



Enhance Facility Energy Management at Naval Expeditionary Base Camp Lemonnier, Djibouti

12 May 2011

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 12 MAY 2011		2. REPORT TYPE		3. DATES COVERED 00-00-2011 to 00-00-2011	
4. TITLE AND SUBTITLE Enhance Facility Energy Management at Naval Expeditionary Base Camp Lemonnier, Djibouti				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Facilities Engineering Command ,1322 Patterson Ave. SE, Suite 1000 ,Washington Navy Yard,DC,20374-5065				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES Presented at the NDIA Environment, Energy Security & Sustainability (E2S2) Symposium & Exhibition held 9-12 May 2011 in New Orleans, LA.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 36	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

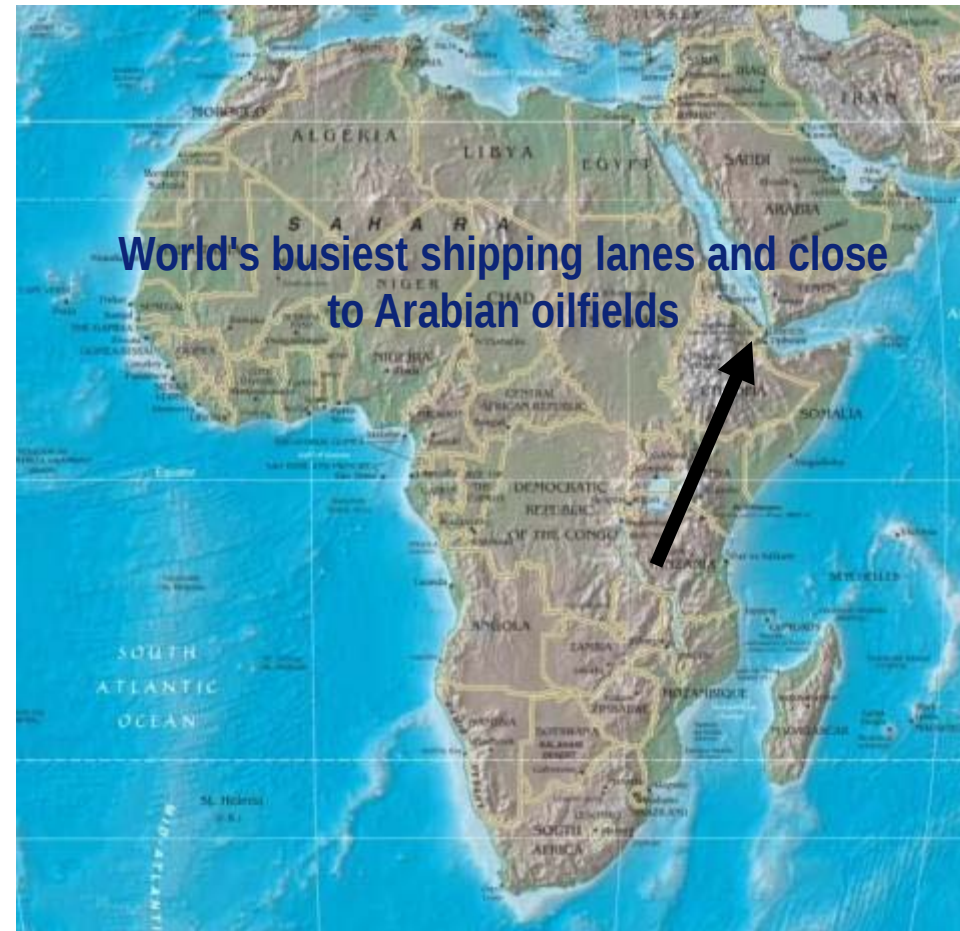
Camp Lemonnier, Djibouti



U.S. Africa Command COMBINED JOINT TASK FORCE–HORN OF AFRICA

Mission: Conduct operations in the East Africa region to build partner nation capacity in order to promote regional security and stability, prevent conflict, and protect US and coalition interests.

World's busiest shipping lanes and close to Arabian oilfields



Camp Lemonnier, Djibouti



- NAVFAC Engineering Service Center - Technical Report, TR-2339-EN



TECHNICAL REPORT TR-2339-ENV

CAMP LEMONNIER DJIBOUTI AFRICA ENERGY AND ENVIRONMENTAL SUSTAINABILITY PROJECT FINAL REPORT FOR TASKS 1C, 2A, 2B and 2C

ATTACHMENT A

Prepared by
Bruce Holden
Brian Quil
Kathryn Rydberg
Robert Schoff
Vern Norstrom

August 2010

Distribution authorized to U.S. Government agencies and their contractors, (Administrative/Operational Use). Other requests for this document shall be referred to the NAVFAC Engineering Service Center.

Attachment A

Camp Lemonnier Djibouti

Containerized Living Unit Heating Ventilation & Air Conditioning Assessment

Robert Schoff
NAVFAC Engineering Service Center
Port Hueneme, CA

Distribution authorized to U.S. Government agencies and their contractors, (Administrative/Operational Use). Other requests for this document shall be referred to the NAVFAC Engineering Service Center.

Camp Lemonnier, Djibouti



- **Harsh Environment**

- Average Daytime Temperature (77 to 111 °F in 2010), can reach 125 °F during the day
- High Humidity (Average Dew point was 72 °F in 2010)
- Average wind flow 8 mph (gusts up to 34 mph)

- **Personnel are Quartered in Containerized Living Units (CLUs)**

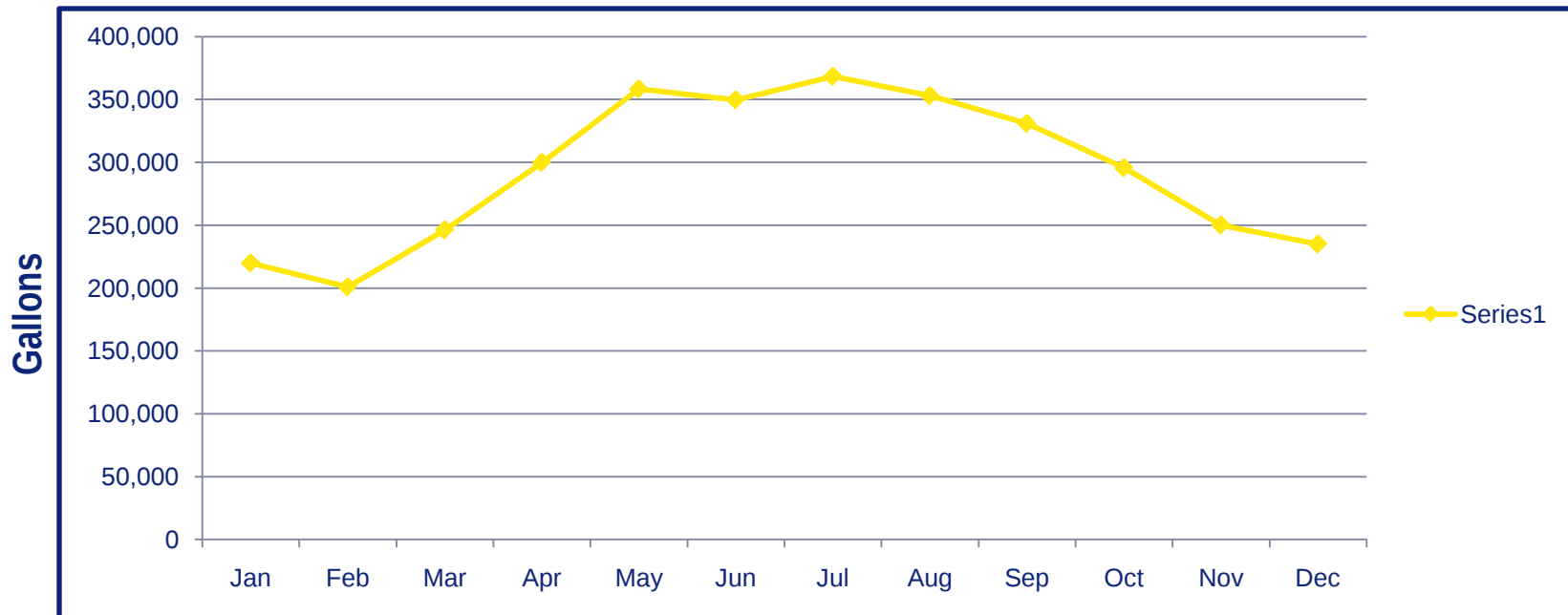
- **Increasing Population**

- Personnel at times Outnumbers available CLUs

Camp Lemonnier, Djibouti



- **Energy Production comes from Diesel Power Generators**
 - Generators run 24/7 (8 x 1.3 MW Caterpillars, 6 x 0.8 MW MUSE, 130-140 smaller generators)
 - Approximately 11,000 gallons of diesel fuel is required to run the generators daily (2010)
 - Estimated monthly cost for fuel is \$600K-1000K (\$3 per gallon)



Camp Lemonnier, Djibouti



Project Team:

- **NAVFAC Engineering Service Center**
 - Abby Goss, Katelyn Rydberg, Lance Batch, Bruce Holden, Gene Griffin, Peter Ly, Bob Schoff, Christine Ahn
- **Camp Lemonnier Public Works**
 - LT Elizabeth Durika, CPO Miguel Fernandez
- **NAVFAC-EURAFSWA**
 - Bryan Long
- **Naval Air Weapons Station China Lake**
 - Hugh Edwards, Mathew Malone
- **Idaho National Laboratory**
 - Kurt Meyers

Camp Lemonnier, Djibouti



- **Proposed Energy Conservation Methods (ECMs)**

- CLU Modification
- Wind Profiler (Sodar)
- High Efficiency Washing Machines
- Incinerator Energy Recovery
- Replace Street Lighting
- Solar Panels with Self Cleaning Equipment
- Retrofit Electric Vehicle with Solar Panels
- Solar Heater for Laundry

Camp Lemonnier, Djibouti



CLUs Current Condition



Camp Lemonnier, Djibouti



CLUs Current Condition

- Poor Air Distribution
- Large Difference in Air Temperature down length of CLU
- Oversized ACU Cycle On and Off every 3-4 Minutes



Camp Lemonnier, Djibouti



CLU Modification Constraints

- No more than 2 hours ACU down time
- No displacement of occupants
 - Work should only be done that can be completed during the day,
 - While occupants are away from CLUs,
 - Should not disrupt sleeping hours.
- Modifications should not limit CLU mobility in the camp
 - System installed needs to be able to be broken down fairly quickly

Camp Lemonnier, Djibouti



CLU Modification

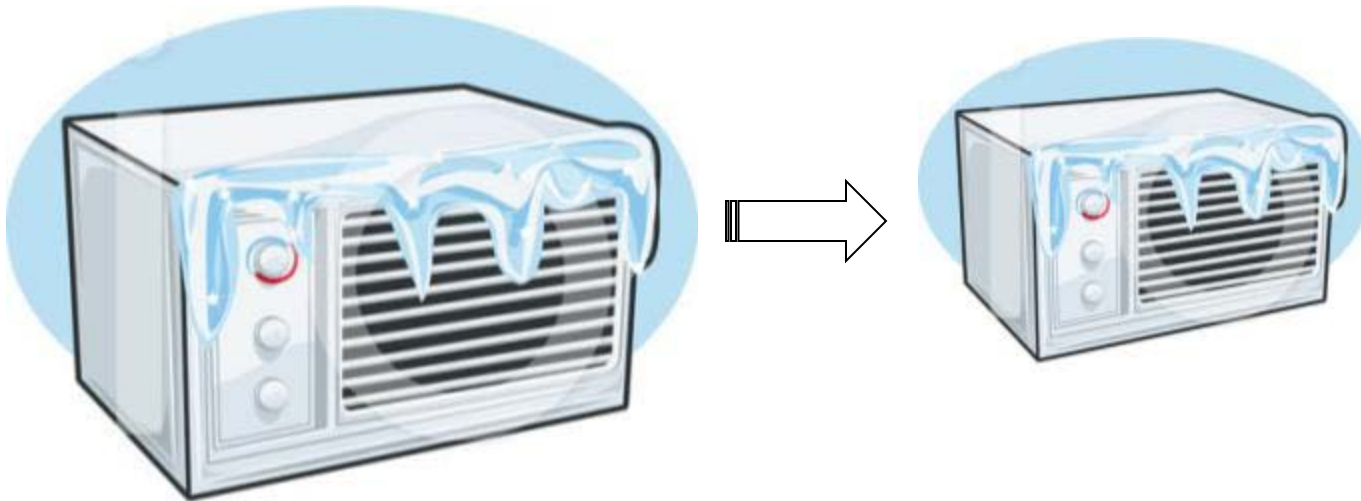
• Replace AC units

– Reduce size of ACU from 2 Ton to $\frac{3}{4}$ Ton

- Reduces Load 2 Ton (24000 BTU/H) to (9000 BTU/H) ACU
- Reduces cycling (on/off) of the compressor in the ACU

– Higher Energy Efficiency Rating (EER)

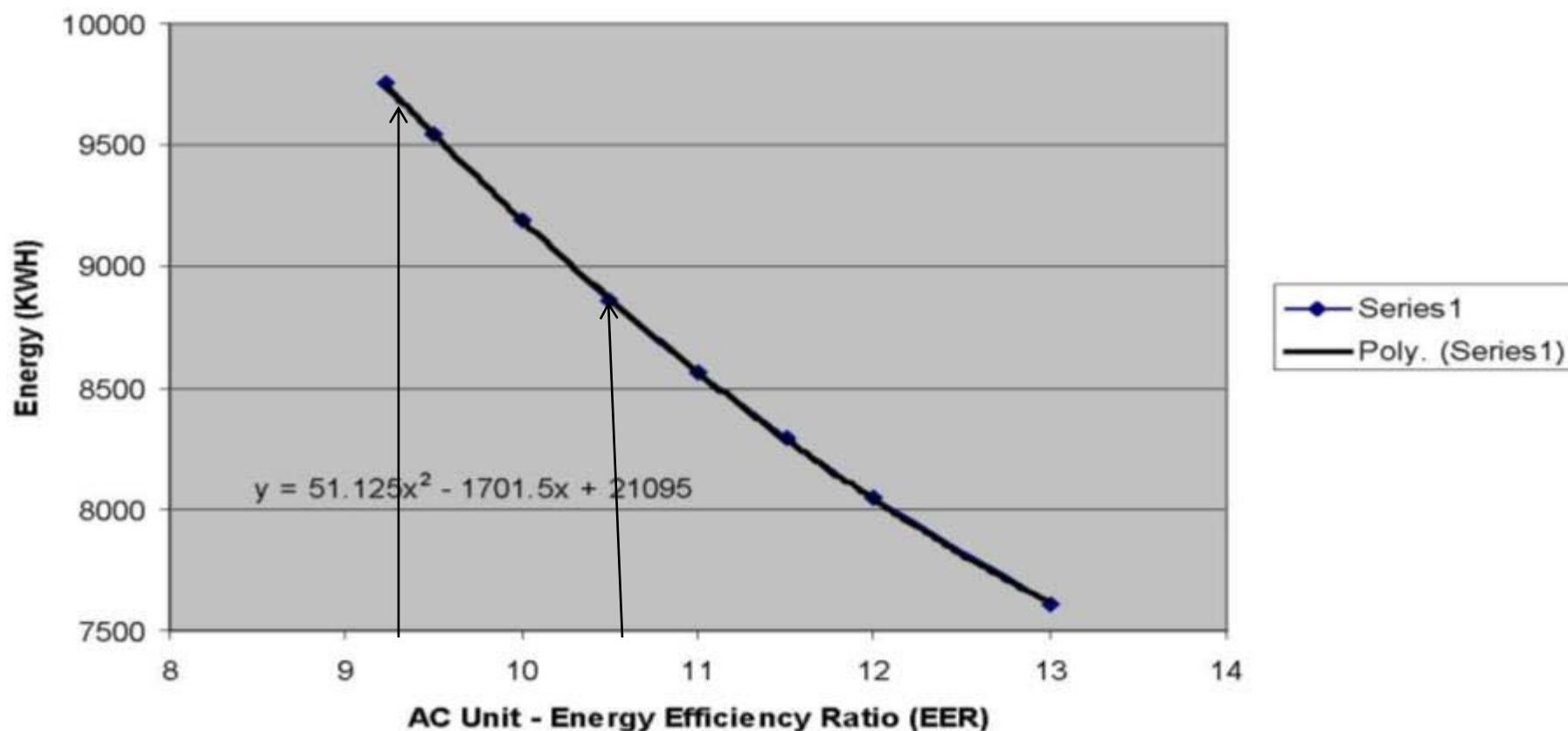
- From 9.23 EER to 10.5 EER



Camp Lemonnier, Djibouti



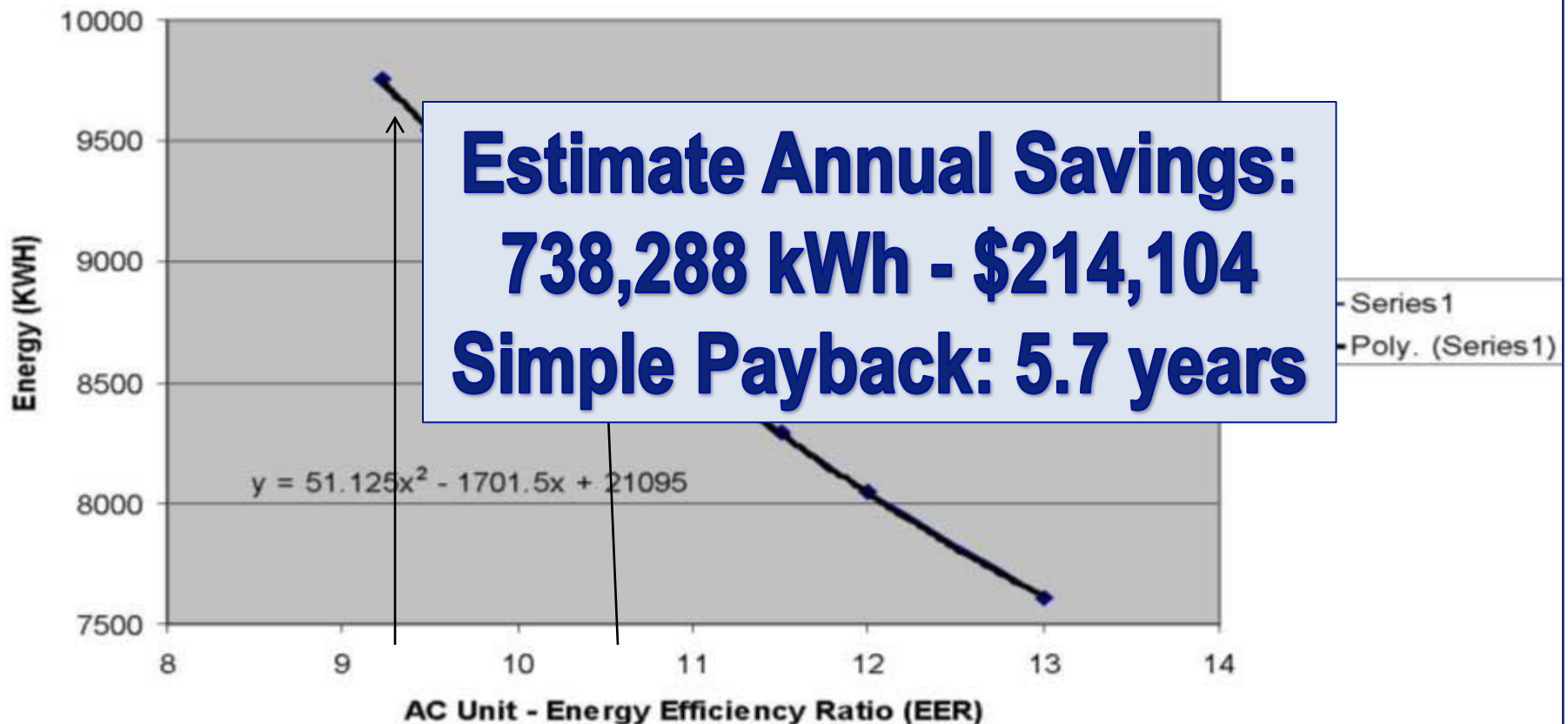
Annual KWH vs. EER
Existing CLU



Camp Lemonnier, Djibouti



Annual KWH vs. EER
Existing CLU



Camp Lemonnier, Djibouti



CLU Modification

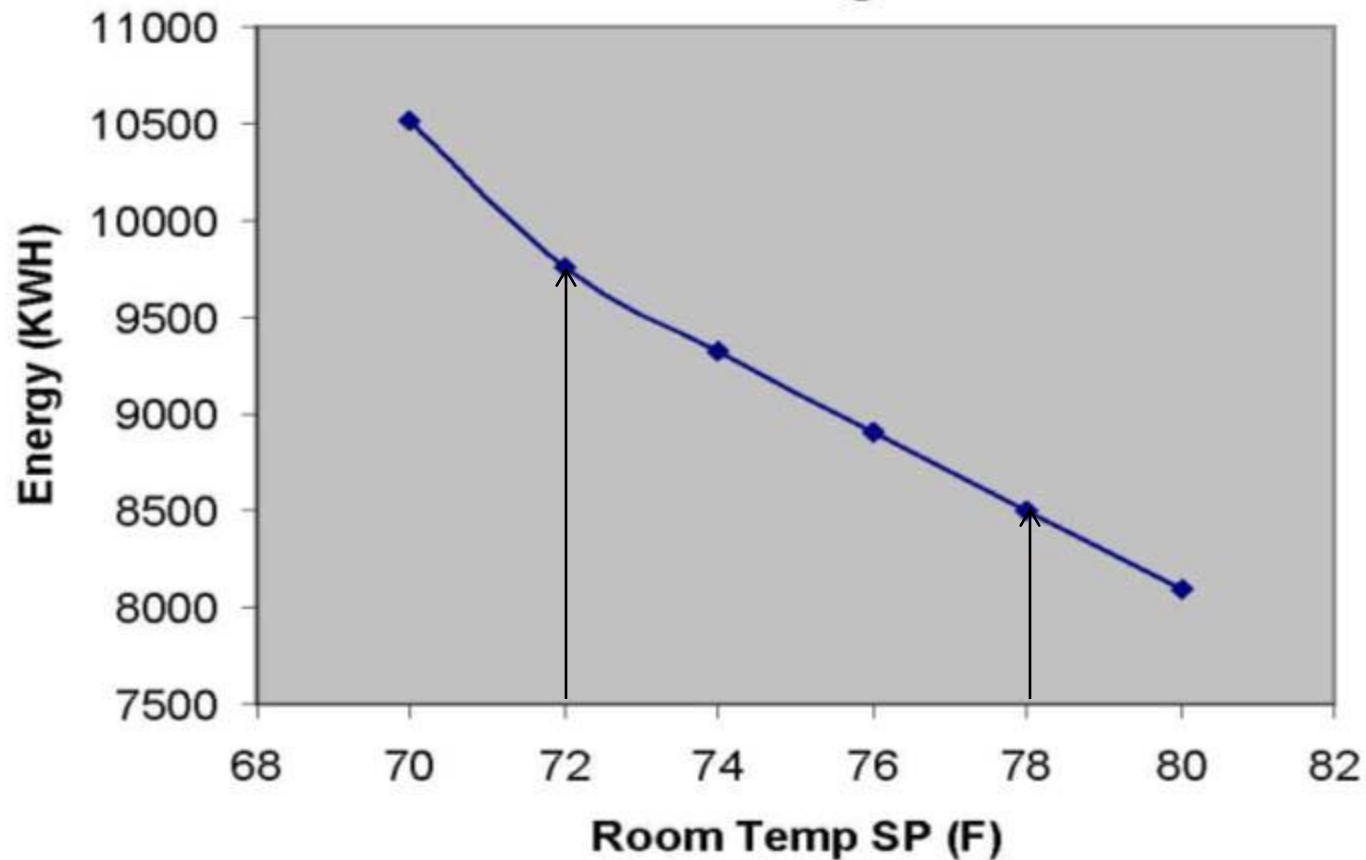
- **Raise Room Set point On ACU**
 - From 72 to 78 degrees (may have to adjust for room occupant comfort)
 - Install Thermostat



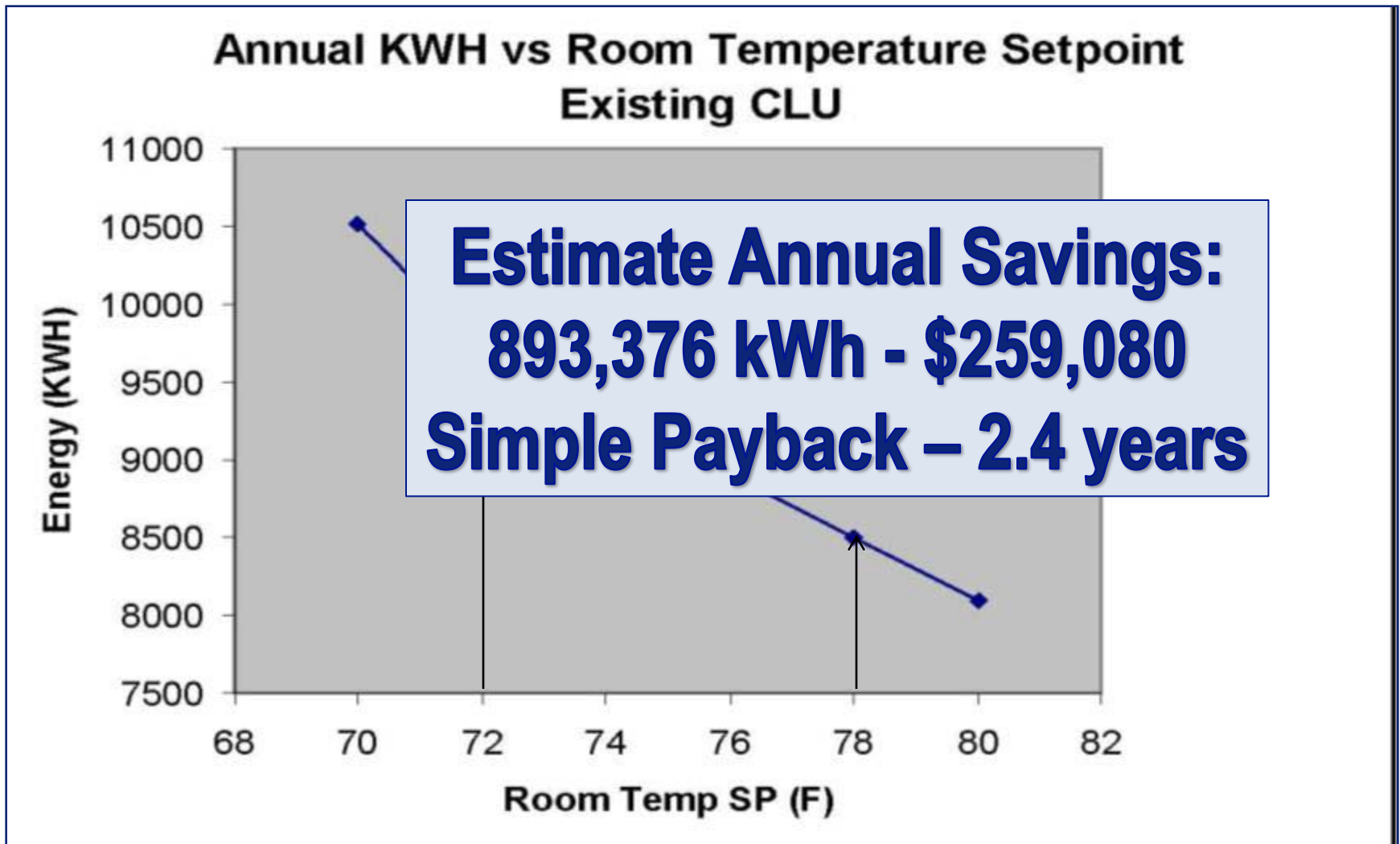
Camp Lemonnier, Djibouti



**Annual KWH vs Room Temperature Setpoint
Existing CLU**



Camp Lemonnier, Djibouti



Camp Lemonnier, Djibouti



CLU Modification

• Replace or Eliminate Exhaust Fans

– Current Exhaust Fan is 50 CFM (2 per CLU)

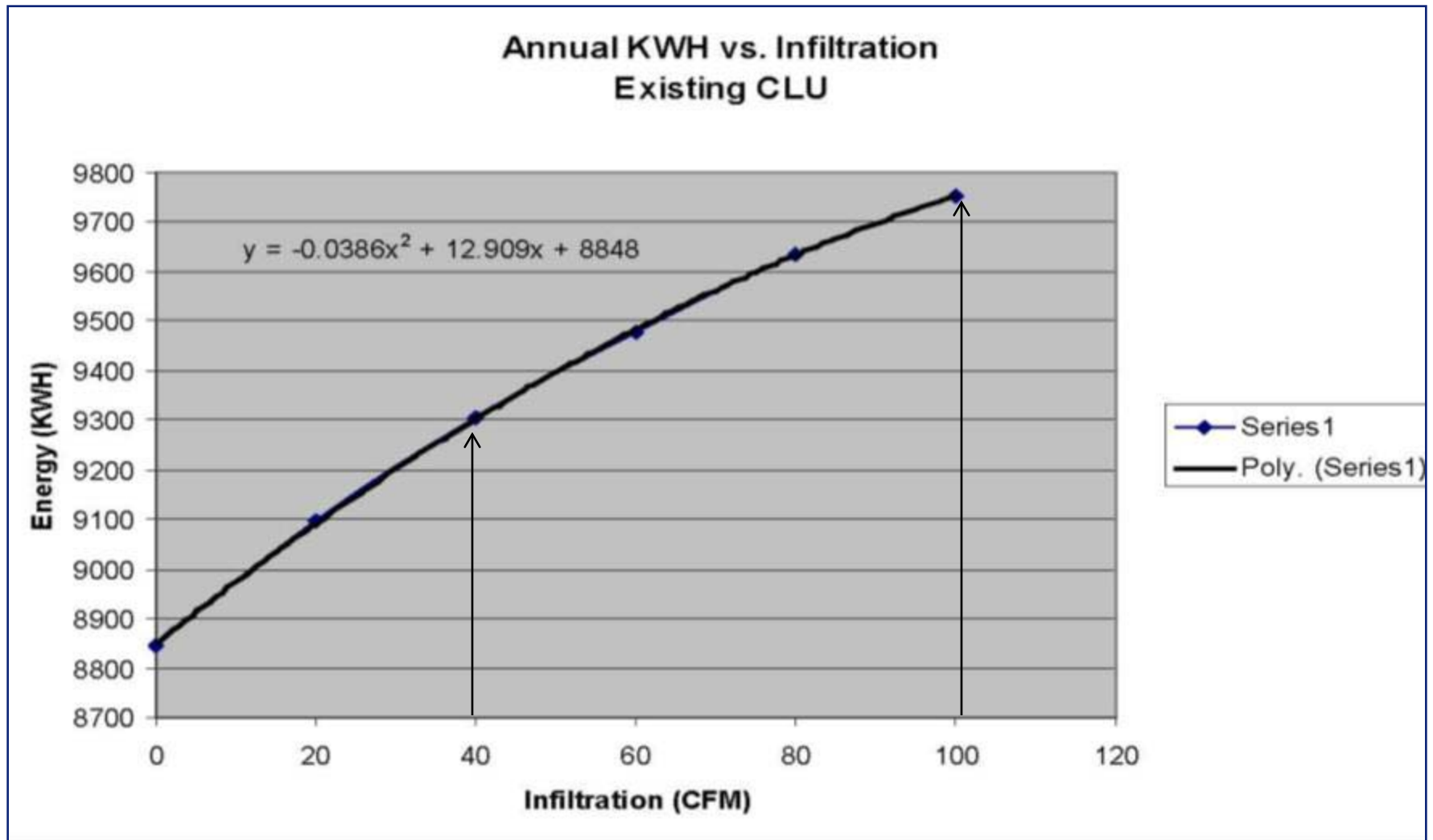
- Installed to help eliminate high relative humidity, and condensation experienced within the CLUs.

– Replace w/20 CFM model to reduce infiltration (or eliminate exhaust fan completely)

- Will reduce the amount of conditioned air that is pumped out of the room during the AC unit “off” period.



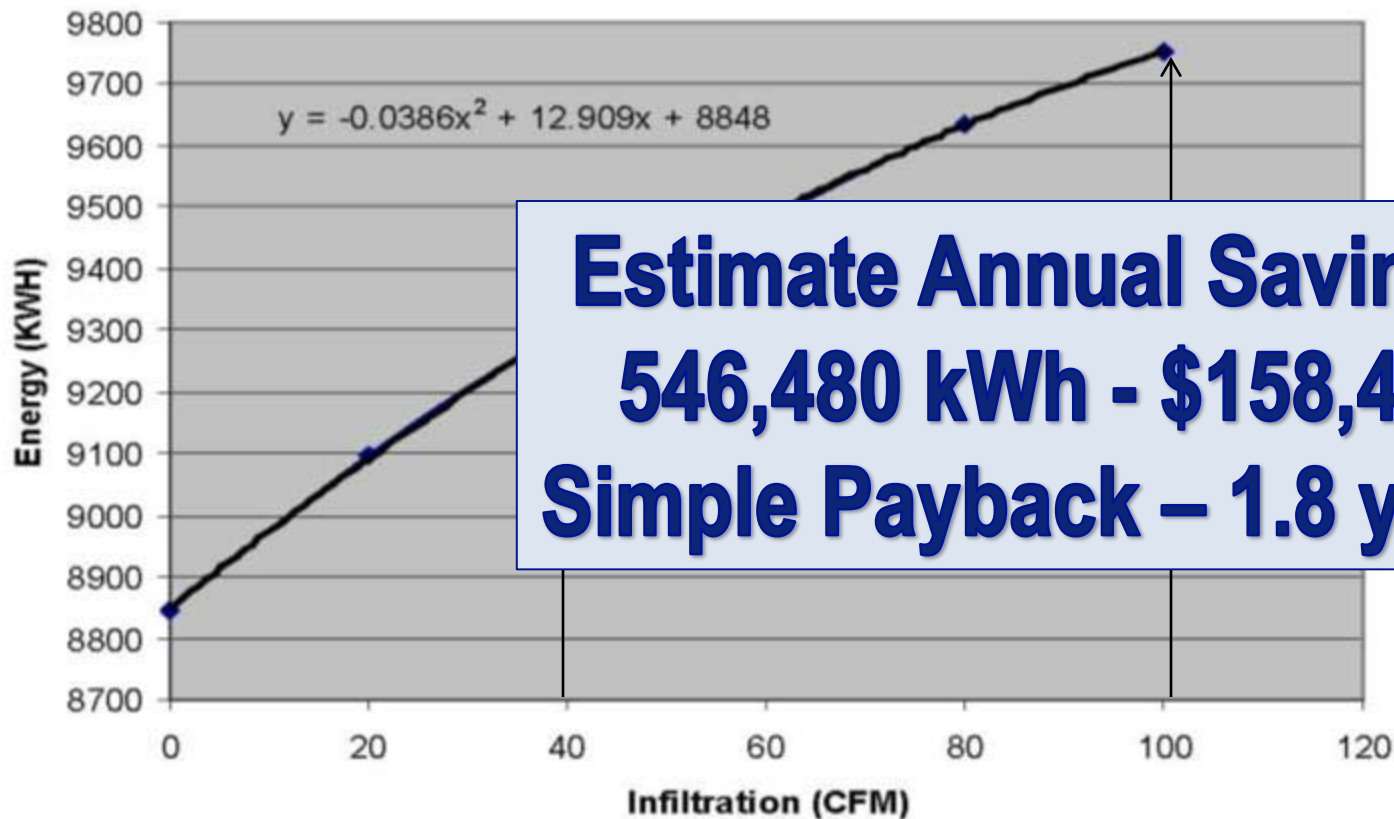
Camp Lemonnier, Djibouti



Camp Lemonnier, Djibouti



Annual KWH vs. Infiltration
Existing CLU



Estimate Annual Savings:
546,480 kWh - \$158,478
Simple Payback – 1.8 years

Camp Lemonnier, Djibouti



CLU Modification

- Apply Foam Insulation to the exterior of the CLU
 - “R” factor rating of R7 per inch of material thickness.
 - Model assumes 2” of foam is applied
 - Very high insulating properties results in a substantial reduction in building load.
 - No moving parts, no new machines, etc.
 - Protects building exterior surface from elements.
 - Durable. Can be painted once dried.



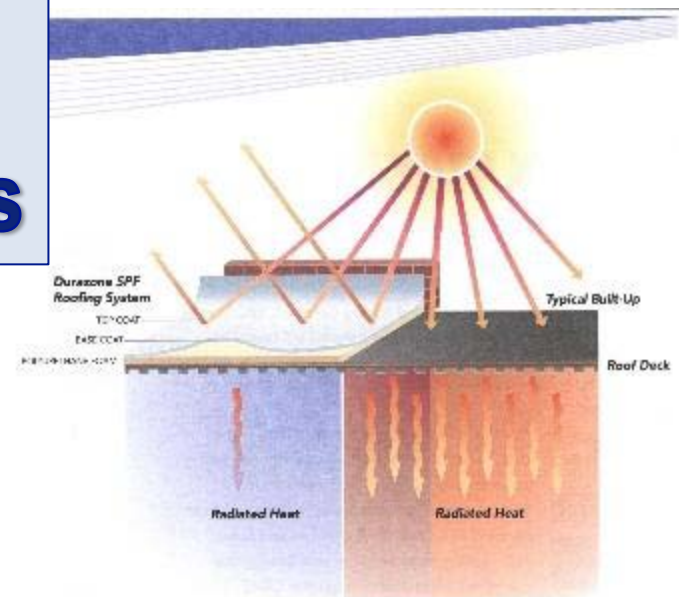
Camp Lemonnier, Djibouti



CLU Modification

- Apply Foam Insulation to the exterior of the CLUs

Estimate Annual Savings:
921,024 kWh - \$267,096
Simple Payback – 3.1 years



Camp Lemonnier, Djibouti



CLU Modification

- Paint the exterior of the CLU (after foaming)

**Estimate Annual Savings:
409,968 kWh - \$118,890
Simple Playback – 2.6 years**

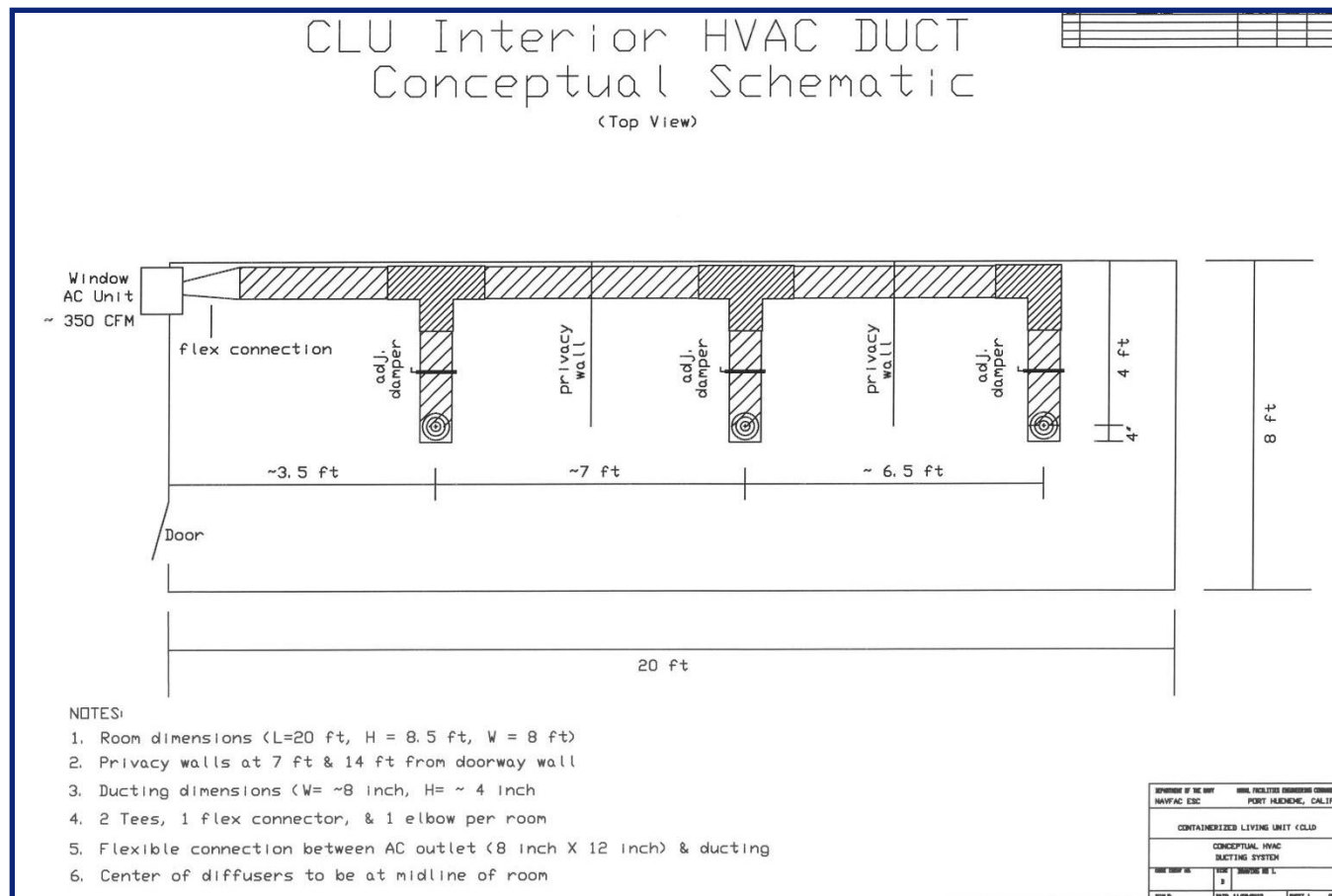


Camp Lemonnier, Djibouti



CLU Modification

• Install Interior Ducting



Camp Lemonnier, Djibouti



CLU Modification

- **Install Interior Ducting**

- **The Amount of Annual Energy Saved, Fuel Funds Saved, and Simple Payback was not calculated**
- **Better Interior Air Distribution should have the following benefits:**
 - Reduction of ACU cycling on and off
 - Uniform Interior Temperature (Currently the Occupant closet to the ACU is much colder than the Occupant further away)

Camp Lemonnier, Djibouti



High Efficiency Washing Machines

- **Reduction of Water (Energy saved from ROWPU)**
 - Currently 34,000 gallons of water used per day at central laundry (2009)
 - Estimated water production cost is \$908/day
 - High Efficiency Washers reduce
 - Total Water by 62%
 - Hot Water by 67%
 - Energy by 28%
 - Estimated Annual Savings for more efficient washers - \$175,164 (includes ROWPU)
- Higher spin also leads to less water needed to be dried by electric dryer



Camp Lemonnier, Djibouti



High Efficiency Washing Machines

- Reduction of Water (Energy saved from ROWPU)

Estimate Annual Savings:
\$175,164
Simple Playback – 0.25 years

- Total Water by 62%
- Hot Water by 67%
- Energy by 28%

– Estimated Annual Savings for more efficient washers - \$175,164 (includes ROWPU)

- Higher spin also leads to less water needed to be dried by electric dryer



Camp Lemonnier, Djibouti



Incinerator Energy Recovery

- **Waste Characterization Study** needed to determine amount of energy that can be captured
- **Estimated Power Generation** of about 477 kW/hr
- **May be able to Produce 5%** of the total base energy need



Camp Lemonnier, Djibouti



Incinerator Energy Recovery

- Waste Characterization Study needed to determine amount of energy that can be captured
- Estimated Power Generation of about 477 kW/hr
- May be able to Produce 5% of the total base energy need

**Estimate Annual Savings:
\$526,089
Simple Payback – 2.4 years**



Camp Lemonnier, Djibouti



Solar Panels with Self Cleaning Equipment

- Soiling causes 25% Energy Production Loss/Month without Cleaning



Camp Lemonnier, Djibouti



Solar Panels with Self Cleaning Equipment

- Soiling causes 25% Energy Production Loss/Month without Cleaning

**Estimate Annual Savings:
\$129,000
Simple Payback – 16 years**



Camp Lemonnier, Djibouti



Solar Heater for Laundry

- Reduction or elimination of energy used by electric water heater in main laundry and mess hall
 - May also have an effect on the ACU

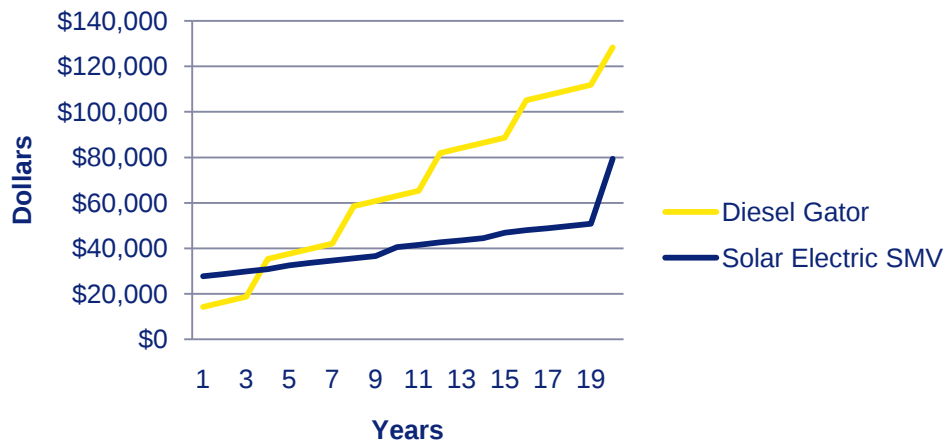


Camp Lemonnier, Djibouti



Retrofit Electric Vehicle with Solar Panels

**Break Even Point
Diesel Gator vs. Solar Electric
SMV**



Camp Lemonnier, Djibouti

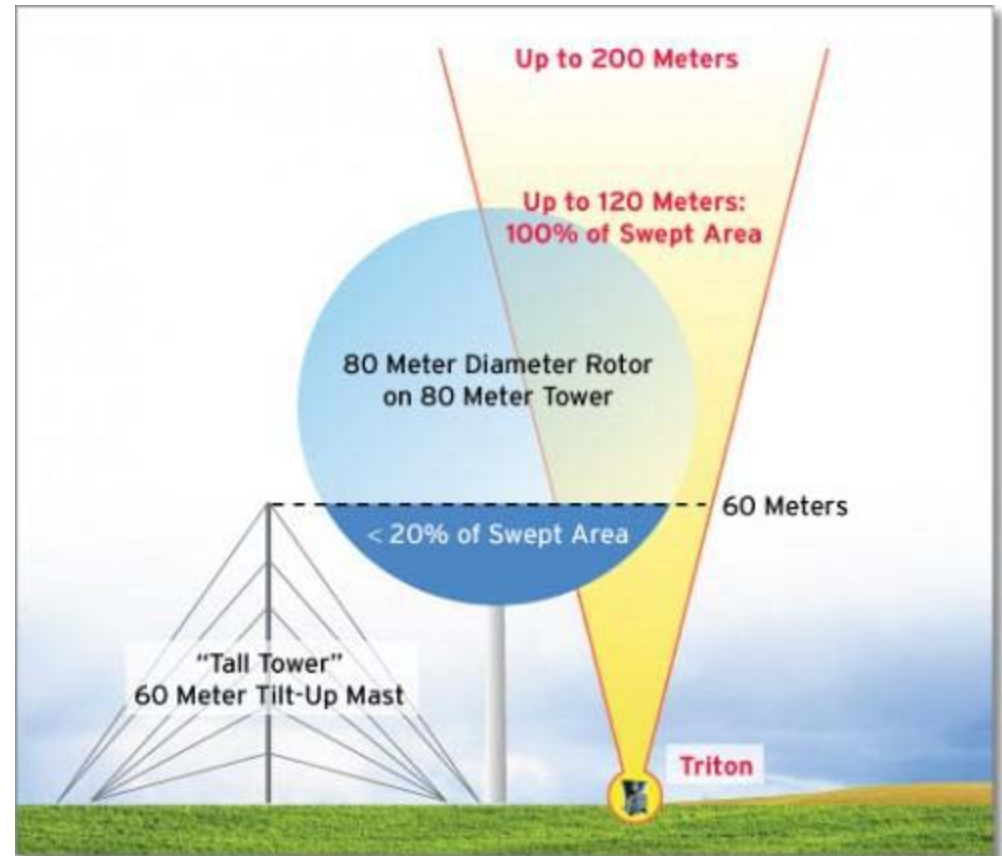
- Replace Street Lighting



Camp Lemonnier, Djibouti



Wind Profiler (Sodar)



Camp Lemonnier, Djibouti



Total Annual Estimated Energy Savings

- **CLU Modifications – \$1,017,648**
- **Incinerator Energy Recovery - \$526,089**
- **High Efficiency Washers - \$164,205**
- **Solar Panel – \$129,000**

QUESTIONS?