Latvia 250 PAX Camp Cost Benefit Analysis/ROI
November 02, 2016
Soft-Walled (Tent) 250 Man Camp

120kW TQG Gen. size based on Air Force Base camp equipment. Force Provider would use 60 kW TQGs
Soft-Walled (Tent) 250 Man Camp

• (42) Billeting Shelters
  • (6) occupants each
  • 110 sq. ft. per occupant (per requirement)
  • Require replacing approximately every 5 years (PM FSS)

• Low efficiency Shelters
  • R values ~4 (https://www.army.mil/article/98542/Rigid_wall)
  • Thermal solar loading has significant impact during summer

• Enduring installation
  • Requires site preparation work to build platforms
  • Platforms are replaced every 2-3 years (PM FSS)

• (10) 120kW generators
  • 815kW maximum camp power requirement as spec’d
WHS Rigid-Walled 250 Man Camp
WHS Rigid-Walled 250 Man Camp

Energy Efficiency (Make the most of what you have)
• Average R-Value of 30 to keep more constant interior temperature
• Reduced power requirement for environmental control of interior temperature
• Utilizes energy storage to gain maximum use of locally generated electricity and drive down fuel requirement
• Harvests renewable power sources to decrease required power from onsite assets or locally sourced power

Power Surety (Confidence of always having power available)
• Energy storage insulates the camp from external power availability on the commercial grid (Incirlik)
• Renewable power sources with energy storage can be leveraged to continually support mission critical loads indefinitely
• Energy storage and renewables enable maximum use of available fuel if onsite generator power is the only option to run the camp

Host Nation Considerations
• Small impact on local commercial grid
• Ability to back feed additional renewable power to local grid if desired
WHS/LexTM3 250 PAX Camp - Buildings & Power

- (21) Billeting Shelters
  - (17) double occupancy with (12) pax each, 2 per room
    - 110 sq ft. per occupant (per requirement)
  - (4) single occupancy with (12) occupants each, 1 per room
- (1) Services building
  - Latrines, Laundry, Showers
- (1) Water Treatment System
  - (1) 20' Conex
- (1) Sewage Treatment System
  - (4) 20' Conex
- Service life of 15-20 years
  - High efficiency Shelters
    - R-values average 30 for roof, walls and flooring
- Semi-permanent installation
  - Requires minimal site preparation work to build platforms
- 505kW maximum camp power requirement as spec’d
- (4) 120kW generators paired with (4) hybrid power system
  - Generators operate to charge batteries and are then silent
- (1) 200kW generator for Services Building and Water/Sewage Treatment Systems

Highly efficient structures make hybrid system more viable and effective
WHS – Billeting Detail

Double and Single Occupancy Configurations, 110sq;/PAX

Unique Support Minimizes Site Prep
WHS – Latrine Design

Male and Female Latrine, Shower and Laundry Layout

23 Toilets, 26 Showers, 5 Washers, 5 Dryers
WHS – Latrine Execution

Male and Female Latrine, Shower and Laundry Layout – 3200 sft.

23 Toilets, 26 Showers, 5 Washers, 5 Dryers
Source water: Lake, river, stream, well or trucked
In water and Grey Water Processing Unit
Systems for 5,000 – 300,000 Gallons per day
WHS – Waste Water Solution

AGBR® (aTached growth biological reactor)

Treatment occurs on a permanent, self-cleaning media and passes through **UV for disinfection.**

**Effluent** is pumped out and **can be used for sub-surface irrigation or discharge into a waterway for dilution.**
LexTM3 – Hybrid Power

- (4) Independent hybrid systems with roof mounted solar arrays, power converters and batteries
  - Redundancy
    - Decreased susceptibility to grid power outages
  - Modular/Scalable
    - The system is scalable to increase both solar & battery (ESMs) penetration
  - Direct and indirect benefits of a hybrid system – clean conditioned power and ability to protect highly sensitive electronics
  - Transportable
    - 20’ Conex
LexTM3 – ESM Concept

5 Solar Inputs

Energy Storage Module (ESM)
200kWh Battery Energy Storage

120kW Generator

Grid Input

200kW Output

Hybrid tactical power system dramatically reduces generator fuel consumption through intelligently managing both power sources AND loads.

Loads 220/380VAC, 50Hz
WHS Building/Soft-Walled Shelter Comparison

**ONE WHS has equivalent living area of TWO 20’ x 32’ Soft-Walled Shelters**

- 1600 sq. ft.
- Walls = R16, Roof = R40, Floor = R32
  - Building as a whole = R30
  - Surface Area = 4500 sq. ft.
    - Used in heat loss applications
- (21) Buildings are required for 250 Man Camp (110 sq. ft. per Pax.)

- 640 sq. ft.
- R4 with insulated liner
  - Radiant barriers have little benefit in cold climates
  - Surface Area = 1950 sq. ft.
    - Used in heat loss applications
- (42) Shelters are required for 250 Man Camp (110 sq. ft. per Pax.)
Building/Shelter Heat Loss Comparison

Heat transfer/loss analysis was performed for each month of the year

- Equation:  \( H_t = U A d_t \)
  - \( H_t \) = heat transfer (Btu/hr) (3412 Btu/hr = 1kW)
  - \( U \) = heat transfer coefficient = 1/R
  - \( A \) = total surface area of structure
  - \( d_t \) = Inside/outside temperature difference (annual inside temp. of 70F)

- Heating analysis only looks at Billeting structures
  - Actual numbers/benefits will be slightly greater

- Analysis focuses on heating/cooling differences

- Other loads are considered equivalent between camps
  - Water heaters (6 hours a day @ 18kW, 8 units = 864 kW-hr/day)
  - Laundry (6 hours a day @ 5.6kW, 10 units = 336 kW-hr/day)
  - Soldier equipment (12 hours at 300W, 250 units = 900 kW-hr/day)
  - Lights (6 hours @ 130W, 170 units = 132 kW-hr/day)
  - Water/Sewage Treatment (12 hours @ 55kW = 660 kW-hr/day)

2.89MW-hr/day baseline load (120kW average power)
Latvia Annual Temperatures

- Moderate climate
- Cooling not often necessary
  - May – August best for solar but energy demand is at lowest
- Heat could be required throughout the year
  - Lows in mid 50s in July/August

![Temperature Chart]

<table>
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<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
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<th>Sep</th>
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Proprietary
For Soft-Walled Camp, total energy loss in one year would be 1363 MW-hr.

For WHS Camp, total energy loss in one year would be 210 MW-hr.
- WHS saves 85% in wasted thermal energy (1153 MW-hr reduction) based on Latvia climate.

Ancillary Loads between two camp configurations are assumed equivalent and do not factor into calculations.

<table>
<thead>
<tr>
<th>Month</th>
<th>WHS kW-hr/day</th>
<th>Soj-Walled kW-hr/day</th>
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<td>July</td>
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<td>December</td>
<td>930</td>
<td>6047</td>
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Heat loss (energy requirement)
Total Camp Energy Consumption by Month

- Baseline daily load of 2890kW-hr added to daily heating requirement for both camps

- WHS camp averages 3.2MW-hr less energy usage per day
  - Does not factor in efficient water treatment or LSA

- 144kW Average power for WHS Camp
  - 126kW in July to 164kW in Jan.

- 276kW Average power for Soft-Walled
  - 162kW in July to 402kW in Jan.

<table>
<thead>
<tr>
<th>Month</th>
<th>WHS Rigid-Walled kW–hr/day</th>
<th>WHS Soft-Walled kW–hr/day</th>
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<td>3900</td>
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<td>December</td>
<td>3822</td>
<td>8939</td>
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Modeling and Simulation

- Monthly average power loads were modeled in HOMER Energy Software

- 4 camp configurations were analyzed to provide options
  - WHS Camp with LexTM3 Hybrid System A
    - 750kW PV
    - 2.4MW Energy Storage
  - WHS Camp with LexTM3 Hybrid System C
    - 250kW PV
    - 0.8MW
  - WHS Camp with generators only
  - Soft-Walled Shelters with generators only
Cost Benefit Analysis/ROI Assumptions

- Fully burdened fuel at $10/$15/$20/gal
- Soft-Walled shelter platforms are replaced every 3 years
  - $0.441M
- Soft-Walled shelters are replaced every 3 years
  - $1.5M
- WHS Camp has 15 year life
  - Site prep ~ $0.03M
- ROM Camp Procurement Costs
  - WHS Camp with Generators = $12.5M
  - WHS Camp with LexTM3 Hybrid A = $23M
  - WHS Camp with LexTM3 Hybrid C = $17M
- LexTM3 hybrid systems require battery replacement after 7 years

Annual Fuel Consumption (1000s of Gallons)
Modeling and Simulation Results

- Simulation compared 100% off-grid operation
  - Diesel generators only or generators used in hybrid configurations

- WHS Camp with LexTM3 Hybrid A reduces fuel consumption by 76%
  - 38% of Camp annual energy needs are met with Solar Array
  - Battery storage provides 15 hours of autonomy (silent watch)

- WHS Camp with LexTM3 Hybrid C reduces fuel consumption by 63%
  - 6% of Camp annual energy needs are met with Solar Array
  - Battery storage provides 5 hours of autonomy (silent watch)

<table>
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<tr>
<th>Configuration</th>
<th>Solar Array (kW)</th>
<th>Storage (kW-hr)</th>
<th>Annual Fuel (k/Gal)</th>
<th>% Fuel Reduction</th>
<th>Silent Watch (hours)</th>
<th>Renewable (%)</th>
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<table>
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<tr>
<th>Configuration</th>
<th>Initial Cost ($M)</th>
<th>$10/Gal ROI (y)</th>
<th>$15/Gal ROI (y)</th>
<th>$20/Gal ROI (y)</th>
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<td>Soft-Walled</td>
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</table>
Projected Lifecycle Cost

$10/Gallon

Life Cycle Cost ($M)

Years Deployed

LexTM3 Hybrid A
LexTM3 Hybrid C
Soft-Walled

Proprietary
Projected Lifecycle Cost

$15/Gallon

Years Deployed

Life Cycle Cost ($M)

LexTM3 Hybrid A
LexTM3 Hybrid C
Soft-Walled
Projected Lifecycle Cost

$20/Gallon

- LexTM3 Hybrid A
- LexTM3 Hybrid C
- Soft-Walled

Life Cycle Cost ($M) vs. Years Deployed
## Project Schedule – 8.5 Month Completion

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<tr>
<th>Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
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<td>Testing</td>
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Conclusions

Efficient structures and hybrid energy systems significantly reduce energy and fuel consumption.

Hybrid Energy Camp provides power surety

- WHS Camp with LexTM3 Hybrid A, has the greatest energy and fuel savings
  - Provides 38% of camp energy needs via Solar Array
  - Allows for up to 15 hours silent operations
  - Reduces fuel consumption by 76% compared to Soft-Walled camp operating on generators in Latvia climate conditions

- WHS Camp with LexTM3 Hybrid C, has the greatest payoff over 6-14 years for all fuel prices
  - $15M/$28M/$38M savings over 15 years compared to Soft-Walled camp
  - ($10/Gal,$15/Gal,$20/Gal)
  - Allows for up to 5 hours silent operations
  - Reduces fuel consumption by 63% compared to Soft-Walled camp operating on generators in Latvia climate conditions