Division 44
Environment and Infrastructure

Special Focus on

- **Enhancing Energy Efficiency in the Transport Sector**
- **The Cost of Promoting Biofuels**

International Fuel Prices 2007

5th Edition – More than 170 Countries

gtz | Sector project
Transport Policy Advisory Service

commissioned by:

Federal Ministry
for Economic Cooperation
and Development

International Fuel Prices 2007
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Your Contribution: International Fuel Price Survey

In order to broaden the database and to provide data series throughout the year we decided to invite the public to participate in our study. Please assist us by completing the form on our special webpage: http://www.sutp.org/fuelprices.

Imprint

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Price board in front of a filling station
Beijing, P. R. China, November 2006

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Eschborn, April 2007

1. Executive summary of results

1.1 Fuel taxation and the GTZ fuel price survey

Since 1991 GTZ has carried out regular worldwide Fuel Price Surveys. One of its goals is to provide a worldwide comparison of selling prices as a vehicle for highlighting energy price policies in developing countries.

Fuel prices result from the interplay of many factors: crude oil prices, scarcity of specific fuels, market forces, processing and distribution costs, and the intensity of competition all have a key influence. Since fuels are a globally traded commodity, however, trade prices are relatively similar worldwide.

National price differences at the fuel pump largely reflect differences in national fuel pricing policy: prices set above a benchmark price (representing a *normal* sales price exclusive of taxation) are an indication that fuels are actually taxed whereas national fuel prices below this benchmark price indicate that a country is actually subsidising its fuel prices. In countries where no free market price is established because fuel prices are set by the state or fuels are sold by a state-run oil company at politically-controlled prices, filling-station prices administered in this way can be interpreted in an analogous manner. A price above the benchmark price indicates that sales are generating revenues above the level required merely to cover production and distribution costs, which can be skimmed off by the state: in a broad sense, this too can be interpreted as *taxation*.

Box 1: Framework conditions: Crude oil prices and exchange rates

Crude oil prices have risen substantially in the past two years (since the last GTZ Fuel Prices Survey). Converted from the barrel price, a price increase per litre of 11 US cents was registered:

***Brent* crude oil price at time of survey**	**per barrel** (159 litres)	**per litre** (US cents)
Mid-November 2004	US$42.84	27
15–17 November 2006	US$60.21	38
Price increase in 2 years		11

At its highest, the crude oil price briefly reached US$71 per barrel in August. As of 3 January 2007 the BRENT price of crude oil had returned to its November 2006 level of US$60 per barrel.

There was virtually no change in the dollar-euro exchange rate between November 2004 (US$1 = €0.77) and November 2006 (US$1 = €0.78).

The following are the orientation and benchmark prices used for the GTZ Fuel Price Survey 2006:

Main categories	**Type of oil**	**Price for 1 litre** (US cents as per 15 November 2006)	
		World market	**Filling station**
I. World market	Crude oil – Brent spot price November 2006 (US$60/barrel)	38	
II. USA[1]	US, diesel		69
	US, super gasoline		63
III. EU[2]	EU-Luxembourg, diesel		114
	EU-Luxembourg, super gasoline		129
IV. Germany[3]	Germany, diesel		138
	Germany, super gasoline		155

[1] The fuel market in the USA is characterised by a high intensity of competition and pricing reflects commercially calculated full-cost prices. The whole-of-USA average filling-station prices quoted above include highway taxes averaging approx. 10 US cents, which are used for the financing of various road funds.

[2] The fuel prices in Luxembourg reflect an orientation level in the European Union. In accordance with EU Directive 92/82, the member states of the EU are obliged to impose minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel. These stipulations also apply to new EU accession countries. Furthermore, petroleum products are subject to regular value-added tax.

[3] Germany is the largest fuel market in Europe. From 2 January 2007 an increase in value-added tax came into force, taking average prices up to 146 US cents for diesel and 166 US cents for super gasoline.

1.2 "Normal" sales price and definition of fuel "subsidisation"

The concept of "subsidisation" used here relates to a benchmark whereby fuel pricing is commercially calculated with reference to world market prices, prevailing legislation, and the normal course of business as the "normal" commercial filling-station price of fuel net of tax. These are the prices used as benchmark prices.

In this sense, "subsidisation" is said to take place when the actual pump price is below the benchmark price which would be arrived at by price calculation on a commercial basis.

Since these "normal" sales prices are very difficult to determine with precision, for practical reasons and with a view to worldwide applicability, for the purposes of this publication fuel prices will be classified as "subsidised" where they are below the average US price-level, after making a deduction for highway tax which is levied in the USA at 10 US cents per litre on average.

The definitions of subsidisation and the associated price boundaries used in the present statistics are as follows:

Subsidy definition	Price
"non-subsidised diesel"	Over 59 US cents/litre
"non-subsidised super gasoline"	Over 53 US cents/litre

The petroleum-producing countries with their own national supplies can be viewed as a special case. Their (low) cost prices are often classified as "non-subsidised" in the national context. This view is to be rejected from a macroeconomic perspective, however: if the volume of national consumption were sold on the world market, it would have achieved higher prices and thus represents missed sales opportunities.

1.3 Definition of fuel taxation

The present publication is based (for the sake of simplification) on the assumption that all fuel prices above the benchmark value for "non-subsidised" fuels indicate that fuel taxation is in place. As a rough estimate it can be assumed that the difference between the actual selling price at the filling station and the benchmark price (below which a subsidy would arise) approximately equates to the amount of taxation. This taxation can take a wide variety of different forms (including additional value-added tax), but the common feature to all is that they are administered by the state.

1.4 Benefits of fuel taxation

Fuel taxes are an important source of income for the financing of the transport sector in that they transfer the costs of transport infrastructure, particularly roads, to users. A suitably framed policy of fuel taxation can yield the financial resources necessary to maintain and develop the road system. In many developing countries, in particular, rather inadequate use is made of this source of income.

Experience shows that in many developing countries, a tax of approx. 10 US cents per litre is sufficient to cover the long-term financing of the existing trunk road network.[4] As another general rule of thumb, an additional 3–5 US cents per litre can yield a stable source of revenue for the financing of urban roads and public transport.[5]

If fuel tax is used for the financing of transport infrastructure, then it is said to cover the "internal costs" of transport; in other words, the direct operating costs of the transport sector. In addition, fuel taxation can also be used to shift the burden of the indirect negative effects of transport (such as environmental impacts, noise pollution, congestion costs, etc.) onto transport users. These effects are known as the "external costs" of transport, and can be passed on to the users of motor vehicles by means of fuel taxation if a tax surplus is generated over and above the level needed to cover the internal costs alone. Such additional taxation makes it more expensive to use motor vehicles and can potentially influence their use—for example, making fuel expensive can create incentives to use public transport or to buy more fuel-efficient vehicles.

In many developing countries tax revenue from the transport sector can make a major contribution towards financing core state functions such as the health service, education, and security, particularly if other forms of taxation are too difficult to administer.

[4] The principle of causation is applied worldwide to road taxation: the costs attaching to roads must be paid by road users. In industrialised countries (such as the USA) a level of 10 US cents covers the entire investment and maintenance costs of roads. In developing countries, due to relatively low vehicle numbers the 10-cent level only covers road maintenance costs (*cf.* World Bank—EU—SSATP Conference, Bamako 2005) whereas new investment requires additional financing.

[5] As a universal and worldwide principle, the expansion of the urban road network, the introduction of express bus routes and provision of public transport/mass rapid transit (MRT) require some form of urban transport tax. (Exceptions: an additional tax on fuels is often replaced in Asian countries such as China with a higher tax on motor vehicles, and in the USA a tax of this nature is virtually never levied.)

1.5 Fuel price trends in the last two years

The GTZ Fuel Price Survey 2006 presents the fuel prices for about 170 countries in total. The following summary of price trends during the last two years deals with the individual countries ranked according to population size. This also facilitates an assessment of the relevance of their energy price policy. For instance, countries with large populations and low fuel prices may be contributing very substantially to global growth in motor vehicle usage.

A. Most highly populated countries (populations over 100 million)

- **CHINA** has raised its fuel prices substantially (over 40%) in the last 2 years and is now subsidy-free. With prices at 61 US cents for diesel and 69 US cents for super gasoline, fuel prices in China have approximately reached US levels (69 and 63 US cents respectively)[6] but are still short of the price levels for Taiwan (71 and 83 US cents) or indeed Macau (102 and 117 US cents) and Hong Kong (106 and 169 US cents).
- **INDIA** has persisted with its high-price policy for fuels (75 US cents for diesel and 101 US cents for super gasoline).
- **PAKISTAN** (64 and 101 US cents) has followed India's example, although smuggling from neighbouring Iran (3 and 9 US cents) is so extensive that entire provinces of Pakistan are being supplied at a price of approx. 32 US cents.
- **BANGLADESH** (45 and 79 US cents) also reacted to the price movements on the world market with price increases of over 30%. However, the diesel price in Bangladesh—due to its low level at the outset—is still state-subsidised (and the persistent price differential between Bangladesh and neighbouring India continues to prompt smuggling across the border into India).
- The countries of the **EUROPEAN UNION** and **KOREA** (113 to 173 US cents for diesel and 129 to 165 US cents for super gasoline) continue to lead the world in terms of taxation and high fuel prices.
- European prices, particularly for gasoline, are more than twice as high as in the **UNITED STATES** (69 and 63 US cents), whereas neighbouring **CANADA** (78 and 84 US cents) tends more towards European price levels.

[6] All fuel prices—and price increases—from this point onward are stated in this sequence: first the diesel price, then the super gasoline price.

Fig. 1
Competition at retail level ensures high level of customer satisfaction.
Photo: Courtesy of ConocoPhilips

- **INDONESIA** (44 and 57 US cents) has more than doubled its diesel and gasoline prices (an unprecedented price revolution, equating to a 144% increase for diesel and 111% for super gasoline). As a result, Indonesia—after more than 11 years under a policy of extreme subsidisation—has almost (not quite, in the case of diesel) returned to being subsidy-free. At the same time this adjustment has eliminated the economic basis for fuel smuggling in the Strait of Malacca.
- **BRAZIL** (84 and 126 US cents) follows the European high-tax model for automobile gasoline, thus ensuring that the biofuel ethanol is more economical (ethanol prices are fixed below fossil fuel prices).
- **RUSSIA** (66 and 77 US cents) has also resolutely abandoned its past subsidisation policy (with price increases of over 40%) and its fuel prices for super gasoline are now above US levels. Its neighbour **BELARUS** (55 and 79 US cents) followed this trend with price increases of around 25%.
- In Africa, **NIGERIA** (66 and 51 US cents) has made major efforts to escape from the subsidy trap. The prices of gasoline and diesel there are ten to twenty times higher compared with the situation 11 years ago. Fuel prices in Nigeria have now reached around half the level of **its** neighbouring countries (*i.e.,* the CFA Franc Zone).
- Fuel prices in **MEXICO** (52 and 74 US cents) remain approximately in line with the trend for the USA.

- The 13 **countries of the CFA FRANC ZONE**—with the exception of Nigeria's neighbour Benin—continue to pursue a high-price policy with prices of 101 to 127 and 103 to 137 US cents.[7)]
- The same can be said of **EAST AFRICA** with reference to 3 larger countries, **TANZANIA**, **KENYA,** and **UGANDA** (98 to 101 and 104 to 117 US cents) and two smaller countries, **RWANDA** (108 and 111 US cents) and **BURUNDI** (122 and 120 US cents).

B. Medium-sized countries (populations between 65-80 million approx.)

- Fuel prices in **EGYPT** are very low (only 12 and 30 US cents) and therefore, by implication, hugely subsidised.
- **IRAN** (3 and 9 US cents) is a particularly troublesome case from an economic point of view. Diesel prices at the very lowest end of the spectrum (only 3 US cents per litre) are only undercut by two anomalous countries, Venezuela and Turkmenistan (1 and 2 US cents). The special feature of Iranian economic and energy policy is that although crude oil is exported in large volumes, a lack of local refinery capacity means that processed fuels have to be imported at world market prices, which must then be brought down to the local level with subsidies. Most of all, however, Iran is becoming a problem in relation to its neighbouring countries, particularly because of the price differential with its neighbours Pakistan and Turkey and the incentives thereby created for smuggling.
- **TURKEY** (162 and 188 US cents) can be classified as a very high-price country (world-record prices, along with Iceland and Norway). The price differential between Turkey and neighbouring Iran is 159 US cents per litre for diesel and 179 US cents per litre for super gasoline. This differential represents the maximum profit margin for cross-border fuel smuggling. No differential on this scale is found anywhere else in the world.
- The **PHILIPPINES** (67 and 76 US cents) have made use of the rise in world market prices to introduce drastic price increases (of almost 100% and 50%) and thus put an abrupt end to past subsidisation.
- **VIET NAM** (53 and 67 US cents) has followed the Chinese example of continuous reduction in subsidies and its diesel price is now at a level of 53 US cents per litre.

[7)] Nevertheless the impact of this high-price policy is often weakened by Africa-specific currency overvaluation (Dutch disease).

- **ETHIOPIA** (62 and 93 US cents) is now subsidy-free on the basis of drastic price increases of approx. 50%.
- With a diesel price increase of 76%, **THAILAND** (65 and 70 US cents) has made major efforts to create the basis for sustainable financing, particularly of its road infrastructure, from its own financial resources.

C. Smaller countries (populations of approx. 20 to 35 million inhabitants)

- **ARGENTINA** (48 and 62 US cents) has kept its diesel and gasoline prices unchanged for the last 2 and the last 4 years respectively—a unique case, with which the only parallels worldwide are a few petroleum-producing countries. It can be concluded that today's diesel price in Argentina is subsidised. Argentina's maverick approach becomes especially obvious by comparison with PERU, for example (86 and 122 US cents), where fuel prices are almost twice as high.
- But other neighbours such as **CHILE** (86 and 109 US cents) and the smaller **URUGUAY** (94 and 124 US cents) are just as much of a contrast with Argentina; again their prices are twice as high.

Fig. 2
Texas City refinery Ariel.
Photo: Courtesy of BP p.l.c.

- Torn by civil war, **AFGHANISTAN** (65 and 68 US cents in Kabul) is geographically situated between the lowest-price country Iran (3 and 9 US cents) and Pakistan (64 and 101 US cents), from which the Afghan capital also receives its supplies. Several international smuggling routes run through the southern provinces of Afghanistan and through Baluchestan, supplying the population with subsidised Iranian fuel at prices of approx. 32 US cents per litre.
- **VENEZUELA** is a country where prices are the absolute lowest (2 and 3 US cents). It is an absolute anomaly in South America, but this status dates back some considerable time: even at the time of the 1995 GTZ Fuel Price Survey, the prevailing fuel prices were only 1 and 3 US cents per litre.
- **SYRIA** (13 and 60 US cents) and **ALGERIA** (19 and 32 US cents) are known as subsidisation countries, mainly because of their own oil production.
- **SAUDI ARABIA** (7 and 16 US cents) has made its presence felt with its most recent pricing policy. During and in reaction to the phase of peak world market prices—and officially out of benevolence to its own population – it was the only country in the world to reduce its own low fuel prices by a further 30%.
- The Saudi price reductions left the neighbouring state of **YEMEN** (28 and 30 US cents) in more desperate straits than before. For under the pressure of its unaffordable fuel subsidies, resource-poor Yemen (which two years ago was affording itself fuel prices of 9 and 19 US cents, lower even than wealthy Saudi Arabia), finally bowed to the inevitable with a radical policy shift (and price rises of 211% and 58%). This gave rise to its current difficulty, namely that of having to explain to the Yemeni public why super gasoline prices are twice as high and diesel prices are four times as high as in neighbouring Saudi Arabia; and why these would need to be doubled once more to achieve abolition of the subsidies. But even if this latest price rise were actually carried through, Yemen would still only have removed subsidies: it generates no taxation revenue in the transport sector from which the maintenance of the road network could be financed.
- **GHANA** (84 and 86 US cents) has quadrupled its fuel prices in the past 6 years (with price increases of 95% and 76% in the last two years) and abruptly abolished its subsidisation of fuel, which had escalated continually in the foregoing 10 years. The present level of fuel taxation even yields sufficient income to finance its existing road funds adequately for road maintenance purposes.

Fig. 3
Poorly installed fuel pump at the premises of a bus terminal.
Photo by Klaus Neumann, Spain, 2006

- **NEPAL** (73 and 94 US cents) has essentially followed the high-price policy of neighbouring India (75 and 101 US cents).

D. Less populated oil-producing countries (populations of below 6 million inhabitants)

- **TURKMENISTAN**, **BAHRAIN**, **LIBYA**, **KUWAIT**, **BRUNEI**, and **TRINIDAD** are oil producers which are known for their low-price policies (with diesel prices between 1 and 24 US cents per litre). Nevertheless their national pricing policies have no major international repercussions.

E. Anomalous countries

- Following the collapse of the **COMECON** in 1991 (and its concluding recommendation of a general transition to world market prices), very few of the world's countries have "soft currencies", double exchange rates and dual pricing (one price for fuel allocated under government rationing, another for fuel purchases on the free market).
- In countries such as **CUBA**, **NORTH KOREA**, **TURKMENISTAN**, **MYANMAR**, and parts of **ERITREA**, however, abnormal conditions still pertain. Rationed and free-market prices sometimes differ on a scale of 1:2. Where data was obtainable, the quoted price was the free market price.

1.6 Combating smuggling

Experience shows that fuel smuggling cannot be combated sustainably with tanker and border controls, but only by means of price harmonization between neighbouring countries.

The most important national frontiers with the highest potential for smuggling can be listed as follows (gross profit from smuggling of more than 64 US cents per litre, *i.e.,* more than US$2.42 per gallon):

The table below shows the worldwide rank order of "fuel-smuggling frontiers". It also shows that the unilateral setting of national fuel prices is of little use unless the surrounding neighbouring countries are taken into account.

Ranking	National frontier and direction of smuggling	Price differential per litre of fuel (US cents)	
		Diesel	Super Gasoline
1	**Iran** to Turkey		179
2	**China** to Hong Kong/China		100
3	**Egypt** to Palestine/Gaza		99
4	**Venezuela** to Colombia		96
5	**Iran** to Pakistan		92
6	**Algeria** to Morocco		90
7	**Angola** to Zambia	86	
8	**Nigeria** to Chad		80
9	**Russia** to Finland		78
10	**Belarus** to Poland	75	
11	**Angola** to Congo	74	
12	**Nigeria** to Mali		71
13	**Libya** to Tunisia		70
14	**Argentina** to Brazil		64

1.7 Summary and outlook

The present Fuel Prices Survey reveals a double trend worldwide. On the one hand, numerous countries have pressed ahead with the reduction of subsidies, particularly populous countries such as Indonesia, Nigeria, and China. On the other hand, higher fuel prices in many countries point to heavier fuel taxation, not only in India but above all in the eastern European EU accession countries and in Russia.

The oil price increases in the summer of 2006 came as a salutary shock worldwide. Nowhere did raised fuel prices bring about a collapse in economic life; in fact India, a country with very high fuel prices, is experiencing economic growth on an unanticipated scale.

The worldwide transparency and comparability of fuel prices is an important preliminary step towards the national implementation of energy-policy based price reforms. The GTZ Fuel Price Survey has made key contributions towards this end in the past, and intends to keep doing so. The future development of fuel taxation, particularly in Asian countries—*e.g.,* China, Viet Nam, and Indonesia—will show whether they will stand still at the US price level they have currently attained, or push up to European price levels.

Fig. 4a, 4b

Highly subsidised Venezuelan fuel sold to Colombian drivers.

Photos: Courtesy of americasforgottenwar.net

2. Enhancing energy efficiency in the transport sector

by Dr Axel Friedrich, Falk Heinen
– Federal Environmental Agency (UBA), Germany –

World energy demand continues to grow. Consumption has increased by 20% in each of the past three decades, and there is no sign of a change in this trend. The reference case of the IEA's[8)] International Energy Outlook for 2006 projects an average annual growth in energy consumption worldwide of 1.6% by 2030.

According to IEA-figures, transport accounts for about 26% of energy consumption and is about 94% dependent on crude oil. Since crude oil is important not only as a source of energy but also for the manufacture of many products, one premise for future economic welfare is higher energy efficiency. Apart from this, security of energy supplies has become a key issue for many countries.

It is therefore important to develop ways to lower energy demand resulting from the transport sector. The focus must be on the developing world, *i.e.,* on transition countries and the remaining non-OECD countries, with their high growth rates of both energy consumption and transport services.

Globally high fuel prices combined with concerns over energy security and climate change provide a window of opportunity to re-think energy consumption in the transport sector. Enhancing energy efficiency in the transport sector is feasible by applying well targeted measures supported by strong economic instruments. Among economic instruments, the taxation of fuels offers a strong tool to increase efficiency in regard to both vehicles and transport systems.

The following chapter gives an overview of anticipated energy demand, highlighting transport and possibilities for reducing energy demand, particularly in developing countries.

2.1 Background – Challenges in the transport sector

2.1.1 Energy demand – Global trends

The IEA expects energy demand to grow about 50% from 2004 to 2030, with regional variations. Although growth rates may decelerate slightly, an end to this growth is not projected until 2050 with a business-as-usual scenario. Developing countries are estimated to have an average annual growth of 2.4%, compared to 1.0% in the OECD countries (International Energy Outlook 2006).

Fig. 5
Energy energy demand is expected to grow substantially.
Photo by Karl Fjellstrom, Cairo, 2002

Fossil fuel will remain the primary source of energy, with some 80% of the energy mix. A growing share of the demand for energy in OECD countries will be met by exports from developing countries, and the importance of the Middle East and Central Asia as an oil producers will continue to grow.

Although the relative share of energy consumption by the developing world will come closer to that of the developed world, per capita consumption in the developed world will remain much higher. China and India predominate in this trend. It is expected that by 2009 China will emit more CO_2 than the United States.

Rates of growth in energy demand vary from region to region. Developing countries, led by developing countries in Asia and Latin America, will account for two-thirds of the increase in demand by 2030.

2.1.2 Zooming in – Energy demand in the transport sector

Currently transport accounts for some 26% of overall final energy consumption (*i.e.,* in all sectors). For purposes of comparison, 33% goes to industry and 38% for the remaining sectors, including households (IEA, Energy Outlook, 2006). More than 90% of the energy consumed in these sectors will be based on fossil fuels; *i.e.,* alternative sources will continue to play a minor role.

8) International Energy Agency

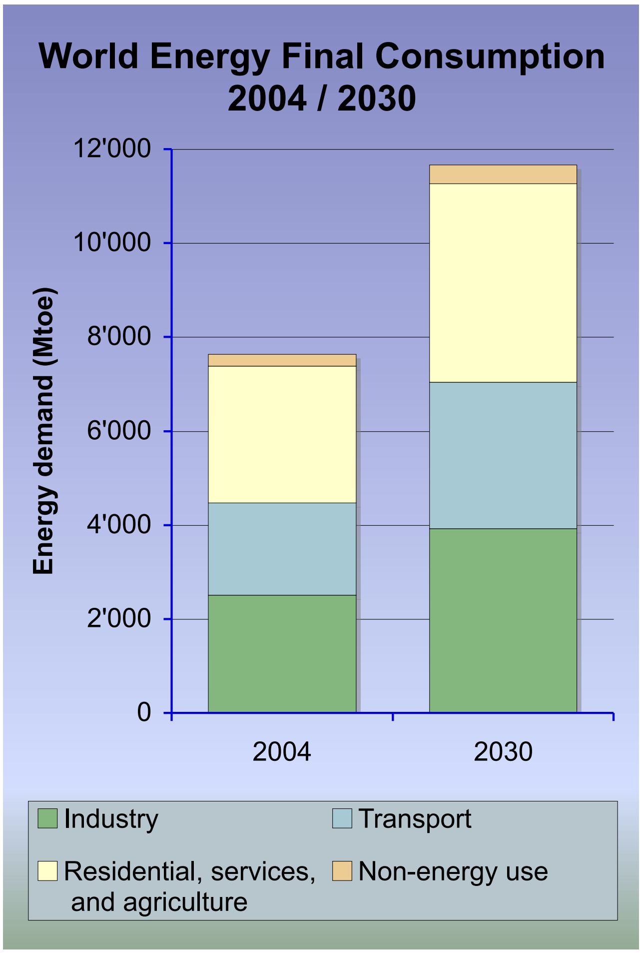


Fig. 6
Energy demand of different sectors.
Source: IEA 2006

Figure 6 shows development in the different sectors up to 2030.

Generally, **the relative proportion of transport** is growing more rapidly than that of other sectors. Currently one fourth of the total demand for energy in the United States, for example, already goes for transport, tendency rising. In Europe, this factor differs from country to country. In Germany, for example, the growth of transport services is expected to cease between 2010 and 2020, whereas in Eastern and Southern Europe further growth is expected beyond that date.

Table 5: Development of Asian oil demand/transport share [ADB]

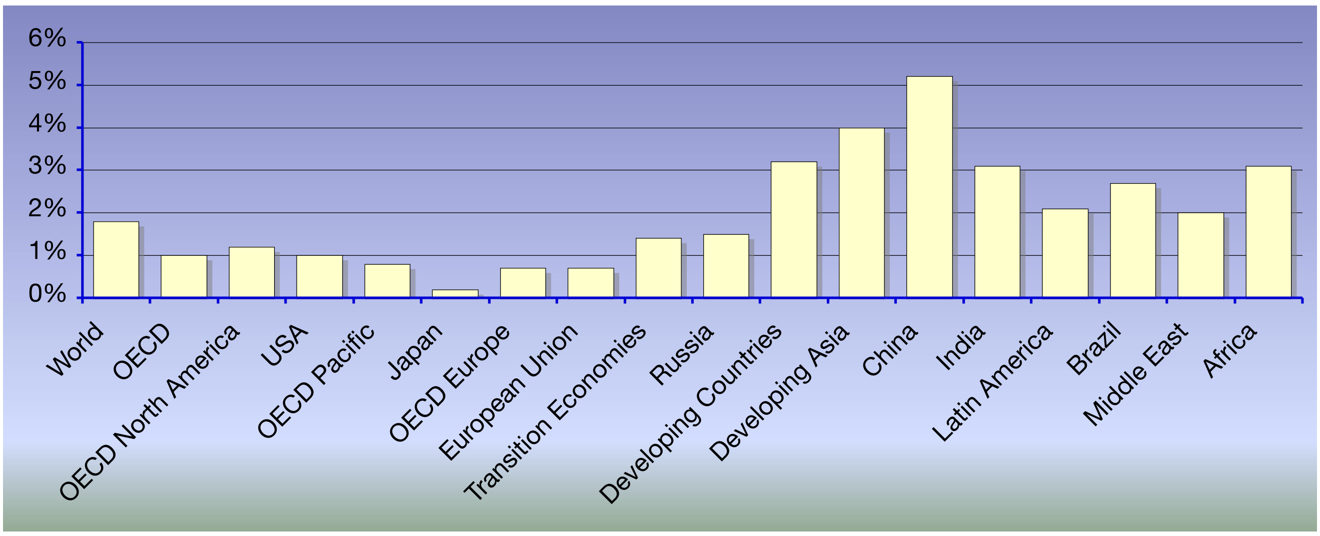
	1971	2002	2030
Asian proportion of global demand for oil	5%	16%	25%
Transport proportion	28%	36%	47%

A significant increase in the relative demand of energy for transport is expected in Asia. The countries that predominate there (and in the whole of the developing world) are China and India. Projections for India put average annual growth for transport energy demand between 2004 and 2030 at 3.1%. China is expected to have an average annual growth of 5.2% in the period between 2003 and 2030.

Table 5 shows Asian oil demand and the relative proportion of transport. As illustrated, by 2030, nearly half of total energy consumption will be for transport.

This growth is driven, for one, by the strong rise in the number of automobiles. For instance, the number of cars in circulation in China will increase from 25 million currently to about 180 million in 2030 (ADB, CAI Asia, Energy Efficiency, and Climate Change Considerations for On-road Transport in Asia).

Fig. 7
Energy demand in the transport sector: Annual average growth rate (%) by region 2004–2030.
Source: IEA, International Energy Outlook 2006



Although non-OECD countries have a higher energy growth rate for transport, OECD countries will still be consuming most of the energy used in transport in 2030. The United States will continue to be the dominant consumer of transport energy in 2030. In Europe and Japan, energy demand will stabilise during that period due to stagnation in population growth and to greater energy efficiency because of higher fuel prices.

Figure 7 shows the trends in transport energy consumption by world region.

In global terms, absolute growth varies among the **different modes of transport**. The steepest increase is expected to occur in light duty vehicles, freight lorries and air transport. The lattermost is expected to have a growth rate of between 4 and 5% annually over the next two decades. This rate is projected to slow or stop in 2030 at the earliest.

Fig. 8

Air transport grows at a rate of about 5% annually— with tremendous impact on global energy consumption.

Photo by Armin Wagner, Frankfurt, 2007

2.1.3 Transport sector – A growing challenge

The transport sector faces a number of serious challenges. On the one hand, rural populations in parts of Africa, Asia and Latin America lack access to basic services such as education, health centers or employment opportunities. Reliable and efficient access to ports, high-standard national roads and auxiliary infrastructure such as inter-modal facilities are a key pre-requisite for integration in regional and international trade. In that sense, high travel costs in terms of time and money caused by absent or poorly maintained roads are a key bottleneck for broader economic and social development.

On the other hand, cities are crowded with cars, public transport is under stress and far too many people die daily in accidents. High-levels of GHG-emissions caused by excessive use of fossil fuels are a serious threat to the global climate and local air pollution kills hundreds of thousands prematurely. An increasing car population and declining shares of sustainable modes in emerging and transformation countries and very high-levels of car usage in developed countries calls for bold steps to design solutions for sustainable development in the transport sector.

There are several reasons for the rapid and steady growth of transport. Important factors are (WBCSD):

- The rising demand for transport runs parallel to growth of GDP, which usually means a growth in per capita[9] income, which in turn gives rise to greater demand for personal transportation.
- Population is growing significantly. Regions with higher population growth tend to have higher growth in transport as long as certain other conditions prevail as well. This trend is even stronger in the case of suburbanisation, which occurs mainly in developed countries: the resultant lower population density creates a greater demand for transport.

[9] Emerging Asia is projected to have an annual growth in GDP of 5% by 2030.

Box 2: Asia – Growth of personal motorisation exceeds GDP

A clear trend toward increasing urbanisation is accompanying population growth in Asia. In China, the percentage of the urban population is expected to increase from 35.8% in 2000 to 57.2% in 2025. Similar trends will take place throughout Asia. At present, most urban areas are not in a position to cope with this growth through transport and land-use planning. As a result, the demand for personal mobility is on the rise and is in the first instance met by 2-wheelers. In some countries, the fleet of passenger cars will double every 5 to 7 years. Despite this rapid growth, relatively few people own cars. Currently only 45 persons per 1,000 own a car in China, compared to 530 per 1,000 in Japan.

- Individual travelling time tends to be constant.
- Technical improvements in vehicles generate greater opportunity for travel. Furthermore, infrastructure supporting mobility has increased significantly.
- Crude oil as a resource for transport is still readily available. The external costs to the environment and society have not yet been internalised.

2.2 Reducing energy demand in the transport sector

The **reduction of energy consumption** is crucial to the creation of a sustainable transport sector, one which guarantees future mobility but limits energy consumption and contributions to global warming (Rio Declaration, 1992).

2.2.1 Focusing on three aspects

Any effort to reduce energy demand in the transport sector will have to consider the complexity of the sector, the multitude of external forces and pace of transformation. Simply making cars more efficient or restricting access to city centres falls short of the wider objective to re-shape the transport sector towards sustainability. As we do advocate a systematic approach that covers all aspects of transport—*i.e.,* the question how transport is generated, how trips are assigned and how modes are chosen - we focus on three aspects in discussing good practices for enhancing energy efficiency.

The **improvement of energy efficiency** of the various modes of transport calls for technical solutions that lower specific fuel consumption. The most important measures for passenger cars are downsizing: i.e., lowering the volume of the engine and size of the car, new engine concepts, and light-weight materials. Further, improving fuel efficiency of new vehicles offers the largest CO_2 abatement opportunities in the transport sector.

One other effective non-technical measure is a **shift towards more efficient modes of transport**, so that less fuel is consumed to transport the same number of persons or amount of goods. These measures have positive side benefits, too, such as reduction of traffic congestion, lower land use and lower risk of accidents.

In the long term, the **reduction of transport demand** by integrating transport and land-use planning as well as production and consumption patterns are the most important and effective measures for reducing energy demand. Important aspects of this are the avoidance of suburbanisation and the revitalisation of inner cities as residential areas, so that there is high population density which is served by public transport. Spatial planning must be integrated into transport policy.

A major element in effective policy to reduce energy consumption must be a mix of concomitant push and pull measures.

2.2.2 Reflecting the regional background

Considering the regional background means to reflect the actual status of development, the fleet composition, travel patterns and economic conditions. In terms of modal split, the world's regions vary widely with changing underlying economic and social patterns.

In 1997 the relative proportion[10] of cars in Canada and the United States was above 80% and the proportion of busses and trains less than 5%. In Eastern Europe, 65% of passenger kilometres were by car and 30% by bus. The world average was 60% car, 20% bus, 8% train, and 12% airplane.

In the Asian Pacific region, the situation was quite different, with a relative proportion of 30% cars and 55% busses. In China and other Asian countries, the relative%age for cars was even lower, with 10% cars and more than 60% busses (WBCSD). However, two-wheelers, the dominant means of transport in Asia, are not included in these figures. More than 55 million of these vehicles were in use in China and more than 35 million in India.

OECD countries have already seen a significant growth in transport. Currently these countries mostly have a relatively modern vehicle fleet which is, however, not necessarily particularly fuel-efficient. Moreover, vehicle categories with high fuel consumption are still of growing relevance for many markets (*e.g.,* SUV[11] in Europe). Nevertheless, recent increases in fuel prices have resulted in some slight indications of a trend toward more fuel-efficient cars. In the United States, for example, diesel-fuelled cars are gaining in attractiveness, and US consumers increasingly tend to consider the fuel consumption of the cars they buy. “Gas guzzlers” have been losing market shares and the diesel share of the market is growing.

In non-OECD countries, the fleet composition tends to be heterogeneous. The growth of the fleets is based mainly on new vehicles, which are often imported or assembled in the countries where they are sold.

Passenger cars often continue to play a minor role and in many countries, such as Viet Nam, the predominat

[10] Based on passenger/kilometres
[11] Sports Utility Vehicle

mode are motorcycles. However, it is typical of most of these countries that as the proportion of privately-owned vehicles increases, the relative proportion of public transport decreases, and that the transportation of goods by on-road vehicles increases at the expense of railways.

2.3 Good practices – The way forward

The following measures are classified according to whether their effects become apparent in the short-term (within 2 years), medium-term (between 2 and 15 years) or long-term (over 15 years). An estimate of reduction potential and associated costs will be given whenever possible. A distinction must be made between technical and non-technical opportunities. Many non-technical measures require a change of existing structures, so that they are time-consuming and must be integrated into strategic policy considerations. Furthermore, the administrative level differs with the measure: *i.e.,* taxes can only be implemented on the national level whereas public transport stakeholders decide mainly on the local level.

Although technological solutions will play a significant role within the next 20 years, strategic and policy aspects need to be considered at first, *i.e.,*:

- Any policy decision related to transport should be assessed in light of its environmental impact, possibly within the framework of **strategic environmental assessment**.

Box 3: Scope of work

The focus in this outline will be on **on-road transport**, *i.e.,* the reduction of energy demand for heavy duty vehicles, light duty vehicles, passenger cars and motorcycles, because measures for these transport modes can be implemented on the local level.

Measures for railways would require—due to the greater proportion of electrification—a detailed consideration of the energy production system of each country, which is not feasible in this context.

Other, non-road transport modes—shipping and aviation—are of major relevance in the global perspective. Each of these modes accounts for about 3% of annual global energy demand. The international character of these modes dictates that measures be implemented globally. With regard to aviation, it will not be possible to stabilise absolute fuel consumption merely by improving fuel efficiency. Stringent economic measures are required, such as mandatory cap-and-trade schemes*) as part of the measures under the United Nations Framework Convention for Climate Change (UNFCCC) and kerosene taxation. For shipping, further technical opportunities exist; it is possible to save fuel by lowering speed. Additionally, stringent economic measures are required for shipping as well. Since measures must be implemented on a global level, shipping and aviation will not be considered further.

*) The European Commission intends to include aviation in the European Emission Trading Scheme. A proposal is expected to be published in December 2006.

Fig. 9

Riding bicycle inside the cities can save fuel and disencumber the centres.

Photo by Klaus Neumann, Maastricht, 2004

- The **avoidance of traffic** and the preference of non-motorised transport or public transport as second choice should be a key principle.

Key criteria:

- **A shift towards energy efficient transport modes**: Busses and trains are the most efficient modes of passenger transportation. Cars and airplanes are inefficient by comparison.
- **Increase of unit efficiency**.
- **Increase of the efficient use of transport capacity**: Trains and inland water shipping use significantly less energy than lorries.
- **Reduction of number of trips and the average distance**.
- **Mix of measures**: Technical solutions alone will not lead to an energy-efficient transport system. The growth in transport demand must be managed and energy-efficient technologies employed.

2.3.1 Short-term measures

Major improvements in energy efficiency can be achieved in the short run. From a technical perspective, the use of the most efficient technology for both private and public transport is the most cost-effective.

2.3.1.1 Low rolling resistance tires and correct tire inflation

The use of low rolling resistance tyres enables an energy reduction of about 5%. New materials like silica make it possible to reduce rolling resistance without compromising other important tyre properties such as wet braking. The tyre industry has recently come to support the introduction of legislation to limit the rolling resistance of tyres. (IEA 2005 IEA/ECMT, (2005). *Making cars more fuel efficient—Technology for real improvements on the road*. OECD, Paris.)

With a 10% reduction of rolling resistance, fuel consumption drops by 1 to 2%. After prolonged reluctance on the part of the tyre industry to introducing standards to limit rolling residence, it is noteworthy that Michelin now proposes just such limits for the EU and also for the USA. In addition to energy expenditure reduction through reduction of rolling resistance, the importance of correct tyre pressure must be mentioned. A number of surveys have revealed that many tyres are under-pressured, which leads to additional fuel consumption and greater risk to safety. More frequent pressure checks promoted by advertising campaigns can lower fuel consumption by about 2%. The installation of tyre pressure monitors is highly recommended.

Box 4: Until now, there has been only one instance of legislation to limit the rolling resistance of tyres.

In 2003, California enacted a law (AB 844) requiring tyre manufacturers to report the rolling resistance properties and fuel economy effects of replacement tyres sold within the state. Charged with implementing the law, the California Energy Commission, with financial support from the California Integrated Waste Management Board, has been gathering information on rolling resistance and other data on passenger tyres. The purpose is to assess the feasibility and desirability of establishing a consumer information programme or defining an energy performance standard for replacement tyres sold in California. Until this testing is completed, the law cannot be enforced.

In the EU, the European Commission announced the introduction of limits for the rolling resistance of tyres in its energy efficiency communication of October 2006.

Trends to bigger and even wider tyres also have a negative impact on fuel consumption, due to their greater weight and air resistance.

The additional costs of better lubricating oils and low resistance tyres are relatively low in relation to the prospective benefit, so these measures are very cost-efficient. Thus such measures should be made mandatory as soon as possible. (*Action Plan for Energy Efficiency: Realising the Potential*; Communication from the Commission; Brussels, 19 October 2006)

2.3.1.2 Eco driving

An important non-technical measure to reduce energy consumption is "**ecodriving**". Testing for the certification of new cars does not reflect driver behaviour and driving patterns in the real world, yet driving behaviour is a central element in traffic speed and flow and in engine speed and load. Ecodriving programmes, which have already been implemented in a number of countries, teach drivers how to optimise fuel consumption. Important elements are early gear-shifting and driving at low revolution speed. "Ecodriving" can also be made mandatory within driver education curricula for a driver's licence. It has been proven in many training courses that driver training can achieve significant reductions. Within the European Union the fleet-wide reduction potential is estimated to be as much as 10%. However, actual potential also depends on the regional traffic situation and customary driving behaviour.

The traffic in many densely populated areas is poorly regulated, with chronic traffic jams. Thus potential depends on the local situation, and programmes must be adapted accordingly.

Since reducing fuel consumption saves money, these programmes are also relevant for fleet owners. Deutsche Telekom, for example, reduced its fuel consumption by 25% for a fleet of 40,000 vehicles within five years by applying environmentally oriented fleet management.

In support of "**ecodriving**", vehicles should be equipped with fuel indicators and gear-shift indicators (GSI). Booklets informing the public and industry about various driving practices and opportunities are another useful tool. (For more information, please refer to Module 4f: *Eco Driving* of Sustainable Urban Transport: Sourcebook for Policy-makers in Developing Cities).

2.3.1.3 Speed limits

Speed limits offer another opportunity to lower energy demand. The energy saving potential by reduction of speed on high speed roads depends on the actual speed. On Germany's Autobahnen, where no general speed limit applies, it is estimated that a speed limit of 120 km/h would reduce CO_2 emissions by about 10%, not counting the indirect effects of mode changes and the influence on car purchasing choices (German Federal Environment Agency, 2000). The measure is very cost-effective, and car owners benefit as well from fuel savings and reduced risk of accident.

2.3.1.4 Improved lubrication oil

Low viscosity oils to reduce internal friction at low and high temperatures (SAE[12]) grades 0W30 and 5W30) have an energy saving potential of up to 5% compared with lubrication oil SAE grades 15W40. The lower the average starting temperature, the higher the fuel consumption reduction. In addition to improvement in fuel economy, the oil change frequency can be reduced by a factor of at least 2. The reduction of fuel consumption and the longer use of the lubrication oil compensates for the higher cost of improved synthetic lubrication oils.

2.3.1.5 Further measures

The influence of **inspection and maintenance** varies with the technical conditions within a given fleet. However, inspection and maintenance mainly offer an opportunity to reduce emissions of air pollutants like NO_X, PM and hydrocarbons. Improvements in fuel efficiency are rather limited, although they can at least cover the costs of inspection and maintenance.

Car pools and car sharing are another promising opportunity. Cities or private enterprises can offer cars to be used by a group of people. Individual persons or groups book the vehicle for a given period and pay accordingly. Some enterprises offer cars or mini-busses for staff transportation mornings and evenings, which reduces emissions, saves the staff money, improves the environmental balance and polishes corporate image.

[12] Society of Automotive Engineers

Fig. 10

Germany's highways are notorious for high speeds and hence high energy consumption.

Photo by Armin Wagner, Darmstadt, 2006

Another good short-term opportunity is to avoid traffic by using modern communication technology. Meetings can take place as **teleconferences**, and commuting can be reduced by increasing the relative share of **teleworking**.

2.3.2 Mid-term measures

The overall objective of mid-term measures is to improve unit and system efficiency. Higher system efficiency in the respect refers to a higher share of energy-efficient modes as well as to the smarter use of existing systems.

Various measures have an effect in the medium term. The most important are fuel efficiency standards, the phasing-out of old vehicles, the priorisation of public transport and non-motorised means of transport and mobility management.

2.3.2.1 More efficient vehicles—Fuel efficiency standards

Fuel efficiency standards are one of the most effective measures for light duty vehicles. Consequently, manufacturers are urged to increase the technical unit efficiency of their products.

Apart from regulation in the United States, efficiency standards are comparatively new. Due to the laxity of U.S. regulation, effects are scarcely detectable. A survey taken worldwide showed average fuel consumption in the European fleet of new vehicles to be the lowest. However, voluntary compliance is apparently unrealistic, so the European Commission is now obliged to prepare further steps (European Commission, communication 1999).

Generally speaking, the best available technique should serve as the basis for any fuel efficiency regulation. The most effective opportunities now in existence for passenger cars are the reduction of engine and car size (“downsizing”), new and improved engine concepts, the reduction of power, and lightweight design. Additional fuel-consuming equipment such as air conditioning systems can also be cut back.

Fuel efficiency standards can be modified to include economic regulations that promote the sale of vehicles with emissions well below required levels. Alternatives to efficiency standards for vehicles are sales weighted average targets either for manufacturers or in combination with emission trading schemes. However, these schemes increase transaction costs and the complexity of regulation.

Currently, no fuel efficiency standards are in place for other transport modes although they too have significant potential for reduction. The reduction

Box 5: Mandatory measures: fuel efficiency and CO_2 standards (EU, US, Japan, China)

Fuel consumption for transport and especially by on-road vehicles is of growing importance in the policy considerations of many countries worldwide. Aside from environmental concerns, many countries wish to minimise their dependency on oil imports.

Countries and regions that have already implemented regulations for minimising CO_2 emissions are: Japan, China, Canada, Australia, the European Union, Switzerland, the United States, and the US State of California with a separate regulation. The systems in the EU, US, California, Japan, and China are described below.

European Union: In 1999 the European Automobile Manufacturers Association (ACEA) agreed to reduce the average CO_2 emissions of their fleet of new cars from 183 to 140 g/km (based on the NEDC[a)]) by 2008, the corresponding associations in Japan (JAMA[b)]) and Korea (KAMA[c)]) by 2009. In the event of non-compliance, the European Commission will decide on other measures (European Commission Communication 1999). According to a report of the European Commission released in August 2006, the average level in the EU-15 is 161 g/km (an improvement of 13% over 1995). To achieve the goal of 140 g/km, ACEA members need to reduce average consumption by 21 g/km within four years. Since this is unrealistic, alternative measures are currently under discussion. The most important is the possibility of implementing mandatory CO_2 standards in order to achieve the Commission's goal of 120 g/km in average by 2012[d)].

United States: Fuel economy standards were adopted as early as 1975. Every manufacturer is obliged to

Table 6: Fuel consumption standards LDT 2006-2010

Year	Standard in mpg	Standard in l/100 km
2006	21.6	10.9
2007	22.2	10.6
2008	22.5	10.45
2009	23.1	10.2
2010	23.5	10.0

Note: Based on CAFE-driving cycle

a) New European Driving Cycle;
b) Japanese Automobile Manufacturers Association;
c) Korean Automobile Manufacturers Association;
d) The European Parliament decided to achieve 120 g CO_2/km already in 2010;

achieve certain limits (unit: miles per gallon, mpg) or is urged to pay a penalty of US$5.50 per 0.1 mpg of non-compliance. In the past penalties were from US$1 million to US$27 million per manufacturer. The US government intends to change the system as of 2011. Between 2008 and 2010, manufacturers can choose between the old and the new system. The latter will be based on the so-called "footprint"[e], and the regulation will also include medium duty passenger vehicles (MDPV) weighing up to 4.54 tonnes; *i.e.,* nearly all pick-ups.

Table 6 gives an overview of standards from 2006 to 2010.

The new regulation will be based on a formula which considers the minimum and maximum fuel consumption target, the "vehicle footprint", and the deviation between minimum and maximum target.

California introduced more stringent regulations with its Low Emission Vehicles (LEV) Program, implemented in 2004. This programme, which entered into force in 2006, sets limits for CO_2–equivalent greenhouse gases[f] (CO_2, CH_4, and N_2O) of new cars as of 2009 for the fleets of manufacturers with a production volume above 60,000 vehicles. Table 7 shows the limit values for the greenhouse gases (GHG) and the corresponding maximum fuel consumption for the short- and medium-term. The regulation differentiates between LDT 1 (passenger cars and light duty vehicles) with a maximum mass of 3,570 pounds (1.7 tonnes), and LDT 2 with a mass between 3,571 pounds and 8,500 pounds (3.86 tonnes) including MDPV[g] up to 4.54 tonnes.

Japan: In April 1999, the Japanese government introduced the "Top Runner Programme", which distinguishes between mass and fuel type. The standard for limiting fuel consumption is the most fuel-efficient vehicle, the "top runner", which was on the market one year before the introduction of the regulation, *i.e.,* 1998.

The values of the year 1998 vary between 4.7 l/100 km for gasoline-fuelled cars weighing less than 702 kg (5.29 l/100 km for Diesel) and 15.6 l/100 km for gasoline cars weighing less than 2,266 kg (Diesel: 11.4 l/100 km)[h]. The system also rates LPG and heavy duty vehicles. Each manufacturer has to report every year on the fuel efficiency of his fleet. Insufficient improvement leads to intervention by the transport ministry. The penalty is financially small but the highest "penalty" means public disgrace for the manufacturer.

China: The Chinese system, which entered into force in 2005, differentiates between 16 mass classes and between manual and automatic transmissions. The values vary between 7.2 l/100 km for a vehicle with manual transmission and weighing less than 756 kg (6.2 l/100 km as of 2008) and the corresponding value for the mass class above 2,530 kg, which is 15.5 l/100 km (13.9 l/100 km as of 2008).

Table 7: GHG emission standards in California (LEV, 2006)

Timeframe	Year	GHG-standard (g CO_2/km)		Fuel consumption (l/100 km)	
		LDT 1	LDT 2	LDT 1	LDT 2
short-term	2009	201	274	8.52	11.59
	2010	188	262	7.95	11.10
	2011	166	242	7.06	10.32
	2012	145	225	6.16	9.52
medium-term	2013	142	221	6.00	9.37
	2014	138	218	5.87	9.26
	2015	133	213	5.63	9.01
	2016	128	207	5.42	8.78

e) The product of a vehicle's wheelbase multiplied by its track width;

f) According to U.S. regulation California is allowed to introduce Greenhouse Gas standards but not fuel efficiency standards;

g) Medium-Duty Passenger Vehicles;

h) The top runner principle means that limit values for gasoline cars are lower than for diesel, since the best car sets the standard;

potential for heavy duty vehicles amounts to as much as 30% for new vehicles. One effective measure is to use selective catalytic reduction to reduce nitrogen oxides, which creates more leeway for increasing engine efficiency. Additional fuel efficiency improvements might be made in city busses, for example, by using hybridisation and light weight vehicles.

Motorcycles, which are a very important form of transportation in many developing countries, continue to lag behind in fuel efficiency. Well-tuned carburettors, 1-cylinder 4-stroke engines, automatic transmission and limited cylinder capacity are important elements in improving the fuel efficiency of this mode of transport.

Fuel efficiency standards are usually in place for the approval of new vehicles. However, it might also be possible to consider **phasing out old vehicles, *i.e.,* a**

13) A transfer of phased-out cars to other markets would not produce any improvement in fuel efficiency from a global perspective.

scrapping of cars[13)], either on a mandatory basis or with the aid of incentives. This would require a clear definition of certain parameters in order to define "old vehicles". Generally, public reluctance to accept such schemes and the effort needed to implement them make these measures undesirable, even though they have a high potential for fuel reduction. Such schemes should be based on vehicle performance, not on age.

Regular mandatory technical inspections for safety and roadworthiness can also lead to the phasing-out of old vehicles. Such inspections must therefore be introduced in countries which do not have regulations requiring them as yet.

For more information please refer to Box 5: "*Mandatory measures: fuel efficiency and CO_2 standards (EU, US, Japan, China)*".

Fig. 11

Bogota sets the standard for a well designed public transport system.

Photo by Manfred Breithaupt, Bogota, 2002

2.3.2.2 Transport demand management & mobility management

Modal shift to more efficient means of transport is a key strategic element for reducing the energy demand of transport. Modal shift policies are based both on effective transport demand management and mobility management.

In that sense, the terms **transport demand management** and **mobility management** refer to strategies that encompass a set of measures such as congestion charges, traffic guidance systems and parking policies as well as the integration of all urban transport modes (institutional, organisational, fare, and time table) and appropriate design of well integrated public transport (incl. MRT) systems and advanced non-motorised transport schemes.

Objectives in this context are providing better access to public transport, reducing the need to use individual motorised transport and improving the economic efficiency of each transport mode.

Four important factors in this regard are:

- The common trend in developing countries is to replace relatively environmentally friendly public transport infrastructure with infrastructure that promotes individual transport, mainly roads. It is therefore important to save existing public transport services infrastructure and to give preference to investments that offer environmental and social benefits by enhancing the quality and attractivness of public transport. Bus Rapid Transit-(BRT)-systems such as the one in Bogota are examples how to implement modern transit systems in developing cities at low costs.
- In many developing countries, bicycling is still an important means of mobility: this mode of transport should be preserved. Trends to more bicycling/walking should be promoted in developed countries. An

Table 8: International urban transport paatterns (1990)

Transport pattern	Asian cities	European cities	US cities
Car ownership (passenger cars per 1,000 persons)	109	392	608
Vehicle ownership (vehicles per 1,000 persons)	224	452	749
Specific road length (meters per capita)	1.1	2.4	6.7
Road density (meters of road per urban ha)	122	115	89
NMT (walk + bicycle + pedicab, % of work trips)	19	18	5
Role of public transport (% of all passenger/km)	48	23	3
Car use per person (km per capita per year)	1,397	4,519	11,155
Energy use per person (private passenger transport/capita(MJ))	6,969	17,218	55,807

Source: Kenworthy and Laube, *et al.,* 1999

Note: The Asian cities included in this average are Tokyo, Singapore, Hong Kong, Kuala Lumpur, Bangkok, Jakarta, Surabaya, and Seoul.

important aspect is the integration of cycling and walking with public transport provision and in spatial planning.

- Government policy should support environmentally friendlier modes of transport. In terms of freight transport, rail should be clearly favoured because it uses on average only one fourth of the energy used by lorries. The use of inland waterways is favourable if it does not involve environmental damage (*e.g.,* nature-destroying construction).
- Investments in public transport and railway infrastructure should be optimised, always taking into account external costs, *i.e.,* costs which are not reflected in actual pricing. The external costs of lorry transport and private passenger cars are much higher than those of busses and rail.

Thus any shift of passengers from individually used cars to public transport (with a satisfactory passenger load) or from road freight transport to rail freight transport leads to energy savings.

A comparison between cities in Asia, Europe and USA illustrates the nexus of car ownership, transport system layout, car ownership and energy consumption in Table 8.

Case studies were conducted in the South Asian cities of Bangalore, Dhaka and Colombo. Emissions scenarios for the next 15 years and the potential benefits of public transport were analysed. According to the study, the fuel saving potential lies between 104 and 765 thousand toe, even though the proportion of public transport is already relatively high.

Demand control is a central element in increasing the efficiency of future transport, but it is difficult to implement because it can reduce the availability of free and cheap motorised transport, so that people to fear economic disadvantage. Finally, demand control must fit the complex transport planning and existing transport structure of each region or country. Thus it is not possible to define demand control measures in detail. Demand control calls for careful consideration of measures and a clear political will (For more information please refer to Module 2b: *Mobility Management* of Sustainable Urban Transport: Sourcebook for Policy-makers in Developing Cities).

2.3.2.3 Green procurement

Another aspect which is relevant for owners of big fleets of vehicles, including governments, is "**green procurement**", *i.e.,* the purchase of vehicles with environmental performance that is above mandatory standards. This not only leads to the improvement of the average fleet but actually realises improved environmental performance. This is even more effective in developing countries with anticipated vehicle fleet growth.

Fig. 12
The way we shape our transport systems determines how much energy we consume.
Photo by Armin Wagner, Shanghai, 2006

2.3.3 Long-term measures

2.3.3.1 Integration of transport and land-use planning

Transport and land-use planning are the most important of all measures, because they highly influence future transport demand. It is crucial to create a link between urban development, land-use planning and travel demand.

The main aim of **transport planning** for sustainable development should be to reduce travel demand and the relative amount of motorised transport. A variety of measures can be used to achieve these goals: for example, congestion pricing, creation of car-free zones and the promotion of public transport. Externalities such as congestion, pollution and climate change must be internalised by the inclusion of fiscal measures in existing pricing schemes. The central challenge in terms of realisation is to communicate the message that these measures are not solely restrictive but foster sustainable economic growth.

Land-use planning is the other core element in reducing transport demand. Analysis of transport streams has shown that urban and suburban needs must be balanced if transport demand is to be lowered. Changes in settlement structures have led in the past to a greater need to travel. New concepts, such as green towns with low individual motorised transport demand, need to be realised.

In the long term, the **integration of transport and land-use planning** are the most important and effective measures for reducing demand. Important aspects of this are the avoidance of suburbanisation and the revitalisation of inner cities as residential areas, so that there is high population density which is served by public transport.

(For more information please refer to Module 2a: *Land Use Planning and Urban Transport* of "Sustainable Urban Transport: Sourcebook for Policy-makers in Developing Cities".)

Fig. 13

City layout and transport demand are closely linked—The planned future of Shanghai as part of the Urban Development Exhibition.

Photo by Armin Wagner, Shanghai, 2006

2.3.3.2 New vehicle concepts

In the long term, completely **new vehicle concepts** can be developed. Nowadays the proportion of hybridisation—a combination of a conventional engine and an electric engine with different specifications—is steadily increasing. Trends toward the use of hybrids were strongest in the US and Japan over the past few years, but hybrids are currently gaining in popularity in Europe as well. Different types of hybrids are currently in use (*e.g.,* mild hybrids and parallel hybrids). As already described, downsizing and lightweight materials offer additional opportunities for reducing fuel consumption. Further factors for use with conventional engines are reduction of rolling and air resistance, change of transmission (*e.g.,* continuous variable transmission, CVT), direct injection in combination with exhaust gas after treatment and shut-down of single cylinders of an engine in order to optimise engine load.

New engine concepts now under discussion are combinations of Diesel- and Otto-engines, for example, homogenous charge compression ignition (HCCI), which is fuel-independent but a long way from being ready for production. Finally, completely new designs with extremely low weight and low air resistance are currently in development.

It is possible to reduce the specific fuel consumption of conventional engines by up to 40% with measures that are already well-known and proven today. The corresponding costs range from €500 to €1,000 per unit. It is not yet possible to estimate the relative contribution of new engine concepts, but it seems clear that these measures are only one element. Furthermore, stringent and mandatory regulations are required to get these concepts onto the market.

2.3.3.3 Shift to alternative fuels

The relative share of **biofuels** is steadily rising. The environmental balance of biofuels depends on their potential to reduce greenhouse gases, additional effects of production (*e.g.,* fertilization), the amount of energy per unit of cultivable land, and related production costs.

The energy saving potential and the CO_2 reduction effect of current biofuels based on plant oils (*e.g.,* methylester of rapeseed oil) is, when considered along with the production chain, zero or only slightly better.

A much more positive picture can be seen in Brazil, which uses sugar cane as the basis for the production of bio-ethanol. The CO_2 benefit is as high as 80%, depending on whether parts of the plants are used for production energy in place of fossil resources. Bioethanol is the foundation for 40% of the fuel used in Brazil. Sweden is currently undertaking a pilot project with wood as the basis for ethanol.

With the increasing demand for agricultural products as a primary source for biofuels, more and more primary forests are being cleared to provide arable land for the cultivation of plants, thus accelerating the deforestation of primary forests. Besides, the crops must be transported, so that energy demand increases and along with it CO_2 emissions. In sum, biofuels based on these strategies are of no benefit to the environment.

The most promising biofuels of the next generation are bio-methane and biomass-to-liquid (BTL[14)]), which have the advantage of exploiting the plant's full energy content. However, it must first be proved that production is environmentally friendly and economically feasible under market conditions without long-term subsidies.

Another alternative fuel which has been discussed for years now is hydrogen. Consideration of economic and environmental factors leads to the conclusion that hydrogen is no alternative in either the short- or medium term, since the hydrogen must first be produced, and hydrogen production is a very energy consuming process. Fuel-cell cars may have zero emissions, but only at the cost of producing emissions elsewhere in the production chain. Hydrogen might be relevant if an excess of renewable energy were available. However, if the storage capacity of newer batteries were to go on improving and if prices were to decrease significantly, the direct use of excess energy in electric cars might be preferable.

Any consideration of the attractiveness of alternative fuels and engines must always be based on well-to-wheel carbon consumption, so that decision-making remains transparent and can be based on net results.

(For aspects of the promotion of biofuels, please refer to Chapter 3 of this publication.)

2.3.4 Instruments

In order to support wider economic, social and ecologic objectives, many regulatory and economic instruments are known. Among them, economic instruments are proven to put measures efficiently and effectively into practice.

14) BTL stands for a variety of production procedures which have not yet been realised or are in the pilot stage.

Economic measures that are a pivotal to promoting greater fuel efficiency are tax incentives, charges and emission trading schemes. Economic incentives and instruments can be designed to discourage motorised vehicle ownership, discourage motorised vehicle use and encourage switch to public transport and non-motorised means of transport and/or encourage lower energy consumption and lower emissions of vehicles.

Tax incentives have proven effective in improving the performance of vehicles and transport systems in environmental terms in several parts of the world. **Imposing or raising fuel taxes** in combination with the use or purchase of vehicles can have an effect on the amount of fuel consumed. In that context, fuel taxation has a very strong impact on the energy efficiency of the road transport. Fuel tax is estimated in a recent report of the ECMT (ECMT 2007) as having highest impact of all reported energy reduction/CO_2 abatement measures. In line with price elasticity, fuel demand declines when fuel prices rise, although the effect varies among different countries. In Germany, it was estimated that the "eco tax", which increased by 1.5 € cents per year for four years, reduced Germany's CO_2 emissions annually by more than 9 million tonnes.

Table 9: Level of fuel taxation has direct or indirect impact on objective and/or effectivity of measure

	Objective/Measure
Short-term	■ Eco driving
Mid-term	■ More efficient vehicles ■ Transport demand management & mobility management incl. priorisation of non-motorized transport and public transport
Long-term	■ Integration of transport and land-use planning ■ New vehicle concepts ■ Shift to alternative fuels

Further, fuel taxes are a strong incentive to produce energy efficient vehicles, as consumers are turning away from gas-guzzlers. On the long-run, high fuel taxes are crucial to signalise planners and transport system users that fuels are a finite ressource. This information will lead in turn to denser settlements, smarter production and consumption patterns and developments that focus on energy efficient modes of transport.

The positive impact of the relatively high fuel taxes in Europe compared to the USA, Canada and Australia are quite clear.

Several countries impose taxes on the purchase of cars (*e.g.*, Singapore, China) depending on the type of the car. Taxes can also be combined with the use of cars; *i.e.*, the owner must pay annual automobile taxes. Both sales and user taxes can be designed to promote the energy efficiency of vehicles. A study carried out for the European Commission estimated that such a regulation would have an effect of up to 6% within eight years in Germany. The corresponding administrative costs of taxation schemes are low, even if a new taxation scheme must be developed.

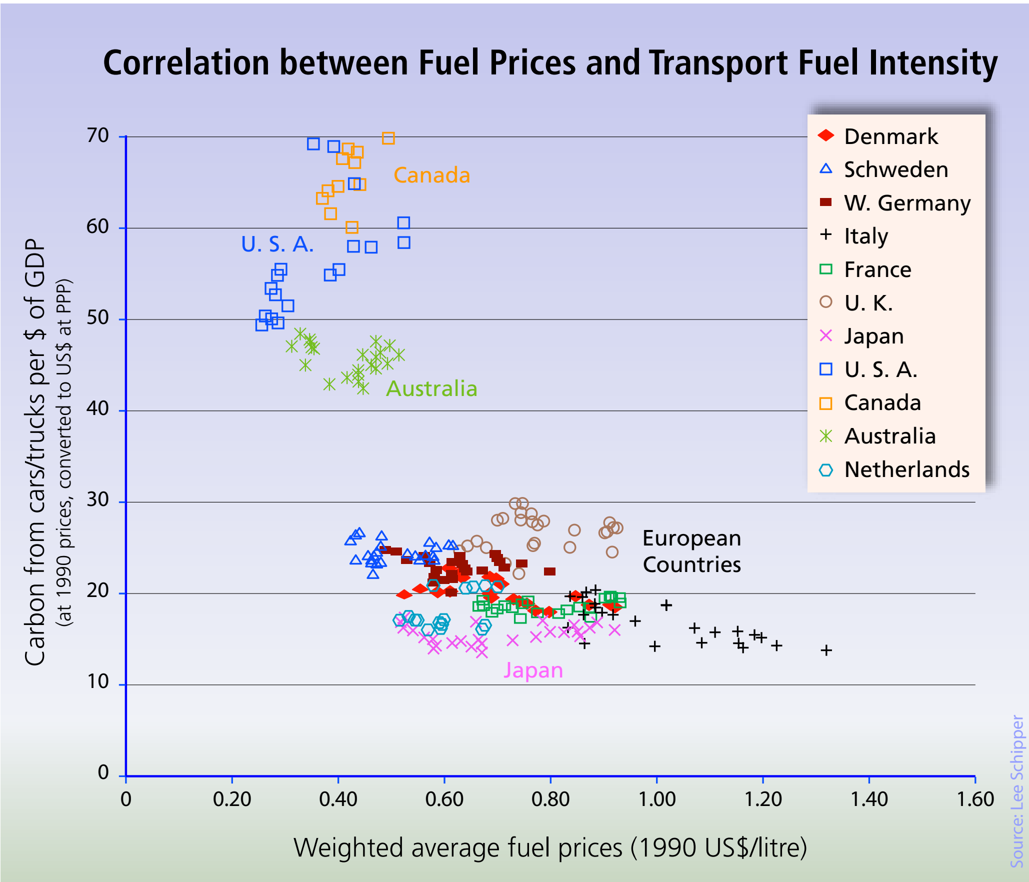


Fig. 14

Correlation between fuel prices and transport fuel intensity (expressed here as carbon emissions).

Source: Shown as Figure 16 in Shipper, Lee *et al.*, 2001. Indicators of Energy Use and Carbon Emissions Annual Review of Energy and Environment, Vol. 26.
Figure provided by the author.

Fig. 15
The level of fuel taxation is a strong signal to decision-makers, planners, and users how to shape and use the transport system.
Photo by Armin Wagner, Bangkok, 2005

Charges can be imposed either in the form of revenue-neutral schemes or as penalty systems that put an additional burden on the owners of vehicles with poor efficiency performance. The latter can also be seen as an added measure for fuel efficiency standards. Toll charges for roads and charges for parking spaces shift the cost of road construction and environmental damage from the state to the user.

(For more information, please refer to Module 1d: *Economic Instruments* of Sustainable Urban Transport: Sourcebook for Policy-makers in Developing Cities.)

2.4 References – Further reading

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3. The cost of promoting biofuels

by Jörg Peters (RWI Essen) and Dr Sascha Thielmann (GTZ)

3.1 Biofuels – An energy option for developing countries?

Biofuels are enjoying growing worldwide interest as concerns about security of energy supply and climate change are moving into the focus of policy makers. Biofuels are increasingly considered by many to be the only feasible option for the substitution of fossil fuels in the transport sector.

Box 6: Biofuel options

Currently, the most important biofuels are biodiesel and bioethanol—commonly referred to as first-generation biofuels. Both can be either used in neat or blended form, though neat usage requires compatible engines. While **biodiesel** is based on oil crops like rapeseed, sunflower, soy, palm oil, jatropha oil etc., **bioethanol** is made out of starch crops like sugar cane, wheat, or corn. In most cases, these biofuels only use part of the feedstock crop. In contrast, the so called second generation biofuels—*e.g.,* **Biomass to Liquid** (BtL) or Ethanol from Lignocellulose—take advantage of the whole crop and the entire plant is converted to liquid fuels by applying synthetic procedures. Second-generation biofuels are not expected to play a significant commercial role within the next ten years.

However, the economics of biofuels are not straightforward. On the contrary: with the exception of special cases (like large-scale bioethanol production in Brazil or biodiesel production from waste fats) production costs of biofuels are still significantly higher than those of their fossil counterparts. As a consequence, adequate promotion measures are indispensable if a country wishes to trigger substantial biofuel demand nationally. In many industrialised countries, tax exemptions or blending mandates with fixed blending quotas for biofuels have been highly successful in boosting the use of biofuels.

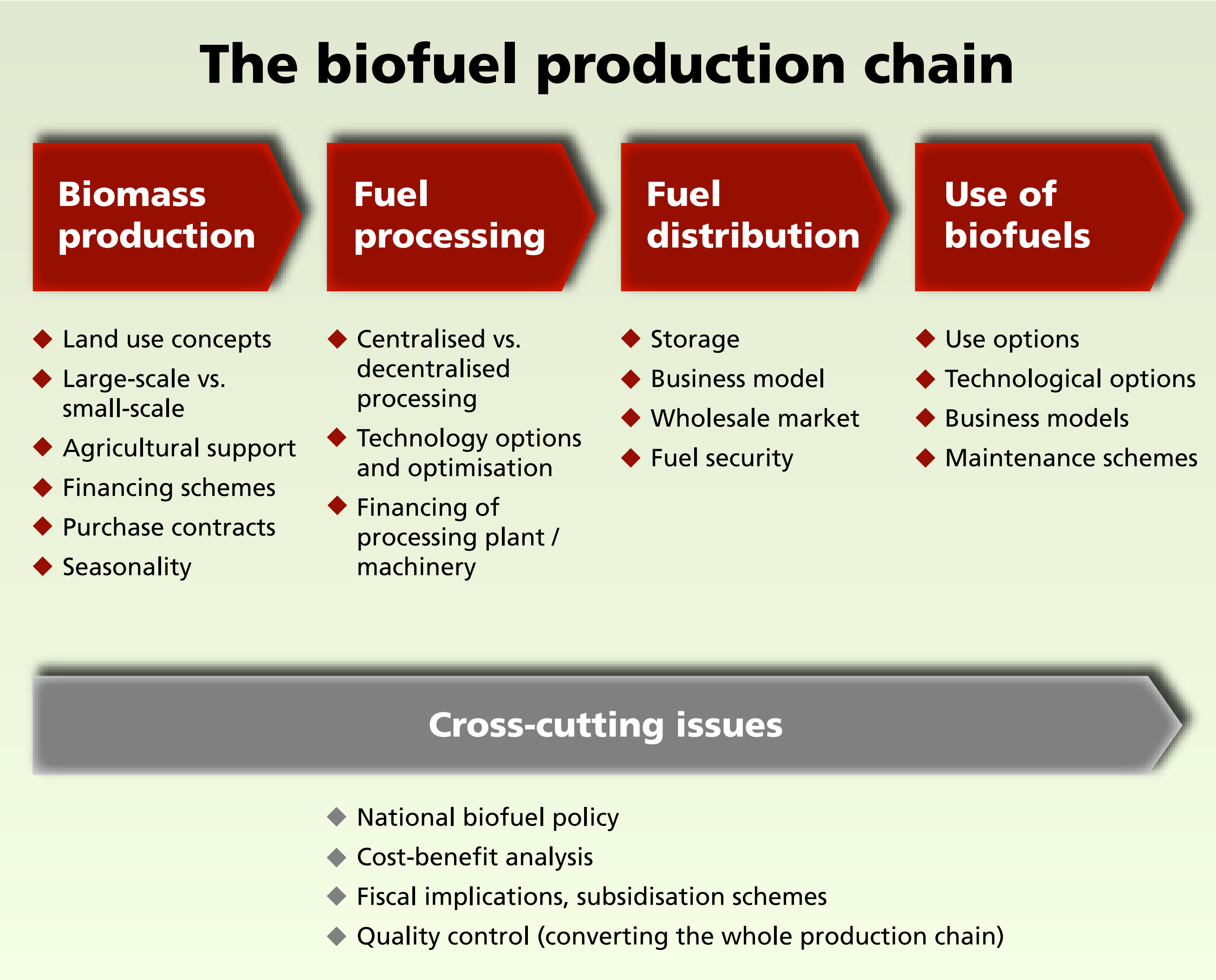
But although biofuels currently still lack economic competitiveness when compared to fossil fuels, they nevertheless have a significant appeal to politicians and private investors alike. First of all, hopes are high that production costs of biofuels will decrease over time, gradually making biofuels a **cheap alternative to fossil fuels**. Rising prices for crude (fossil) oil and petroleum products have fired these hopes.

Box 7: The current biofuel boom

Biofuel promotion policies in several countries have led to substantially increased production since the beginning of the new millennium. World ethanol production doubled between 2000 and 2005, while according to figures from the International Energy Agency (IEA) biodiesel production worldwide even increased by the threefold in the same period. Brazil has expanded its bioethanol production between 2000 and 2004 from 8 million tonnes to 12 million tonnes, while the EU tripled the biodiesel production from 1.1 million tonnes in 2002 to 3.2 million tonnes in 2005, with Germany being the largest biodiesel producer in the world. More and more developing countries are examining possibilities to substitute fossil fuels in the transport sector by locally produced biofuels. IEA expects the production of biofuels in developing countries to increase substantially in the following years.

Yet, there are many arguments in favour of biofuels that go beyond the narrow commercial competition with fossil counterparts. A powerful argument is that domestically produced biofuels can reduce the dependence on oil imports which implies a **diversification of**

Fig. 16
Fuel sold from barrels at road-side stand.
Photo by Sascha Thielmann



fuel resources inducing increased political independence from oil exporting countries (**energy security**) and **savings on foreign currency**. The latter may be particularly important for developing countries.

Furthermore, the substitution of fossil oil imports by biofuels can induce positive impacts outside the energy sector as well. As EU biofuel policies show, farmers can benefit because biofuels and the necessary cultivation of energy crops open up promising **outlet channels for agricultural production**. The promotion of domestic biofuel production can thus be a powerful instrument to push domestic agriculture.

For developing countries, the **promotion of rural development** through biofuels may be particularly attractive. Biofuels can be both produced and used locally and can thus strengthen the local economy, *e.g.,* when oil plants are cultivated by a village community and the pressed vegetable oil is directly used for lighting or to power electricity generators.

In many developing countries biofuels are met with enthusiasm. In fact, climatic conditions in many developing countries are beneficial for biomass production and biofuel feedstock crops in particular. Therefore, biofuels could be a promising option for developing countries—both as a cash crop for export and as a domestic energy resource.

However, increasing biofuel production does not only trigger positive impacts as sketched out above. If implemented at large scale, crop production requires massive acreage, and conflict with food production may arise quickly. In addition, environmental effects of biofuels are two-edged if irrigation schemes or heavy use of fertilisers are necessary. Furthermore, financial incentives from export markets or national promotion policy might induce logging of tropical rain forests. Therefore, biofuel programs have to be scrutinised carefully in order to avoid unwanted side effects. The whole production chain must be taken into consideration (see the figure above).

3.2 Promoting biofuels can be costly

Depending on the specific national policy objectives and national framework conditions, the promotion of biofuels can be a sensible political decision. However, the cost resulting from the chosen promotion instruments must not be forgotten. As long as biofuel production costs are higher than production costs of fossil fuels, promotional policies will be necessary and will come at a cost. These costs will have to be borne by either the state or the fuel consuming households and firms.

Table 10 summarises some examples of minimum levels of fuel production costs. The figures are indicative only, as detailed cost assessments are not readily available and are often highly dependent on very specific circumstances. In particular, estimates are very rough for countries where large-scale production is not yet in place. In addition, within the past months biomass feedstock prices have started to increase due to rising biofuel demand in many countries. For example, palm oil prices have increased from approx. US$380 in January 2006 to more than US$550 in March 2007.[15] With processing costs of approx. 10 US cents per litre for the transesterfication of vegetable oil to biodiesel, production costs of biodiesel from palm oil amount to approx. 60 US cents per litre.

Large scale biofuel production in most countries has not been realised yet, and hence costs at this scale have not been observed. The figures presented in Table 10 are either estimates based on feedstock and processing cost

[15] http://www.palmoil.com

Table 10: Minimum production costs of biodiesel (the figures are rough estimates)

	Minimum production costs per litre fossil fuel equivalent	**Source, Date**
Reference: Fossil fuels for diesel/gasoline (very rough world average estimates)	**Approx. 45 US ¢** (excl. distribution cost, sales margin, etc.)	Rough average cost (at a crude oil price of 60 US$ per barrel)
Bioethanol Brazil	**30 US ¢**	Estimates based on BMELV/FNR/GTZ 2005*)
Biodiesel Brazil	Production costs (based on production costs for vegetable oil of approx. 200US$ per tonne): **30–35 US ¢** Opportunity costs (based on market prices for vegetable oil of approx. 400US$ per tonne): **45–50 US ¢**	Estimates based on BMELV/FNR/GTZ 2005*)
Ethanol China	**60–80 US ¢**	Estimates based on BMELV/FNR/GTZ 2005*)
Pure Vegetable Plant Oil Germany (rapeseed)	**65 US ¢**	FNR 2006**)
Ethanol Tanzania	**60–70 US ¢** (estimates)	Estimates based on MELV/FNR/GTZ 2005*)
Ethanol India	**65–70 US ¢**	Estimates based on BMELV/FNR/GTZ 2005*)
Pure Vegetable Plant Oil Madagascar (Jatropha)	**70 US ¢**	GTZ 2006***)
Biodiesel India (Jatropha-based)	**60–80 US ¢**	Estimates based on BMELV/FNR/GTZ 2005*)
Biodiesel Tanzania (Jatropha-based)	**70-80 US ¢**	Rough estimate, based on regional experience
Biodiesel Germany (rapeseed-based)	**90 US ¢**	FNR 2006**)
Ethanol Germany (sugar-based)	**100 US ¢**	FNR 2006**)

*) BMELV/FNR/GTZ 2005, Liquid Biofuels for Transportation: Potential and Implications for Sustainable Agriculture and Energy in the 21st Century. Regional Studies for Brazil, China, India and Tanzania.
Note: The figures given are rough estimates based on the BMELV/FNR/GTZ study, but also taking into account regional and sectoral experience. As large-scale biofuel production in most countries has not been realised yet, the figures indicate estimated production costs that could be achieved in the medium-term.

**) FNR (Fachagentur für nachwachsende Rohstoffe) 2006, Biokraftstoffe: eine vergleichende Analyse, available at http://www.fnr.de

***) GTZ, 2006, Project report on the Jatropha potential of the SAVA Region in Madagascar.

Box 8: The function of a fuel tax

Taxation of fuels for transport purposes can be justified as **road user charges**. The optimal tax would cover all costs caused by vehicle usage, including costs for maintenance and expanding roads. Mainly in developing countries fuel taxes are a **major source of government revenue**. The reason is that fuel tax can be easily collected and enforced—much more easily than income taxes or value added taxes, since production is concentrated in just a few refineries or fuel distribution centres. In addition, fuel taxes are imposed to **internalise external costs** induced by vehicle usage. The driver of the motor vehicle does not take into account the environmental costs that the vehicle causes and therefore drives "excessively". The fuel tax increases consumer prices and in that way creates direct financial incentives to use less fuel—be it via more efficient engines, fuel-saving driving or the reduction of car use.

information or have been generated in pilot projects—assuming large scale production in the respective case.

In most of the countries listed in the table, ethanol production costs are lower than biodiesel production cost. This may be attributed to the fact that ethanol production is already well established (although not as fuel).[16)]

The fiscal implication of the cost difference between fossil fuels and biofuels can be illustrated when looking at the two most common promotion instruments: tax exemptions for biofuels on the one hand and blending quotas on the other hand.

3.3 Promoting biofuels through tax exemptions and subsidies

The most trivial opportunity to compensate for higher costs of biofuels in order to enhance its usage is to directly subsidise their consumption. In practice, since most countries levy substantial excise taxes on transport fuels, subsidising biofuels is implemented by exempting them from this taxation. The exemption is either partial or total but has to be at least as large as the cost difference of biofuels and their conventional counterparts—taking into account different energy contents. By eliminating the cost difference the tax exemption renders biofuels competitive to taxed fossil fuels.[17)]

The tax exemption should be reviewed regularly in order to avoid over-compensation. It is assumed that in the medium–to long-term, production costs of biofuels will decline due to improved production processes, cost savings from larger production volumes and technological improvements ("learning curve effect"). As a consequence, the tax exemption may be designed as to **decline over time**. A gradual decrease of tax exemption also is important to keep up incentives for the biofuel producers to further improve the economy of the production processes. Yet, in this respect crude oil prices should be taken into account as well. While low oil prices call for an increase of the subsidy, high oil prices allow to decrease the tax exemption.

Furthermore, the level of tax exemption could be **differentiated by fuel type** to reflect cost differences in production and/or environmental benefits. *E.g.,* biofuels which have a very positive environmental benefit (for example, a high potential of CO_2 reduction) but are costly to produce could receive a high tax exemption, whereas biofuels with "average" environmental benefits but already low production costs should receive less.

In countries with low levels of fuel taxation petroleum prices are low. In such cases it may be particularly

Fig. 17
Rice: food for human beings or "sake" for cars?
Photos by Klaus Neumann, Senegal, 2002

16) Note that the energy content of ethanol is significantly lower than that of petrol. 1 litre of ethanol is equal to approx. 0.65 litre of petrol. 1 litre of biodiesel is equal to approx. 0.91 litre of fossil diesel.

17) In countries where fuel prices are not fixed by the market-plus-taxation mechanism the situation depends on the actual implementation of the fuel pricing mechanism. *E.g.,* if prices are fixed by a state-owned petroleum company, that company must be obliged to purchase biofuels from biofuel producers at a purchase price that covers production costs. In consequence, this is similar to a subsidy.

Fig. 18a, b, c
"Jatropha curcas" plantation in Madagascar.
Photos by Sascha Thielmann

difficult for biofuels to compete with fossil fuels, and a fuel tax exemption may not be sufficient if the fuel tax is less than the cost difference. Fuel tax exemption in these cases would not be an appropriate instrument for biofuels promotion. Egypt could constitute an extreme case in this respect: with a diesel price of 12 US cents per litre, biofuels are not economically viable as for most biofuel types production costs start at about 50 US cents per litre. As no fuel taxation is in place in Egypt (on the contrary: fuel consumption is already heavily subsidised), the promotion of biofuels would require heavy subsidies.

Tax exemption of biofuels can erode an important basis of revenues

When tax exemptions are considered as a biofuels promotion instrument, serious thought should be given to the potential impact of such an instrument. It is obvious that direct subsidisation of biofuel consumption will be a financial burden for the state budget. But tax exemptions—though less obvious—represent just the same burden because tax exemptions are equal to foregone tax revenues.

Tax exemptions thus may undermine the basic functions of a fuel tax. But what are these functions?

First and foremost fuel taxation has the function of a source of revenues. It can be regarded as a **road user charge to cover the internal costs of transport**, *i.e.,* costs for infrastructure and its management and operation. An optimal road user charge would create enough revenues to cover all costs caused by vehicle usage, including costs for road maintenance and network extensions. Appropriately set fuel taxes can serve as a proxy for road use and generate revenues for the transport sector and beyond.[18]

If biofuels are exempted from fuel taxation, the natural consequence is that the strong revenues basis that a fuel tax normally delivers is eroded. As long as only small quantities of biofuels are being used, the tax loss may be small. However, losses are far from being negligible once significant shares of fossil fuels are substituted.

[18] However, fuel taxation is only a second best solution to charge for road usage because the charge that a road user has to pay does not precisely correspond with road use. The most efficient way would be direct road pricing, however, road pricing is in most cases precluded by both political and technical hurdles, particularly in developing countries.

And, in fact, this is what promotion policies aim at: signifgicant increases in the market shares of biofuels.

Since revenues from fuel taxation contribute significantly to overall tax returns in most countries, these tax losses could become a serious challenge that may eventually call biofuel promotion via tax exemption into question. Estimates show that tax losses in the European Union could easily amount to more than €10bn per year if the EU biofuel blending target was to be achieved by tax exemption (on average 5.75% of all fuels should be biofuels by 2010). As a consequence, Germany has started to switch its initial policy approach from tax exemption to a blending quota (see below). The current tax exemption for biodiesel will be almost completely phased out by 2012.

To sum up: If fuels are taxed to charge for road use as direct road pricing is not available, there is clearly no reason to exempt biofuels from taxation. As transport infrastructure is frequently considered to be one of the most important prerequisites for development, levying transport taxation is crucial as a relatively direct charge in order to finance maintenance and extension of roads.

Secondly, fuel taxes can also be used to **generate revenues for non-transport public expenditure**, such as education, health or social security. From an administrative point of view, fuel taxes are comparably easy to collect. With just a few refineries or fuel distribution centres, a fuel tax can be easily collected and enforced—much more easily than income taxes or value added taxes, which in many developing countries are hard to levy and thus often constitute an unreliable source of public revenues. Given that the extreme poor in least developed countries use fuels at most for cooking or lighting purposes whereas cars are mainly driven by the rich, fuel taxation is even desirable from a redistributive point of view.

In this respect, tax exemptions for biofuels would not only reduce revenues for the transport sector only, but may also affect the public budget as a whole. Countries like Sierra Leone (fuel tax revenues estimated at 24% of total tax income), Swaziland (23%), Côte d'Ivoire, Rwanda, or South Africa (all 20%) could easily loose more than 2% of their national tax income if tax exempted biofuels substitute for 10% of conventional fuels.

Based on available data, Table 11 presents the fiscal implications of a biofuels promotion programme for various countries. The figures assume that 10% of the domestic fuel consumption will be substituted by biofuels and that, in order to achieve this target, the cost difference between fossil fuel and biofuel

Table 11: Fiscal implications of a biofuels promotion programme

Country	**Fuel consumption** (Data source: http://www.wri.org, based on IEA data)	**Fossil fuel sales prices incl. fuel taxation** (November 2006)	**Fossil fuel production costs** (excl. distribution cost, sales margin, etc.)	**Minimum biofuel production costs** per litre fossil fuel equivalent	**Cost difference** between fossil fuel production costs and biofuel production costs	**Total amount of subsidy for a 10% blend*)**
Germany						
Gasoline	33.2 bn litres	155 US ¢ (Super)	45 US ¢	100 US ¢ (Ethanol)	55 US ¢	US$1,825 mn
Diesel	28.1 bn litres	138 US ¢	45 US ¢	90 US ¢ (Biodiesel)	45 US ¢	US$1,265 mn
People's Republic of China						
Gasoline	48.3 bn litres	69 US ¢ (Super)	45 US ¢	60-80 US ¢ (Ethanol)	15-35 US ¢	US$725–1,690 mn
Diesel	37.3 bn litres	61 US ¢	45 US ¢	60 US ¢ (Biodiesel)	15 US ¢	US$560 mn
Tanzania						
Gasoline	0.228 bn litres	104 US ¢ (Super)	45 US ¢	60-80 US ¢ (Ethanol)	15-25 US ¢	US$3–6 mn
Diesel	0.612 bn litres	99 US ¢	45 US ¢	70-80 US ¢ (Biodiesel)	25-35 US ¢	US$15–21 mn
India						
Gasoline	10.2 bn litres	101 US ¢ (Super)	45 US ¢	65-70 US ¢ (Ethanol)	20-25 US ¢	US$204–255 mn
Diesel	24.5 bn litres	75 US ¢	45 US ¢	60-80 US ¢ (Biodiesel)	15-35 US ¢	US$368–858 mn

*) Note: The energy content of biofuels is normally lower than that of their fossil counterparts.
The estimation of the total amount of subsidy assumes that 10% of the fossil fuel volume is substituted by biofuels.
The needed volumes of biofuels will be higher.

production costs has to be covered by the promotion programme, *i.e.,* from the national budget.

It is worth highlighting again that in order to assess consequences for the national budget it is useless to compare production costs of biofuels with the retail price of fossil fuels. It is rather the relation between production costs of fossil fuels and biofuels that indicates the fiscal burden induced by biofuel promotion via tax exemption.

Tax exemption of biofuels can have implications for environmental policies

Beyond the mere revenues aspects sketched out above, fuel taxation can also be used to **internalise external costs of transport** caused by vehicle usage. External costs are costs like environmental damage which are not being paid for by the vehicle users. Because the driver of the motor vehicle does not take into account the costs that he imposes on others via air pollution and noise, he drives excessively. Economic theory proposes to internalise these externalities by imposing a fuel tax, thereby reducing the consumption of fuels. In other words, the fuel tax increases the cost of driving and in that way creates direct financial incentives to use fuel in a more economical way—be it via more efficient engines, fuel-saving driving, the reduction of car use or mode shifts towards public transport.

The implications of this reasoning for biofuel tax exemptions are obvious. Tax exemptions will reduce the incentive to use fuel more economically. As long as

Fig. 19
Road tanker in Madagascar.
Photo by Sascha Thielmann

Fig. 20
Gasoline station in Madagascar.
Photo by Sascha Thielmann

biofuels are less damaging, this may not be a problem. Yet, this is only partially the case. Some external costs, such as noise or congestion costs, are not at all reduced by biofuels. Other external cost, such as environmental damage, may actually be lower. But this needs further exploration by making a distinction between locally and globally harmful emissions. While the most important global impact is certainly the abatement of CO_2 emissions, local effects might be induced by potentially intensive agricultural production.

With regard to global environmental impacts and global warming, it is argued that biofuels will reduce the emission of the greenhouse gas CO_2 due to the fact that the carbon released in the combustion process was removed from the atmosphere during the cultivation of the biomass. In this respect, biofuels are "carbon-neutral". However, this neglects the production process in which significant quantities of greenhouse gases (both CO_2 and methane) may be emitted, thus reducing the overall environmental benefit. It is therefore essential to always look at the whole supply chain ("life-cycle analysis") to assess the environmental impact of biofuels.

Even beyond global warming, environmental impacts arising during the production process of biofuels can be significant. Deforestation of rain forest, as observed in Southeast Asia due to increased palm oil production, induces local environmental problems. Intensive usage of fertilisers is required for the cultivation of biofuel feedstocks, which contribute to eutrophication and acidification of surface water. Furthermore, considerable irrigation, if necessary, may lead to soil degredation. In addition to CO_2, locally harmful particulates are emitted during the combustion process of fossil fuels. Emissions of such pollutants are significantly reduced by using bioethanol, but only slightly by using biodiesel.

Altogether, whether biofuel tax exemption can be justified on the ground that biofuels cause less environmental damagage remains an open question. Although biofuels may reduce CO_2 emissions, other environmental problems may arise. In any case, the environmental balance has to be checked carefully, and the entire supply chain of the biofuel has to be investigated and compared with conventional fuels.

3.4 Promoting biofuels through blending quotas

Quotas are mandatory and dictate that oil marketing companies blend their fuel with a certain percentage of biofuels. In most cases, quotas are defined for both fossil diesel and gasoline which have to be substituted by biodiesel and bioethanol, respectively. In principle, however, the decision of which fuel to blend could be left to the companies allowing the cheapest option to be used.

Blending quotas allow governments to bring biofuels into the market without dispensing funds for subsidies or tax credits that are required to compensate for higher production costs of biofuels. However, the burden will be directly carried by the consumers of the fuels as the blending of fuels with more expensive biofuels will increase production costs. The exact burden of the quota for consumers will depend on the extent to which fuel producers can shift the costs increases on to the consumers and on potential changes in overall fuel demand. For a more detailed discussion see the box on demand elasticity.

Empirical data is lacking, as only few industrialised countries have introduced blending quotas so far. Those countries who do so currently grant tax relief to biofuels at the same time. In contrast, Germany has introduced taxed blending quotas of 2–4% recently. They are expected to increase consumer prices by 3–7 € cents (4–9 US cents) per litre.

Box 9: Demand elasticity

The extent to which the consumers carry the burden of the increased costs depends on both the elasticity of demand and supply. Elasticities reflect the sensitivity of producers and consumers to price variations. Demand elasticities, for example, measure how much more of a product is demanded if the price decreases by 1% and vice versa. Demand or supply are said to be elastic if they strongly react to price variations. If production costs increase—as in the case of blending quotas—producers try to transmit the additional costs to the demand side. If, however, demand elasticity is high—*i.e.,* consumers do not “accept” higher prices—transmission of higher costs is limited. Suppliers respond in this case by reducing the offered amount of goods. Yet, the elasticity of fuel demand is considered to be relatively low. This means that consumers demand a relatively fixed amount of fuels at almost any price. Therefore, it can be expected that producers are able to transmit a large share of cost increase due to blended biofuels to the demand side.

A quota schemes should be designed carefully. The quota can be either fulfilled with domestically produced biofuels or with imported biofuels, basically depending on the availability of feedstocks and fuels and on their sales prices. As long as biofuel markets are not liberalised, droughts or bad weather can induce a breakdown of biofuel supply threatening the ability of oil marketing companies to meet blending quotas. Governments often try to react by relaxing blending obligations giving rise to discretionary policies and lobbying. Nevertheless, to address the risk of volatile and even collapsing feedstock markets, blending quotas should be flexible. Oil marketing companies should be allowed to shift the obligation both regionally and with respect to time. This means that oil marketing companies have to accomplish the quota on a nation-wide and annual basis instead of mixing the required percentage in every single litre sold at a petrol station. Additionally, the magnitude of the blending quota could be linked to feedstock prices: Rising feedstock prices induce a decreasing quota and vice versa. In fact, Brazil, the most successful promoter of biofuels, applied exactly this policy.

The flexibility of mandatory quota systems can be enhanced by endowing companies who blend biofuels with tradable certificates. Those companies that are able to blend biofuels at least costs will do so as much as possible and sell the excess certificates to competitors.

Fig. 21
In Germany biodiesel is available at gas stations.
Photo by Klaus Neumann, Germany, March 2007

While these possibilities to increase the flexibility of the quota system enhance the efficiency, technical limits of blending biofuels have to be taken into account. Most cars are not able to run on fuels consisting of more than 10% of biofuels.

In general, mandatory blending quotas are an effective and accurate instrument to initiate a precisely targeted biofuel usage. The risk of crowding out acreage originally used for food crops is controllable as the necessary quantities of biofuels can be set relatively precisely. The quota could be adjusted with respect to requirement and availability of arable land. Furthermore, pressure on national budgets—as observed in tax exemptions systems—can be avoided by blending quotas. However, welfare costs are not negligible. The reason is that—in contrast to a subsidy—a quota will increase production costs so that biofuels will be more expensive than fossil fuels. As a consequence oil marketing companies will try to pass on the additional costs to consumer as already described above.

3.5 Conclusion

More and more countries consider biofuels to be one part of a strategy to reduce the dependency on energy imports and to combat environmental problems in the transport sector. As these fuels are not yet competitive with their fossil counterparts, promotion measures are required in order to stimulate demand.

Tax exemptions may not be the best option. Fuel taxation in many cases contributes significantly to the national budget and is a major element in the financing of the transport sector. Tax exemptions for any fuel might induce harmful tax losses if the fuel is used at a large scale.

Blending quotas may be a better measure to promote biofuels. The reason is that the quotas are much more precise concerning the targeted outcome, preventing a "genie is out of the bottle-effect", which is often observed in renewable energy policies when feed-in tariffs are applied. In the case of tax exemptions, forces of the manipulated market are not always controllable and overproduction might be the consequence. Resulting distortions on feedstock markets and environmental consequences are more difficult to control. Tax exemptions, though, are more flexible in times of supply shortages and increasing feedstock prices. In these cases, oil marketing companies just stop blending biofuels as soon as taxed fossil fuels are cheaper than tax exempted biofuels. Several examples show that oil marketing companies face severe problems if blending quotas are applied. However, blending quotas can be designed appropriately to address supply shortages by linking the required quota to feedstock prices.

In any case, it should be kept in mind that any promotion instrument is prone to becoming entrenched and can only be reversed with supreme political effort. It could even be necessary to extend the support in times of collapsing oil prices in order to sustain the industry.

With regards to land availability, conditions have to be carefully examined in developing countries. The European example shows that the combination of relatively high population density and weak agricultural conditions result in very limited potentials of first generation biofuels. The contribution to security of energy supply and GHG abatement is low in these cases.

As the potential of first generation biofuels is limited in most regions of the world, countries should always focus on paving the way for the promising second generation biofuels. The performance of second generation biofuels is much better with regards to all critical factors: Local pollution, GHG abatement, and high-quality farmland requirement.

In general, biofuels should not only be compared with fossil transport fuels. Stationary biomass utilisation for electricity generation and co-generation should also be taken into account, as it is in most cases the more efficient option in terms of both costs and land usage. And above all, in order to reduce the dependency on oil imports and to combat environmental problems in the transport sector, a wide range of transport policy instruments is readily available in order to reduce fuel consumption in the transport sector. The instruments range from smart planning of land-use and transport infrastructure, via traffic demand management and economic intruments to technical or behavioural improvements of the fuel-efficiency of transport. Such measures can achieve similar results, that is: they reduce fossil fuel consumption … but in many cases at significantly lower costs.[19)]

3.6 Case studies – International experiences with promoting biofuels

A. Brazil[20)]

Ethanol production in Brazil is building upon 70 years of history. Blending ethanol into gasoline was first authorized in 1931 and a quota of 5% became mandatory in 1938. In the following years the country faced various difficulties in biofuels production but ultimately emerged as the world's largest producer of bioethanol and the only one to provide biofuels at costs competitive to fossil fuels. One factor of success is the feedstock: Bioethanol from Brazil is based on sugar cane, which yields a high production per ha compared to biofuels based on cereals or oil crops. Brazil has a long tradition of sugar production and is today the largest supplier. Bagasse, a by-product of sugar cane production, is used in combined heat and power generation and thereby significantly reduces the fossil energy requirement for the processing. Though sugar cane cultivation is rather water-intensive, this does not induce severe problems as the country's climatic conditions provide sufficient rainfall.

Taking advantage of bioethanol's long tradition in Brazil, production boosted after the promotion program *Proálcohol* was launched in 1975. It started by granting favourable credits to investments in production capacities. The first effective instrument targeting the demand side was to fix the ethanol retail price at 65% of the gasoline price, thereby making the biofuel cheaper than its fossil counterpart even taking into account different heating values. During the first five years of *Proálcohol*, bioethanol production increased by the tenfold to 2.2 million tonnes in 1980. Such a policy calls for substantial subsidies in times of low oil or high feedstock prices and therefore led to serious fiscal problems in the 1980s.

In addition, bioethanol production increased by 35% annually and peaked at a market share of 57% of total fuel consumption. Such a quota was only possible by simultaneously supporting the use of ethanol compatible vehicles as shares above 30% are not technically feasible in ordinary engines. In fact, vehicles running only on neat ethanol were strongly supported after the oil crisis of 1979. Success of *Proálcohol* in terms of ethanol output was enormous: At the end of the 1980s ethanol's market share outperformed that of gasoline.

Yet, the Brazilian example shows that biofuel usage is not without market risks resulting from price volatility. In the late 1980s world sugar prices increased significantly, attracting Brazilian sugar cane to the world market. In order to service its large fleet of ethanol compatible vehicles with the biofuel, Brazil became an ethanol importing nation. These supply shortages triggered a serious crisis of confidence. Furthermore, the decline in oil prices between 1985 and 1990 increased the pressure on the ethanol program. The governmental price guarantee at 65% of the gasoline price was relaxed to 75%, making bioethanol more expensive than gasoline in terms of energy content. In addition, a mandatory blending quota of 20 to 26% assures the

Fig. 22

The availability of biodiesel at a filling station in Germany is highlighted in the price board.

Photo by Gerhard P. Metschies, Germany, April 2007

19) A comprehensive overview over sustainable transport policies and measures can be found in GTZ's Sustainable Transport Sourcebook for Policy-Makers in Developing Cities or on the GTZ website http://www.sutp.org.

20) Based on ESMAP, 2005, Potential for Biofuels for Transport in Developing Countries; Schmitz, N., 2005, Innovationen bei der Bioethanolerzeugung, Schriftenreihe "Nachwachsende Rohstoffe", Band 26, Landwirtschaftsverlag.

usage of bioethanol beyond the neat utilisation and is determined by the government taking into account current sugar prices. Thus, the blending quota increases if bioethanol is cheap and vice versa.

One important reason for the credibility loss in the wake of this turbulence was the inflexibility of the ethanol cars running only on the neat biofuel. In 1990, four million of these vehicles were running in Brazil. The so-called flexible fuel vehicle (FFV) is able to run on both ethanol and gasoline in any given blending ratio. Its broad introduction in the early 1990s re-established confidence in the ethanol market among the users. Additionally, rising oil prices have rendered bioethanol competitive to gasoline and have even made the governmental price guarantee redundant: In 2005, the price of gasoline was twice as high as the price of bioethanol. However, Brazilian bioethanol is still enjoying strong indirect subsidies. As a consequence, bioethanol production is increasing again: After peak production in 1997 of almost 13 million tonnes it decreased to 8 million tonnes in 2000 and has recently recovered to again around 12 million tonnes. In 2004, bioethanol's share in total road-fuel consumption was more than 13.5%.

In addition to *Proálcohol*, the government launched a national program for the use of biodiesel in 2003. A 2% blend will be compulsory between 2008 and 2012, increasing to 5% by 2013.

B. Germany

The promotion of renewable energies has a long tradition in Germany. It was one of the first European countries that promoted directly the usage of biofuels in the early 1990s by completely exempting neat biodiesel from mineral oil taxation. In 2004, this exemption was extended to all biofuels in both neat and blended forms. While biodiesel production had already been increasing slightly during the 1990s, the opportunity to blend it with fossil diesel and to save fuel taxes at the same time boosted the production: Between 2002 and 2005 German biodiesel production quadrupled to 1.8 million tonnes. In the past, bioethanol has only been used in order to increase the octane number of gasoline. Thanks to the tax exemption granted since 2004, bioethanol production shot up from almost zero in 2004 to 230,000 tonnes in 2005.

It is not surprising, therefore, that these developments led to massive tax losses: In 2005, biodiesel and bioethanol were subsidised by €890 million (US$1.2bn) and €160 million (US$211 million), respectively. In order to avoid such tax losses, the German Government decided in 2006 to reintroduce taxation of neat first generation biofuels successively and completely replace tax credits by mandatory blending quotas: Oil marketing firms are obliged to blend gasoline with 2% of bioethanol and fossil diesel with 4.4% of biodiesel in 2007. By 2010, an overall biofuel quota of 6% has to be achieved. Biofuels used to fulfil these quotas are taxed to the same extent as their fossil counterparts. Though the quotas are designed rather flexibly—oil marketing companies can shift the blending over time and regions and are even allowed to trade "certificates"—production costs of each litre of fuel will increase significantly. It is expected that oil marketing companies are able to pass on these costs to such an extent that consumer prices will increase by 3 to 6%. Furthermore, consumers might be charged by increasing food prices as food crops compete with the same acreage. Around 1.5 million ha of acreage are available for non-food purposes, while 1.4 million ha were already required for biodiesel production in 2006. Since biofuel consumption accounted for 3.75% of total fuel consumption in 2005, it is easy to grasp how serious the rivalry between energy and food crops becomes if blending quotas are fulfilled in 2010.

C. France[21]

Since 1993, France has offered financial incentives for biofuel production. While biodiesel is exempted from 33 € cents (44 US cents) per litre of mineral oil taxation—equalling to a 64% tax reduction—bioethanol receives credits amounting to 38 € cents (50 US cents) per litre or 80%. However, the amount of biofuels receiving these tax credits is not unlimited. In 2005, the French government declared 417,000 tonnes of biodiesel and 100,000 tonnes of bioethanol to be exempted from taxation. These quantities would substitute for around 2% of total fuel consumption in terms of energy content. Yet, production capacities were not sufficient to meet these quotas in 2005. Nevertheless, the government announced in 2004 to further increase the amounts of biofuels qualified for tax exemptions in order to reach the biofuel target defined by the EU directive. The national biofuel target is even more ambitious than given by EU directive 2003/30: In 2015, 15% of total fuel consumption should be substituted by biofuels.

In 2004, tax losses due to biodiesel promotion were as high as €144 million (US$190 million) and €32 million (US$42 million) for bioethanol, a total amount of €176

[21] Based on US Department of Agriculture (USDA), 2005, New Incentives for Biofuel Production 2004; US Department of Agriculture (USDA), 2006, French Biofuel Production Booms 2005.

Fig. 23
In Germany, rapeseed is the major feedstock for biodiesel.
Photos by Klaus Neumann, Westphalia/Germany, 2006

million (US$232 million). If the French targets for 2010, which are in accordance with EU objectives, are fulfilled, tax losses would jump up to €1.2bn (US$1.6bn).

The availability of arable land represents a natural limitation to biofuel production in France. In 2004, an area of 300,000 ha was required for biodiesel production. If the French targets were to be fulfilled the area dedicated to biodiesel production would triple during the following three years. In practice, however, France cannot produce the amount of rapeseed necessary to process the quantities of biodiesel to meet the 2008 quota.

D. India[22)]

In early 2003, mandatory ethanol blending quotas of 5% were set for nine Indian states. Although environmental and energy supply security benefits were also mentioned, the program was mainly motivated by overcapacities in the sugar sector. In addition, the government introduced a tax exemption for blended ethanol to support the mandatory quotas, but withdrew it in June 2004.

The annual ethanol requirement of 360 million litres resulting from the 5% quota has never been covered: In the 2003–2004 period, only 200 million litres were available. After harvest problems in late 2004, it became evident that even this amount could not be delivered. As a consequence, the mandatory blending quota was taken back and replaced by a law requiring the blending of ethanol only if it is economical. In August 2005, the government supplemented the law by pursuing an ethanol pricing policy under which the ethanol price was fixed in negotiation both with ethanol producers and oil marketing companies in order to avoid supply shortages. Given the combination of unfavourable agronomic conditions and misguided promotional policies, the country's biofuel program is far from viable.

In addition to the bioethanol promotion, India intends to support biodiesel usage and envisages a share of 20% by 2013. As feedstock, jatropha plants have been investigated in pilot projects. Although the fruit seems to be a good option from an environmental point of view and with regard to a minimisation of land-use conflicts with food production, production costs are still high.

[22)] Based on ESMAP, 2005, Potential for Biofuels for Transport in Developing Countries.

4. Fuel taxes and the financing of road infrastructure

by Dr Gerhard P. Metschies (Metschies Consult) and Dr Sascha Thielmann (GTZ)

Fuel prices, fuel taxation and subsidies for petrol and diesel fuel rank high on the world's political agenda, particularly after the spectacular increases in world market prices for crude oil (up to US$75 a barrel in August 2006 and the subsequent slide to US$54 in January 2007), attaining an average of US$60 in November 2006 and in February 2007.

In this age of high and volatile fuels prices, a critical assessment of the role and functions of fuel prices and fuel taxation is crucial.

4.1 Fuel taxation is important

First and foremost, fuel taxes are a means of generating revenues for the state. Fuel taxes can be seen as a reliable source of revenues for the state, because—with just a few refineries or fuel distribution centres—a fuel tax can be collected and enforced relatively easily. Thus fuel taxes are much easier to collect than, for example, income taxes or value added taxes which, in many developing countries, are hard to enforce and thus often constitute a weak and unreliable basis for public revenues.

Apart from this general advantage, fuel taxes are a crucial component in sound financing of the transport sector, and in developing countries the fuel tax could be an ideal instrument for the financing of road infrastructure. However, as income levels in many developing countries are low and infrastructure requirements and investment backlogs are high, it is generally accepted that many developing countries will rely on external funding for road infrastructure investment. But it is also generally accepted that such external funding should, in principle, be limited to the construction of new roads or to substantial rehabilitation schemes. The regular management and maintenance of roads, however, should be largely funded from internal financial resources. The fuel tax can be a key element in securing sufficient domestic funding.

The fuel tax is a means to implement the "users pay principle", which basically states that road users should pay for the provision of road infrastructure. Although for many developing countries this principle may be restricted to merely paying for the maintenance of roads (and not for the full investment cost), it is still a crucial guiding principle for the transport sector—and a powerful argument for fuel taxes.

But apart from the mere revenue aspect, fuel taxation plays another important role: it increases fuel prices and thus creates direct financial incentives to use fuels in an economical way. Excessive individual car use, a major problem in many cities, becomes more expensive whilst public transport gains in attractiveness. High fuel prices also promote fuel efficiency—either by stimulating the purchase of fuel-efficient vehicles or by encouraging economical driving behaviour ("eco driving"). In the medium – to long term, it is also an incentive to shape transport networks in smarter and more energy-efficient ways.

All this can help reduce a country's dependency on oil. For oil-importing countries the advantage of this is obvious. But even for oil-exporting countries with seemingly abundant oil reserves, the promotion of fuel efficiency makes sense—because every barrel of oil that is not consumed by the domestic market today can be exported in the future.

Fig. 24
Well-maintained roads are essential for safe and efficient transportation.
Photo by Armin Wagner, Lesotho, 2006

4.2 How should fuel tax revenues be used?

The general budget approach

The "users pay principle" primarily focuses on the question of who pays for infrastructure. But this is only one relevant aspect of ensuring sustainable financing for the roads sector. The second highly important aspect is the question of how the funds collected from road users should be spent.

Economic theory normally stipulates that all state revenues should enter into the general budget. Revenues should never be earmarked for particular purposes but should rather benefit the general budget. The decision on how revenues are eventually spent should be left to the discretion of parliaments and governments. In this view, fuel tax revenues should enter into the general budget.

Past experience, however, shows that the general budget approach often leads to insufficient funding of the roads sector. The reasons are manifold: weak fiscal institutions and limited budgetary transparency often lead to a diversion of funds to other purposes. In addition, in the short-term thinking of many political decision-makers, road maintenance is not the highest political priority, because—seemingly—neglecting road maintenance does not immediately lead to a deterioration of road conditions. Therefore politicians have always tended to prioritise other, more visible measures and apparently more urgent issues, such as education, health care, etc.

But in the medium—to long term, such thinking has proved to be a mistake. Neglecting road maintenance soon leads to a serious deterioration of roads, and once critical levels of neglect have been reached, expensive and very valuable road infrastructure investment is irretrievably lost. To avoid road deterioration and to ensure the sustainability of road investment, a steady stream of financial resources is needed to enable regular and steady road management and maintenance. A road fund, combined with adequate road agencies, can be a crucial instrument for the attainment of this aim.

The sector or road fund approach

When a road fund is in place, revenues from user charges such as a fuel tax can be directly channelled to the road sector. The basic idea behind a road fund is that a fixed amount of the fuel tax (plus other revenues such as road tolls) is set aside for a dedicated fund. This road fund is administered by an independent committee with representatives of both the public sector and road users. The fund's financial resources are reallocated by the committee to specific segments of the road network in order to ensure efficient and effective management and maintenance of the roads. To ensure that road funds will work effectively, a number of requirements have to be met. Major requirements have been developed within the framework of the Road Management Initiative (RMI), some examples being: road funds must be set up as independent legal entities with clearly defined responsibilities and a firm legal basis; a powerful oversight board with participation of road user groups; reliable and steady sources of revenues based on the users-pay principle; a lean and efficient day-to-day management structure; regular auditing by independent auditors. A more detailed description of how to set up a road fund can be found in the relevant publications of the World Bank and on the website of the Sub-Saharan African Transport Policy Program (SSATP).[23)]

Fig. 25

The stabilization of the flanks of rough-roads decreases the break-away drastically and thus reduces maintenance costs.

Photo by Klaus Neumann, Serranía de Turiminquire/Venezuela, 2006

As a very rough rule of thumb, in many developing countries the equivalent of a minimum of 10 US cents per litre of diesel and gasoline may be sufficient to ensure the proper maintenance of all national, provincial and rural roads. For the maintenance of rural roads, a fixed allocation of perhaps 20% or the equivalent of 2 US cents per litre of fuel may suffice. On this basis, the road fund can become a means—and on the evidence to date, the only effective means—to finance this

[23)] See, *e.g.,* ⇨Roads & Highways ⇨Road Financing & Road Funds and the SSATP page http://www.worldbank.org/afr/ssatp.

often neglected but important part of the road network, which represents the largest share of roads in developing countries. (In economic terms, this way of financing rural roads may be regarded as limited cross-subsidisation within the road sector.)

The major benefit of a road fund is that a steady and reliable stream of financial resources is available and spent primarily on road maintenance (or, in principle, even on network extensions if sufficient funds could be raised) in an efficient and transparent way. In countries that have set up road funds, setting a sufficient rate of fuel tax is crucial.

4.3 Does fuel taxation hamper development and poverty alleviation?

Governments in developing countries often argue that, for economic and social reasons, fuel prices have to be low, and that significant fuel taxation is not feasible.

But in reality, the view that low prices for road users (in the form of cheap fuel, for instance) will underwrite economic growth and social equity has frequently turned out to be a fallacy. India, for example, can boast substantial economic growth despite extraordinarily high fuel prices.

Fig. 26

Without proper road maintenance and sufficient funding roads are left to decay.

Photo by Hans Maennchen, 1992

It is primarily the wealthy, who can afford a car, who benefit from cheap gasoline. A fuel tax is therefore inappropriate as an instrument for social equity, since it cannot be targeted with sufficient precision to benefit the poor specifically.

Road infrastructure contributes to poverty reduction primarily when roads give the poor access to institutions, information and opportunities—for instance when transport facilities are in place at all, for which the poor are frequently willing to pay. The alternative to a functioning, user-financed road infrastructure is often the absence of any transport provision at all—or failing that, much more expensive transport. For example, transporting seed in handcarts on poor tracks is more than ten times as expensive as taking it by truck on surfaced roads.

Moreover, low fuel prices are not a requirement for economic growth. The greatest contribution to economic growth comes from a functioning infrastructure—and not necessarily cheap, untaxed or even subsidised fuel. On the contrary, if no fuel tax is collected, the financial resources for the sector are generally inadequate, making it impossible to ensure the maintenance of an effective nationwide road network. This itself can become an impediment to growth.

In addition, low fuel prices induce wasteful use of energy whereas higher fuel prices tend to promote the development, diffusion and adoption of energy-efficient technologies and more environmentally-friendly behaviour (see Chapter 2: *Enhancing energy efficiency in the transport sector*).

4.4 Designing a proper fuel-taxation policy is crucial

The design of national fuel-taxation policy is a complex issue. The following pragmatic principles can provide some guidance towards a rational fuel-taxation policy.

Principle 1: Fuel taxes help implement the "user pays" principle

Fuel taxes are a good instrument for charging road users. Although fuel consumption does not precisely reflect road use, it is a sufficiently accurate approximation, *i.e.,* the more people drive, the more fuel they will consume. Therefore, taxing fuel consumption is—at least in broad terms—similar to charging for road use.

Fuel taxation can thus help implement the "users pay" principle, which states that road users should pay for their use of road infrastructure.

Despite certain shortcomings, for most developing countries fuel taxes seem to be the most appropriate way to charge road users. Other options, such as road tolls, are costly to implement and constrain traffic flows. In addition, they can never cover the whole road network but only certain sections such as highways or bridges.

The financing of the roads and highways sector via fuel taxes is the primary pricing-policy instrument throughout the world. On global average, some 80% to 90% of all transport-sector revenues are raised via fuel taxes. The remaining share mainly stems from annual vehicle taxes, which normally increase with the size of the vehicle, *i.e.,* small passenger cars normally pay less than large trucks.

In the US, fuel taxes of about 10 US cents per litre of diesel and gasoline are used to cover all direct expenditure on the roads and highways sector (maintenance, refurbishment, new construction and capital recovery for the roads and highways departments).

Due to the lower traffic density (*i.e.,* the presence of fewer vehicles) in developing countries in Africa and elsewhere, however, 10 US cents per litre will cover only day-to-day and periodic road maintenance expenditures, but no new construction or capital recovery for the roads and highways network.

A rate of 10 US cents per litre of fuel (plus a vehicle tax of US$75 per annum for small passenger vehicles and US$500 for medium-size trucks) was adopted as a recommendation by the World Bank within the scope of the International Road Maintenance Initiative for less developed countries.[24)]

Principle 2: Limited cross-subsidisation within the road network is needed

The existing road network in developing countries should be regarded as a comprehensive unified network in which the more heavily frequented, "better-off" roads are expected to help finance the less heavily frequented, "worse-off" roads. As a matter of fact, cross-subsidisation takes place between the national roads of the main trunk-road network, on the one hand, and rural roads on the other. Although in countries like Tanzania and Zambia, most fuel revenues stem from the users of main roads, 20–25% of the fuel tax revenues should always be earmarked for rural roads.

24) The recommendation was reconfirmed by the annual SSATP Minister Meetings in Bamako (2005) and Lesotho (2006).

Principle 3: Fuel taxes are an important component of transport-sector financing

Transport subsectors other than the road sector are also in need of funding, and in certain cases it may be difficult to generate sufficient funding from within the subsector, *e.g.,* railways or public urban transport. In these cases, deficits will have to be covered with funding surpluses achieved in other subsectors. A fuel tax can be a promising instrument for generating such surpluses and could partly contribute to the financing of other subsectors.

In Germany, for instance, parts of the fuel-tax revenues are reserved for the improvement of regional and urban transport. In the USA, the fuel-tax Federal Highway Trust Fund and the State Highway Funds contributed to the financing of "surface transportation programs" and also to "air quality improvements" and "highway safety programs".

Principle 4: Tax rates can be differentiated

A worldwide comparison of fuel-price tables illustrates that, practically all over the world, taxes on gasoline are higher than taxes on diesel. This is often a result of the view that diesel is mainly used by commercial vehicles and that the tax burden for such uses should be lower. (However, this reduced financial burden is often compensated by higher vehicle-taxes for large trucks.)

Another possible differentiation of fuel-tax rates relates to fuel quality, and can be justified on environmental grounds. For example, in European countries, higher tax rates on "dirty fuels" (such as leaded fuel or fuels with high sulphur contents) have helped to reduce (or phase out) the use of these more damaging fuels.

Principle 5: Fuel should also be subject to a value added tax (VAT) or sales tax

As fuels should be regarded as any other commercial good, they should always be subject to value added tax. This tax is a major source of revenue for the state budget, and the transport sector should contribute to the general budget just like any other sector. VAT should thus be charged on the full sales value of fuels (including the fuel tax element).

4.5 Transition to adequate levels of fuel taxation

If fuel taxation is to be introduced or increased, great care should be devoted to the actual design of the implementation process. Gradual, step-by-step adjustments, flanked by carefully designed public awareness campaigns to communicate the reasons for tax increases are key to success. Often fuel-tax increases face strong opposition on the grounds that price increases will lead to social problems, since the poor will be unable to pay the higher prices. Step-by-step increases, stretched over several years can reduce political opposition to such unpopular measures.

Past experience shows that in quite a few developing countries, such fuel price increases are frequently implemented in an unprofessional manner. After months or years of official passivity, all the incremental price hikes that should have been instituted in the past are suddenly lumped together and imposed on an unprepared population all at once.

Even if a country's fuel prices are amongst the lowest in the world, this is not an appropriate approach. Numerous examples from the past document how such irresponsible behaviour on the part of governments can lead to riots and bloody conflicts—up to and including the overthrow of the government itself. In some cases, such as Indonesia and Zimbabwe in 1998, popular discontent forced the state to rescind such price hikes.

It should be noted that such revolts as a result of opposition against fuel price rises are always triggered by the relative increase (often 30% or more), while the absolute level of increase (frequently only a few cents being added to "dirt cheap" fuel prices) plays practically no role at all. This is particularly true for Nigeria where fuel-price increases have repeatedly led to rioting, even though fuel had already become—in objective terms—cheaper than drinking water. When Ghana discarded its traditional cheap-fuel policy in the 1980s, and fuel prices nearly tripled within a relatively short time, the country descended into major unrest. The only way to remedy the situation was for the government to temporarily interrupt the country's supply of fuel. Immediately, black-market traders from neighbouring countries began selling fuel at four times the previous price level. After about four weeks, the government resumed its official imports, thus forcing the black-market price down by about one-half. This found the approval of the public at large, and the final result of the politically risky manoeuvre was that fuel then cost twice as much as before.

The lesson to be learnt is simple: fuel price increases (via increases in fuel taxation or via administered price levels) should—in relative terms—never be too high. In practice, price increases in the range of 10% seem to be publicly acceptable.

Fig. 27
The prioritised rehabilitation of bridges may yield substantial gains at relatively small costs.
Photo by Hans Maennchen, near Kindu, Kongo/Kinshasa, 1992

One fuel-price-adjustment policy that has been quite successful politically was instituted in January 1996 by the 14 countries of the CFA Franc Zone in Western and Central Africa (extending from Senegal across Côte d'Ivoire to Cameroon and the Central African Republic). Although the regional currency was practically slashed in value by about 50% overnight, fuel prices were adjusted to the devalued exchange rate slowly and incrementally.

Long-term price strategies based on a series of modest but regular price increases are to be recommended over short-sighted, steep fuel-price increases, as they will face significantly less public opposition.

If the heavily populated and economically dynamic states of Asia were to gradually raise their fuel prices to the European level, this would provide a major incentive to achieve greater efficiency in the transport sector, since high fuel prices act as an incentive to conserve fuel. This would not only save valuable oil resources (and foreign currency for oil-importing countries) but would also help to cut hazardous emissions. Furthermore, it would make a major contribution to cutting CO_2 emissions in the transport sector. But for developing countries, the major advantage is that fuel taxation can tap a broad base of revenues, providing a significant source of financing for both their roads and their general budgets.

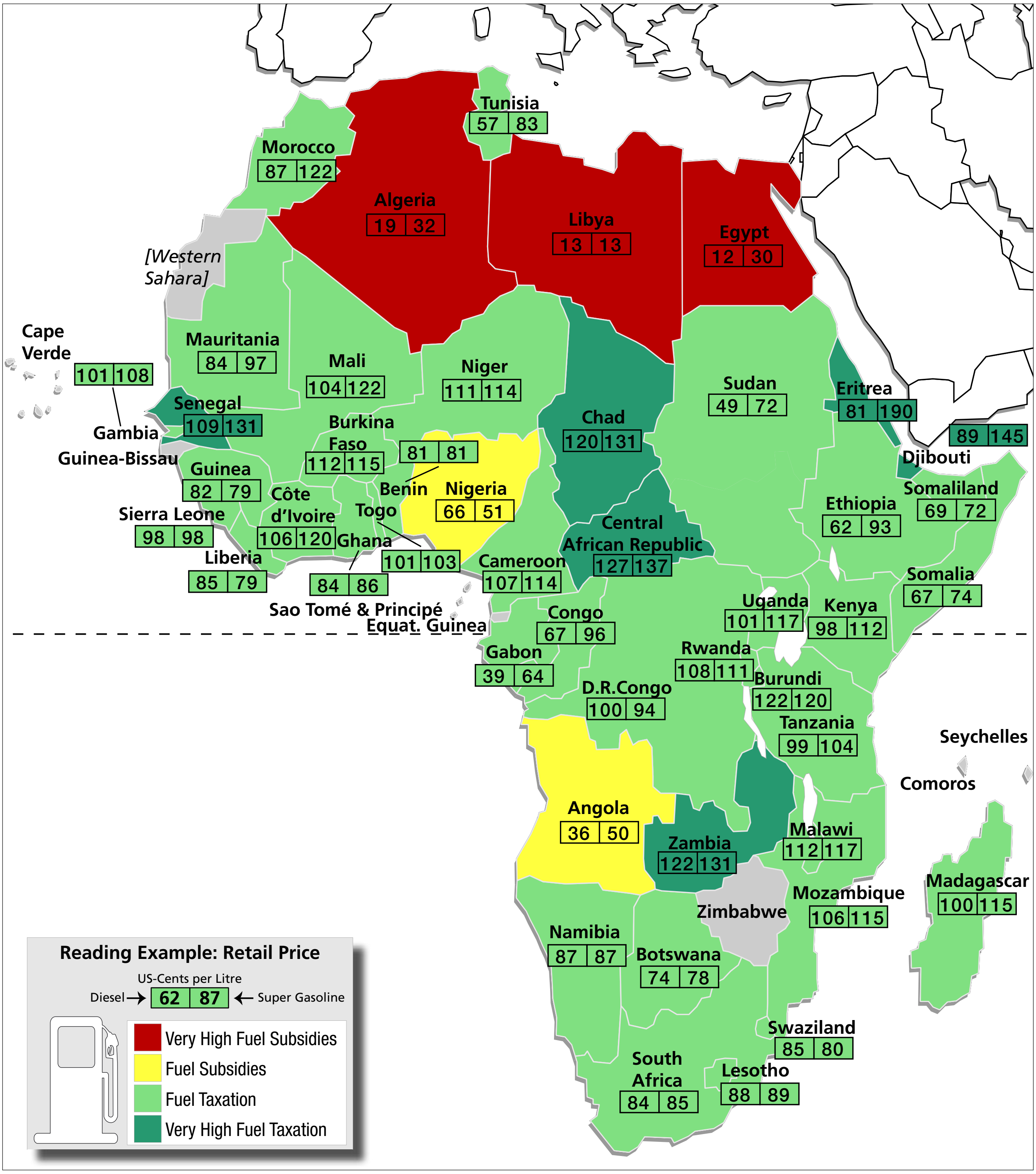
5. Fuel prices by continent

5.1 Fuel prices in Africa

- *Retail fuel prices in Africa*
- *Comparison of retail fuel prices in Africa*
- *Time Series of retail fuel prices in Africa*
- *Detailed time series of fuel prices in Africa*

5.1.1 Retail fuel prices in Africa

as of November 2006 (in US cents/Litre)



Fuel Taxation Category 1: Very high Fuel Subsidies
The retail price of fuel (average of Diesel and Super Gasoline) is below the price for crude oil on world market.

Fuel Taxation Category 2: Fuel Subsidies
The retail price of fuel is above the price for crude oil on world market and below the price level of the United States.

Note: The fuel prices of the United States are aver. cost-covering retail prices incl. industry margin, VAT and incl. approx. US cents 10 for the two road funds (federal and state). This fuel price being without other specific fuel taxes may be considered as the international minimum benchmark for a non-subsidised road transport policy.

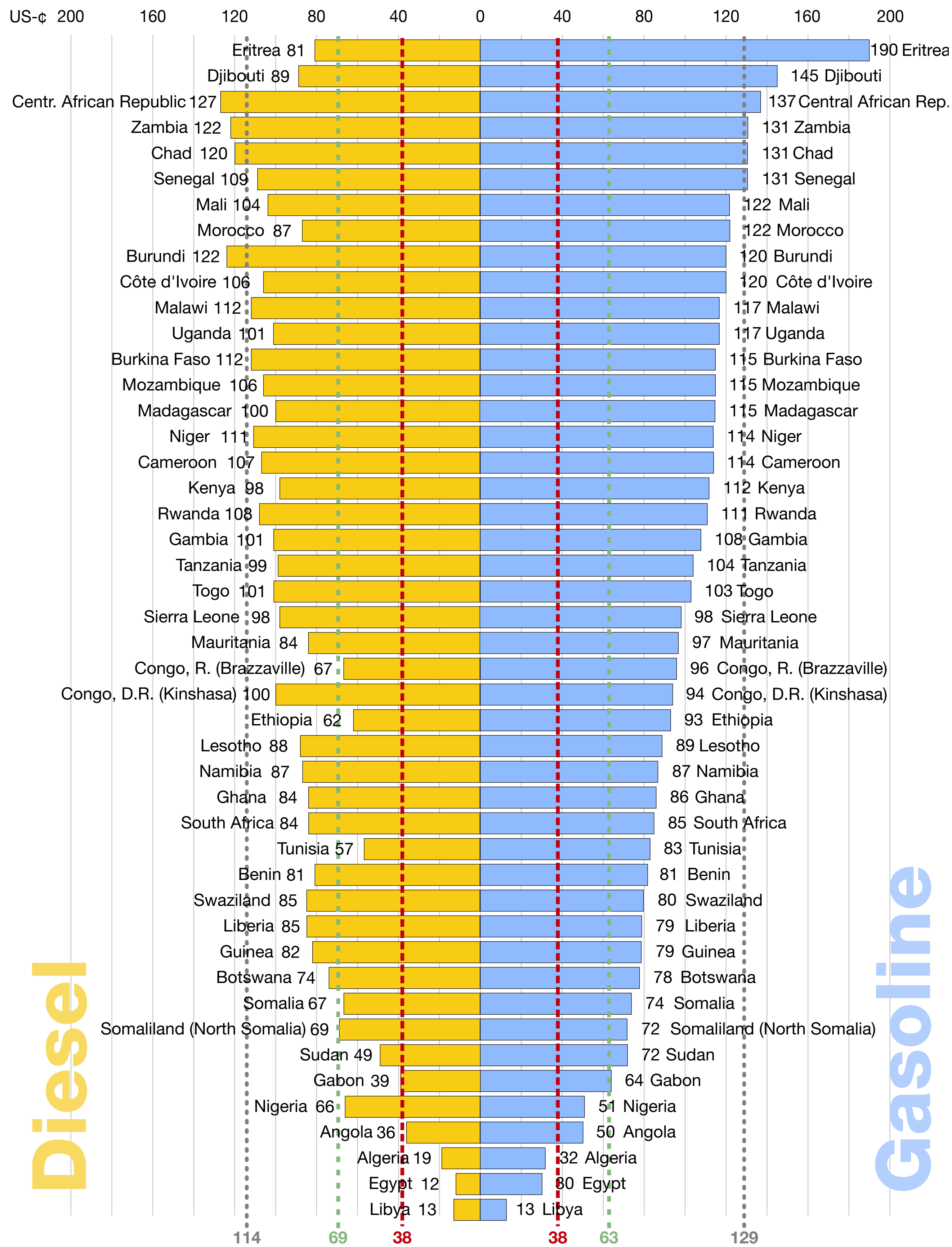
Fuel Taxation Category 3: Fuel Taxation
The retail price of fuel is above the price level of the United States and below the price level of Luxembourg.

Note: The fuel prices in Luxembourg reflect an orientation level in the European Union. Prices in EU countries are subject to VAT, a EU-imposed minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel as well as other country-specific duties and taxes.

Fuel Taxation Category 4: Very high Fuel Taxation
The retail price of fuel is above the price level of Luxembourg.

5.1.2 Comparison of retail fuel prices in Africa

as of November 2006 (in US cents/litre)



Grey Benchmark Line = Retail Fuel Prices of LUXEMBOURG = Orientation Level in European Union. In accordance with EU Directive 92/82, the member states of the EU are obliged to impose minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel. Furthermore, petroleum products are subject to regular value-added tax.

Green Benchmark Line = Retail Fuel Prices in the UNITED STATES = aver. Cost-Covering Retail Prices incl. Industry Margin, VAT and incl. approx. US cents 10 for the 2 Road Funds (Federal and State). This Fuel Price being without other Specific Fuel Taxes may be considered as the International Minimum Benchmark for a non-subsidised Road Transport Policy.

Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.1.3 Time Series of retail fuel prices in Africa

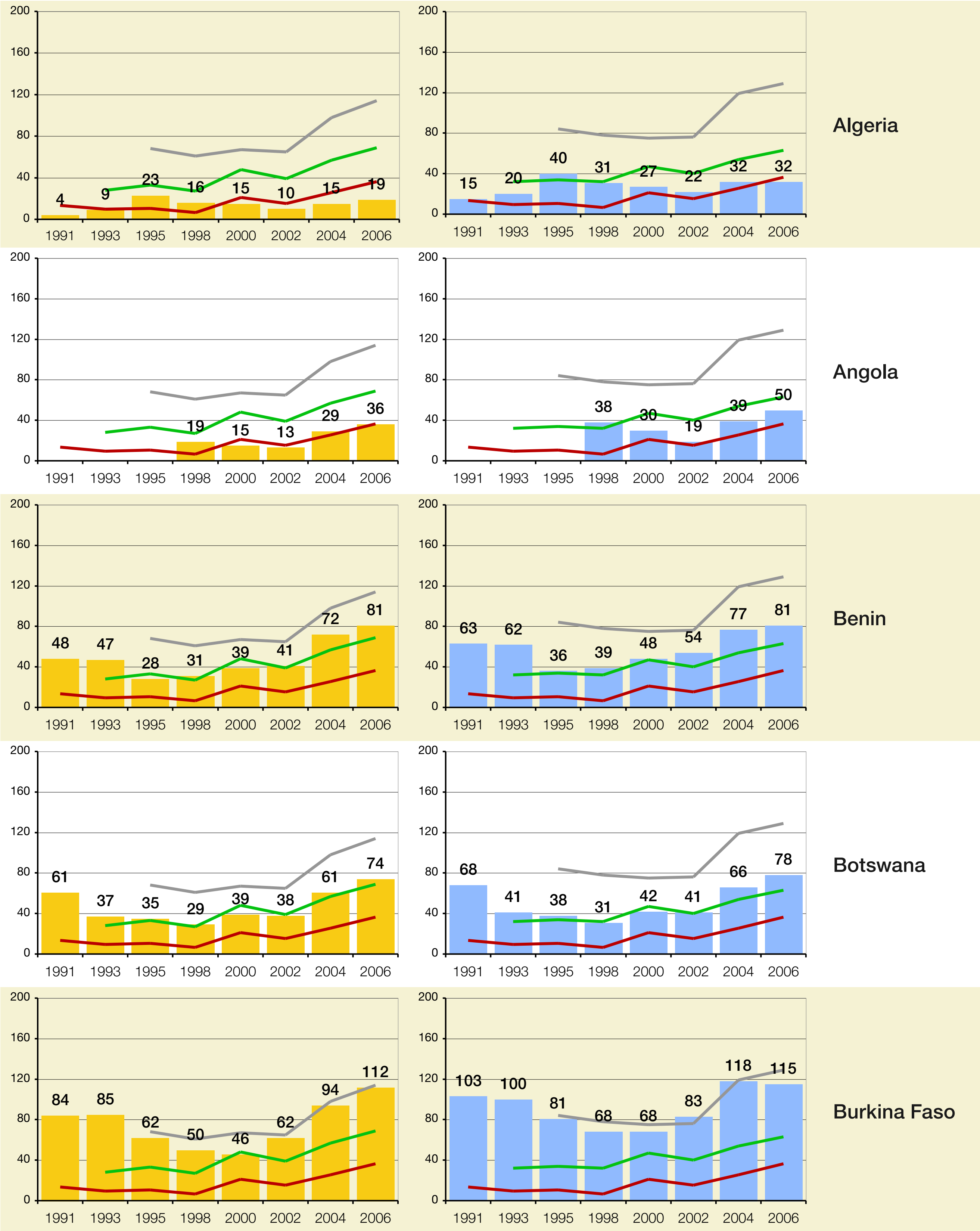
in US cent per litre (last survey 15–17 November 2006)

	Diesel [US cents/Litre]								Super Gasoline [US cents/Litre]							
Country	**1991**	**1993**	**1995**	**1998**	**2000**	**2002**	**2004**	**2006**	**1991**	**1993**	**1995**	**1998**	**2000**	**2002**	**2004**	**2006**
Algeria	4	9	23	16	15	10	15	19	15	20	40	31	27	22	32	32
Angola				19	15	13	29	36				38	30	19	39	50
Benin	48	47	28	31	39	41	72	81	63	62	36	39	48	54	77	81
Botswana	61	37	35	29	39	38	61	74	68	41	38	31	42	41	66	78
Burkina Faso	84	85	62	50	46	62	94	112	103	100	81	68	68	83	118	115
Burundi	61	54	48	66	71	54	108	122	63	59	52	72	101	58	104	120
Cameroon	58	58	50	48	47	57	83	107	68	69	68	64	56	68	95	114
Cape Verde	40			43	39		81		68			81	59		140	
Central African R.	99	98	64	65		87	114	127	133	128	82	81		100	129	137
Chad	97	95	70	61	60	77	101	120	105	102	80	70	68	79	117	131
Congo, D. R. (Kin)	73	67	70	50	93	69	81	100	81	74	73	50	100	70	92	94
Congo, R. (Braz)	71			40	30	48	59	67	105			72	53	69	87	96
Côte d'Ivoire	115	86	56	45	51	60	95	106	124	123	83	74	76	85	114	120
Djibouti	38	56	40	40	53	54	35	89	77	61	93	91	105	98	52	145
Egypt	7	9	12	12	10	8	10	12	29	30	29	29	26	19	28	30
Eritrea		29	19	23	33	25	40	81 [1]		50	40	37	56	36	80	190 [1]
Ethiopia	14	19	24	25	27	32	42	62	27	26	32	36	46	52	60	93
Gabon	83	70		39	37	53	69	39	118	116		63	53	69	90	64
Gambia	52	48		63	47	40	73	101	73	67		83	64	46	75	108
Ghana	43	45	33	30	19	23	43	84	53	53	38	32	20	28	49	86
Guinea	61	56		56	69	56	69	82	67	61		68	85	66	75	79
Guinea-Bissau	61	56							30	27						
Kenya	37	33	43	54	60	56	76	98	53	40	56	70	71	70	92	112
Lesotho				38	47		68	88				39	50		73	89
Liberia							77	85							75	79
Libya				17	16	8	8	13				22	25	10	9	13
Madagascar	25	31	32	33	45	65	79	100	43	54	47	47	76	108	105	115
Malawi	56	67	55	45	68	62	88	112	64	71	65	51	69	66	95	117
Mali	74	74	57	48	43	55	90	104	112	114	82	77	70	69	116	122
Mauritania	53	43		31	40	39	59	84	86	85		59	67	63	80	97
Morocco	45	41	47	47	53	55	70	87	82	75	94	79	82	87	110	122
Mozambique	26	21	32	41	54	43	79	106	74	48	53	55	56	46	88	115
Namibia	41	38		36	44	43	65	87	46	42		38	47	45	68	87
Niger	81	60	55	52	48	55	91	111	94	92	79	76	68	77	102	114
Nigeria	4	1	3	10	27	19	45	66	5	2	13	13	27	20	39	51
Rwanda	79	88		72	84	84	99	108	81	93		72	89	84	98	111
São Tomé & Princ.					71								90			
Senegal	74	88	62	48	52	53	90	109	119	123	94	71	73	75	110	131
Seychelles								[2]								135 [2]
Sierra Leone	43	44		53		50	89	98	45	49		61		51	76	98
Somalia						29	89	67						35	136	74
Somaliland	15						49	69	21						63	72
South Africa		52	46	39	50	40	80	84		52	51	43	50	43	81	85
Sudan	6	58	25	26	24	24	29	49	7	58	50	33	28	30	47	72
Swaziland	41	40		36	44		73	85	46	43		37	47		76	80
Tanzania	25	30	44	57	73	61	87	99	42	43	56	63	75	67	93	104
Togo	66	63	40	37	40	46	83	101	81	72	47	42	48	56	85	103
Tunisia	33	31	44	33	29	19	39	57	58	52	64	60	49	29	68	83
Uganda	55	71	85	68	75	70	88	101	69	79	98	86	86	83	102	117
Zambia	24	66	57	49		60	98	122	40	72	60	53		72	110	131
Zimbabwe	37	28	29	22	72	5	65	[3]	68	47	38	26	85	5	61	[3]

[1] Rationing, [2] Source: ADAC, [3] Hyper Inflation,

Note: Survey data of mid November of each year

Diesel [US cents per litre] **Super Gasoline** [US cents per litre]



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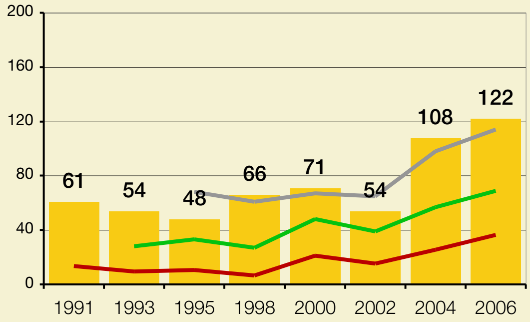
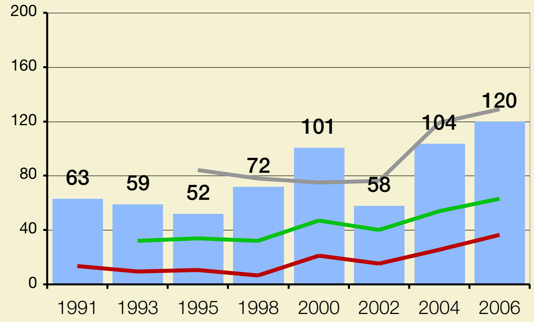
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

Diesel
[US cents per litre]

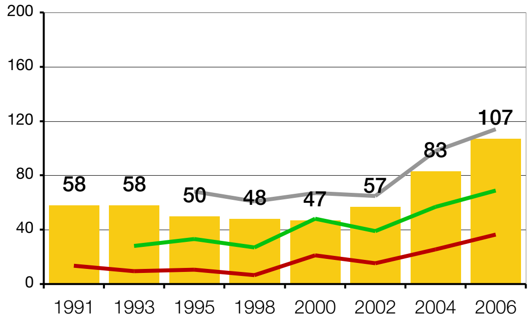
Super Gasoline
[US cents per litre]

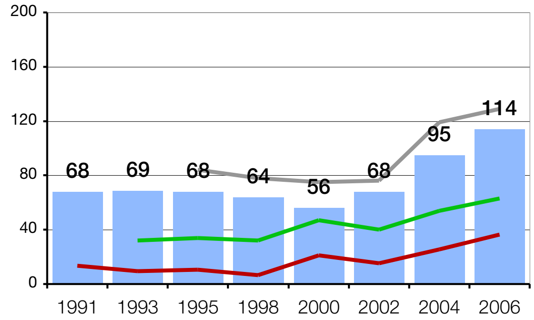
Burundi



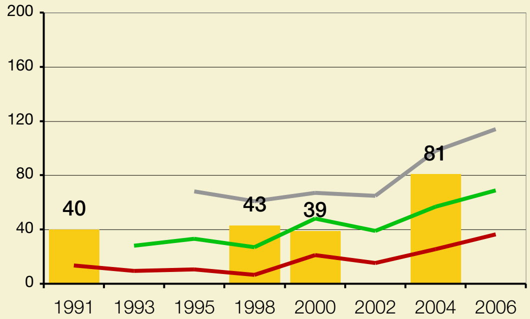


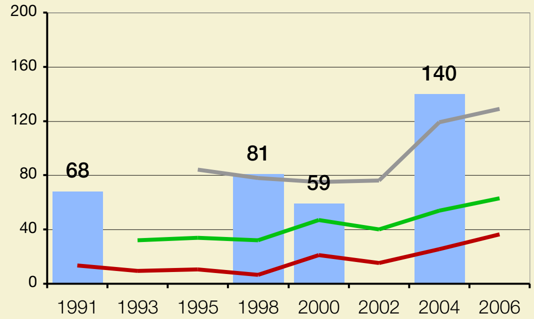
Cameroon



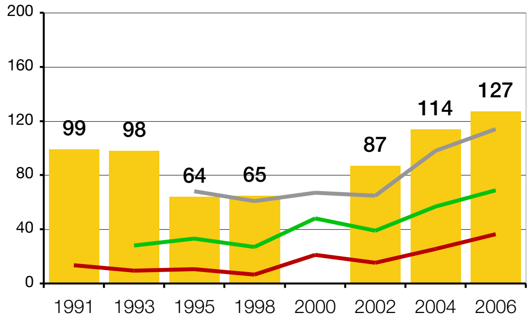


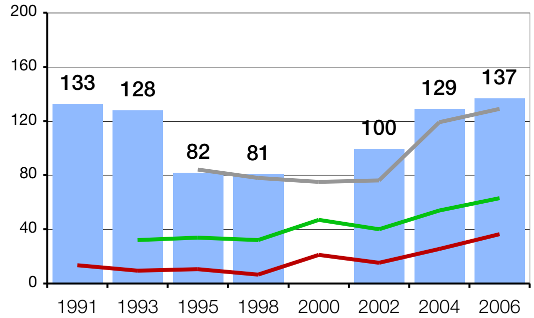
Cape Verde



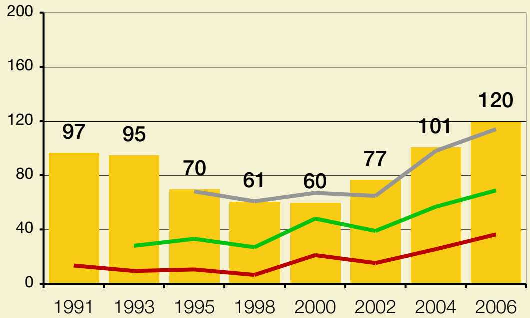


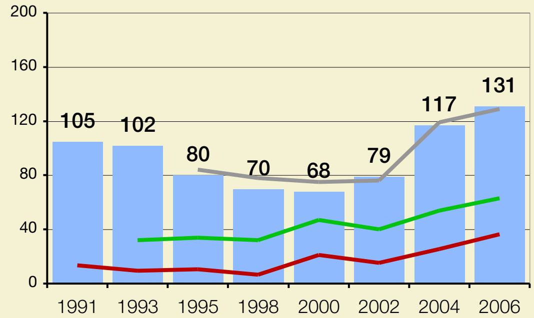
Central African Republic





Chad





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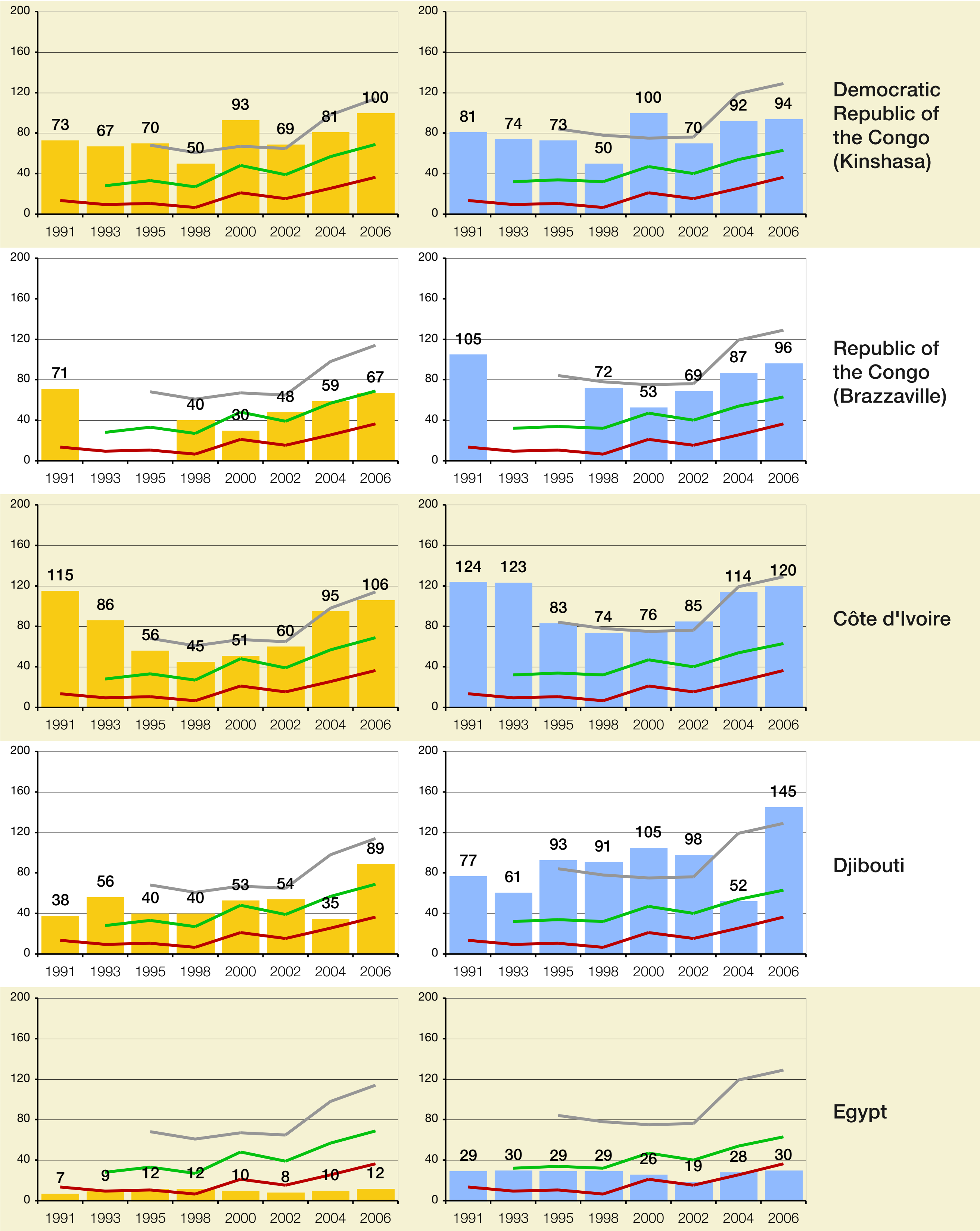
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.1.4 Detailed time series of fuel prices in Africa

1991 – 2006 (from Democratic Republic of the Congo to Egypt)

Diesel [US cents per litre] **Super Gasoline** [US cents per litre]



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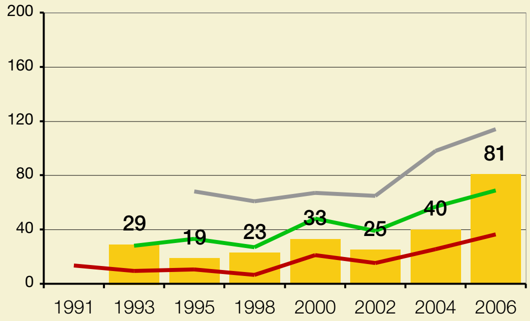
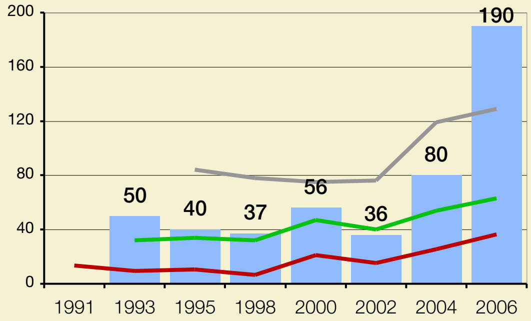
5.1.4 Detailed time series of fuel prices in Africa

1991 – 2006 (from Eritrea to Ghana)

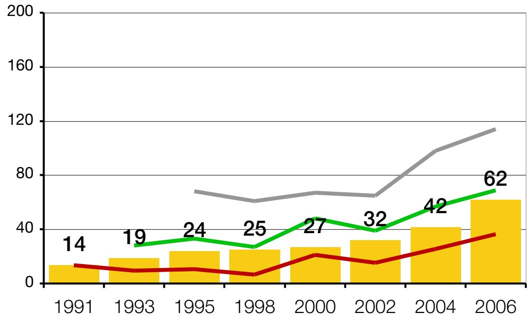
Diesel [US cents per litre] | **Super Gasoline** [US cents per litre]

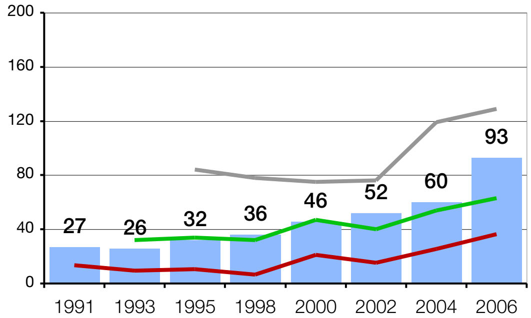
Eritrea



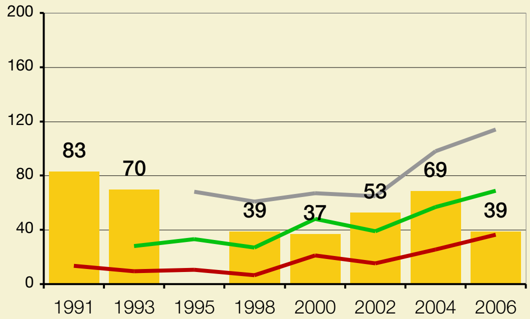


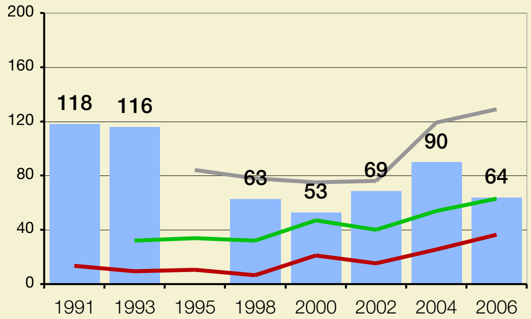
Ethiopia



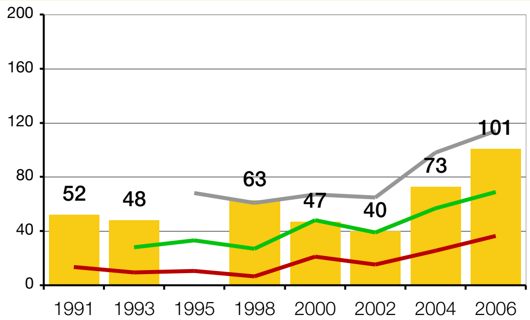


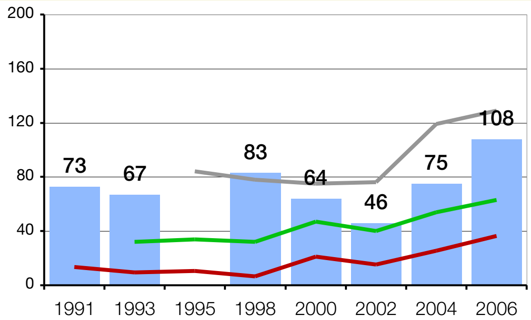
Gabon



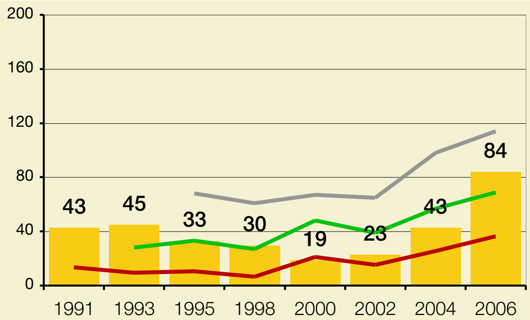


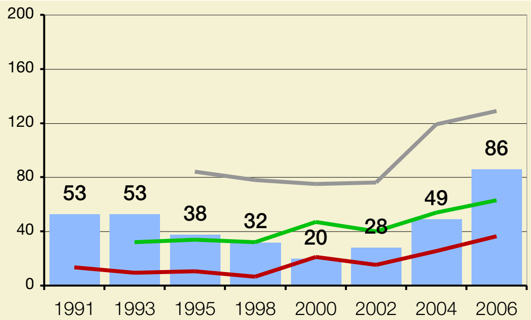
Gambia





Ghana





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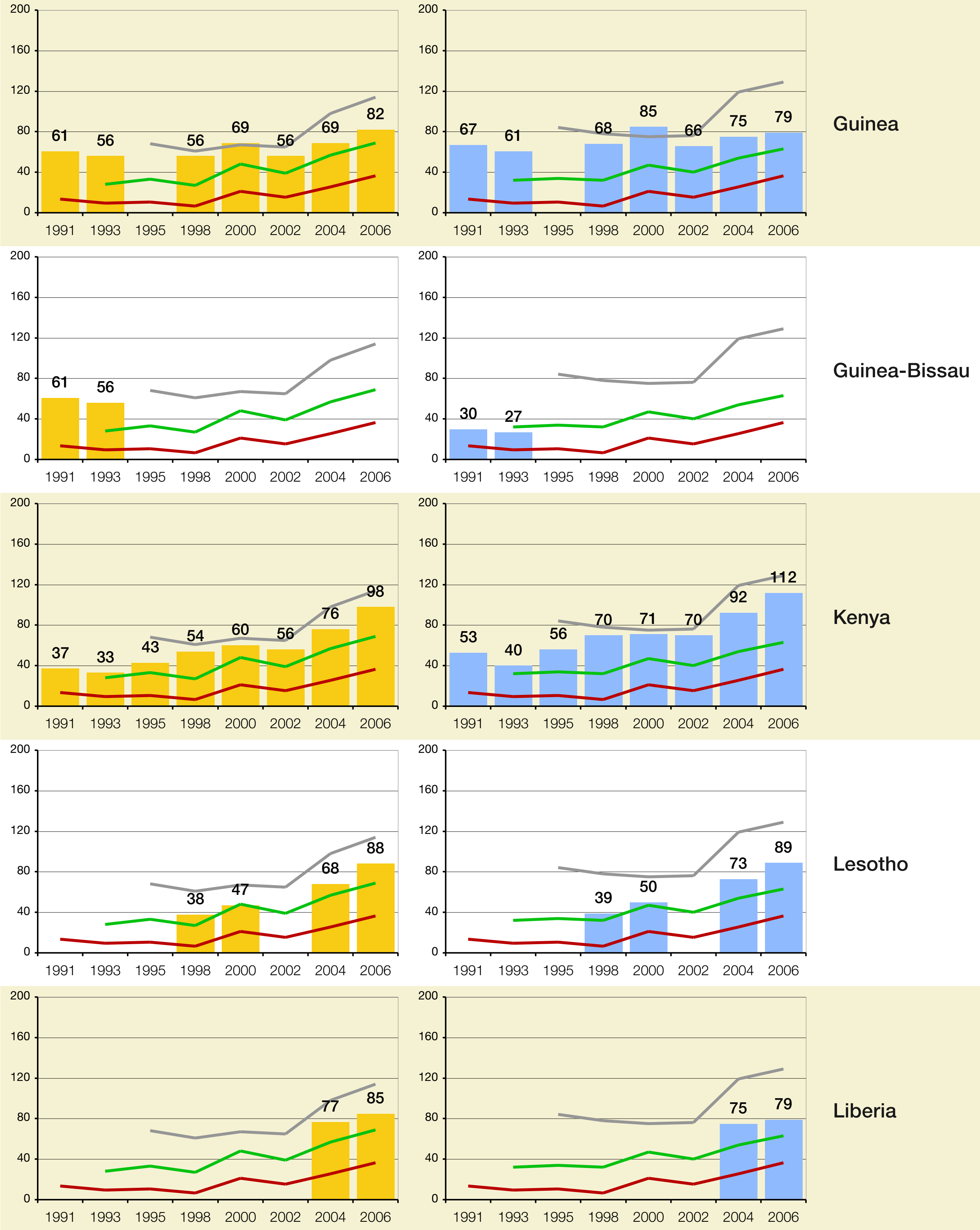
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.1.4 Detailed time series of fuel prices in Africa

1991 – 2006 (from Guinea to Liberia)

Diesel [US cents per litre]

Super Gasoline [US cents per litre]



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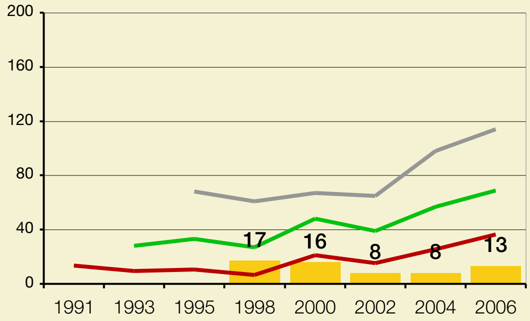
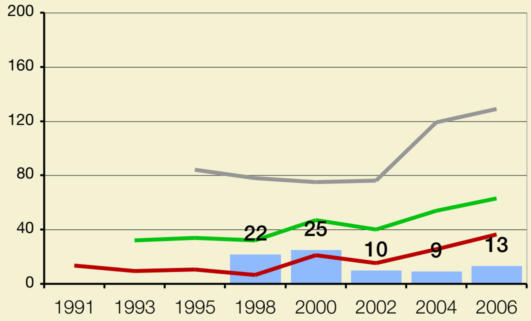
5.1.4 Detailed time series of fuel prices in Africa

1991 – 2006 (from Libya to Mauritania)

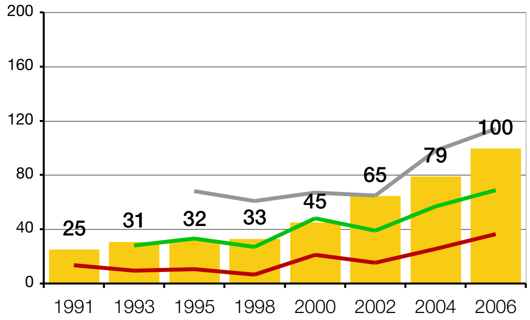
Diesel [US cents per litre] | **Super Gasoline** [US cents per litre]

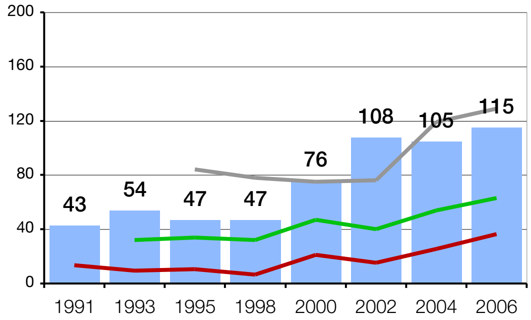
Libya



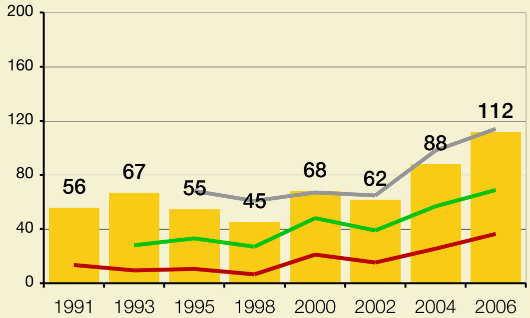


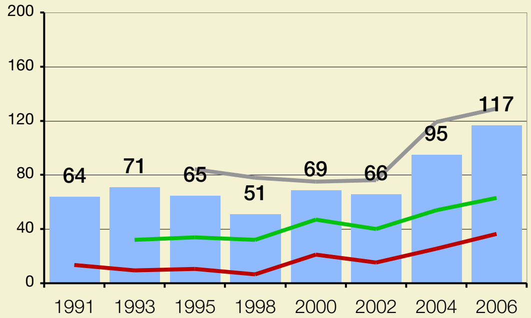
Madagascar



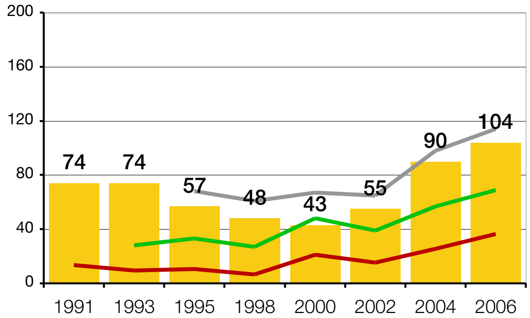


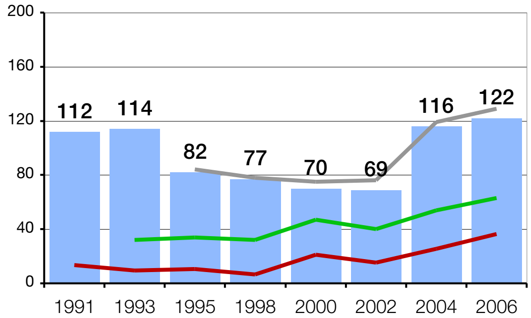
Malawi



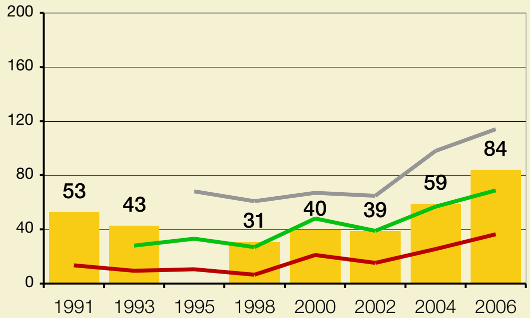


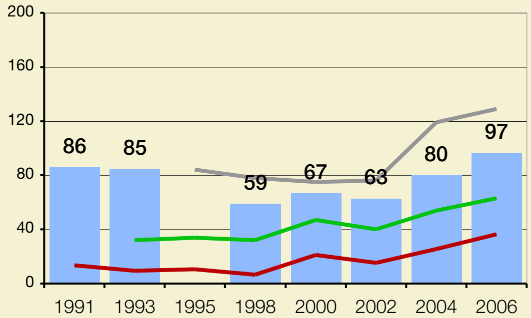
Mali





Mauritania





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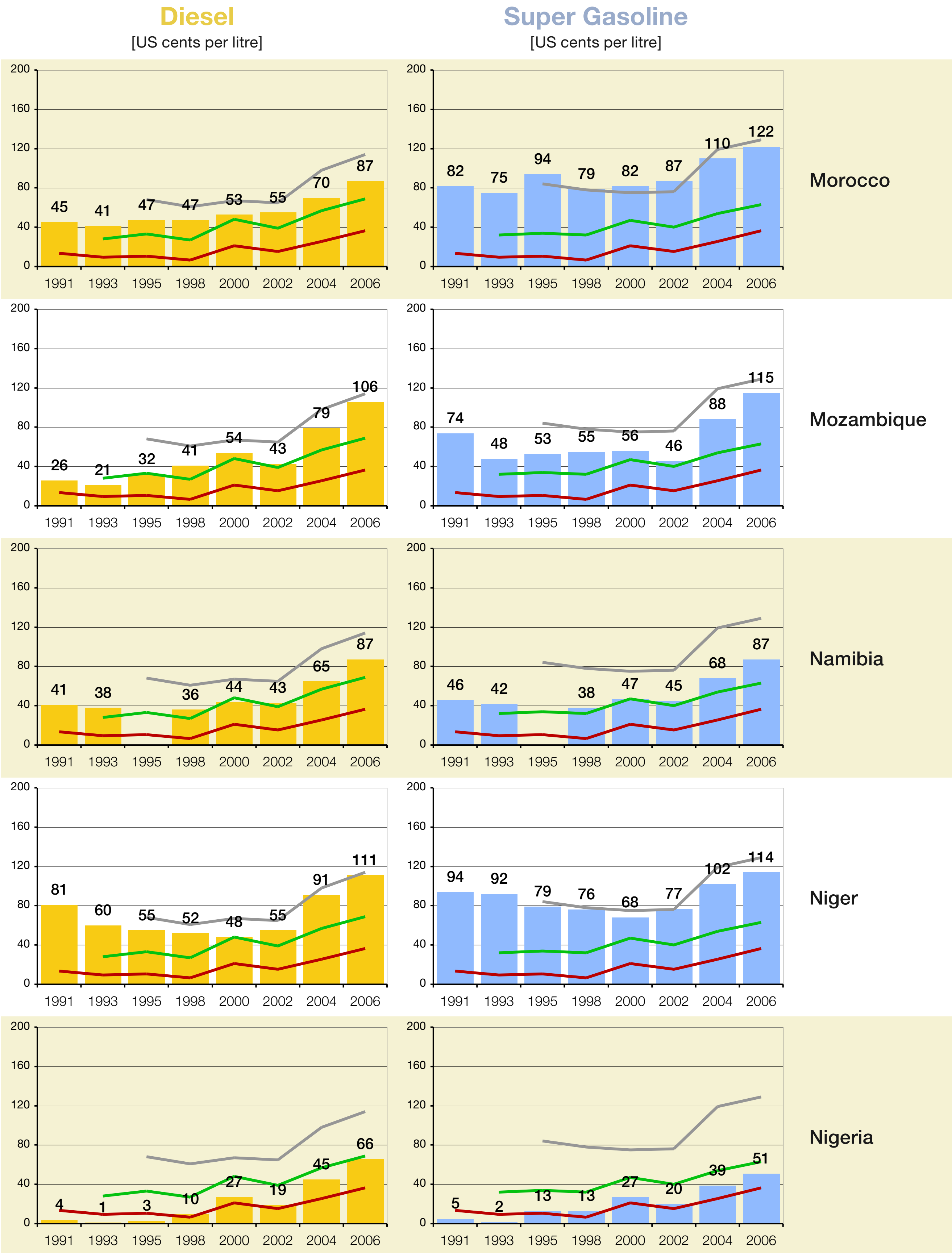
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.1.4 Detailed time series of fuel prices in Africa

1991 – 2006 (from Morocco to Nigeria)



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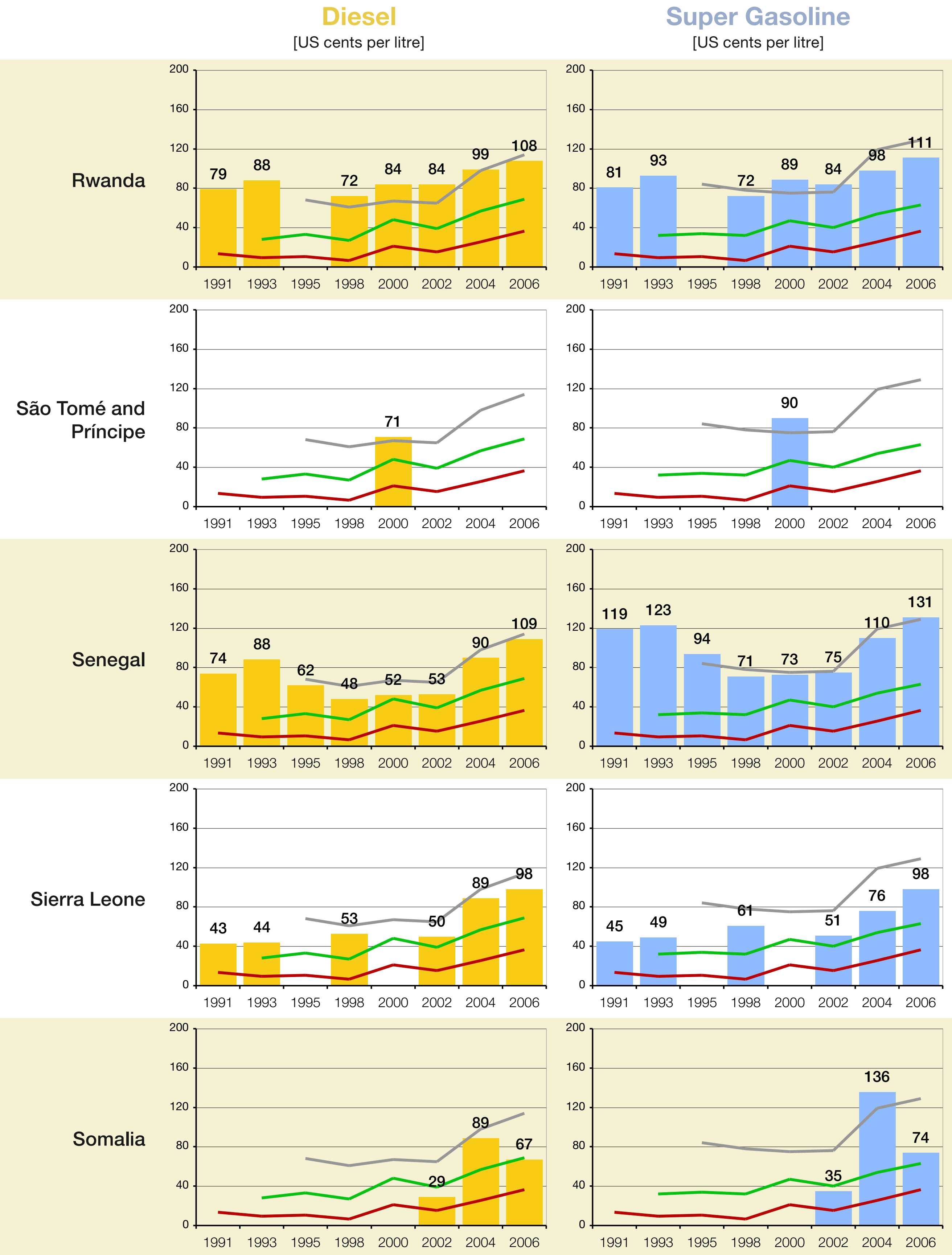
5.1.4 Detailed time series of fuel prices in Africa

1991 – 2006 (from Rwanda to Somalia)



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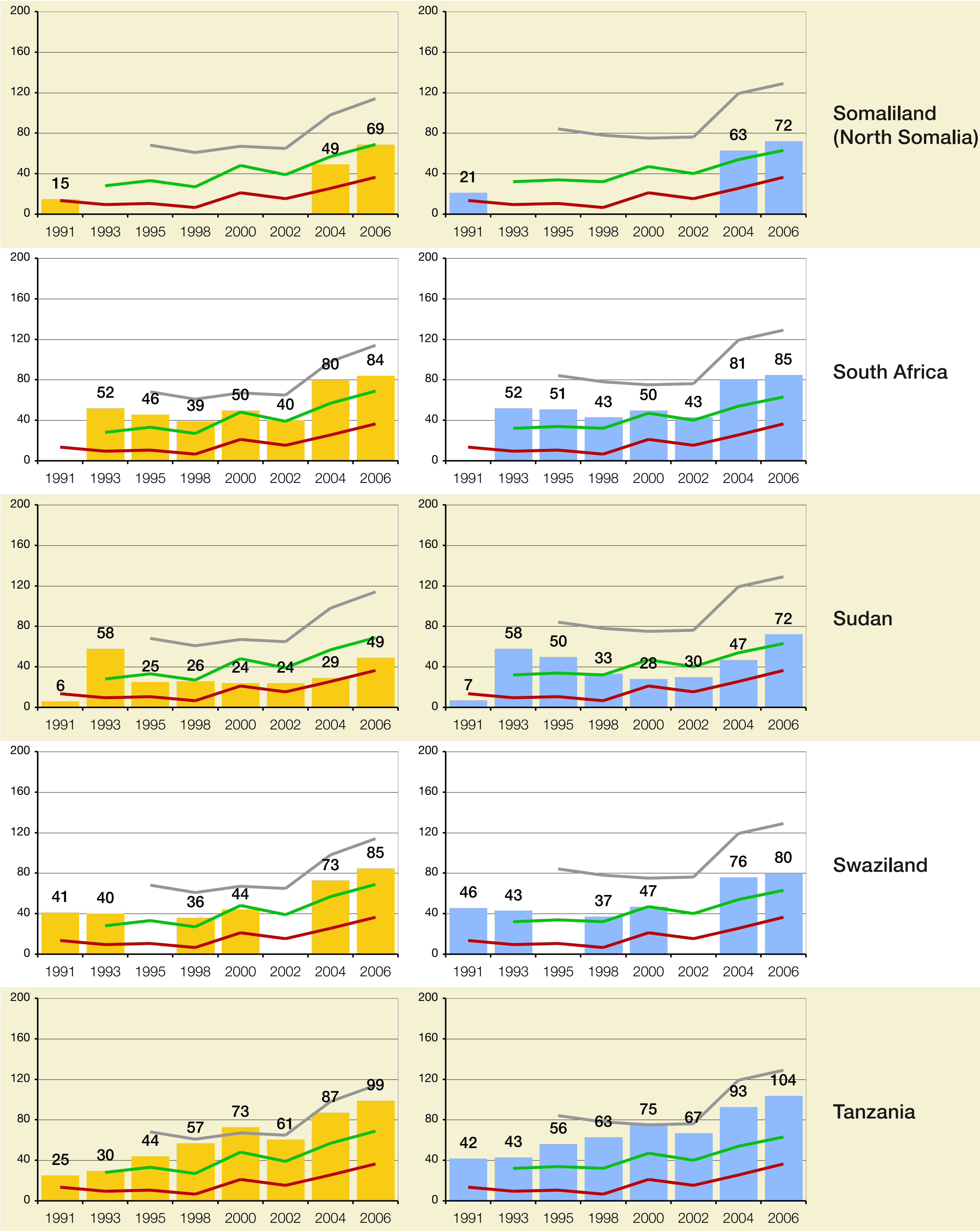
5.1.4 Detailed time series of fuel prices in Africa

1991 – 2006 (from Somaliland to Tanzania)

Diesel [US cents per litre]

Super Gasoline [US cents per litre]



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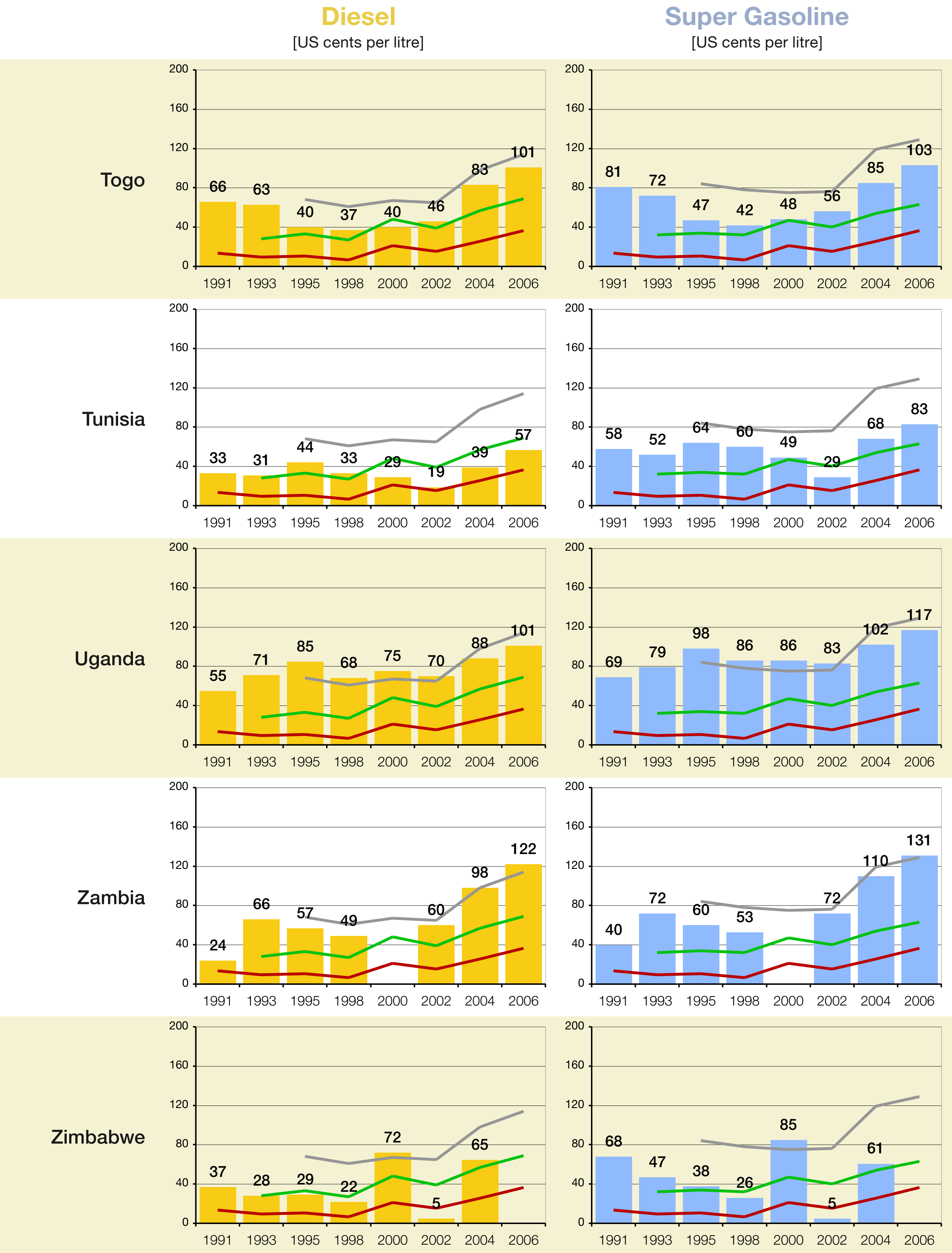

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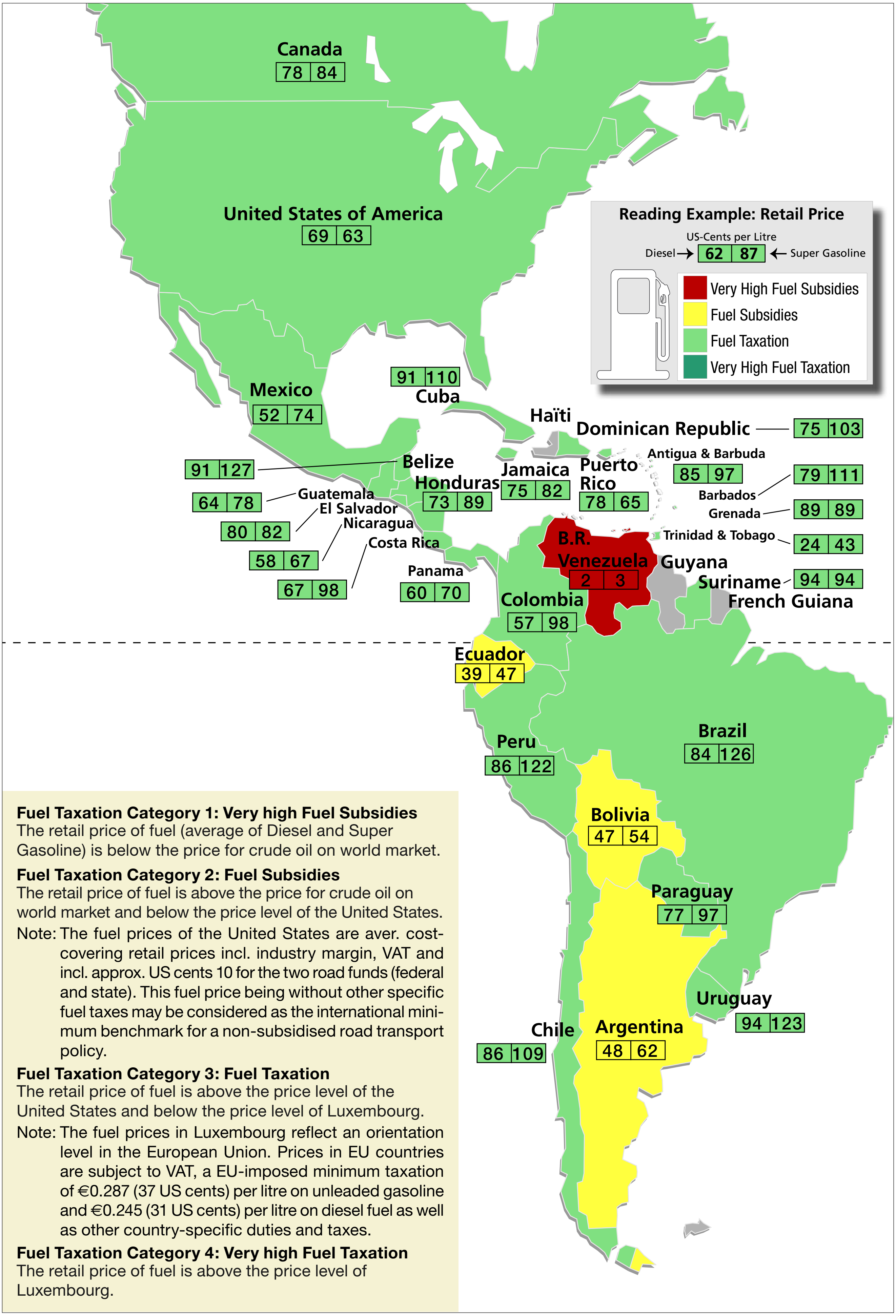
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.2 Fuel prices in America

- *Retail fuel prices in America*
- *Comparison of retail fuel prices in America*
- *Time Series of retail fuel prices in America*
- *Detailed time series of fuel prices in America*

5.2.1 Retail fuel prices in America

as of November 2006 (in US cents/Litre)



Fuel Taxation Category 1: Very high Fuel Subsidies
The retail price of fuel (average of Diesel and Super Gasoline) is below the price for crude oil on world market.

Fuel Taxation Category 2: Fuel Subsidies
The retail price of fuel is above the price for crude oil on world market and below the price level of the United States.

Note: The fuel prices of the United States are aver. cost-covering retail prices incl. industry margin, VAT and incl. approx. US cents 10 for the two road funds (federal and state). This fuel price being without other specific fuel taxes may be considered as the international minimum benchmark for a non-subsidised road transport policy.

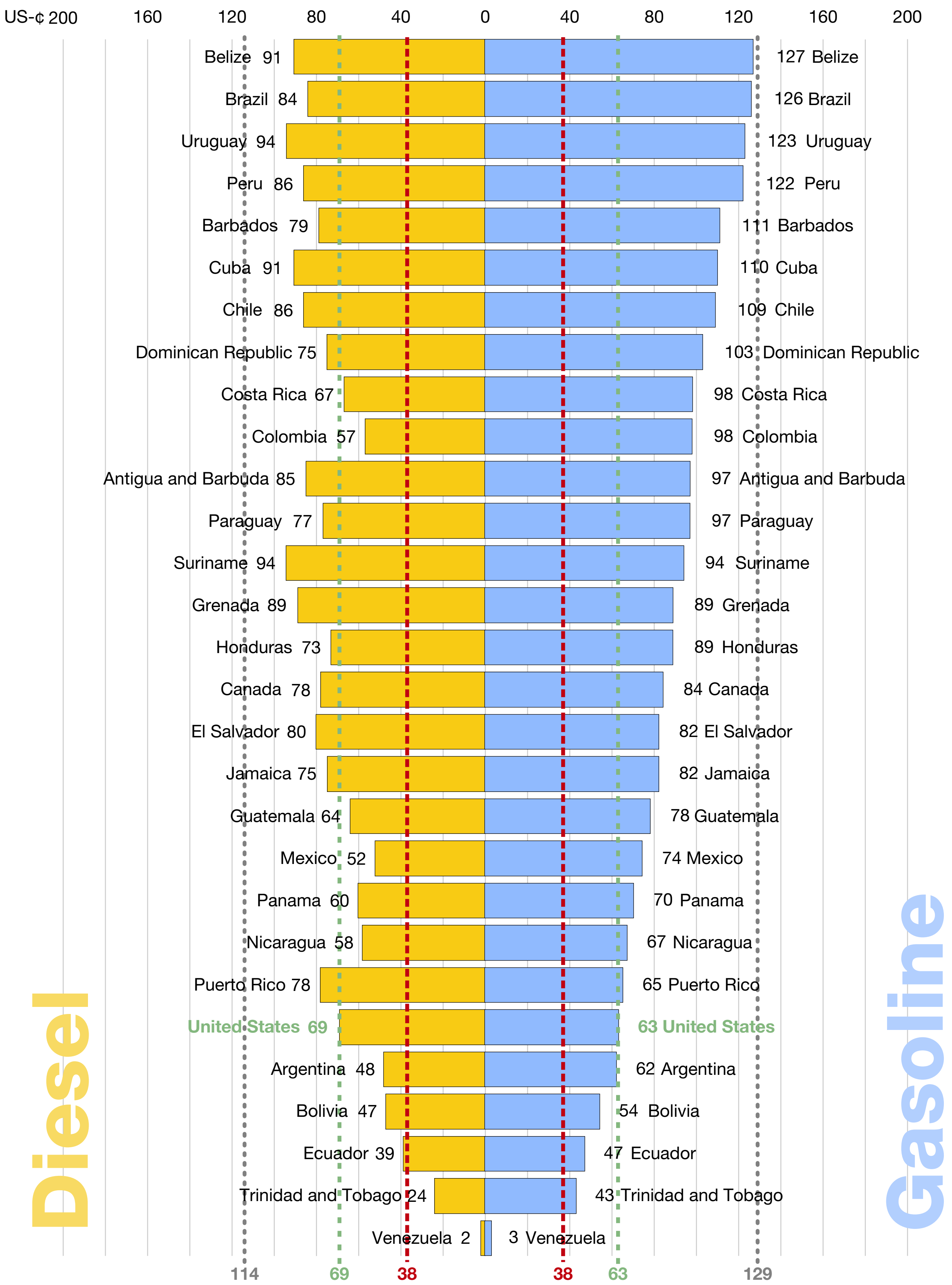
Fuel Taxation Category 3: Fuel Taxation
The retail price of fuel is above the price level of the United States and below the price level of Luxembourg.

Note: The fuel prices in Luxembourg reflect an orientation level in the European Union. Prices in EU countries are subject to VAT, a EU-imposed minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel as well as other country-specific duties and taxes.

Fuel Taxation Category 4: Very high Fuel Taxation
The retail price of fuel is above the price level of Luxembourg.

5.2.2 Comparison of retail fuel prices in America

as of November 2006 (in US cents/litre)



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Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.2.3 Time series of retail fuel prices in America

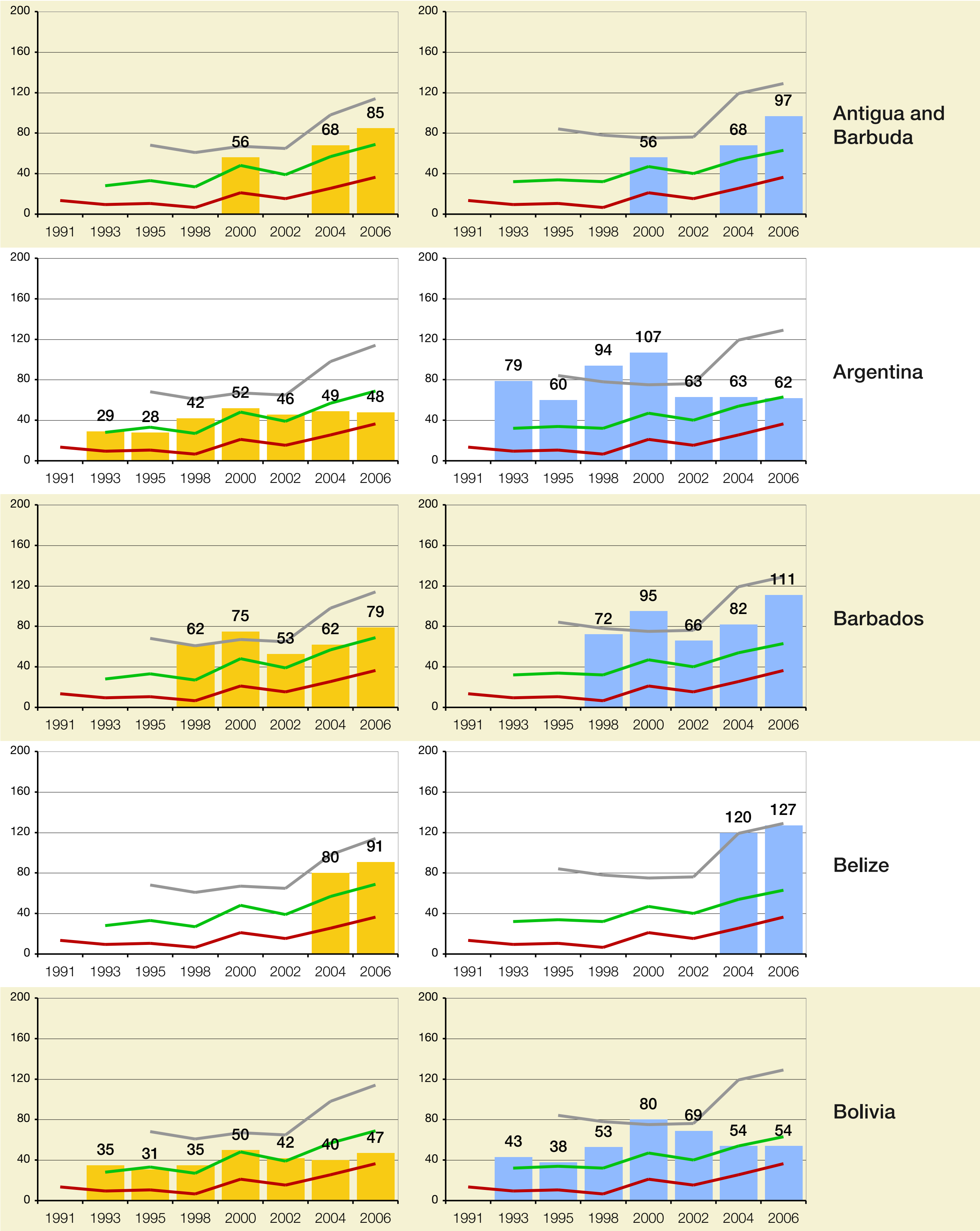
in US cent per litre (last survey 15–17 November 2006)

	Diesel [US cents/Litre]								Super Gasoline [US cents/Litre]							
Country	**1991**	**1993**	**1995**	**1998**	**2000**	**2002**	**2004**	**2006**	**1991**	**1993**	**1995**	**1998**	**2000**	**2002**	**2004**	**2006**
Antigua & Barbu.					56		68	85					56		68	97
Argentina		29	28	42	52	46	49	48		79	60	94	107	63	63	62
Barbados				62	75	53	62	79				72	95	66	82	111
Belize							80	91							120	127
Bolivia		35	31	35	50	42	40	47		43	38	53	80	69	54	54
Brazil		38	39	34	34	31	49	84		53	63	80	92	55	84	126
Canada		39	36	39	47	43	68	78		47	45	41	58	51	68	84
Chile		31	33	29	47	39	64	86		43	53	49	64	58	85	109
Colombia		19	27	20	35	24	36	57		23	35	24	49	44	72	98
Costa Rica						44	56	67						64	78	98
Cuba				18		45	55	91				50		90	95	110
Dominican Rep.			28	22	39	27	61	75			40	40	71	49	85	103
Ecuador		19	28	24	18	27	27	39		31	33	38	31	55	54	47
El Salvador				30	40	33	58	80				54	67	46	65	82
Grenada				41	41	41	68	89				54	54	54	73	89
Guatemala		25	28	32	42	32	63	64		32	39	41	53	48	68	78
Guyana				27	37	27	61					30	37	31	74	
Haiti				36	35	30	60					59	64	54	88	
Honduras		26	25	30	46	46	66	73		41	35	50	62	63	81	89
Jamaica				33	49	44	57	75				37	62	52	63	82
Mexico		28	25	28	45	47	45	52		39	32	36	61	62	59	74
Nicaragua		30	31	35	54	41	64	58		69	62	47	62	54	69	67
Panama		30		28	41	36	48	60		43		41	53	51	54	70
Paraguay		27	28	24	34	34	51	77		43	44	47	72	56	62	97
Peru		32	43	33	54	48	76	86		56	68	55	80	74	112	122
Puerto Rico				32			52	78				34			51	65
Suriname				41	41	41	50	94				56	56	56	50	94
Trinidad & Tobago				20	20	21	24	24				39	39	40	35	43
United States		28	33	27	48	39	57	69		32	34	32	47	40	54	63
Uruguay			38	42	53	20	71	94			89	90	119	46	113	123
Venezuela			1	8	6	5	2	2			3	14	12	5	4	3

Note: Survey data of mid November of each year

Diesel [US cents per litre]

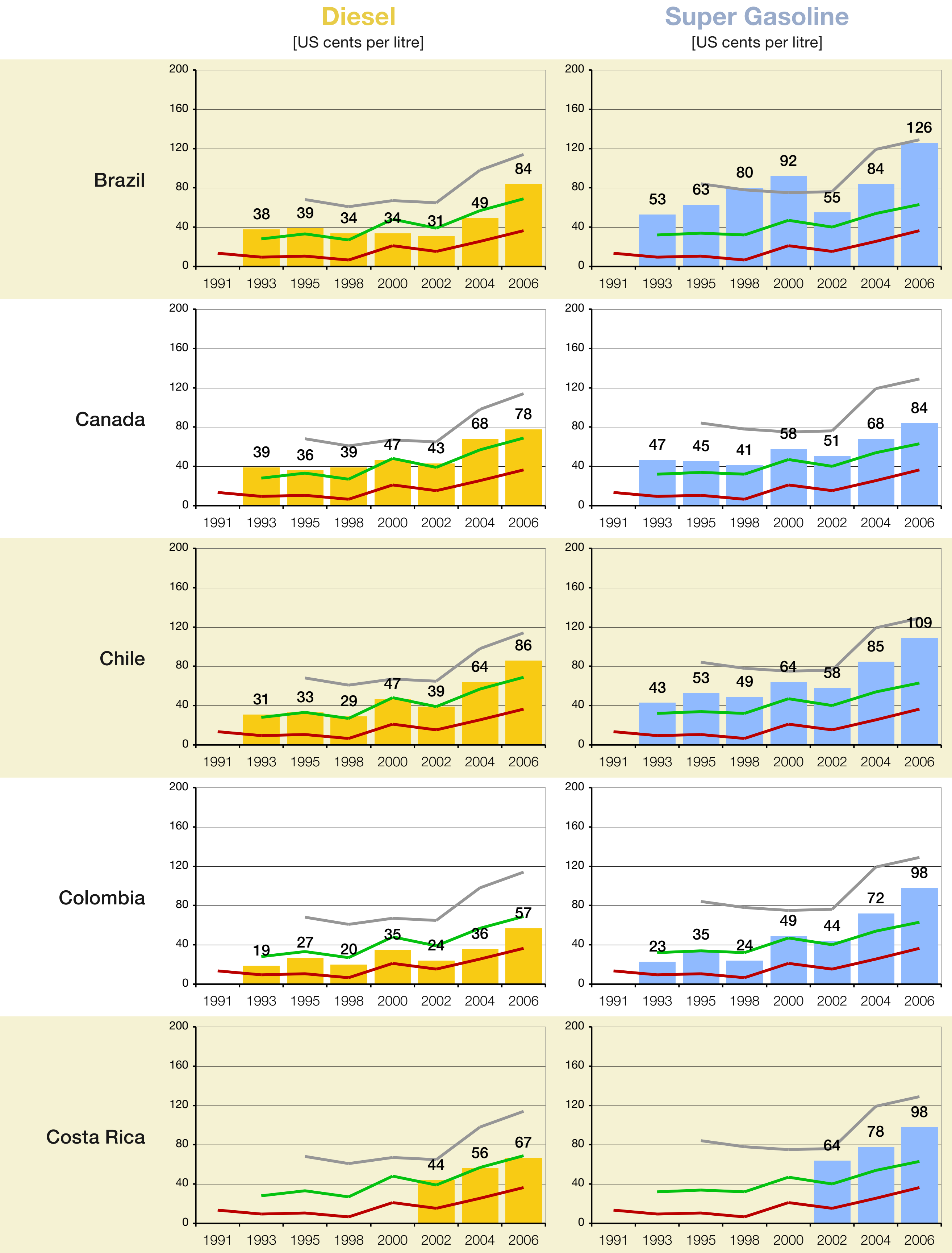
Super Gasoline [US cents per litre]



Grey Benchmark Line = Retail Fuel Prices of LUXEMBOURG = Orientation Level in European Union. In accordance with EU Directive 92/82, the member states of the EU are obliged to impose minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel. Furthermore, petroleum products are subject to regular value-added tax.

Green Benchmark Line = Retail Fuel Prices in the UNITED STATES = aver. Cost-Covering Retail Prices incl. Industry Margin, VAT and incl. approx. US cents 10 for the 2 Road Funds (Federal and State). This Fuel Price being without other Specific Fuel Taxes may be considered as the International Minimum Benchmark for a non-subsidised Road Transport Policy.

Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).



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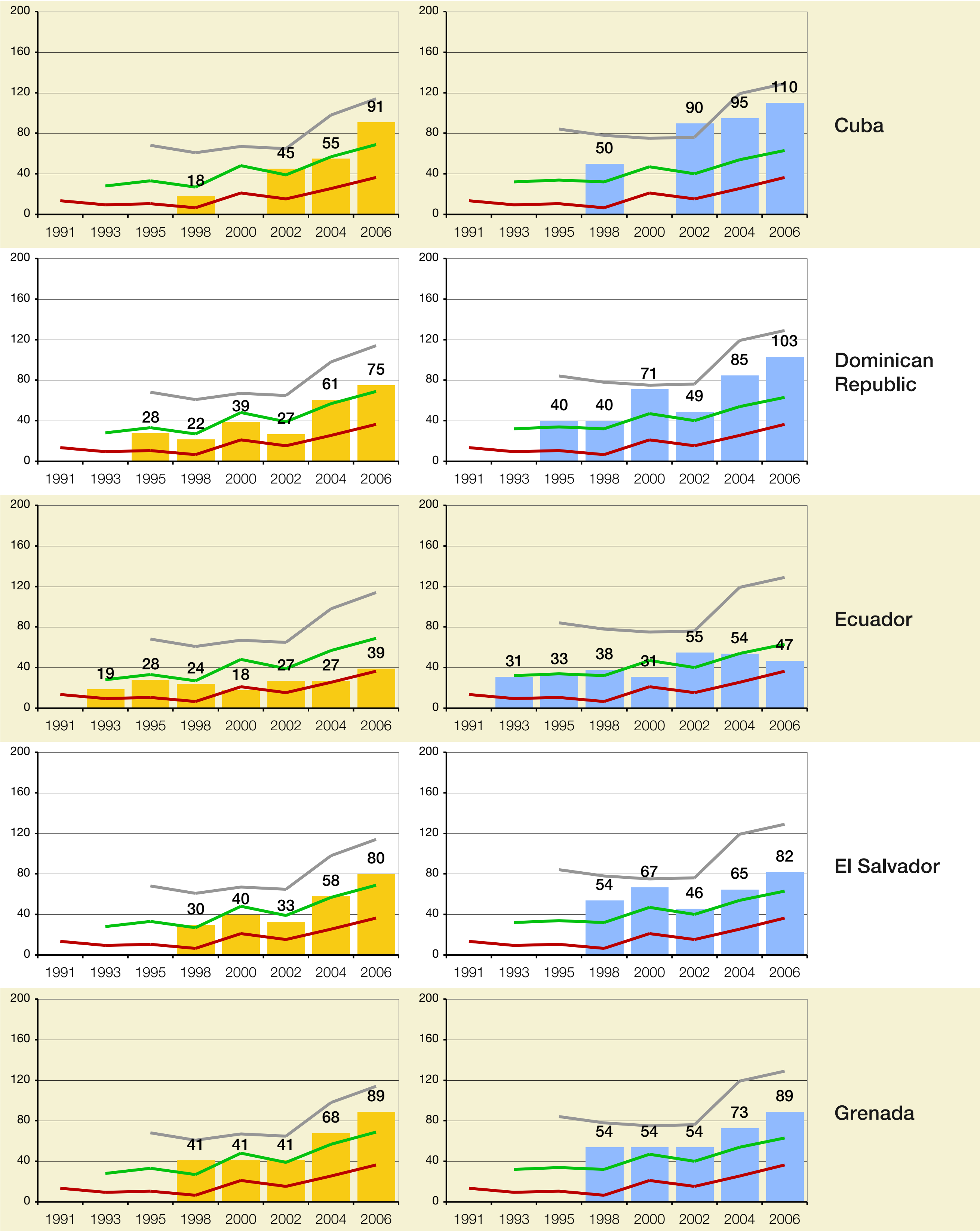
5.2.4 Detailed time series of fuel prices in America

1991 – 2006 (from Cuba to Grenada)

Diesel [US cents per litre] | **Super Gasoline** [US cents per litre]



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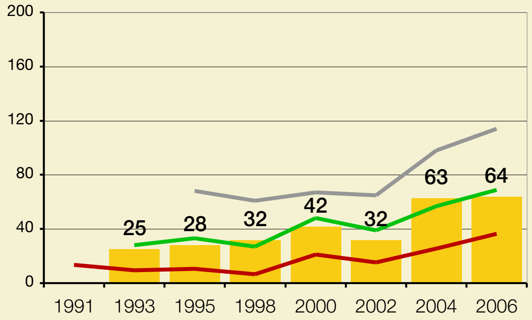
5.2.4 Detailed time series of fuel prices in America

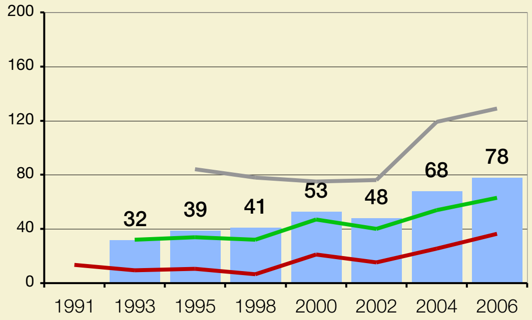
1991 – 2006 (from Guatemala to Jamaica)

Diesel [US cents per litre]

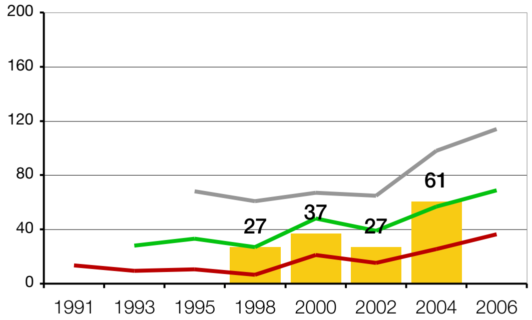
Super Gasoline [US cents per litre]

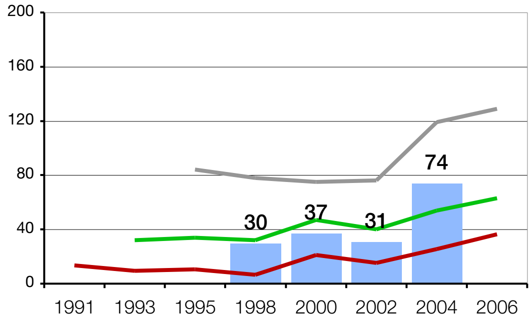
Guatemala



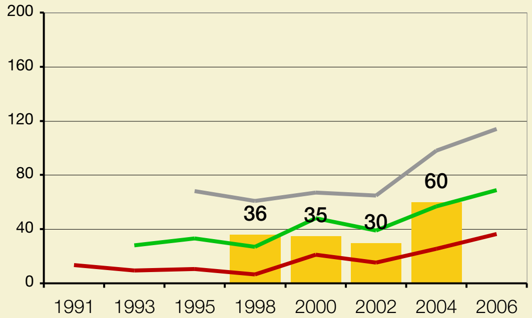


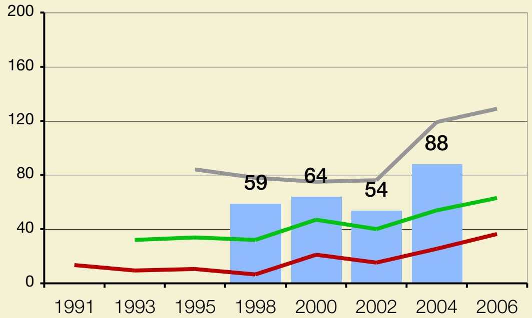
Guyana



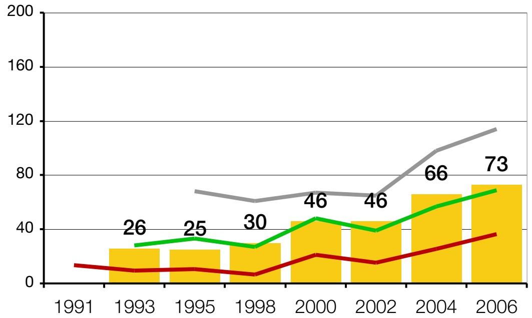


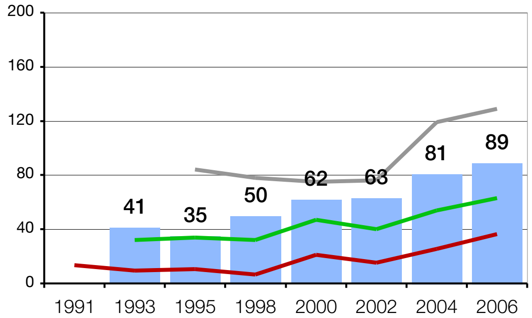
Haïti



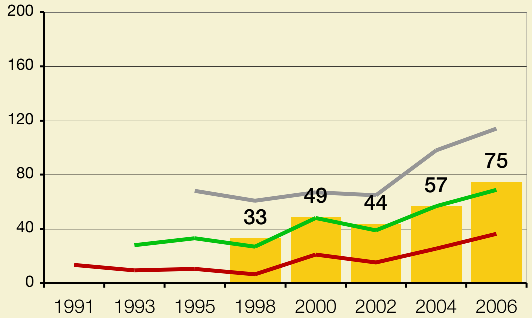


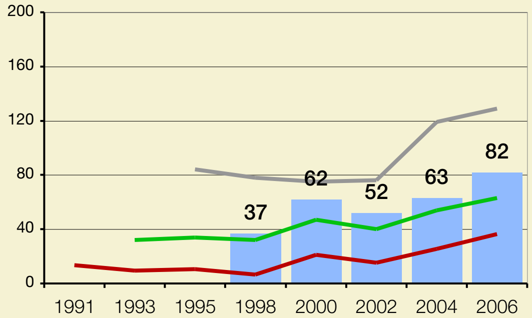
Honduras





Jamaica





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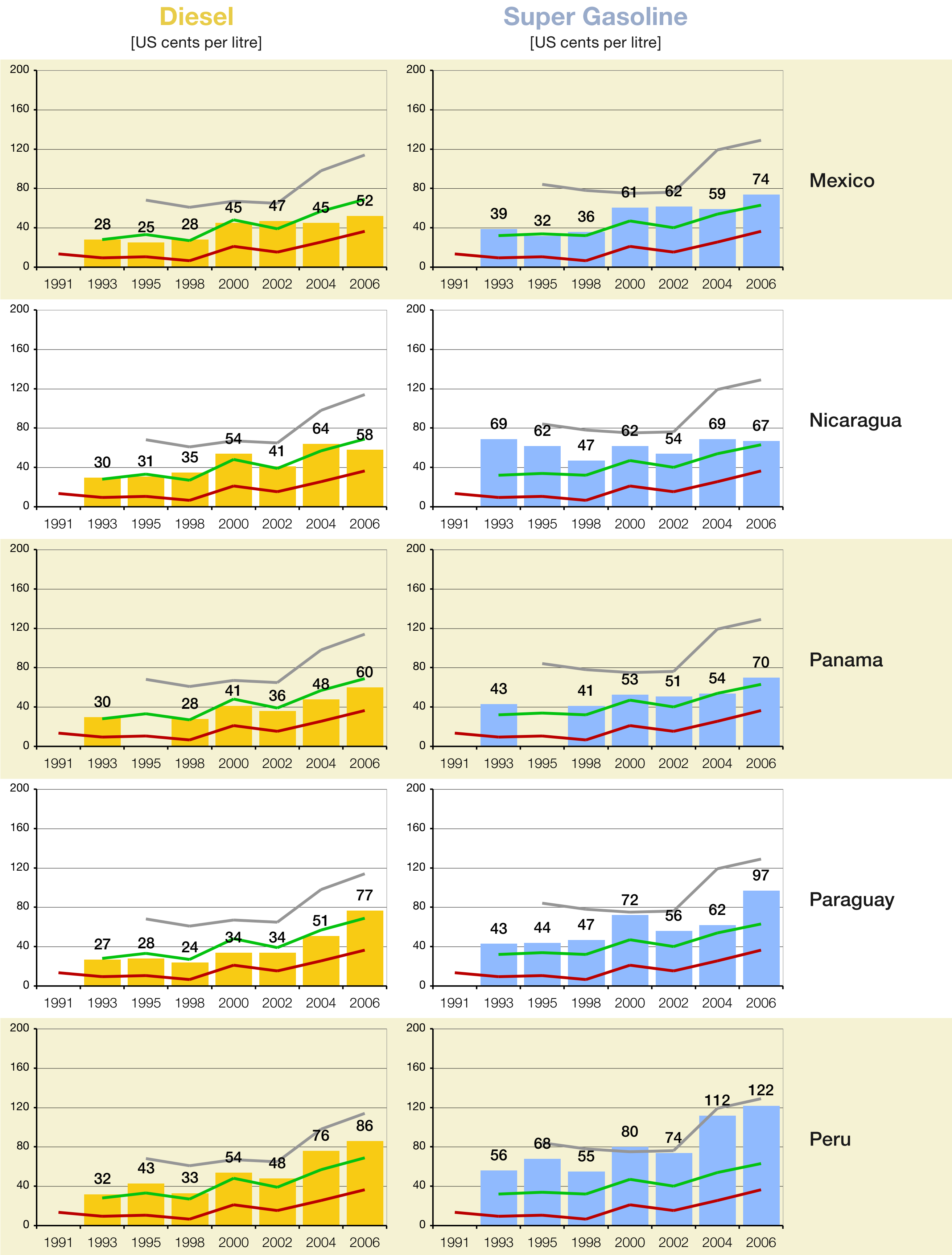
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).



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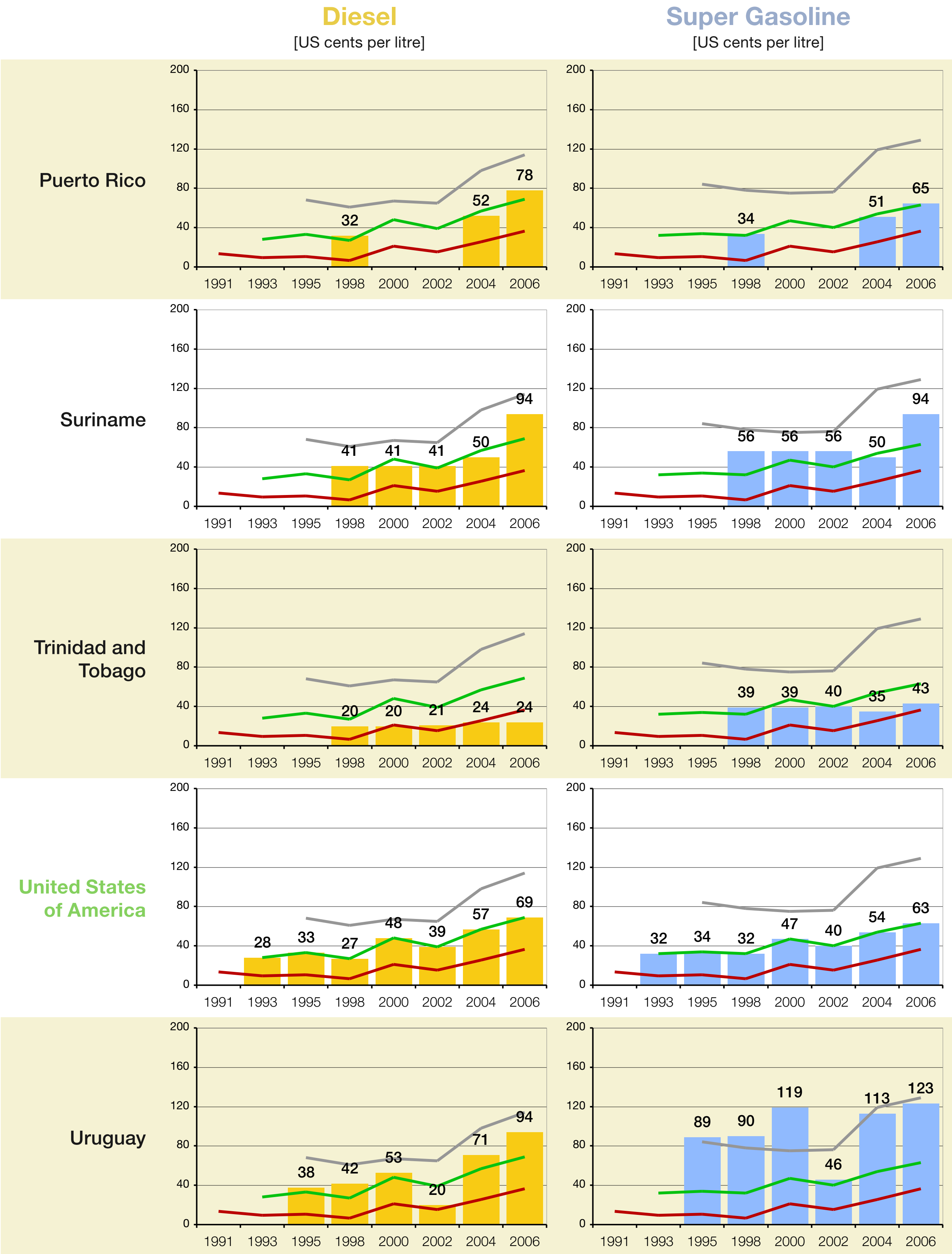

Grey Benchmark Line = Retail Fuel Prices of LUXEMBOURG = Orientation Level in European Union. In accordance with EU Directive 92/82, the member states of the EU are obliged to impose minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel. Furthermore, petroleum products are subject to regular value-added tax.

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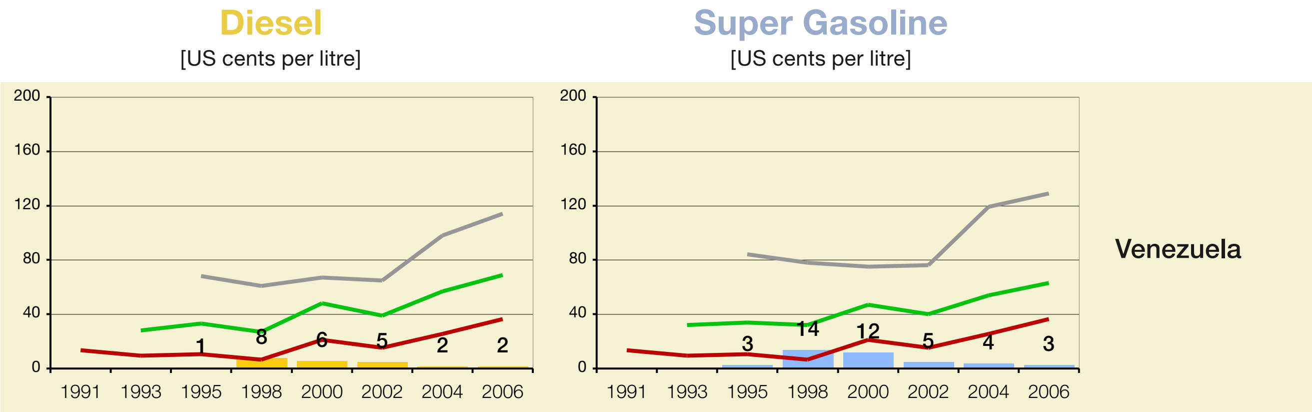
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.2.4 Detailed time series of fuel prices in America

1991 – 2006 (Venezuela)



Grey Benchmark Line = Retail Fuel Prices of LUXEMBOURG = Orientation Level in European Union. In accordance with EU Directive 92/82, the member states of the EU are obliged to impose minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel. Furthermore, petroleum products are subject to regular value-added tax.

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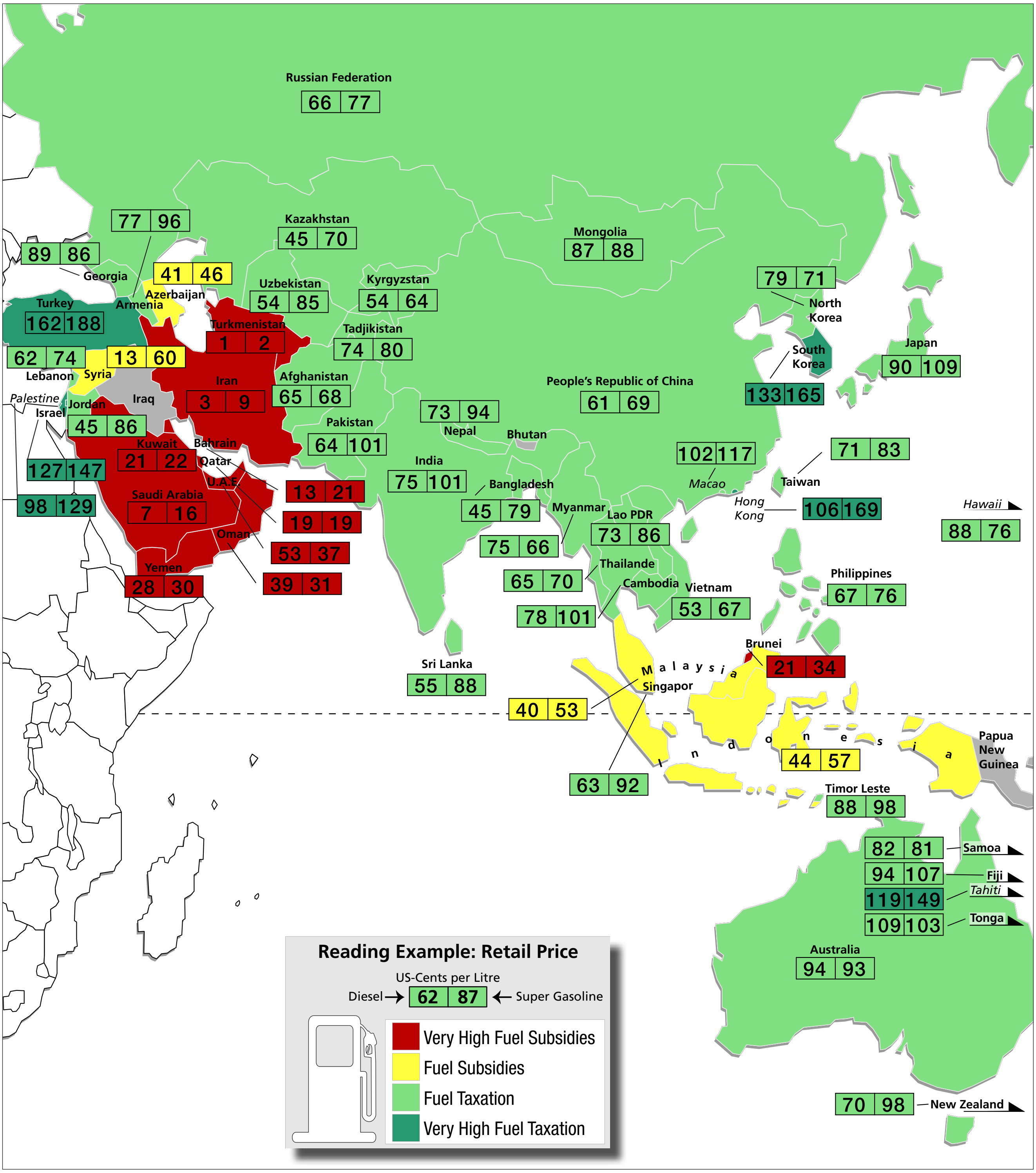
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.3 Fuel prices in Asia, Australia, and Pacific

- *Retail fuel prices in Asia, Australia, and Pacific*
- *Comparison of retail fuel prices in Asia, Australia, and Pacific*
- *Time Series of retail fuel prices in Asia, Australia, and Pacific*
- *Detailed time series of fuel prices in Asia, Australia, and Pacific*

5.3.1 Retail fuel prices in Asia, Australia, and Pacific

as of November 2006 (in US cents/Litre)



Fuel Taxation Category 1: Very high Fuel Subsidies
The retail price of fuel (average of Diesel and Super Gasoline) is below the price for crude oil on world market.

Fuel Taxation Category 2: Fuel Subsidies
The retail price of fuel is above the price for crude oil on world market and below the price level of the United States.

Note: The fuel prices of the United States are aver. cost-covering retail prices incl. industry margin, VAT and incl. approx. US cents 10 for the two road funds (federal and state). This fuel price being without other specific fuel taxes may be considered as the international minimum benchmark for a non-subsidised road transport policy.

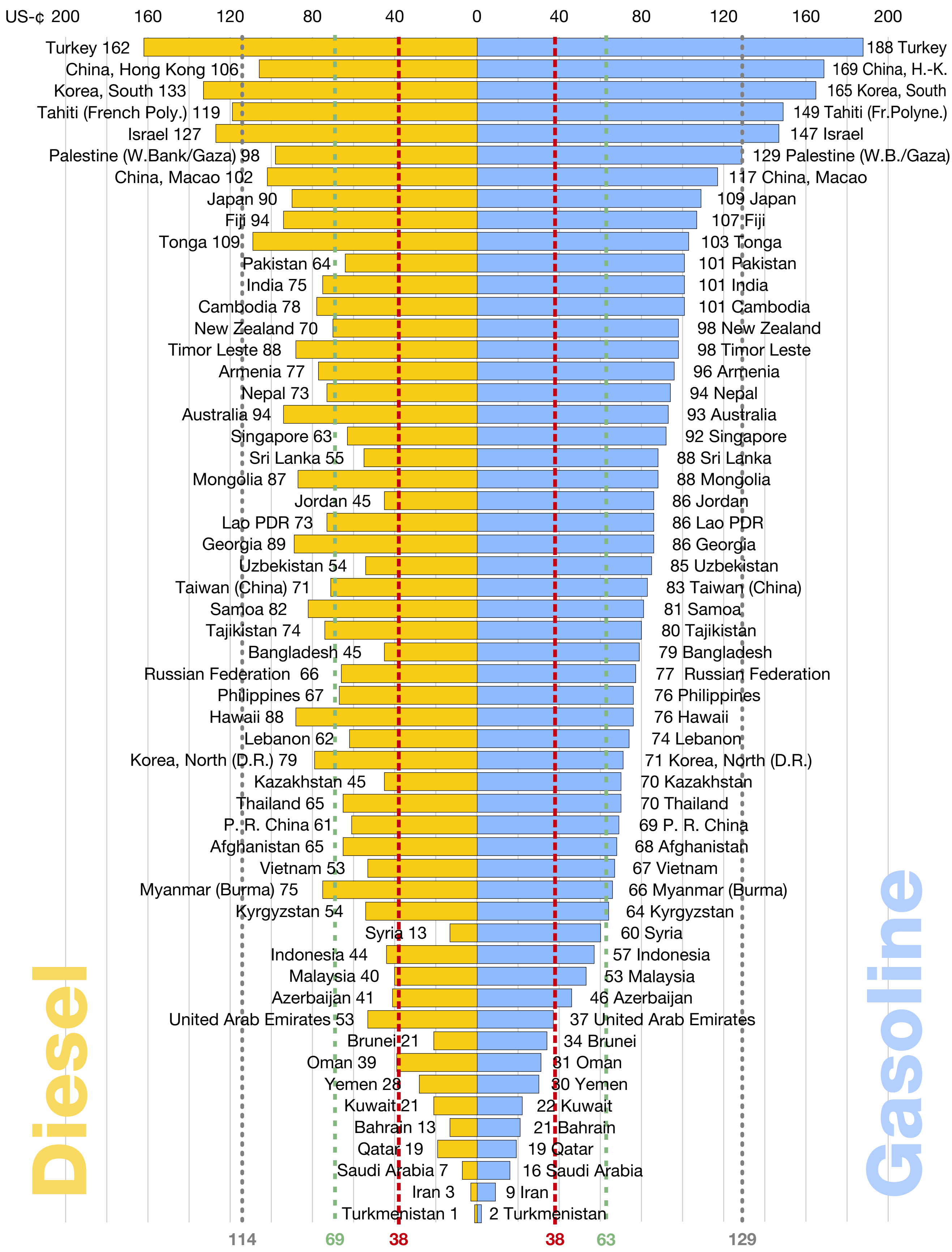
Fuel Taxation Category 3: Fuel Taxation
The retail price of fuel is above the price level of the United States and below the price level of Luxembourg.

Note: The fuel prices in Luxembourg reflect an orientation level in the European Union. Prices in EU countries are subject to VAT, a EU-imposed minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel as well as other country-specific duties and taxes.

Fuel Taxation Category 4: Very high Fuel Taxation
The retail price of fuel is above the price level of Luxembourg.

5.3.2 Comparison of retail fuel prices in Asia, Australia, and Pacific

as of November 2006 (in US cents/litre)



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5.3.3 Time Series of retail fuel prices in Asia, Australia, and Pacific

in US cent per litre (last survey 15–17 November 2006)

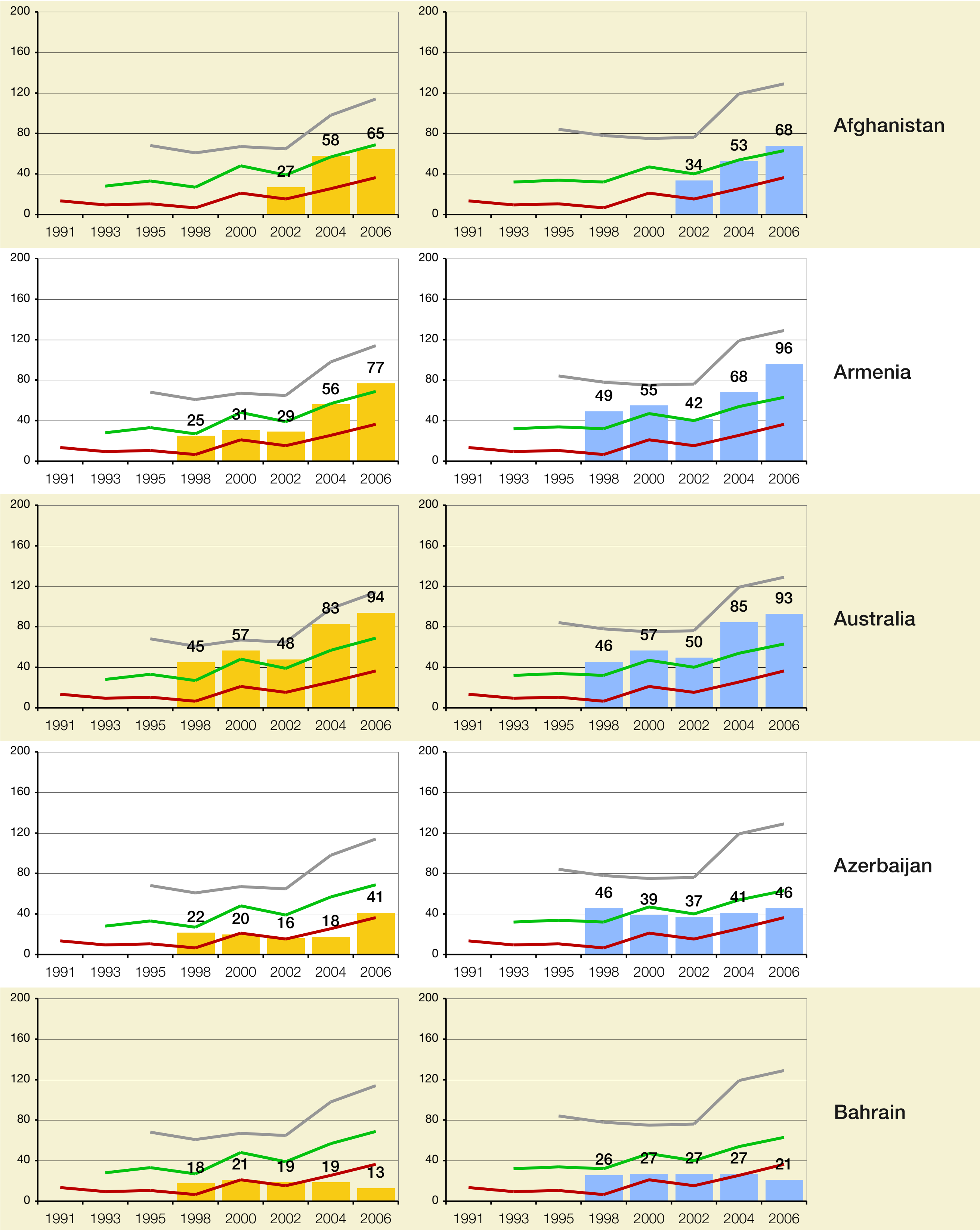
	Diesel [US cents/Litre]								Super Gasoline [US cents/Litre]							
Country	**1991**	**1993**	**1995**	**1998**	**2000**	**2002**	**2004**	**2006**	**1991**	**1993**	**1995**	**1998**	**2000**	**2002**	**2004**	**2006**
Afghanistan						27	58	65						34	53	68
Armenia				25	31	29	56	77				49	55	42	68	96
Australia				45	57	48	83	94				46	57	50	85	93
Azerbaijan				22	20	16	18	41				46	39	37	41	46
Bahrain				18	21	19	19	13				26	27	27	27	21
Bangladesh			31	26	29	29	34	45			36	47	46	52	59	79
Bhutan				26	38		59					59	58		78	
Brunei				18	18	18	19	21				34	31	30	32	34
Cambodia				28	44	44	61	78				47	61	63	79	101
China			24	25	45	37	43	61			27	28	40	42	48	69
China, Hong Kong	57		74	85	80	77	100	106	82		119	136	146	147	154	169
China, Macao				51	50			102				74	73			117
Fiji				37			73	94				50			91	107
Georgia				25		41	67	89				46		48	73	86
Hawaii								88 [4]								76 [4]
India	23		19	21	39	41	62	75	56		48	56	60	66	87	101
Indonesia	13		20	7	6	19	18	44	24		44	16	17	27	27	57
Iran				1	2	2	2	3				8	5	7	9	9
Iraq				1	3	1	1					1	3	2	3	
Israel			31	31	64	62	80	127			73	86	114	90	105	147
Japan			75	69	76	66	95	90			125	102	106	91	126	109
Jordan			15	15	15	17	19	45			40	42	45	52	61	86
Kazakhstan				24	29	29	38	45			30	30	36	35	52	70
Korea, North (D.R.)				41	35	41	61	79				73	55	55	78	71
Korea, South (R.)	25		33	41	66	64	95	133	54		79	93	92	109	135	165
Kuwait				13	18	18	24	21				17	21	20	24	22
Kyrgyzstan				27	33	25	43	54				47	44	39	48	64
Lao PDR				24	32	30	48	73				31	41	36	54	86
Lebanon				22	31	25	43	62				35	53	65	71	74
Malaysia	22		26	17	16	19	22	40	40		42	28	28	35	37	53
Mongolia				22	38	37	67	87				23	38	38	61	88
Myanmar (Burma)				12	12	28	10	75 [5]				13	33	36	12	66 [5]
Nepal	31		22	24	37	34	49	73	65		52	59	63	66	72	94
New Zealand			32	39	34	33	41	70			61	64	48	55	77	98
Oman				26	29	26	26	39				31	31	31	31	31
Pakistan			20	19	27	35	41	64			47	46	53	52	62	101
Palestine (WB Gaza)				31	61	52	70	98				86	108	99	117	129
Papua New Guinea				28	34		64					41	53		94	
Philippines	25		27	22	28	27	34	67	40		34	34	37	35	52	76
Qatar				15			16	19				16			21	19
Russian Federation			28	18	29	25	45	66			35	28	33	35	55	77
Samoa								82 [6]								81 [6]
Saudi Arabia			9	10	10	10	10	7			16	16	24	24	24	16
Singapore	28		33	36	38	38	55	63	61		85	72	84	85	89	92
Sri Lanka	27		23	30	27	31	41	55	75		75	84	66	54	72	88
Syria				14	13	18	13	13				45	44	53	46	60
Tahiti (French Polyn.)								119 [7]								149 [7]
Taiwan (China)	48		38	41	50	41	55	71	69		59	57	61	51	71	83
Tajikistan				13	55	24	59	74				26	45	36	67	80
Thailand	26		30	27	35	32	37	65	36		34	30	39	36	54	70
Timor-Leste							65	88							65	98
Tonga								109 [8]								103 [8]
Turkey			37	47	66	78	112	162			56	78	88	102	144	188
Turkmenistan				5	2	1	1	1				9	2	2	2	2
Utd. Arab Emirates				15	26	30	28	53				23	25	29	28	37
Uzbekistan			31	9	9	26	30	54 [9]			32	11	14	38	35	85 [9]
Vietnam			25	26	27	27	32	53			34	35	38	34	48	67
Yemen				7	6	10	9	28				26	21	21	19	30

[4] Price 04-2006, [5] Normal Price, [6] Price 04-2006, [7] Price 04-2006, [8] Price 04-2006, [9] Average Price

Note: Survey data of mid Nov. of each year

Diesel [US cents per litre]

Super Gasoline [US cents per litre]



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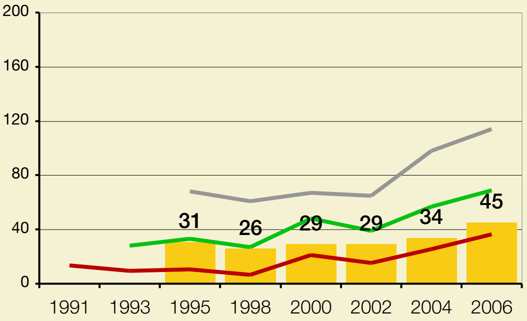
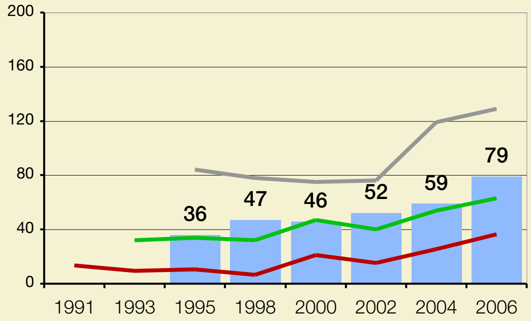
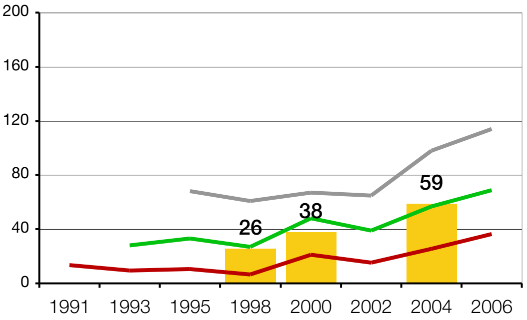
Diesel [US cents per litre] | **Super Gasoline** [US cents per litre]

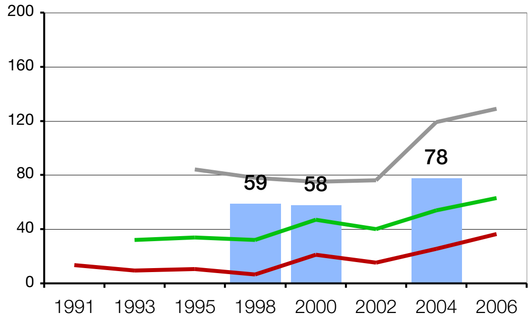
Bangladesh



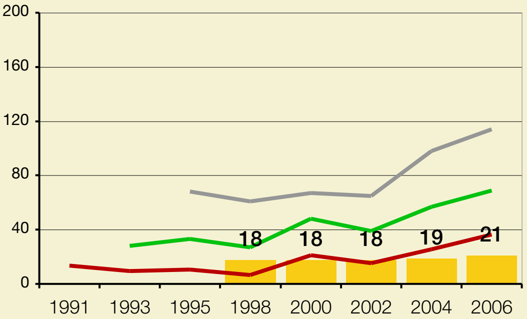


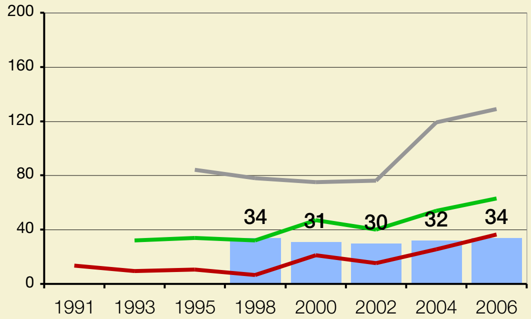
Bhutan



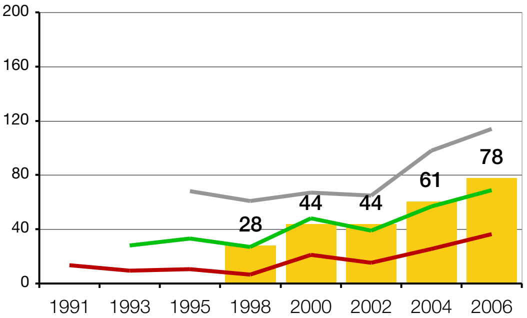


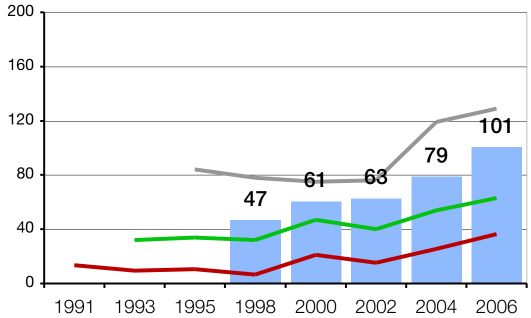
Brunei



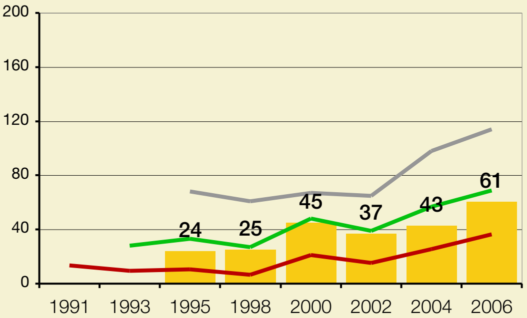


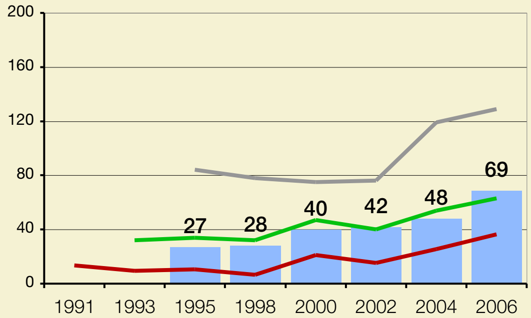
Cambodia





People's Republic of China





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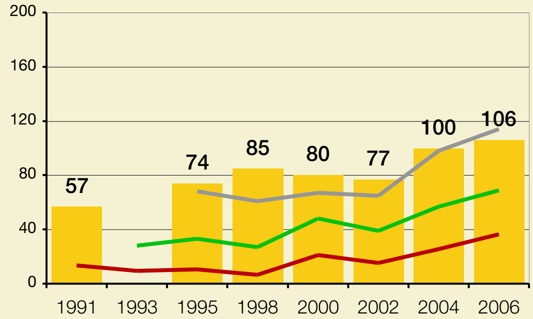
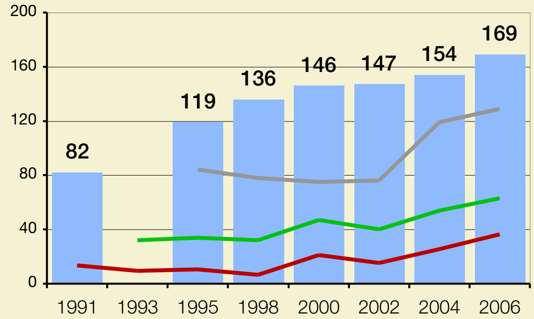
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

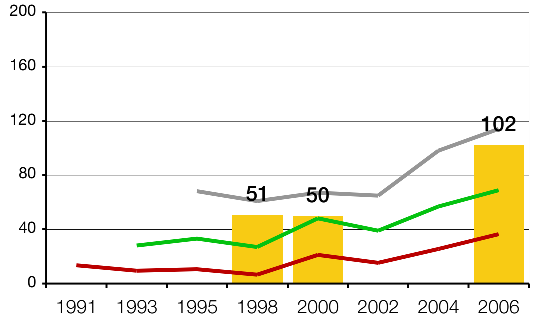
Diesel [US cents per litre]

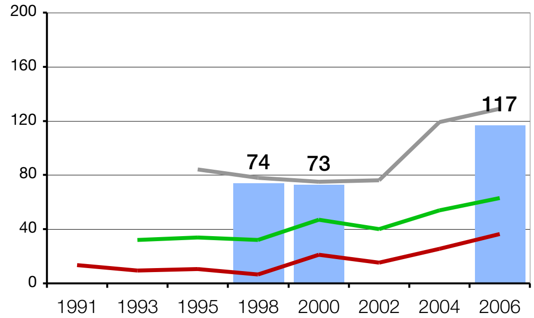
Super Gasoline [US cents per litre]



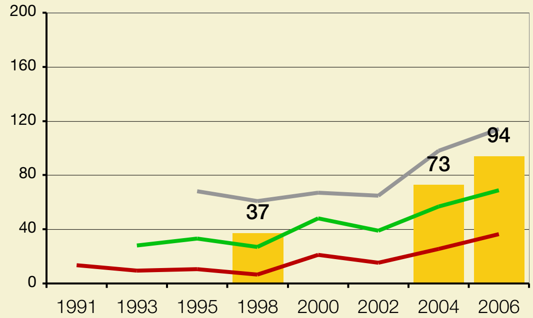


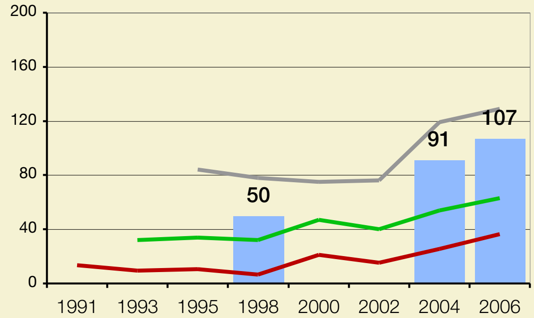
People's Republic of China: Hong Kong



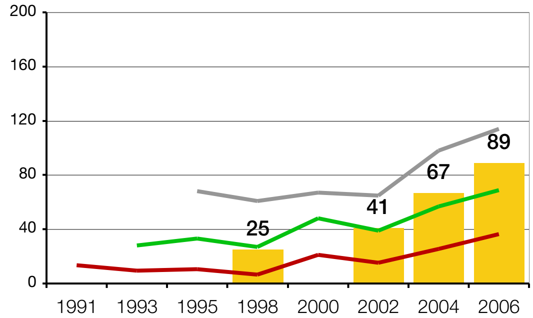


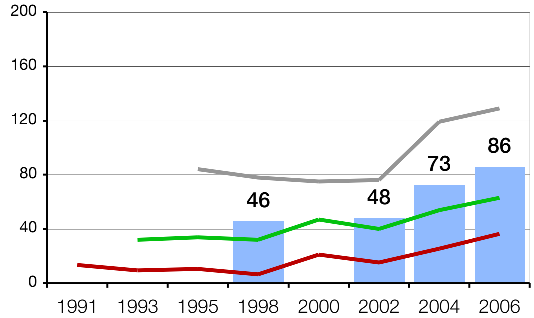
People's Republic of China: Macao



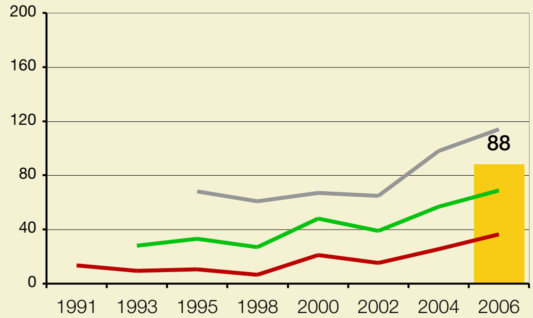


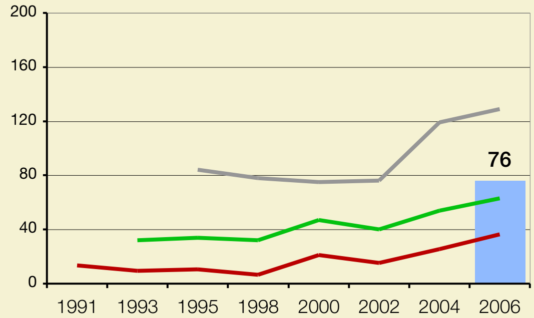
Fiji





Georgia





Hawaii (USA)

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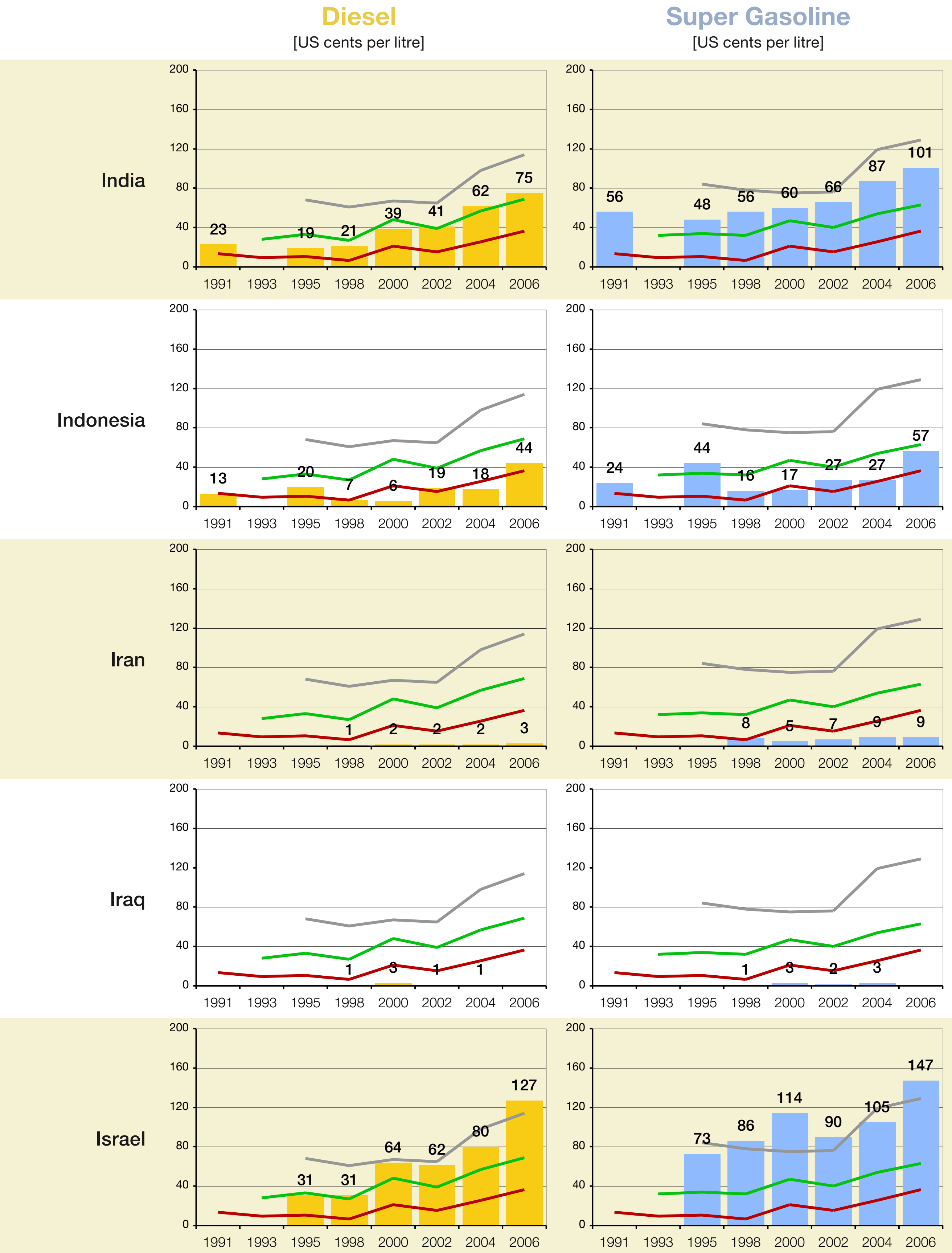
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.3.4 Detailed time series of Asia, Australia, and Pacific

1991 – 2006 (from India to Israel)



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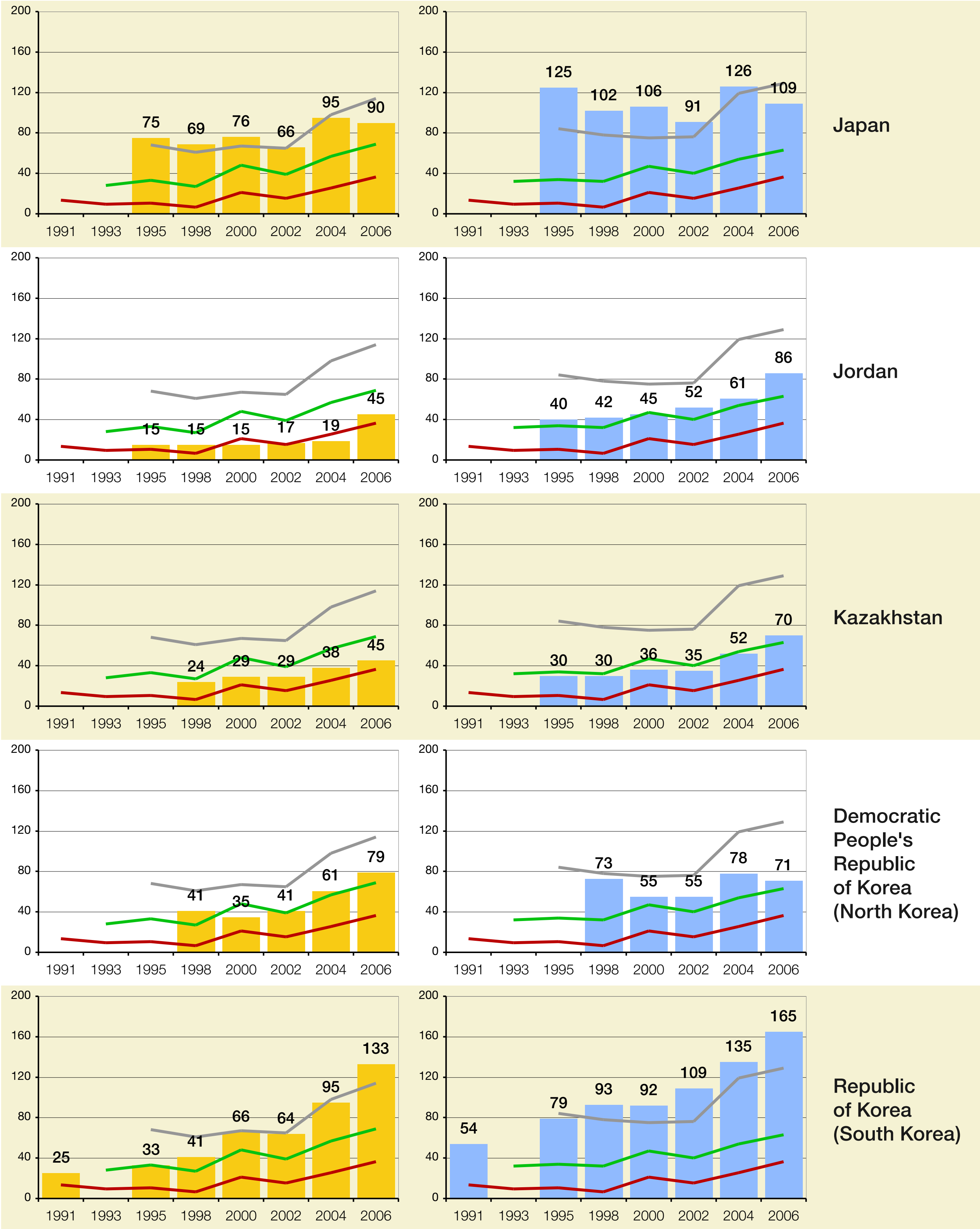
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

Diesel
[US cents per litre]

Super Gasoline
[US cents per litre]



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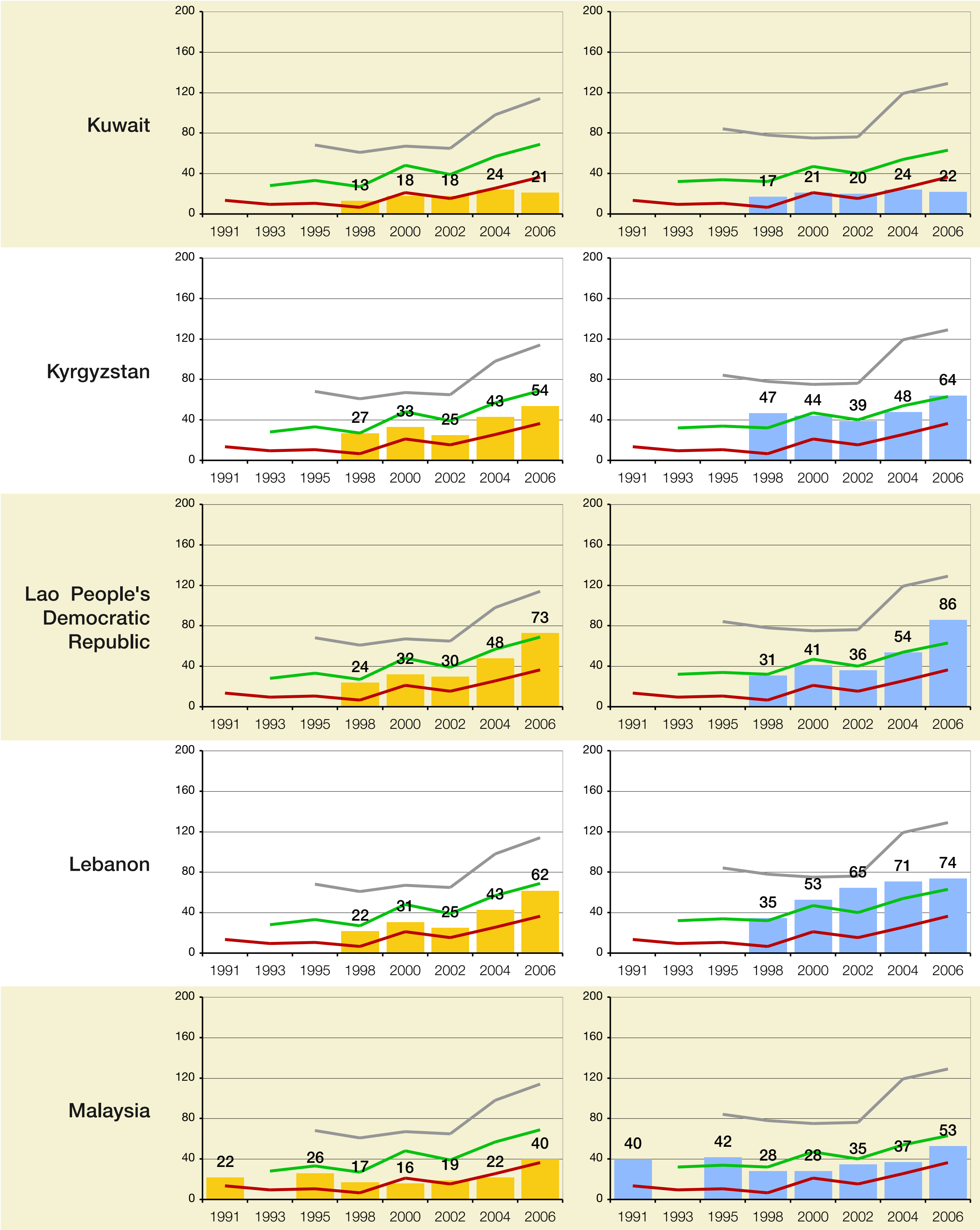
5.3.4 Detailed time series of Asia, Australia, and Pacific
1991 – 2006 (from Kuwait to Malaysia)

Diesel [US cents per litre]

Super Gasoline [US cents per litre]



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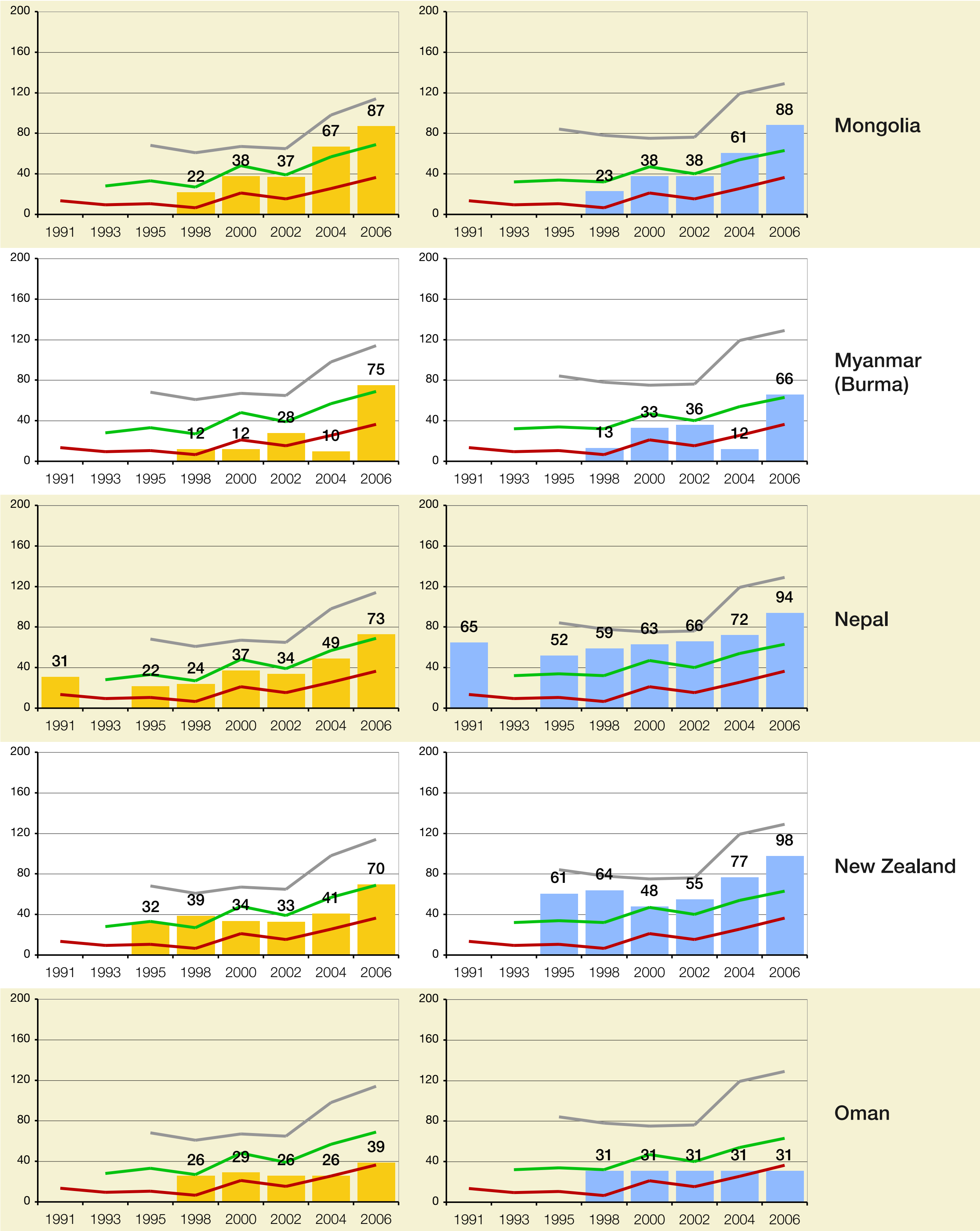
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

Diesel
[US cents per litre]

Super Gasoline
[US cents per litre]



Grey Benchmark Line = Retail Fuel Prices of LUXEMBOURG = Orientation Level in European Union. In accordance with EU Directive 92/82, the member states of the EU are obliged to impose minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel. Furthermore, petroleum products are subject to regular value-added tax.

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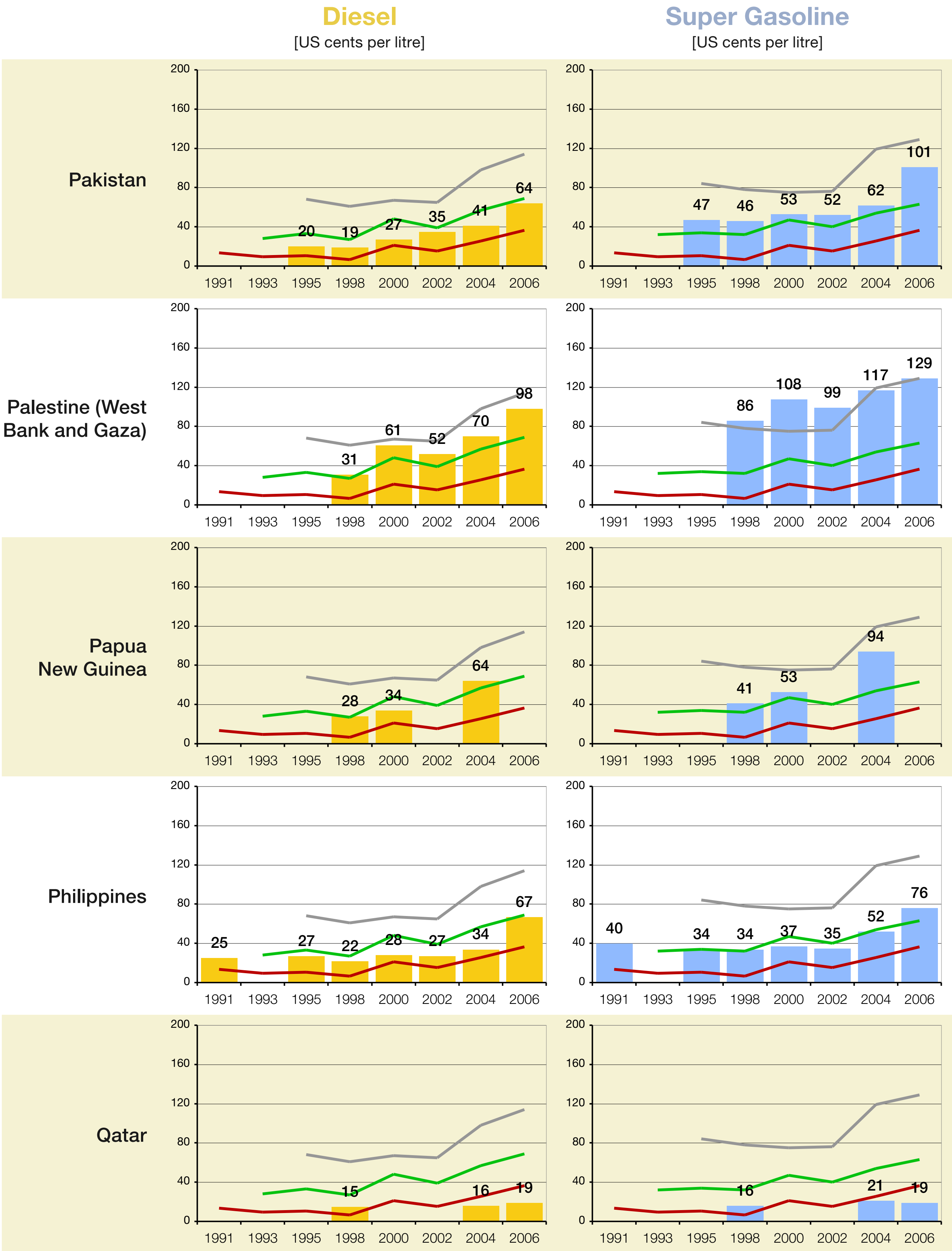

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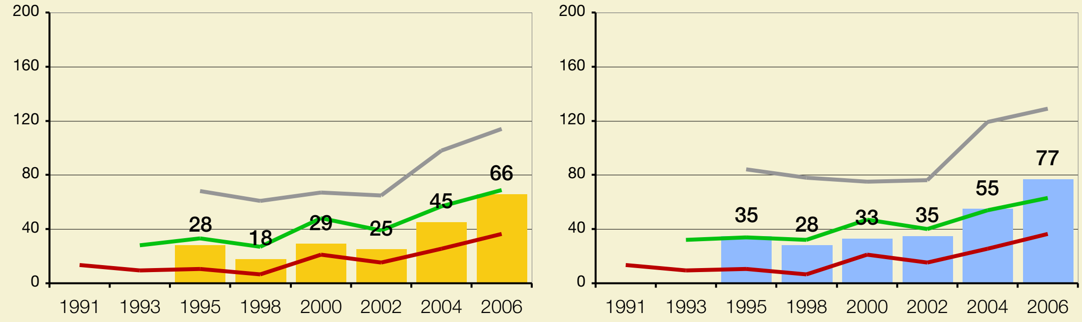
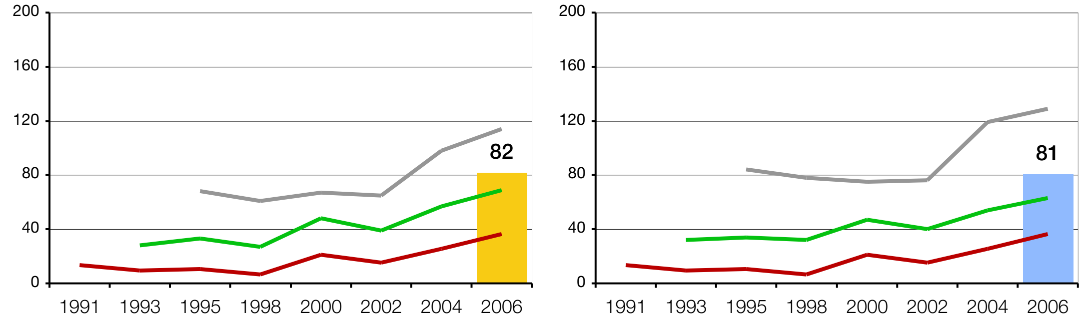
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.3.4 Detailed time series of Asia, Australia, and Pacific
1991 – 2006 (from Russian Federation to Singapore)

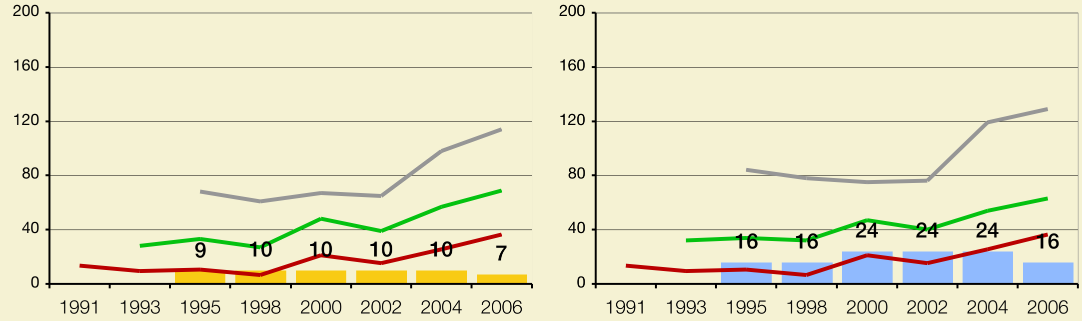
Diesel [US cents per litre] | **Super Gasoline** [US cents per litre]



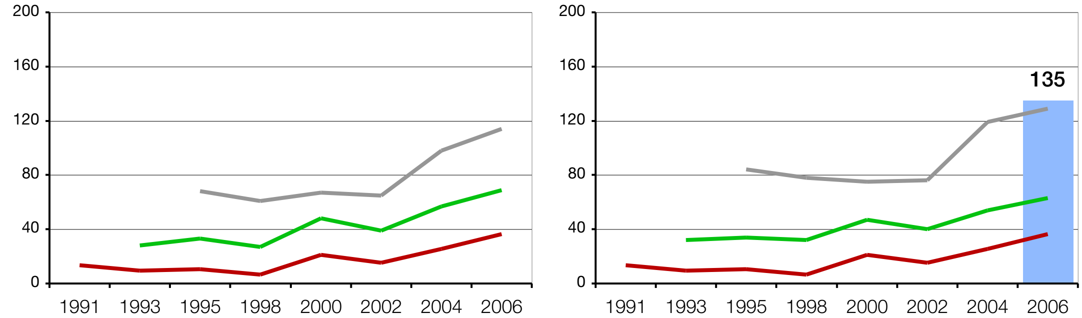
Russian Federation



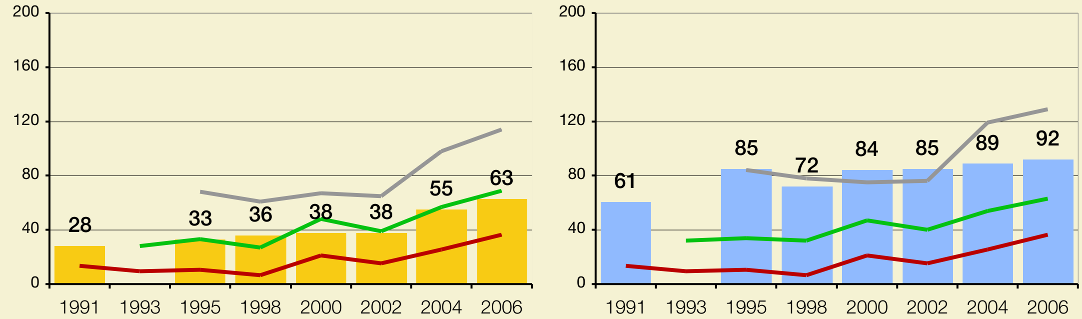
Samoa



Saudi Arabia



Seychelles



Singapore

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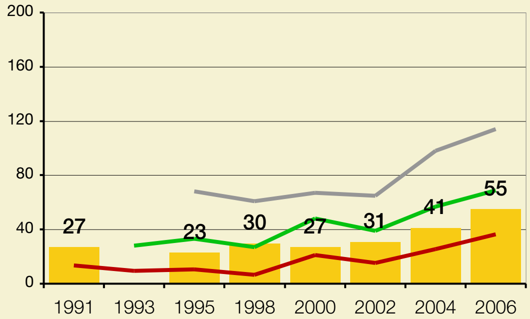
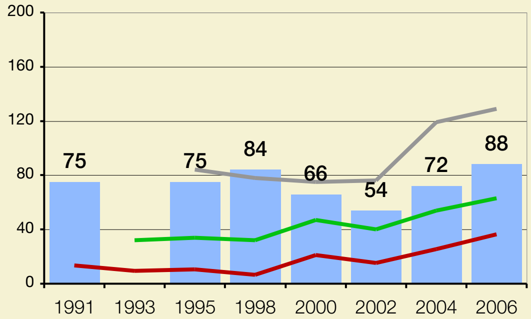
Diesel [US cents per litre]

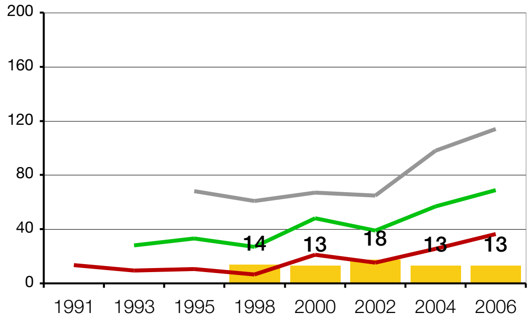
Super Gasoline [US cents per litre]

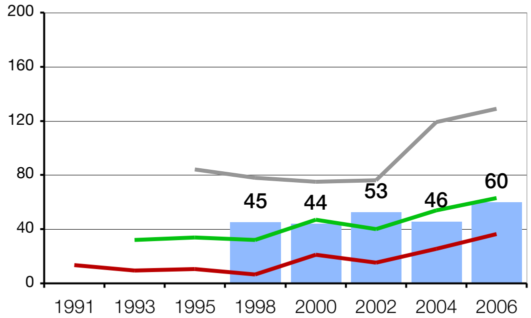
Sri Lanka



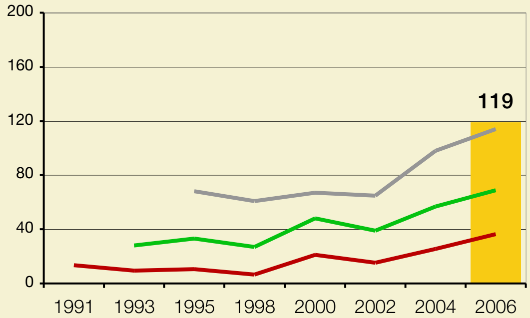


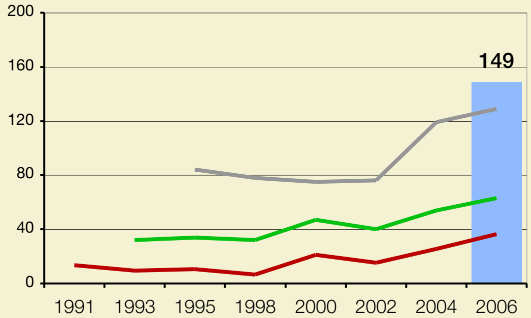
Syria



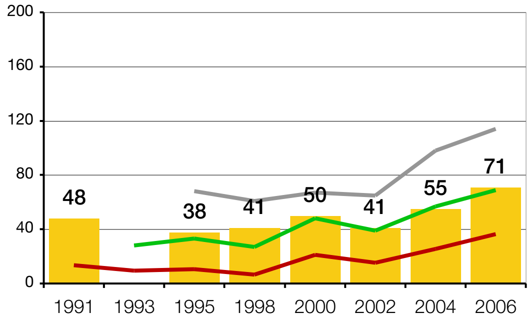


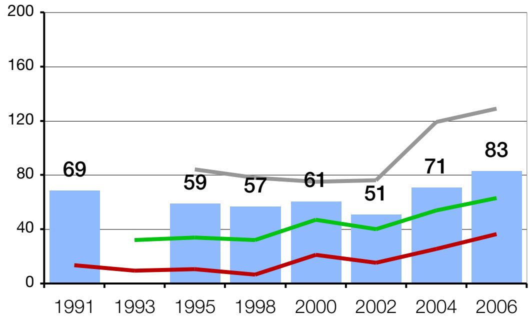
Tahiti (French Polynesia)



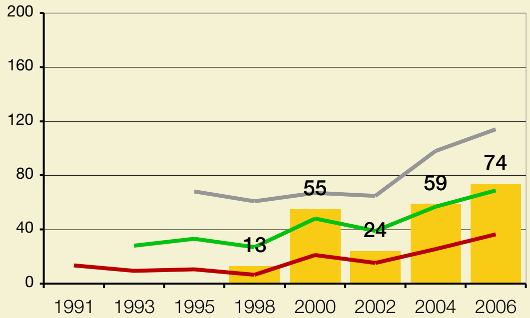


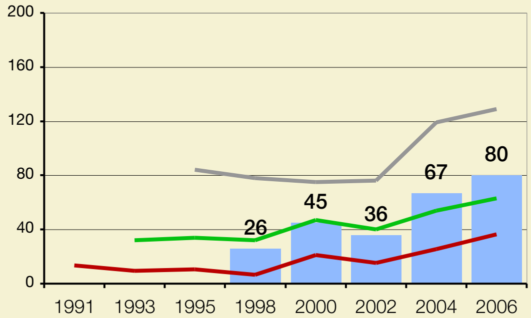
Taiwan (Republic of China)





Tajikistan





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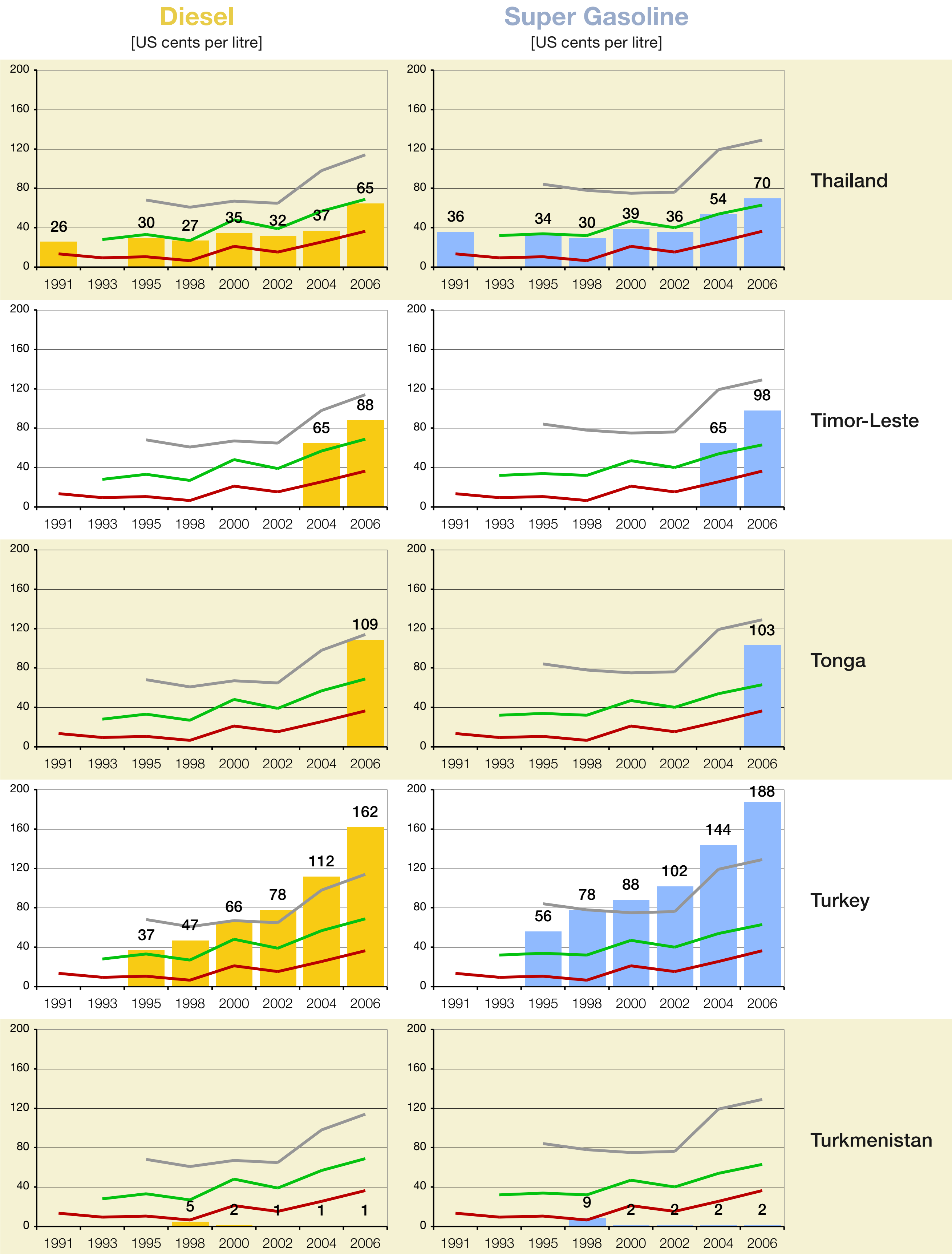

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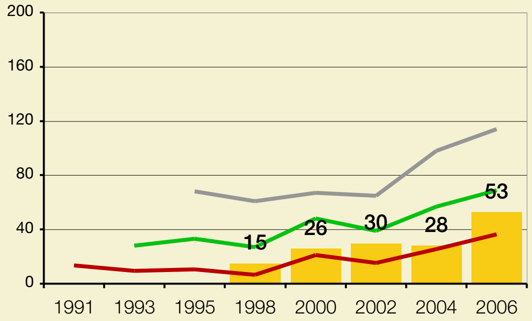
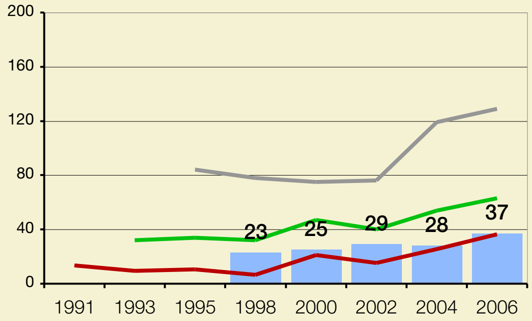
5.3.4 Detailed time series of Asia, Australia, and Pacific

1991 – 2006 (from United Arab Emirates to Yemen)

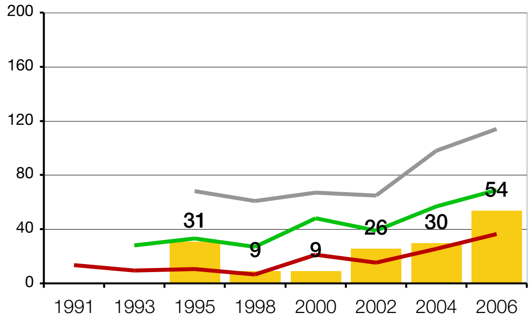
Diesel [US cents per litre] | **Super Gasoline** [US cents per litre]

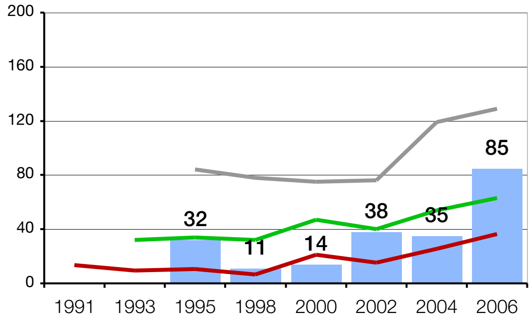
United Arab Emirates



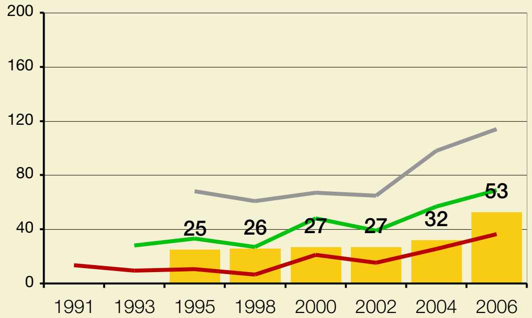


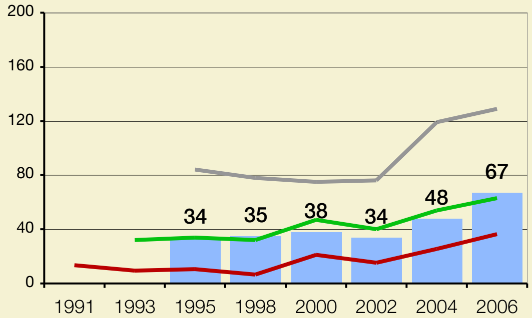
Uzbekistan



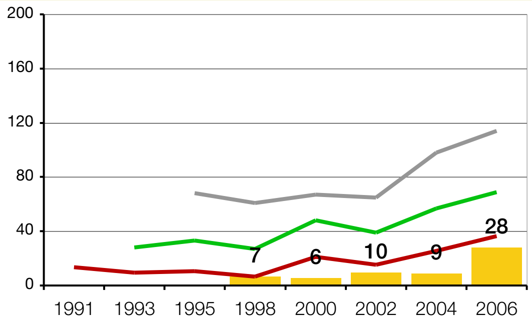


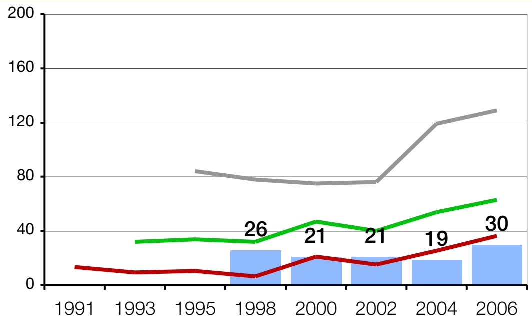
Vietnam





Yemen





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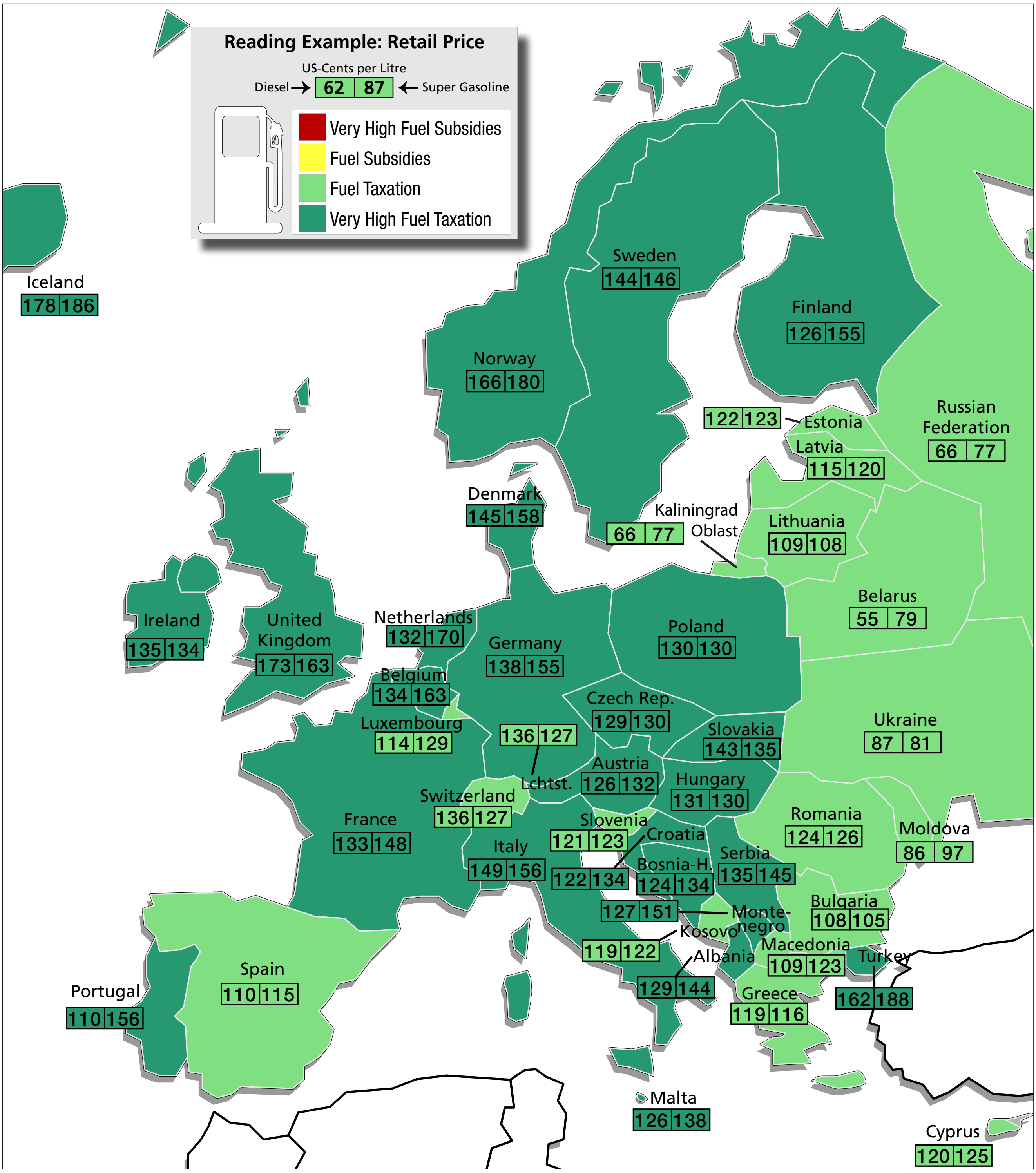
5.4 Fuel prices in Europe

- *Retail fuel prices in Europe*
- *Comparison of retail fuel prices in Europe*
- *Time Series of retail fuel prices in Europe*
- *Detailed time series of fuel prices in Europe*

as of November 2006 (in US cents/Litre)



Fuel Taxation Category 1: Very high Fuel Subsidies
The retail price of fuel (average of Diesel and Super Gasoline) is below the price for crude oil on world market.

Fuel Taxation Category 2: Fuel Subsidies
The retail price of fuel is above the price for crude oil on world market and below the price level of the United States.

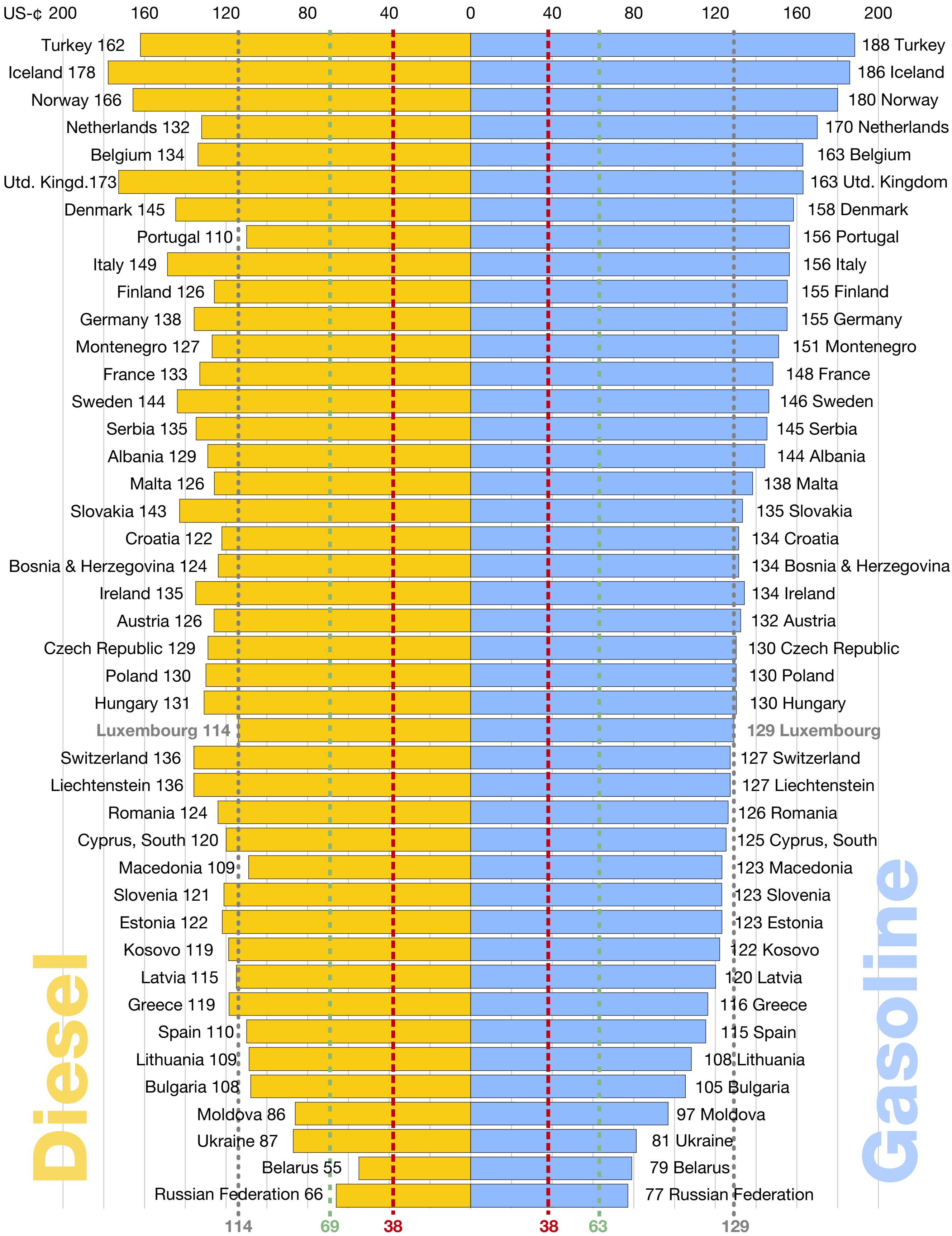
Note: The fuel prices of the United States are aver. cost-covering retail prices incl. industry margin, VAT and incl. approx. US cents 10 for the two road funds (federal and state). This fuel price being without other specific fuel taxes may be considered as the international minimum benchmark for a non-subsidised road transport policy.

Fuel Taxation Category 3: Fuel Taxation
The retail price of fuel is above the price level of the United States and below the price level of Luxembourg.

Note: The fuel prices in Luxembourg reflect an orientation level in the European Union. Prices in EU countries are subject to VAT, a EU-imposed minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel as well as other country-specific duties and taxes.

Fuel Taxation Category 4: Very high Fuel Taxation
The retail price of fuel is above the price level of Luxembourg.

5.4.2 Comparison of retail fuel prices in Europe
as of November 2006 (in US cents/litre)



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Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.4.3 Time series of retail fuel prices in Europe

in US cent per litre (last survey 15–17 November 2006)

	Diesel [US cents/Litre]								Super Gasoline [US cents/Litre]							
Country	**1991**	**1993**	**1995**	**1998**	**2000**	**2002**	**2004**	**2006**	**1991**	**1993**	**1995**	**1998**	**2000**	**2002**	**2004**	**2006**
Albania				43	30	51	102	129				86	57	80	123	144
Austria			87	82	74	73	119	126			115	104	82	84	132	132
Belarus				13	36	36	44	55				34	55	50	62	79
Belgium			82	85	78	80	107	134			118	112	96	104	150	163
Bosnia & Herzego.				60	57	74	97	124				66	68	74	97	134
Bulgaria			26	52	58	59	89	108			46	66	70	68	92	105
Croatia			64	61	60	74	113	122			75	67	76	89	124	134
Cyprus, South				25	18	44	95	120				78	57	83	108	125
Czech Republic			60	60	68	71	107	129			85	72	77	81	108	130
Denmark			87	85	90	94	135	145			108	105	101	109	151	158
Estonia			33	36	55	56	94	122			33	45	60	58	94	123
Finland			85	79	84	80	121	126			120	117	106	112	154	155
France			78	77	82	80	125	133			117	111	99	105	142	148
Germany			77	69	78	82	129	138			112	96	91	103	146	155
Greece			59	40	71	68	123	119			88	65	72	78	114	116
Hungary			65	64	79	85	122	131			74	72	81	94	130	130
Iceland				40	45	62	88	178				112	105	116	164	186
Ireland			87	102	72	80	129	135			96	102	72	90	129	134
Italy			86	93	83	86	131	149			118	119	97	105	153	156
Kosovo			84	43	56	66	103	119			76	61	56	74	116	122
Latvia			34	35	58	65	90	115			41	55	67	70	94	120
Liechtenstein				89	84	93	137	136				85	81	89	129	127
Lithuania			30	34	55	59	102	109			35	51	66	69	103	108
Luxembourg			68	61	67	65	98	114			84	78	75	76	119	129
Macedonia			59	46	56	63	92	109			93	70	76	85	117	123
Malta				49	44	53	97	126				77	81	87	118	138
Moldova				31	40	31	31	86 *)				45	45	45		97 *)
Montenegro			84	43	56	66	106	127			76	61	56	74	120	151
Netherlands			82	79	78	81	123	132			121	114	103	112	162	170
Norway			109	110	115	118	144	166			133	121	119	123	161	180
Poland			42	44	65	68	109	130			55	54	76	83	120	130
Portugal				71	54	71	108	110				102	77	97	138	156
Romania			19	40	35	57	91	124			29	53	46	64	96	126
Russian Federation			28	18	29	25	45	66			35	28	33	35	55	77
Serbia			84	43	56	66	85	135			76	61	56	74	100	145
Slovakia			40	54	68	70	119	143			66	61	69	74	117	135
Slovenia			50	64	66	67	111	121			59	66	63	76	112	123
Spain			70	70	65	72	110	110			89	84	73	83	121	115
Sweden			101	84	80	96	137	144			117	109	94	106	151	146
Switzerland			101	91	84	93	137	136			102	86	78	89	129	127
Turkey			37	47	66	78	112	162			56	78	88	102	144	188
Ukraine				25	30	34	44	87				49	37	47	55	81
United Kingdom			85	111	122	120	160	173			92	111	117	118	156	163

*) Moldova: data 2006 = April 2007

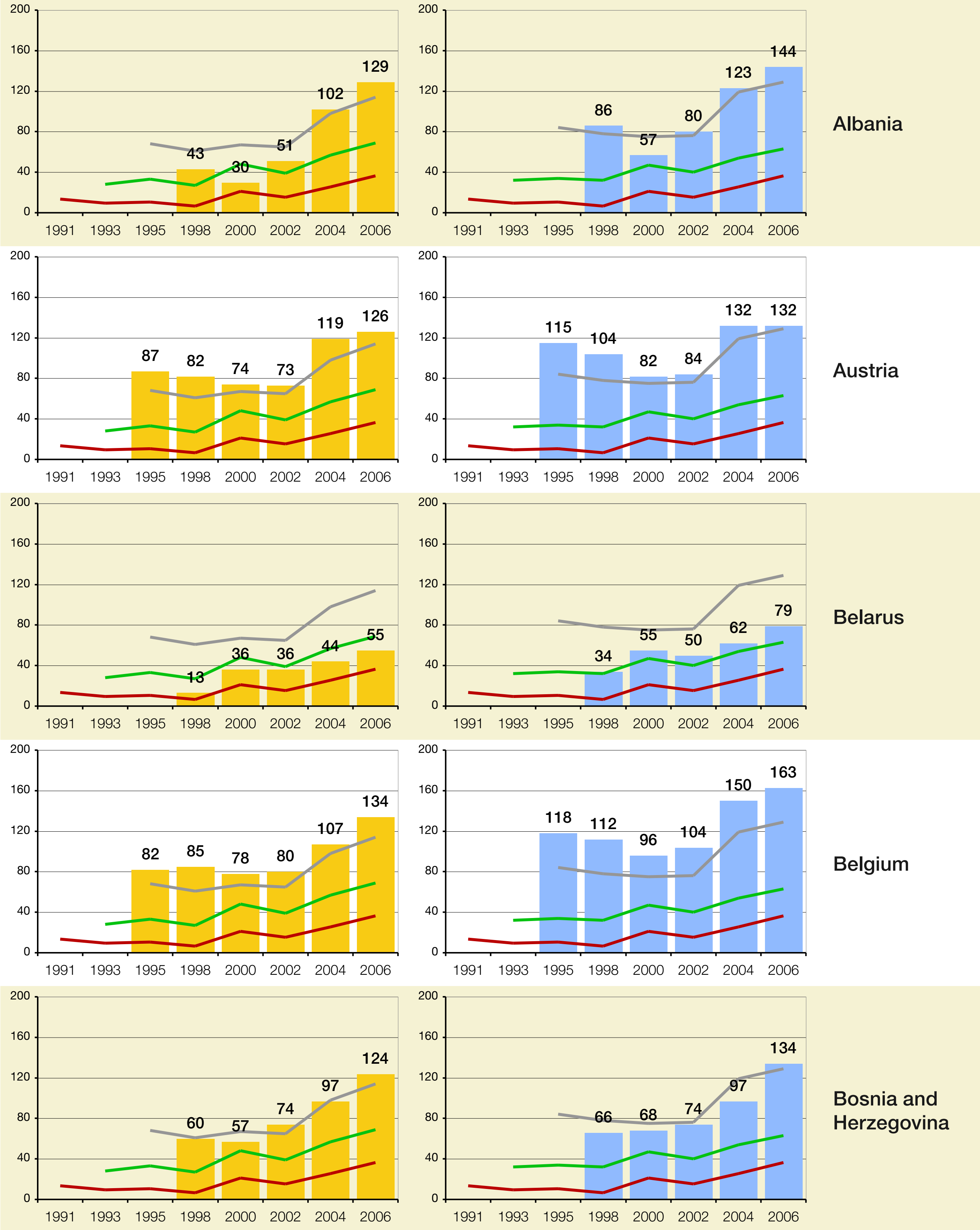
Note: Survey data of mid November of each year

5.4.4 Detailed time series of Europe

1991 – 2006 (from Albania to Bosnia and Herzegovina)

Diesel
[US cents per litre]

Super Gasoline
[US cents per litre]



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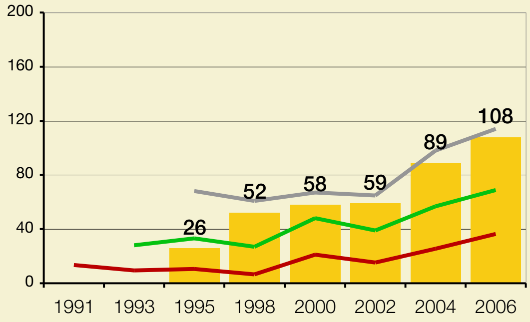
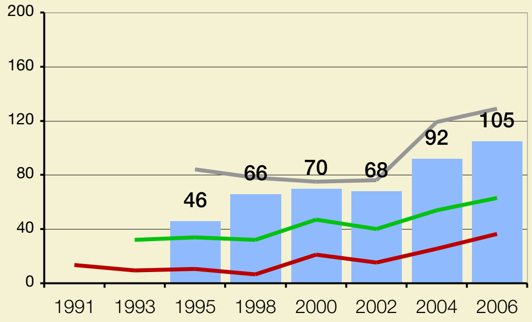
Green Benchmark Line = Retail Fuel Prices in the UNITED STATES = aver. Cost-Covering Retail Prices incl. Industry Margin, VAT and incl. approx. US cents 10 for the 2 Road Funds (Federal and State). This Fuel Price being without other Specific Fuel Taxes may be considered as the International Minimum Benchmark for a non-subsidised Road Transport Policy.

Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

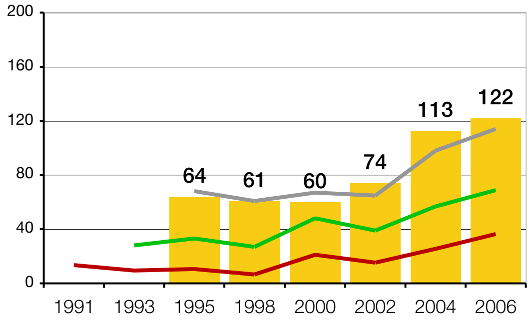
	Diesel [US cents per litre]	**Super Gasoline** [US cents per litre]

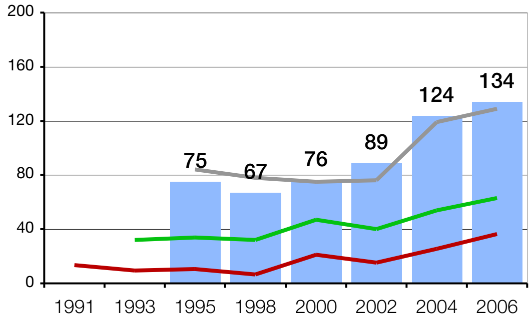
Bulgaria



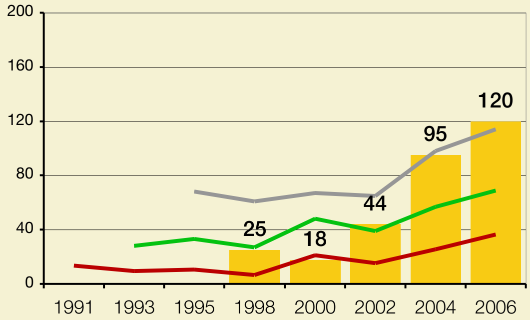


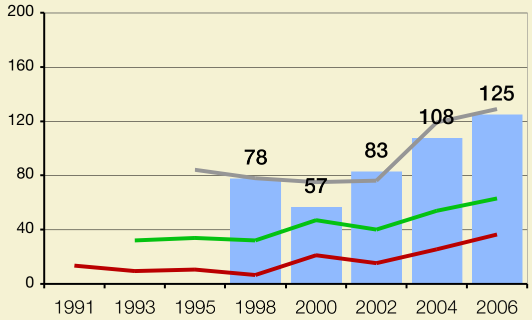
Croatia



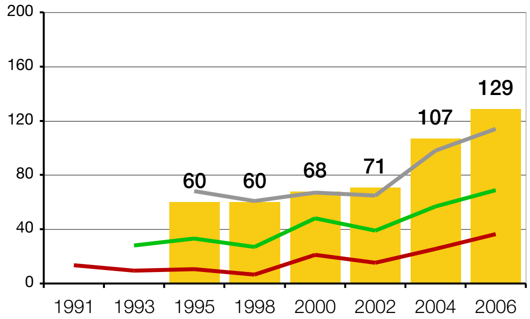


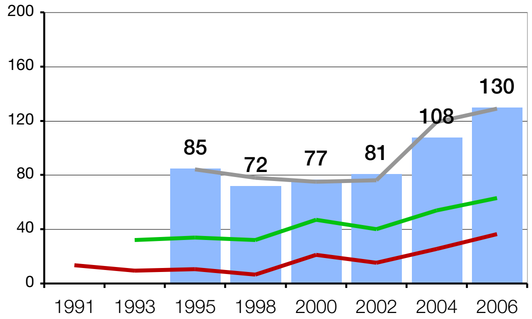
South Cyprus



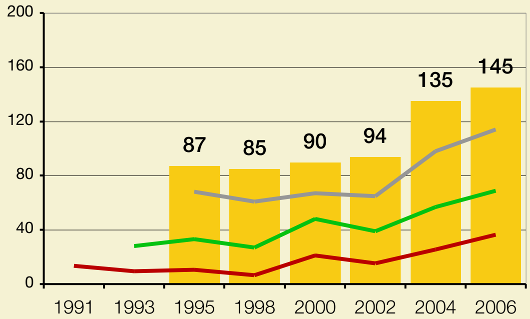


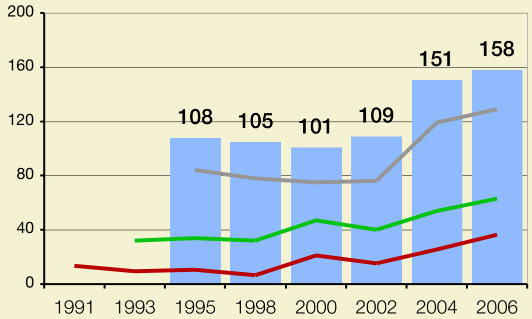
Czech Republic





Denmark





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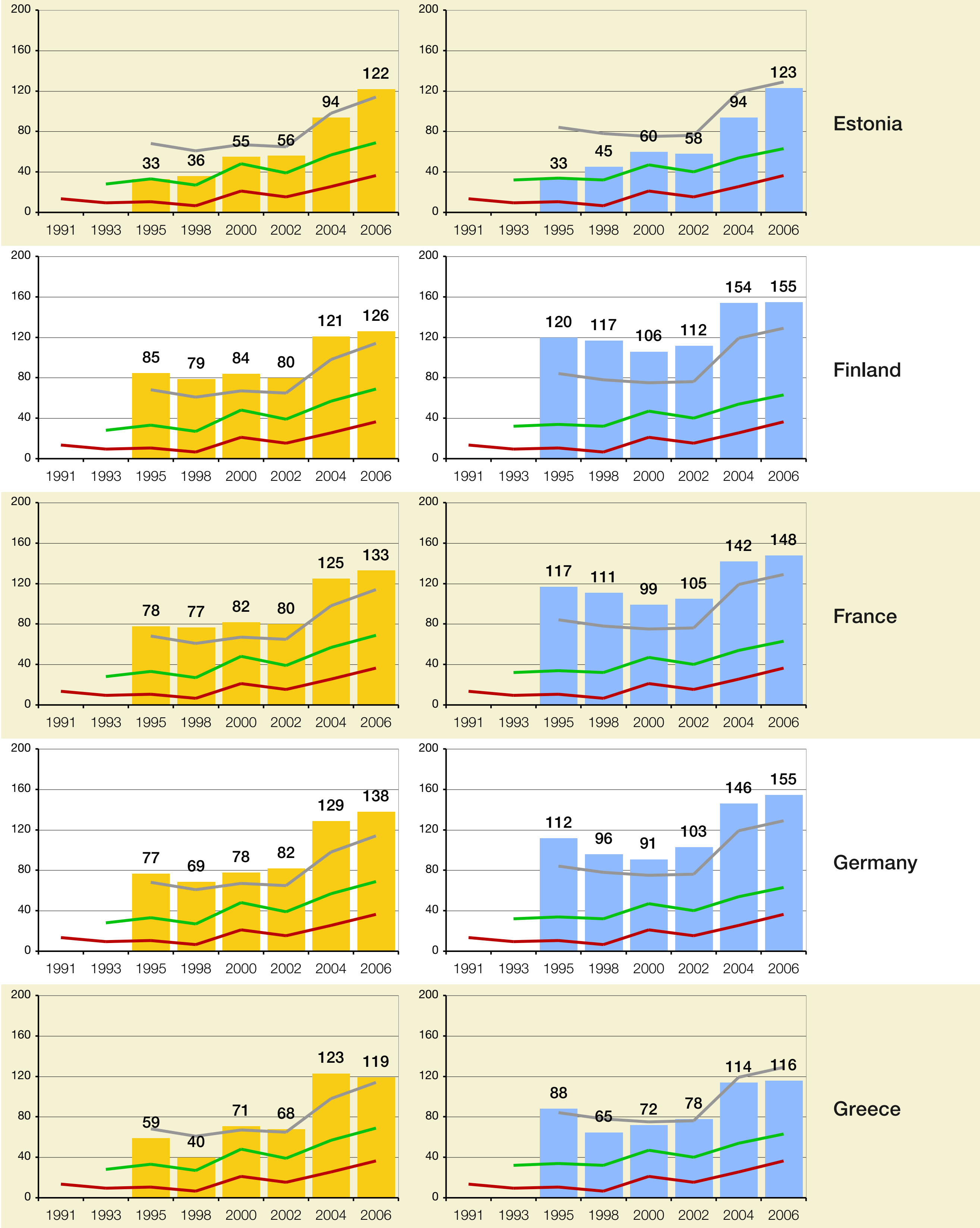
Green Benchmark Line = Retail Fuel Prices in the UNITED STATES = aver. Cost-Covering Retail Prices incl. Industry Margin, VAT and incl. approx. US cents 10 for the 2 Road Funds (Federal and State). This Fuel Price being without other Specific Fuel Taxes may be considered as the International Minimum Benchmark for a non-subsidised Road Transport Policy.

Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

Diesel [US cents per litre]

Super Gasoline [US cents per litre]



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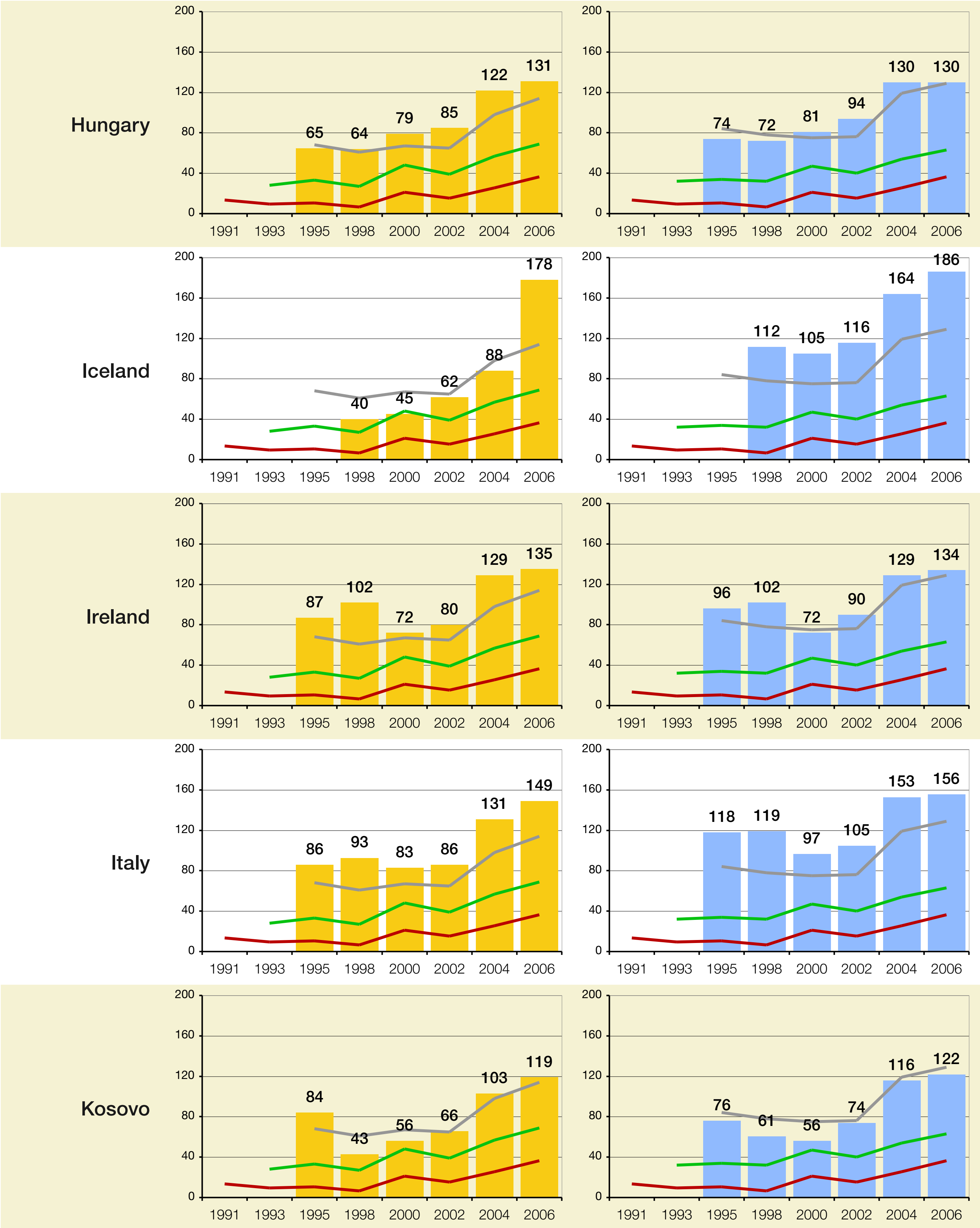
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

Diesel [US cents per litre] | **Super Gasoline** [US cents per litre]



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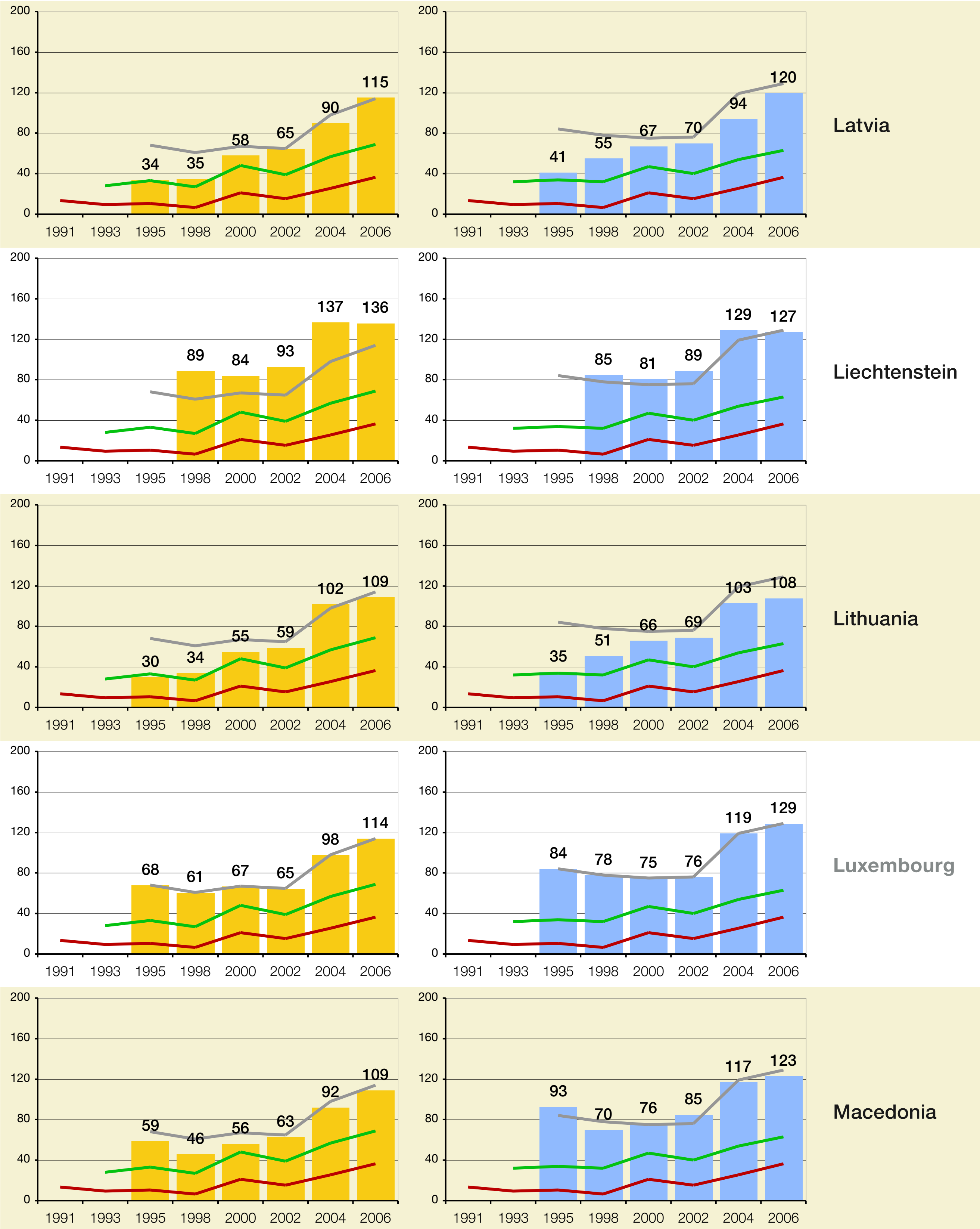
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.4.4 Detailed time series of Europe

1991 – 2006 (from Latvia to Macedonia)

Diesel
[US cents per litre]

Super Gasoline
[US cents per litre]



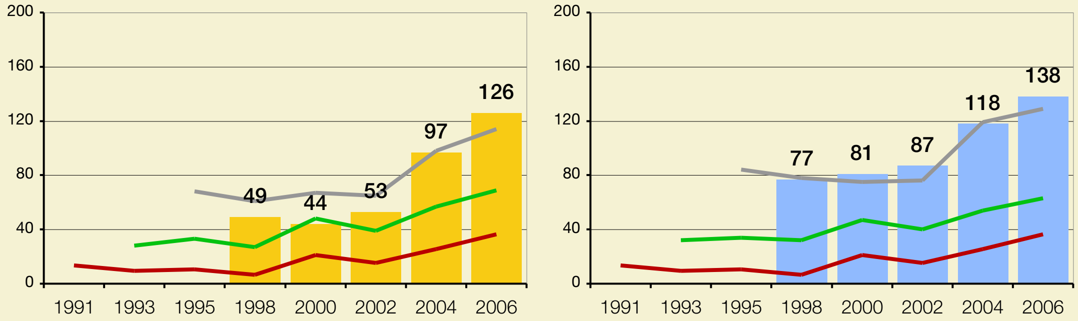
Grey Benchmark Line = Retail Fuel Prices of LUXEMBOURG = Orientation Level in European Union. In accordance with EU Directive 92/82, the member states of the EU are obliged to impose minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel. Furthermore, petroleum products are subject to regular value-added tax.

Green Benchmark Line = Retail Fuel Prices in the UNITED STATES = aver. Cost-Covering Retail Prices incl. Industry Margin, VAT and incl. approx. US cents 10 for the 2 Road Funds (Federal and State). This Fuel Price being without other Specific Fuel Taxes may be considered as the International Minimum Benchmark for a non-subsidised Road Transport Policy.

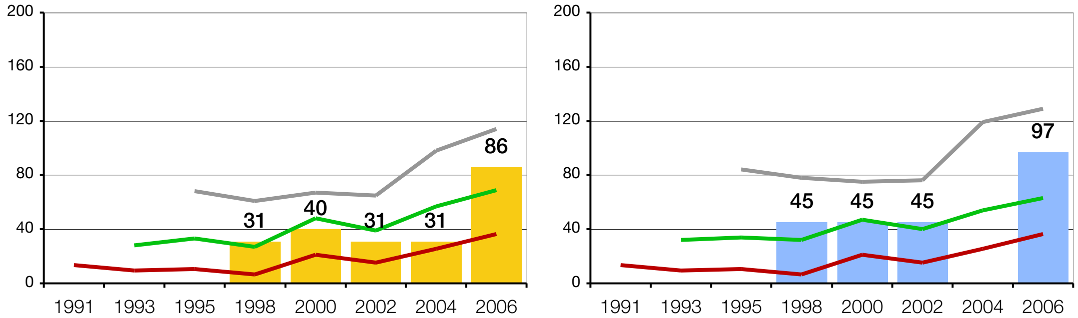
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

Diesel [US cents per litre] | **Super Gasoline** [US cents per litre]

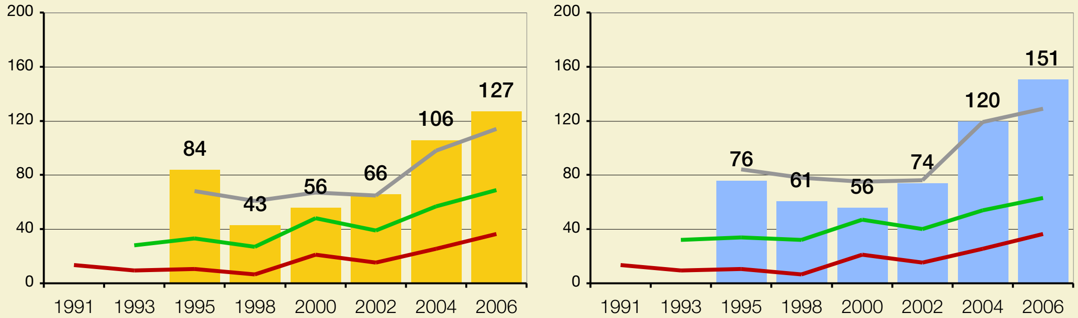
Malta



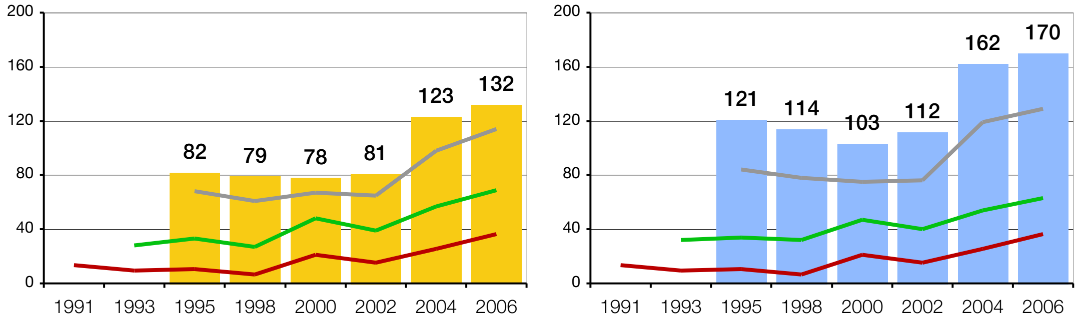
Moldova
(Data 2006 = April 2007)



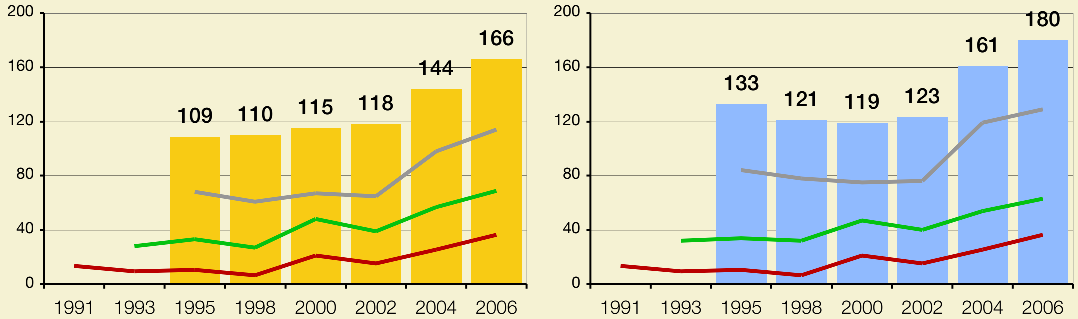
Montenegro



Netherlands



Norway



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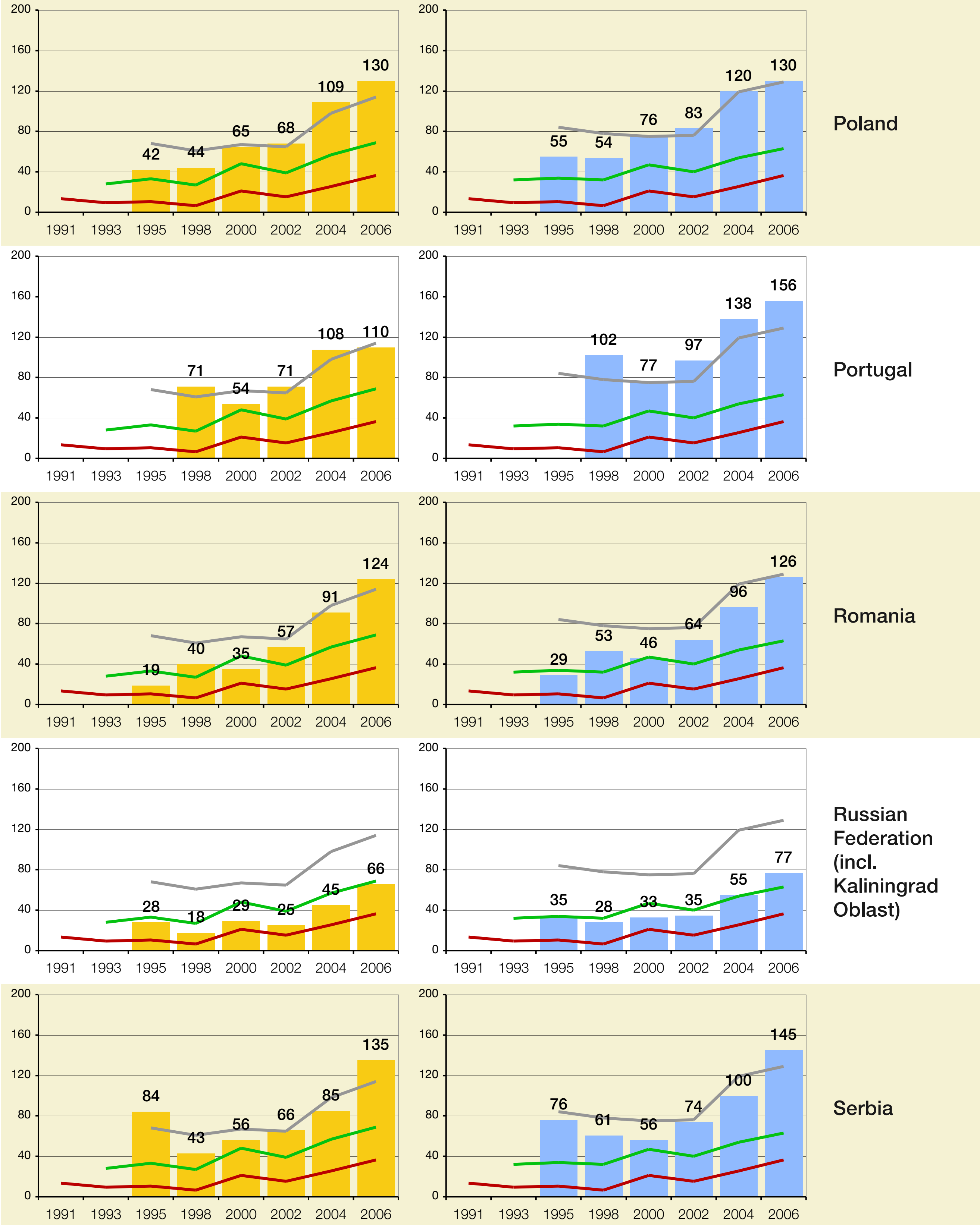
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.4.4 Detailed time series of Europe

1991 – 2006 (from Poland to Serbia)

Diesel [US cents per litre]

Super Gasoline [US cents per litre]



Grey Benchmark Line = Retail Fuel Prices of LUXEMBOURG = Orientation Level in European Union. In accordance with EU Directive 92/82, the member states of the EU are obliged to impose minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel. Furthermore, petroleum products are subject to regular value-added tax.

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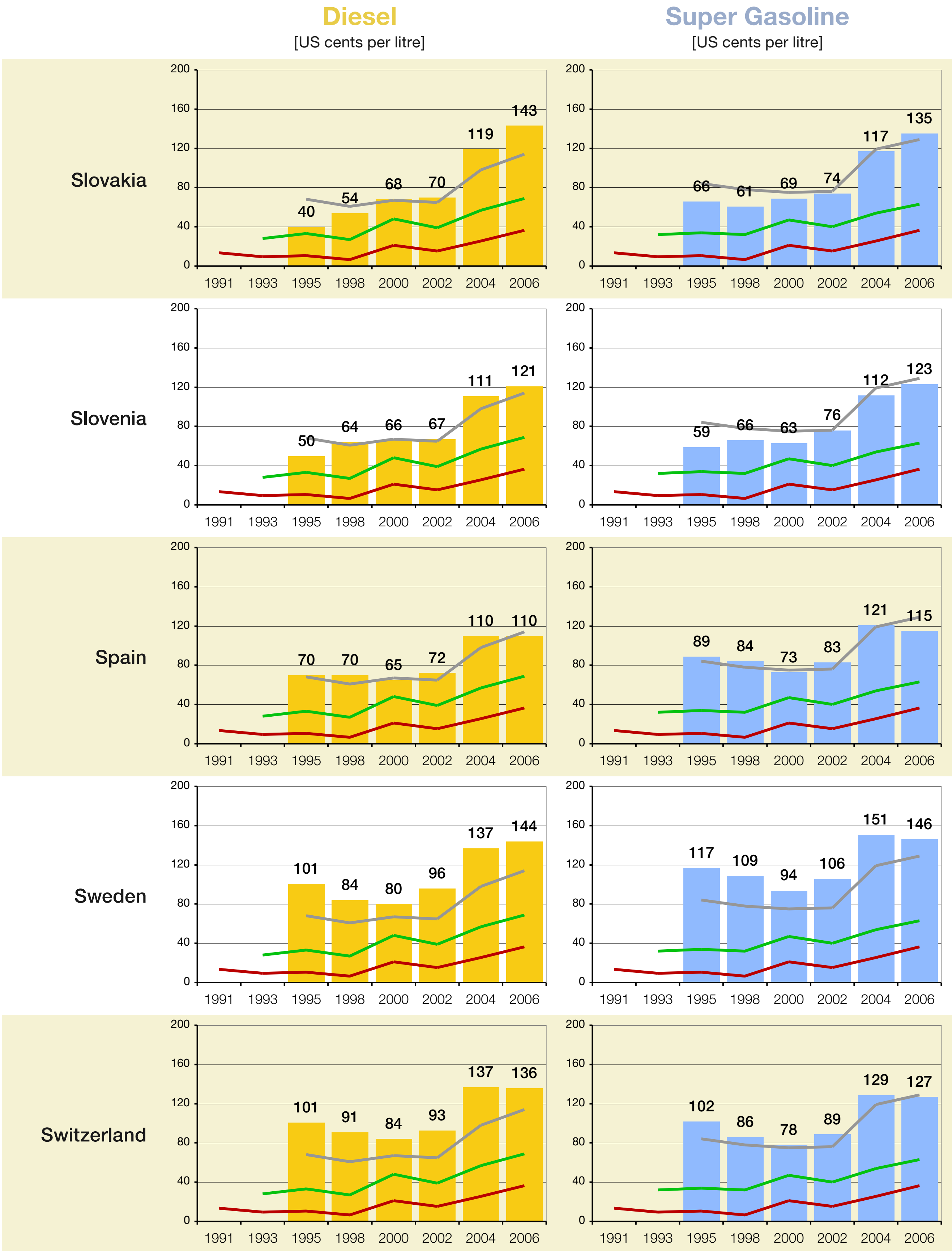
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

5.4.4 Detailed time series of Europe

1991 – 2006 (from Slovakia to Switzerland)



Grey Benchmark Line = Retail Fuel Prices of LUXEMBOURG = Orientation Level in European Union. In accordance with EU Directive 92/82, the member states of the EU are obliged to impose minimum taxation of €0.287 (37 US cents) per litre on unleaded gasoline and €0.245 (31 US cents) per litre on diesel fuel. Furthermore, petroleum products are subject to regular value-added tax.

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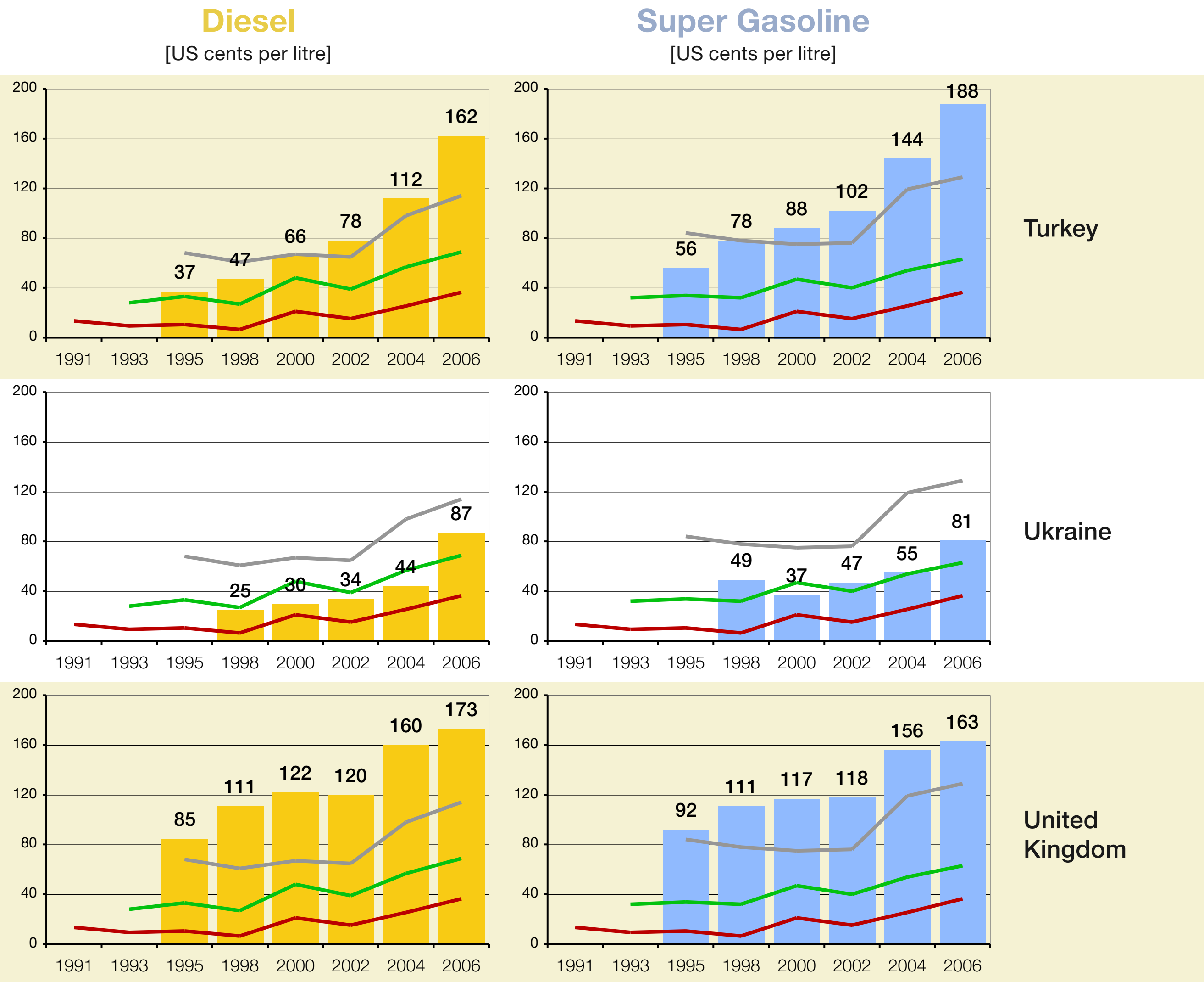
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).



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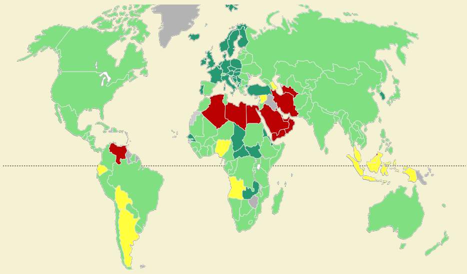
Red Benchmark Line = CRUDE OIL Prices on World Market ("Brent" at Rotterdam).

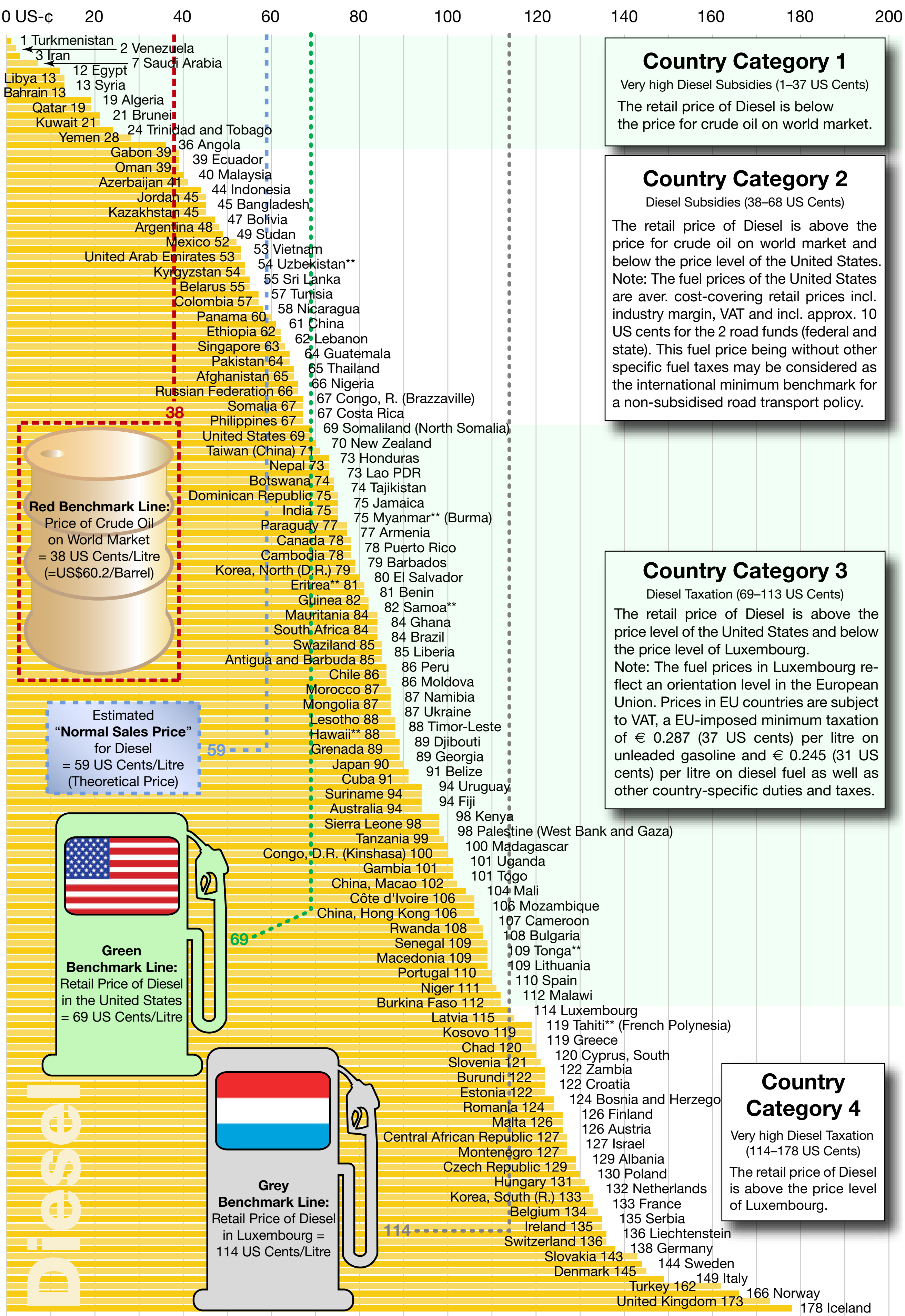


5.5 Retail fuel prices of 171 countries

- *World ranking of diesel prices*
- *World ranking of gasoline prices*

5.5.1 Retail prices of diesel in 171 countries

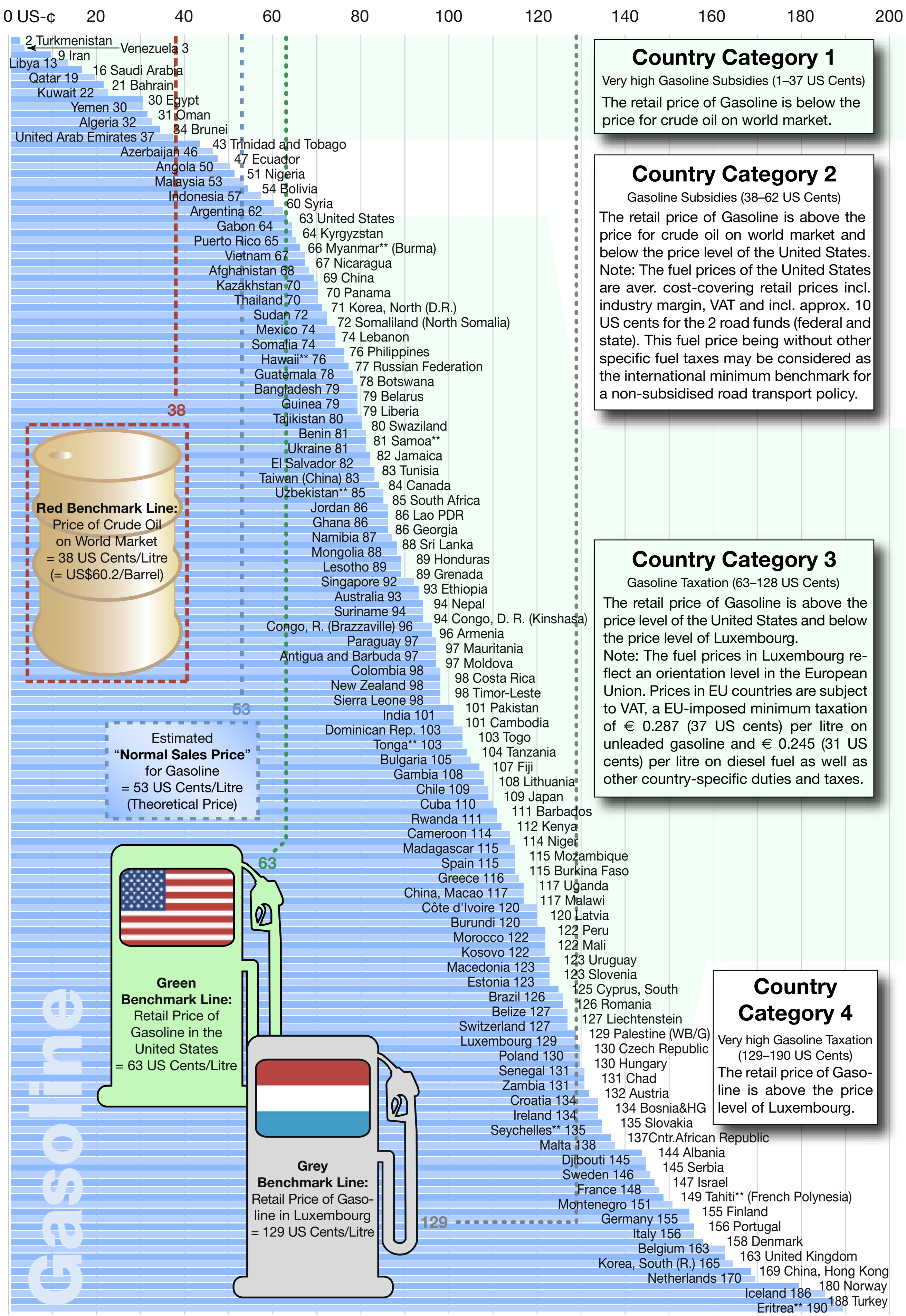
as of November 2006 (in US cents/litre)



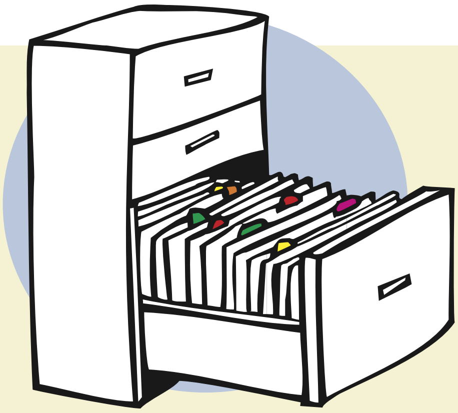
** For more information, please refer to main document.

5.5.2 Retail prices of gasoline* in 171 countries

as of November 2006 (in US cents/litre)



* Normal grade gasoline, if super gasoline is not commonly available in a country. ** For more information, please refer to main document.



6. Annex

- *Data sources and unit conversion*

6.1.1 Data sources

The data for industrialised countries stem from various sources, primarily from the German automobile club "Allgemeiner Deutscher Automobil Club" (ADAC) in Munich.

Most of the data for developing countries, especially those in Africa and Asia, are based on local price surveys conducted by GTZ's local offices. In some cases, *e.g.,* Cuba, Myanmar, Sudan, Turkmenistan, North Korea, and several Arabian Gulf countries, the German embassies/consulates worldwide kindly assisted us in our efforts to collect the relevant data.

6.1.2 Method of collection

Around the world, fuel prices vary not only from country to country as a function of global oil prices or due to individual legal frameworks, but also within individual countries. For European countries, countrywide average filling-station fuel-price statistics (pump prices) were utilised in this survey, whereas for all other countries fuel prices as posted at filling stations in the respective capital cities were collected. The latter was done by way of a questionnaire circulated to GTZ local offices worldwide. When several fuel prices for major cities were available, the unweighted average has been used.

Fig. 28
Colours on the filler pistols mark the different fuel-type available in a gas station.
Photo by Klaus Neumann, Germany, 2007

6.1.3 Fuel qualities

In some countries, as in Danmark or Austria, several grades of gasoline quality are on sale. Often the Octan grades of 91 and 92 locally are defined as Regular Gasoline, while Octan 95 is defined as Super Gasoline. In many countries Octan 98 gasoline is called Super Plus. Throughout the present study gasoline prices refer to Super Gasoline and mean "leadfree Octan 95".

6.2.1 Unit conversion for non-litre countries

All fuel prices are converted into metric litres as the unit of measurement.

Region	Country	Fuel unit
Africa	Liberia	US Gallon
	Sierra Leone	US Gallon
America	Antigua and Barbuda	Imperial Gallon
	Belize	US Gallon
	Colombia	US Gallon
	Dominican Republic	US Gallon
	Ecuador	US Gallon
	El Salvador	US Gallon
	Grenada	US Gallon
	Guatemala	US Gallon
	Guyana	Imperial Gallon
	Haiti	US Gallon
	Honduras	US Gallon
	Nicaragua	US Gallon
	Panama	US Gallon
	Peru	US Gallon
	Puerto Rico	US Gallon
	United States of America	US Gallon
Asia	Myanmar (Burma)	US Gallon
	United Arab Emirates	Imperial Gallon

Unit conversions		
1 US Gallon	=	3.785 Litres
1 Imperial Gallon	=	4.546 Litres
1 Barrel	=	159.000 Litres

6.2.2 Conversion of US$ per barrel to US cents per litre

Crude oil price	*study*	Equivalent					
per Barrel	$60.2	$50	$55	$60	$65	$70	$75
per Litre	38¢	31¢	35¢	38¢	41¢	44¢	47¢

6.2.3 Currency conversion

The objective was to compare the fuel-price situation in various countries around the world. The US$ was chosen once again as the reference currency, since all crude oil prices and most countries' import statistics are quoted in US dollars. The US$ conversion rates are those applicable as per 15–17 November 2006.

In countries with different or double exchange rates, the "market rate/parallel rate/black market rate" was given preference over the official exchange rate, not only because it is the rate consumers mostly rely on, but also because experience shows that sooner or later the official exchange rate tends to be replaced by the parallel exchange rate.

Fig. 29
Standardized self-service filling station are easy to use.
Photo by Klaus Neumann, Germany, 2007

Compared to 2004, there was virtually no change in the dollar-euro exchange rate between November 2004 (US$1 = €0.77) and November 2006 (US$1 = €0.78).

6.2.4 Crude oil price at world market

Crude oil prices have risen substantially in the past two years (since the last GTZ Fuel Prices Survey). Converted from the barrel price, a price increase per litre of 11 US cents was registered:

Brent crude oil price at time of survey	per barrel (159 litres)	per litre (US ¢)
Mid-November 2004	US$42.84	27
15–17 November 2006	US$60.21	38
Price increase in 2 years		11

At its highest, the crude oil price briefly reached US$71 per barrel in August. As of 3 January 2007, the BRENT price of crude oil had returned to its November 2006 level of US$60 per barrel.

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