Zero Energy Infantry Training Bases

6th Jeffrey Cook Workshop
In Desert Architecture,
Zeroplus Energy Settlements
The Department Of Engineering & Construction, MOD

Professional Authority In Engineering

Executive division – IDF & MOD

Managing 2.6 billion $ a year

Constructing 2.5 million square meters in the next few years
A complex containing energetically efficient buildings whose annual energy consumption is equal or less than the renewable energy produced within it.
Construction & upgrading the Infantry Training Base for the 933 Brigade

Construction of a new Infantry Training Base for 84 Brigade
Infantry Training Base In Numbers

- 80 Acres Fenced Area
- 100 Acres Ranges Area
- 50,000 SqMt Built Up Area
- 3,000 SqMt Options
- 24 Buildings, +30 Structures
- 1700 Recruits
- 350 Staff
Design Principles

- Accessibility
- Sheltering
- Sustainability
- Renewable Energy
- Building & Base Control
- Building Code & IDF Code
- LCC
- Maintenance
- Machinery & equipment
- Security & Defence
- IDF Communication
- Fire Safety
- Design Principles
84 ITB - Simulation
933 ITB - Simulation
Reaching ZEB - Comprehensive vision

- Green Building Code
- Solar Thermal System
- B²MS
- ZEB
- Energy Models
- Thermal Storage
- Electric Energy Sources
All buildings are designed to withstand an energetic rating of at least 1 star (there are also 3-star buildings)

The rating relates to environmental aspects, electrical installations, lighting, air conditioning, water, building control, green energy production, insulation in all components of the building, waste, recycling and more

Is expected to save 25-40% per building in current electricity consumption following compliance with the standard requirements
An example of a residential building, companies compunds, approved for a 3-star rating

<table>
<thead>
<tr>
<th>סעיף</th>
<th>פרק</th>
<th>פאוץ</th>
<th>מגורים</th>
<th>נקודות (סוכרים)</th>
<th>נקודות (מגני)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>1</td>
<td>15.00</td>
<td>23.00</td>
<td>84.00</td>
<td>100</td>
</tr>
<tr>
<td>1.2</td>
<td>2</td>
<td>80.00</td>
<td>60.00</td>
<td>15.50</td>
<td>80.00</td>
</tr>
<tr>
<td>1.3</td>
<td>3</td>
<td>24.00</td>
<td>36.00</td>
<td>81.50</td>
<td>91.50</td>
</tr>
<tr>
<td>1.4</td>
<td>4</td>
<td>90.00</td>
<td>90.00</td>
<td>180.00</td>
<td>180.00</td>
</tr>
<tr>
<td>1.5</td>
<td>5</td>
<td>120.00</td>
<td>150.00</td>
<td>270.00</td>
<td>270.00</td>
</tr>
<tr>
<td>1.6</td>
<td>6</td>
<td>180.00</td>
<td>210.00</td>
<td>420.00</td>
<td>420.00</td>
</tr>
<tr>
<td>1.7</td>
<td>7</td>
<td>300.00</td>
<td>330.00</td>
<td>660.00</td>
<td>660.00</td>
</tr>
<tr>
<td>1.8</td>
<td>8</td>
<td>540.00</td>
<td>570.00</td>
<td>1170.00</td>
<td>1170.00</td>
</tr>
</tbody>
</table>

**Green Building code 5281**

- **1**. LED Lighting
- **2**. BMS
- **3**. PV, Heat Pumps
- **4**. Night ventilation
- **5**. Energy Center, Thermal Storage
- **6**. Controlled outdoor lighting and full cut-off
- **7**. Dosed showers and faucets
- **8**. Waste and recycling points
- **9**. Extensive vegetation, gray water for irrigation
The base management system consists of controllers who connect to central systems (electricity, lighting, air conditioning, fuel, fire, water and sewage, irrigation, etc.) and read the data.

The system performs management in each structure including scoring, setting thresholds, bouncing alerts, generating reports, comparing similar structures, etc.

Micro Grid: The system performs management of energy sources, PV, generators, storage of electrical energy, thermal storage, gray water, hot water and more.
Electric Energy Sources

1. Production of electricity from PV installed on all rooftops above 200 square meters.

2. The peak production is about 2 MW (annual production 3,400,000 kWh)

3. An 1800 KVA generator is installed, including a smart loading system as part of the microgrid

4. Purchase of electricity from a private producer - Dorad - High voltage connection
Cold storage facility for saving electricity costs for AC purposes

1. Loading the cold reservoir (with eutectic salts) and the fire protection reservoir at night with low cost with 2 chillers, also at weekends and from PV balances.

2. Discharge of reservoirs (cold water) to the consumer at peak demand when the price is high for 5 hours or more.

3. Energy saving during the high price peak (2000 tons of cooling per day, 400 tons of cooling per hour).

4. Return on investment in 5 years.
Solar thermal system for hot water (residential and DFAC)

1. Thermal panels absorb sunlight during the day
2. Storage tank is heated through the liquid which comes from the panels
3. Water for consumption is heated by the tank as a heat exchanger
4. A consumer receives hot water
5. Heat pumps work at night at low price to warm the water for the morning
Annual energy consumption prediction models

1. Each building will have an electric consumption forecasting model which considers lighting, electricity, air conditioning, fresh air, etc.

2. The model considers location in the country, planned isolation in walls, glazing, aluminium, etc.

3. In cooperation with the client, a daily consumption schedule was built with the distribution of percentages of use of buildings

4. The model predicts the required consumption throughout the year and the result can be compared to the proposed planning
Annual energy consumption prediction models

Power consumption KWH / SqMt / year

- Total 99 kilowatt per hour/SqMt for a building that works from 06:30 until 00:00 at night
- Efficiency of 37% of annual consumption!

Standard Building vs 84 Offices

- AC
- Heating
- Lighting
- Ventilation
- Electrical Equipment
84 ITB – Offices Building – general data

### Phase 1
- **Gross built area (sqm)**: 659
- **Amount of rooms / spaces**: 47
- **Net available roof space (net)**: 238
- **Exterior Wall Area (sqm)**: 1190

### Phase 2
- **Capacity on the roof**: 40.46 kwp
- **By amount of rooms / spaces**: Active – Presence detectors
- **Shadows Insulation of walls**: Passive
- **Insulation of windows**: Passive
- **Roof insulation**: Passive
Green Extras Cost Calculation

Phase 3

<table>
<thead>
<tr>
<th></th>
<th>With PV</th>
<th>Without PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost of green additions</td>
<td>62.6 K $</td>
<td>28.6 K $</td>
</tr>
<tr>
<td>Cost of additions per square meter</td>
<td>84.45 $</td>
<td>38.53 $</td>
</tr>
<tr>
<td>Construction cost addition to the MOD price list by 1,485 $ per square meter</td>
<td>5.7%</td>
<td>2.60%</td>
</tr>
</tbody>
</table>
Calculation Of Energy Intake

Annual Consumption Distribution By Systems

- AC
- Heating
- Ventilation
- Lighting
- Electrical Equipment

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>28,348</td>
<td>10,017</td>
</tr>
<tr>
<td>Heating</td>
<td>5,741</td>
<td>3,588</td>
</tr>
<tr>
<td>Ventilation</td>
<td>2,182</td>
<td>992</td>
</tr>
<tr>
<td>Lighting</td>
<td>36,404</td>
<td>19,678</td>
</tr>
<tr>
<td>Electrical Equipment</td>
<td>31,365</td>
<td>31,365</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>104,041</strong></td>
<td><strong>65,640</strong></td>
</tr>
</tbody>
</table>
### Energy Reset & ROI

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Structure</td>
<td>10.4 K $</td>
<td>6.5 K $</td>
</tr>
<tr>
<td>Green Structure</td>
<td>3.9 K $</td>
<td></td>
</tr>
<tr>
<td><strong>ROI</strong> - 7 years</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Of Green Additions</th>
<th>(PV Maintenance Cost) - (Electric Cost + Savings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Build.</td>
<td>62.6 K $</td>
</tr>
<tr>
<td>Green Build.</td>
<td>68,782 KWH</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electricity Consumption</th>
<th>PV Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>KWH 104,041</td>
<td>KWH 65,040</td>
</tr>
<tr>
<td>KWH 68,782</td>
<td></td>
</tr>
</tbody>
</table>
Green Building Code

Solar Thermal System

B²MS

Energy Models

Thermal Storage

Electric Energy Sources

ZEB
### Modeling All Buildings / Interpolation Entire Base

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity</th>
<th>Yearly Usage</th>
<th>Yearly Cost</th>
<th>Monthly Cost</th>
<th>Annual Cost</th>
<th>Return on Investment</th>
<th>Payback Period</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chambers</td>
<td>6</td>
<td>9,107</td>
<td>15,566</td>
<td>40,957</td>
<td>146,340</td>
<td>10,265</td>
<td>55,282</td>
<td>1</td>
</tr>
<tr>
<td>Marvels</td>
<td>6</td>
<td>11,291</td>
<td>19,298</td>
<td>50,776</td>
<td>181,424</td>
<td>12,726</td>
<td>68,536</td>
<td>1</td>
</tr>
<tr>
<td>Gymnasiums</td>
<td>6</td>
<td>14,005</td>
<td>23,937</td>
<td>62,984</td>
<td>225,042</td>
<td>15,785</td>
<td>85,013</td>
<td>1</td>
</tr>
<tr>
<td>Churches</td>
<td>8</td>
<td>13,867</td>
<td>23,702</td>
<td>62,364</td>
<td>113,907</td>
<td>15,630</td>
<td>84,177</td>
<td>1</td>
</tr>
<tr>
<td>Hotels</td>
<td>8</td>
<td>4,445</td>
<td>7,598</td>
<td>19,992</td>
<td>36,515</td>
<td>5,010</td>
<td>26,984</td>
<td>1</td>
</tr>
<tr>
<td>Yard</td>
<td>6</td>
<td>58,853</td>
<td>100,591</td>
<td>264,672</td>
<td>945,681</td>
<td>66,333</td>
<td>357,245</td>
<td>1</td>
</tr>
<tr>
<td>Museums</td>
<td>6</td>
<td>57,043</td>
<td>97,498</td>
<td>256,534</td>
<td>916,603</td>
<td>64,293</td>
<td>346,260</td>
<td>1</td>
</tr>
<tr>
<td>Theaters</td>
<td>6</td>
<td>68,845</td>
<td>117,670</td>
<td>309,610</td>
<td>1,106,245</td>
<td>77,595</td>
<td>417,900</td>
<td>1</td>
</tr>
<tr>
<td>Gyms</td>
<td>6</td>
<td>29,505</td>
<td>50,430</td>
<td>132,690</td>
<td>474,105</td>
<td>33,255</td>
<td>179,100</td>
<td>1</td>
</tr>
<tr>
<td>Aquariums</td>
<td>6</td>
<td>43,766</td>
<td>74,805</td>
<td>196,824</td>
<td>703,256</td>
<td>49,328</td>
<td>265,665</td>
<td>1</td>
</tr>
<tr>
<td>Cafeterias</td>
<td>6</td>
<td>22,660</td>
<td>38,730</td>
<td>101,906</td>
<td>364,113</td>
<td>201,024</td>
<td>137,549</td>
<td>1</td>
</tr>
<tr>
<td>Administrations</td>
<td>6</td>
<td>34,344</td>
<td>58,701</td>
<td>154,451</td>
<td>551,858</td>
<td>304,677</td>
<td>208,472</td>
<td>1,746</td>
</tr>
<tr>
<td>Flights</td>
<td>6</td>
<td>335,157</td>
<td>572,851</td>
<td>1,507,270</td>
<td>5,385,517</td>
<td>2,973,306</td>
<td>2,034,457</td>
<td>11</td>
</tr>
<tr>
<td>Dining</td>
<td>6</td>
<td>14,556</td>
<td>24,879</td>
<td>65,460</td>
<td>233,892</td>
<td>129,130</td>
<td>88,356</td>
<td>1</td>
</tr>
<tr>
<td>Parking</td>
<td>6</td>
<td>38,750</td>
<td>66,231</td>
<td>174,266</td>
<td>622,658</td>
<td>343,765</td>
<td>235,218</td>
<td>1</td>
</tr>
<tr>
<td>Fuels</td>
<td>6</td>
<td>36,792</td>
<td>42,048</td>
<td>140,160</td>
<td>210,900</td>
<td>140,160</td>
<td>210,900</td>
<td>1</td>
</tr>
<tr>
<td>Water</td>
<td>6</td>
<td>59,700</td>
<td>72,000</td>
<td>180,000</td>
<td>270,000</td>
<td>180,000</td>
<td>270,000</td>
<td>1</td>
</tr>
<tr>
<td>Electricity</td>
<td>6</td>
<td>98%</td>
<td>103,200</td>
<td>3,468,000</td>
<td>1,015,511</td>
<td>1,334,535</td>
<td>1,334,535</td>
<td>1</td>
</tr>
<tr>
<td>Solar</td>
<td>6</td>
<td>1,344,535</td>
<td>3,540,916</td>
<td>13,638,056</td>
<td>6,775,539</td>
<td>852,303</td>
<td>4,590,214</td>
<td>25</td>
</tr>
</tbody>
</table>

**Notes:**
- Costs are in ₪.
- Payback period is in years.
- 98% denotes the percentage of all buildings.
Modeling All Buildings / Interpolation Entire Base

98% Annual Energy Reset!

Total 3% addition to project value!

ROI within 6 years for entire camp!

Total 6% added to the value of buildings!
Summary

Low Cost > Short ROI and Full Energy Reset

Promoting Economy Towards ZEB

An Integrated Approach Between All Systems And Consumers
THANK YOU