Systems perspective on the global development for bioethanol

Per Carstedt

BioAlcohol Fuel Foundation

www.BAFF.info

BioEthanol in Europe

Feasibility study and recommendations

Large scale introduction of BioEthanol for a sustainable transport sector

BioAlcohol Fuel Foundation

What´s hindering the development?

Attitudes and perceptions

No sufficient sense of urgency.

Not perceived by the system as a sustainable and substantial alternative.

Realities

Undeveloped potentials for cost-, energy- CO_2, and market efficiency

Feedstock, Production, Vehicles, Distribution, Legal framework, Dynamic markets

Uncertainty

Holding back the dynamic market forces for developing Feedstock, Production facilities, Vehicles, Distribution network and End-users

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2003-02-21

Population Growth

billions
9
8
7
6
5
4
3
2
1
0
200 000 BC
1776
1945
1992

990922/MG1-1

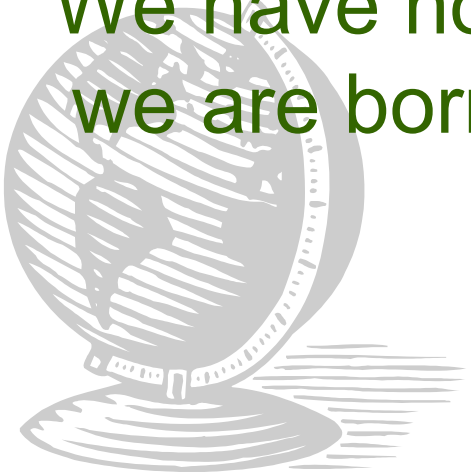
Sustainable development

”A development which satisfies our needs today without jeopardising the possibilities of future generations to satisfy theirs”

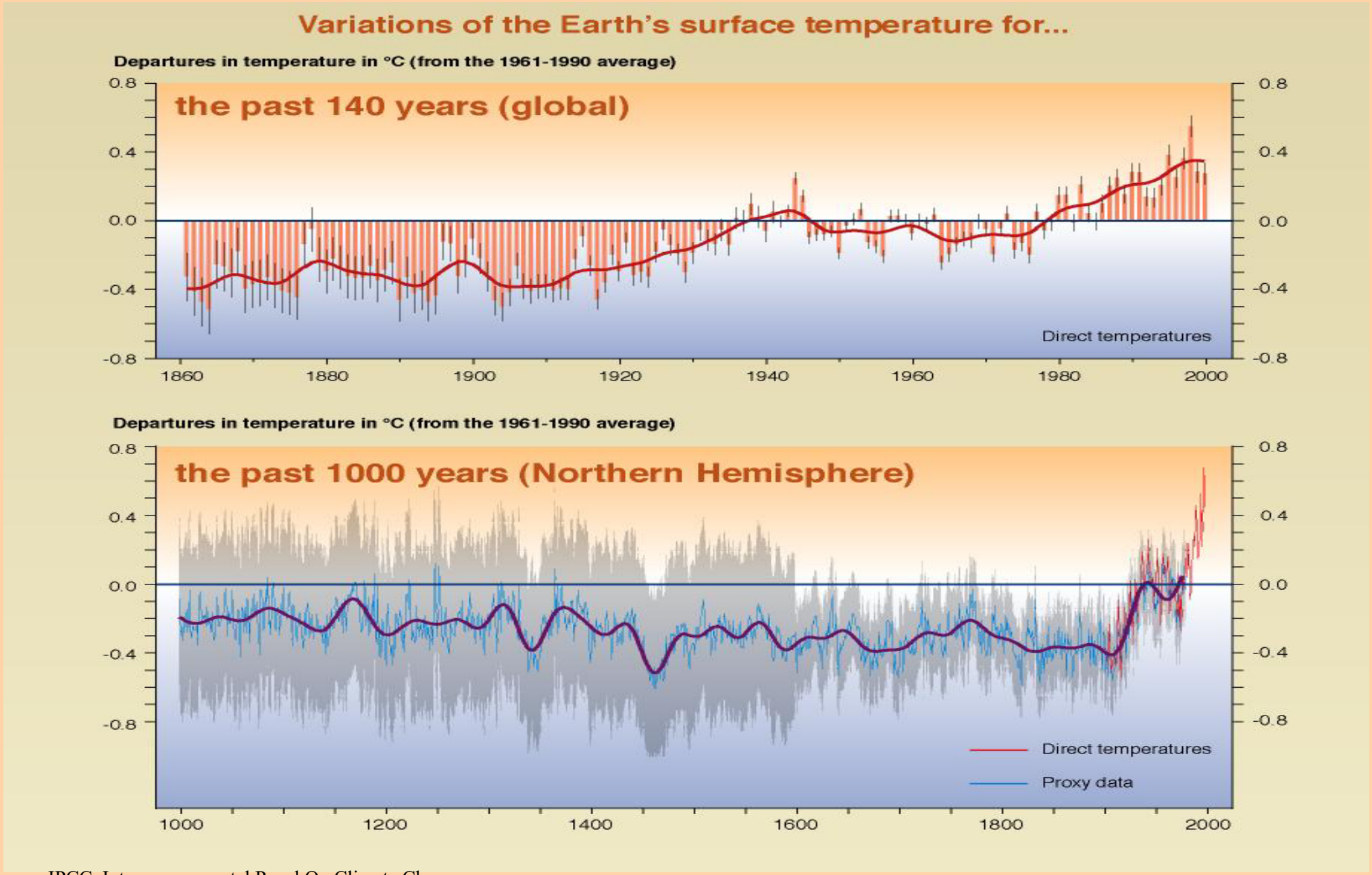
-The Bruntland Commission

“We have not inherited the Earth from our ancestors, we are borrowing it from our children.”

- An old Indian saying

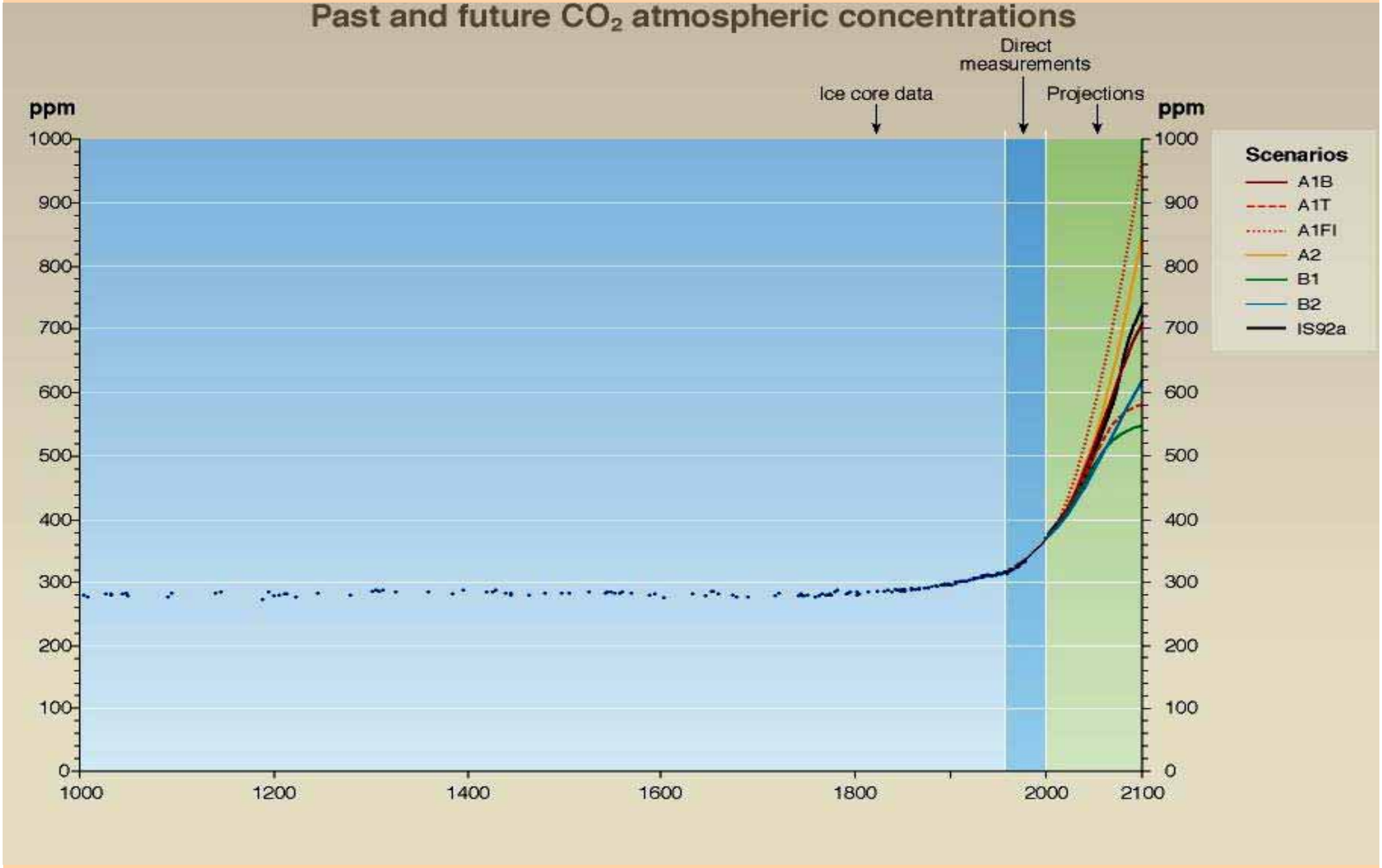


Global mean surface temperatures have increased

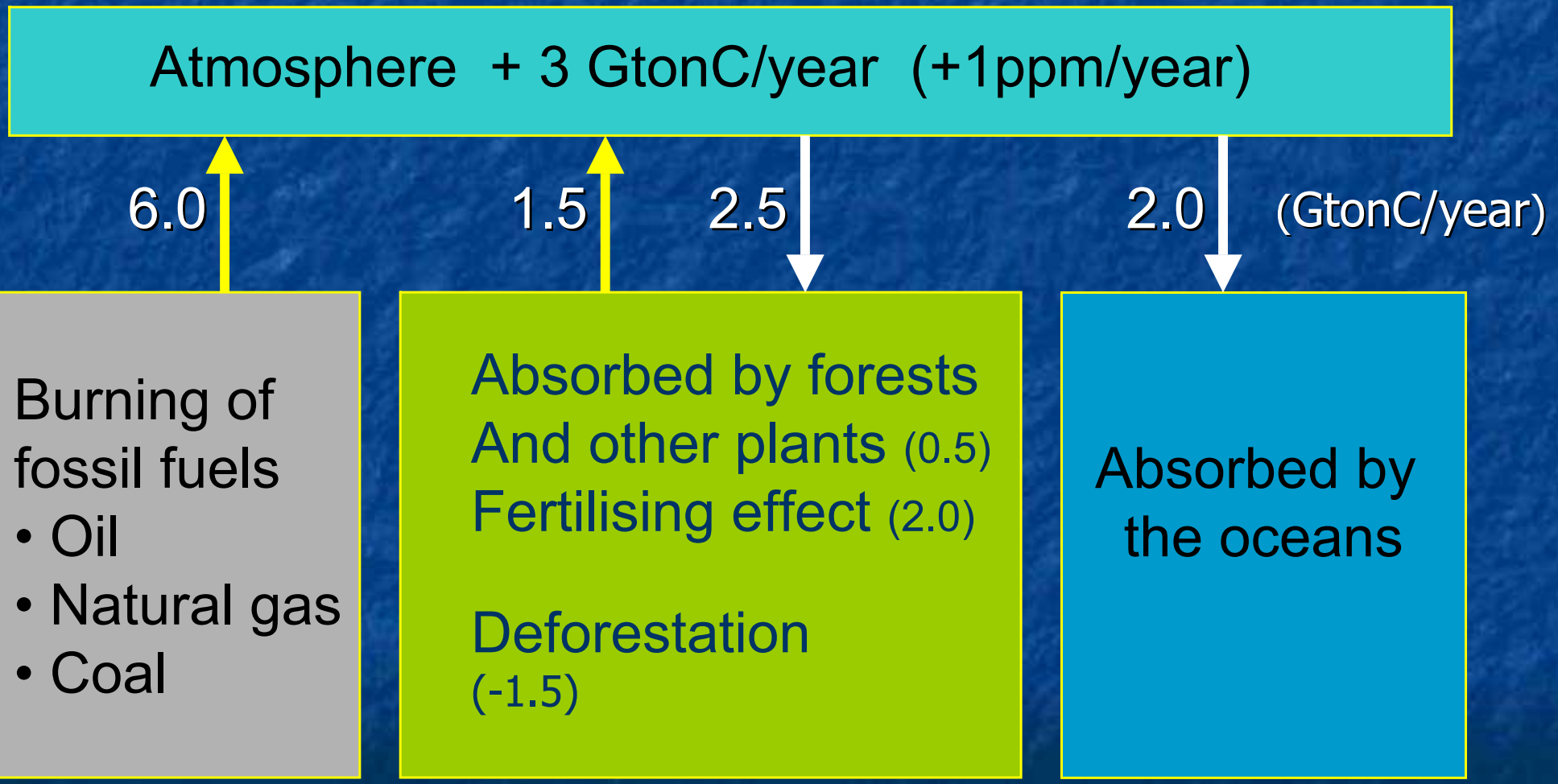


Source: IPCC, Intergovernmental Panel On Climate Change

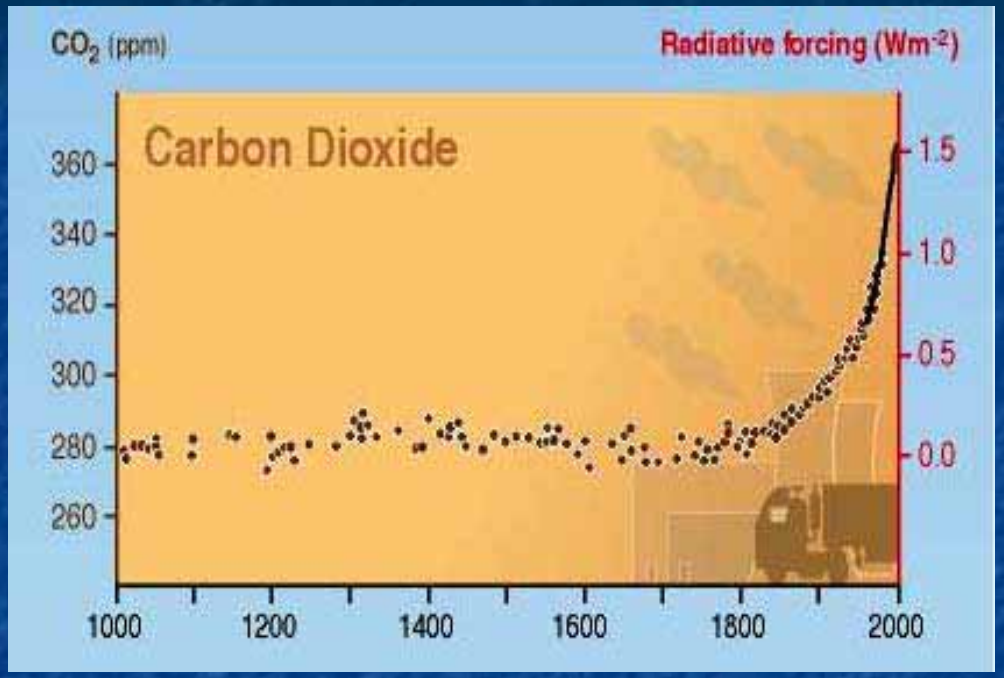
Projected concentrations of CO_2 during the 21st century are two to four times the pre-industrial leve

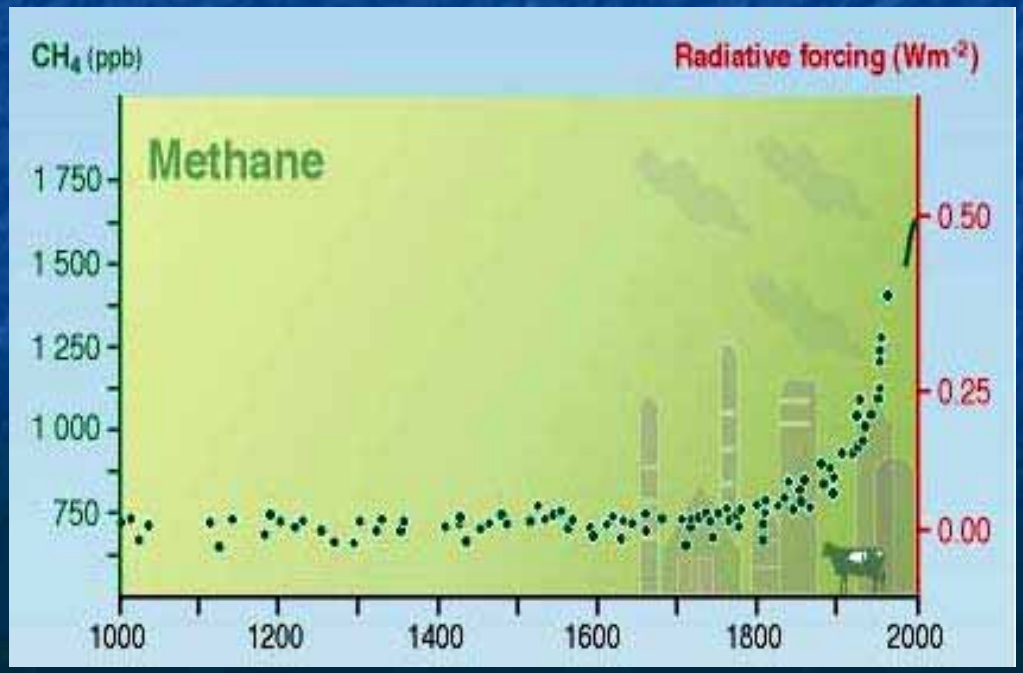


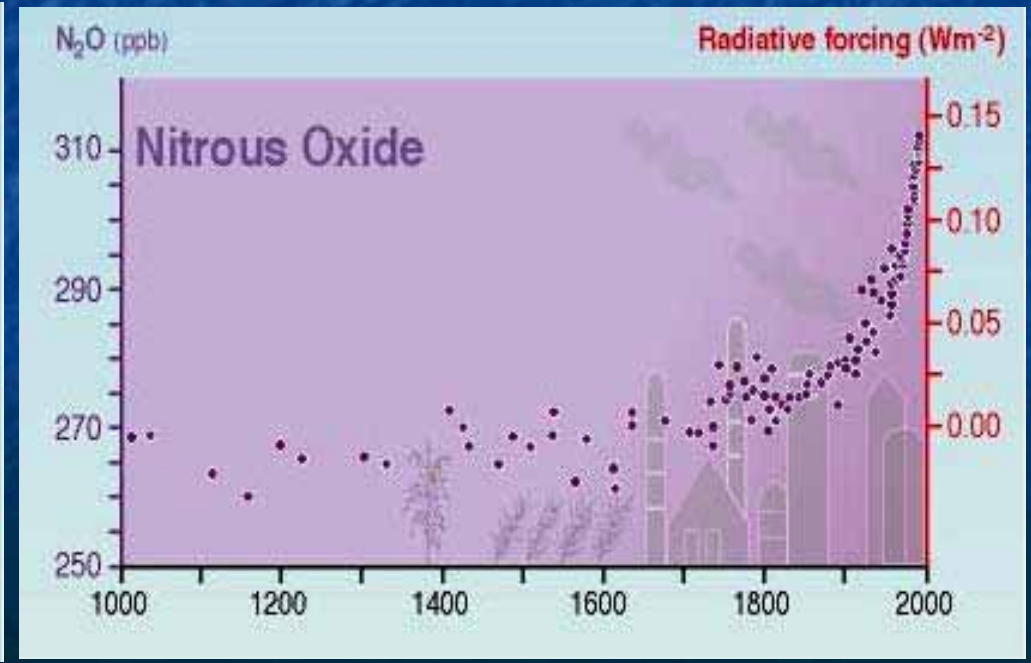
Our impact on the Carbon cycle



Our impact on greenhouse gases !

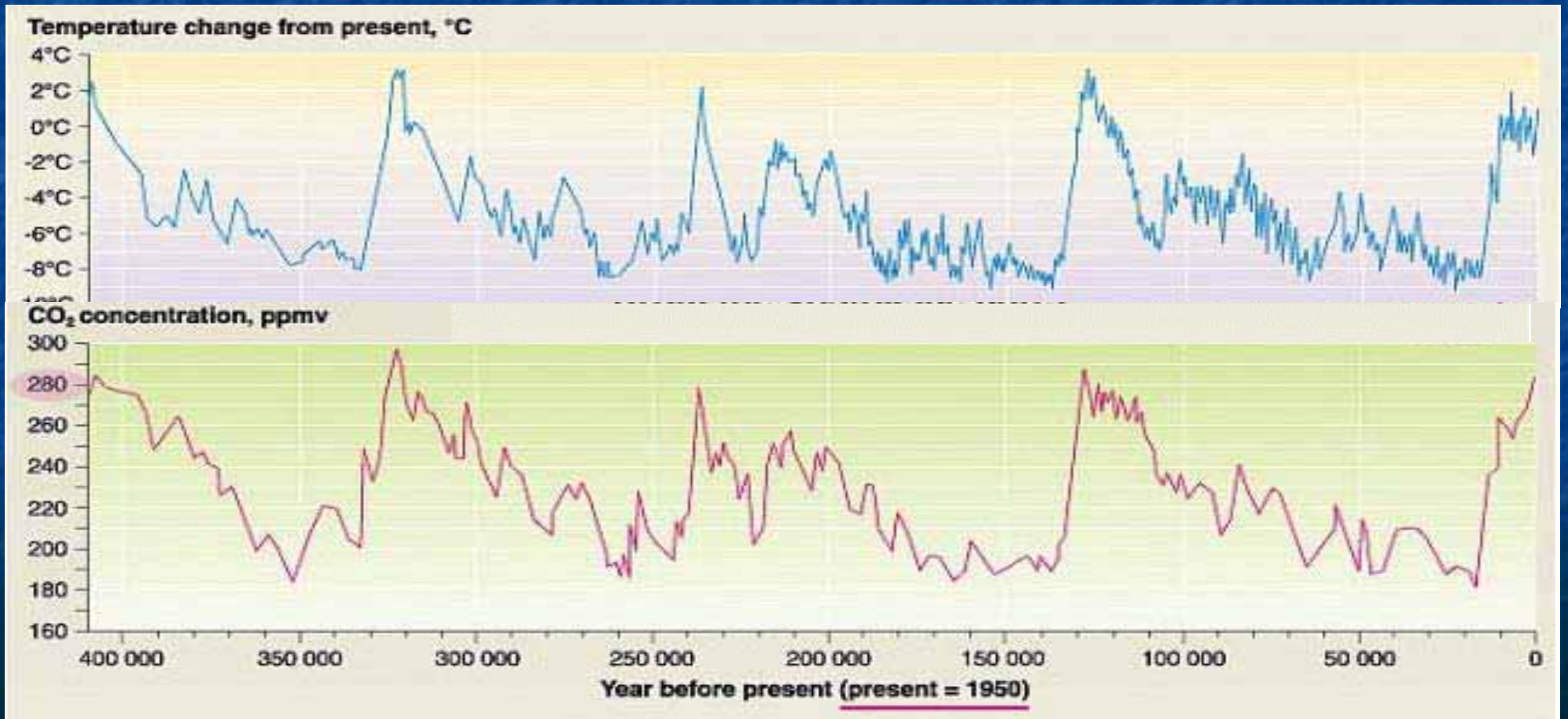






Is there a relationship between CO_2 and climate change?

Last 400 000 years
from ”the Vostok Ice Core”

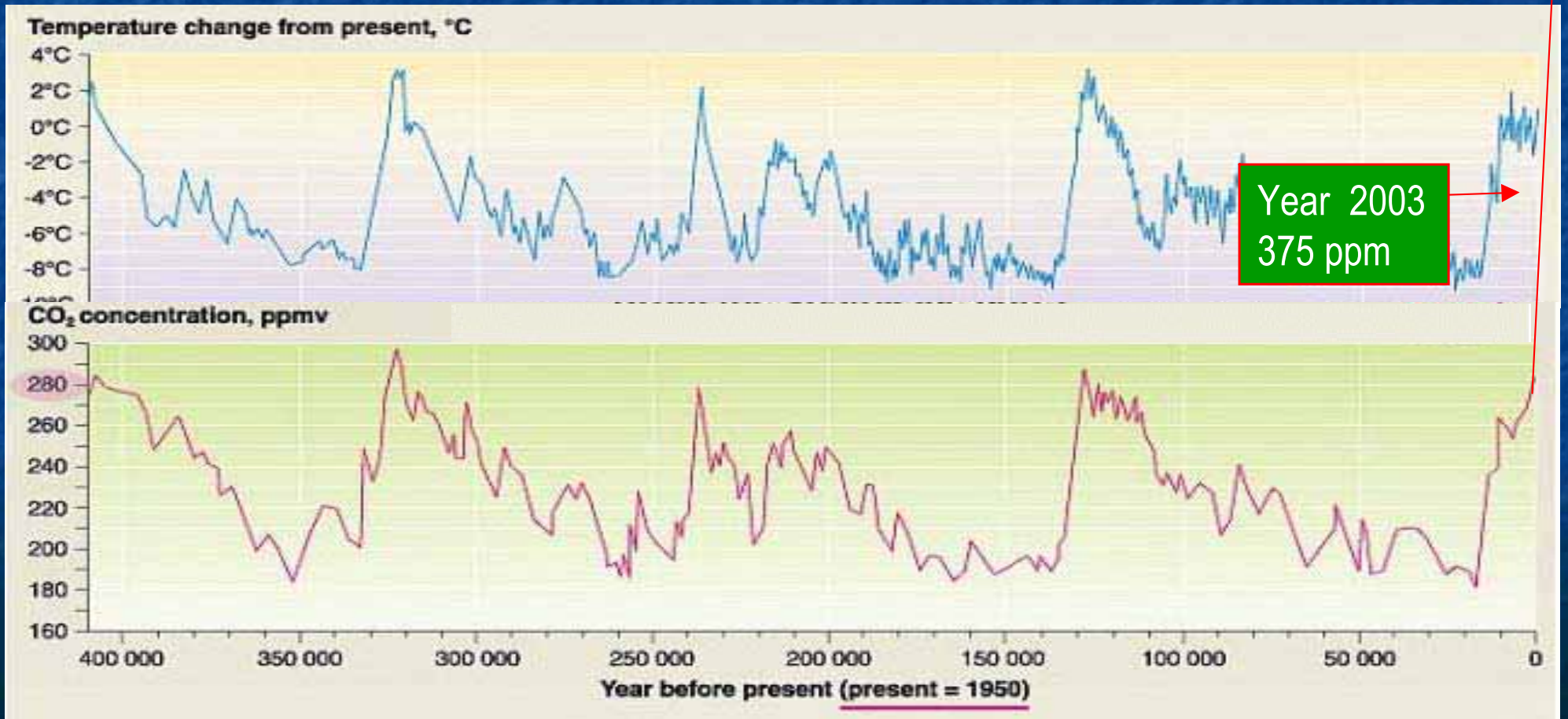


Is there a relationship between CO_2 and climate change?

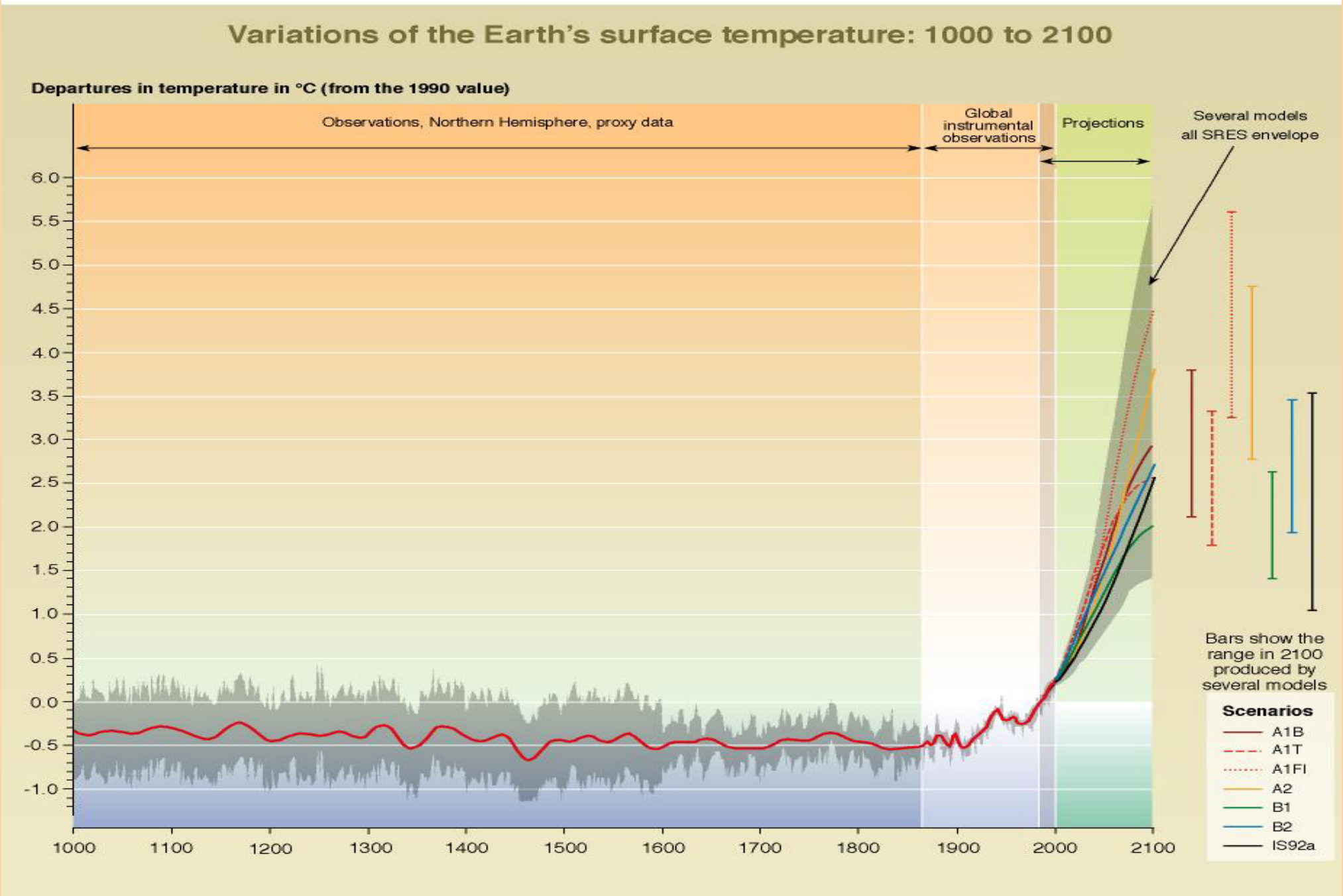
Last 400 000 years
from "the Vostok Ice Core"

Year 2100
base case
700ppm

Year 2003
375 ppm



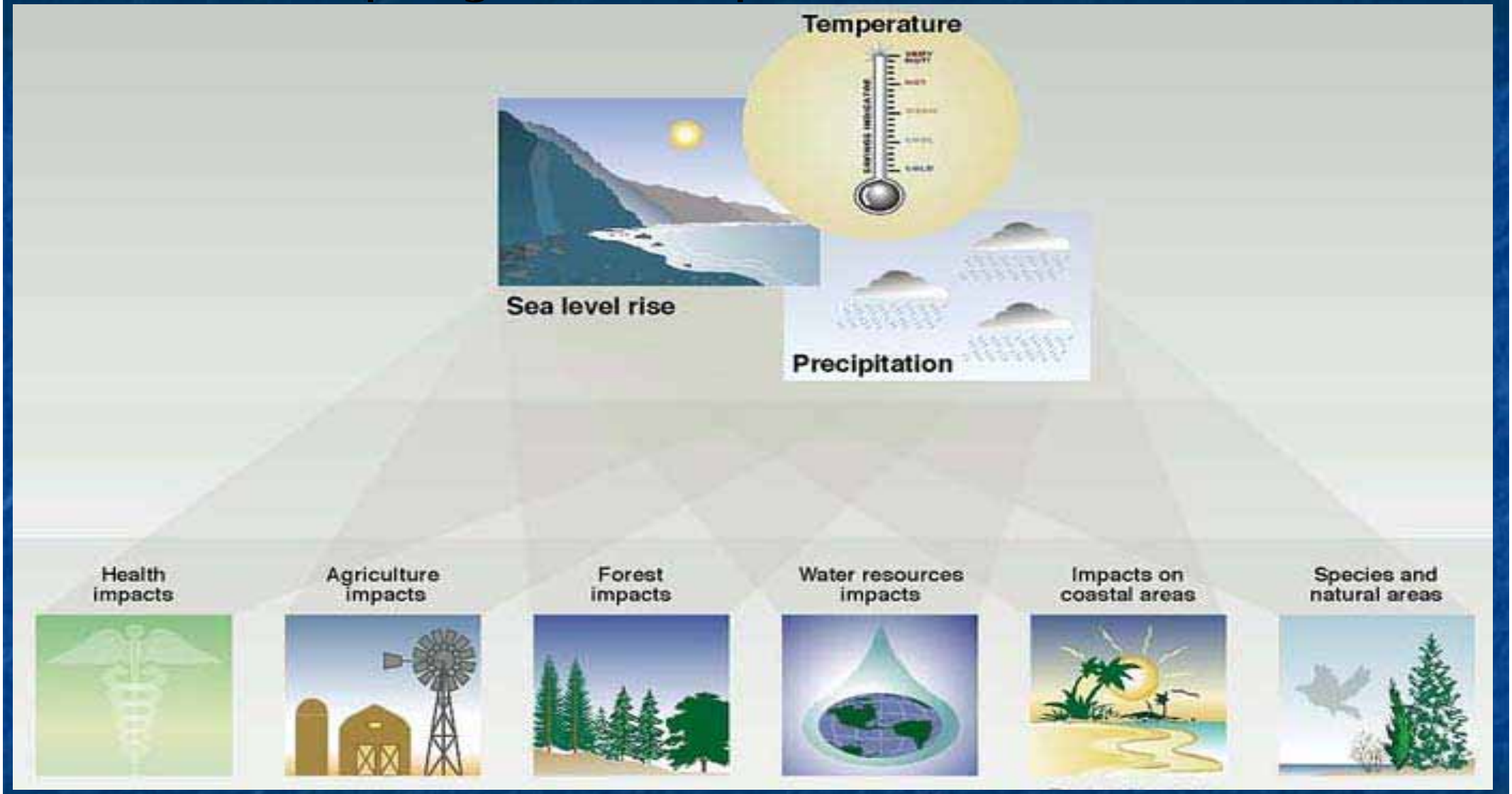
Projected Temperatures During the 21st Century Are Significantly Higher Than at Any Time During the Last 1000 Years



Source: IPCC, Intergovernmental Panel On Climate Change

A warmer climate
sounds pleasent.
Is that a problem?

More negative then positive effects from a rapid global temperature increase!



- Infektions
- New deceases, Malaria etc

- Unrelible turnout
- More need for irrigation

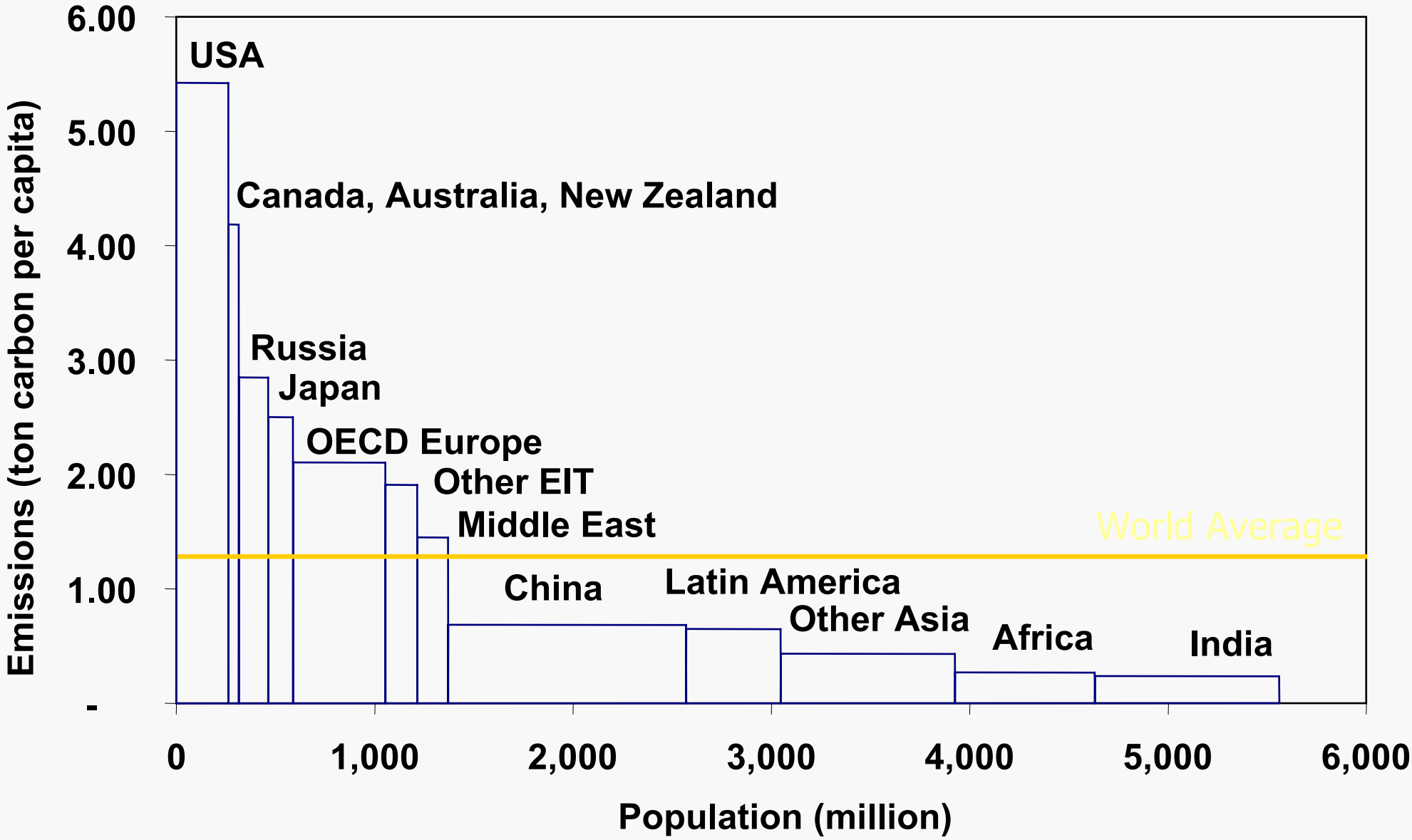
- Quick changes for a "slow adapter"
- Threat to health stauts

- Access to Quantity and Quality

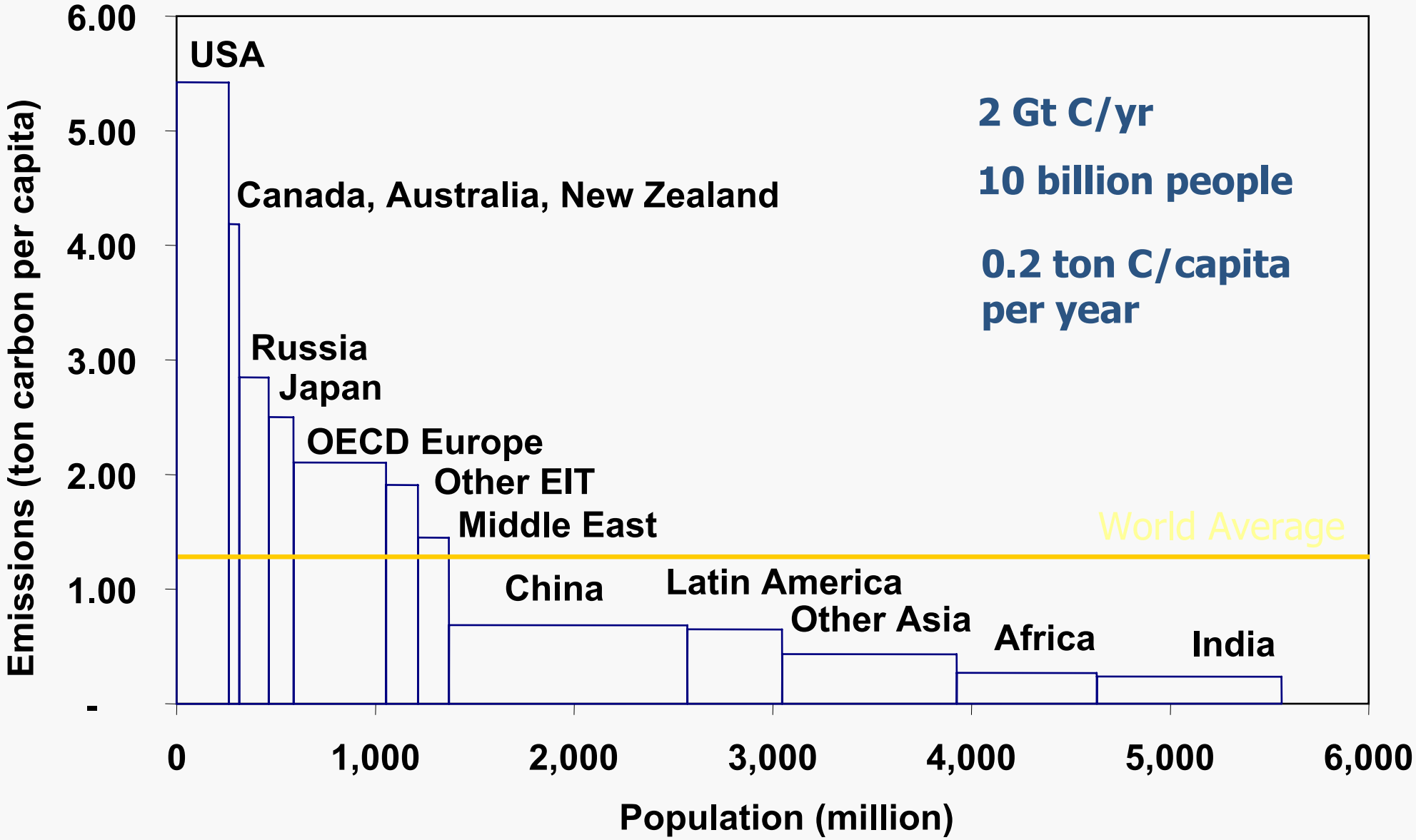
- Water erosion
- Floding

- Accelerated loss of species

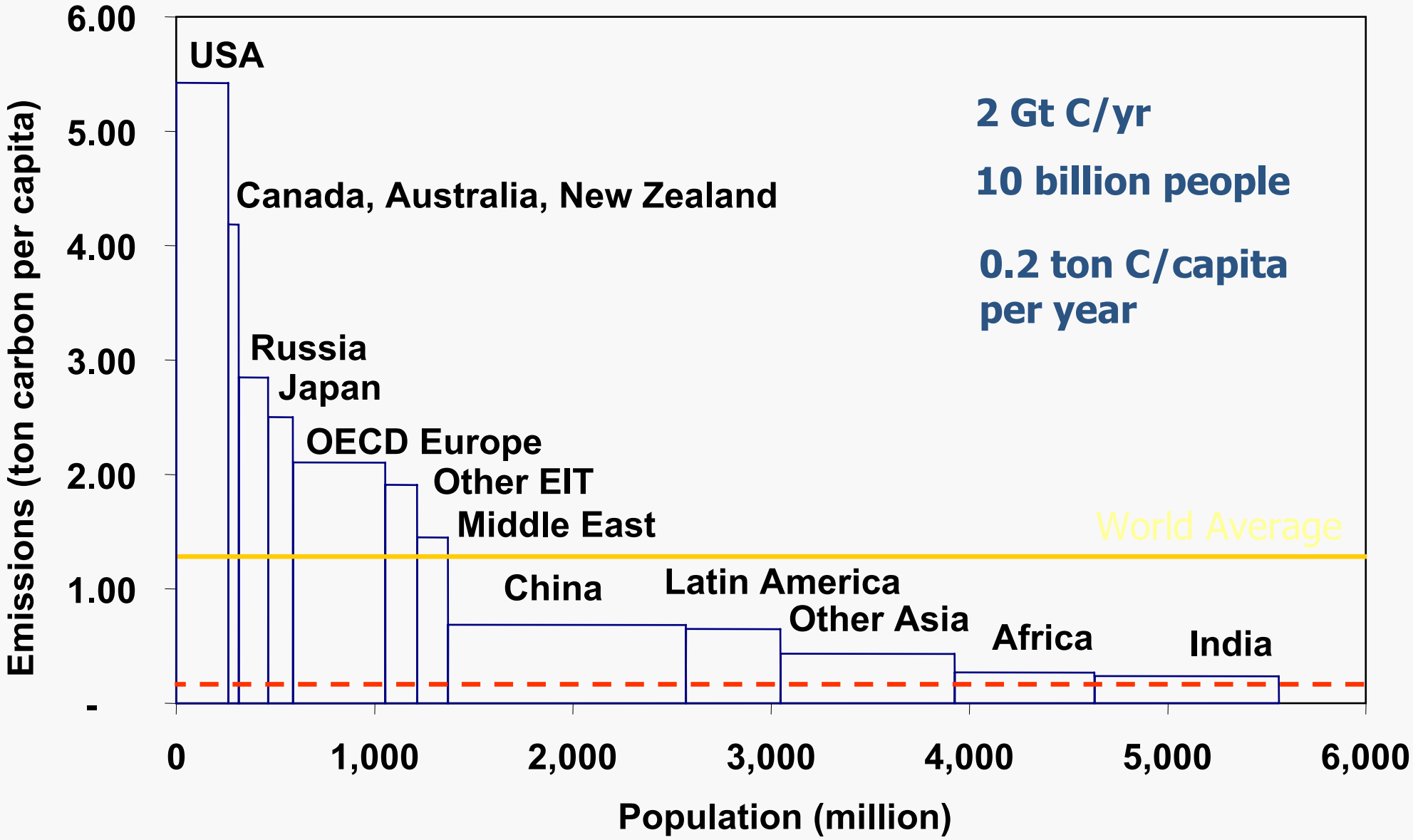
Carbon emissions per capita, 1998



Carbon emissions per capita, 1998



Carbon emissions per capita, 1998



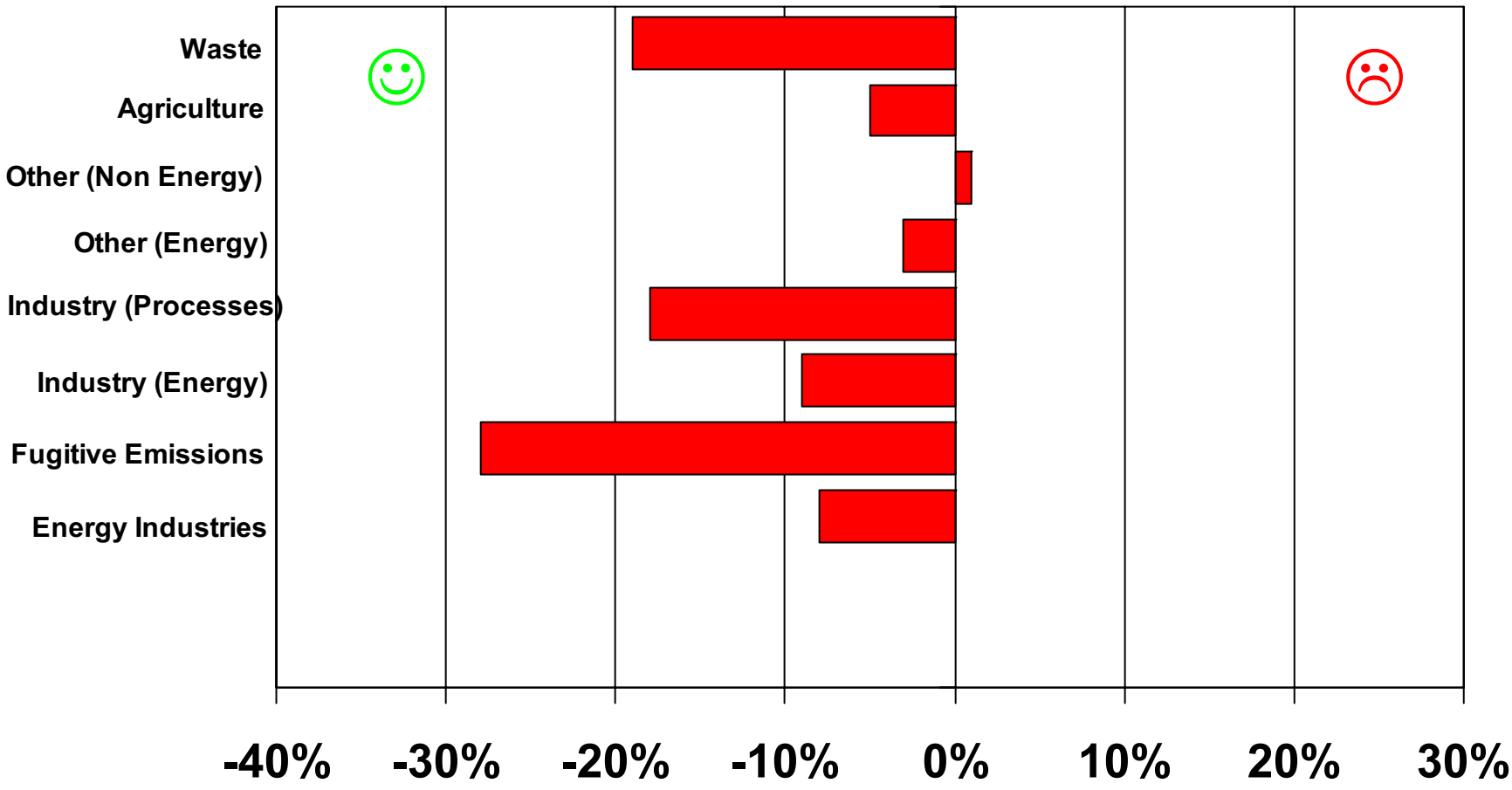
Motor traffic is probably the major challenge to obtain sustainability

- Therefore, there is a great danger that limitations will be placed on motor traffic, which will be a major problem for people who have built their lives or their business around it.

- Can choose either to let ”others” solve the problems, or to be proactive and actively participate in the process providing sustainable solutions.

- Are we part of the Problem or part of the Solution?

Change (%) in EU greenhouse gas emissions by sector and pollutant (1990-1999)



Source: Eorupean Environment Agency
2002-04-10/JeL/BAFF

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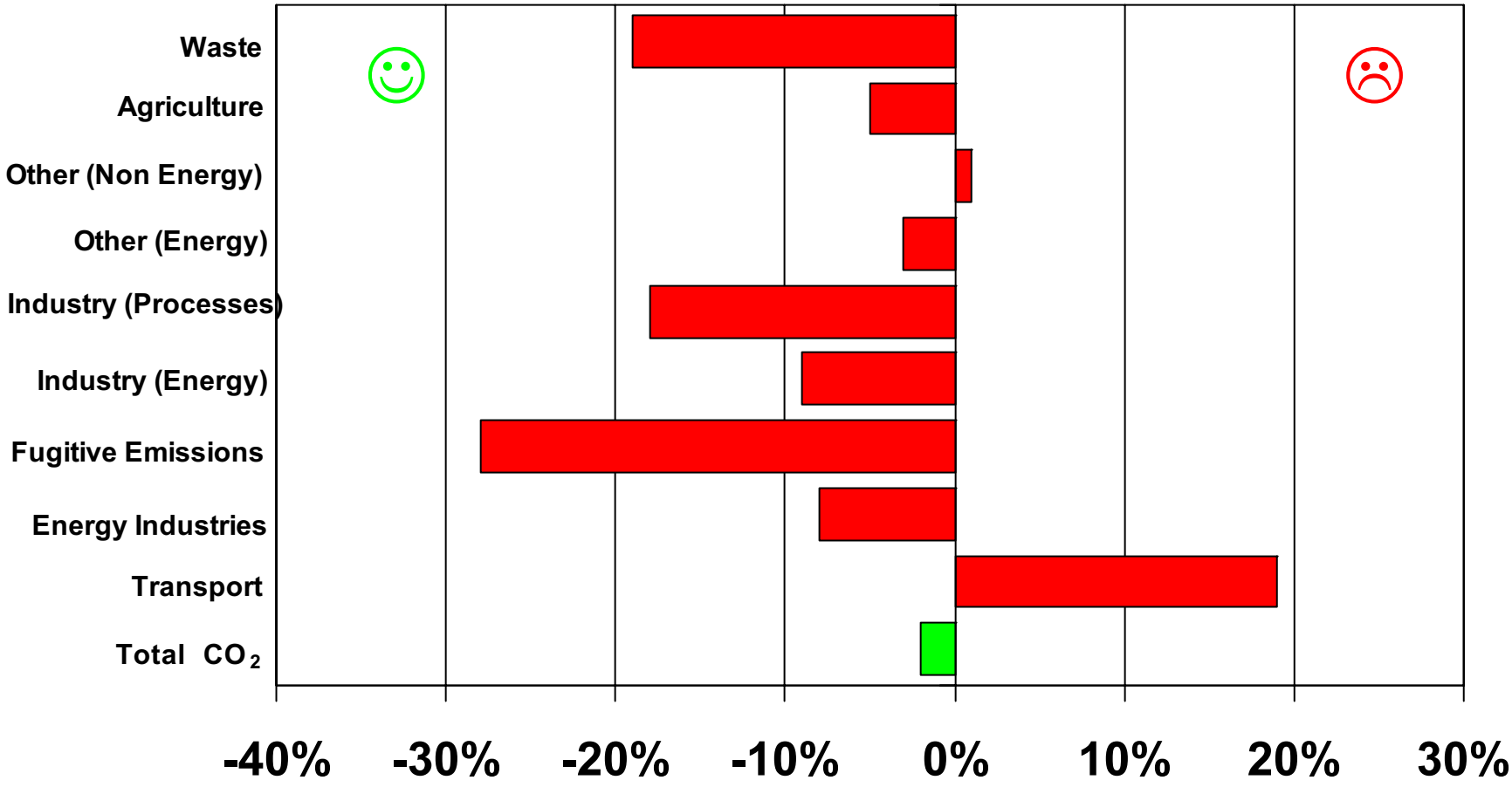
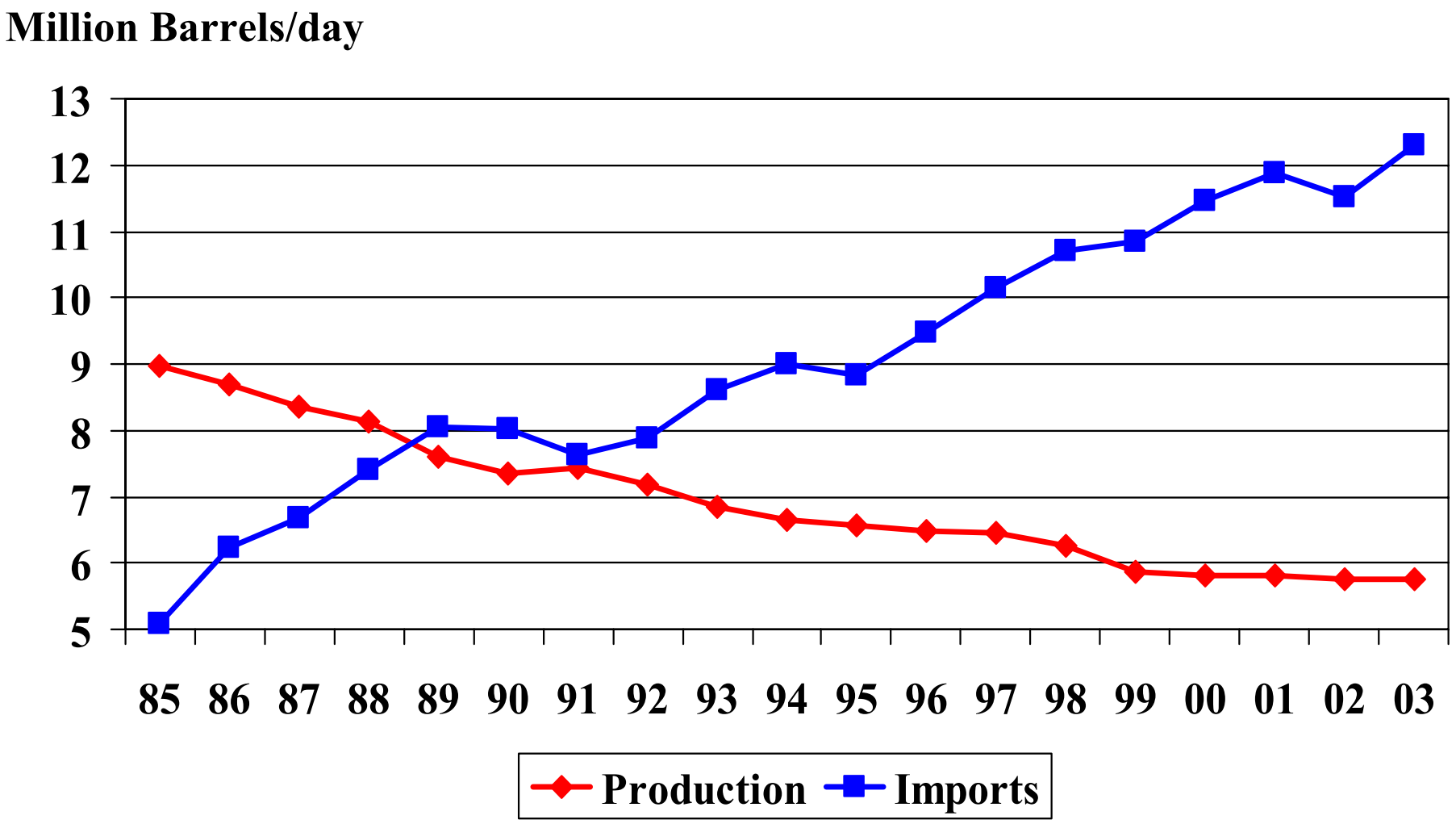


Source: Eorupean Environment Agency
2002-04-10/JeL/BAFF

USA, Oil Production vs Imports



2004-01-13/LN

Source: Energy Information Administration

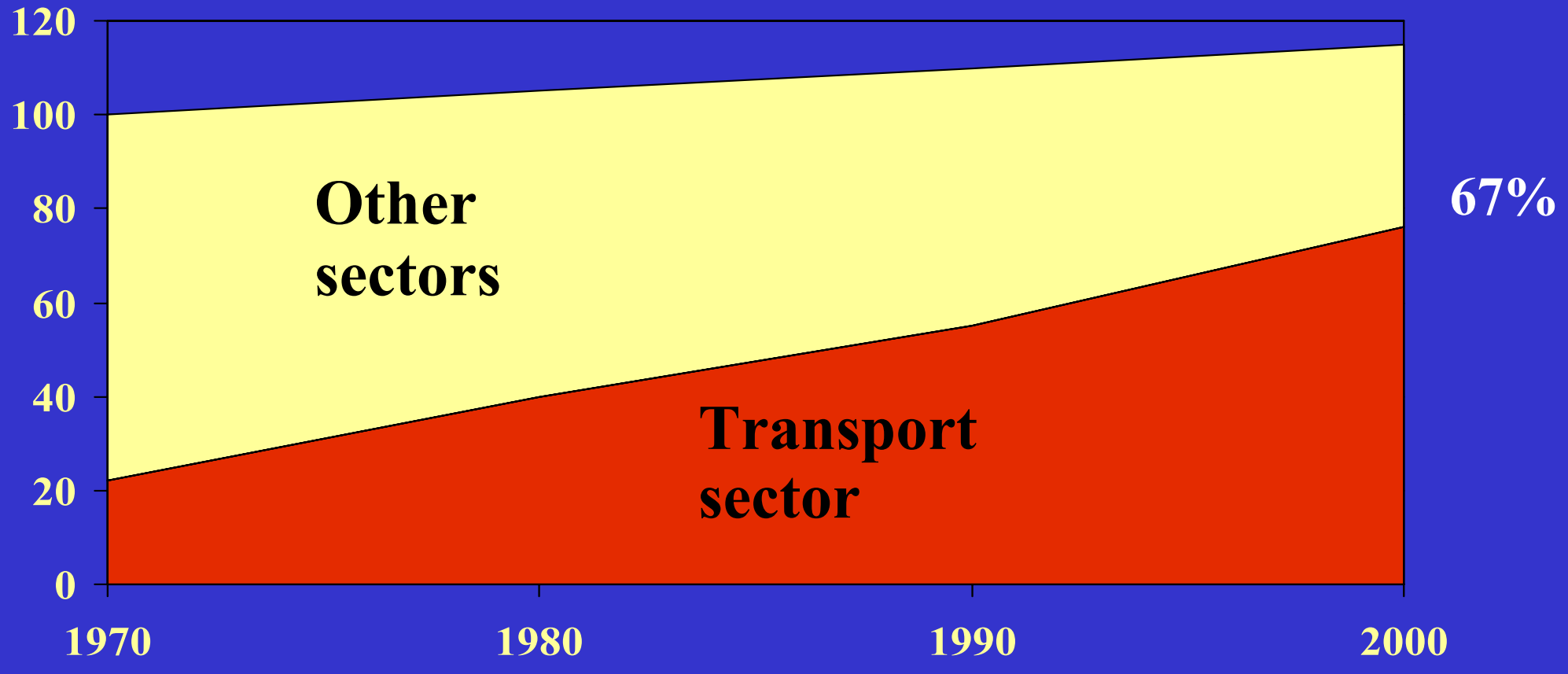
EU, Green Paper on security of Energy Supply **Transports**

- Dependency on oil imports today 7**0%** ➔ 2020 95%
- Transports dependency on oil today -- **98%**

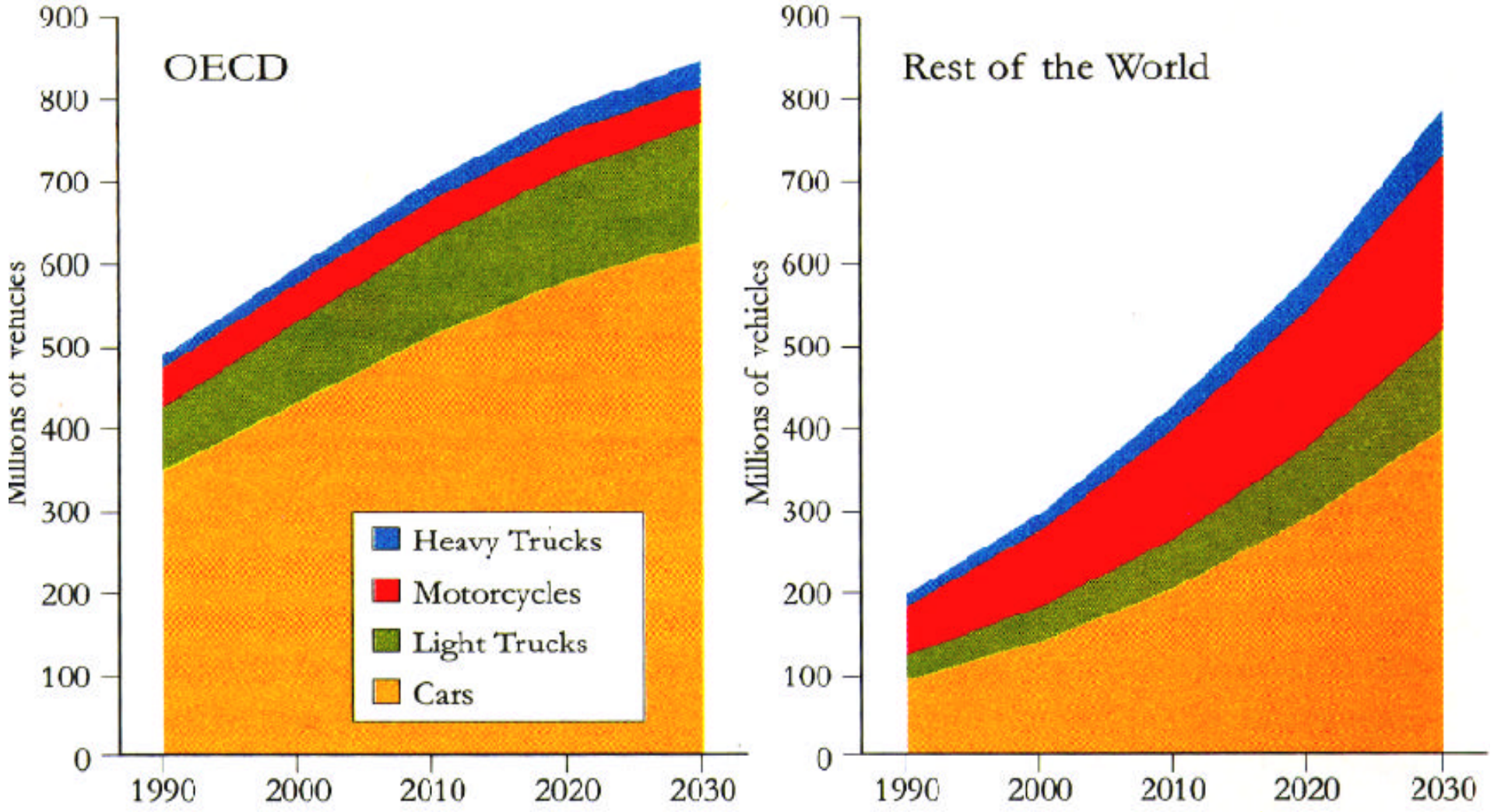
Source: Commission of the Europena Communities

2002-03-14/KS/BAFF

Oil Addiction

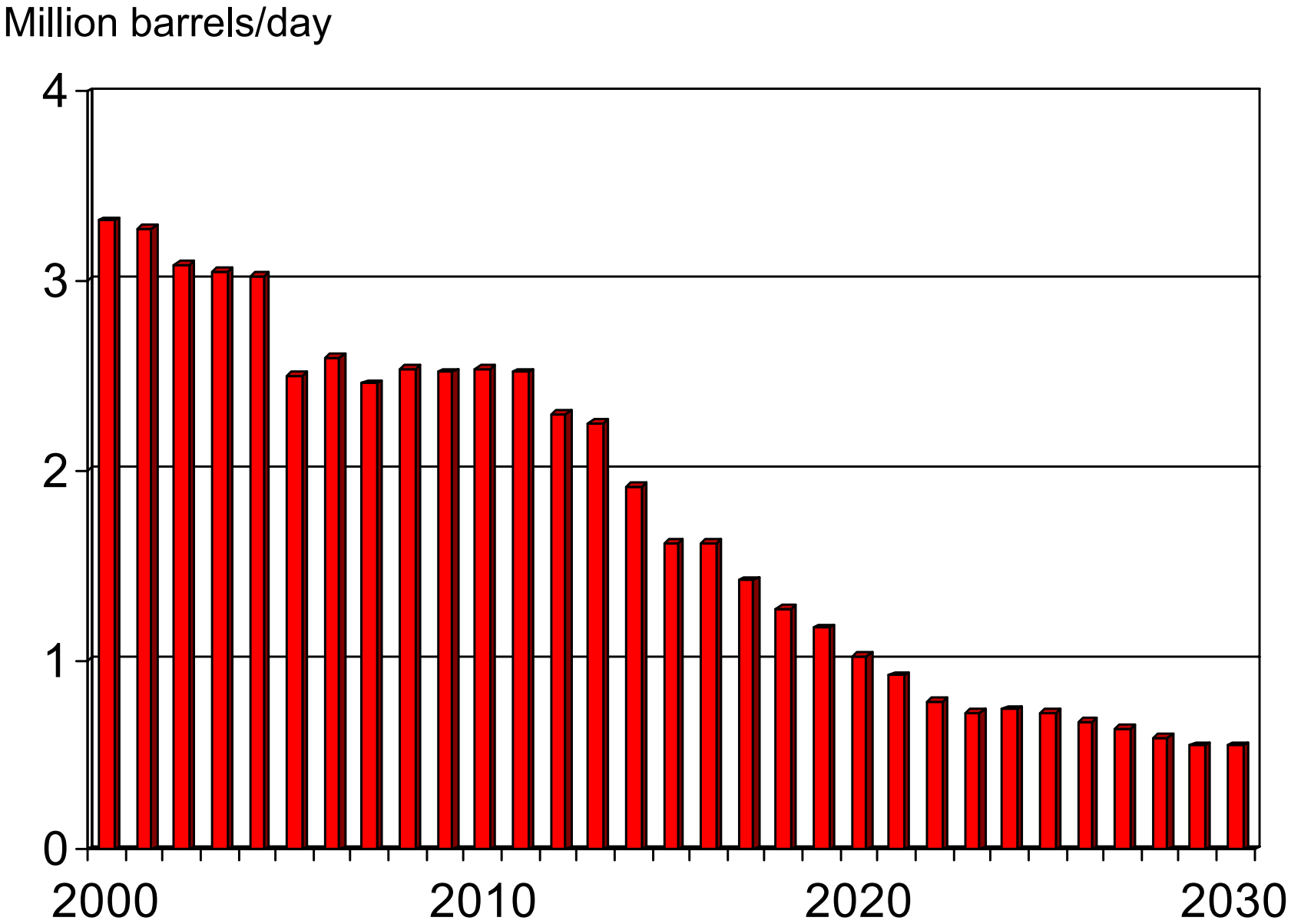


Where Vehicles Will Be Located In The Future



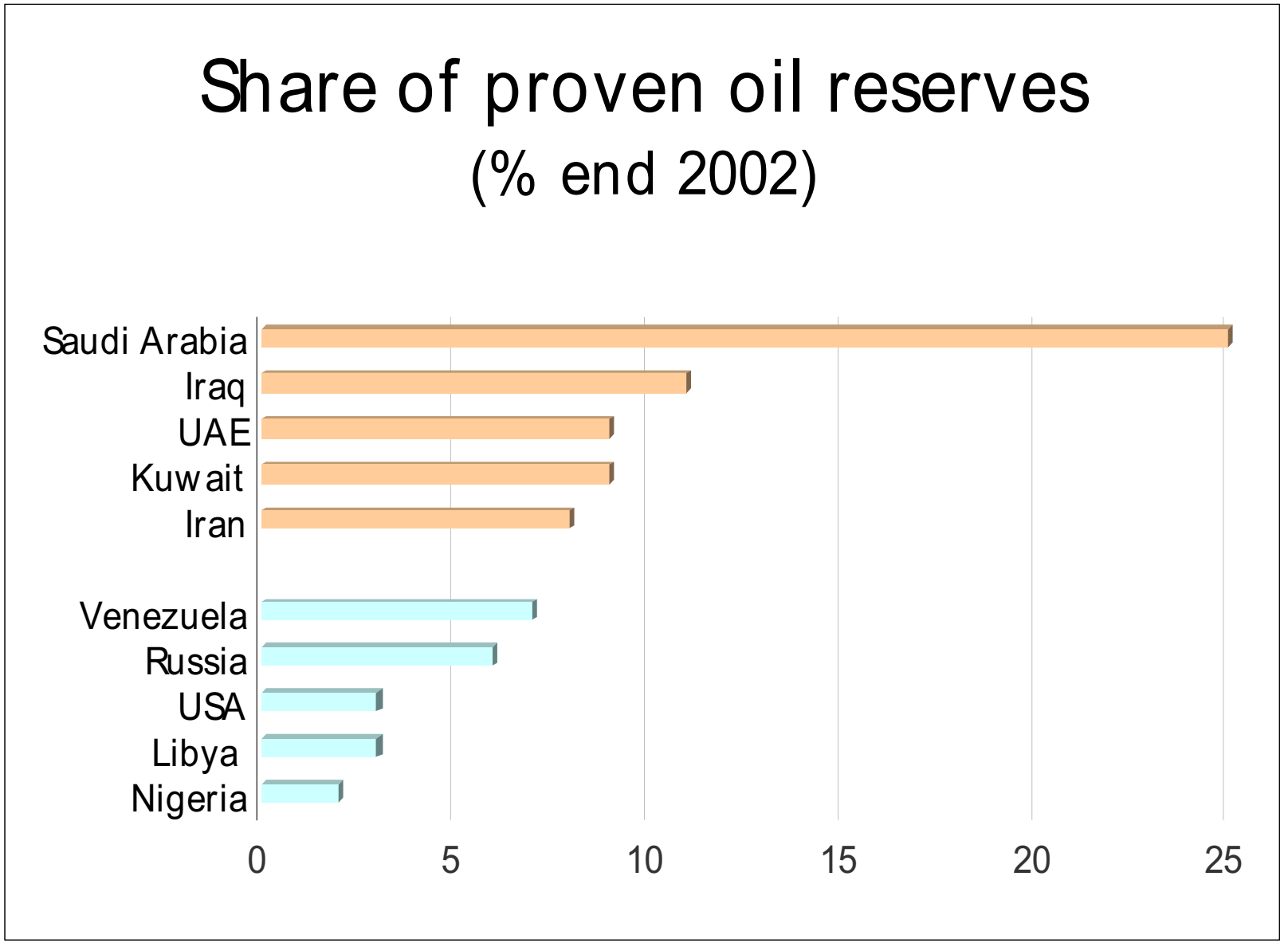
SUSTAINABLE MOBILITY

Oil production in Norway



Source: Norwegian Oil Reservate

2004-01-07/LN


Share of proven oil reserves
(% end 2002)
Saudi Arabia
Iraq
UAE
Kuwait
Iran
Venezuela
Russia
USA
Libya
Nigeria
0
5
10
15
20
25

Source: BP

The Economist

OCTOBER 25TH–31ST 2003

www.economist.com

The end of the Oil Age

WHY

Do we have to develop sustainable transport systems?

HOW

Do we develop sustainable transport systems?

How to reduce Oil dependency and Fossil CO_2 from transports

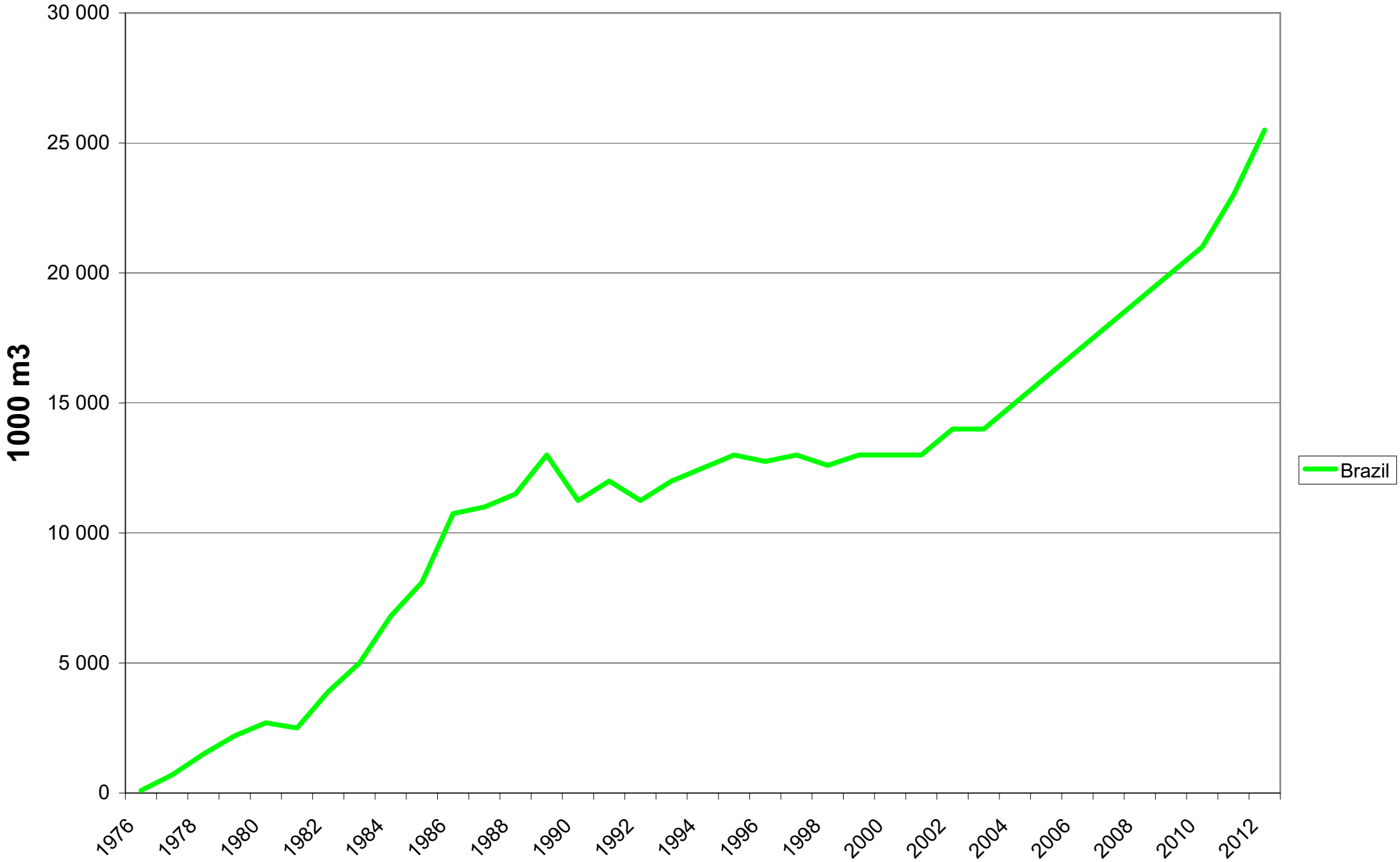
Reduce the amount of transportation

Increase energy effiency

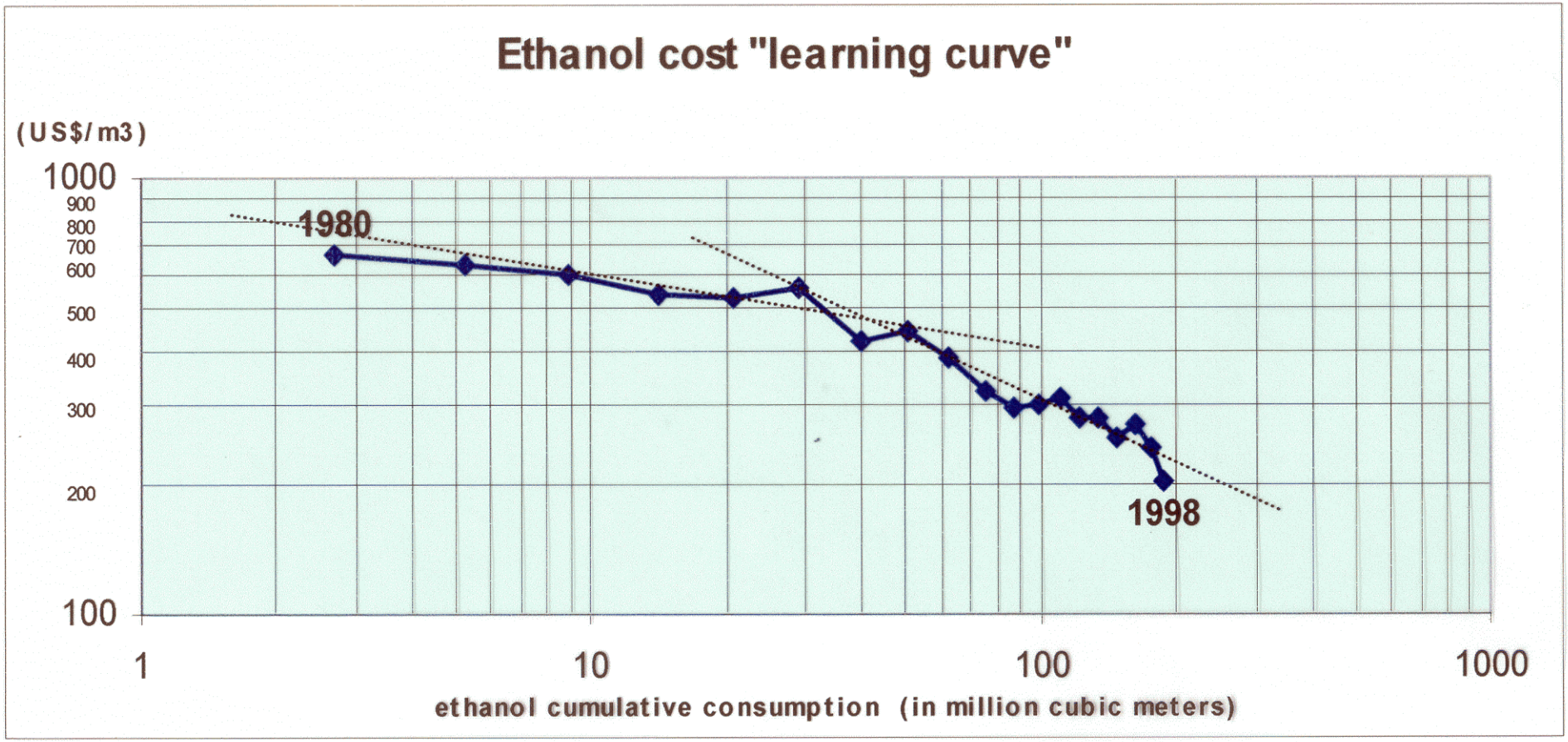
Higher proportion of renewable fuels

Fossil CO_2 = (miles)x(gallon/miles)x(fossil CO_2/gallon)

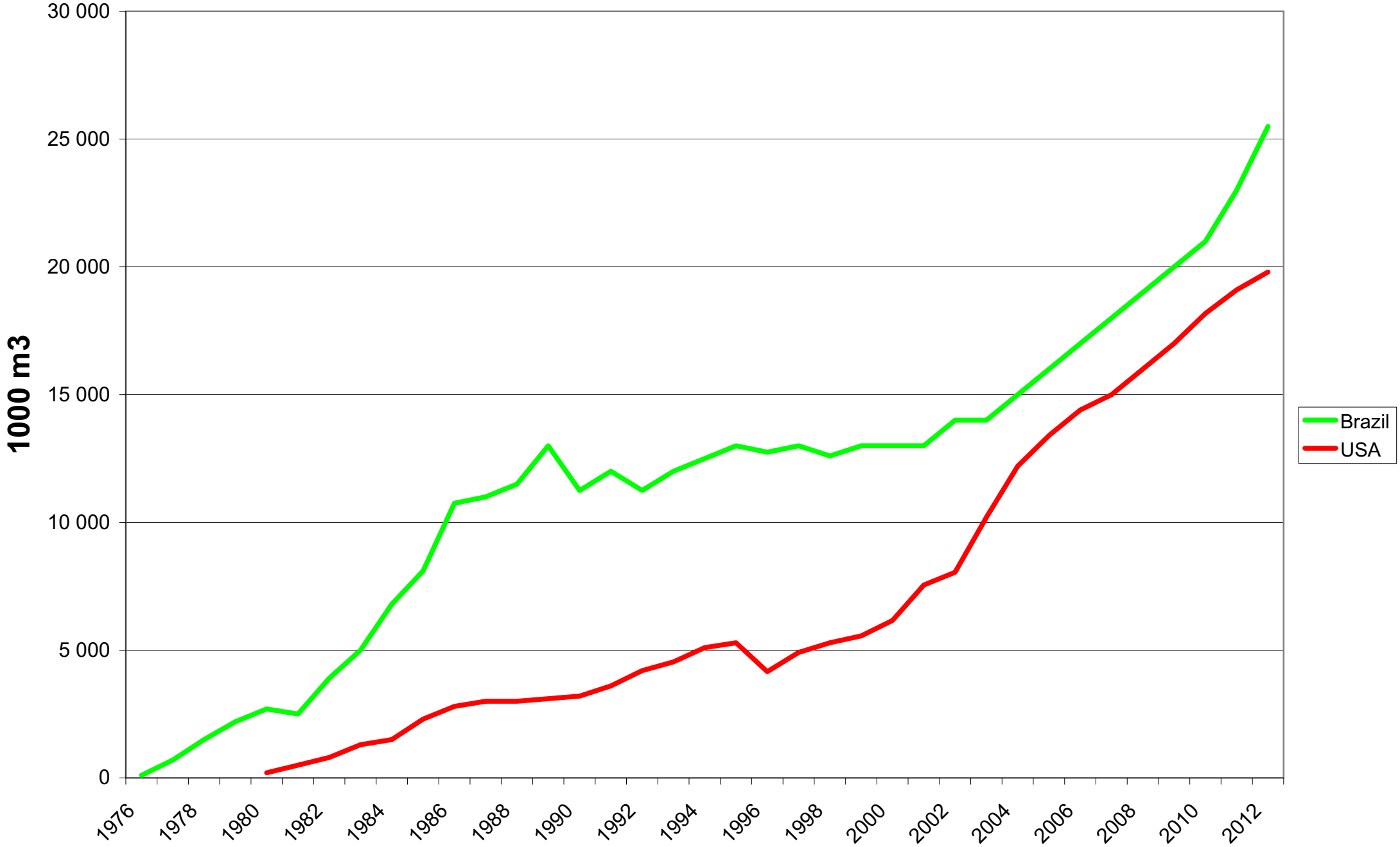
Ethanol markets develops rapidly



2003-12-11/LN

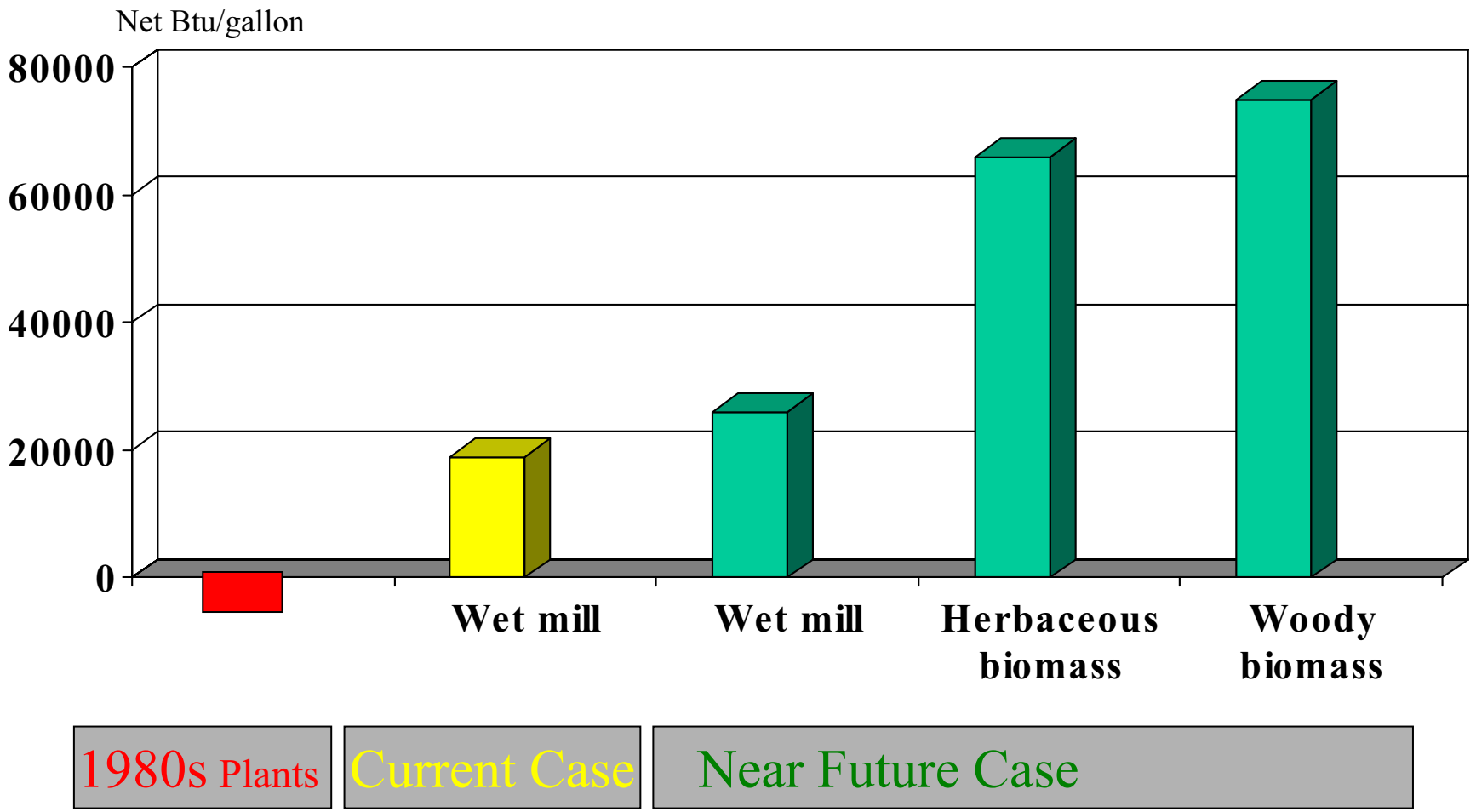

Ethanol cost "learning curve"
(US$/m3)
1000
900
800
700
600
500
400
300
200
100
1980
1998
1
10
100
1000
ethanol cumulative consumption (in million cubic meters)

Ethanol markets develops rapidly



2003-10-30/LN

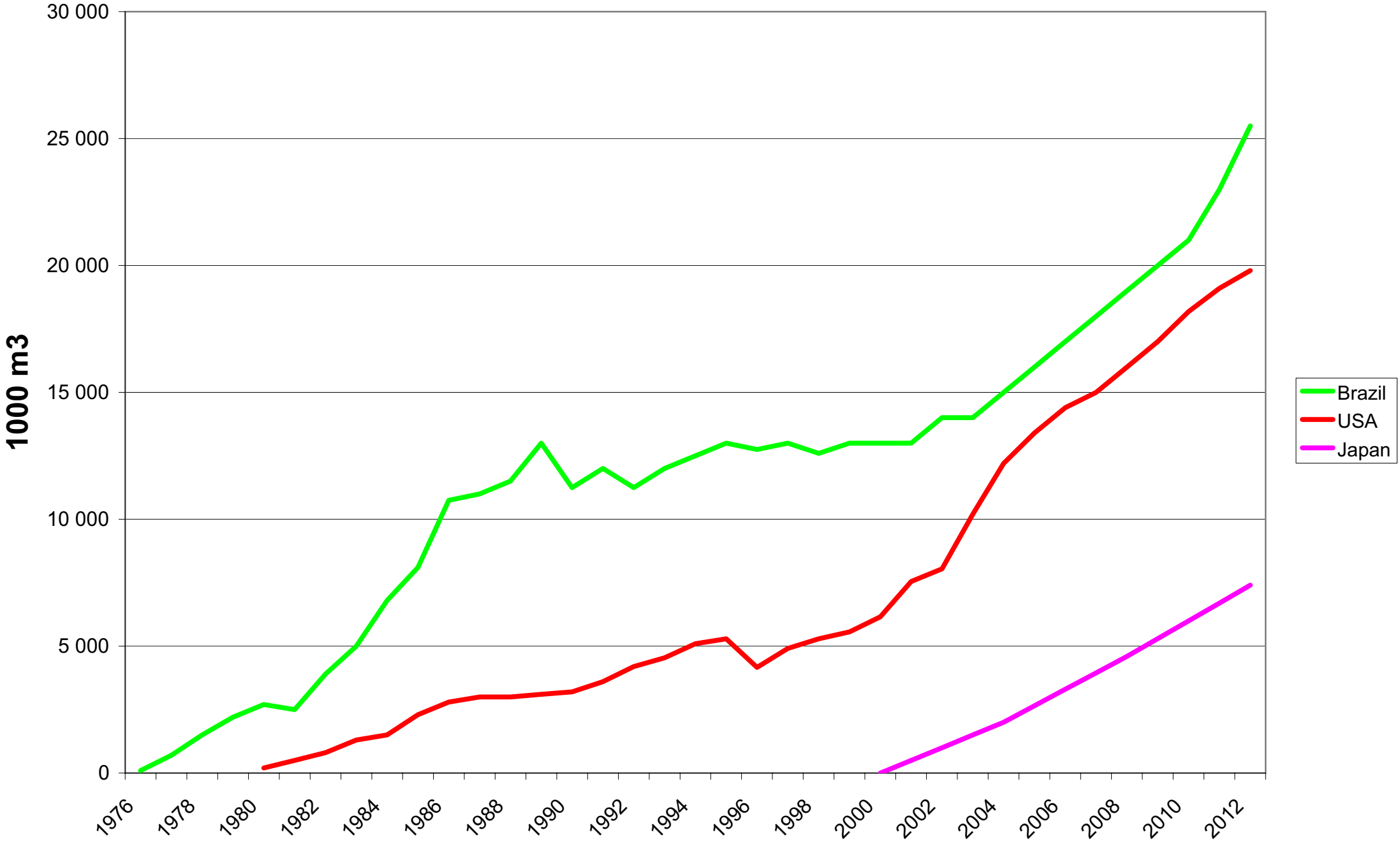
Ethanol produced from lignocellulose will achieve much greater Energy and GHG benefits



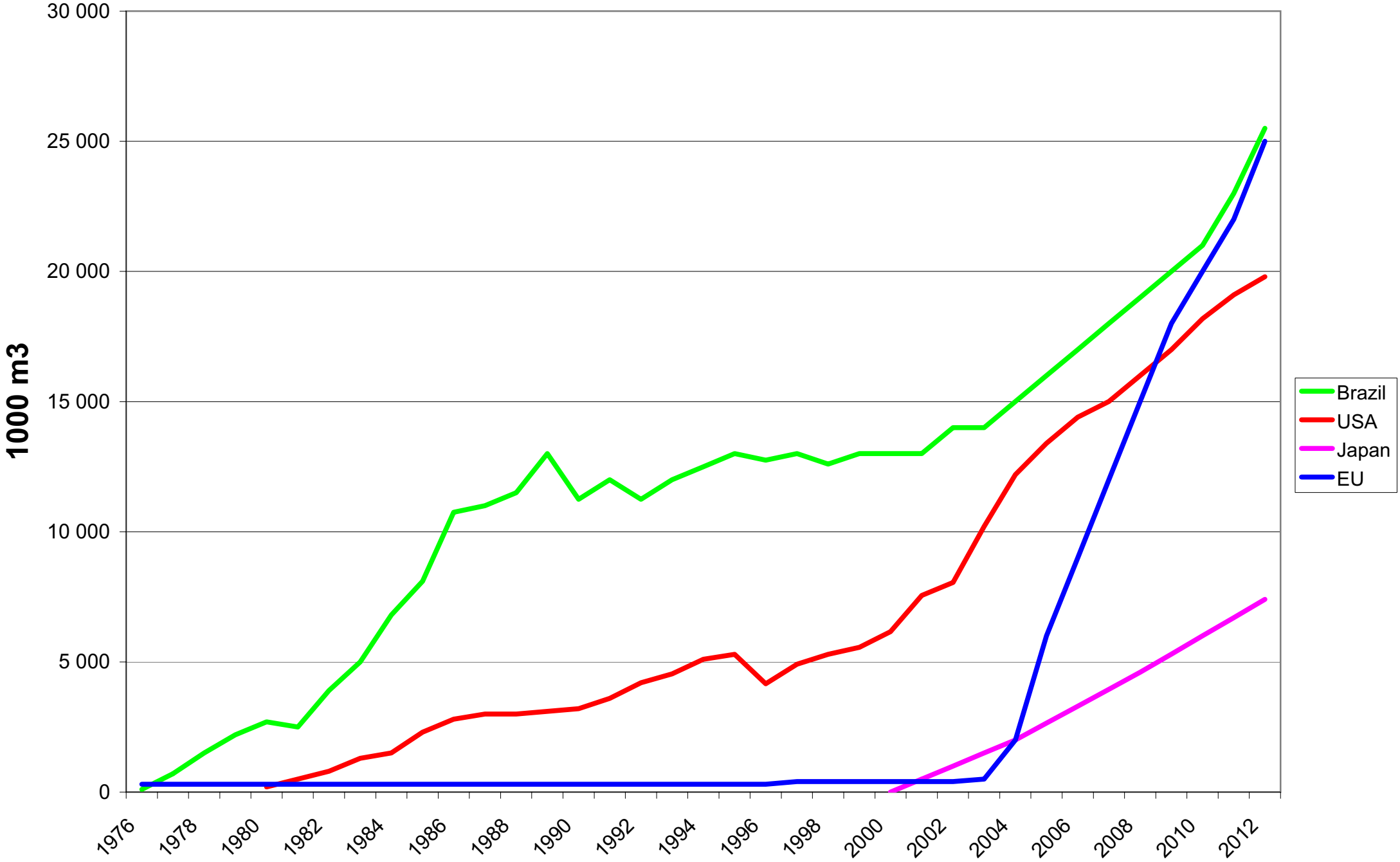
Source: Argonne National Laboratory

2002-03-19

Ethanol markets and production develops rapidly



Ethanol markets and production develops rapidly



2004-02-24/LN

Why Biofuels in EU, and Now?

Nations and large systems always behave wisely and decisive…..,
… once they have exhausted all other alternatives! Churchill

1. Sense of urgency- Urgency to initiate a long term strategy towards a system shift with short term actions as decisive as possible.
   Desperately dependent on Middle Eastern oil, jeopardised CO2 objectives.
2. Lead the global development towards lower usage of oil derivates
   EU most dependent on imported oil and most concerned and active in the Kyoto process
3. Position European industry as a leading player
   A gigantic industrial development is emerging. Sustainable fuels applied in energy efficient vehicles
4. Enlargement Utlilise biofuels as a tool for rural development

4E´s – Energy, Environment, Economy, Enlargement

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Scope to 2010?

Focus on 5,75% as an end-result ?

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Scope to 2010?

Focus on 5,75% as an end-result ?

Or ?

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Scope to 2010?

Focus on 5,75% as an end-result ?

Or ?

Meeting the 6% objective as a mean to kick-start a powerful shift towards sustainable transport systems in 2030.

A system, based on very energy efficient vehicles fuelled by very large volumes of sustainable biofuels!

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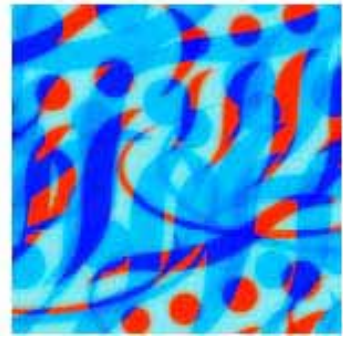
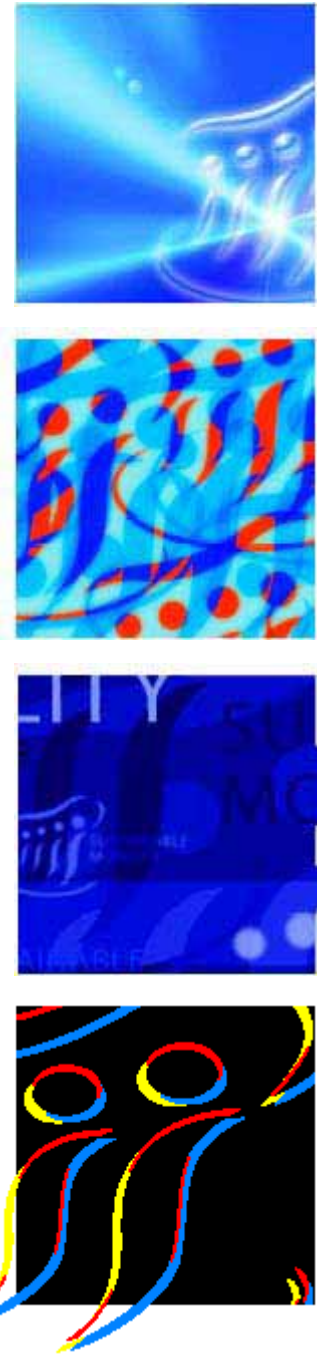


World Business Council for Sustainable Development

SUSTAINABLE MOBILITY

Objective of the Sustainable Mobility Project

To establish a vision of sustainable mobility in 2030 and various pathways for getting there



SUSTAINABLE MOBILITY

Sustainable Mobility Project - members -

bp

MICHELIN

DAIMLERCHRYSLER

RENAULT

Ford Motor Company

GM General Motors.

TOYOTA

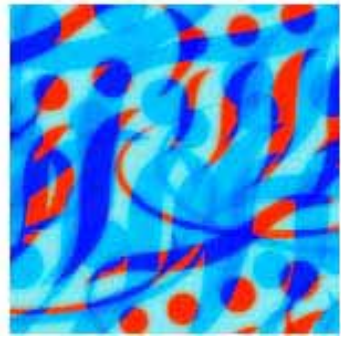
HONDA

VOLKSWAGEN AG

HYDRO

NISSAN

SUSTAINABLE MOBILITY



World Business Council for Sustainable Development

Mobility 2001 Results - 7 Grand Challenges

1: Ensure the essential role of transport systems for economic and social development

2: Match the future use of automobile/transport with actual accessibility and needs

3: Re-invent public transport

4: Re-invent the process of planning, developing and managing mobility infrastructure

5: Drastic reduction of mobility's carbon emissions

6: Resolve the competition for infrastructure use between personal and freight transport

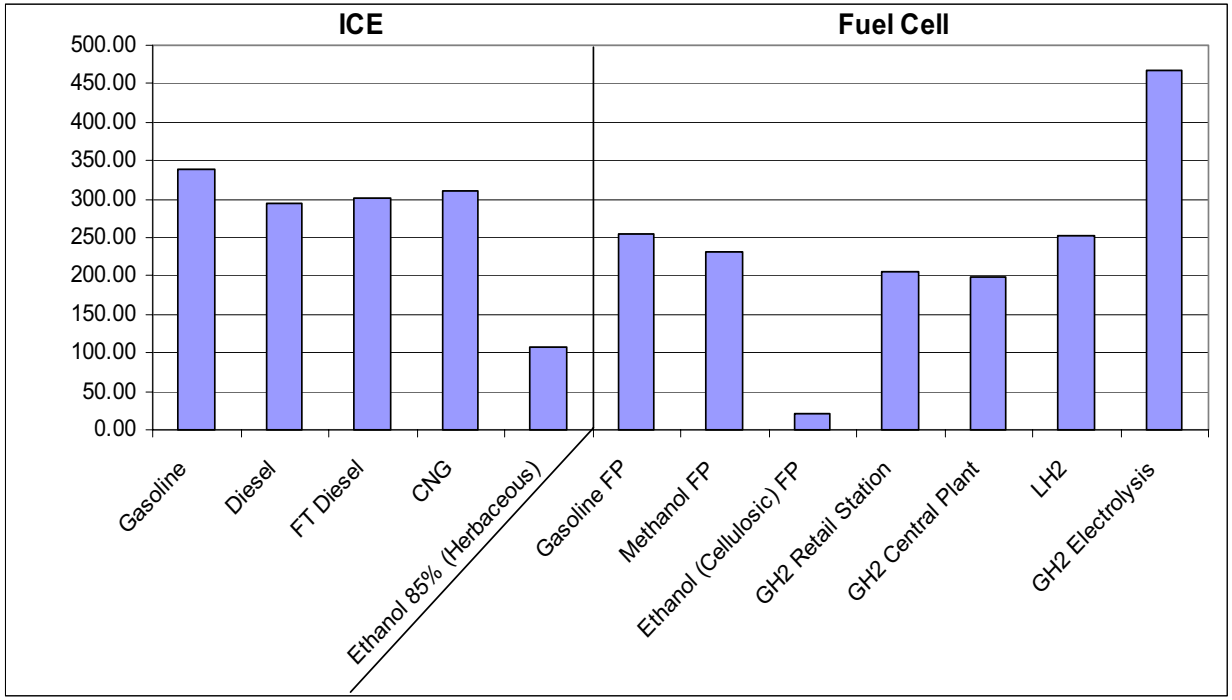
7: Anticipate intercity congestion & develop mobility options for people and freight

SUSTAINABLE MOBILITY

World Business Council for Sustainable Development

GHG Emissions

Well-to-Wheel, Potential of Factor 10



Source: GM/Argonne

SUSTAINABLE MOBILITY

“.....fuel cells and bioethanol will
make a significant dent into the oil economy...

...it cannot happen soon enough”.

Economist leader, 25/10/2003

Why BioEthanol? 1

- **Dominating global biofuel both in the short- and medium term**
- **Cellulose based ethanol offers vast feedstock potentials, sufficient for a substantial change in global transport systems**
- **Integrated bio-refineries offers an extra magnitude of improvement in energy-, CO2 and cost efficiency**
- **Process either based on enzymatic hydrolysis or GTL**

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Why BioEthanol?$_2$

- **Very promising bio-hydrogen carrier for transports**
- **Safe, technically and economically easy to introduce**
- **Offers a seamless transition towards an energy- CO2- and economically efficient global transport system**
- **Very low risk to unveil a large scale program such as the "Airbus project" or the "Apollo program"**

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Long term strategy towards a system shift with short term actions

1. Changing attitudes and scope
2. Initiating the systems change towards a desired future
3. Reducing short term uncertainties on the market
4. Removing short term non-adequate barriers

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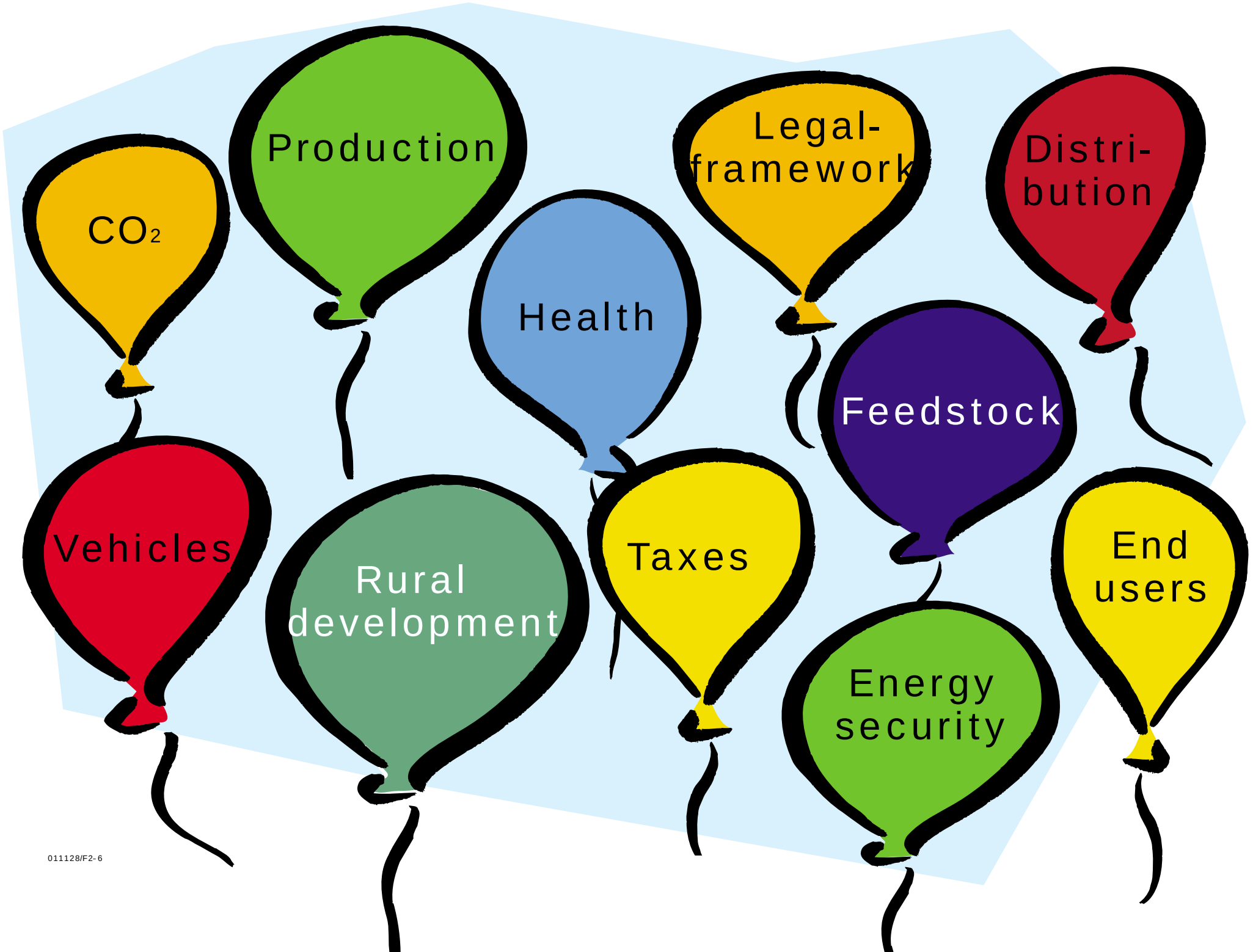
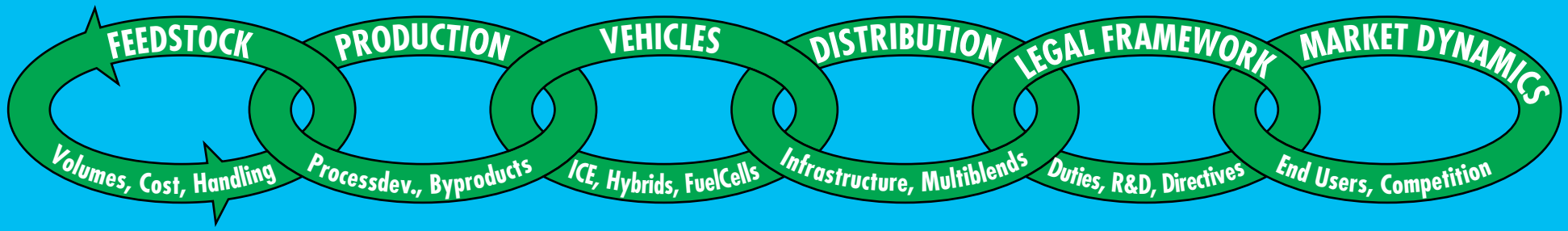
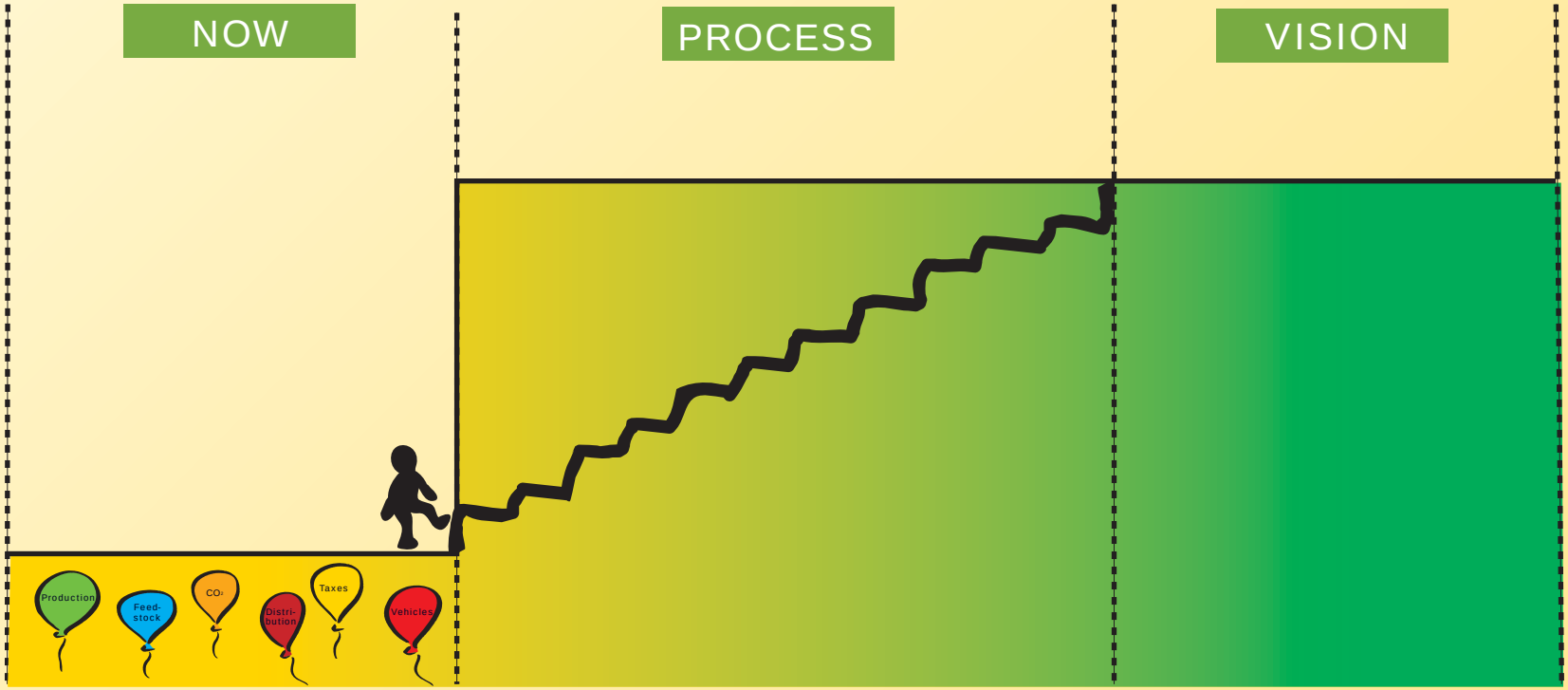

CO_2
Production
Health
Legal-framework
Distri-bution
Vehicles
Rural development
Taxes
Feedstock
Energy security
End users
011128/F2-6

BIO-
ETHANOL


FEEDSTOCK
Volumes, Cost, Handling
PRODUCTION
Processdev., Byproducts
VEHICLES
ICE, Hybrids, FuelCells
DISTRIBUTION
Infrastructure, Multiblends
LEGAL FRAMEWORK
Duties, R&D, Directives
MARKET DYNAMICS
End Users, Competition

Systems development is made stepwise



Here we are!

This has to be done...

...to reach sustainability!

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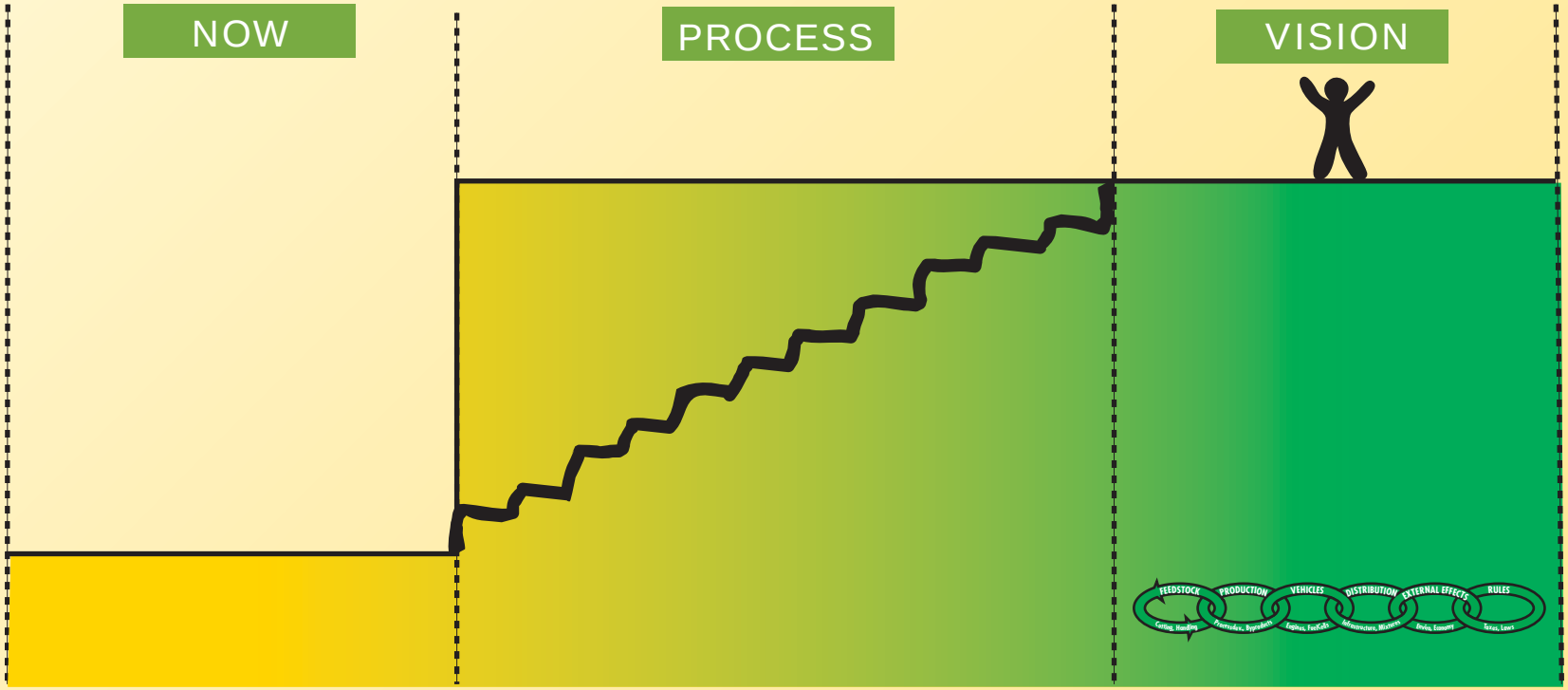
Systems development needs a vision



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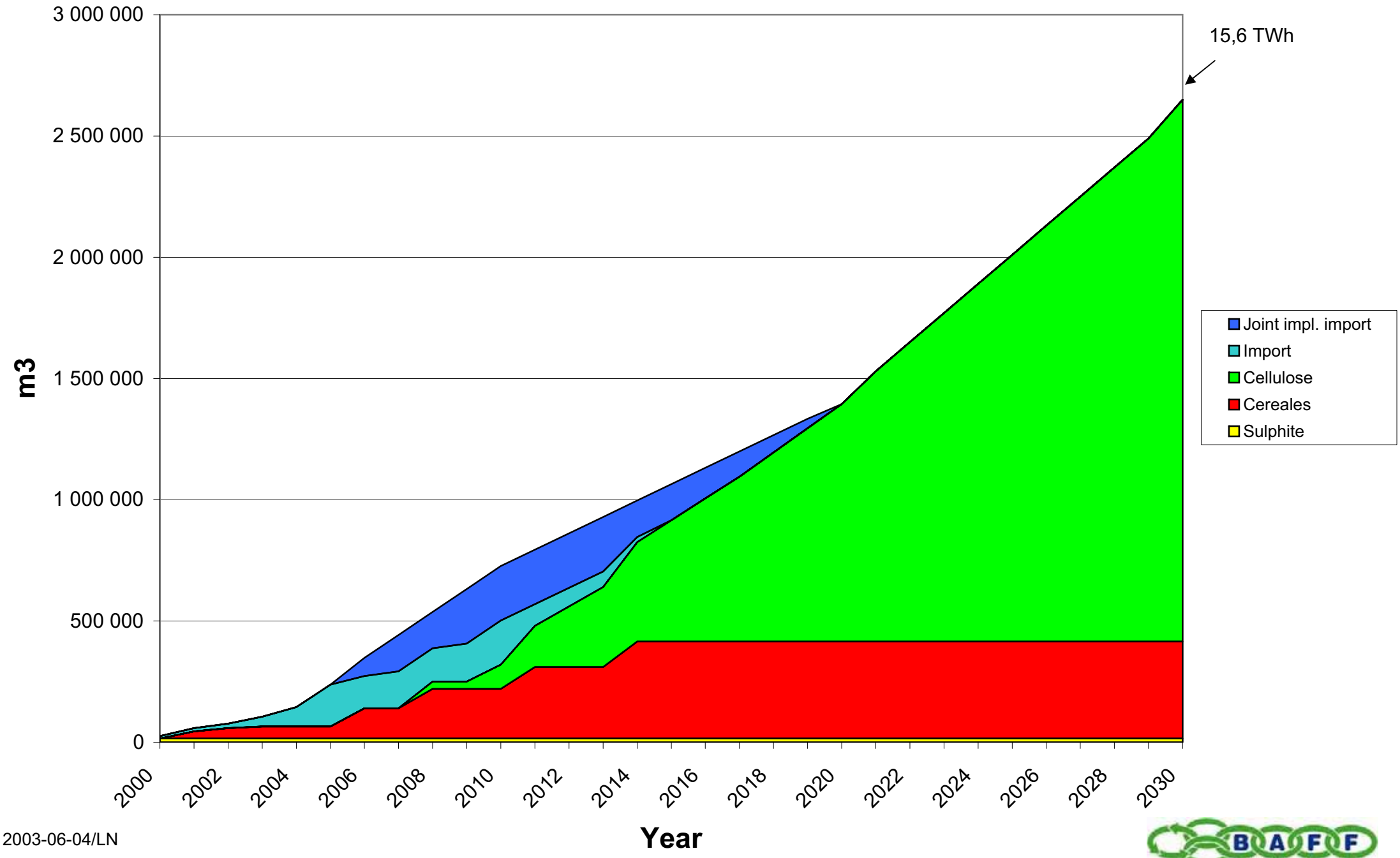
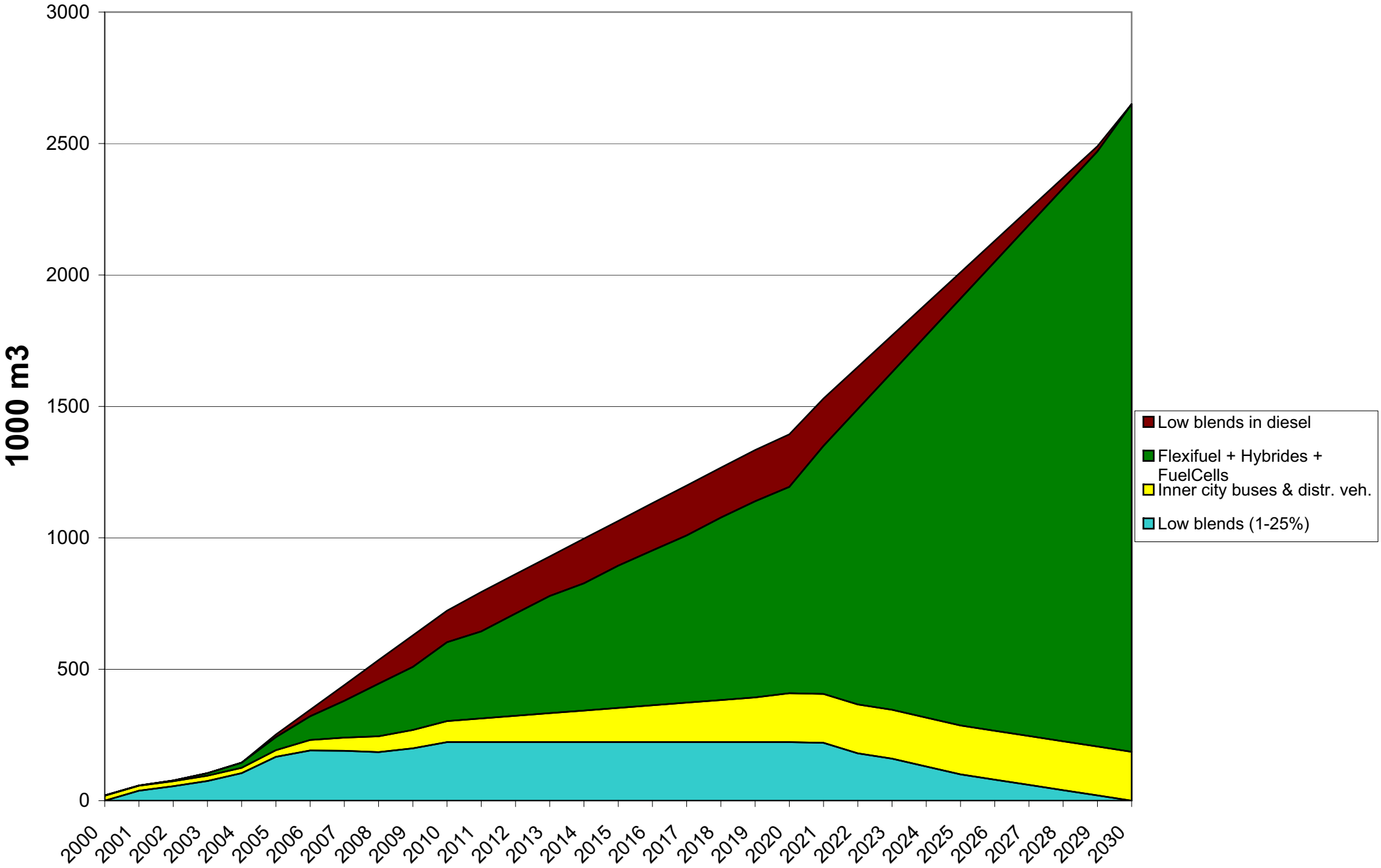
Supply 2030 - Volumes of ethanol (including ev. syngas)



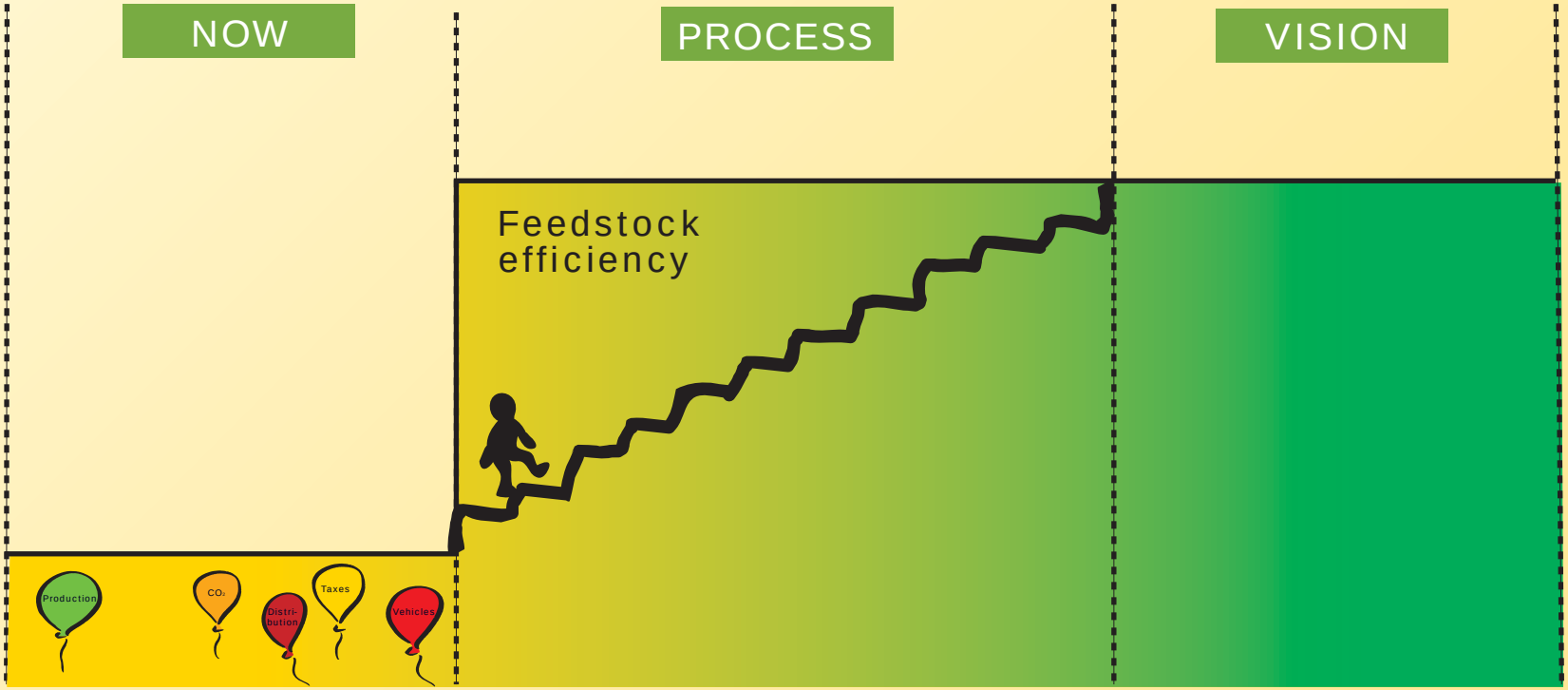
2003-06-04/LN

Demand 2030 - Systems development of biofuels application



2003-06-04/LN

Systems development is made stepwise



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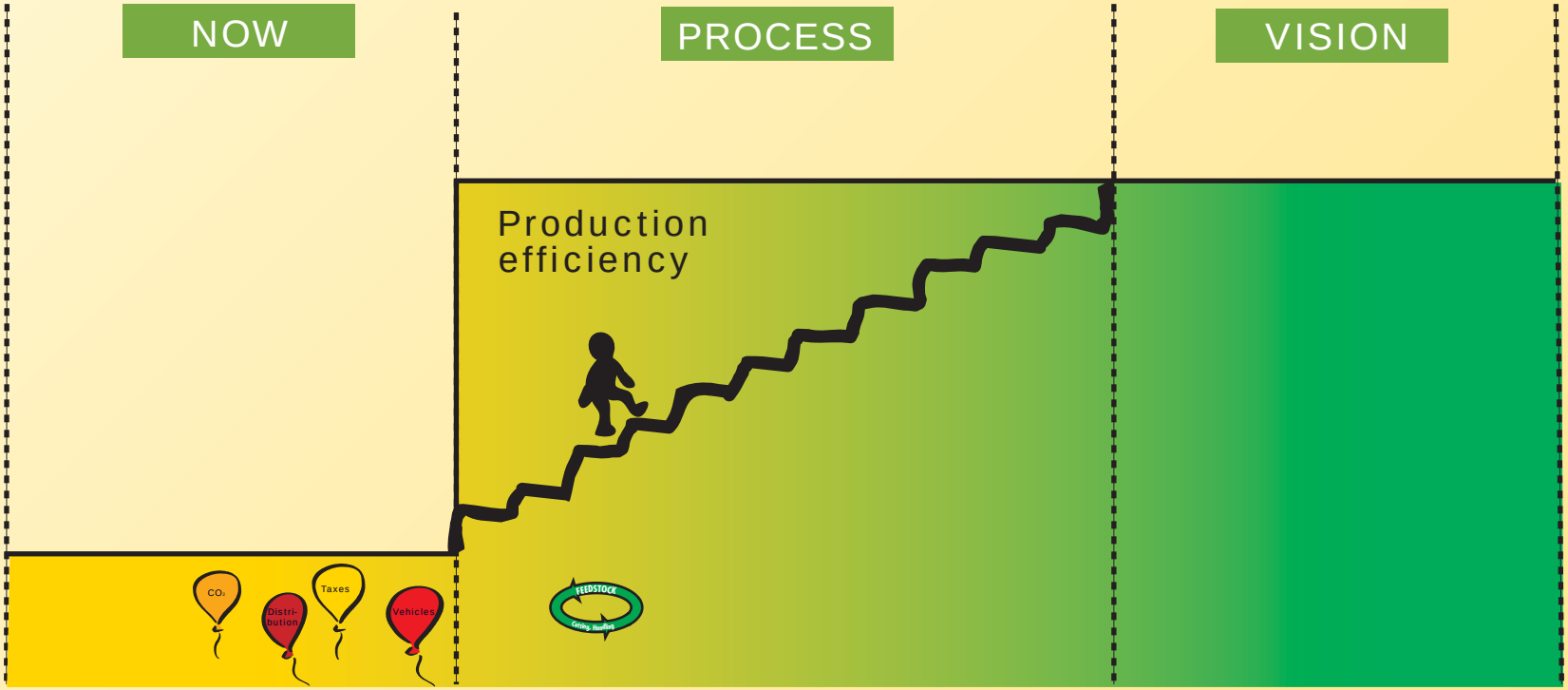

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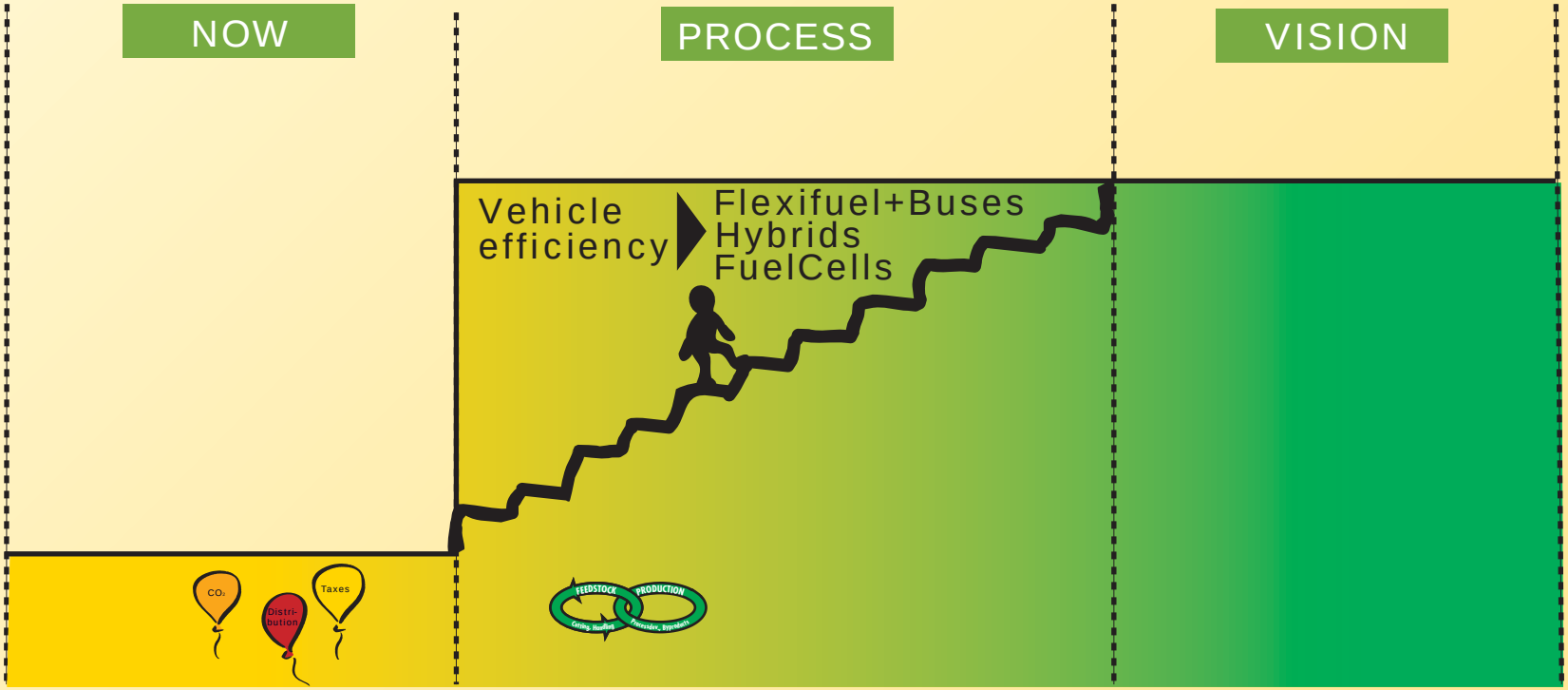

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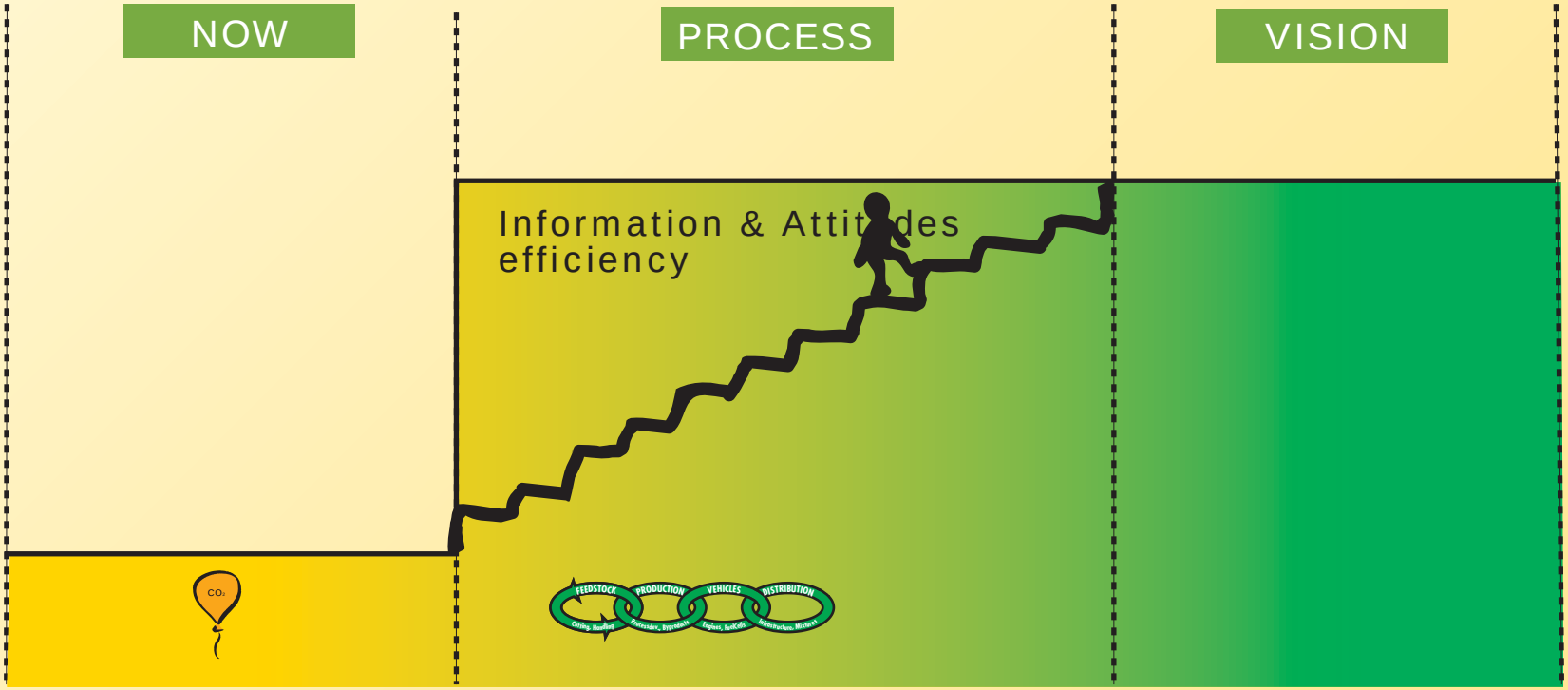

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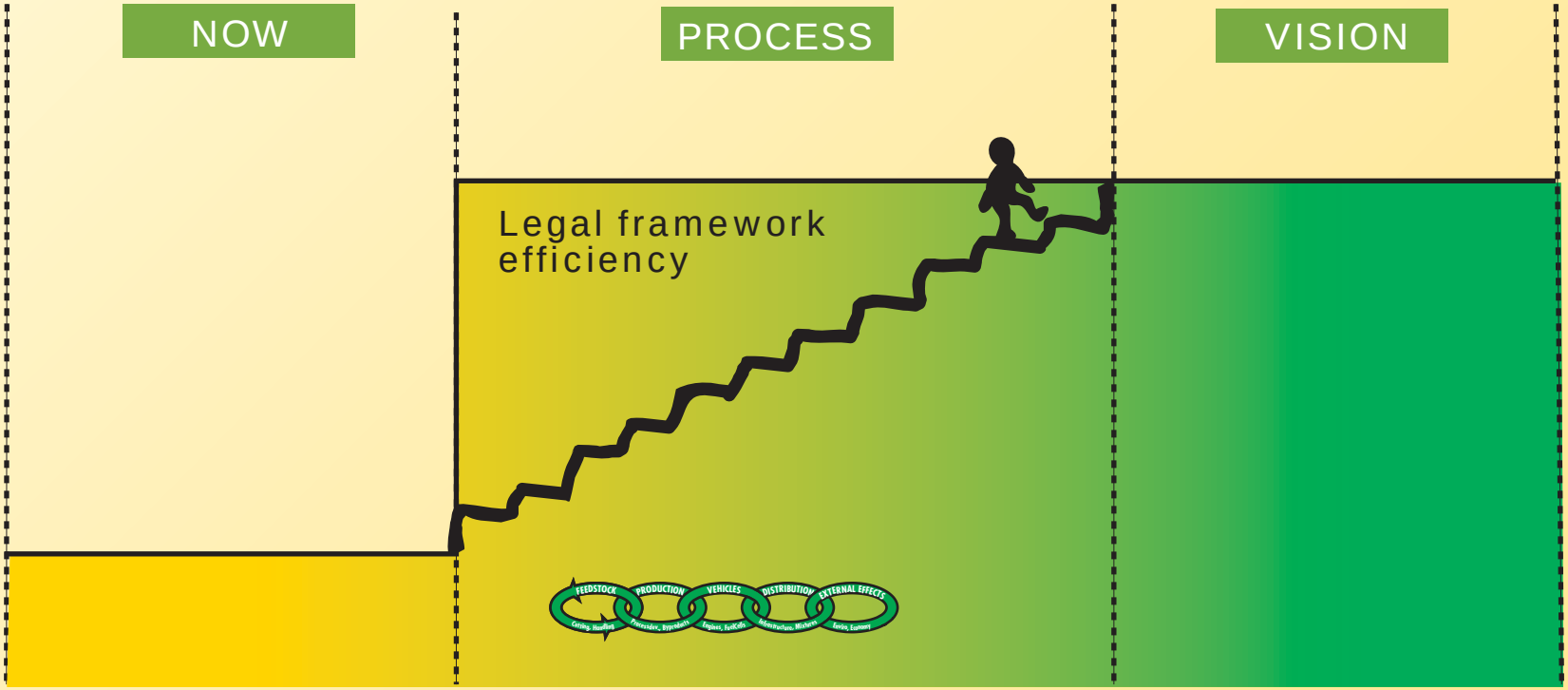

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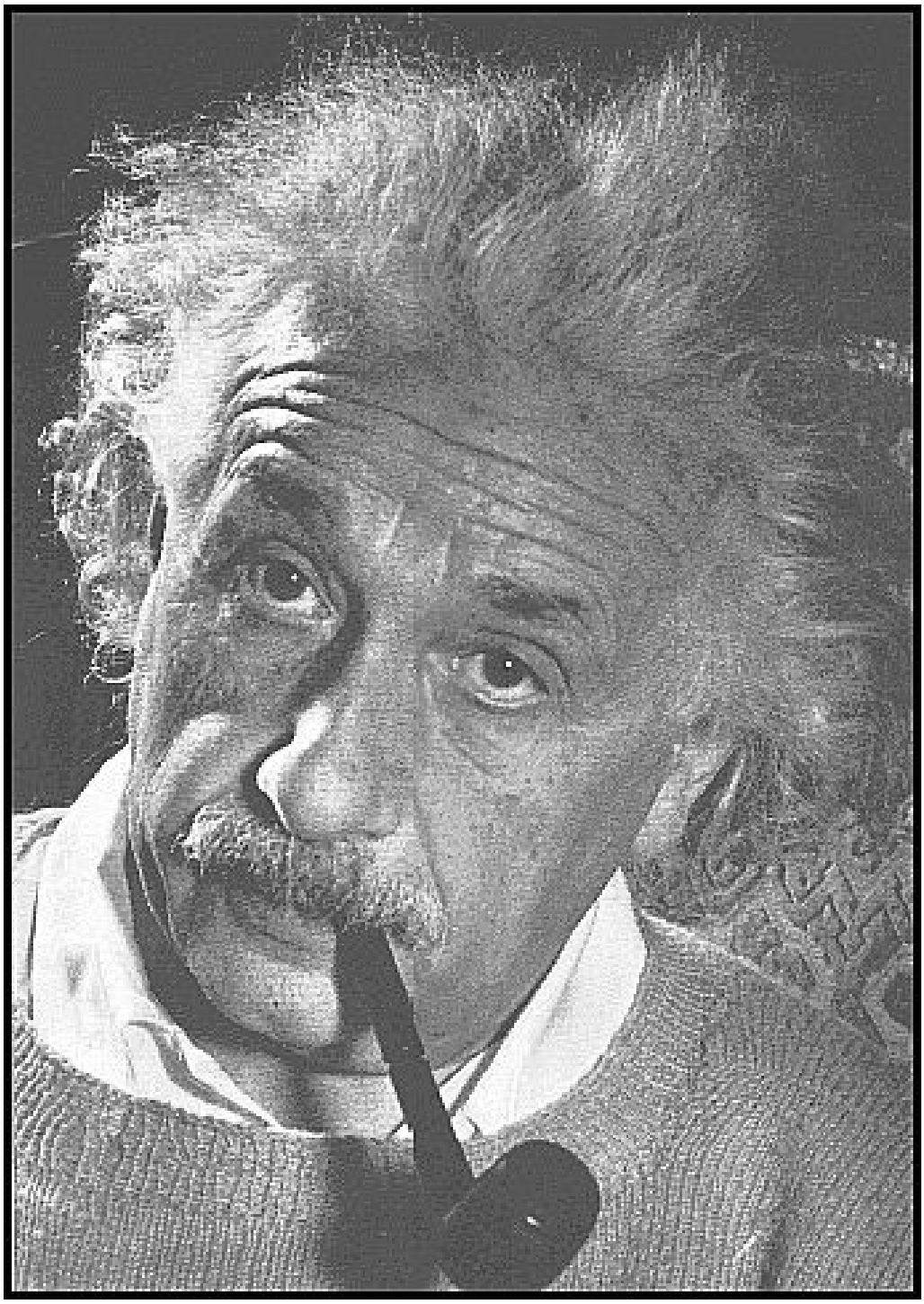


”You can not solve the problem with the same kind thinking that has created the problem

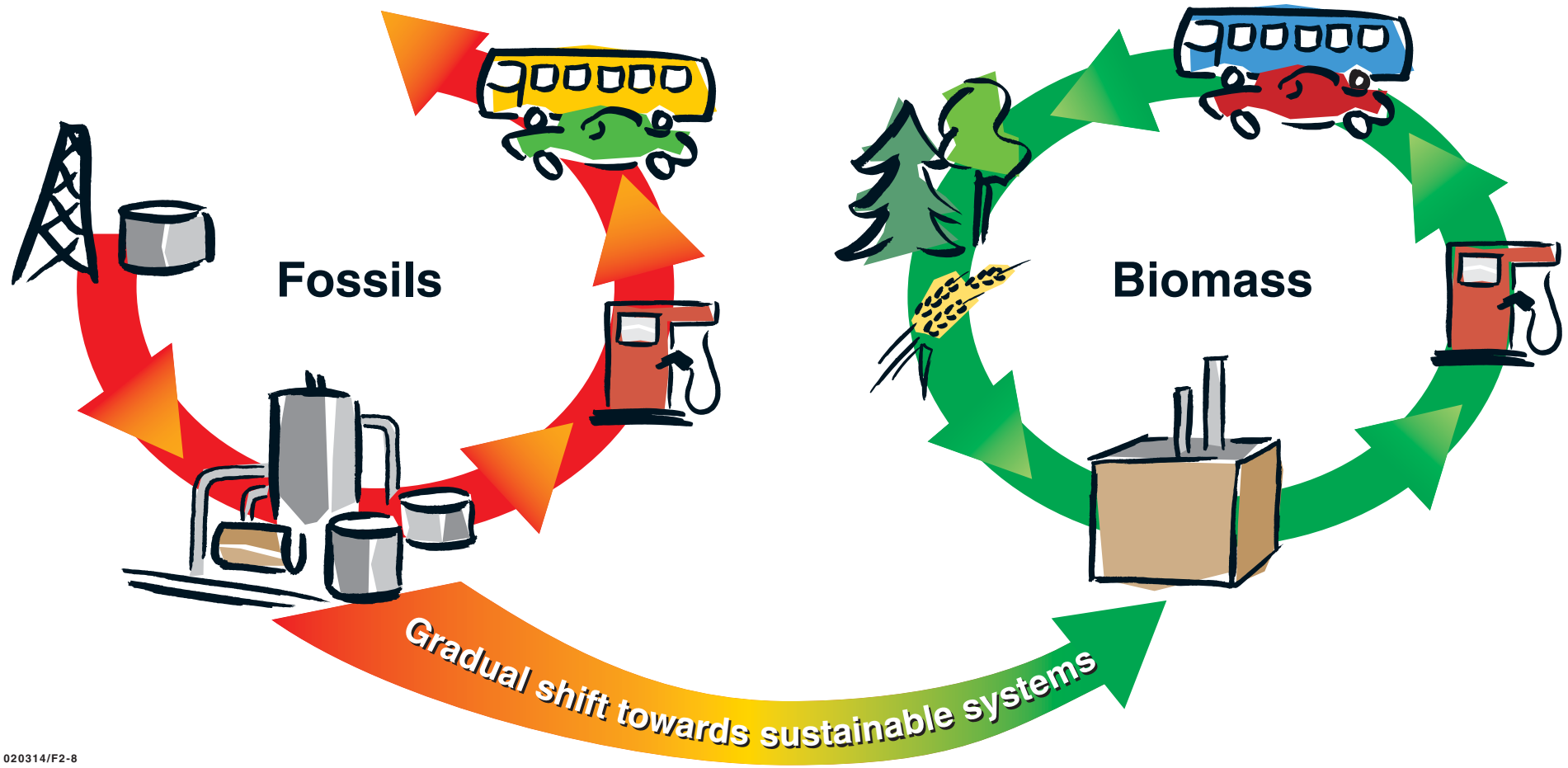
Albert Einstein

2000-03-16/KS5/BAFF

The Carbon Circle

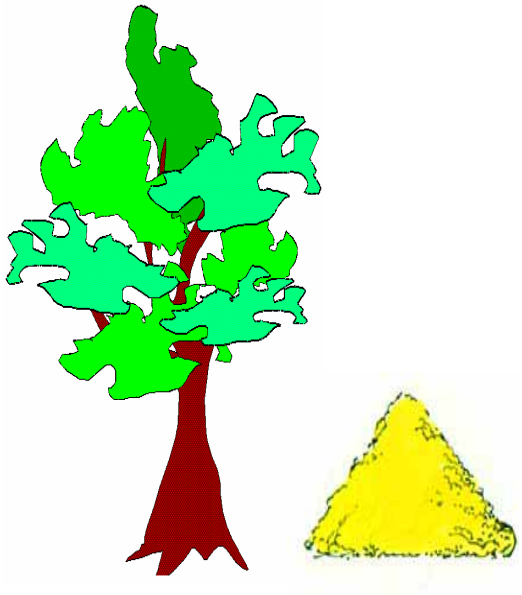
BROKEN CIRCLE

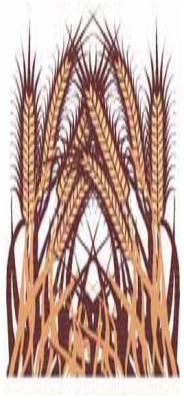
CLOSED CIRCLE



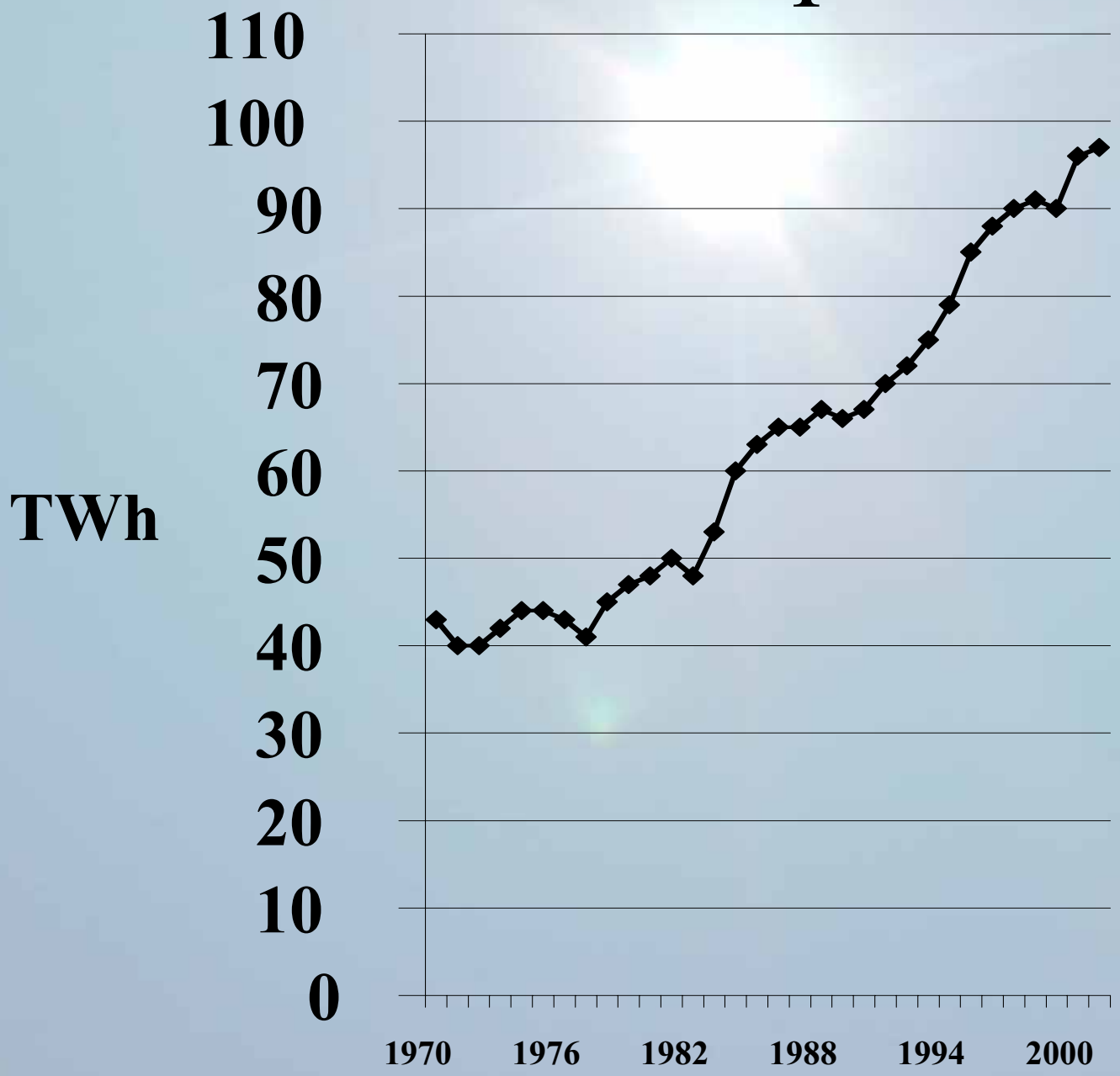
WIDE RAW MATERIAL POTENTIAL
GRAIN ⟶ CELLULOSE BIOMASS

Wood	**Cultivation**	**Recycling**
Cutting residuals	Straw, switchgrass	Industrial waste
Sawdust	Energywood	Household garbage
Clearing/Thinnings	Corn, Wheat, Sugar	Waste fibre

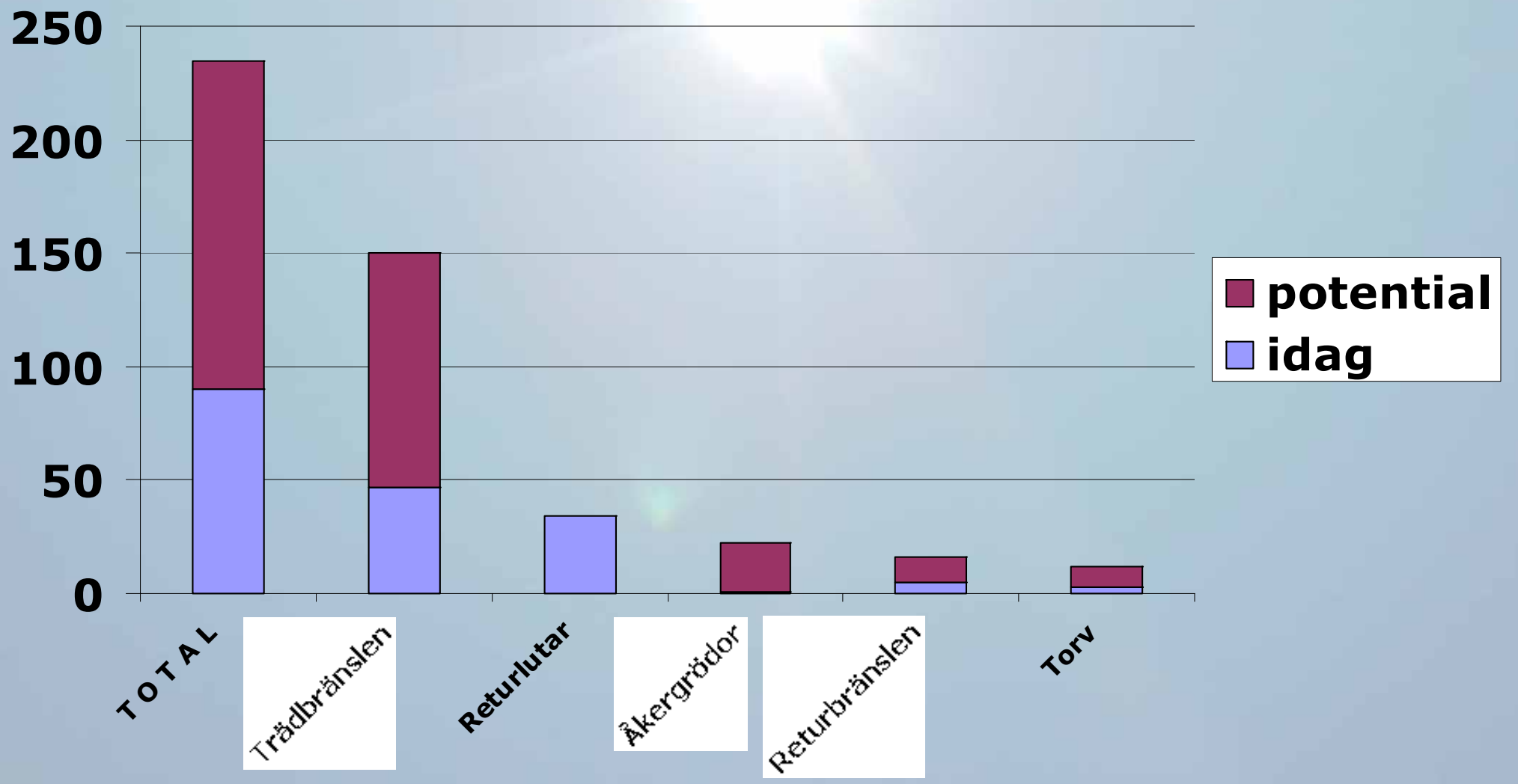




Evolution in Sweden for heat and power



Swedish potential within 20 years

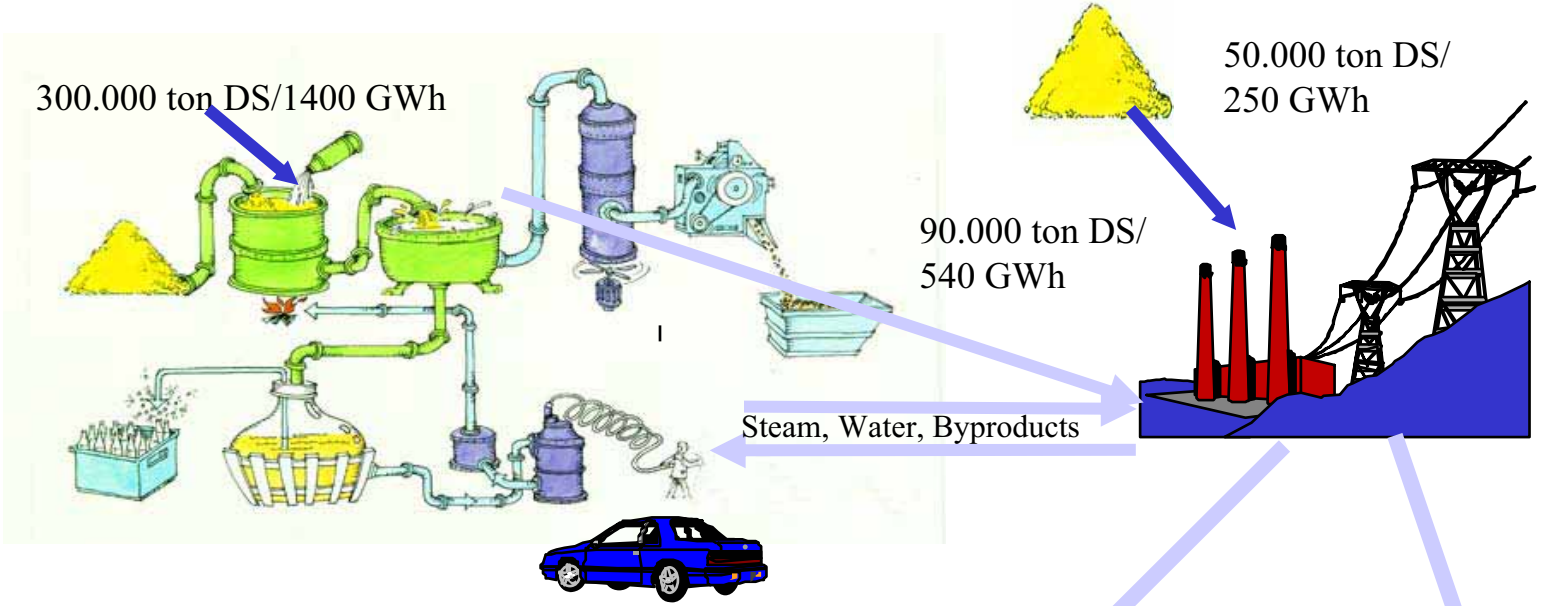


Residues:

- Forestry (logging) residues
- Forest industry residues
  - (together half the above-ground tree)
- Products after use, re-use and recycling
  - All together: approximately all harvested wood
- Agricultural residues
- Food industry residues
- Household food residues
- Sewage sludge
- Global total more than 1/3 of global energy use!

BIOREFINERY & ENERGYCOMBINE

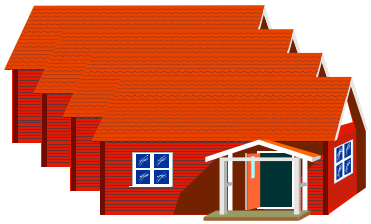
(Ethanol- Electricity-, District heating production)



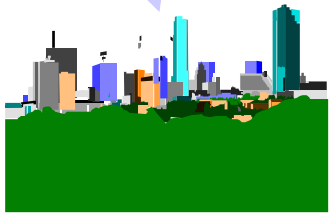
62.500 m^3/350 GWh ethanol
for about 80.000 cars
(5 l/100 km, 18 kWh/100 km)

Energy efficiency 70-75%

CO_2 efficiency >90%



585 GWh district heating
for about 40.000 normal
houses
(15.000 kWh /house)



260 GWh household electric for
53.000 household (5.000 kWh/house)

Källa: BAFF

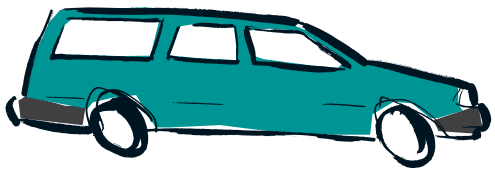
2002-10-17/KS3/BAFF

RD & Pilot plant, Opens in May !

- Two-steps diluted acid- and enzyme hydrolysis
- Develop cost efficiency and synergy effects
- Complete plant with recirculation of process streams
- Investment 20 million US$, European test platform

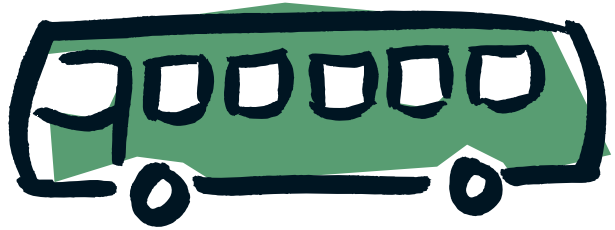
Etek
Etanolteknik AB

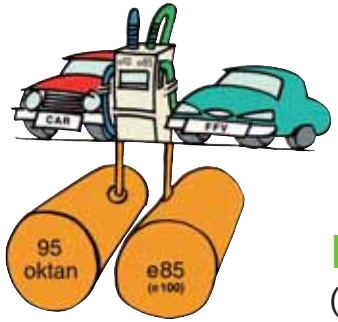
Ethanol-
pathway towards sustainability



Future power systems
(dehydratated ethanol)

e100	Fuelcells	100 %
e85	Hybrids	85, 100 %





Gasoline engines
(dehydrated ethanol)

e100	Optimised engines	100 %
e85	Flexifuel	85 %
e5 e10	Mixed fuels	10-20 %

Diesel engines
(Hydrated ethanol incl. water)

e95	Ethanol	95 %
e10	Mixed fuels	10-20 %

KÄLLA: BAFF

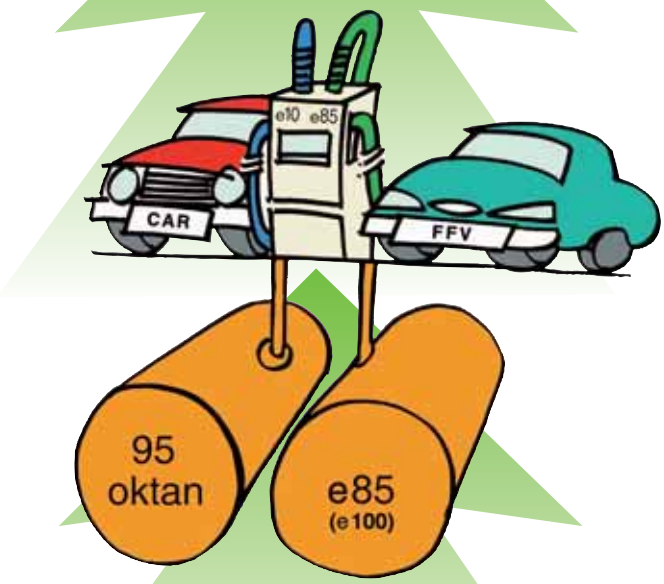
030128/F4-1

Bioalcohols

- pathway towards sustainability

Future vehicle technology

e100	Fuelcells	100 %
e85	Hybrids	85, 100 %



Otto engines

e100	Optimised engines	100 %
e85	Flexifuel	85 %
e5 e10	Mixed fuels	5-25 %

SOURCE: BAFF

European projects!

- Flexifuel strategy for cars

- International Buyers Consortium for Ethanol city buses and flexifuel vehicl.

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FlexiFuel strategy

How many new residential houses are being built today only dependent on oil?

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How many new vehicles are sold today, only dependent on oil?

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FlexiFuel Vehicles

- Can use any blend of ethanol/gasoline
- Technical development has dramatically changed the economical fundamentals
- VW, GM, Ford, Mercedes, Fiat and soon Peugeot have all access to 4-cyl flexifuel engines
- Marginal or no extra cost with large scale introduction

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FORD FOCUS Flexifuel

1999-11-25/SSBU4

PROTIMA

Aktuella Flexifuelbilar för etanoldrift i Brasilien

PROTIMA

MERIVA FLEXPOWER 1.8

PROTIMA

MONTANA SPORT & OFF ROAD

PROTIMA

CORSA HATCH 1.8 FLEXPOWER

PROTIMA

CORSA SEDAN 1.8 FLEXPOWER

PROTIMA

VW Parati City 1.6 Total Flex Golf kombi
VW Parati Track & Field 1.6 Total Flex Golf kombi

PROTIMA

VW Fox City 1.0 Total Flex
VW Fox Plus 1.0 Total Flex
VW Fox Plus 1.6 Total Flex
VW Fox Sportline 1.6 Total Flex

PROTIMA

VW Saveiro City 1.6 Total Flex Pick-up
VW Saveiro SuperSurf 1.6 Total Flex Pick-up

PROTIMA

VW Gol City 1.6 Total Flex
VW Gol Plus 1.6 Total Flex VW Gol Power 1.6 Total Flex

PROTIMA

Fiat Novo Siena 1.3 & 1.8 Flex

PROTIMA

Fiat Novo Palio 1.3 Flex

PROTIMA

Ford Fiesta Flexifuel 1.6

PROTIMA

Ford EcoSport Flexifuel 1.6

We need an European development!

- 10% of sales in the USA 2003
- 0-30% of sales in Brazil 2003-2004
- 75% of sales in Brazil 2007
- 75% of Ford Focus sales in Sweden

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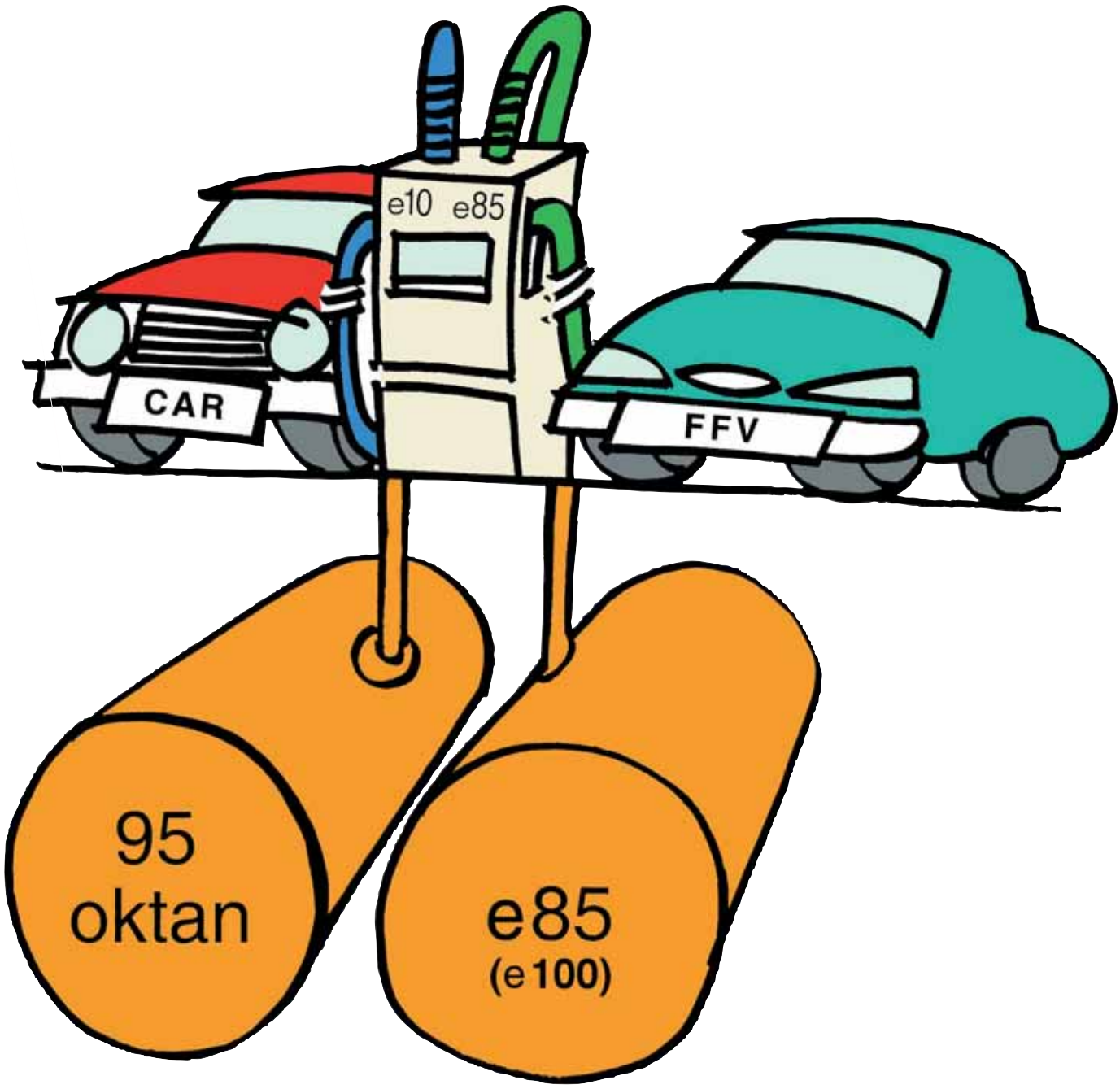
Ethanol blending at Flexifuel stations



020410/F7-1

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FlexiFuel Pumps

- Can offer any blend of ethanol/gasoline
- Known and well established technique
- Dedicated flexifuel pumps for ethanol certified for EU
- Activates new market dynamics, new vehicle lines, new distributors
- Seamless ethanol platform, from the vehicles of today to the Hybrids and FuelCells of tomorrow
- No extra cost with a smooth introduction

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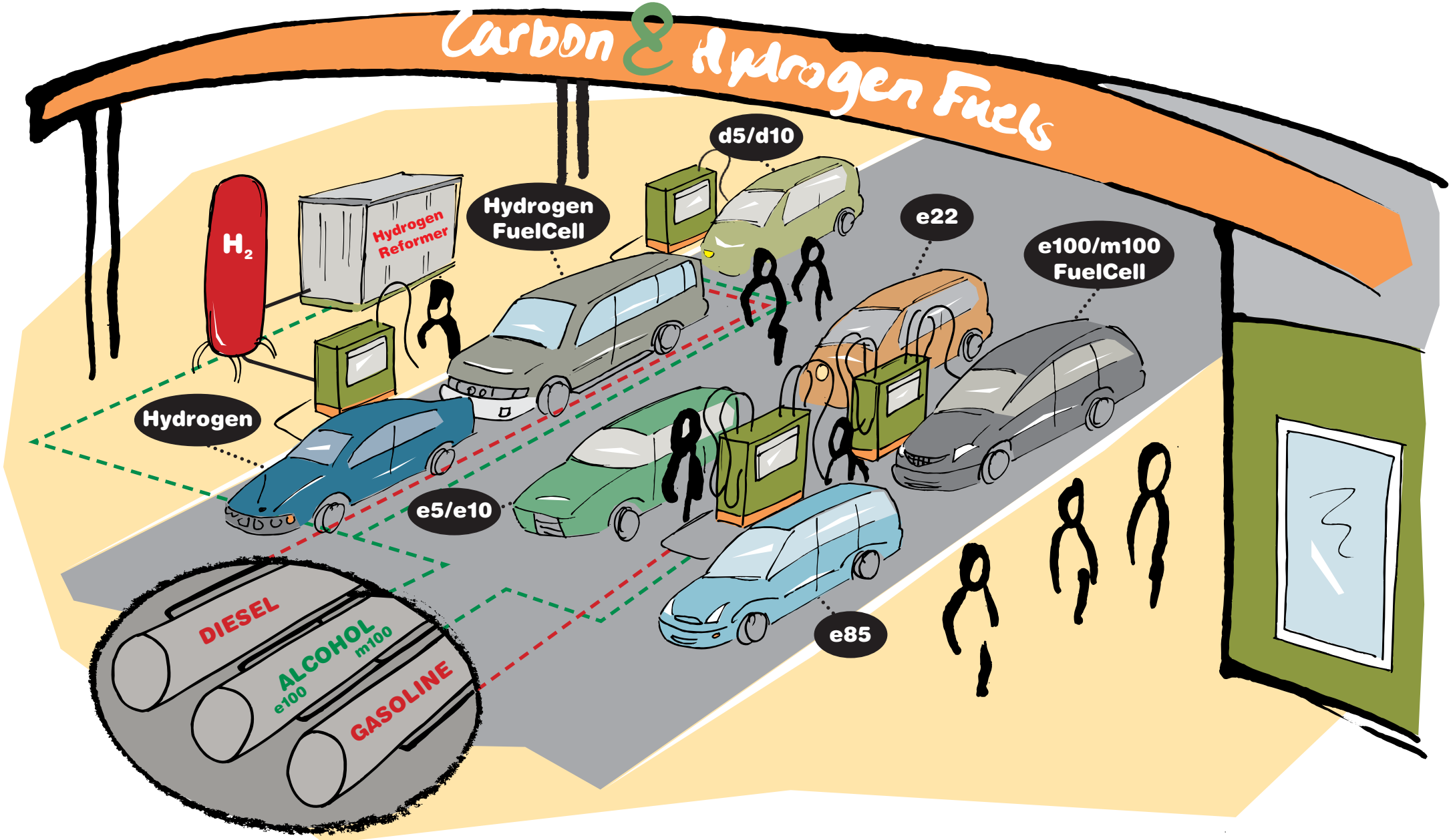
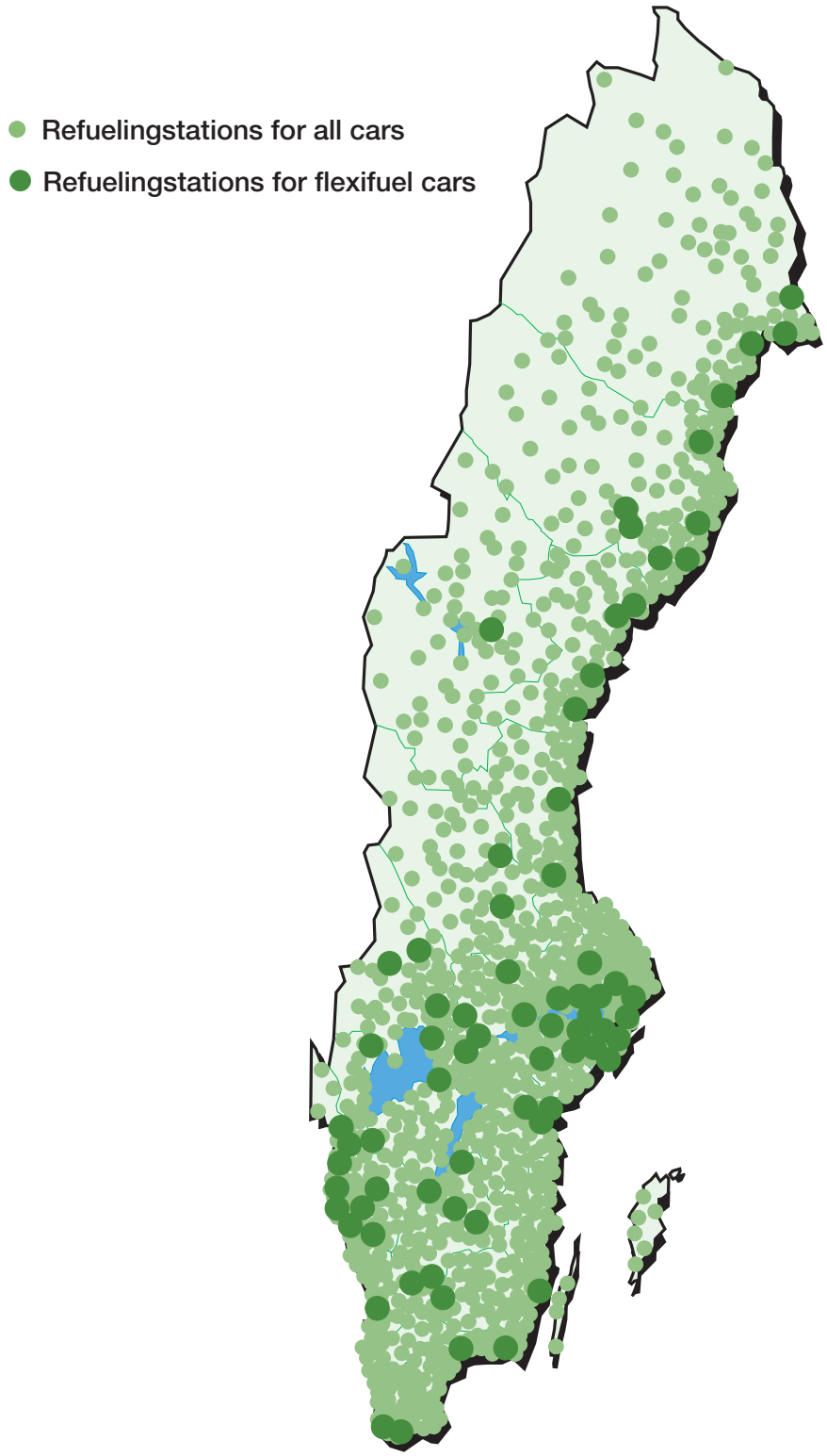
Flexible Infrastructure for the future



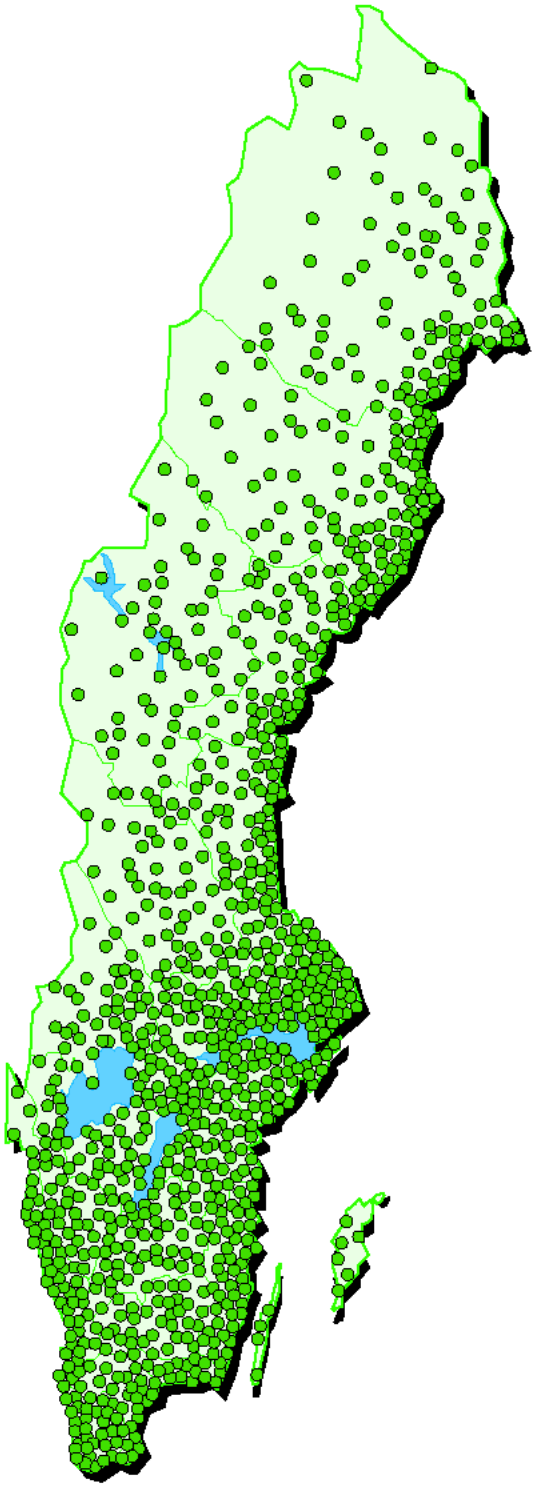
Flexifuel stations for flexifuel vehicles



2003

030128/F7-4

Development of infrastructure in Sweden for light vehicles Government Intention

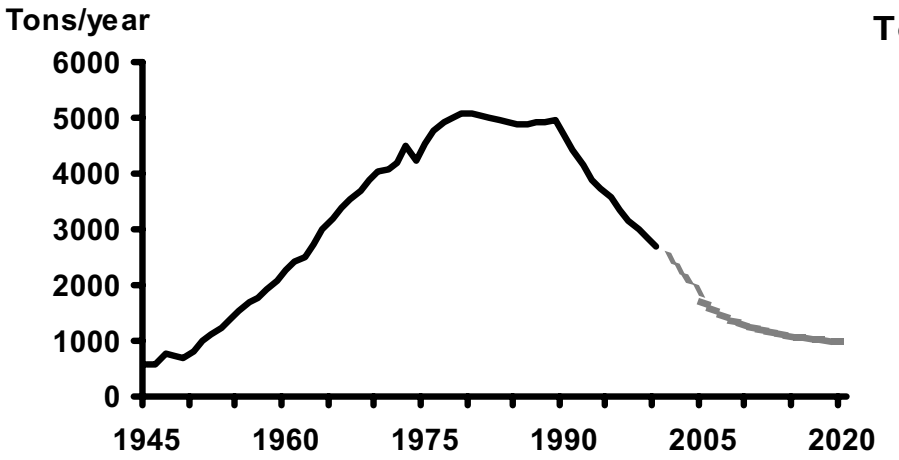


2005

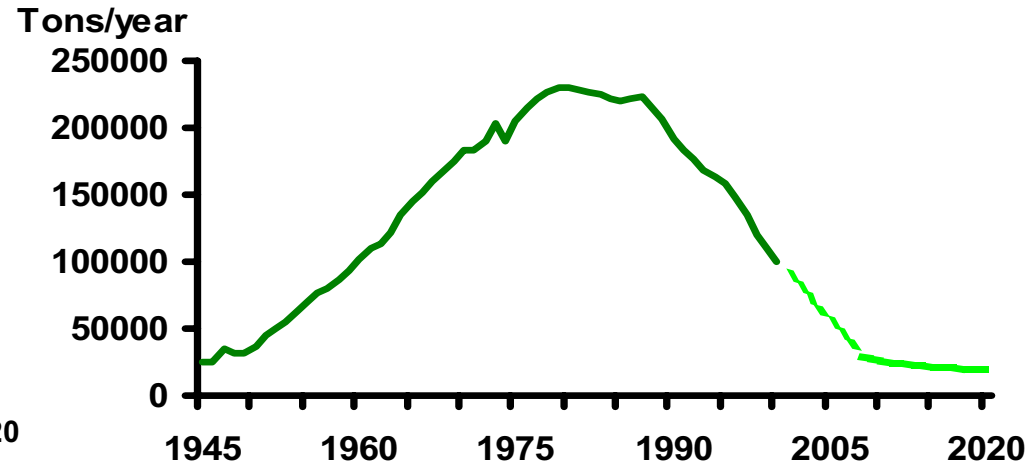
021014/F7-9

Controlled emissions from road traffic

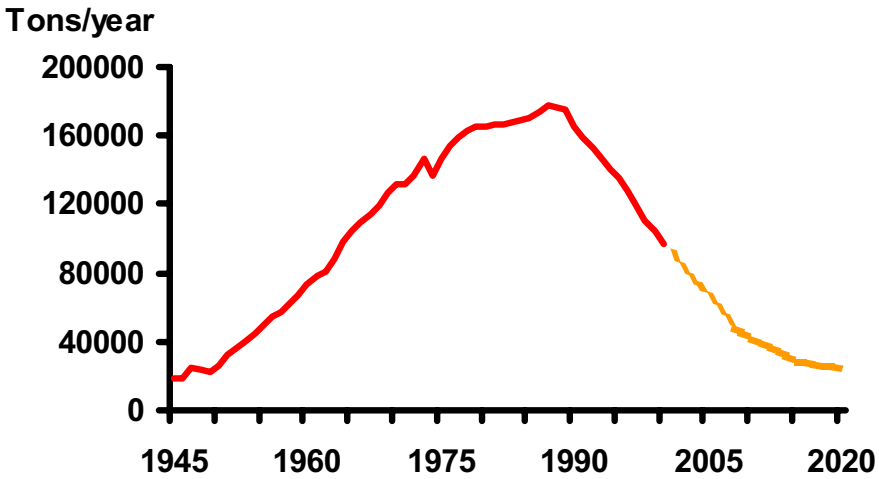
Particles



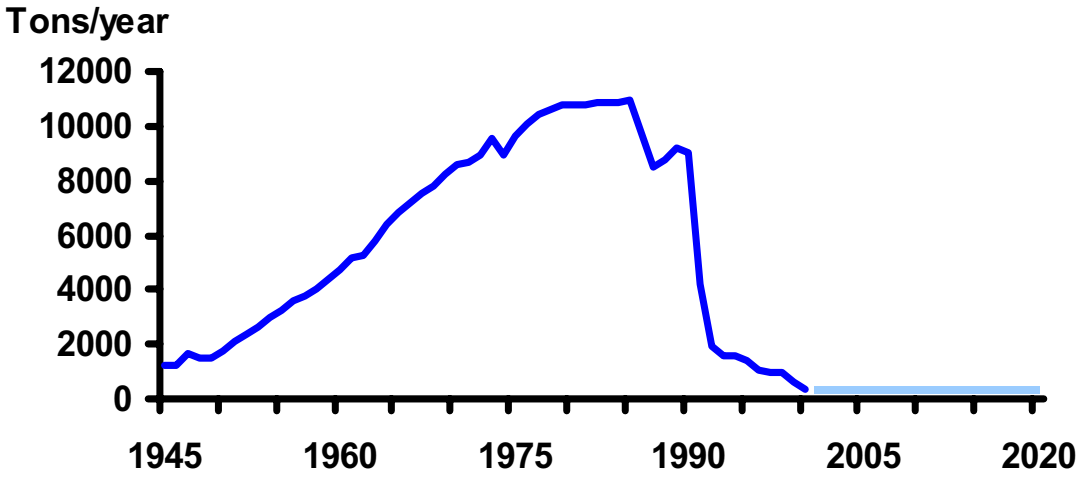
Hydrocarbons



Nitrous oxides

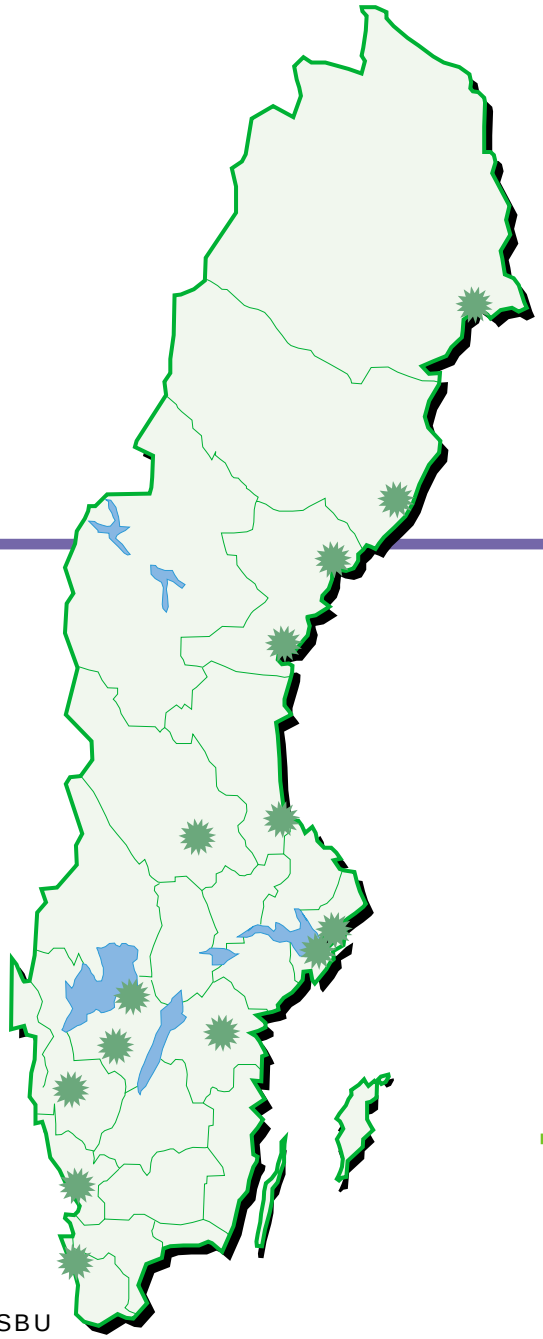


Sulphur dioxide



Källa: Vägverket och SPI, Data from Sweden
2000-03-16/UN1/BAFF

Public transport on BioEthanol



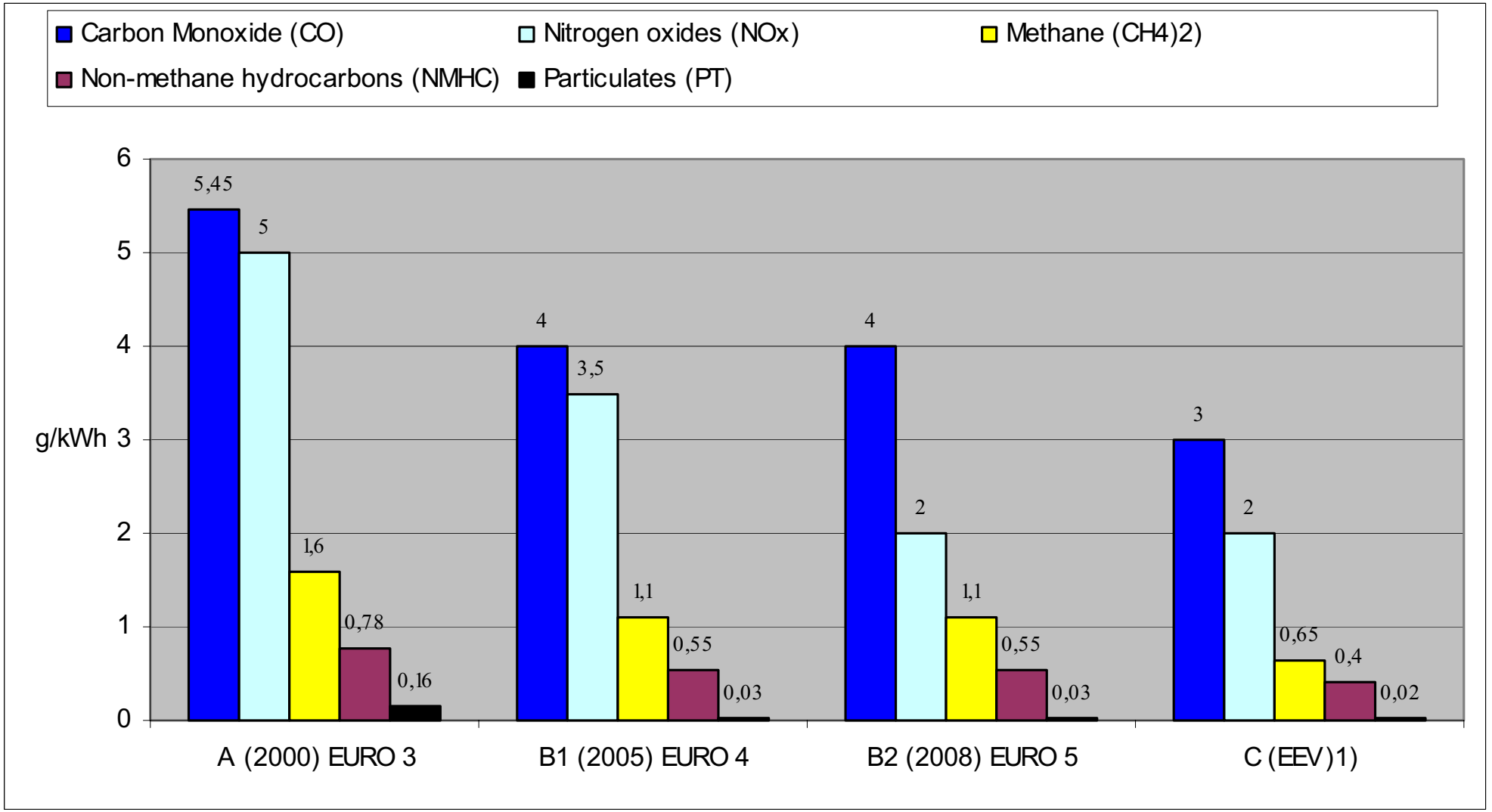
Ethanol buses

Stockholm	250
Umeå	28
Borås	17
Helsingborg	16
Gävle	16
Falun	15
Ö rnsköldsvik	12
Norrköping	11
Skövde	11
Halmstad	11
Sundsvall	9
Luleå	8
Mariestad	3
BUSES IN SWEDEN	407

SOURSE: SSBU

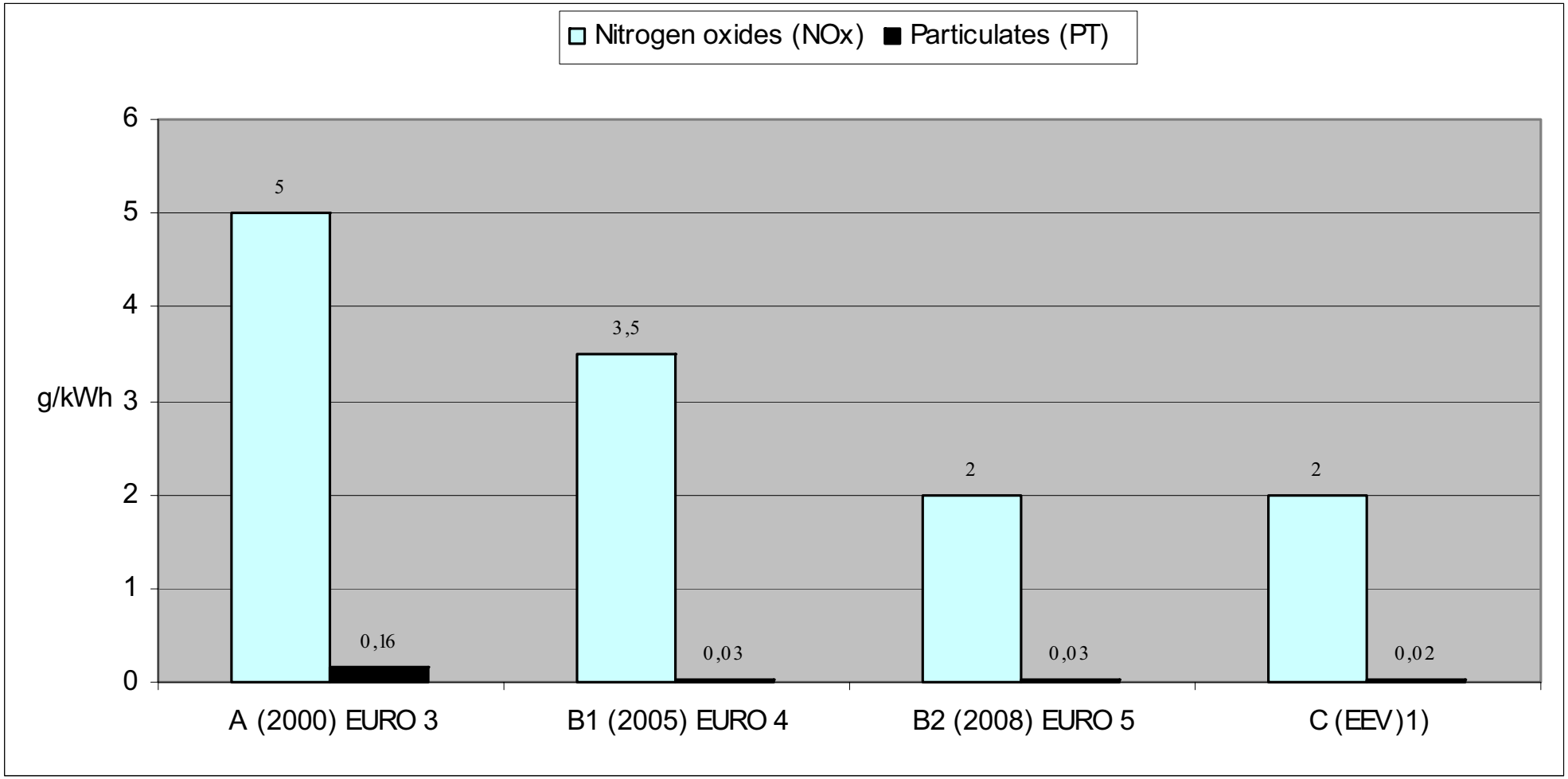
000818/F4-4

Limit values – ETC tests = European Transient Cycle



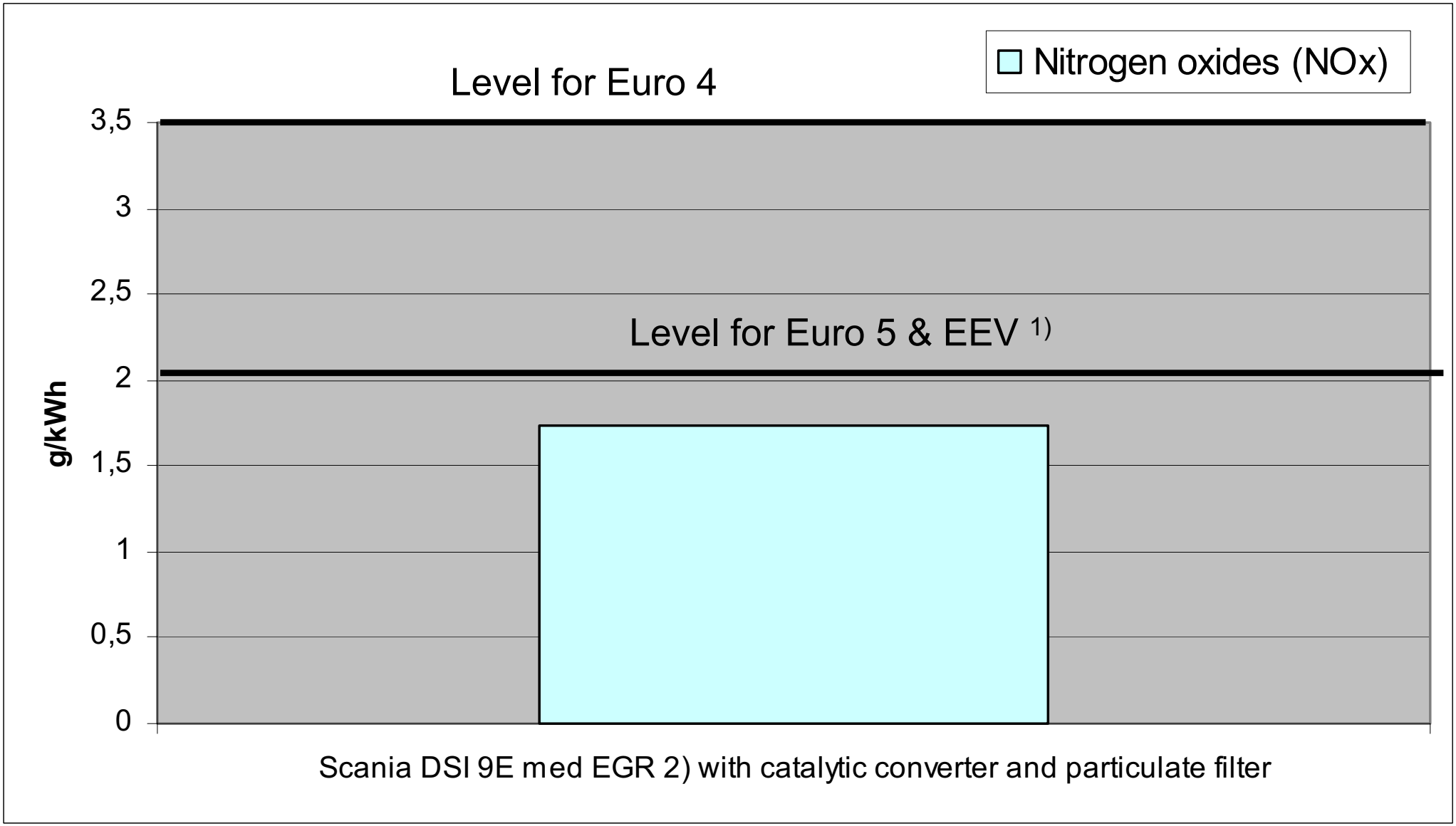
1) EEV = Enhanced Environmentally Friendly Vehicle
2) Only for methane gas engines

Limit values – ETC tests = European Transient Cycle



1) EEV = Enhanced Environmentally Friendly Vehicle
2) Only for methane gas engines

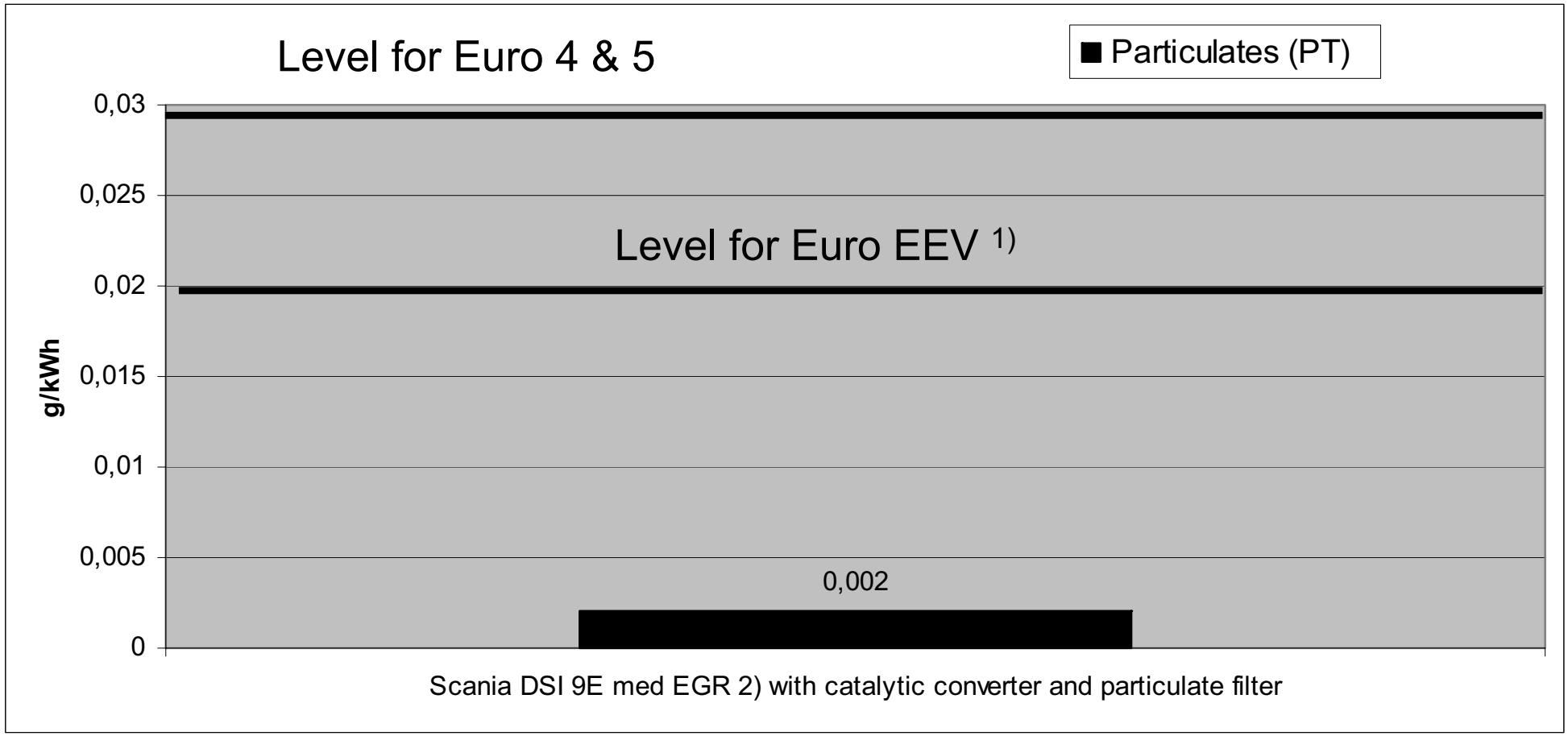
Emissions values from a Scania engine DSI 9E using ethanol as fuel



1) EEV = Enhanced Environmentally Friendly Vehicle

2) EGR = Exhaust Gas Recirculation

Emissions values from a Scania engine DSI 9E using ethanol as fuel



1) EEV = Enhanced Environmentally Friendly Vehicle

2) EGR = Exhaust Gas Recirculation

International Buyers Consortium for Ethanol Buses and other city vehicles

- 17 years of experience
- Operating on pure Ethanol
- 50-100% lower CO2 emissions
- Much lower regulated emissions
- Same availability
- Same purchase price
- Lower, same or slightly higher operating cost ??
- Market development needs critical mass & legal framework

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Invitation

Clean Vehicles and Fuels

European Symposium and Exhibition 2004

2-5 June 2004
Stockholm, Sweden

ORGANISERS AND PARTNERS:
The Swedish Electric and Hybrid Vehicle Association
The Swedish Biogas Association
The Swedish Gas Association
The BioAlcohol Fuel Foundation
The H2-forum
The City of Stockholm, Environment and Health Administration
OPET Sweden
CIVITAS Initiative
SL - Stockholm Transport

www.cleanvehicles.net

2003-02-21

“Be the change you want to see happen in the world”

Gandhi