Turkish National Report on TES Activities

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Contents

A. Energy situation in Turkey
B. Challenges and Opportunities
C. Legislation
D. R&D activities on thermal energy storage
E. Commercial applications
F. Thermal energy storage projects
G. Conclusion
Energy Situation in Turkey

- Turkey - a developing country
- Rapid population growth
- Energy demand increasing
- Not enough native resources
- Investment necessary not at desired rate
Energy Situation in Turkey

Energy consumption-production trends

Energy consumption distribution among sectors

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Energy Situation in Turkey

- Turkey not a rich country as far as the energy resources concerned
- Very limited oil and gas reserves
- Lignite reserves—low calorific value with high content of impurities
- Hydrolic plays an important role in power generation
- Electric demand will be two folds in 2010
- Local energy production provided only 34% of the total primary demand
- Electricity supply expected to reach 290 billion KWh/year in 2010
Energy Situation in Turkey

Primary energy resources distribution

Electrical energy production

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Challenges and Opportunities

✓ Turkey has high reliance on foreign resources
✓ Turkey has to import significant part of her energy demand
✓ This trend seems to persist in the near future (70% import in 2004)
✓ Has to provide cheap and reliable energy to the consumer
✓ Losses in transmission and distribution (22% according to IEA)
✓ Transit country linking oil and gas rich Caspean Area to Mediterranean
✓ Blue Stream project under the Black Sea completed
✓ Baku-Tibilisi-Ceyhan crude oil pipeline nearing completion
✓ Positive effect on diversity and security of supply
✓ Hydro potential – 125 billion KWh/year
✓ New scenario four nuclear power station till 2012

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Recent Legislation

- Encouraging steps towards liberalisation
  - restructuring
  - privatisation
- Privatisation introduced into Turkish Constitution for the first time
- Legislation adopted in 2001
  - to compete in electricity market
  - adopt Turkish Legislation for EU membership
- Gas Market Law adopted in May 2001 for the same purpose
- Using different financial models BOO and BOT
- Energy Efficiency National Regulation accepted at the end of 2004
R&D activities on thermal energy storage

- R&D topics of interest
  - Solar energy
  - Geothermal energy
  - Biomass
  - Groundsource heat pumps
  - Energy efficiency & conservation

- R&D Groups
  - Universities (Anadolu, Cukurova, Ege, Hacettepe, ODTU, ITU, IYTE, Dokuz Eylul, Harran, KTU,...)
  - Research institutes (TUBITAK, Ege Univ. Solar Energy Institute...)
  - Research activities in industry (Limited activities, university-industry collaboration)
Commercial Applications

- Geothermal energy
  - District heating
  - Greenhouses
  - Electricity production

- Groundsource heat pumps

- Solar energy domestic hot water systems
Participation of ÇU in IEA ECES IA


Turkish delegate in IEA ECES IA since 1995

Chair and secretary of Executive Committee of ECES (1999-2002)

Participated in annexes

- Annex 13: Design Construction and Maintenance of UTES Wells and Boreholes
- Annex 14: Cooling in All Climates with Thermal Energy Storage (Operating Agent)
- Annex 20: Sustainable Cooling with Thermal Energy Storage

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Underground Thermal Energy Storage Potential in Turkey

- Geographic Information System (GIS) used to analyze the following related topics:
  - Energy situation
  - Climate conditions
  - Population
  - Groundwater reserves
  - Geological conditions
  - Agricultural production
  - Industrial areas
  - Air Pollution

- Maps showing potential areas for UTES are prepared as a result of GIS analysis.

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Cukurova University Hospital Aquifer Thermal Energy Storage - Feasibility Study

Cold Sources

- Seyhan Lake
- Winter Air

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Cukurova University Hospital Aquifer Thermal Energy Storage - Feasibility Study

Operational simulations with CONFLOW
Pumping and reinjection of the basic concept is simulated to determine:

- number of wells
  - 6 warm, 6 cold wells
- distance between wells
  - Optimum distance between straight well groups is 300-350 m
  - The distance between the wells in the same group is 60-80 m
- thermal and hydraulic impact on the surrounding area

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Cukurova University Hospital Aquifer Thermal Energy Storage - Feasibility Study

ATES system description

Basic concept

Summer
- cold stored from winter used as “free cooling”

Winter
- stored heat from summer used to preheat ventilation air in hospital
Cukurova University Hospital Aquifer Thermal Energy Storage - Feasibility Study

- **Economic feasibility**
  - Investment cost: 1,000,000 USD
  - Energy savings: 500,000 USD
  - Pay-back time: ~ 2 years

- **Annual savings**
  - Electricity: 3,250 MWh
  - Fuel oil: 1,000 m³

- **Decrease in Emissions**
  - CO2: 2,100 tons/year
  - SOx: 7 tons/year
  - NOx: 8 tons/year
Yonca Supermarket in Mersin Aquifer Thermal Energy Storage

- Peak cooling load: 195 kW
- Peak heating load: 74 kW
- Energy savings: about 60%
- Operating since 2001

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Thermal Response Test (TRT) for Borehole Thermal Energy Systems

- Donated by Lulea Technical Univ of Sweden
- The only TRT equipment in Turkey
- Measurements at
  - Istanbul (2 sites)
  - Cukurova University campus
- Results of measurements
  - Thermal resistance of the borehole system
  - Thermal conductivity of ground

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Winter Air as a Cold Source for Borehole Thermal Energy Storage

Experiments done in Lulea, Sweden (1998) (Lulea Technical Univ.)
Cooling in all climates with TES
State-of-the-art-report

Survey covering

- all possible TES technologies for cooling based on any existing or planned applications
- dealing with technical, financial and environmental aspects

A general report and five country specific reports (Canada, Japan, Sweden, Turkey, USA) are prepared.

Results are disseminated with a brochure and CD including the reports and proceedings from 6 workshops (> 100 papers).

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Natural Fatty Acid Mixtures as Phase Change Materials

Candidates

- Coco oil, 22-24 °C, 71.2 J/g
- Palm oil 36-38 °C, 19.1 J/g
- Palm stearin oil, 46-48 °C, 22 J/g

Can be designed as PCMs

Benefits

- Very cheap (0.2-0.3 USD/kg) compared to pure fatty acids (20-30 USD/kg)
- Thermally stable after 1000 thermal cycles
- No supercooling
- Non-toxic
Natural Fatty Acid Mixtures for Climate Control of a Test Cabin

Effect of using coco oil mixture on indoor temperature of test cabin (December 7, 1999, Adana)

PCMs:
- Coco oil, 22-24°C, 71.2 J/g
- Palm oil 36-38°C, 19.1 J/g
- Palm stearin oil 46-48°C, 22 J/g

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Glauber Salt Blends with Polyacrylamide (PA) Gel

- Decreasing supercooling to 3 – 4°C
- Effect of modifying pore size of PA gel on supercooling

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Microencapsulation of Phase Change Materials for Thermal Energy Storage

Microcapsules of paraffins and natural fatty acid mixtures are prepared in the laboratory by chemical methods.

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New PCM Mixtures

More than 60 mixtures prepared and tested:

- Organic + Organic Mixtures
  - Paraffins + Fatty acids

- Organic + Inorganic Mixtures
  - Fatty acids + Salt hydrates

- Modules containing paraffin+palmitic acid mixture to enhance stratification in water tanks of solar energy
  - In collaboration with Lleida University, Spain and funded by TÜBİTAK
  - Duration of utilization of hot water is increased by about 10 hours

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Aquifer Thermal Energy Storage for Greenhouse Heating and Cooling

- Greenhouse (360 m²) on Çukurova University Campus
- Estimated Energy Savings 70%

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New Grouting Materials for BTES

- Lab scale borehole model used for testing new grouting materials
- New grouting mixtures
- Using PCM as grouting material to utilize BTES also for peak-shaving

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PCMs for Buildings

- Joint project with IZOCAM (Funded by State Planning Organization)
- Determining PCMs suitable for humid and warm climates
- Decreasing heating and cooling load of building by
  - Integrating PCMs in insulation sandwich
  - Using PCMs in suspended ceilings

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Ground Cooling of Telecommunication Base Stations in Turkey

Project description

- High efficiency ground cooling with boreholes of telecommunication stations
  - First station on a chosen site, 3000 * stations in future
- Utilizes renewable natural resource for direct cooling
  - Natural cold air & ground
- Estimated to generate 72 GWh of free cooling (3000 stations)
- Corresponds to 27 000 t CO2 reduction annually

* To be determined after the feasibility study

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Increasing Energy Efficiency in Household Appliances Using TES

✓ Joint project with industry (ARÇELIK)
✓ Funded by TUBITAK and Cukurova University Research Fund
✓ Project started in June 2006
✓ Waste heat recovery using PCMs
EIE Energy Efficiency Demonstration Project

- Energy efficiency demonstration facility
- Constructed by State Electric Works (EIE) in March 2006
- Well insulated two store building (275 m²) using
  - Renewable energy (solar, GHP)
  - Fiber optic systems and day light control
- 94% energy conserved
Snow Storage in Turkey
Conclusions

- Increased awareness in renewable energy
- New laws on renewable energy (within the frame of EU Annexes)
- Groundsource heat pump applications increasing for residential and commercial sectors
- First ATES applications on the market
- Interest from building sector on PCMs
- Increasing energy efficiency in household appliances using TES
- Energy efficiency demonstration project using renewables promising for construction sector

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Conclusions

- Meeting energy demand is of high importance
- Exploiting the country’s large energy efficiency potential is vital
- Finally Turkey has to rely on her alternative sources for energy safety and security