   • Overview of Pilot rates
     • Whole house rate
     • EV-only rate
   • Preliminary analysis of pilot results

V. Electric Vehicle Market
   • Current status in Virginia:
     • 120,000 hybrid vehicles (Source: IHS, Inc.)
     • About 3,700 PHEVs and EVs (Source: IHS, Inc.)
     • Most popular: Chevy Volt, Nissan Leaf, Tesla models
     • About 350 charging stations in Virginia (Source: Virginia Clean Cities)
   • DVP 2015 Integrated Resource Plan Future Projections:
     152,000 vehicles, 168MW, 666 GWh in 2025

VI. Cost Parity with Conventional Vehicles
   • Timeframe for Europe, China, US