ESCO and Thermal Energy Storage for DSM in Korea

April, 2007

EnE System, Inc.

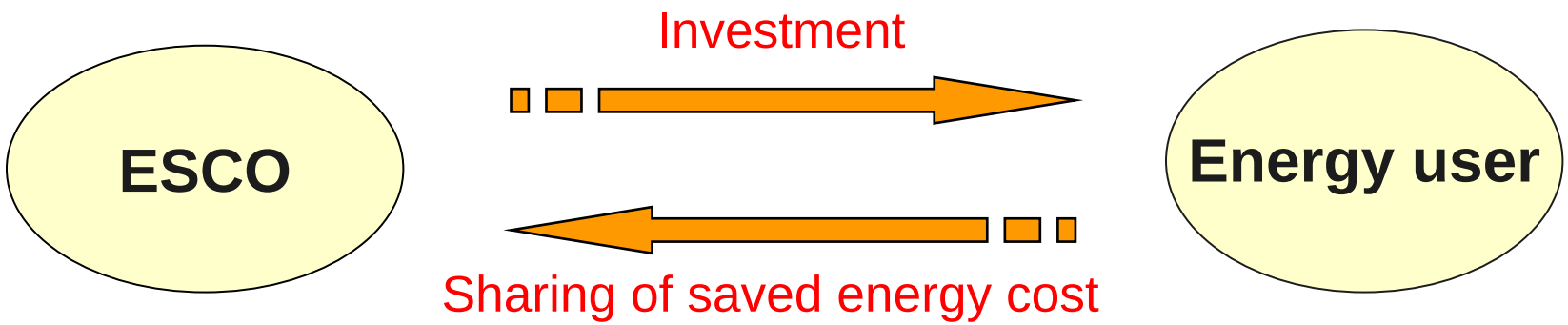
Korean Association for Energy Service Companies

ESCO in Korea

- **ESCO business were formed based on "*Rational Energy Utilization Act*" in 1991**
- **Korean government provides low interest loans for ESCO and tax credits for energy users since 1993**

Energy Service Company (ESCO)

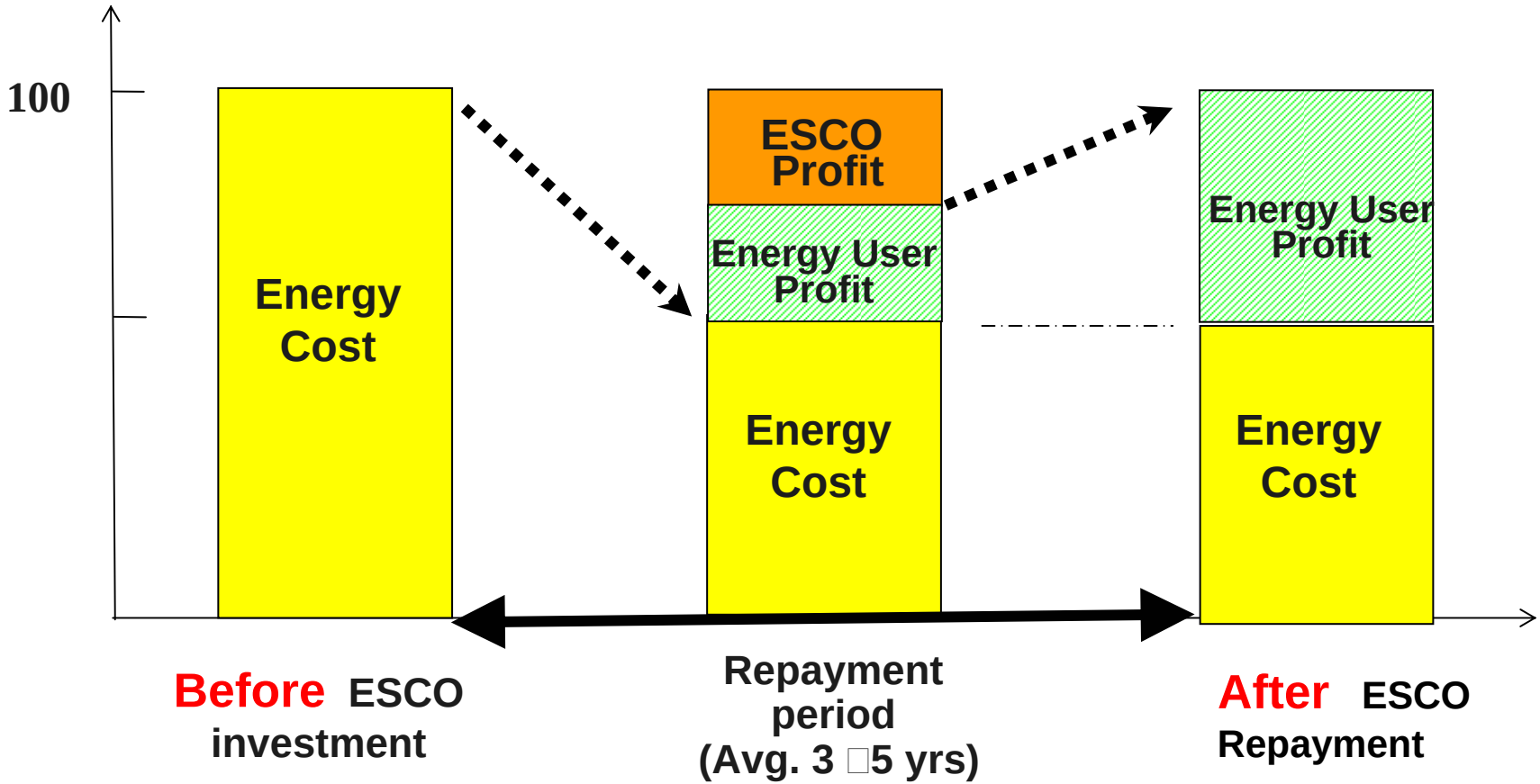
ESCOs are investing their engineering skills and fund to install energy-saving facilities for energy users, and then earn their profit from the saved energy cost of energy users



Advantage of ESCO business

- **Energy User Perspective**
  - **Energy cost reduction without financial burden**
  - **Elimination of financial and technical risk**
  - **Professional engineering service from ESCO**
- **Nation-wide Perspective**
  - **Promotion of investment in energy-saving**
  - **Growth of energy-saving industry**

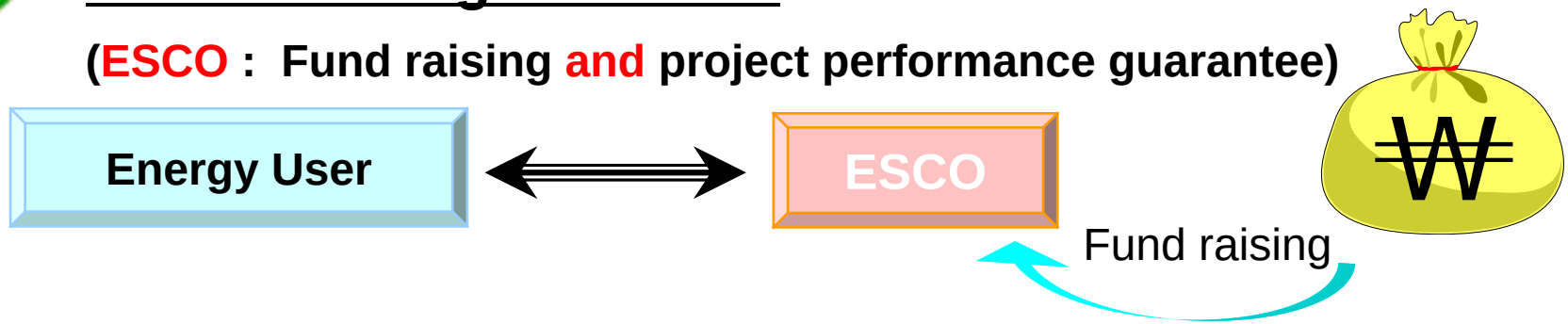
ESCO investment and profit sharing



ESCO Contract

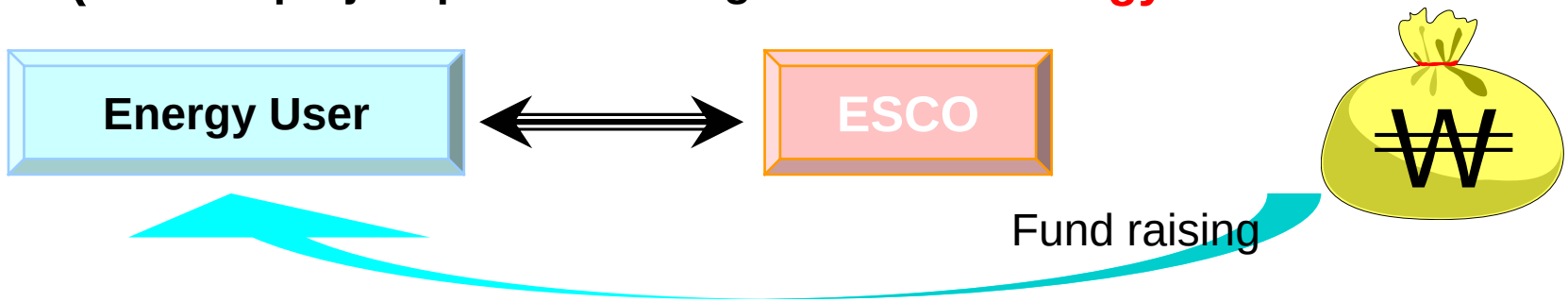
shared savings contract

(ESCO : Fund raising and project performance guarantee)

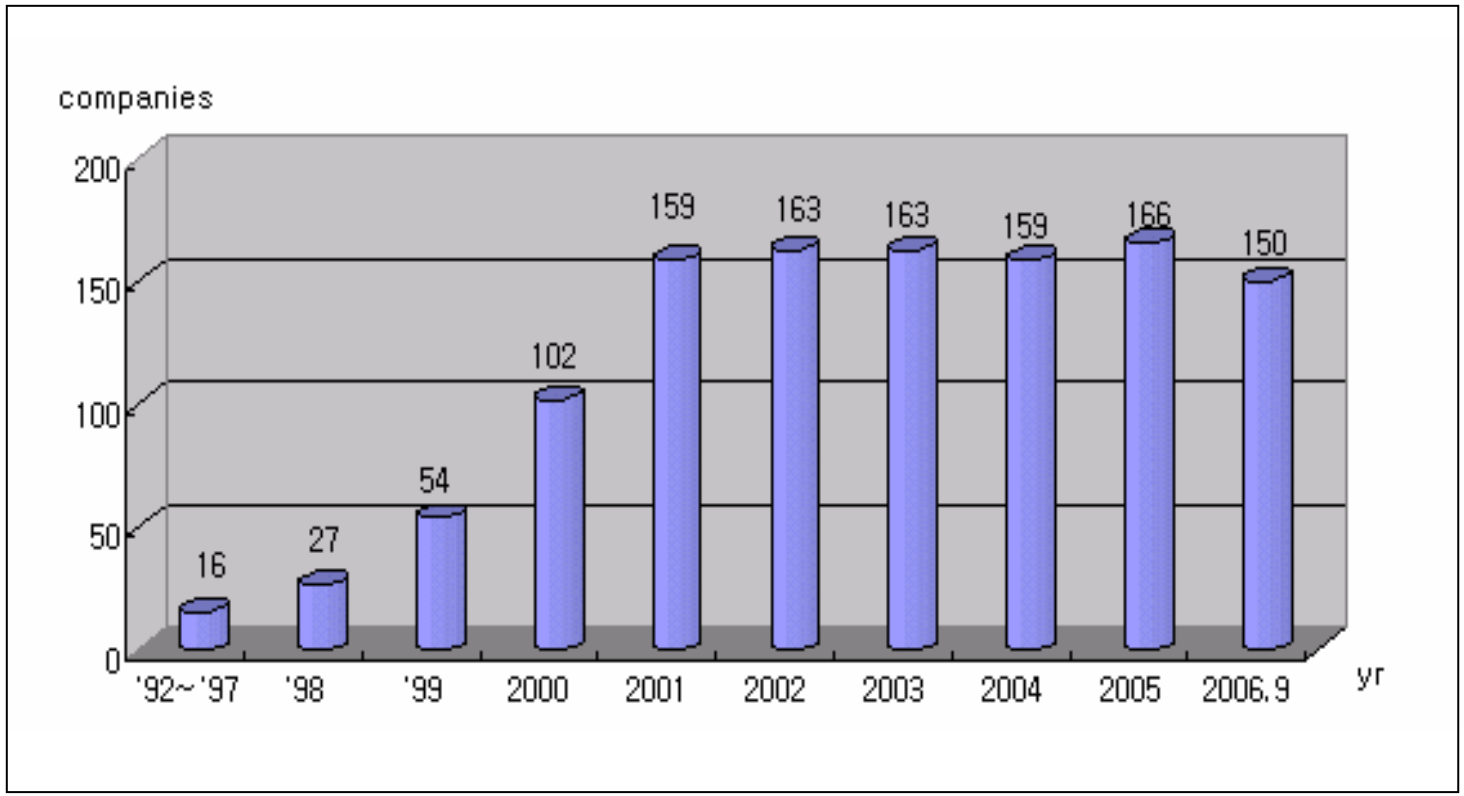


Guaranteed savings contract

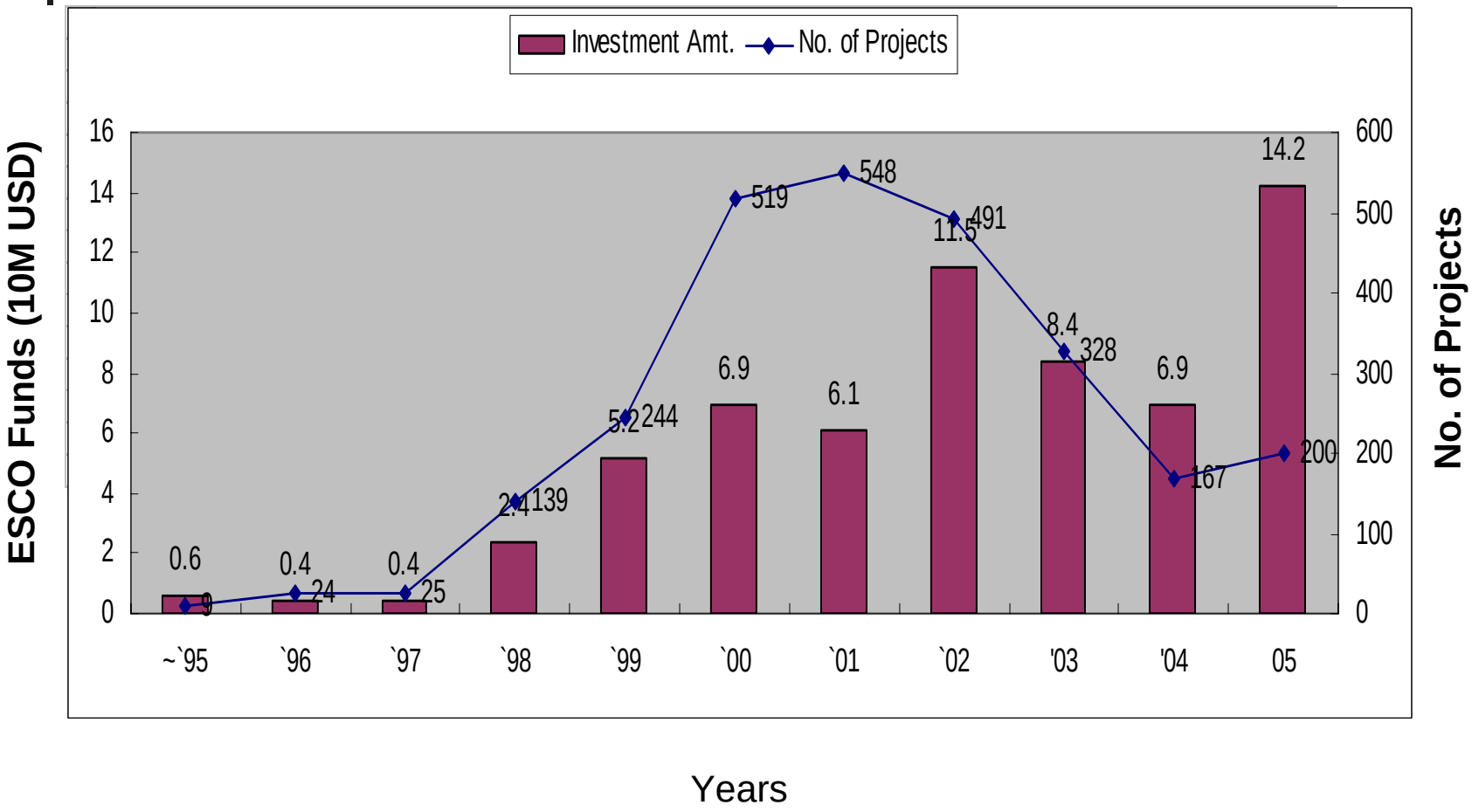
(ESCO : project performance guarantee / Energy user : Fund raising)



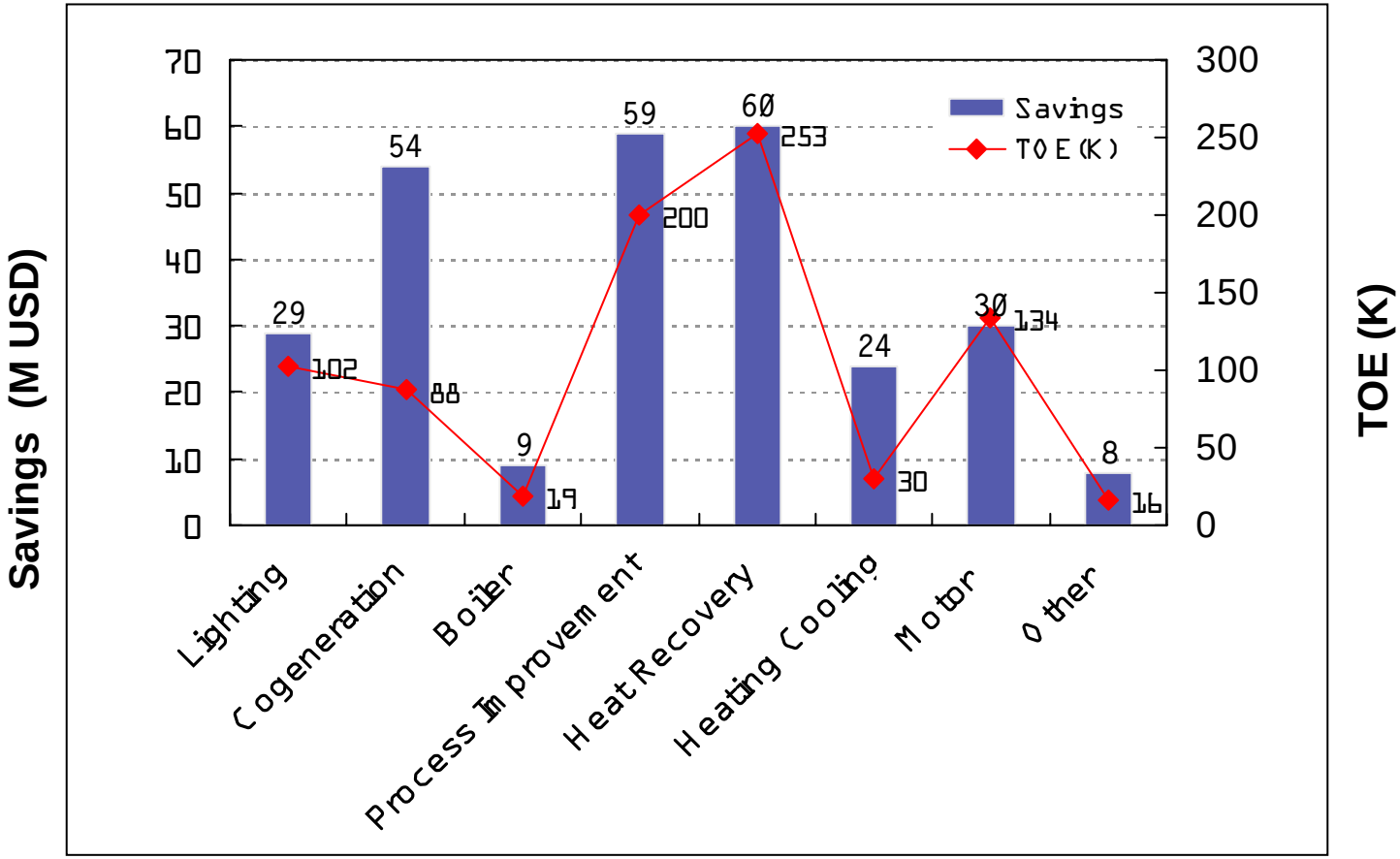
Registration of ESCO's



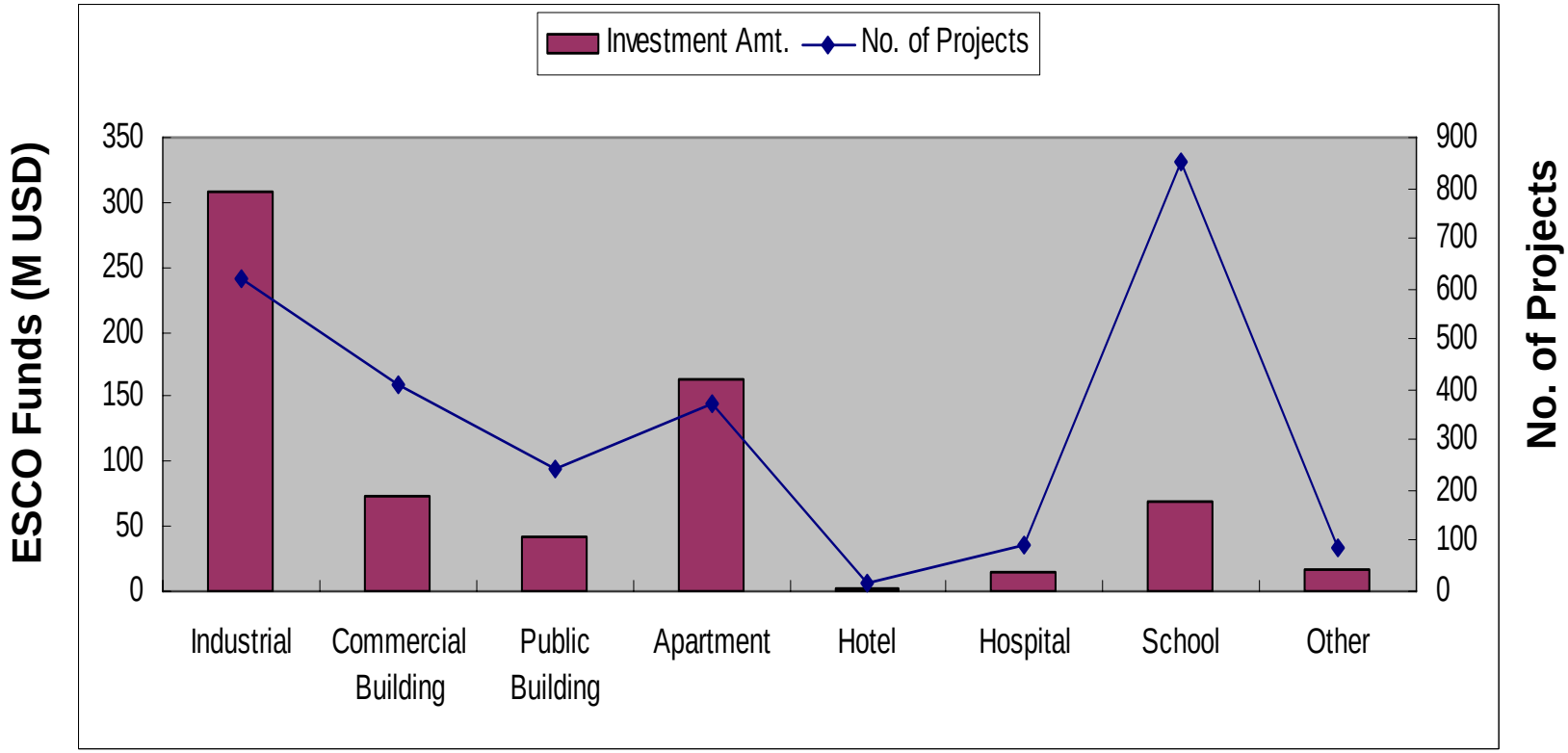
ESCO Investment by Year



Saved Energy after ESCO



ESCO Investment by Business Sector



Energy Saving Technologies in **Industry**

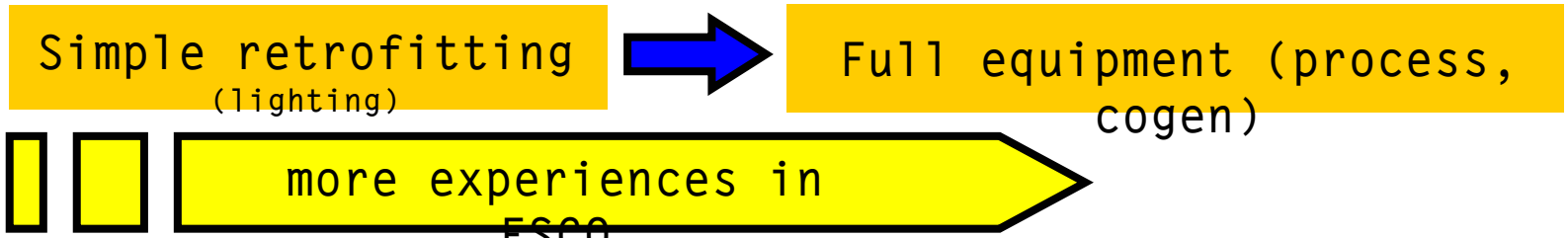
- **Waste Heat Recovery System**
  - Heat Recovery Boiler,
  - MVR, TVR
  - Heat exchanger for Heating, cooling
- **Co-Generation** (electricity and steam)
- **Process Improvement**
  - Naphta Cracking Heater Coil Replacement
  - N_2 Recovery System in PTA Unloading Process
  - R/C Flow Improvement in EPS Process
  - Air compressor
- **Others**

Energy Saving Technologies in **Building**

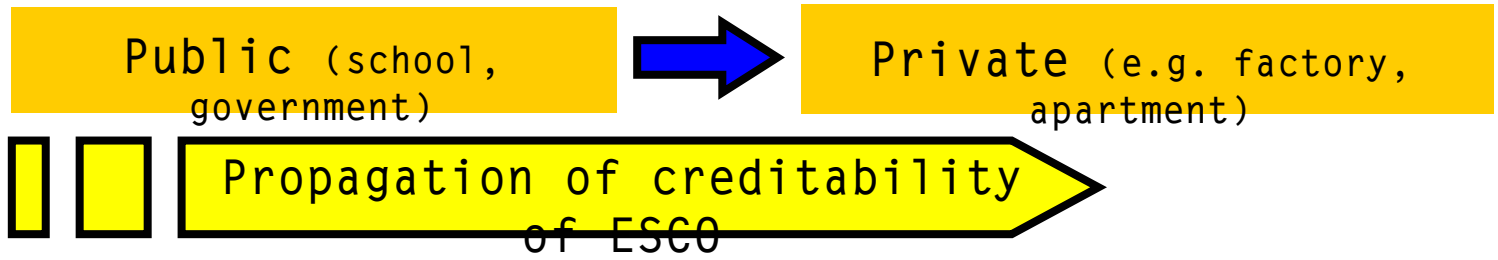
- Ice thermal storage system
- High efficient lighting system
- Co-generation system
- Heat recovery system (AHU, Steam)
- Chiller (absorption chiller unit)
- Inverter
- Building automation controls
- Electric power factor improvement
- Others

Trends of ESCO market

- Large scale ESCO projects

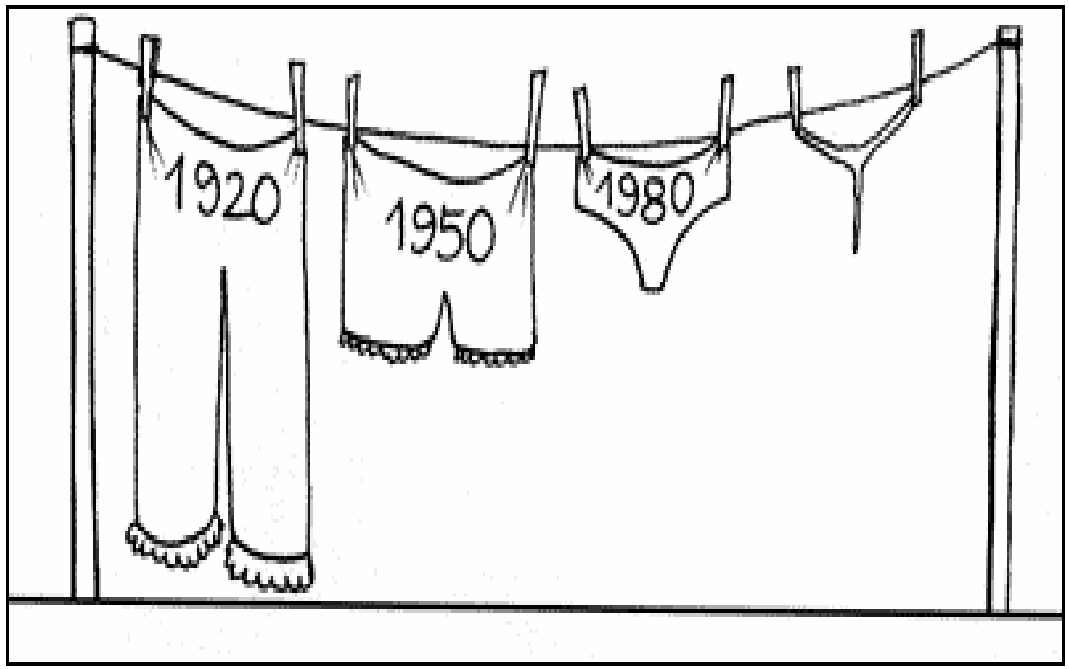


- Private sector from Public sector (client & funding)



Thanks a lot
for your interests in Energy Saving!

The proof of Global Warming



KAESCO

Korean Association for Energy Service Companies

DSM

with Thermal Energy Storage

Jein Yoo / CEO

EnE System, Inc.

Today's Menu

Brief on EnE System

I. Policy of Electricity Load Management in Korea

II. Why we needs TES ?

III. What is in TES ?

IV. Experiences of EnE System

Company History & General Information

Largest Market Share Holder in Thermal Energy Storage

History

Jump for the Global Leader

- 2005.12 New & Renewable E. Company
- 2005. 8 Capital Increased to 2.3 MM
- 2004. 4 First foreign proj award in Singapore
- 2003. 7 M&A of AFT for gas and environment business
- 2003. 3 EnE SEA (Singapore) established
- 2002. 7. KOSDAQ listing (July 30, 2002)
- 2002. 5. Good Products Award (Government Procurement Service)
- 2002. 2 ISO9001 : 2000 / KS A 9001 : 2001
- 2002. 2. KT certification : thermal storage

Development & Commercialization

- 2001. 11. Energy saving company Award (MOCI&E)
- 2001. 3. ESCO license
- 2000. 8. Venture company certification
- 1999. 6. Promising venture (KEPCO)
- 1998. 4. Establishment of R&D institute

The first venture spun off from KITECH

- 1997. 7. IR-52 Award (MOST)
- 1997. 6. Establishment

General Information

establishment	June 1997
Business area	Energy system such as TES, Heat pump, HRV, GHP
Paid-in cap.	US$ 2.3 MM (as of 2006)
Sales/net profit	US$ 42.0 MM / US$ 1.7 MM
# of employees	53 (49 engineers)
website	www.enesystem.co.kr

Company Overview

A specialized TES company with proprietary technology for ESCO

Sole technology developer in Korea (ice thermal storage cooling system) (chilled water storage cooling system)

- Ice-Bon / Ice-Son and Aqua-Bon Geo-Bon , IAQ-Bon
- KT Certification and IR52 Award
- High potential for continuous technology development

an ESCO specialized company

- ESCO specializing in TES cooling & heating system, Geothermal Heat Pump, HRV, Gas Engine Heat Pump and High illumination reflectors
- One of the market leaders in energy conservation engineering

Strong price & performance competitiveness through utilization of propriety technology

- Cost reduction by development of core hardware and engineering capability
- No royalty burden
- Strong marketing network and engineering consulting capabilities

Strong growth of approx. 100% revenue increase per annum

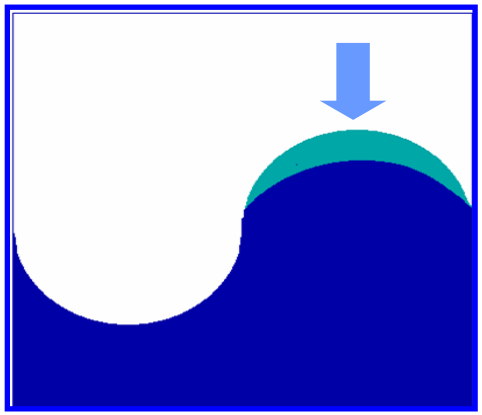
- CAGR growth of 48.8% in `99 ~ `04
- Strong drive by Government for the installation of TES and energy conservation equipment

- **ESCO(Energy Service Company) ?**

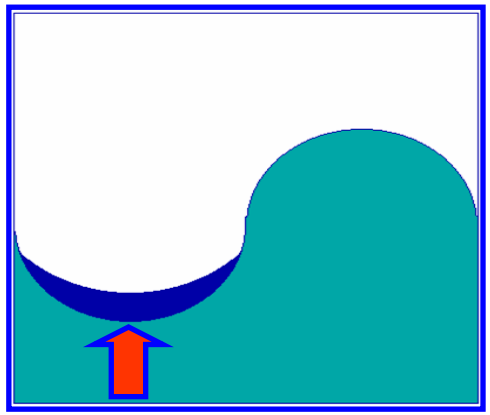
The government funds the substitution of out-dated energy facilities to high energy efficient ones with the help of qualified companies such as EnE System. Those companies receives the funds for what they contributed to the energy savings in a project.

I. Demand Side Management (DSM)

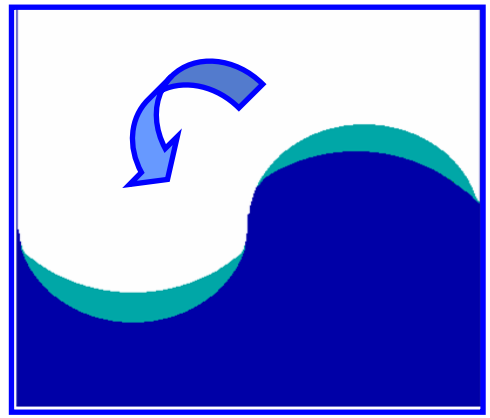
- difference in electricity demand between day and night due to cooling load
- peak demand for cooling purpose during short duration in summer time



Peak Shaving



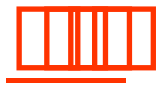
Valley
Filling



Peak Shifting

TES)

Thermal Energy Storage (TES) :



or Two birds with a stone

DSM Policy in Korea

- Mandatory installation of TES by law for central cooling facilities since 1991
- Free incentives for Chilled Water TES and Ice TES
- Low electricity tariff for off-peak during night time (22:00~08:00) , *i.e.* only ¼ compared to that of day time
- Tax reduction for the invested cost of TES

II. Why TES ?

Optimum tool for energy conservation & environment protection

Environment aspects

* Large scale equipment enjoys higher efficiency
* All machines are operating at designed optimum capacity w/ high efficiency

→ Less emission of CO_2 due to consuming less gas or oil

Power Company aspects

* Load factor of existing power plant can increase ; more sales with existing plant
* Reduction of new plant construction to supply peak demand ; save investment

→ Saving fossil fuel cost as well as construction cost for new plant

Facility Owners aspects

* Saving in utility cost with low electricity tariff during off-peak
* Stable operating with additional cold source(□□□) with storage

→ Saving utility cost as well as stable operating of cooling system

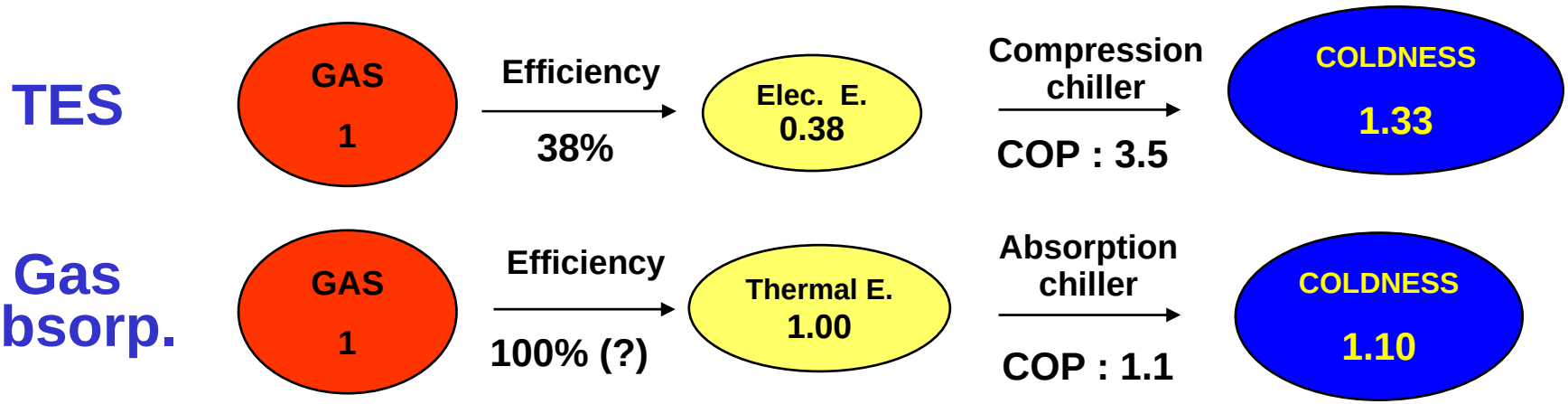
Method of Cooling or Refrigerating

(1) Vapor Compression　　(2) Absorption

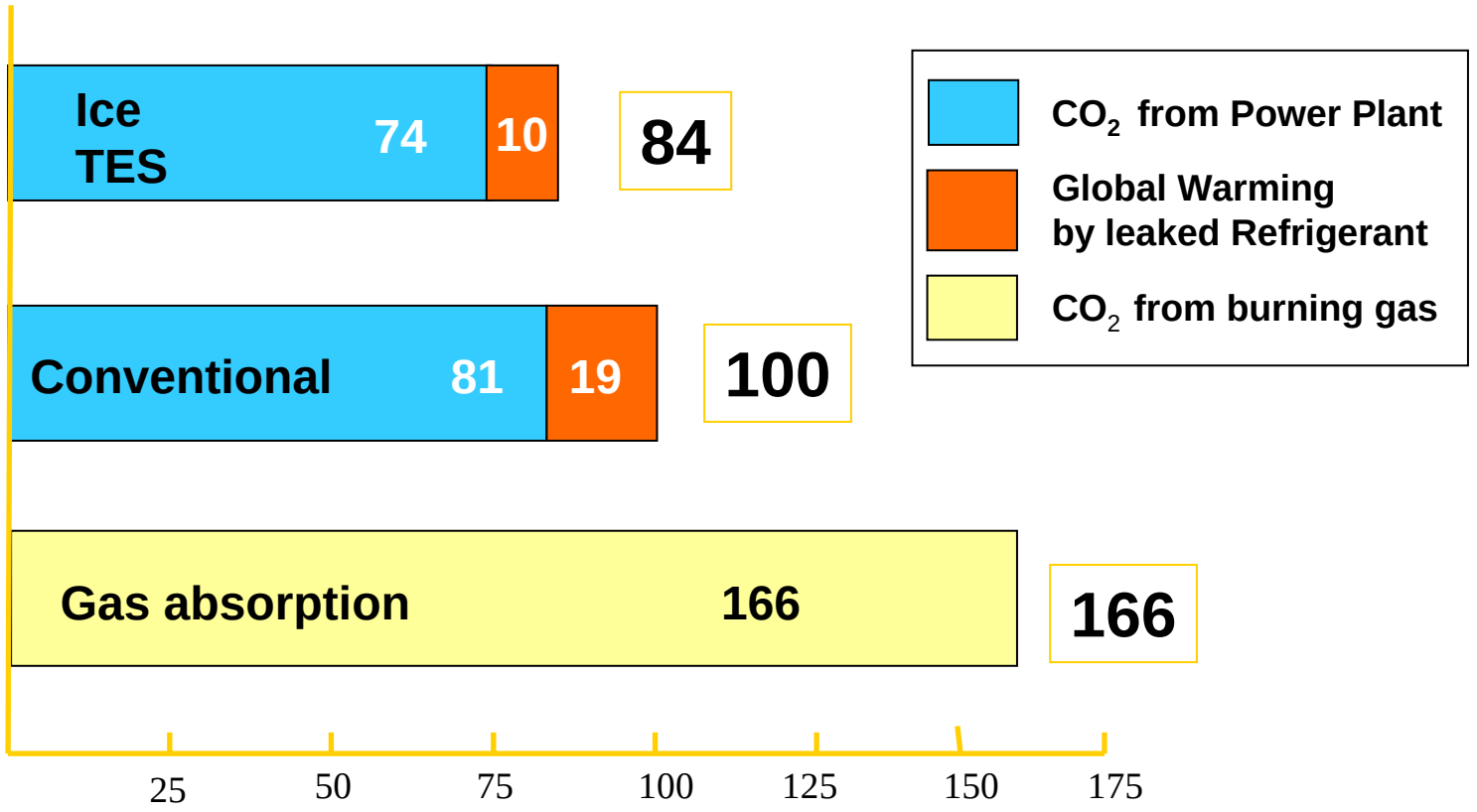
COP： **Coefficient of Performance**

definition : the ratio of coldness output to energy input

	(1) Vapor Compression		(2) Absorption
Energy	Electricity for motor		Gas or Coal for boiler
COP	Chilled water	Ice	Chilled water only
	Higher than 4	About 3	Max 1.1



CO_2 emission from various cooling methods



- data from Tokyo Electric Power Company of which nuclear plant is about 20%

III. What is in TES

- Chilled Water TES (CW TES)

  Stratified CW TES

- Ice TES

  Ice-on-Coil

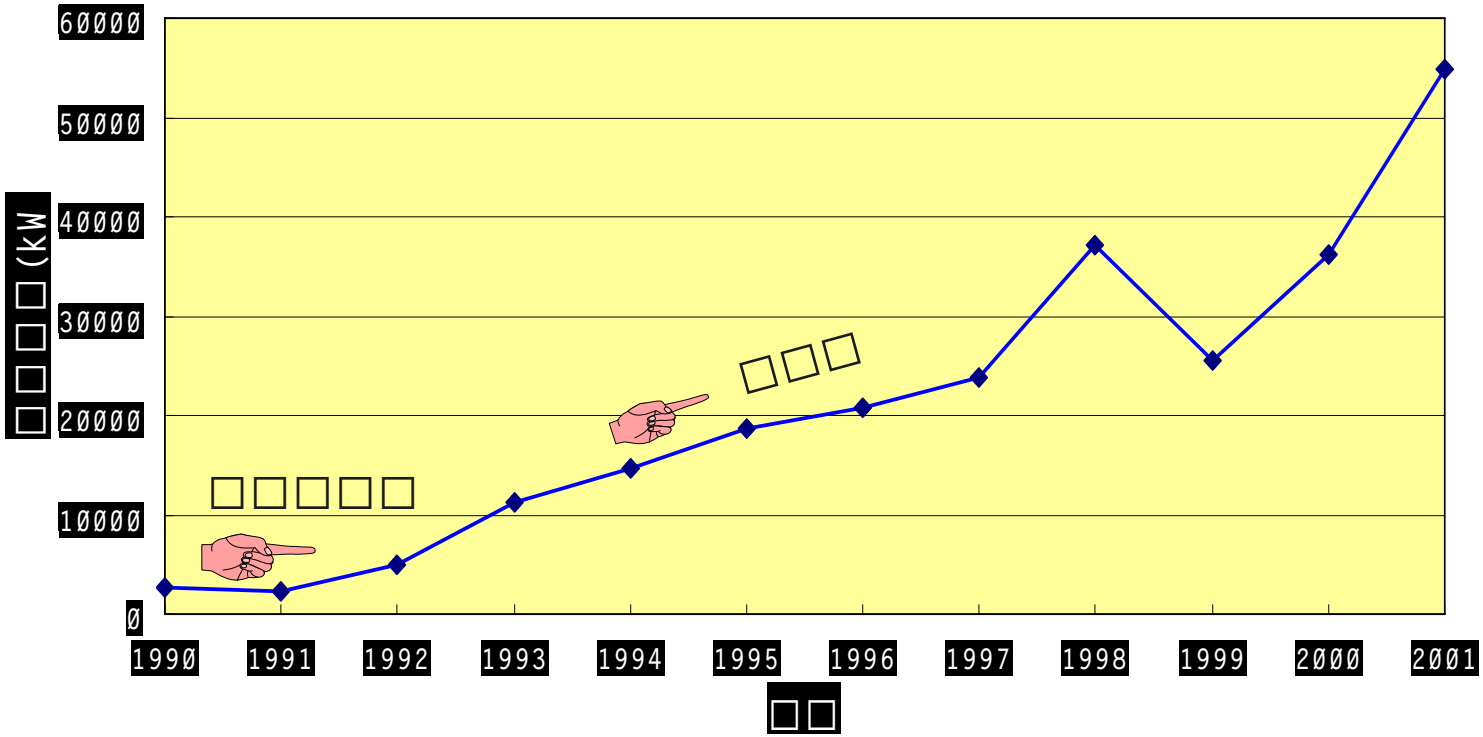
  Slurry

  Capsule

* Capsule is mentioned at the last, but not the worst. It is the best

Growth of TES in Korea

- **starting year : USA - 1980 Japan- 1985 Korea- 1991**
- **about 10 companies are in the market**



These may be yours for DSM tomorrow

- **Ice TES references**
- **Chilled Water TES references**

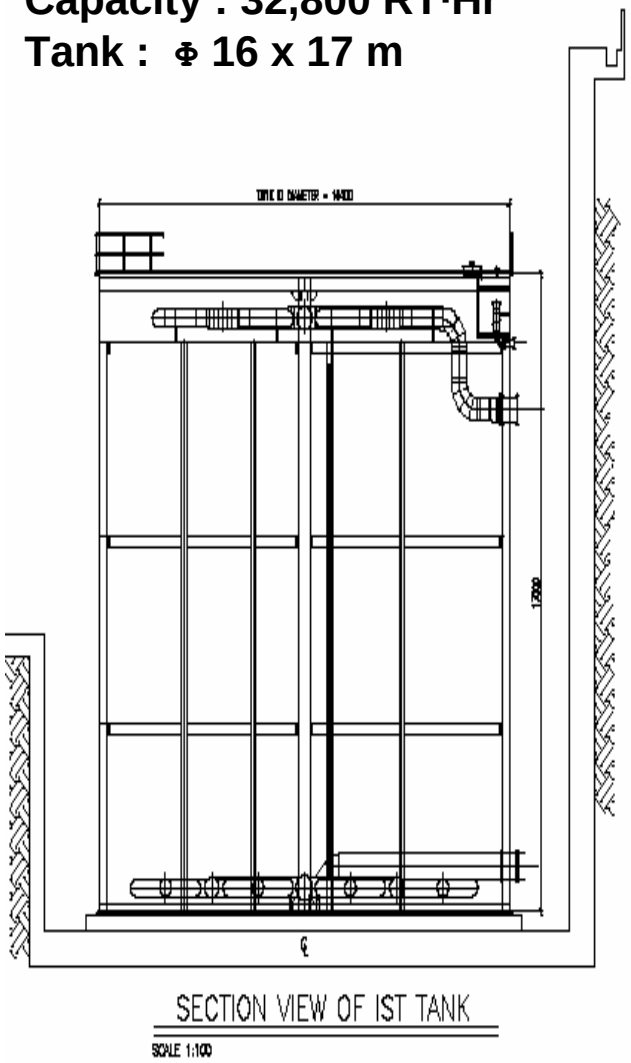
Ice TES (1/2)

Cylindrical Steel Tank Type

Biopolis Proj. at Singapore

Capacity : 32,800 RT·Hr

Tank : Φ 16 x 17 m



1st project of conversion from CW TES to Ic

→ very smart design !

→ Increasing cooling capacity about 4 t

→ good for continuing expansion of deve
with existing power plant

Ice TES (2/2)

Concrete Tank Type

Sang-Am DMC

45,000 RT·Hr

18x7x7 m, 4 sets

Rodamco Plaza

24,000 RT·Hr

15x10x9m, 1 set

15x4x9m, 1 set

63 Bldg. Seoul

17,900 RT·Hr

13x14x8m, 1 set

Chilled Water TES (1/2)

Steel Tank Type

Dubai Investment Park

14,220 RT•Hr

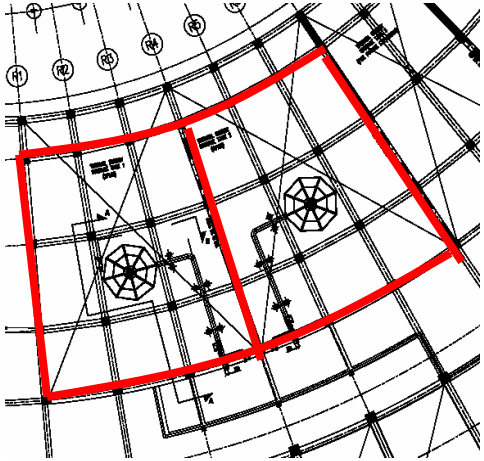
Ø 21.6 x 15 m

upper radial diffuser

lower radial diffuser

Chilled Water TES (2/2)

Concrete Tank Type



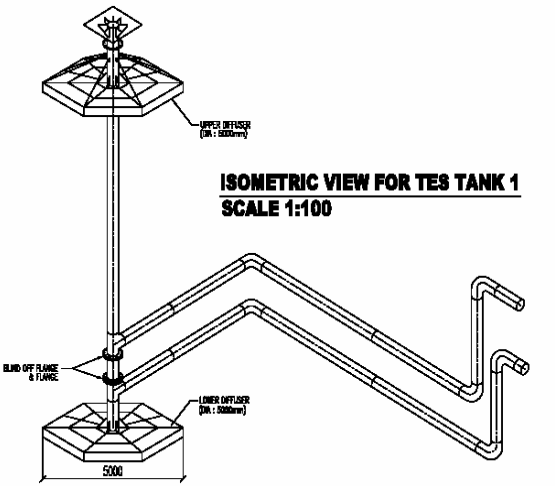
Nanyang Tech. Univ. at Singapore

22,000 Rt·Hr

15x19x21 m , 2 sets

Korea Aerospace Ind.

14,274 Rt·Hr



References of Thermal Storage Installation

List of projects with the pride of good performance of Ice-Bon and Aqua-Bon (selected projects only)

Aqua-Bon Chilled Water TES

More than 40 projects

PROJECT	Completion Date	Tank m X m X m	Capacity RTHr
LG-SILTRON Plant #3	2002. 09	15 X 45 X 6	6,700 RTHr
OTIS-LG	2003. 6	45 X 8 X 8	9,770 RTHr
Daehan Fabric	2005. 03	Φ 19 x 15	14,000 RTHr
Republic Poly.	2005. 04	15 X 19 X 21 (2 set)	26,000 RTHr
LG Philips LCD Plant #7	2005. 10	94 X 10 X 13	27,000 RTHr
Tabreed T-06	2005. 11	Φ 20.0 X 15.0	12,000 RTHr
Tabreed Al Dhafra	2006. 02	Φ 19.5 X 15.0	10,000 RTHr

Ice-Bon Ice TES

more than 150 projects

PROJECT	Completion Date	Tank m X m X m	Capacity RTHr
KyoBo Insurance	2002. 12	15 X 13 X 6	13,200 RTHr
63 Building	2003. 06	13 X 14 X 8	17,900 RTHr
Rodamco Plaza	2003. 04	15 X 10 X 9 & 15 X 4 X 9	24,000 RTHr
National Museum	2003. 06	46 X 6 X 5	13,000 RTHr
Sang Am DMC	2006. 05	18 X 7 X 7 (4 set)	45,000 RTHr
Biopolis	2006. 12	Φ 16 x 17	32,800 RTHr

Retrofitting of 63 Building in Seoul, Korea

- Originally completed in September 1986 and a landmark building in Seoul, Korea
- Total floor area : 166,000 ㎡
- Office, department store, convention centre and many retail stores
- Peak cooling load :

Original design – 3,000 RT (Gas ABS chillers) + 2,100 RT(turbo chillers)

After retrofitting – 3,000 RT (Gas ABS chillers) + 3,900 RT (Ice TES of EnE System)

(1) Brief on M&E retrofitting

- 63 Building was due for M&E replacement due to inefficient operation of 18 years old equipment
- Furthermore, the cooling load increased 35% from 5,100 RT to 6,900 RT due to office equipment load increase, increasing retail demands and global warming compared to that of 18 years ago.
- 3 each of 1,000 RT gas absorption chillers were replaced to 3 new unit for 3,000 RT cooling load
- 3 each of 700 RT turbo chillers were replaced to 3 each of 750 RT brine chillers with 17,000 RT·hr Ice TES for the 3,900 RT cooling load
- If Ice TES was not employed for meet increased cooling load 3,900 RT from previous 2,100 RT, 63 Building would have had to install 3 each of 1,300 RT turbo chillers.
- Ice TES supplied by EnE System has a storage capacity of 17,000 RT·Hr which correspond to a 1,700 RT chiller since it is designed to discharge the coldness for 10 hours.
- The abandoned oil tank which had not been used after natural gas pipe line was connected was ideal for thermal storage tank for EnE's Ice-Bon cooling system

(2) List of equipment installed and assessment

	CONVENTIONAL – Proposed new equipment to be installed			Ice TES – EnE's Ice Bon System		
	Capacity	Quantity	Electric Power	Capacity	Quantity	Electric Power
Ice Storage	–			17,000 RT·hr		
Chiller	1,300 RT	3	2337 kW	(Day) 750 RT	3	1526.1 kW
				(Night) 580 RT		1420.5 kW
Cooling Tower	1,600 RT	3	225 kW	1000 RT	3	142.5 kW
Water Pump	175 hp	4	492.2 kW	100 hp	4	281.3 kW
Brine Pump				60 hp	3	112.5 kW
				50 hp	1	46.9 kW
				40 hp	2	75 kW
Plate Heat Exchanger				900 RT	2	
				800 RT	1	
				650 RT	2	
Total electric Power			3054.2 KW			2184.3 kW

▣ Electric Power

	CONVENTIONAL	Ice TES	Remarks
Required Power	3,054.2 kW	2,184.3 kW	~ 30 % saving

▣ Operating Cost

	CONVENTIONAL	Ice TES	Remarks
Operating Cost	448,079,000 KRW	164,079,000 KRW	~ 63 % saving

Note : Calculation based on electricity tariff in Korea

Ice TES - 73.4 KRW/kWh for on-peak time

26.9 KRW/kWh for off-peak time (22:00 ~ 08:00)

CONVENTIONAL - 111.9 KRW/kWh for day time

TES for air-conditioning could achieve about 600 MW peak shaving for KEPCO .

Thanks a lot in advance

for your interests

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