



# **History, Status and Future Plans for the Energy Team**

**Energy Security and Resiliency  
Fort Knox, KY**

**FEMP Symposium Presentation  
17 Feb 2021**



# FORT KNOX ENERGY INITIATIVES BRIEF



## Fort Knox, Kentucky

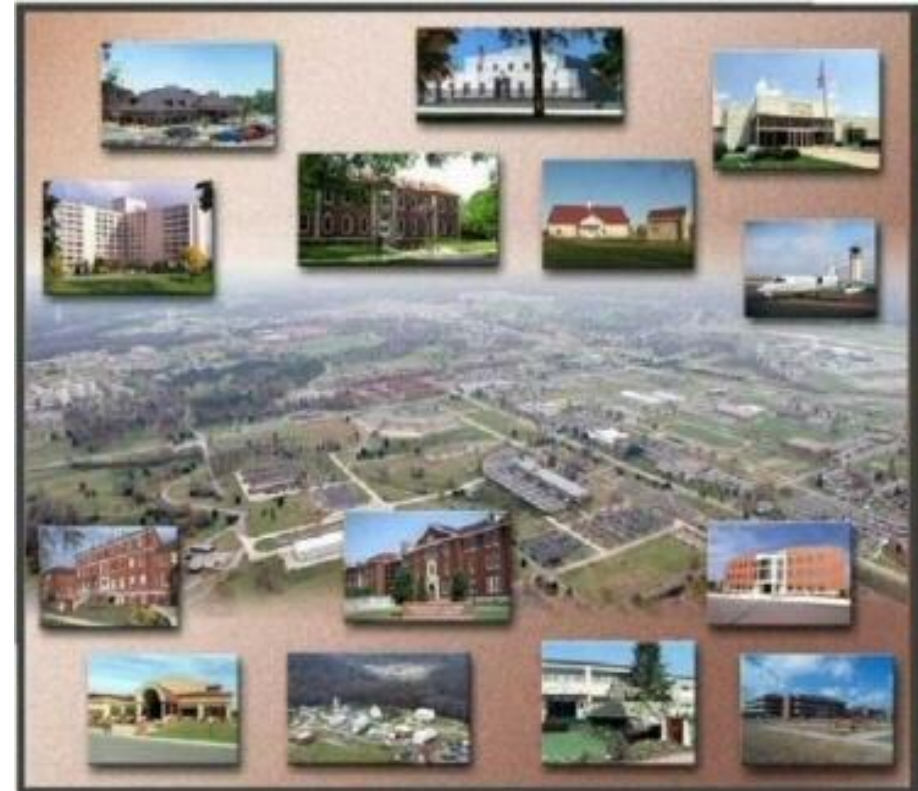
6<sup>th</sup> largest city in Kentucky

- 109,000 acres
- 20,000+ Soldiers & 8,600 civilians
- 17,264,000 ft<sup>2</sup> of building space
- Hospital/Clinic, Classroom, barracks, 900SF HRC, Airfield, Post Office, PX, Commissary
- Retail/Shopping, MWR Venues
- 61 Training Ranges, Mess Halls
- Day Care Program and DoD Schools

Home for 6- Army 2 Star Commands  
And New 3 star Command V-Corp



Cadet Command, Human  
Resources Command, 1<sup>st</sup> Theater  
Sustainment Command, Recruiting  
Command, 84<sup>th</sup> Training Command,  
1<sup>st</sup> Army East Div. Command



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# FORT KNOX ENERGY INITIATIVES



- Ice Storm January 2009 cripples Fort Knox
- Military installations told to develop 90 day emergency plan
- Army Directive 2020-03 requests at least 14 days of energy Independence
- Goal to achieve Energy, Water and Waste Independence !!

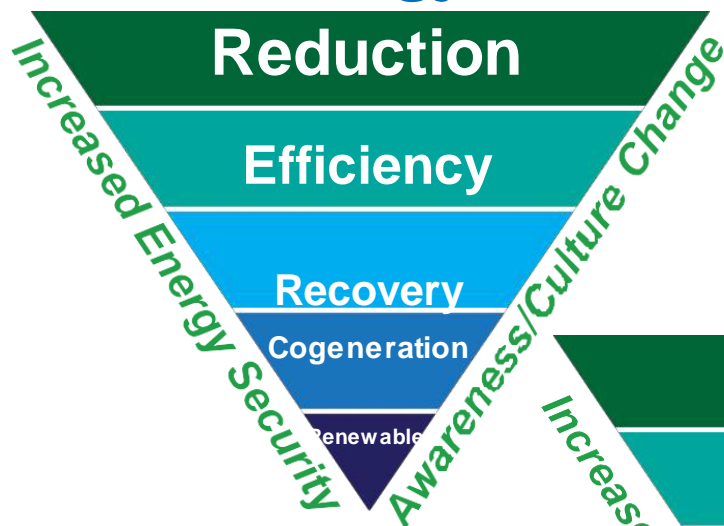


# Fort Knox Energy Program Initiatives - Brief

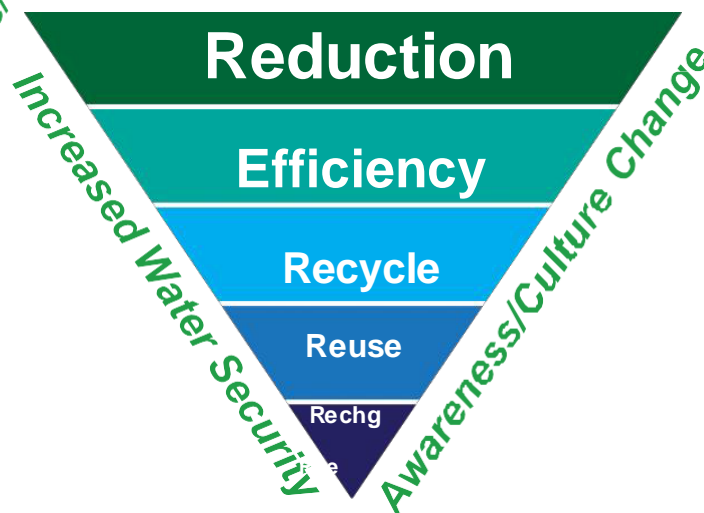


## The Army's path Forward to NET ZERO

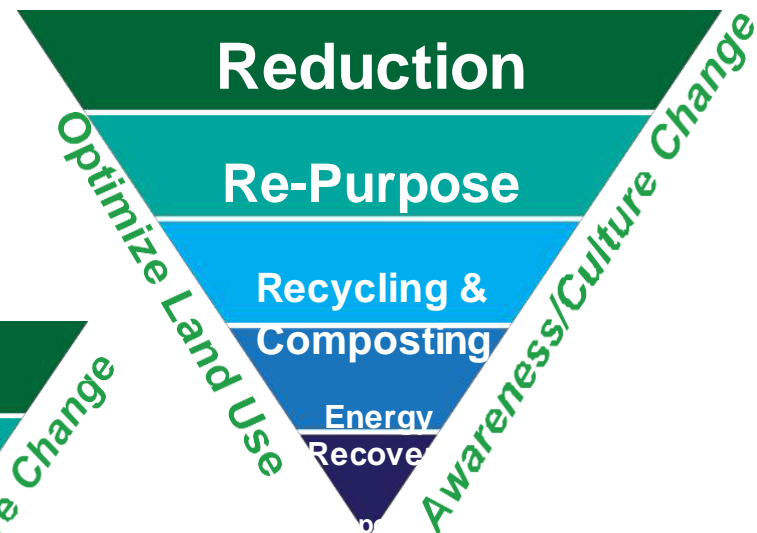
### *Energy*



### *Water*



### *WASTE*







## Energy Reduction Mandate

- Energy Policy Act (EPACT)
  - In 1992 the Clinton Administration passed the Energy Policy Act
  - Newest Executive Order 13834, 17 May 2018, sets a path for efficient federal operations
- Fort Knox energy conservation program started in the 1970s
  - Multiple diverse programs at Ft Knox to meet Energy Independence goals per Army Directive 2020-03 calls for Energy Independence





# Fort Knox Energy Program

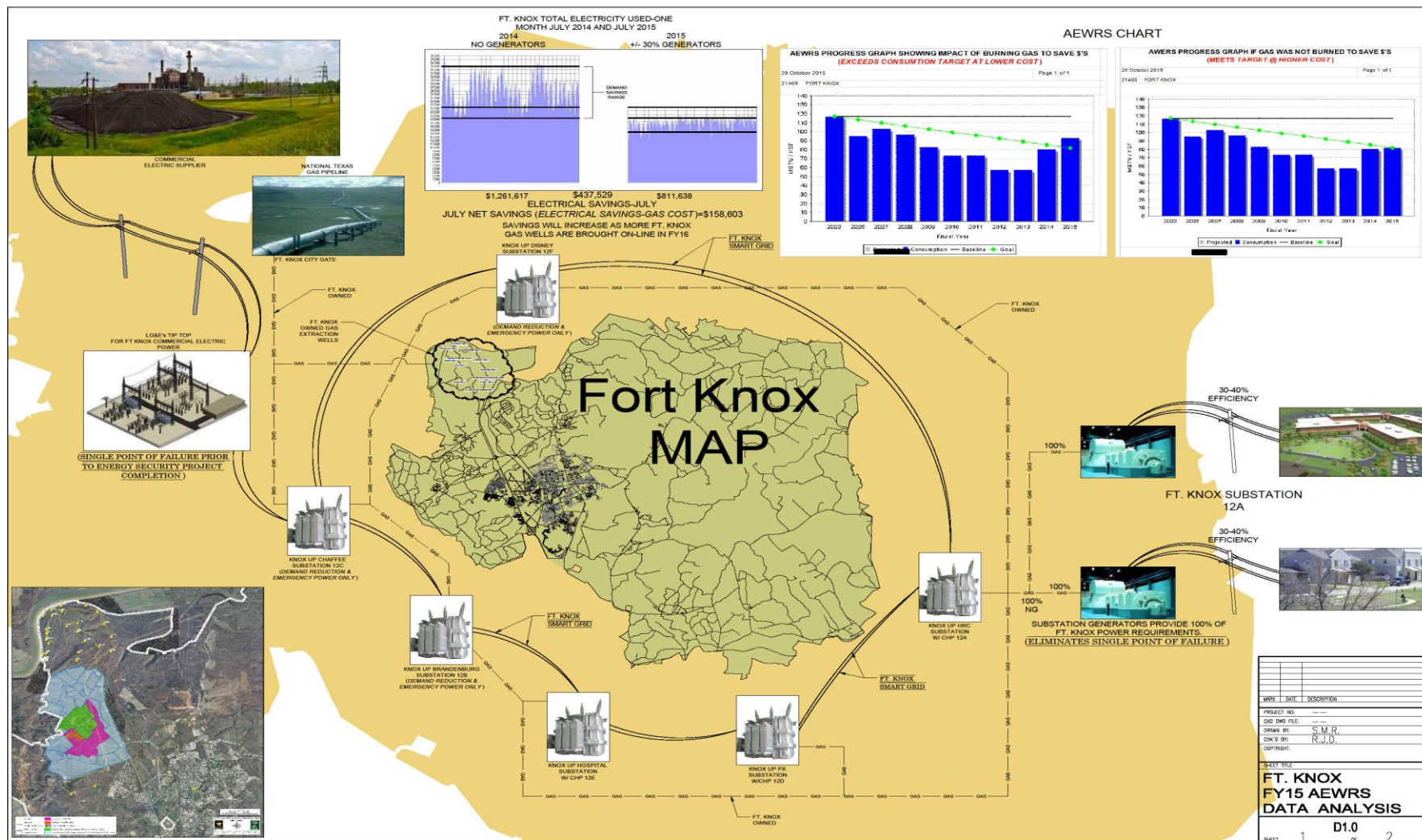
- Decentralized Power Generation
- Peak Shaving and Appropriate Tariff and Contract, “Time of Day” Rate
- Demand Management via “Smart Grid” Controls
- Direct Connection to the National Natural Gas Pipeline,
- Geothermal Heat Pumps
- Monitoring/Controls, Education
- LED lighting
- Envelope Improvements
- Fort Knox Methane Gas Wells



# FORT KNOX ENERGY INITIATIVES



## Last 5 year's of reaction to the "ICE" storm





# **Fort Knox Energy Program**

## **Details of the Road taken**

### **UESC ( Utility Energy Savings Contract – 117 Task Orders)**

Geothermal HVAC, controls, envelopes, 1<sup>st</sup> new generation of lights

### **UP ( Utility Privatization)**

Solar Array, Decentralized Power Generation w/ CHP, Fiber Optic ring,  
Smart Grid, wind street LED lighting

### **Innovative Ideas (ECIP, QUTM.....)**

Geothermal pond, Smart Meters, Net Zero House

### **ESPC (Energy Saving Performance Contract - 8 ECM)**

LED Interior and Exterior Lighting, HVAC scheduling, water

### **ESPC - HRC Video Link – before and after**

<https://www.youtube.com/watch?v=CxNH7m0cdfw>





# **Fort Knox Energy Program**

## **Details of the Road forward**

### **UP ( Utility Privatization)**

Substation for Voltage Increase

### **Innovative Ideas (ERCIP, EEWC, WECR)**

Fuel Cells

### **Gas Storage**

**Show the Money !!! This strictly driven as the price of Natural Gas goes up**



# Current Energy Resiliency in Place

**20 MW** New Diesel Emergency Generation – Substation Level

**16 MW** New Natural Gas Lean Burn Peak Shaving Generation

**8 MW** New CHP Generation

**44 MW** New Emergency Power Generation plus existing emergency power generation exceeds post needs

## Future Plans

**Convert in coming primary power form 34.5 KV to 69 KV**

- Cost \$8M, minimum annual savings \$800K

**Add a 2<sup>nd</sup> redundant gas line for the National transmission line**

- Cost \$8M

**Add 5 - 4 MW Natural Gas Fuel cells at 2 different Substations**

- Cost \$25M

**Develop our own Natural gas underground Storage –Costs Unknown**

**Expand our existing Natural Gas well field – Current and future gas costs dependent Costs per well about \$200K/ well need 40-60 wells**



# FORT KNOX ENERGY INITIATIVES



## Maude Complex Geothermal Pond

**The Geo Pond supplies cold water to one of 6 Army Enterprise Data Centers. Saving more than \$10K/month in HVAC costs**





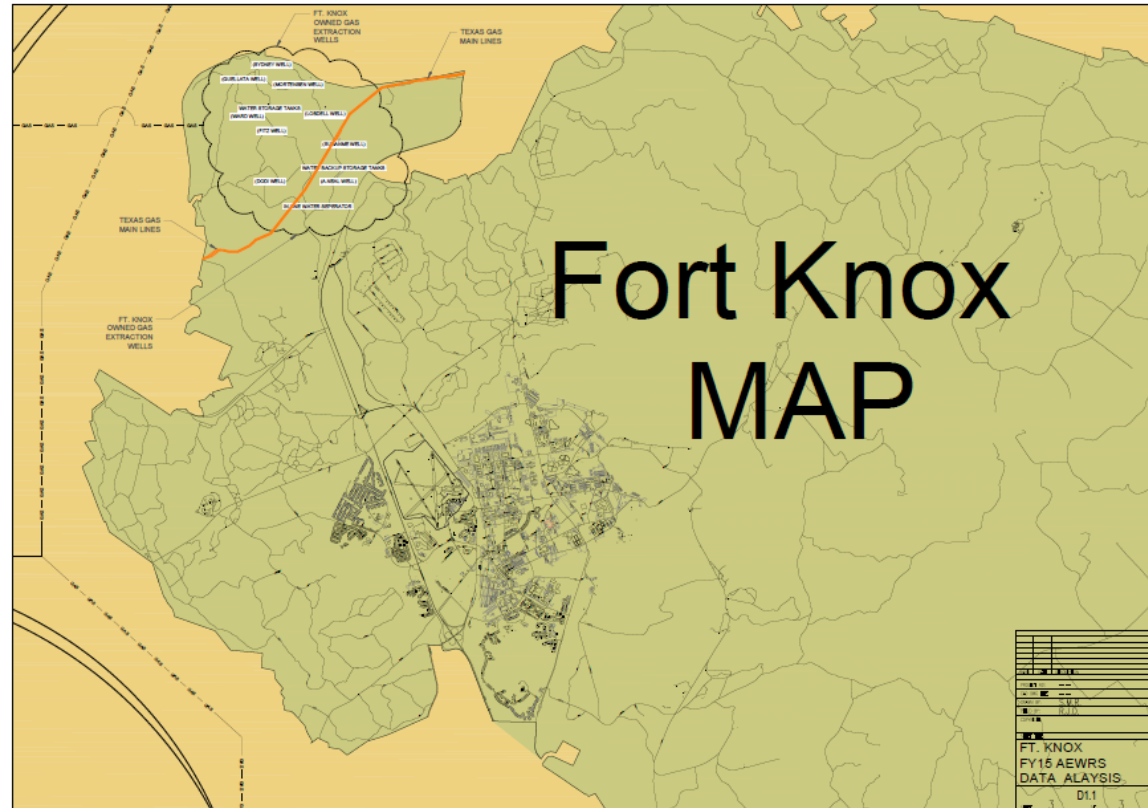
## FORT KNOX ENERGY INITIATIVES



# National Pipeline on Fort Knox

**Texas Gas National pipeline shown in red: 2 – 42” pipes, one running north and the other running south from the Henry Hub in south to the New England area. Extremely high Pressure, Fort Knox has a “City Gate” on that pipeline, just like the local utilities**

**This pipeline serves Fort Knox for either its primary gas when the price of pipeline gas is cheap or it is a backup gas when pipeline gas is expensive. When the pipeline gas is expensive, the Fort Knox wells shown in white are operating in the primary gas service role.**

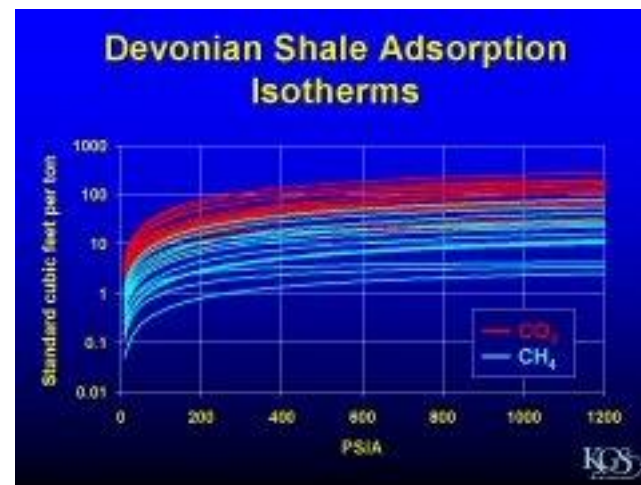






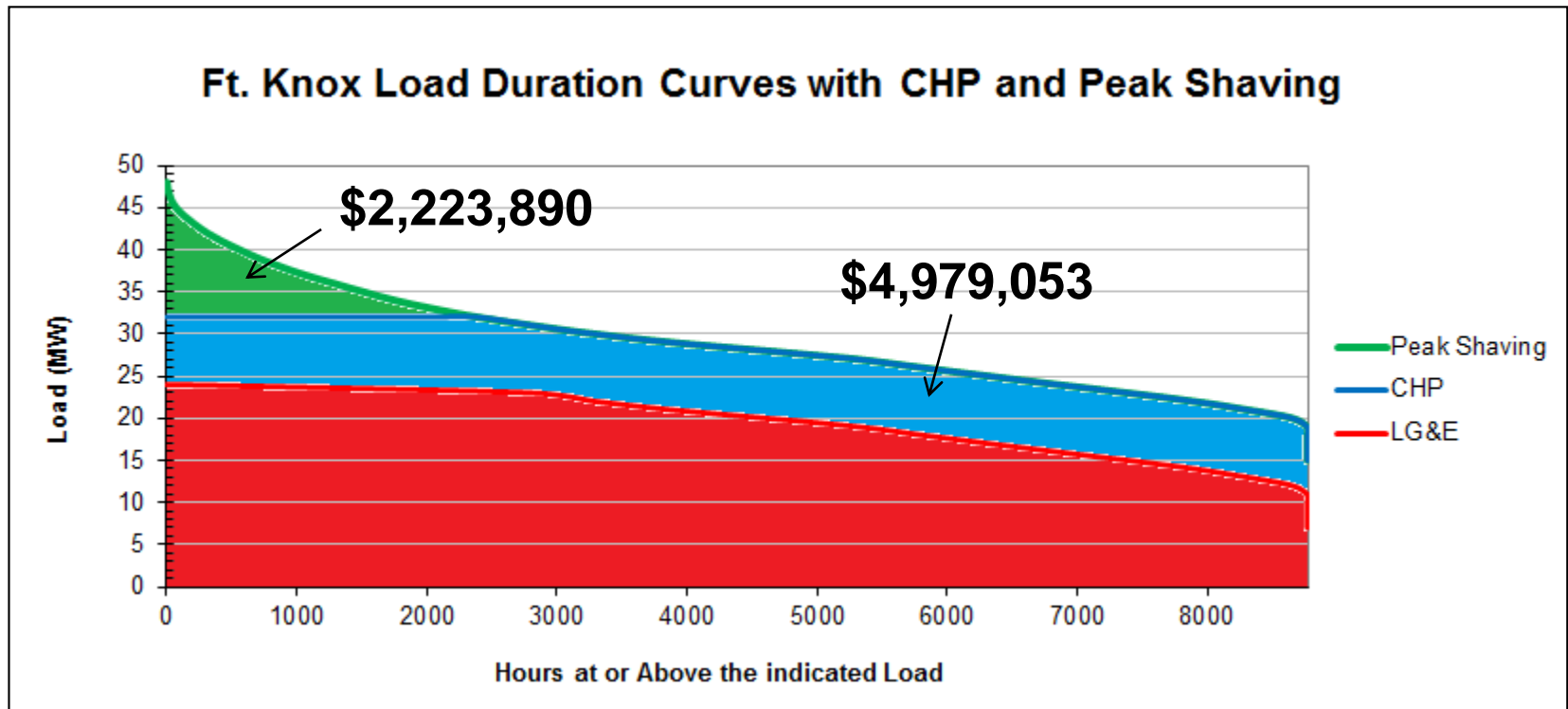
# Renewable Methane Gas

- Drill renewable energy from below Fort Knox that is trapped within the Devonian Shale.
- Entire project conceived and accomplished at no cost to the Army.
- Gas production began in January 2009
  - Government saves transportation and marketing fees.
- Provides enough gas for entire summertime load. (without electrical Generation).
- It also provides on-site back up for the Texas Gas National Pipeline gas





## Optimizing Purchased Power FY 2010 data shown



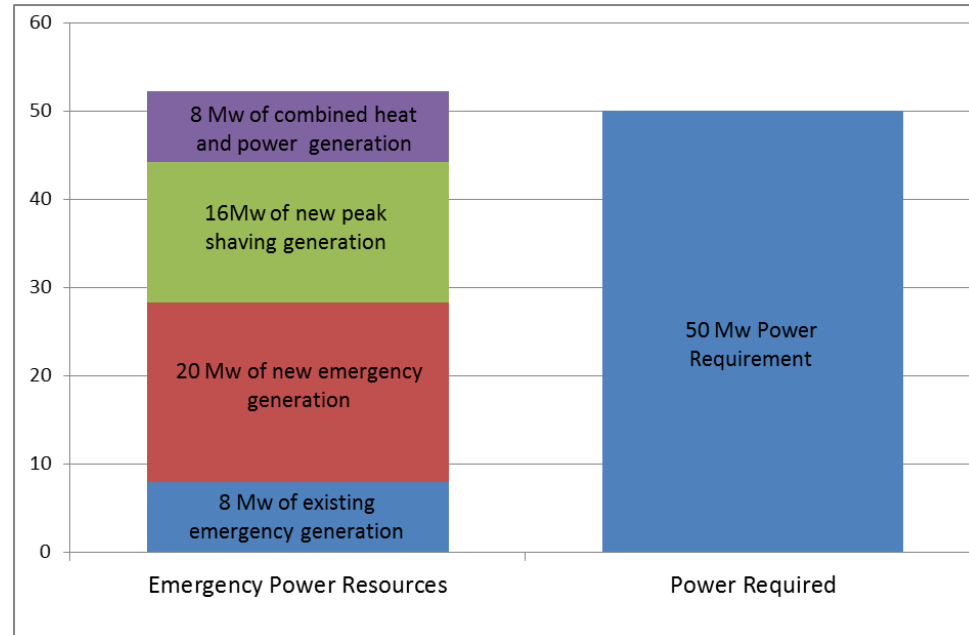


# FORT KNOX ENERGY INITIATIVES



## The Start to become Energy Independent

- 44MW of new power generation
  - Distributed to 6 sites across 5 substation locations for greater security and reduced losses.
  - Integrated at the 7,200 volt distribution lines in the event of a power interruption.
  - Reciprocating ( Natural gas and Diesel) engine technology.
  - New 44MW+ existing power generation for HRC and IACH exceeds the installation's need
  - Incremental step forward for Energy, Water and Waste Independence.





# The way to pay for the project

- Peak Demand Shaving ( the Green Part )
  - Maximum load peak shaving of 16MW.
  - Lean burn lowest emission reciprocating engine technology.
  - Economic dispatch model will determine the most economic level of power production, consider NG prices, weather, ratchet effects.
  - Peak monthly demand at LG&E billing meter will be managed to achieve the lowest cost of delivered power by eliminating the most expensive power.
  - Lowest run hours performed by peak shaving, while CHP systems utilize continuous duty cycle.





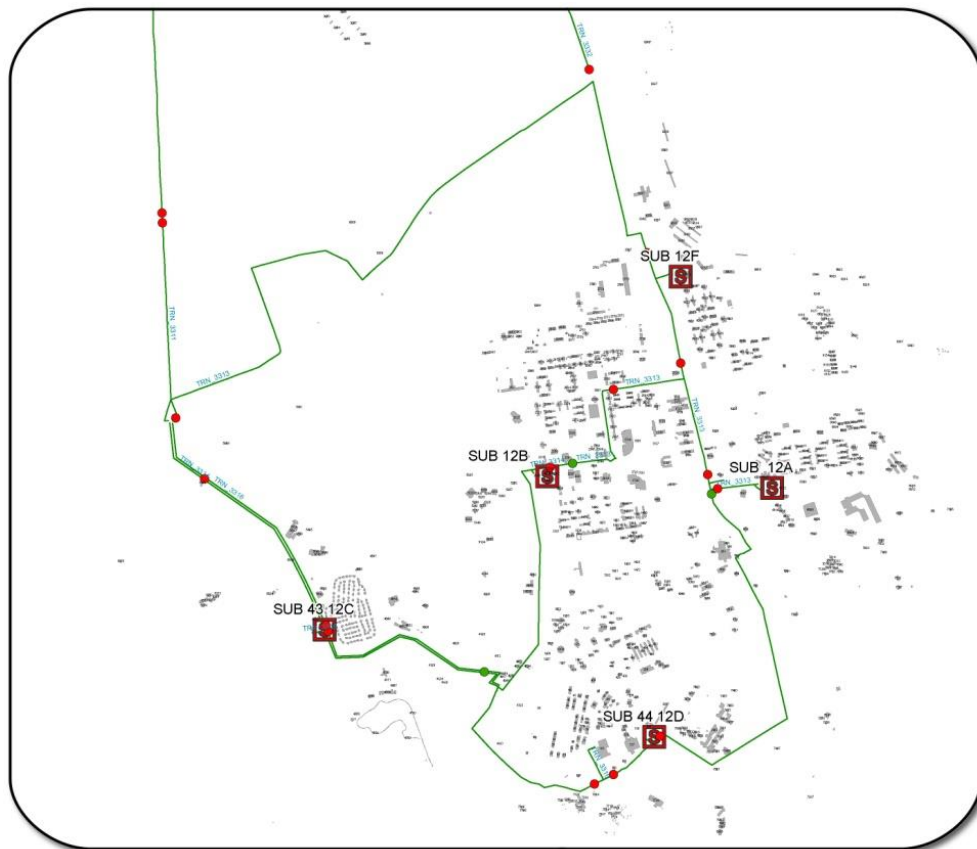
# The next step after Decentralized Power Generation

- Combined Heat & Power (CHP – The Blue Part )
  - Minimum 8MW capacity sized to address thermal loads
  - Lean burn lowest emission reciprocating engine technology
  - Reduces the LG&E peak/base demand by 8MW
  - Over 90% efficiency strategy for power generation
  - Multiple configurations of heating, cooling, and domestic hot water ( boilers, absorption chillers or whatever is needed)
  - Potential for future “bolt-on” renewables such as biofuels, fuel cells or what ever comes next.



## Energy Security Power Generation Sites

- The electrical power for the post is delivered in three different transmission voltages
  - LG&E 138K V transmission power
  - LG&E 34.5K V for the distribution ring
  - Fort Knox 7,200 V for the primary feeders to the building level transformers
  - New generation installed on 7,200 V circuits, hopefully soon to upgrade to 69K V
  - Tied it all together with a Micro Grid





# New Power Generation Facilities







# FORT KNOX ENERGY INITIATIVES



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# FORT KNOX ENERGY INITIATIVES



## New Power Generation Facilities



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# Peak Demand Reduction Strategies Operational since May 2015

Current Peak Demand	48 MW
Combined Heat and Power Reductions	-1 MW
Building Automation Demand Reductions	<u>-1 MW</u>
2012 Peak Demand	46 MW

### Normal Peak Operating Conditions

LG&E	22 MW
Combined Heat and Power	8 MW
Peak Shaving	<u>16 MW</u>
Total	46 MW





# Resiliency-Emergency Operations

- 1<sup>st</sup> on natural gas power generation
- 2<sup>nd</sup> on diesel power generation
  - 20,000 Gallons stored at each substation
- Central diesel storage
- Under extended emergency outages, government personnel will dispatch fuel as required
- Dual fuel and substation switching can facilitate multiple modes of operation
- Complete backup control center located on & off post





# FORT KNOX ENERGY INITIATIVES

## "OFF THE GRID"

### UTILITY SECURITY



**Central Water Plant**



**Production Capacity: 10,500 Kgal /day**  
**Summer Avg. Daily Usage: 2,300 Kgal /day**  
**Storage Capacity: 5,100 Kgal /day**

**Waste Water Treatment Plant**



**Natural Gas Compression**



**Production Capacity: 1,000 Mcf /day**  
**Summer Peak Demand: 700 Mcf day**  
**Winter Peak Demand: 2,500 Mcf day**

**Energy Security Project**



**2.1 Megawatt Solar Array**



**Daily Baseline Power Generation:**

**14 MW**

**Additional Local Utility Power Reduction Due To Cogeneration:**

**2 MW**

**Peak Power Generation To Reduce Demand Charge:**

**16 MW**

**Peak Demand Last 12 Months:**

**38.2 MW**





# FORT KNOX ENERGY INITIATIVES

## AWARD Winning ESPC Effort





# FORT KNOX ENERGY INITIATIVES

## AWARD Winning ESPC Effort (Con't)



### About the Project

In 2019, ESPC Contractor completed installation of \$26 million of infrastructure upgrades financed via an Energy Savings Performance Contract at Fort Knox. Fort Knox is a large Army base in Kentucky whose core missions include cadet training and military personnel management. The project won four awards through the Department of Energy Better Buildings Initiative, including best use of lighting controls and highest percentage of annual savings for the lighting retrofit portion of the project.

### Key Challenges:

- **Low utility rates:** The blended cost of electricity at the site was only \$0.06 per kWh; natural gas cost \$0.27 per therm; and the site did not pay for water.
- **Recent large-scale upgrades:** The site had recently completed over \$250 million in energy upgrades through 108 separate Utility Energy Service Contract task orders.
- **Aggressive schedule:** Detailed audits and analysis of almost 500 buildings (~10 million square feet) needed to be completed within six months.

### The ESPC Contractor Solution:

In its search for cost-effective upgrades, applied an analytics-based approach to analyze data on the operation and energy consumption of tens of thousands of pieces of equipment. This analysis of millions of data points allowed the contractor to identify 16 cost-effective energy and water conservation opportunities, including the following:

- HVAC and control upgrades in 201 buildings
- Domestic water upgrades in 438 buildings
- Interior LED lighting upgrades of over 50,000 fixtures in 133 buildings
- Exterior LED lighting upgrades in 147 buildings
- Data center upgrades at one of the Army's enduring data centers



# FORT KNOX ENERGY INITIATIVES

## AWARD Winning ESPC Effort - Results



### RESULTS:

- 20% reduction in grid electricity usage
- 30 billion Btu per year in natural gas savings
- 50 million gallons of water savings annually
- Reduced O&M costs
- Improved occupant comfort
- Annual cost savings of \$2.3 million
- International recognition from DOE DOA and IES

### FINANCIAL

Project Cost:

\$26,400,000

### PROJECTED SAVINGS:

**\$66,109,138**

Simple Payback:

11.5 Years



## FORT KNOX ENERGY INITIATIVES



# U.S. Army Fort Knox ESPC Phase II Airfield



estimated annual savings: \$56,395







## FORT KNOX ENERGY INITIATIVES



To Sum it all up

With some very low quality acting and highly under paid and poorly dressed, I present to you the Army's only Energy Independ installation

**Fort Knox**

youtube video on Fort Knox  
Energy



# FORT KNOX ENERGY INITIATIVES

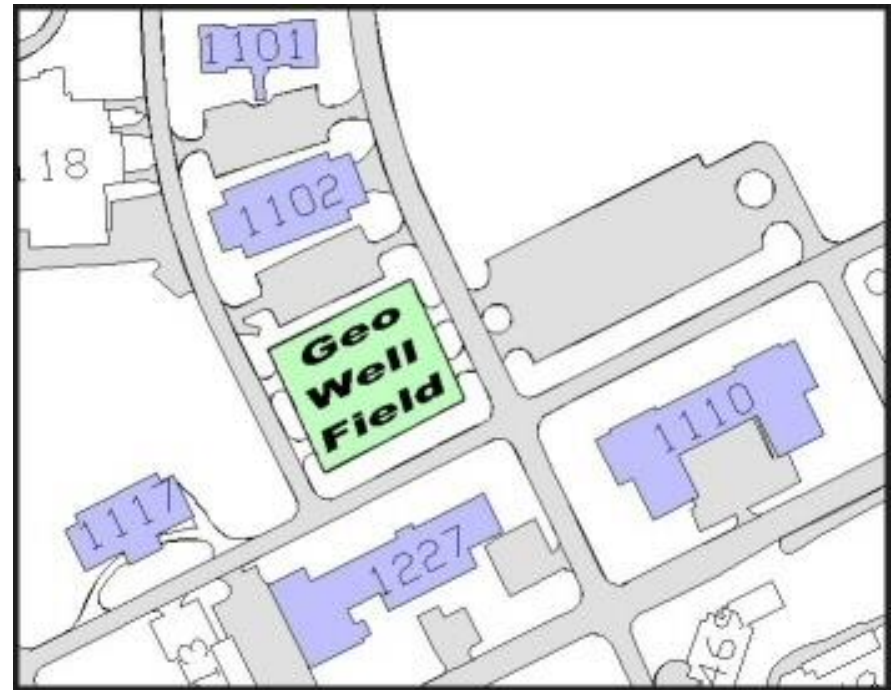


- BACK UP SLIDES !!!!



# Geothermal (Ground Coupled) Well Field

- Consolidated Well Fields
  - Provides heating, cooling, and domestic hot water
  - Maximizes building diversity
  - Minimizes construction expenses
- Project won Secretary of the Army Energy and Water Management Award in 2009
- Bldg #1110 won an Energy Star Rating for 2008

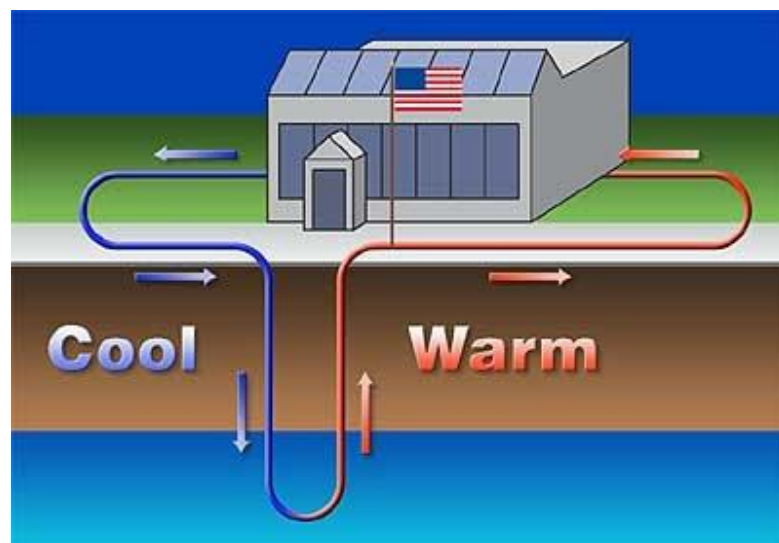




# Ground Coupled Heat Pumps

### Facts:

- ~6+ million ft<sup>2</sup> of “eligible” 12 million ft<sup>2</sup> heated and cooled from constant earth temperature
- ~6000 wells (500 ft deep) to couple with the earth temp of 57°F
- ~900+ miles of underground piping
- HVAC-automation with more than 550 smart meters for gas, water and electric.







## FORT KNOX ENERGY INITIATIVES BRIEF



# Lighting Improvements

*On our way to becoming a total LED city*

- Improve low lighting conditions while saving energy
- Provide on-demand lighting through use of occupancy sensors
- Harvest natural light when applicable
- LED street lighting on timers and motion sensors





## 2.1 MegaWatt Solar Array

- Electrical Privatization Contractor, constructed a 2.1 MW Solar Array on post. Began operation July 2013
- Financing the project over 25 years. Fort Knox will pay a fixed rate comparable to our blended electric rate.
- This green renewable power will supplant electricity generated by our coal-fired power plants. The rate we pay for this solar power is extremely cheap for green power.
- This will support EPACT 2005 mandate of >7.5% renewable energy by 2013
- The Solar Array is on a 10 acre parcel
- As of Dec 2017, we are \$29K in the black as compared to purchase reg. electricity
- Fort Knox has an additional 1.56 MW of solar power installed at various locations on post.





# Program Results

- Decreased energy consumption
  - Total energy consumption decreased 35% from 2003 baseline
  - Over 50 buildings that are Energy Star certified.
- Annually saves Fort Knox over \$15+ million due to energy initiatives
- Decreased pollutants
  - Geothermal systems have greatly reduced number of boilers
- Fort Knox has been recognized as a leader within the Army and local community for their energy efficiency practices
- Improved indoor air quality
  - Providing the correct amount of ventilation
  - More comfortable and productive working conditions
  - Significant component to mold elimination
  - No more of that 15 April, you get A/C and 15 Oct you get heat – whether or not you need heating or air conditioning.





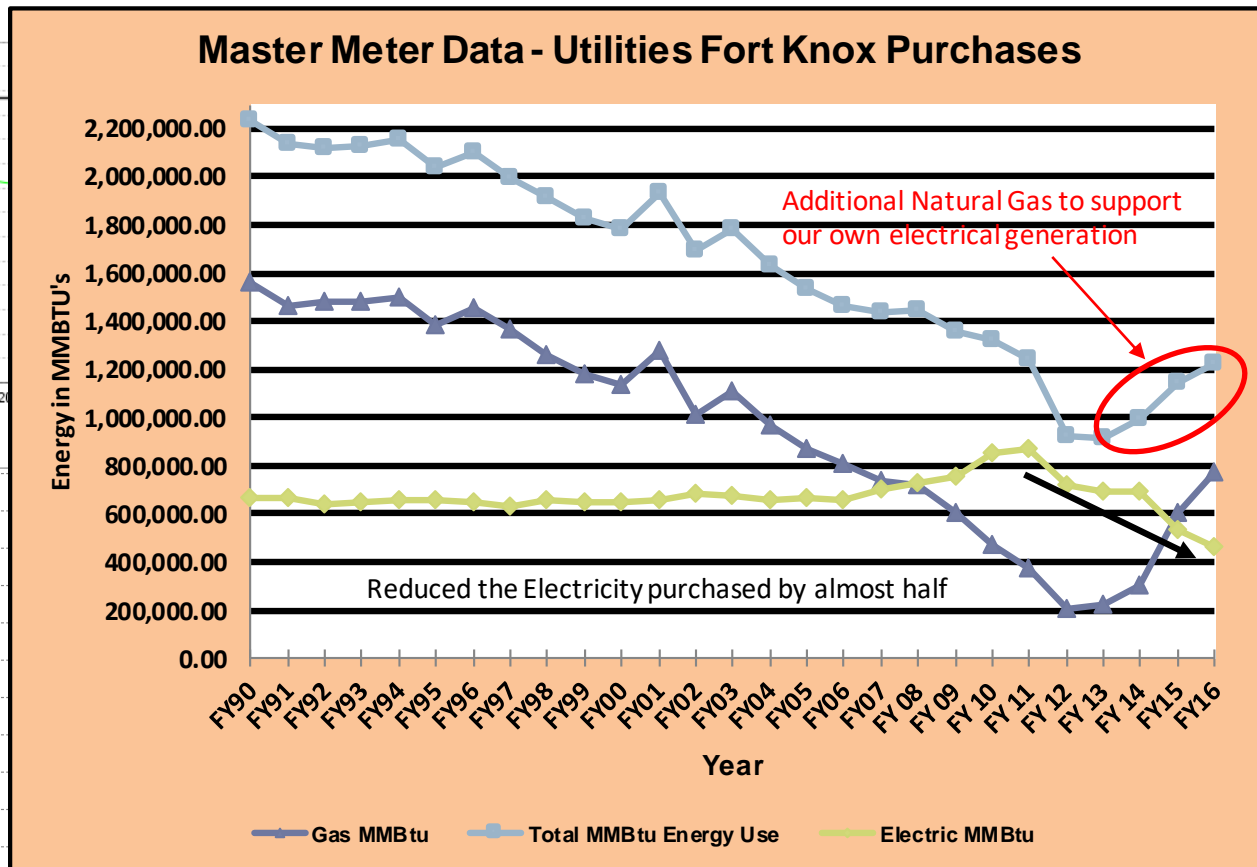
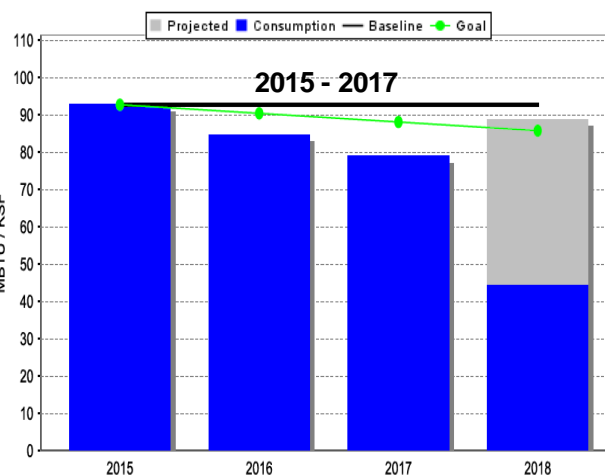
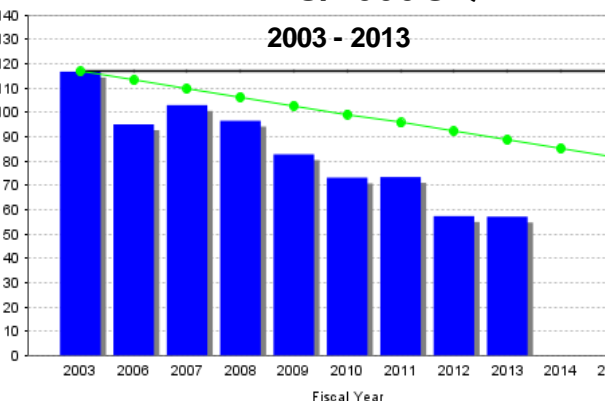


# FORT KNOX ENERGY INITIATIVES



\* Energy reduction of > 57% since 1992

## How our buildings are preforming In MMBTU/1000 SQ FT



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# Next Steps?

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**8 MW** New CHP Generation

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