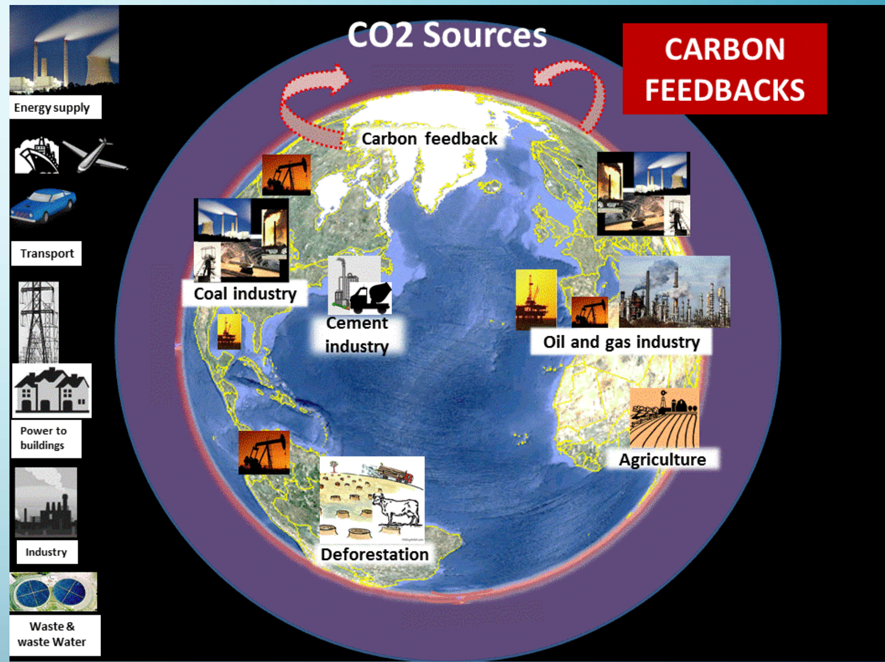
CARBON FOOTPRINT OF FERTILIZER TECHNOLOGIES



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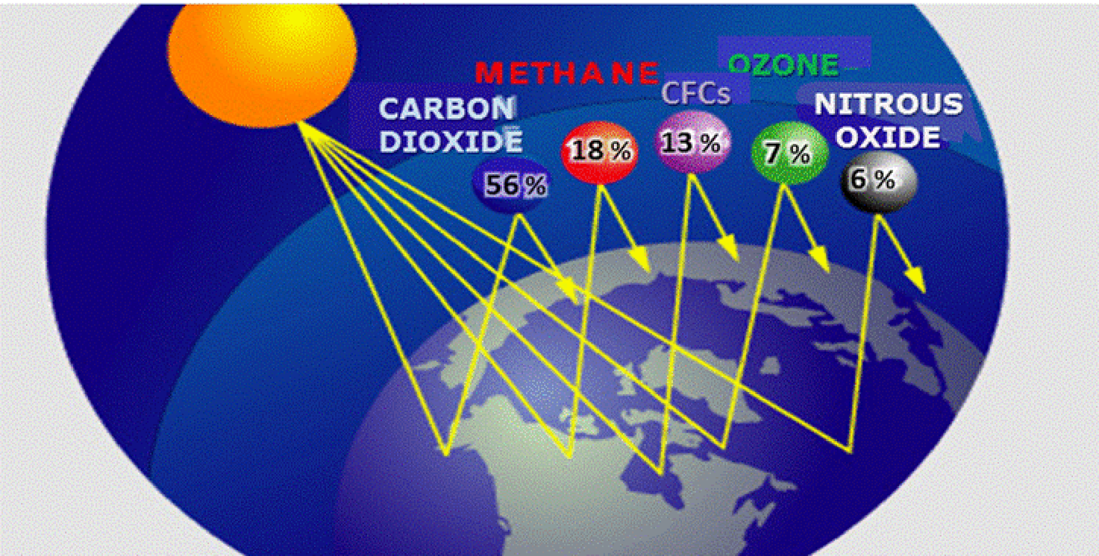
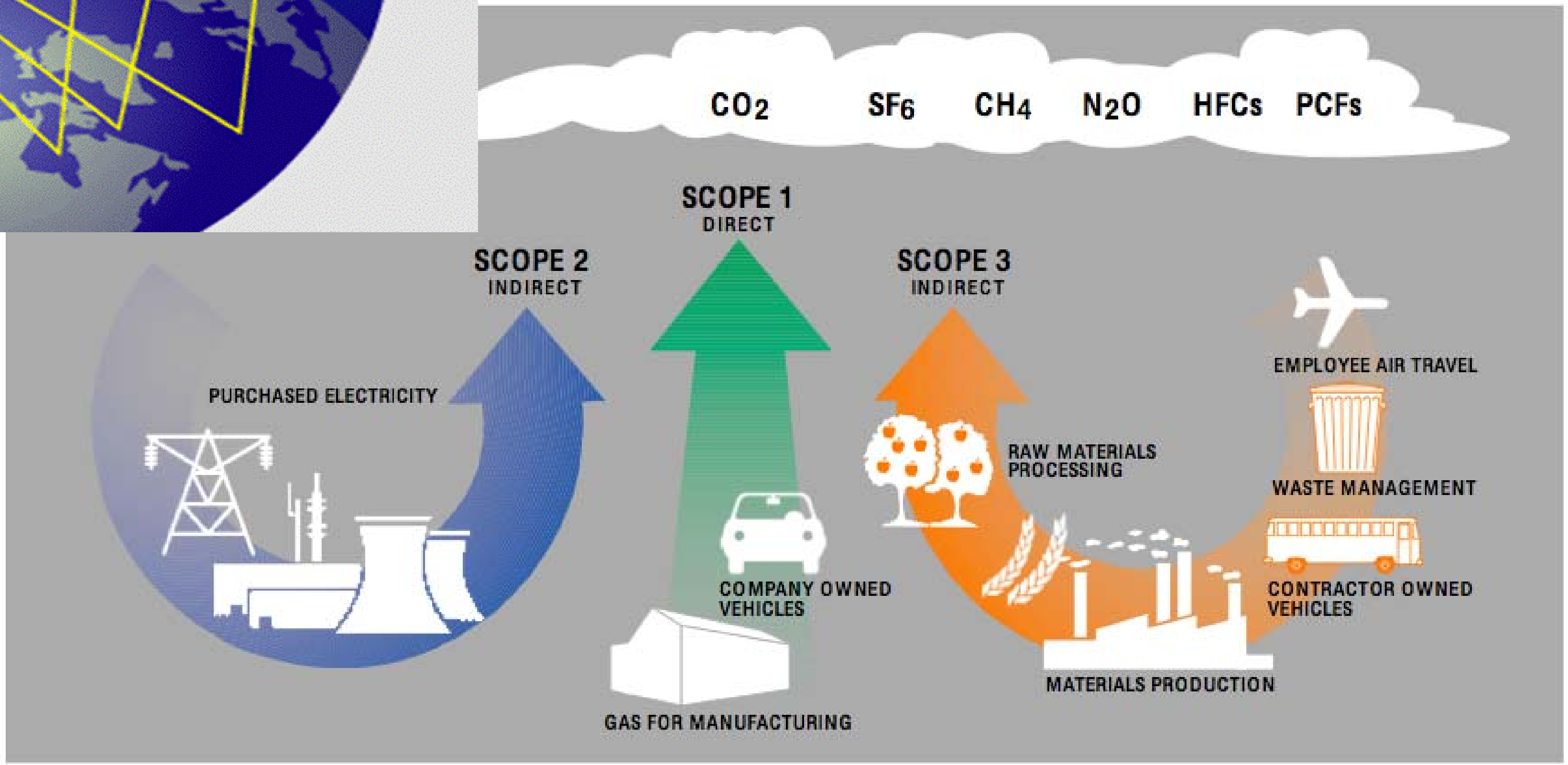
- Greenhouse Gases (GHG) emission
- Impact on the environment – EU ETS – the system of charges
- LCA Methodology
- Carbon footprint, environmental footprint
- New recommendations from the European Commission
  - take into account the history of raw materials, not only the technology itself, but also the use of the product to the exclusion of use – concept: from cradle to grave
- It is necessary to develop a single European LCA methodology

GHGs relative contribution to global warming

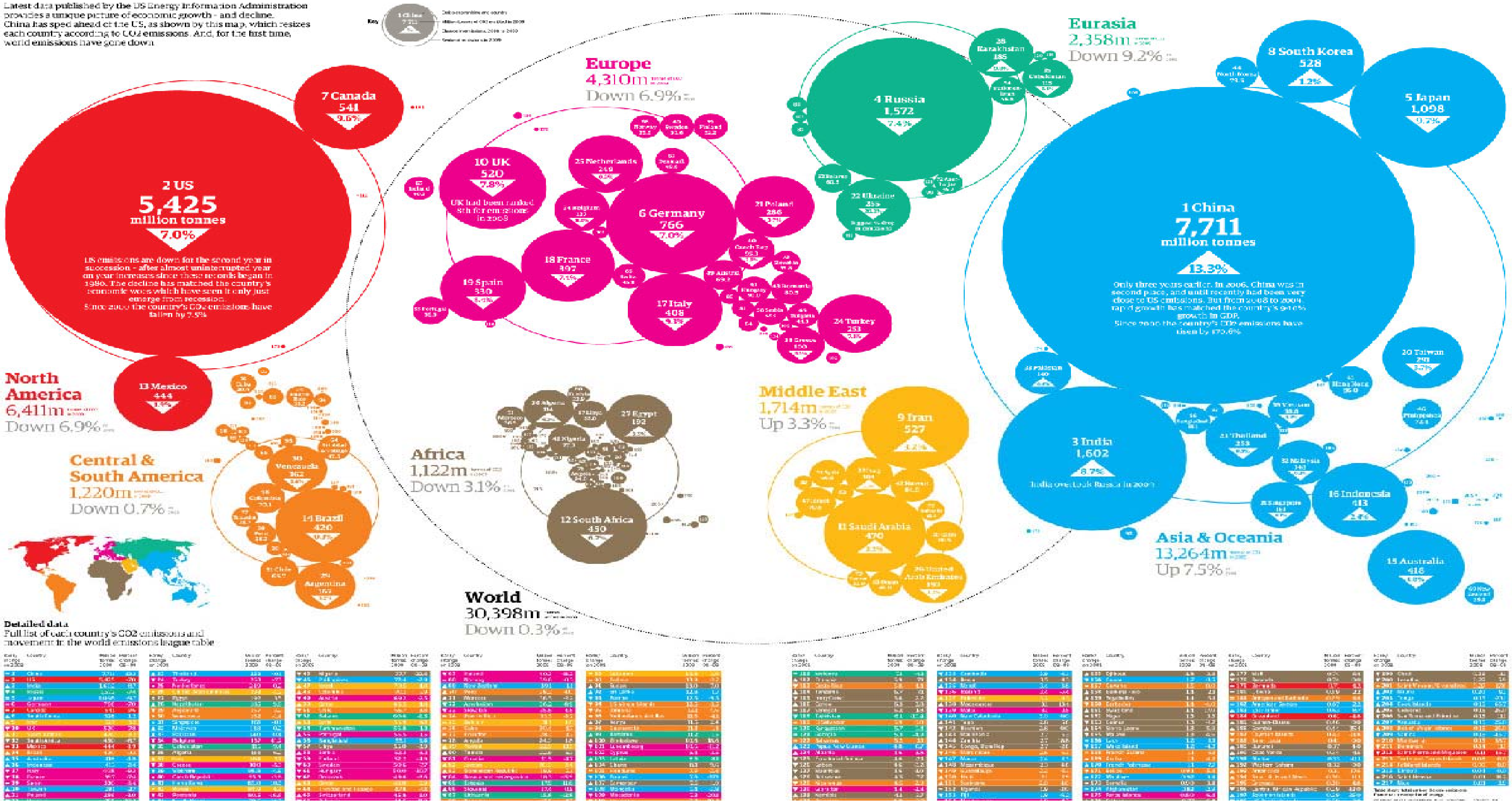
National Science Museum





An atlas of pollution: the world in carbon dioxide emissions

Latest data published by the US Energy Information Administration provides a unique picture of economic growth – and decline. China has sped ahead of the US, as shown by this map, which resizes each country according to CO2 emissions. And, for the first time, world emissions have gone down



Data summary

Carbon Dioxide emissions by country
Click heading to sort. Download this data

Table id	Rank, 2009	Country or region	2008, mil tonnes	2009, TOTAL, mil tonnes	2009, per capita, tonnes	% change, 2008 to 2009
225		**World**	**30,493.23**	**30,398.42**	**4.49**	**-0.3**
179		**Asia & Oceania**	**12,338.41**	**13,264.09**	**3.53**	**7.5**
188	1	China	6,803.92	7,710.50	5.83	13.3
1		**North America**	**6,885.07**	**6,410.54**	**14.19**	**-6.9**
7	2	United States	5,833.13	5,424.53	17.67	-7
54		**Europe**	**4,628.98**	**4,310.30**	**7.14**	**-6.9**
91		**Eurasia**	**2,595.86**	**2,358.03**	**8.32**	**-9.2**
107		**Middle East**	**1,658.55**	**1,714.09**	**8.22**	**3.3**
194	3	India	1,473.73	1,602.12	1.38	8.7
102	4	Russia	1,698.38	1,572.07	11.23	-7.4
8		**Central & South America**	**1,228.65**	**1,219.78**	**2.57**	**0.7**
122		**Africa**	**1,157.71**	**1,121.59**	**1.13**	**-3.1**
196	5	Japan	1,215.48	1,097.96	8.64	-9.7
67	6	Germany	823.07	765.56	9.30	-7
3	7	Canada	598.46	540.97	16.15	-9.6
199	8	Korea, South	521.77	528.13	10.89	1.2
109	9	Iran	510.61	527.18	6.94	3.2
90	10	United Kingdom	563.88	519.94	8.35	-7.8
118	11	Saudi Arabia	455.62	470.00	18.56	3.2
169	12	South Africa	482.88	450.44	9.18	-6.7
5	13	Mexico	452.05	443.61	3.99	-1.9
17	14	Brazil	421.60	420.16	2.11	-0.3
182	15	Australia	425.34	417.68	19.64	-1.8
195	16	Indonesia	403.74	413.29	1.72	2.4
73	17	Italy	449.75	407.87	7.01	-9.3
66	18	France	428.54	396.65	6.30	-7.4
86	19	Spain	360.13	329.86	7.13	-8.4
217	20	Taiwan	301.94	290.88	12.66	-3.7
80	21	Poland	294.78	285.79	7.43	-3
105	22	Ukraine	355.48	255.07	5.58	-28.2
218	23	Thailand	253.55	253.38	3.80	-0.1
89	24	Turkey	272.90	253.06	3.29	-7.3
78	25	Netherlands	249.50	248.91	14.89	-0.2
120	26	United Arab Emirates	195.85	193.43	40.31	-1.2
138	27	Egypt	185.85	192.38	2.44	3.5

EMISSIONS TRADING SYSTEM: EMISSION PERMISSION AS A NEW ECONOMIC AND LEGAL TOOL

Emissions trading is the market

1. Very diversified:
   1. Large power installations and oil refineries
   2. Very small ceramic kilns
   3. International capital groups
   4. Small family businesses
2. Very shaky and unbalanced:
   1. Significant impact of EC administrative decisions and EU governments on market size.
   2. The prices vary from € 9 to almost € 30 to fall to € 18-22.
3. Decisive about the competitiveness of the economy or industry
4. Requires transparency and credibility

FEARS OF GLOBAL WARMING AND HALT CLIMATE CHANGE HAVE BECOME ONE OF THE KEY ISSUES IN GLOBAL POLITICS

- **In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was signed - briefly the Climate Convention.**
- **In 1997, industrialized countries and transition economies agreed to reduce greenhouse gas emissions of the GHG - the Kyoto Protocol was signed.**

KYOTO PROTOCOL (KP) AND EU ETS

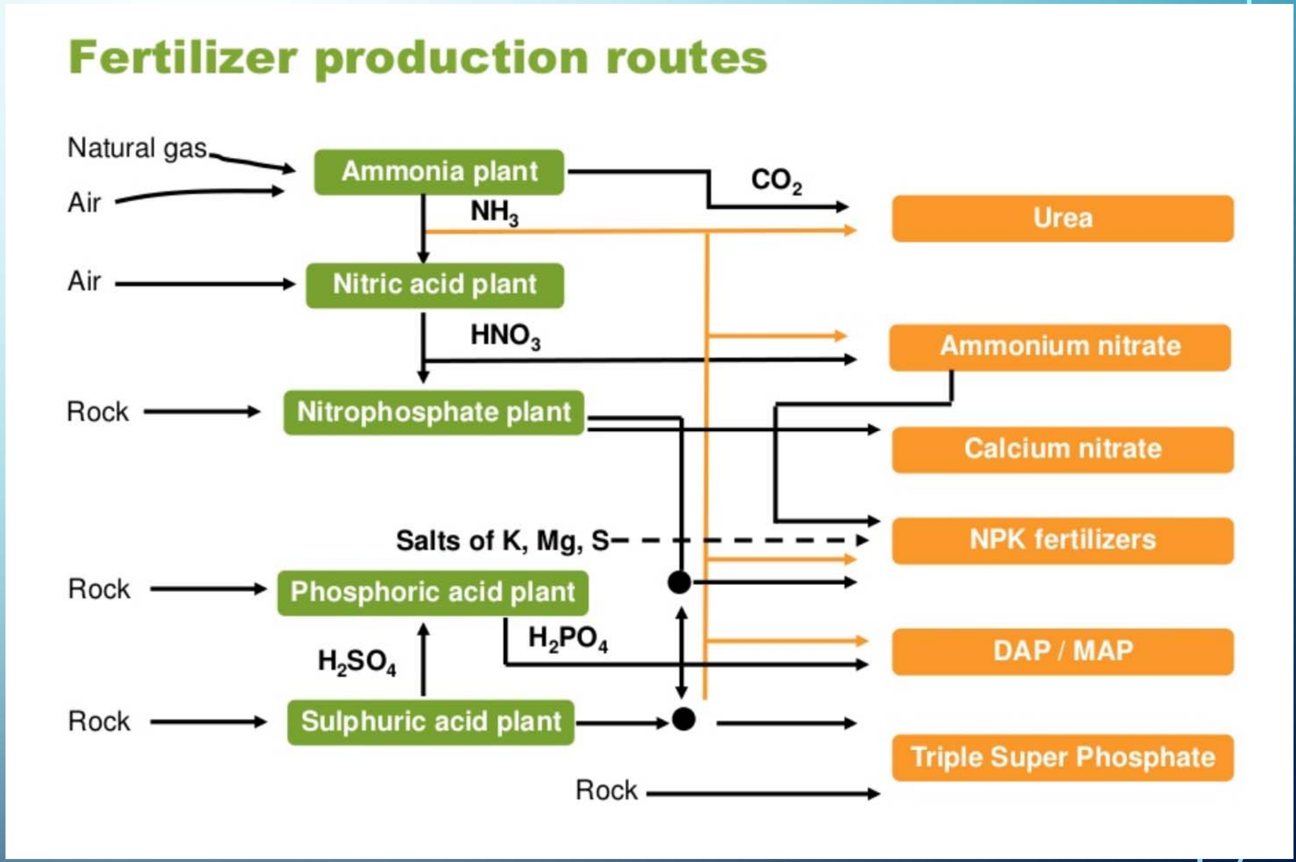
- The Kyoto Protocol has been in force since February 16, 2005, as a legal act of international law - published in DU No. 203 of 2005 item. 1684
- KP introduced three flexible mechanisms:
  - International Emission Trading - ET,
  - Joint implementations - JI, and
  - Clean Development Mechanism – CDM
- Since 1999, the European Community has been considering the introduction of a trading system for emissions at the enterprise level.
- In March 2003, Emission Trading Directive 2003/87 was adopted

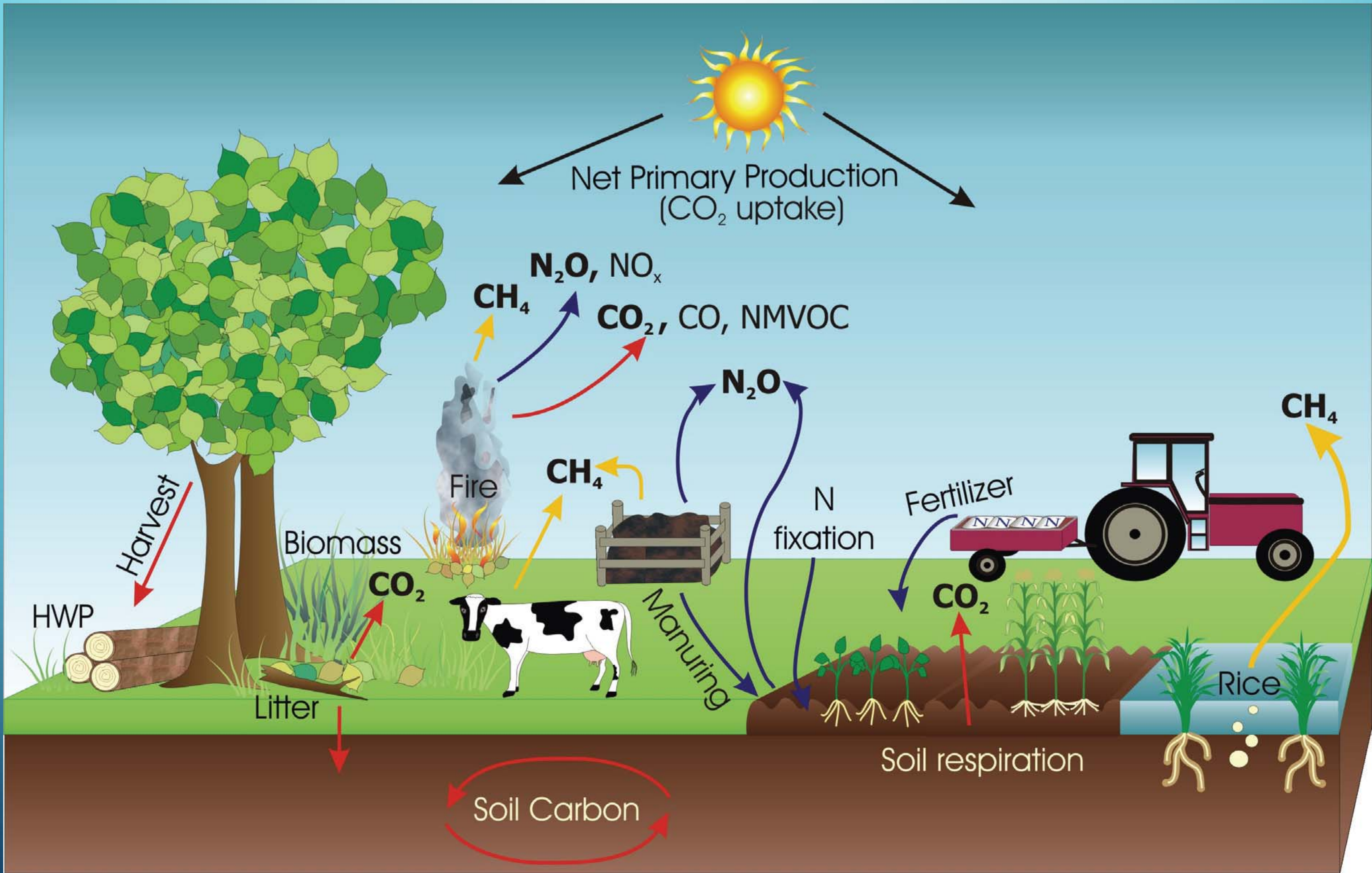
Greenhouse gases
GWP - Global Warming Potential
CO2e - CO2 equivalent

GAS	GWP / CO_2e
CO_2	1
CH_4	21
N_2O	296
HFC	150 – 11 700
PFC	6 500 – 9 200
SF_6	23 900

FERTILIZER TECHNOLOGIES…

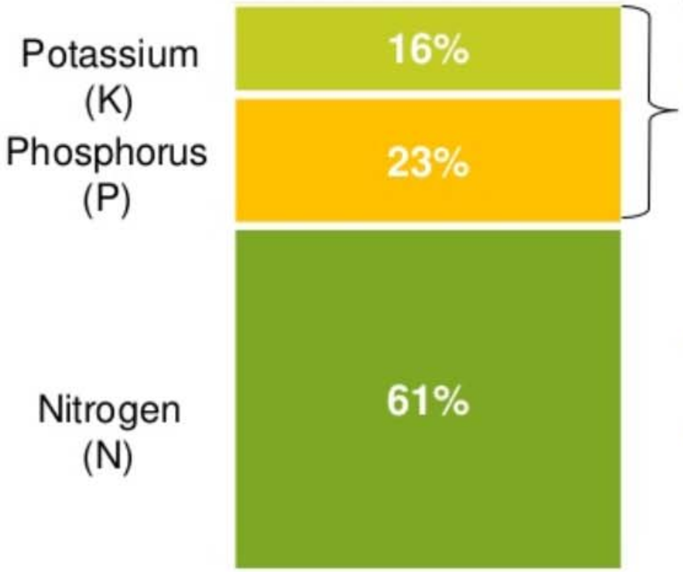
Should the fertilizer industry pay a fee for CO_2 emissions?





Net Primary Production
(CO_2 uptake)
N_2O, NO_x
CH_4
CO_2, CO, NMVOC
N_2O
CH_4
CH_4
Fire
Harvest
Biomass
CO_2
HWP
Litter
Manuring
N
fixation
Fertilizer
CO_2
Rice
Soil respiration
Soil Carbon

Nitrogen – the most important nutrient



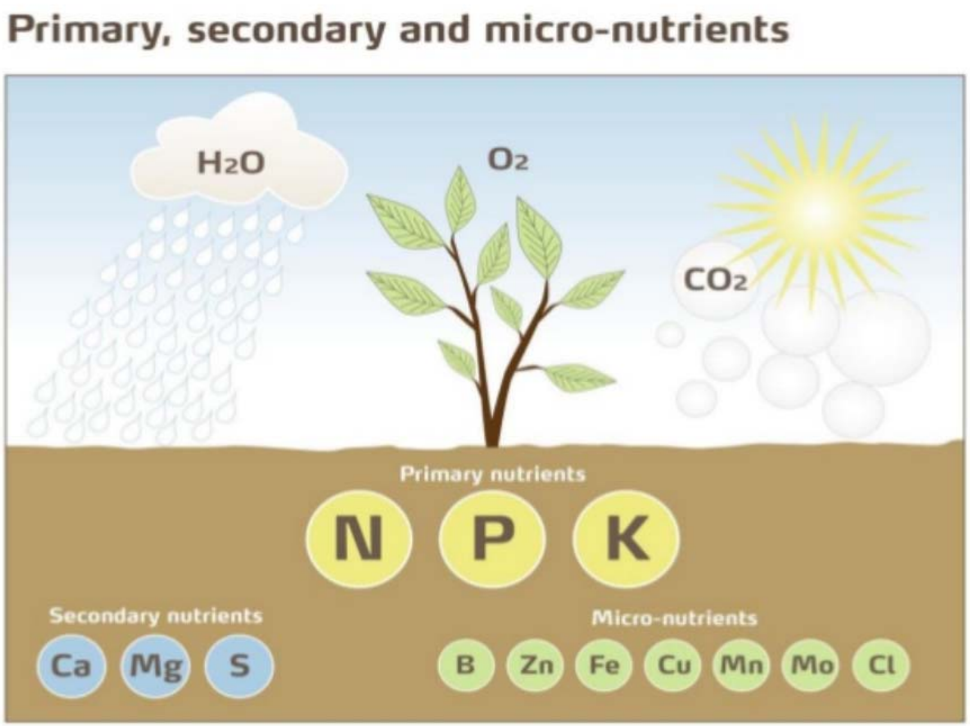
Total 176 million tons nutrients

Nutrient characteristics

	Primary benefit	Application	Industry structure
Potassium (K), Phosphorus (P)	• Improve crop quality	• Annual application not always done	• Fewer suppliers, production discipline
Nitrogen (N)	• Increase crop size • Most important and commonly lacking nutrient	• Annual application critical	• Industry more fragmented, under consolidation • More dynamic prices, but stable volume

What is fertilizer?

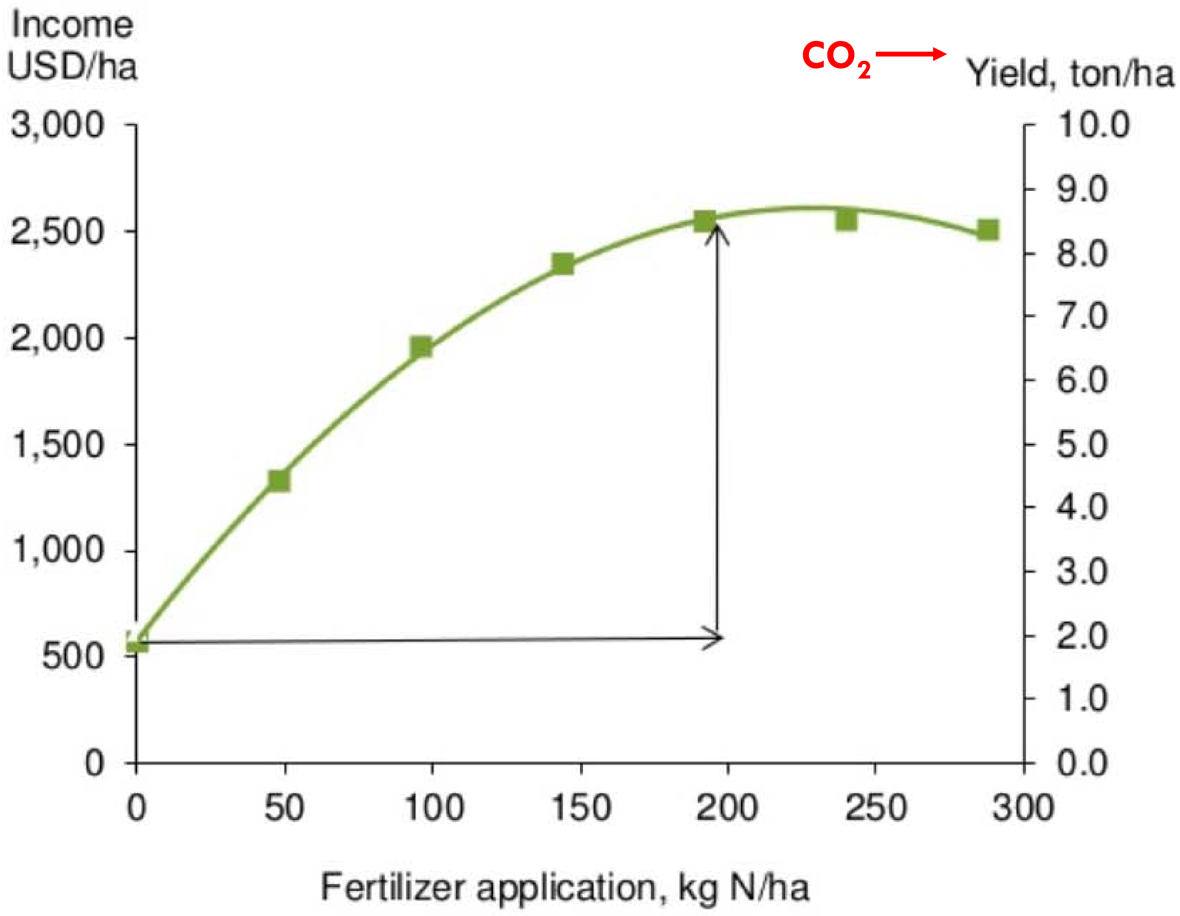
Photosynthesis: $CO_2 \Rightarrow C_{Biomass} + O_2$



Nitrogen is the main driver of yield

Profitability of investment in mineral fertilizers

Yield response (monetary value) to N fertilizer rate



- The investment in nitrogen fertilizer is highly profitable for growers
- Fertilizer investment: 248 USD/ha
- Net return: 1,711 USD/ha
- **Net return > 7 x investment**

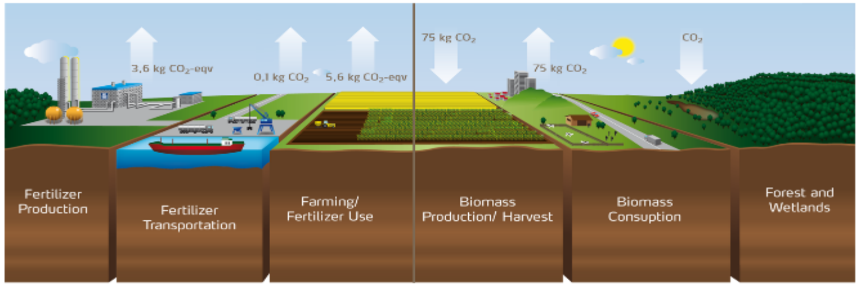
In biomass: 40-50 % C

Photosynthesis: CO_2=> $C_{Biomass}$+O_2

$CO_{2\ assimilation}$~Crop

Life Cycle Analysis of Ammonium Nitrate

The images illustrate the life cycle of ammonium nitrate (AN), the most common source of nitrogen in European agriculture.



It can be found in fertilizer products such as YaraBela, YaraMila, UNIKA KALI and others. It explains the carbon footprint from production, transportation and application, to growing of crops, their consumption as food, feed or bio-energy, and the protection of natural CO_2 sinks such as forests and wetlands.

To make different GHGs comparable, they are converted into CO_2 equivalents (CO_2-eqv).

1 kg N_2O = 296 kg CO_2 eqv

Which means it has a 296 times stronger effect on the climate than CO_2. All data are expressed per kg of nitrogen applied.

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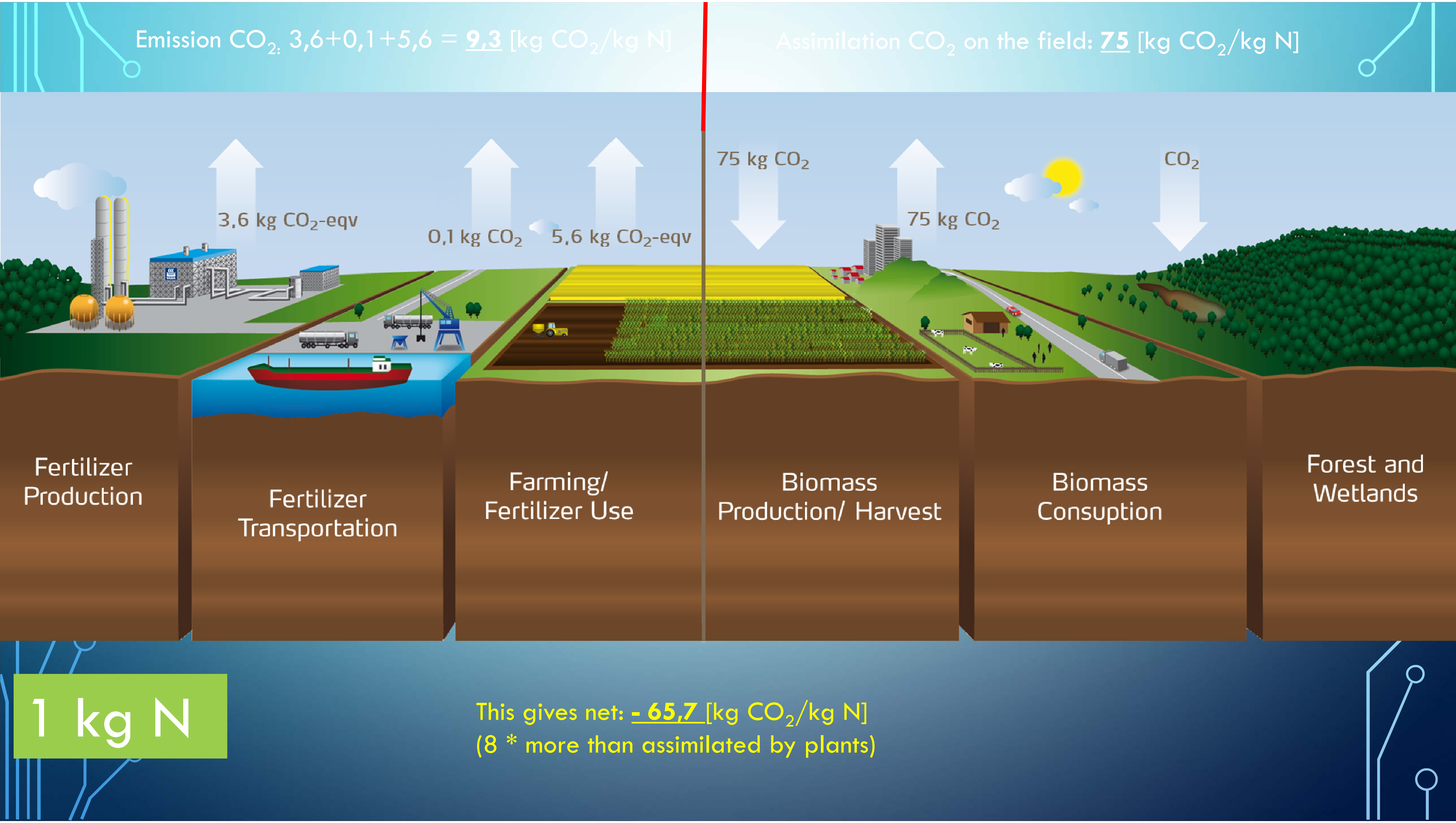
Safety Data Sheets


Emission CO_2: 3,6+0,1+5,6 = 9,3 [kg CO_2/kg N]
Assimilation CO_2 on the field: 75 [kg CO_2/kg N]
3,6 kg CO_2-eqv
0,1 kg CO_2
5,6 kg CO_2-eqv
75 kg CO_2
75 kg CO_2
CO_2
Fertilizer Production
Fertilizer Transportation
Farming/ Fertilizer Use
Biomass Production/ Harvest
Biomass Consuption
Forest and Wetlands
1 kg N
This gives net: - 65,7 [kg CO_2/kg N]
(8 * more than assimilated by plants)

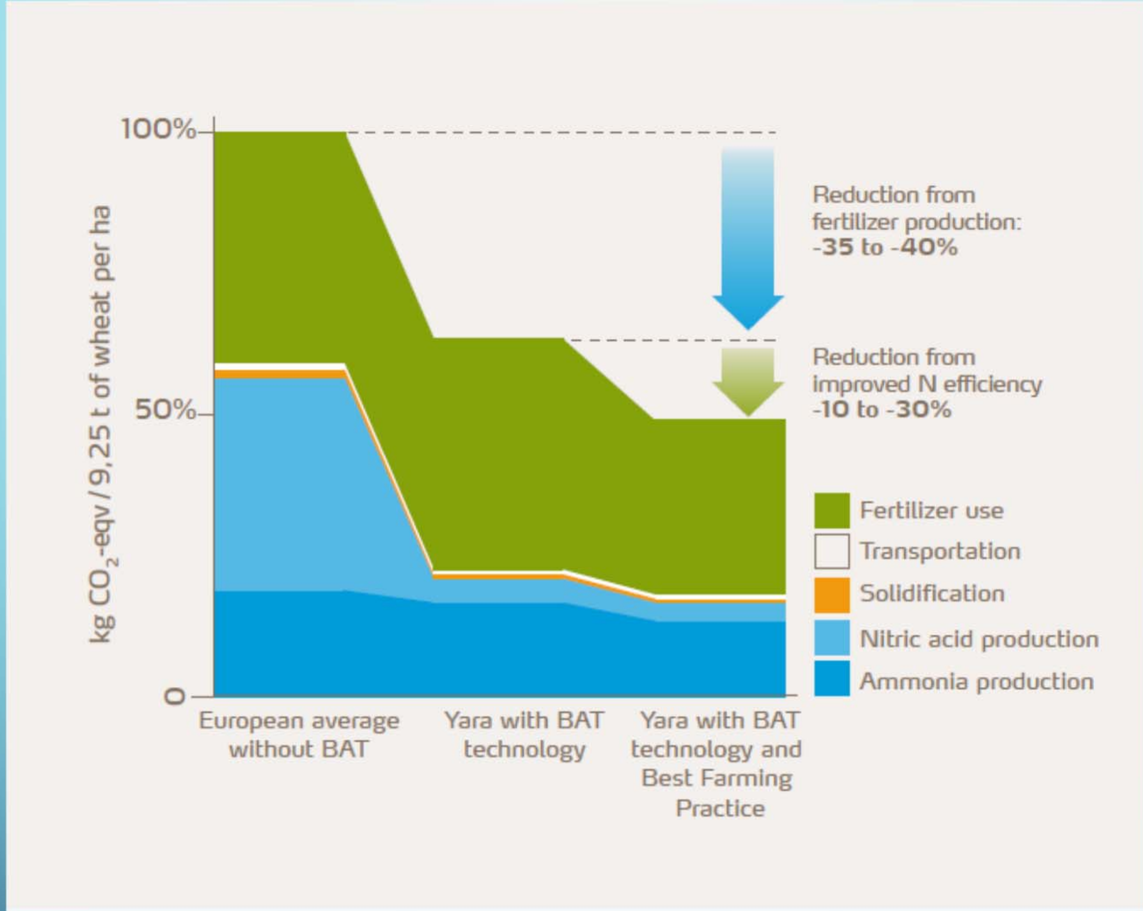


FIGURE 6: Yara has reduced the carbon footprint of nitrate fertilizer production by 35 - 40%. Enhancing N efficiency in fertilizer use can contribute by another 10-30%

Ⓐ FERTILIZER PRODUCTION

When operating with 'Best Available Technique' (BAT) ammonia and nitric acid plants, the total carbon footprint of AN is 3.6 kg CO_2-eqv per kg N.

Ammonia production

Binding nitrogen from the air requires energy. Natural gas is the most efficient energy source. Yara plants are among the best performers in terms of energy efficiency worldwide.

- European average energy consumption: 35.2 GJ per ton ammonia
- EU BAT energy consumption: 31.8 GJ per ton ammonia (= 2.2 kg CO_2 per kg N in AN)

Nitric acid production

Nitric acid is used for making AN-based fertilizers. Its production releases N_2O. Catalytic cleansing developed by Yara reduces N_2O emissions below BAT level.

- N_2O emission without cleansing: 7.5 kg N_2O per ton nitric acid
- EU BAT emission with cleansing: 1.85 kg N_2O per ton nitric acid (= 1.3 kg CO_2-eqv per kg N in AN)

Solidification

AN solutions made from ammonia and nitric acid are granulated or prilled to form high-quality solid fertilizer. Solidification needs energy.

- European average energy consumption: 0.5 GJ per ton of product (= 0.1 kg CO_2 per kg N in AN)

MITIGATION POTENTIAL:

- Improve the energy efficiency of ammonia production and other production systems
- Install and further optimize catalytic cleansing of N_2O

Ⓑ TRANSPORTATION

Ammonium nitrate is transported by ship, barge, road or rail.

- European average: 0.1 kg CO_2 per kg N

MITIGATION POTENTIAL:

- Optimize logistics chain from production sites to farmers

Ⓒ FERTILIZER USE

Nitrogen, whether from organic or inorganic sources, is subject to natural microbial conversion in the soil. During this process N_2O can be lost to the air. In addition, CO_2 is also released by liming and farming machinery.

- Average footprint for AN: 5.6 kg CO_2-eqv per kg N

MITIGATION POTENTIAL:

- Assure balanced nutrition
- Tailor N-application according to actual crop needs
- Use placement fertilization when appropriate
- Just-in-time application to ensure rapid uptake
- Use of precision farming tools (N-Sensor, N-Tester, online applications)
- Maintain good soil structure (draining, avoid packing)
- Select appropriate fertilizer (AN or CAN based rather than ammonium or urea)
- Efficient manure management

Ⓓ BIOMASS PRODUCTION

Plants capture large amounts of CO_2 during growth. Optimum fertilization can increase biomass production, and thus CO_2 uptake, by a factor of 4-5 compared to fields that remain long-term unfertilized. For example, at a yield of 8 t / ha achieved with 170 kg N / ha, the grain fixes 12 800 kg / ha of CO_2. This corresponds to 75 kg of CO_2 fixed per kg of N applied.

- Example footprint: -75 kg CO_2-eqv per kg N

MITIGATION POTENTIAL:

- Ensure optimal fertilization to increase biomass production and CO_2 uptake per ha.
- Avoid land-use change at one place to compensate for reduced efficiency at another place
- Preserve and improve soil carbon stocks by increased inputs of organic material to the soil (e.g. residues) and conservation tillage techniques
- Catch and cover vegetation in between actual crops in order to reduce N leaching losses and to produce additional CO_2-fixing biomass
- Restore degraded agricultural land

Ⓔ BIOMASS CONSUMPTION

Most of the biomass produced is consumed as food or feed. CO_2 fixation is therefore only short term and cannot be considered a saving on a global scale. The balance is different for bio-energy since it avoids the burning of fossil fuels. For example, using biomass instead of mineral oil for heating purposes reduces the CO_2 emission by as much as 70-80%.

MITIGATION POTENTIAL:

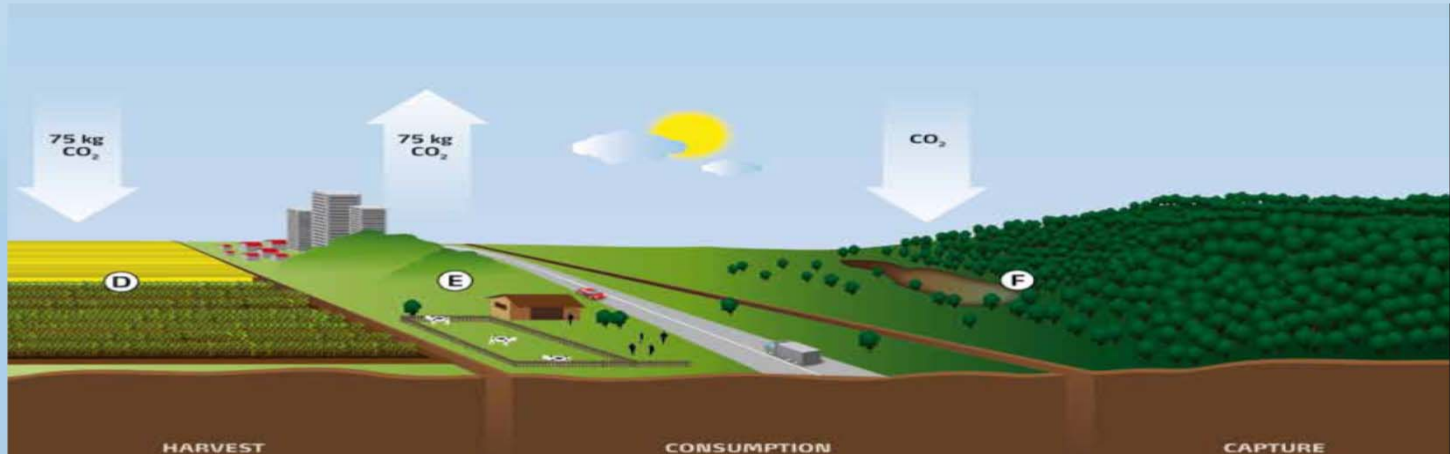
- Optimize efficiency of bio-energy production
- Increase productivity in food and feed production, allowing more acreage for bio-energy production

Ⓕ FOREST AND WETLANDS

Forests and wetlands store 2-8 times more CO_2 than croplands. Land use change, mainly due to burning of tropical forests, is a large source of CO_2 emissions, accounting for 20% of manmade CO_2 emissions. Preserving tropical and boreal forests is the most important contribution to mitigate climate change.

MITIGATION POTENTIAL:

- Protect tropical forests and wetlands
- Reforestation, restoration of wetlands
- Forest fertilization to increase long-term carbon capture
- Avoid further land-use change by increasing productivity on existing agricultural land



fertilizers europe

ENERGY EFFICIENCY AND GREENHOUSE GAS EMISSIONS

IN EUROPEAN NITROGEN FERTILIZER PRODUCTION AND USE

SUSTAINABLE AGRICULTURE IN EUROPE

At a yield of 18.5 t/ha (grain plus non-grain biomass including straw at economic optimum N rate) this amounts to 29.6 t CO_2 fixation per hectare (i.e. almost 12 times the CO_2 emissions).

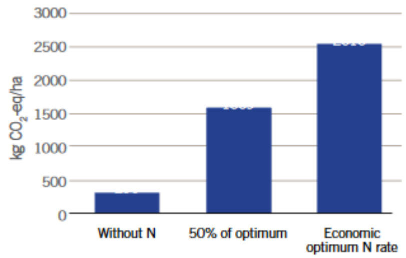
If this biomass is used as biofuel (e.g. for direct incineration) and thereby prevents fossil fuels from being burned, a substantial net saving of CO_2 emissions is the result. However, by far most of the grain is still consumed as food or feed and in this case the CO_2 fixation is only short to medium-term and is usually not considered as a credit.

Assuming that most farmers in the developed countries operate at an intensity represented by the 'economic optimum N rate', which is equivalent to recommended 'good agricultural practice', and considering the current and future demand for cereals as indicated in Figure 2, any reduction in the production intensity in one area has to be compensated by additional production at another. In many cases this results in changes in land use from natural areas into agricultural land (FAO, (2006b) and Fig. 2).

Figure 8 shows the additional CO_2 emissions that would occur due to conversion of temperate forest into cropland in order to compensate for the lower yields in the 'without N' and '50% of optimum' treatments

Figure 7

GREENHOUSE GAS EMISSIONS OF WHEAT PRODUCTION (INCLUDING PRODUCTION AND TRANSPORT OF FARMING INPUTS) AT DIFFERENT N FERTILIZATION INTENSITIES

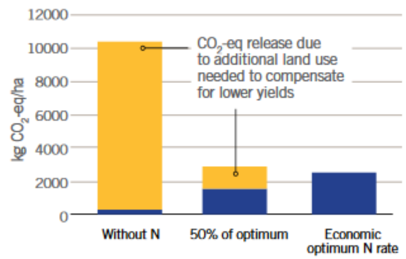


(based on data in Bellarby et al., 2008). The additional CO_2-eq emissions due to land use change has been spread over a time period of 100 years (i.e. 2.6 t CO_2/ha/yr).

Without any nitrogen input, the grain yield is so low (2.07 t/ha) that the land required to compensate this yield loss would lead to four times higher CO_2 emissions than those of the intensive system.

Figure 8

GREENHOUSE GAS EMISSIONS OF WHEAT PRODUCTION (INCLUDING PRODUCTION AND TRANSPORT OF FARMING INPUTS AND LAND USE CHANGE) AT DIFFERENT N FERTILIZATION INTENSITIES.



CO_2 has numerous industrial applications

Food additive:
High-quality CO_2
for beverage carbonisation

Food care:
CO_2 for greenhouses, chilling and freezing, processing and transport

Animal care:
Controlled atmosphere for livestock stunning

Manufacturing:
Welding and cutting gases

Blasting :
Multipurpose cleaning

Industries Served :

- ✓ Breweries
- ✓ Dairies
- ✓ Bakeries
- ✓ Meat and Poultry processing
- ✓ Fish Farming and processing
- ✓ Greenhouses
- ✓ Airline catering
- ✓ Refrigerated transport

IF CARBON DIOXIDE IS SO BAD FOR THE PLANET, WHY DO GREENHOUSE GROWERS BUY CO_2 GENERATORS TO DOUBLE PLANT GROWTH?

- **CO_2 is a plant NUTRIENT.**

  CO_2 actually increases plant yields, accelerates "re-greening" and improves reforestation. Today's atmosphere contains 400 ppm CO_2, CO_2 generators can help raise that level to 1500 ppm inside greenhouses, thereby **accelerating plant growth and food production.**

CO₂ GENERATORS & WATER STORAGE TANKS

111081/
111082

111114

Improve plant quality, while increasing production with Johnson Gas CO_2 Generators. These generators automatically provide the carbon dioxide needed to meet maximum growing potential for only pennies per day.

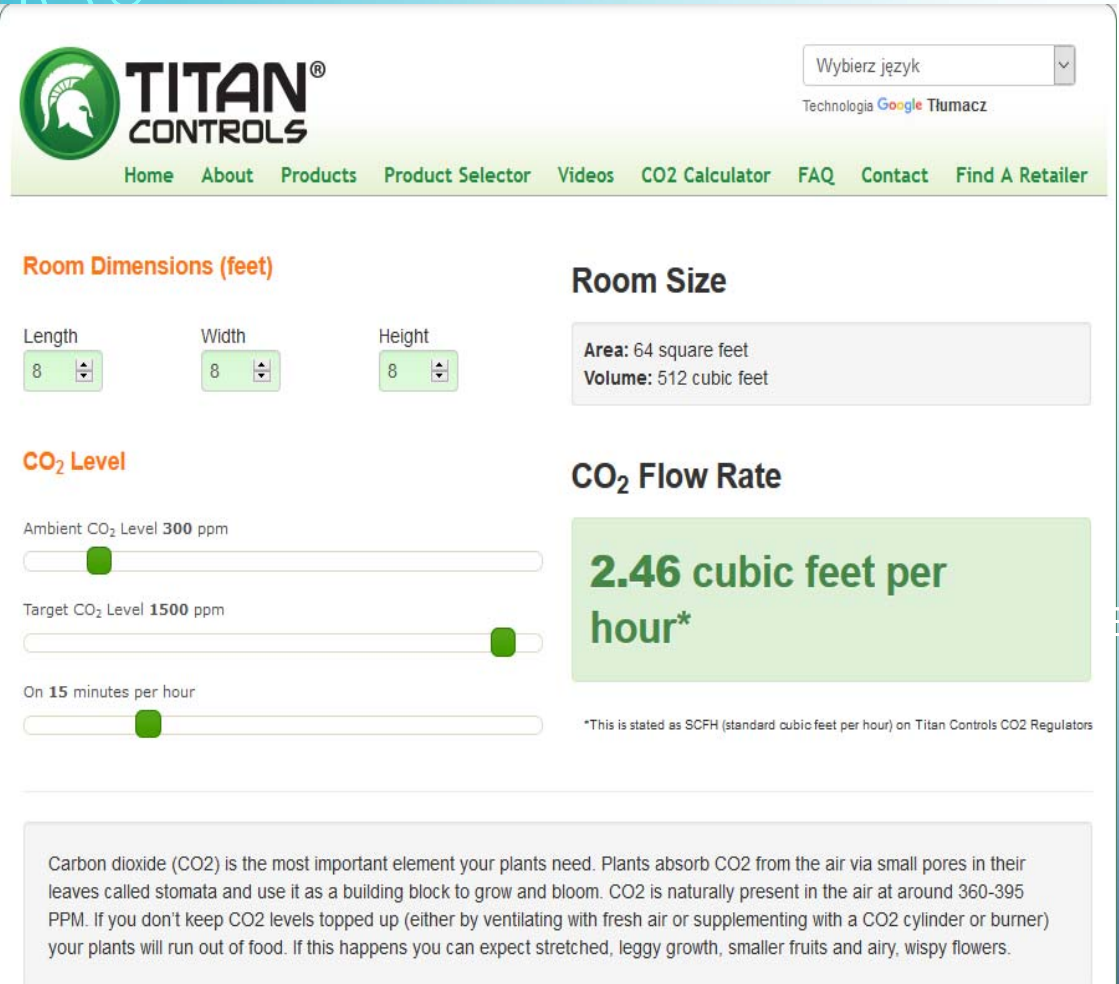
- Easy to install in any greenhouse, without expensive duct work.
- CO_2 is diffused evenly throughout greenhouse. No supplemental fans required.
- Small size for easy movement.
- Constructed from high-quality steel for corrosion resistance and long life.
- Controls subject to rigorous testing during production to ensure safe and proper operation.
- Automatic gas shut-off in case of pilot failure.
- Based on one air exchange per hour, 1,500 ppm can be obtained per unit in a 4,800 sq. ft. greenhouse or an equivalent 50,000 cu. ft. volume.
- Transformer is required for operation. Can operate up to three units with one transformer. 115V/24V, 40VA.
- 1 year manufacturer's warranty.

MADE IN USA

CO_2 GENERATORS

STK#	ITEM	FUEL TYPE	EACH
111081	CO_2 Generator	Propane	$729.00
111082	CO_2 Generator	Natural Gas	729.00
111114	24 V Transformer	–	49.95

Commercial greenhouse growing hydroponic tomatoes with CO_2 enriched air.



Exhale bag CO_2 system

- CO_2 generators "improve plant quality" and "increase production."

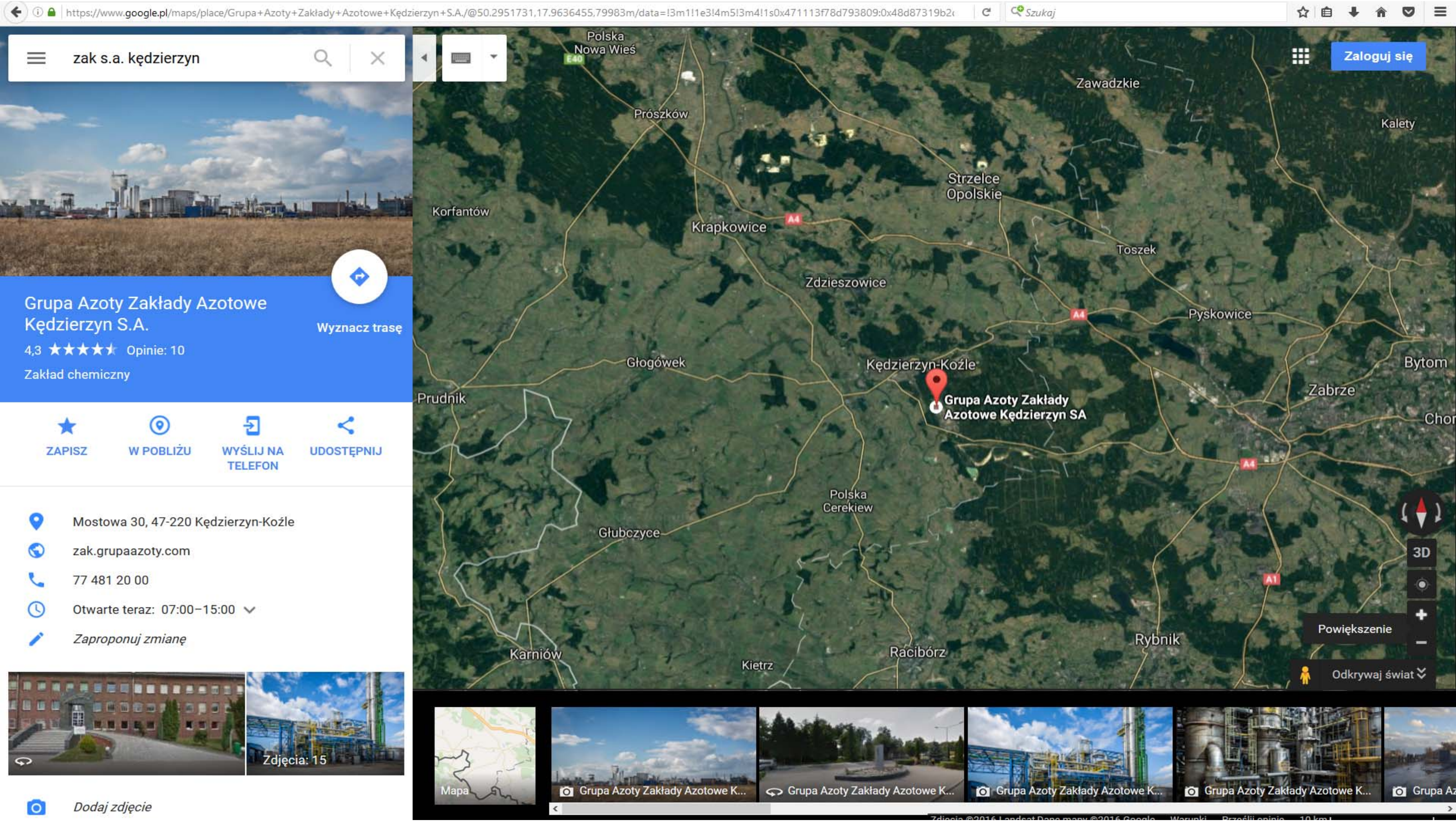
- "The benefits of carbon dioxide supplementation on plant growth and production within the greenhouse environment have been well understood for many years," says the Ontario Ministry of Agriculture and Food.

- "CO_2 increases productivity through improved plant growth and vigour. Some ways in which productivity is increased by CO_2 include earlier flowering, higher fruit yields, reduced bud abortion in roses, improved stem strength and flower size. Growers should regard CO_2 as a nutrient... **increasing the CO_2 level to 1,000 ppm will increase the photosynthesis by about 50% over ambient CO_2 levels**."


Elite's Greenhouse Solution
Multiple Resources From 1 Fuel Source
Reduce Your Carbon Footprint and Save Money!
Natural Gas
ELITE ENERGY ENGINEERING
CO2
Heat/*Cooling
w/ *absorbtion chiller
Electricity
ENVIROGEN
ENERGY MODULES
LEASING BY:
WELLS FARGO
ELITE ENERGY ENGINEERING
POWERED BY:
CAT

GREENHOUSE - TOMATOES

- Crop yield: (2 x 100 t/ha)/year
- Biomass (50 % crop): (100 t/ha)/year
- 8 t wheat grain – 13 t CO_2
- 300 t/ha – assimilation: 490 t CO_2/ha year
- Charge for emission allowances 8-14 €/t
- 16 500 – 29 000 zł/ha year + crop
- Charge/year: 2.5 mln Euro -> 440 ha (without crop)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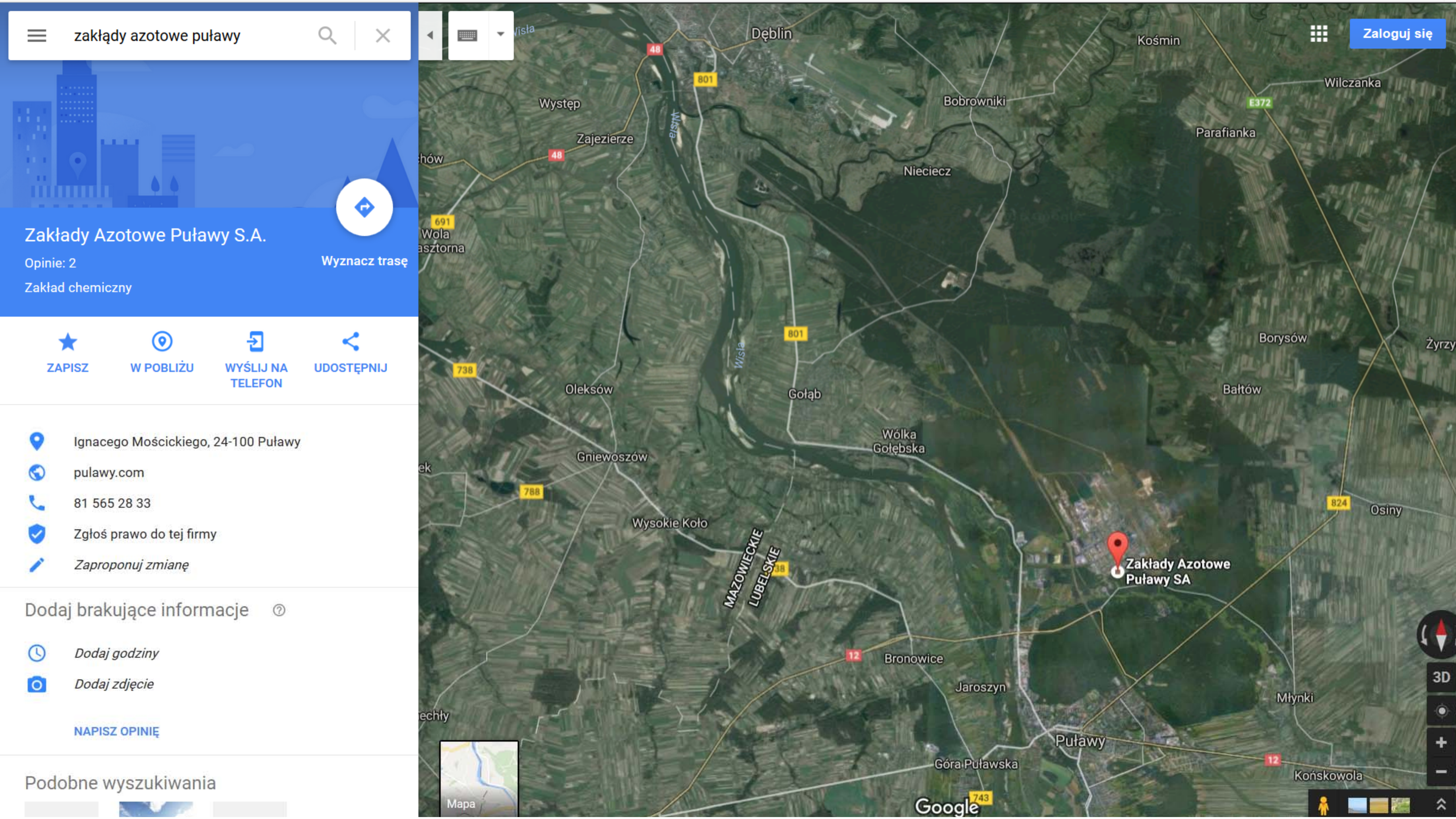
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Zakład chemiczny
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Zaloguj się
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Kośmin
Wilczanka
Występ
Bobrowniki
Parafianka
Zajezierze
Nieciecz
Wola
Oleksów
Gołąb
Borysów
Bałtów
Żyrzyn
Wólka
Gołębska
Gniewoszów
Wysokie Koło
MAZOWIECKIE
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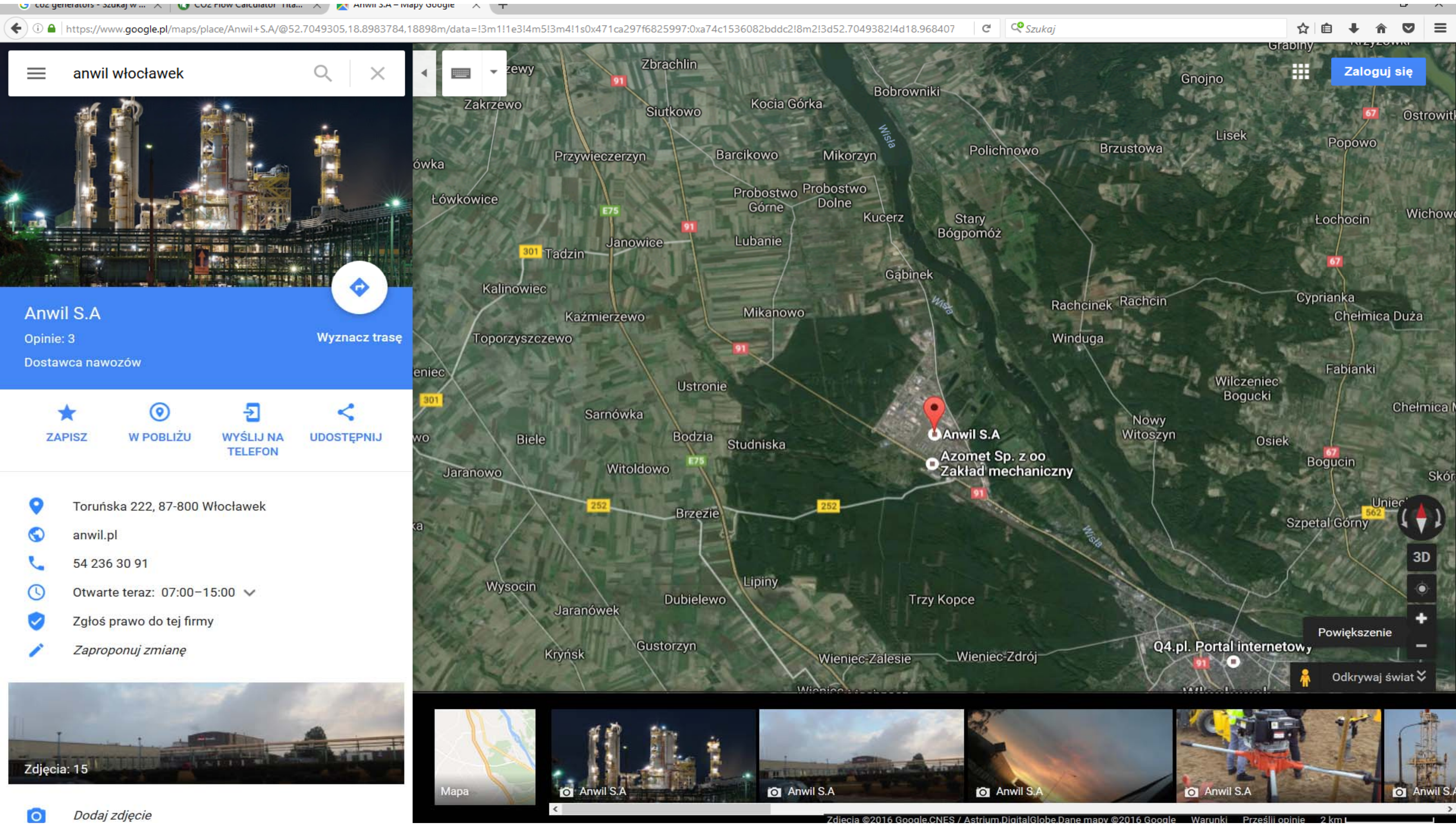
3D


https://www.google.pl/maps/place/Anwil+S.A/@52.7049305,18.8983784,18898m/data=!3m1!1e3!4m5!3m4!1s0x471ca297f6825997:0xa74c1536082bddc2!8m2!3d52.7049382!4d18.968407
Szukaj
anwil włocławek
Anwil S.A
Opinie: 3
Dostawca nawozów
Wyznacz trasę
ZAPISZ
W POBLIŻU
WYŚLIJ NA TELEFON
UDOSTĘPNIJ
Toruńska 222, 87-800 Włocławek
anwil.pl
54 236 30 91
Otwarte teraz: 07:00–15:00
Zgłoś prawo do tej firmy
Zaproponuj zmianę
Zdjęcia: 15
Dodaj zdjęcie
Zaloguj się
Zbrachlin
Bobrowniki
Zakrzewo
Siutkowo
Kocia Górka
Gnojno
Lisek
Popowo
Przywieczerzyn
Barcikowo
Mikorzyn
Polichnowo
Brzustowa
Łówkowice
Probostwo Górne
Probostwo Dolne
Kucerz
Stary Bógpomóż
Łochocin
Tadzin
Janowice
Lubanie
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Kalinowiec
Kaźmierzewo
Mikanowo
Rachcinek
Rachcin
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Chełmica Duża
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Winduga
Fabianki
Ustronie
Wilczeniec Bogucki
Sarnówka
Biele
Bodzia
Studniska
Anwil S.A
Azomet Sp. z oo Zakład mechaniczny
Nowy Witoszyn
Osiek
Bogucin
Jaranowo
Witoldowo
Brzezie
Szpetal Górny
Wysocin
Lipiny
Dubielewo
Trzy Kopce
Jaranówek
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Warunki
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2 km

ANALYSIS OF LCA FOR FERTILIZER INDUSTRY INCLUDING PLANT VEGETATION

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