A parametric cost – benefit analysis for the use of DG technologies in the island of Cyprus

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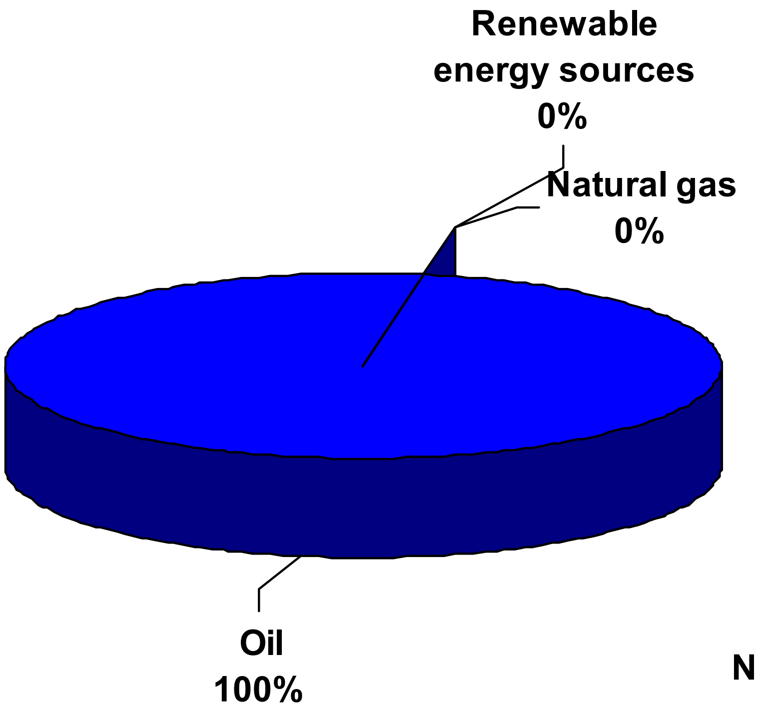
The electricity sector in Cyprus

Present status

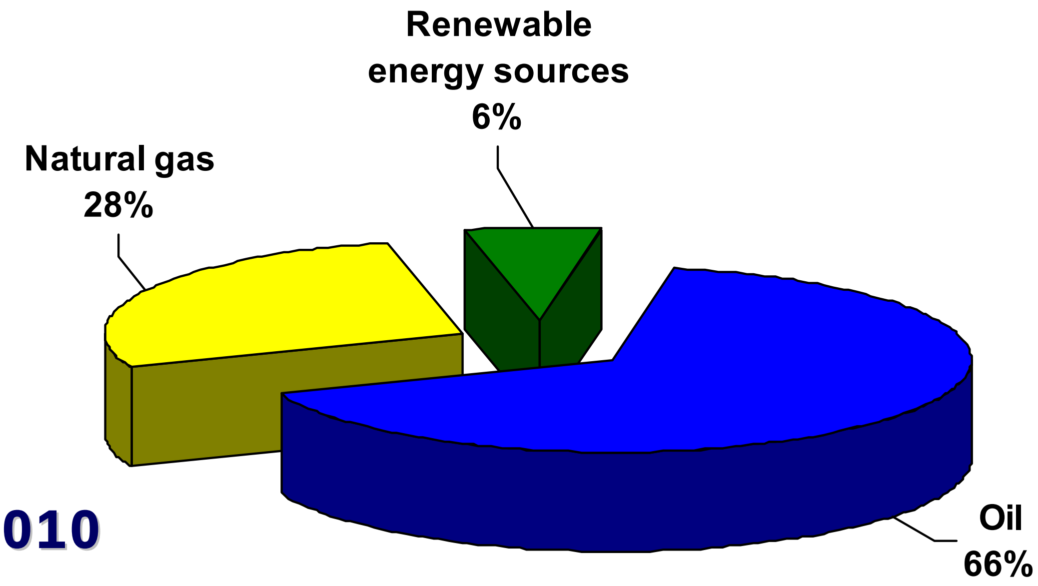
1. Small isolated island power system
2. Depend on fossil fuels
3. Installed capacity 988MWe
4. Generation 4.043 million kWh (in 2003)
5. Peak load 776MWe (in 2003)

Fuel share for electricity generation

Cyprus fuel share in electricity



Today



Year 2010

Simulation algorithm

IPP technology selection algorithm*

1. Economic model

2. Evaluation of candidate power technologies:

- Capital cost
- Fuel consumption and cost
- Operation and maintenance cost
- Plant load factor
- Life expectancy etc.

3. Least cost power generation configuration

***Poullikkas A., "A technology selection algorithm for independent power producers", *The Electricity Journal*, 2001.**

IPP algorithm

Cost Function*

$$\min\left[c_k\right] = \min\left[\frac{\sum_{j=0}^{N} \frac{C_{Cj} + 12\times P_C \times \left\{O_{MFj} + 1000\times LF \times \left[0{,}73\times O_{MVj} + 2628\times\left(\frac{F_j}{\eta\times CV}\right)\right]\right\}}{(1+i)^j}}{\sum_{j=0}^{N}\frac{8760\times P_C\times LF}{(1+i)^j}}\right]_k$$

Capital cost (€)
Power (MW)
Fixed O&M (€/kW-month)
Capacity factor (%)
Variable O&M (€/kWh)
Fuel cost (€/t)
Electricity unit cost (€/kWh)
Fuel calorific value (kJ/kg)
Efficiency (%)

*Poullikkas A., "A technology selection algorithm for independent power producers", *The Electricity Journal*, 2001.

Modified Cost Function for PVs

$$\min\left[c_k\right] = \min\left[\frac{\sum_{j=0}^{N} \frac{C_{Cj} + \left(12 \times P_C \times O_{MFj}\right) + \left(I \times A \times \eta \times O_{MVj}\right)}{\left(1+i\right)^j}}{\sum_{j=0}^{N} \frac{I \times A \times \eta}{\left(1+i\right)^j}}\right]_k$$

Electricity unit cost (€/kWh)

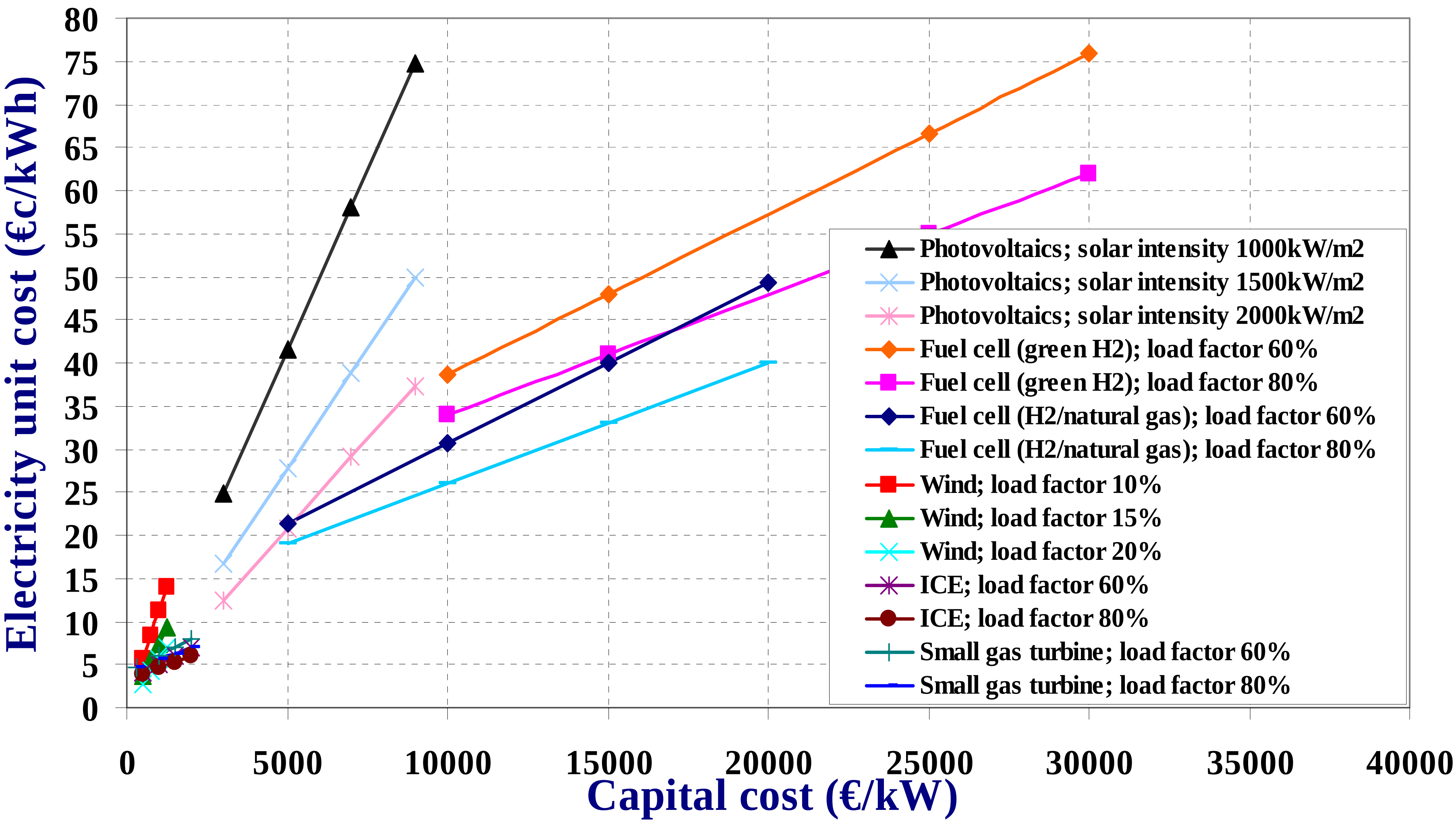
Annual solar radiation (kWh/m²)

PV panels area (m²)

Input parameters

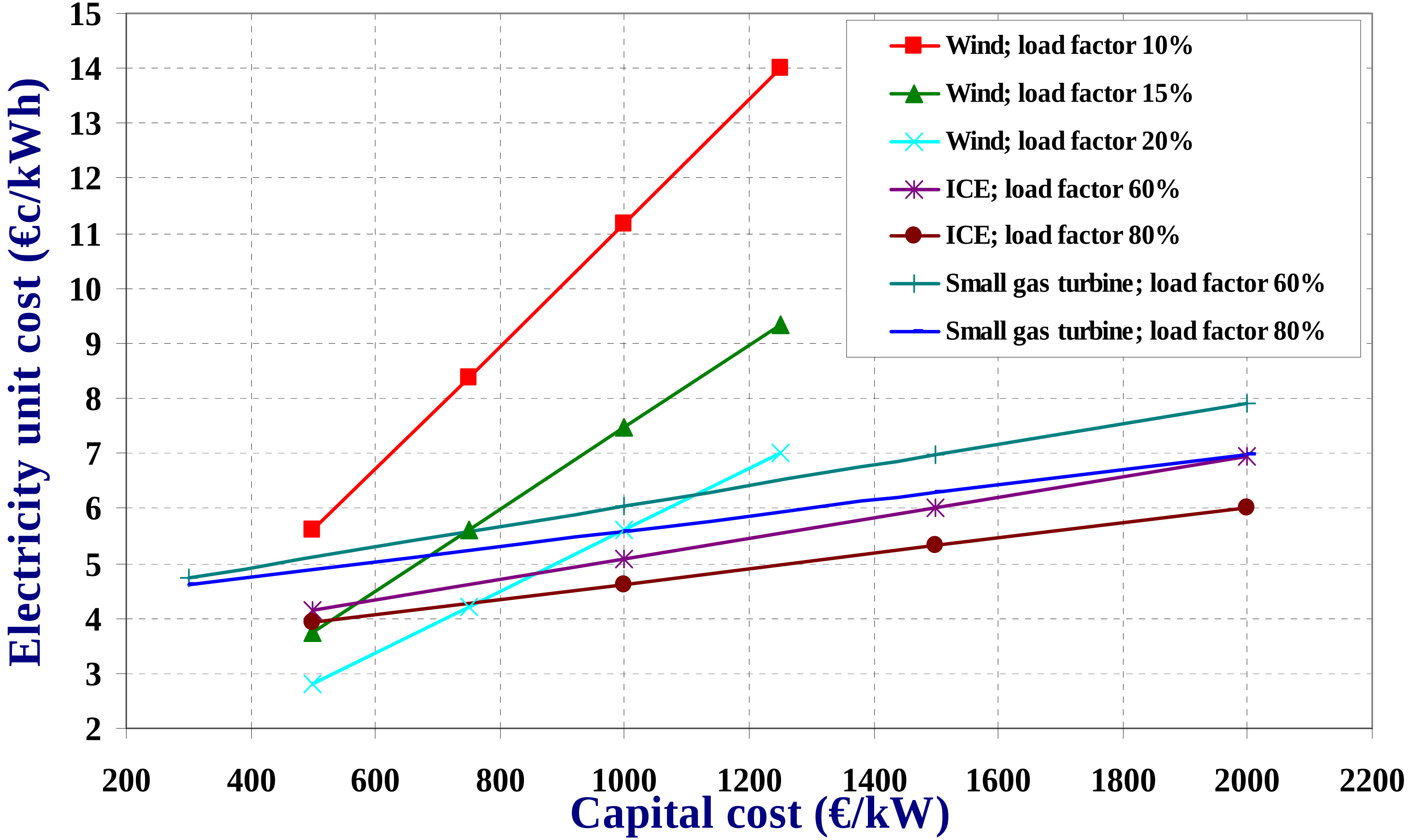
Option No	Technology	Fuel type	Capacity MWe	Capital cost € / kW	Efficiency %	Fuel net calorific value GJ / t	Fuel cost € / t	Fuel cost € / GJ
1	Wind	-	1 - 10	500-1250	-	-	-	-
2	Internal combustion engines	Natural gas	1 - 10	500-2000	35,00	45,0	141	3,13
3	Small gas turbines	Natural gas	1 - 10	300-2000	27,00	45,0	141	3,13
4	Fuel cells	H_2 (natural gas)	1 - 10	5000-20000	45,00	120,0	1800	15,00
5	Fuel cells	H_2 (green)	1 - 10	10000-30000	45,00	120,0	3000	25,00
6	Photovoltaics	-	1 - 10	3000-9000	14,00	-	-	-

Results


Electricity unit cost (€c/kWh)
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0
5000
10000
15000
20000
25000
30000
35000
40000
Capital cost (€/kW)
Photovoltaics; solar intensity 1000kW/m2
Photovoltaics; solar intensity 1500kW/m2
Photovoltaics; solar intensity 2000kW/m2
Fuel cell (green H2); load factor 60%
Fuel cell (green H2); load factor 80%
Fuel cell (H2/natural gas); load factor 60%
Fuel cell (H2/natural gas); load factor 80%
Wind; load factor 10%
Wind; load factor 15%
Wind; load factor 20%
ICE; load factor 60%
ICE; load factor 80%
Small gas turbine; load factor 60%
Small gas turbine; load factor 80%

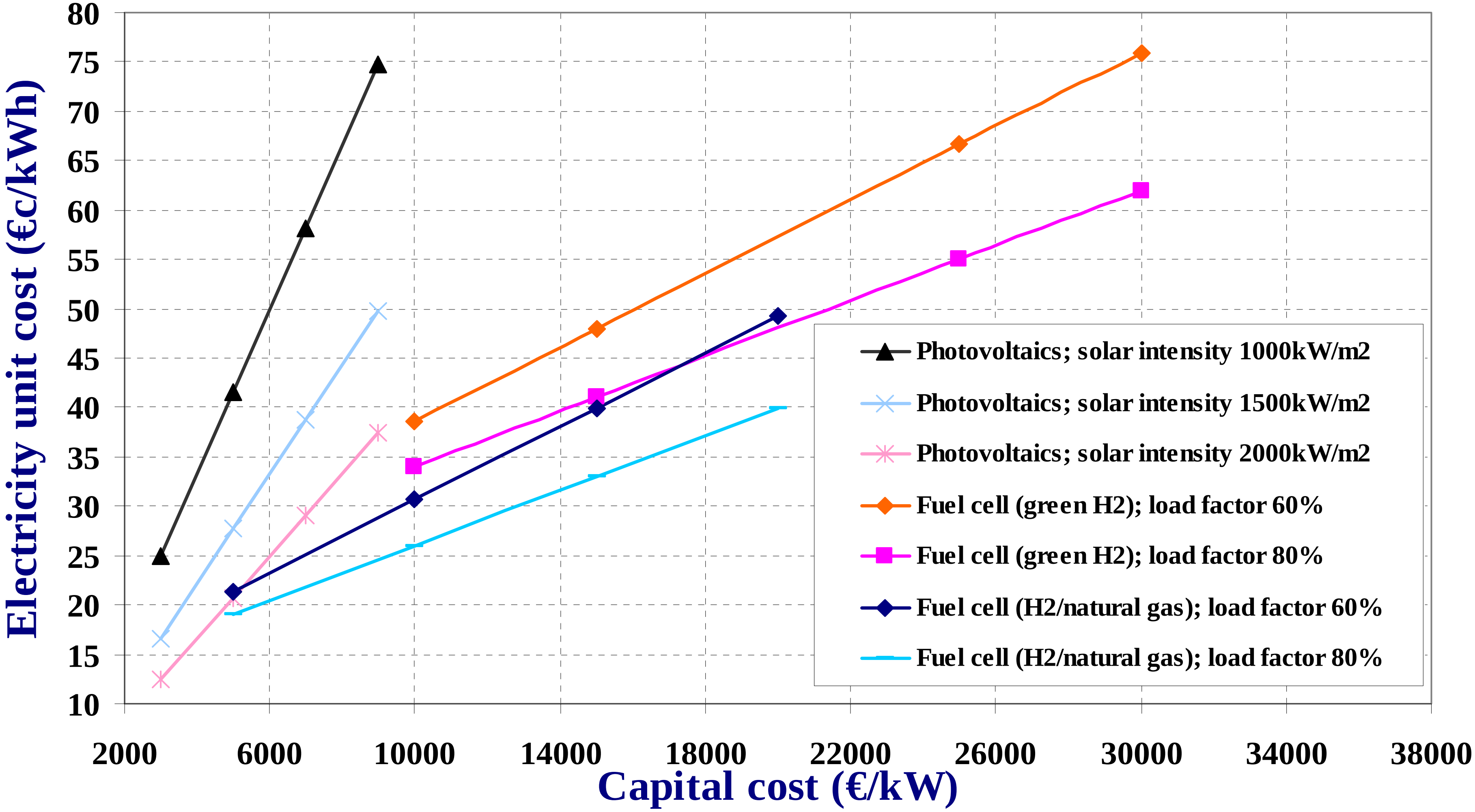
Results

"High" potential technologies



Results

“Low” potential technologies



Conclusions

1. **DG cost – benefit analysis**

2. **High potential DG – wind vs ICE**

3. **Low potential DG – fuel cells vs PVs**

FP6 Project: SES6-CT-2003-503516