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A River of Energy Solutions

Energy Innovations

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Golden Field Office's mission:

- **Support** DOE's Office of Energy Efficiency and Renewable Energy through:
 - R&D partnerships in renewables & energy efficiency
 - outreach to stakeholders nationwide to further the use of EE technologies
 - Contract administration of National Renewable Energy Laboratory

Energy Efficiency Areas:

- Industrial Technologies
- State Energy Program
- Weatherization Assistance
- Community Block Grants
- Federal Energy Management Program
- Tribal Energy

Renewable Resources:



Solar



Wind



Biomass energy & fuels

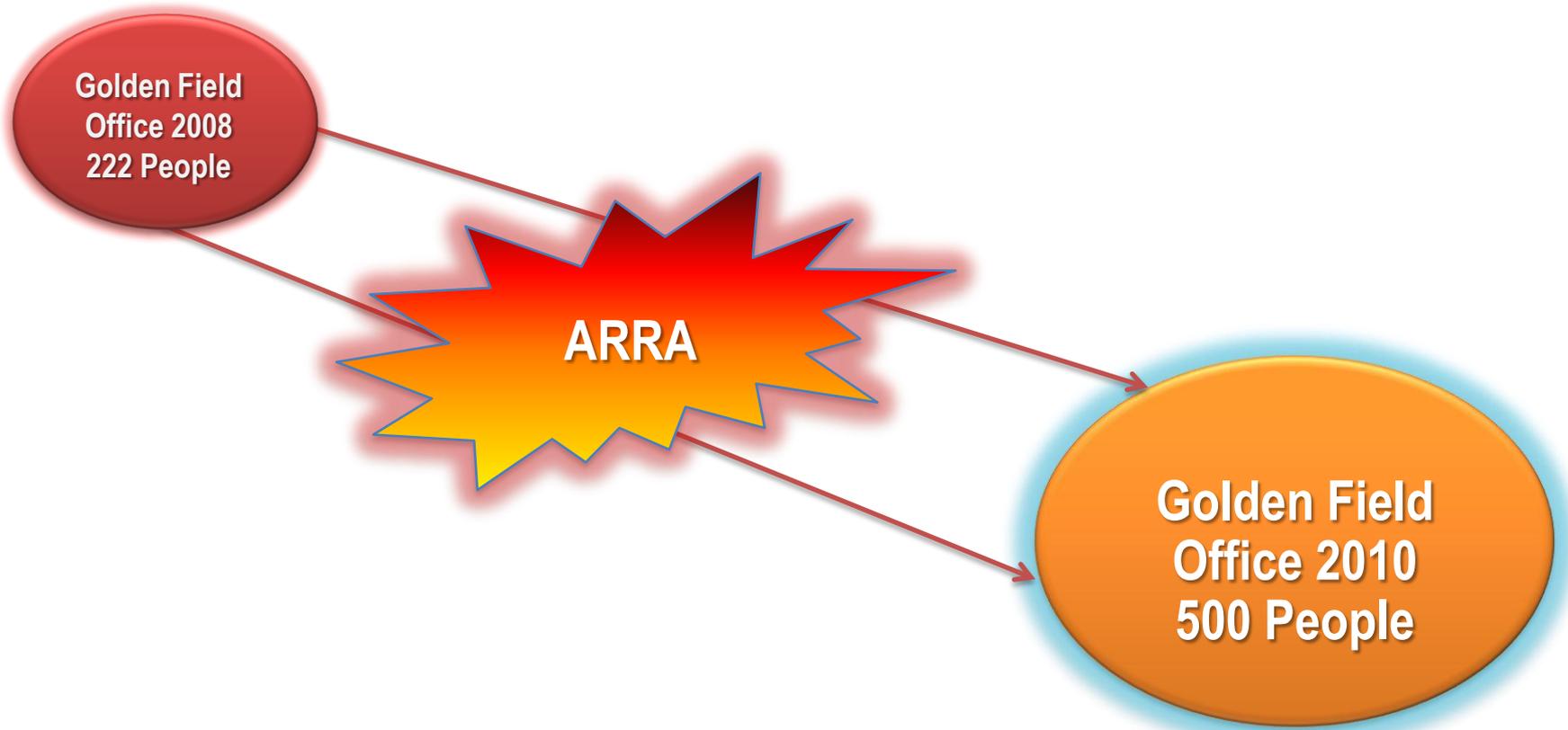


Geothermal



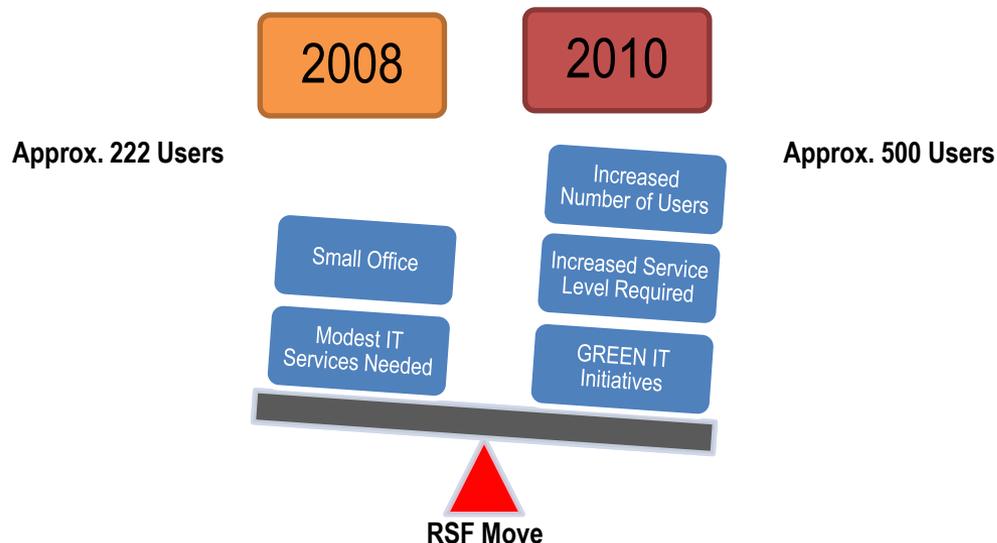
Hydrogen

Golden Field Office Growth



Golden Field Office ARRA Growth

- Golden receives ARRA funding and requires additional employees
 - March 2008 Golden consists of only 222 employees
 - January of 2010 Golden grows to approximately 500 employees
- IT had been preparing to move Golden employees to the NREL RSF
 - The RSF is a Leeds Platinum Plus certified facility
 - Power consumption was restricted to 60 watts per user
 - Golden IT must increase network resources while reducing power



Golden Field Office Challenges

With these changes upon us, the IT staff quickly realized there was only one way to accomplish what we were faced with. Large reduction in energy consumption, a very large increase in staff could only be handled one way:

Virtualization of Servers and Desktops

Golden Standard Operating Environment

- Standardization

 - All desktops, laptops, and virtual computers run standard software images

- Software refresh

 - All laptop and desktop machines are reimaged annually

 - All virtual machines are reimaged monthly

- Security

 - All users -Workstations in Golden have no administrative rights

 - Vulnerability scans performed weekly

 - All patching is automated and critical patches applied within 24 hours

 - Standardized builds reduces security risk

- A robust telecommuting capability – Successfully provides over 200 connections simultaneously for Colorado winters

Golden Field Office Virtualization Project

Golden Field Office grows with ARRA responsibilities

Challenges

- Reducing energy consumption
- Scaling out resources quickly
- Minimizing administrative overhead on IT staff

Golden deploys virtual desktops and servers

- Thin client and monitor use total of 24 watts
- All services supported by Dell M1000e blade servers
- Energy efficient storage arrays over 1.5 petabytes
- Reduced desktop support
- Quickly deliver desktop systems to 500 users
- Goal: Maintain a PUE in the data center of 1.15
- Maintain a DCiE ration of 0.9

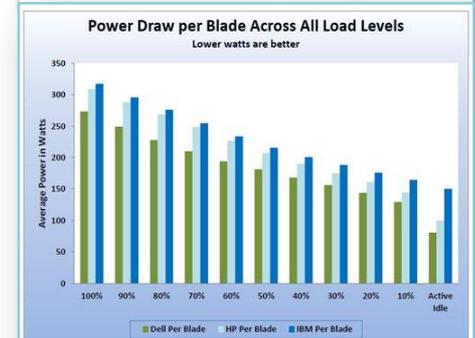
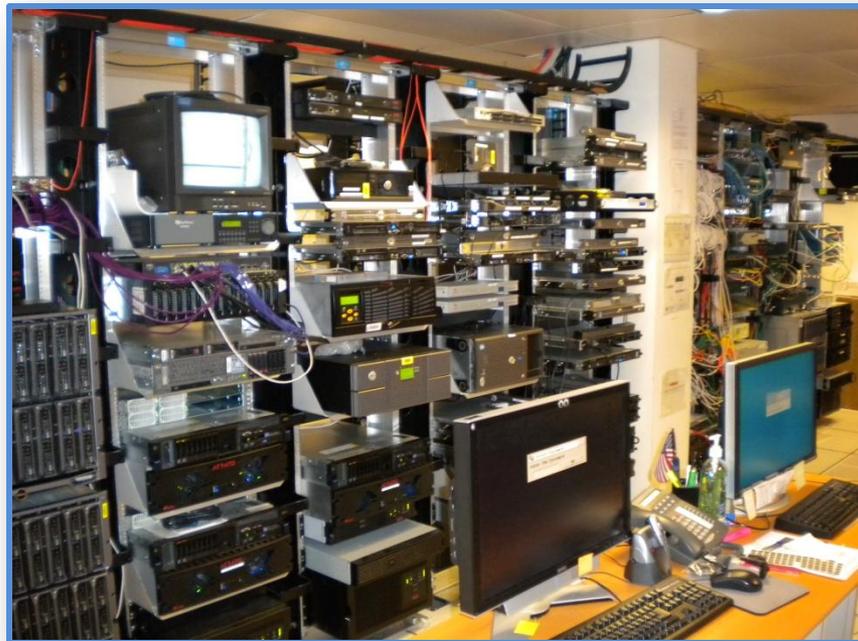


Figure 7. Comparison of the Power Utilization on a per Blade Basis



Challenges for Golden

- Data center in a building built in 1975 (36 years old)
- Open 2 post rack systems
- Not ideal for energy efficiency



Data center Upgrades

Immediate Upgrades

- Replace power distribution units
- Add battery backup capability
- Energy efficient cooling

Future Upgrades

- Free cooling – Air Side Economizer – Colorado cold air
- Thermal containment – Heat exhausted to central heating system for the building

Power Reduction Strategies

- Free cooling – 8 months of cold weather/ evenings in the summer around 50-60 degrees
- Shutdown cooling units entirely during this time
- Humidity- Controlled by simple evaporative cooling on battery backup system with humidistat

Expected return is a PUE of 1.01 to 1.05

A significant reduction in carbon footprint by reducing data center energy consumption while boosting ambient heating for the building thereby reducing building energy consumption

Better Power Management

State of the art APC Uninterruptible Power Supplies

- 97% Energy Efficient
- Scalable
- In-Row chilling
- APC Infrastruxure energy monitoring software



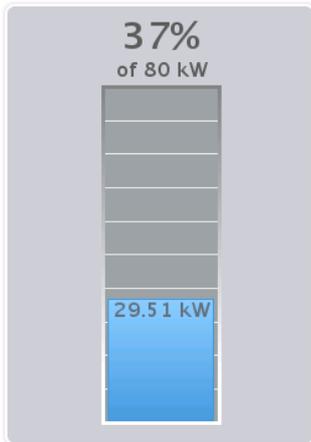
Golden Data Center PUE

InfraStruxure Energy Efficiency Dashboard

Current PUE

Historical PUE

Subsystem Cost



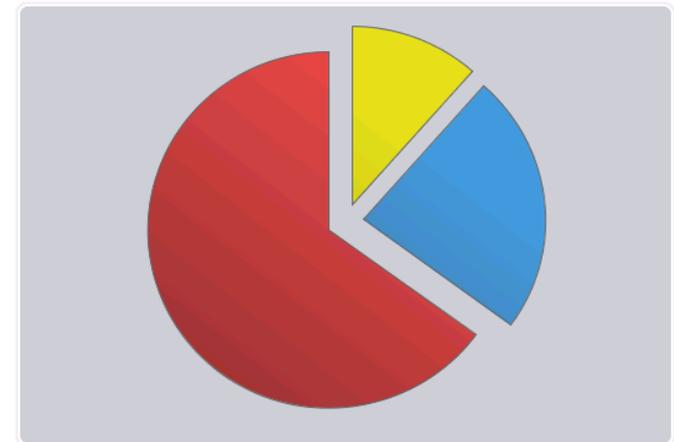
Your Current Capacity Utilization

The IT load is expressed as a percentage of the full theoretical capacity rating of the physical infrastructure.



Your Current PUE

This dial displays the infrastructure efficiency expressed as Power Usage Effectiveness (PUE). PUE is a measure which is expressed as the relationship between the total data center input power and the IT load.



Your Current Losses by Subsystem

This pie chart displays the energy consumption by the infrastructure subsystems.

- Power system 64.9%
- Cooling system 23.6%
- Auxiliary System 0.0%
- Lighting 11.5%

PUE – Power Utilization Efficiency
DCIE – Data Center Infrastructure Efficiency

DCIE = 0.9

Golden Field Office Data Center Efficiency

While the user population increased requiring a greater energy consumption, the energy consumption per user decreased by 39.73%

Golden Field Office grows with ARRA responsibilities

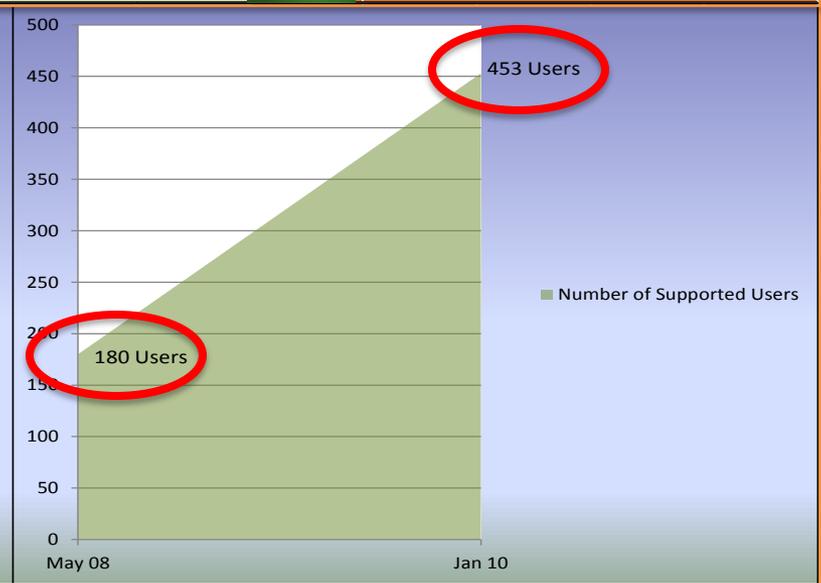
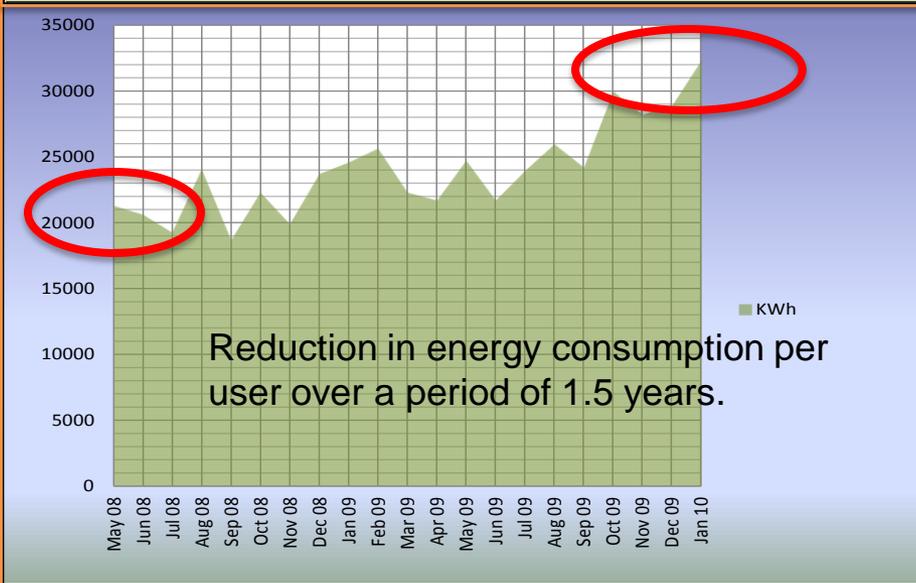
- **Challenges**
 - Reducing energy consumption
 - Scaling out resources quickly
 - Minimizing administrative overhead on IT staff



Golden Field Office - Building 15 Data Center



Golden Field Office uses 100% Renewable Wind Powered Energy



Energy Consumption by Type at the Golden Field Office

Golden standard desktop in 2008

Based on 222 Users

18 users

Dell D610 Laptop – 72 watts

204 Users

Dell Optiplex 280 – 185 watts

Dell 19" Monitor – 56 watts

227.48 watts per user average



Golden standard desktop in 2011

Based on 500 Users

Dell 6400e Laptop – 27.2 watts

60 Users

Dell Optiplex 745 – 70.8 watts

110 Users

Dell 22" LED Monitor – 12 watts

WYSE Thin Client w/Monitor
24 watts

330 Users

29.42 watts per user average



Greenhouse Gas Equivalencies Before Desktop & Server Virtualization

2008 Before Virtualization Started at Golden Field Office - 227.48 Watts Per User		
125 People	Total Office Occupation	
Desktops & Laptops		
The sum of the greenhouse gas emissions is	5.6 Tons	of Carbon Dioxide Equivalent.
Annual Equivalency Results		TONS
Annual greenhouse gas emissions from passenger vehicles ?	1	
CO2 emissions from gallons of gasoline consumed ?	573	
CO2 emissions from barrels of oil consumed ?	11.9	
CO2 emissions from tanker trucks' worth of gasoline ?	0.067	
CO2 emissions from the electricity use of homes for one year ?	0.62	
CO2 emissions from the energy use of homes for one year ?	0.434	
Carbon sequestered by tree seedlings grown for 10 years ?	131	
Carbon sequestered annually by acres of pine or fir forests ?	1.1	
Carbon sequestered annually by acres of forest preserved from deforestation ?	0.051	
CO2 emissions from propane cylinders used for home barbeques ?	213	
CO2 emissions from burning railcars' worth of coal ?	0.028	
Greenhouse gas emissions avoided by recycling tons of waste instead of sending it to the landfill ?	1.8	
Annual CO2 emissions of coal fired power plants ?	0	

GREENHOUSE GAS EQUIVALENCIES

5.6 Metric Tons
Produced
Annually

Greenhouse Gas Equivalencies After Desktop & Server Virtualization

2010 After Virtualization Started at Golden Field Office - 29.42 Watts Per User	
500 People Total Office Occupation	
Thin Clients/Virtual Machines	
The sum of the greenhouse gas emissions is	2.6 Tons of Carbon Dioxide Equivalent.
Annual Equivalency Results	TONS
Annual greenhouse gas emissions from passenger vehicles ?	0.518
CO2 emissions from gallons of gasoline consumed ?	296
CO2 emissions from barrels of oil consumed ?	6.1
CO2 emissions from tanker trucks' worth of gasoline ?	0.035
CO2 emissions from the electricity use of homes for one year ?	0.321
CO2 emissions from the energy use of homes for one year ?	0.225
Carbon sequestered by tree seedlings grown for 10 years ?	67.8
Carbon sequestered annually by acres of pine or fir forests ?	0.563
Carbon sequestered annually by acres of forest preserved from deforestation ?	0.026
CO2 emissions from propane cylinders used for home barbeques ?	110
CO2 emissions from burning railcars' worth of coal ?	0.014
Greenhouse gas emissions avoided by recycling tons of waste instead of sending it to the landfill ?	0.921
Annual CO2 emissions of coal fired power plants ?	0

GREENHOUSE GAS EQUIVALENCIES

5.6 Metric Tons
Reduced To
2.6 Metric Tons

A savings of
**3.0 Metric
Tons Annually**

Golden Field Office Data Center Consolidations

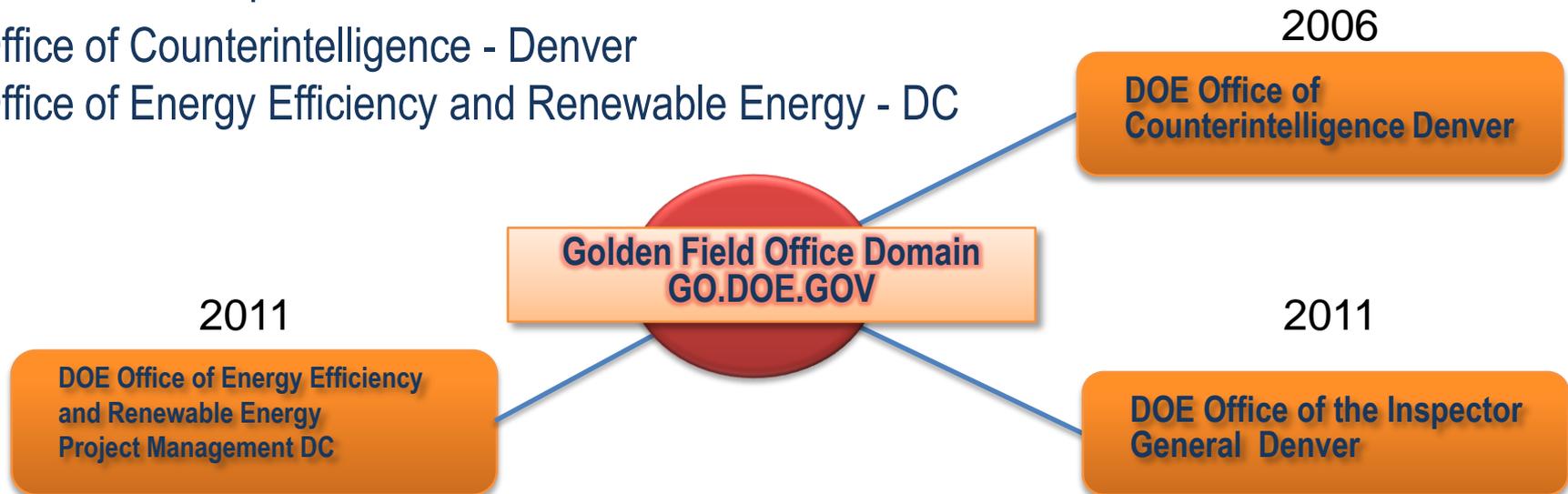
The Golden Field Office network domain currently supports 3 offices:

Golden Field Office

Office of the Inspector General – Denver

Office of Counterintelligence - Denver

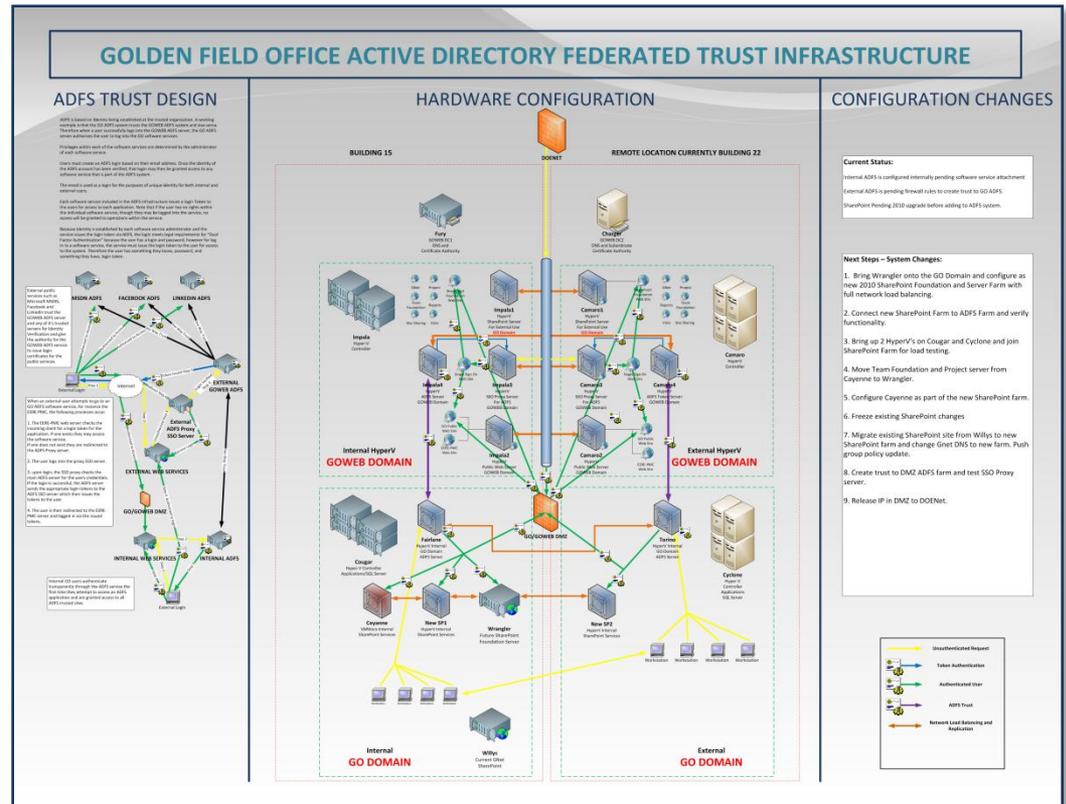
Office of Energy Efficiency and Renewable Energy - DC



Reducing Complexity and Continuing to Innovate

Private Cloud Opportunities

- Configuration and change Management practices
- Critical Design Reviews
- Identifying Opportunities
 - Local
 - DOE
 - Federal
 - Industry



Currently working with Gartner on deployment strategies

Golden's Private Collaboration Cloud

