Living Lab of the Future

FPL's Living Lab platform requires a consistent year over year program to fully sustain innovation, research, and its commitment to a cleaner energy future

Executive Summary

- **The Living Lab was built to explore technologies for future FPL solar projects**
  - Several business units were able to leverage value from the Living Lab, however with no recent upgrades new learnings have diminished
- **FPL's Living Lab expansion will integrate new technologies, research partners and locations expanding it into a meaningful research platform**
  - Strengthening innovation
  - Demonstrating our commitment to a cleaner energy future
- **FPL Development engagement and oversight will facilitate ongoing DG research and maximize customer value**

FPL's Living Lab platform expansion will strengthen innovation and demonstrate our commitment to a cleaner energy future

Juno Beach

- Solar PV
  - Technologies
  - Applications
- Solar Thermal
- Inverters
  - Micro
  - String
- Energy Storage
  - Thermal
  - Battery
- Electric Vehicle
  - V2Grid
  - Workplace Charging

45th Street (PDC)

- Inverters
  - Applications
  - Capabilities
- Energy Storage
  - Battery Capabilities

CISPP

- Solar PV
  - Grid impacts
- Inverters
  - Control
  - Capabilities
- Electric Vehicle
  - Workplace Charging
- Solar integration study
  - Feeder validation

Mobile

- Education
- Portable Micro-Grid
  - Storage
  - PV Solar
  - Backup Generation

Existing
New
Expansion

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Our R&D strategy leverages several research partnerships and the Living Lab to build an innovative research program

FPL LivingLab™

Research Partners

FIU Florida International University

NASA

The Scripps Research Institute

NREL National Renewable Energy Laboratory

Research Locations

Daytona USA

FIU Florida International University

Ryder

Palm Beach State College

Kennedy Space Center

FPL

Technology Vendors

SMA

Fronius

ABB

S&C

MiaSolé

Gexpro

AlsoEnergy

Hanwha Solar

stem

ICE Energy

ALSTOM

The "Living Lab of the Future" will integrate new technologies, partners and locations expanding it into a meaningful research platform

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The Living Lab was built to explore technologies for future FPL solar projects

Living Lab History

- **Built between 2009 – 2012**
- **Located at FPL Headquarters in Juno Beach**
  - Total solar capacity of 114 kW_{DC}
    - -- E Rooftop – 3 Thin Film, 2 Crystalline
    - -- A Solar Canopy – 9 Silicone
    - -- B Solar Canopy – 3 Thin Film
    - -- Universe Blvd – Pole Mounted Solar
  - Net metered installation (not an interactive "lab")
  - AMI "smart" meters have been installed on arrays to monitor systems
    - -- Data collection limited to capture historic energy output

Helped the company get comfortable with solar PV during the industries early stages of development

Several business units were able to leverage value from the Living Lab, however with no recent upgrades new learnings have diminished

Living Lab – Current State

- **Previous Learnings**
  - Generation profile monitoring (technological, seasonal comparisons, etc.)
  - Installation practices for various solar technologies
  - Identification of potential investment partners
  - General awareness and education of solar PV technologies
- **Current Limitations**
  - Outdated equipment
  - Limited testing and utilization of data
  - Visitor engagement limited to simple tour
  - No budget or single asset “owner”

Renewing the FPL Development engagement and oversight will facilitate ongoing DG research and maximize customer value

Innovating the Living Lab with new technologies can provide further value for future projects

Living Lab – Future Technology Roadmap

2008-2012 — Living Lab Current State

- Multiple solar PV systems
- Various panel technologies from 11 vendors
  - Polycrystalline
  - Monocrystalline
  - Amorphous silicon
  - Thin film
  - CIGS
- Basic inverter technologies
  - String
  - Micro

2015/2016 — Living Lab Near-Term

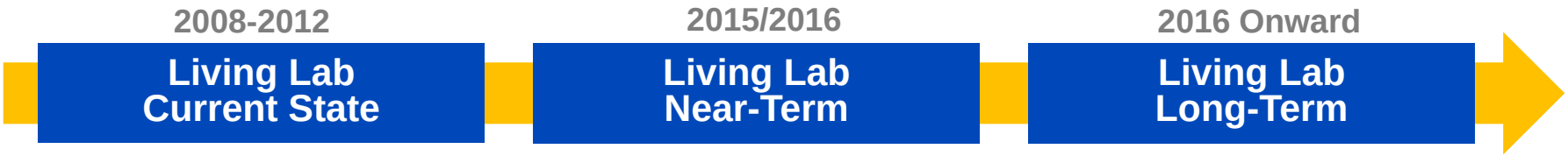
- Repair existing equipment
- Install new technologies
  - Battery Storage
  - Ice Energy
  - Low cost inverters
  - EV-2-Grid
- Innovative technologies
  - Thin film pole application
  - BMW 2nd use batteries
- Incorporate new monitoring tools
- Develop asset documentation

2016 Onward — Living Lab Long-Term

- Build innovative visitor experience center
- Generation, storage, charging, and control system analytics
- Mobile Living Lab partnership with Palm Beach State College
- Evaluate additional emerging technologies
  - Fuel Cells
  - Floating Solar

To fully unlock the value of this new equipment, a managed research program is necessary

Living Lab – Research & Results Focused



- PV Generation profile monitoring
- Installation and construction best practices
- Investment partnership opportunities

- Battery discharge and charge cycle profiles
- Battery health and control systems
- Energy storage demand management
- EV-2-Grid energy services
- EV charging usage analytics
- Data cloud and control capabilities

- Generation, storage, charging, and control system analytics
- Mobile Living Labs micro-grid concepts
- Research additional emerging technologies

Experience and learnings will shape future customer program offerings and help educate all our stakeholders

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Near-term spend focused on getting equipment installed or working again, then focus shifts to expanding the experience

Living Lab – Cost Estimates

Living Lab Near-Term		Living Lab Long-Term	
• Repair existing equipment	$30K	• Build new visitor experience	$250K
• Install new technologies	$250K	• Mobile Living Labs micro-grid concept*	$50K
• Vendor donated equipment	($100K)		
• Monitoring Equipment	$20K		
	$200K		$300K

* Subject to PBSC securing retired DoD demo unit at no cost to FPL beyond renovation and branding costs

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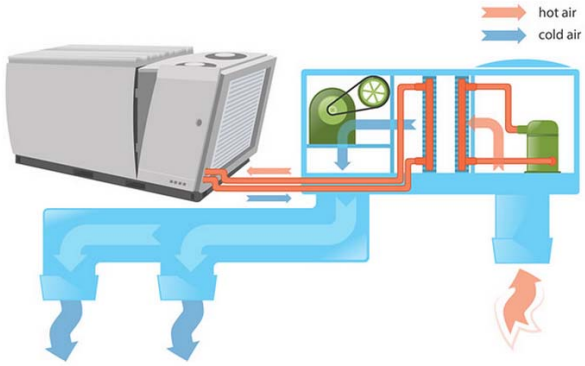
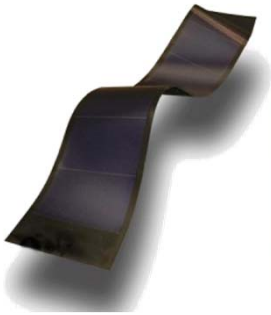
Initial upgrades include vendor provided equipment, but FPL will have to pay for shipping and installation

Examples

- **Battery Storage Demo**
  - Vendors: STEM, GexPro
- **Energy Storage Demo**
  - Vendors: ICE Energy
- **Utility light/pole mounted application**
  - Using flexible thin film products





Beyond a panel and closet tour, FPL must deploy a meaningful experience to excite visitors and employees about new technologies

Visualization Studio

- **To be fully designed with M&C, expect tour to include key attributes:**
  - Monitors showing ongoing research
  - Project production
  - Media content (i.e. videos and pictures)
  - Cut-away displays (i.e. battery cell to pack and solar panels)

- **Demonstrate what a smart grid of the future will do for our customers:**
  - Integrate all distributed technologies
  - Educate visitors and employees
  - How utility control makes DER an asset vs. a management challenge
  - New tools & technology demo

In addition to FIU research for CISPP, team recommending NREL help optimize Daytona installation to ensure equipment and testing results meet research objectives

Inverter Evaluation Project

- **Specialized skills and laboratories necessary FIU cannot provide, so we're seeking a leading labs support**
- **As part of this help, NREL will provide design and evaluation support in two phases which includes:**

	Cost	Timing
– Phase 1 (Testing Design):	$25k	3Q2015
-- System design recommendations		
– Phase 2 (Equipment Validation):	$100k	1Q2016
-- Smart inverter feature testing and validation		
-- Inverter efficiency assessments		
-- Inverter reliability analysis		
Total:	$125k	

Adding NREL to the R&D team adds significant credibility and will help ensure our capital spend is optimized