



NATIONAL TECHNICAL UNIVERSITY OF ATHENS
SCHOOL OF CHEMICAL ENGINEERING
LABORATORY OF FUEL TECHNOLOGY AND LUBRICANTS

**Directive 2003/30/EC: The Greek Report
Cost Benefit Analysis for the Introduction of Biofuels in
Fuels Market in Greece**

Athens, February 2006

Project Team

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Key Points

1. Detaxation Cost

- A. Prices of Fuel / Biofuel Blends
- B. Four Detaxation Scenarios

2. Benefits from the Introduction of Biofuels

- A. Energy Cultivation Subsidy
- B. Currency Benefits
- C. New Employment Positions
- D. Reduction of Pollutants Emissions

3. Conclusions

Detaxation Cost

A. Prices of Fuel / Biofuel Blends

- Desirable detaxation calculation formula:

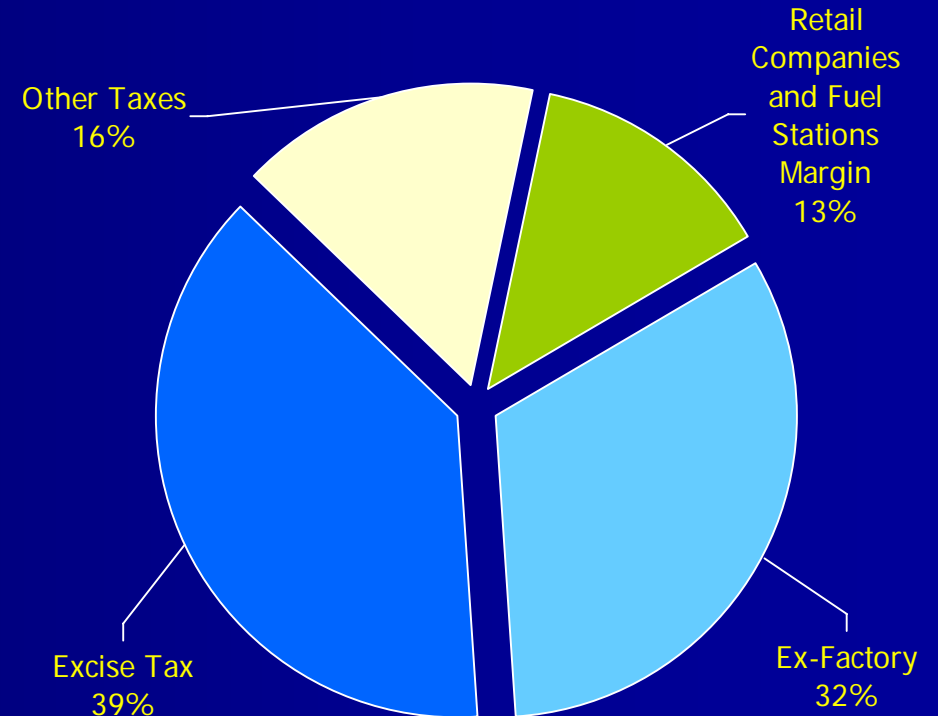
$$\text{Ex-Factory Fuel Price} + \text{Excise Tax} = \text{Ex-Factory Biofuel Price} + \text{Excise Tax}$$

- Given Transport Fuel Prices for the period April 2003 to September 2004
- Blends are calculated on 95% Petroleum Fuel and 5% Biofuel

Detaxation Cost

Automotive Fuel Prices

- Ex Factory Price
- Excise Tax
- Retail Company, Service Station, etc Margins
- Other Taxes (Including VAT)



Detaxation Cost

i. Automotive Diesel

- Excise Tax of Automotive Diesel: **245 € / 1000 L**
Expected to increase at **264 € / 1000 L**
 - Biodiesel price in the international market: **600 – 800 € / 1000 L**
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- Automotive Diesel Price Variance in the period April 2003 to September 2004: **0,17 €/L**
 - Fuel price increase for full detaxation: **~0,01 €/L**

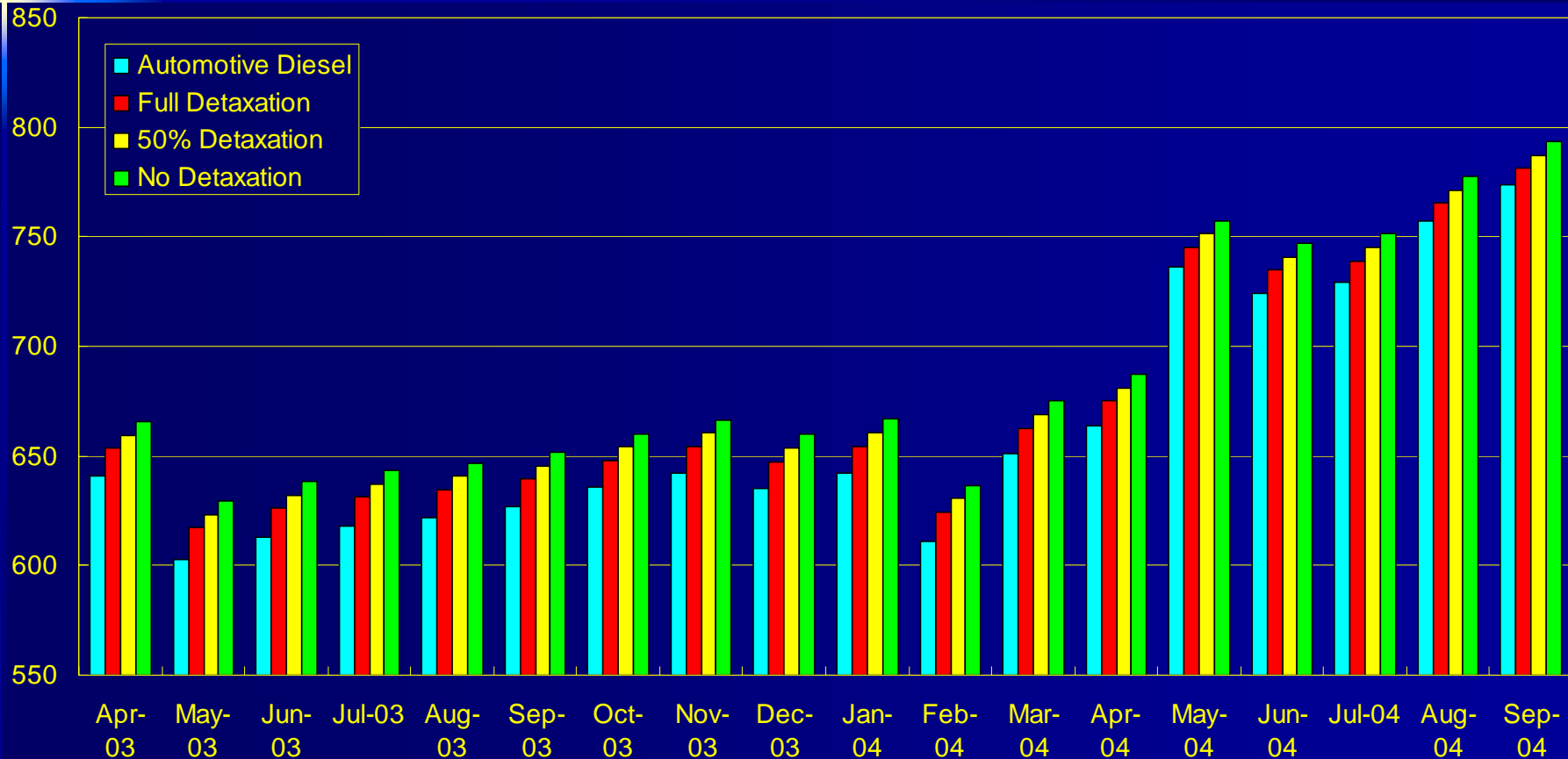
Automotive Diesel with 5% (vol) Biodiesel, Prices in € / 1000 L

Diesel Excise Tax: 245 € / 1000 L – Biodiesel Price: 600 € / 1000 L

Period	Ex-Factory Diesel Price	Retail Companies and Fuel Stations Margin	Total Taxes	Other Taxes	Diesel Price	Diesel Price with 5% (vol) Biodiesel				Biodiesel Excise Tax for Equal Prices
						Biodiesel Taxation				
						100%	50%	10%	0%	
Apr 03	207	85	349	104	641	661	655	650	648	-148
May 03	170	92	342	97	603	625	618	614	612	-186
Jun 03	193	78	342	97	613	633	627	622	621	-162
Jul 03	191	83	344	99	618	638	632	627	626	-164
Aug 03	205	72	345	100	622	642	636	631	630	-150
Sep 03	205	77	345	100	627	647	641	636	635	-150
Oct 03	218	70	348	103	636	655	649	644	643	-137
Nov 03	211	84	347	102	642	661	655	650	649	-144
Dec 03	206	83	346	101	635	655	649	644	642	-149
Jan 04	205	90	347	102	642	662	656	651	650	-150
Feb 04	187	80	344	99	611	632	626	621	619	-168
Mar 04	220	82	349	104	651	670	664	659	658	-135
Apr 04	233	80	351	106	664	682	676	671	670	-122
May 04	274	100	363	118	736	752	746	741	740	-81
Jun 04	248	116	361	116	724	742	736	731	730	-107
Jul 04	259	109	362	117	729	746	740	735	734	-96
Aug 04	296	95	366	121	757	773	766	762	760	-59
Sep 04	300	104	369	124	774	788	782	777	776	-55

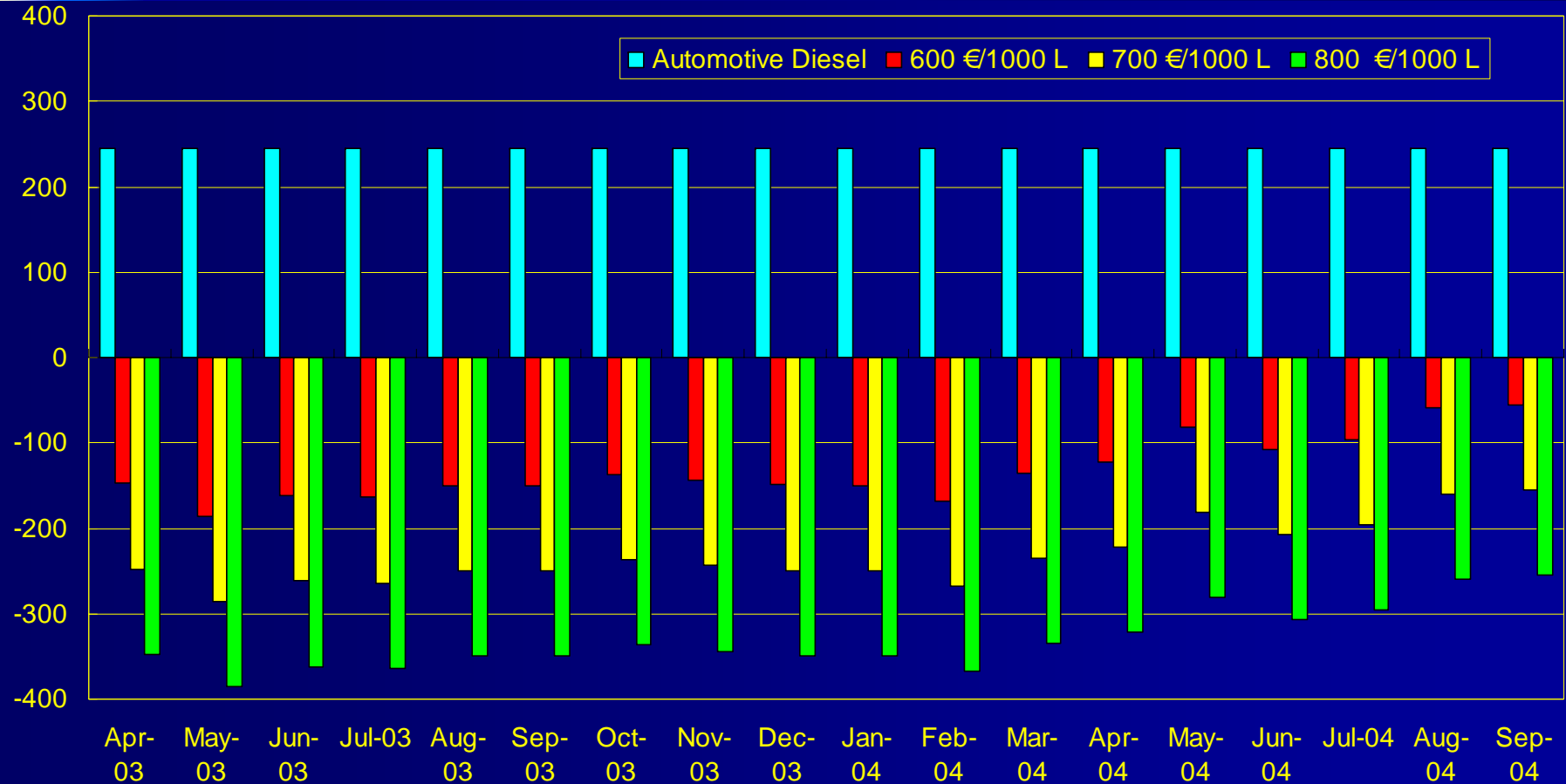
Automotive Diesel with 5% (vol) Biodiesel, Prices in € / 1000 L

Diesel Excise Tax: **245 € / 1000 L** – Biodiesel Price: **700 € / 1000 L**



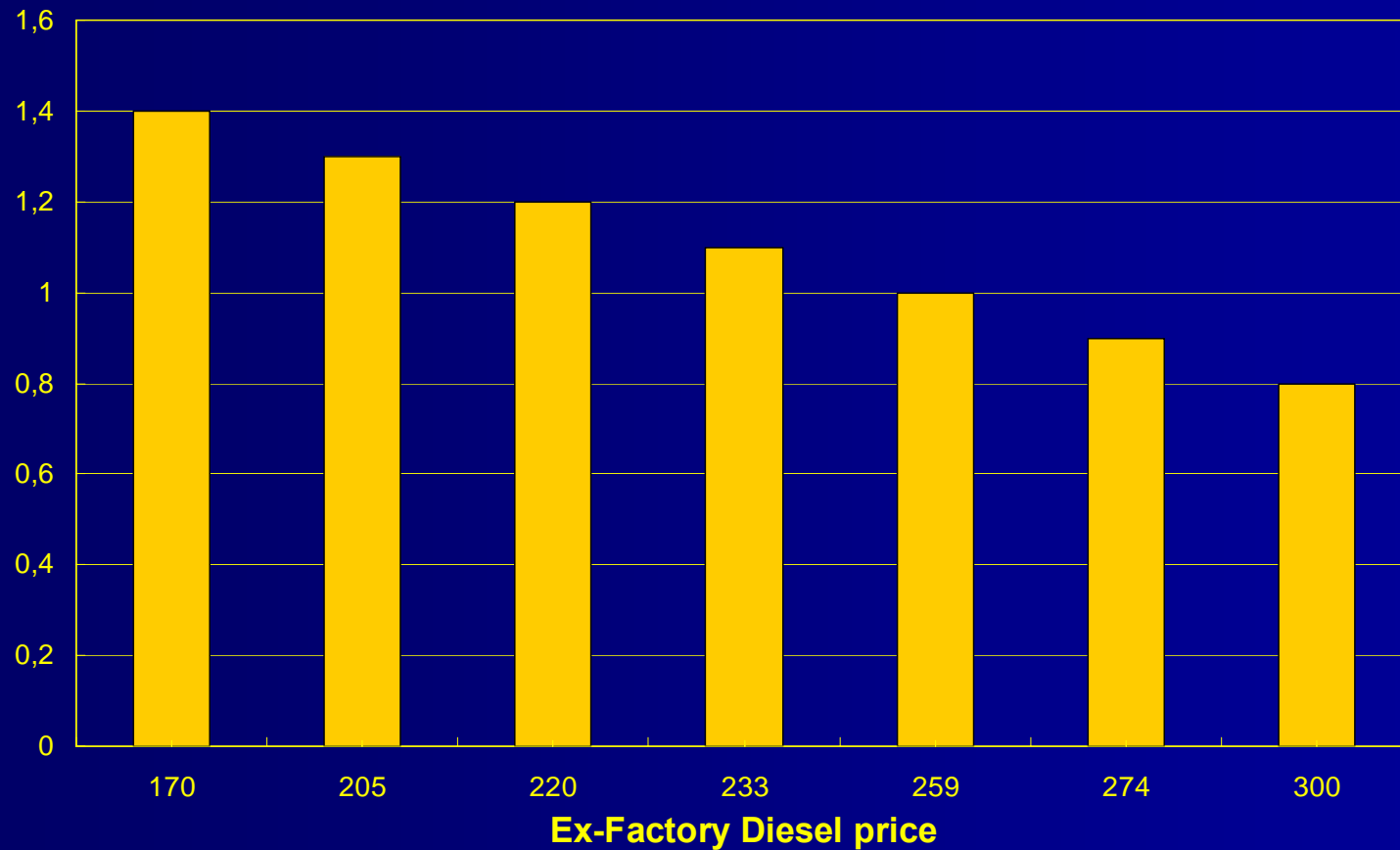
Excise Tax for Equal Prices for Diesel and Biodiesel, Prices in € / 1000 L

Diesel Excise Tax: **245 € / 1000 L**



Price Increase for the Diesel / Biodiesel Blend, Prices in € / 1000 L

Biodiesel Price: **700 € / 1000 L**



Detaxation Cost

ii. Motor Gasoline

- i. Excise Tax of Motor Gasoline: **296 € / 1000 L**
 - ii. Bioethanol price in the international market: **400 – 600 € / 1000 L**
-
- Automotive Diesel Price Variance in the period April 2003 to September 2004: **0,14 €/L**
 - Fuel price increase for full detaxation: **~0,02 €/L**

Motor Gasoline with 5% (vol) Bioethanol,

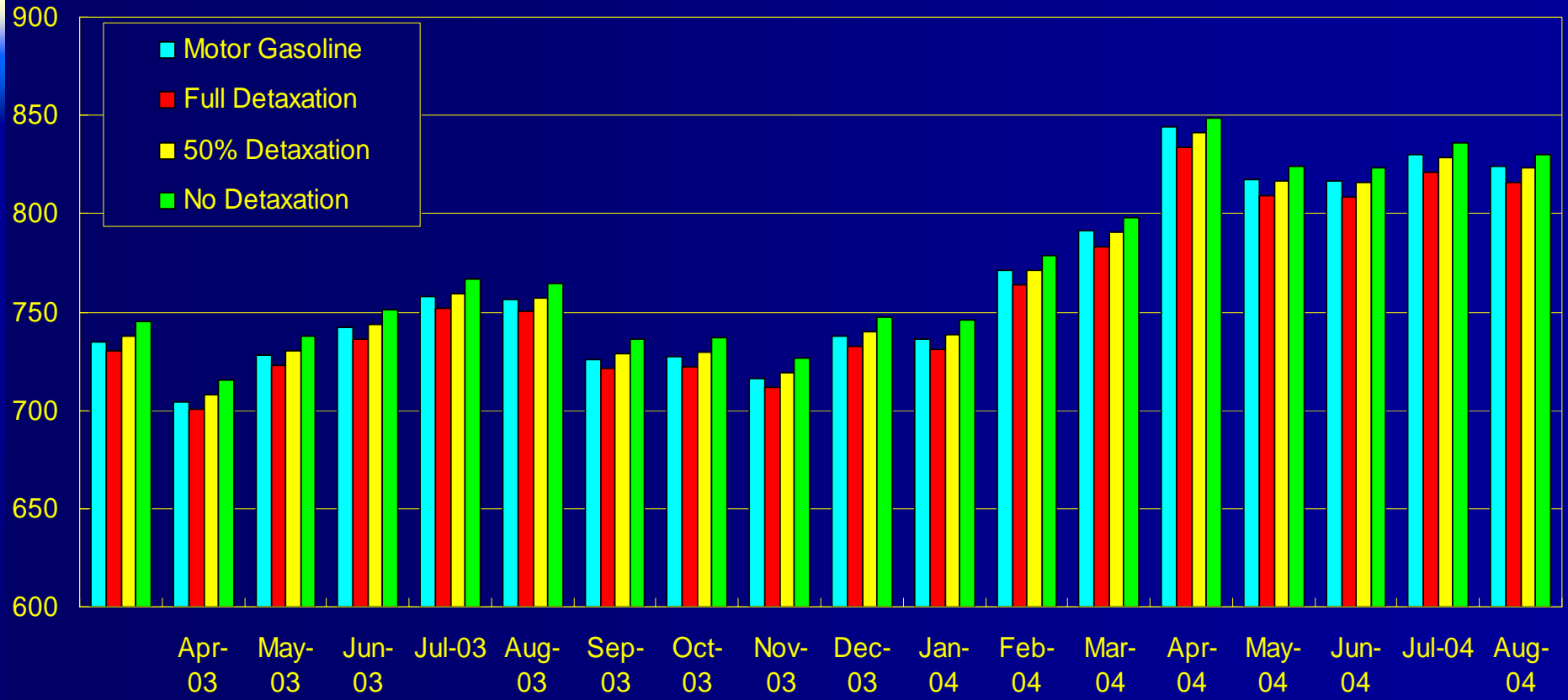
Prices in € / 1000 L

Gasoline Excise Tax: 296 € / 1000 L – Bioethanol Price: 400 € / 1000 L

Time	Ex-Factory Gasoline Price	Retail Companies and Fuel Stations Margin	Total Taxes	Other Taxes	Gasoline Price	Gasoline Price with 5% (vol) Bioethanol				Bioethanol Excise Tax for Equal Prices
						Bioethanol Taxation				
						100%	50%	10%	0%	
Apr 03	196	126	413	117	735	745	738	732	730	92
May 03	177	117	410	114	704	715	708	702	700	73
Jun 03	203	114	411	115	728	738	730	725	723	99
Jul 03	216	114	414	118	742	751	744	738	737	112
Aug 03	223	112	418	122	758	767	759	753	752	119
Sep 03	228	117	415	119	756	765	757	751	750	124
Oct 03	204	113	412	116	726	736	729	723	721	100
Nov 03	199	110	412	116	727	737	729	723	722	95
Dec 03	189	116	411	115	716	727	719	713	712	85
Jan 04	207	116	411	115	738	747	740	734	733	103
Feb 04	209	120	412	116	736	746	738	732	731	105
Mar 04	236	115	413	117	771	779	771	766	764	132
Apr 04	377	122	414	118	791	798	791	785	783	273
May 04	310	121	413	117	844	849	841	835	834	206
Jun 04	266	125	426	130	817	824	816	810	809	162
Jul 04	263	127	426	130	817	823	816	810	809	159
Aug 04	281	120	429	133	830	836	829	823	821	177
Sep 04	273	124	427	131	824	830	823	817	816	169

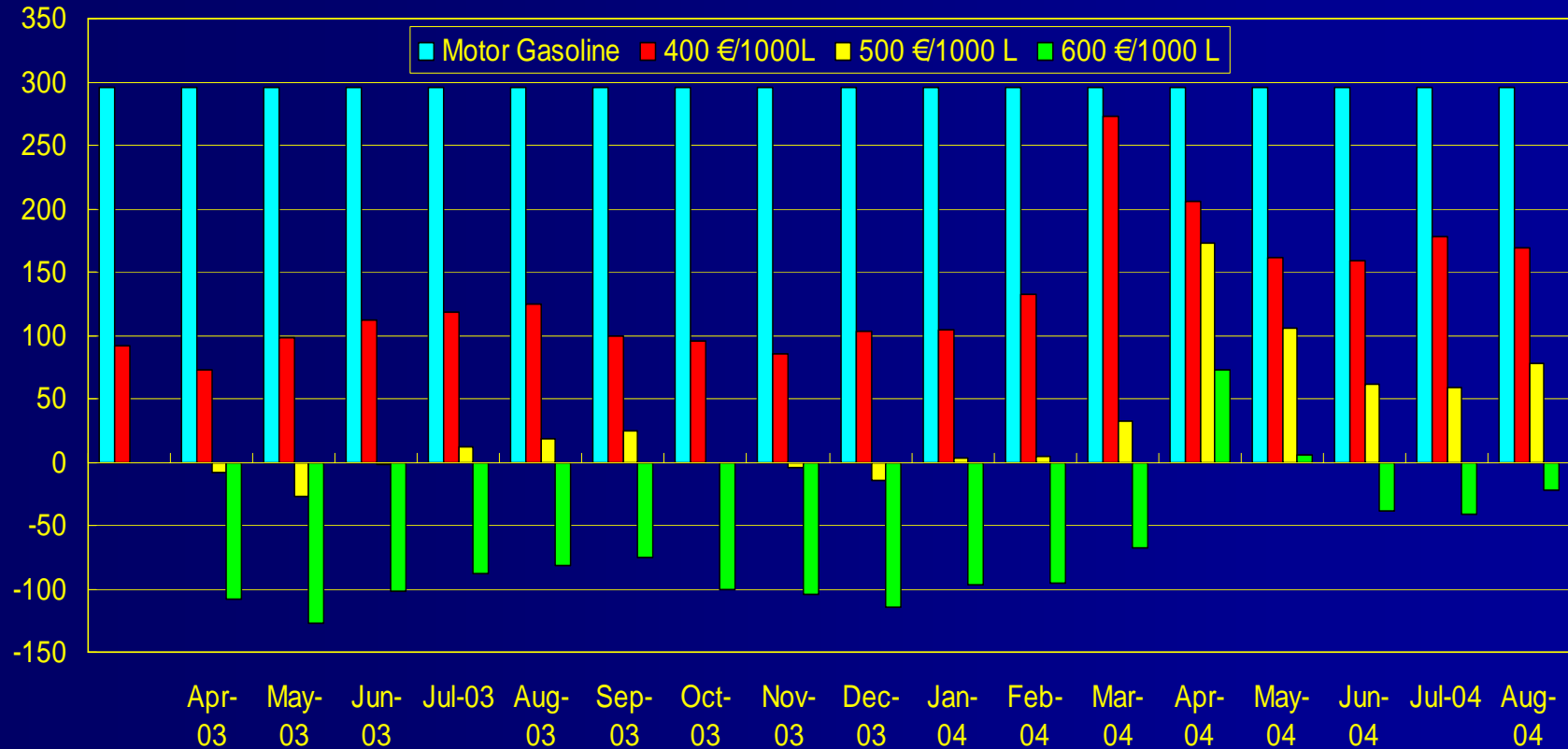
Motor Gasoline with 5% (vol) Bioethanol, Prices € / 1000 L

Gasoline Excise Tax: **296 € / 1000 L** – Bioethanol Price: **400 € / 1000 L**



Excise Tax for Equal Prices of Gasoline and Bioethanol, Prices in € / 1000 L

Gasoline Excise Tax: **296 € / 1000 L**



Detaxation Cost

B. Detaxation Scenarios

1. Full Detaxation of Biodiesel and Bioethanol
Introduction of Biodiesel and Bioethanol in 2005
2. Full Detaxation of Biodiesel and Bioethanol
Introduction of Biodiesel in 2005 and Bioethanol in 2006
3. 50% Detaxation of Biodiesel and Bioethanol
Introduction of Biodiesel in 2005 and Bioethanol in 2006
4. Full Detaxation of Biodiesel and 50% Detaxation of Bioethanol
Introduction of Biodiesel in 2005 and Bioethanol in 2006

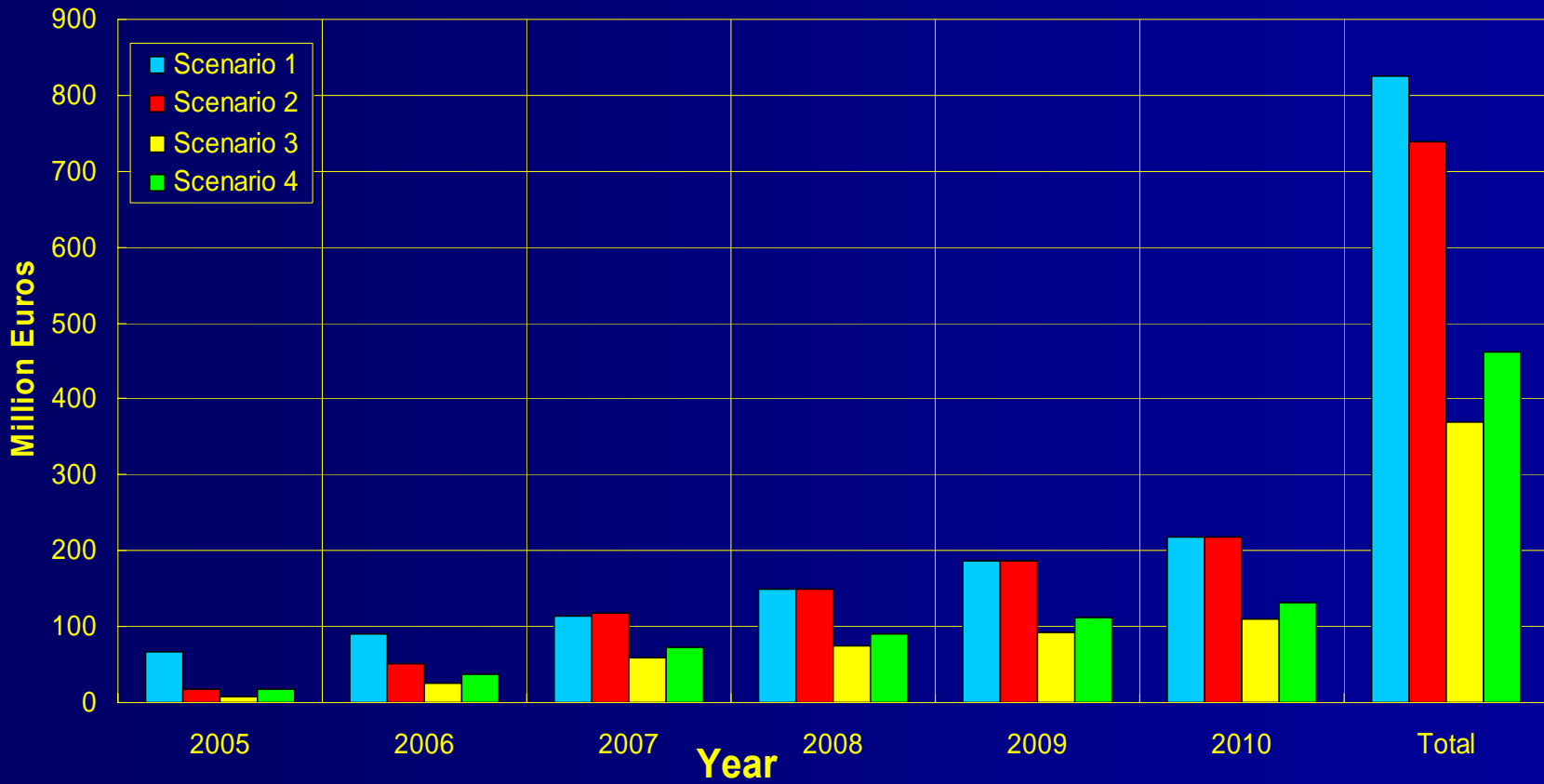
Assumptions for Calculations

$$\text{NHV}_{\text{gas}} = 10444 \text{ kcal/kg}, \quad \text{NHV}_{\text{bioet}} = 6429 \text{ kcal/kg}$$

$$\text{NHV}_{\text{dies}} = 10200 \text{ kcal/kg}, \quad \text{NHV}_{\text{biod}} = 9050 \text{ kcal/kg}$$

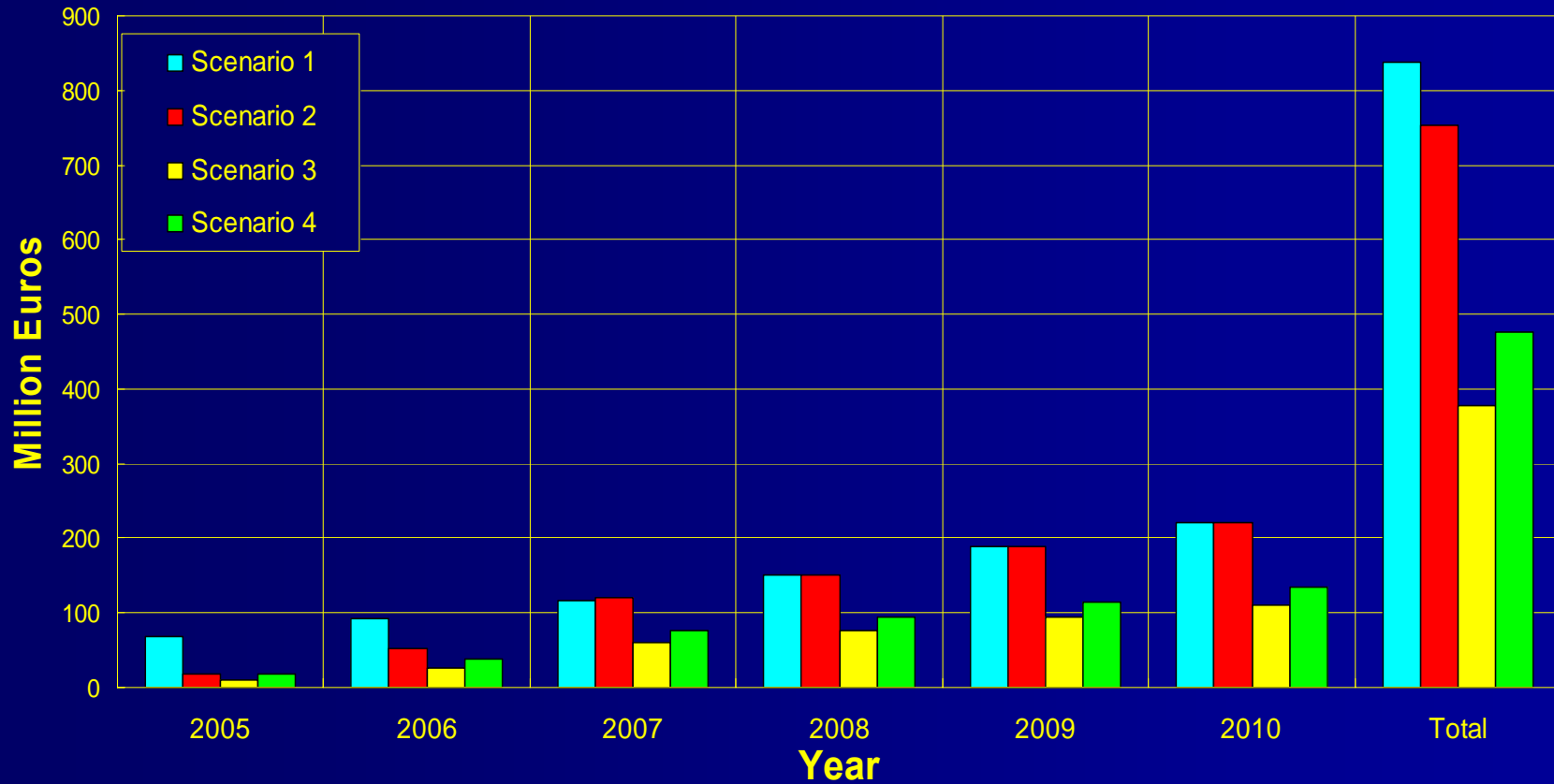
Detaxation Scenarios

Diesel Excise Tax: **245 € / 1000 L**



Detaxation Scenarios

Diesel Excise Tax: **264 € / 1000 L**



Benefits from the Introduction of Biofuels

A. Energy Cultivation Subsidy

- **4,5 € / thousand square meters (45 €/ha)**
 - Average Biodiesel Production: **50 L / 1000 m² (500 L/ha)**
 - Average Bioethanol Production: **460 L / 1000 m² (4600 L/ha)**

Cultivation Subsidy

Year	Biodiesel Required, tons	Area Required, 1000 m ²	Theoretical Subsidy € million	Land Use Scenario	€ million
2005	47.967	959.340	4,32	0%	0,00
2006	73.505	1.470.100	6,62	10%	0,66
2007	100.080	2.001.600	9,01	20%	1,80
2008	114.922	2.298.440	10,34	30%	3,10
2009	130.283	2.605.660	11,73	40%	4,69
2010	152.806	3.056.120	13,75	50%	6,88
Total					17,13

Year	Bioethanol Required, tons	Area Required, 1000 m ²	Theoretical Subsidy € million	Land Use Scenario	€ million
2005	122.046	265.317	1,19	0%	0,00
2006	156.452	340.113	1,53	10%	0,15
2007	192.415	418.293	1,88	20%	0,38
2008	262.784	571.270	2,57	30%	0,77
2009	336.268	731.017	3,29	40%	1,32
2010	395.664	860.139	3,87	50%	1,94
Total					4,55

Benefits from the Introduction of Biofuels

B. Currency Benefits

Year	Substituted Diesel, tons	Diesel Price, €/L	Currency Benefit € million
2005	47.967	0,224	12,72
2006	73.505	0,224	19,49
2007	100.080	0,224	26,53
2008	114.922	0,224	30,46
2009	130.283	0,224	34,54
2010	152.806	0,224	40,51
Total			164,24

Benefits from the Introduction of Biofuels

C. New Employment Positions

- 30 Employees per 50.000 tons Biodiesel Produced
- 18 Employees per 50.000 tons Bioethanol Produced
- € 1.500 per month Average Salary
- Total Biodiesel Production within Greece
- Gradual Increase of Bioethanol Production

New Employment Positions for Biofuels Production

Year	Biodiesel Produced tons	New Employment Positions	Employees Compensations, € million
2005	47.967	28,8	0,52
2006	73.505	15,3	0,28
2007	100.080	15,9	0,29
2008	114.922	8,9	0,16
2009	130.283	9,2	0,17
2010	152.806	13,5	0,24
Total		91,6	1,65

Year	Bioethanol Required, tons	Production in Greece, %	New Employment Positions	Employees Compensations € million
2005	122.046	0	0	0
2006	156.452	20	11,3	0,20
2007	192.415	30	9,5	0,17
2008	262.784	40	17,0	0,13
2009	336.268	45	83,3	1,50
2010	395.664	50	21,3	0,38
Total			142,4	2,56

Benefits from the Introduction of Biofuels

D. Reduction of Pollutants Emissions

- Estimated Cost of CO₂ Emissions: **10 €/ton**
- Life Cycle Analysis
- All Emissions Converted to kg of CO₂ Equivalent
 - CO₂ : 1
 - CH₄ : 23
 - N₂O : 296

Greenhouse Gases Emissions from Life Cycle Analysis

Fuel	Greenhouse Gases Emissions (tons CO₂ Equivalent/TJ)
Gasoline	86
Diesel	79
Bioethanol (wheat)	29
Bioethanol (beet)	40
Biodiesel (sunflower)	24
Biodiesel (rape)	20

Estimation of Economic Benefit from Greenhouse Gases Emissions due to the Biofuels Use

Year	Sunflower Biodiesel (tons equivalent CO ₂)	Benefit, € million	Rape Biodiesel (tons equivalent CO ₂)	Benefit, € million	Average Benefit, € million
2005	100.280	1,0	107.573	1,1	1,0
2006	153.671	1,5	164.847	1,7	1,6
2007	209.231	2,1	224.447	2,3	2,2
2008	240.262	2,4	257.735	2,6	2,5
2009	272.377	2,7	292.186	2,9	2,8
2010	319.465	3,2	342.699	3,4	3,3

Year	Wheat Bioethanol (tons equivalent CO ₂)	Benefit, € million	Beet Bioethanol (tons equivalent CO ₂)	Benefit, € million	Average Benefit, € million
2005	187.802	1,9	151.559	1,5	1,7
2006	240.752	2,4	194.291	1,9	2,2
2007	296.102	3,0	238.960	2,4	2,7
2008	404.403	4,0	326.361	3,3	3,7
2009	517.540	5,2	417.635	4,2	4,6
2010	608.930	6,1	491.417	4,9	5,5

Total benefits from Biofuels Production

Year	CO ₂ Emissions Reduction, € million		Subsidy € million		Currency Benefit, € million		New Employment Positions, € million	
	Biodiesel	Bioethanol	Biodiesel	Bioethanol	Biodiesel	Bioethanol	Biodiesel	Bioethanol
2005	1,0	1,7	0,00	0,00	12,72		0,52	0,00
2006	1,6	2,2	0,66	0,15	19,49		0,28	0,20
2007	2,2	2,7	1,80	0,38	26,53		0,29	0,17
2008	2,5	3,7	3,10	0,77	30,46		0,16	0,13
2009	2,8	4,6	4,69	1,32	34,54		0,17	1,50
2010	3,3	5,5	6,88	1,94	40,51		0,24	0,38
Total	13,4	20,4	17,13	4,55	164,24		1,65	2,56
Total Biodiesel					196,42			
Total Bioethanol					27,51			
Grand Total					233,93			

Conclusions

- The economic analysis followed, assumes that:
 - The fuels/biofuels blend does not influence other economic parameters except market prices, like various taxes, etc.
 - However the diesel/biodiesel blend affects the quality of the fuel in parameters such as cetane number, sulphur content, density, etc.
 - Therefore these changes influence the ex-factory price of diesel since they influence its quality.
 - These changes are rather positive, since cetane number of biodiesel is high and its sulphur content is almost zero.
 - Therefore, any change in the ex-factory price of diesel due to the blend with biodiesel, will rather support the proposed financial analysis.
 - The situation is similar in the case of bioethanol introduction in the gasoline market. In this case the cost for the transformation of bioethanol into bio ETBE should be taken into account.

- From the four scenarios of this study, the most interesting one is the Scenario 2.
 - This scenario assumes introduction of 60.000 tons of biodiesel, that represents 2,51% of the total automotive diesel consumption in Greece.
 - Taking into consideration that no bioethanol production plans exist in Greece, this scenario assumes that no bioethanol will be introduced in 2005, and it will start in 2006.
 - Until now no specifications exist in the EU for bioethanol, as they exist for biodiesel (EN 14214). Specifications for bioethanol are expected to be announced by 2006.
 - The introduction of bioethanol in 2006 will give the required time for the cultivation of proper plants for the production of raw materials, and for the construction of bioethanol production plans.
 - This scenario assumes biofuels use that amounts to 0,89% of the total transport fuels (automotive diesel and motor gasoline) used in Greece for the year 2005.

Proposed Scenario (2)

A. Gasoline ($NHV_{gas} = 10444$, $NHV_{bioet} = 6429$)

1. LRP

Year	Contribution, %	Thousand Tons	Bioethanol, Tons	Proposal	Proposal, %	Detaxation Cost, € Million Excise Tax: € 337/1000 Lt
2005	2,00%	633	20.564	0	0,00%	0,0
2006	2,50%	516	20.944	8.378	1,00%	3,7
2007	3,00%	398	19.421	20.457	3,16%	9,0
2008	4,00%	281	18.278	18.278	4,00%	8,0
2009	5,00%	164	13.326	13.326	5,00%	5,9
2010	5,75%	47	4.376	4.376	5,75%	1,9

2. Unleaded

Year	Contribution, %	Thousand Tons	Bioethanol, Tons	Proposal	Proposal, %	Detaxation Cost, € Million Excise Tax: € 296/1000 Lt
2005	2,00%	3123	101.482	0	0,00%	0,0
2006	2,50%	3337	135.507	54.203	1,00%	23,8
2007	3,00%	3550	172.994	182.221	3,16%	80,2
2008	4,00%	3763	244.506	244.506	4,00%	107,6
2009	5,00%	3976	322.941	322.941	5,00%	142,1
2010	5,75%	4189	391.287	391.287	5,75%	172,1

Proposed Scenario (2)

B. Gasoline – Diesel

1. Total Gasoline

Year	Contribution, %	Thousand Tons	Bioethanol, Tons	Proposal	Proposal, %	Detaxation Cost, € Million
2005	2,00%	3756	122.046	0	0,00%	0,0
2006	2,50%	3852	156.452	62.581	1,00%	27,5
2007	3,00%	3948	192.415	202.677	3,16%	89,2
2008	4,00%	4044	262.784	262.784	4,00%	115,6
2009	5,00%	4140	336.268	336.268	5,00%	147,9
2010	5,75%	4236	395.664	395.664	5,75%	174,1

2. Diesel (NHV_{dies} = 10200, NHV_{biod} = 9050)

Year	Contribution, %	Thousand Tons	Biodiesel, Tons	Proposal	Proposal, %	Detaxation Cost, € Million Excise Tax: € 245/1000 Lt
2005	2,00%	2128	47.967	60.198	2,51%	17,5
2006	3,00%	2174	73.505	80.855	3,30%	23,4
2007	4,00%	2220	100.080	100.080	4,00%	29,0
2008	4,50%	2266	114.922	114.922	4,50%	33,3
2009	5,00%	2312	130.283	130.283	5,00%	37,8
2010	5,75%	2358	152.806	152.806	5,75%	44,3

Proposed Scenario (2)

C. Biodiesel and Bioethanol

Year	Total, Tons	Biodiesel Equivalent	Bioethanol Equivalent	Proposal, %	Detaxation Cost € Million
2005	60.198	60.198	84.740	0,89%	17,5
2006	143.436	125.312	176.400	1,92%	51,0
2007	302.757	236.769	333.296	3,52%	118,2
2008	377.706	301.600	424.558	4,19%	148,9
2009	466.550	369.163	519.665	5,00%	185,7
2010	548.469	433.880	610.766	5,75%	218,4

Total Detaxation Cost of the Scenario **739,6 million €**

Proposed Scenario Biofuels Quantities

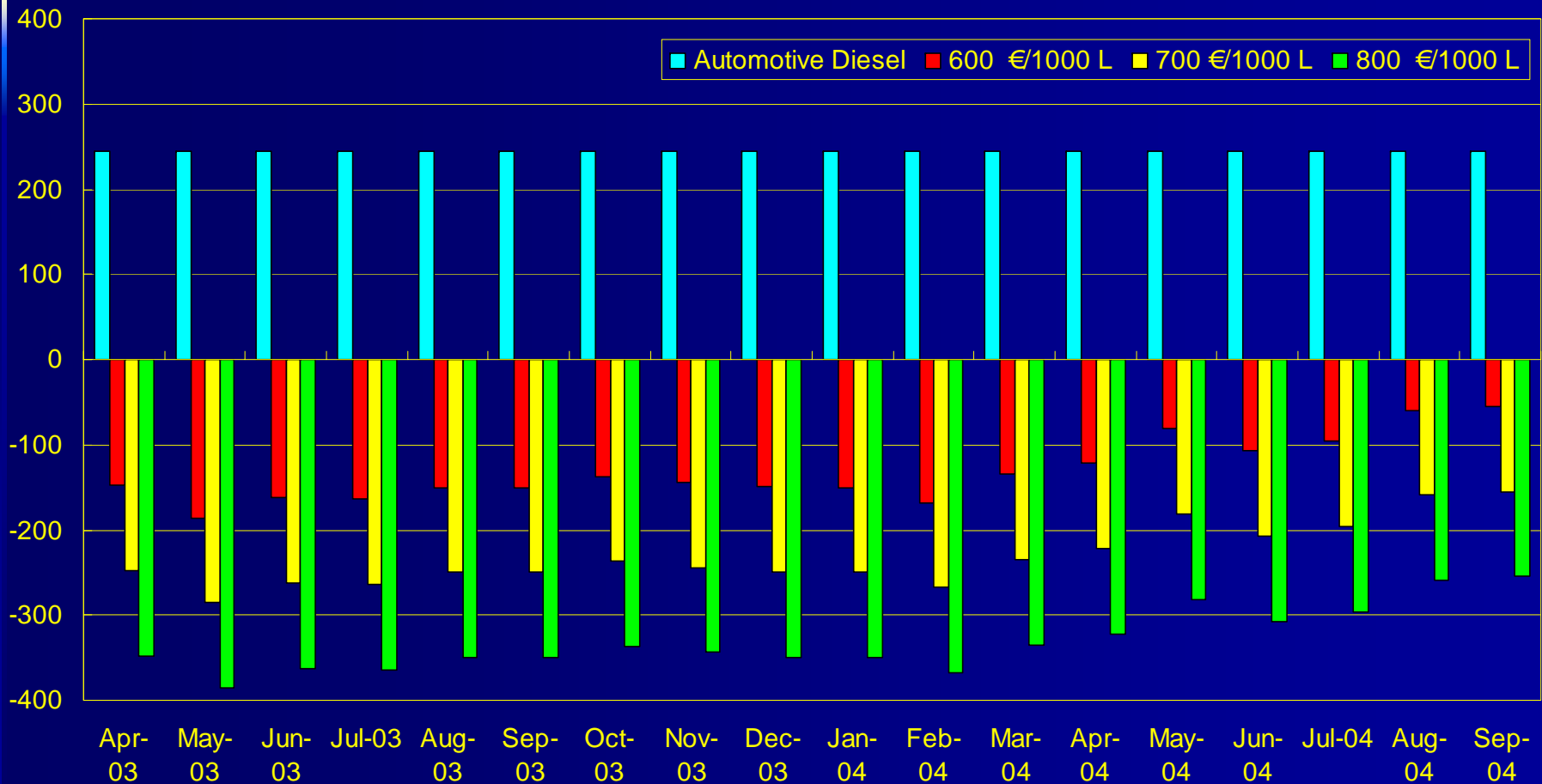
Year	Biodiesel (tons)	Bioethanol (tons)
2005	60.158	0
2006	80.855	62.581
2007	100.080	202.677
2008	114.922	262.784
2009	130.283	336.268
2010	152.806	395.664
Total	549.104	1.259.974

- The average biodiesel price is in all cases higher than the sum of ex-factory diesel price and diesel excise tax. This means that **full detaxation of biodiesel** is required for the harmonisation to the EU legislation.
- For **bioethanol** price of € 400/1000 L partial bioethanol detaxation can be applied (**50% detaxation**). For bioethanol price of € 500/1000 L the **detaxation** can be in the range of **10 – 20%**. For **higher bioethanol prices**, **full bioethanol detaxation** will be required

Excise Tax for Equal Prices of Diesel and Biodiesel

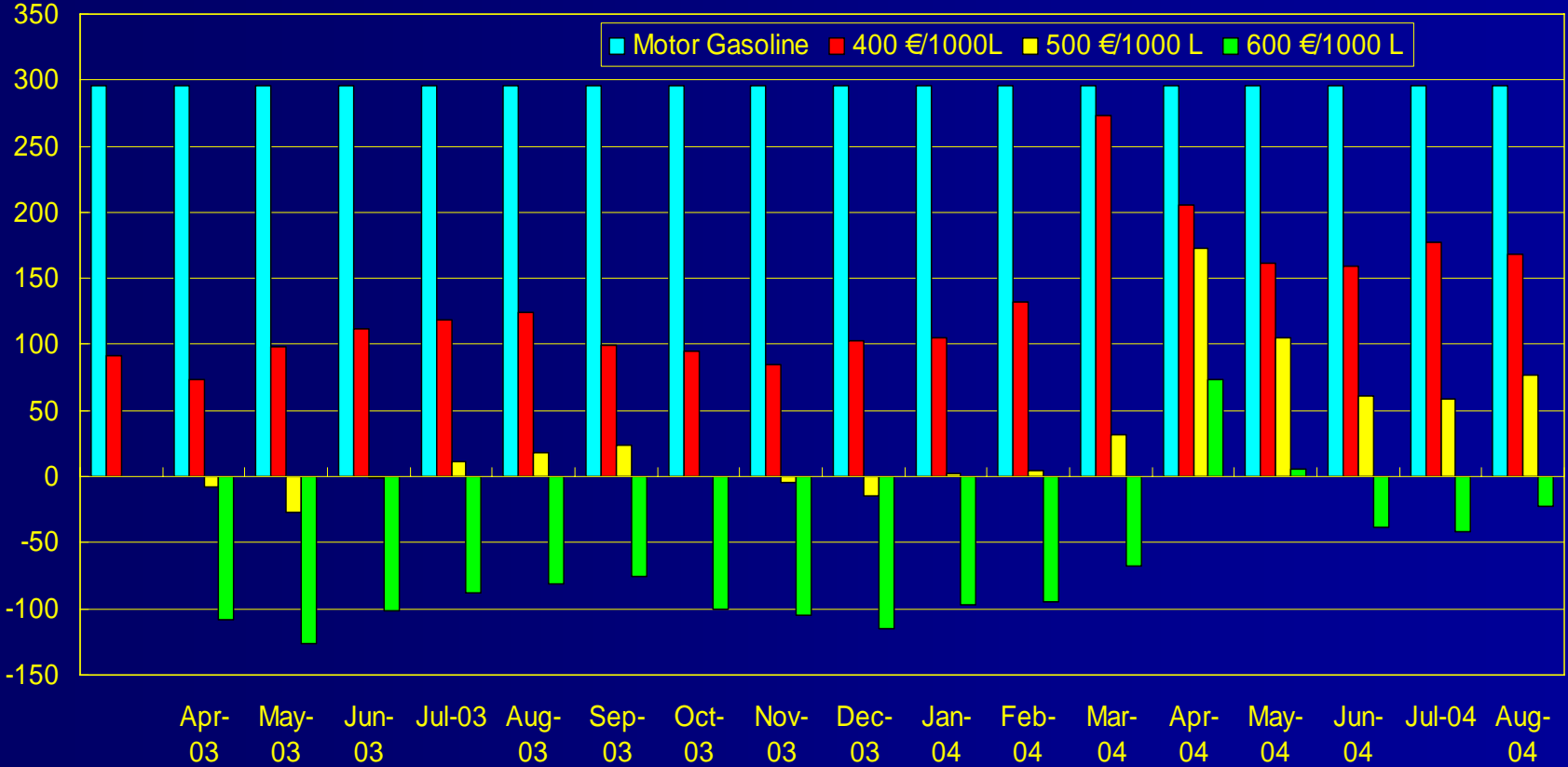
Prices in € / 1000 L

Diesel Excise Tax: **245 € / 1000 L**



Excise Tax for Equal prices of Gasoline and Bioethanol, Prices in € / 1000 L

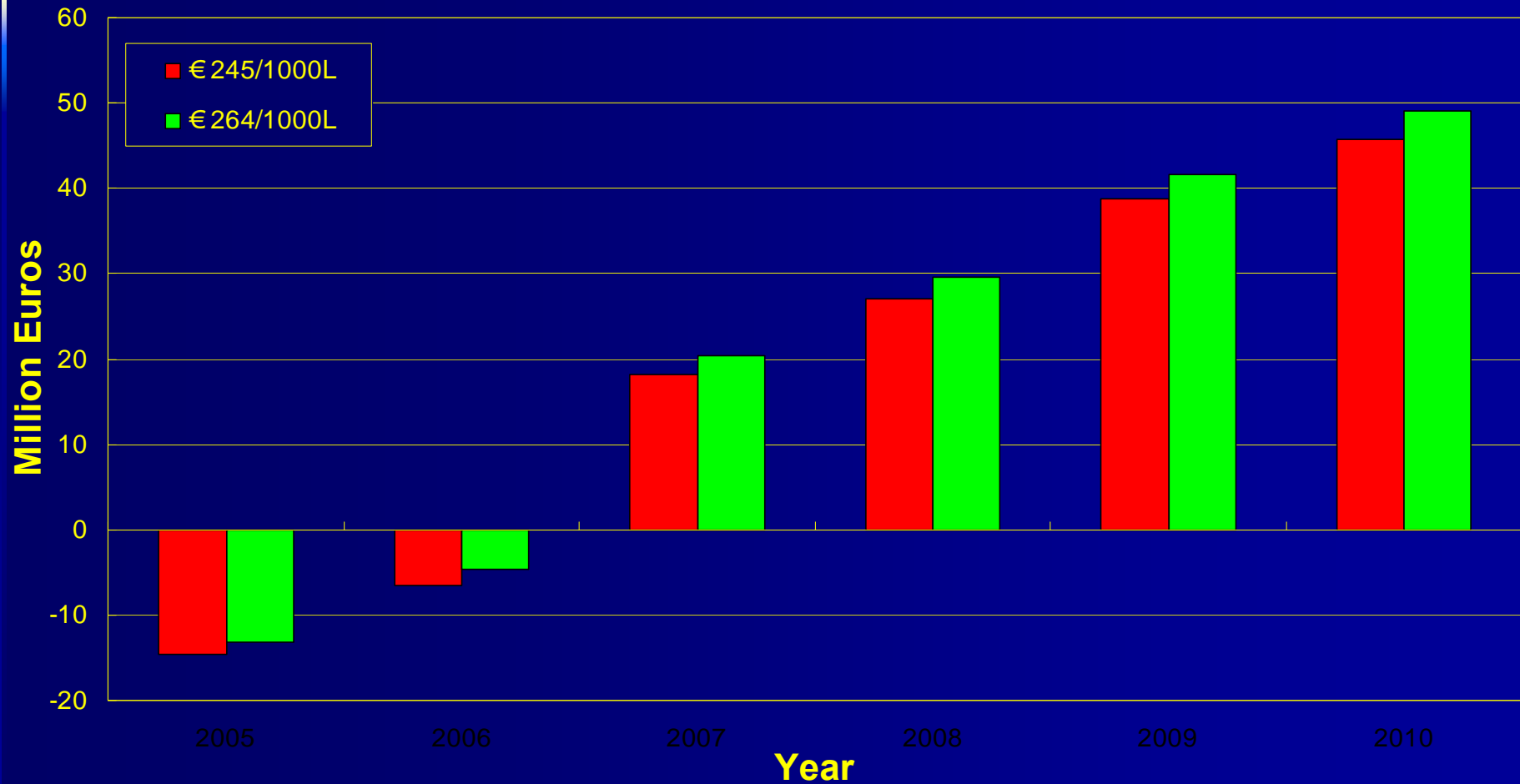
Gasoline Excise Tax: 296 € / 1000 L



- The most probable price for **bioethanol** in Greece for 2005 is assumed € 400/1000 L and for **biodiesel** € 700/1000 L.
- For these biofuels prices, and for motor fuel prices those of the year 2004, the excise tax for biofuels will be:

Year	Excise Tax, €	
	Diesel Excise Tax € 245/1000L	Diesel Excise Tax € 264/1000L
2005	-14,6	-13,2
2006	-6,5	-4,7
2007	18,1	20,3
2008	27,1	29,6
2009	38,7	41,6
2010	45,7	49,1

Detaxation of Total Biofuels



- Taking into consideration zero use of bioethanol in 2005, full detaxation of biofuels will be required. Gradual introduction of bioethanol in 2006, will not alter the scenario, and full detaxation will also be required. These calculations should be repeated each year, taking into account the actual fuel prices.
- Total detaxation cost for 2005 is estimated at € 17,5 million and for 2010 at € 218,4 million, for diesel excise tax at € 245/1000 L. If diesel excise tax increases to € 264/1000 L, total detaxation cost for 2005 will be € 18,8 million, and for 2010 € 221,8 million.
- Total detaxation cost for the first 6 years is estimated at € 739,6 million, or € 754 million, for the high diesel excise tax.
- Financial benefits due to the introduction of biofuels is estimated at about € 200 million for this 6 years period.

Detaxation Scenarios Cost

Year	Scenario 1 (Full Detaxation)	Scenario 2 (Full Detaxation)	Scenario 3 (50% Detaxation)	Scenario 4 (Mixed Detaxation)
2005	67,6	17,5	8,7	17,5
2006	90,1	51,0	25,5	37,2
2007	113,7	118,2	59,1	73,6
2008	148,9	148,9	74,5	91,1
2009	185,7	185,7	92,9	111,7
2010	218,4	218,4	109,2	131,3
Total	824,4	739,7	369,9	462,4

Detaxation Scenarios

Diesel Excise Tax: **245 € / 1000 L**



Thank you very much for your attention!