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Reducing the Carbon Footprint of Building Operations: GSA's Portfolio-Wide Strategy

Agenda

- Carbon footprint of building operations
- Portfolio-wide reduction strategies
- Education and awareness
- Metrics
- Costs

GHG Emissions – Scopes 1 & 2

- Baseline:
 - 2.4 million MtCO₂ (FY 2008)
- 99% of GSA's GHG emissions come from energy consumption in Federal buildings and leased space (FY 2010)
- Target:
 - By FY 2020, reduce building related Scope 1 & 2 GHG emissions by 28.7% below the FY 2008 baseline.

GHG Emissions - Scope 3

- Data Needs

- Owner:

- Travel
 - Commuting
 - T&D losses
 - Leased Assets

- Occupant:

- What am I Using?
 - What is My Influence?
 - How Does My Performance Compare?

Measurement

- Energy Intensity
- Fuel Source
- LEED
- Building
- Organization
- GHG Emissions
- Fuel Result
- LEEP
- Portfolio
- Enterprise....Country



Greening of Recovery Act Projects (1)

- Minimum Performance Criteria To Guide The Scoping And Execution Of Recovery Act Projects To Transform Federal Buildings Into *High-Performance Green Buildings*.
- Following Improvements Incorporated, Where Possible, Based On Funding And Return On Investment:
 - Building Tune-up (Re- or Retro-Commissioning + Controls Improvements)
 - Lighting
 - HVAC Retrofit/Replacement
 - Renewable Energy Generation By Photovoltaic, Thermal Solar Or Wind
 - Roof Replacement with Solar, Cool or Planted Roofs; R-50 Insulation
 - Water Conservation Projects
- Established Geothermal And Lighting Technology Acceleration Programs.

Greening of Recovery Act Projects (2)

Standard Specs & Criteria for:

- Lighting w/ & w/o Ceiling Replacement
- LEDs for Garages and Parking Lots
- Exit Stairway Lighting
- PV & PV Integrated Membrane Roof
- Planted Roof, Cool Roof
- Performance Criteria for Whole and Partial Building Modernization
- Lighting Controls
- Commissioning; Energy Audits
- Meters & Data Feeds from Meters
- Improvements to Existing Engineering Design

ALL Available on the Whole Building Design Guide

Old + New = GREEN ?

- Existing Designs + New Goals = ISSUES
 - How Do You Set Priorities?
 - Triage Process
 - Integrated Design
 - New Technologies
 - Design/Build Contracting Techniques
 - Measurement Changes:
 - Process vs. End State
 - Budget & Schedule vs. Budget & Schedule & Green
 - Reliability of Modeling
 - Quality of Review Process
 - Ability To Apply Rigorous Life-Cycle Methods

Examples: “Shovel Ready” Projects

- Broad Range of Opportunities and Challenges

- Historic 1917 Building
- Last Upgraded in 1935

Plan:

- Modernization with Infill
- \$161 M from Recovery Act, as Phase I
- Must Redesign for Energy Goals
- Future Funding Needed for Phase II

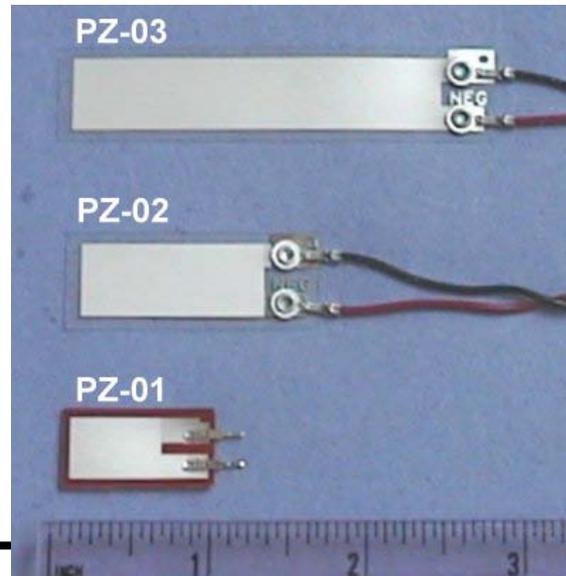


Washington, D.C.



GovEnergy 2010

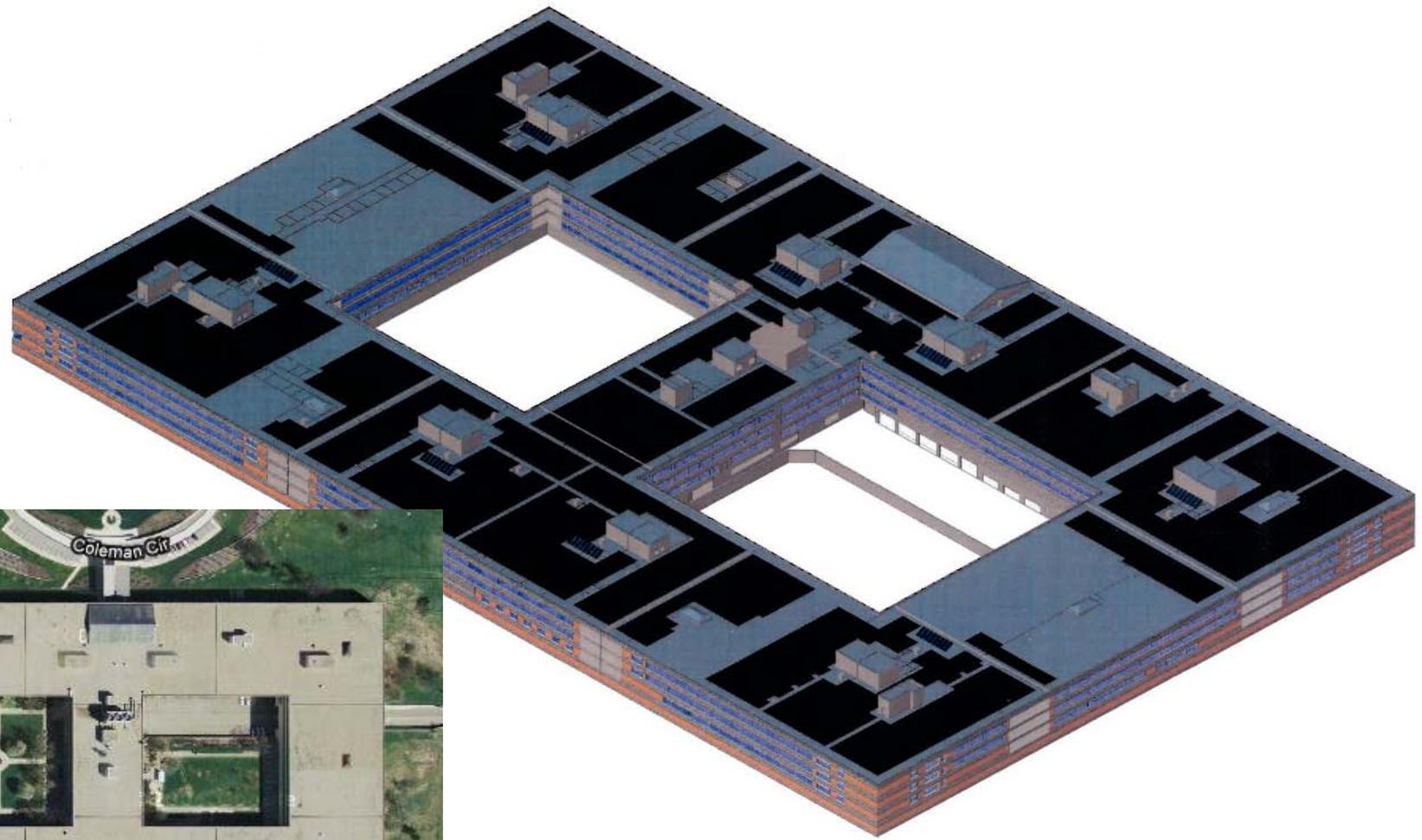
Green Proving Ground



Green Proving Ground

- Use GSA portfolio of buildings as a proving ground for green building technologies and practices
 - Test
 - Evaluate
 - Publicize results
 - Help lead market transformation
- Examples:
 - Digitally Controlled Workstation Specific Lighting
 - “Smart Buildings” Controls Integration
 - Comparative evaluation of photovoltaic solar panels

Emmett Bean—4 Solar Comparison



① ELECTRICAL ROOF ISOMETRIC VIEW
Scale: N.T.S.

New Construction & Major Modernization

- New Federal Buildings To Deliver Energy Performance At Least 30 Percent Below Industry Standards (ASHRAE 90.1-2007) For Energy Efficiency In Non-residential Buildings
- Achieve The U.S. Green Building Council's Leadership In Energy And Environmental Design (LEED) Gold Certification
- Design to ENERGY STAR
- Identify Demonstration Projects To Begin Designing Toward Zero Net Energy
- Consideration Of Local And Regional Impacts When Planning Federal Activities

Existing Buildings – Energy Use Reduction

- Target:
 - By 2020, Reduce Total Energy Consumption Per Square Foot Of Space By 37.5% By Compared To The FY 2003 Baseline, For EPACT “Covered” Buildings
- Approach:
 - Energy Evaluations/Energy Audits
 - Energy Conservation Projects
 - Rcx
 - Advanced Metering; Move Towards Sub-Metering By Tenant
 - Renewable Energy
 - Alternative Sources Of Electricity
 - Central Operations Data Collection & Analysis
 - ESPCs & UESCs

Existing Buildings – Water Use Reduction

- Target:
 - By FY 2020, Reduce Its Potable Water Consumption By 26% Over The FY 2007 Baseline
- Approach:
 - Implement Water Management Best Practices
 - Water Evaluations
 - Advanced Water Meters
 - Separately Meter Cooling Tower Water Usage Where Cost-Effective

Existing Buildings – Waste Reduction

- Target:
 - By FY 2015, GSA Will Divert At Least 50% Of Its Non-hazardous Solid Waste (Not Including C&D Waste)
 - By FY 2015, GSA Will Divert At Least 50% Of Its C&D Debris—Already Achieving 90% In Some Projects
- Approach:
 - Increase Recycling Of Non-Hazardous Solid Waste
 - Increase Diversion Of C&D Debris And Organic Waste
 - Minimize Generation Of Pollutants

Existing Buildings – Green Operations & Maintenance Practices

- Guiding Principles for Sustainable Existing Buildings
 - LEED EBOM certification
 - *Federal High Performance Sustainable Buildings Checklist* in Portfolio Manager
- Opportunities for Changes in Green Cleaning Procedures

SFO - Green Leases Clauses

- Leased Construction Requirements
 - Meet the Same Requirements as for Federal Construction
- Leased Space
 - Green Lease Clauses For Sustainable Fit-out
 - Designed To Achieve The Guiding Principles Application To Existing Buildings
- Upcoming Requirement Pursuant To EISA – December 2010
 - Federal Leases Over 10,000 SF, With A Few Exceptions, Must Be In ENERGY STAR[®] Labeled Buildings.

Education & Awareness

- Engaging Tenants In Sustainable Office Practices:
 - Space Utilization Requirements
 - Improvements in Work Place Effectiveness
 - Use Of Power Management Features In Electronic Equipment
 - Participation In Recycling Programs
 - Sub-Metering of Tenant Uses
 - Shared Incentives
 - Increased Measurement (e.g., Waste)
- Initiatives To Provide Tenants With Data And Recommendations To Increase Environmental Efficiency

Metrics

- Energy:
 - Energy Intensity : -14.3%
 - 10.8% Purchased Or Generated Renewable Energy (2009); 30% by 2020
 - Installed Advanced Meters At 209 Facilities, = 41% Of Energy Consumed
 - All Recovery Act Projects Will Have Advanced Meters For Electricity, Water, Chilled Water & Steam, Covering Over 75% Of Electrical Consumption
 - Re-commissioned 34 Covered Facilities
- Water:
 - Water Intensity: - 8.6%
 - Advanced Water Meter Projects Completed Or Underway At 209 Facilities
- Third-Party Labels/Certifications
 - Since 2003, GSA Has Designed All Of Its New Federal Buildings To Achieve LEED Certification.
 - 48 LEED Certifications In 47 Buildings And Leases.
 - Over 180 Buildings With An Energy Star® Buildings Label.

Costs

- The Great Unknown
- Positive: Demonstrated Cases Where Savings of 15%—20% are Possible in Buildings Operations With Minor Capital Cost
- Negative: Whole Building Renovation Costs 4-5x the Energy Reduction Cost
- Negative: Balanced Budget = Less Capital
- Positive: ESPCs & UESCs
- Negative: ESCOs & Utilities Avoid Risk
- Positive: The Government Can Change the ESPC Risk Profile
- Unknown: Zero Fossil Fuel Consumption



GovEnergy 2010



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“Getting your Greenhouse in
Order”

Outline

- Introduction
- Carbon Reduction Frameworks
 - Reduce, Renew, Offset
 - Carbon Management Continuum
 - Climate Neutral Initiative – NREL
- Case Studies
 - Energy Efficiency
 - Cogeneration
 - Forestry Assets

MGM Innova

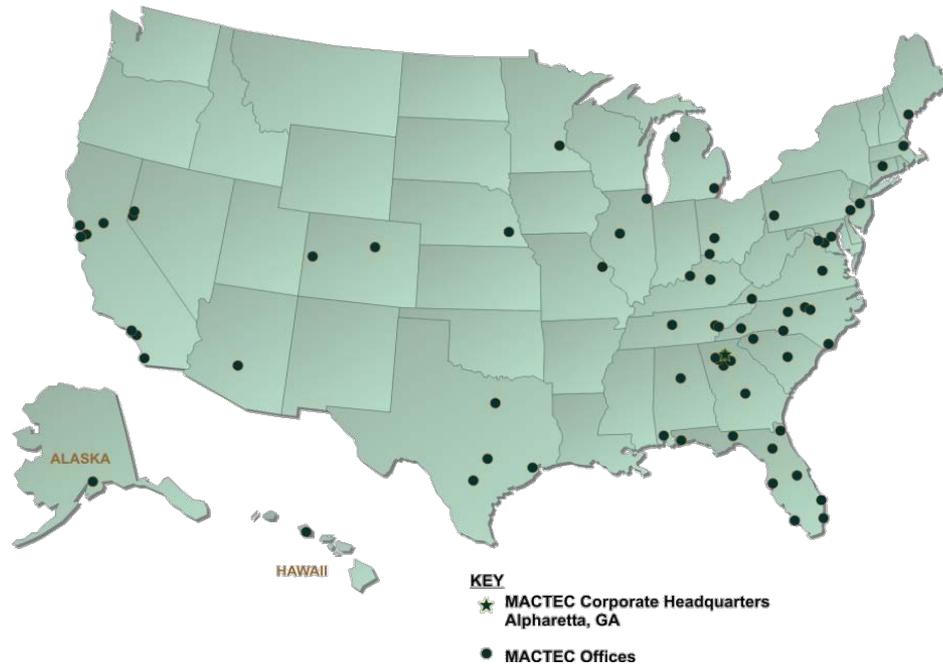


MGM Innova

- Carbon Management Strategy
- GHG Inventories, Carbon Footprint & Neutrality
- Feasibility Studies
- Project Identification & Development
- Program Structuring & Management
- Environmental Assets & Liabilities Mgmt.
- Carbon Finance Services
- Monitoring Services
- Trading & Commercialization
- Risk Management Services
- Self-Certified Small Disadvantaged Business



MACTEC



- **Established:**
 - Founded in **1946**
 - **80** Locations
- **Capacity:**
 - **3,000** Employees
 - **1,200** Engineers and Scientists
 - **50** Technical Disciplines Covering
 - Facilities and Energy Engineering
 - Environmental/Natural Resources
 - Geotechnical/Geology/Hydrology
 - Planning/Civil/Site Design
 - Construction Management
- **Recognition:**
 - **32nd** in ENR Top 500 Design Firms
 - **33rd** in ENR Top 200 Environmental Firms
 - **46th** in ENR Top 100 Design-Build Firms

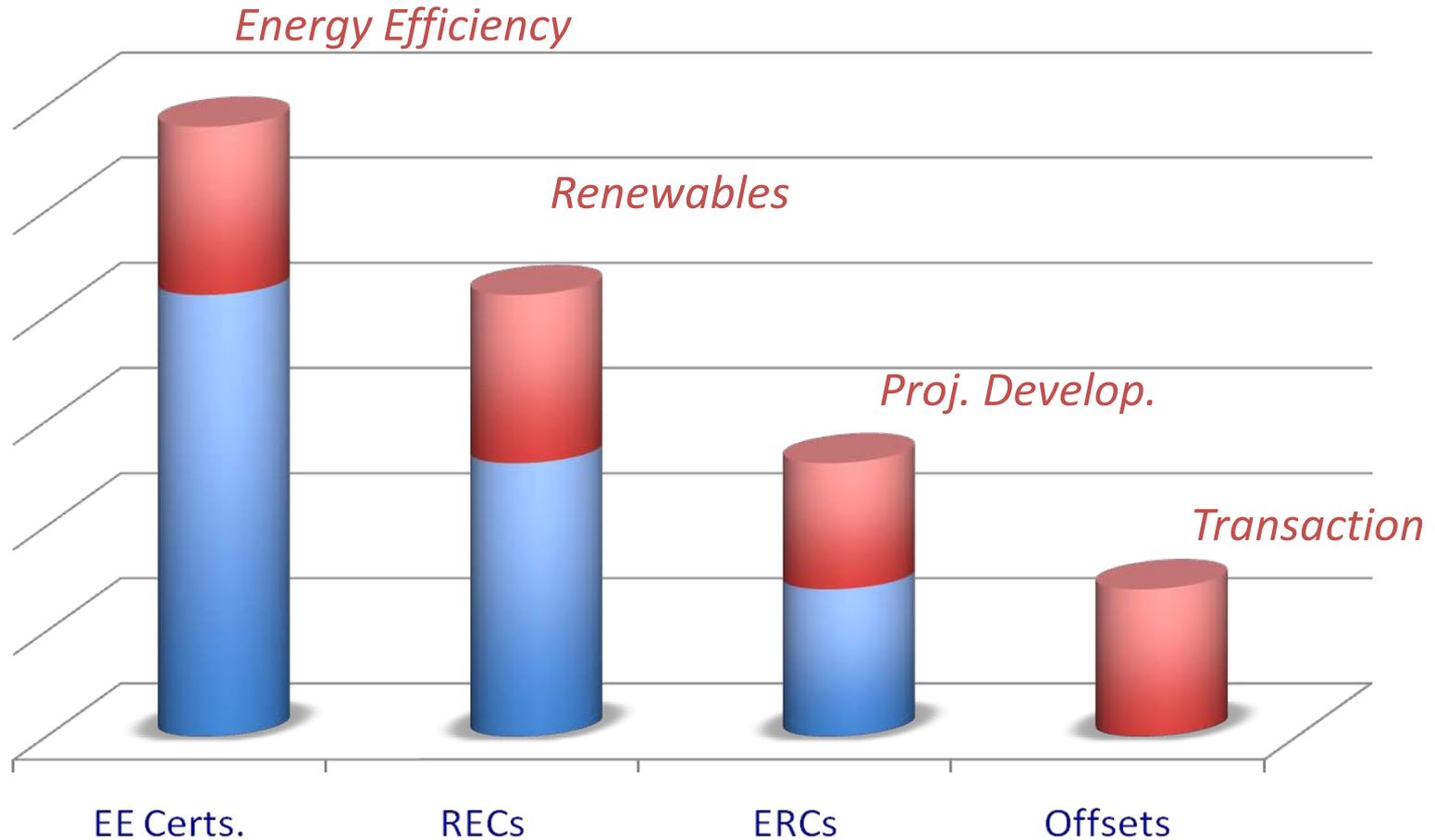
Representative MACTEC Clients

Dominion Resources
Olin Corporation
Alcoa
Abengoa
AES

Thyssen-Krupp
Caterpillar
Southern Company
General Dynamics
Textron
Honeywell

Constellation Energy
Duke Energy
Johnson Controls
Florida Power & Light
United Technologies Corp

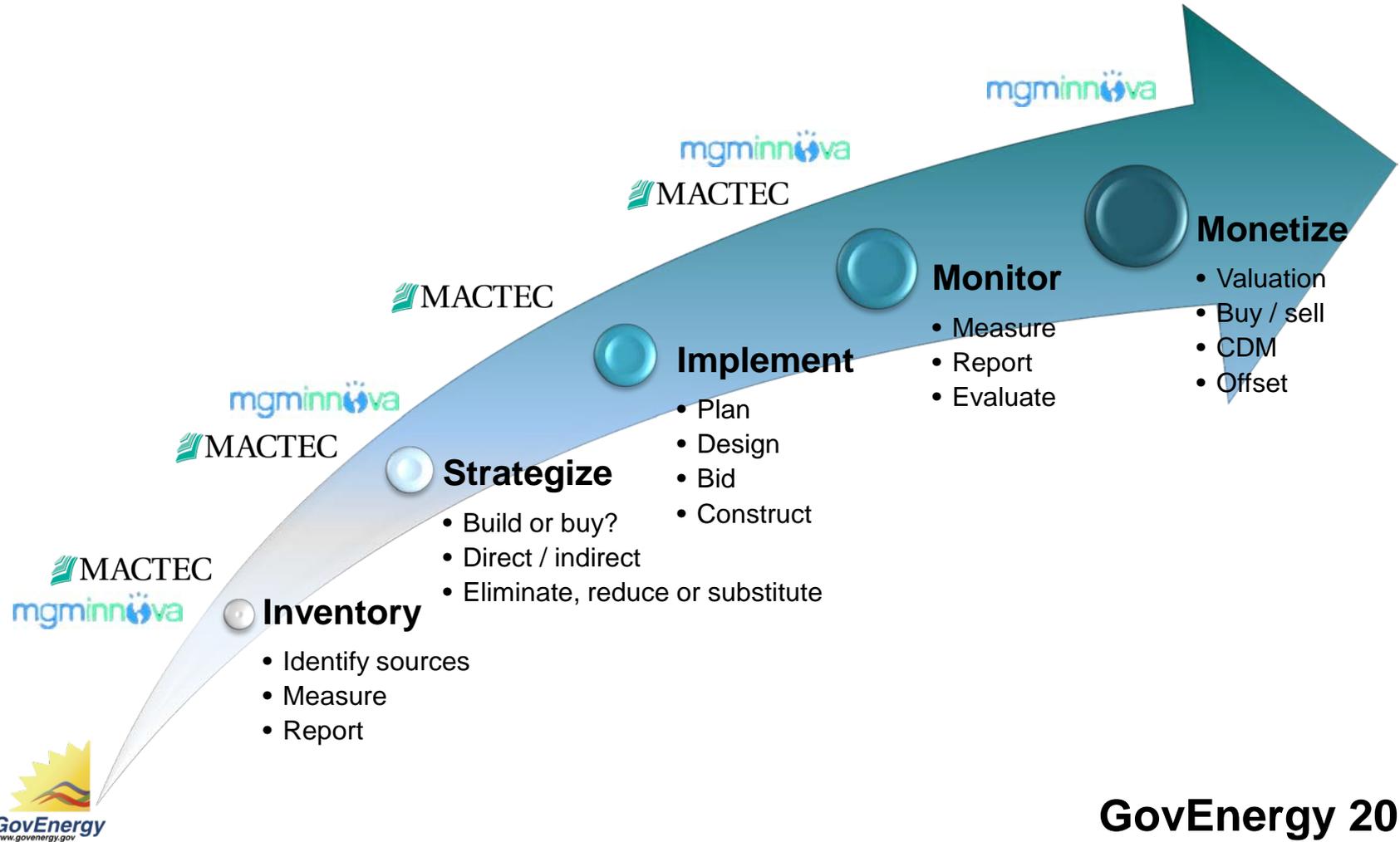
Reduce, Renew, Offset



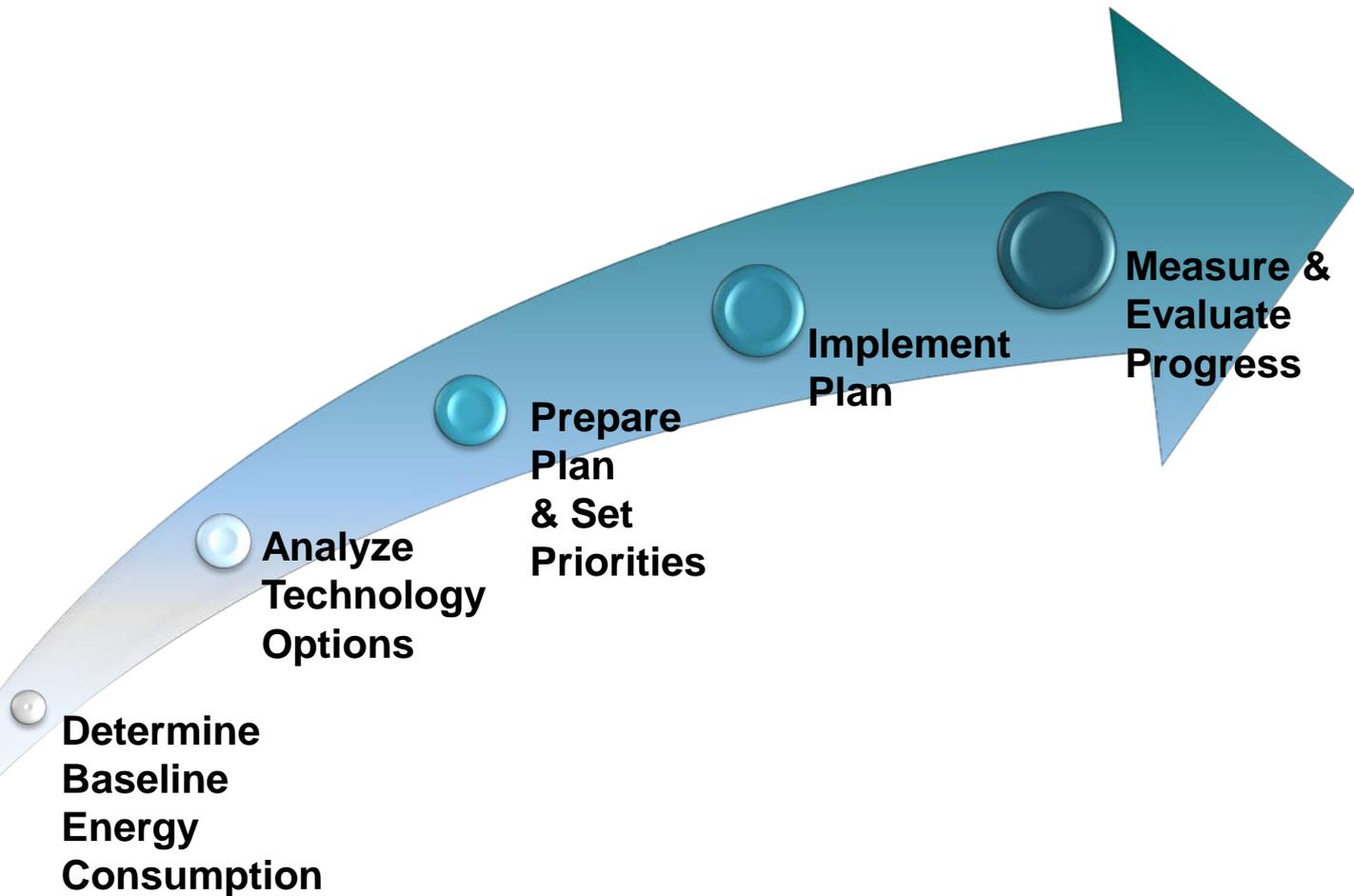
Least Costly ➔ **More Costly** = **Cost Optimized!**

Under cap and trade , these mitigation actions will free up allowances

Carbon Management Continuum



NREL's Climate Neutral Initiative



USPS' Southeast Area Strategic Energy Plan Project

- Comprehensively addresses reduction of energy at more than 3,700 USPS facilities in the Southeast US
 - 36% energy consumption reduction at these facilities
- Plan includes
 - audit requirements
 - report format
 - reduction goals
 - QA/QC
 - project implementation options
 - awareness training, and
 - measurement and verification alternatives.

Building EE & Carbon Credits

- Current state: Step-wise progress & Barriers
 - Single and multi-measure CDM methodologies applicable in CDM or VCS
 - Additionality barriers for incremental innovation
 - Cost barriers for single projects; aggregation necessary
 - Programmatic CDM in infancy
- Carbon credits as driver of innovation and diffusion of advanced building systems (towards zero emission buildings)
- Performance standard as an enabler
- Private sector to lead?

Small Cogeneration Technologies

Technology	Recip Engine	Microturbine	Fuel Cell
Efficiency	70 - 80 %	65 – 75 %	55 – 85 %
Typical Capacity	.01 – 5 MW	30 – 250 kW	5 – 400 kW
Installed Cost	\$1000 - \$2200 / kW	\$3000 - \$4000 / kW	\$4500 - \$6500 / kW
Fuel	NG, LFG, Biogas	NG, Biogas, Fuel Oil	NG, H2, Propane
Availability	92 – 97 %	90 – 98 %	> 95 %
Noise	High	Moderate	Low
Emissions	Moderate	Low	Low

CCHP Project Examples

- Johnson Matthey Industrial, 200 KW Fuel Cell
- St. Helena Hospital, 400 KW Fuel Cell
- Whole Foods, 200 KW Fuel Cell - several locations
- Clarkson University, three 65 KW Microturbines
- Current TV, 123 Townsend Ave, Microturbines
- Ritz Carlton, San Francisco, Microturbines



St Helena Hospital Fuel Cell

- 181 Bed Full Service Hospital
- 400 kW Fuel Cell with 1700 KBtu/Hr of Hot Water used for space heating
- Partially funded by State (CSGIP)



Fuel Cell – Carbon Credit Value

- Estimated 4,000 tCO₂e/yr available from installation of 1 MW natural gas fired fuel cell.
- 10 MW of installed capacity would produce 40,000 tCO₂e/ yr or \$120,000 in marginal gross carbon revenue.
 - Anticipated payback time < 2 years
- 10 MW of installed capacity in Lat America would produce approximately 40,000 tCO₂e / yr or ~\$500,000 in marginal gross carbon revenue
 - Anticipated payback time < 1 year

Fuel Cells – Available CDM Methodologies

- AM0014 ("Natural Gas-based Package Co-generation") appears to be relevant for fuel cells in the case of electricity generation for a facility's own use.
- Should an end user be selling electricity back to the grid, MGM Innova has a draft CDM methodology which could be polished for use through the CDM or the Voluntary Carbon Standard.

Project types accepted under



Reforestation: restoring tree cover on land that is not at optimal stocking levels and has minimal short-term (30-years) commercial opportunities.



Improved Forest Management: management activities that maintain or increase carbon stocks on forested land relative to baseline levels of carbon stocks.



Avoided Conversion: preventing the conversion of forestland to a non-forest land use by dedicating the land to continuous forest cover through a conservation easement or transfer to public ownership.

Listed Climate Action Reserve Projects



Argos CO₂ Offset Project, through reforestation activities for commercial use, Colombia

- This project consists of the reforestation of 2,750 hectares with teak (*Tectona grandis*) plantations for commercial purposes (local and international markets) in extensively managed or unmanaged lands located in the departments of Sucre and Antioquia, Colombia.
- MGM has accompanied Argos during the whole CDM project cycle. The project has been successfully validated and is currently requesting registration from the CDM Executive Board.



Redd Forests, Tasmania, Australia

- It is the first Reduced Emissions from Deforestation and Degradation (REDD) project in Australia.
- This project demonstrates the commercial viability of using the carbon market to reward landowners who, traditionally, have logged their land for income. Instead, landowners can now assign those same logging rights to Redd Forests in return for a percentage of the proceeds of sale of the resulting carbon credits.
- These credits are generated by Redd Forests 'locking up' the land for a period of 25 or more years thus avoiding the release of greenhouse gas emissions resulting from logging and land clearing practices.
- successful registered under the CCBA standard (7 July 2009).



Forestry Projects

No.	Project name	Location	Type	Size (ha)	Standard	Status
1	EPM Porce River biological corridor project	Colombia	REDD	≈12,000	CCBS/VCS	Feasibility study under development
2	Sucumbíos avoided deforestation project	Ecuador	REDD	≈750,000	CCBS/VCS	Feasibility study under development
3	Argos reforestation program for commercial use.	Colombia	A/R	≈30,000	CDM	under development
4	Argos CO ₂ Offset Project, through reforestation activities for commercial use.	Colombia	A/R	≈2,750	CDM	Validated
5	Soroteca Agroflorestal Ltda. Forestry Project	Brazil	MF	≈6,000	CCX	Validated
6	Tectona Agroflorestal Ltda. Forestry Project	Brazil	MF	≈1,500	CCX	Registered
7	Reducing carbon emissions by protecting a native forest in Tasmania	Australia	REDD	≈950	CCBS	Registered

THANK YOU!

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**Managing an Installation's GHG
Footprint:
Using Geospatial Tools for GHG
Inventory**

GHG Management: Can we....

- Create a geospatial tool that:
 - Calculates and illustrates GHG footprint of an AF installation - quickly, easily, accurately
 - Accounts for both GHG sources and sinks
 - Is a visual tool and quantitative for carbon management and decision-making
 - Is real-time

Our Team

- Air Force Research Labs
 - Mr. Gary Wright
- University of Dayton Research Institute
 - Dr. Sukh Sidhu
 - Dr. Shang-Ye Wu
- Woolpert Inc.
 - Nadja Turek
 - Aaron Lawrence



UDRI





201

4

444

Wright-Patterson AFB

Fairborn

Rohrer's Island

Riverside

844

675

WRIGHT PATTERSON AIR FORCE BASE, OH

Image State of Ohio / OSIP
Image U.S. Geological Survey

Research Goals

- Phase I (Spring-Fall, 2010):
 - Create a static geospatial tool accounting for GHG sources and sinks for a baseline year
 - Quantify the resolution of data that is “meaningful”

Scope of Effort

- Our analysis includes:
 - Sequestration of vegetation – the primary focus of our research effort
 - CO2 emissions data
 - Concurrent effort by AFCEE to do a comprehensive GHG emissions inventory
 - Will integrate AFCEEs data when available
- Within the fence line of WPAFB

Data Sets

- Satellite imagery
 - Landsat (1999-2003) – 30 meter resolution
- Aerial photography and LiDAR
 - 2006 and 2010 – 6 inch resolution
- Thermal imagery
 - Small strip of data from 2010



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Estimating Carbon Sink for Wright Patterson Air Force Base

$$NPP = \sum PAR * fPAR * e$$

- **NPP: Net Primary Production (g Carbon/m²/year)** - is the rate at which all the plants in an ecosystem produce net useful chemical energy
- **PAR: Photosynthetically Active Radiation (W/m²)** - the spectral range (wave band) of solar radiation from 400 to 700 nanometers that photosynthetic organisms are able to use in the process of photosynthesis
- **fPAR: Fraction of Absorbed Photosynthetically Active Radiation (unitless)** - the fraction of the incoming solar radiation in the photosynthetically active radiation spectral region that is absorbed by a photosynthetic organism
- **e: Conversion Efficiency (g Carbon/MJ)** – the fraction of absorbed PAR converted into organic dry matter; dictated by plant metabolism

Photosynthetically Active Radiation (PAR)

- Source: “PV Solar Radiation Static Maps” National Renewable Energy Laboratory (www.nrel.gov)
- 43-47% of total solar radiation received on surface
- Total solar radiation and PAR for WPAFB

Month	Total Incoming Solar Radiation (W/m ²)	Photosynthetically Active Radiation (W/m ²)
January	121	54
February	171	77
March	192	86
April	204	92
May	221	99
June	225	101
July	229	103
August	225	101
September	221	99
October	179	81
November	138	62
December	100	45

NDVI and fPAR

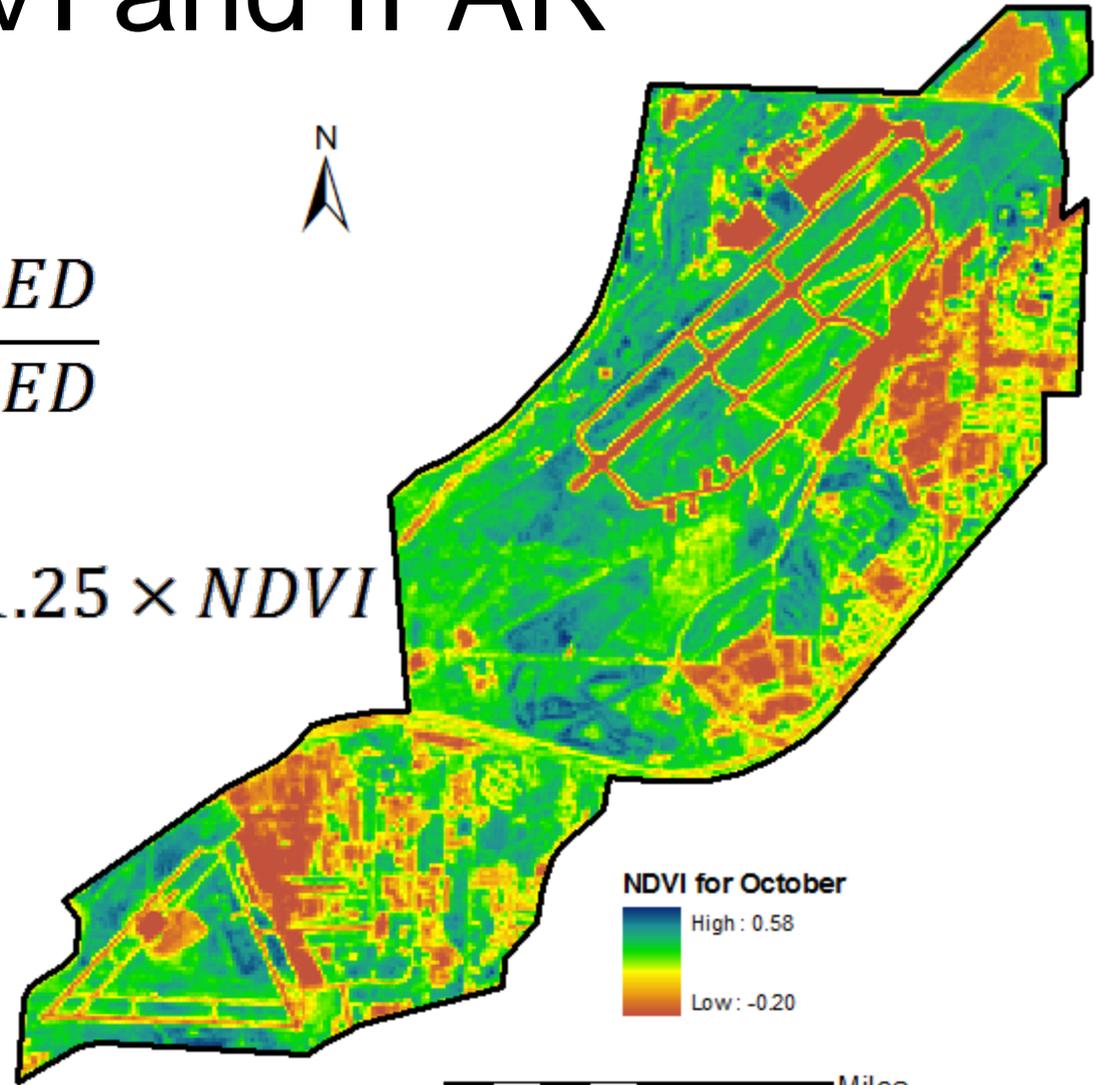
- fPAR: Fraction of Absorbed Photosynthetically Active Radiation
 - Calculated based on color imagery of the base
 - Linearly related to normalized difference vegetation index (NDVI), based on red (R) and near-infrared (NIR) surface reflectances of vegetation

NDVI and fPAR

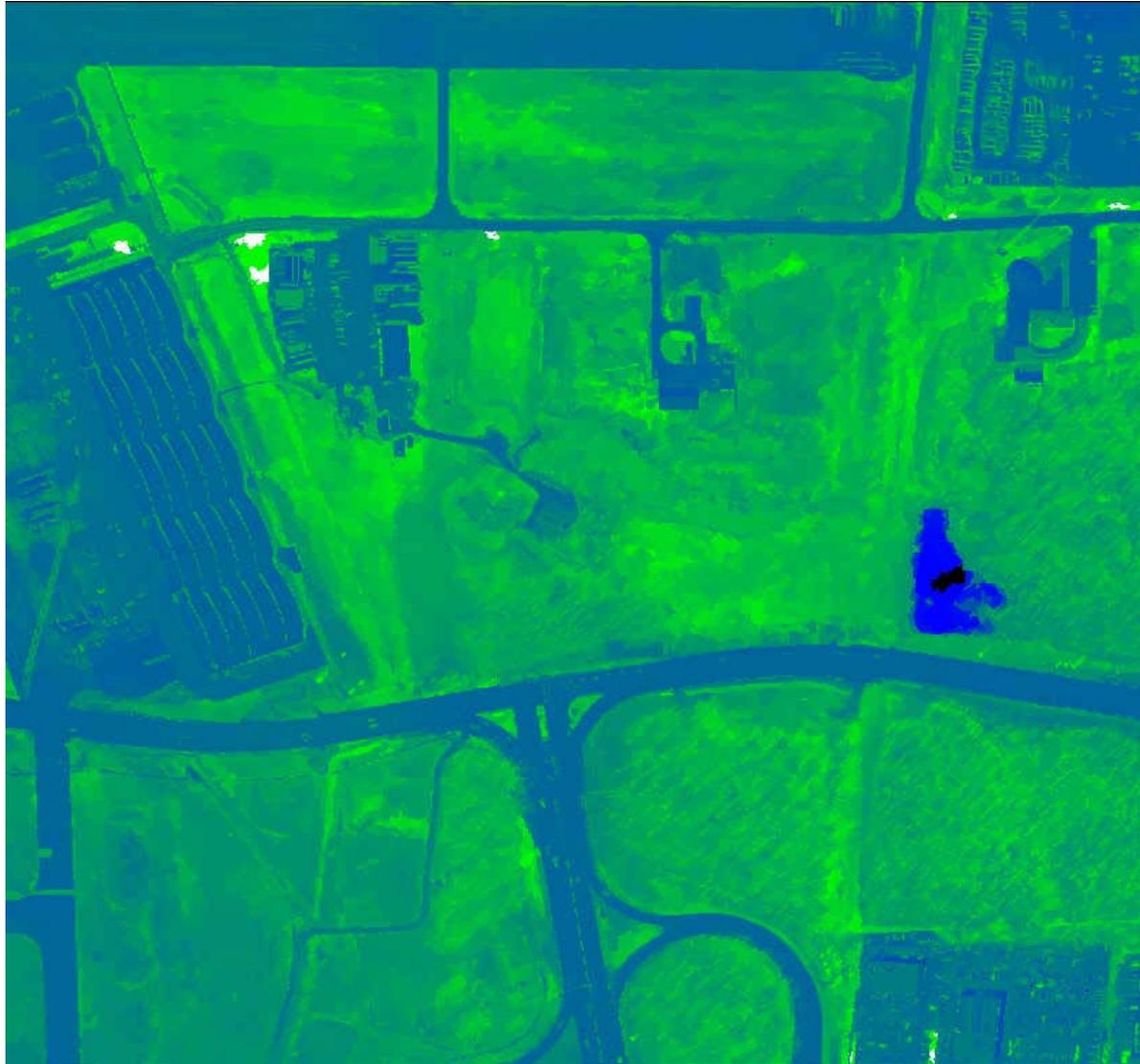
$$NDVI = \frac{NIR - RED}{NIR + RED}$$

$$fPAR = -0.025 + 1.25 \times NDVI$$

(Ruimy 1994)



NDVI polygon generation process



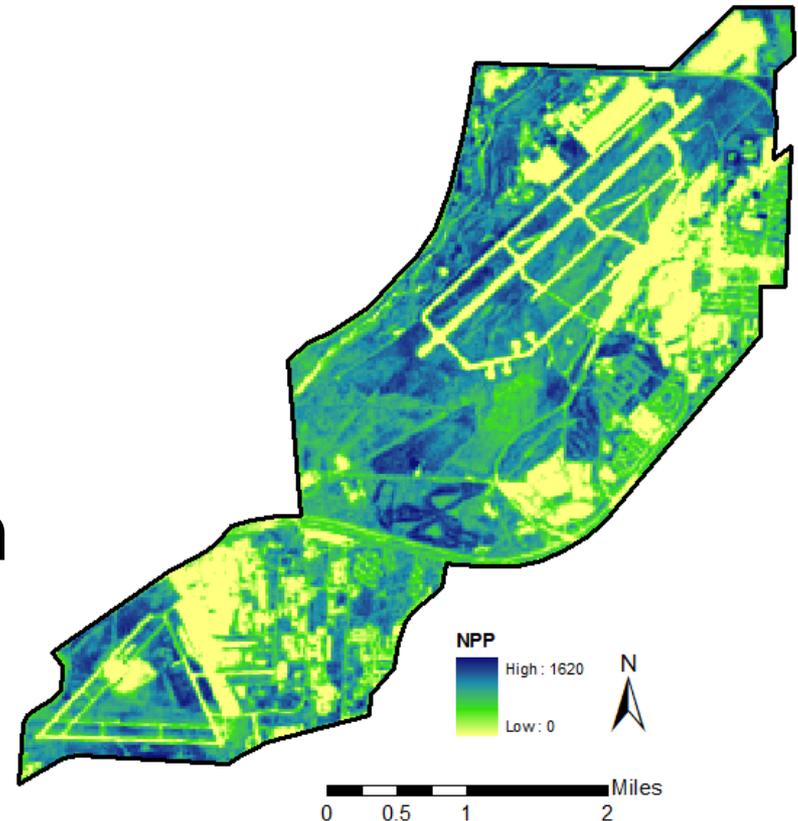
Net Primary Productivity (NPP)

$$NPP = \sum PAR * fPAR * e$$

- Conversion efficiency (e) is biome dependent, and is set to 1.26 for temperate grassland (Ruimy, 1994)
- NPP is then calculated for each pixel for each of 12 months.
- Total NPP per year is calculated by integrating the NPP values over the study area and over 12 months.

Results

- Average NPP for WPAFB is 653 gC/m²/year
- Total carbon sink is 21,527 tons of carbon per year
- Base CO₂ emissions for 2005 were 170,818 tons per year



Base CO₂ Emissions

Base-wide Carbon Dioxide Emission by Source Category for 2005

Source Group	Source Type	Fuel Type	Est. Annual Quantity Consumed	Units	Est. Annual CO ₂ Emission (TPY)
Fuel Burning	Boilers	Coal	51,925	tons	124,879
		Natural Gas	240	MMft ³	14,402
	Emergency Generators (stationary)	Diesel	20,144	gal	229
	Engines/Generators (including portable ones)	Diesel	13,660	gal	156
	Fire Training	Propane	4,750	gal	30
	Process Heaters/Burners	Natural Gas	9.55	MMft ³	573
	Incinerator	Natural Gas	0.56	MMft ³	34
Solid Waste		144	lbs.	144	
Maintenance	Non-road Engines *	Gasoline	4,657	gal	220
		JP-8	506	gal	384
R&D	Test Range	Jet Fuel	28,653	gal	302
Mobile Fleet	Fleet Vehicles	Gasoline	2,730,064	gal	26,705
		Diesel	246,597	gal	2,760
Misc.	Landfill	Methane	N/A		negligible***
	Incinerator	Natural Gas	0.56	MMft ³	0
		Solid Waste	144	lbs.	0

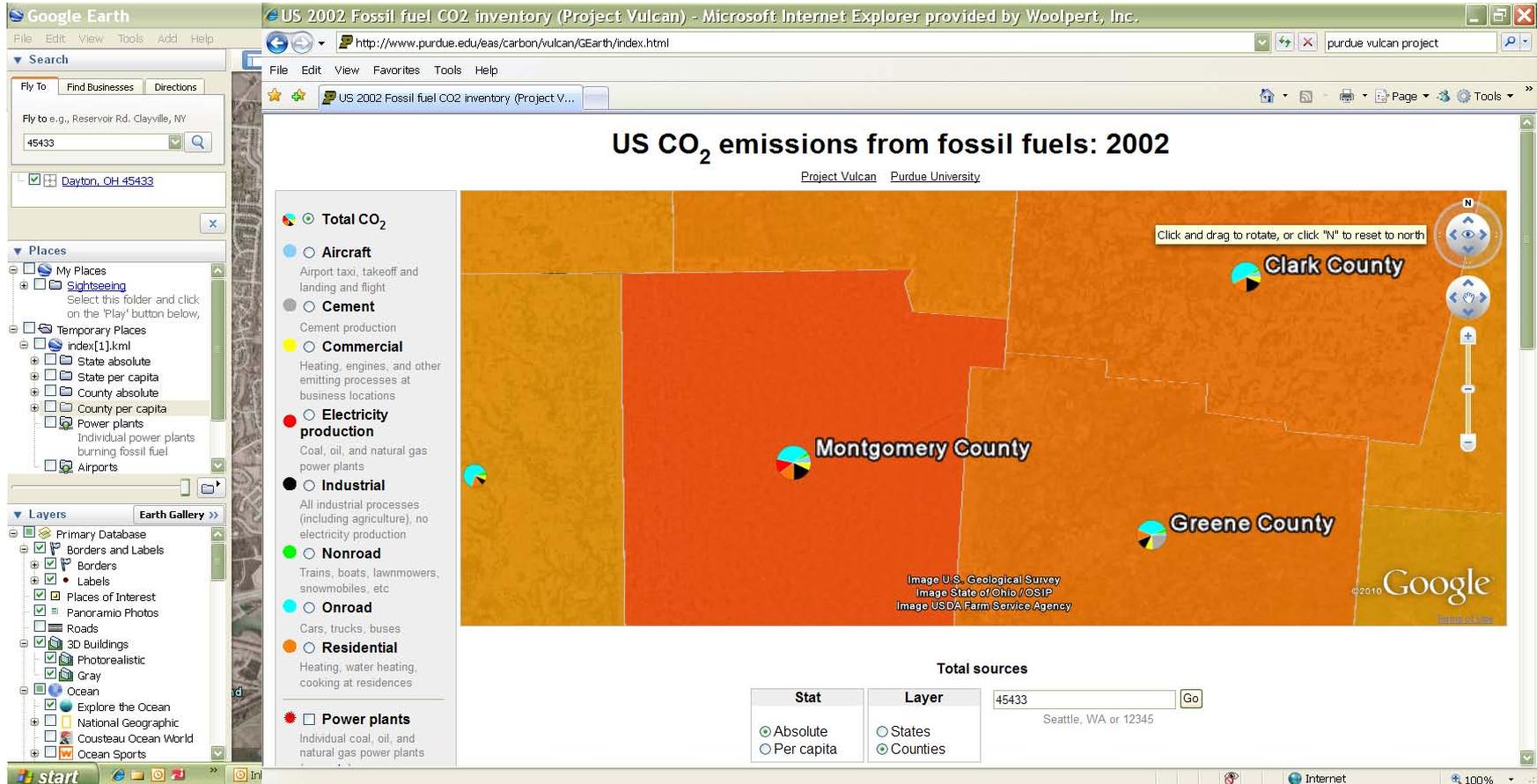
* Including bulldozers, bobcats, and other similar equipment. Also includes Gardening equipment (e.g. Trimmers, blowers, mulchers, etc.)

*** based on conversation with Dave Duell 11/13/06.



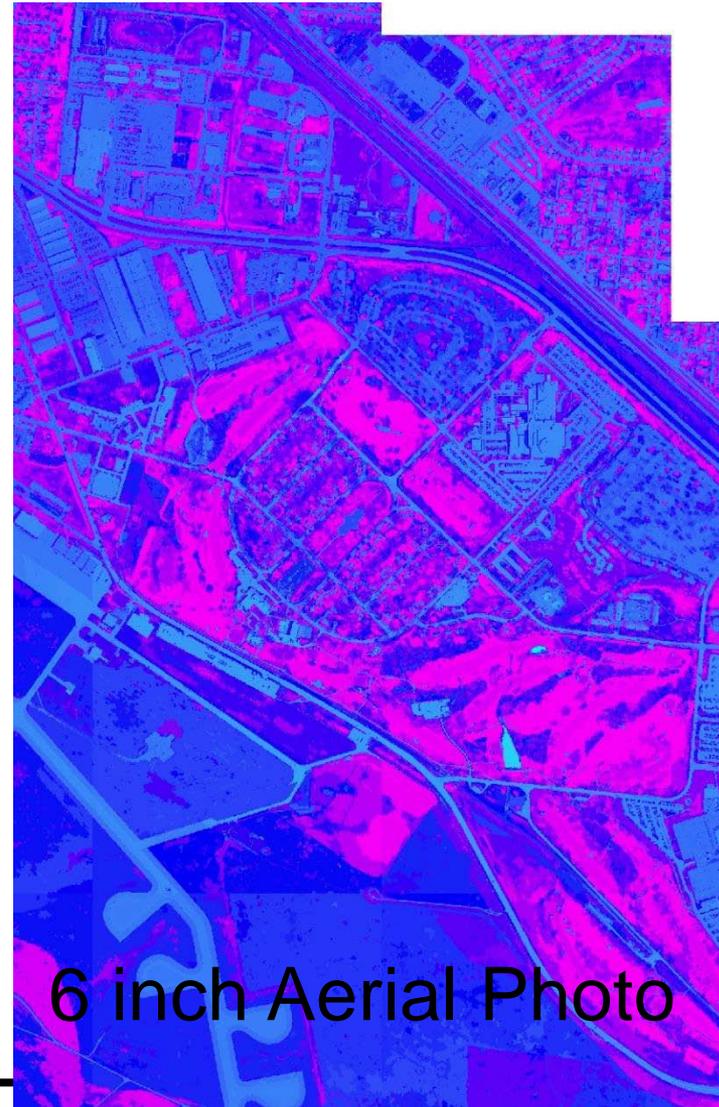
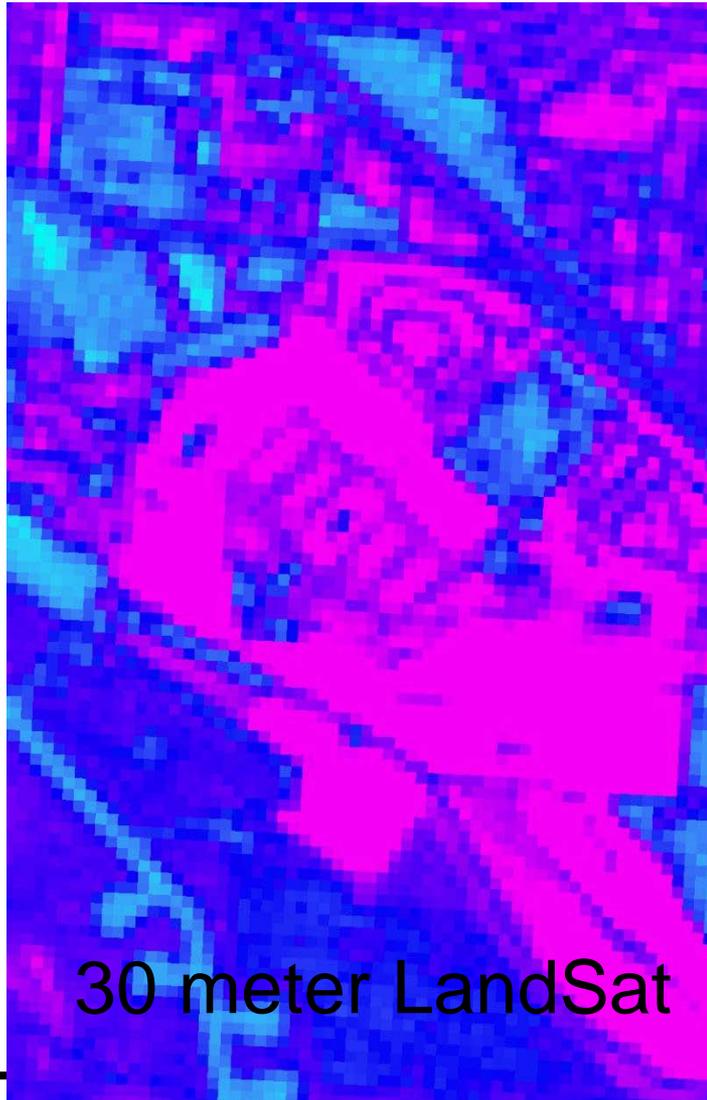
Influence of imagery resolution on
carbon sequestration calculation

Google Earth Vulcan Project Plugin



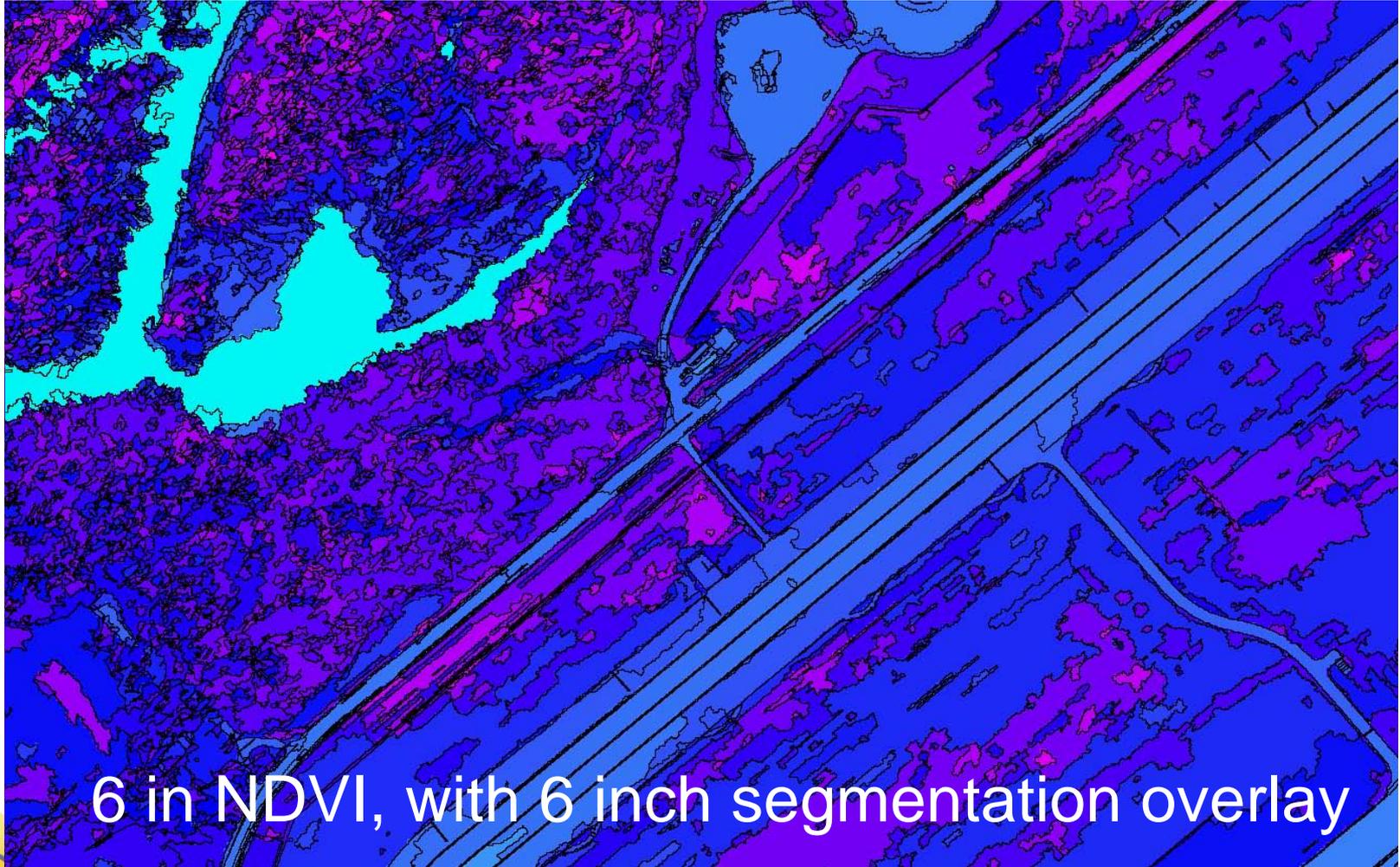
“The Vulcan Project is a NASA/DOE funded effort under the North American Carbon Program (NACP) to quantify North American fossil fuel carbon dioxide (CO₂) emissions at space and time scales much finer than has been achieved in the past.” <http://www.purdue.edu/eas/carbon/vulcan/index.php>

Comparison of Satellite vs. Aerial Photography Derived NDVI



2010

Comparison of Satellite vs. Aerial Photography Derived NDVI



6 in NDVI, with 6 inch segmentation overlay

Geospatial data for environmental management

- Existing aerial imagery + existing base IGI&S (Geobase) + air emission data = most of the information needed for a carbon sink/source map
- Tip of the geospatial analysis iceberg
 - Carbon sequestration
 - Impervious surfaces
 - Forest inventory and speciation
 - Thermal losses (steam lines, roofs, etc)

LiDAR Data



Conclusions

- Estimating carbon sequestration is one component of creating a geospatial GHG management tool
- Leveraging existing data and GIS tools allows for quick, low cost assessment
- Future work:
 - Live carbon source/sink tool for decision-making (i.e. land use)
 - Year over year comparisons
 - Refine NPP calculations (e, fPAR calcs)



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