**Θέμα:** Η διεθνής τράπεζα - πρωτοβουλία για την ηλιακή ενέργεια

**Εισηγητής:** Α. Αδαμαντίάδης, MH

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**Πρόγραμμα Παρουσιάσεως**

1. Το φαινόμενο του θερμοκηπίου
2. Σεμινάρια Αναπτύξεως
3. Σύμβαση - Πλαίσιο για την αλλαγή του Κλίματος
4. Εξοικονόμηση / Αποδοτικότητας Ενέργειας
5. Τεχνολογίες Ανανέωσιμων Πηγών Ενέργειας
   - Ηλιακή
   - Αιολική
   - Γεωθερμική
   - Βιομάζα
   - Μικρά Υδροπολεκτρικά
6. Δανεισόδοτηση Δ.Τ.
7. Έρευνα στις Α.Π.Ε.

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**Radiative Forcing From Human-Made Greenhouse Gas Sources**

- **CFCs 11 & 12**: 17%
- **Other CFCs**: 7%
- **Nitrous Oxide**: 6%
- **Methane**: 15%
- **Carbon Dioxide**: 55%
Changes in Concentrations of Greenhouse Gases in the Atmosphere
CUMULATIVE CO2 EMISSIONS
BY REGION
(1870 - 1986)

Profiles of Atmospheric CO2
Concentrations Leading to
Stabilization

Profiles of Anthropogenic
Emissions of CO2
Per Capita Consumption

Net Installed Generating Plant Capacity

Energy Consumption Projections At Current Growth Rates

million tons of oil equivalent

OECD

Developing Countries
Framework Convention on Climate Change

- Signed by 158 nations in Rio, June 1992 (UNCED)
- Expected to be ratified and enter into force in 1995
- Implements precautionary principle -- stabilization of emissions at levels that prevent danger
  
  "Common but differentiated responsibilities"

- Developing countries [and EITs] reduce year 2000 emissions to 1990 levels and provide finance to developing countries

- Developing countries also reduce emissions, but only to extent that $$$ are forthcoming
Country Commitments under the FCCC

Annex I (OECD + EITs)
- GHG inventories and specific abatement policies and measures
- Reduce year 2000 emissions to 1990 level
- Promote tech transfer
- Provide new and additional $$ (OECD only)

Non-Annex I
- GHG inventories and general abatement policies and measures
- Reduce emissions to extent $$$ forthcoming

*Sales-weighted average from Association of Home Appliance Manufacturers
NAECA=National Appliance Energy Conservation Act, 1987
DOE=Department of Energy
Compressor with high efficiency

Operation controls:
- Optimized compressor operation
- Fuzzy-logic-based adaptive defrost
- Efficient anti-sweat strategies
- Improved temperature controls

(vacuum insulation available on 1995 models)

Thicker insulation in door

Gasket systems with improved materials and design to reduce leakage

Cabinet foam insulation

HCFC-141b increased in thickness (vacuum insulation available on 1995 models)

Vacuum insulation panel

Heat exchangers, with enhanced surface are for improved heat transfer

Fans:
- High-efficiency, low-energy motors
- Aerodynamically efficient

Refrigerant HFC-134a

Drain trap (controls heat leakage)

Compressor with high efficiency optimized for HFC-134a
Photovoltaic home lighting systems

Solar module

Charge controller

Battery
Wind/PV/Diesel Hybrid Power System
HCPV INTEGRATED ARRAY

Fresnel lens parquet
250x fresnel lens parquet (4x6 matrix) mounted to front of array structure

Array
- Output at 850 DNI:
  - 20 kW @ 20°C ambient
  - 21.6 kW @ 25°C cell temperature
- 155 m²

PV Panel
- matrix - 12w x 14h
- 168 panels
- 24 cells / panel
- 120 W/panel

PV panel mounted to back to array structure

Photovoltaic Module Costs

Costs required for commercial application

Small scale applications
Power generation (decentralized) at peak load
Power generation (decentralized) at base load
ECONOMICS:
PV Systems vs. conventional Line Extensions

<table>
<thead>
<tr>
<th>Energy Requirements (kWh/month)</th>
<th>Line Extension Costs Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>1</td>
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</table>

<table>
<thead>
<tr>
<th>Length of Line Extension (feet)</th>
<th>PV System Costs Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>1,000</td>
<td></td>
</tr>
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<td>10,000</td>
<td></td>
</tr>
<tr>
<td>100,000</td>
<td></td>
</tr>
</tbody>
</table>

PV Module Cost: $6/Watt
Total System Cost: $10-$30/Watt
The Kramer Junction companies operate and manage five 30-megawatt Solar Electric Generating Systems (SEGS). These SEGS comprise 150 of the 354 megawatts of installed parabolic trough solar thermal electric generating capacity located in California. The combined California facilities produce more than 90% of the world’s commercially available solar thermal electric power.

KJJC is committed to the successful operation and refinement of solar thermal parabolic trough technology, as well as to the advancement of all solar thermal electric technology, because it is reliable, cost-competitive and environmentally beneficial.

Kramer Junction Company (KJC) is the Managing General Partner of the five 30-megawatt solar thermal electric generating facilities located in the Mojave Desert near Kramer Junction, California. Together with its wholly owned subsidiaries, KJC Consulting Company and KJC Operating Company, KJC operates and manages these facilities.

KJC Consulting Company (KJC CC) provides management services for the owners of the Kramer Junction SEGS projects, which have combined assets of $500 million. KJC CC is responsible for the financial and administrative activities required to properly manage and evaluate the solar thermal electric projects—providing owners and lenders with immediate access to operational and financial data. KJC CC acts as the contract administrator and power purchase agent for the Kramer Junction SEGS projects. In addition, KJC CC monitors regulatory and legislative activities relevant to the projects.

The primary focus of KJC Operating Company (KJC OC) is the operation and maintenance of the five solar thermal electric plants at Kramer Junction. In addition, KJC OC is recognized as a leader and experienced resource for solar thermal plant services:

- On Site Management – providing day-to-day management, administration and staffing for operations and maintenance activities.
- Operations – daily start-up and operations; optimizing the collection of available solar radiation and the strategic use of natural gas.
- Maintenance – providing centralized maintenance to multiple power plants and collector fields using the latest predictive, preventive and corrective maintenance techniques.
- Engineering – monitoring and analysis of collector field and power plant component performance in a large-scale solar thermal electric environment; development of design enhancements; spare parts specification.
- Training – specialized training for cyclic plant and collector field operation, monitoring and repair.
- Systems Upgrade and Modifications – unique control and information systems development, design and optimization, major plant upgrades, incorporation of new techniques, installation and/or modification of process equipment and solar collector fields; start-up and commissioning of plants and systems.
SUMMARY - % OF PEAK PERIOD CAPACITY  
KRAMER JUNCTION - SEGS III - VII

![Graph showing % of Peak Production Capacity for various years and segments.]

SEGS Efficiency *  
TYPICAL YEAR FOR 30 MW SEGS PLANT

![Graph showing efficiency of SEGS plant over a typical year.]

- Solar Field Efficiency  
- Solar to Electric Efficiency
Collector Availability

Figure 2
Calculated Cost of Electricity from Large-Scale Solar-Thermal Technologies

Costs required for commercial applications (includes storage to provide dispatchable power) at peak load.

Costs required for commercial applications (includes storage to provide dispatchable power) at base load.

Costs for years up to and including 1992 are based on the technology of the time, and are both data from actual plants as well as results of engineering studies: costs for years after 1992 are from projected data.

KEY: 
○ parabolic trough (solar only)
★ parabolic trough (solar/natural gas hybrid)
□ parabolic dish
× central receiver

"Forecasts" scenarios of energy demand. (million TOE)

Comparison between the "Forecasts" scenario and the energy conservation scenario. (million TOE)
Electricity Interconnections

Existing line
Planned line
Towards a new pattern of energy exchanges
**WIND ENERGY COSTS**  
*(1993 constant dollars)*

<table>
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<tr>
<th>Period</th>
<th>Cost (cents/kWh)</th>
<th>Resource Required</th>
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</thead>
<tbody>
<tr>
<td>Early 1990s:</td>
<td>7-9</td>
<td>good winds¹</td>
</tr>
<tr>
<td>Mid 1990s:</td>
<td>5-6</td>
<td>good winds¹</td>
</tr>
<tr>
<td>Late 1990s:</td>
<td>5</td>
<td>moderate winds¹</td>
</tr>
<tr>
<td>Early 2000s:</td>
<td>4</td>
<td>moderate winds¹</td>
</tr>
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</table>

¹ 16 mph annual average at hub height  
² 13 mph annual average at hub height
Fig. 4: Unit cost of electricity and environmental subsidy

Fig 3: Decreasing kWh Cost by Increasing Capacity Factor
U.S. Department of Energy wind Program

Wind Installations in the U.S.

On Line: 1630 MW

"Future" Breakdown:
- Under Contract: 370 MW
- Mandated: 455 MW
- Proposed: 2690 MW

Total "Future": 3515 MW

October 1994
The World Bank and Renewable Energy:

THE «SOLAR INITIATIVE»

The World Bank’s

Solar Initiative 100

- Preparation and Finance of Commercial and Near-Commercial Applications
- Facilitating an International Program for Research, Development and Demonstration
Solar Initiative

I. Project Development Objective

- Mobilizing Project Financing
  - IBRD/IDA
  - IFC
  - GEF Grants
  - Blend
- Increasing Resources for Preparatory Work
  - Conventional PPF
  - GEF
  - ESMAP
  - Bilateral Programs
  - Others: UN, USDOE, etc
GEF Investment Operations, FY93 Renewables/Global Warming

Philippines Geothermal Energy $30
India Renewable Energy $26
Brazil Biomass Gasification $23
Cote d'Ivoire Crop Waste Power $5
Tunisia Solar Water Heating $4
Mauritius Sugar Energy Efficiency $3

Current WB Prospects

- Indonesia Renewable Energy Development
- Sri Lanka Energy Services
- China Renewable Energy Assessment
- Mexico Solar Thermal Conversion (prefeasibility financed by Rockefeller Foundation)
- Morocco Solar Thermals/Windfarms
- Afrika Prospects: West Africa, SADCC PV
- Outer Mongolia Decentralized Power
## India Renewable Energy Project:
### Financing Plan, US$m

<table>
<thead>
<tr>
<th>Source</th>
<th>World Bank (IDA)</th>
<th>Windfarms</th>
<th>Solar PV</th>
<th>Total</th>
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<table>
<thead>
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<th>Windfarms</th>
<th>Solar PV</th>
<th>Total</th>
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<tr>
<td></td>
<td>94</td>
<td>125</td>
<td>55</td>
<td>274</td>
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**Source:** Staff Appraisal Report, IBRD (1992)

---

### GEF Renewable Energy Projects and Pipeline

<table>
<thead>
<tr>
<th>Country</th>
<th>Project Description</th>
<th>Stage</th>
<th>Current Status</th>
<th>Remarks</th>
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<tr>
<td>Argentina</td>
<td>Geothermal District Heating</td>
<td>1.0</td>
<td>1.72</td>
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<tr>
<td>Rwanda</td>
<td>Sugar Bio-Energy Technology</td>
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<tr>
<td>Mexico</td>
<td>Solar Thermal-Electric</td>
<td>50.6</td>
<td>225.8</td>
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<tr>
<td>Morocco</td>
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<td>225.8</td>
<td>1.0</td>
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<tr>
<td>Morocco</td>
<td>Wind-Electric District Heating</td>
<td>5.0</td>
<td>17.2</td>
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<tr>
<td>Malaysia</td>
<td>Solar Thermal-Electric</td>
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<td>170.0</td>
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<td>Philippines</td>
<td>Geothermal Energy Development</td>
<td>30.0</td>
<td>123.3</td>
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<tr>
<td>Romania</td>
<td>Fossil Fuel Substitution</td>
<td>10.6</td>
<td>20.7</td>
<td>Pre-investment</td>
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<td>St. Lucia</td>
<td>Private Sector Renewable Energy &amp; Efficiency Fund</td>
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<td>36.1</td>
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<td>Tanzania</td>
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<td>14.0</td>
<td>1.0</td>
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<td>Benin</td>
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<td>20.7</td>
<td>1.0</td>
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</table>
Figure 5. R & D Expenditures for Renewables by OECD Governments, 1982-1993

Source: Energy Policies of IEA Countries (Paris: IEA, 1993), Annex II, Tables B11 and B12, pp. 582-83. “Renewables” in the above graph include solar (heating, PV, thermal); wind; ocean; biomass; and geothermal (IEA hydro data are excluded).