De-carbonized Society: How it should be built

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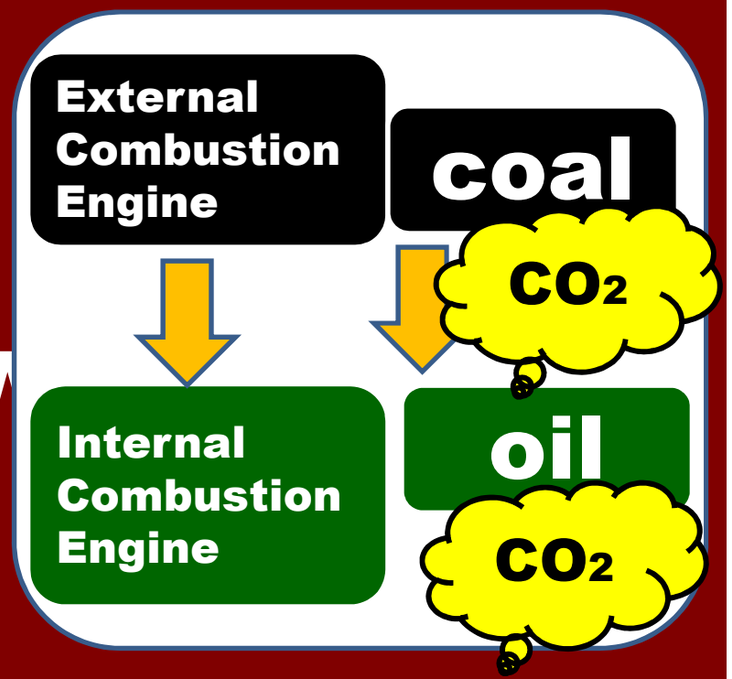
Industrial Revolution

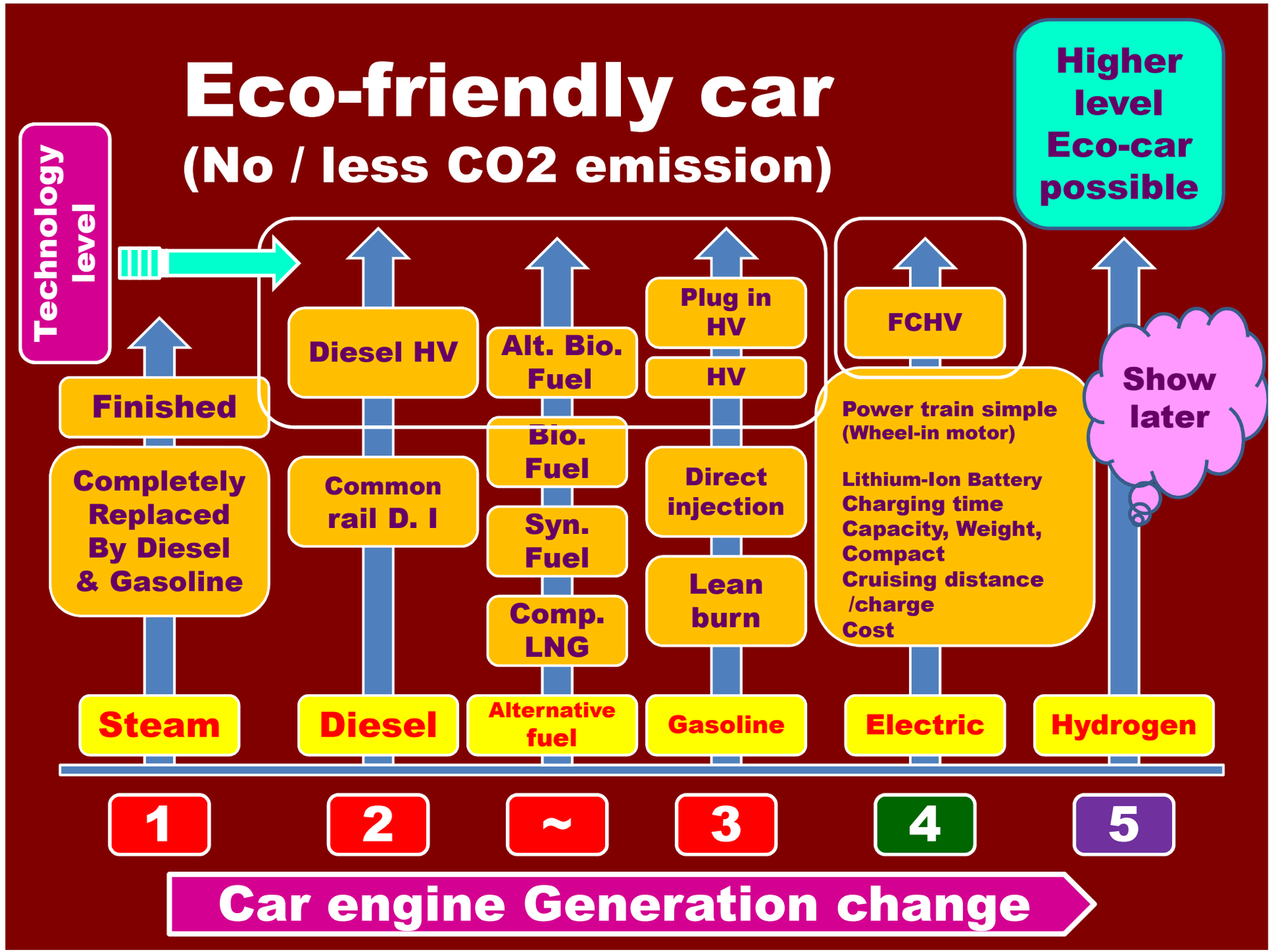
- **Steam** Engine, James Watt
- **Steam** Locomotive, Thomas Newcommen ,
- **Gasoline** engine Nikolaus August Otto
- **Diesel** engine, Rudolf
- **Rotary** engine, Felix W
- Jet engine
- Rocket engine

1700~



How many cars now?

- **Total number of car production :**
  80,145,988 / year
  (Source: Global Note March 2022, OICA (International Organization of Motor Vehicle Manufacturers
- **Total number of cars in the world:**
  1,492,040,000
  Japan:
  78,420,000 in 2019
- **One car owned for two persons**
  （December 2019）
  https://www.mitsubishi-motors.com/jp/sustainability/contribution/people/kids/question/box/category08/qa05/


Eco-friendly car
(No / less CO2 emission)
Higher level Eco-car possible
Technology level
Finished
Completely Replaced By Diesel & Gasoline
Diesel HV
Common rail D. I
Alt. Bio. Fuel
Bio. Fuel
Syn. Fuel
Comp. LNG
Plug in HV
HV
Direct injection
Lean burn
FCHV
Power train simple (Wheel-in motor)
Lithium-Ion Battery
Charging time
Capacity, Weight, Compact
Cruising distance /charge
Cost
Show later
Steam
Diesel
Alternative fuel
Gasoline
Electric
Hydrogen
1
2
~
3
4
5
Car engine Generation change

Fossil fuel-based Internal Combustion Engine & Its beyond

- Internal combustion engines which work on fossil fuels, especially automobile engines, are pefectly completed so that there are no problems pointed out as products socially accepted from the viewpoint of Excellent Performance, Ease of Operation and Control, Safety, Maintenance, etc.
- It is highly evaluated as a technology except that the only fuel used is fossil fuel to produce CO_2.
- Active use of CO2 shoud be promoted from this viewpoint too.

Continued 1

- **What will be happened to the fossil fuel-based internal combustion engines?**
- **Will it be disappeared?**
- **It is not good to think from the perspective of De-carbonization, the fossil fuel-powered internal combustion engines may be mostly replaced by Electricic powered ones (automobiles).**

Continued 2

- It seems dificult to think the completed technology will be disappeared so easily.
- There is a need, at least while fossil fuels are present, and electricity can’t be used without power generation and storage.
- If it is discharged, it needs to be charged.
- Fossil fuels can be used directly and have a great effect on power generation.
- It works not only with fossil fuels but also with bio-fuels and hydrogen.

Energy (Oil) Crisis

Energy crisis encountered twice

- 1st Oil shock 1973
  (The 4th Middle East War)
- 2nd Oil shock 1979~1980
  (Iranian revolution)
- World noticed the importance of Energy (Oil)

What happened however ?

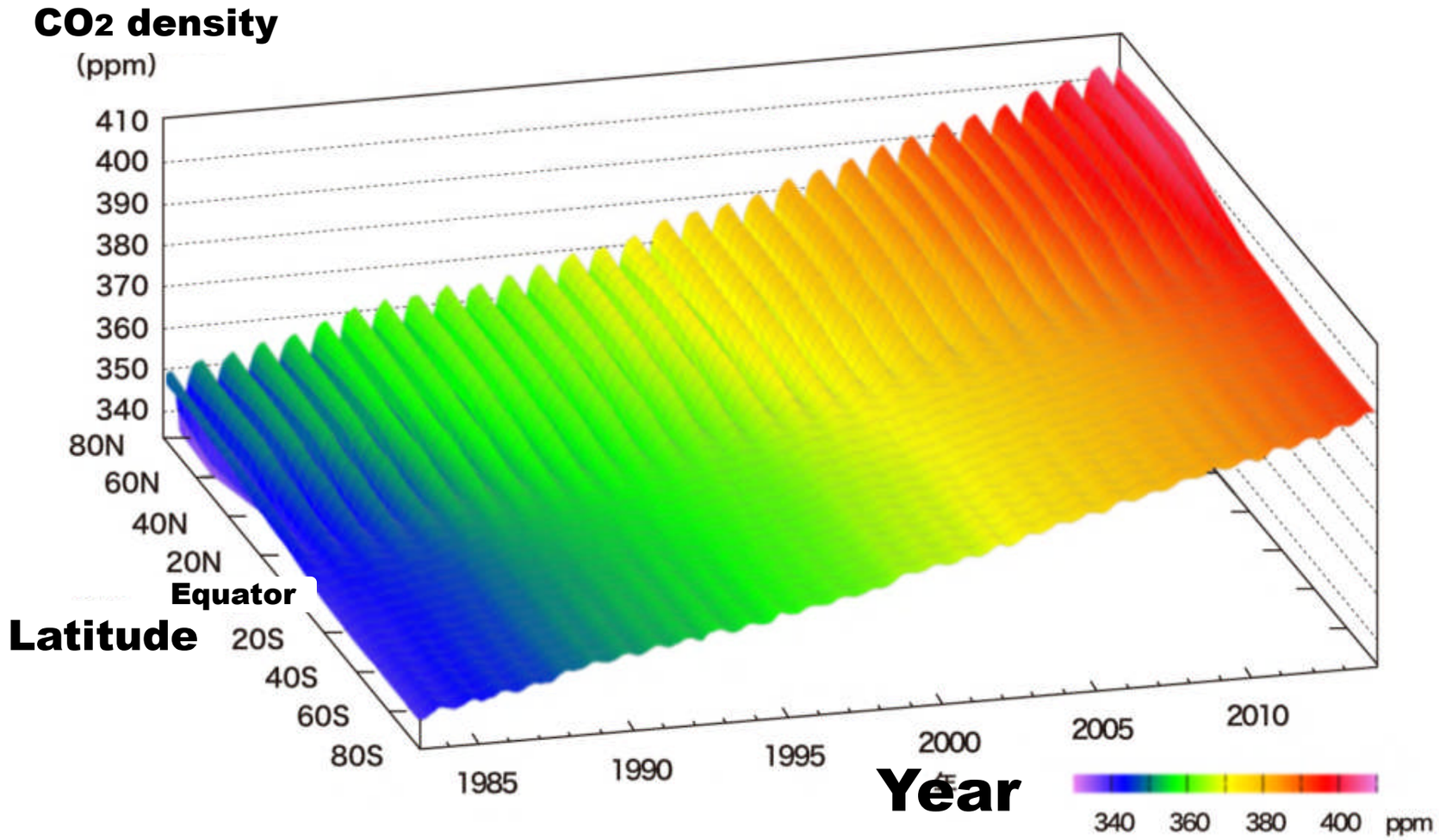
- 20 years later after energy crisis, COP3 was held in Kyoto, Japan
  Notified Environment was jeopardized
- 40 years later COP26 in England, since
- CO2 emission is still increasing now
  Why ? Main countries chose Energy for economic promotion than Environment

COP, Conference of Parties

- **COP3 :**
  Kyoto protocol agreed and approved in 1997
  From 2008 to 2012, it was obliged to reduce greenhouse gas emissions by 6% compared to 1990. Japan achieved

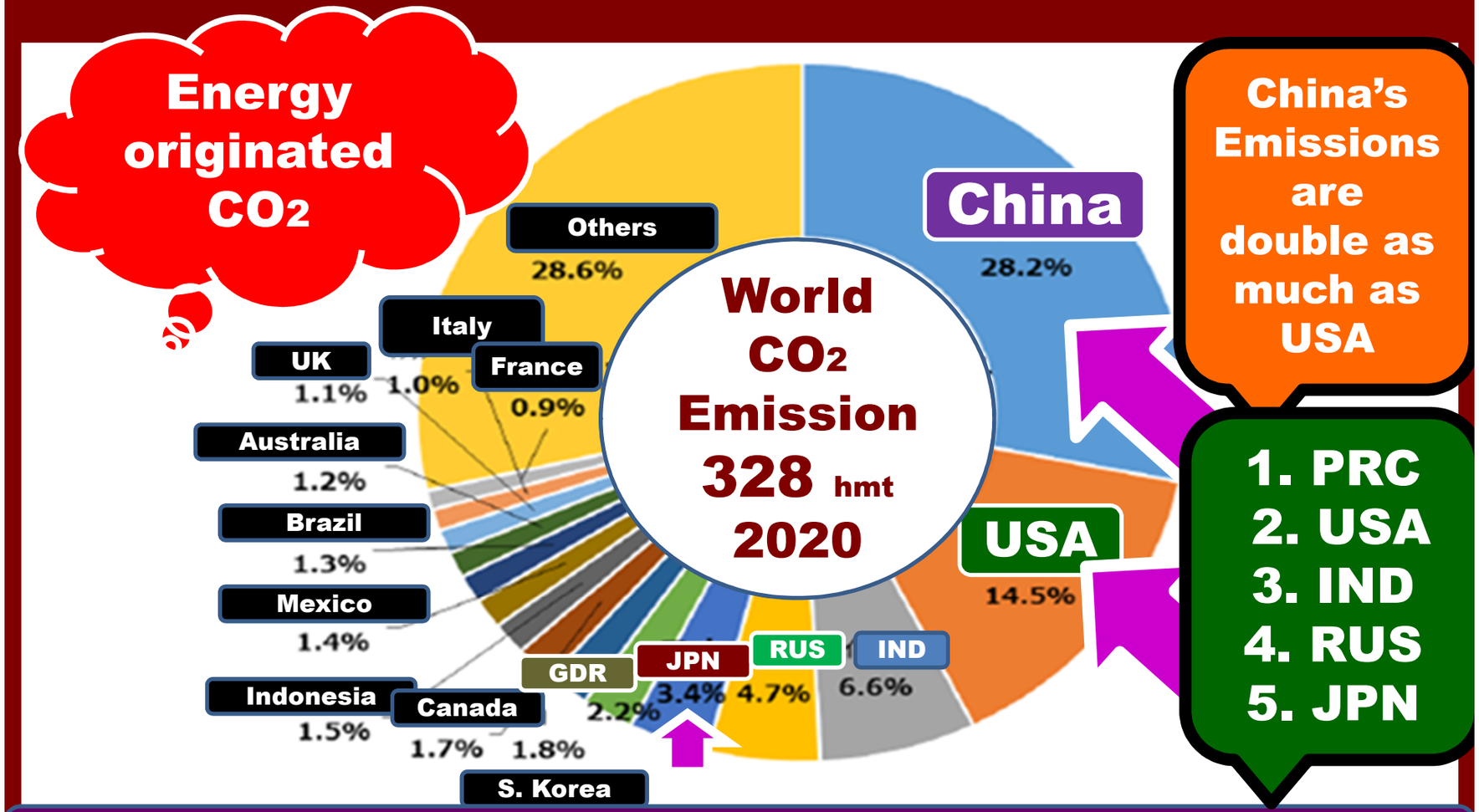
- **COP26 :**
  Glasgow, England 2021
  1) It was formally agreed at the COP that the world will work towards the 1. 5° C target.
  2) For each specific initiative, the means by which supporting countries and companies gathered to form a coalition of the willing was utilized.
  3) The goal has been set. In the future, the focus will be on how much we can accelerate the movement to reach this goal.

Changes in carbon dioxide concentration in the atmosphere (by latitude)



Source: Climate change monitoring report (2014)

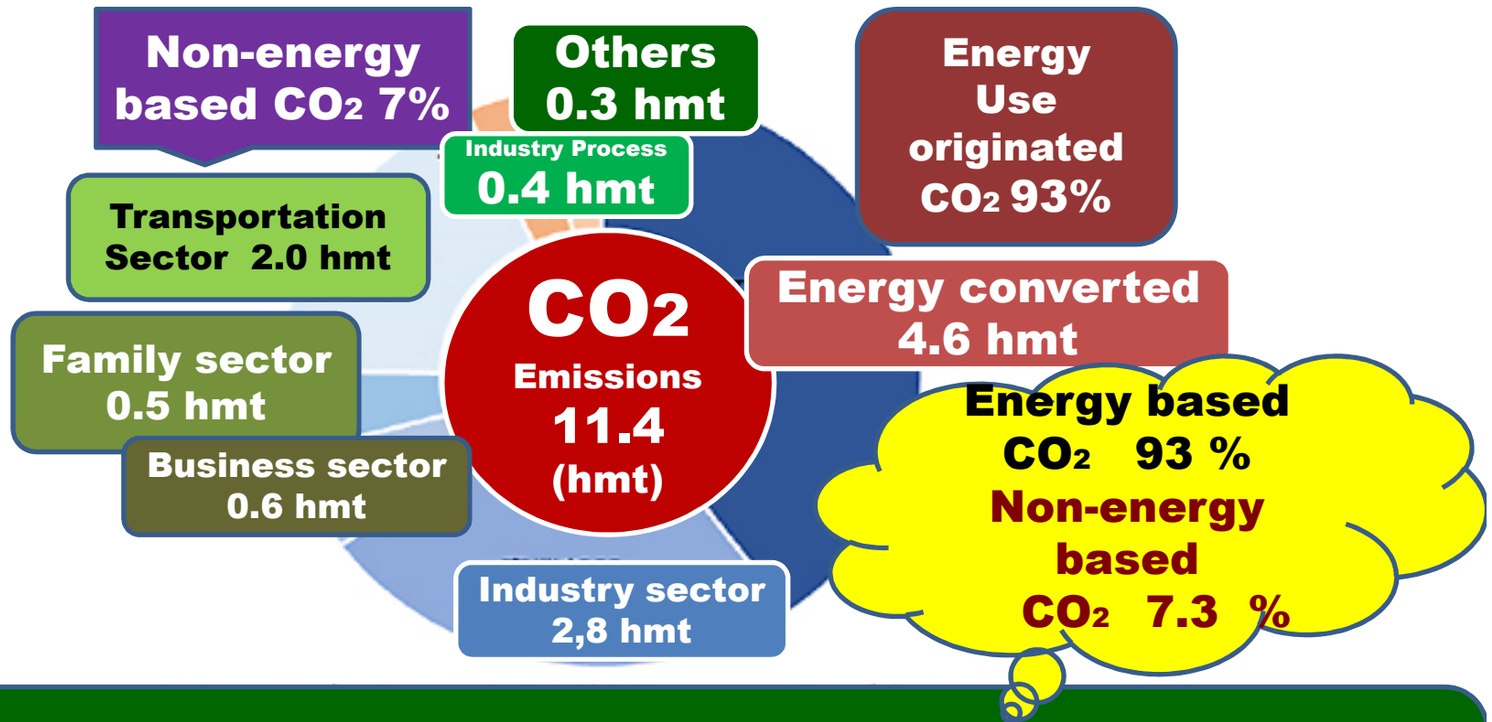
World CO_2 Emission



Source: made from GHG Inventory Office

Japan's CO_2 Emissions

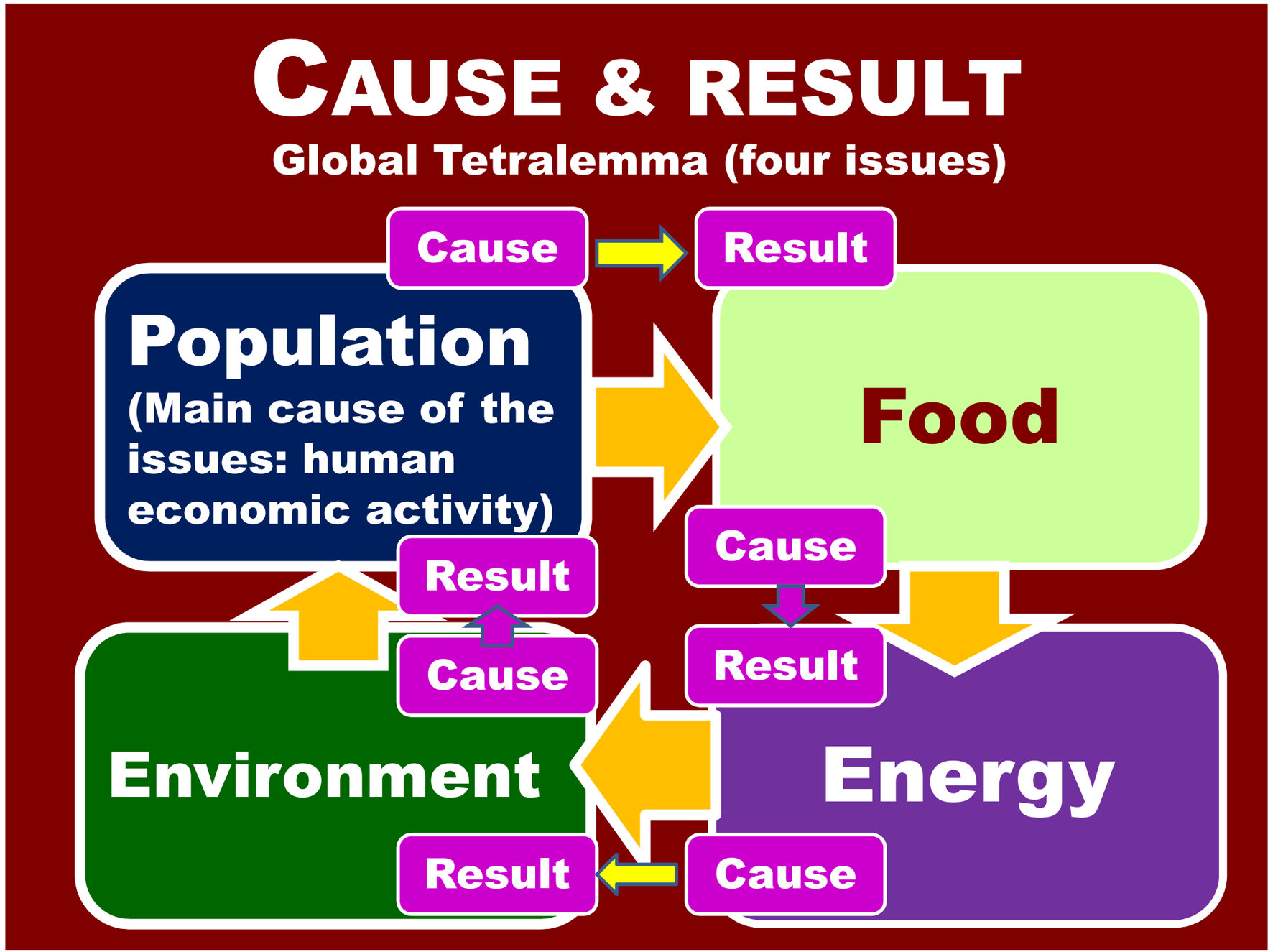
Source: Ministry of Economy, Trade and Industry, Agency for Natural Resources and Energy, October 13, 2020, p.81)



Source: GIO, General Incorporated Association Low Carbon Investment Promotion Organization
https://www.teitanso.or.jp/

CAUSE & RESULT

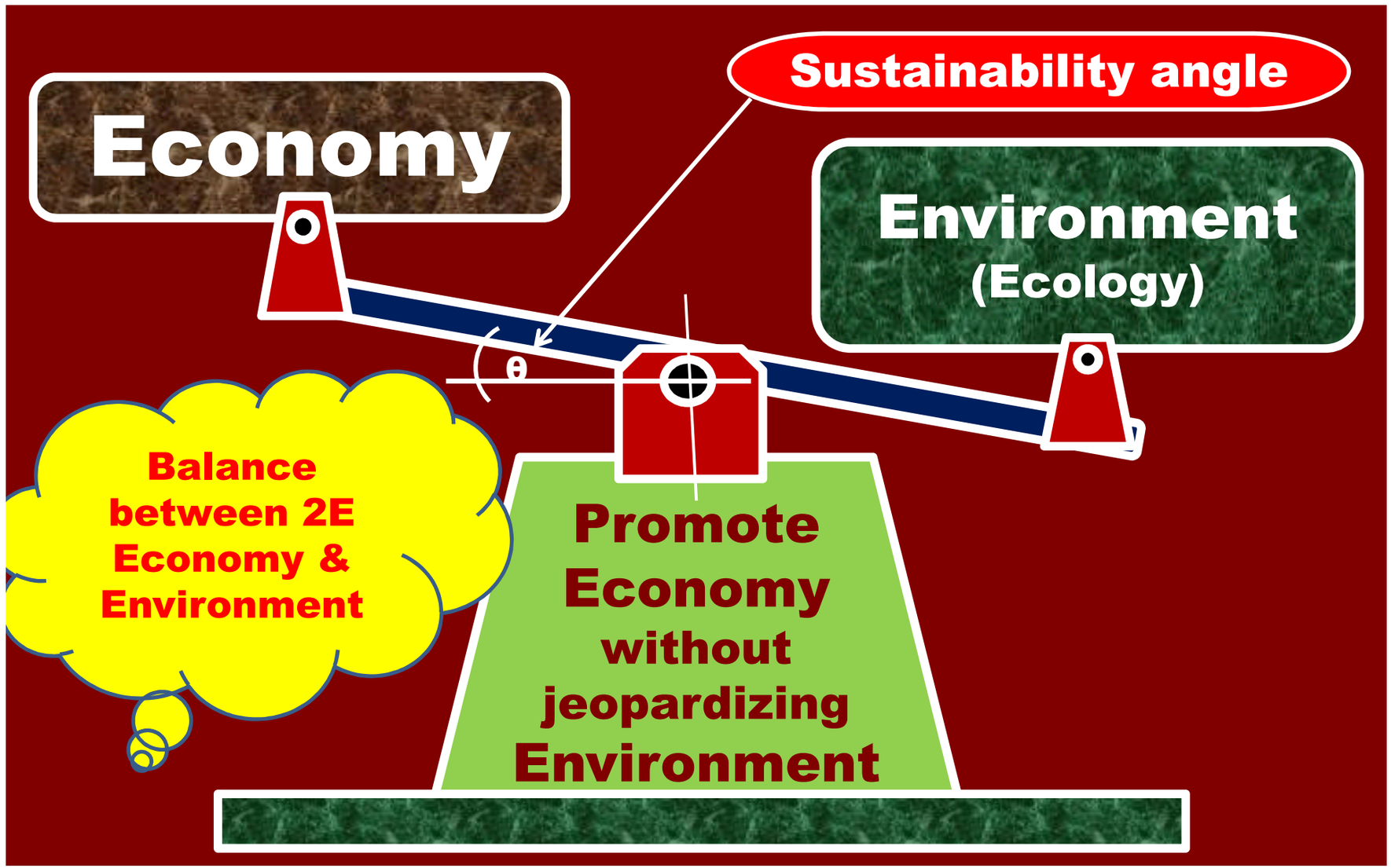
Global Tetralemma (four issues)



SUSTAINABILITY

- **Sustainability concept means something to develop and promote under Continuous, Circular, Connected conditions**
- **Simply to say it can be defined as " To promote Economy without jeopardizing Environment "**
- **In this case, Energy (mainly oil) consumption caused the result of Environmental issue such as Global warming & Climate change**

Concept of Sustainability

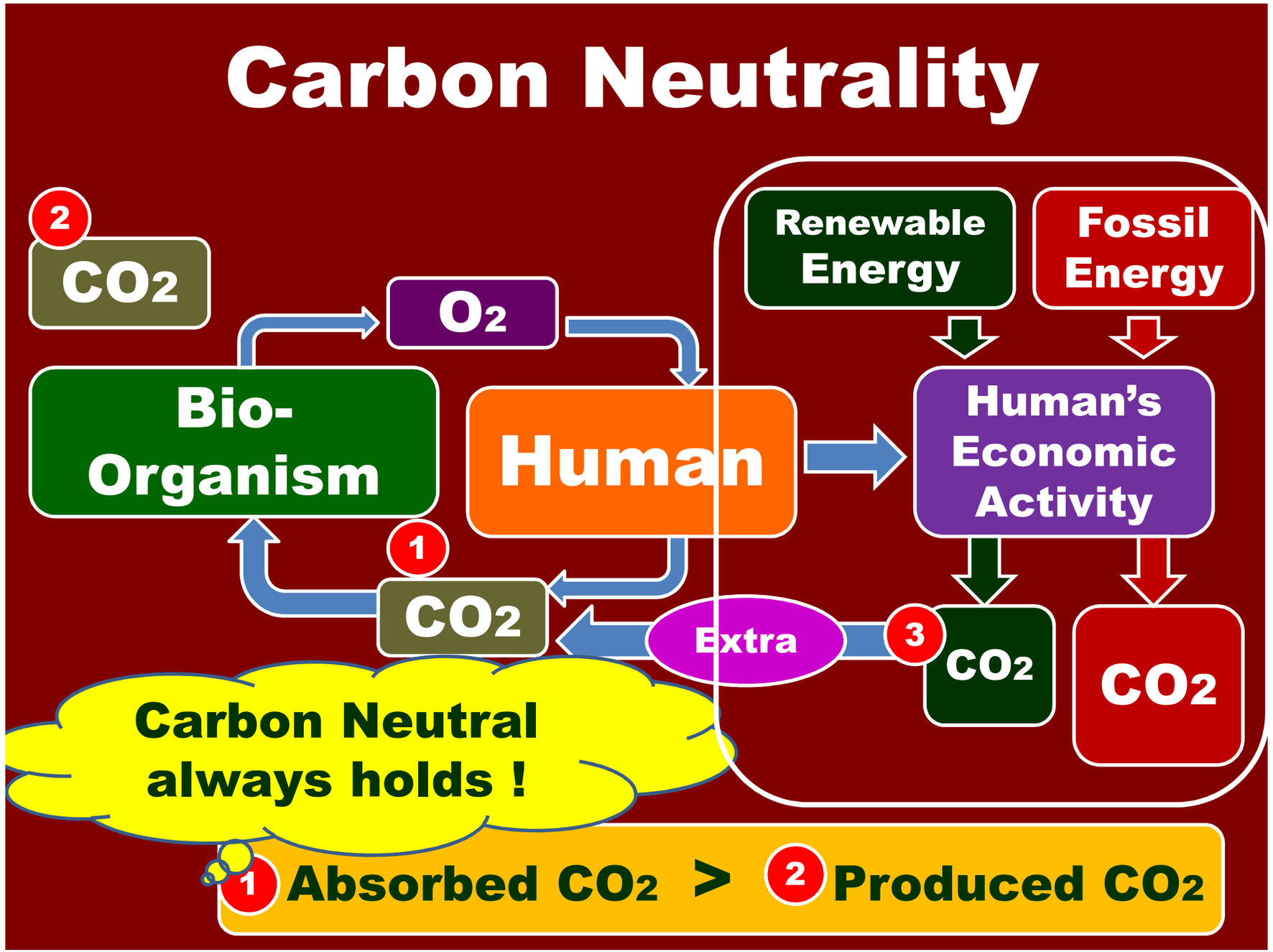


ECONOMY vs / & ECOLOGY

- Planet of Earth is totally controlled now by Humans
- Ecosystems are no longer maintained after the introduction of the concept of Economy
- Greedy humans aiming to make money were "indifferent to the fact that the earth is the only planet that is irreplaceable for all.
- The cause of the previous problem produces the result of the latter problem.

Where those issues come from

- **Environmental issues are coming from the cause of huge amount of CO2 production due to fossil energy combustion**
- **Many of the suspected natural disasters might be often caused by human economic activity.**
- **Ecological chain may be disconnected**
- **The problem at the back is mostly the result of the problem at the front as shown below**


Carbon Neutrality
Renewable Energy
Fossil Energy
2
CO2
O2
Bio-Organism
Human
Human's Economic Activity
1
CO2
Extra
3
CO2
CO2
Carbon Neutral always holds !
1 Absorbed CO2 > 2 Produced CO2

Methods for 3 cases

1	No CO_2 production	Energy shift
2	Less CO_2 production allowed	Waste energy recovery Waste to Energy Warming, Heating
3	Active use of produced CO_2	EUGLENA Algae

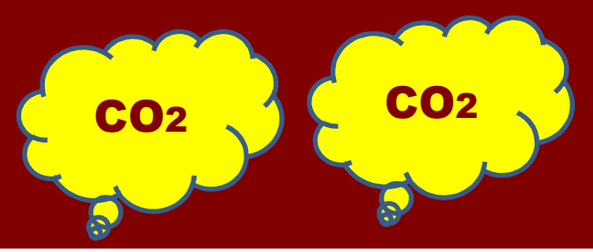
Right way to go

1. Active use of produced CO_2 ⇔ EUGLENA Algae
2. Less CO_2 production allowed ⇔ Waste energy recovery
Waste to Energy
Warming, Heating
3. No CO_2 production ⇔ Energy resources shift to Hydrogen

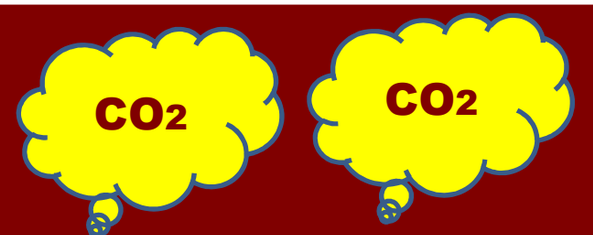
Decarbonized Society Building

1. **No carbon emission**
2. **Energy shift to**
   Natural energy, Renewable energy, Hydrogen, Nuclear power (Nuclear fusion)
3. **CCS; Carbon Capture & Storage**
   CCU: CO_2 Capture & Utilization
   - Locally distributed type
   - Centralized type
4. **New products from Biomass**
   Cosmetics, Health supplement, Animal feed, Fertilizer
   Bio-fuel, Bio-jet fuel
   Euglena

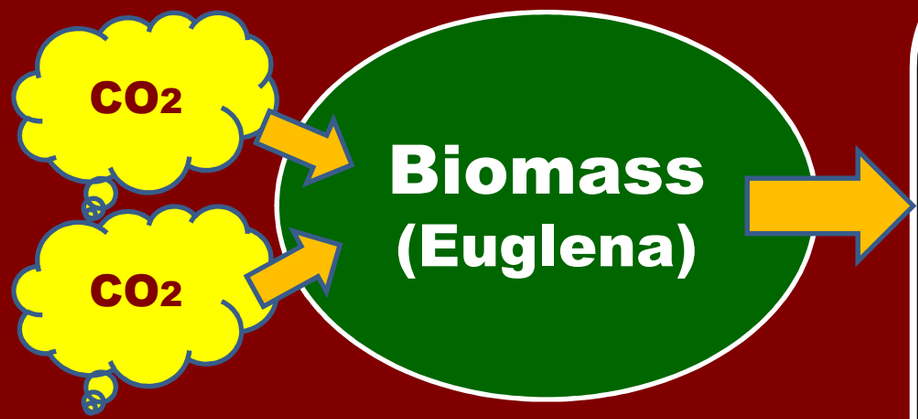
→ **Solution**



- **Active Use of CO_2**



Bio-based Decarbonized Society



Various products from Biomass

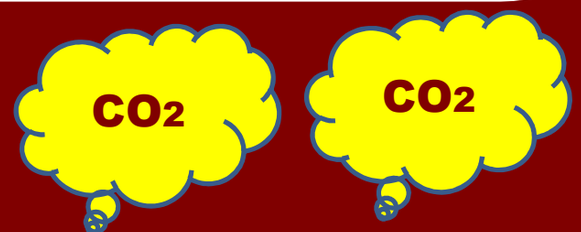
- Energy → Electricity
- Food
- Material
- Machines
- Plants, Houses
- Public construction

etc

Gas, Liquid

Required conditions

- Functional components relying on the purpose of usage
- EPR > 1.0
- Cost
- CO_2 absorption (CCS & CCU)



EPR and Efficiency

- **The more the energy production process increases, so does the loss.**
- **EPR, Energy Profit Ratio value should be more than 1.0 at least, otherwise, the loss and waste increase**
- **EPR value should be importantly considered in energy production, however, the total loss should be minimized in energy consumption (Energy efficiency should be maintained high)**

Energy production & consumption

Energy production

Corn > 1.2
Sugarcane > 2~3

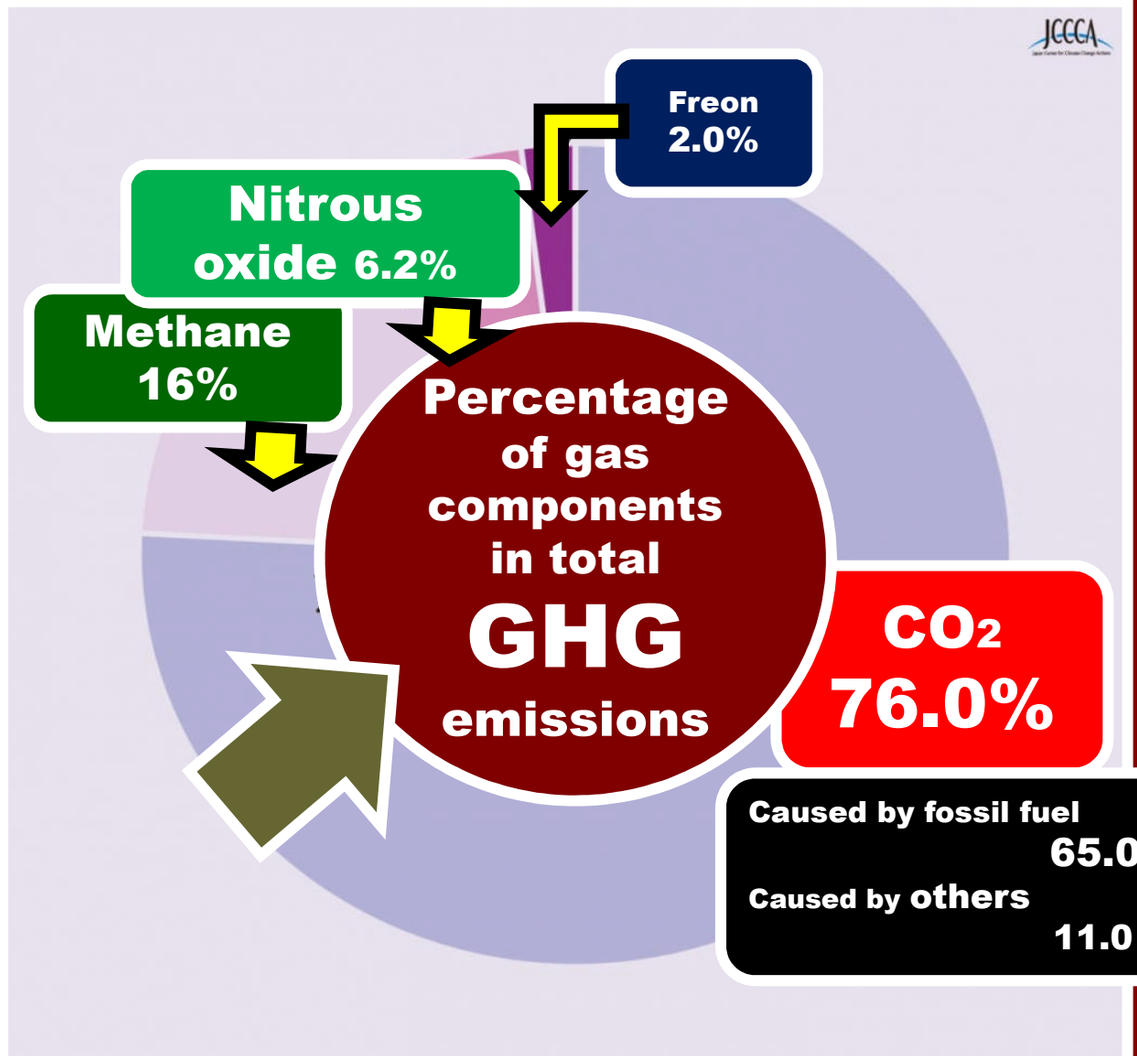
- $EPR = \frac{\text{Total Output energy}}{\text{Total input energy}}$ > 1.0

Efficiency

- $\text{Efficiency} = \left| \frac{TIE - TEL}{TIE} X\ 100 \right|$ < 100 %

where TIE: Total input energy
TEL: Total Energy loss

Japan Center for Climate Change Actions



GHG composition

- CO_2 76.0%
  - Fossil fuel 65.0%
  - Others 11.0%
- Methane 16.0%
- Nitrous oxide 6.2%
- Freon 2.0%

Source:
IPPC 5th Evaluation Report & Various Emissions (2010)

ELECTRICITY

Final Form of Energy

Various kinds of Energy resources

Natural & Renewable

- Hydro
- Wind
- Solar(photovoltaic)
- Solar (thermal heat)
- Bio(mass, gas, fuel)

- Fossil
- Hydrogen
- Nuclear (Fusion)

Electric generation

Under conditions

1. No / low CO2 production, Or
2. Active use of CO2 as Energy
3. EPR should be > 1.0

Ultimate type of Energy

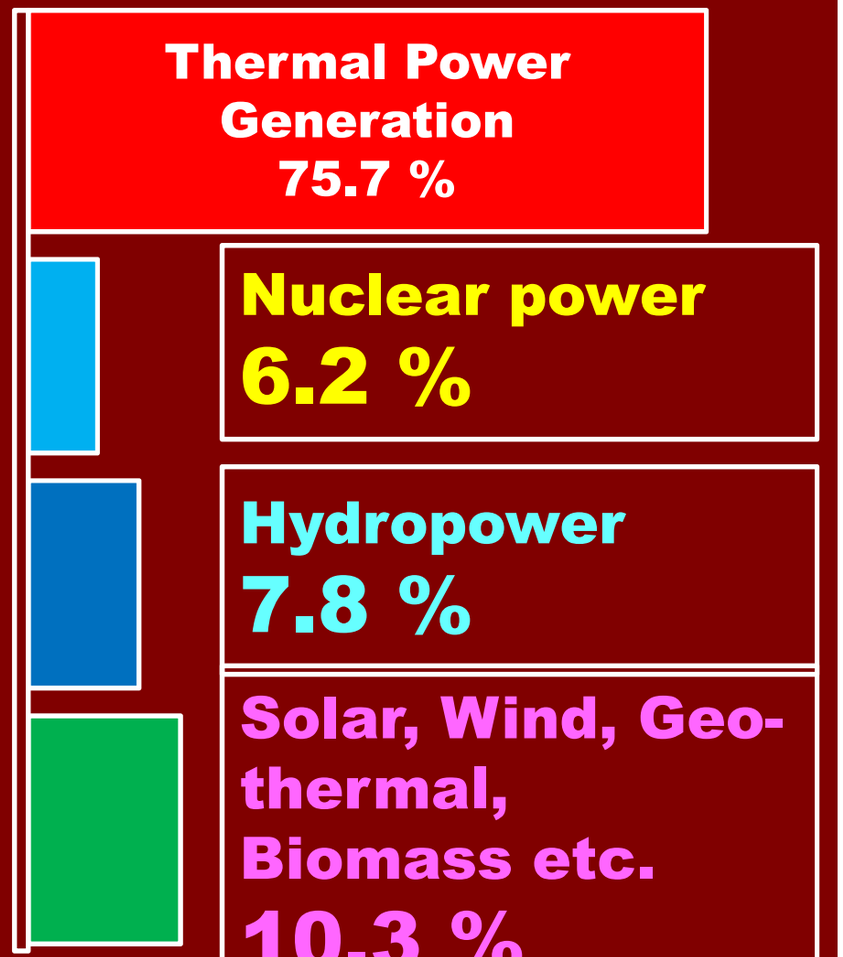
Electricity

1. Planned Cultivation of Biomass for stable supply of Energy on Needs & demand
2. Battery to secure Stable Energy output

Japan's Electricity Composition (FY2019)

Types of Renewable Energy

- Solar power
- Wind-power generation
- Biomass power generation
- Hydropower
- Geothermal power generation
- Utilization of solar heat
- Use of snow and ice heat
- Utilization of temperature difference heat
- Use of geothermal heat



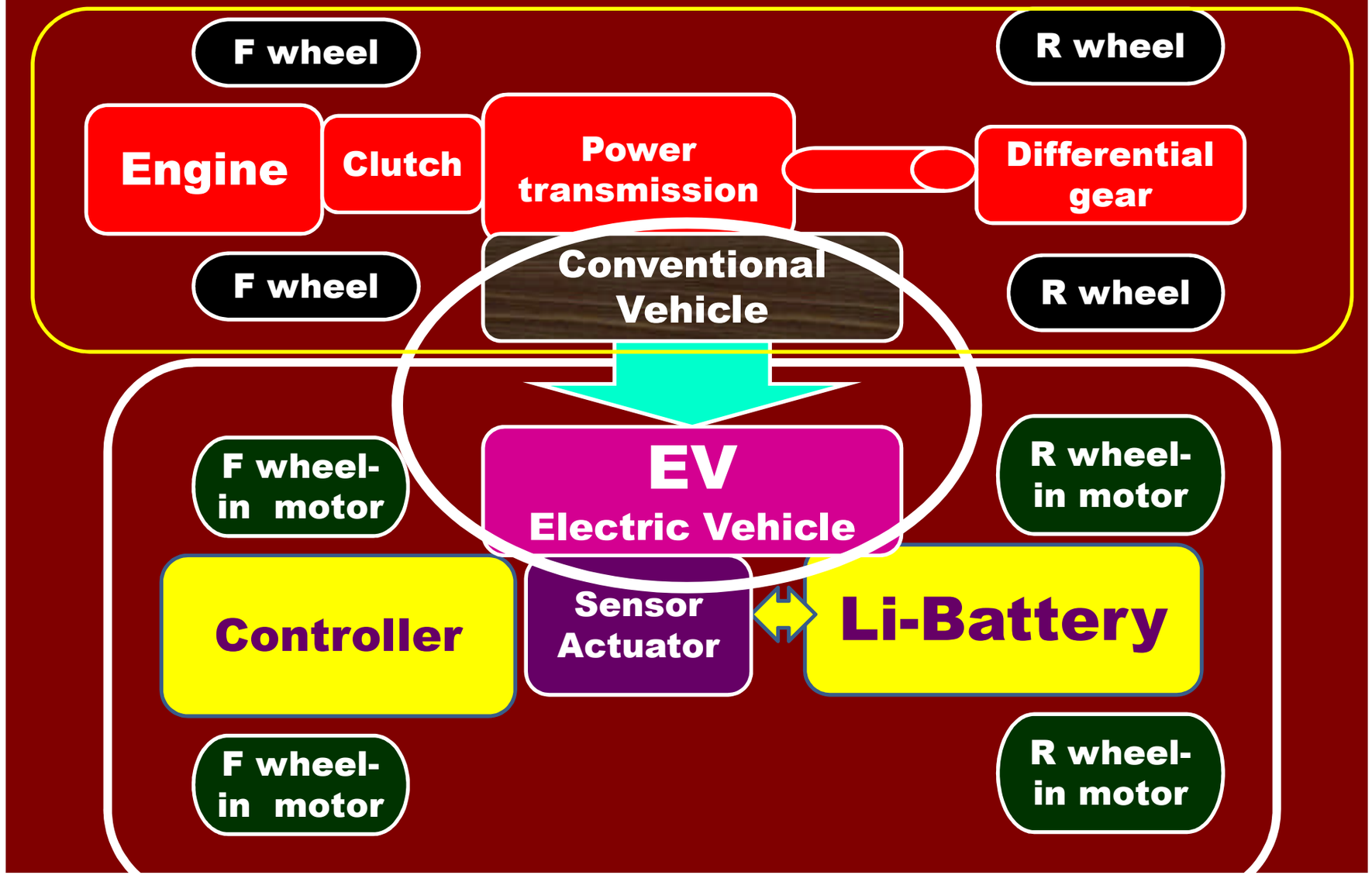
Lithium Ion Battery

- Prof., Dr, Akira Yoshino, Asahi Kasei Chemistry, Inventor, Honorary Fellow, Meijo University, Japan, 2019, Novel Prize winner awarded by the Reearch on The Development of Lithium Ion Battery
- Tokyo University of Science develops negative electrode for "sodium ion battery" that exceeds lithium ion battery
- World share: 70% or more
- Application examples: Submarines, Electric tankers, EV (already known)

Which is better, EV or Conventional car ?

- **EV**
  No CO2 production while operating
  CO2 is produced at Power Generation Plant
- **Conventional car**
  CO_2 is produced while operating
  No need to develop EV except for export
- **The conflict between food and energy issues a drawback, but also an advantage if the control could be done well using abandoned farmland (GMO)**
- **For economic promotion, both ways should be chosen**

EV changes car drastically



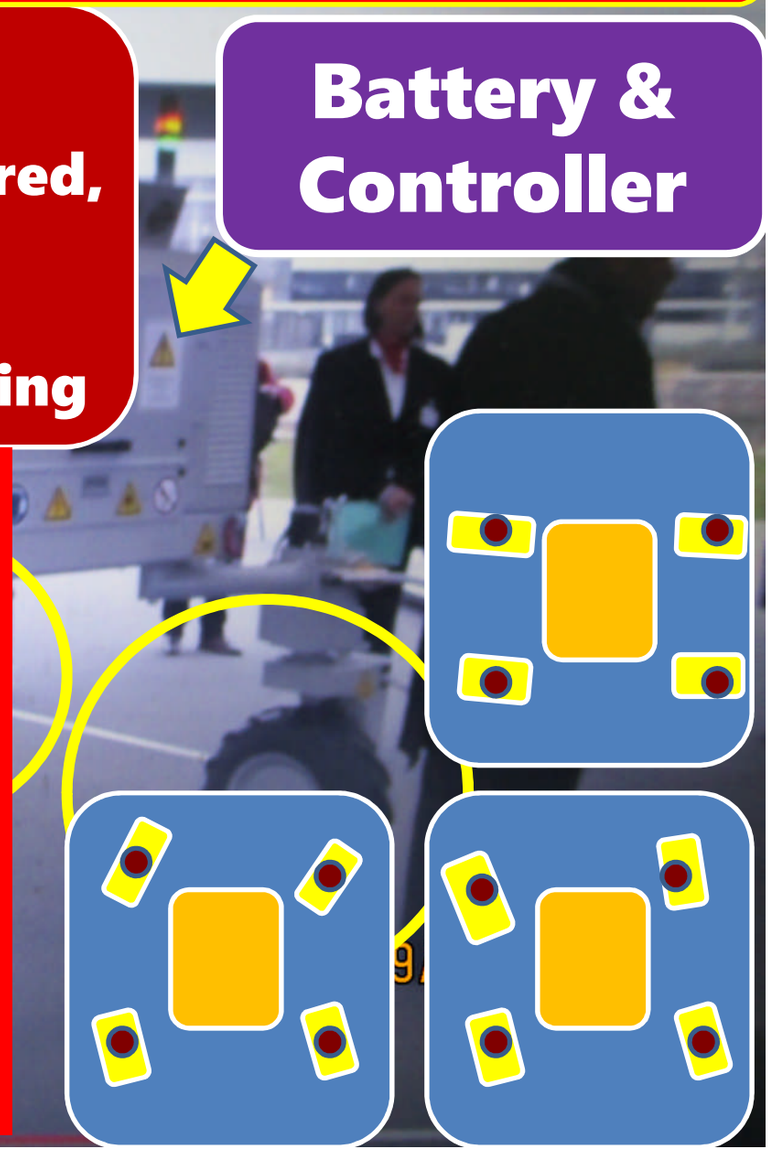
Electric Powered Tractor

4 Wheel-in motors

independently powered and steered, but synchronously controlled for various operation modes : Quick, Soft, Spin, Skid turn & Crab steering

Prof. Sato
Mie University
20 years ago

Battery & Controller



Renewable Energy Increasing Rate

Japan
Now to future !!!

15 %

22 ~ 24 %

Geo
Bio
Wind
Solar
Hydro

FY 2019

Geo-thermal

Biomass

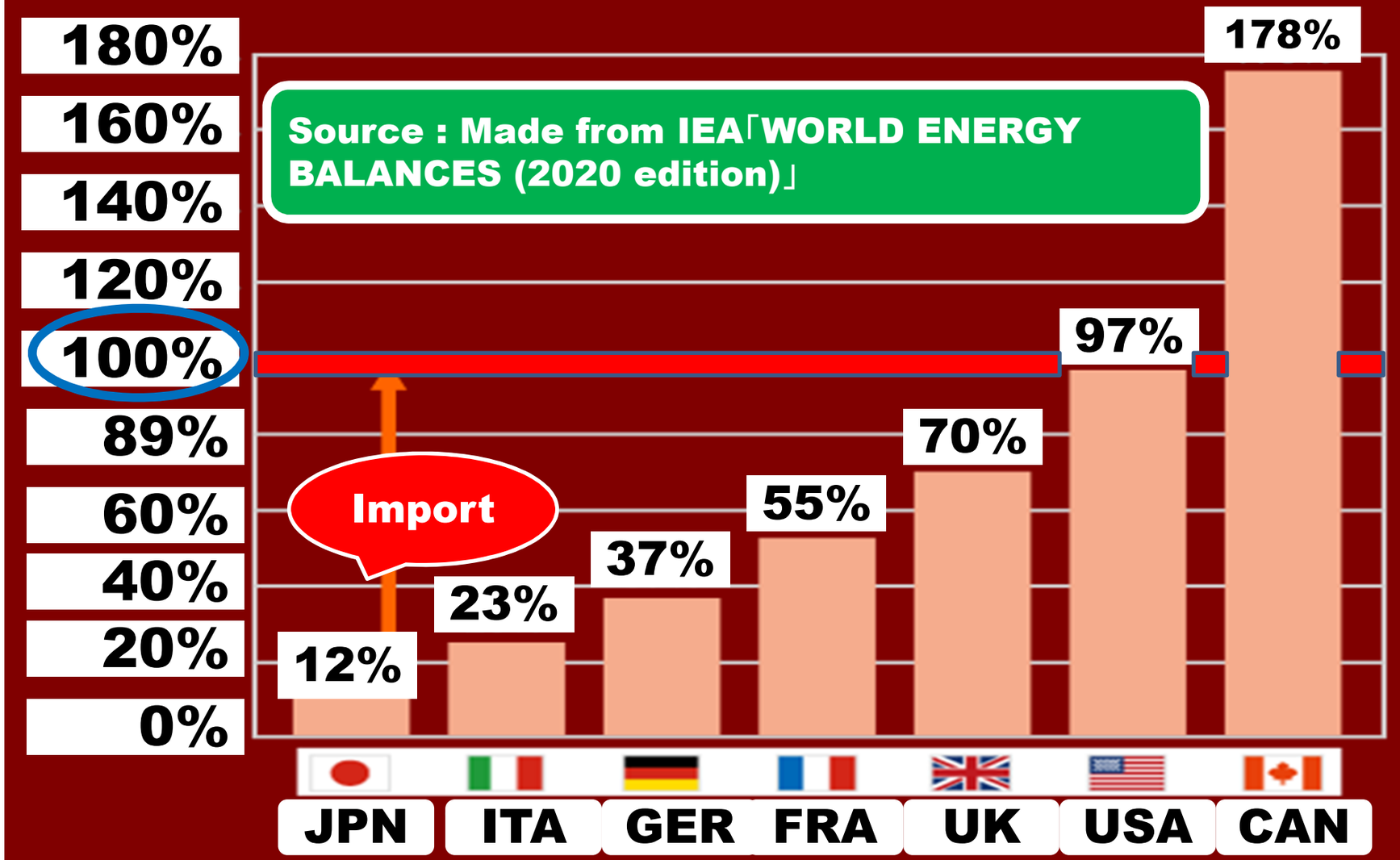
Wind

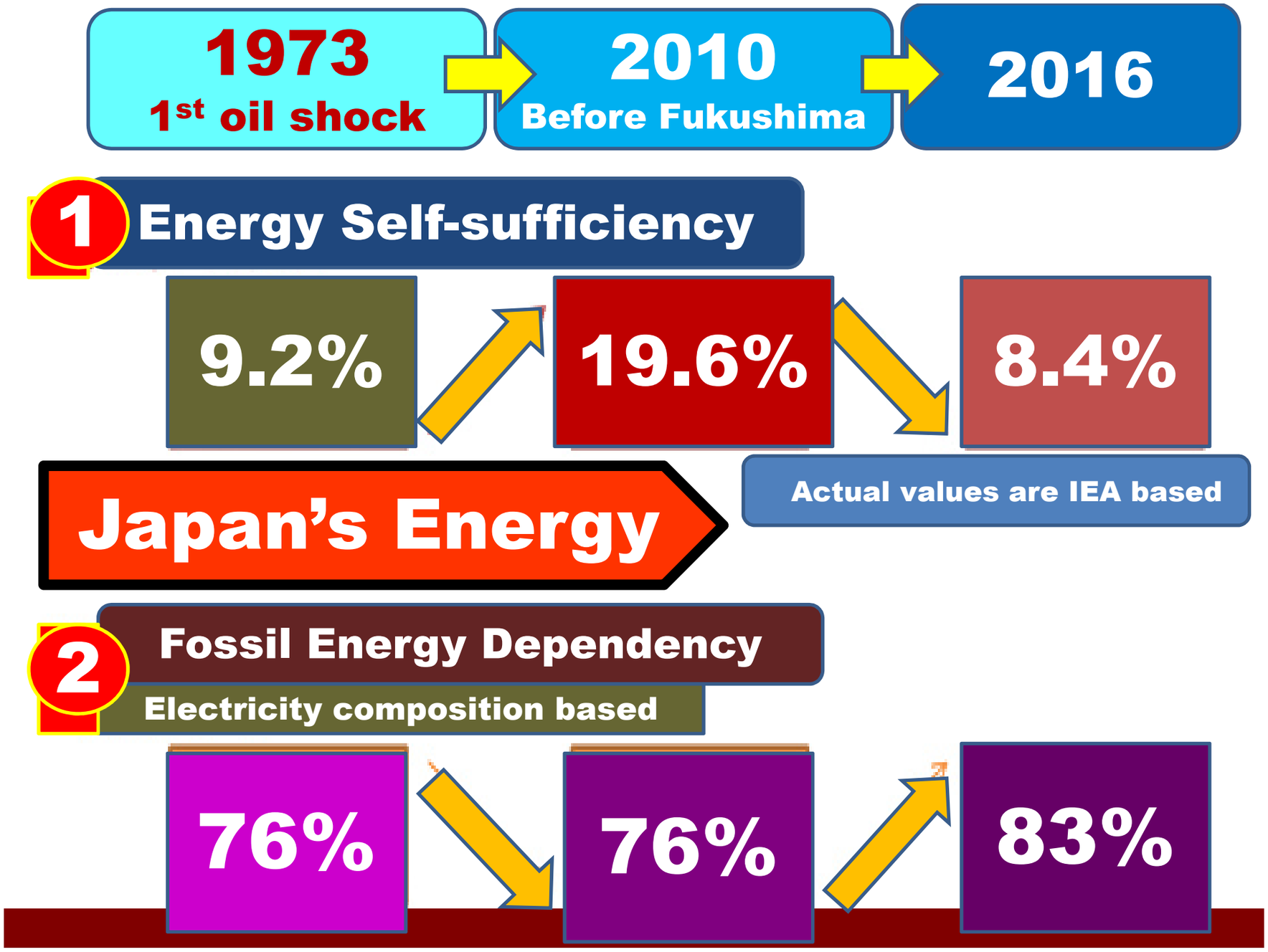
FY 2030

Solar

Hydro-power

World Energy Self-sufficiency




1973
1st oil shock
2010
Before Fukushima
2016
1
Energy Self-sufficiency
9.2%
19.6%
8.4%
Actual values are IEA based
Japan's Energy
2
Fossil Energy Dependency
Electricity composition based
76%
76%
83%

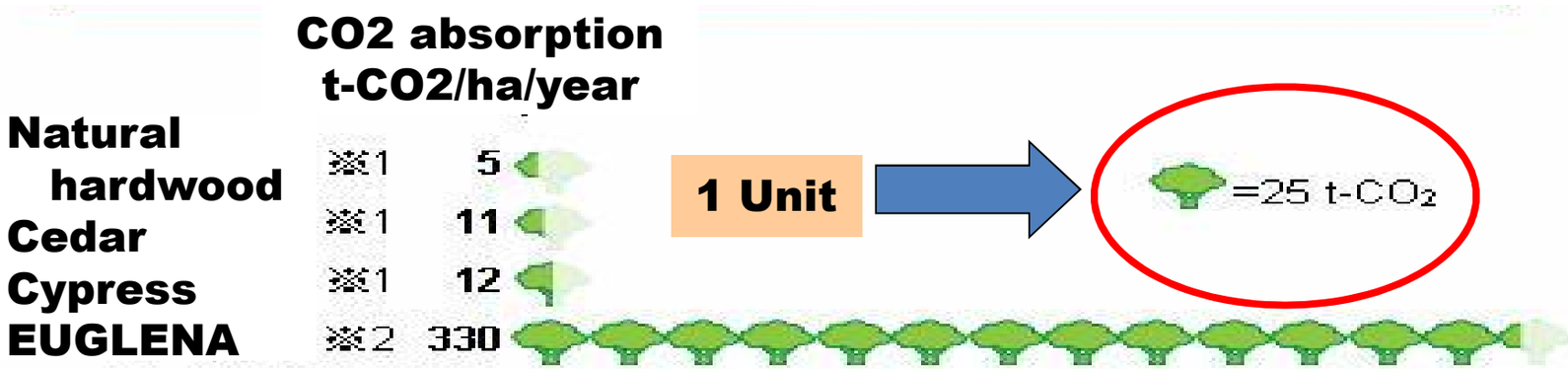
Hydrogen Vehicle

- **Dr. Shoichi Furuhama: Basic Research and Prototype of Hydrogen Vehicle (1977), President of Musashino Polytechnic Institute (1989) Professor Emeritus (1998) Musashi Institute of Technology, Japan**
- **Storage and transportation of hydrogen (hydrogen storage alloy) Transportation by liquid hydrogen Immediately compatible with conventional reciprocal engines (direct injection) Hydrogen production cost "Reform method" to produce hydrogen from gas, "Electrolysis method" to produce hydrogen from water**

VARIOUS MERITS OF EUGLENA

- **Available Key resources as same as (Rice)**
  - **Energy : No CO2 due to Carbon Neutral**
  - **Food**
  - **Environment : In CO2 absorption**
  - **Supplement for Health**

EGLENA absorbs 30 times CO2 more than Cedar & Cypress tree



Why Euglena ?

Simplify processes

Proc Proc ••• Proc

Electricity

Various kinds of Energy resources

1)
2)
2)

Demerit

- Hard to carry & store
- Frequent recharge
- Generation is needed

Proc

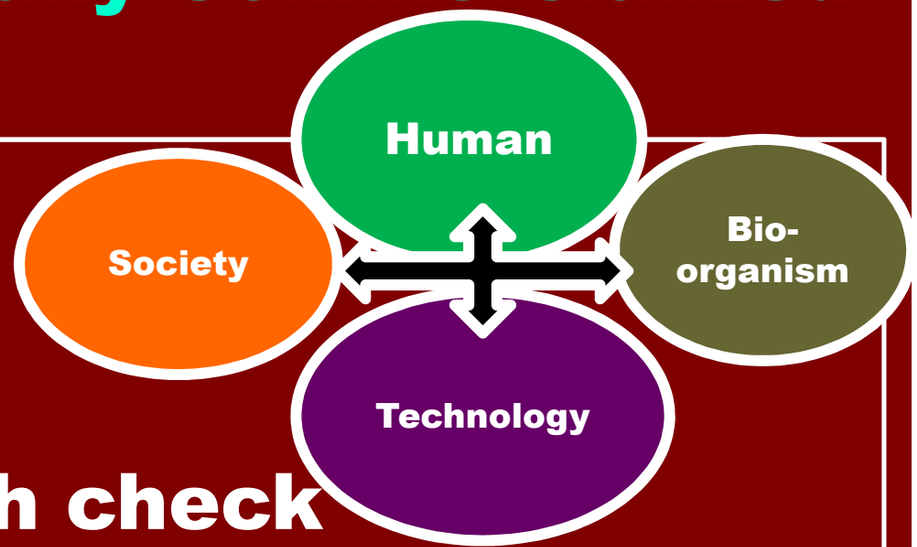
Euglena

Generation Proc

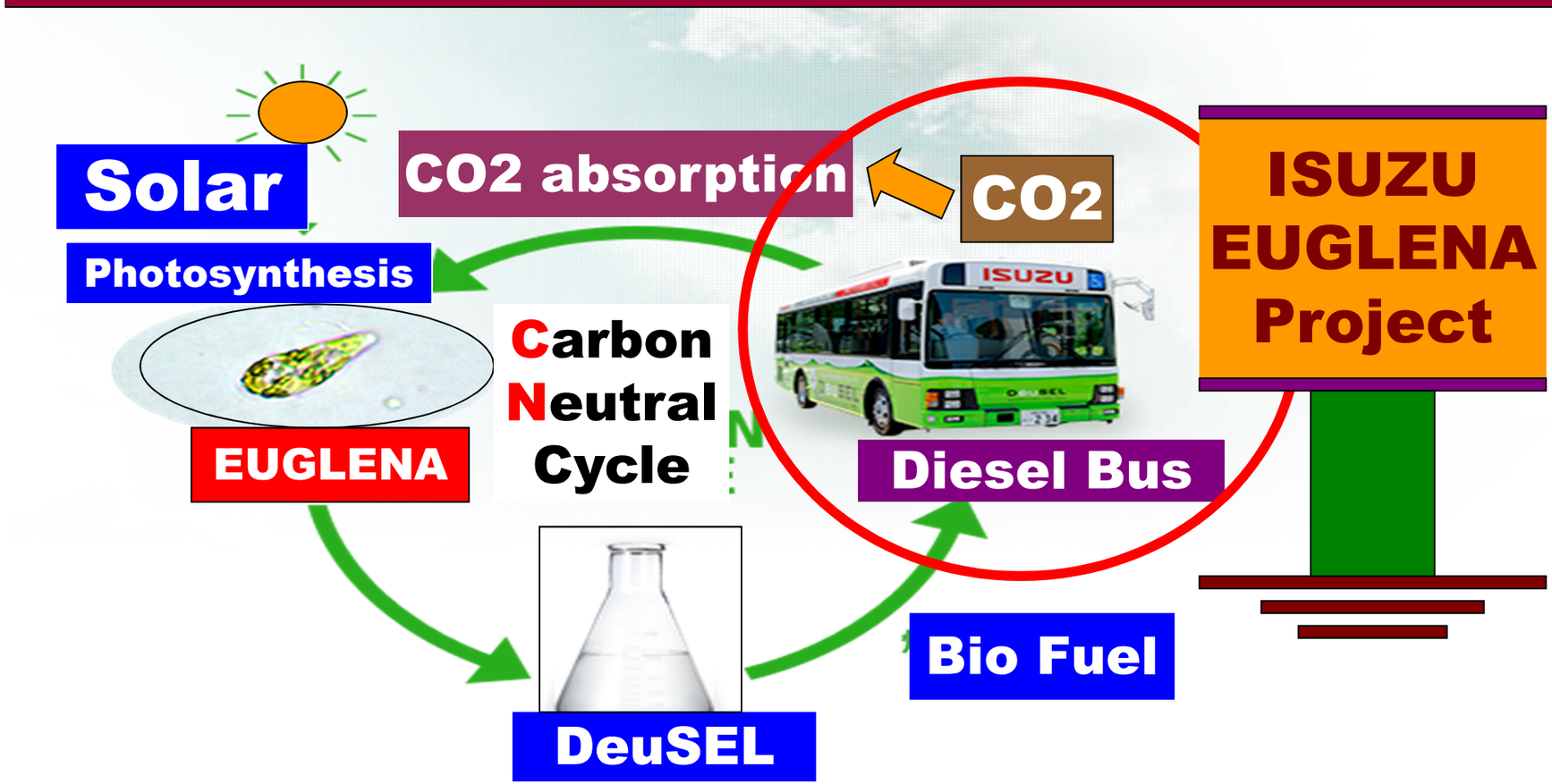
Responding to the Issue of De-carbonization

- Zero emission of CO_2
- Active use of produced CO_2
- 「EUGLENA」actually Commercialized Business model

1) Health care
2) Beauty care
3) Biofuel
4) Genome/Health check
5) Improving Children's health



DeuSEL® MAY SAVE OUR PLANET OF EARTH



EUGLENA (Algae)
Decarbonization Business Project

BIO JET FUEL SUPPLY INDUSTRY

EPCO
Electric Power Company

CO_2

EUGLENA Co. LTD

HITACHI PLANT Co. LTD

Plant providing

Providing crude oil before refining

Providing residues such as proteins

JX NISSEKI

Industry Farm

AIR LINE CO. LTD

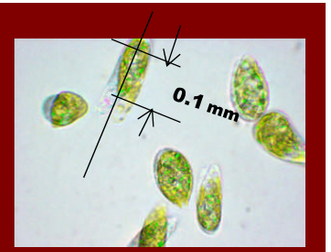
Use of bio-jet fuel for existing engines

ASTM-D1655
Use of compliant algae fuel

Bio-jet fuel refining

Diversion to food, feed & fertilizer

Euglena, Now & Future



	Now	Future
Cost Assuming US$ 1 dollar = JPN \100	2020 \10,000 /L (US$ 100 / L)	2025 Commercial based plant operation \100 / L (US$ 1 /)
Production capacity	2020 125 kL / year	2030 1 million k*L* / year

Source: Chugoku Newspaper, Euglena news, Jan. 22, 2921

Calorific value for various fuels

No.1	Fuels	Unit	Calorific value (MJ)
2	Petroleum	L	38.2
3	Gasoline	L	34.5
4	Kelosine	L	36,7
5	Jet fuel	L	36.7
6	Light oil	L	38.2
7	Bio-ethanol	L	21.3 (5070 kcal)

Unit for
Solid: kg, Liquid: L, Gas: Nm3

Unit conversion
1 kcal = 0.00418 MJ, 1 MJ = 238.9 kcal

World's first Euglena outdoor Mass culture technology plant)

Soursce: Established in December 2005, EUGLENA Co. Ltd

R&D by Tokyo University

Euglena culture pond

Decarbonize with “Euglena resin” and challenge raw material cost in the 100 yen range / kg.

Euglena President Izumo "New market for fuel and plastic, creating in Japan with bio"

Flight demonstration test with biofuel

Euglena built a bio-jet diesel fuel production demonstration plant in Yokohama and started test run in the fall of 2018. Currently, the plant produces biofuel by combining Euglena and waste cooking oil (Source: Euglena).

Replace light oil 100%”, ISUZU still never give up the lubrication performance

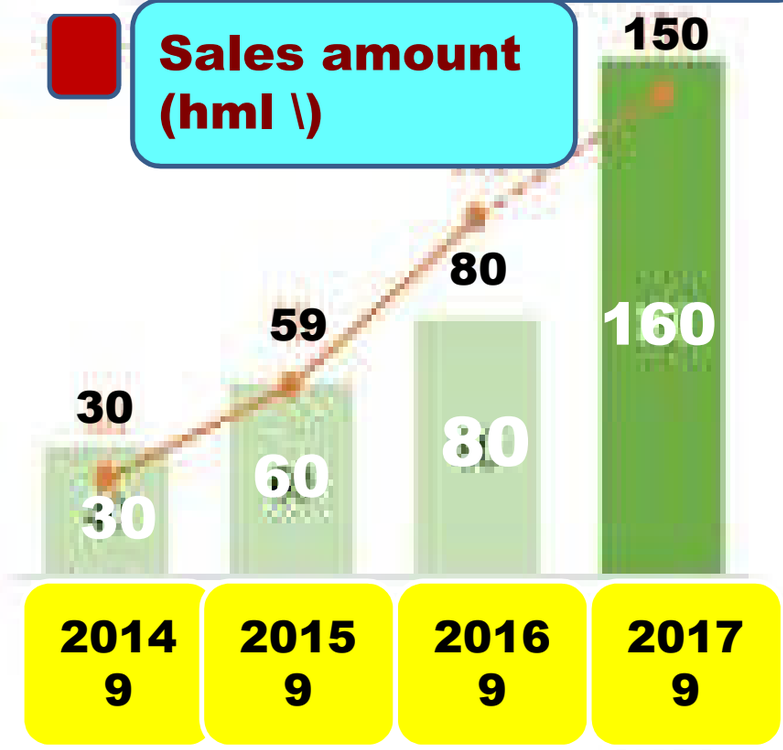
BUSINESS PROMOTION ASPECT

\100 mlt / ton
(\10,000/L)

\ 100 / *L*

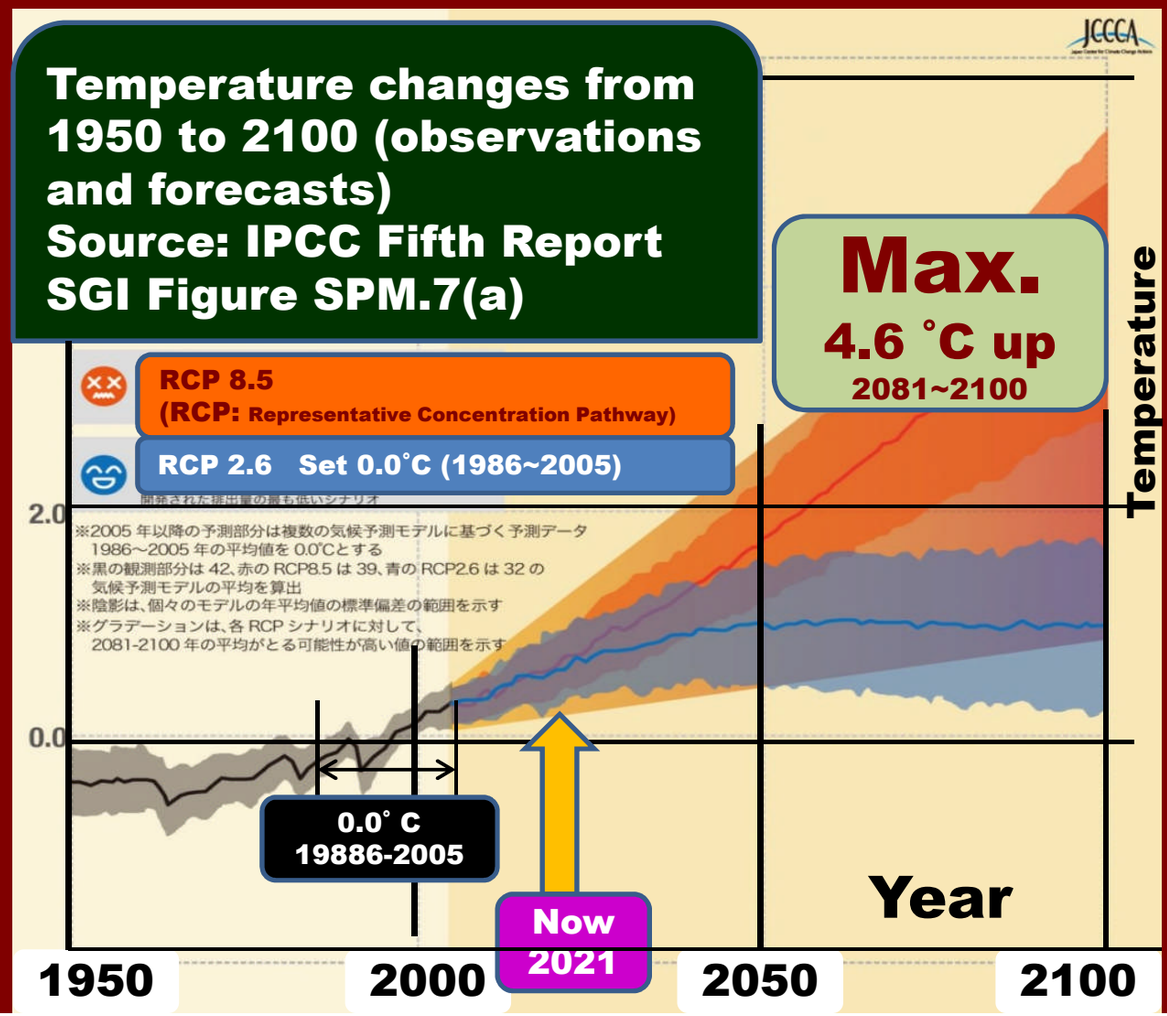
Production amount
(hml t) / year

Sales amount
(hml \)



How will the Earth temperature change in the future?

Temperature changes from 1950 to 2100 (observations and forecasts)
Source: IPCC Fifth Report
SGI Figure SPM.7(a)



100% replacement of light oil by Euglena. Even for lubricating oil by ISUZU Co. Ltd

Things to keep in mind

before discussing decarbonization

- It should be noted that the power generation requires many kinds of energy resources due to total energy shortage toward the future
- Consider the Apropriate optimal combinations of various energy sources and the Optimal use of energy resources in the right place (Best Mix)
- No Airplanes fly yet with electricity, but did with EUGLENA

ENERGY Best mix

- On the other hand, in Japan, in the "Energy Best mix" that shows the appearance of energy in 2030,
- Japan is aiming for about 1.7% of the "Power source composition" (combination of methods for generating electricity) to be wind power generation.
- As of March 2017, Solar power generation has been introduced to about 61% of the 2030 forecast, while Wind power generation is only about 34%.

Continued 1

- CO_2 emission should be regulated for stopping global warming, but on the other hand, the produced CO_2 should be used actively to develop and create new products, rather than completely suppressing CO_2 emissions (Ex. EUGLENA)
- If the battery is left unused, electricity will be discharged, so "Recharging is always necessary"

Continued 2

- Any kinds of energy resoucrces except some, produce CO_2 in production and consumption process, more or less
- Bio-fuel and hydrogen can be directly used for the existing engine, however Electricity needs the power generation for use
- Electric vehicle do not emit CO_2 while operating, but CO_2 is emitted during the process of power generation.

Continued 3

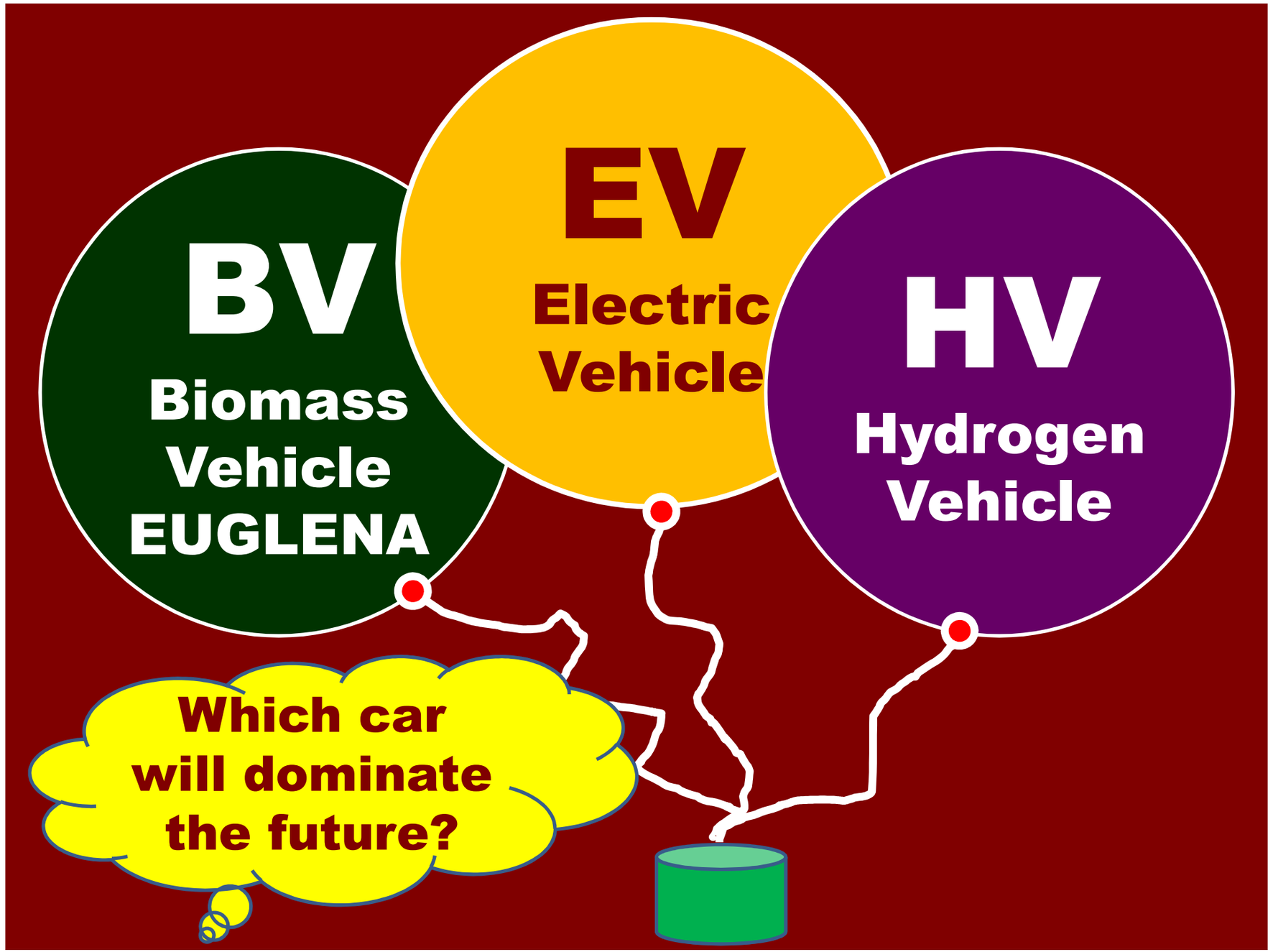
- **Biomass including both fuel and gas, and hydrogen can also be "directly used" for operating the existing conventional reciprocating engines**
- **A reciprocating engine completed with a certain high level of technology will not disappear as long as there is fossil fuel. It will be actively used for power generation.**

Continued 4

- The concept of de-carbonization does not mean that ”CO_2 shouldn’t be emitted at all”, but it is desirable to “Proactively and Effectively” utilize the emitted carbon dioxide to reduce the total amount of CO_2

  A typical example. Is Euglena.

- Bio-fuels can be used directly, but electrical energy must go through definitely and inevitably the process of power generation.


BV
Biomass
Vehicle
EUGLENA
EV
Electric
Vehicle
HV
Hydrogen
Vehicle
Which car
will dominate
the future?

Continued 5

- **EV has higher potentiality to change the car concept image drastically from the existing one**
- **This means the car company needs more investments to start the new business based on the technological challenge from the beginning**
- **Which type of car to choose from EV, HV, and BV is one of the bets, and the mischoice will affect the future of the company.**

Continued 6

- **"Electric Vehicles" are not the only ones that do not emit CO_2 while driving. Hydrogen vehicle discharges no CO_2 either**
- **Hydrogen has a merit that it can be used directly for the existing engines which are already widespread, but not for the electric vehicles.**
- **In addition, "Global trends(?)" are heading towards "Electric vehicle"**
- **For the purpose of regulating CO_2 emissions, hydrogen or bio-fuel should be included. But why is it only for EV?**

Continued 7

- As already shwon above, some of the big car companies have already commercialized Hydrogen Vehicles, but the world is going to EV, not to HV. Does it look a little strange?
- Did some of the companies really mistake the direction they should go? It looks really strange.
- The other viewpoint may be which car will be beneficial for car industries in EU and others, not only from the CO2 reduction viewpoint.
- Because any kinds of car will be accepted as far as CO2 emission can be reduced

Current topic in Energy Technology

- **"Mitsubishi Heavy Industry Corp. Ltd., Japan successfully developed Small Scale Nuclear fusion-based Power plant portable by Truck**
- **Emergency power supply device in disaster areas and home use, etc.**
- **No CO_2 – Contribution to De-carbonized Society building**
- **The amount of GHG (greenhouse gases) has doubled in 50 years.**
- **The amount of produced GHG by mankind far exceeds the amount that the earth can absorb.** CO_2 (dis) < CO_2 (abs)

CONCLUSION

1. Euglena has good capability in CCS and CCU leading to de-carbonization and active use of CO_2
2. Euglena can be used for many purposes, not only human health care, animal feed, fertilizer, but also bio-jet fuel production
3. Problem is the mass production and supply enough to meet with the demand and needs due to consumption, but already solved

Continued 1

④ Productivity increase for quality control especially size and shape measurement of Euglena cell

⑤ Cost down for business promotion

⑥ Most of the issues are caused by the human economic activity

⑦ Environmental issue can be easily solved if the people basically have normal morals and ethics

Continued 2

⑧ **Others are not responsible for this matter of issue. Polluter should be responsible for CO_2 production in proportion to the amount. (PPP)**

⑨ **Main target is the de-carbonization how it can be achieved, not to stop the production of internal combustion engine (Industry)**

Many people working for car industry lose job. Car Industry needs additional investment for R&D, and manufacturing plant. Even for EV promotion, biomass needs to generateelectricity

Once again !

For the achievement of De-carbonization,

"Active use of surplus CO_2" is a more realistic and practical solution as much as it does not emit CO_2

Thank you very much for your attention & patience

Attention !
The problem is CO_2 emission, not the car

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