Ciclo di seminari
IL POTENZIALE INNOVATIVO DELL'UNIVERSITÀ DEGLI STUDI DI MILANO E L'IMPRESA SOSTENIBILE
(Milano, 25 gennaio, 2023).

Bioeconomia e Cultura del Riciclo

GRUPPO RICICLA

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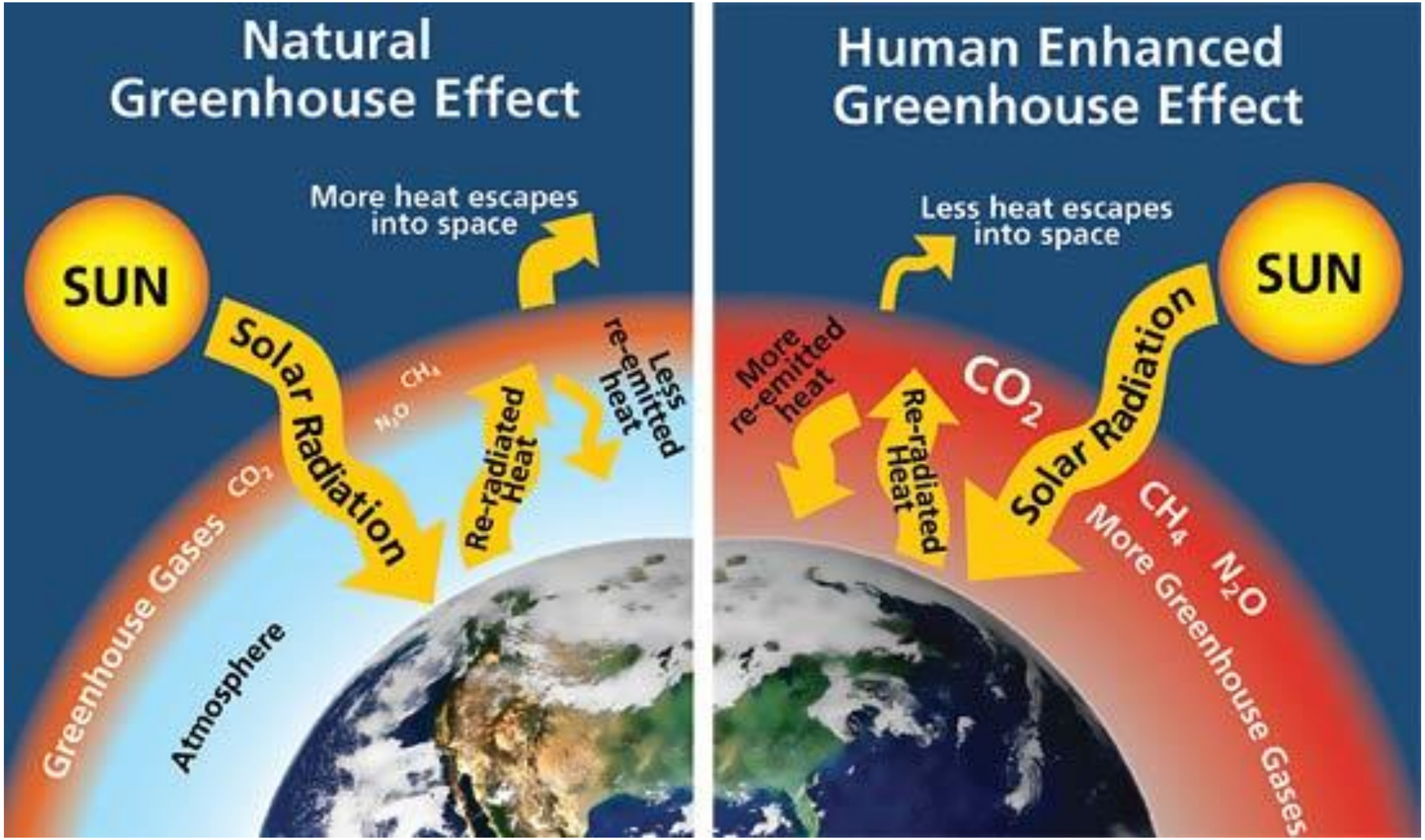
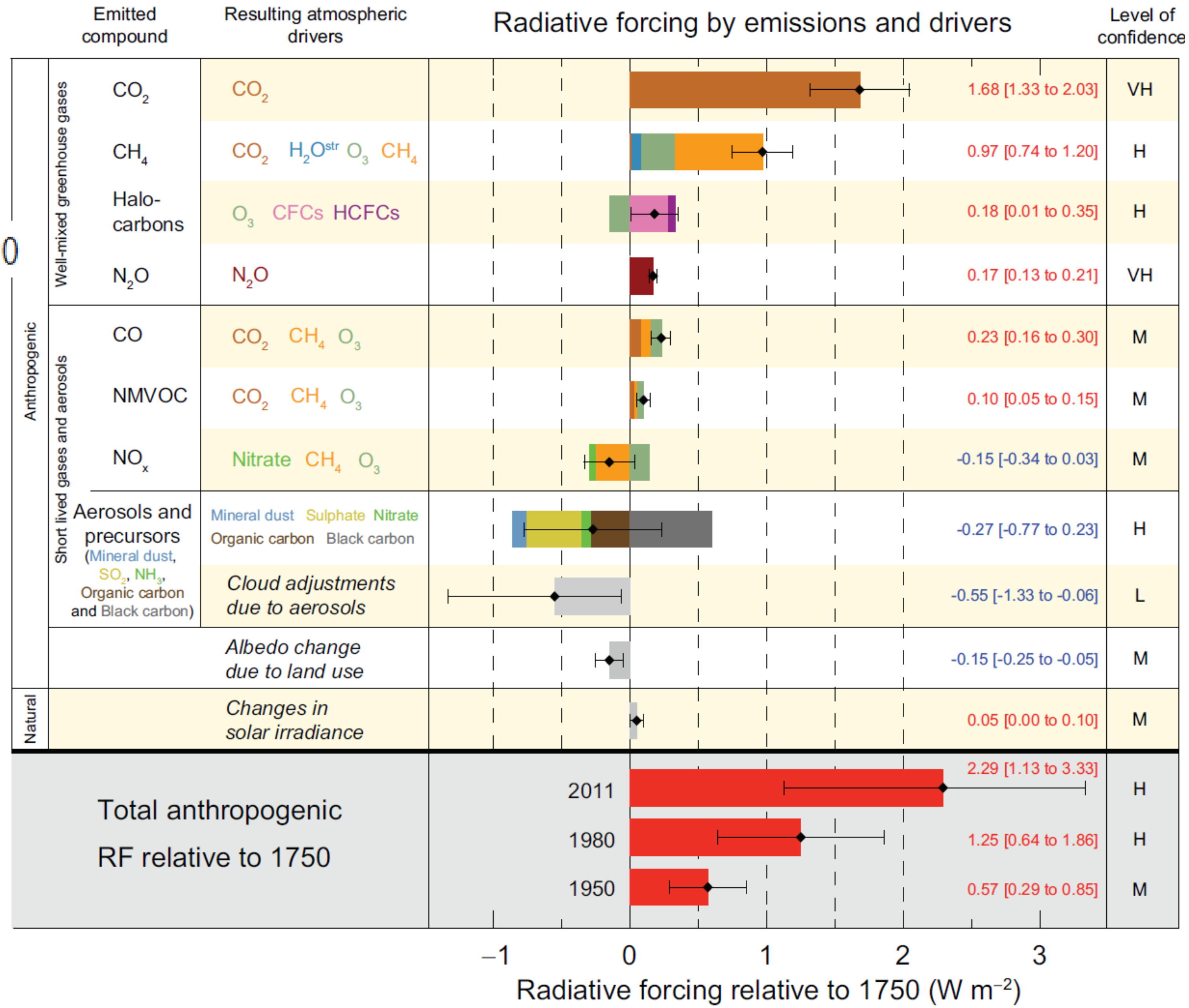
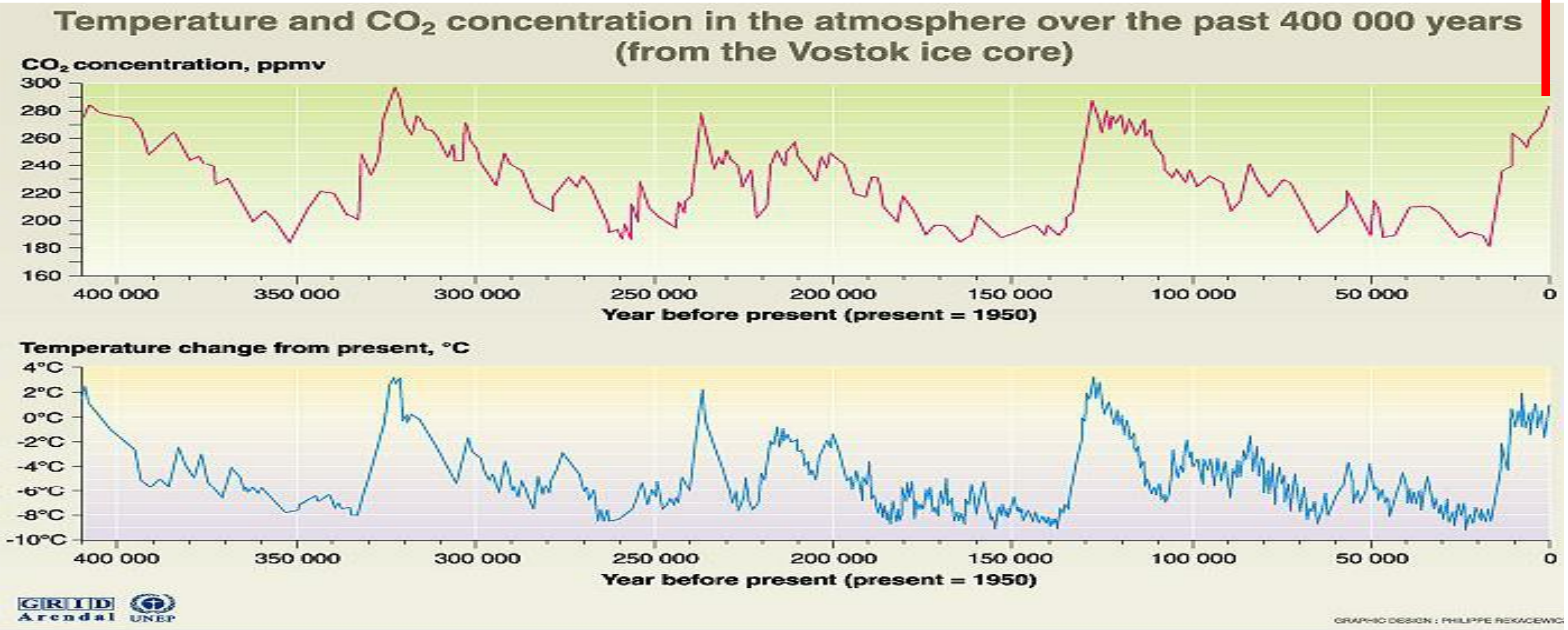

Natural Greenhouse Effect
SUN
More heat escapes into space
Solar Radiation
Re-radiated Heat
Less re-emitted heat
CH₄
N₂O
CO₂
Greenhouse Gases
Atmosphere
Human Enhanced Greenhouse Effect
Less heat escapes into space
SUN
More re-emitted heat
Re-radiated Heat
CO₂
Solar Radiation
CH₄
N₂O
More Greenhouse Gases

Radiative forcing estimates in 2011 relative to 1750 and aggregated uncertainties for the main drivers of climate change.

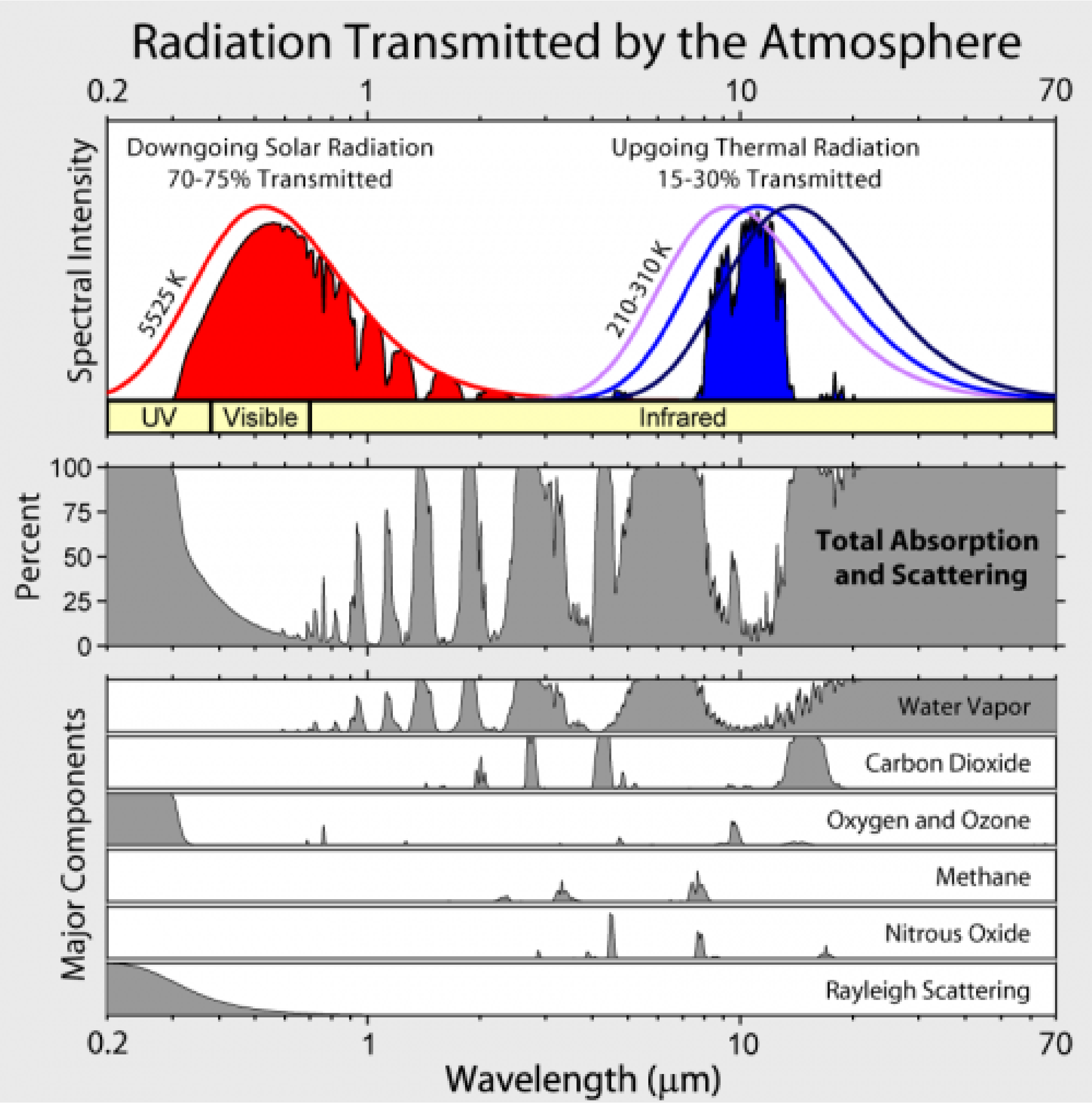


Carbon Dioxide and Temperature

“Business as Usual”
(fossil intensive)
2100



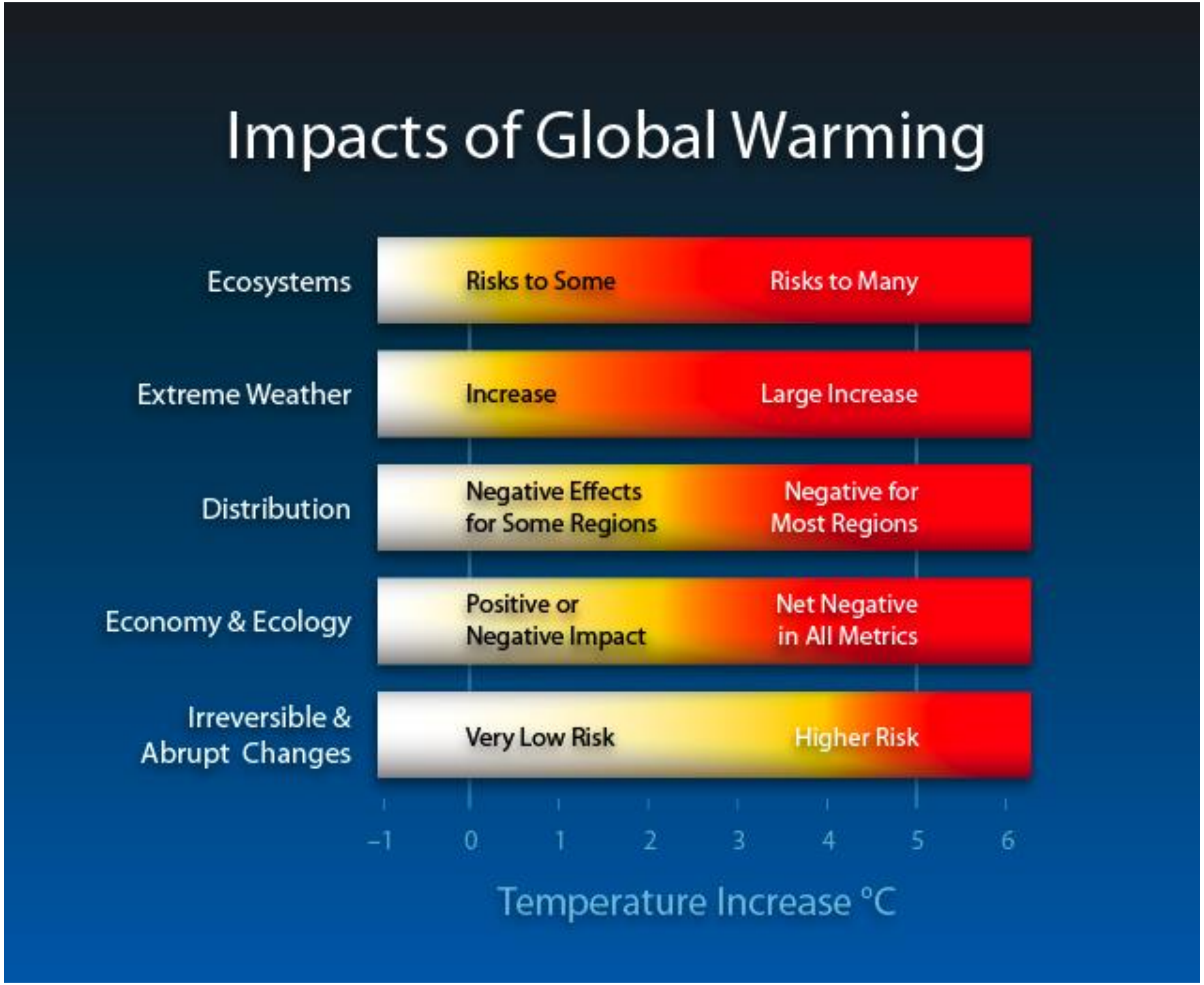
Source: J.R. Petit, J. Jouzel, et al. Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, Nature 399 (3JUne), pp 429-436, 1999.



Radiation Transmitted by the Atmosphere
0.2
1
10
70
Spectral Intensity
Downgoing Solar Radiation
70-75% Transmitted
Upgoing Thermal Radiation
15-30% Transmitted
5525 K
210-310 K
UV
Visible
Infrared
Percent
100
75
50
25
0
Total Absorption and Scattering
Major Components
Water Vapor
Carbon Dioxide
Oxygen and Ozone
Methane
Nitrous Oxide
Rayleigh Scattering
0.2
1
10
70
Wavelength (µm)

GHG emission: the consequence

Consequence ?



Global warming effect

A cosa è dovuto tutto ciò ???

1.3 Petroleum: The Fossil Fuel that Changed the World

Combustibili fossili

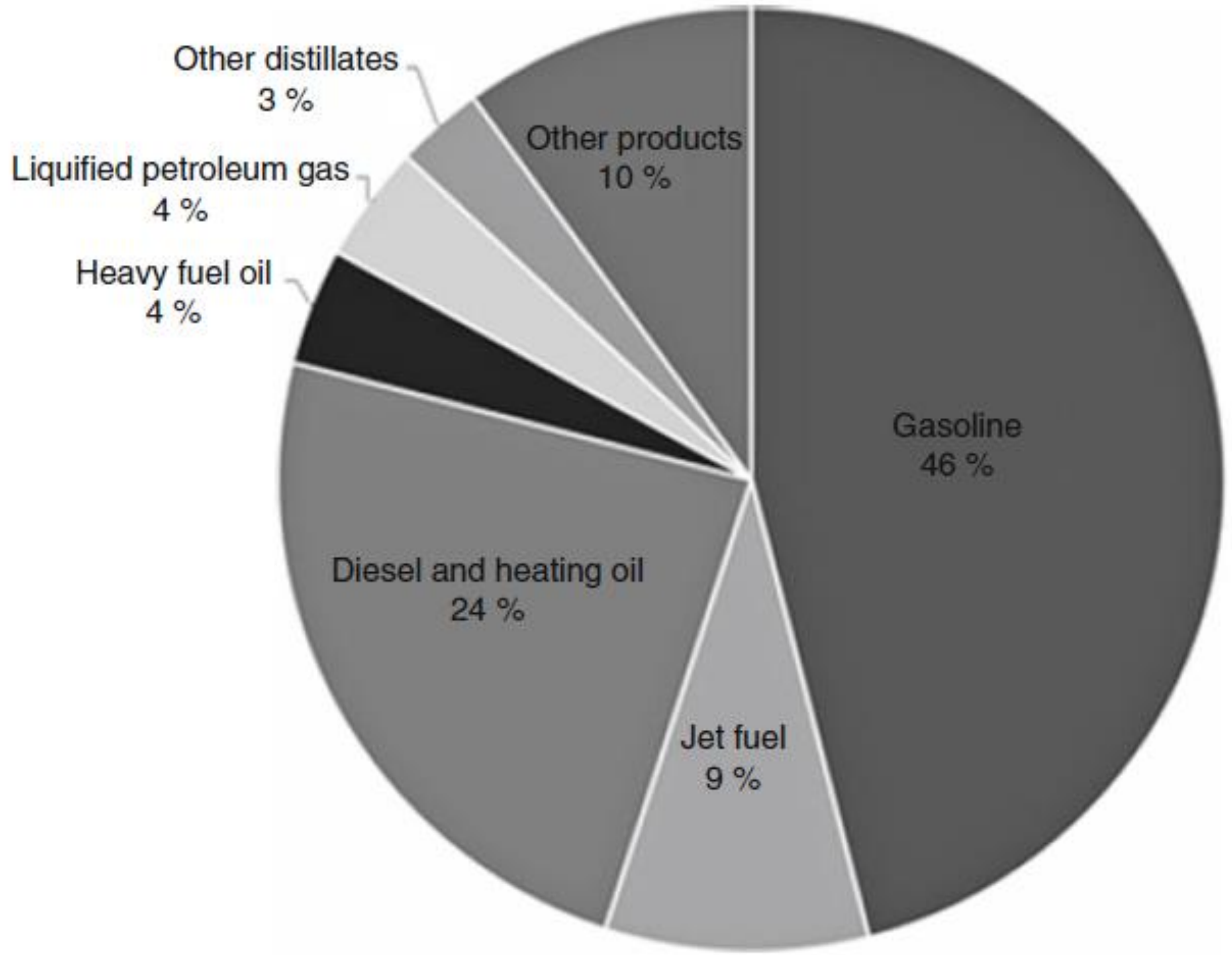


Fig. 1.4 A breakdown of barrel of crude oil into various products (Data source [9, 10])

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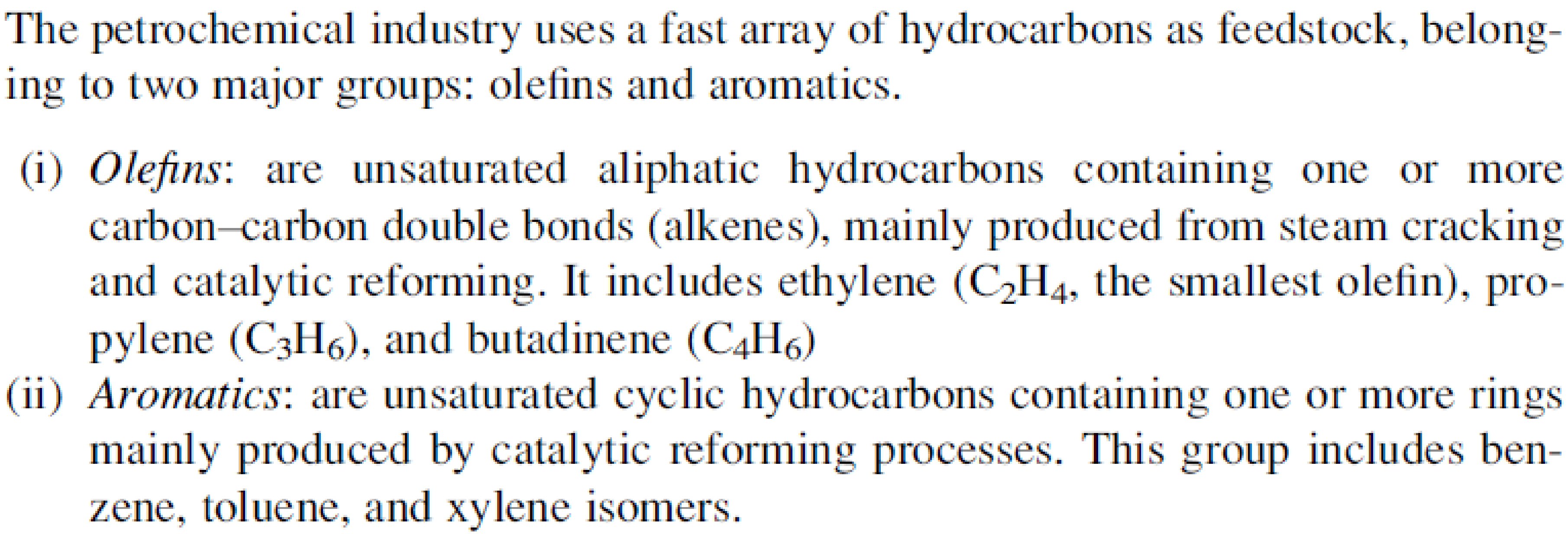
Products from the Petrochemical Industry



The petrochemical industry uses a fast array of hydrocarbons as feedstock, belonging to two major groups: olefins and aromatics.

(i) *Olefins*: are unsaturated aliphatic hydrocarbons containing one or more carbon–carbon double bonds (alkenes), mainly produced from steam cracking and catalytic reforming. It includes ethylene (C_2H_4, the smallest olefin), propylene (C_3H_6), and butadinene (C_4H_6)

(ii) *Aromatics*: are unsaturated cyclic hydrocarbons containing one or more rings mainly produced by catalytic reforming processes. This group includes benzene, toluene, and xylene isomers.

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Prodotti dal petrolio

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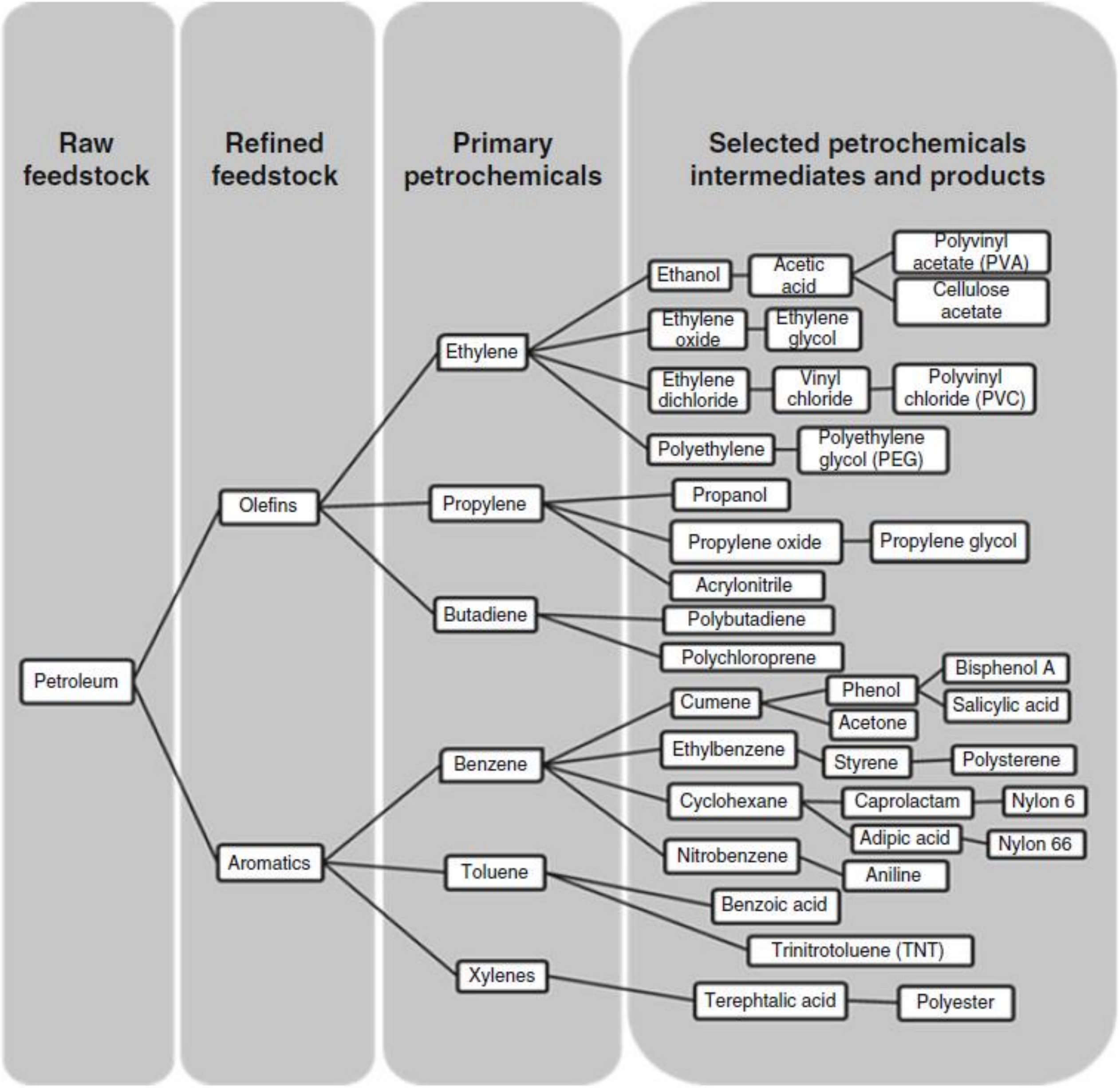

Fig. 1.5 From raw feedstock to petrochemicals: a flow-diagram illustration

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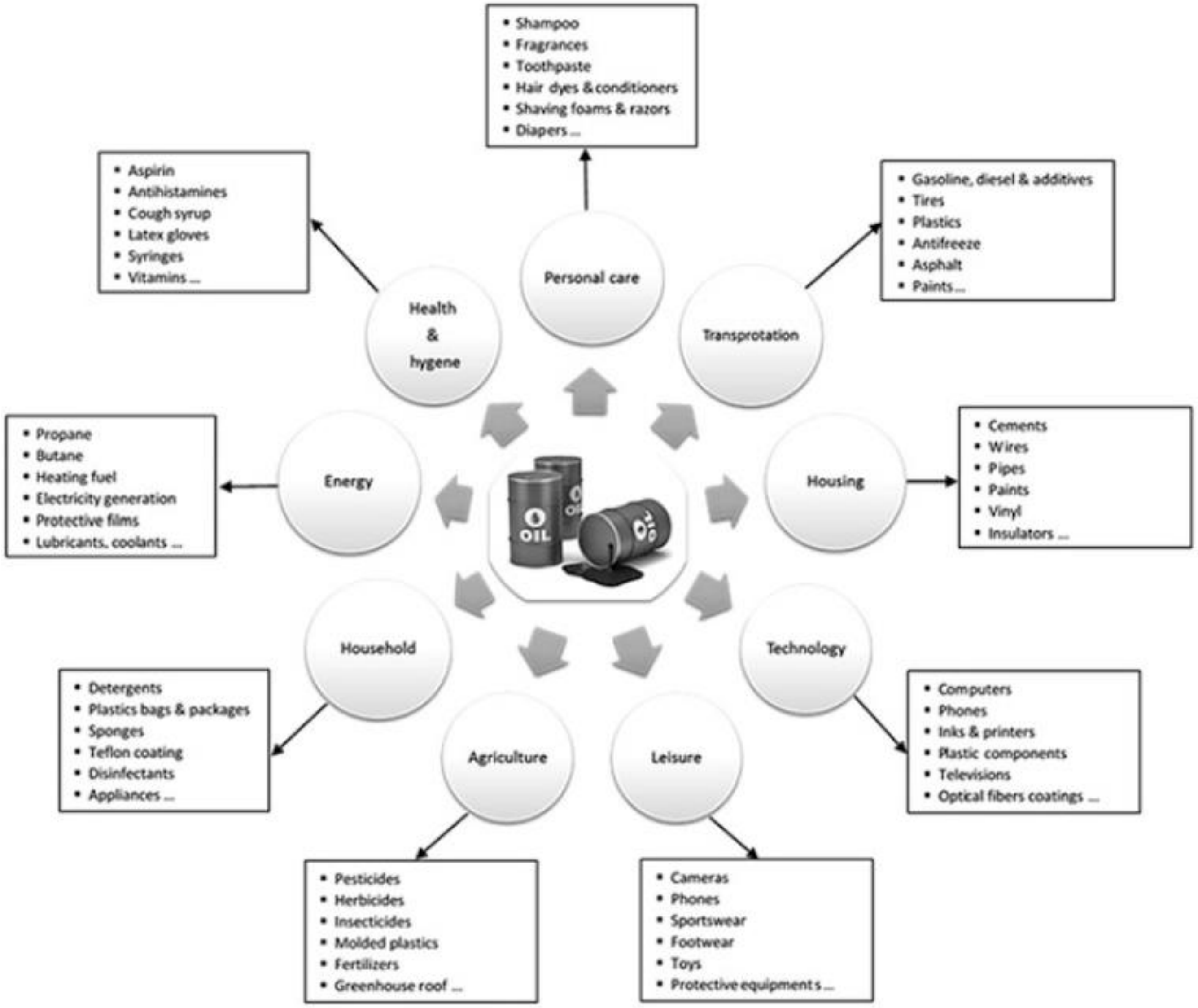
Petroleum-derived end products and markets



Personal care
- Shampoo
- Fragrances
- Toothpaste
- Hair dyes & conditioners
- Shaving foams & razors
- Diapers ...

Transprotation
- Gasoline, diesel & additives
- Tires
- Plastics
- Antifreeze
- Asphalt
- Paints ...

Housing
- Cements
- Wires
- Pipes
- Paints
- Vinyl
- Insulators ...

Technology
- Computers
- Phones
- Inks & printers
- Plastic components
- Televisions
- Optical fibers coatings ...

Leisure
- Cameras
- Phones
- Sportswear
- Footwear
- Toys
- Protective equipments ...

Agriculture
- Pesticides
- Herbicides
- Insecticides
- Molded plastics
- Fertilizers
- Greenhouse roof ...

Household
- Detergents
- Plastics bags & packages
- Sponges
- Teflon coating
- Disinfectants
- Appliances ...

Energy
- Propane
- Butane
- Heating fuel
- Electricity generation
- Protective films
- Lubricants, coolants ...

Health & hygene
- Aspirin
- Antihistamines
- Cough syrup
- Latex gloves
- Syringes
- Vitamins ...

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Problemi connessi con l’uso dei fossili

Global Warning and Climate Change

Public Health Risk

Soil and Ground Water Contamination

Air Pollution

Corruption, Wars, and Geopolitical Instability

Last But Not Least Problem: Consumerism

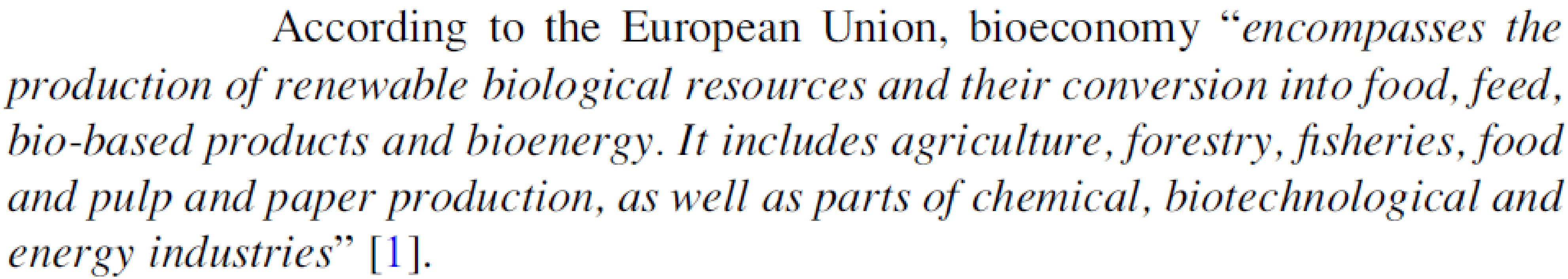
E’ necessario sostituire il fossile col rinnovabile nelle sue diverse forme………….per ridurre le emissioni di CO_2 in atmosfera

es. Usare molecole carboniose rinnovabili, i.e. le biomasse

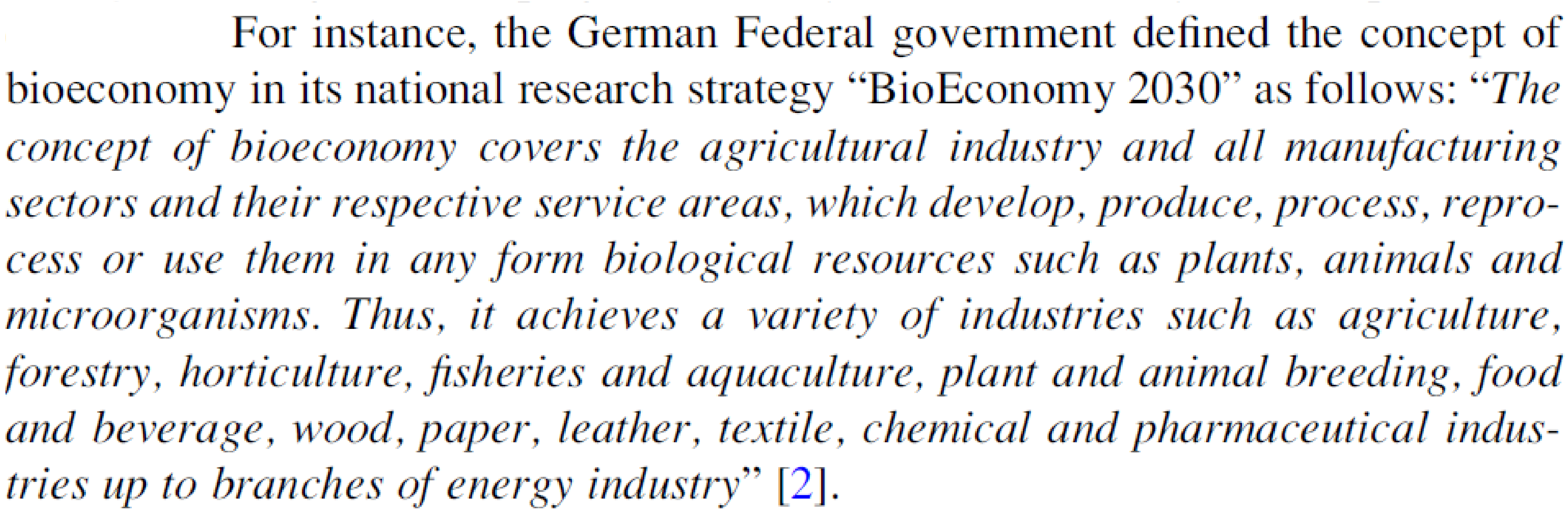
Una risposta: la bioeconomia

Bioeconomy: The Path to Sustainability

Definition of Bioeconomy



According to the European Union, bioeconomy "*encompasses the production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy. It includes agriculture, forestry, fisheries, food and pulp and paper production, as well as parts of chemical, biotechnological and energy industries*" [1].



For instance, the German Federal government defined the concept of bioeconomy in its national research strategy "BioEconomy 2030" as follows: "*The concept of bioeconomy covers the agricultural industry and all manufacturing sectors and their respective service areas, which develop, produce, process, reprocess or use them in any form biological resources such as plants, animals and microorganisms. Thus, it achieves a variety of industries such as agriculture, forestry, horticulture, fisheries and aquaculture, plant and animal breeding, food and beverage, wood, paper, leather, textile, chemical and pharmaceutical industries up to branches of energy industry*" [2].

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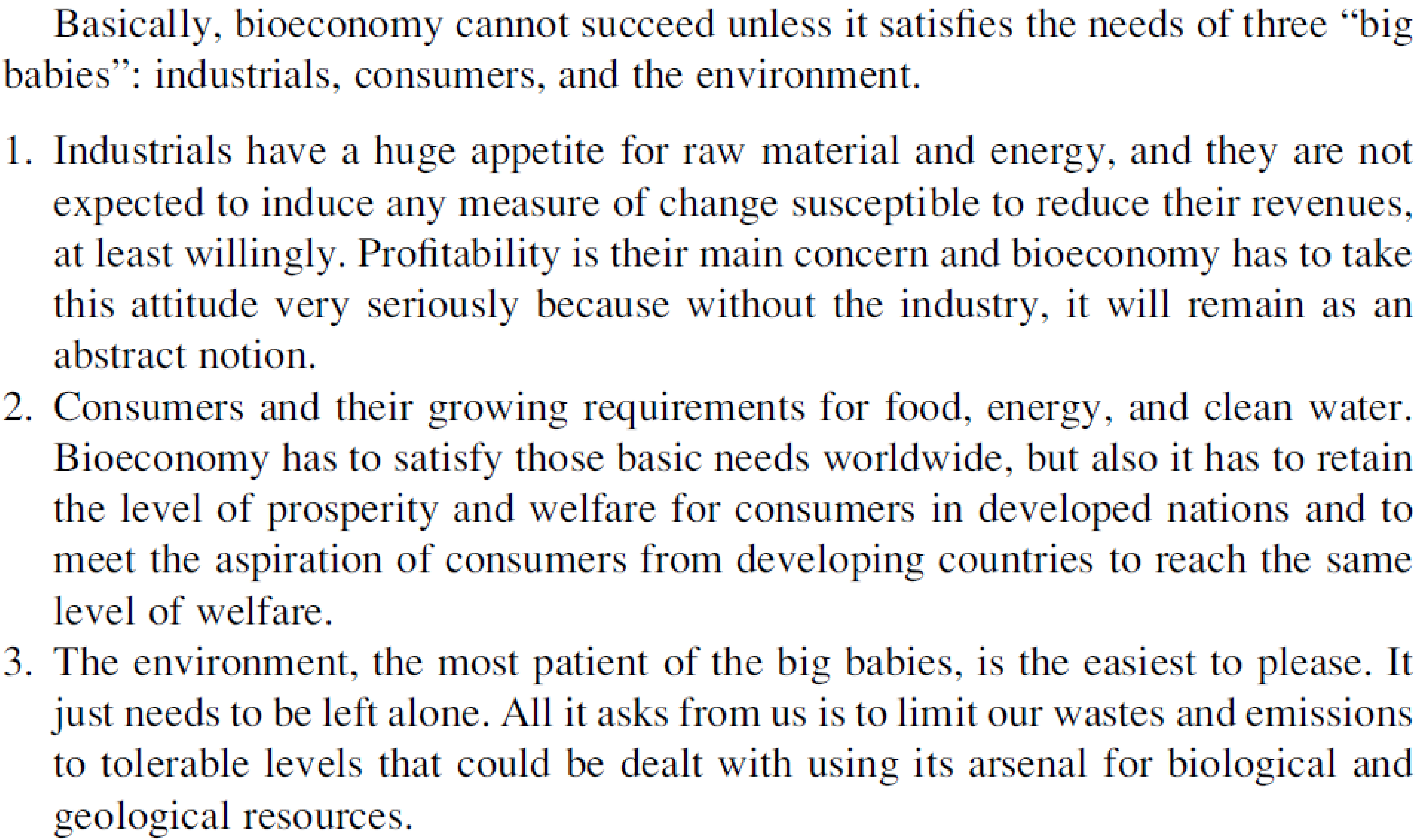

Basically, bioeconomy cannot succeed unless it satisfies the needs of three "big babies": industrials, consumers, and the environment.

1. Industrials have a huge appetite for raw material and energy, and they are not expected to induce any measure of change susceptible to reduce their revenues, at least willingly. Profitability is their main concern and bioeconomy has to take this attitude very seriously because without the industry, it will remain as an abstract notion.
2. Consumers and their growing requirements for food, energy, and clean water. Bioeconomy has to satisfy those basic needs worldwide, but also it has to retain the level of prosperity and welfare for consumers in developed nations and to meet the aspiration of consumers from developing countries to reach the same level of welfare.
3. The environment, the most patient of the big babies, is the easiest to please. It just needs to be left alone. All it asks from us is to limit our wastes and emissions to tolerable levels that could be dealt with using its arsenal for biological and geological resources.

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Biomass: The Sustainable Core of Bioeconomy

What Is Biomass?

Photosynthesis :

the best way to store solar energy

- An industrial process requires 100 more energy than biochemical system

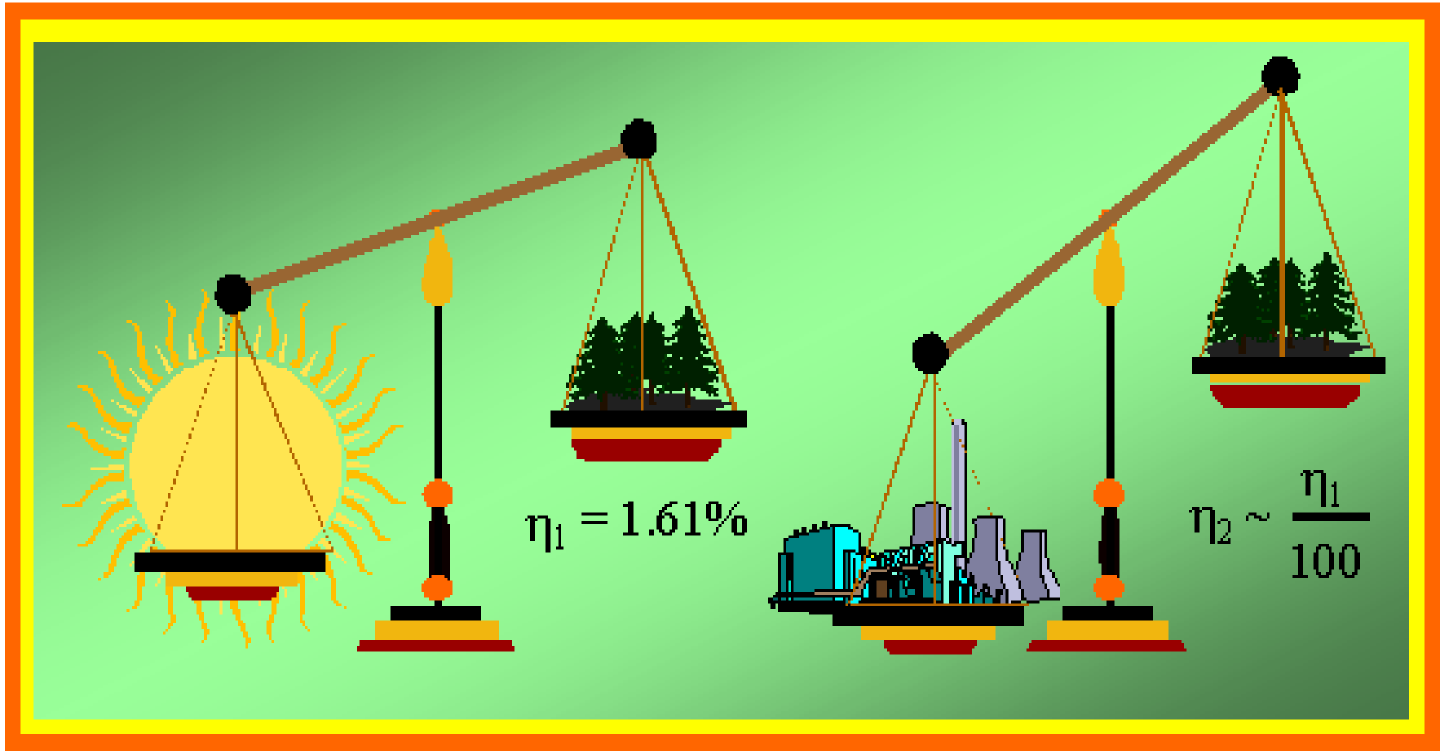
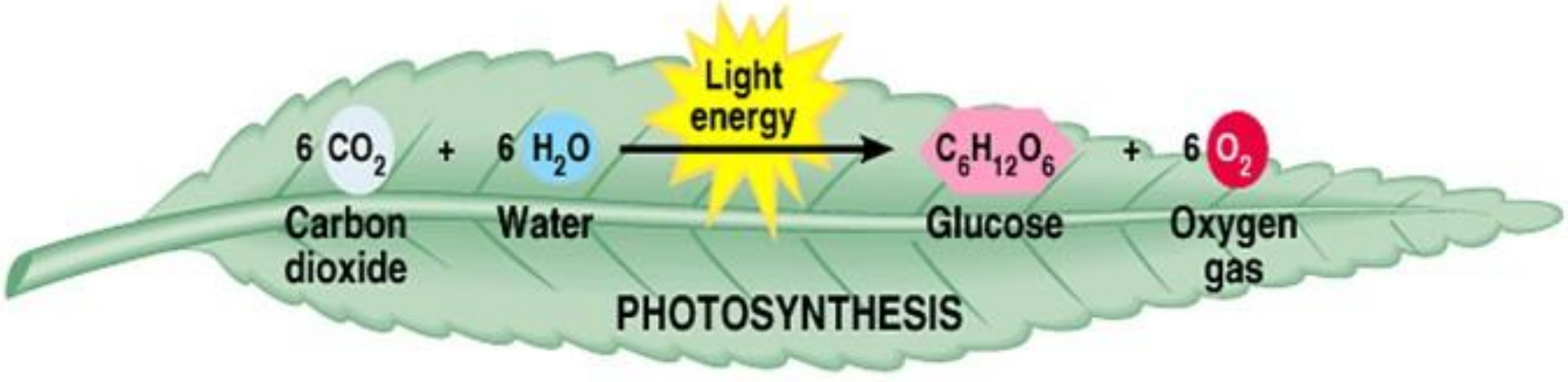


Figure 7.3 Photosynthesis is the most suitable route to convert solar energy – Biomass is the most convenient form to store solar energy

Photosynthesis



$6\ CO_2 + 6\ H_2O \text{ --> } C_6H_{12}O_6 + 6\ O_2$

Dal fossile alla biomassa:

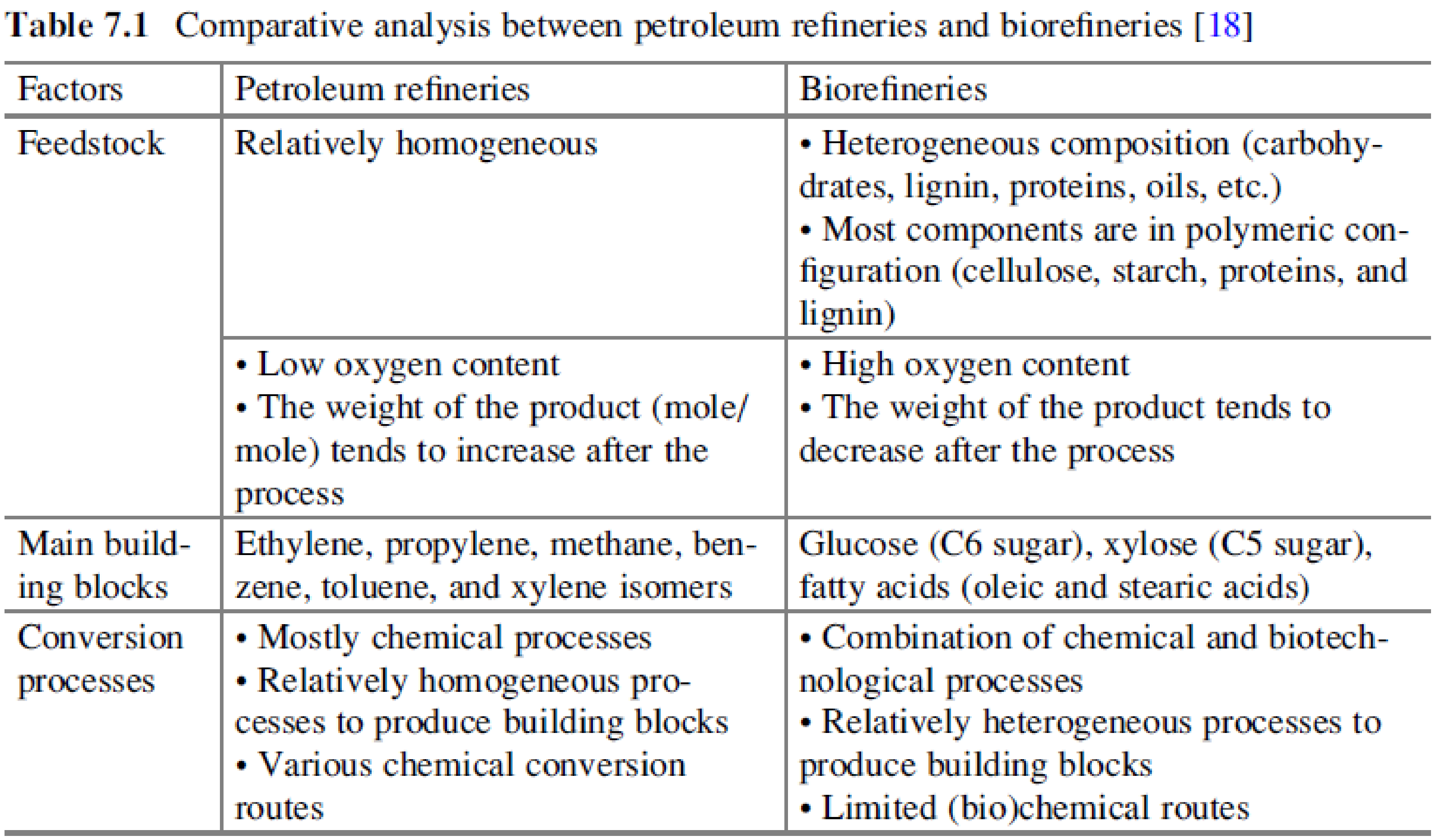


Table 7.1 Comparative analysis between petroleum refineries and biorefineries [18]

Factors	Petroleum refineries	Biorefineries
Feedstock	Relatively homogeneous	• Heterogeneous composition (carbohydrates, lignin, proteins, oils, etc.) • Most components are in polymeric configuration (cellulose, starch, proteins, and lignin)
	• Low oxygen content • The weight of the product (mole/mole) tends to increase after the process	• High oxygen content • The weight of the product tends to decrease after the process
Main building blocks	Ethylene, propylene, methane, benzene, toluene, and xylene isomers	Glucose (C6 sugar), xylose (C5 sugar), fatty acids (oleic and stearic acids)
Conversion processes	• Mostly chemical processes • Relatively homogeneous processes to produce building blocks • Various chemical conversion routes	• Combination of chemical and biotechnological processes • Relatively heterogeneous processes to produce building blocks • Limited (bio)chemical routes

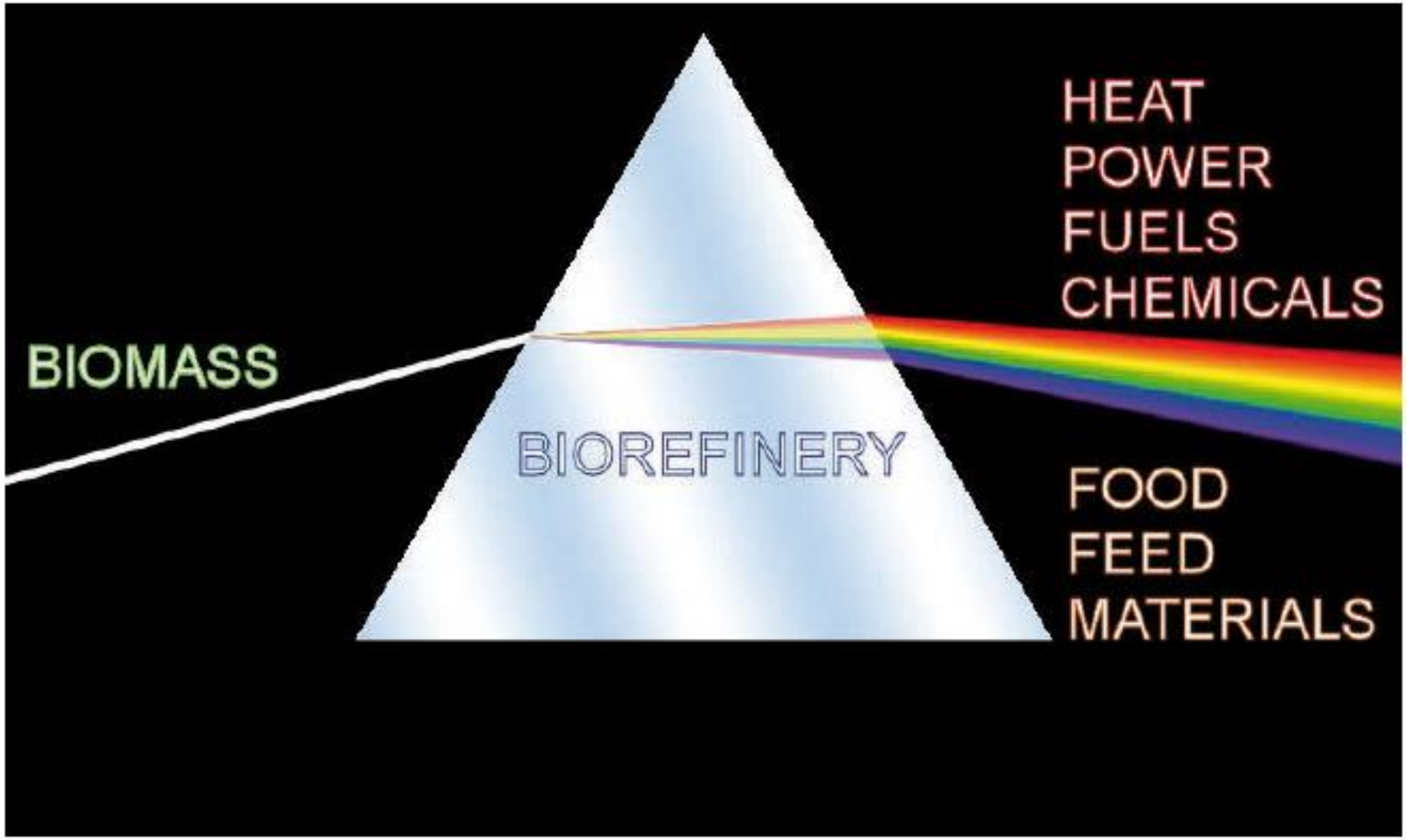


Figure 2: Biorefinery and its role in the transformation of biomass.

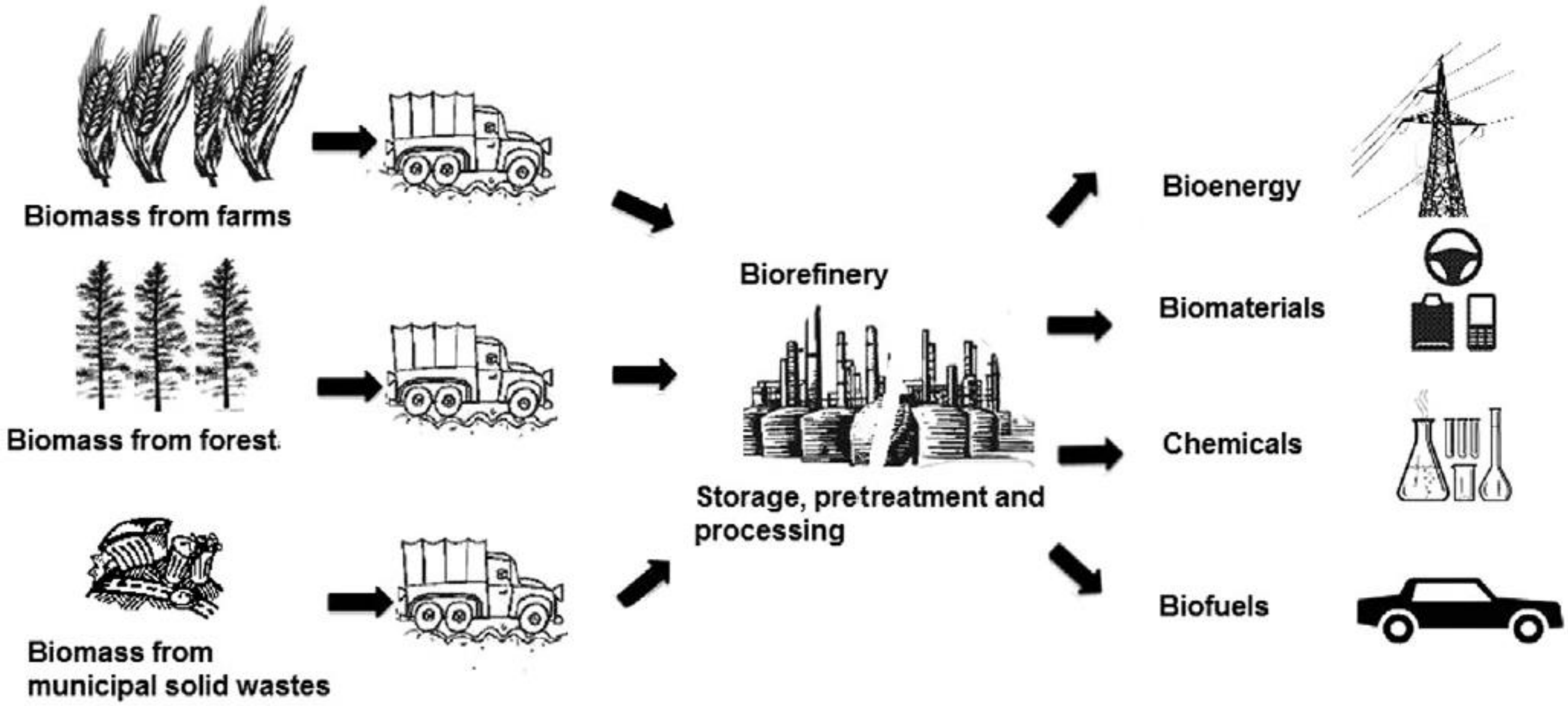


Fig. 1. Prevalent biomass logistics for biorefinery operations.

Biorefineries Versus Petroleum Refineries

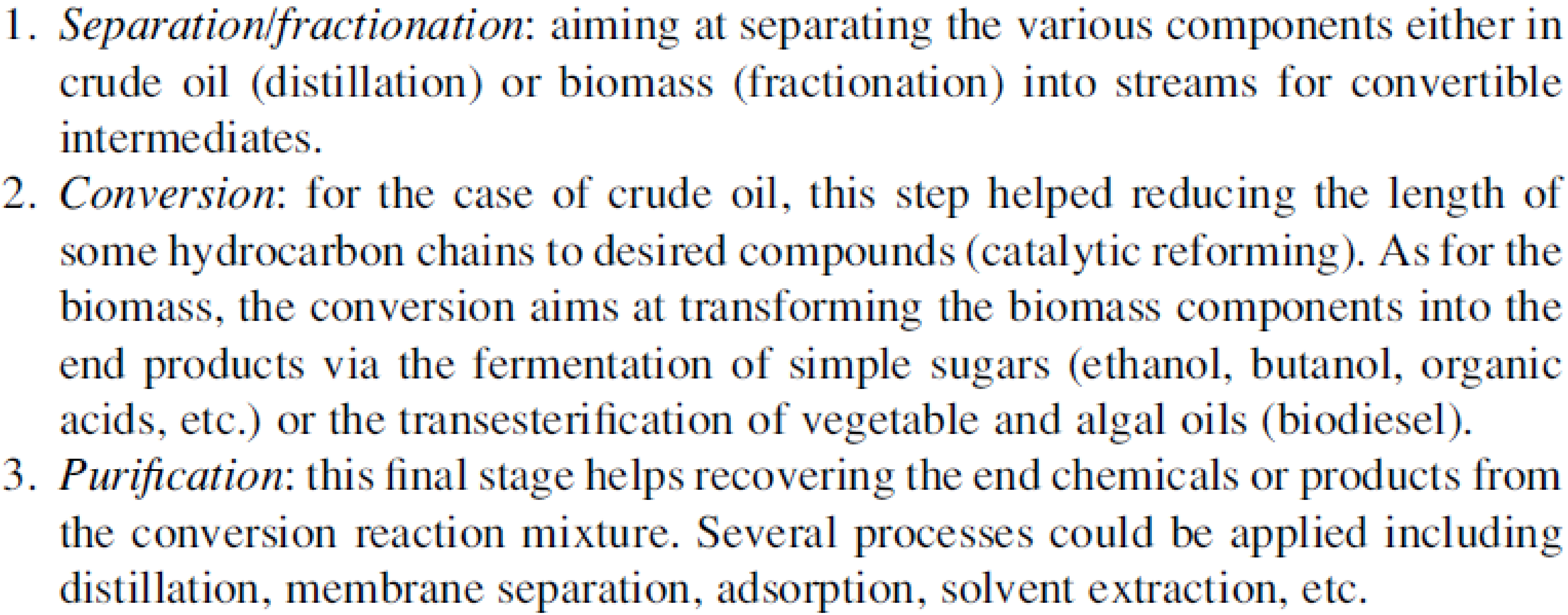
In the recent past, humanity witnessed several shifts in raw materials aiming at creating wealth and prosperity, mainly through the industrial sector. The first shift was during the industrial revolution from biomass to coal. Later, another shift occurred and coal was gradually replaced by petroleum and natural gas.

Nowadays, the world is preparing itself for another shift, this time back to biomass. So, we started with renewable resources, shifted to a fossil resource, traded one fossil resource for two others, and now going back to the only resource that will never run out, biomass. Therefore, substituting fossil resources by renewable ones should be seen from this angle. Indeed, contextualizing this expected shift will lay a solid ground for its proper implementation, benefit for the previous advantageous aspects, and avoid the disadvantageous ones.

In practice, there are many analogies between petroleum refineries and biorefineries. Indeed, for both processes, refining includes three main operations to convert petroleum or biomass into various end products:

……………………………to be continued ……………………………

……………………………to be continued ……………………………



1. *Separation/fractionation*: aiming at separating the various components either in crude oil (distillation) or biomass (fractionation) into streams for convertible intermediates.
2. *Conversion*: for the case of crude oil, this step helped reducing the length of some hydrocarbon chains to desired compounds (catalytic reforming). As for the biomass, the conversion aims at transforming the biomass components into the end products via the fermentation of simple sugars (ethanol, butanol, organic acids, etc.) or the transesterification of vegetable and algal oils (biodiesel).
3. *Purification*: this final stage helps recovering the end chemicals or products from the conversion reaction mixture. Several processes could be applied including distillation, membrane separation, adsorption, solvent extraction, etc.

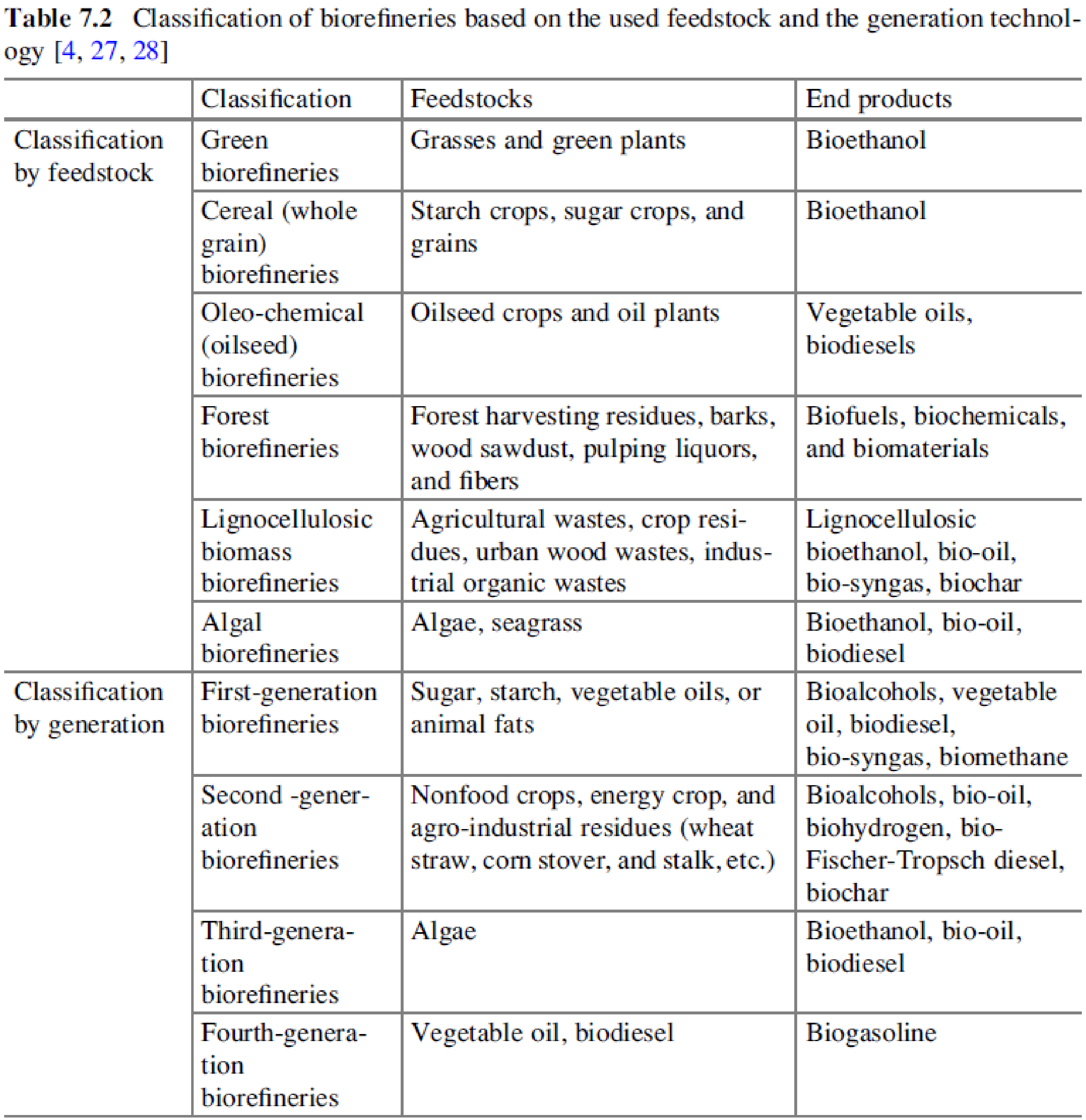


Table 7.2 Classification of biorefineries based on the used feedstock and the generation technology [4, 27, 28]

	Classification	Feedstocks	End products
Classification by feedstock	Green biorefineries	Grasses and green plants	Bioethanol
	Cereal (whole grain) biorefineries	Starch crops, sugar crops, and grains	Bioethanol
	Oleo-chemical (oilseed) biorefineries	Oilseed crops and oil plants	Vegetable oils, biodiesels
	Forest biorefineries	Forest harvesting residues, barks, wood sawdust, pulping liquors, and fibers	Biofuels, biochemicals, and biomaterials
	Lignocellulosic biomass biorefineries	Agricultural wastes, crop residues, urban wood wastes, industrial organic wastes	Lignocellulosic bioethanol, bio-oil, bio-syngas, biochar
	Algal biorefineries	Algae, seagrass	Bioethanol, bio-oil, biodiesel
Classification by generation	First-generation biorefineries	Sugar, starch, vegetable oils, or animal fats	Bioalcohols, vegetable oil, biodiesel, bio-syngas, biomethane
	Second -generation biorefineries	Nonfood crops, energy crop, and agro-industrial residues (wheat straw, corn stover, and stalk, etc.)	Bioalcohols, bio-oil, biohydrogen, bio-Fischer-Tropsch diesel, biochar
	Third-generation biorefineries	Algae	Bioethanol, bio-oil, biodiesel
	Fourth-generation biorefineries	Vegetable oil, biodiesel	Biogasoline

Classificazione delle bioraffinerie

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Classificazione delle bioraffinerie

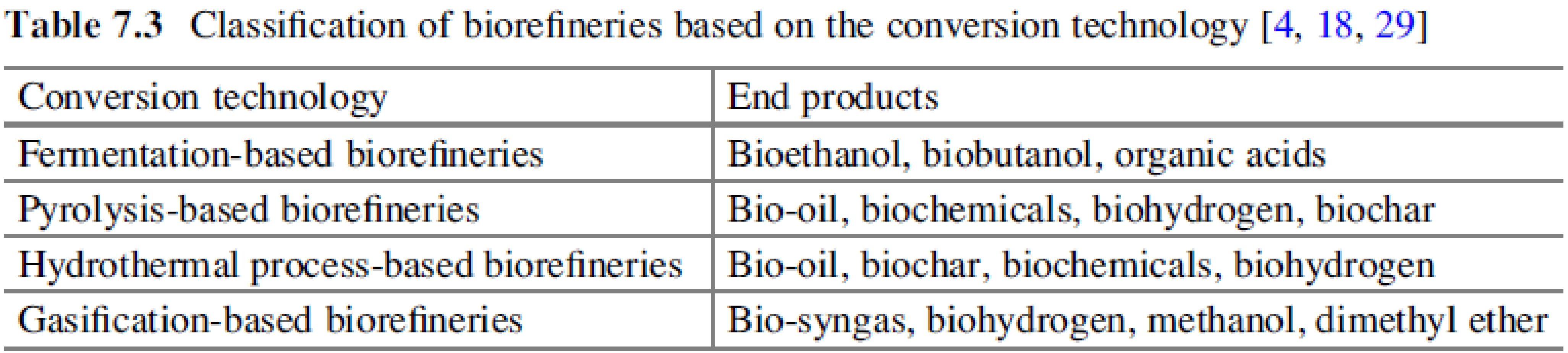

Table 7.3 Classification of biorefineries based on the conversion technology [4, 18, 29]

Conversion technology	End products
Fermentation-based biorefineries	Bioethanol, biobutanol, organic acids
Pyrolysis-based biorefineries	Bio-oil, biochemicals, biohydrogen, biochar
Hydrothermal process-based biorefineries	Bio-oil, biochar, biochemicals, biohydrogen
Gasification-based biorefineries	Bio-syngas, biohydrogen, methanol, dimethyl ether

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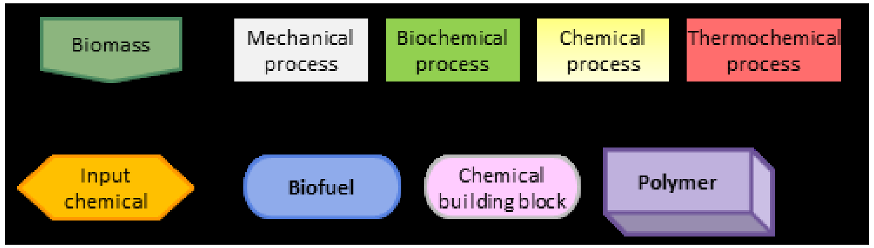
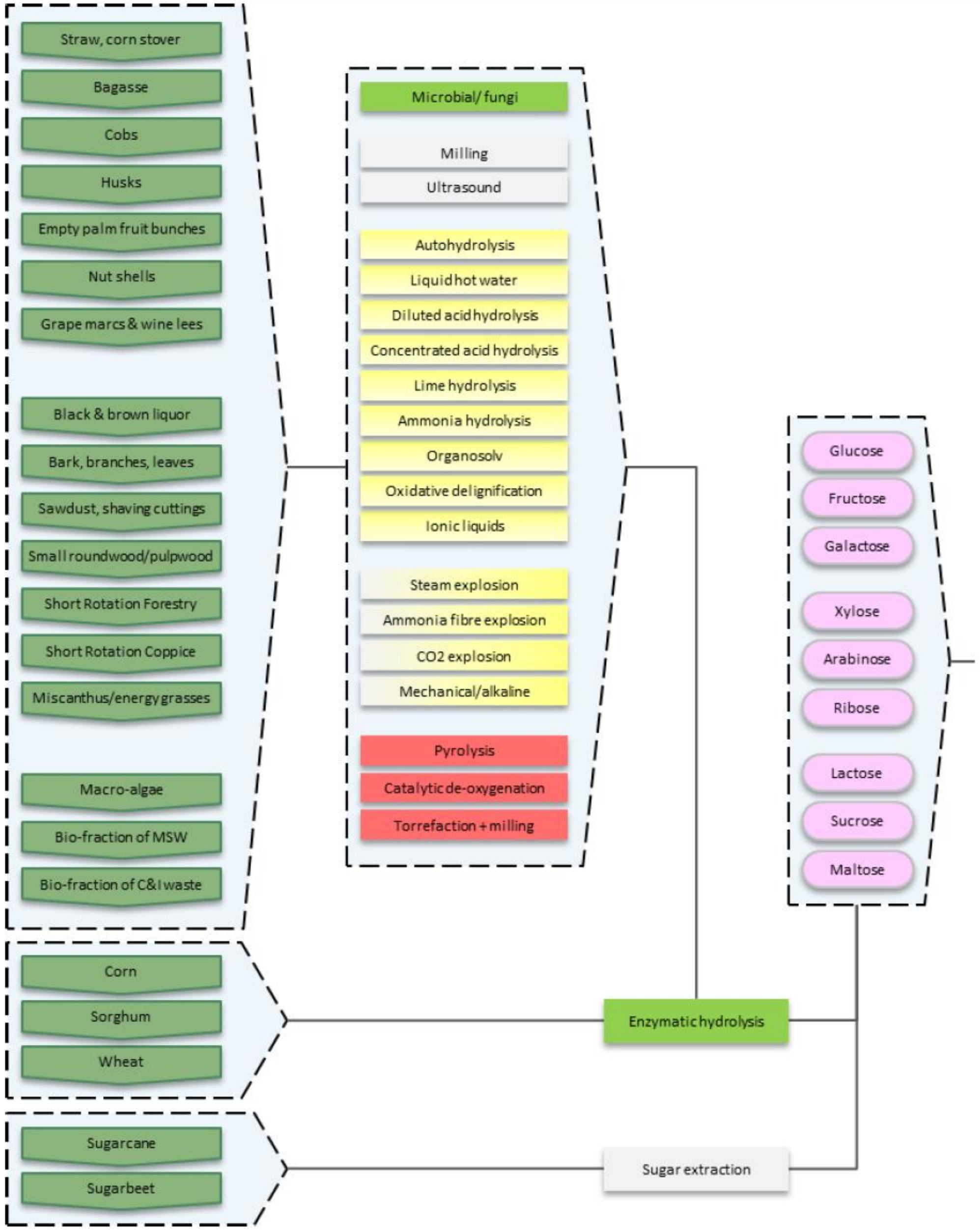
From the Sugar Platform to biofuels and biochemicals


Biomass
Mechanical process
Biochemical process
Chemical process
Thermochemical process
Input chemical
Biofuel
Chemical building block
Polymer

Legend

From the Sugar Platform to biofuels and biochemicals


Straw, corn stover
Bagasse
Cobs
Husks
Empty palm fruit bunches
Nut shells
Grape marcs & wine lees
Black & brown liquor
Bark, branches, leaves
Sawdust, shaving cuttings
Small roundwood/pulpwood
Short Rotation Forestry
Short Rotation Coppice
Miscanthus/energy grasses
Macro-algae
Bio-fraction of MSW
Bio-fraction of C&I waste
Corn
Sorghum
Wheat
Sugarcane
Sugarbeet

Microbial/ fungi
Milling
Ultrasound
Autohydrolysis
Liquid hot water
Diluted acid hydrolysis
Concentrated acid hydrolysis
Lime hydrolysis
Ammonia hydrolysis
Organosolv
Oxidative delignification
Ionic liquids
Steam explosion
Ammonia fibre explosion
CO2 explosion
Mechanical/alkaline
Pyrolysis
Catalytic de-oxygenation
Torrefaction + milling

Enzymatic hydrolysis
Sugar extraction

Glucose
Fructose
Galactose
Xylose
Arabinose
Ribose
Lactose
Sucrose
Maltose

Figure 4: Mapping of feedstock and pre-treatment options to sugars

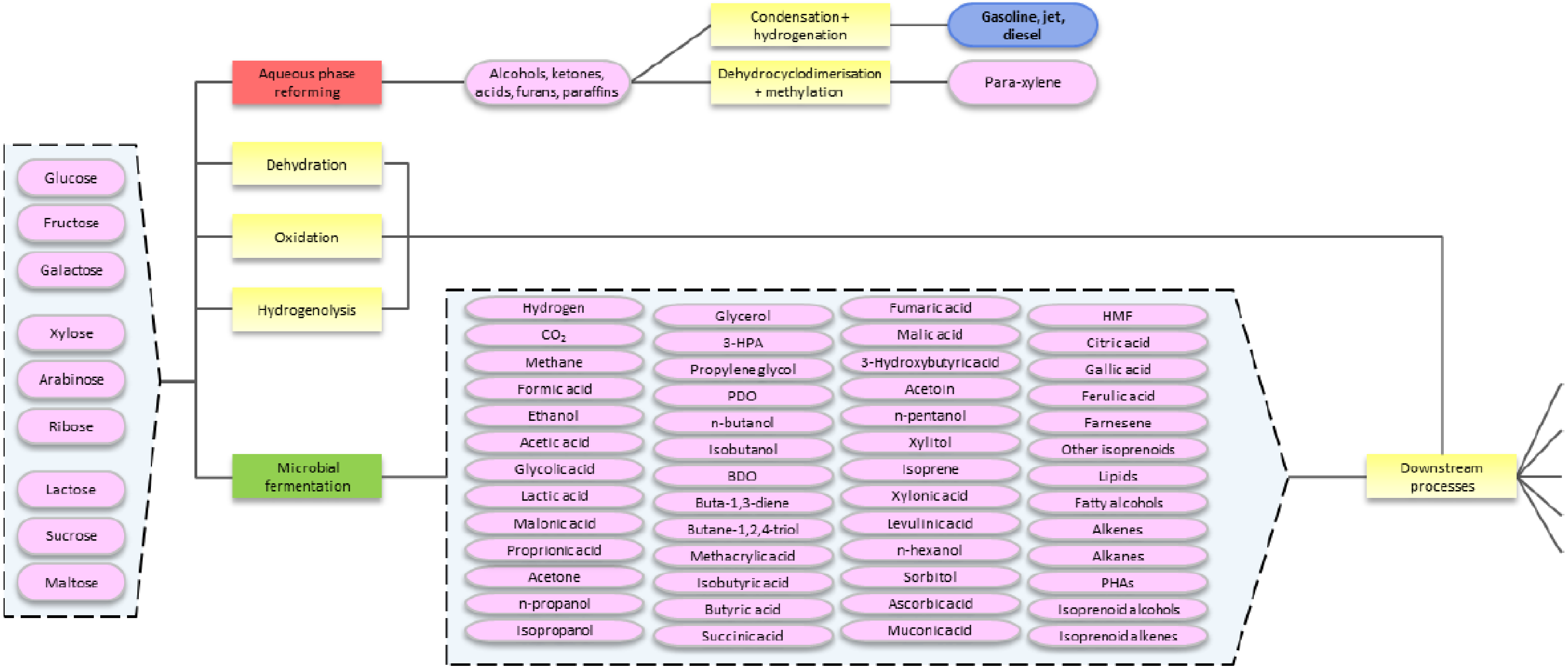


Figure 5: Downstream process options from sugars (the majority of which are fermentation based)

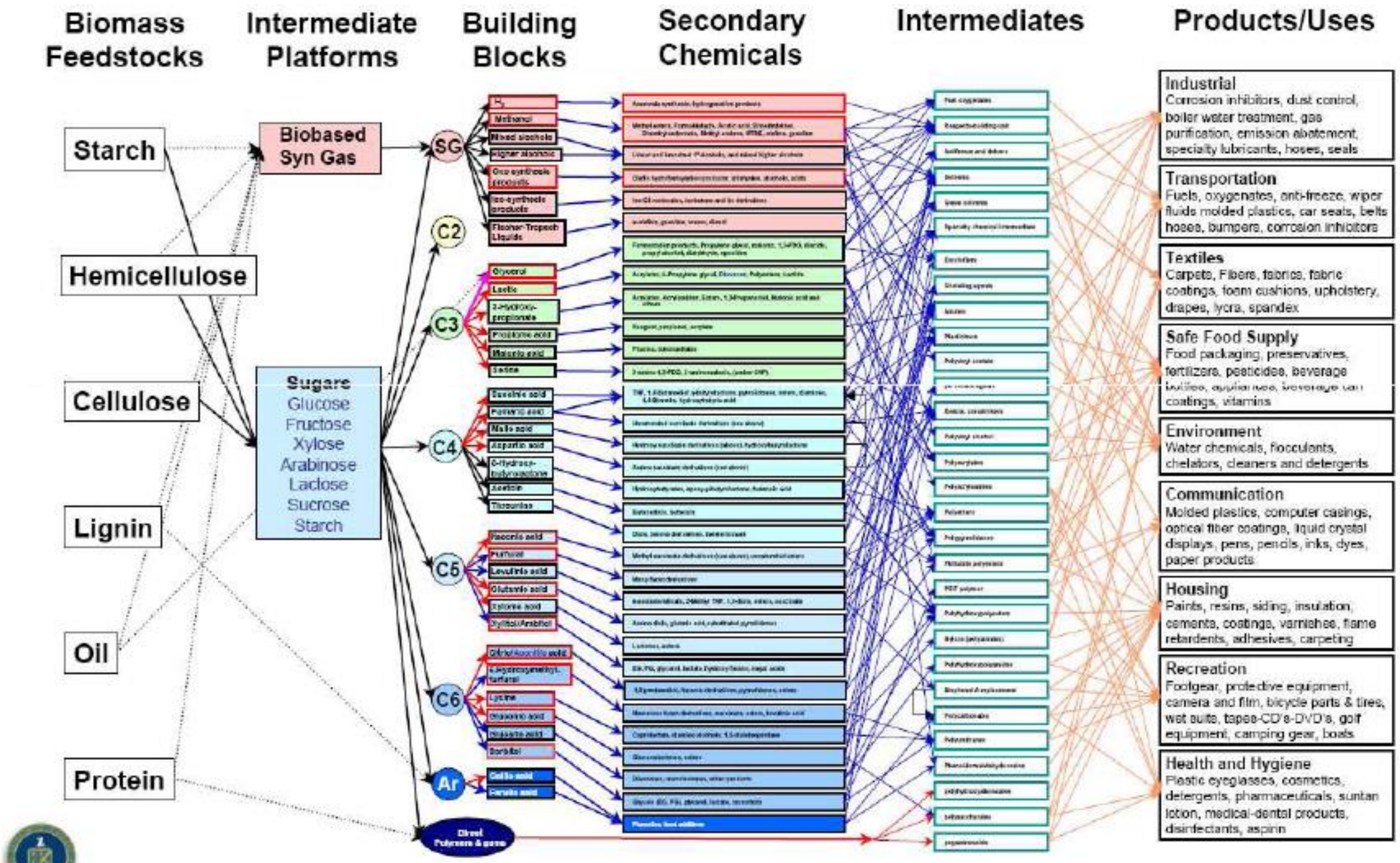


Figure 3 – Analogous Model of a Biobased Product Flow-chart for Biomass Feedstocks

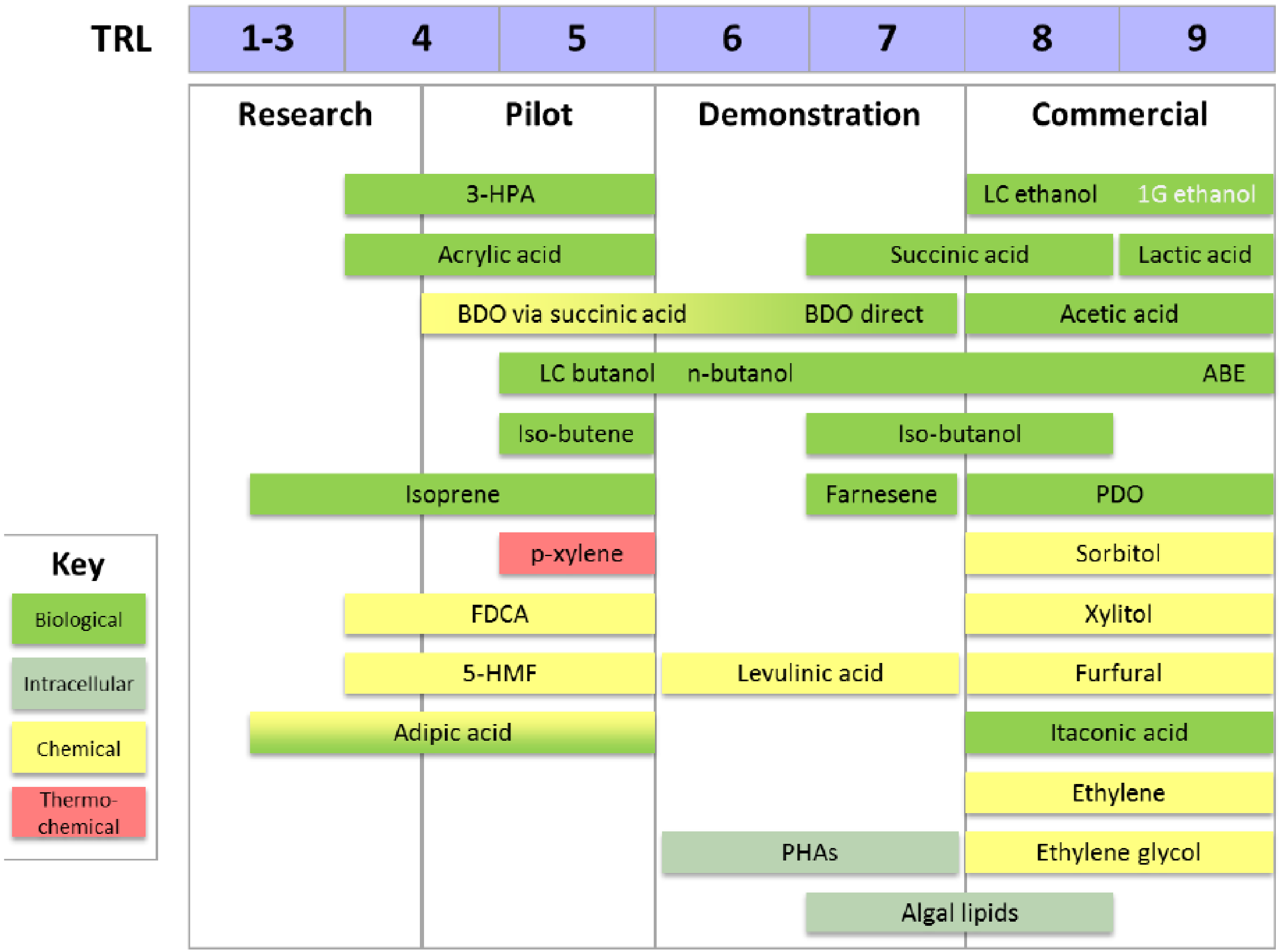


Figure 13: Commercialisation status of the 25 selected sugar platform products

Table 4: Status and industrial activity for each product (ordered by TRL)

Product	Max TRL	# firms	Production facilities				Leading actors (within 1 TRL of max)
			EU	N Am	S Am	Asia	
Ethyl acetate	8-9	7	M	D		M	Dhampur Alco-Chem, Jubilant Lifescience, Laxmi Organic Industries, Sekab , Somaiya, Songyuan Ji'an Biochemical
Sorbitol	8-9	2		M		M	ADM, Roquette
1,2 butanediol	8-9	1				M	Global Biochem
1,3 propanediol	8-9	3	R	M		M	DuPont Tate & Lyle BioProducts, Zhangjiagang Glory Biomaterial
2,3 butanediol	8-9	3				M	Global Biochem, Novepha , Zhangjiagang Glory Biomaterial
Acetic acid	8-9	5	M	D		M	Jubilant Lifescience, Sekab , Songyuan Ji'an Biochemical
Acetic anhydride	8-9	1				M	Jubilant Lifescience
Acetone	8-9	10	R	D		M	Cathay Industrial Biotech, Jiangsu Lianhai Biological Technology, Laihe Rockley Bio-Chemicals, Lianyungang Lianhua Chemicals, Shi Jinyan, Songyuan Ji'an Biochemical, Tongliao ZhongKe Tianyuan Starch Chemical Co
n-butanol	8-9	13	R	D		M	
Epichlorohydrin	8-9	5	M			M	Solvay, Spolchemie, Yang Nong Jiang Su
Ethylene glycol	8-9	6	R			M	Global Biochem, Greencol Taiwan Corporation, India Glycols, Novepha
Ethylene	8-9	3			M		Braskem
Furfural	8-9	2	D	M			Central Romana Corporation
Furfuryl alcohol	8-9	2	M			M	TransFuran Chemicals, Zibo Shuangyu Chemical
Glutamic acid	8-9	4				M	Fufeng, Juhua, Meihua, Vedan
Itaconic acid	8-9	5		R		M	Alpha Chemika, Jinan Huaming Biochemistry, Qingdao Kehai Biochemistry Co, Zhejiang Guoguang Biochemistry
Lactic acid	8-9	11	M	M	M	M	Chongqing Bofei Biochemical Products, Corbion Purac, Galactic, Henan Jindan, HiSun, Wuhan Sanjiang Space Gude Biotech
Lactide	8-9	1	D			M	Corbion Purac

Lysine	8-9	2		M		M	BBCA, Evonik
PEG	8-9	1		M			DuPont
Propylene glycol	8-9	7	M	M		M	ADM, Global Biochem, Novepha , Oleon
PTT	8-9	2		M		M	DuPont, Zhangjiagang Glory Biomaterial
Squalene	8-9	1	M				Amyris
Terpenes	8-9	1		M			Allylix
Xylitol	8-9	3	M	R		M	DuPont Danisco, Roquette
Acetaldehyde	8-9	1	M				Sekab
EPDM	8	1			M		Lanxess
Iso-butanol	8	2	R	M			Butamax, Gevo
ETBE	8	1			M		Braskem
Fatty acids	8	2		M	M		Solazyme
PE	8	2			M		Braskem
PLA	8	4	D	M			Natureworks
Succinic acid	8	4	M	M			Myriant, Reverdia, Succinity, BioAmber
Isosorbide	7	3	D	R		D	Jinan Hongbaifeng Industry & Trade, Roquette
PBS	7	3				D	Anqing He Xing Chemical Corp
1,4 butanediol	7	5	R	D			BASF, Genomatica
Farnesene	7	1	R	R	D		Amyris
PHB	7	4	D		R	D	Biomer, Tianjin GreenBio Materials, Yikeman Shandong
Dimethyl isosorbide	6-7	1				D	Jinan Hongbaifeng Industry & Trade
Ethyl lactate	6-7	1		D			Vertec BioSolvents
Fatty alcohols	6-7	1		D			LS9
Furan	6-7	1		D			Pennakem
Levulinic acid	6-7	4	D	R		D	Segetis, Zibo Shuangyu Chemical
Methyl THF	6-7	1		D			Pennakem

Biomassa da dove ????

Biomaterial

The production of biomass for bioenergy May affect the availability dimension of food security in several ways. First, through land: if land is used for the production of biomass for bioenergy, it may no longer be available for food production, and thus in principle, it negatively affects food production. Biomass production can have a positive effect on producer prices: when food production decreases, food prices will increase. This, in turn, may lead producers to grow more food and less biomass for energy, until a new equilibrium is found. Shortfalls in domestic food production could require increases in food imports expenses, and thus negatively affect food trade.

Biomaterial

In the discussion on the competition for land between biomass production for bioenergy and food production, two types of land use change (or LUC) are usually distinguished (Dehue, Cornelissen, and Peters 2011; Laborde 2011; Lange and Delzeit 2012):

1. Direct land use change (DLUC) is the conversion of land that was not used for crop production before, into land used for a particular bioenergy feedstock production. Direct land use change can be observed and measured and attributed to the party that caused them
2. Indirect land use change (ILUC) is an external effect of the promotion of biofuels. The effect is caused by changes in prices for agricultural products on the world or regional market. When bioenergy feedstocks are increasingly planted on areas used for agricultural products, there is a reduction of food and feed supply on the world market. If the demand for food remains on the same level and does not decline, prices for food rise due to the reduced supply. These higher prices create an incentive to convert formerly unused areas for food production since the conversion of these areas becomes profitable at higher prices. This is the ILUC effect of the bioenergy feedstock production. Several studies that use economic models have tried to measure the ILUC effect.

There are various options to minimise the effects of direct and indirect land use change. First, by intensifying land use or by integrating food and energy production. Second, by using abandoned or degraded lands for bioenergy production. Third, by using wastes and residues and finally by co-producing bioenergy with another product. Such sustainable, Integrated Food-Energy Systems (IFES) have the potential to reduce the impacts and competition arising from bioenergy production on food security (Bogdanski and Ismail 2012; Bogdanski et al. 2010).

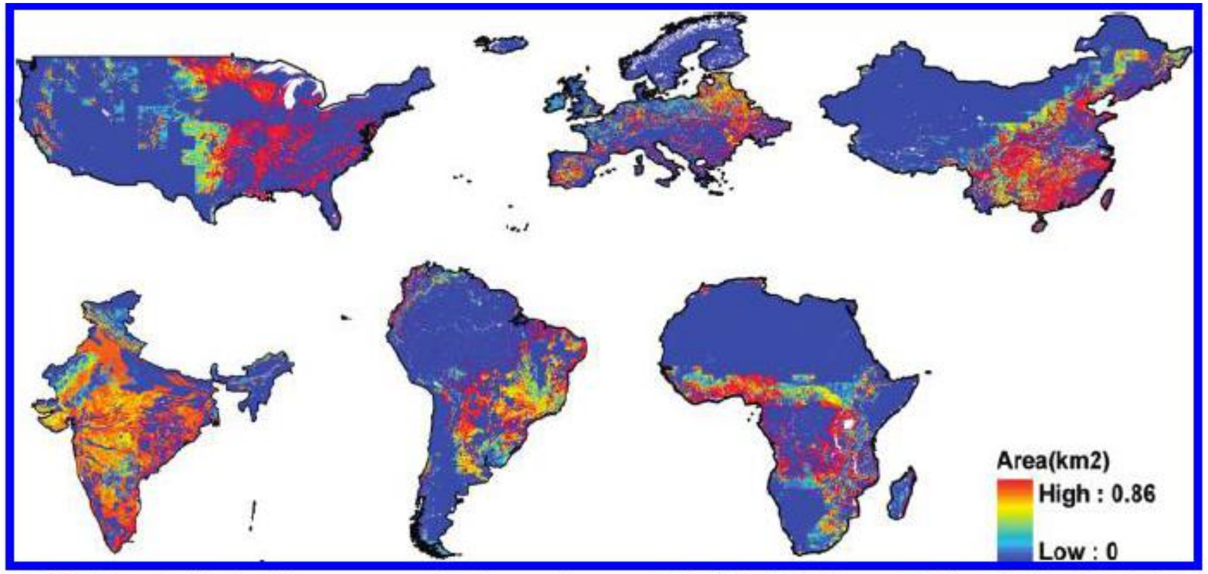


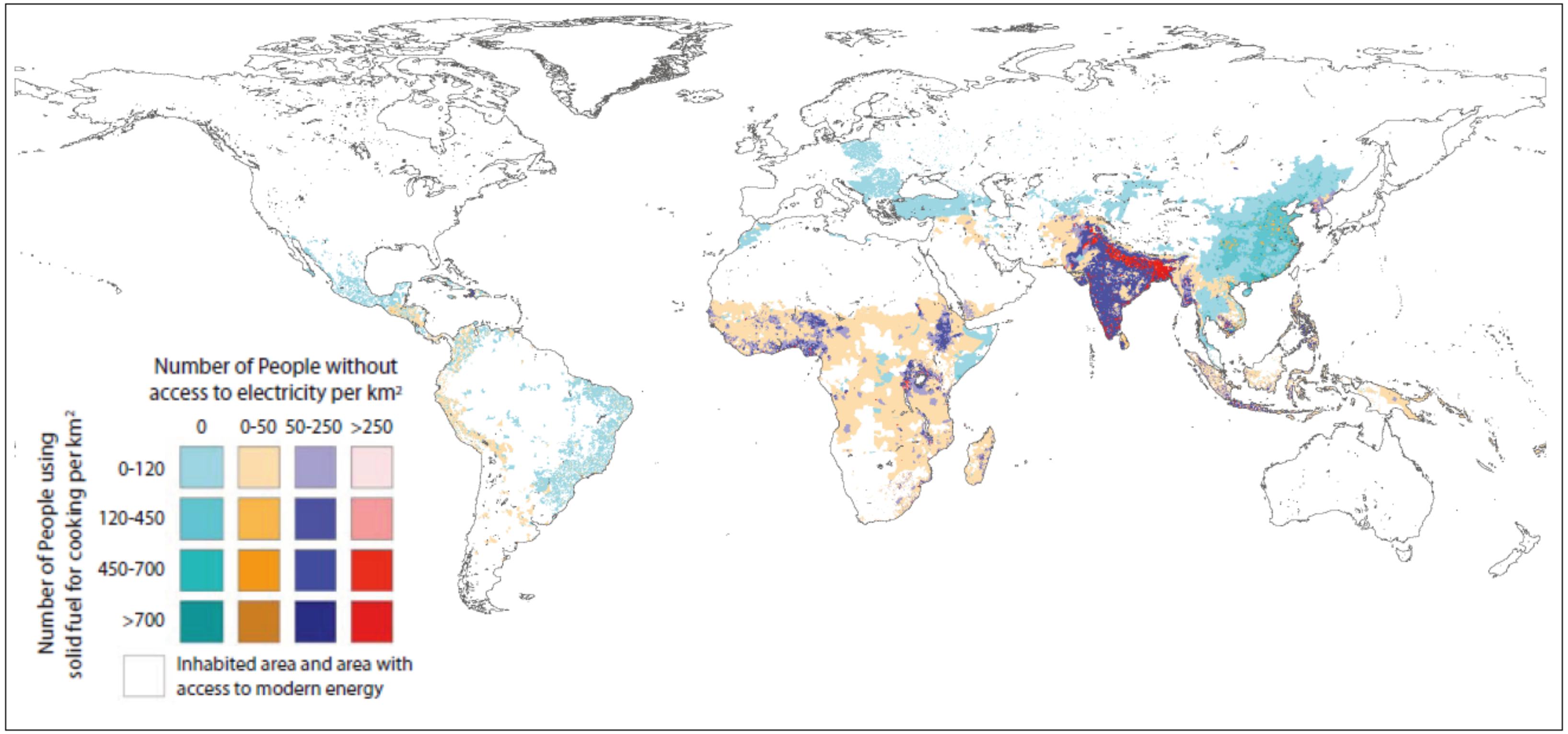
FIGURE 2. Maps of land available for bioenergy production under scenario 4 in U.S., Europe, China, India, South America, and Africa.

Cai et al., 2011 Env. Sci Technol.,

1200-1400 x 10^6 Ha di terre marginali= 25-50 % del teorico necessario……fattibile ???

Final energy access (non-commercial share) in relation to population density

La biomassa è disponibile nelle aree dove non c'è disponibilità di energia: vantaggio svantaggio ???



Biomass trade road

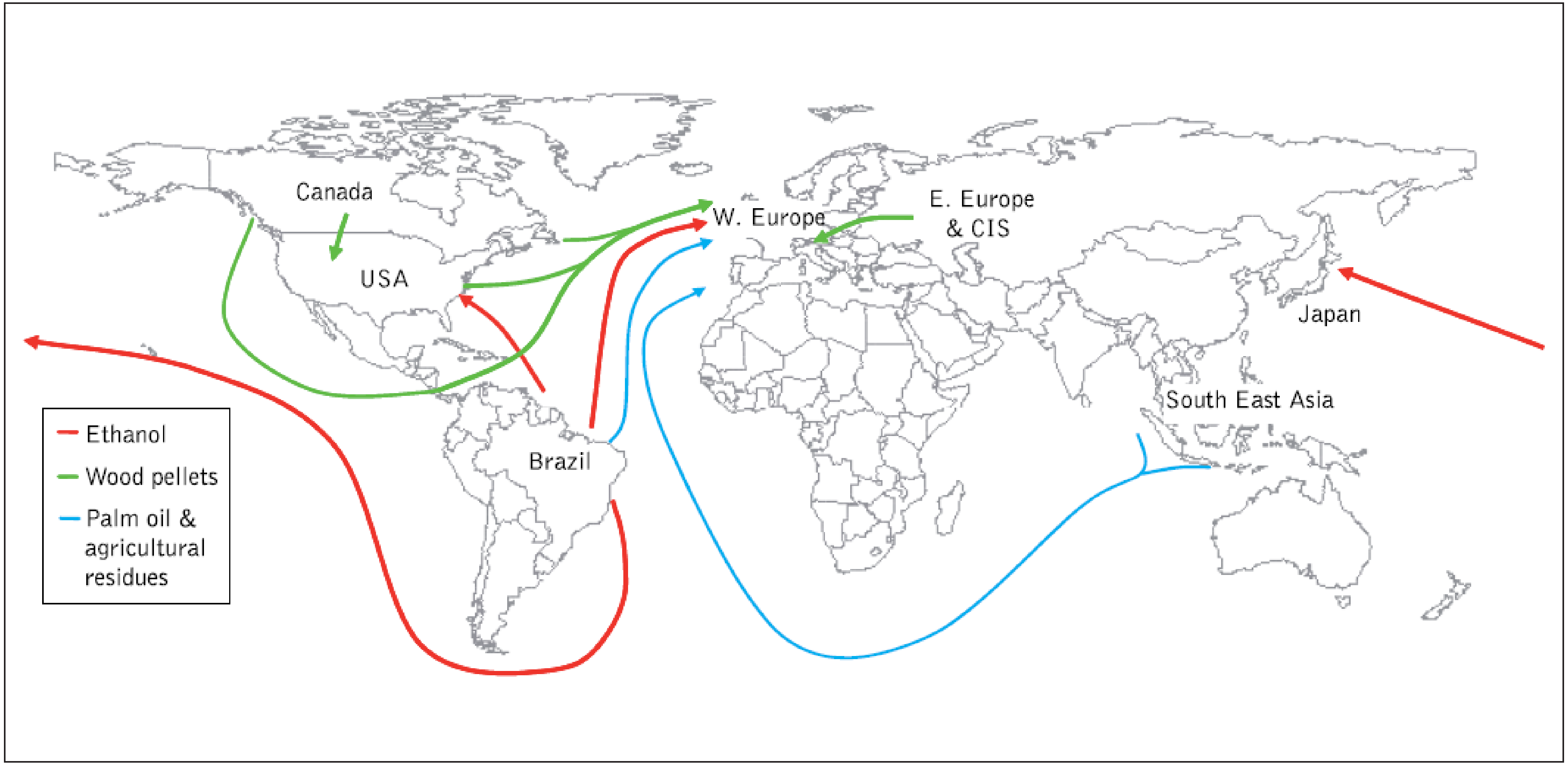


Figure 7: Main international biomass for energy trade routes. Intra-European trade is not displayed for clarity. Source: Junginger and Faaij, 2008.

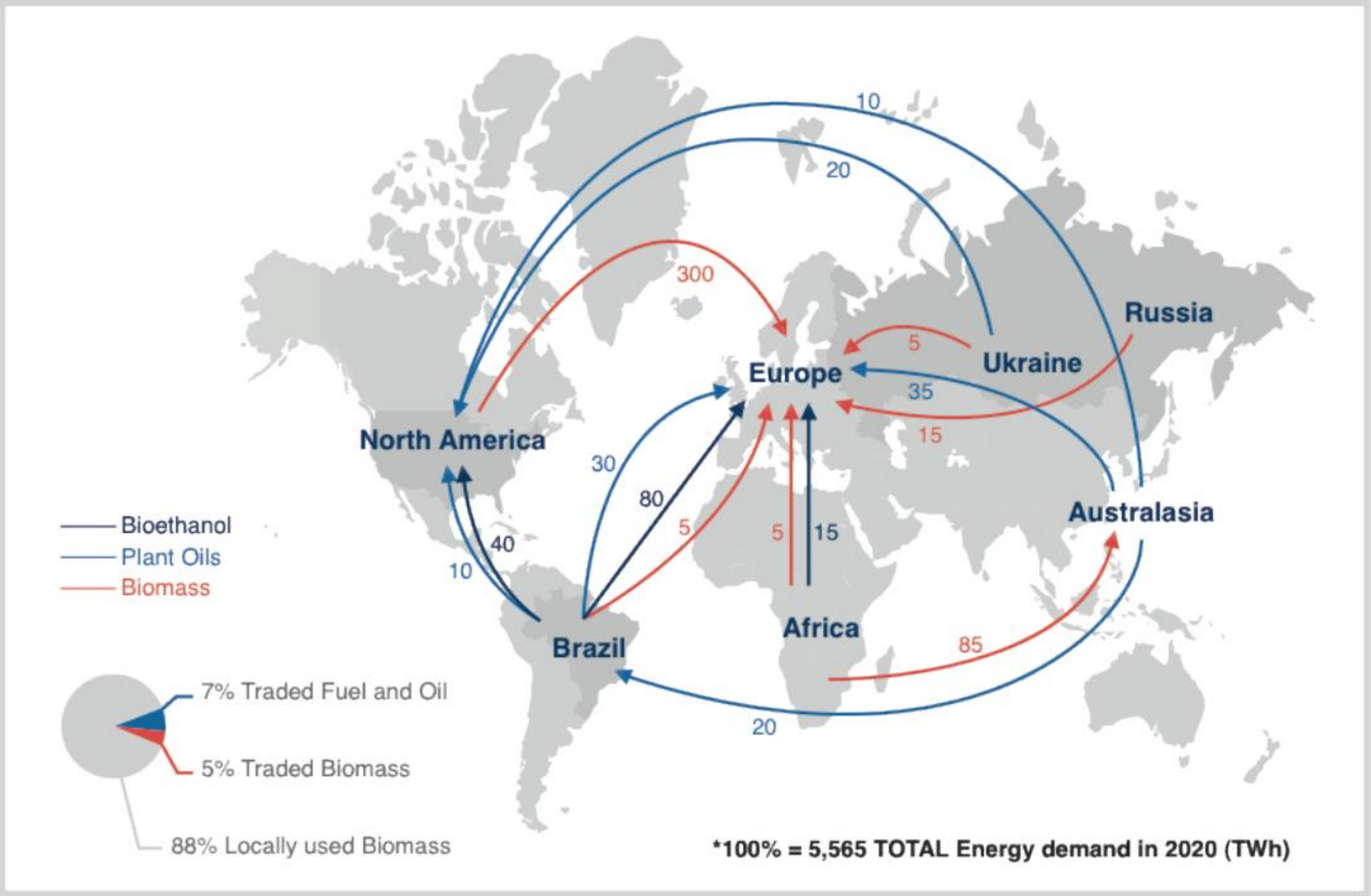


Figure 5: *Expected Biomass Trade Routes.* Values represent final energy demand in 2020.

Il Sole 24h Sostenibilità 10 Nov. 2021: La sfida energetica di Eni e i biocarburanti: dagli agri-hub africani una spinta per una transizione ecologica equa.

Eni starts exporting vegetable oil from Kenya for biorefining in Sicily

Biobased
Diesel Daily®
Oct 11. 2022

FoodNOfood

Courtesy , Boccasile, 2011

Food security has four dimensions:

1. *Availability* of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid). Available land and food production play an important role.
2. *Access* by individuals to adequate resources for acquiring appropriate foods for a nutritious diet. Land, income and consumer prices play an important role
3. *Utilisation*: Utilisation of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met. Income and local consumer food prices play an important role.
4. *Stability*: To be food secure, a population, household or individual must have access to adequate food at all times. Macro-economic conditions play an important role in stability.

Bioenergia: Vantaggio o svantaggio per l'agricoltura

The effect of bioenergy production on food security through these variables is sometimes positive (e.g. on food access through producer prices and household income), sometimes negative (on food availability through food production, food trade or food access through consumer prices) and sometimes goes either way (on utilisation and stability dimensions through macro-economic variables). As a result, generic claims stating that bioenergy production is a risk to food security or benefits food security should be treated with caution. Such claims often reflect a partial view on the issues at hand.

COMBINING BIOENERGY AND FOOD SECURITY | May 2013

Biofuel and bioenergy use could give a further push to the global demand for biomass. Van Ittersum (2011) suggests that agricultural output will need to triple between 2010 and 2050, if global biomass will deliver 10 per cent of global energy use by 2050. For biofuels only, Achterbosch et al. (2012) indicate that, in volume terms, the demand for feedstock would be largest in China and US. A threefold challenge faces the world (Godfray et al. 2010):

1. Match the rapidly changing demand for food from a larger and more affluent population to its supply.
2. Do so in ways that are environmentally and socially sustainable.
3. Ensure that the world's poorest people are no longer hungry.

1. Increased sustainable food production.
2. Improved access to food of sufficient quality.
3. Improved functioning of markets.
4. Improved investment climate.

Food production vs. land and energy consumption ?

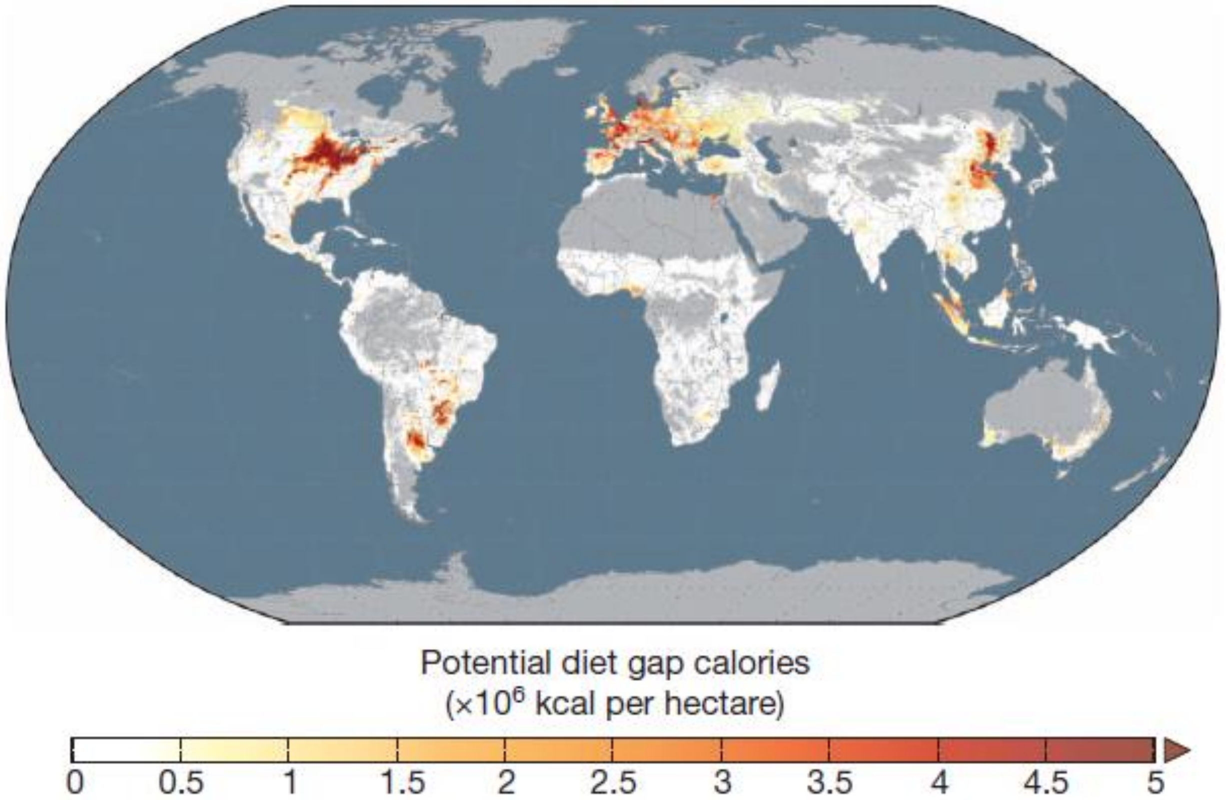
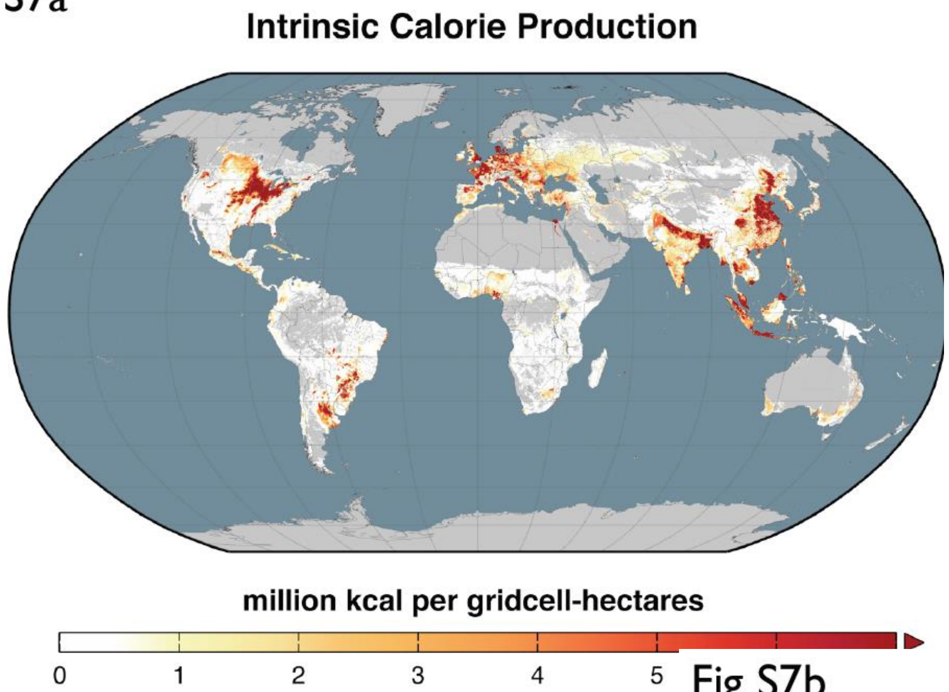


Figure 4 | Closing the diet gap. We estimate the potential to increase food supplies by closing the 'diet gap': shifting 16 major crops to 100% human food and away from the current mix of uses (see Fig. 1) could add over a billion tonnes to global food production (a 28% increase for those 16 crops), the equivalent of $\sim 3 \times 10^{15}$ kilocalories more food to the global diet (a 49% increase in food calories delivered).

- 62% crop production is for food
- 35 % animal feed
- 3% bioenergy

Foley et al., 2011, Nature

Fig S7a



If crop 100% human use = + 28 % production + 49% food kilocalories

Fig S7b

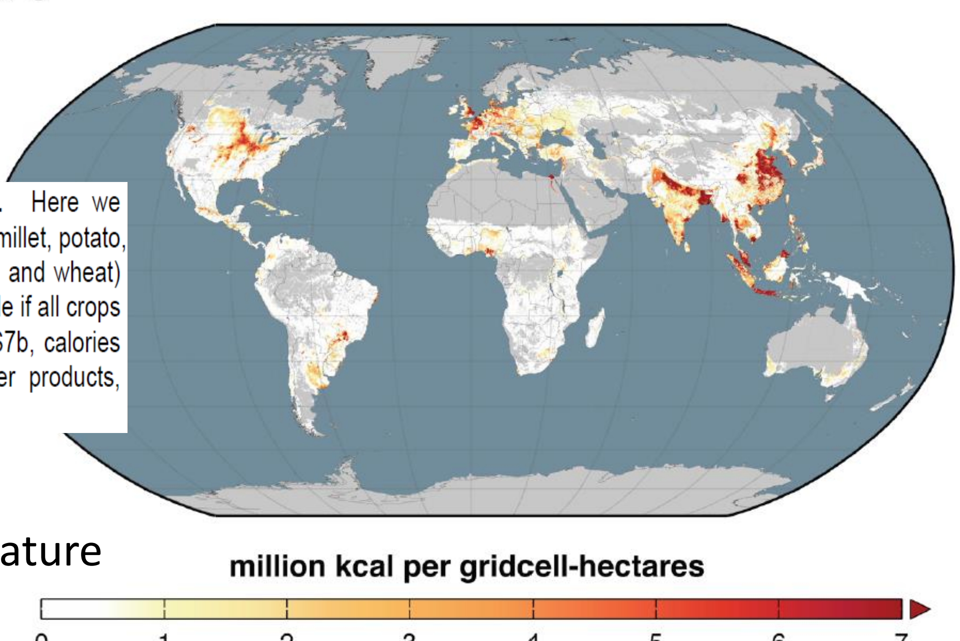


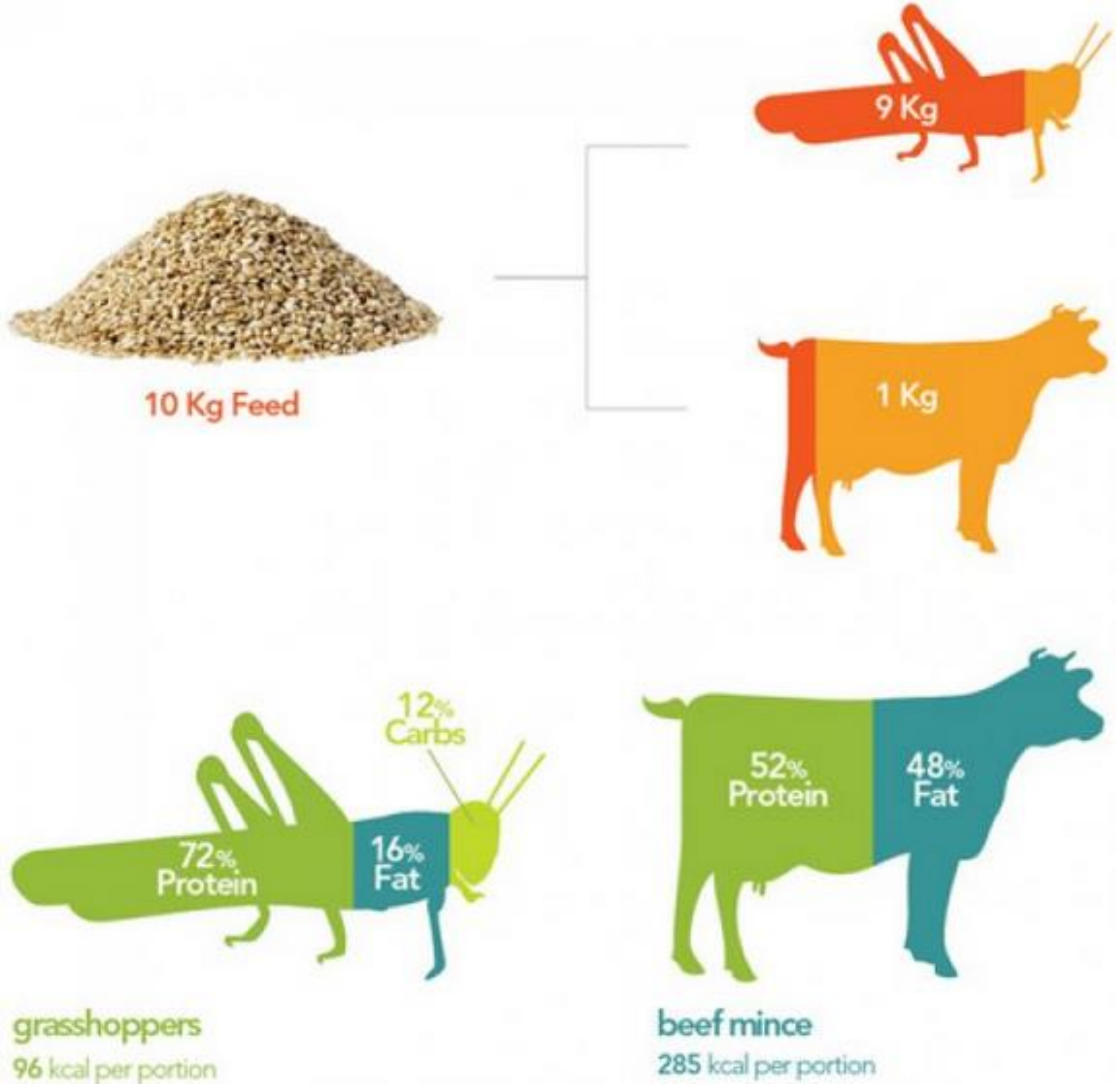
Figure S7. Differences Between Intrinsic and Delivered Food Production. Here we compare global crop yields for 16 staple crops (barley, cassava, groundnut, maize, millet, potato, oil palm, rapeseed, rice, rye, sorghum, soybean, sugarbeet, sugarcane, sunflower, and wheat) in terms of their *intrinsic food production* (Figure S7a, calories that would be available if all crops were consumed by humans directly) and their *delivered food production* (Figure S7b, calories available based on today's allocation of crops to food, animal feed, and other products, assuming standard conversion factors).

Foley et al., 2011, Nature

GRUPPO RICICLA

The future ?

The image shows how much more energy and protein efficient insects are over cattle. It takes 10 kg of feed to produce 9 kg of insect meat, whereas a cow produces only 1 kg. The majority of an insect’s body mass is protein and less fat, unlike a cow.



100 g insect:
up to 96 calories
40-72 % protein
about 16 % fat
about 12 % carbohydrates
up to 75.8 mg calzium

needed for production : 0.157 g CO2
almost no water

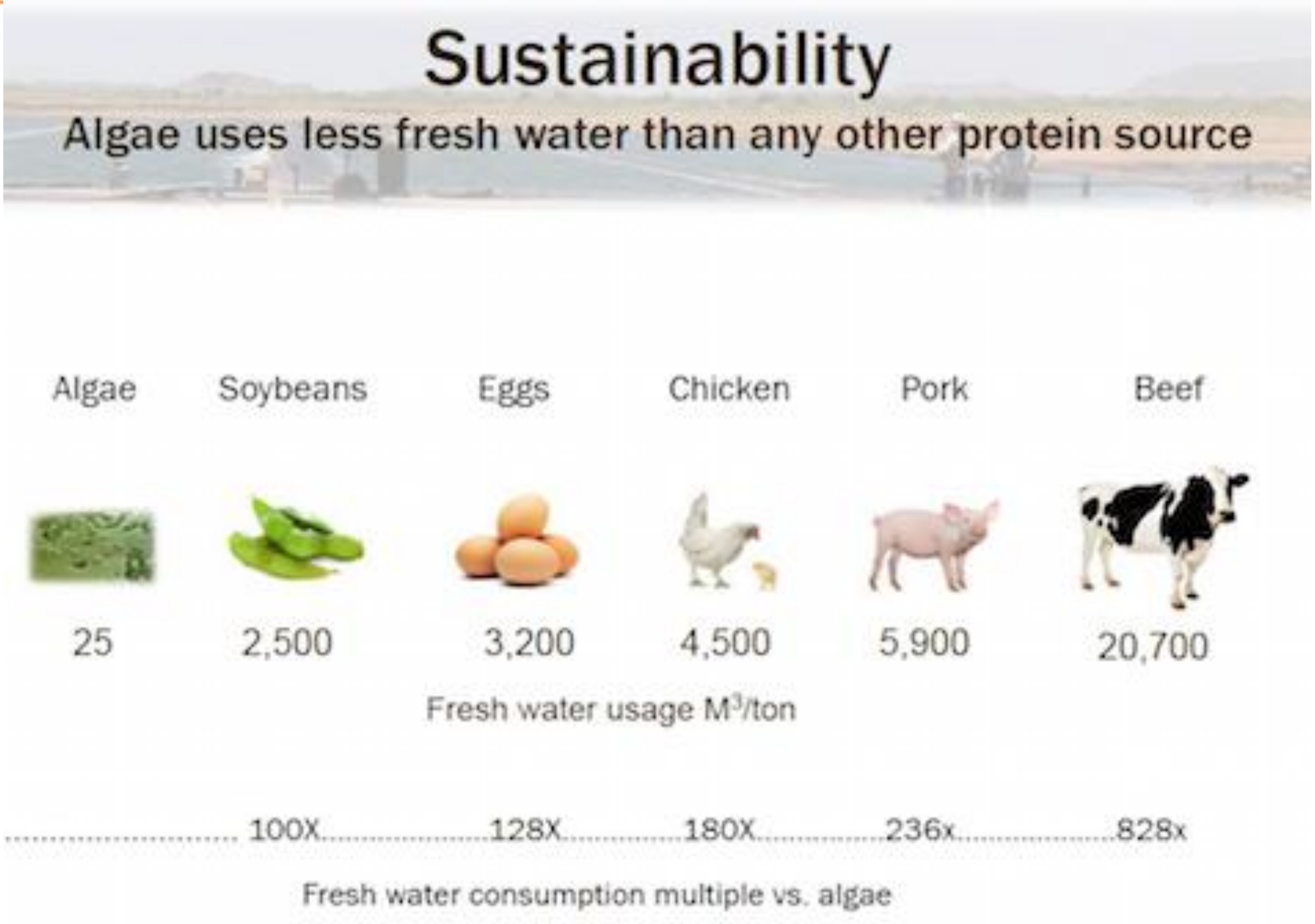
100 g beef:
285 calories
52 % protein
48 % fat
0 carbohydrates
30 mg calzium

needed for production : 285 g CO2
2193 litres of water

Spirulina

1 teaspoon =
4 grams of protein

One Green Planet



Sustainability

Algae uses less fresh water than any other protein source

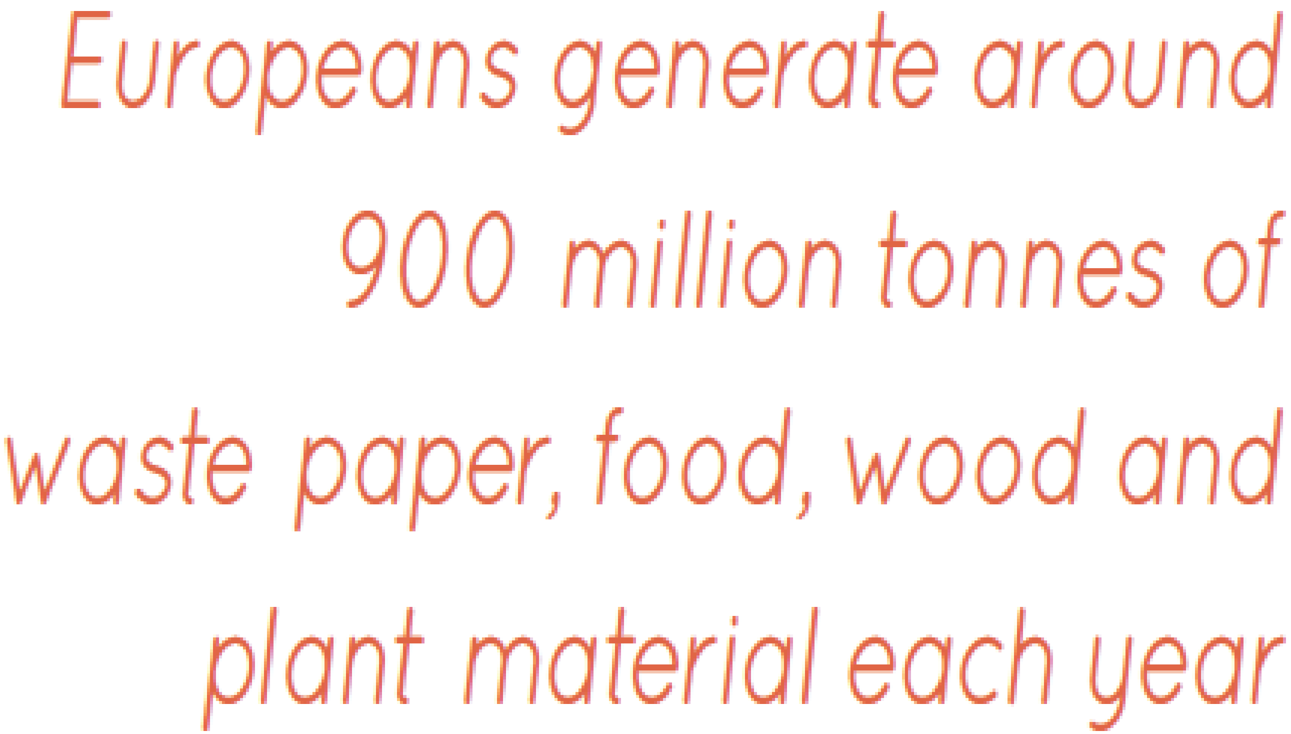
Algae	Soybeans	Eggs	Chicken	Pork	Beef
25	2,500	3,200	4,500	5,900	20,700

Fresh water usage M^3/ton

.... 100X.................... 128X.............. 180X.............. 236x.................... 828x

Fresh water consumption multiple vs. algae

Wastes



Europeans generate around
900 million tonnes of
waste paper, food, wood and
plant material each year

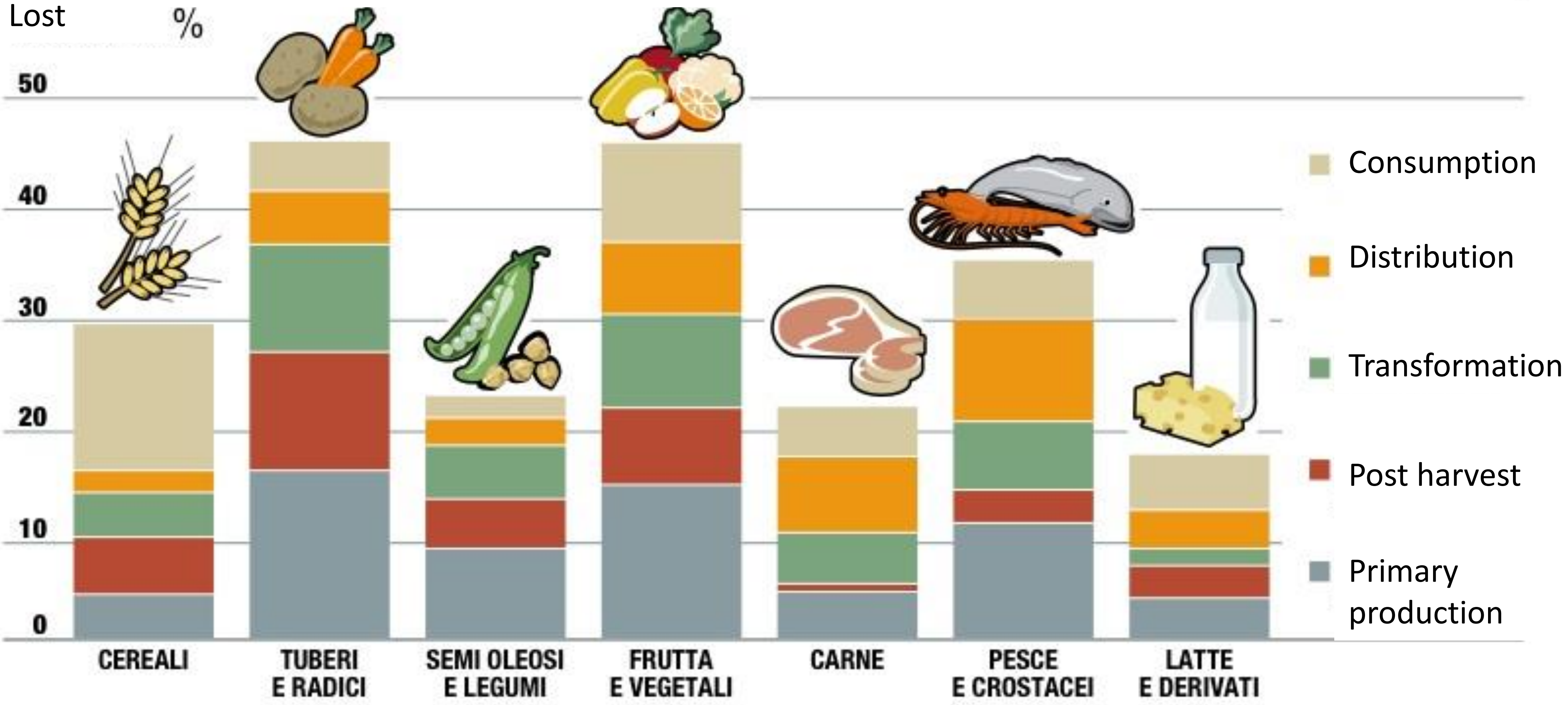
1 million tonnes of
Used Cooking Oil
(+ imports)

40 million tonnes of
Forest Slash

44 million tonnes of
Municipal Solid Waste

139 million tonnes of
Crop Residues

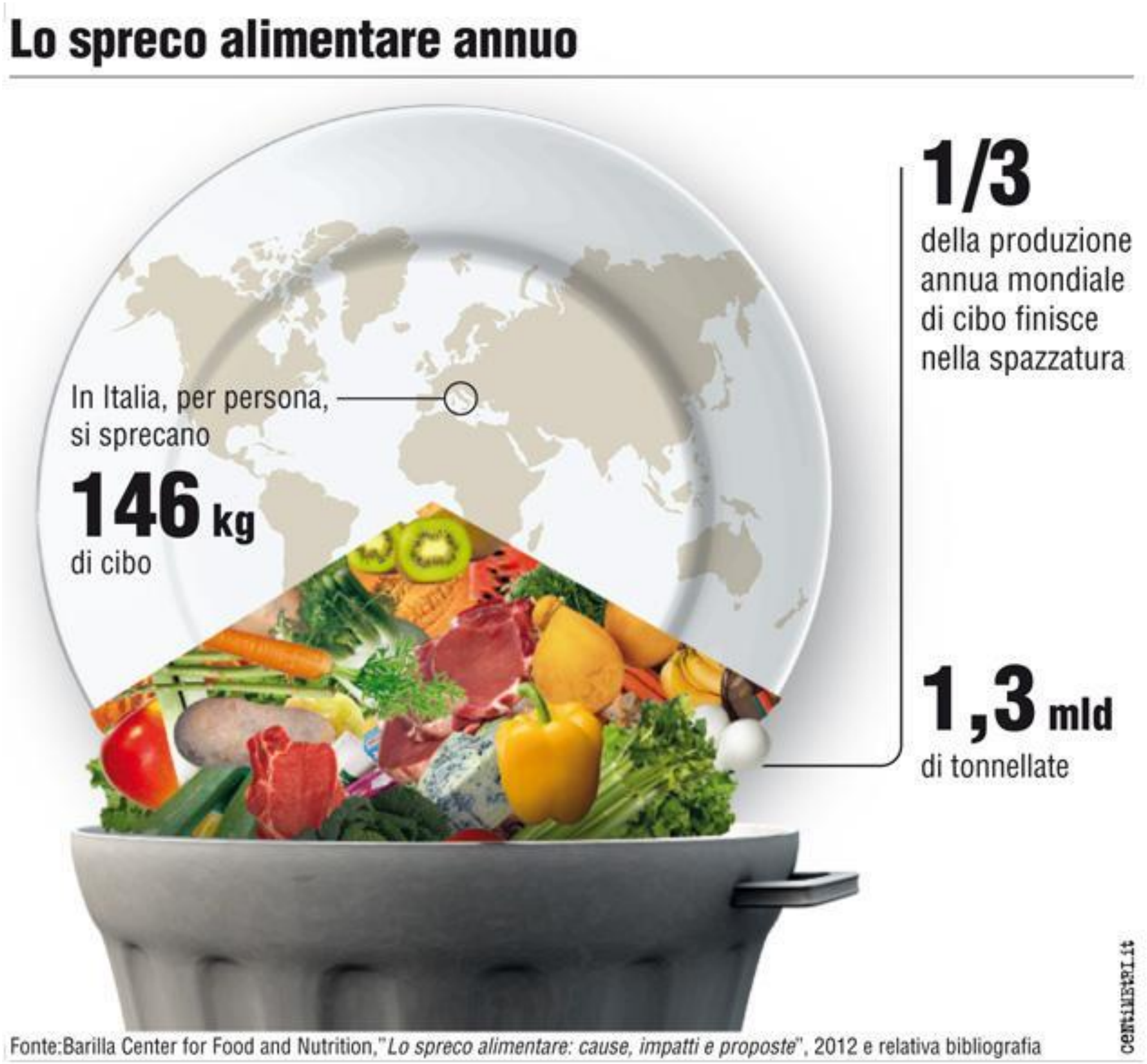
Food wastes



Fonte FAO 2011. Perdite e sprechi di cibo nel mondo. Dimensioni del fenomeno, cause e prevenzione

GRUPPO RICICLA

Food waste in Italy kg/year



Lo spreco alimentare annuo

In Italia, per persona, si sprecano

146 kg

di cibo

1/3

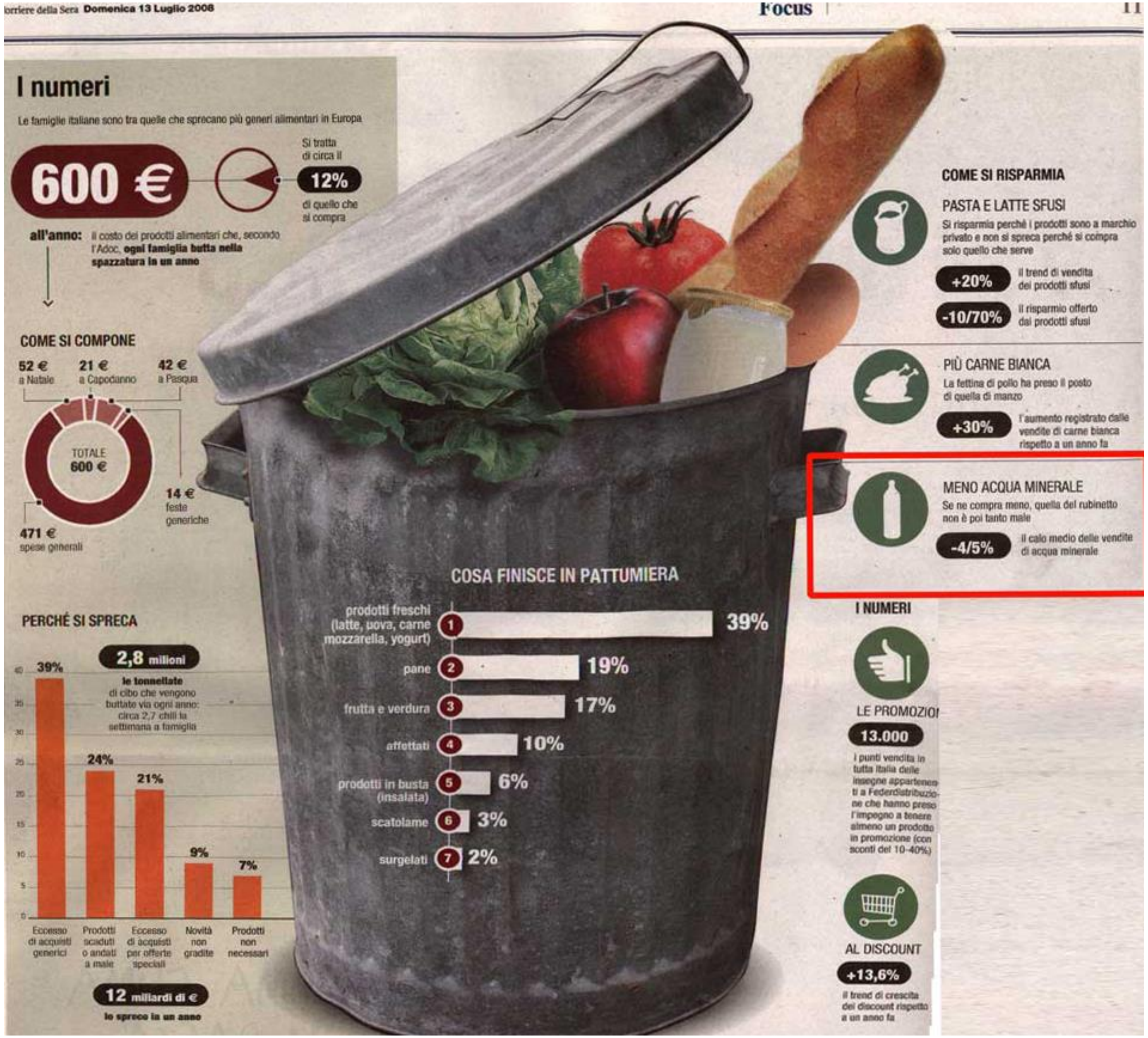
della produzione annua mondiale di cibo finisce nella spazzatura

1,3 mld

di tonnellate

Fonte:Barilla Center for Food and Nutrition,"*Lo spreco alimentare: cause, impatti e proposte*", 2012 e relativa bibliografia

centimetri.it



orriere della Sera **Domenica 13 Luglio 2008** Focus | 11

I numeri

Le famiglie italiane sono tra quelle che sprecano più generi alimentari in Europa

600 € **all'anno:** il costo dei prodotti alimentari che, secondo l'Adoc, **ogni famiglia butta nella spazzatura in un anno**

Si tratta di circa il **12%** di quello che si compra

COME SI COMPONE

52 €	a Natale
21 €	a Capodanno
42 €	a Pasqua
14 €	feste generiche
471 €	spese generali
TOTALE 600 €	

PERCHÉ SI SPRECA

2,8 milioni **le tonnellate** di cibo che vengono buttate via ogni anno: circa 2,7 chili la settimana a famiglia

Eccesso di acquisti generici	39%
Prodotti scaduti o andati a male	24%
Eccesso di acquisti per offerte speciali	21%
Novità non gradite	9%
Prodotti non necessari	7%

12 miliardi di € **lo spreco in un anno**

COSA FINISCE IN PATTUMIERA

1	prodotti freschi (latte, uova, carne mozzarella, yogurt)	39%
2	pane	19%
3	frutta e verdura	17%
4	affettati	10%
5	prodotti in busta (insalata)	6%
6	scatolame	3%
7	surgelati	2%

COME SI RISPARMIA

PASTA E LATTE SFUSI

Si risparmia perché i prodotti sono a marchio privato e non si spreca perché si compra solo quello che serve

+20% il trend di vendita dei prodotti sfusi

-10/70% il risparmio offerto dai prodotti sfusi

PIÙ CARNE BIANCA

La fettina di pollo ha preso il posto di quella di manzo

+30% l'aumento registrato dalle vendite di carne bianca rispetto a un anno fa

MENO ACQUA MINERALE

Se ne compra meno, quella del rubinetto non è poi tanto male

-4/5% il calo medio delle vendite di acqua minerale

I NUMERI

LE PROMOZIO

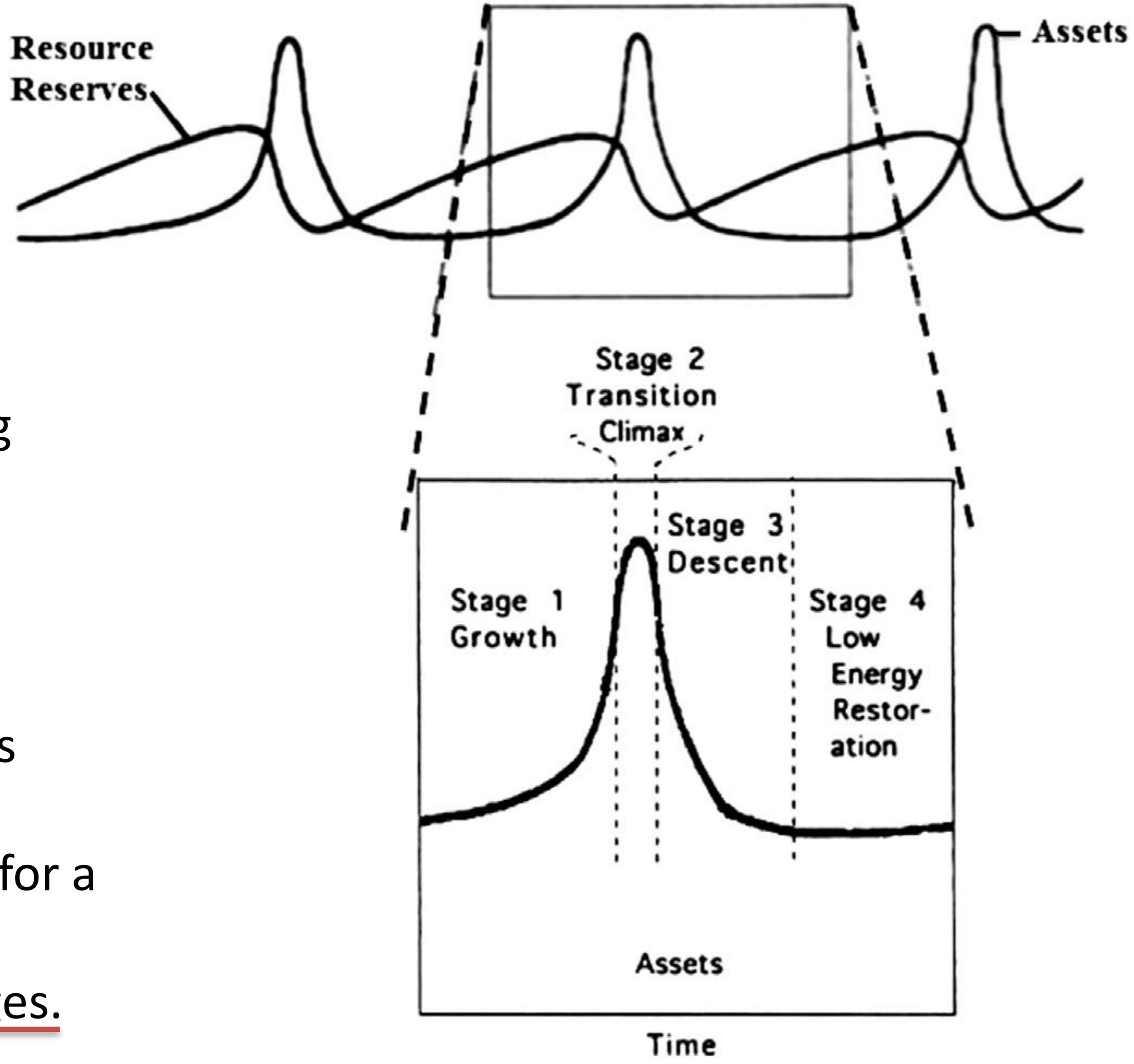
13.000 i punti vendita in tutta Italia delle insegne appartenenti a Federdistribuzione che hanno preso l'impegno a tenere almeno un prodotto in promozione (con sconti del 10-40%)

AL DISCOUNT

+13,6% il trend di crescita dei discount rispetto a un anno fa

L’Economia Ciroclare

The pulsing paradigm according to Odum and Odum (2001, 2006). In a pulsing dynamics, the first stage (growth) is characterized by high net yields, low efficiency and increasing load on environment; in the transition, steady-state phase, a declining growth rate is accompanied by low net yields, increasing efficiency, decreasing environmental loads; during degrowth, no net yields are achieved, efficiency reaches its maximum possible value to get the most out of less resources available, environmental loads keep decreasing due to less resource use. Finally, a phase of resource restoration occurs, for a new cycle ahead. CE contributes to transition and degrowth phases, while is not requested in growth and restoration stages.



Ghisellini et al., 2015

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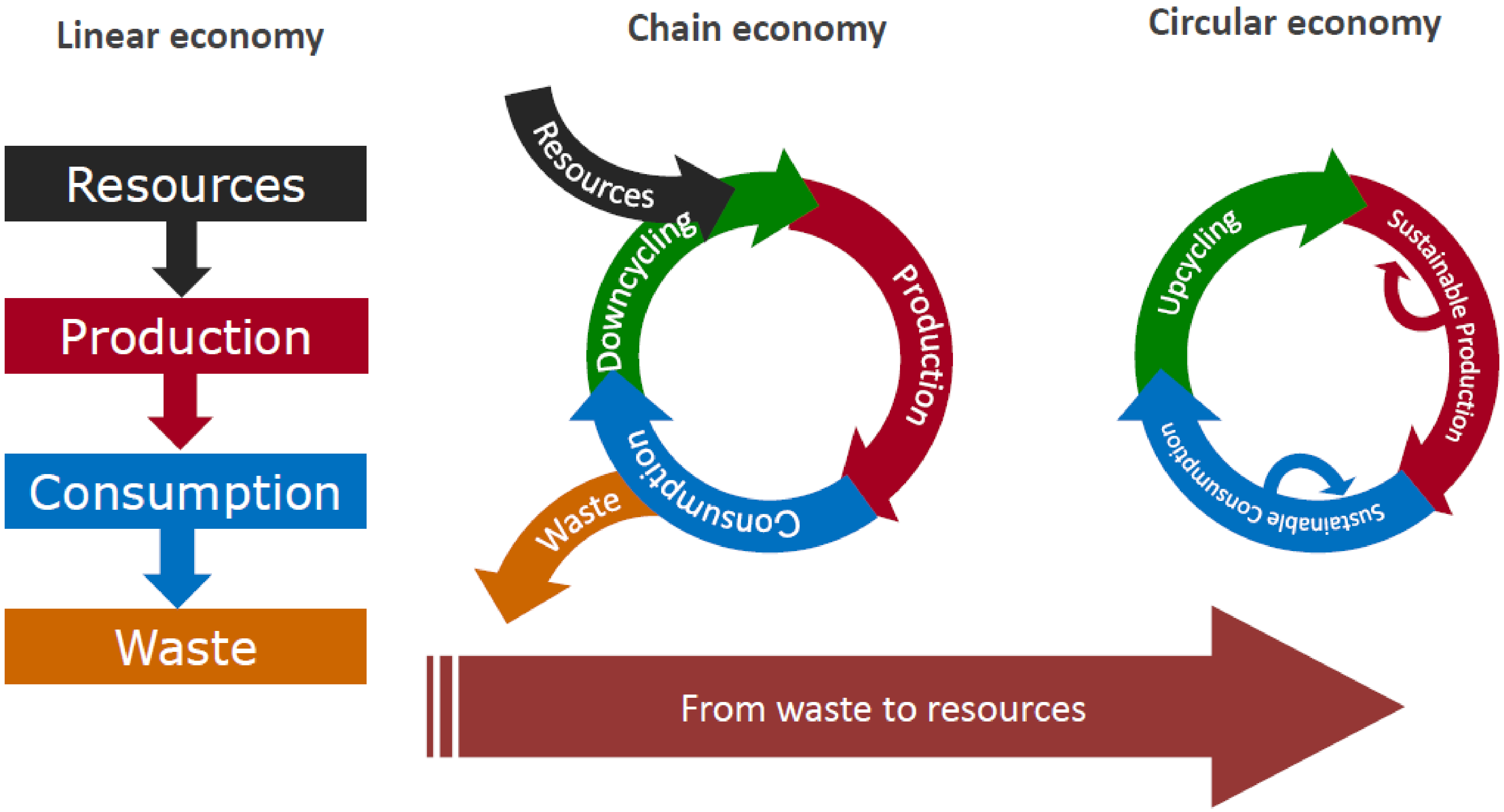
What is Circular Economy

CE started developing in the 1970s as an alternative economic model, challenging the traditional linear industrial economy. The **linear economy** is based on a linear process, optimised towards high throughput and low production costs relying on the abundant availability of raw materials at relatively low cost. The typical process consists of a series of steps – resource extraction, manufacturing, consuming and disposing of products at the end of their life cycle – which is also referred to as a **take-make-consume-dispose model.** The **circular economy**, on the other hand, aims at low environmental impact by minimising waste and excessive resource use by turning goods at the end of their lifespan into resources for others through re-use, re-manufacture, re-cycle, waste reduction and other practices. In other words, CE **is restorative by design and intention**.

Circular economy = the way to go

CIRCULAR ECONOMY
saving resources, creating jobs
Green Week, Brussels > 3-5 June 2014



Linear economy

Resources
Production
Consumption
Waste

Chain economy

Resources
Production
Consumption
Waste
Downcycling

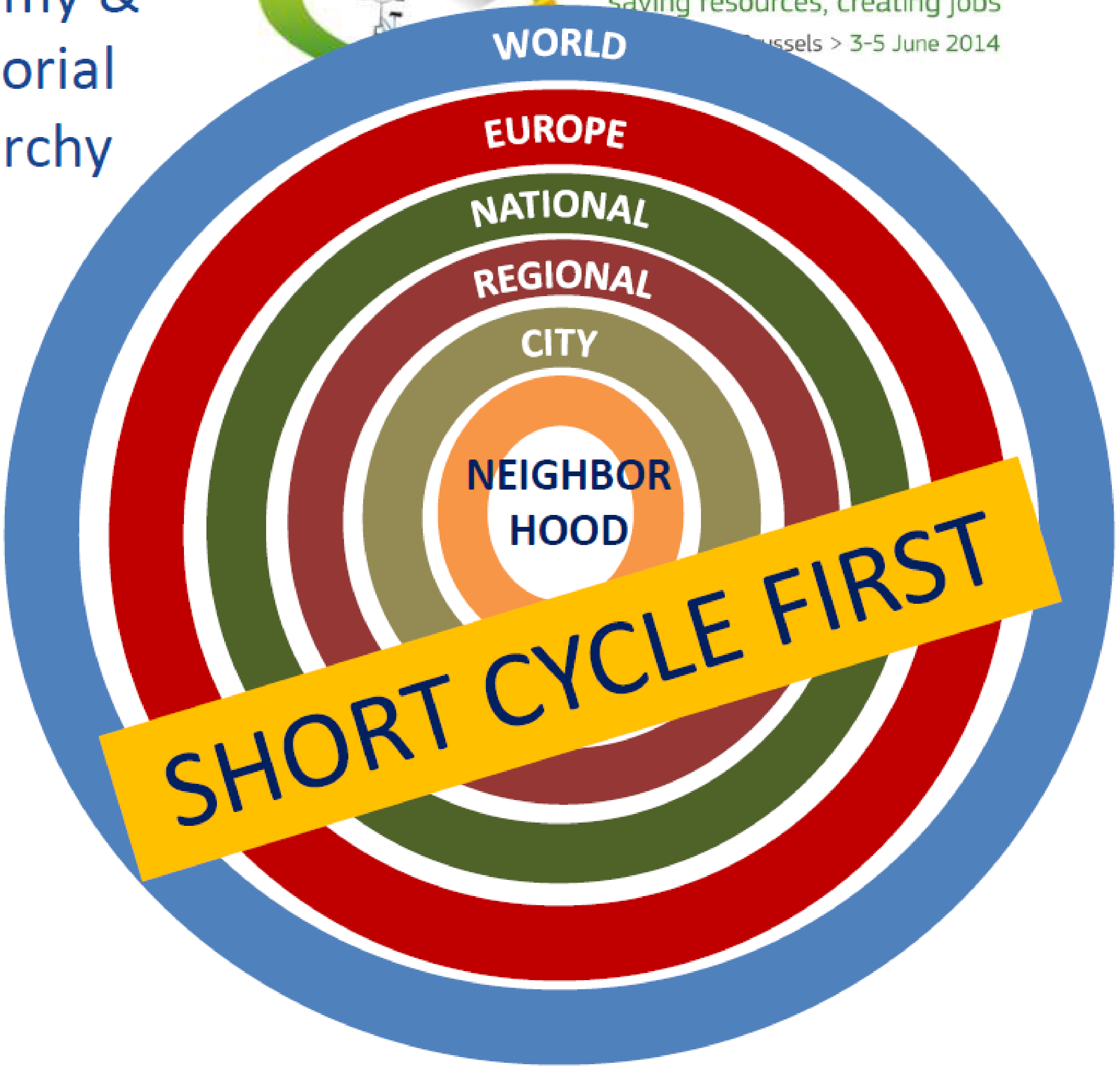
Circular economy

Sustainable Production
Sustainable Consumption
Upcycling

From waste to resources

Circular economy & territorial hierarchy

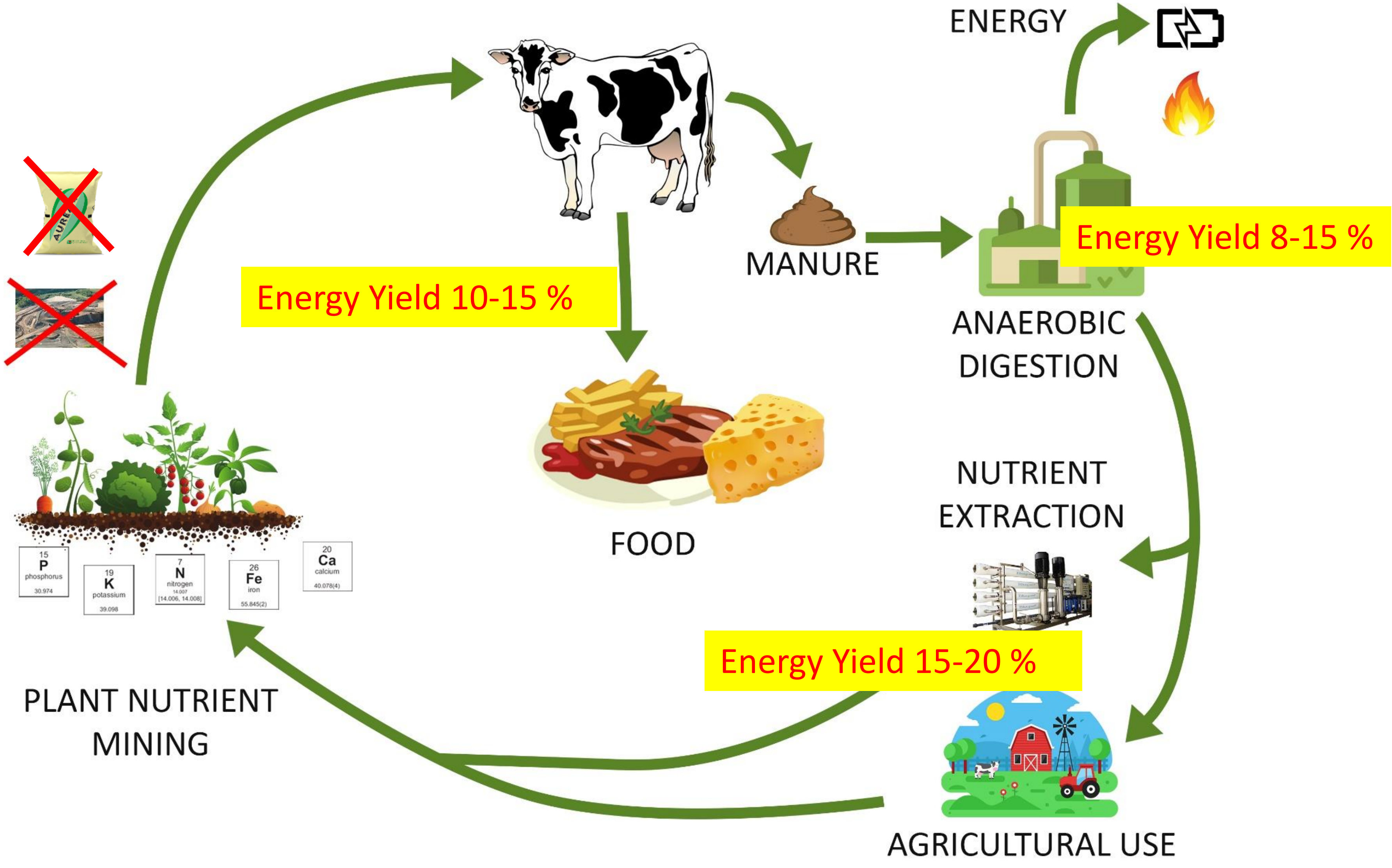
CIRCULAR ECONOMY
saving resources, creating jobs
ussels > 3-5 June 2014



From biorefinery to Circular Economy : allevamenti sostenibili

Linear economy:
Energy yield 10-15 %

Circular economy:
Energy yield 35-50 %



ENERGY

MANURE

Energy Yield 10-15 %

Energy Yield 8-15 %

ANAEROBIC DIGESTION

FOOD

NUTRIENT EXTRACTION

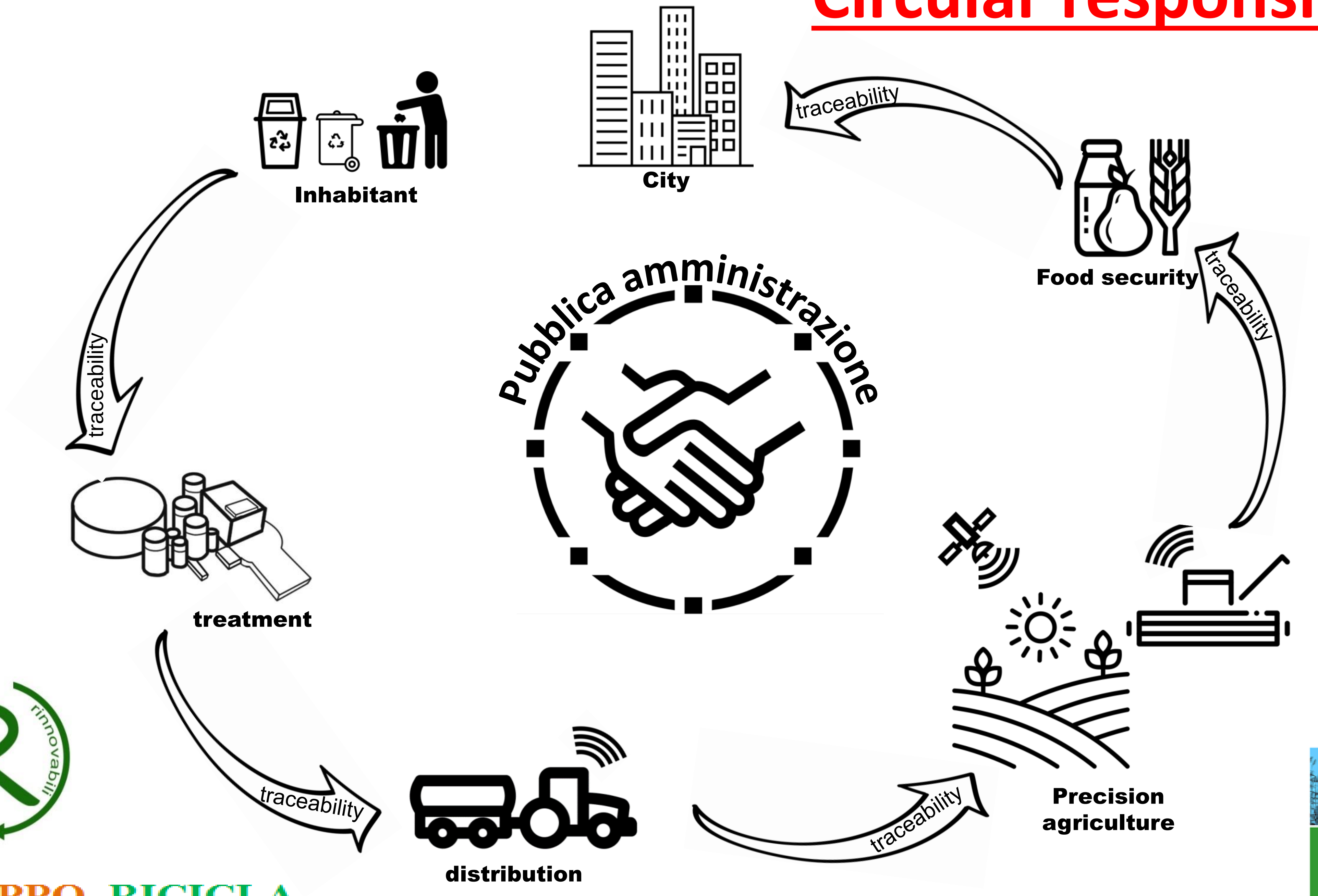
Energy Yield 15-20 %

PLANT NUTRIENT MINING

AGRICULTURAL USE

GRUPPO RICICLA

Circular responsibility


City

traceability

Food security

traceability

Precision agriculture

traceability

distribution

traceability

treatment

traceability

Inhabitant

Pubblica amministrazione

GRUPPO RICICLA

acqua & sole

ANAEROBIC DIGESTION
transforms biomass into

BIOFUELS

renewable fertilizers®

……and more……….

Impatti misurati con LCA

Concimi chimici
di sintesi

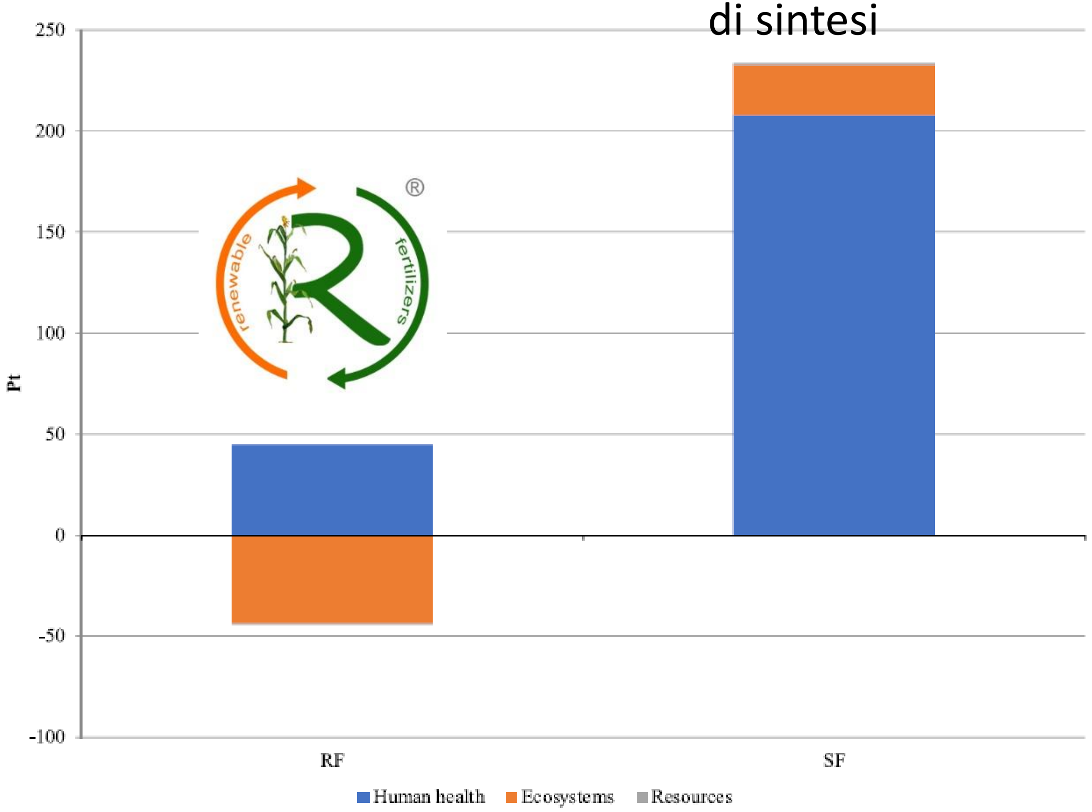


Figure 2. Comparative environmental results for Scenarios Recovered Fertilizers (RFs) and Synthetic Fertilizers (SFs). Impact assessment (Ecopoint—Pt) calculated according to the ReCiPe 2016 end point (H) V 1.03 impact assessment method.

Ciclo di seminari
IL POTENZIALE INNOVATIVO DELL'UNIVERSITÀ DEGLI STUDI DI MILANO E L'IMPRESA SOSTENIBILE

Grazie !!!!

GRUPPO RICICLA

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