TNM102 | TEKNOLOGI HIJAU

APLIKASI ROBOTIKA & KECERDASAN BUATAN DALAM TEKNOLOGI HIJAU I

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Fakultas Teknologi Maju dan Multidisiplin (FTMM) Univ. Airlangga
2021

01

PERGESERAN BUDAYA MENUJU KONSEP TEKNOLOGI HIJAU

Apa, mengapa, dan bagaimana

02

APLIKASI ROBOT UNTUK LINGKUNGAN

Apa & bagaimana robot dapat membantu lingkungan?

03

SISTEM CERDAS MANAJEMEN LIMBAH

Pemanfaatan AI dan IoT dalam "*Smart Waste Management System*"

04

AI DAN ENERGI TERBARUKAN

Implementasi kecerdasan buatan pada energi terbarukan

01

PERGESERAN BUDAYA MENUJU KONSEP TEKNOLOGI HIJAU

Apa, mengapa, dan bagaimana

MENGAPA TEKNOLOGI HIJAU DIPERLUKAN?

Gas rumah kaca

Diklaim menghasilkan gas rumah kaca yang sangat sedikit atau tidak sama sekali

Polutan

Polutan sangat sedikit atau tidak sama sekali

Keamanan energi

Mengurangi kebergantungan suatu negara terhadap yang lain terkait energi

Resiliensi energi

Sistem terdistribusi lebih tahan kerusakan

Ekonomi

Biaya perawatan yang relatif rendah.

TANTANGAN DALAM GO GREEN

Permasalahan dan isu gaya hidup

Sebagian besar orang sangat “keranjingan” terhadap teknologi sehingga seluruh kegiatan berkutat di seputar elektronik.

Manajemen pembuangan limbah yang kurang baik

Limbah perlu untuk dipisahkan berdasarkan kelompoknya agar mudah untuk di olah lebih lanjut,

Sulitnya mendapatkan produk yang eco-friendly

Produk ramah lingkungan masih sulit ditemukan dan relatif mahal.

Kurangnya kepedulian masyarakat umum

Kurangnya kepedulian karena masih kurangnya edukasi di masyarakat tentang lingkungan.

Menanam pohon masih menjadi tantangan

Kurangnya lahan karena peningkatan populasi menyebahkan pohon sulit ditanam.

02

APLIKASI ROBOT UNTUK LINGKUNGAN

Apa & bagaimana robot dapat membantu lingkungan?

Robotics Role on Cleaning & Preserving Environment

Robotics & AI
Application on
Green Technology

Familiar with Robot?

Robot?

automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a humanlike manner.

Robotics?

Robotics is an interdisciplinary sector of science and engineering dedicated to the design, construction and use of mechanical robots.

Robotics Common Purpose

Pemanfaatan Robotika :

- Industri
- Transportasi
- *Entertainment* (Hiburan)
- Pertahanan Negara







Dangerous or uncomfortable for Human

- Space exploration
- Pet litterbox cleanup
- Disarming bombs

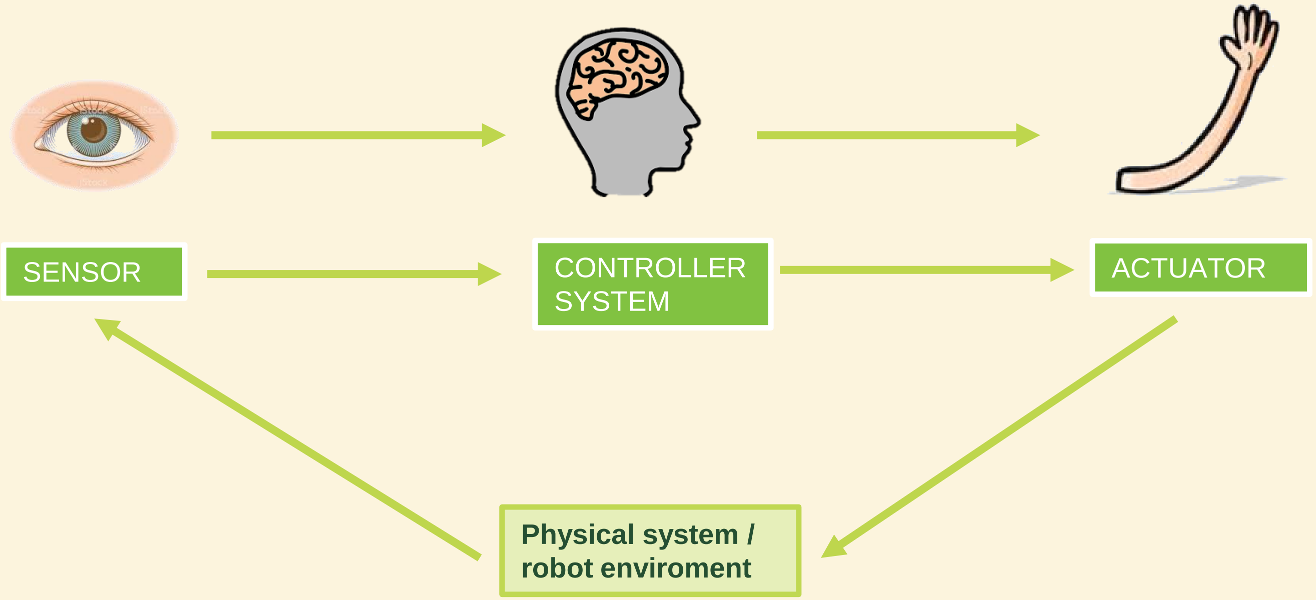
Boring and/or repetitive

- Car manufacture (welding,drilling,etc)
- Pick & place
- Parts assembly

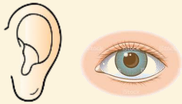
High precision, speed, strength

- Electronic testing
- Precision machining
- Micro-Surgery robotics
- Driving Car

How Robot Works ??

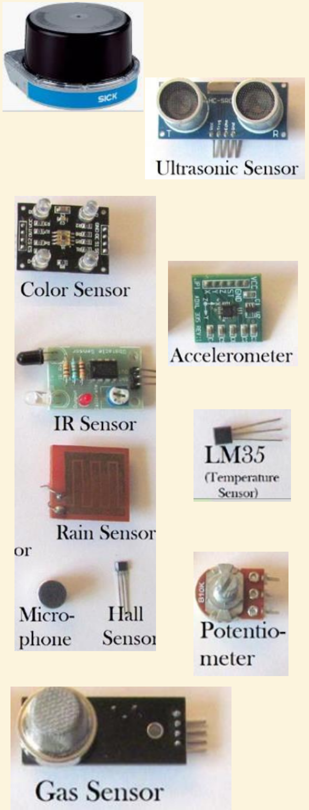


Sensor

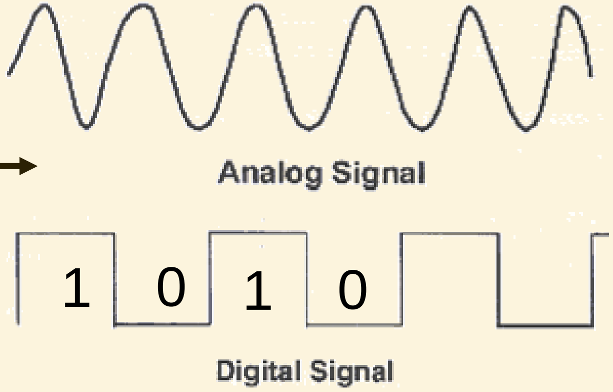


PHYSICAL ENVIRONMENT INPUT

- Force
- Humidity
- Pressure
- Temperature
- Color/image
- Acidity level
- Rotation
- Speed
- Photon
- Acceleration
- Magnetic Field



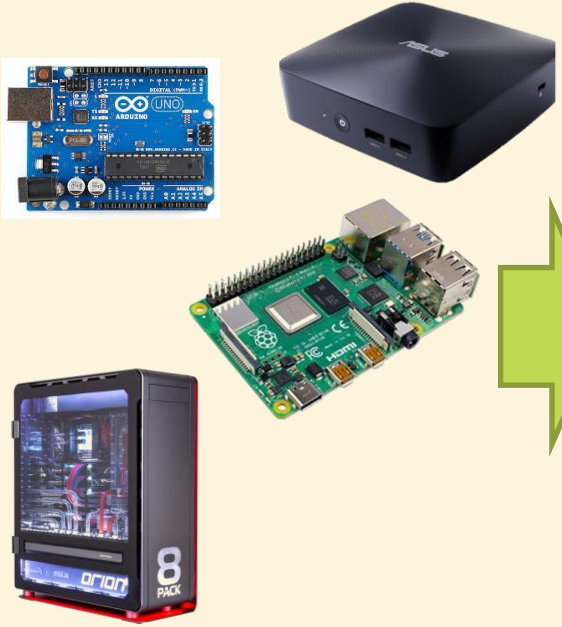
Electronic Signal



Brain of the robot

Data from Sensor

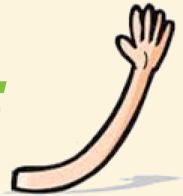
Control System



- Numerical computation
- Algorithm
- Control Method
- Data Conversion
- AI / Machine learning
- Database/ Big Data
- Human Machine Interface

Signal for actuator

Actuators



Energy source

Signal from controller

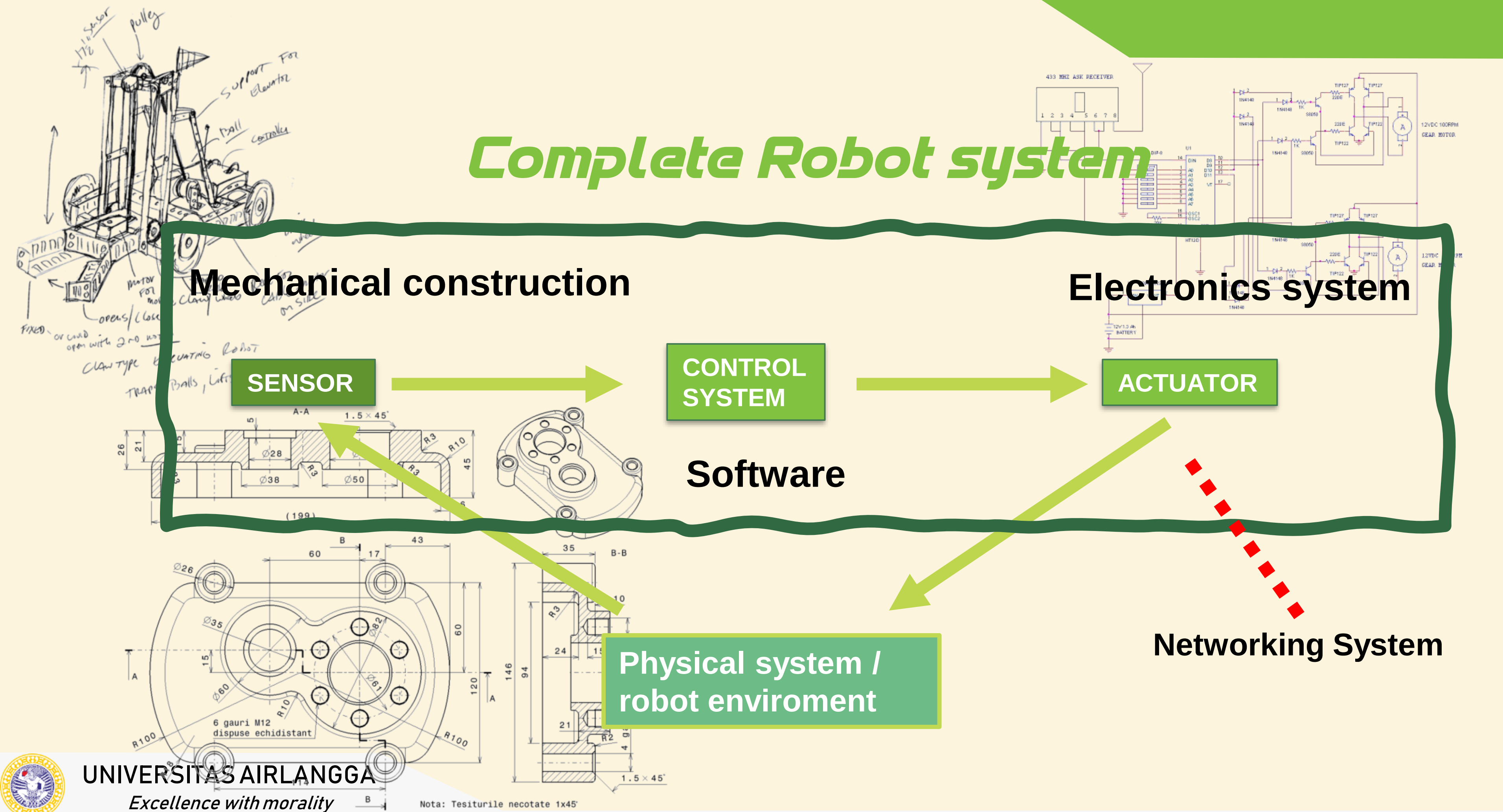
Heat

Motion

Magnetic field

On/off Valve

Complete Robot system



How Robot Will Help the Environment?

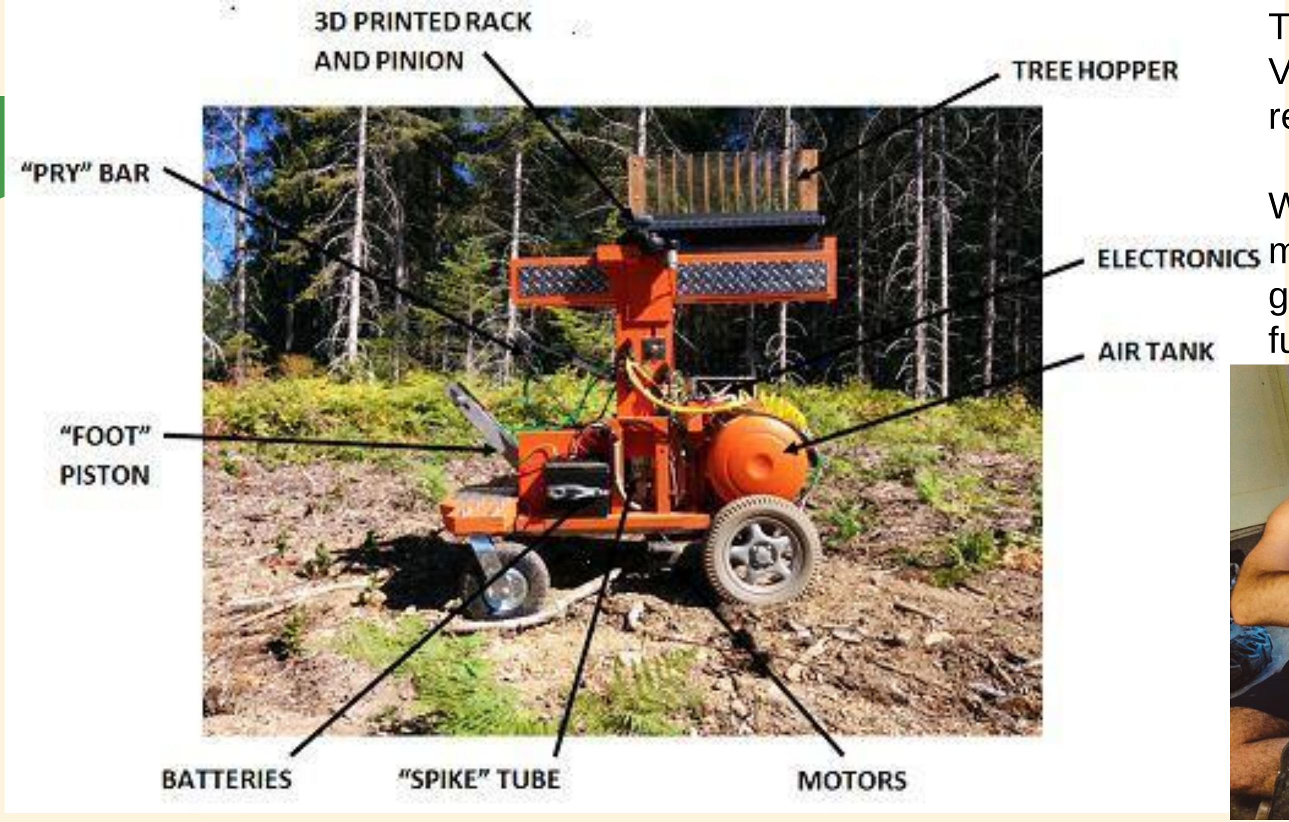
“The saddest aspect of life right now is that science gathers knowledge faster than society gather wisdom”

— **Isaac Asimov**

TreeRover– University of Victoria

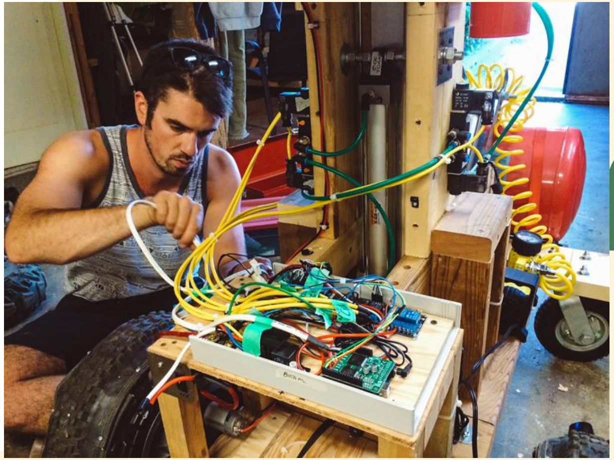
https://www.youtube.com/watch?v=uPNf37S35oY&t=25s

TreeRover– University of Victoria



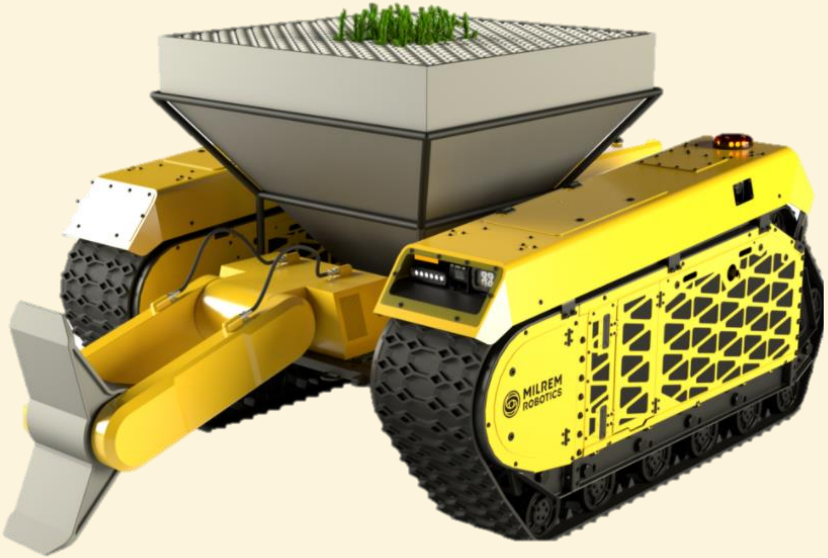
Two students from University of Victoria have robotics idea for reforestation.

With simple robotics control & mechatronics integration. They gained >5000 USD from *kickstarter* funding



https://www.youtube.com/watch?v=uPNf37S35oY&t=25s

Multiscope Forester Planter – Milrem Robotics



- One robot, a planter that carries more than 380 seedlings in one batch, can plant a hectare (about 2.5 acres) of new forest in five to six hours, while recording the exact location of each new tree so the other robot, a brush cutter, can trim vegetation around seedlings.

- The robots’ navigation uses laser-based LiDAR, cameras, and global positioning systems, with LiDAR producing a three-dimensional geometric representation of the environment (and high-resolution camera images fill in the blanks).

Wasteshark

Ranmarine Tech & Nobleo Tech

Modelled on Planet Earth’s biggest fish, the Whaleshark, our autonomous surface vessels (ASV’s) are designed to be efficient, long-lived, non-threatening and unobtrusive.
With zero greenhouse emissions – our ASV’s are intelligent tools used for cleaning our waters.

Wasteshark

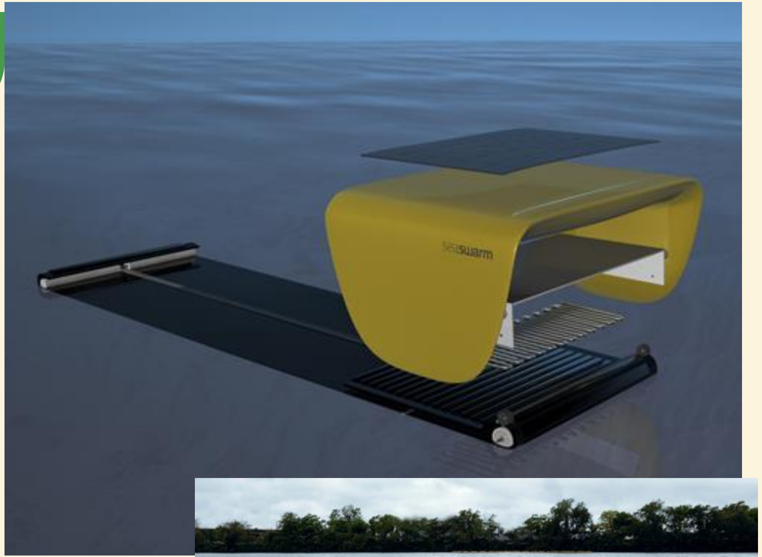
Ranmarine Tech & Nobleo Tech

Video Source:
https://www.youtube.com/watch?v=4Amk5Das_U0&t=20s


WasteShark

Seaswarm

Seaswarm is a fleet of low-cost oil absorbing robots from MIT Senseable City Lab



Each Seaswarm robot is comprised of a head, which is covered by a layer of photovoltaic cells, and a nanowire covered conveyor belt. The photovoltaic cells generate enough electricity to keep the fleet moving for several weeks and provide the energy to propel the vehicles forward.

As the head moves through the water the conveyor belt constantly rotates and sucks up pollution. The nanowire-covered belt is then compressed to remove the oil. As the clean part of the belt comes out of the head it immediately begins absorbing oil, making the collection process seamless and efficient.

seaswarm

https://www.youtube.com/watch?v=KlHapZoIXqg&t=2s

Interceptor

The OceanCleanup

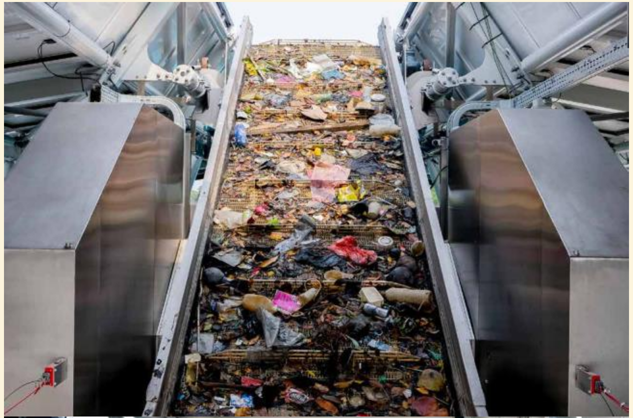
the Interceptor™ is the first scalable solution to prevent debris from entering the world's oceans from rivers.
it is 100% solar-powered, extracts debris autonomously, and can be placed in the majority of the world's most polluting rivers.

If you think about the trash in Indonesian River, yes the first prototype was used in Cengkareng Drain, Indonesa

Interceptor 001 (Cengkareng, Indonesia)

Interceptor

The OceanCleanup



- | **Off grid power generation**
- | **Solar capacity – 5.6 kWp**
- | **Battery capacity – 20 kWh Li-ion**
- | **4G data uplink to cloud**
- | **Direct measurement of extracted debris**
- | **Measurement of local weather conditions**
- | **Remote monitoring dashboard**
- | **Automated extraction control**

Maximum conveyor belt extraction rate
24 kg/s*
| Multiple barge exchanges possible per day
| Fully operational Interceptors can extract up to 50,000 kg a day; at optimal efficiency, this capacity can theoretically be as high as 100,000 kg a day

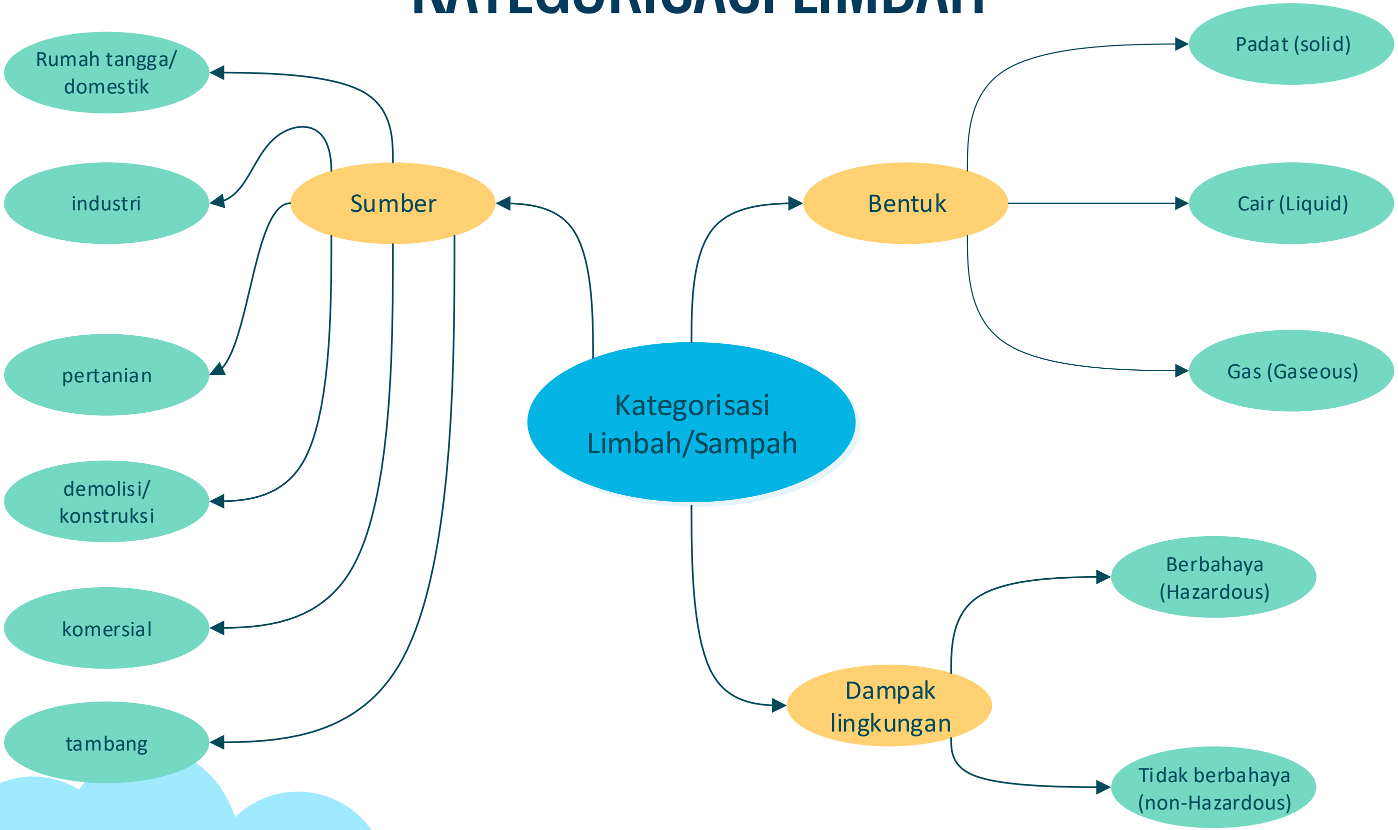
What is your idea to preserve environment with robotics ??

03

SISTEM CERDAS MANAJEMEN LIMBAH

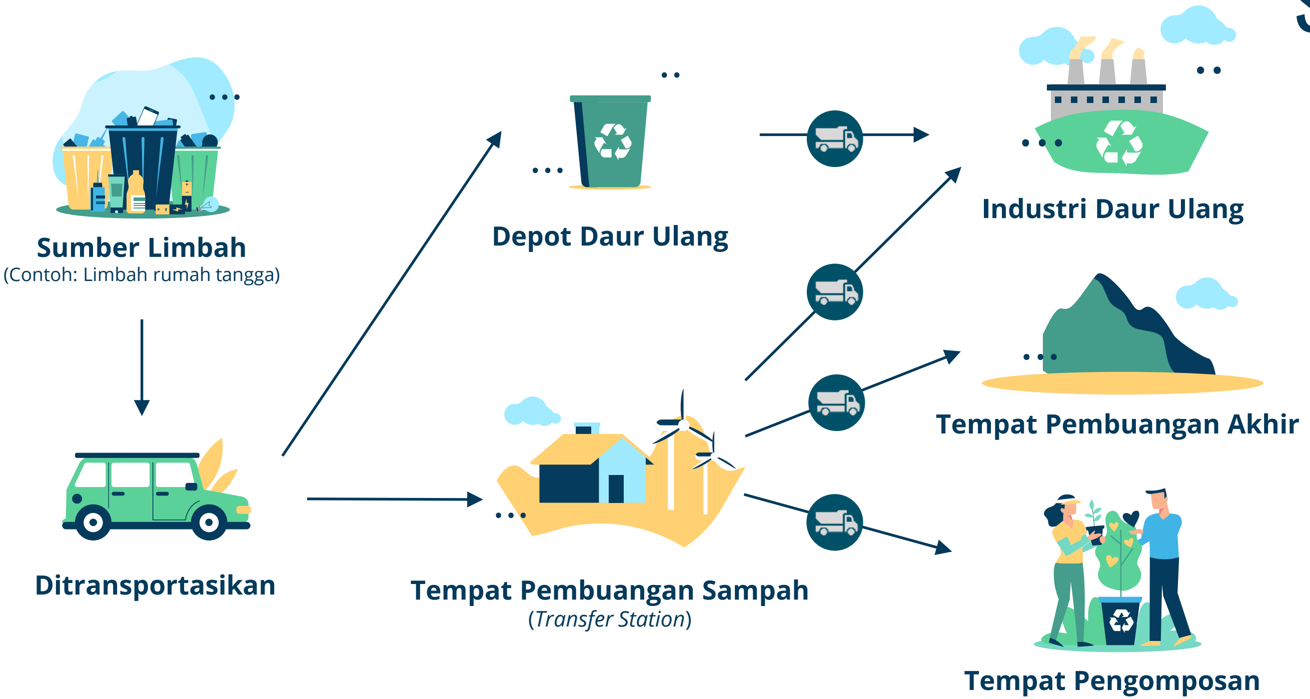
Pemanfaatan AI dan IoT dalam
"Smart Waste Management System"

KATEGORISASI LIMBAH



Sumber: Amasuomo & Baird, 2016

SISTEM MANAJEMEN LIMBAH SECARA UMUM



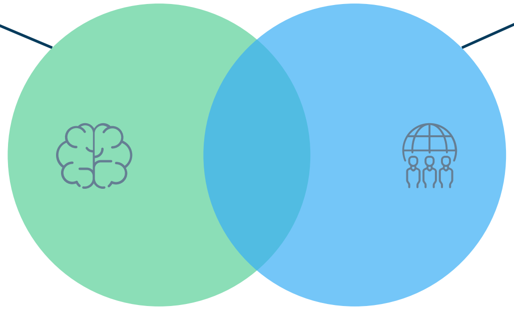
Bagaimana jika sistem di atas dibuat "cerdas"? **RAISE YOUR HAND!**

OVERVIEW: SMART WASTE MANAGEMENT SYSTEM
Source: eCube Labs

TEKNOLOGI YANG BERPERAN DALAM
"SMART WASTE MANAGEMENT SYSTEM"

IoT
(*Internet of Things*)

Digunakan untuk mengumpulkan data monitoring secara *real-time* pada proses manajemen sampah



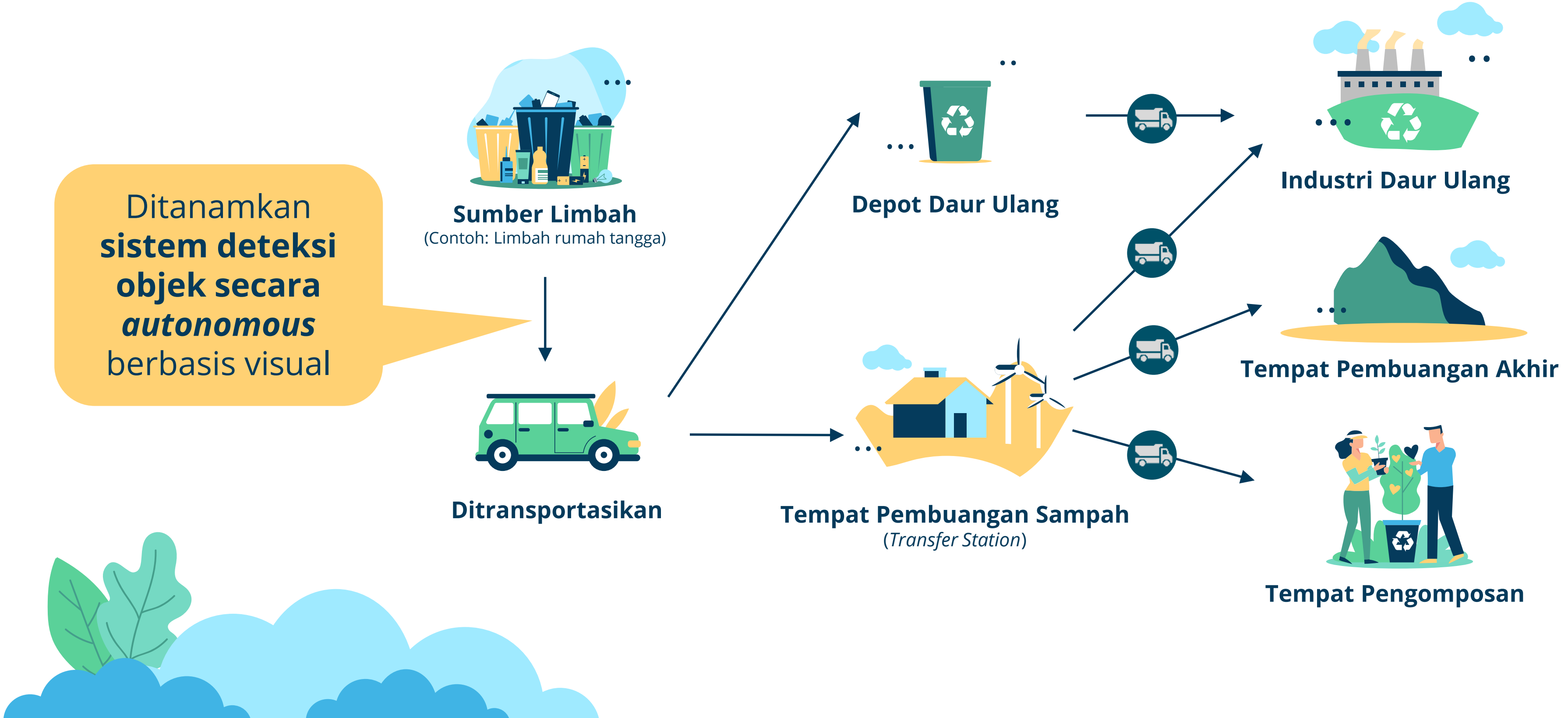
Kecerdasan Buatan

Digunakan dalam proses pengambilan keputusan pada sistem manajemen limbah.

Contoh:
Klasifikasi dalam proses pemisahan sampah

Kenapa ini hal ini penting? **RAISE YOUR HAND!**

KONSEP "SMART WASTE MANAGEMENT SYSTEM"



PERGESARAN IoT KE GREEN IoT

Apa itu IoT?

Suatu konsep yang memanfaatkan jaringan internet untuk mengoneksikan jutaan hingga milyaran *device* satu sama lain.

Membutuhkan **energi yang tinggi** dalam pengoperasiannya

Kekurangan IoT Konvensional

KONSEP GREEN IoT (G-IoT)

TUJUAN

Mendukung **konsumsi daya yang lebih rendah** daripada IoT konvesional serta membuat **lingkungan lebih aman** dan **lebih hijau**.

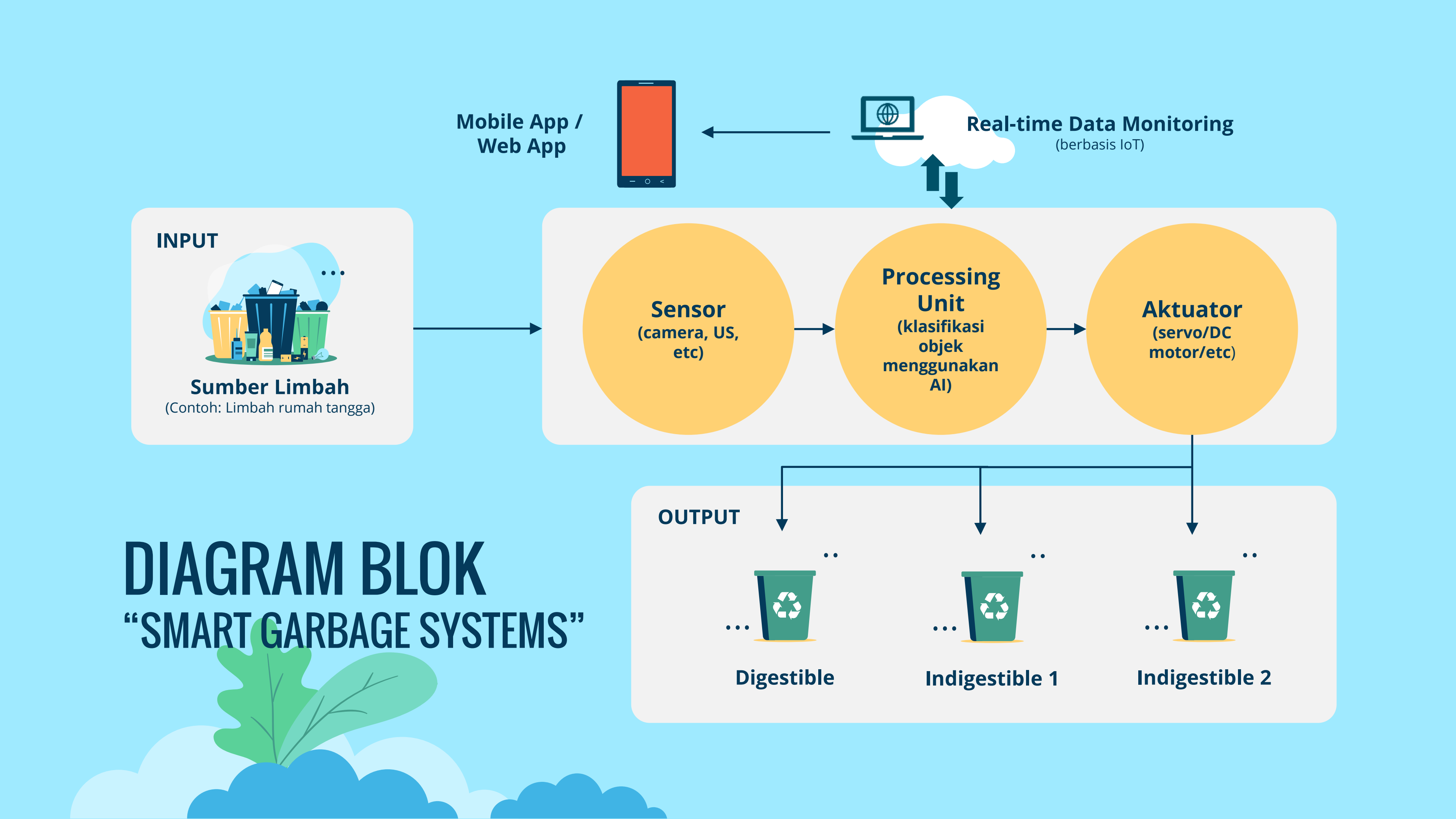
TEKNOLOGI YANG BERPERAN PADA G-IoT

- *Radio Frequency Identification* (RFID)
- *Optical tags* dan QR *(Quick Responses) codes*
- *Bluetooth low Energy* (BLE)
- Jaringan sensor nirkabel (*wireless*)

AI PADA KLASIFIKASI SISTEM MANAJEMEN LIMBAH

PRINSIP

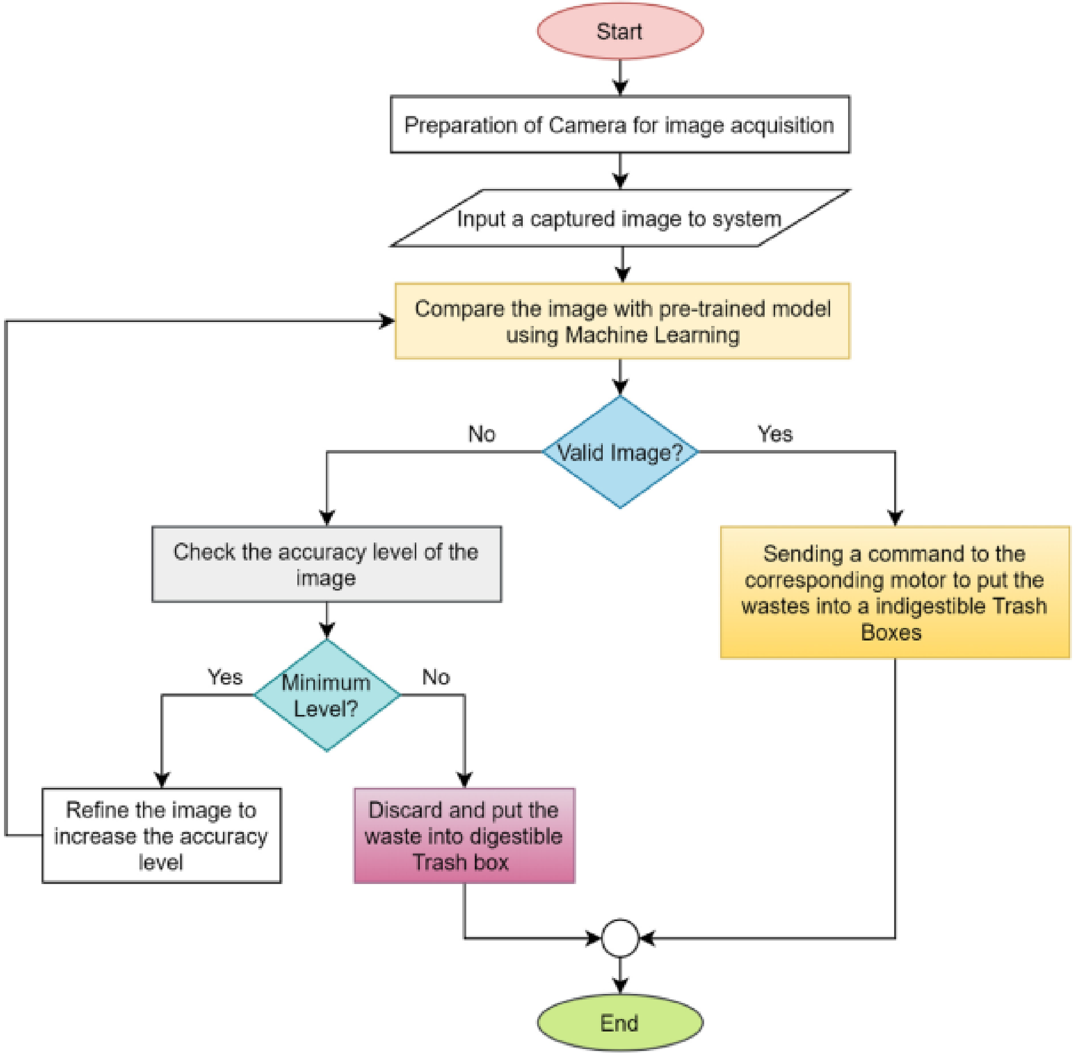
AI digunakan untuk **memisahkan jenis limbah agar lebih mudah diolah pada proses selanjutnya**. Klasifikasi dapat disesuaikan dengan sistem manajemen yang berlaku di tempat implementasi. Dibutuhkan sensor yang memadai untuk menjadi data input yang reliabel. Dalam beberapa kasus data visual (dari kamera) menjadi data input yang banyak dipakai.



Mobile App /
Web App
Real-time Data Monitoring
(berbasis IoT)
INPUT
Sumber Limbah
(Contoh: Limbah rumah tangga)
Sensor
(camera, US,
etc)
Processing
Unit
(klasifikasi
objek
menggunakan
AI)
Aktuator
(servo/DC
motor/etc)
OUTPUT
Digestible
Indigestible 1
Indigestible 2
DIAGRAM BLOK
“SMART GARBAGE SYSTEMS”

DIAGRAM ALIR SISTEM KLASIFIKASI

Sumber: M.W. Rahman, et al, 2020

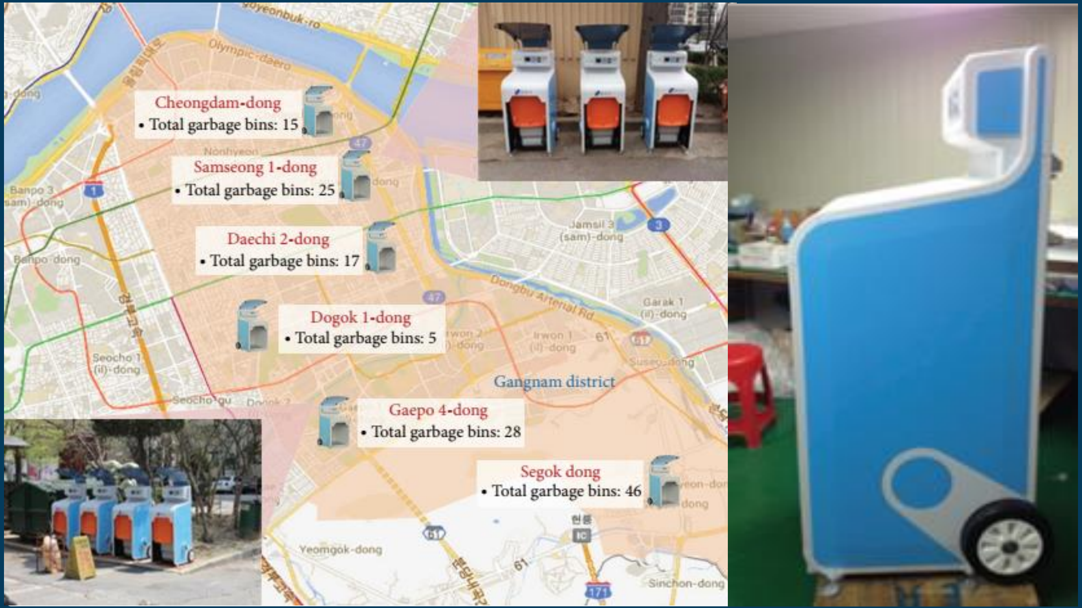


IMPLEMENTASI

...

Implementasi *pilot project* "*Smart Garbage Systems*" di distrik Gangnam, Seoul, Korea Selatan

Sumber: Hong et al., 2014



IMPLEMENTASI

• • •

Implementasi *pilot project* "*Smart Garbage Systems*" di distrik Gangnam, Seoul, Korea Selatan

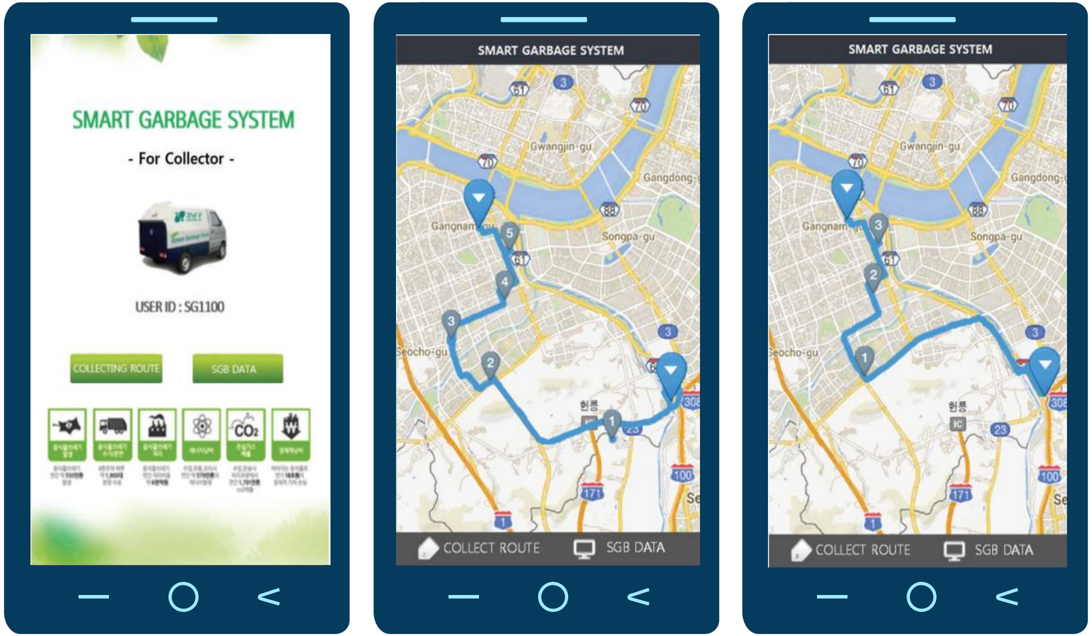
Sumber: Hong et al., 2014

APLIKASI MOBILE

...

Ilustrasi aplikasi mobile untuk kolektor limbah

Sumber: Hong et al., 2014



04

AI DAN ENERGI TERBARUKAN

Implementasi kecerdasan buatan pada energi terbarukan

KONTEN

01.

Energi terbarukan

02.

Apa yang dimaksud dengan AI?

03.

Contoh implementasi AI

04.

AI dalam energi terbarukan

01

sciencedirect.com

Energi yang dihasilkan oleh sumber-sumber alam yang dapat diperbarui dalam waktu yang relatif singkat. Contoh: cahaya matahari, angin, gelombang pasang, geotermal.

02

nrdc.org

Energi yang berasal dari proses atau sumber alami yang selalu terbarukan.

03

edfenergy.com

Energi yang berkelanjutan, yang tidak dapat habis, selalu tersedia.

04

US Department of Energy

Sumber energi yang selalu diperbarui secara alami.

Ada apa dengan energi terbarukan?

Mengapa energi terbarukan sangat penting?

ENERGI TERBARUKAN

Gas rumah kaca

Diklaim menghasilkan gas rumah kaca yang sangat sedikit atau tidak sama sekali

Polutan

Polutan sangat sedikit atau tidak sama sekali

Keamanan energi

Mengurangi kebergantungan suatu negara terhadap yang lain terkait energi

Resiliensi energi

Sistem terdistribusi lebih tahan kerusakan

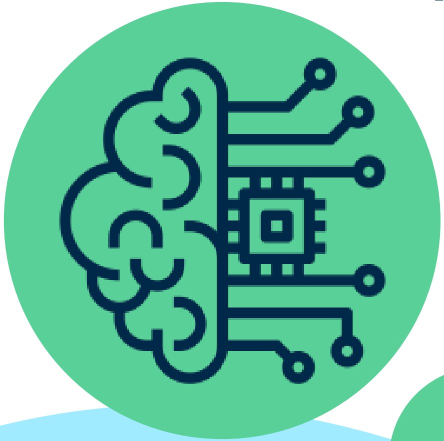
Ekonomi

Biaya perawatan yang relatif rendah.

GREEN ENERGY

- Panel surya
- Turbin angin
- Geotermal
- Energi air

HUBUNGAN DENGAN AI?



ARTIFICIAL INTELLIGENCE

Cabang dari ilmu komputer yang membuat mesin dapat melakukan tugas yang membutuhkan kecerdasan seperti manusia.

Mesin yang meniru kemampuan berpikir manusia.

Mampu belajar dari contoh, pengalaman, mengenali objek, mengenali dan merespon bahasa, membuat keputusan, memecahkan masalah.

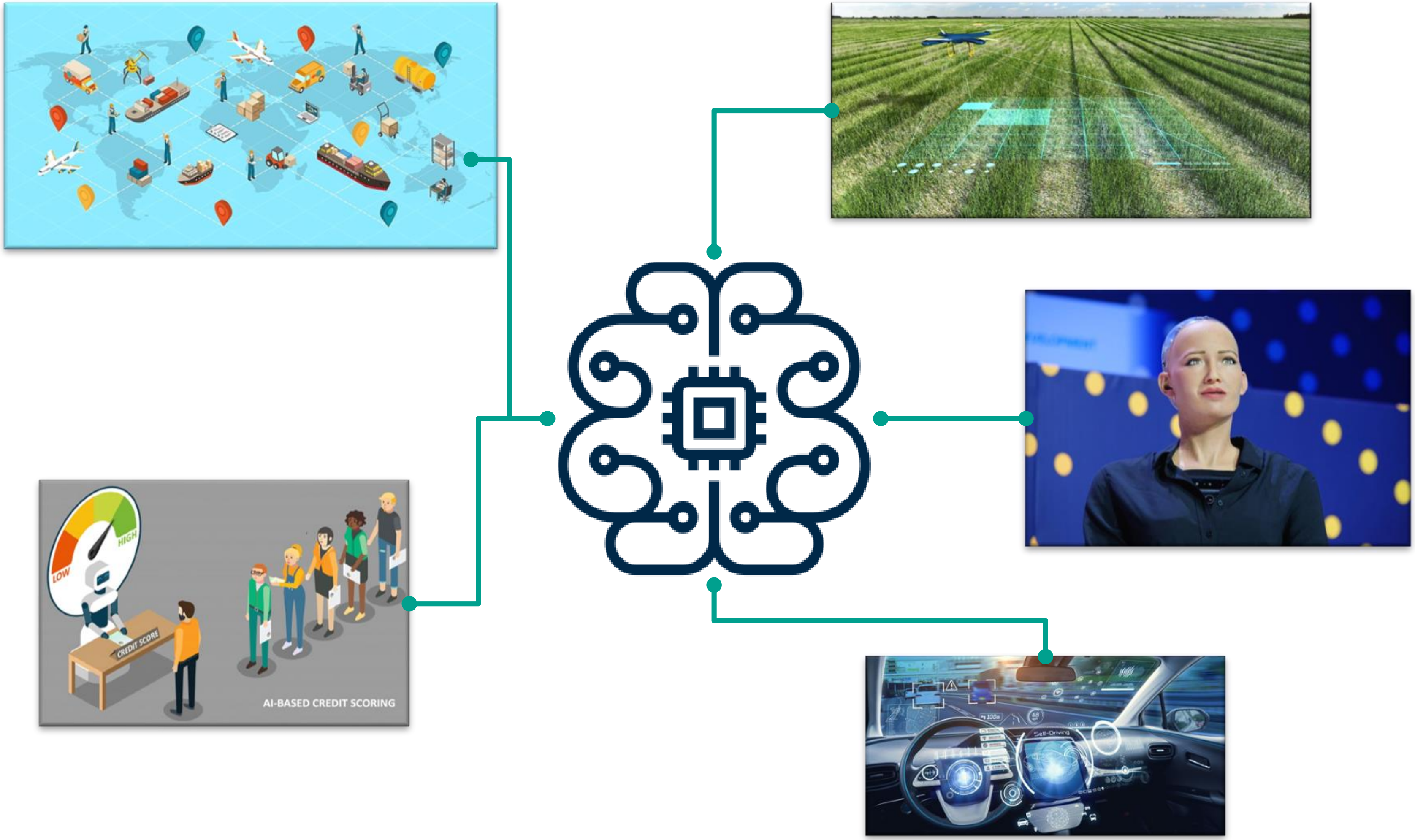
HAL YANG DAPAT DITINGKATKAN DENGAN AI

Kecepatan

Efektivitas

Akurasi

Efisiensi


HIGH
LOW
CREDIT SCORE
AI-BASED CREDIT SCORING

APLIKASI AI PADA ENERGI TERBARUKAN

GIZ Renewable Energy Programme Indonesia/ASEAN
Energising Development (EnDev) Indonesia, March 2014

APLIKASI AI PADA PV

Identifikasi parameter model panel surya

Penentuan ukuran sistem panel surya (jumlah panel, jumlah baterai, posisi optimal, sudut kemiringan)

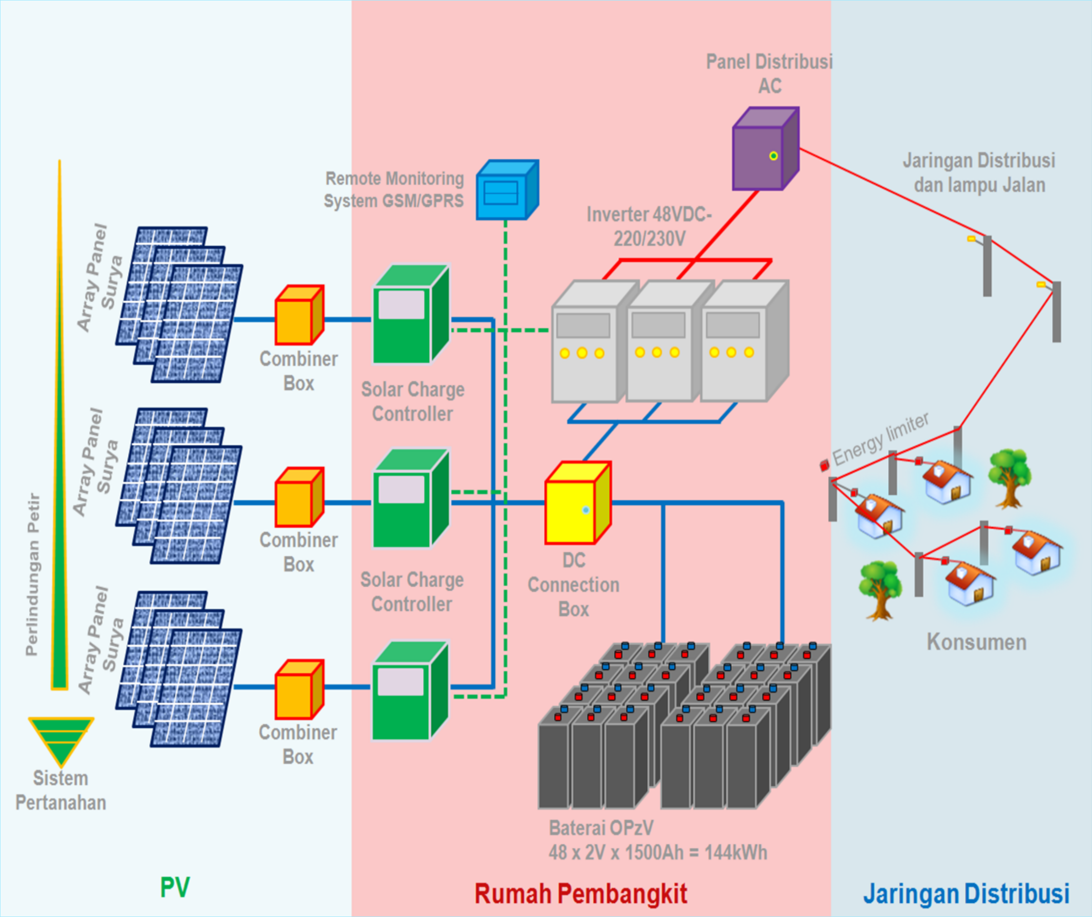
Kendali sistem PV

Prakiraan intensitas dan daya keluaran PV

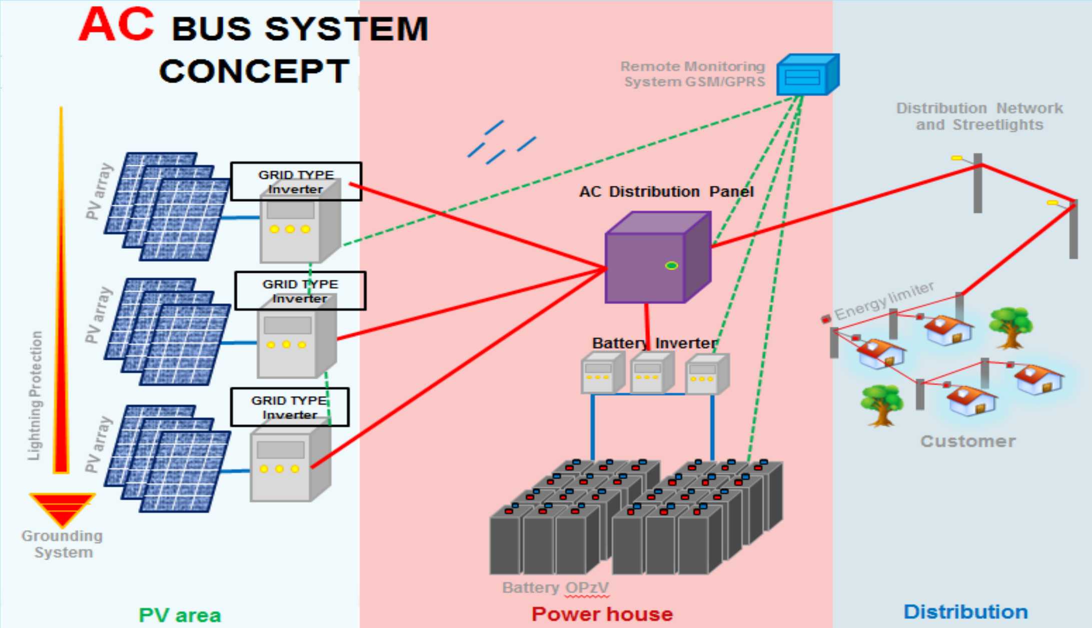
Diagnosis kegagalan sistem PV

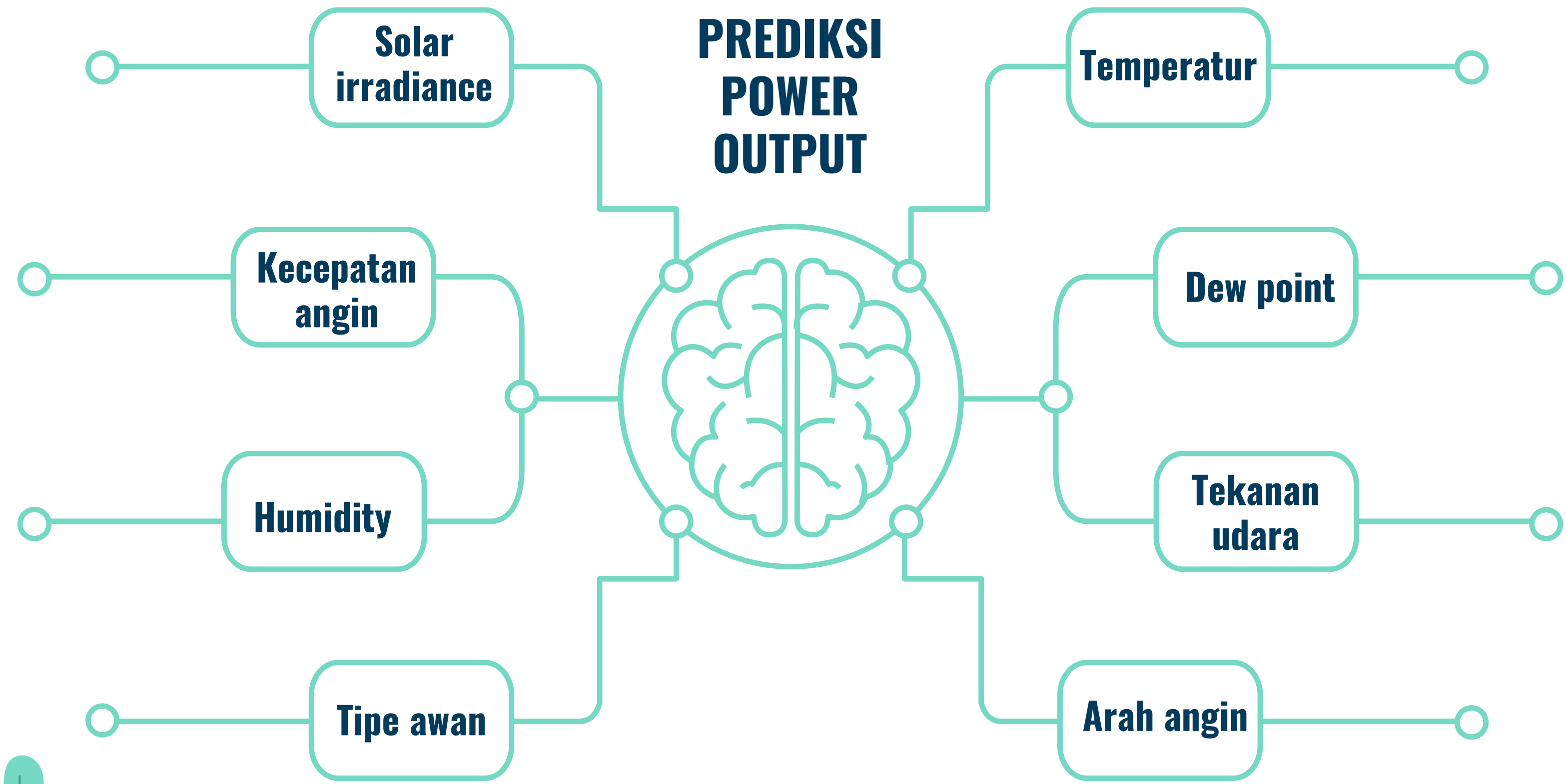
The role of artificial intelligence in photo-voltaic systems design and control: A review (Youssef, 2017)

SISTEM DC Bus



SISTEM AC Bus





Prediksi dilakukan berdasarkan **data historis yang menjadi data latih bagi komputer**

STUDI KASUS

Irradiance

Data intensitas cahaya matahari pada rentang waktu tertentu

Output power

Data daya keluaran panel surya dengan intensitas cahaya matahari yang terkait.

Kecepatan angin

Data kecepatan angin pada waktu yang sama.

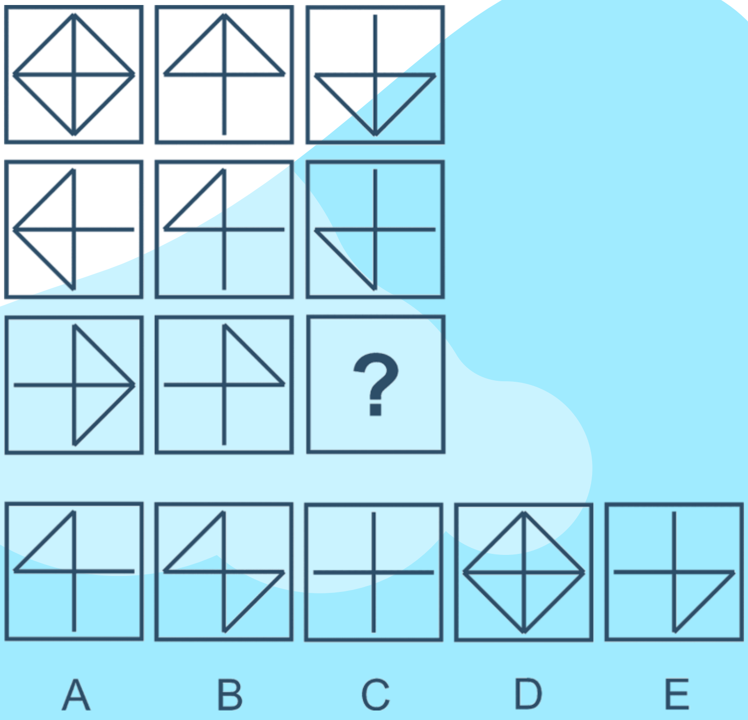
Suhu udara

Data suhu udara pada waktu pengukuran irradiance dan output power.

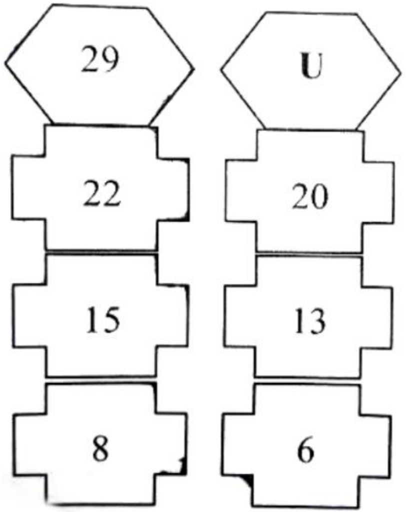
Humidity

Kelembaban udara disekitar panel surya.

Jawaban yang tepat adalah?



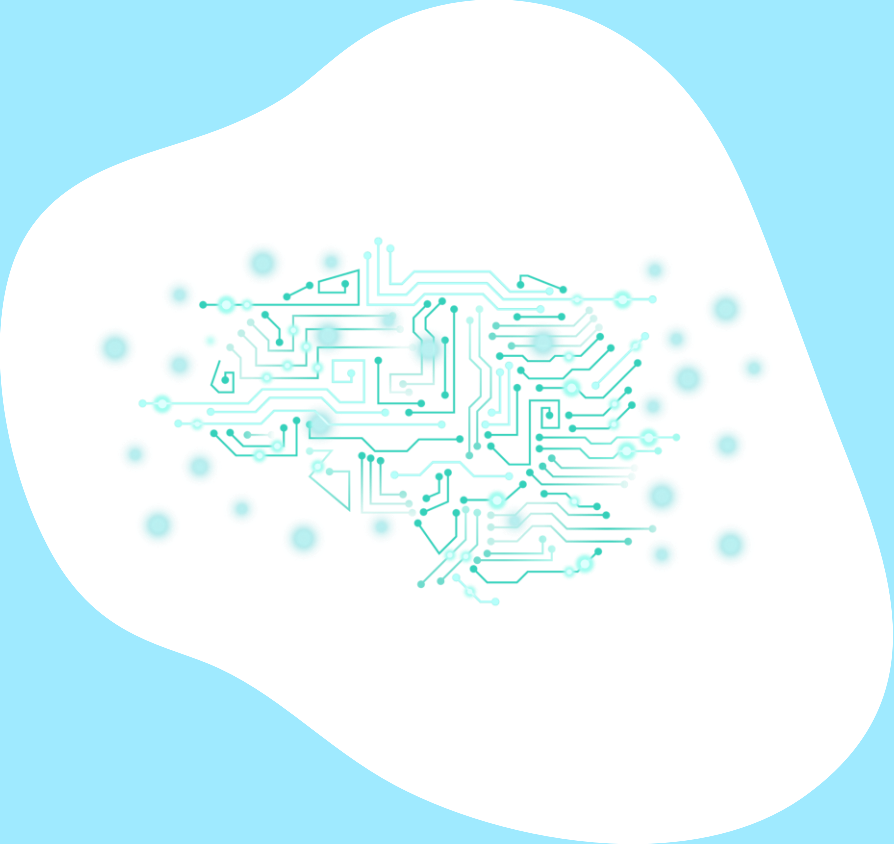
Jawaban yang tepat adalah?



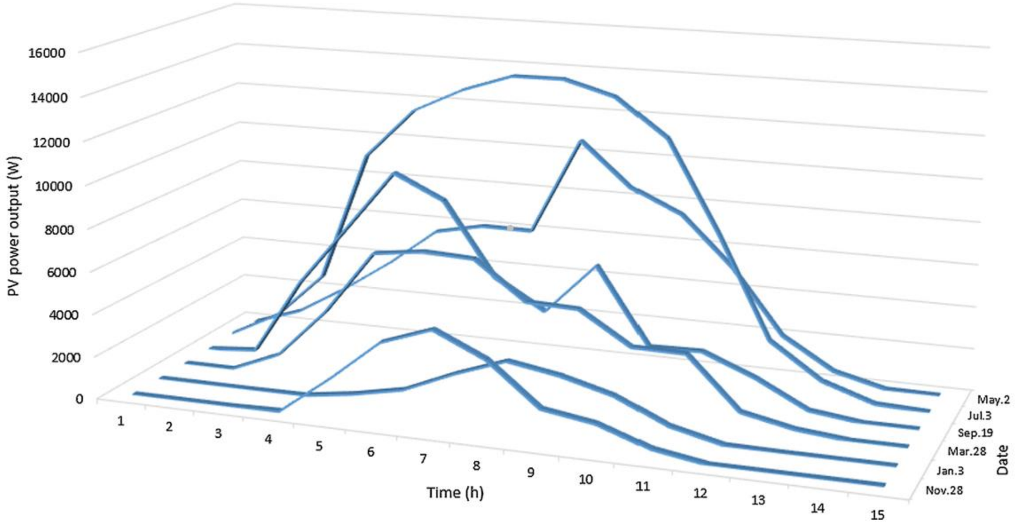
AI membuat mesin mampu mengenali pola seperti kemampuan berpikir manusia

Data

Fitur



APLIKASI AI PADA PV



Pola grafik daya keluaran panel surya terhadap waktu dapat menjadi fitur.

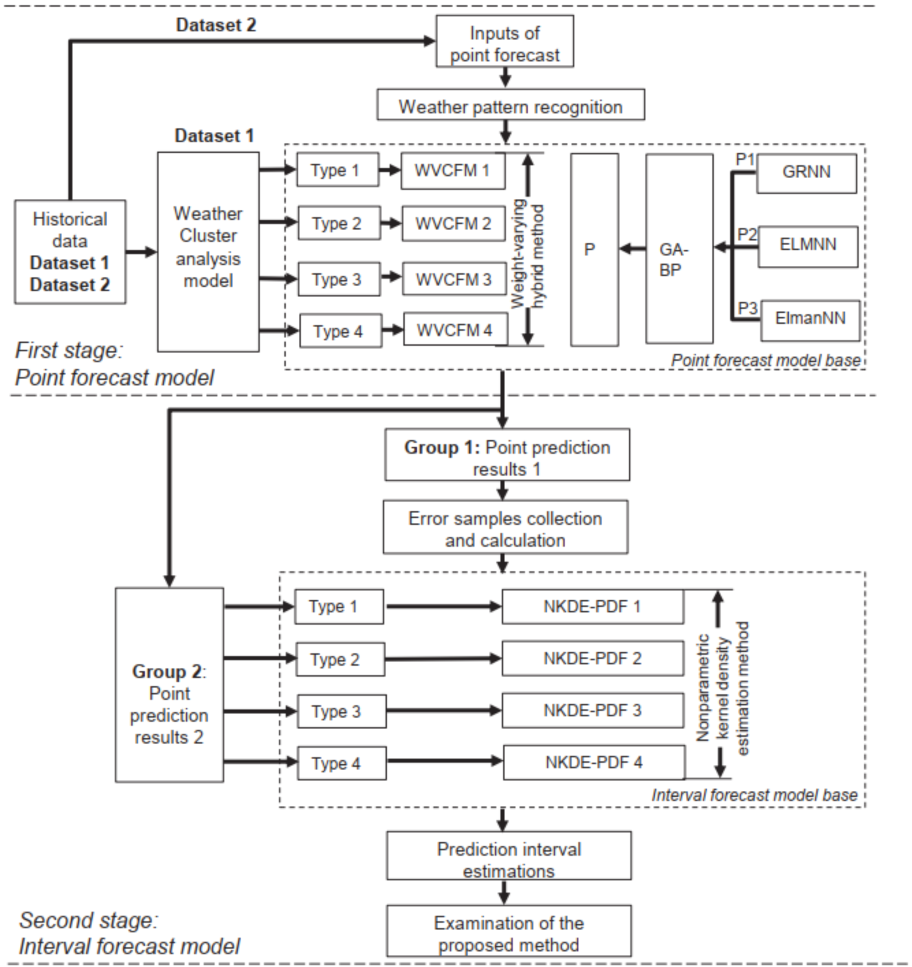
Prediction of short-term PV power output and uncertainty analysis (Liu, 2018)

Menentukan fitur

Fitur apa yang tepat untuk digunakan?

Meteorological factor	Correlation coefficient
Solar irradiance	0.9840
Air temperature	0.7615
Cloud type	−0.4847
Dew point	0.6386
Relative humidity	−0.4918
Precipitable water	0.3409
Wind direction	0.1263
Wind speed	0.1970
Air pressure	0.0815

Prediction of short-term PV power output and uncertainty analysis (Liu, 2018)

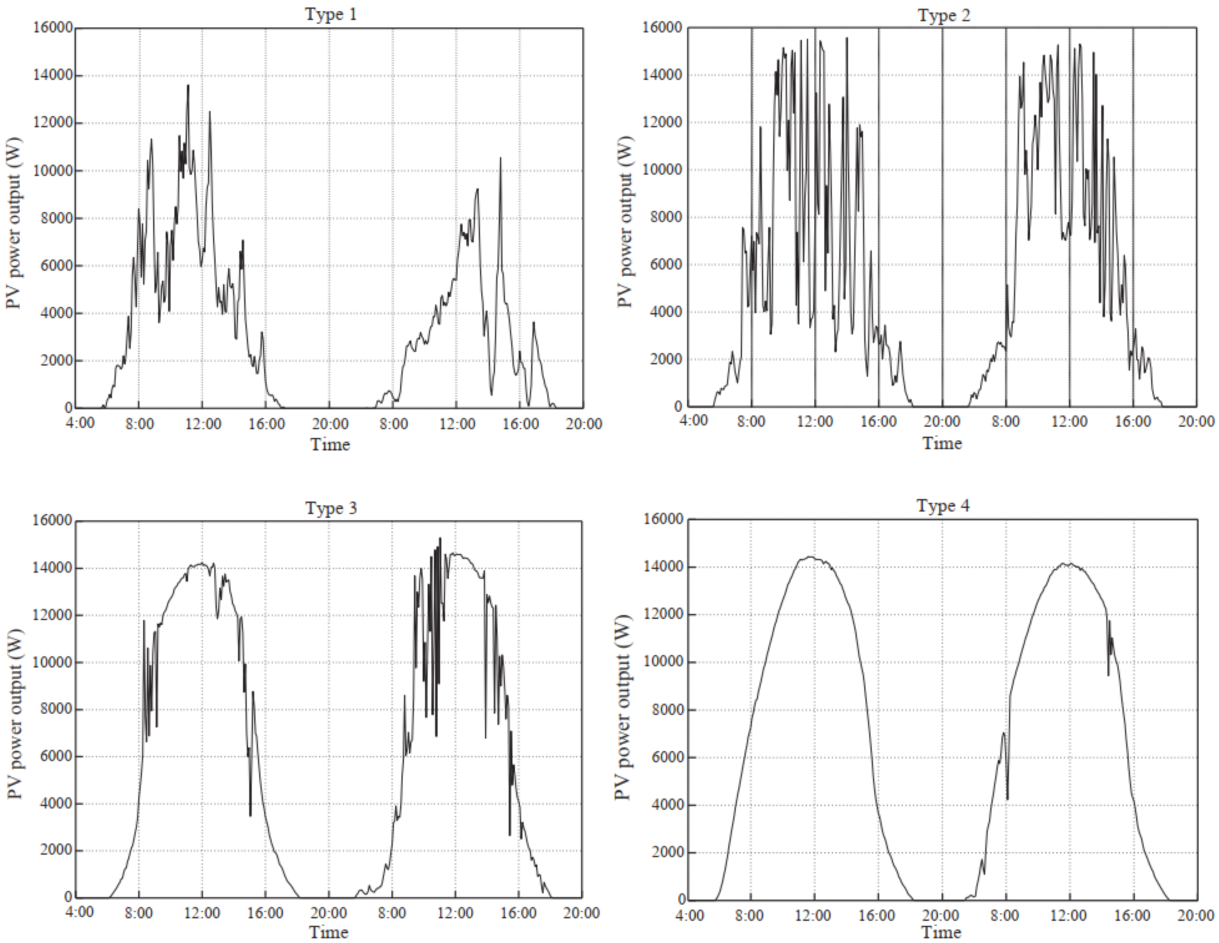


Proses training

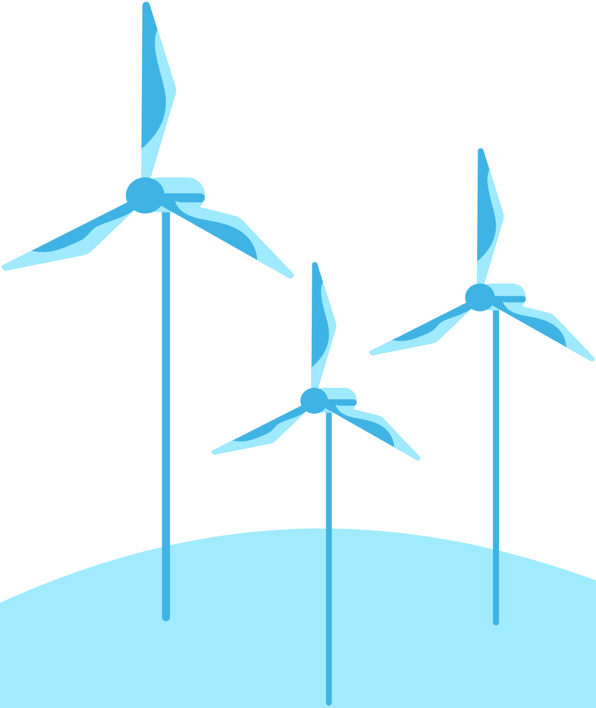
1. Tipe 1: Hujan
2. Tipe 2: Mendung
3. Tipe 3: Berawan Sebagian
4. Tipe 4: Cerah

Jumlah dataset:
Dataset 1 = 366 hari
Dataset 2 = 365 hari

Mengapa ada dua dataset?



Prediction of short-term PV power output and uncertainty analysis (Liu, 2018)



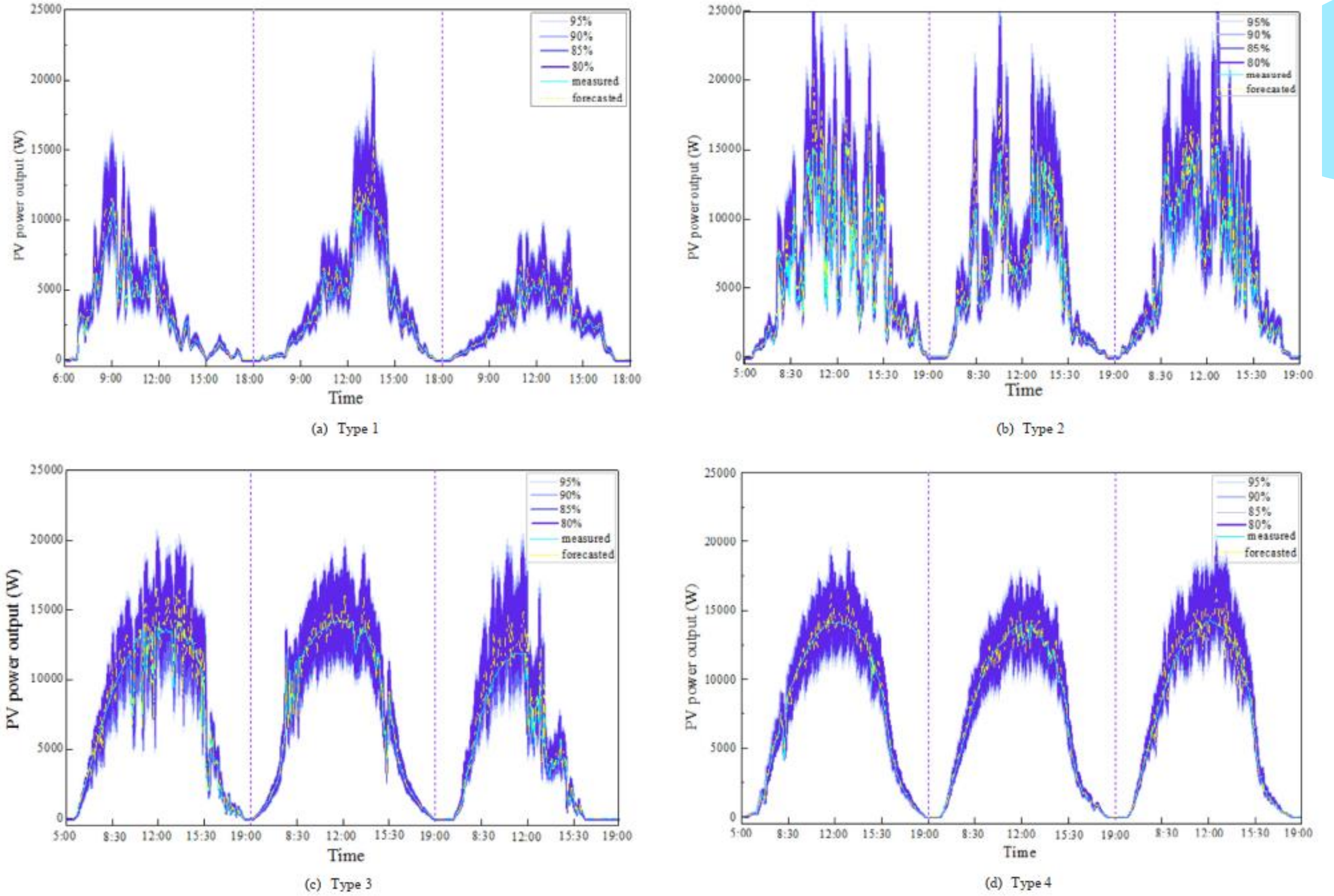
DATASET 1

Data latih bagi komputer. Memberikan pengetahuan / pengalaman kepada komputer

DATASET 2

Data test / data uji. Digunakan untuk menilai kemampuan komputer dalam memprediksi.

Hasil prediksi



Mengapa perlu prediksi?

THANKS!

Any Question?

Attribution to slidesgo.com

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Kuliah Teknologi Hijau

Potensi dan Teknologi Pemanfaatan Sumber Energi Baru dan Terbarukan di Indonesia

Prisma Megantoro – Teknik Elektro

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Prisma Megantoro

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Instruktur, Program Studi Metrologi dan Instrumentasi, Sekolah Vokasi, UGM, Mar 2015-Okt 2018, Yogyakarta, Indonesia
Memberikan mata praktikum kepada siswa di bidang Teknik Instrumentasi, seperti: Analisis Sistem Instrumentasi, Sistem Pengukuran Listrik, Gambar Teknik, Gambar Instrumentasi, Antarmuka Komputer., Listrik dan Elektronik. Saya mengajar 12 kelas (30 siswa per kelas) per semester.

Konsultan, Dinas PU dan ESDM Yogyakarta, 2016-2017, Indonesia
Mendesain PV Solar Home System (SHS) yang memiliki kapasitas daya 1 kW untuk setiap sistem pada bangunan kantor sipil di Yogyakarta. Kami mendesain SHS untuk 24 gedung kantor.

Konsultan, Dinas ESDM Blora, 2015, Indonesia
Mendesain detailed engineering design (DED) untuk 2 instalasi PLTS di 2 lokasi berbeda di Blora, Jawa Tengah

Konsultan, Dinas PU dan ESDM Yogyakarta, 2015, Indonesia
Mendesain DED untuk beberapa proyek terkait PLTS di beberapa lokasi di Provinsi DIY, seperti sistem PLTS terpusat dan tersebar

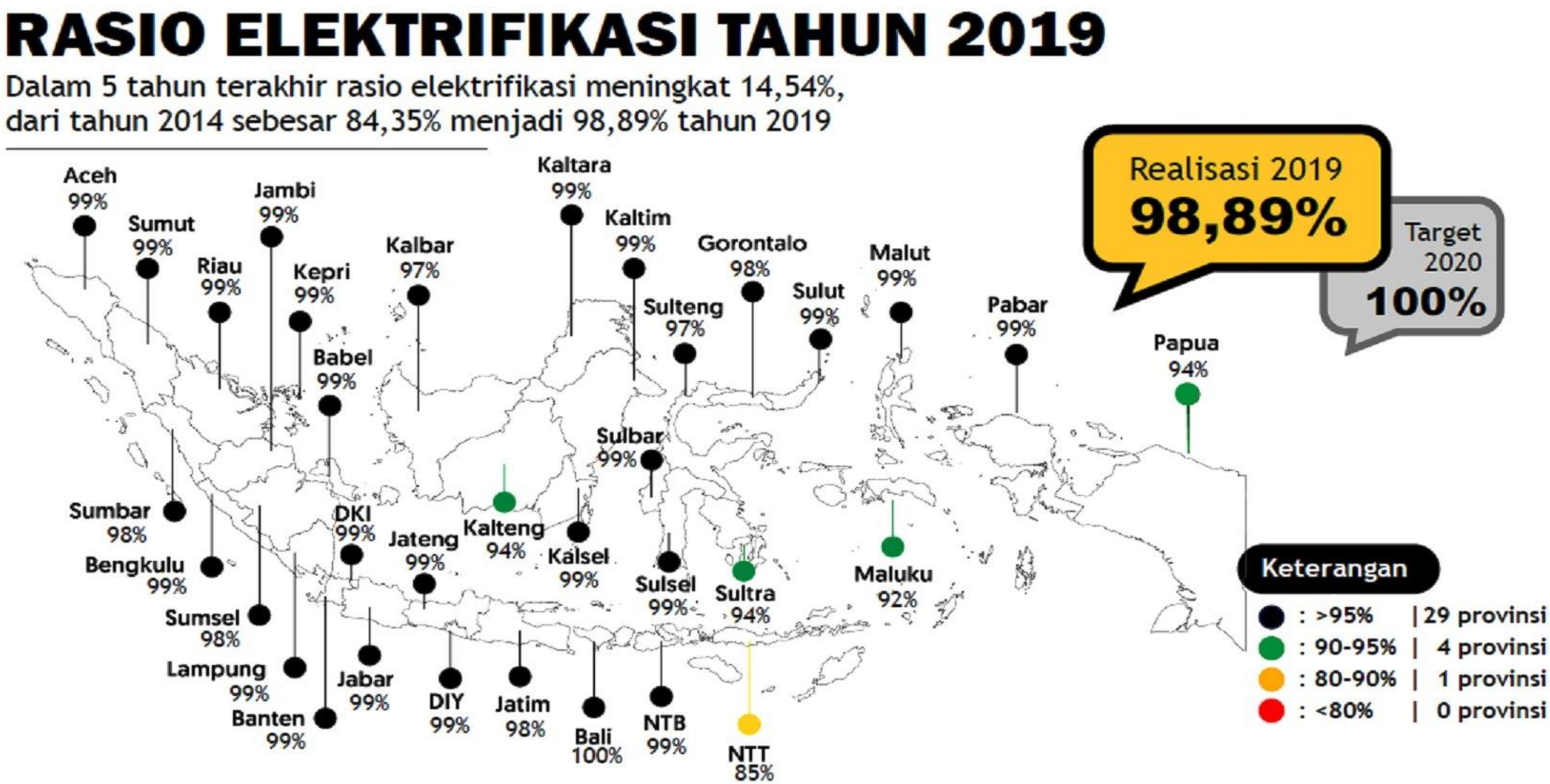
Konsultan teknis, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Mar 2014-Nov 2014, Jakarta, Indonesia

1. Investigasi Data dan Diagnosis Sistem Powerplant PV Desa di Yogyakarta
2. Proyek Inspeksi Proyek PVVP 2013 dari Kementerian Energi dan Sumber Daya Mineral

Asisten peneliti di Pusat Studi Energi, UGM, (2011-2014). Memperoleh pengalaman dalam pengembangan energi terbarukan, mengelola penelitian dan proyek lapangan dalam sistem instrumentasi energi terbarukan, terutama pada sistem bertenaga surya atau PLTS. Proyek saya seperti;

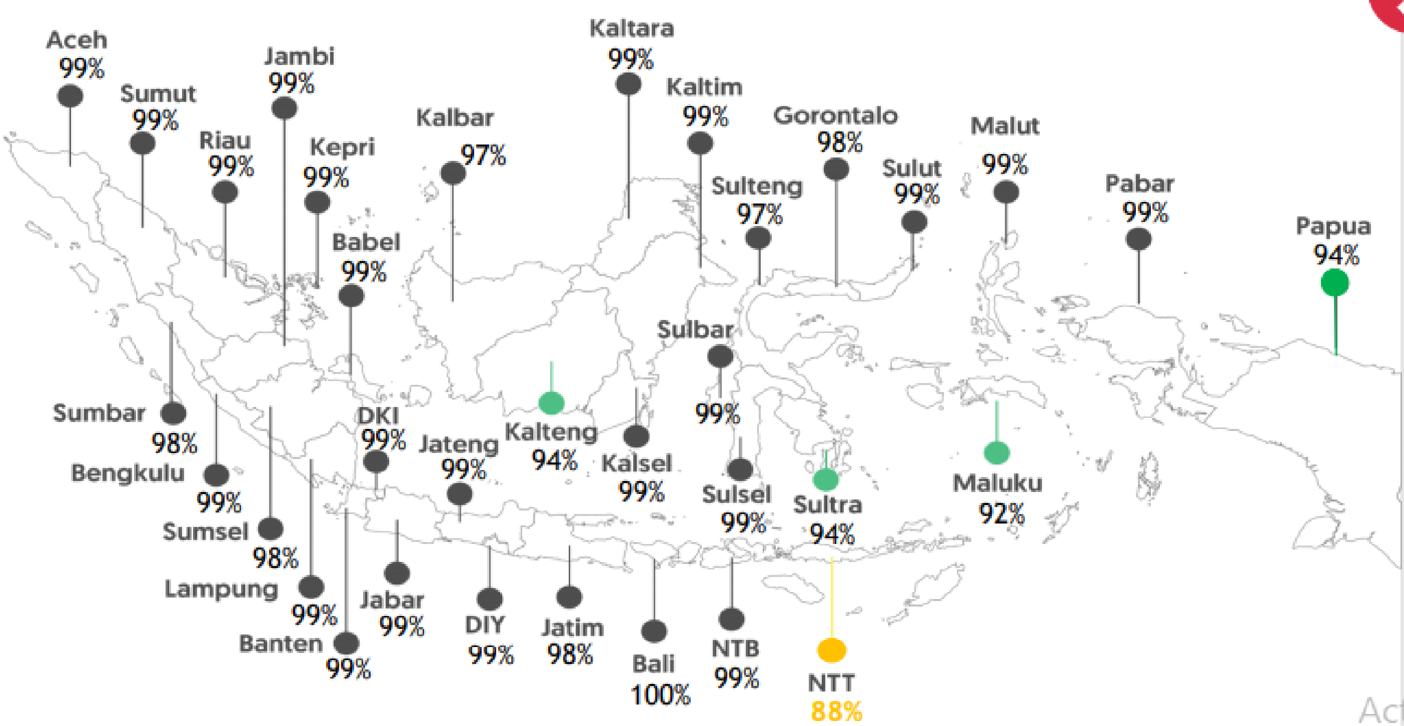
1. Bekerja pada proyek pengembangan energi terbarukan untuk daerah pedesaan di Yogyakarta, dana penelitian dari DIKTI, Kementerian RISTEK
2. Bekerja pada proyek referigerator ikan berdasarkan energi surya, dana penelitian dari DIKTI, Kementerian RISTEK
3. Pengembangan energi terbarukan untuk daerah pedesaan di Gunung Kidul dan Bantul, Yogyakarta
4. Pengembangan dan revitalisasi sumber energi terbarukan di Bantul, Daerah Istimewa Yogyakarta
   Pengembangan pengontrol pengisian daya baterai 120 VDC pada mesin pembuat es berbasis di pembangkit listrik hibrida, Yogyakarta

Menurut data ESDM, **potensi** listrik dari energi terbarukan mencapai **432 GW, atau 7-8 kali** dari total kapasitas pembangkit terpasang saat ini. 7 GW yang telah dimanfaatkan secara komersial, dan hingga tahun 2028, akan ada **penambahan sekitar 29 GW** oleh PLN. Total kapasitas terpasang energi terbarukan pada tahun **2025 mencapai 48 GW**.



RASIO ELEKTRIFIKASI TAHUN 2020

Dalam 6 tahun terakhir rasio elektrifikasi meningkat 14,85%, dari tahun 2014 sebesar 84,35% menjadi 99,20% tahun 2020



Realisasi 2020

99,2%

Target 2021

99,9%

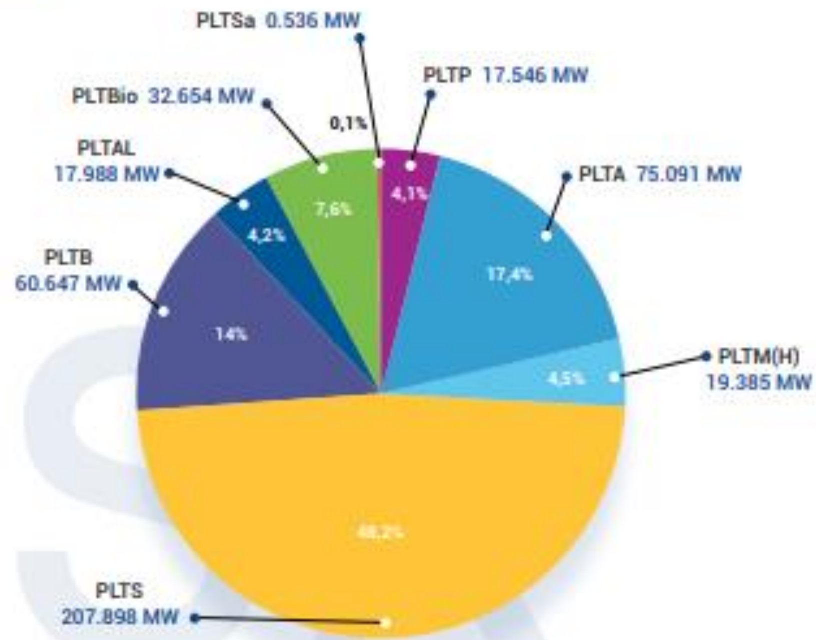
Keterangan:

- >95% | 29 provinsi
- 90-95% | 4 provinsi
- 80-90% | 1 provinsi
- <80% | 0 provinsi

Potensi Energi Terbarukan di Indonesia

10 daerah dengan potensi energi terbarukan terbesar

Provinsi	Potensi (MW)	Kapasitas Terpasang 2018 (MW)
Kalimantan Barat	26.841	247
Papua	26.529	20
Jawa Barat	26.190	3.184
Jawa Timur	24.240	275
Kalimantan Timur	23.841	-
Sumatera Utara	22.478	839
Nusa Tenggara Barat	21.991	17
Sumatera Selatan	21.866	18
Kalimantan Tengah	19.568	-
Jawa Tengah	19.450	366



Gambar 1. Potensi energi terbarukan nasional menurut teknologi

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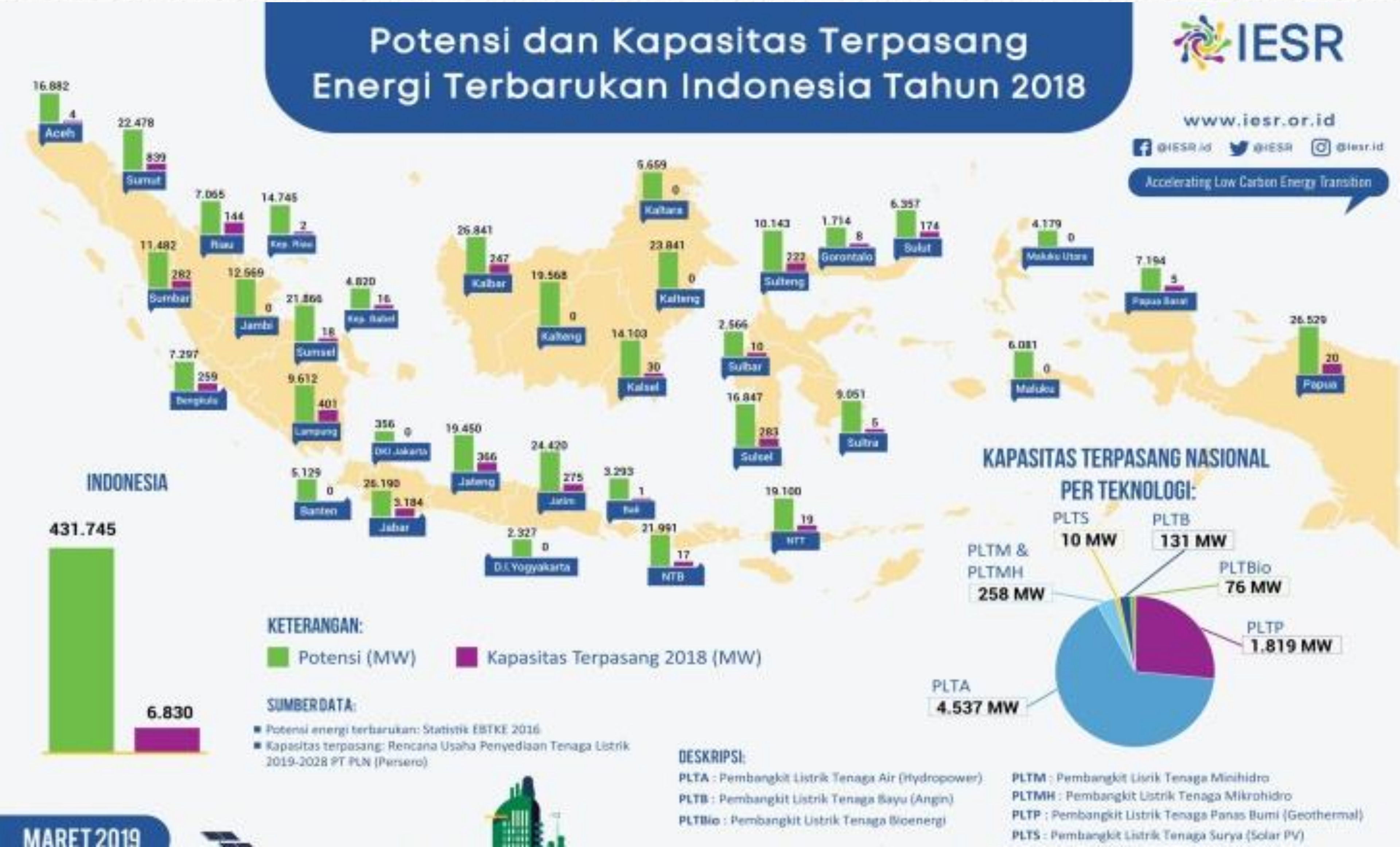
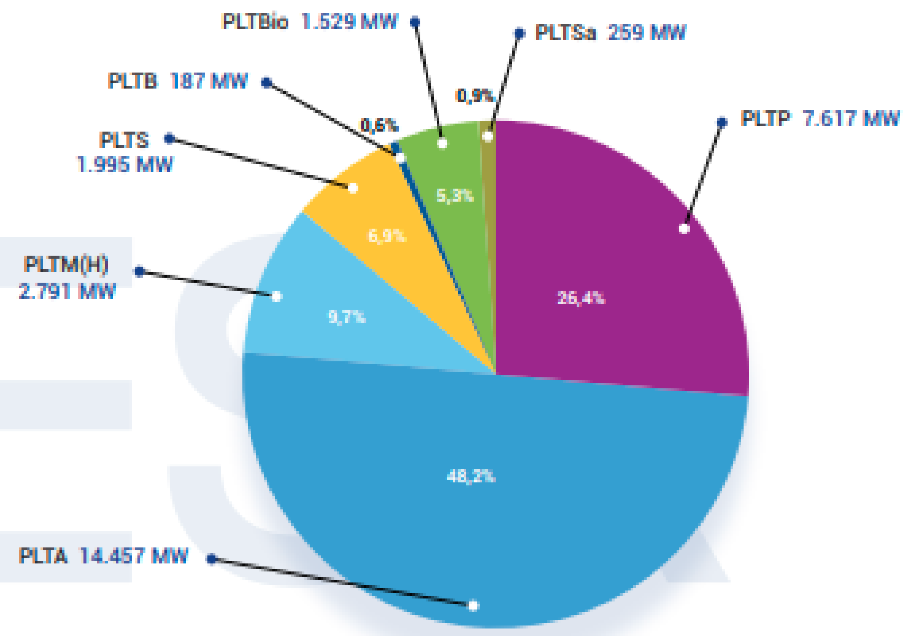


Rencana Pembangunan Pembangkit Energi Terbarukan

10 daerah dengan rencana pembangunan pembangkit energi terbarukan terbesar menurut RUPTL 2019-2028

Provinsi	Rencana Pembangunan (MW)
Sumatera Utara	3.568
Jawa Barat	2.911
Sumatera Selatan	2.261
Jambi	2.189
Jawa Timur	2.145
Jawa Tengah	2.072
Sumatera Barat	2.068
Bengkulu	1.992
Lampung	1.992
Aceh	1.917



Gambar 2. Rencana pembangunan pembangkit energi terbarukan dalam RUPTL

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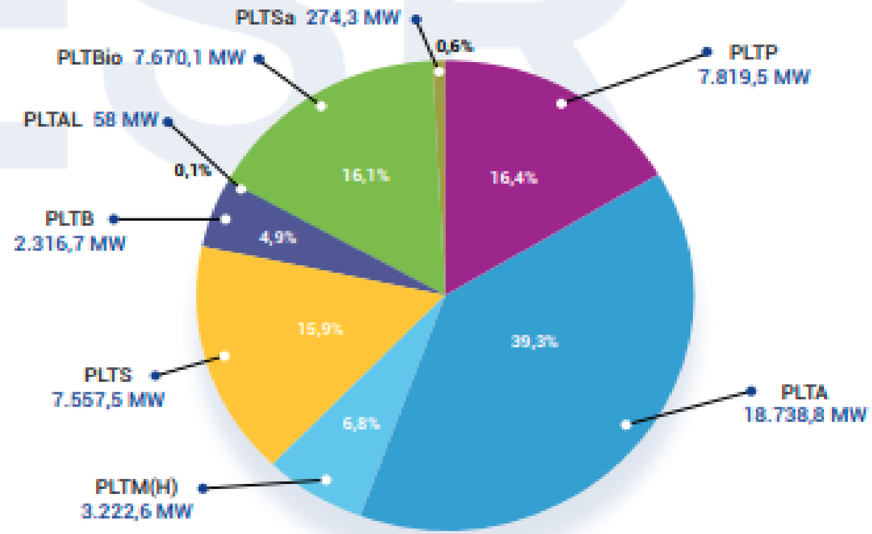
Rencana Umum Energi Daerah

Provinsi	Target 2025 (MW)	Provinsi	Target 2025 (MW)
Aceh	2.530	NTB	360
Sumut	4.935	NTT	291
Sumbar	1.244	Kalbar	1.045
Riau	2.972	Kalsel	890
Kep. Riau	187	Kalteng	705
Kep. Babel	239	Kaltim	1.270
Jambi	850	Kaltara	1.836
Sumsel	1.686	Sulut	371
Bengkulu	755	Sulteng	1.546
Lampung	2.004	Gorontalo	97
Banten	1.070	Sulsel	2.411
DKI Jakarta	305	Sultra	518
Jabar	8.767	Sulbar	518
Jateng	2.722	Maluku	205
DIY Yogyakarta	105	Maluku Utara	84
Jatim	4.230	Papua	269
Bali	571	Papua Barat	64

Target kapasitas energi terbarukan per daerah pada 2025 yang dicanangkan dalam RUED jauh lebih tinggi dan bervariasi sumbernya dibanding rencana pembangunan pembangkit yang disusun oleh PLN. Hal ini mengindikasikan adanya keinginan dari pemerintah daerah untuk mengembangkan energi terbarukan yang lebih besar dari rencana PLN. Adapun total rencana pembangungan pembangkit energi terbarukan dalam RUED 34 provinsi mencapai 47.658 MW.



Gambar 3. Rencana pembangunan pembangkit energi terbarukan dalam RUED

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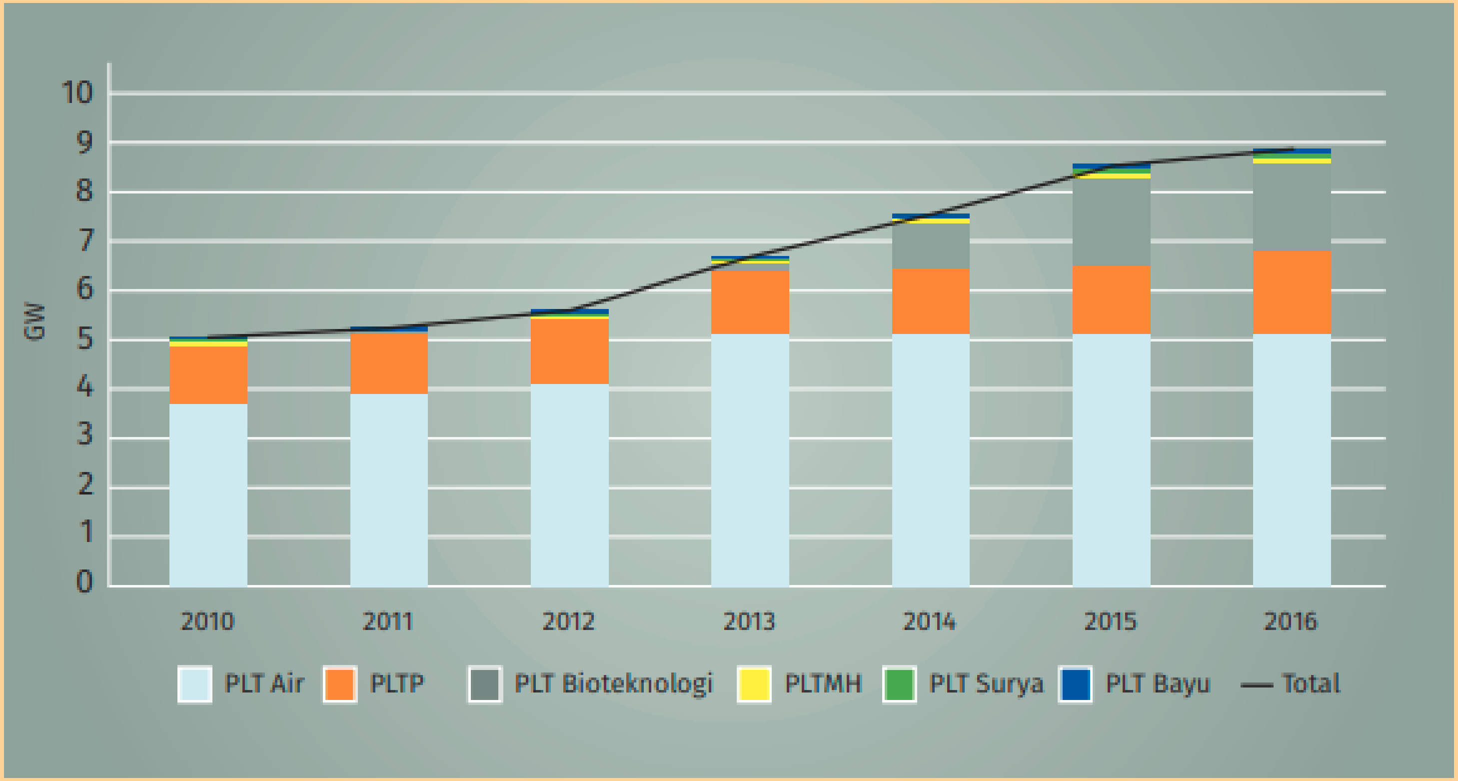
Gambar 1. Kapasitas terpasang pembangkit listrik EBT (DJEBTKE KESDM, 2017)

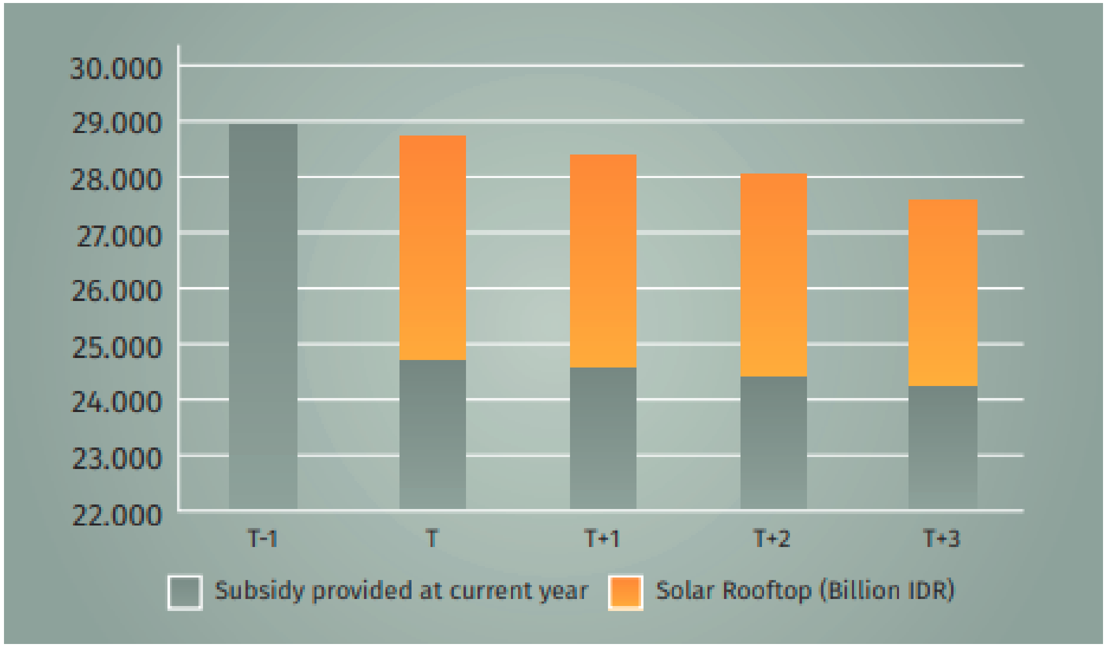


Kapasitas pembangkit listrik terpasang dari sumber EBT **meningkat 7,9% per tahun**. Pembangkit listrik dari sumber EBT didominasi oleh PLTA (air) dan PLTP (panas bumi). Untuk EBT lain seperti surya dan angin, pembangkit listrik yang dibangun masih terbatas, termasuk di antaranya **PLTS (surya) 5 MW** di Kupang, NTT dan **PLTB (bayu/angin) 70 MW** di Sidrap, Sulawesi Selatan.

Tantangan

- Biaya produksi listrik masih relatif lebih tinggi
- Beberapa komponen juga masih diimpor
- kapasitas sumber daya manusia masih perlu ditingkatkan
- Kebijakan dalam negeri yang juga dinilai belum kondusif
- Sifat beberapa sumber energi terbarukan yang *intermittent* (tidak kontinyu) dan tidak dapat ditransportasikan

Gambar 2. Model pengalihan subsidi listrik untuk instalasi solar PV rooftop (IESR, 2017)



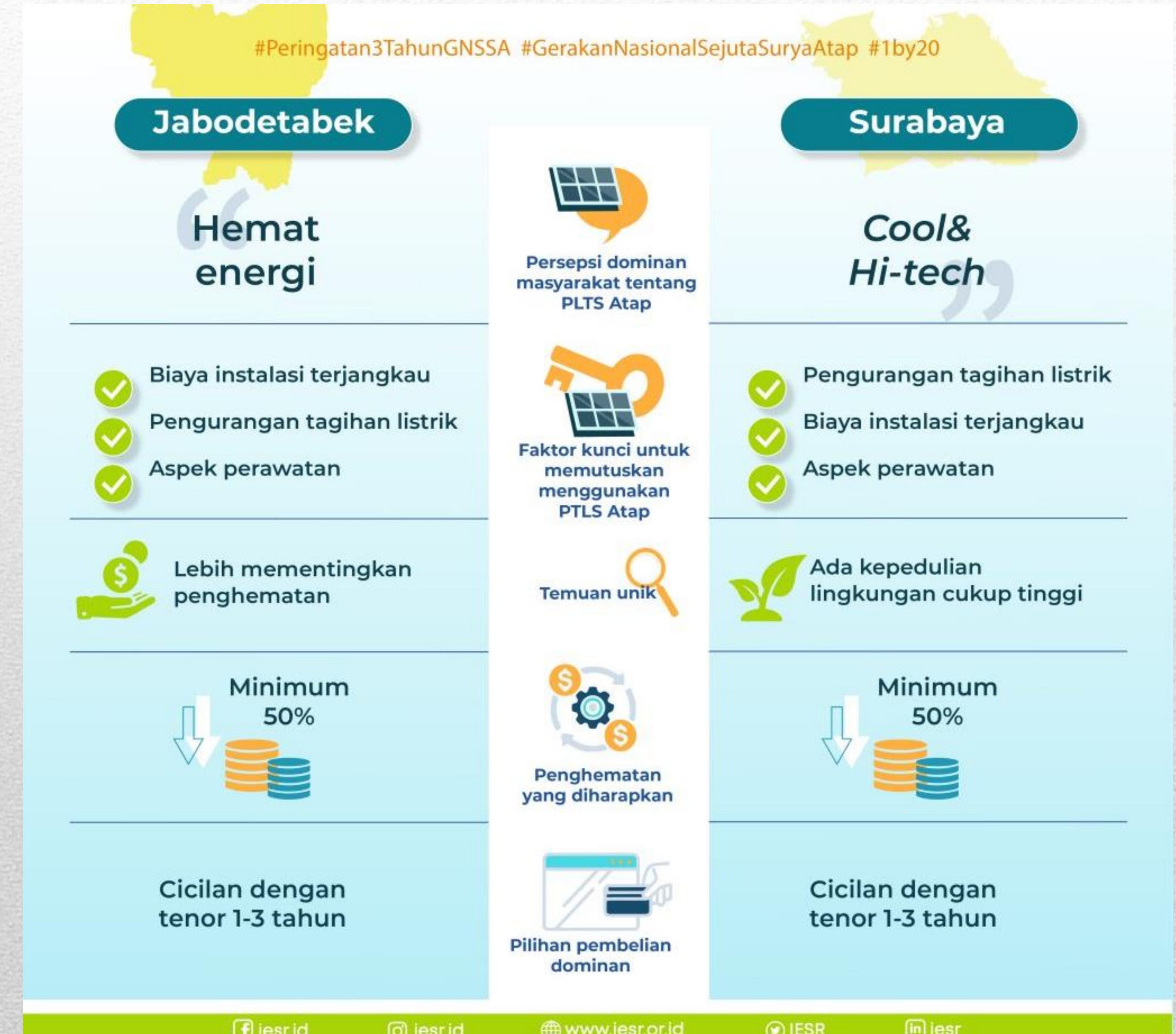
10-12% dana hasil pengalihan subsidi setiap tahunnya untuk instalasi listrik surya atap, dalam jangka waktu 4 tahun setelah program dimulai, bisa tercapai **1 juta rumah tangga** pelanggan listrik R1-450VA yang terpasang listrik surya atap dengan kapasitas 1 kWp *on-grid* per rumah. Total kapasitas yang terpasang sebesar **1 GW** atau sekitar **15%** dari total target solar PV

Rekomendasi utk Pemerintah

Sumber: IESR (2017)

- Kebijakan energi nasional yang konsisten
- Perlu melibatkan pemerintah daerah dalam perencanaan, pembangunan, dan evaluasi
- Perlu lebih aktif melibatkan masyarakat, komunitas, dan pihak swasta
- Perlu membuat kebijakan yang menaungi produksi teknologi energi terbarukan dalam negeri dan merumuskan kebijakan insentif keuangan
- Gunakan pengalihan subsidi energi sebagai sumber pendanaan alternatif
- Pembelajaran penyediaan akses energi dengan energi terbarukan yang dilakukan oleh berbagai pihak
- Pemerintah, pemerintah daerah, dan lembaga non-pemerintah perlu aktif mendorong masyarakat secara umum untuk memahami energi bersih dan terbarukan


IESR
Potensi Pasar
Pembangkit Listrik
Tenaga Surya (PLTS) Atap
di Jabodetabek dan Surabaya
#Peringatan3TahunGNSSA #GerakanNasionalSejutaSuryaAtap #1by20
Jabodetabek
13%
berpotensi sebagai
early followers
dan early adopters*
setara
166.000-
184.000
rumah tangga
Surabaya
19%
berpotensi sebagai
early followers
dan early adopters*
setara
83.000-
93.000
rumah tangga
Tidak ada
preferensi gender
Pemilihan responden berdasarkan
Rumah
minimum tipe 45
Kapasitas listrik terpasang
minimal 1.300 VA
Pemegang keputusan di
rumah tangga terkait
hal-hal kelistrikan


#Peringatan3TahunGNSSA #GerakanNasionalSejutaSuryaAtap #1by20
Jabodetabek
Surabaya
Hemat energi
Persepsi dominan masyarakat tentang PLTS Atap
Cool& Hi-tech
Biaya instalasi terjangkau
Pengurangan tagihan listrik
Aspek perawatan
Faktor kunci untuk memutuskan menggunakan PTLS Atap
Pengurangan tagihan listrik
Biaya instalasi terjangkau
Aspek perawatan
Lebih mementingkan penghematan
Temuan unik
Ada kepedulian lingkungan cukup tinggi
Minimum 50%
Penghematan yang diharapkan
Minimum 50%
Cicilan dengan tenor 1-3 tahun
Pilihan pembelian dominan
Cicilan dengan tenor 1-3 tahun
iesr.id
iesr.id
www.iesr.or.id
IESR
iesr

Sumber data:

- Potensi energi terbarukan : Statistik EBTKE 2016
- Kapasitas terpasang : Rencana Usaha Penyediaan Tenaga Listrik 2019-2028 PT PLN (Persero)
- Rencana pembangunan : Rencana Usaha Penyediaan Tenaga Listrik 2019-2028 PT PLN (Persero)
- Rencana Umum Energi Daerah : Dokumen RUED Provinsi

TEKNOLOGI PEMANFAATAN SUMBER ENERGI TERBARUKAN






PLTS Terpusat 15 kW Gunung Kidul, Yogyakarta (2014)

PLTS Terpusat 15 kW Gunung Kidul, Yogyakarta (2014)

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PLTS Tersebar 200Wp, Gunung Kidul, Yogyakarta (2015)

PLTS Terpusat 15 kWp, Blora (2015)

Moveable Solar Water Pumping System, Yogyakarta (2012)

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Solar Home System (SHS) 1 kWp, Kantor DPRD, Yogyakarta (2015)

PLT Hibrid (Surya dan Angin), Bantul, Yogyakarta (2012)

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Inspeksi PLTS dan PLTMH Kementrian ESDM – GIZ Indonesia, Jakarta (2014)

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PLTS 15 kWp, Takalar, Sulawesi Selatan (2014)

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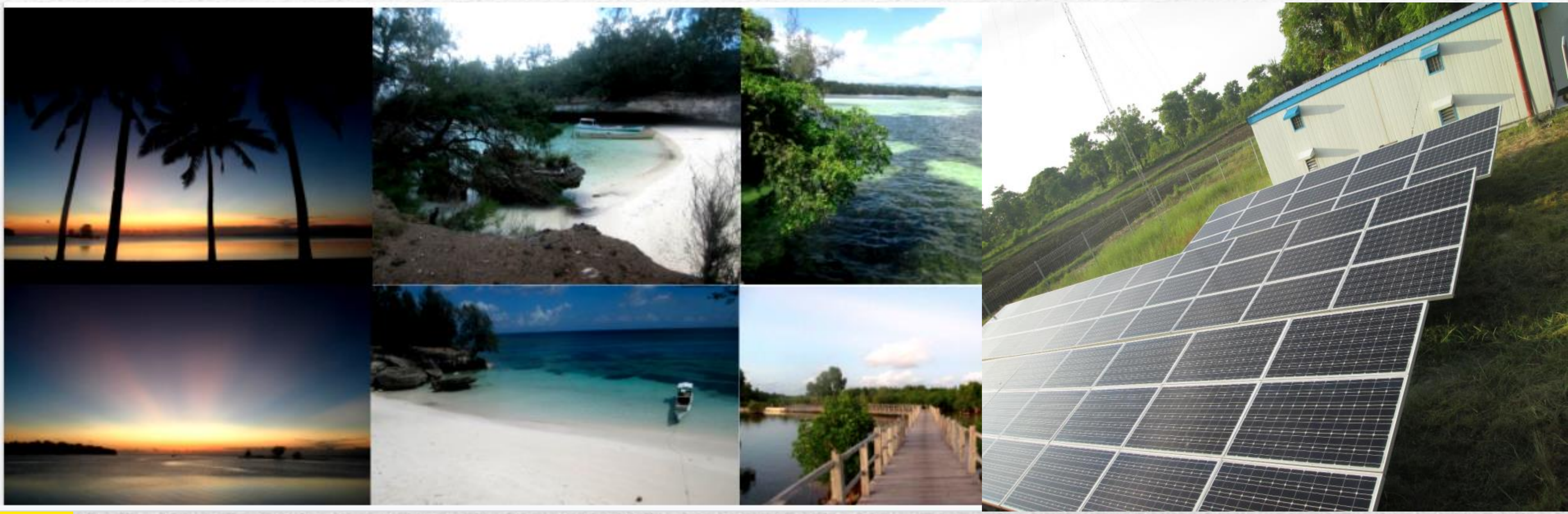

PLTS 15 kWp, Takalar, Sulawesi Selatan (2014)

PLTS 15 kWp, Sulawesi Utara (2014)

PLTS 5 kW, Perpustakaan UGM, Yogyakarta (2016)

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PLTS 1 kWp, Gd. Nanizar Zaman Joenoes, UNAIR, Surabaya (2020)

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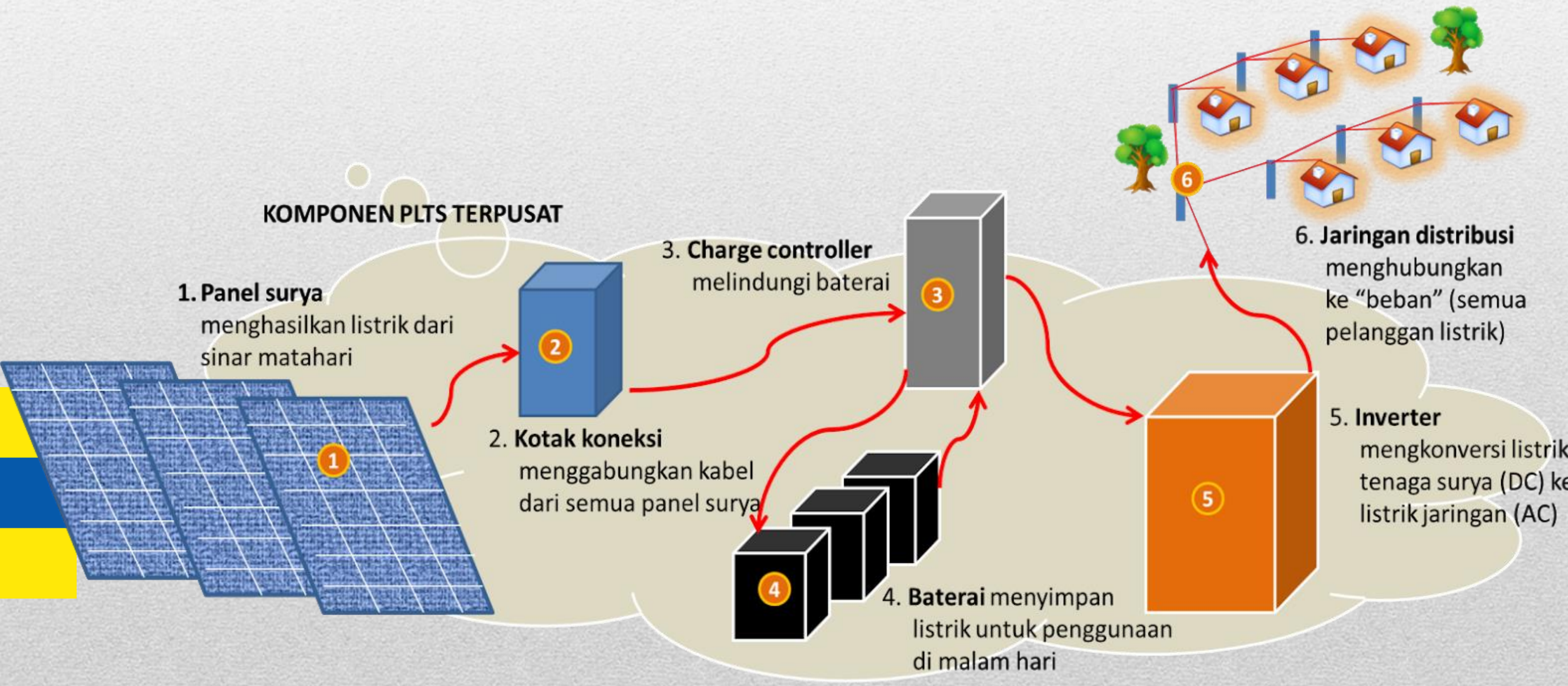
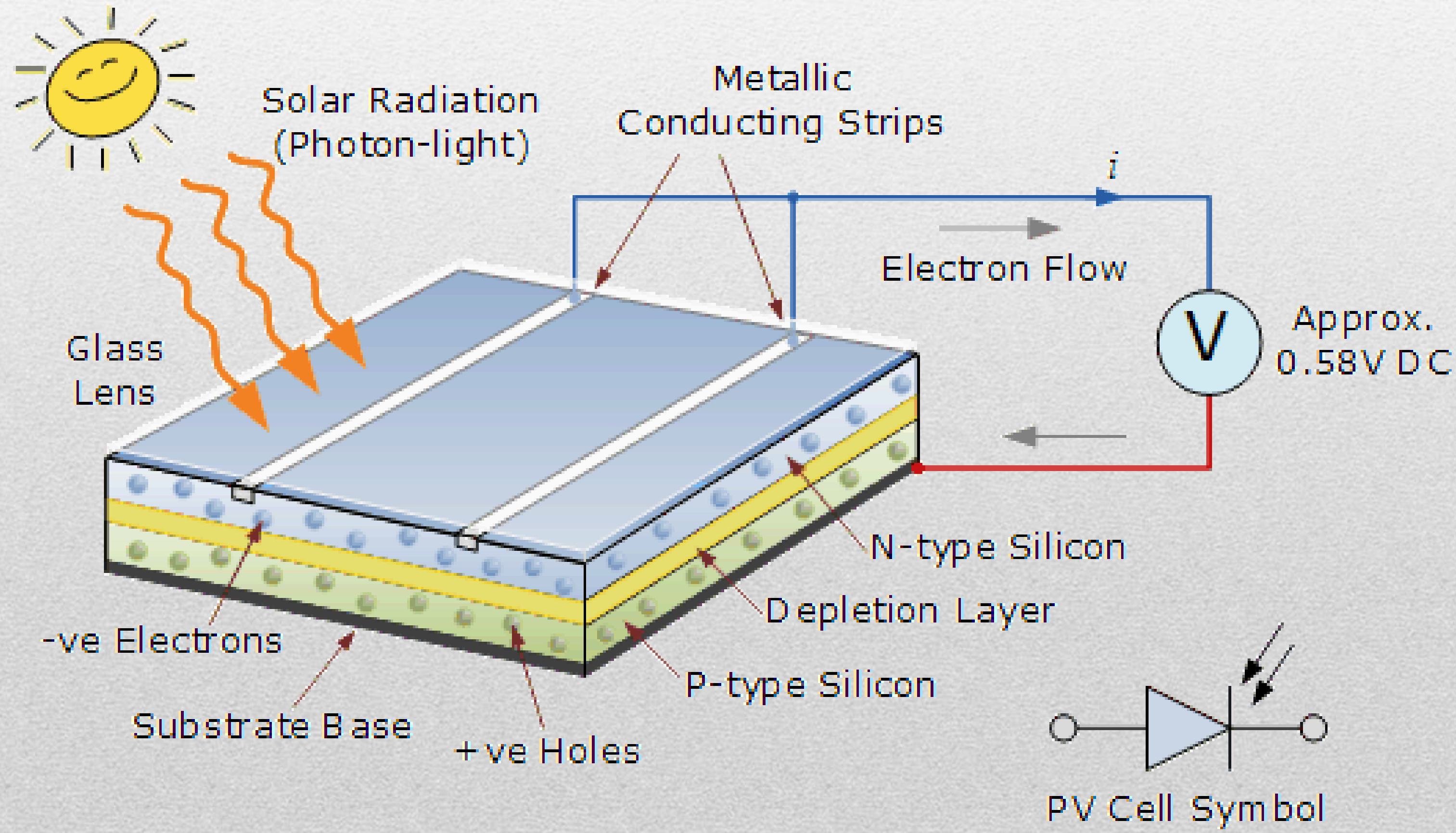
PLTS 1 kWp, Gd. Nanizar Zaman Joenoes, UNAIR, Surabaya (2020)

Tenaga Surya



Tenaga Surya (Sel surya)



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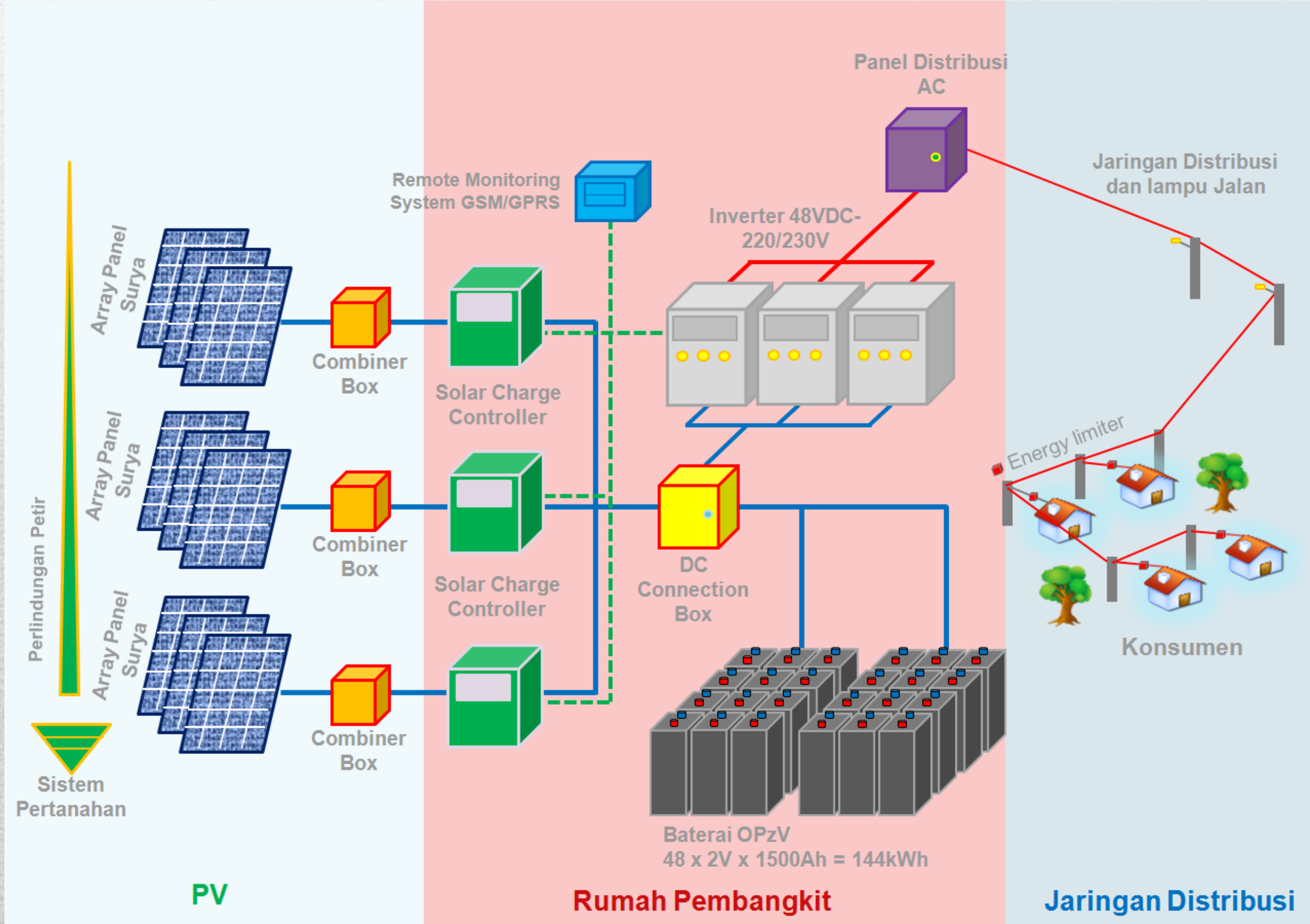
Tenaga Surya (DC Bus)



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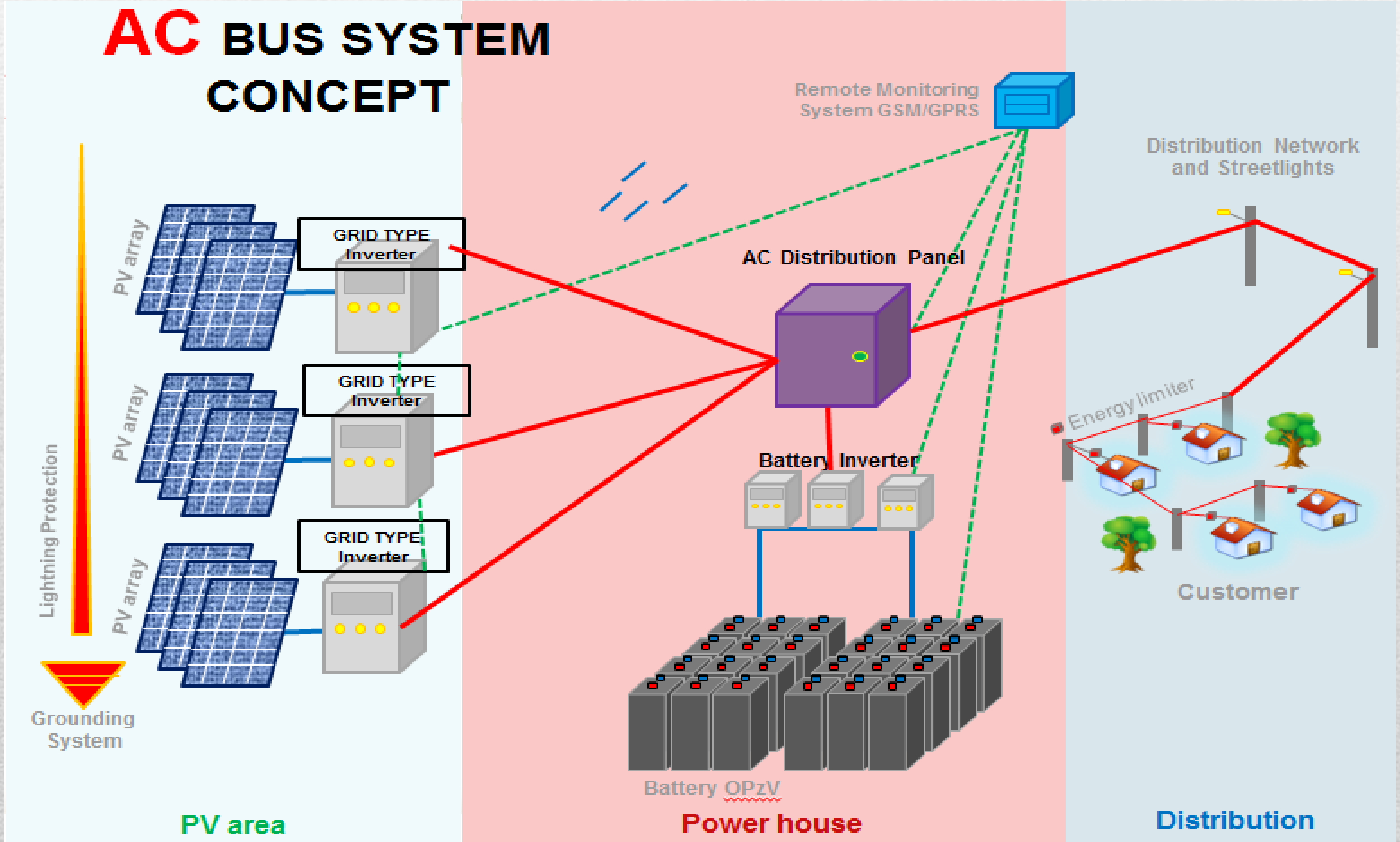
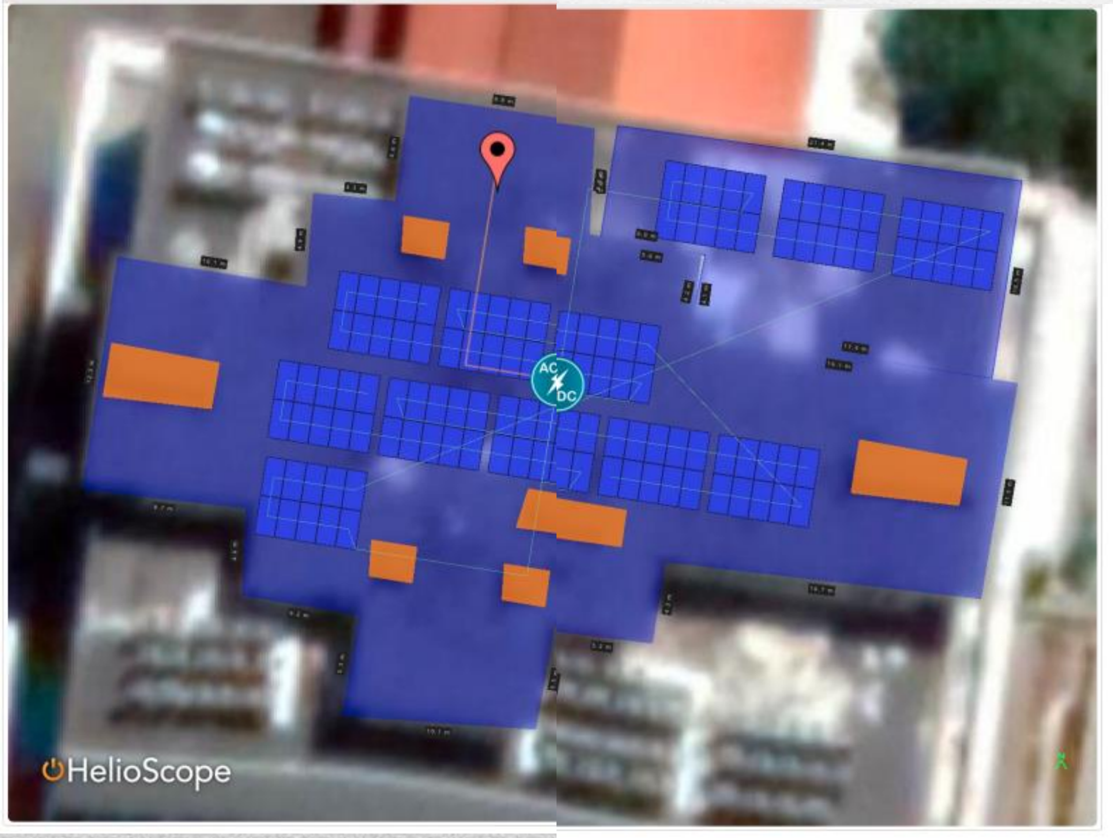
Tenaga Surya (AC Bus)



Simulasi PLTS



PLTS 60 kWp, Gd. Nanizar Zaman Joenoes, UNAIR, Surabaya (2021)

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Simulasi PLTS

PLTS 72 kWp, Gd. GKB, UNAIR, Surabaya (2021)

PVVP SIZING TOOL

PV POWER PLANT

SUMMARY

INPUT KEY		
Electricity Consumers		
Type	Amount	Energy per Day
HOUSEHOLDS	60	63.00 kWh
SOCIAL INSTITUTIONS	4	2.56 kWh
PRODUCTIVE USE OF ENERGY	2	12.20 kWh
Total Energy Consumed per Day		77.76 kWh

Total Energy Generated per Day	113.40 kWh
Total Energy Stored per Day	85.05 kWh

Cost Estimation (Rp)		Other Currency
Components		14000
PV Modules	1,000,000,000.00	71428.57
Controllers	36,000,000.00	2571.43
Energy Storage	873,600,000.00	62400.00
DC/AC Converters	560,000,000.00	40000.00
Other devices	250,000,000.00	17857.14
Land	116,580,000.00	8327.14
Transportation	407,940,000.00	29138.57
Labour	271,960,000.00	19425.71
Building	50,000,000	3571.43
total	3,566,080,000.00	254,720

OUTPUT KEY		
PVPP Components		
Type	Amount	Total capacity
PV modules	**200**	**40.00 kWp**
string	8	
module per string	23	
(parallel)	5	
(series)	5	
Charge Controllers	**8**	**40.00 kW**
Batteries	**96**	**230 kWh**
Battery string (parallel)	4	
battery per string (series)	24	
Inverters	**7**	**42.00 kW**
PV Field Area		195.0 m²
Power House Area		38.2 m²
Total Plant Area		**233.2 m²**

Other Costs:	
Transportation	15%
Labour	10%

INPUT DATA FOR SPESIFICATIONS

SOLAR MODULE			
Parameter	Units		Value
Power	Wp		200.00
Vmpp	Volt		38.16
Impp	Ampere		5.26
Dimension		120.0 cm	65.0 cm
Price	:		5,000,000.00

Assumptions for Calculations
1. Overall DC to AC derate factors is 0.75
2. Irradiance level on STC is 1000 W/m²
2. Space between PV string is 50 cm
3. Space between battery string is 50 cm

LOCATION		
Parameter	Units	Value
Irradiance Level	W/m²	630.00
Peak Sun Hours	hours	4.50
System Op. Voltage	Volt	48.00
land price per m²	:	500,000.00

BATTERY			
Parameter	Units		Value
Op. Voltage	Volt		2.00
Capacity	Ah		1200.00
Deep of Discharge	%		80%
Autonomy	Days		3.00
Dimension		20.0 cm	20.0 cm
Price	:		9,100,000.00

CHARGE CONTROLLER		
Parameter	Units	Value
Max. Voltage	Volt	180.00
Max. Current	Ampere	60.00
Rate Power	kWatt	5.00
Price	:	4,500,000.00

INVERTER		
Parameter	Units	Value
Rated Power	kWatt	6.00
Price	:	80,000,000.00

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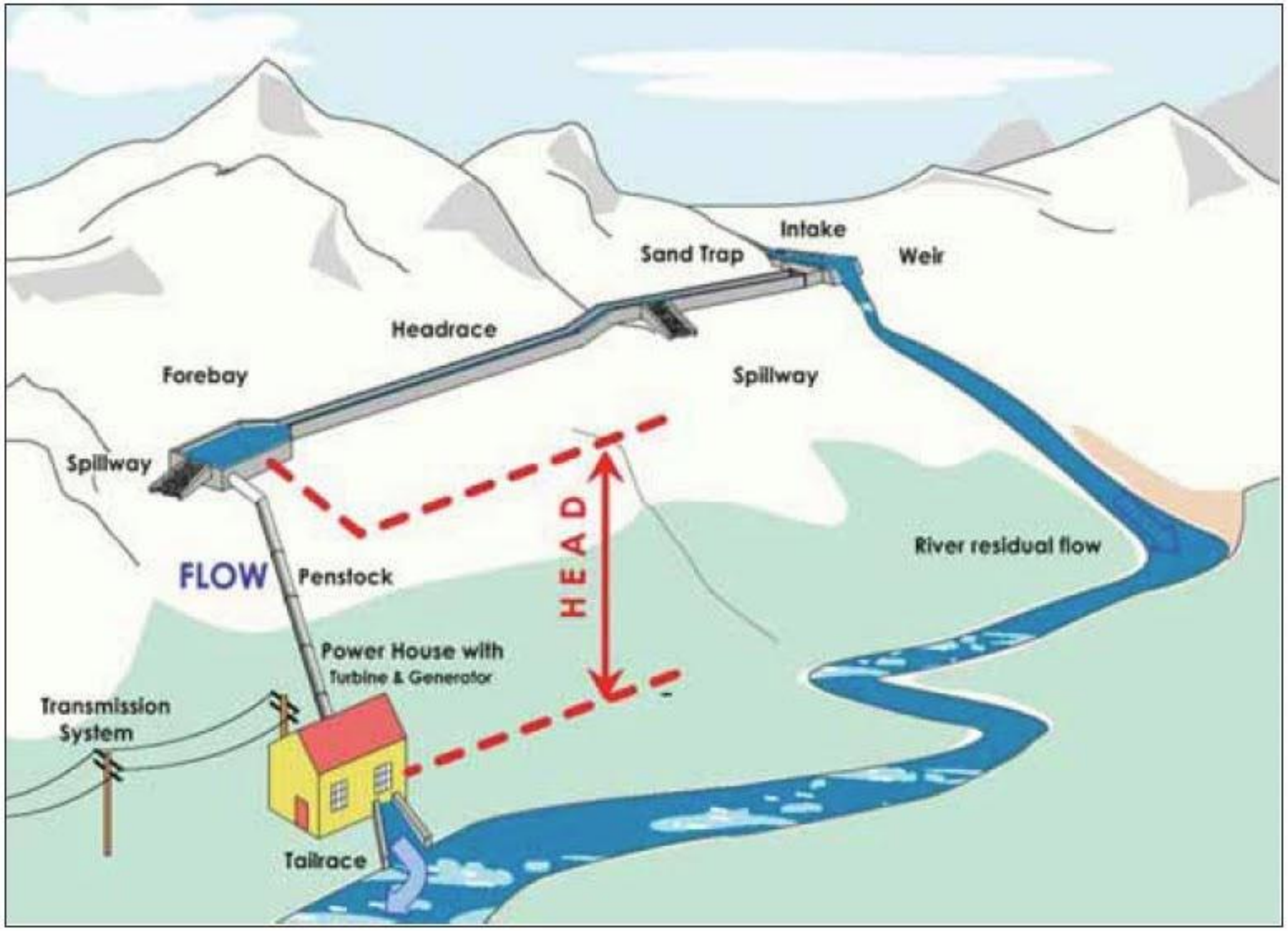
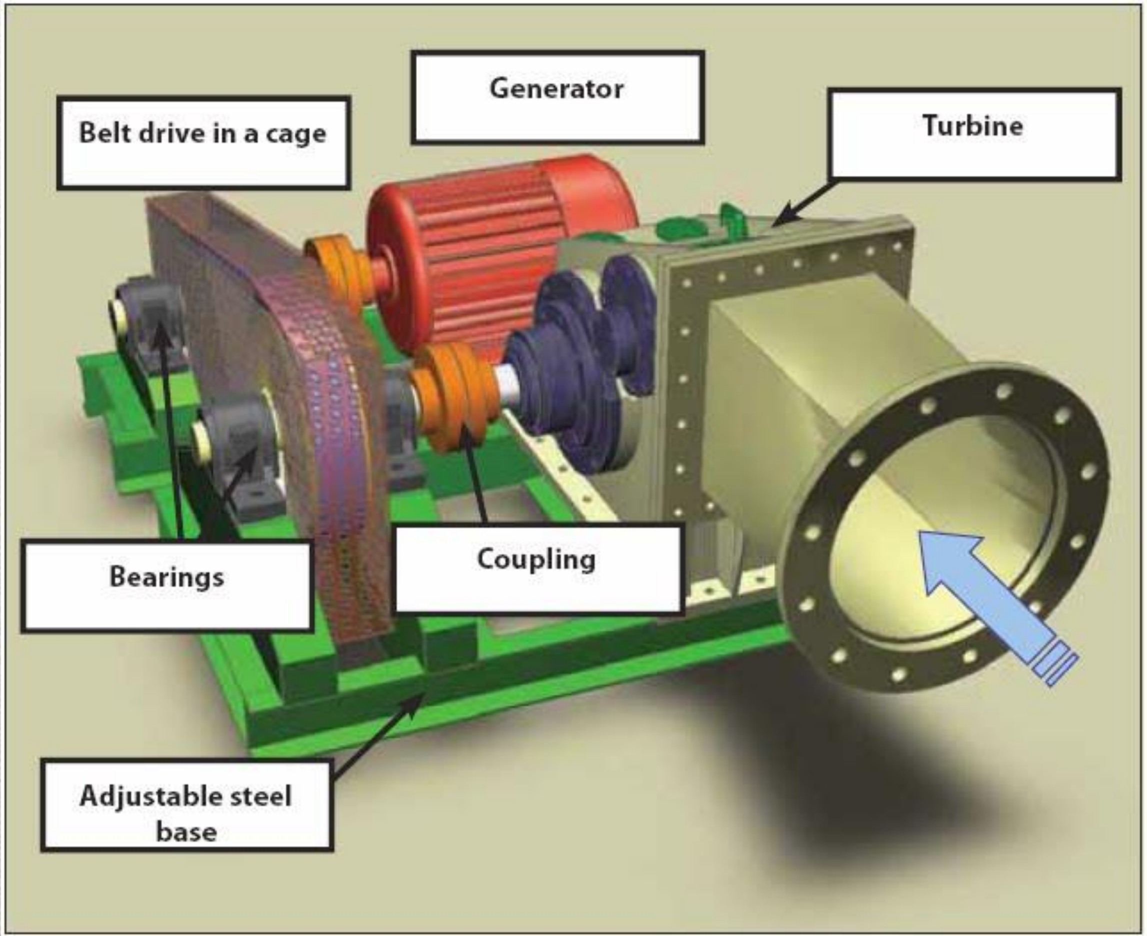
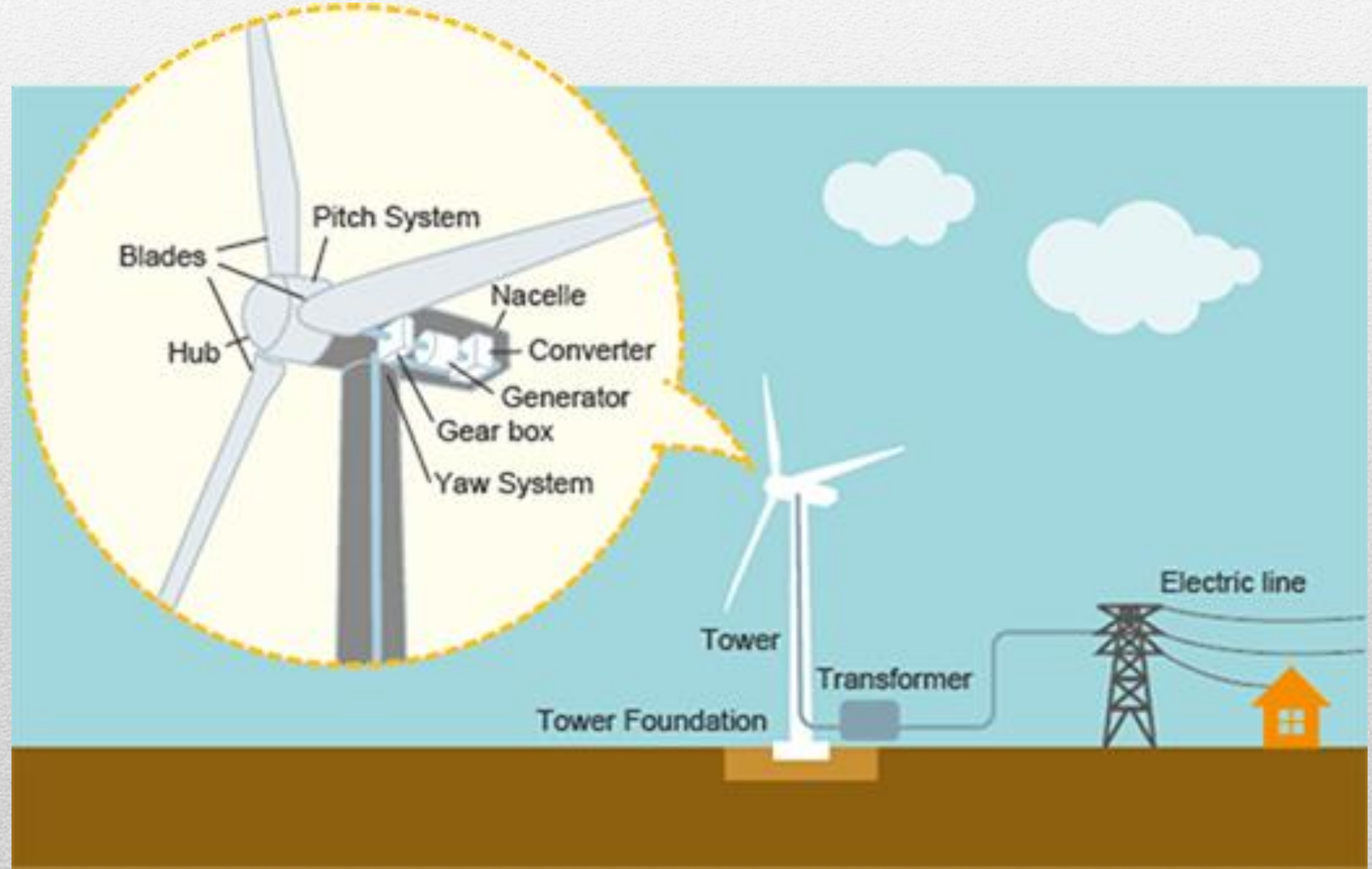


Tenaga Mikro Hidro



Tenaga Bayu/Angin

Tenaga Bayu/Angin



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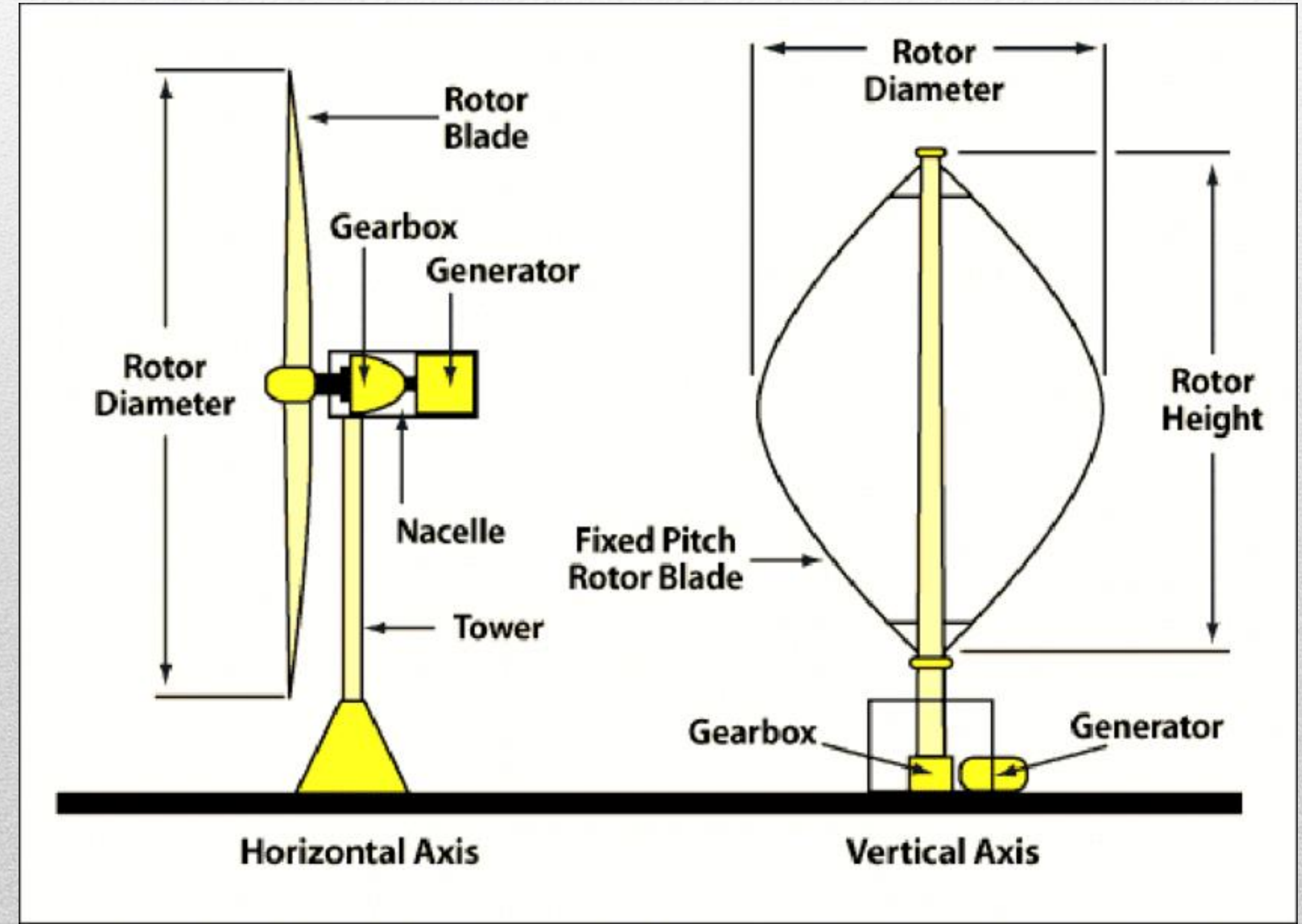
Tenaga Bayu/Angin



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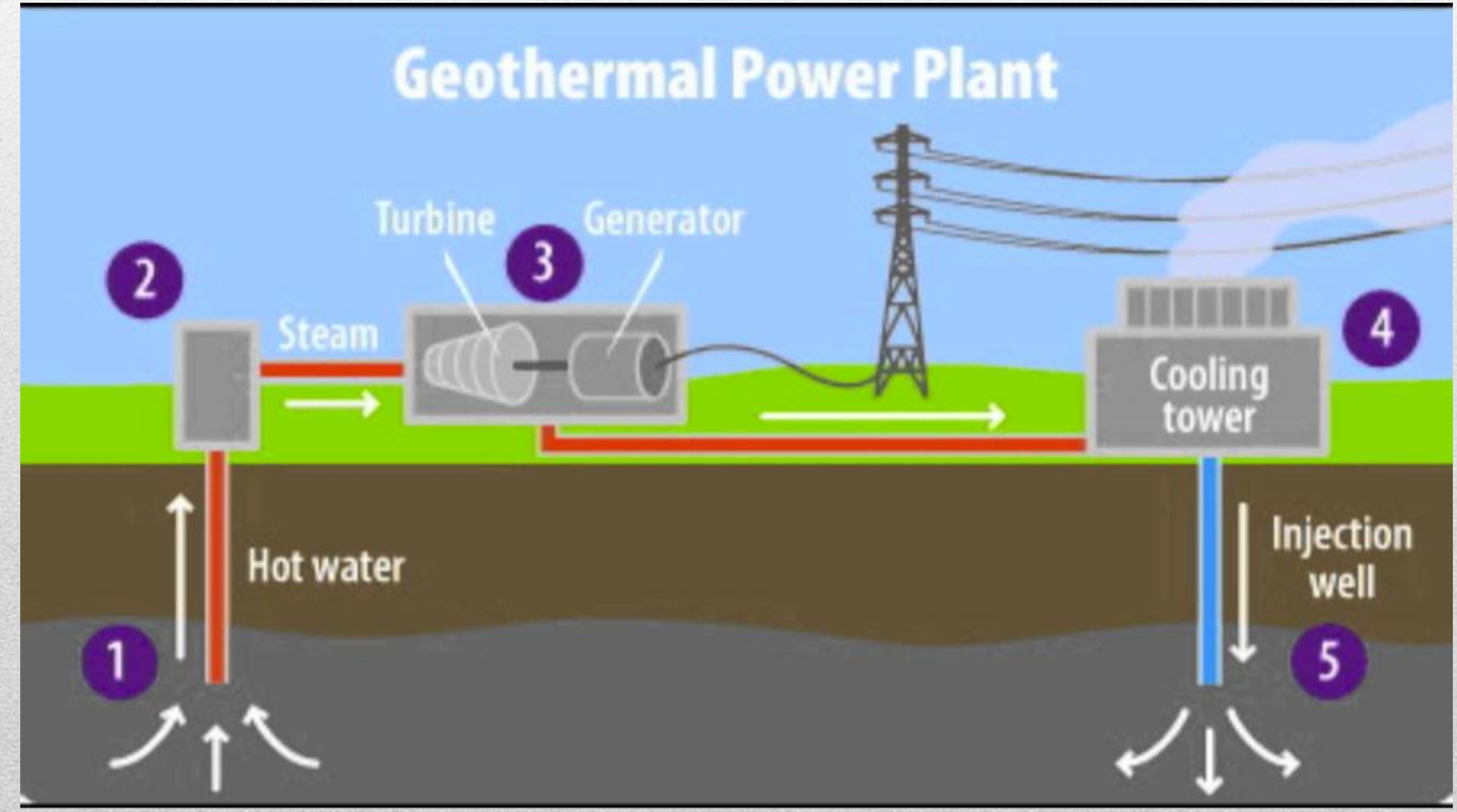
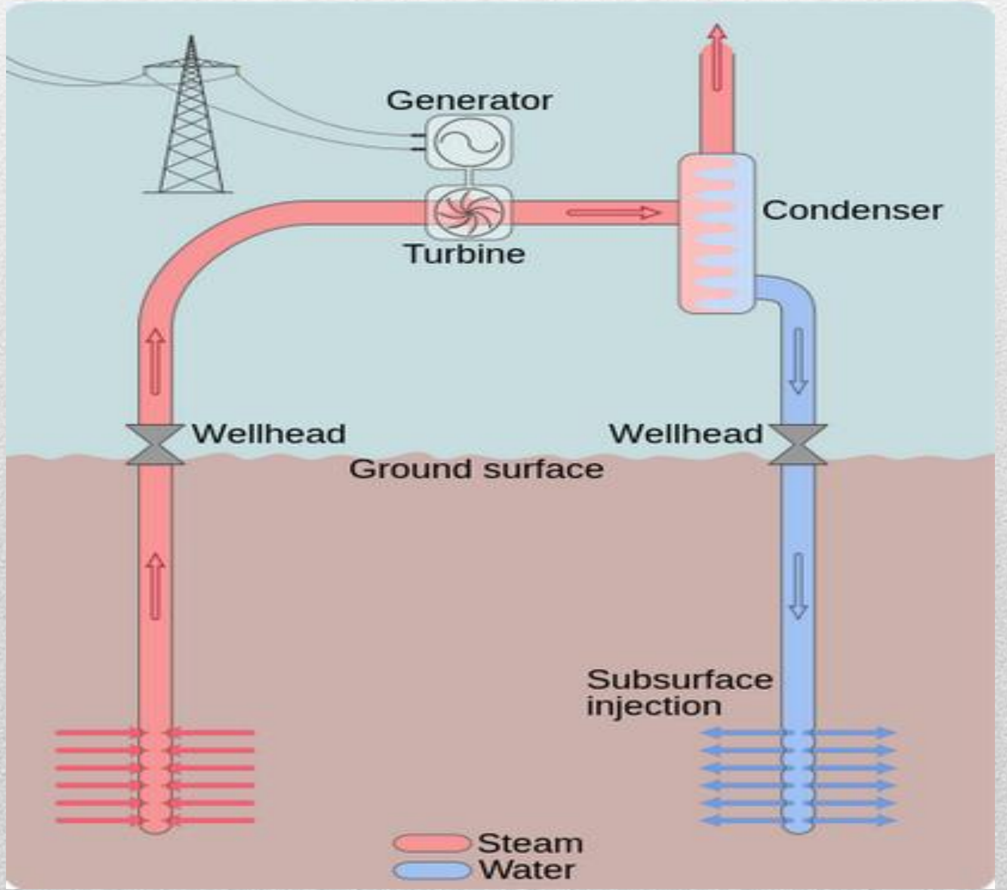
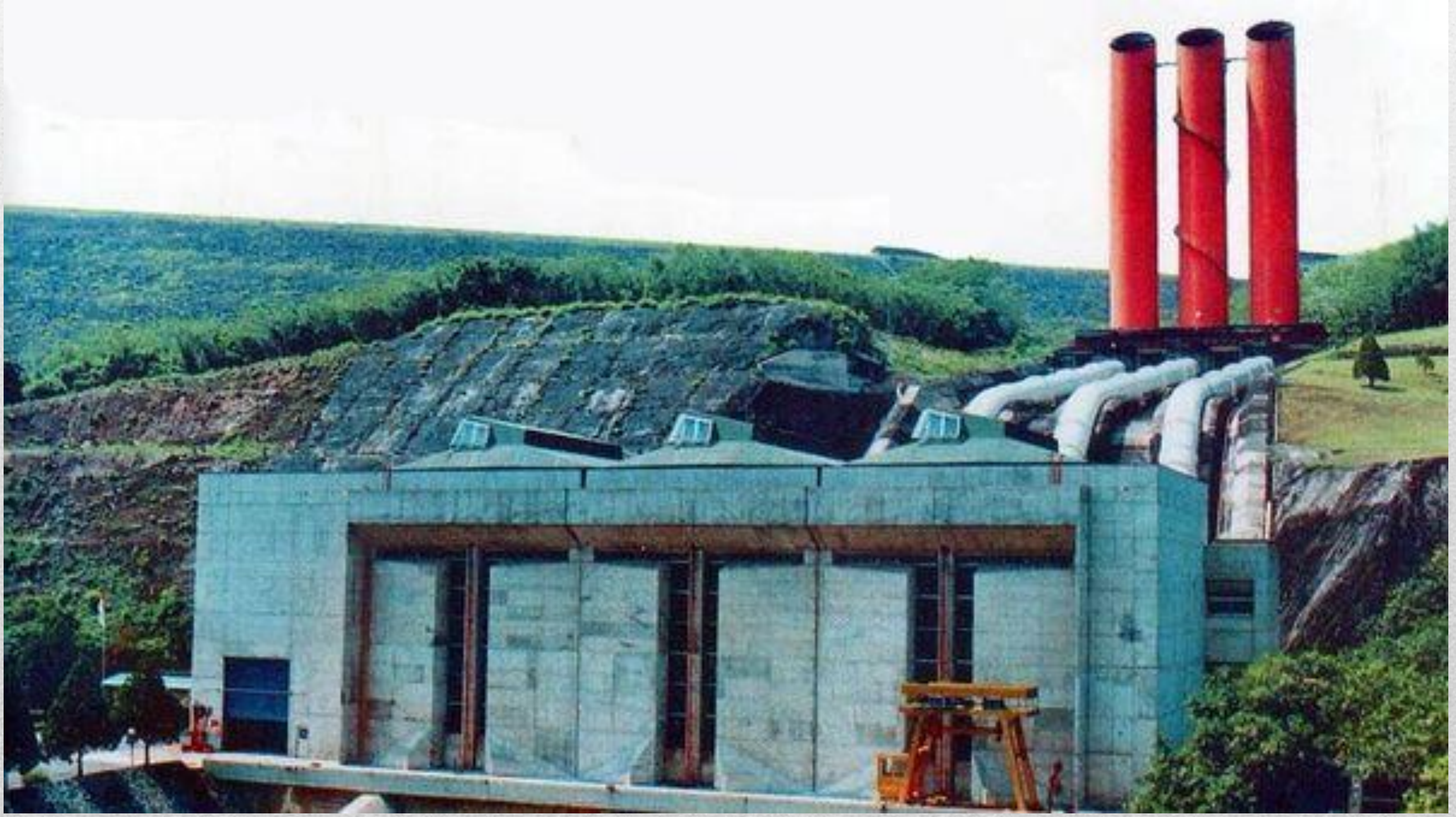
Tenaga Geotermal Uap



Tenaga Geotermal Uap



Tenaga Air



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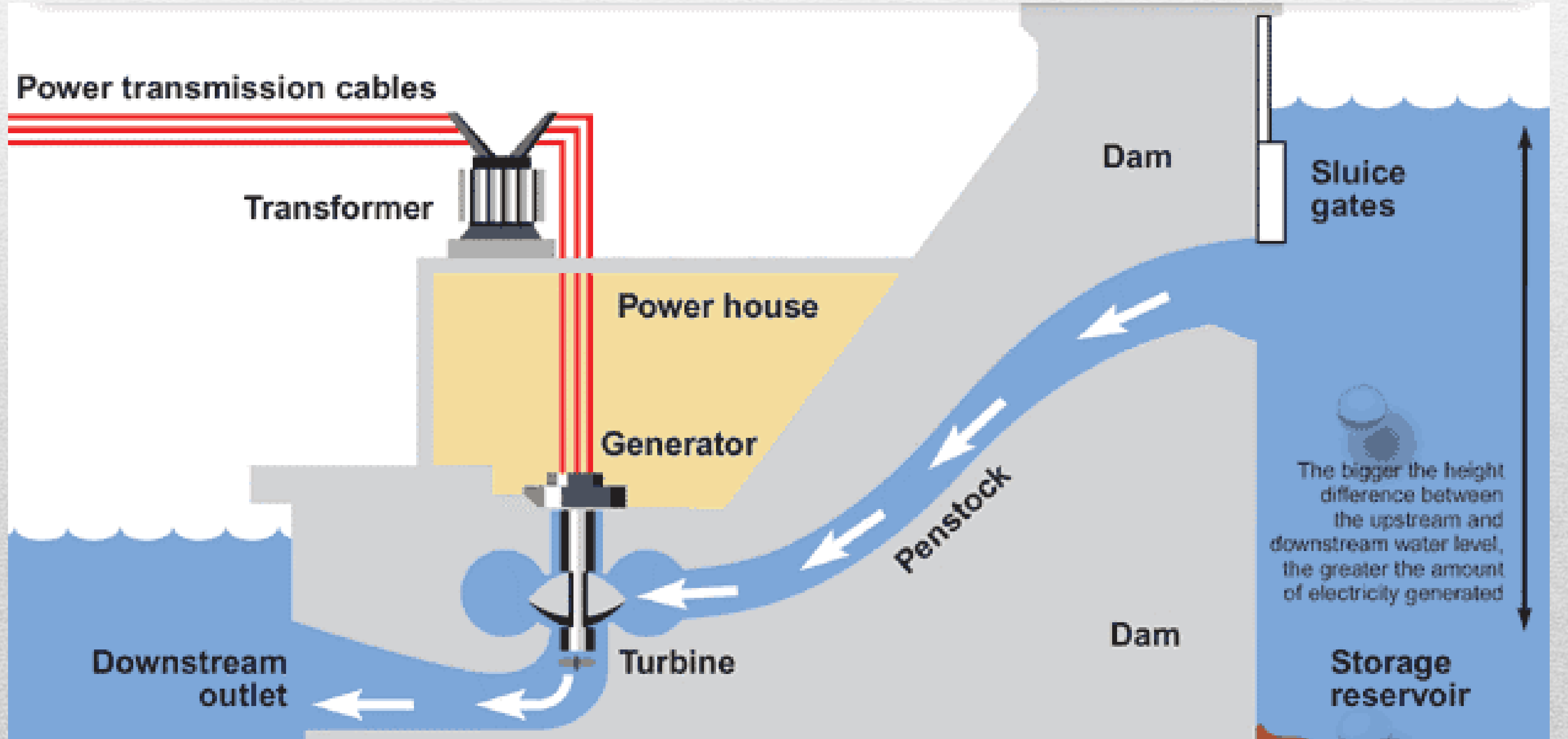

Source: Environment Canada

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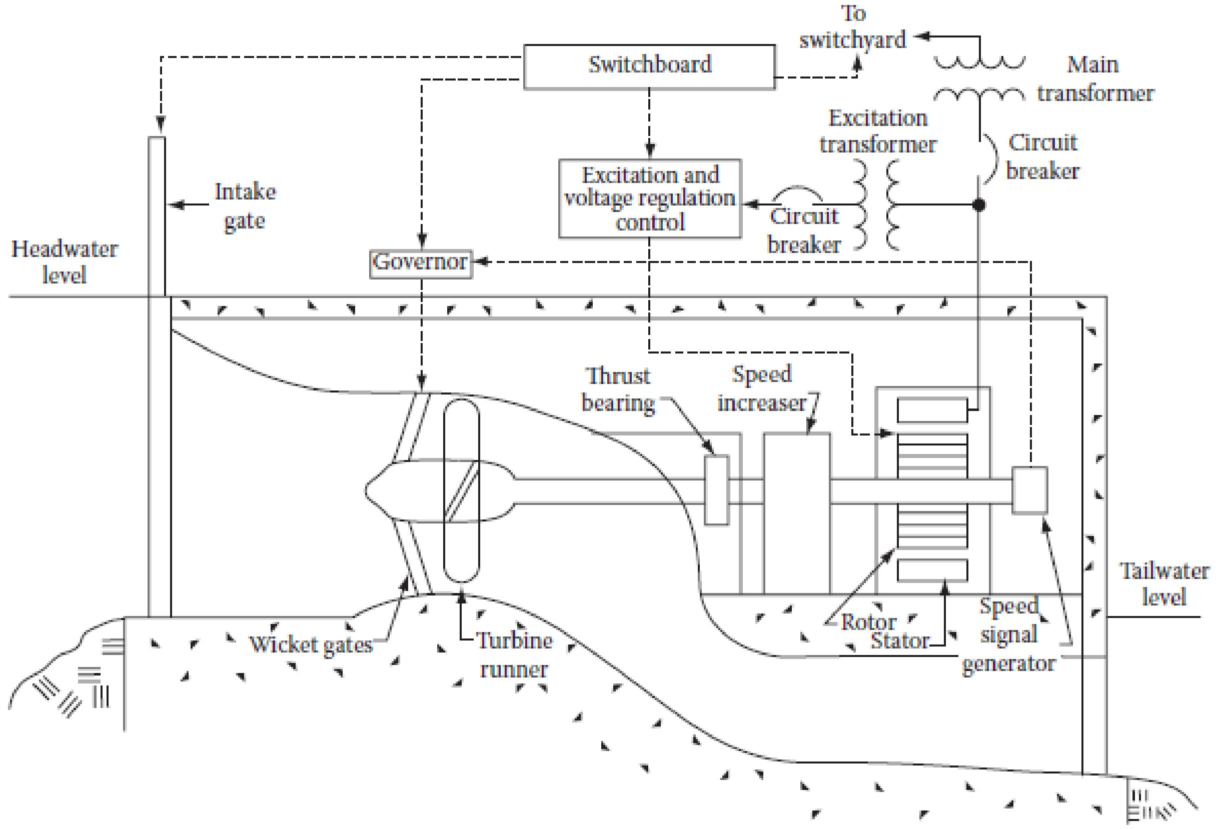

FIGURE 5.2 Horizontal axial-flow unit arrangement. (From IEEE Standard 1020, IEEE Guide for Control of Small Hydroelectric Power Plants.

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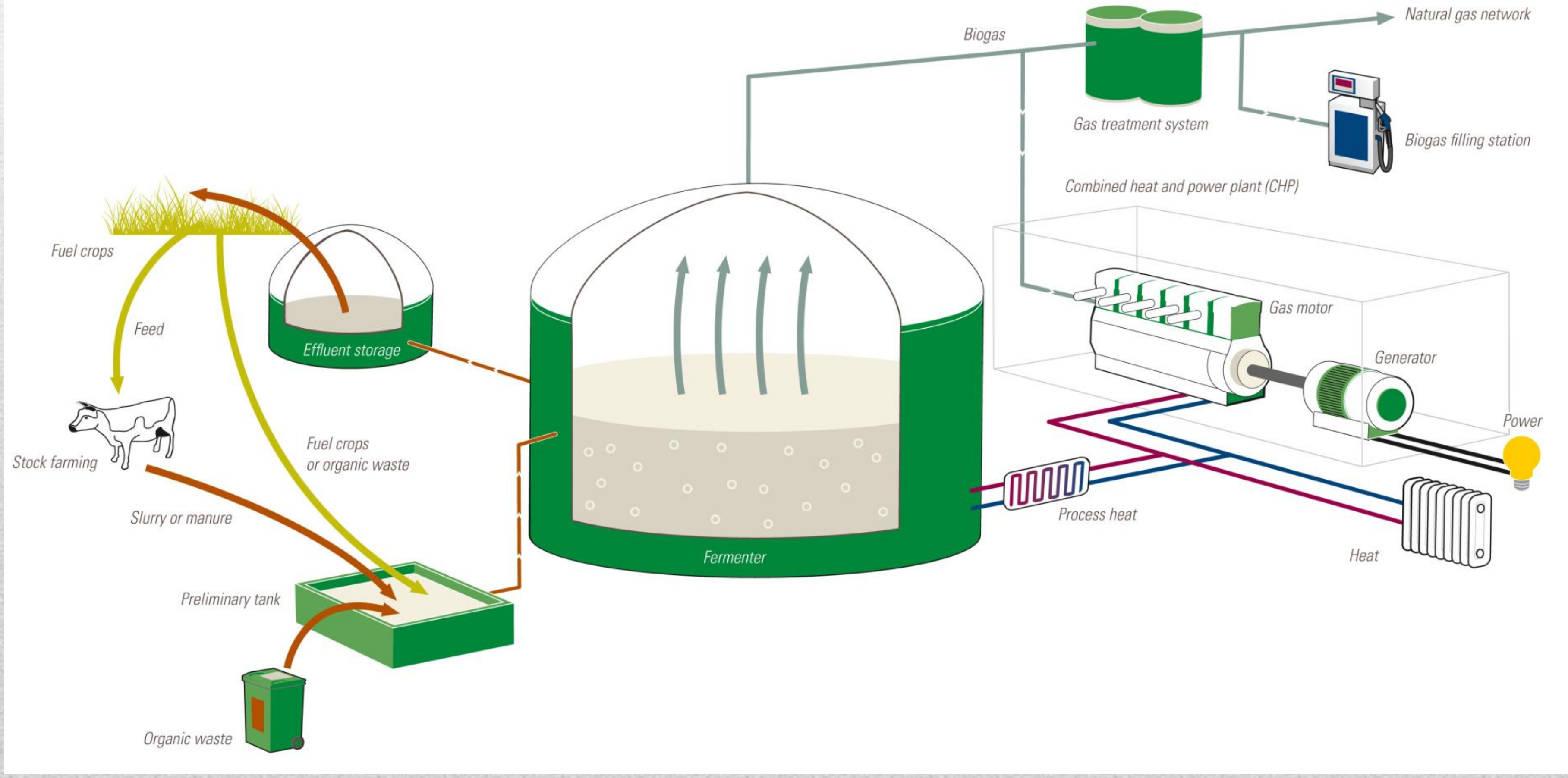


Pertemuan Kedua

GREEN TECHNOLOGY: HISTORY AND CONCEPT

Prodi Teknik Lingkungan
Departemen Biologi
Fakultas Sains dan Teknologi
Universitas Airlangga

INDUSTRIAL REVOLUTION

Industrial Revolution

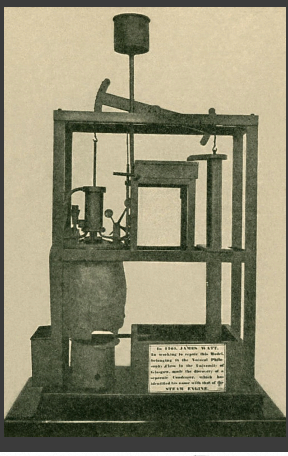
1st Industrial Revolution

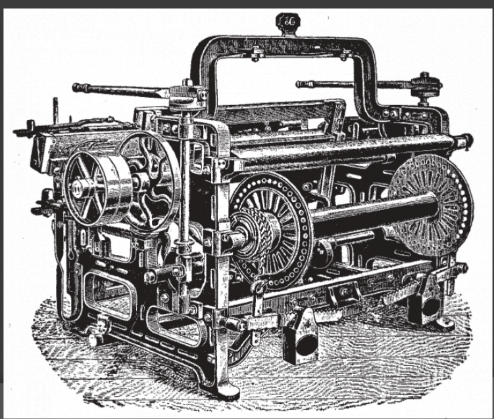
- Began in 18th century (1760-1841)
- The use of **steam power** and **mechanisation of production**
- **Steam power** was already known and it is used for **increasing human productivity**
- Developments such as the **steamship** or (some 100 years later) the **steam-powered locomotive** brought about further massive changes because humans and goods could move great distances in fewer hours.

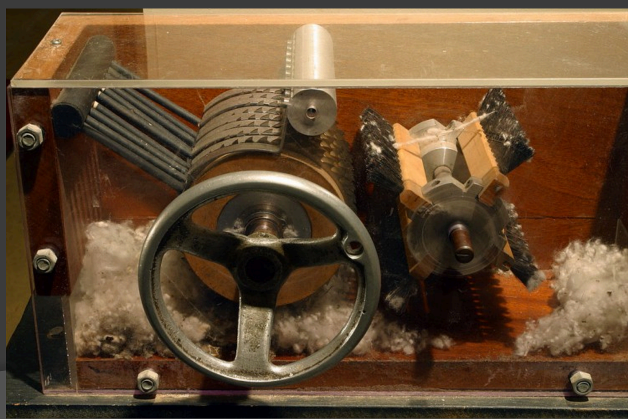
2nd Industrial Revolution

- Began in 19th century
- It was began when **electricity** and **assembly line production** discovered**.**
- **Henry Ford** (1863-1947) took the idea of **mass production** from a slaughterhouse in Chicago: The pigs hung from conveyor belts and each butcher performed only a part of the task of butchering the animal.
- Henry Ford carried over these principles into **automobile production** and drastically altered it in the process.

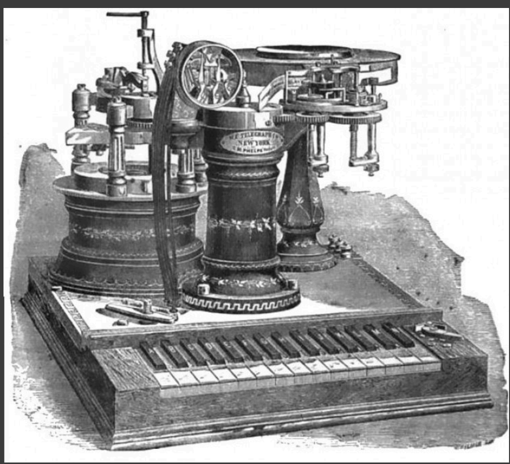
Industrial Revolution (con't)

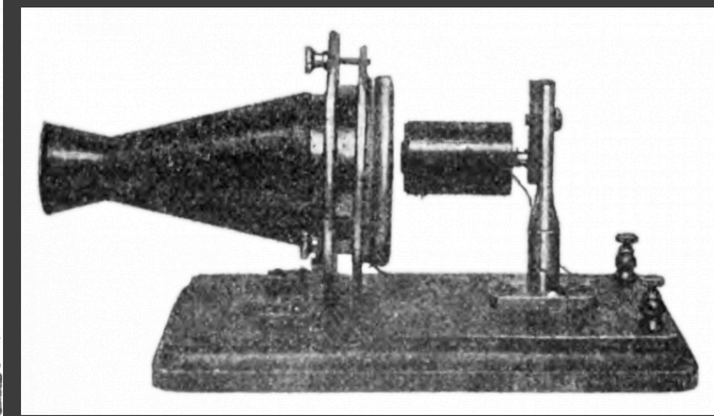






Industrial Revolution (con't)





Industrial Revolution (con't)

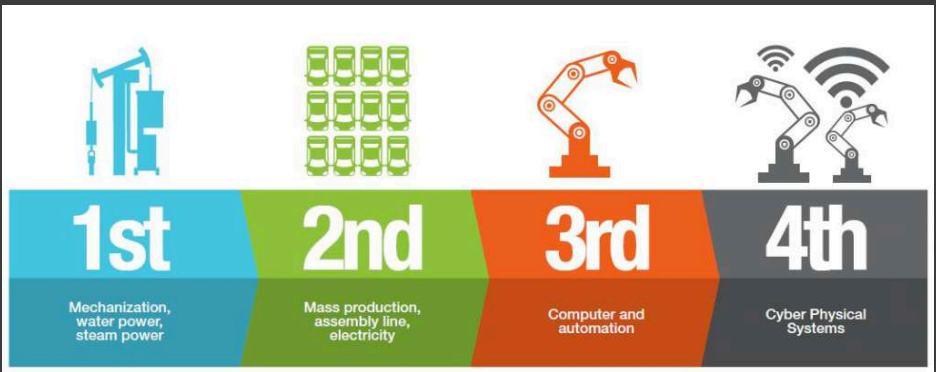
3rd Industrial Revolution

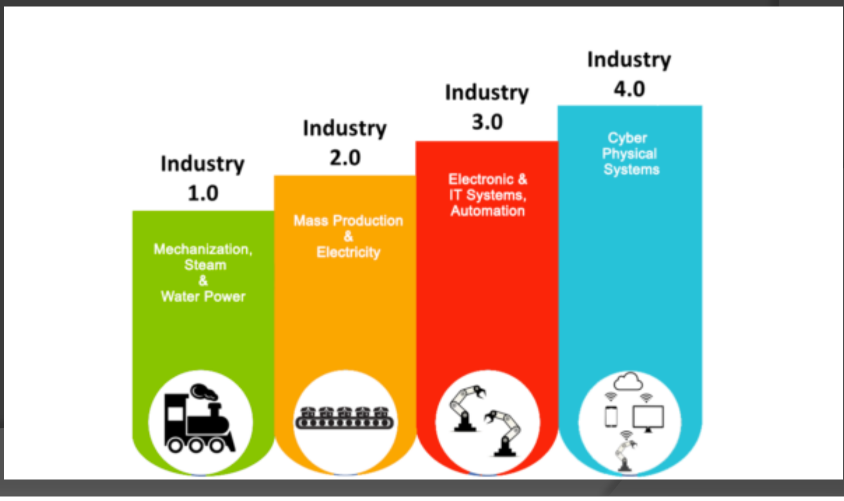
- Began in 1969-20th century
- It was began when the **partial automation** using **memory-programmable controls** and **computers**.
- Known examples of this are **robots** that perform programmed sequences without human intervention.

4th Industrial Revolution

- It builds on the developments of the **Third Industrial Revolution**
- This is characterised by the application of **information** and **communication technologies** to **industry** and is also known as "**Industry 4.0**".

Industrial Revolution (con't)





GREEN TECHNOLOGY

Green Technology...?

A system that uses innovative methods to create an environmental friendly products.

The term environmental technologies is also used to describe a class of electronic devices that can promote sustainable management of resources

Green Technology...? Why...?

Reduce energy usage

- We can minimize the usage of non-renewable energy and conserve it for the future

Increase Human Quality in Life

- Make world to live humans, animals, and other living to live

Lifetime and Property Value

- Green technologies can have long lifetimes due to proper maintains

Kind of Green Technology

Green Chemistry

Green Energy

Green IT

Green Building

Green Nanotechnology

Green Chemistry…

…is the design of chemical products and processes that reduce or eliminate the generation of hazardous substances

Whereas environmental chemistryis the chemistry of the natural environment, and of pollutant chemicals in nature, green chemistry seeks to reduce and prevent pollution at its source

While no reaction is perfectly green,therefore there are 12 principles are implemented

Green Chemistry: The principles

Green Chemistry: The Goals

- To reduce adverse environmental impact, try appropriate and innovative choice of material & their chemical transformation
- To develop processes based on renewable rather than non-renewable raw materials
- To develop processes that are less prone to obnoxious chemical release, fires & explosion.

Green Chemistry: The Goals (con't)

- To minimize by-products in chemical transformation by redesign of reactions & reaction sequences
- To develop products that are less toxic
- To develop products that degrade more rapidly in the environment than the current products

Green Chemistry: The Goals (con't)

- To reduce the requirements for hazardous persistent solvents & extracts in chemical processes
- To improve energy efficiency by developing low temperature & low pressure processes using new catalysts
- To develop efficient & reliable methods to monitor the processes for better & improved controls

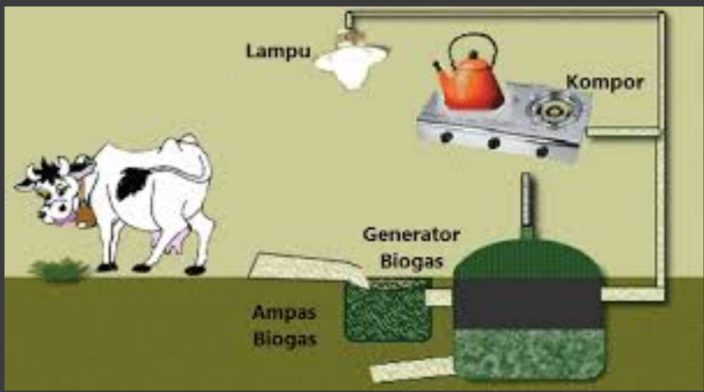
Green Energy

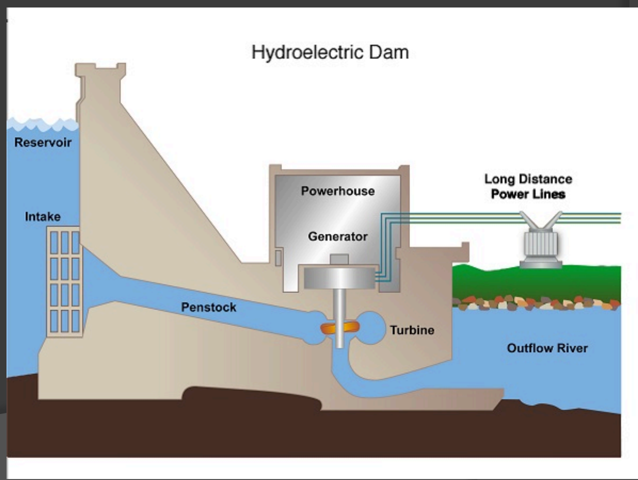
- Green energy comes from natural sources such as sunlight, wind, rain, tides, plants, algae and geothermal heat.
- Green energy provides the highest environmental benefit and includes power produced by solar, wind, geothermal, biogas, low-impact hydroelectric, and certain eligible biomass sources.
- These energy resources are renewable

Green Energy: Kind of..

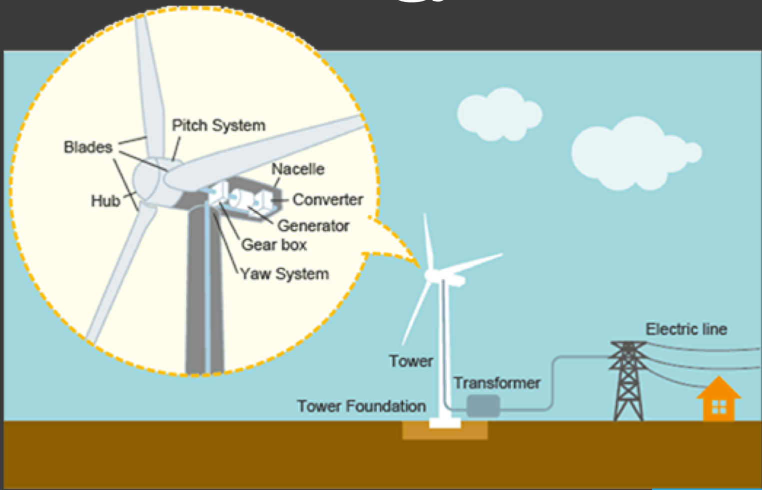
- Biogas
- Biomass
- Hydroelectric
- Wind energy
- Solar energy

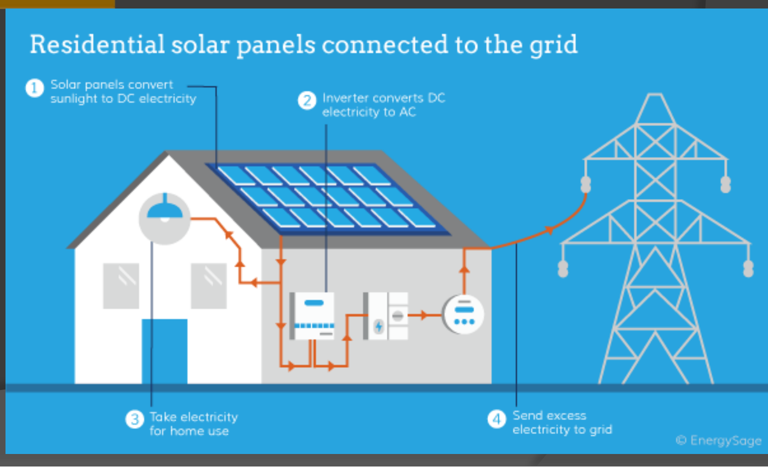
Green Energy: Kind of…





Green Energy: Kind of... (con't)





Green IT...

- It is refers to environmentally sustainable computing or IT.
- It is the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems such as monitors, printers, storage devices, and networking and communications systems efficiently and effectively with minimal or no impact on the environment.

Green IT...? Why?

- IT is 40% of the average corporate electricity bill
- IT Electricity demand from is growing
- Desktops contribute 43% of the IT emissions profile
- Server energy costs to exceed purchase costs on useful life

Green IT...? The Facts...

More energy is consumed by gaming consoles than data centres in Australia

1m tons of electronic waste become obsolete each year

Averages worker prints 1000 pages/month

Average office employee wastes $85 per year on paper and ink from unnecessary printing

To make 1 pc it takes at least 240 kgs of fossil fuels, 22 kgs of chemicals. And over 1500 lts of water

IT vs GHG Emissions

3% GHG emissions from IT sectors

3% emissions from aviation sectors

How...?

Reducing Environmental Waste

- The office can start with the computers of its employees use and how dispose of them.
- Computers become outdated within a few years and need to be replaced regularly to keep office efficiency up.
- office could salvage them for parts needed for hardware repairs or could donate the old computers to families who can make use of them, thus keeping them out of landfills.

Improving Energy Efficiency

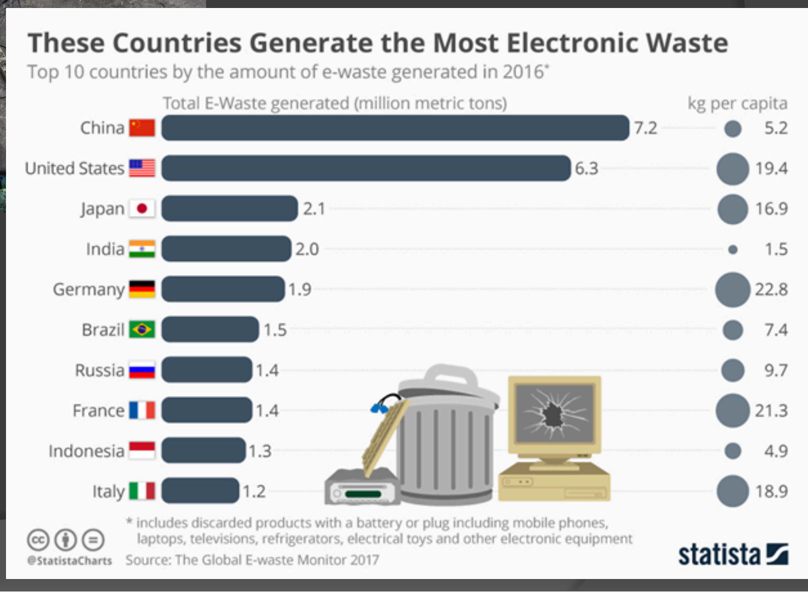
- One great initiative that can help makes the IT department greener while also saving the company money is to encourage better energy consumption
- Many offices leave their computers on at all times, which over one year creates carbon emissions equal to over 2,000 cars on the road for a day.
- By turning off computers at night or when not in use for a long period of time, can save thousands of kilowatts of electricity and dramatically decrease the company's energy bill at the same time

How...?

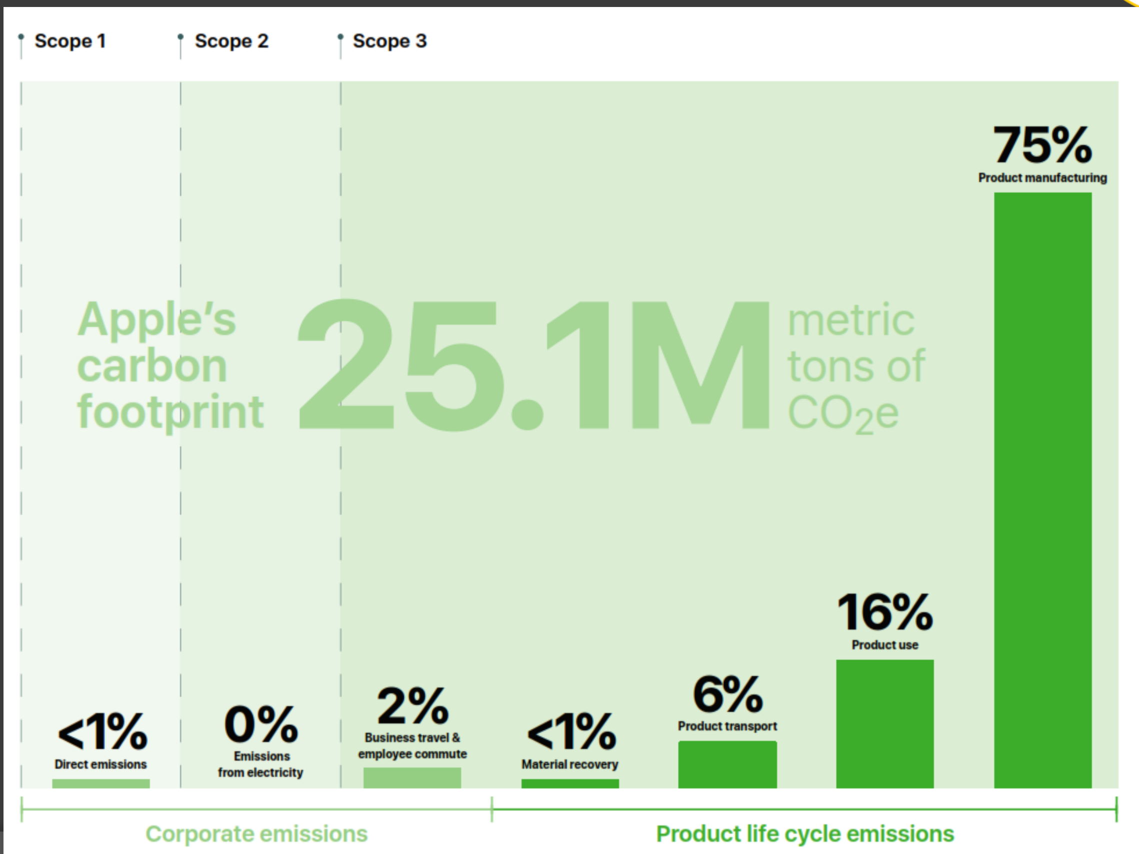
Green IT Purchasing

- Evaluate company needs carefully and determine what technology will help the environment while saving money at the same time.
- When ordering new monitors, choose LCD monitors to use less energy.
- Encourage the use of laptops or tablets over more wasteful desktop models.
- Seek out laser printers and copiers that have effective hibernation modes that leave them powered down when not in use.
- Most importantly, go to a paperless system wherever possible.
- One of the biggest wastes in any office comes from the massive amount of paper needless used on a daily basis.

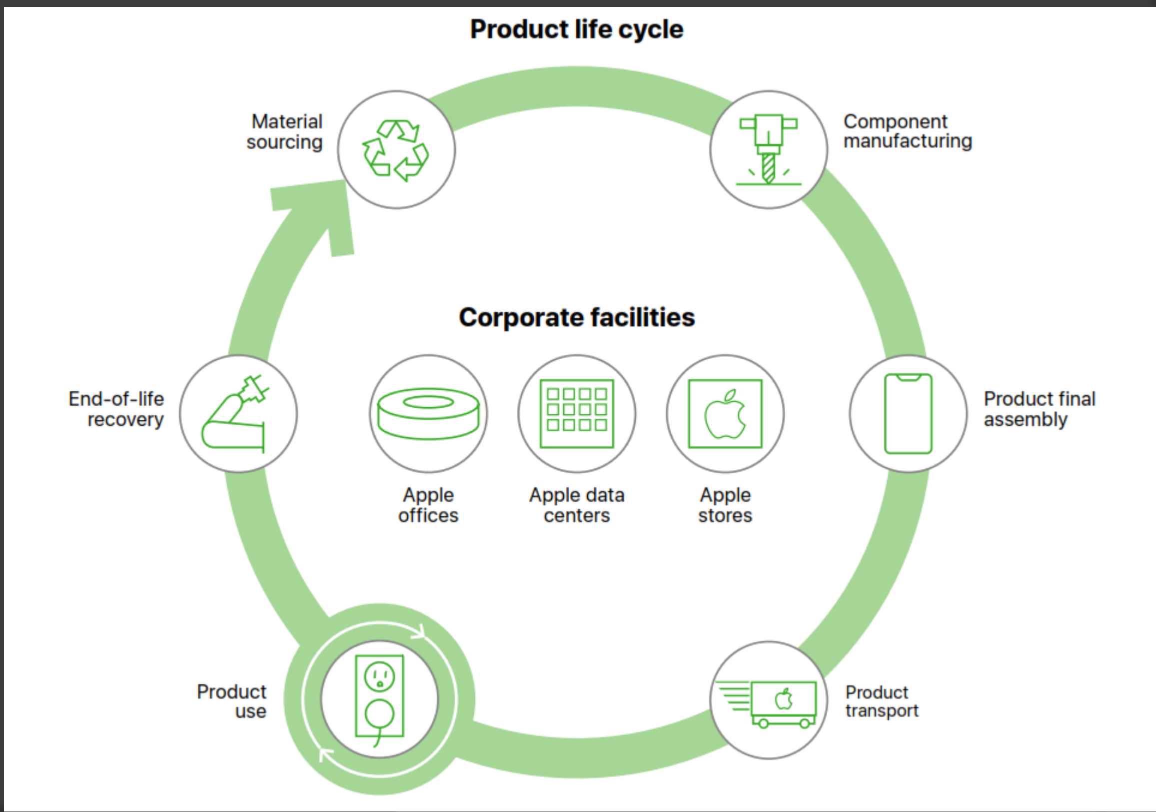
E-waste...


These Countries Generate the Most Electronic Waste
Top 10 countries by the amount of e-waste generated in 2016*
Total E-Waste generated (million metric tons)
kg per capita
China 7.2 5.2
United States 6.3 19.4
Japan 2.1 16.9
India 2.0 1.5
Germany 1.9 22.8
Brazil 1.5 7.4
Russia 1.4 9.7
France 1.4 21.3
Indonesia 1.3 4.9
Italy 1.2 18.9
* includes discarded products with a battery or plug including mobile phones, laptops, televisions, refrigerators, electrical toys and other electronic equipment
@StatistaCharts
Source: The Global E-waste Monitor 2017
statista

Apple's Carbon Footprint



Apple's Product Life Cycle



Green Building

- Green building (also known as green construction or sustainable building) refers to both a structure and the using of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition.

Green Building (con’t): The concept

- These are buildings that ensure that waste is minimized at every stage during the construction and operation of the building, resulting in low costs, according to experts in the technology.
- The techniques associated with the `Green Building' include measures to prevent erosion of soil, rainwater harvesting, use of solar energy, preparation of landscapes to reduce heat, reduction in usage of water, recycling of waste water and use of world class energy efficient practices.

Green Building (con't)

The Structure

- The Design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and its occupants.
- Green Buildings are the Eco-Friendly Structures

The cost

- A green building may cost more up front, but saves through lower operating costs over the life of the building.
- The green building approach applies a project life cycle cost analysis for determining the appropriate up-front expenditure.

Green Building (con’t)

The Concept

- Green Building Technology envision a new approach to save water, energy and material resources in the construction and maintenance of the buildings and can reduce or eliminate the adverse impact of buildings on the environment and occupants.

The Fundamental Objectives

- To conserve natural resources and increase energy efficiency.
- Increasing energy efficiency involves harnessing nature to minimize need for energy for operation and maintenance of the building.

Green Building (con't): The Benefit

Environmental benefits

- Enhance and protect ecosystems
- Improve air and water quality
- Reduce waste streams
- Conserve and restore natural resources

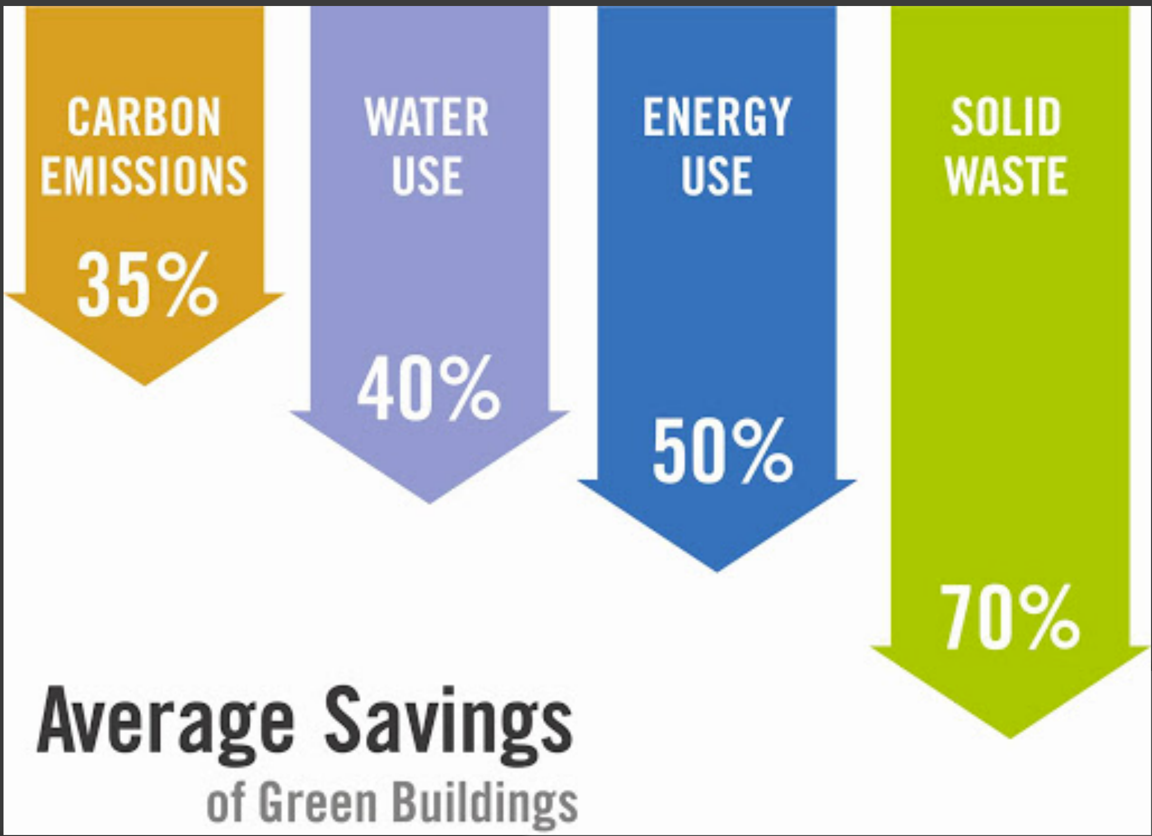
Social benefits

- Enhance occupant comfort and health
- Heighten aesthetic qualities
- Minimize strain on local infrastructure
- Improve overall quality of life

Economic benefits

- Reduce operating costs
- Improve occupant productivity
- Optimize life-cycle economic performance

Green Building (con't): The Benefit



Green Building

Green Nanotechnology...?

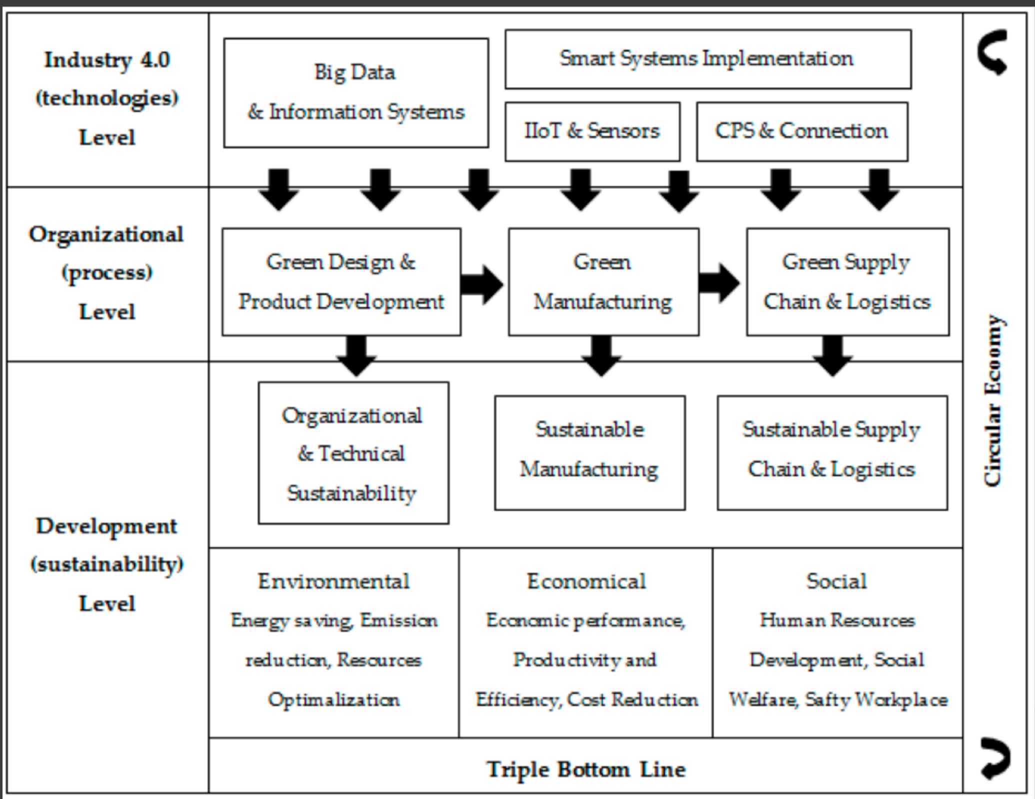
- How nanotechnology can benefit the environment, such as by using less energy during the manufacturing process, the ability to recycle products after use, and using eco-friendly materials.

Green Nanotechnology...?Why?

- Nanoparticles could also be used to remove industrial pollutants in contaminated air, soil, and groundwater, and nano filters might be used to purify water and to desalinate water at an affordable cost.
- The technology could also be used to turn garbage into breakfast by mimicking how nature turns wastes into plant nutrients, thus following the nutrient cycling principle of sustainability.

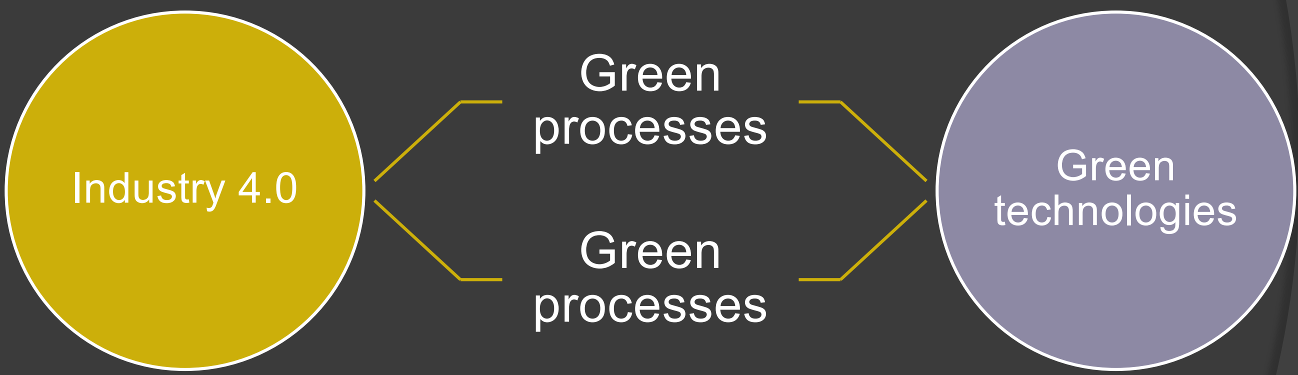
INDUSTRY 4.0 VS GREEN TECHNOLOGY

Green technologies as a key component of Industry 4.0



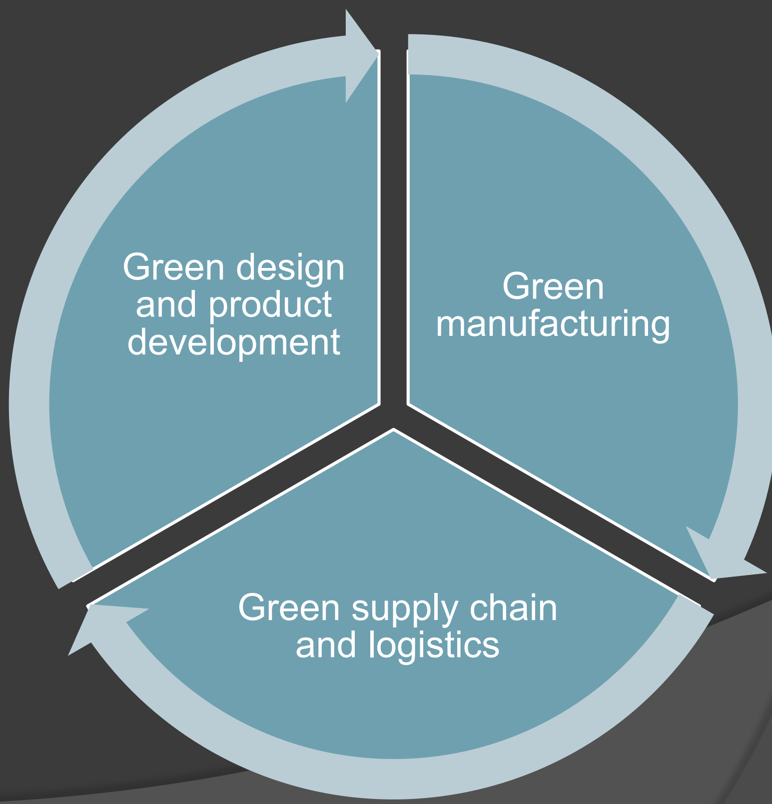
Sustainability
Green
Industry 4.0

Green technologies as a key component of Industry 4.0 (con't)



Green technologies as a key component of Industry 4.0 (con't)

Green processes consists of:



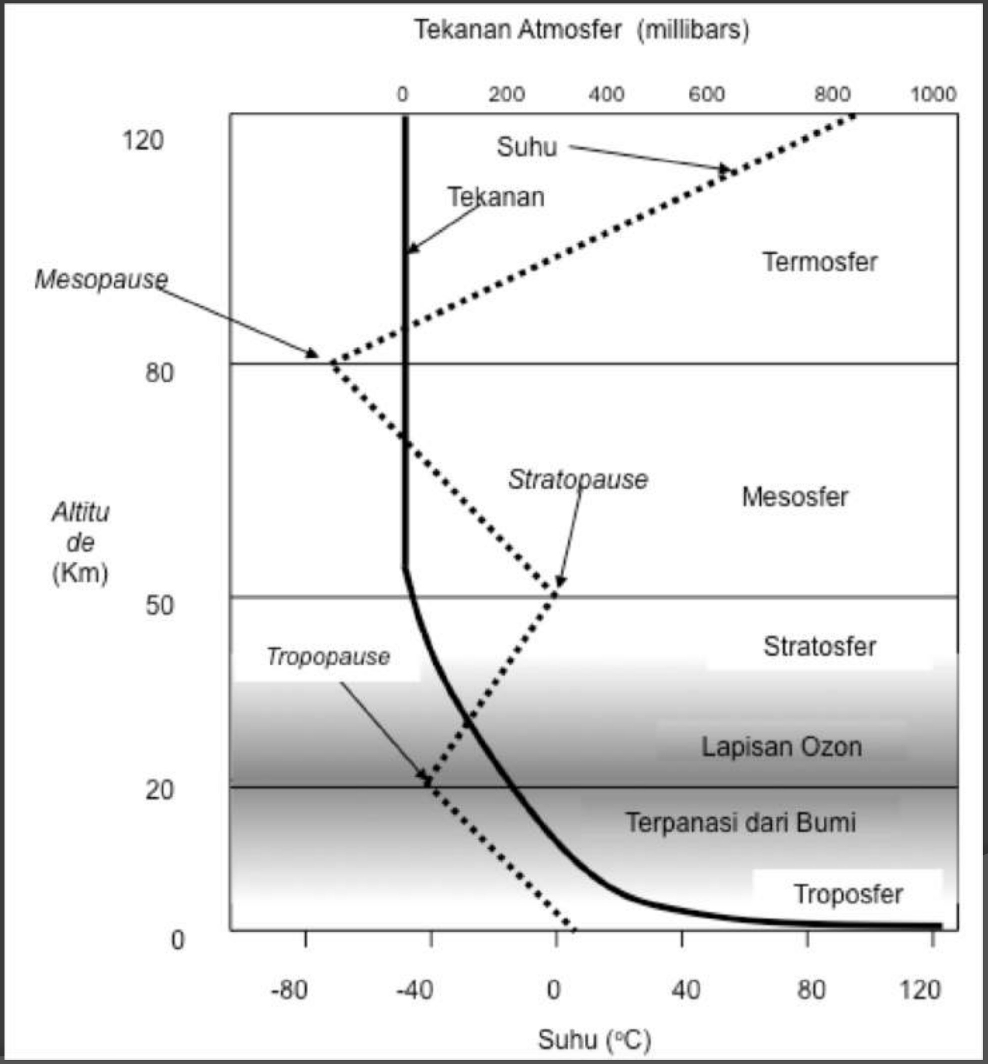
TERIMA KASIH

Pertemuan Kesembilan

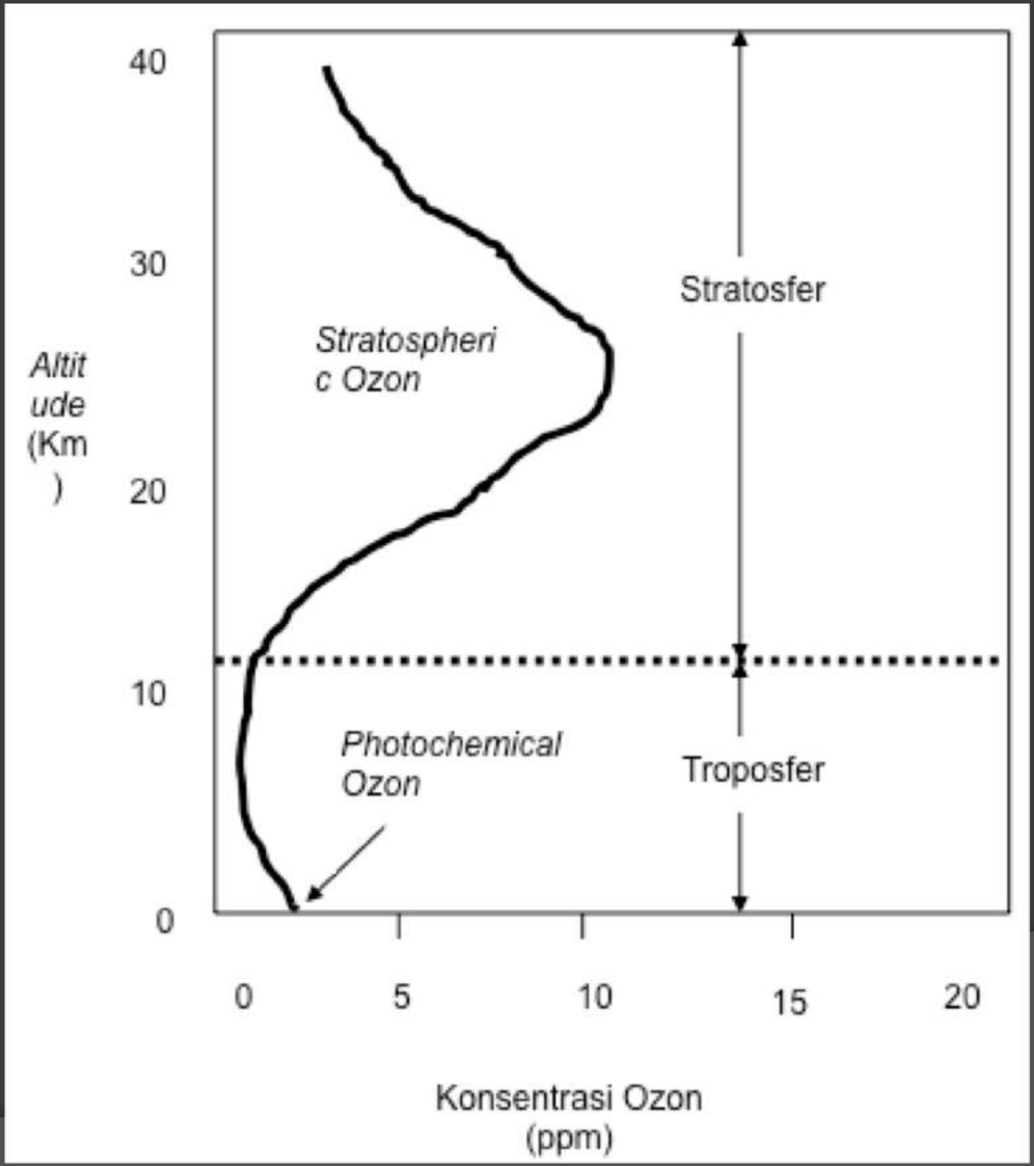
PENCEMARAN UDARA DAN PERUBAHAN IKLIM

Fakultas Sains dan Teknologi
Universitas Airlangga

Atmosfer Bumi



Konsentrasi distribusi ozon



UV...?

- Radiasi UV memiliki panjang gelombang antara sinar X dan cahaya tampak.
- Ultraviolet→karena frekuensinya lebih tinggi dari sinar ungu (violet).

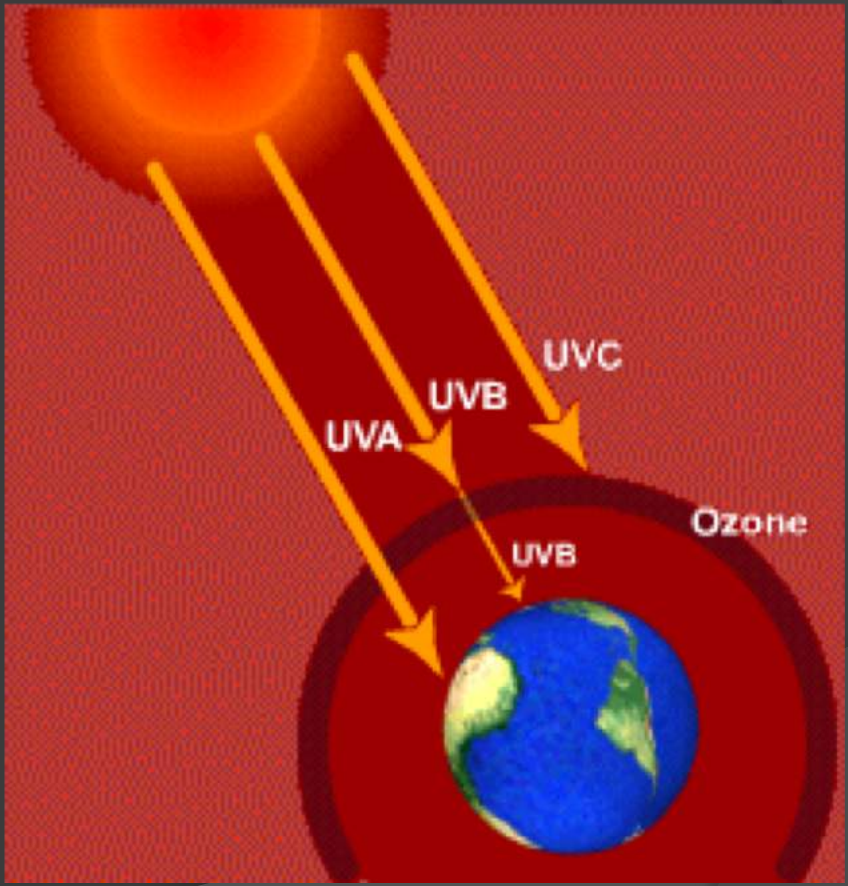
UV…? (con't)

UV

UV A (400-320 nm)

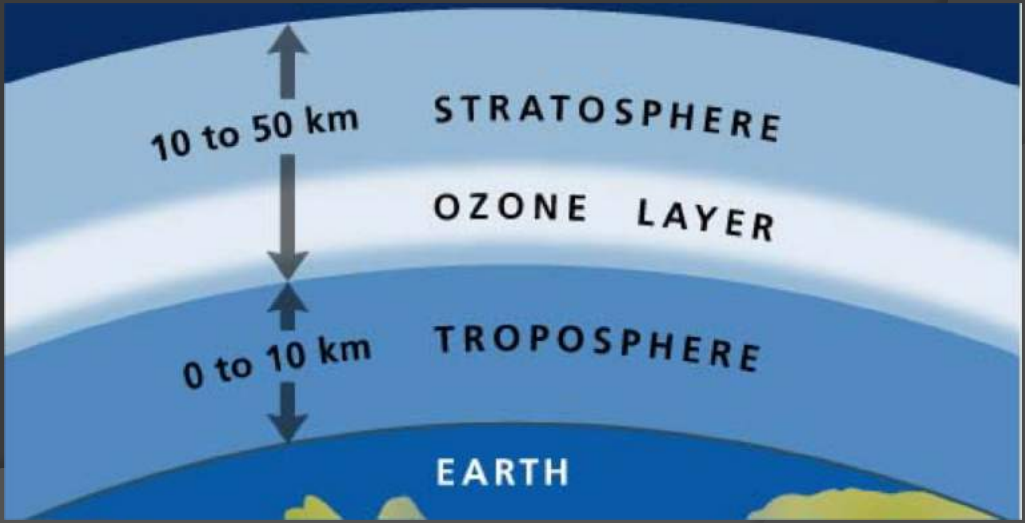
UV B (320-290 nm)

UV C (290-100 nm)



Lapisan ozon...?

- Lapisan atm pada ketinggian 20-35 km diatas permukaan bumi yang mengandung molekul-molekul
- Konsentrasi ozon→ mencapai 10 ppm→ UV matahari dan O2.



Lapisan ozon...? (con’t)

- Mengatur jumlah sinar UV yang masuk ke permukaan bumi
- Menjaga suhu bumi tetap stabil
- Melindungi permukaan bumi dari benda-benda langit yang jatuh.

Kelas utama bahan pencemar udara

Kelas	Contoh
Carbon oxides	*Carbon monoxide* (CO), *Cabon dioxide* (CO_2)
Sulfur oxides	*Sulfur dioxide* (SO_2), *Sulfur trioxide* (SO_3)
Nitrogen oxides	*Nitric oxide* (NO), nitrogen dioksida (NO_2), *nitrous oxide* (N_2O) (NO dan NO_2 sering tergabung bersama dan diberi label NOx
Volatile Organic Compound (VOCs)	*Methane* (CH_4), *propane* (C_3H_8), *chlorofluorocarbons* (CFCs)
Suspended particulate matter (SPM)	Partikel padat (debu, jelaga, asbestos, timbal, nitrat dan garam sulfat), butiran air (asam sulfat, PCBs, dioxines dan pestisida)
Photochemical oxidants	Ozon (O_3), *peroxyacyl nitrates* (PANs), *hydrogen peroxide* (H_2O_2)
Radioactive substances	Radon-222, iodine-131, strontium-90, plutonium-239
Hazardous air pollutants (HAPs), yang dapat menyebabkan gangguan kesehatan seperti kanker, gangguan sistem saraf dan cacat kelahiran	*Carbon tetrachloride* (CCl_4), *methyl chloride* (CH_3Cl), *chloroform* ($CHCl_3$), *benzene* (C_6H_6), *etylene dibromide* ($C_2H_2Br_2$), *formaldehyde* (CH_2O_2).

Wujud fisik pencemaran udara

Mist (kabut)	• Partikel cair yang berada di udara (cairan terdispersi/buih)
Fog	• Kabut yang padat/tebal • Masih dapat dilihat dengan mata
Smog (asap)	• Partikel karbon yg padat akibat pembakaran yg tdk sempurna
Fume	• Partikel padat yg terjadi karena kondensasi dari penguapan logam-logam cair, oksidasi di udara

Wujud fisik pencemaran udara (con't)

Wujud fisik pencemaran udara (con’t)

Wujud kimia pencemar udara

Pencemar udara

- Gas/uap
- Partikel (debu mineral/debu organik)

- Contoh: silika, asbes

Wujud kimia pencemar udara

- Pencemar udara
  - Gas/uap
  - Partikel (debu mineral/debu organik)

- Contoh: silika, asbes

Bentuk khusus partikel

Dust (debu)

- Ukuran kecil dan padat
- Merupakan pecahan dari bahan yang lebih besar melalui proses ‘Crushing’; ‘Grinding’; ‘blasting’. Contoh : semen, tepung
- Ukuran 1-10 000 μm

Smoke (asap)

- Halus dan padat
- Hasil pembakaran tidak sempurna dari partikel organik
- Terdiri dari karbon dan bahan terbakar lainnya
- Ukuran : 0,5 - 1μm

Bahan cemaran udara

Fumes (uap/asap)

- Keadaan gas dari zat padat volatil atau cairan
- Halus dan padat
- Banyak terdiri dari oksida logam: seng, timbal
- Terbentuk dari kondensasi uap bahan padat
- Proses-proses yang menghasilkan fumes: Sublimasi, Distilasi, peleburan logam
- Ukuran 0,03- 0,3 μm

Fly ash

- Berasal dari sisa/proses pembakaran
- Partikel yang tidak dapat terbakar
- Inorganik material
- Ukurannya : 1 – 1000 μm

Bahan cemaran udara

Mist (kabut)

- Merupakan cairan
- Ukuran partikel kurang dari 10 μm
- Pada intensitas tinggi FOG
- Awan yang terdapat di ketinggian yang rendah

Spray

- Hasil atomisasi dari cairan, seperti pestisida, herbisida
- Ukuran 10-1000 μm

Sumber pencemar

- Pencemar
  - Pergerakan
  - Karakteristik sumber pencemar

Sumber pencemar (con’t)

- Pergerakannya

Sumber tetap (stasioner)	Sumber bergerak
• Berasal dari industri, rumah tangga, atau pemukiman	• Berasal dari kendaraan bermotor

Sumber pencemar (con’t)

- Karakteristik sumber pencemar

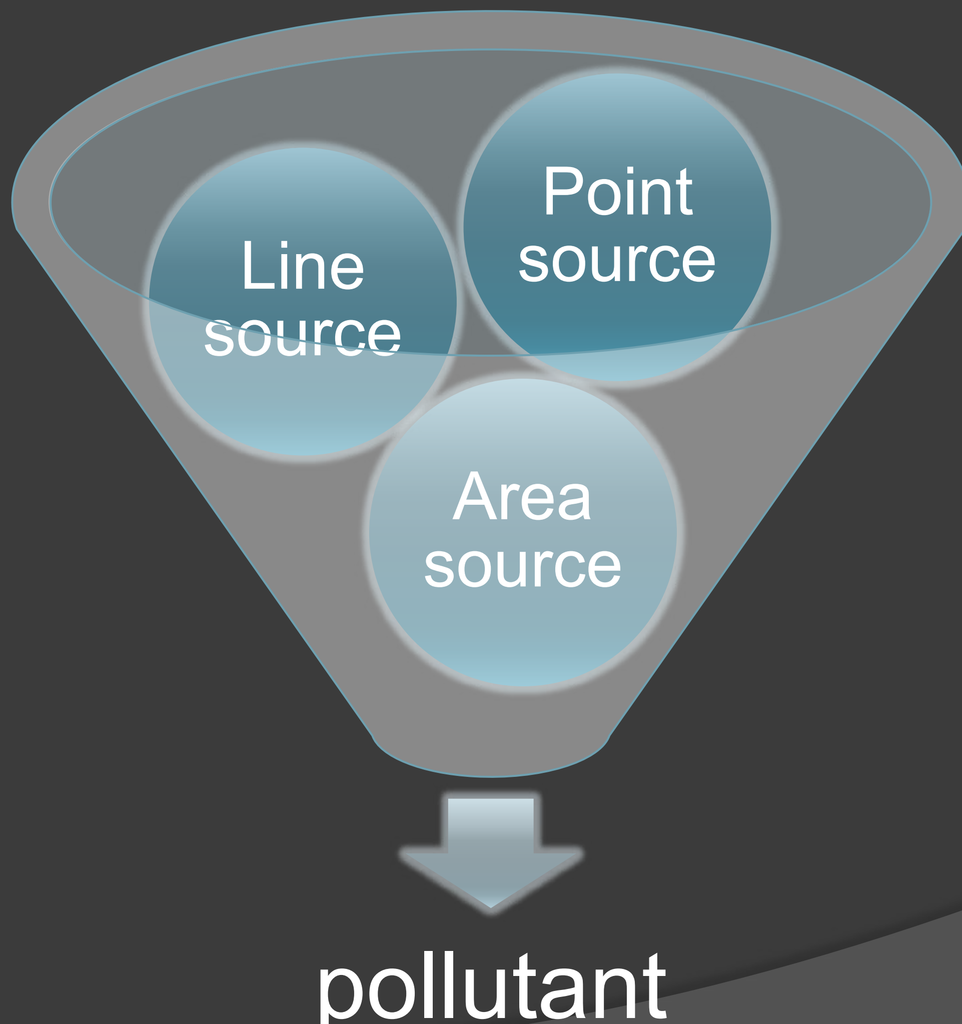
Sumber alami

- Gunung api, rawa-rawa

Sumber antropogenik

- Transportasi: CO, HC, NOx, Pb
- Industri: Sox, CO2
- Rumah tangga: bahan bakar, sampah
- Pertanian dan peternakan: methan

Distribusi ruang



Point source pollutant

Line source pollutant

Area source pollutant

Faktor-faktor yang mempengaruhi konsentrasi

- Intensitas dan kekuatan sumber
- Karakteristik bahan pencemar
- Kondisi meteorologi/klimatologi
- Faktor geografi/topografi

Penurunan Pencemaran Udara

Hujan

- Membantu membersihkan udara dari pencemar

Angin

- Membantu menyapu pencemar untuk pindah ke tempat lain
- Mengencerkan kadar pencemar

Peningkatan Pencemaran Udara

Bangunan perkotaan

- Dapat menghalangi atau menurunkan kecepatan angin→ mengurangi pengenceran polutan

Bukit dan gunung

- Mengurangi aliran udara yang menuju lembah di bawahnya

Suhu tinggi

- Merangsang reaksi kimia sehingga terbentuk *photochemical smog*

Penyebab utama

- Kendaraan bermotor

- Pembakaran hutan

Penyebab utama

- Kegiatan pabrik

- Ketidakpedulian manusia

Dampak pencemaran udara

- Penurunan kualitas udara
- Peningkatan resiko kesehatan
- Hujan asam
- Pemanasan global
- Penipisan lapisan ozon

Penurunan kualitas udara

PENCEMAR	SUMBER	KETERANGAN
Karbon monoksida (CO)	Buangan utama kendaraan bermotor terutama dari mesin berbahan bakar bensin.	Standar kesehatan: 10 mg/m3 (9 ppm)
Sulfur dioksida (S02)	Panas dan fasilitas pembangkit listrik	Standar kesehatan: 80 ug/m3 (0.03 ppm)
Partikulat Matter (PM10)	Buangan kendaraan bermotor; beberapa proses	Standar kesehatan: 50 ug/m3 selama 1 tahun; 150 ug/m3
Nitrogen dioksida (N02)	Buangan kendaraan bermotor dan industri	Standar kesehatan: 100 pg/m3 (0.05 ppm) selama 1 jam
Ozon (03)	Terbentuk di atmosfir	Standar kesehatan: 235 ug/m3 (0.12 ppm) selama 1 jam

Sumber: BPLHD Provinsi DKI Jakarta.

Peningkatan resiko kesehatan

PM 10	• Gangguan pernapasan, misal: ISPA, bronkhitis
CO	• Mengganggu saluran pernapasan • Meningkatkan angka kematian bayi • Menimbulkan stress fisiologis
SO2	• Iritasi pada saluran pernapasan
HC dan VOC	• Leukimia dan kanker lain • Sesak nafas

Peningkatan resiko kesehatan

NOx

- Kerusakan paru-paru
- Iritasi mata dan saluran pernapasan

Ozon

- Inflamasi
- Selaput lendir dan mata
- Gangguan pernapasan

Timah hitam, nikel, dan mekuri

- Mengganggu penglihatan
- Kerusakan pada ginjal
- Sistem pernapasan

CLIMATE CHANGE: GLOBAL WARMING

Global Warming and Global Cooling Are Not New…

- Perubahan iklim bukan merupakan sesuatu yang baru bagi bumi.
- Suhu permukaan dan iklim bumi telah mengalami perubahan sejak 4,7 milyar tahun lalu, kadang-kadang berubah secara gradual (ratuan sampai jutaan tahun) dan kadang sangat cepat (beberapa dekade).
- Pada 10 ribu tahun terakhir ini bumi kita mengalami <u>keajaiban</u> karena iklim dan suhu permukaan bumi relatif <u>stabil</u>.

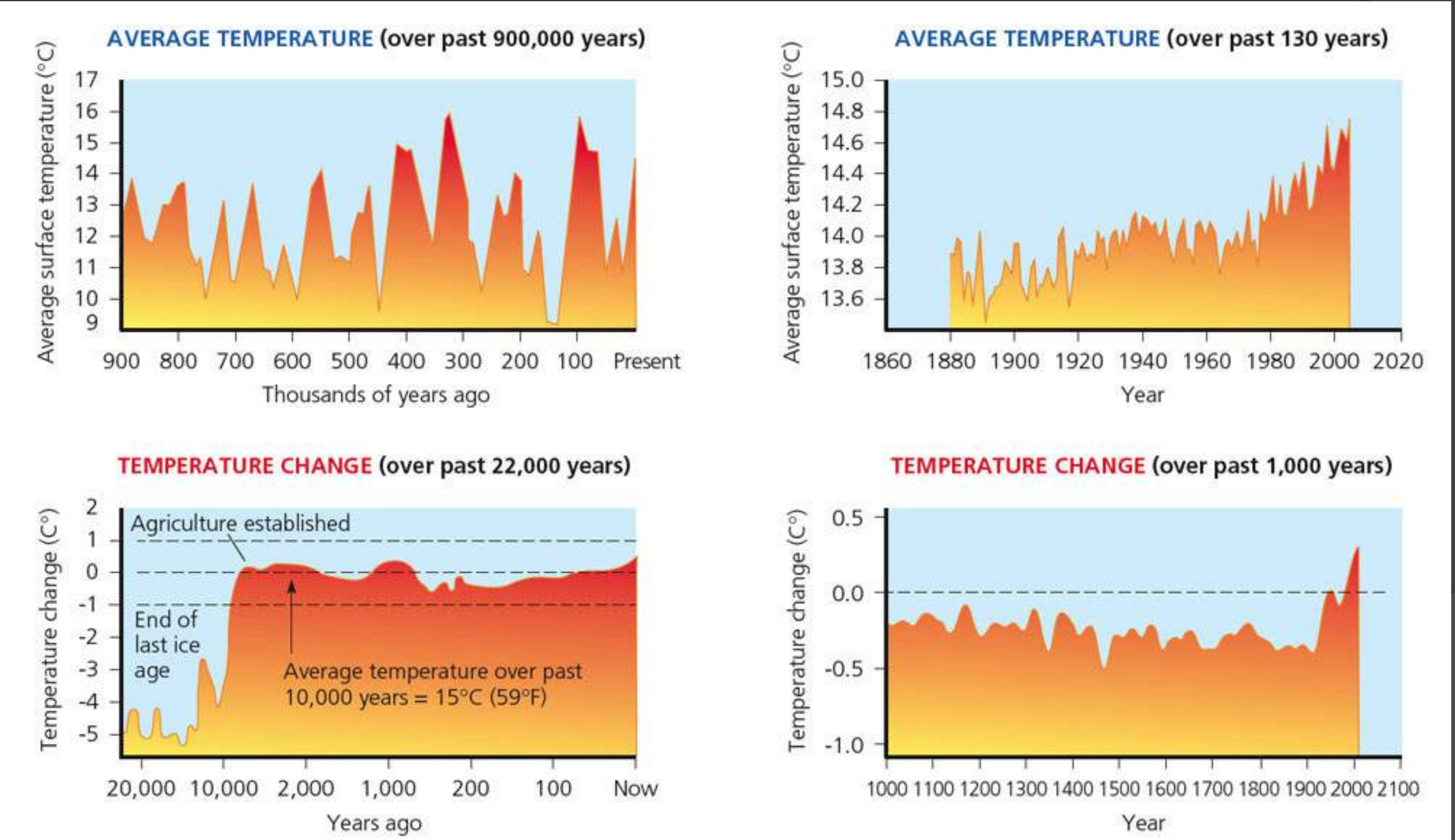
Global Warming and Global Cooling Are Not New (con't)

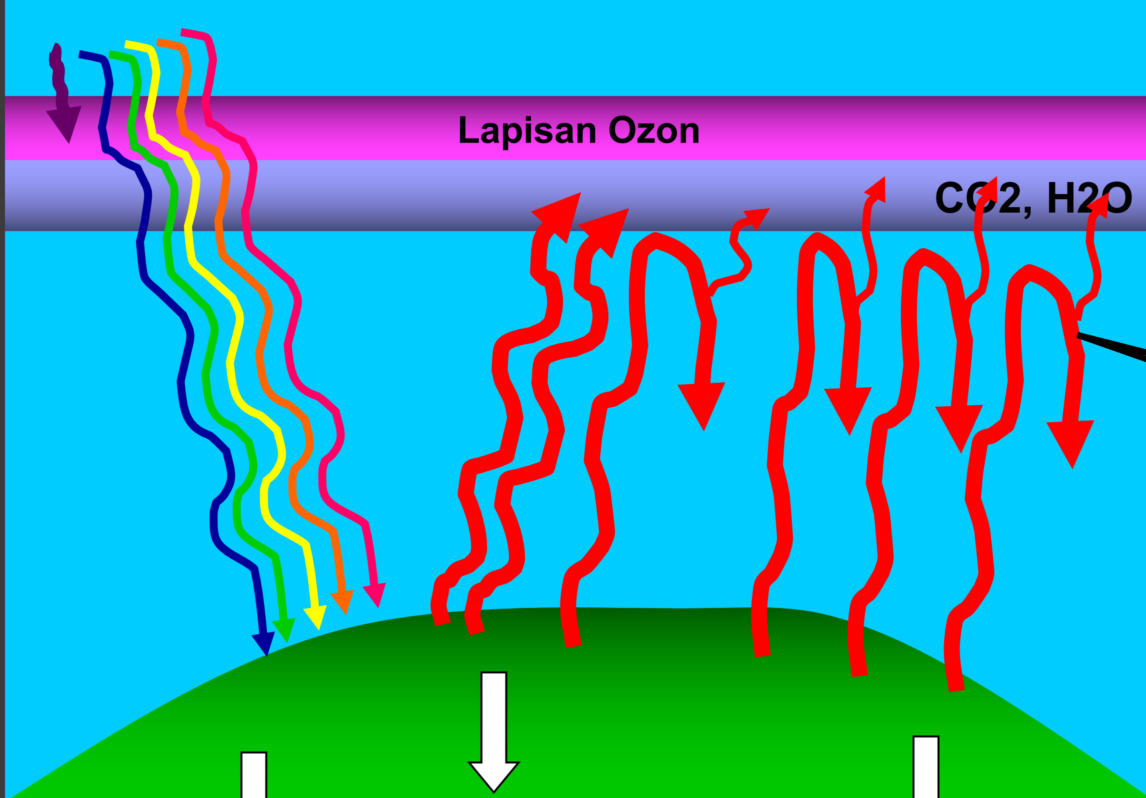
- Over the past 4.7 billion years the climate has been altered by
  - Volcanic emissions
  - Changes in solar input
  - Movement of the continents
  - Impacts by meteors
- Over the past 900,000 years
  - Glacial and interglacial periods

Global Warming and Global Cooling Are Not New (con't)

- Over the past 10,000 years
  - Interglacial period
- Over the past 1,000 years
  - Temperature stable
- Over the past 100 years
  - Temperature changes; methods of determination

Estimated Changes in the Average Global Temperature of the Atmosphere





efek rumah kaca
(*greenhouse effect*)

Sinar matahari (gelombang pendek) menembus atmosfer bagian bawah dan menghangatkan bumi

Permukaan bumi menyerap radiasi matahari yang datang dan mengubahnya menjadi panjang gelombang yang lebih panjang (inframerah, panas), dan naik ke atmosfer bagian bawah. Sebagian panas lepas ke angkasa dan sebagian diserap oleh molekul gas rumah kaca dan diemisikan sebagai radiasi inframerah, yang menghangati atmosfer bagian bawah.

Jika konsentrasi gas rumah kaca meningkat, molekul gas tersebut akan mengabsorpsi dan mengemisikan lebih banyak radiasi inframerah, yang menyebabkan suhu atmosfer bagian bawah lebih panas lagi.

Green house effect...?

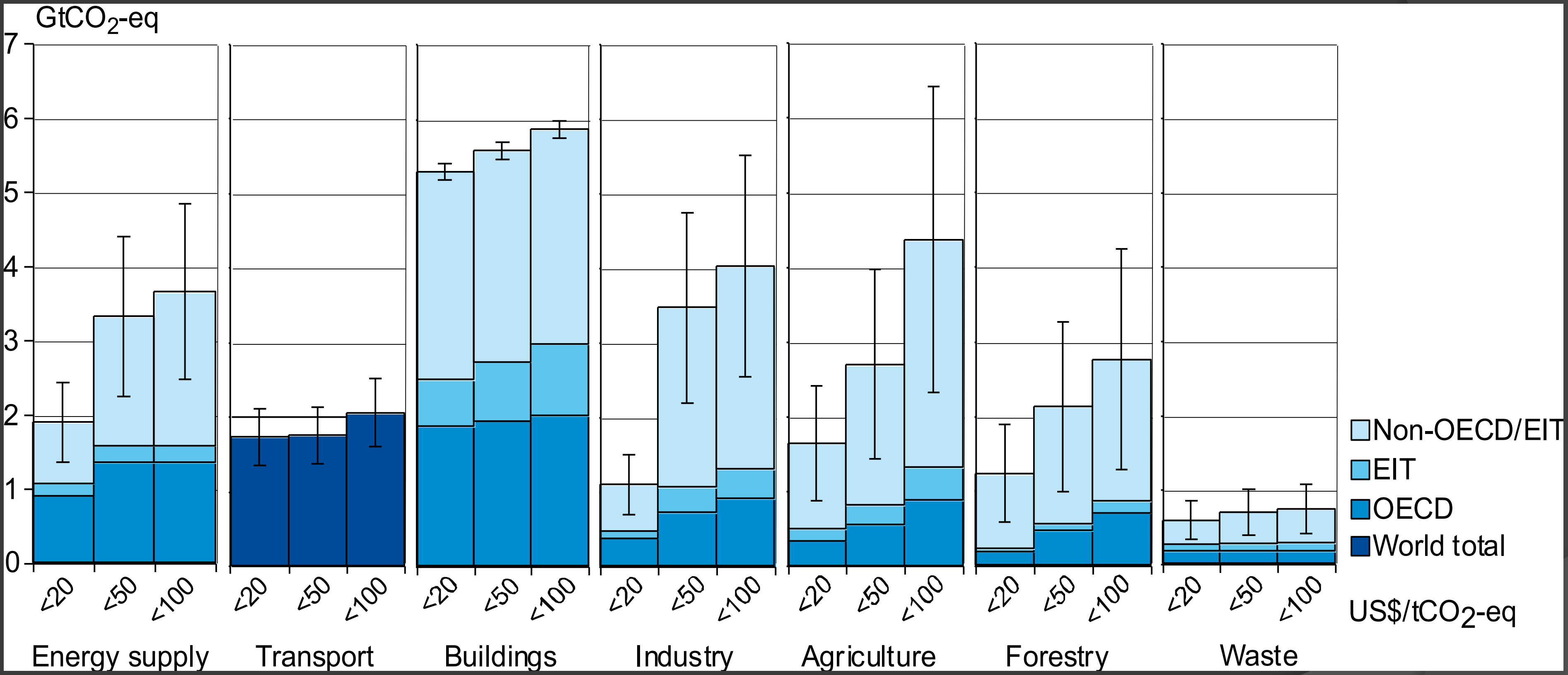
Greenhouse gas...

- Dua gas rumah kaca yang memiliki konsentrasi terbanyak di atmosfer adalah:
  1) uap air yang dikendalikan oleh siklus hidrologi dan
  2) karbon dioksida yang dikendalikan oleh siklus karbon.
- Gas rumah kaca lain yang jumlahnya lebih kecil adalah methane (CH4), N2O, CFCs, SF6, dan SF5CF3. Gas rumah kaca ini masuk ke atmosfer berasal dari sumber alam dan kegiatan manusia,
- CFCs, SF6, dan SF5CF3 berasal sepenuhnya dari kegiatan manusia

Human activity...?

Gas rumah kaca	Sumber dari Manusia	Waktu Rata-rata di Troposfer	Potensi Pemanasan Relatif (dibandingan dengan CO_2)**
Karbon dioksida (CO_2)	Pembakaran bahan bakar fosil, khususnya batu bara (70-75%), deforestation, dan kebakaran hutan (20-25%)	50-500 tahun	1
Methane (CH_4)	Sawah padi, perut ternak dan rayap, landfills, produksi batu bara, kebocoran pipa gas	9-15 tahun	24
Nitrous oxide (N_2O)	Pembakaran bahan bakar fosil, pupuk, limbah ternak, produksi nylon	120 tahun	360
Chlorofluorocarbons (CFCs)*	Air conditioners, refrigerator, plastic foam	11-20 tahun (65-110 tahun di stratosfer)	1500-7000
* Penggunaan CFC sudah dilarang, tetapi untuk membersihkannya dari lapisan ozon membutuhkan 50-100 tahun			
** Potensi pemanasan relatif untuk SF_5CF_3 adalah 18000 kali dari CO_2, dan molekul SF_5CF_3 akan tinggal selama 1000 tahun di troposfer			

Human activity...?



IPCC, 2007

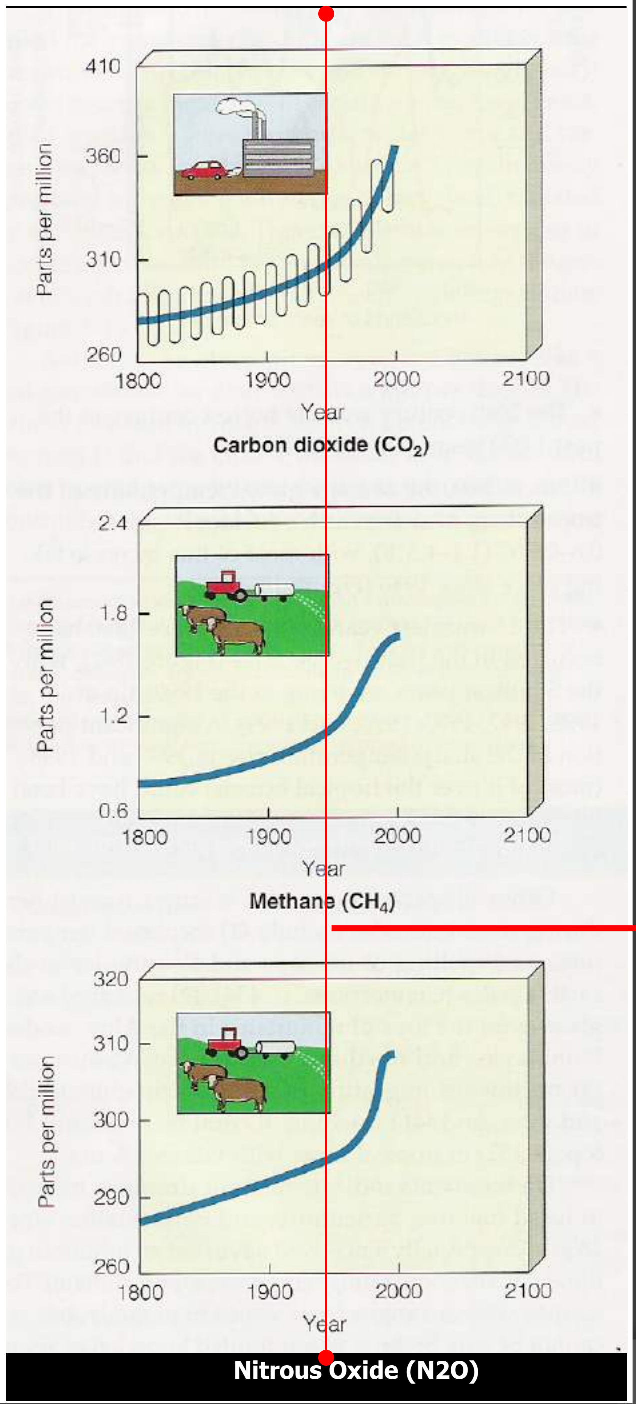
National anthropogenic emissions of greenhouse gases

Mt CO_2 equivalent (excluding forestry/land-use change), 2004

Australia	528
Canada	758
France	562
Italy	582
Netherlands	218
Poland	388
Spain	427
Ukraine	413
United Kingdom	665
United States	6067

Sejak dimulainya revolusi industri (1950), terjadi peningkatan:

- Penggunaan bahan bakar fosil, yang melepaskan sejumlah besar gas rumah kaca (CO_2 dan CH_4) ke dalam troposfer;
- Pembabatan hutan dan pembakaran padang rumput untuk pembukaan lahan pertanian, yang melepaskan CO_2 dan N_2O ke dalam atmosfer;
- Pertanian padi dan penggunaan pupuk anorganik, yang melepaskan N_2O ke dalam troposfer.

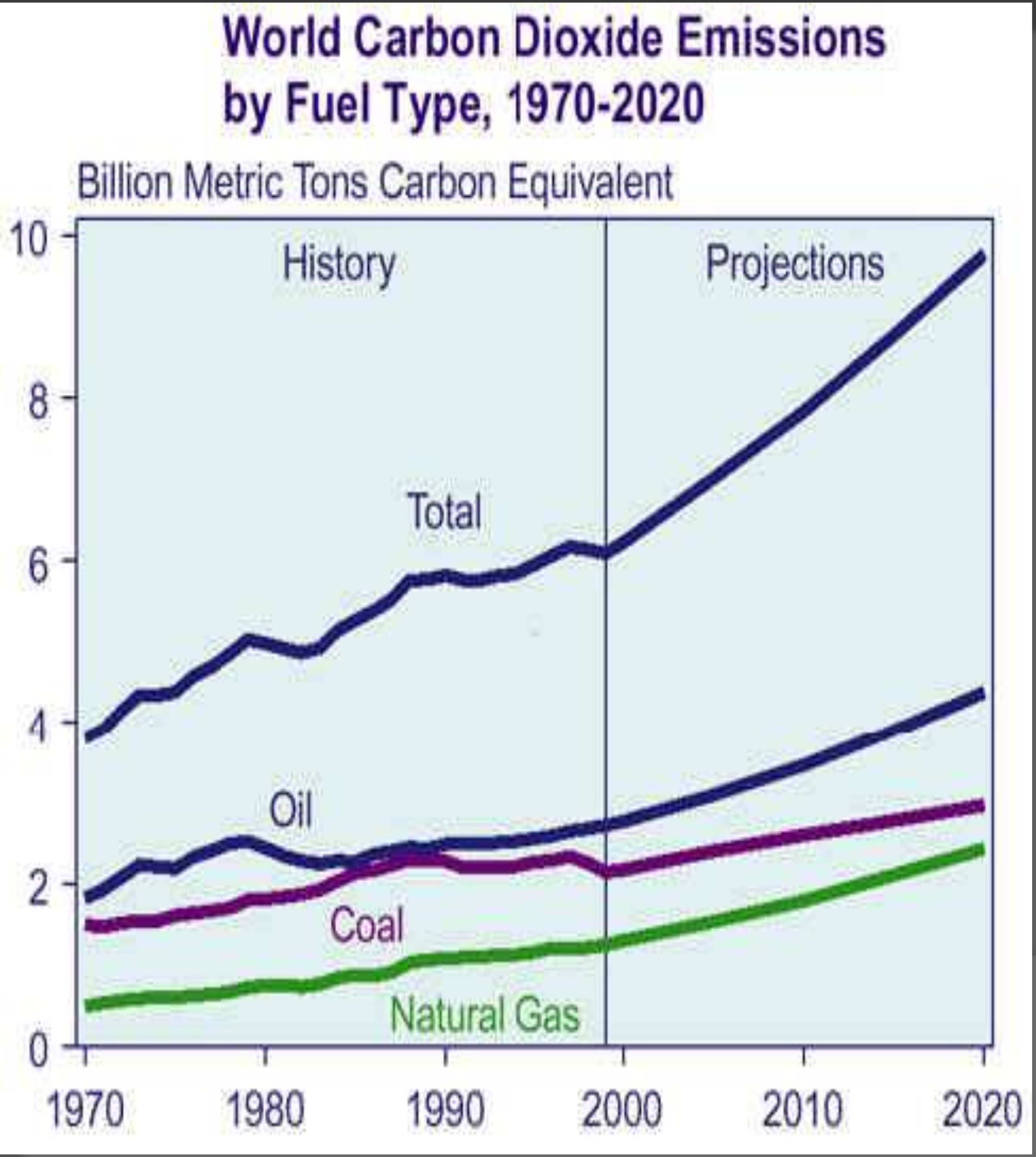


Peningkatan kadar gas rumah kaca dalam troposfer 1860 -1999 (IPCC)

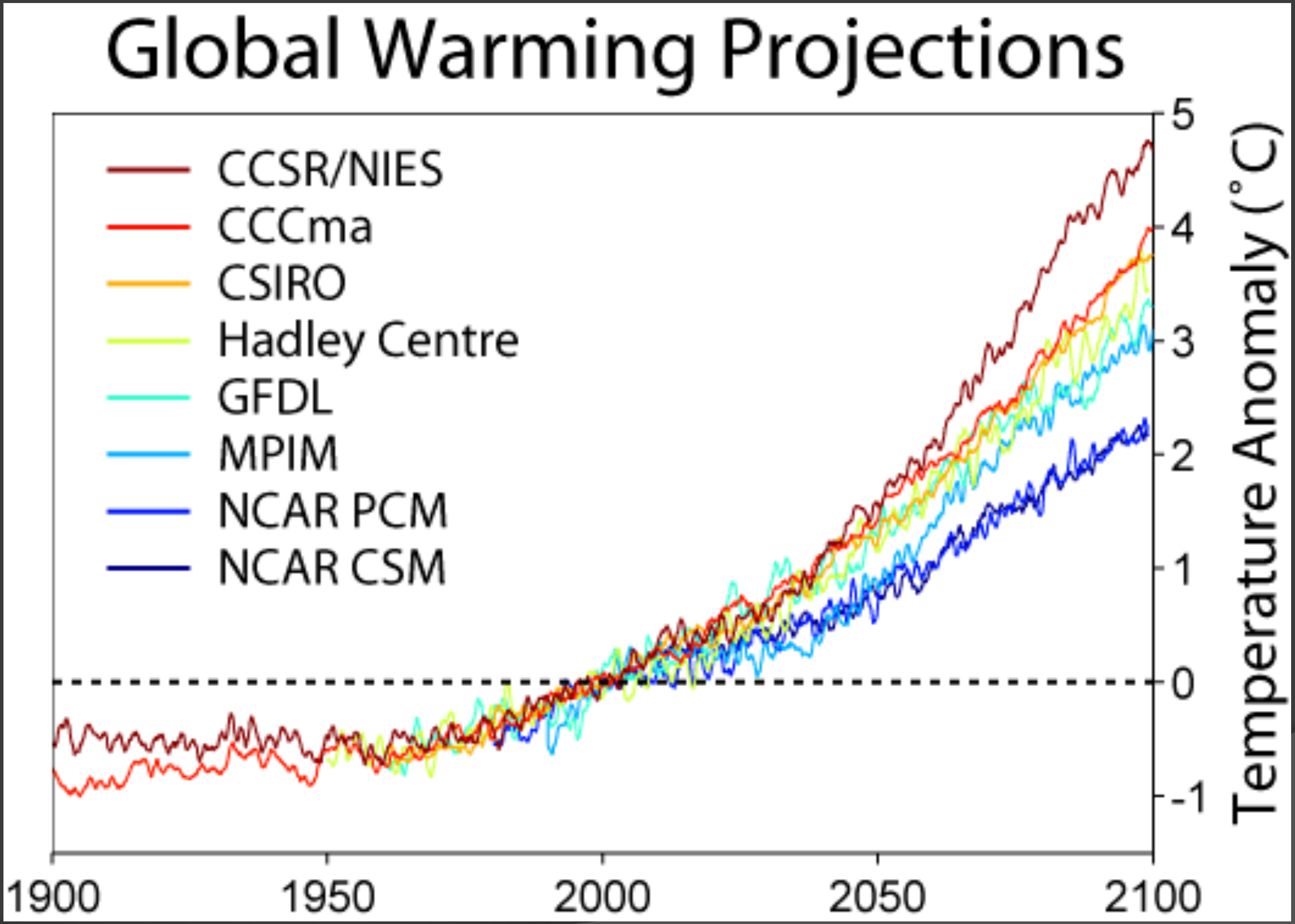
Suhu rata-rata atmosfer dekat permukaan bumi meningkat

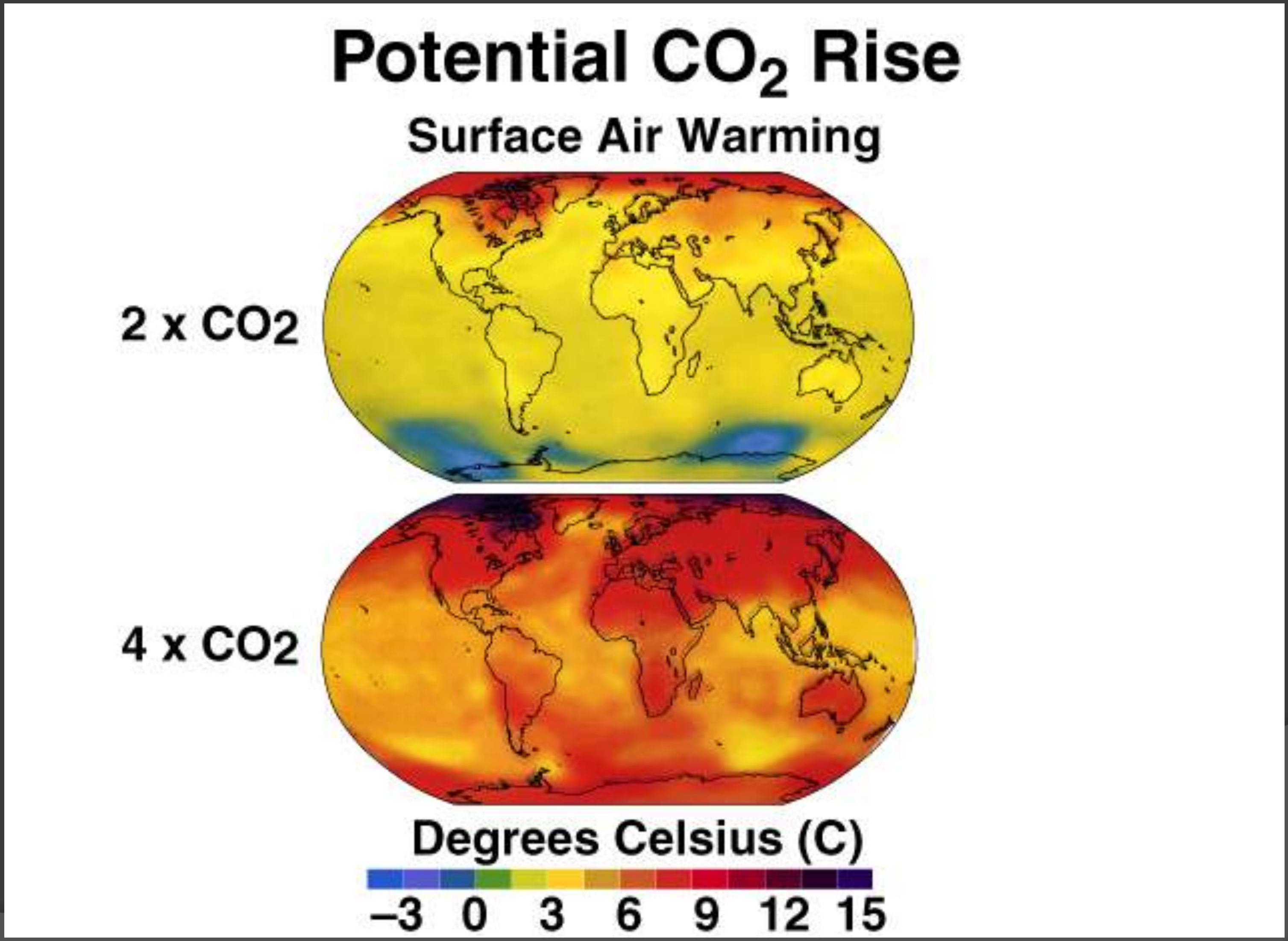
GLOBAL WARMING

1950 an


World Carbon Dioxide Emissions
by Fuel Type, 1970-2020
Billion Metric Tons Carbon Equivalent
History
Projections
Total
Oil
Coal
Natural Gas
0
2
4
6
8
10
1970
1980
1990
2000
2010
2020

Perubahan temperatur permukaan bumi antara tahun 1900 dan 2000 serta proyeksinya selama abad 21




Potential CO_2 Rise
Surface Air Warming
2 x CO2
4 x CO2
Degrees Celsius (C)
–3 0 3 6 9 12 15

Contribution of GHG…

CO2
55%

CH4
15%

N2O
6%

CO_2 Emissions Play an Important Role

- From burning fossil fuels and forests
- Abetted by deforestation; forests remove CO_2 from the atmosphere

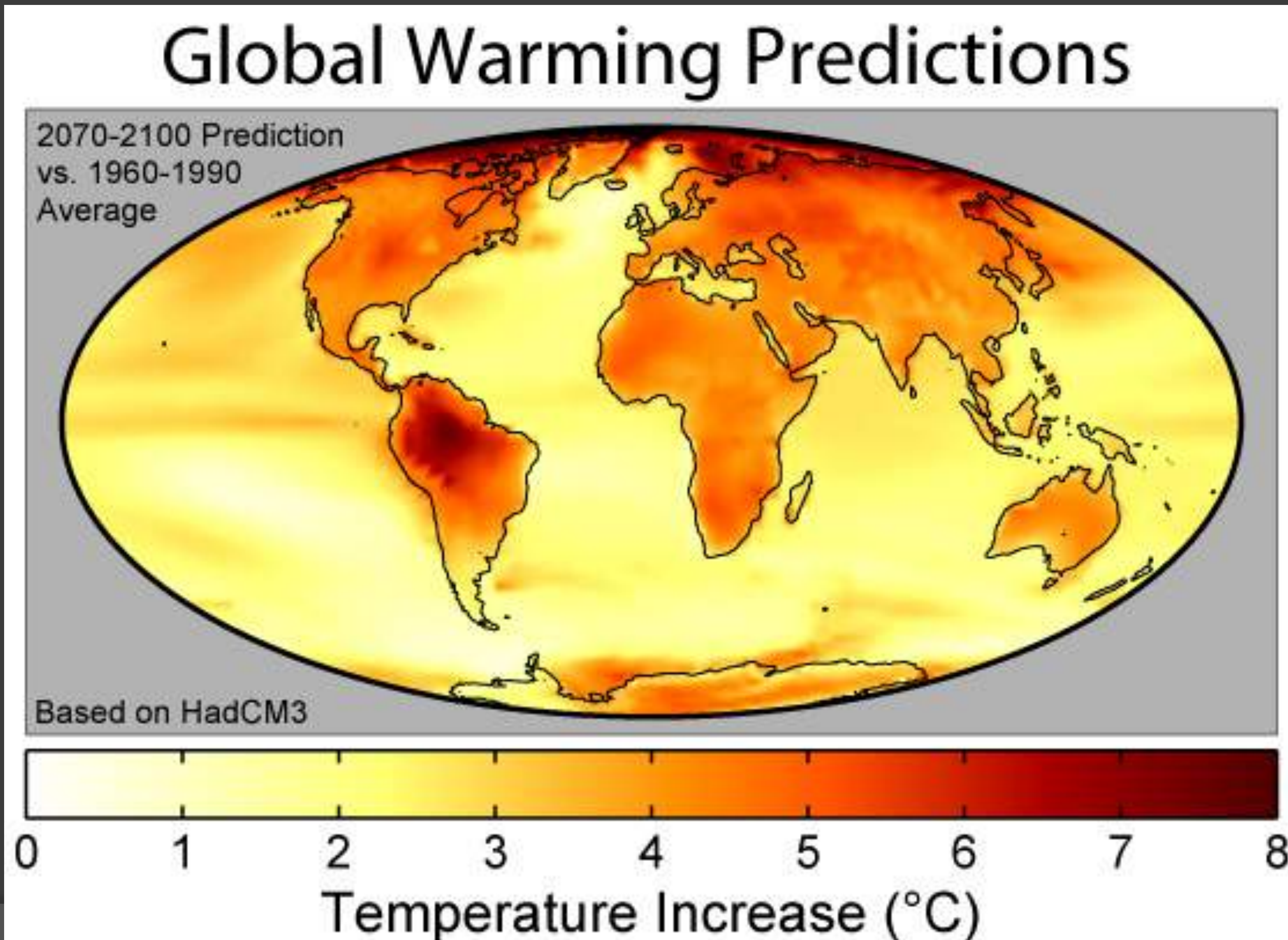
- 2010: 389 ppm
- 2050: 560 ppm
- 2100: 1,390 ppm
- 450 ppm as tipping point

CO_2 Emissions Play an Important Role, but…

- Efektivitas pemanasan gas(*global warming potential*) dari:
  - CH_4 di atmosfir **21** lebih besar dibandingkan CO_2
  - N_2O di atmosfir 296 kali $CO_2 \rightarrow$ sangat stabil di atmosfir dan mempunyai waktu tinggal sampai 150 tahun

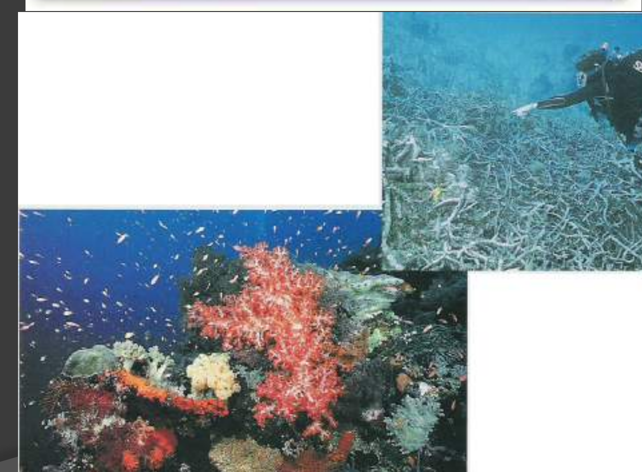
CO_2 Emissions Play an Important Role (con’t)

- Largest emitters, 2009
  1. China
  2. United States
  3. European Union (27 countries)
  4. **Indonesia**
  5. Russia
  6. Japan
  7. India

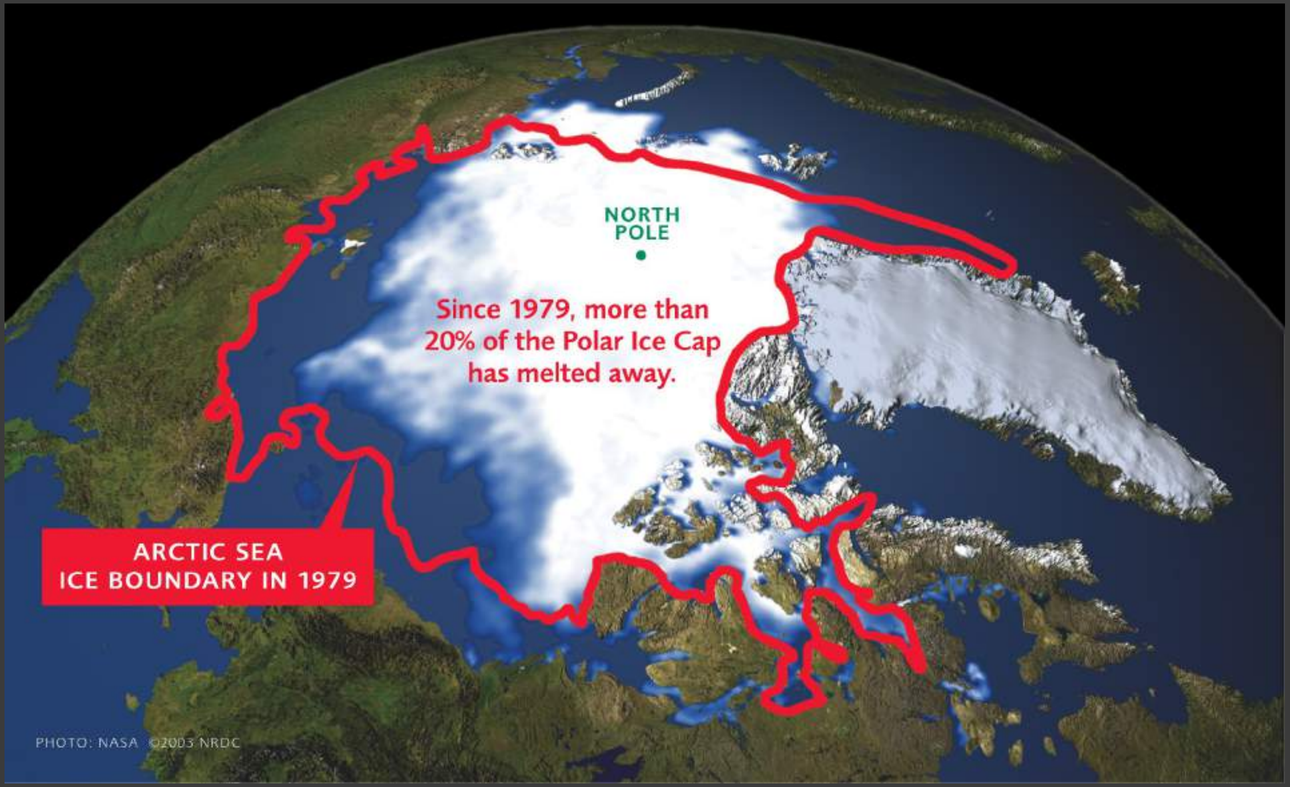

Global Warming Predictions
2070-2100 Prediction
vs. 1960-1990
Average
Based on HadCM3
0
1
2
3
4
5
6
7
8
Temperature Increase (°C)

Tanda-tanda lain bahwa troposfer mengalami pemanasan selama dekade ini adalah:

- Peningkatan suhu dan mencairnya es dan mengapungnya es di kutub bumi.
- Berkurangnya lapisan es pada puncak pegunungan Alpen, Andes, Himalaya, dan Cadcades of Washington.
- Bermigrasinya beberapa ikan iklim hangat ke arah utara.
- *Bleaching* (pemutihan) terumbu karang di daerah tropis oleh adanya air yang lebih hangat.

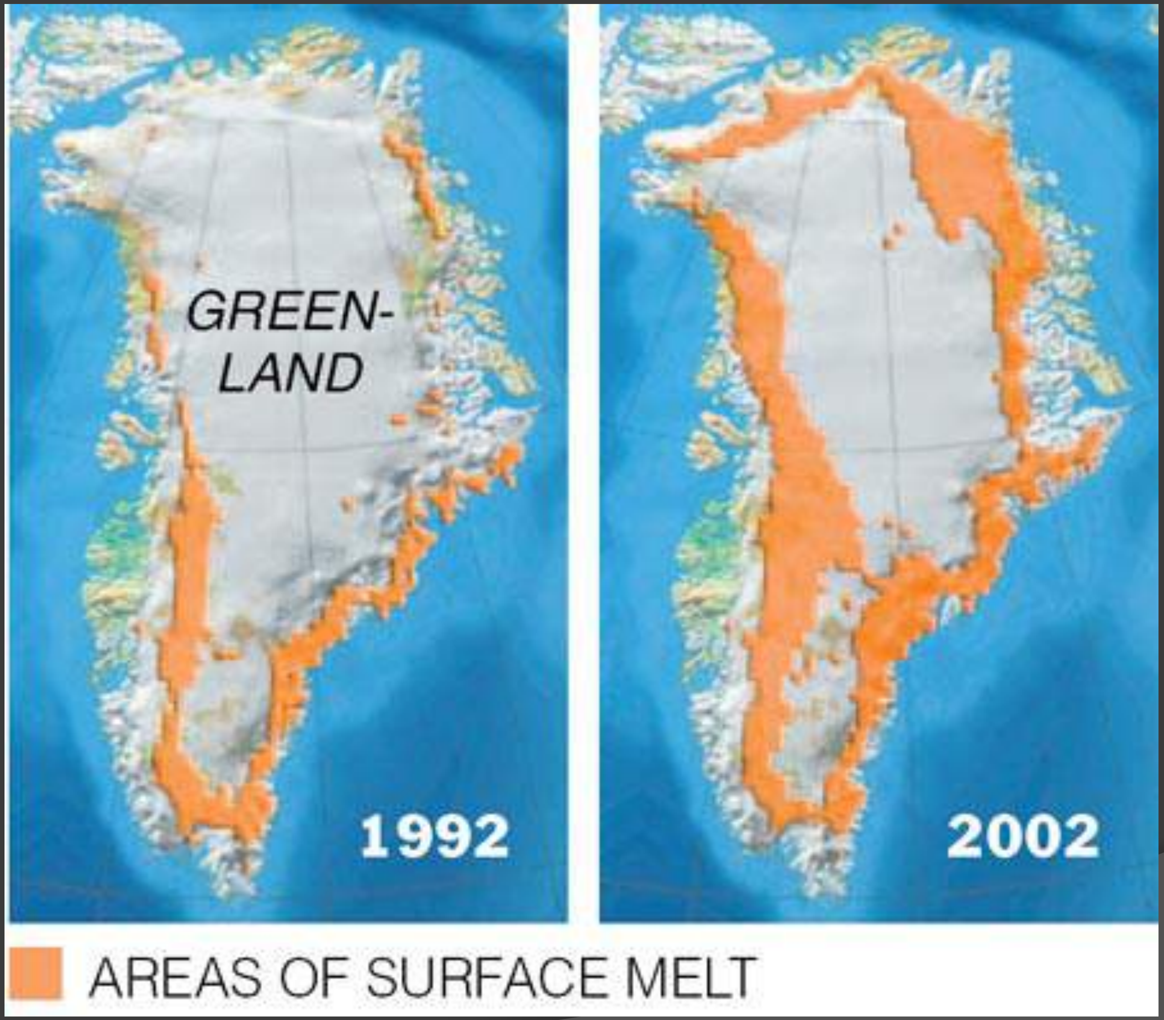


The Earth is de-glaciating



- There are now observations of many manifestation of this general warming. These include significant changes to sea-ice extent and glaciers around the world. This picture simply show the areal extent of the Arctic polar ice has been reduced significantly since the red line in 1979. The ice cap is also substantially thinner.

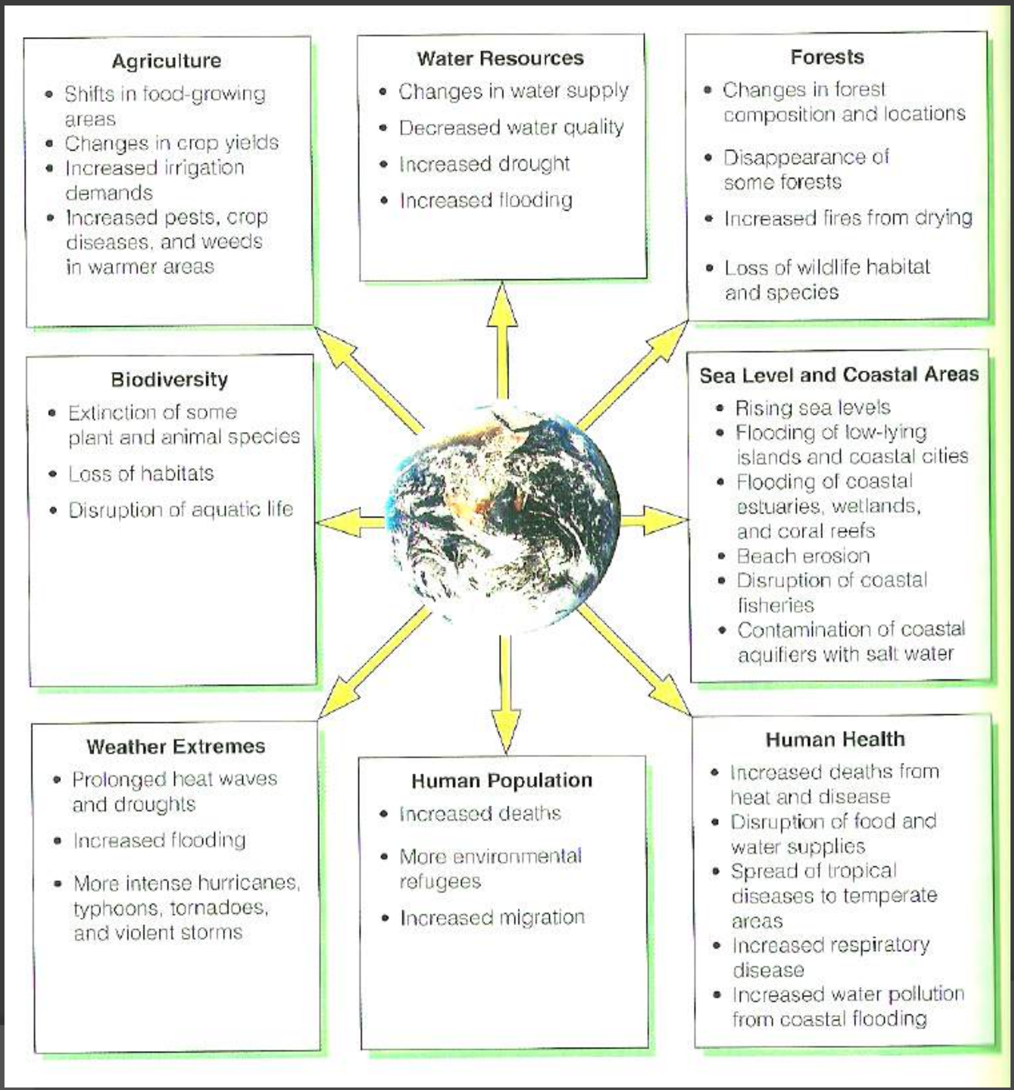
The Earth is de-glaciating (con't)



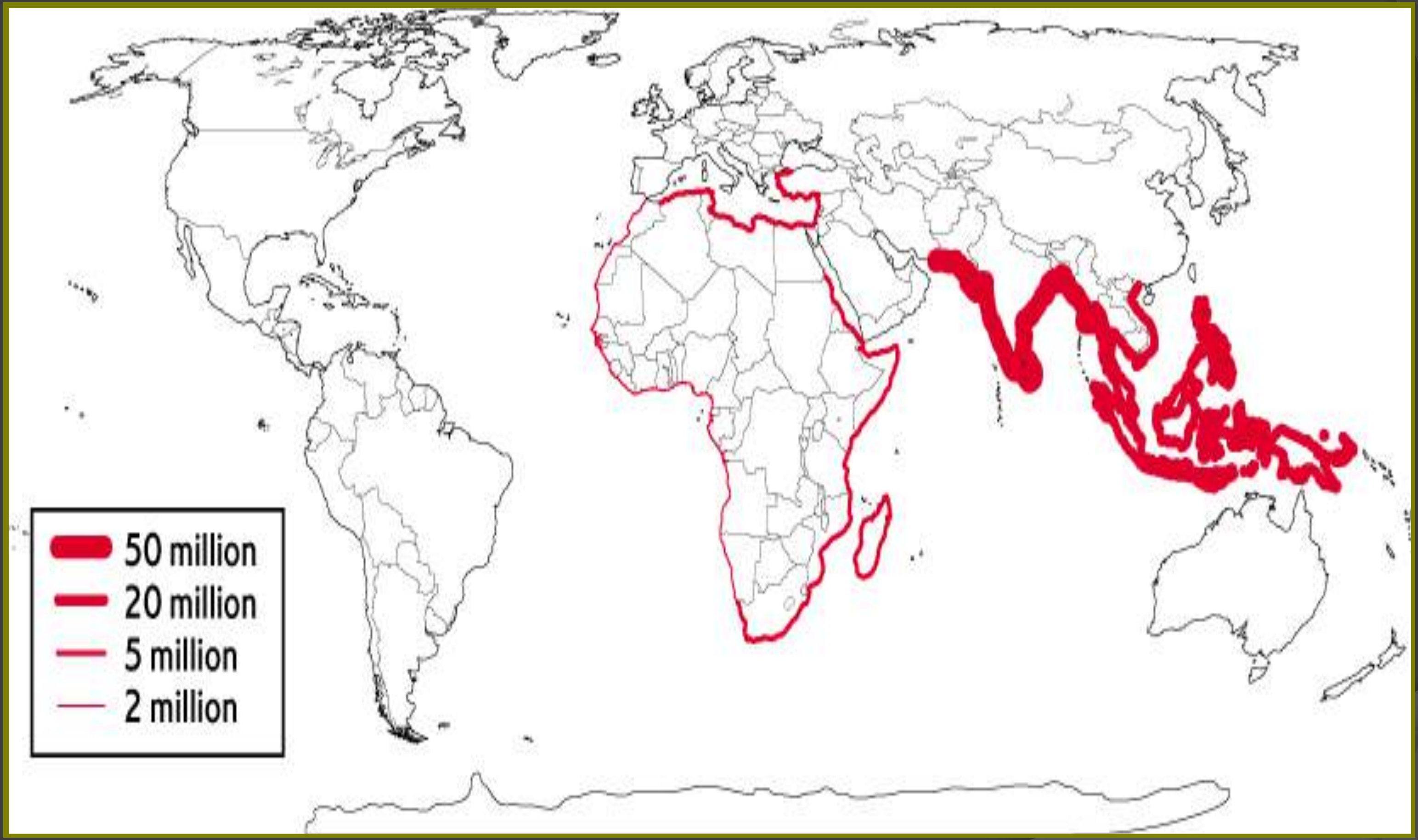
The Earth is de-glaciating (con’t)

- Melting of Alaska’s Muir Glacier between 1948 and 2004

Dampak Perubahan Iklim yang Cepat



Number of people at risk from coastal flooding by the 2080s



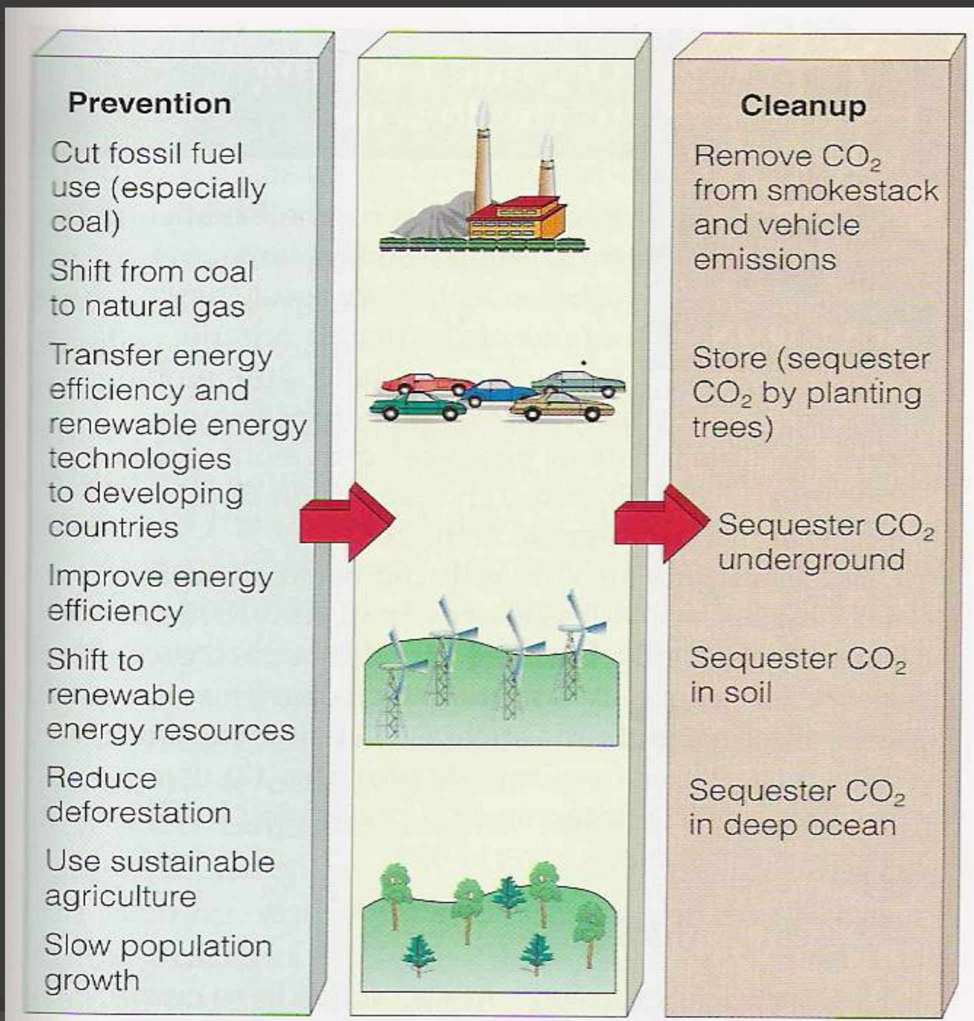
AAAS, Seattle, 13 February 2004
David A Warrilow

Sumber pencemar (con't)

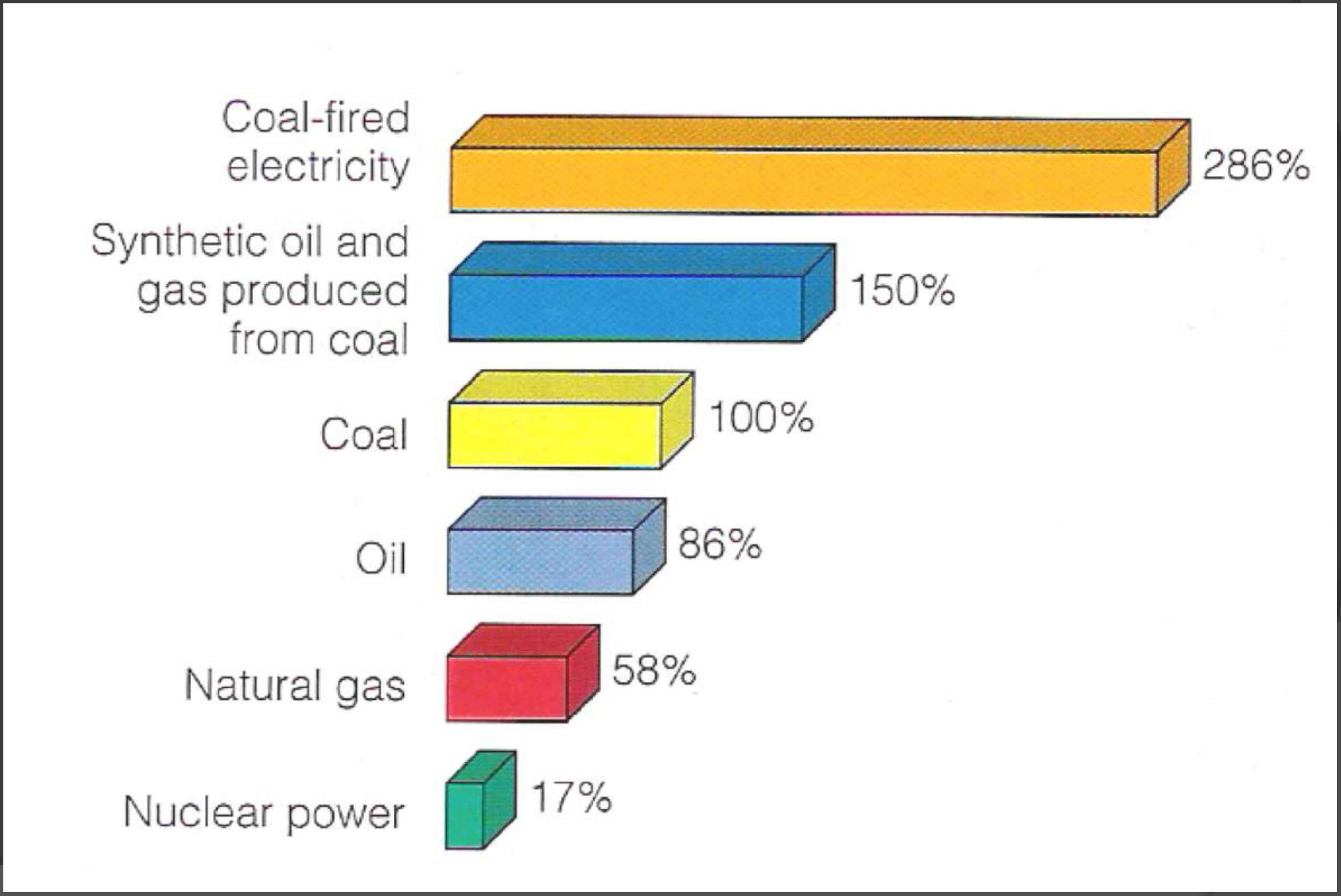
Ecological thresholds

More than a million species committed to extinction by 2050?

Upaya Memperlambat Terjadinya Global Warming



Emisi CO2 yang Dihasilkan oleh Berbagai Bahan Bakar



What they have done?

- **Earth Summit 1992 Rio de Janeiro**, 106 negara menandatangani *Convention on Climate Change* untuk mengurangi gas rumah kaca di bawah level 1990. Sebagian besar negara tidak dapat mencapai tujuan ini pada tahun 2000.

- **Protokol Kyoto, Desember 1997**, tujuan memperlambat *Global Warming* ditandatangani 160 negara, USA-Australia-Kazakhstan tidak ikut.
  - 38 negara maju diminta menurunkan gas rumah kaca 5,2% di bawah level 1990, antara 2008-2012.
  - Negara berkembang tidak perlu menurunkan gas rumah kaca (Termasuk China dan India sebagai negara potensial penyumbang gas rumah kaca)

What they have done?

- **Tahun 2000**, beberapa perusahaan minyak dan *automobile* USA keluar dari koalisi menolak *Global Warming*.
  - *Global warming* mempunyai risiko lingkungan yang perlu diperhatikan
  - Dengan menurunkan gas rumah kaca, malah akan merangsang pertumbuhan ekonomi USA dan menciptakan lapangan kerja baru.
- **Tahun 2010**, Intergovernmental Panel on Climate Change (IPCC)

IPCC, 2010

- 90–99% likely that lower atmosphere is warming
  - Especially since 1960
  - Mostly from human-caused increases in greenhouse gases
  - Earth's climate is now changing from increased greenhouse gases
- Increased greenhouse gas concentrations will likely trigger significant climate disruption this century
- Ecological, economic, and social disruptions

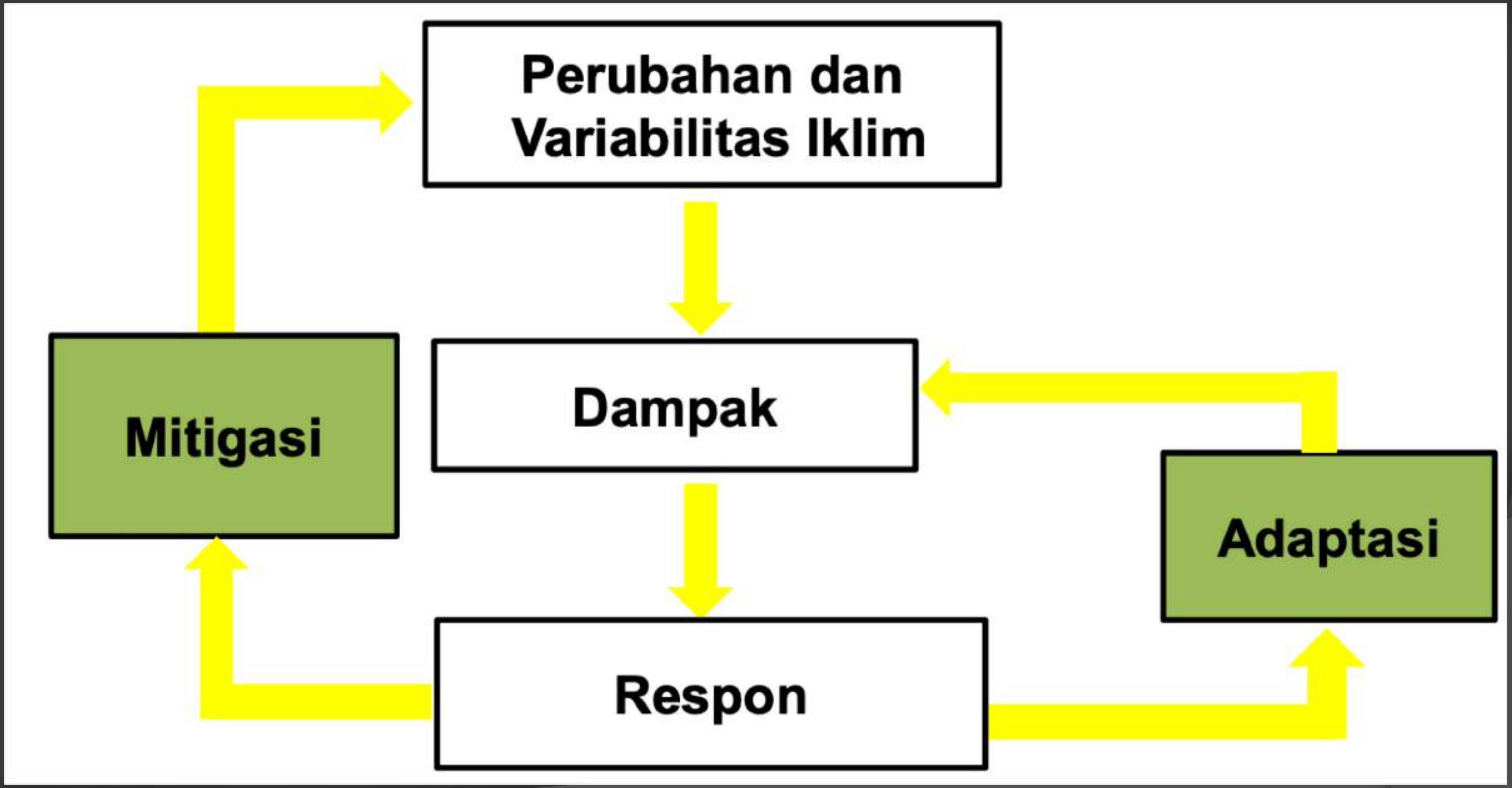
IPCC, 2010 (con't)

- Intergovernmental Panel on Climate Change (IPCC), with 2010 updates, cont.
  - 1906–2005: Ave. temp increased about 0.74˚C
  - 1970–2009: Annual greenhouse emissions from human activities up 70%
  - 2000-2009 warmest decade since 1881
  - Past 50 years: Arctic temp rising almost twice as fast as the rest of the earth
  - Melting of glaciers and increased floating sea ice
  - Last 100 years: sea levels rose 19 cm

ADAPTASI DAN MITIGASI

KEBIJAKAN NASIONAL MITIGASI DAN ADAPTASI PERUBAHAN IKLIM

- Mitigasi dan Adaptasi terhadap Perubahan Iklim



Mitigasi vs Adaptasi

Mitigasi:

Mengurangi peningkatan emisi GRK

Adaptasi:

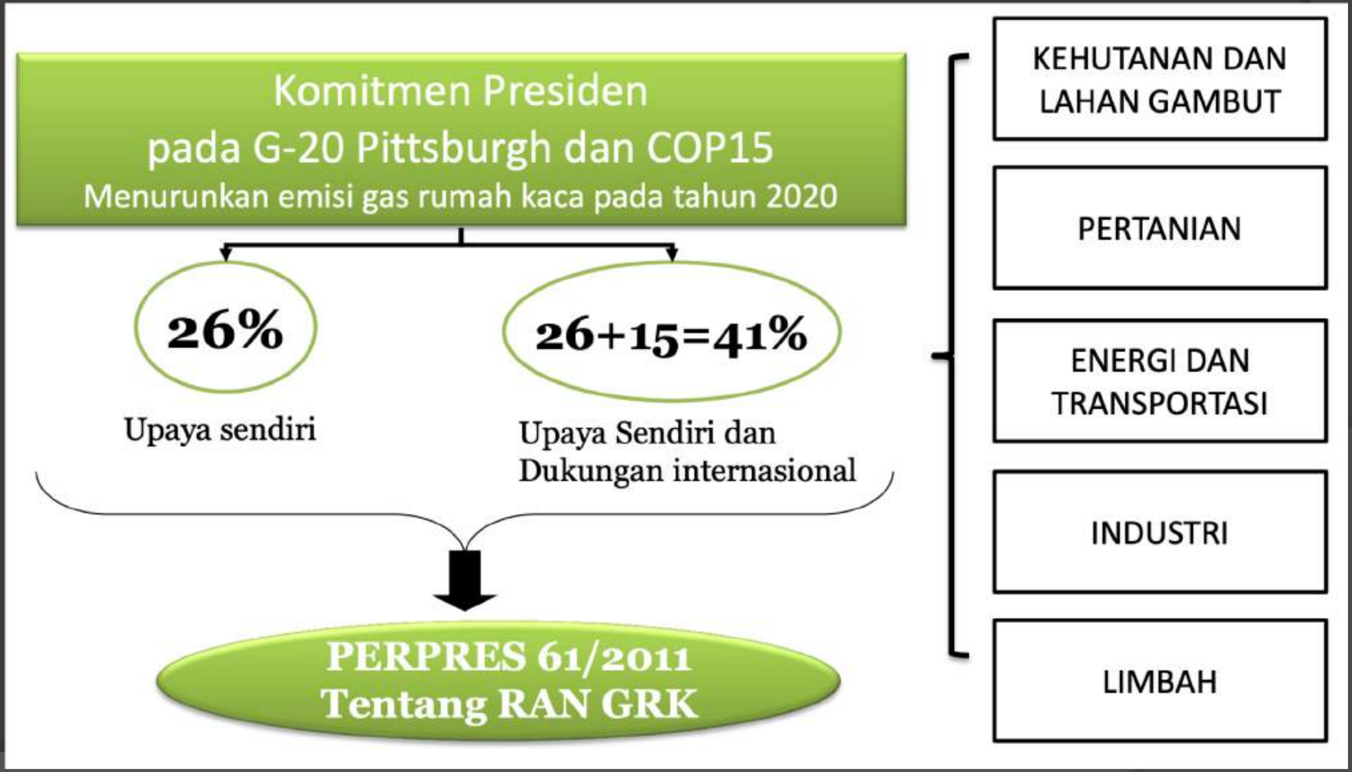
Penyesuaian diri terhadap kondisi perubahan iklim → menyesuaikan kegiatan ekonomi pada sektorsektor rentan

Tujuan adaptasi:

- Perencanaan yang lebih baik mempertimbangkan kondisi iklim (perubahan iklim) → pengelolaan sumber daya air, pertanian
- Mengurangi kemungkinan bencana karena iklim → contoh: banjir, kebakaran hutan, longsor.

RAN-GRK

- Adalah pedoman untuk langkah-langkah dalam memfasilitasi mitigasi perubahan iklim.

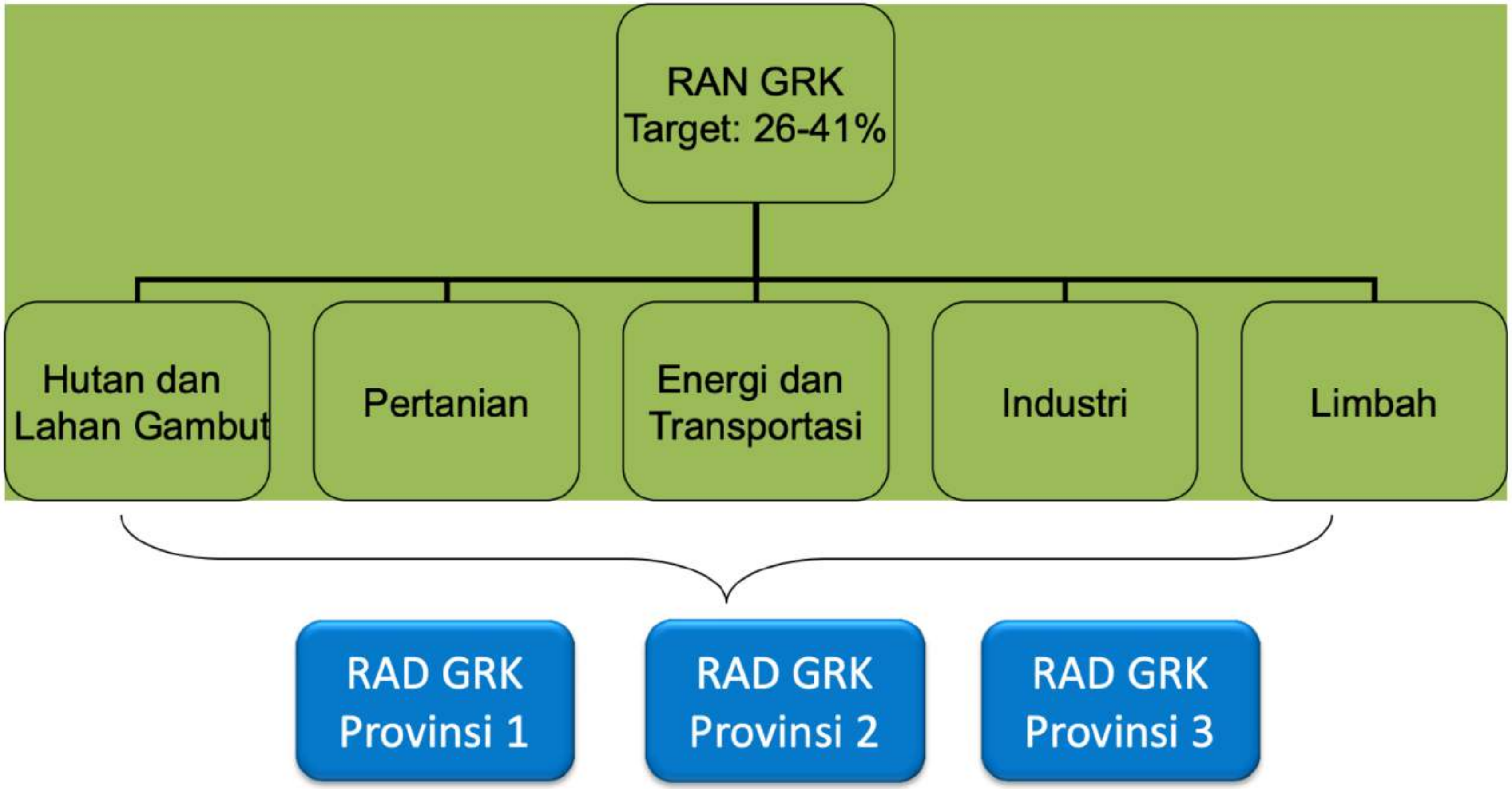


MITIGASI:Target Penurunan Emisi di 5 Sektor Nasional

- Identifikasi Program Sektoral dan Estimasi Anggaran Pemerintah

SEKTOR	TARGET PENURUNAN (Gton CO^2e)	
	26%	41%
Kehutanan dan Lahan Gambut	0.672	1.039
Pertanian	0.008	0.011
Energi dan Transportasi	0.036	0.056
Industri	0.001	0.005
Limbah	0.048	0.078
Total	0.767	1.189

RAN vs RAD



RAD GRK adalah bagian dari RAN GRK

Contoh upaya mitigasi salah satu sektor: Bidang Energi dan Transportasi

Kebijakan

- Penggunaan bahan bakar yang lebih bersih (fuel switching)
- Peningkatan penggunaan energi baru dan terbarukan (EBT)
- Pemanfaatan teknologi bersih baik untuk pembangkit listrik, dan sarana transportasi

Strategi

- (Avoid) -pengurangan kebutuhan akan perjalanan terutama daerah perkotaan (trip demand management) melalui penata-gunaan lahan mengurangi perjalanan
- •(Shift) - pergeseran pola penggunaan kendaran pribadi (sarana transportasi dengan konsumsi energi yang tinggi) ke pola transportasi rendah karbon
- •(Improve) - peningkatan efisiensi energi dan pengurangan pengeluaran karbon pada kendaraan bermotor pada sarana transportasi

Contoh upaya mitigasi salah satu sektor: Pengelolaan Limbah

- **Kebijakan**
  - Meningkatkan pengelolaan sampah dan air limbah domestik
- **Strategi**
  - Peningkatan kapasitas kelembagaan dan peraturan di daerah (Perda)
  - Peningkatan pengelolaan air limbah di perkotaan
  - Pengurangan timbulan sampah melalui 3R (reduce, reuse, recycle)
  - Perbaikan proses pengelolaan sampah di TPA

ADAPTASI

Sektor utama: kesehatan dan kebencanaan

Perubahan perilaku dan kemampuan adaptasi

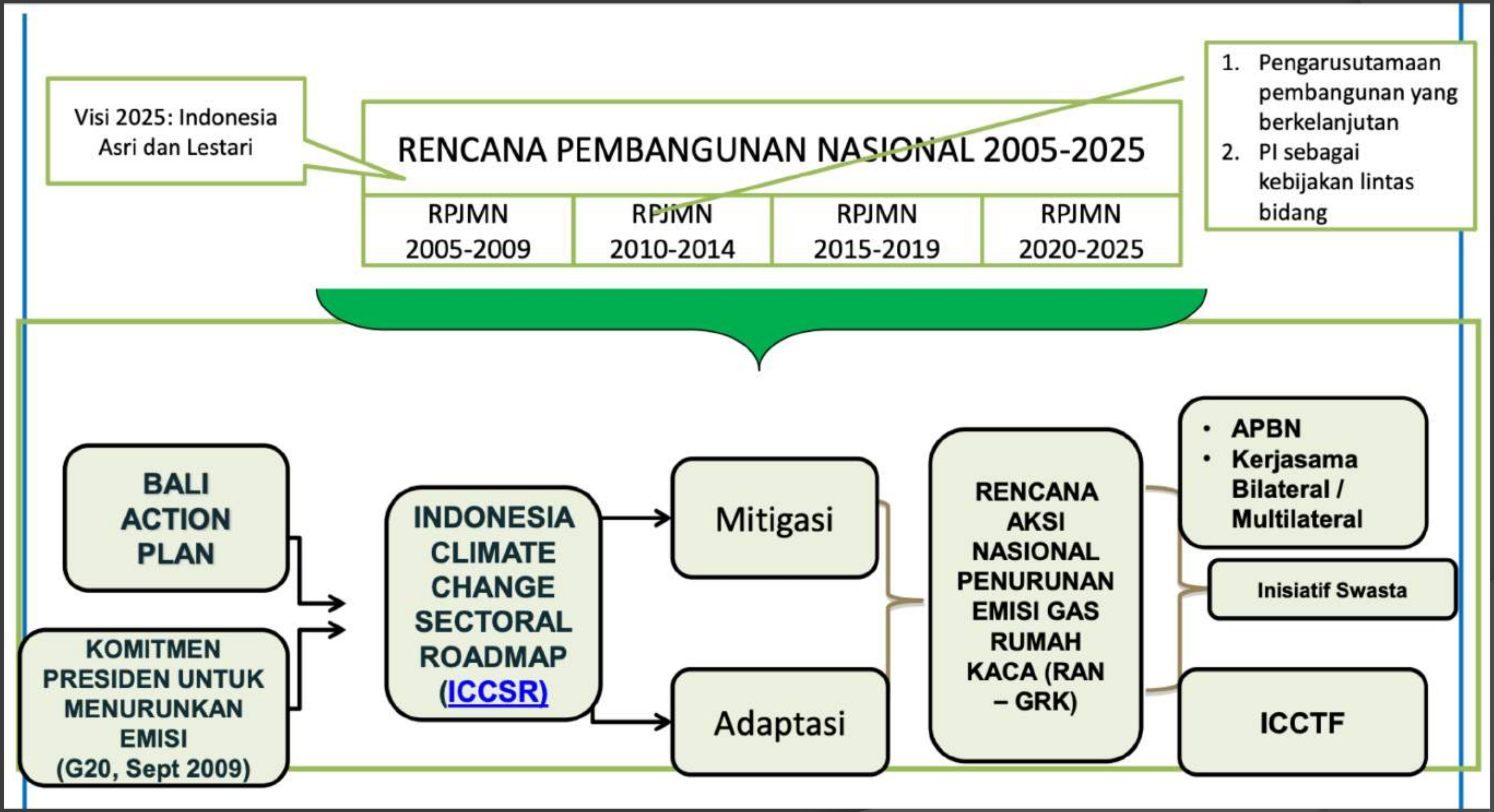
Rancangan Strategi Adaptasi Sektor Kesehatan

BAPPENAS

<table>
<tr><th>Strategi</th><th>Program</th><th>Aktivitas (Contoh)</th></tr>
<tr><td rowspan="3">Peningkatan kewaspadaan dini terhadap bencana di masyarakat
Memperkuat kajian kerentanan bencana dan penilaia resiko akibat adanya perubahan iklim
Mengembangkan kerangka kebijakan
Meningkatkan kerjasama sektor dan juga partisipasi masyarakat</td><td>Manajemen Data, Informasi dan Pengetahuan</td><td>Kajian dan analisis kerentanan perubahan iklim terhadap kesehatan masyarakat
Kajian dan analisis hubungan perubahan iklim terhadap perkembangan penyakit bawaan</td></tr>
<tr><td>Perencanaan dan Kebijakan, Peraturan dan Pengembangan Institusi</td><td>Membuat UU yang mendukung percepatan peningkatan sanitasi lingkungan
Membuat UU yang mendukung usaha adaptasi kesehatan terhadap perubahan iklim</td></tr>
<tr><td>Perencanaan dan Implementasi, Monitoring dan Evaluasi Program</td><td>Pengembangan teknologi adaptasi
Penguatan sistem pelayanan kesehatan masyarakat</td></tr>
</table>

RAN GRK DALAM PEMBANGUNAN NASIONAL

Kebijakan Perubahan Iklim dalam Pembangunan Nasional



Contoh Implementasi

1. Tata kota dan keseimbangan ruang publik dan privat
2. Mobilitas masyarakat dan arus transportasi
3. Pembenahan transportasi publik
4. Lampu jalanan: efisiensi dan sumber energi baru
5. Pengelolaan sampah: sanitasi dan kesehatan serta sumber energi baru
6. Gedung publik: efisien energi dan ramah lingkungan.

TERIMA KASIH

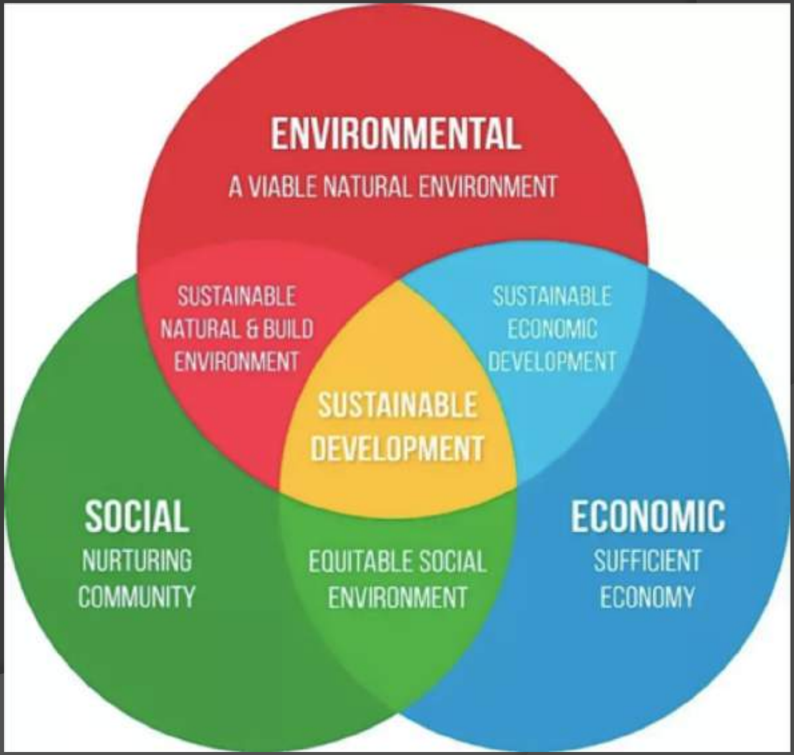
Pertemuan Kesepuluh

GREEN TECHNOLOGY TOWARDS SDG'S (TPB)

Fakultas Sains dan Teknologi
Universitas Airlangga

Pembangunan Berkelanjutan...?

- **Sustainable development** is **development** that meets the needs of the present without compromising the ability of future generations to meet their own needs (Our Common Future, 1987)




TUJUAN PEMBANGUNAN BERKELANJUTAN
1 MENGHAPUS KEMISKINAN
2 MENGAKHIRI KELAPARAN
3 KESEHATAN YANG BAIK DAN KESEJAHTERAAN
4 PENDIDIKAN BERMUTU
5 KESETARAAN GENDER
6 AKSES AIR BERSIH DAN SANITASI
7 ENERGI BERSIH DAN TERJANGKAU
8 PEKERJAAN LAYAK DAN PERTUMBUHAN EKONOMI
9 INFRASTRUKTUR, INDUSTRI DAN INOVASI
10 MENGURANGI KETIMPANGAN
11 KOTA DAN KOMUNITAS YANG BERKELANJUTAN
12 KONSUMSI DAN PRODUKSI YANG BERTANGGUNGJAWAB
13 PENANGANAN PERUBAHAN IKLIM
14 MENJAGA EKOSISTEM LAUT
15 MENJAGA EKOSISTEM DARAT
16 PERDAMAIAN, KEADILAN, DAN KELEMBAGAAN YANG KUAT
17 KEMITRAAN UNTUK MENCAPAI TUJUAN
TUJUAN GLOBAL
Untuk Pembangunan Berkelanjutan

Agenda TPB (SDGs) 2030

NO	TUJUAN
1	Tanpa Kemiskinan
2	Tanpa Kelaparan
3	Kehidupan Sehat dan Sejahtera
4	Pendidikan Berkualitas
5	Kesetaraan Gender
6	Air Bersih dan Sanitasi Layak
7	Energi Bersih dan Terjangkau
8	Pekerjaan Layak & Pertumbuhan Ekonomi
9	Industri, Inovasi, dan Infrastruktur

NO	TUJUAN
10	Berkurangnya Kesenjangan
11	Kota & Permukiman yang Berkelanjutan
12	Konsumsi & Produksi yang Bertanggung Jawab
13	Penanganan Perubahan Iklim
14	Ekosistem Air
15	Ekosistem Daratan
16	Perdamaian, Keadilan, dan Kelembagaan yang Tangguh
17	Kemitraan untuk Mencapai Tujuan

The Goals…


1 TANPA KEMISKINAN
TUJUAN 1
MENGAKHIRI KEMISKINAN DALAM SEGALA BENTUK DIMANAPUN

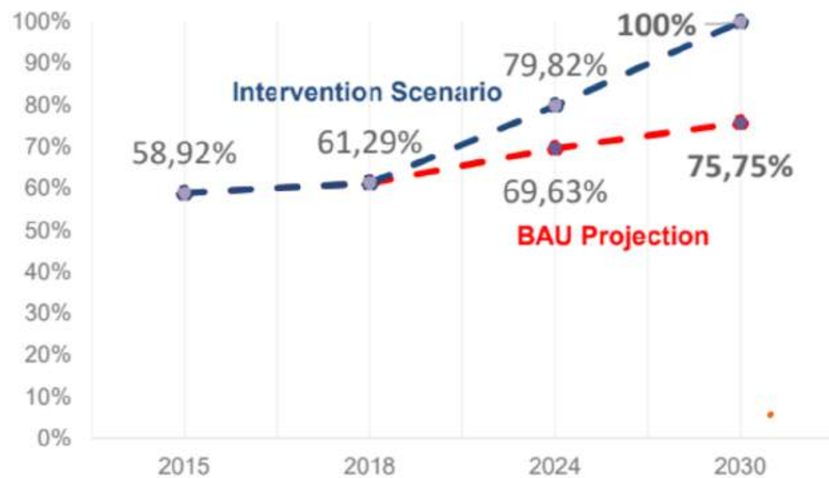

2 TANPA KELAPARAN
TUJUAN 2
MENGHILANGKAN KELAPARAN, MENCAPAI KETAHANAN PANGAN DAN GIZI YANG BAIK, SERTA MENINGKATKAN PERTANIAN BERKELANJUTAN


3 KEHIDUPAN SEHAT DAN SEJAHTERA
TUJUAN 3
MENJAMIN KEHIDUPAN YANG SEHAT DAN MENINGKATKAN KESEJAHTERAAN SELURUH PENDUDUK SEMUA USIA

The Goals... (con't)

The Goals… (con't)

GOAL 6 CLEAN WATER AND SANITATION



75.8%

in 2030 with BAU projection

100%

in 2030 with intervention projection

- Policy intervention scenario using annual increasing rate of 4.5%

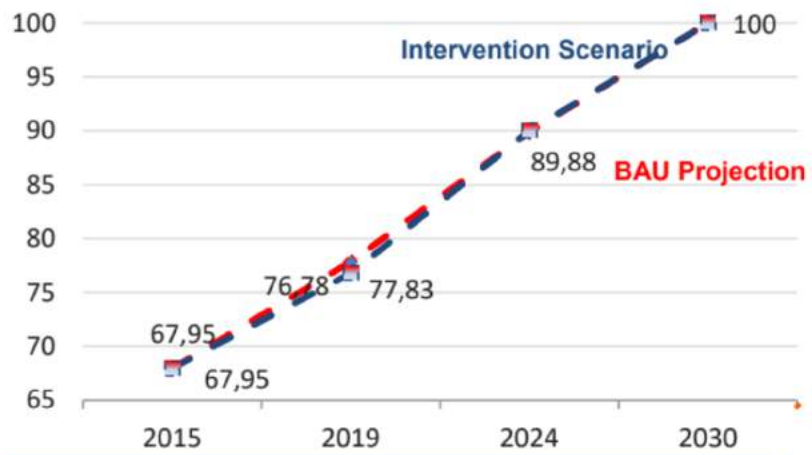
Source: Directorate for Development of Urban, Housing, and Settlement Areas, Bappenas

- **Access to an improved drinking water service** is strongly correlated with other development issues such as **health, hunger, and poverty and human development**. Almost 1/10 of global disease burden could be prevented by increasing access to safe drinking water. **Diarrhoea, which contributes 31% in infant mortality in Indonesia, could be reduced by 42-47% with an improved drinking water service** (WHO, 2012).

- Access to an improved drinking water service has been increasing annually. However, there are still **80 million people have not had an access to an improved drinking water service**, which makes them more vulnerable to nutrition problems. Even in the capital city, Jakarta, the access to safe drinking water **has not reached 100%.**
- Efforts are still required to attain a universal access to a clean and safe drinking water for all. Business as usual projection will still leave around 70 million of people have no access to safe drinking water. Well designed programs should be accelerated to provide safe drinking water for all.

The Goals… (con't)

GOAL 6 CLEAN WATER AND SANITATION



Source: Directorate for Development of Urban, Housing, and Settlement Areas, Bappenas

100%

universal access to clean sanitation in 2030 is going to be achieved

- The data has accommodated the change of clean sanitation classification in SUSENAS, BPS

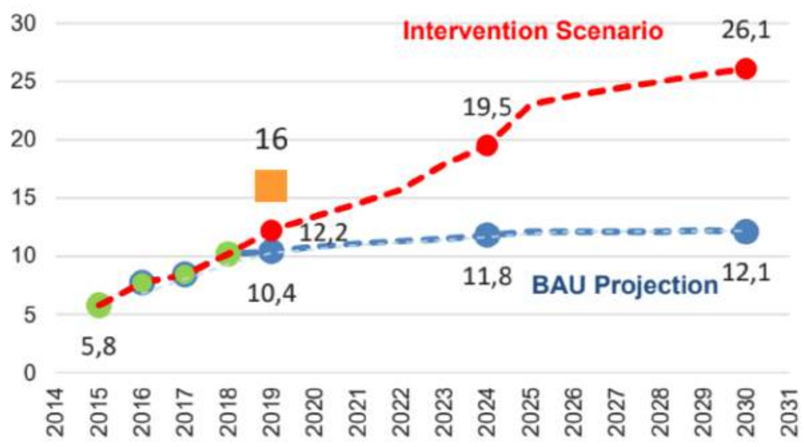
- Similar to access to an improved drinking water, access to an improved sanitation correlates strongly with development issues. Particularly, **poor sanitation causes inflamation** in small intestines which makes the nutrient absorption is not optimal. The whole process creates higher probability of **stunting in the households who have poor sanitation**.

- Issues in sanitation is not only about access to toilet facility or the septic tank, but it is also about septage and wastewater management. Indonesia has 150 septage treatment plants, but 90% of them are no longer in operation and only 4% of collected septage is treated at a facility (Bappenas, 2018). At the same time, **open defecation practice** are still persistent in **rural areas** in Indonesia.
- A stronger leadership and technical support for local implementation from national government through clear regulations and guidelines are needed to tackle the challenges in clean sanitation provision for all.

The Goals… (con’t)

The Goals… (con't)

GOAL 7 AFFORDABLE AND CLEAN ENERGY



12.1% Renewable energy mix in 2030 with business-as-usual scenario

26.1% Renewable energy mix in 2030 with intervention scenario

RPJMN 2020-2024's target is 20%

Data source: Ministry of Energy and Mineral Resources

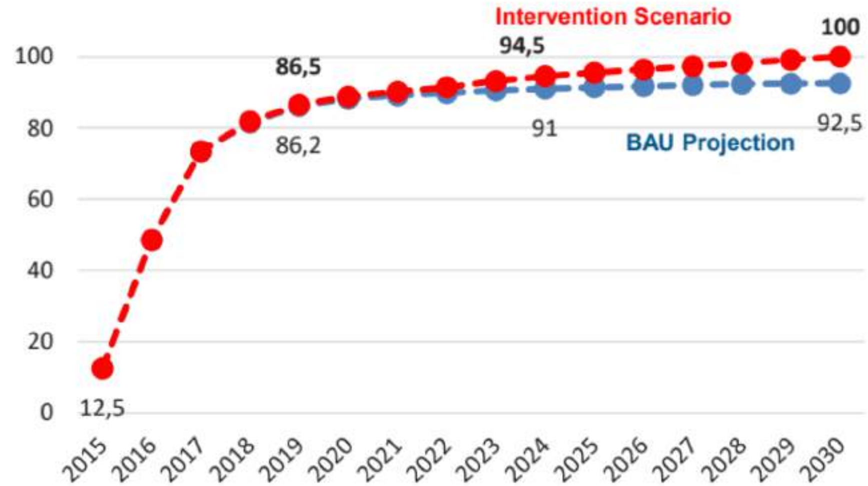
- Primary energy mix in Indonesia is still **dominated** by **fossil fuel and coal** which account for **38% and 30% of total primary energy** in 2016.[1] The use of new renewable energy (NRE) continues to increase but still not realized at its full potential and lag behind other traditional sources of energy such as coal and fossil fuel.
- Presently, the main supplies of NRE in Indonesia come from hydropower, then followed by biomass, geothermal, and biodiesel. These sources of power have not been developed optimally due to various constraints such as high initial investment costs, geographical location, and low efficiency.

[1]Indonesia Energy Outlook 2018, Agency for the Assessment and Application of Technology (2018).

- With the current pace of NRE development, the government target of NRE mix at 23% in 2025 is difficult to achieve. A study by the Agency for the Assessment and Application of Technology (2018) estimates **NRE proportion to total primary energy will only reach 12.9% in 2025 and 14.9% in 2050.**
- More ambitious policies and a comprehensive NRE program that include stakeholders both from the demand and supply sides have to be implemented in order to accelerate renewable energy mix in Indonesia.

The Goals… (con't)

GOAL 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



92.5% in 2030 with BAU projection

100% in 2030 with intervention projection

Source: Ministry of Communications and Information Technology

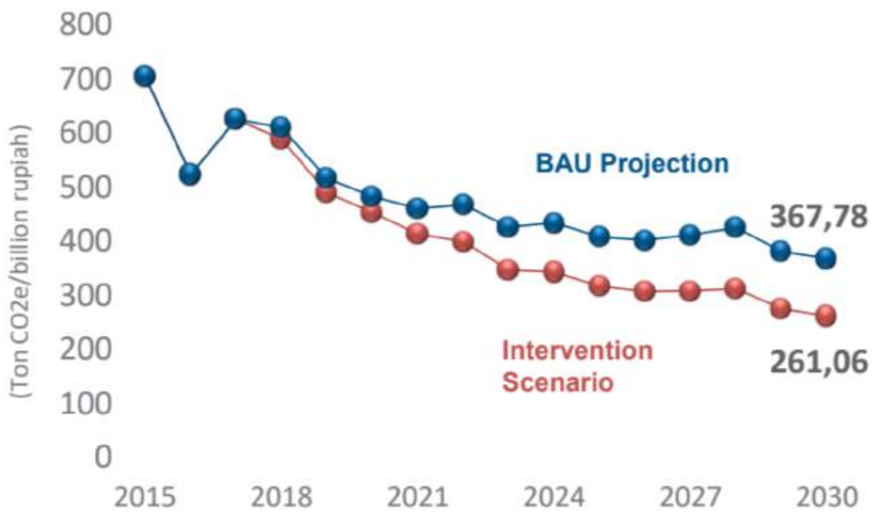
- In the era where digital technology is inevitable and more people need to be connected to keep up with the changing-era, mobile broadband service is a **necessary feature to help people be more empowered**. Government's commitment to provide mobile broadband service in all regions in Indonesia had shown a fruitful result as **mobile broadband's penetration reached 90%** in 2019 (Kominfo, 2019).
- Nevertheless, disparity in regional development between the eastern and the western part of Indonesia still persists as it affects to the low rate of population served by mobile broadband service. In Maluku and Papua, for instance, **55% of villages had not received a cellular phone signal, and only 60% of the population master the cell-phone** (SUSENAS, 2014).
- Strong commitment from national and local government with a well-targeted policy package should be accelerated to reach the 2030 agenda. This number is highly possible as the rate is showing a promising trend for the upcoming decade.

The Goals… (con't)

The Goals… (con't)

The Goals... (con't)

GOAL 13 CLIMATE ACTION



367.78
Ton CO^2e/billion Rupiah
in 2030 with BAU scenario

261.06
Ton CO^2e/billion Rupiah
in 2030 with intervention scenario

Source: Directorate for the Environment, Bappenas

In 2030, green house gas emissions in Indonesia will be mostly sourced from fossil fuel consumption where it contributed 57% from the total GHG emissions.

- Came the second, **deforestation and land-use diversion also contributed 30% of the total emissions** (Bappenas, 2019). **Forest and peat fires in Indonesia emitted more than 1 billion tons of CO^2** (Anderson et al, 2016) which mostly caused by **land clearing**.
- Tackling the climate change would involve the improvement in **renewable energy and energy efficiency**, and also the increase in **reforestation**. However, as the development target requires a multi-sectoral approach, addressing the climate change issue should also be in line with maintaining the economic growth.

The Goals… (con't)

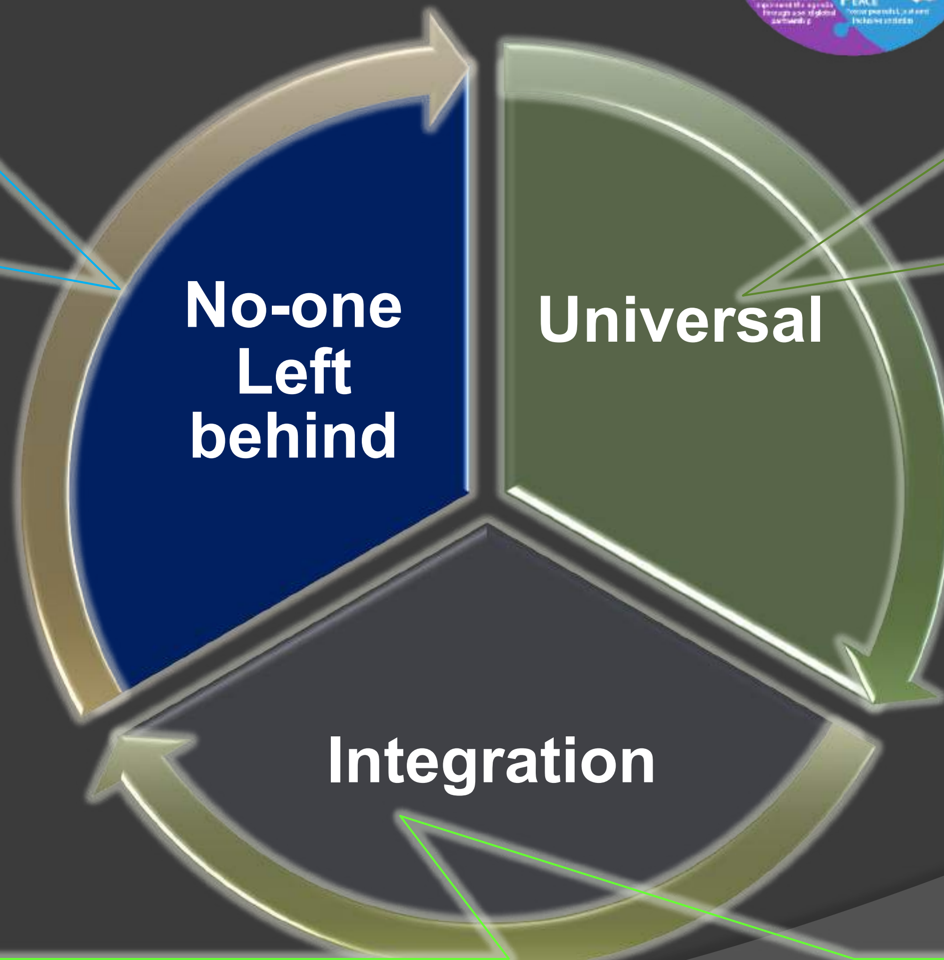
MDGs to SDGs (TPB)

2016-2030

MDGs to SDGs (TPB) (con't)

Prinsip TPB/SDGs

TPB/SDGs harus memberi manfaat bagi semua, terutama yang rentan; serta pelaksanaannya melibatkan semua pemangku kepentingan;



Dilaksanakan oleh dunia terkait dengan tujuan dan sasaran yang transformatif, berpusat pada manusia, komprehensif, dan berjangka panjang

TPB/SDGs dilaksanakan secara terintegrasi dan saling terkait pada semua dimensi sosial, ekonomi dan lingkungan

TPB/SDGs: Kemajuan Semua Bangsa

Prinsip Universal SDGs bertujuan untuk kemajuan semua bangsa di dunia

- Kemajuan pada satu dimensi membutuhkan keterlibatan aktif dimensi lain;
- Katalis untuk kemitraan internasional;
- Kepemilikan bersama;
- SDGs sebagai kerangka komprehensif, terintegrasi dan tidak terpisahkan.

Kerangka Pelaksanaan TPB di Indonesia

- 17 tujuan global (dan 169 target) yang ditetapkan di PBB tahun 2015: *the 2030 Agenda for Sustainable Development*
- Diratifikasi oleh 193 negara, termasuk Indonesia
- Di tingkat lokal, setiap negara harus menerjemahkan TPB ke dalam kebijakan nasional, perencanaan, dan program (KRP), serta mengalokasikan anggaran dan menemukan mitra untuk mencapai tujuan tersebut
- Di Indonesia, diturunkan ke dalam Permendagri No.7/2018 tentang KLHS:
- Pasal 3(b,c): pengkajian PB, perumusan skenario PB
- Pasal 5(2): a] mengkaji kondisi umum daerah, b] menentukan capaian indikator TPB yang relevan, dan c] menentukan pembagian peran antar pemangku kepentingan

Kerangka Pelaksanaan TPB di Indonesia

DIMENSI PEMBANGUNAN NASIONAL (RPJMN 2015-2019)

DIMENSI PEMBANGUNAN MANUSIA

- **Pendidikan**
- **Kesehatan**
- **Perumahan**

DIMENSI PEMBANGUNAN SEKTOR UNGGULAN

- **Ketahanan Pangan**
- **Ketahanan Energi & Ketenagalistrikan**
- **Ketahanan Air**
- Kemaritiman
- Pariwisata dan Industri

DIMENSI PEMERATAAN & KEWILAYAHAN

- Antar Kelompok Pendapatan
- Antar Wilayah

Relevansi TPB/SDGS dengan Pembangunan Nasional

Indonesia:

- Negara Kepulauan Terbesar (17,000 pulau)
- Negara Keempat dengan Populasi Terbesar (255 Juta Orang)

<u>Tantangan Terbesar:</u>
Memastikan pertumbuhan yang inklusif dan pemerataan kesejahteraan untuk semua

Kondisi saat ini

- **Pertumbuhan ekonomi yang relatif tinggi**
- **Inflasi yang rendah dan nilai tukar yang stabil**
- **Berkurangnya tingkat pengangguran dan koefisien gini**
- **Peningkatan Indeks Pembangunan Manusia**

- **TPB/SDGs menawarkan kerangka pelaksanaan yang fokus pada pengurangan kesenjangan dan memastikan tidak ada satu orang pun yang tertinggal**

Empat Pilar Pelaksanaan TPB

TPB
17 Goals, 169 Target, 241 Indikator

Pilar Pembangunan Sosial
5 Goals, 47 Target, 77 Indikator

- **Goal 1**: TanpaKemiskinan;
- **Goal 2**: TanpaKelaparan;
- **Goal 3**: Kehidupan Sehat dan Sejahtera;
- **Goal 4**: Pendidikan Berkualitas;
- **Goal 5**: Kesetaraan Gender;

Pilar Pebangunan Ekonomi
5 Goals, 54 Target, 72 Indikator

- **Goal 7**: Energi Bersih & Terjangkau;
- **Goal 8**: Pekerjaan Layak & Pertumbuhan Ekonomi;
- **Goal 9**: Industri, Inovasi, & Infrastruktur;
- **Goal 10**: Berkurangnya Kesenjangan;
- **Goal 17:** Kemitraan untuk Mencapai Tujuan

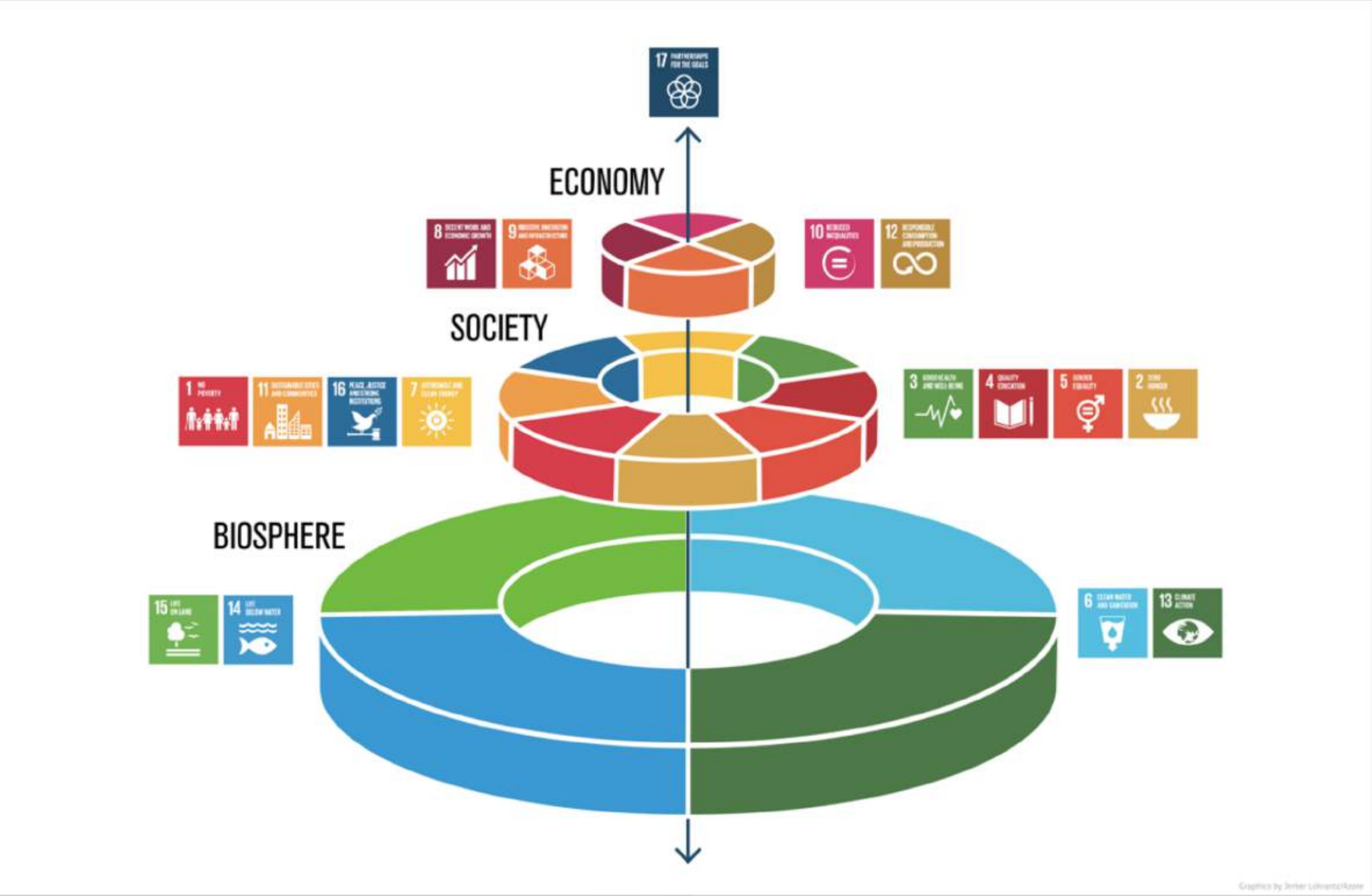
Pilar Pembangunan Lingkungan
6 Goals, 56 Target, 69 Indikator

- **oal 6 :** Air Bersih dan Sanitasi Layak;
- **oal 11**: Kota% permukiman yangBberkelanjutan
- **Goal 12**: Konsumsi & Produksi yang Bertanggung Jawab;
- **oal 13**: Penanganan Perubahan Iklim;
- **oal 14**: Ekosistem Lautan;
- **oal 15**: Ekosistem Daratan;

Pilar Pembangunan Hukum dan Tata Kelola
1 Goals, 12 Target, 23 Indikator

- **Goal 16**: Perdamaian, Keadilan, dan Kelembagaan yang Tangguh;

Pengelolaan Lingkungan Sebagai Dasar TPB



Strategi Pencapaian TPB

1. Sinergi dan Terpadu
2. Multidimensional
3. Kerjasama Multipihak
4. Perspektif Jangka Panjang
5. Internalisasi Dampak Lingkungan dan Sosial dalam Pertumbuhan Ekonomi

Peran para Pemagku Kepentingan

1. Penetapan Indikator dalam Setiap Target/Sasaran
2. Pengembangan Kebijakan, Regulasi, & Penyelarasan Program /Kegiatan
3. Penyiapan Data dan Informasi yang Digunakan
4. Sosialisasi/Diseminas, Komunikasi & Advokasi
5. Monev & Pelaporan
6. Pendanaan

PEMERINTAH & PARLEMEN

AKADEMISI & PAKAR

1. Peningkatan Kapasitas
2. Pemantauan dan Evaluasi
3. *Policy Paper/Policy Brief* sebagai dasar *Policy Formulation*

Implementasi TPB

FILANTROPI & BISNIS

1. Advokasi kepada Pelaku Usaha
2. Fasilitasi Program/Kegiatan kepada Pelaku Usaha
3. Peningkatan Kapasitas
4. Dukungan Pendanaan

OMS & MEDIA

1. Diseminasi dan Advokasi kepada Masyarakat
2. Fasilitasi Program/Kegiatan di Lapangan
3. Membangun pemahaman publik
4. *Monitoring* Pelaksanaan

Komitmen Indonesia dalam Pelaksanaan TPB/SDGs

Tujuan Pembangunan Berkelanjutan/SDGs adalah pembangunan yang menjaga:

- peningkatan kesejahteraan ekonomi masyarakat;
- keberlanjutan kehidupan sosial masyarakat,
- kualitas lingkungan hidup;
- pembangunan yang menjamin keadilan dan terlaksananya tata kelola.

Komitmen:

1. Melaksanakan TPB/SDGs untuk **transformasi peradaban global yang lebih adil, damai, sejahtera, dan berkelanjutan;**
2. **Penepatan Perpres Nomor 59 Tahun 2017** tentang Pelaksanaan Pencapaian Tujuan Pembangunan Berkelanjutan;
3. **Melaksanakan Nawacita yang selaras dengan TPB/SDGs,** diterjemahkan **ke dalam RPJMN 2015-2019;**
4. Presiden RI memimpin dan memantau pelaksanaan TPB/SDGs karena **pencapaian TPB/SDGs sekaligus menjadi tolok ukur tercapainya agenda pembangunan nasional**.

GREEN TECHNOLOGY TOWARDS SDG's

Key Messages

Science, technology and innovation (STI) policy is fundamental to implement the new United Nations “2030 Agenda” for sustainable development (SD)

It enables economic and environmental efficiency, fosters new and sustainable ways to satisfy human needs and empowers people to take their own future in hand.

Green Technology towards SDGs: Environment, Climate Change, and Circular Economy

ICT and climate change

- **ITU-L.1002** "External universal power adapter solutions for portable information and communication technology devices "

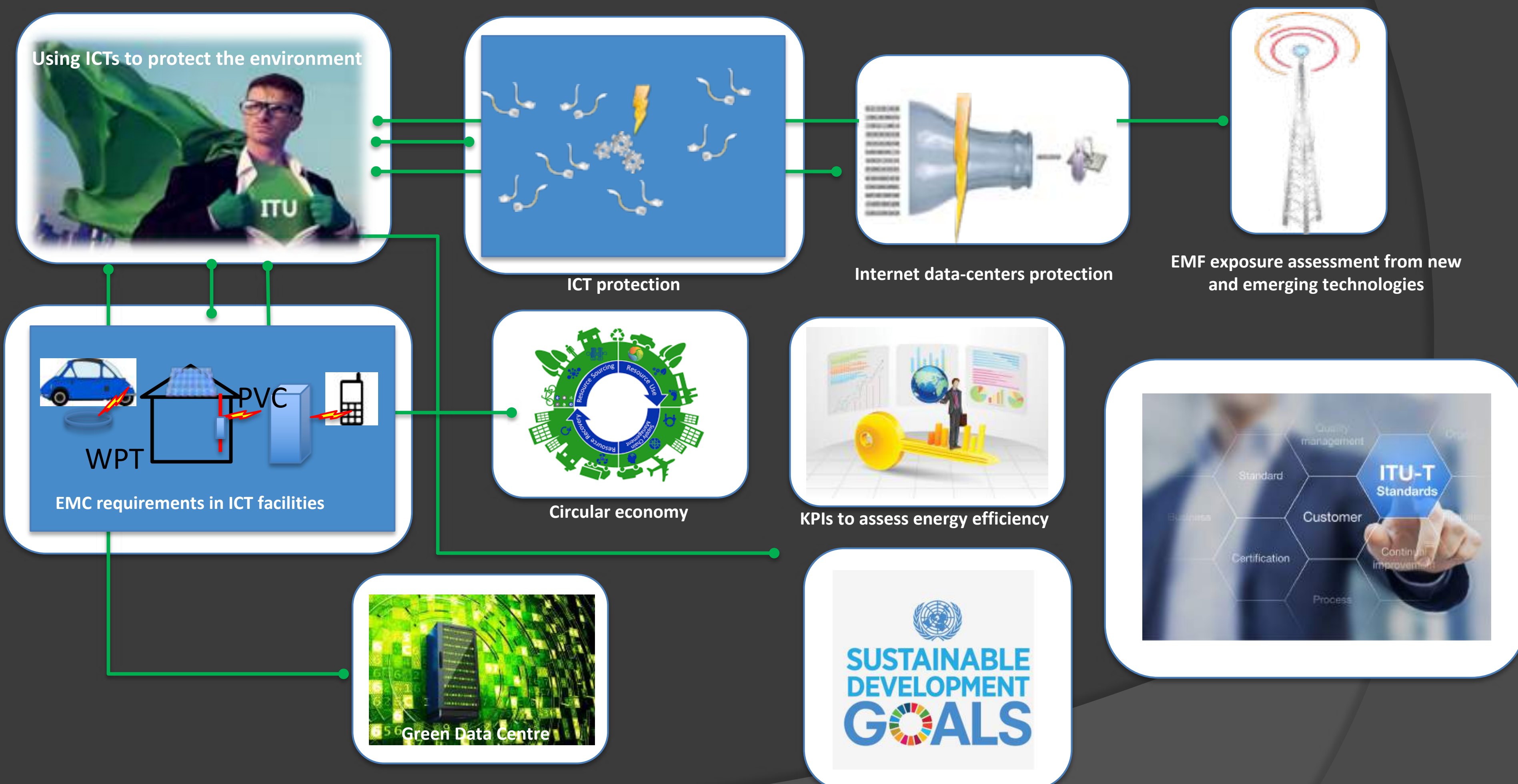
☞ **Builds on ITU-T standards defining universal chargers for hand-held devices such as mobile phones (ITU-T L.1000) and stationary devices such as xDSL modems (ITU-T L.1001)**

Latest Reports

Report on "Monitoring of electromagnetic field levels in Latin America"

Report on "Sustainable Management of waste electrical and Electronic equipment in Latin America"

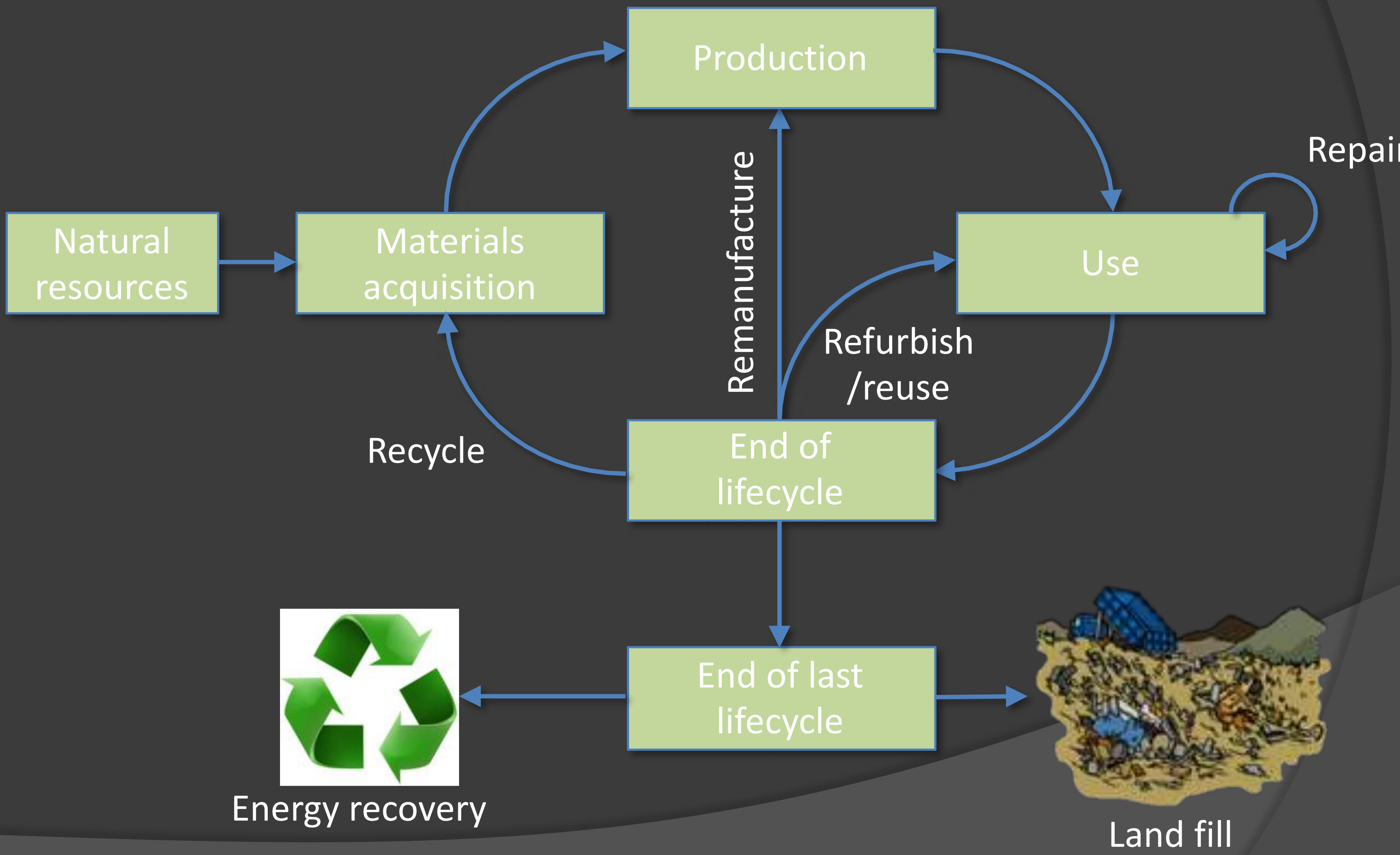
Green Technology towards SDGs



Green Technology towards SDGs: Environment, Climate Change, and Circular Economy

SUSTAINABLE DEVELOPMENT GOALS

Circular Eonomy: Concept



Environment: Concepts

E-waste

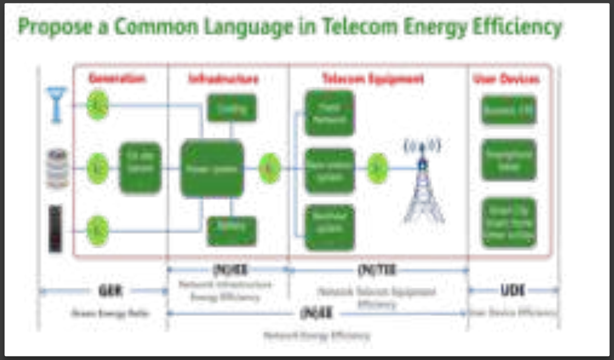
Adaptation to climate change

Counterfeit ICT devices

Low-cost, sustainable, resilient ICTs

Energy efficiency: Concepts

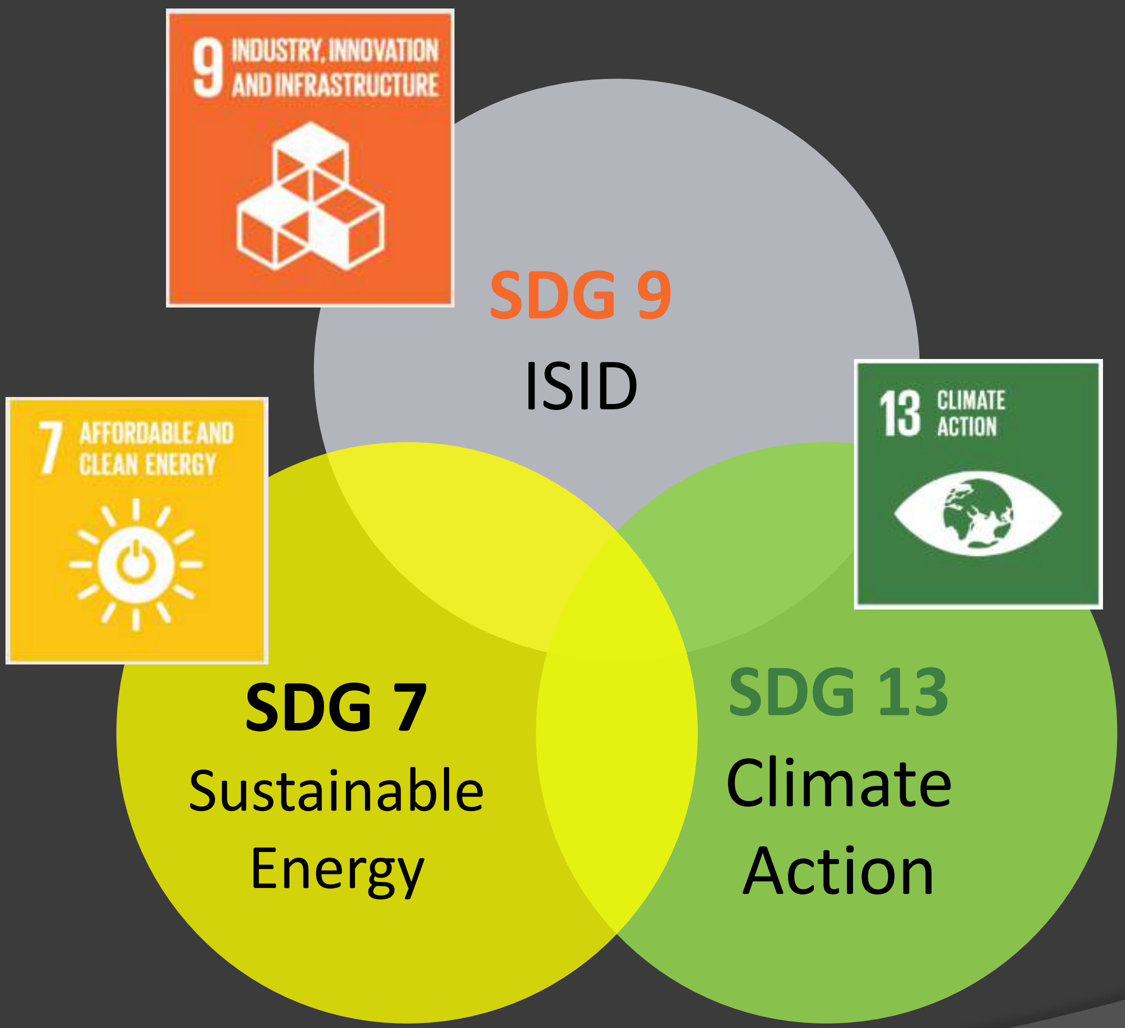
Guides and terminology



Energy efficiency

Green Technology: Green Building

SDGs: Industry, SE4ALL



- **Business Models**
- **Women's Empowerment**
- **Sustainable Energy and Climate Agreement**

Promoting sustainable energy solutions for productive capacities, industrial competitiveness and job creation

Industrial Energy Efficiency

Renewable Energy for Productive Uses

Low-Carbon Low Emission Technologies

Climate Policy, Partnership and Global Forums

Low Carbon Low Emission Clean Energy Technology Transfer (LCET) Programme

Promoting dissemination of low carbon technologies in developing countries to increase access to renewable energy for productive uses and job creation in rural areas.

Countries targeted: Ethiopia, Kenya

Pilots:
Demonstrating innovative advanced Micro Hydropower and Solar Energy Technologies in the initial phase

UNIDO for Indonesia through cleaner production programes towards Green Industry

- Introduction of an Environmentally Sound Management and Disposal System for PCB Wastes and PCB Contaminated Equipment in Indonesia,
- National Network for Implementation of Resource Efficient and Cleaner Production in Indonesia
- Introduction of BAT and BEP in the Thermal Processes in Metallurgical Industry in Indonesia
- Support to the Government of Indonesia to fulfill its obligations on the Minamata Convention on Mercury, and
- Phase-out of HBCD-based flame retardant in the EPS and XPS

TERIMA KASIH

POTENSI ENERGI TERBARUKAN DI INDONESIA
(PANAS BUMI, BIO ENERGI DAN ANEKA EBT)

Yusrizal Afif, S.T.,M.T
Teknik Elektro

SUMBER ENERGI DI INDONESIA

Rencana Umum Energi Nasional (RUEN), 2017

Energi Tak Terbarukan

- Minyak Bumi
- Gas Bumi
- Batu Bara

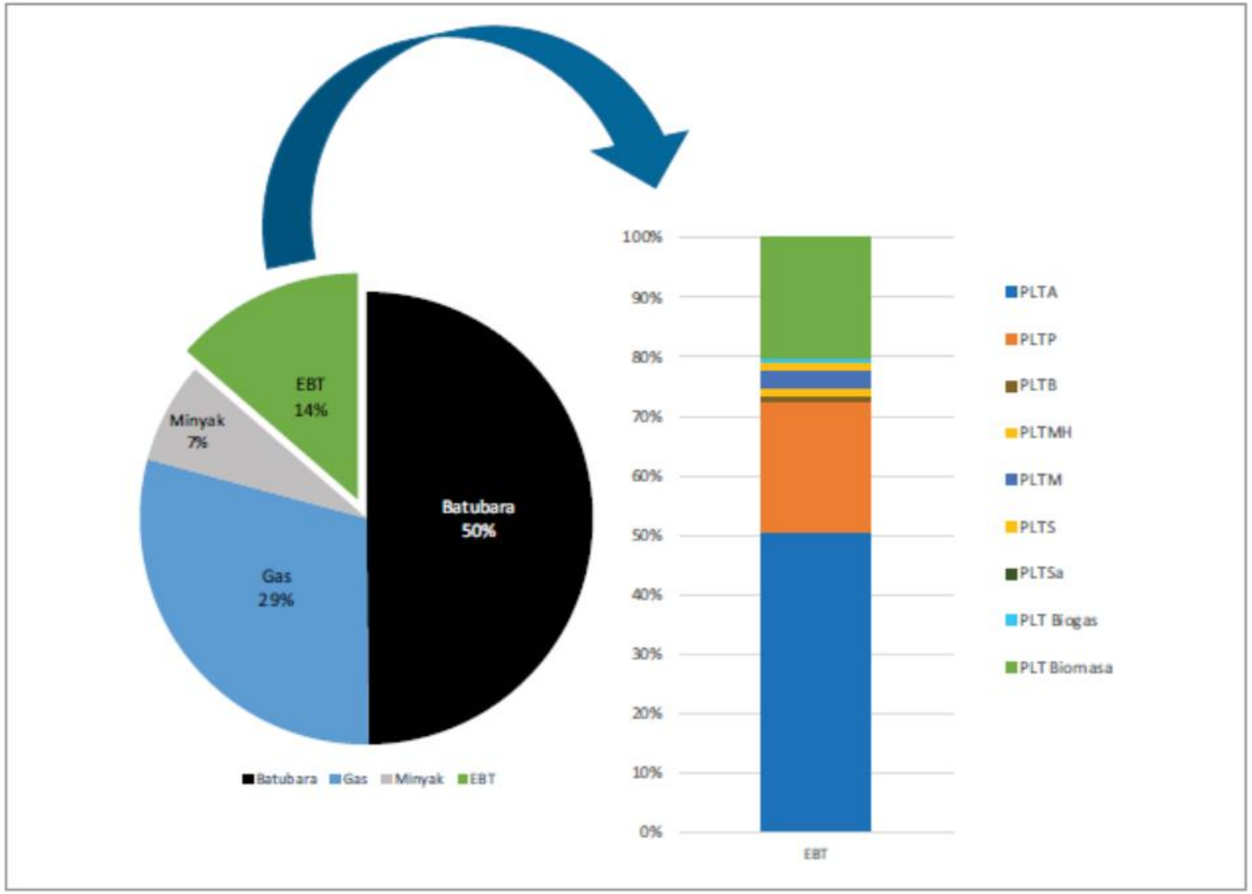
Energi Terbarukan

- Panas Bumi
- Air
- Minihidro dan Mikrohidro
- Bioenergi
- Surya
- Angin
- EBT Lain (PLTD campuran bioenergy, PLT Arus Laut, PLT gelombang Laut, PLT energy panas laut)

KAPASITAS PEMBANGKIT TERPASANG

Outlook Energi Indonesia (OEI) 2019

Kapasitas pembangkit tenaga listrik sampai dengan tahun 2018 mencapai 64,5 GW atau naik sebesar 3% dibandingkan kapasitas tahun 2017. Kapasitas terpasang pembangkit listrik tahun 2018 sebagian besar berasal dari pembangkit energi fosil khususnya batubara (50%), diikuti gas bumi (29%), BBM (7%) dan energi terbarukan (14%)



Sumber : HEESI, 2018

IDENTIFIKASI POTENSI ENERGI

Rencana Umum Energi Nasional (RUEN), 2017

Identifikasi potensi energi baru terbarukan dapat didefinisikan menjadi 5 (lima) jenis, antara lain :

1. Potensi teoritis (potensi terukur berdasarkan data lapangan melalui sistem permodelan)
2. Potensi teknis (potensi yang teridentifikasi apabila suatu teknologi dapat diterapkan di lokasi tersebut)
3. Potensi praktis (potensi teridentifikasi apabila teknologi dan alat pengukur bisa diterapkan dan dipasang di lokasi potensi)
4. Potensi ekonomis (potensi energi yang benar-benar bisa dimanfaatkan)
5. Potensi aksesibel (potensi yang memperhitungkan demand, infrastruktur jalan, tata masyarakat dan jaringan listrik eksisting)

Panas Bumi

Kepulauan Indonesia secara geografis terletak di wilayah pertemuan antara Lempeng Benua Eurasia (Eropa-Asia), Lempeng Hindia-Australia, dan Lempeng Samudra Pasifik. Pertemuan lempeng samudra yang menunjam ke bawah lempeng benua mengakibatkan adanya aktivitas tektonik yang menyebabkan pembentukan rangkaian gunung api aktif yang tersebar sepanjang Sumatera, Jawa, Bali, Sulawesi hingga ke Maluku serta kemunculan jalur-jalur pegunungan dan sesar-sesar aktif.

Satuan: MW

No.	Provinsi	Potensi						
		Sumber Daya			Cadangan			
		Speculative	*Hypothetical*	Total	*Possible*	*Probable*	*Proven*	Total
1	Jawa Barat	1.225	934	2.159	1.687	543	1.535	3.765
2	Sumatera Utara	300	134	434	1.996	-	320	2.316
3	Lampung	600	643	1.243	1.319	-	20	1.339
4	Sumatera Selatan	273	645	918	964	-	-	964
5	Jawa Tengah	130	387	517	949	115	280	1.344
6	Sumatera Barat	532	269	801	1.035	-	-	1.035
7	Nusa Tenggara Timur	226	403	629	748	-	15	763
8	Jawa Timur	105	257	362	1.012	-	-	1.012
9	Bengkulu	357	223	580	780	-	-	780
10	Aceh	640	340	980	332	-	-	332
11	Jambi	348	74	422	566	15	40	621
12	Sulawesi Utara	55	73	128	540	150	78	768
13	Maluku Utara	190	7	197	580	-	-	580
14	Sulawesi Tengah	349	36	385	368	-	-	368
15	Maluku	370	84	454	220	-	-	220
16	Banten	100	161	261	365	-	-	365
17	Sulawesi Barat	316	53	369	162	-	-	162
18	Sulawesi Selatan	172	120	292	163	-	-	163
19	Bali	70	22	92	262	-	-	262
20	Sulawesi Tenggara	200	25	225	98	-	-	98
21	Gorontalo	129	11	140	110	-	-	110
22	Nusa Tenggara Barat	-	6	6	169	-	-	169
23	Bangka Belitung	100	6	106	-	-	-	-
24	Papua Barat	75	-	75	-	-	-	-
25	Kalimantan Barat	65	-	65	-	-	-	-
26	Kalimantan Selatan	50	-	50	-	-	-	-
27	Kalimantan Utara	20	30	50	-	-	-	-
28	Riau	41	-	41	-	-	-	-
29	Kalimantan Timur	18	-	18	-	-	-	-
30	Yogyakarta	-	-	-	10	-	-	10
	Total	7.055	4.943	11.998	14.435	823	2.288	17.546

Kapasitas Terpasang PLT Panas Bumi dan Rencana Sampai 2025

Satuan: MW

No.	Provinsi	Total Kapasitas Terpasang per Tahun										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	Jawa Barat	1.164,0	1.194,0	1.194,0	1.194,0	1.269,0	1.449,0	1.569,0	1.767,0	1.767,0	1.917,0	1.972,0
2	Lampung	110,0	165,0	220,0	220,0	220,0	220,0	220,0	275,0	495,0	605,0	825,0
3	Sumatera Utara	12,0	122,0	232,0	342,0	347,0	507,0	587,0	587,0	587,0	717,0	717,0
4	Jawa Tengah	60,0	60,0	70,0	70,0	80,0	140,0	200,0	420,0	640,0	710,0	710,0
5	Jawa Timur		-	-	-	-	55,0	165,0	165,0	220,0	440,0	520,0
6	Bengkulu		-	-	55,0	110,0	140,0	140,0	255,0	255,0	340,0	505,0
7	Sumatera Selatan		-	55,0	110,0	110,0	201,0	201,0	256,0	371,0	371,0	505,0
8	Sumatera Barat		-	-	-	80,0	80,0	80,0	100,0	100,0	300,0	300,0
9	Sulawesi Utara	80,0	100,0	125,0	130,0	150,0	150,0	170,0	170,0	170,0	210,0	250,0
10	Aceh	-	-	-	-	10,0	10,0	10,0	65,0	65,0	120,0	230,0
11	Jambi		-	-	-	55,0	60,0	115,0	115,0	145,0	145,0	200,0
12	Banten		-	-	-	-	-	-	110,0	110,0	150,0	150,0
13	Nusa Tenggara Timur	12,5	12,5	12,5	12,5	42,5	77,5	82,5	92,5	102,5	102,5	117,5
14	Maluku Utara		-	-	-	-	-	-	20,0	20,0	55,0	70,0
15	Sulawesi Tengah		-	-	-	-	-	-	-	-	-	60,0
16	Nusa Tenggara Barat		-	-	-	-	-	-	-	-	20,0	40,0
17	Sulawesi Tenggara		-	-	-	-	-	-	-	-	-	20,0
18	Gorontalo		-	-	-	-	-	-	-	-	20,0	20,0
19	Maluku		-	-	-	20,0	20,0	20,0	20,0	20,0	20,0	20,0
20	Bali		-	-	-	-	-	-	-	-	-	10,0
21	Kalimantan Tengah		-	-	-	-	-	-	-	-	-	-
Total Kapasitas Terpasang		1.438,5	1.653,5	1.908,5	2.133,5	2.493,5	3.109,5	3.559,5	4.417,5	5.067,5	6.242,5	7.241,5
Total Tambahan/Tahun		-	215,0	255,0	225,0	360,0	616,0	450,0	858,0	650,0	1.175,0	999,0

Air

Sebagai negara yang berada di wilayah khatulistiwa, Indonesia memiliki curah hujan yang sangat tinggi setiap tahunnya sehingga memiliki sumber air yang cukup besar baik itu run off river ataupun bendungan, sehingga memiliki potensi energi air yang potensial untuk dapat dimanfaatkan dan dikembangkan baik untuk pembangkit listrik.

Satuan: MW

No.	Wilayah/Provinsi	Potensi
1	Papua	22.371
2	Kalsel, Kalteng, Kaltim	16.844
3	Sulsel, Sultra	6.340
4	Aceh	5.062
5	Kalimantan Barat	4.737
6	Sulut, Sulteng	3.967
7	Sumatera Utara	3.808
8	Sumatera Barat, Riau	3.607
9	Sumsel, Bengkulu, Jambi, Lampung	3.102
10	Jawa Barat	2.861
11	Jawa Tengah	813
12	Bali, NTB, NTT	624
13	Jawa Timur	525
14	Maluku	430
	Total	75.091

Kapasitas Terpasang PLT Air dan Rencana Sampai 2025

Satuan: MW

No.	Provinsi	Total Kapasitas Terpasang per Tahun										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	Jawa Barat	1.991,9	1.991,9	2.038,9	2.038,9	2.148,9	2.148,9	2.148,9	2.148,9	2.148,9	2.148,9	3.116,6
2	Sulawesi Selatan	521,6	521,6	521,6	521,6	521,6	569,1	803,6	965,6	1.586,6	2.051,6	2.412,6
3	Sumatera Utara	922,5	967,5	967,5	967,5	1.204,0	1.211,5	1.211,5	1.241,5	1.916,5	1.916,5	2.269,8
4	Papua	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	27,9	47,9	2.208,9
5	Aceh	2,4	2,4	12,4	110,4	128,4	128,4	187,4	187,4	318,4	318,4	1.573,4
6	Nusa Tenggara Timur	-	-	-	-	-	10,0	16,5	16,5	16,5	16,5	929,9
7	Sulawesi Barat	-	-	-	-	-	-	-	28,0	56,0	206,0	847,8
8	Jawa Tengah	306,8	306,8	306,8	306,8	306,8	306,8	306,8	306,8	306,8	656,8	667,1
9	Kalimantan Timur	-	-	-	-	-	-	-	-	-	275,0	605,0
10	Jawa Timur	293,2	293,2	293,2	293,2	293,2	293,2	293,2	430,2	430,2	430,2	430,2
11	Sulawesi Tengah	195,0	195,0	195,0	195,0	195,0	265,0	265,0	265,0	265,0	345,0	425,0
12	Sumatera Barat	254,2	254,2	254,2	254,2	254,2	254,2	254,2	306,2	306,2	395,2	395,2
13	Jambi	-	-	-	-	-	-	-	175,0	350,0	350,0	370,7
14	Papua Barat	2,0	2,0	2,0	2,0	2,0	2,0	2,0	2,0	22,0	22,0	358,1
15	Bengkulu	248,0	248,0	248,0	269,0	269,0	269,0	269,0	296,5	321,5	321,5	348,5
16	Kalimantan Barat	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	243,5
17	Kalimantan Utara	-	-	-	-	-	-	-	-	-	110,0	220,0
18	Sulawesi Tenggara	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	146,6	182,6	182,6
19	Kalimantan Selatan	30,0	30,0	30,0	30,0	30,0	30,0	30,0	30,0	30,0	30,0	95,0
20	Sulawesi Utara	51,4	51,4	51,4	51,4	51,4	63,4	93,4	93,4	93,4	93,4	93,4
21	Lampung	-	-	-	56,0	56,0	56,0	56,0	83,0	83,0	83,0	83,0
22	Riau	-	-	-	-	-	-	-	-	-	-	76,4
23	Nusa Tenggara Barat	-	-	-	-	-	-	-	-	12,0	18,0	18,0
24	Maluku	-	-	-	-	-	-	-	-	16,0	16,0	16,0
Total Kapasitas Terpasang		4.826,7	4.871,7	4.928,7	5.103,7	5.468,2	5.615,2	5.945,2	6.583,7	8.455,7	10.036,7	17.986,7
Total Tambahan/Tahun		-	45,0	57,0	175,0	364,5	147,0	330,0	638,5	1.872,0	1.581,0	7.950,0

Minihidro dan Mikrohidro

Selain memiliki potensi energi air yang dapat dimanfaatkan menjadi Pembangkit Listrik Tenaga Air (PLTA) berskala besar, Indonesia juga memiliki Potensi energi air lainnya, yaitu berupa Pembangkit listrik minihidro dan mikrohidro (PLTM/H) berskala kecil.

Satuan: MW

No.	Provinsi	Potensi
1	Kalimantan Timur	3.562
2	Kalimantan Tengah	3.313
3	Aceh	1.538
4	Sumatera Barat	1.353
5	Sumatera Utara	1.204
6	Jawa Timur	1.142
7	Jawa Tengah	1.044
8	Kalimantan Utara	943
9	Sulawesi Selatan	762
10	Jawa Barat	647
11	Papua	615
12	Sumatera Selatan	448
13	Jambi	447
14	Sulawesi Tengah	370
15	Lampung	352
16	Sulawesi Tenggara	301

Satuan: MW

No.	Provinsi	Potensi
17	Riau	284
18	Maluku	190
19	Kalimantan Selatan	158
20	Kalimantan Barat	124
21	Gorontalo	117
22	Sulawesi Utara	111
23	Bengkulu	108
24	Nusa Tenggara Timur	95
25	Banten	72
26	Nusa Tenggara Barat	31
27	Maluku Utara	24
28	Bali	15
29	Sulawesi Barat	7
30	DI. Yogyakarta	5
31	Papua Barat	3
	Total	19.385

Kapasitas Terpasang PLT Minihidro dan Mikrohidro dan Rencana Sampai 2025

Satuan: MW

No.	Provinsi	Total Kapasitas Terpasang per Tahun										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	Sumatera Utara	23,9	40,8	48,9	93,9	150,8	160,8	170,8	236,3	236,3	289,8	352,0
2	Kalimantan Tengah	0,5	0,5	0,5	28,9	28,9	59,5	93,3	122,3	164,8	199,5	243,9
3	Jawa Barat	18,3	23,3	48,3	91,3	113,8	132,1	167,6	178,1	195,3	219,7	237,4
4	Kalimantan Timur	0,7	0,8	0,8	13,4	13,4	32,7	71,5	97,8	144,9	173,9	173,9
5	Nusa Tenggara Timur	4,1	5,2	5,6	23,6	25,2	46,7	66,4	85,7	111,0	134,9	163,5
6	Sumatera Barat	18,8	20,1	37,8	37,8	77,8	91,2	91,2	111,8	117,8	142,5	142,5
7	Aceh	1,1	1,1	1,1	9,3	11,5	21,8	44,6	81,7	88,5	107,7	132,4
8	Papua	3,5	3,7	8,4	13,6	27,4	28,5	46,5	61,4	84,0	101,5	124,5
9	Sulawesi Selatan	39,1	39,4	48,6	68,9	97,3	107,3	107,3	109,0	109,0	122,3	122,3
10	Jawa Tengah	4,7	8,3	9,2	9,2	16,2	25,3	25,3	39,0	47,8	91,9	119,0
11	Sulawesi Barat	5,0	5,1	5,1	13,3	13,3	27,3	43,2	56,7	76,6	92,6	113,4
12	Bengkulu	0,7	0,7	0,7	0,7	0,7	0,7	7,4	13,4	29,4	34,4	95,4
13	Sulawesi Tengah	42,3	42,3	43,5	43,5	74,6	74,6	74,6	76,0	76,0	90,0	90,0
14	Sulawesi Tenggara	2,9	2,9	7,7	7,7	12,7	14,0	29,4	40,1	58,8	70,7	88,0
15	Jambi	0,3	0,3	0,3	4,4	4,4	11,4	27,4	37,9	57,3	68,7	86,0
16	Maluku	0,0	0,0	0,0	3,3	37,1	42,1	42,1	42,1	50,7	60,7	76,2
17	Nusa Tenggara Barat	13,2	13,3	13,3	14,6	32,0	32,0	32,0	32,3	49,0	58,7	73,6
18	Maluku Utara	0,0	0,0	0,0	3,2	3,2	8,7	22,5	31,2	47,8	57,2	71,8
19	Jawa Timur	1,7	1,7	1,7	1,7	1,7	4,5	4,5	8,9	37,1	49,2	63,0
20	Gorontalo	4,0	4,1	4,1	4,1	6,1	6,1	16,4	24,1	40,6	48,2	61,7
21	Banten	0,1	4,3	15,3	15,3	16,8	21,8	34,8	43,3	43,3	58,3	58,3
22	Lampung	0,6	0,6	0,6	0,6	0,6	0,6	10,1	31,8	35,1	41,2	54,4
23	Sumatera Selatan	1,3	1,3	1,3	2,7	2,7	2,7	20,2	30,2	30,2	36,2	52,4
24	Kalimantan Barat	0,9	0,9	1,0	2,3	17,5	17,5	17,5	17,5	29,7	34,7	46,2
25	Riau	0,2	0,2	0,2	0,2	0,2	0,2	0,2	2,4	20,5	22,9	33,8
26	Kalimantan Utara	0,0	0,1	0,1	0,1	0,1	0,1	0,1	0,1	14,4	14,4	28,4
27	Sulawesi Utara	8,2	8,2	8,2	8,7	16,4	16,4	19,7	19,7	19,7	26,1	26,1
28	Kalimantan Selatan	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	15,1	16,3	25,8
29	Bali	0,0	0,0	0,0	1,4	1,4	1,4	1,4	7,3	7,3	23,5	23,5
30	Papua Barat	1,0	1,0	1,0	2,0	11,0	11,0	11,0	11,0	11,1	11,5	19,8
31	Yogyakarta	0,2	0,2	0,2	0,2	0,2	0,8	0,8	0,8	0,8	0,8	0,8
Total Kapasitas Terpasang		197,4	230,5	313,7	520,0	815,1	1.000,0	1.300,0	1.650,0	2.050,0	2.500,0	3.000,0
Total Tambahan/Tahun		-	33,1	83,2	206,3	295,1	184,9	300,0	350,0	400,0	450,0	500,0

Bioenergi

Pembangkit **biomassa** menggunakan bahan baku dari hasil industry/limbah pabrik kelapa sawit (EFB/tankos), pabrik pulp dan paper (black liquor), pabrik tebu (ampas tebu), pabrik penggilingan padi (sekam padi), pabrik pengolahan jagung (bonggol jagung).

Untuk pembangkit **biogas** menggunakan bahan baku limbah cair kelapa sawit, limbah cair pabrik tapioca, dan terakhir untuk pembangkit sampah kota bahan baku yang digunakan adalah sampah kota yang berada di TPA masing-masing daerah.

Satuan: MW

No.	Provinsi	Potensi		
		Biomass/Biofuel	Biogas	Total
1	Riau	4.157,4	37,7	4.195,1
2	Jawa Timur	2.851,3	569,6	3.420,9
3	Sumatera Utara	2.796,1	115,5	2.911,6
4	Jawa Barat	1.979,8	574,3	2.554,1
5	Jawa Tengah	1.884,1	348,4	2.232,5
6	Sumatera Selatan	2.061,4	71,2	2.132,6
7	Jambi	1.821,0	18,9	1.839,9
8	Kalimantan Tengah	1.486,7	12,2	1.498,9
9	Lampung	1.407,6	84,5	1.492,1
10	Kalimantan Barat	1.279,3	28,9	1.308,2
11	Kalimantan Selatan	1.266,3	23,6	1.289,9
12	Aceh	1.136,6	37,7	1.174,3
13	Kalimantan Timur/Utara	946,6	17,7	964,3
14	Sulawesi Selatan	890,3	69,1	959,4
15	Sumatera Barat	923,1	34,7	957,8
16	Bengkulu	633,0	11,8	644,8
17	Banten	346,5	118,6	465,1
18	Nusa Tenggara Barat	341,3	52,8	394,1
19	Sulawesi Tengah	307,4	19,5	326,9
20	Nusa Tenggara Timur	192,5	48,0	240,5
21	DI. Yogyakarta	183,1	41,1	224,2
22	Bangka Belitung	217,7	5,4	223,1
23	Sulawesi Barat	197,8	8,1	205,9
24	Bali	146,9	44,7	191,6
25	Sulawesi Utara	150,2	13,8	164,0
26	Sulawesi Tenggara	132,8	17,7	150,5
27	Gorontalo	119,1	11,5	130,6
28	DKI Jakarta	0,5	126,1	126,6
29	Papua	81,4	15,1	96,5
30	Papua Barat	50,8	4,1	54,9
31	Maluku Utara	27,5	7,0	34,5
32	Maluku	23,6	9,0	32,6
33	Kepulauan Riau	11,6	4,3	15,9
	Total	30.051,2	2.602,6	32.653,8

Kapasitas Terpasang PLT Bioenergi dan Rencana Sampai 2025

Bioenergi per-komoditas

No	Potensi	Sumatera	Kalimantan	Jamali	Nusa Tenggara	Sulawesi	Maluku	Papua	Total (MWe)
1	Kelapa Sawit	8,812	3,384	60	-	323	-	75	12,654
2	Tebu	399	-	854	-	42	-	-	1,295
3	Karet	1,918	862	-	-	-	-	-	2,781
4	Kelapa	53	10	37	7	38	19	14	177
5	Sekam Padi	2,255	642	5,353	405	1,111	22	20	9,808
6	Jagung	408	30	954	85	251	4	1	1,733
7	Singkong	110	7	120	18	12	2	1	271
8	Kayu	1,212	44	14	19	21	4	21	1,335
9	Limbah ternak	96	16	296	53	65	5	4	535
10	Sampah Kota	326	66	1,527	48	74	11	14	2,066
Total (MWe)		15,588	5,062	9,215	636	1,937	67	151	32,654

Satuan: MW

No.	Provinsi	Total Kapasitas Terpasang per Tahun										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	Riau	179,4	183,4	193,4	195,4	195,4	195,4	195,4	220,7	260,9	306,8	359,0
2	Nusa Tenggara Timur	38,8	39,8	43,8	81,0	110,5	136,9	161,4	190,2	224,0	263,3	308,1
3	Jawa Timur	145,4	145,4	145,4	145,4	145,4	145,4	145,4	172,5	204,7	240,9	281,9
4	Sumatera Utara	126,0	174,5	174,5	176,5	176,5	176,5	176,5	176,5	192,2	226,1	264,5
5	Jambi	88,4	104,4	104,4	104,4	104,4	108,9	132,2	157,1	185,5	218,1	255,2
6	Sulawesi Barat	30,0	30,0	31,0	41,2	75,3	100,7	120,3	142,3	167,9	197,3	230,9
7	Jawa Tengah	98,5	98,5	98,5	98,5	98,5	98,5	111,3	134,5	159,6	187,8	219,8
8	Sumatera Selatan	94,6	98,6	101,1	101,1	101,1	101,1	110,0	132,7	157,4	185,2	216,7
9	Jawa Barat	109,3	121,8	121,8	121,8	121,8	121,8	121,8	131,7	157,0	184,9	216,4
10	Kalimantan Tengah	71,7	72,7	72,7	82,7	82,7	84,2	105,0	125,8	148,9	175,1	204,9
11	Lampung	70,6	70,6	70,6	70,6	70,6	79,5	100,2	120,4	142,6	167,7	196,3
12	Kalimantan Barat	63,9	63,9	85,9	105,9	105,9	105,9	105,9	117,6	139,2	163,8	191,7
13	Aceh	58,2	71,2	81,0	82,5	82,5	82,5	92,2	110,9	131,3	154,5	180,8
14	Papua Barat	10,2	10,2	10,2	10,8	49,8	75,5	92,0	109,5	129,3	152,0	177,9
15	Nusa Tenggara Barat	31,1	31,1	32,1	32,1	46,5	74,6	91,6	109,3	129,2	151,9	177,8
16	Kalimantan Selatan	60,4	66,8	66,8	66,8	66,8	66,8	81,9	99,6	118,4	139,4	163,1
17	Sulawesi Tenggara	20,8	20,8	20,8	20,8	38,0	65,5	81,1	97,0	114,7	134,9	157,9
18	Sulawesi Tengah	26,5	26,5	26,5	26,5	33,6	63,1	78,9	94,6	112,0	131,8	154,2
19	Maluku Utara	16,2	16,2	16,2	16,2	35,7	62,6	77,8	93,0	110,1	129,4	151,5
20	Bengkulu	36,8	42,8	42,8	42,8	42,8	58,2	74,8	90,4	107,3	126,2	147,7
21	Sulawesi Selatan	47,3	47,3	57,3	57,3	57,3	57,3	72,5	88,5	105,2	123,8	144,9
22	Maluku	15,2	15,2	21,2	21,2	30,5	58,1	72,8	87,4	103,5	121,7	142,4
23	Gorontalo	17,8	23,8	23,8	29,8	29,8	53,6	68,3	82,3	97,6	114,8	134,3
24	Sumatera Barat	46,1	46,1	47,1	47,1	47,1	47,6	66,2	81,6	97,4	114,7	134,2
25	Kalimantan Timur	45,2	46,2	58,3	67,8	67,8	67,8	67,8	67,8	67,8	76,7	89,8
26	Sulawesi Utara	14,5	14,5	14,5	14,5	14,5	28,9	43,2	54,2	64,9	76,5	89,6
27	Banten	24,8	24,8	24,8	24,8	24,8	24,8	41,2	53,2	64,1	75,7	88,6
28	Papua	21,2	21,2	21,2	31,2	31,2	31,2	41,8	52,4	62,8	74,1	86,7
29	Bangka Belitung	15,9	25,7	25,7	65,7	65,7	65,7	65,7	65,7	65,7	70,7	82,7
30	DI. Yogyakarta	15,4	15,4	15,4	15,4	15,4	20,2	35,7	46,3	56,0	66,1	77,3
31	Kalimantan Utara	-	-	-	-	-	9,0	29,8	42,1	51,8	61,4	71,8
32	Bali	11,7	12,1	12,1	12,1	12,1	12,1	19,2	29,7	37,3	44,3	51,8
33	Kepalauan Riau	13,0	14,0	14,0	14,0	14,0	14,0	14,0	16,2	22,1	26,6	31,1
34	DKI Jakarta	6,2	6,2	6,2	6,2	6,2	6,2	6,2	6,2	11,8	15,8	18,4
Total Kapasitas Terpasang		1.671,0	1.801,6	1.881,0	2.030,0	2.200,0	2.500,0	2.900,0	3.400,0	4.000,0	4.700,0	5.500,0
Total Tambahan/Tahun		-	130,6	79,4	149,0	170,0	300,0	400,0	500,0	600,0	700,0	800,0

Surya

Sebagai negara yang berada di wilayah khatulistiwa, Indonesia hampir sepanjang tahun mendapatkan sinar matahari yang cukup, sehingga memiliki potensi energi surya yang potensial untuk dapat dimanfaatkan dan dikembangkan baik untuk pembangkit listrik ataupun untuk keperluan lainnya.

Satuan: MW

No.	Provinsi	Potensi
1	Kalimantan Barat	20.113
2	Sumatera Selatan	17.233
3	Kalimantan timur	13.479
4	Sumatera Utara	11.851
5	Jawa Timur	10.335
6	Nusa Tenggara Barat	9.931
7	Jawa Barat	9.099
8	Jambi	8.847
9	Jawa Tengah	8.753
10	Kalimantan Tengah	8.459
11	Aceh	7.881
12	Kepulauan Riau	7.763
13	Sulawesi Selatan	7.588
14	Nusa Tenggara Timur	7.272
15	Papua Barat	6.307
16	Sulawesi Tengah	6.187
17	Kalimantan Selatan	6.031

Satuan: MW

No.	Provinsi	Potensi
18	Sumatera Barat	5.898
19	Kalimantan Utara	4.643
20	Sulawesi Tenggara	3.917
21	Bengkulu	3.475
22	Maluku Utara	3.036
23	Bangka Belitung	2.810
24	Banten	2.461
25	Lampung	2.238
26	Sulawesi Utara	2.113
27	Papua	2.035
28	Maluku	2.020
29	Sulawesi Barat	1.677
30	Bali	1.254
31	Gorontalo	1.218
32	DI. Yogyakarta	996
33	Riau	753
34	DKI Jakarta	225
	Total	207.898

Kapasitas Terpasang PLT Surya dan Rencana Sampai 2025

Satuan: MW

No.	Provinsi	Total Kapasitas Terpasang per Tahun										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	Nusa Tenggara Timur	4,2	14,2	15,0	15,0	20,3	40,5	96,8	159,6	238,0	320,7	414,9
2	Kalimantan Barat	1,3	1,3	1,6	15,1	24,3	43,8	88,3	140,9	209,2	282,4	366,4
3	Gorontalo	0,7	4,7	9,7	9,7	19,7	19,7	35,7	65,4	128,8	218,6	343,3
4	Sumatera Selatan	1,1	1,1	1,1	12,8	20,0	35,8	71,7	114,1	169,3	228,5	296,6
5	Nusa Tenggara Barat	4,7	4,9	25,2	90,2	90,2	90,2	90,2	112,3	167,2	225,4	292,0
6	Sulawesi Barat	0,5	0,5	0,5	2,4	9,8	23,3	60,5	100,7	150,4	202,6	261,8
7	Jambi	1,0	1,0	3,0	7,1	13,6	27,1	60,7	98,6	146,7	197,9	256,3
8	Kalimantan Timur	1,6	1,9	2,0	8,4	15,3	27,7	56,1	89,3	132,5	178,9	232,1
9	Sumatera Utara	16,0	17,7	57,7	57,7	57,7	57,7	57,7	86,2	128,0	176,2	224,1
10	Sulawesi Tengah	1,4	1,4	11,4	11,4	31,4	31,4	52,7	86,2	128,4	173,1	224,1
11	Kalimantan Tengah	0,8	1,1	1,1	6,7	13,4	23,7	52,5	85,0	126,5	170,6	221,1
12	Papua	7,8	8,2	19,4	19,4	39,4	39,4	50,7	84,2	125,7	169,3	218,8
13	Sulawesi Tenggara	1,9	2,4	9,6	9,6	10,5	21,6	49,7	81,9	122,1	164,6	212,9
14	Aceh	0,8	0,8	2,8	6,2	12,7	22,5	50,2	81,3	121,0	163,2	211,4
15	Maluku Utara	4,5	4,6	9,6	9,6	9,7	18,9	47,3	78,3	116,8	157,3	203,5
16	Jawa Tengah	0,4	0,4	0,4	6,7	12,3	22,1	44,6	71,7	106,6	143,8	186,4
17	Jawa Timur	0,5	0,6	3,4	7,7	13,2	23,1	44,9	71,7	106,4	143,6	186,4
18	Sulawesi Selatan	3,9	7,0	8,1	8,1	11,5	21,2	43,8	70,8	105,2	142,0	184,0
19	Maluku	5,0	5,3	10,3	15,3	15,3	17,6	41,9	69,6	103,8	139,9	180,8
20	Papua Barat	1,8	4,1	4,1	5,0	15,0	19,0	39,8	64,6	96,1	129,5	167,8
21	Jawa Barat	0,3	0,3	0,4	6,8	11,5	20,2	39,3	62,7	93,1	125,6	163,0
22	Kalimantan Selatan	1,9	3,9	3,9	4,8	9,7	18,1	38,0	61,5	91,5	123,5	160,0
23	Bengkulu	0,6	0,7	0,7	3,1	8,2	16,5	37,3	61,2	91,3	123,0	159,2
24	Sumatera Barat	1,7	2,0	2,9	4,6	9,3	17,2	35,9	58,1	86,4	116,6	151,0
25	Lampung	1,3	1,6	1,6	2,1	6,5	13,5	31,3	51,6	77,0	103,8	134,3
26	Kepulauan Riau	1,1	1,1	1,1	5,8	9,5	16,5	31,5	50,2	74,4	100,5	130,4
27	Sulawesi Utara	3,8	3,8	3,8	3,8	5,6	11,5	26,5	43,7	65,1	87,8	113,6
28	Bangka belitung	1,6	1,6	3,6	3,6	5,9	11,7	25,9	42,4	63,2	85,2	110,3
29	Bali	4,4	7,5	8,2	8,2	8,2	108,2	108,2	108,2	108,2	108,2	108,2
30	Kalimantan Utara	0,4	0,6	0,6	3,6	6,6	12,0	24,3	39,1	58,1	78,5	101,7
31	Banten	0,2	0,2	0,3	2,1	5,1	10,0	22,2	36,3	54,0	72,9	94,3
32	Riau	0,9	1,0	1,0	1,0	4,1	9,0	21,8	36,2	54,1	72,8	94,2
33	DI. Yogyakarta	0,1	0,1	0,1	1,1	3,7	8,0	18,9	31,3	46,8	63,0	81,5
34	Jakarta	0,2	0,2	0,3	0,3	0,7	1,4	3,2	5,3	7,9	10,7	13,8
Total Kapasitas Terpasang		78,5	107,8	224,5	375,0	550,0	900,0	1.600,0	2.500,0	3.700,0	5.000,0	6.500,0
Total Tambahan/Tahun		-	29,3	116,6	150,5	175,0	350,0	700,0	900,0	1.200,0	1.300,0	1.500,0

Angin

Indonesia sebagai negara kepulauan memiliki garis pantai yang panjang dan dapat dimanfaatkan sebagai Pembangkit Listrik Tenaga Bayu (PLTB). Salah satu program yang harus dilakukan sebelum mengembangkan PLTB adalah pemetaan potensi energi angin di Indonesia.

Kecepatan minimal angina yang dapat dioptimalkan menjadi sumber energy yaitu ≥ 4 m/s

Satuan: MW

No.	Provinsi	Potensi
1	Nusa Tenggara Timur	10.188
2	Jawa Timur	7.907
3	Jawa Barat	7.036
4	Jawa Tengah	5.213
5	Sulawesi Selatan	4.193
6	Maluku	3.188
7	Nusa Tenggara Barat	2.605
8	Bangka Belitung	1.787
9	Banten	1.753
10	Bengkulu	1.513
11	Sulawesi Tenggara	1.414
12	Papua	1.411
13	Sulawesi Utara	1.214
14	Lampung	1.137
15	DI. Yogyakarta	1.079
16	Bali	1.019
17	Kalimantan Selatan	1.006

Satuan: MW

No.	Provinsi	Potensi
18	Kepulauan Riau	922
19	Sulawesi Tengah	908
20	Aceh	894
21	Kalimantan Tengah	681
22	Kalimantan Barat	554
23	Sulawesi Barat	514
24	Maluku Utara	504
25	Papua Barat	437
26	Sumatera Barat	428
28	Sumatera Utara	356
29	Sumatera Selatan	301
30	Kalimantan timur	212
31	Gorontalo	137
27	Kalimantan Utara	73
32	Jambi	37
33	Riau	22
34	DKI Jakarta	4
	Total	60.647,0

Kapasitas Terpasang PLT Angin dan Rencana Sampai 2025

Satuan: MW

No.	Provinsi	Total Kapasitas Terpasang per Tahun										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	Jawa Barat	0,0	0,9	0,9	80,9	160,9	250,9	250,9	250,9	250,9	250,9	410,9
2	Nusa Tenggara Timur	0,1	0,1	0,1	0,1	5,1	31,2	131,1	175,0	216,7	261,1	266,1
3	Sulawesi Selatan	0,5	0,5	70,5	70,5	130,5	170,5	170,5	170,5	230,5	230,5	230,5
4	Banten	0,0	0,0	0,0	0,0	35,0	70,0	70,0	70,0	70,0	70,0	150,0
5	Maluku	0,0	0,0	0,0	0,0	5,0	10,0	41,3	67,8	86,9	108,8	113,8
6	Sulawesi Barat	-	-	-	-	-	-	33,1	52,1	66,3	82,4	82,4
7	Nusa Tenggara Barat	0,0	0,0	0,0	0,0	5,0	5,0	23,2	43,5	56,7	72,4	72,4
8	Papua	-	-	-	-	-	-	23,1	41,6	54,0	68,5	68,5
9	DI. Yogyakarta	0,1	0,1	0,1	50,1	50,1	50,1	50,1	50,1	50,1	50,1	60,1
10	Sulawesi Tenggara	0,0	0,0	0,0	0,0	0,0	0,0	14,4	32,6	43,4	56,6	56,6
11	Jawa Timur	0,1	0,1	0,1	0,1	0,1	0,1	0,1	14,6	27,6	46,8	46,8
12	Jawa Tengah	0,1	0,1	0,1	0,1	0,1	0,1	0,1	12,3	22,3	36,9	36,9
13	Kalimantan Tengah	-	-	-	-	-	-	-	14,7	22,9	34,2	34,2
14	Aceh	-	-	-	-	-	-	-	13,3	21,3	32,4	32,4
15	Bengkulu	-	-	-	-	-	-	-	10,4	17,6	27,8	27,8
16	Kalimantan Barat	-	-	-	-	-	-	-	10,2	17,4	27,6	27,6
17	Lampung	-	-	-	-	-	-	-	5,9	12,4	22,2	22,2
18	Sulawesi Utara	0,5	0,5	0,5	0,5	0,5	0,5	0,5	2,8	9,9	20,8	20,8
19	Bali	1,5	1,5	1,5	1,5	6,5	11,5	11,5	11,5	11,5	11,5	11,5
20	Papua Barat	-	-	-	-	-	-	-	-	1,4	10,5	10,5
21	Bangka Belitung	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	9,1	9,1
22	Kalimantan Selatan	-	-	-	-	-	-	-	-	-	8,8	8,8
23	DKI Jakarta	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
24	Maluku Utara	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total Kapasitas Terpasang		3,1	3,9	73,9	203,9	398,9	600,0	820,0	1.050,0	1.290,0	1.540,0	1.800,0
Total Tambahan/Tahun		-	0,9	70,0	130,0	195,0	201,1	220,0	230,0	240,0	250,0	260,0

Arus Laut, Gelombang Laut Dan Energy Panas Laut

Indonesia sebagai negara maritim memiliki potensi yang besar untuk dimanfaatkan sebagai sumber energi. Sumber energi maritime yang dapat dimanfaatkan yaitu arus laut (arus untuk memutar turbin), gelombang laut (energi kinetik dari naik turunnya gelombang) dan energy panas laut (pemasangan solar panel dipermukaan laut)

Satuan: MW

No.	Wilayah/Provinsi	Potensi		
		Teoritis	Teknis	Praktis
1	Nusa Tenggara Barat	138.308	34.577	8.644
2	Kepulauan Riau	96.432	24.108	6.027
3	Jawa Barat-Lampung	36.367	9.092	2.273
4	Papua Barat	6.261	1.565	391
5	Nusa Tenggara Timur	5.335	1.334	333
6	Bali	5.119	1.280	320
	Total	287.822	71.955	17.989

Tantangan Di Sektor PLT Panas Bumi

Pemanfaatan dan pengembangan energi panas bumi yang sesuai secara efektif membutuhkan waktu tujuh tahun hingga pembangkit listrik tersebut beroperasi. Akan tetapi, pada realitas di lapangan, proses tersebut memerlukan waktu yang lebih lama yang dikarenakan beberapa tantangan baik dari sisi teknis, ekonomi, lingkungan, dinamika sosial.

Ada lima tantangan yang dihadapi dari pihak badan usaha antara lain:

1. Area prospek berada pada kawasan hutan konservasi
2. Risiko pengembangan Energi Panas Bumi
3. Efisiensi biaya untuk mencapai keekonomian harga listrik
4. Isu sosial
5. Pendanaan proyek panas bumi

PLTP Kamojang, Bandung, Jawa Barat

Tantangan Di Sektor PLT Bioenergi

Beberapa hal yang menjadi tantangan dalam pengembangan bioenergi secara umum adalah:

1. Harga: tidak ada jaminan kepastian harga bioenergi karena sangat dipengaruhi oleh harga bahan baku yang merupakan 60% komponen biaya produksi.
2. Pendanaan dan Investasi: perbankan kurang tertarik untuk mendanai. mengakibatkan biaya produksi energi dari sumber bioenergi relatif tinggi sehingga tidak mampu bersaing dengen energi konvensional yang masih disubsidi.
3. Lahan: Belum tersedianya lahan khusus untuk penanaman tanaman diversifikasi bahan baku BBN.
4. Bahan Baku: kurangnya jaminan ketersediaan bahan baku yang berkelanjutan untuk beberapa komoditi bioenergi.
5. Infrastruktur: Pengembangan infrastruktur pendukung yang masih kurang.
6. Sosial Budaya: Masyarakat masih lebih tertarik untuk menggunakan energi konvensional (karena masih disubsidi)

Pembangkit Listrik Tenaga Biomassa (PLTBm), Desa Wajok Hulu, Provinsi Kalimantan Barat

Tantangan Di Sektor PLT Air, Minihydro dan Microhydro

Dari 94.476 MW potensi energi air di Indonesia, baru sebesar 6.256 MW (data pusdatin ESDM) yang telah dimanfaatkan dan sebesar 88.200 MW belum termanfaatkan, hal ini dikarenakan terdapat beberapa kendala antara lain:

1. Terbatasnya ketersediaan data potensi dan informasi energi air yang siap diimplementasi.
2. Terbatasnya kemampuan industri dalam negeri di bidang energi air.
3. Masih terbatasnya penelitian dan pengkajian
4. Terbatasnya jumlah dan kompetensi SDM dalam bidang energi air.
5. Potensi demand dan potensi pasokan seringkali tidak match, karena pada umumya lokasi demand jauh dari lokasi sumber energi terbarukan.
6. Kurangnya optimalnya dukungan pembiayaan dalam negeri terhadap pengembangan energi air.
7. Terbatasnya akses publik terhadap data kebutuhan listrik di setiap wilayah oleh PT PLN

PLT Minihidro Kabupaten Solok Selatan, Sumatera Barat

Tantangan Di Sektor PLT Surya

Lokasi geografis Indonesia yang berada di wilayah khatulistiwa membuat wilayah Indonesia mendapatkan sinar matahari yang cukup sepanjang tahun. tetapi hal ini tidak sejalan dengan pengembangan pemanfaatan energi surya di Indonesia. Hal ini dikarenakan :

1. harga jual listrik
2. regulasi perusahaan dan industri dalam bidang energi surya dalam negeri yang belum mendukung penuh
3. regulasi atau kebijakan fiskal dan non fiscal
4. sumber daya manusia
5. kesiapan sistem dan kondisi jaringan distribusi PLN

PLTS ,Dusun Bajaneke, Desa Oelpuah, Kupang, NTT

Tantangan Di Sektor PLT Angin

Pengembangan energi angin di Indonesia dirasakan masih belum optimal, hal ini disebabkan beberapa kendala antara lain:

1. Terdapat banyak lokasi potensial yang belum termanfaatkan, belum teridentifikasi, belum terukur serta jauh dari pusat beban.
2. Teknologi turbin angin dan pasar dalam negeri untuk turbin angin skala kecil belum berkembang.
3. Umur teknologi sangat tergantung material pembuat komponen, kondisi dan iklim lingkungan lokasi pemasangan. Korosif dan lembab mempengaruhi umur turbin angin.
4. Investasi PLTB yang relatif masih tinggi dibanding dengan pembangkit listrik konvensional.
5. Regulasi fiskal dan non fiskal belum dapat mendukung investasi terkait pengembangan energi angin secara optimal.
6. Jumlah dan kompetensi sumber daya manusia
7. Program dan anggaran Pemerintah dalam hal pengukuran potensi, penelitian dan pengembangan Keterbatasan infrastruktur pendukung pada lokasi potensial

pembangkit listrik tenaga bayu (PLTB) di Kabupaten Sidenreng Rappang (Sidrap), Provinsi Sulawesi Selatan

Tantangan Di Sektor PLT Arus Laut, Gelombang Laut Dan Energy Panas Laut

Pengembangan energi laut di Indonesia masih sangat belum optimal walaupun Indonesia merupakan negara maritim, hal ini disebabkan beberapa kendala antara lain:

1. Terbatasnya ketersediaan data potensi dan informasi energi air yang siap diimplementasi.
2. Terbatasnya kemampuan industri dalam negeri di bidang energi laut.
3. Masih terbatasnya penelitian dan pengkajian
4. Terbatasnya jumlah dan kompetensi SDM dalam bidang energi laut
5. Kurangnya optimalnya dukungan pembiayaan dalam negeri terhadap pengembangan energi laut
6. Regulasi terkait konservasi laut, jalur transportasi angkutan laut dan sosial masyarakat

PB3 PowerBuoy di UK central North Sea.

PRINSIP KERJA PEMBANGKIT ENERGI BARU TERBARUKAN

Diyajeng Luluk Karlina, S.T.,M.T
Teknik Elektro

SUMBER ENERGI DI INDONESIA

Rencana Umum Energi Nasional (RUEN), 2017

Energi Tak Terbarukan

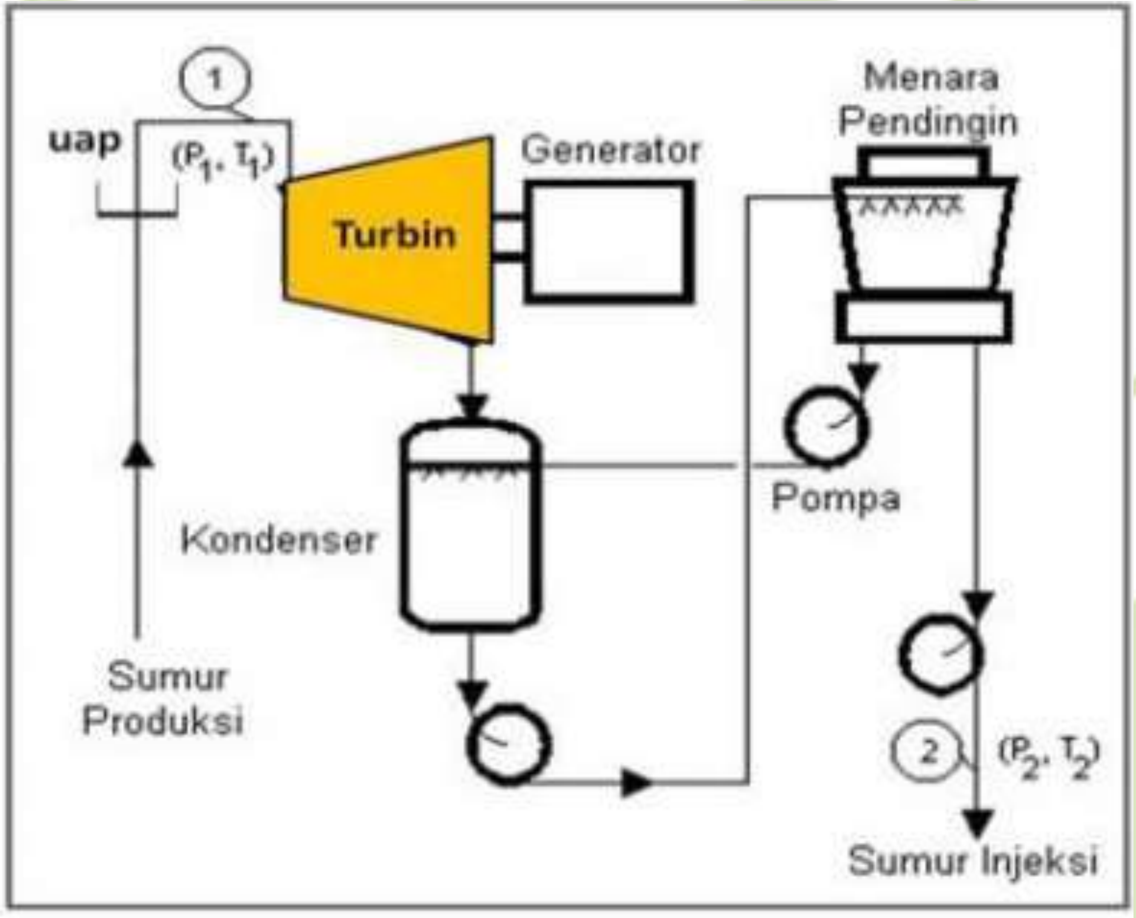
- Minyak Bumi
- Gas Bumi
- Batu Bara

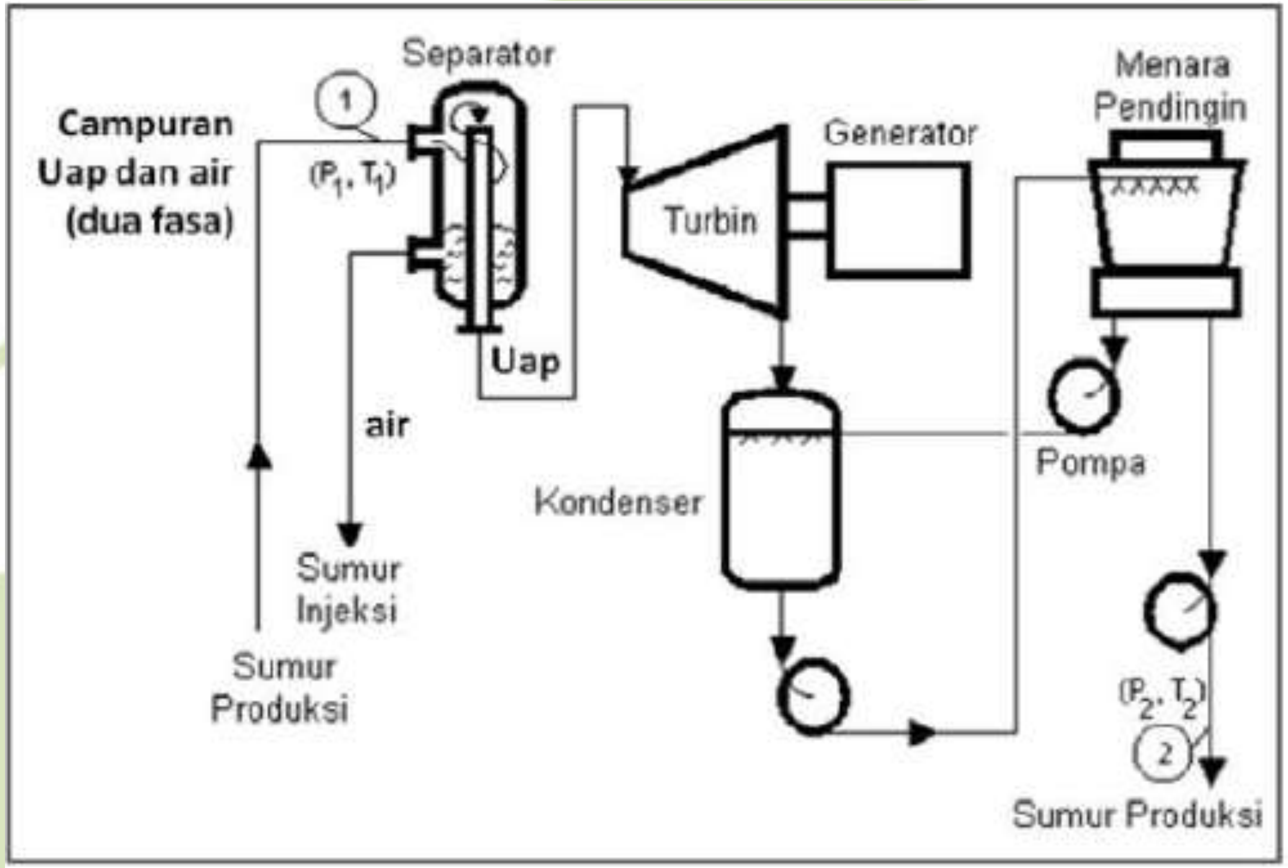
Energi Terbarukan

- Panas Bumi
- Air
- Minihidro dan Mikrohidro
- Bioenergi
- Surya
- Angin
- EBT Lain (PLTD campuran bioenergy, PLT Arus Laut, PLT gelombang Laut, PLT energy panas laut)

Prinsip kerja PLT Panas Bumi

Sistem panas bumi di Indonesia umumnya merupakan sistem hidrotermal yang mempunyai temperatur tinggi (>225°C) dan hanya beberapa diantaranya yang mempunyai temperatur sedang (150-225°C). Potensi sumber daya panas bumi Indonesia sangat besar yaitu sekitar 27.500 MW, sekitar 30-40% potensi panas bumi dunia. Mekanisme kerja Pembangkit Listrik Tenaga Panas bumi (PLTP) pada prinsipnya sama seperti Pembangkit Listrik Tenaga Uap (PLTU).





Kelebihan PLT Panas Bumi

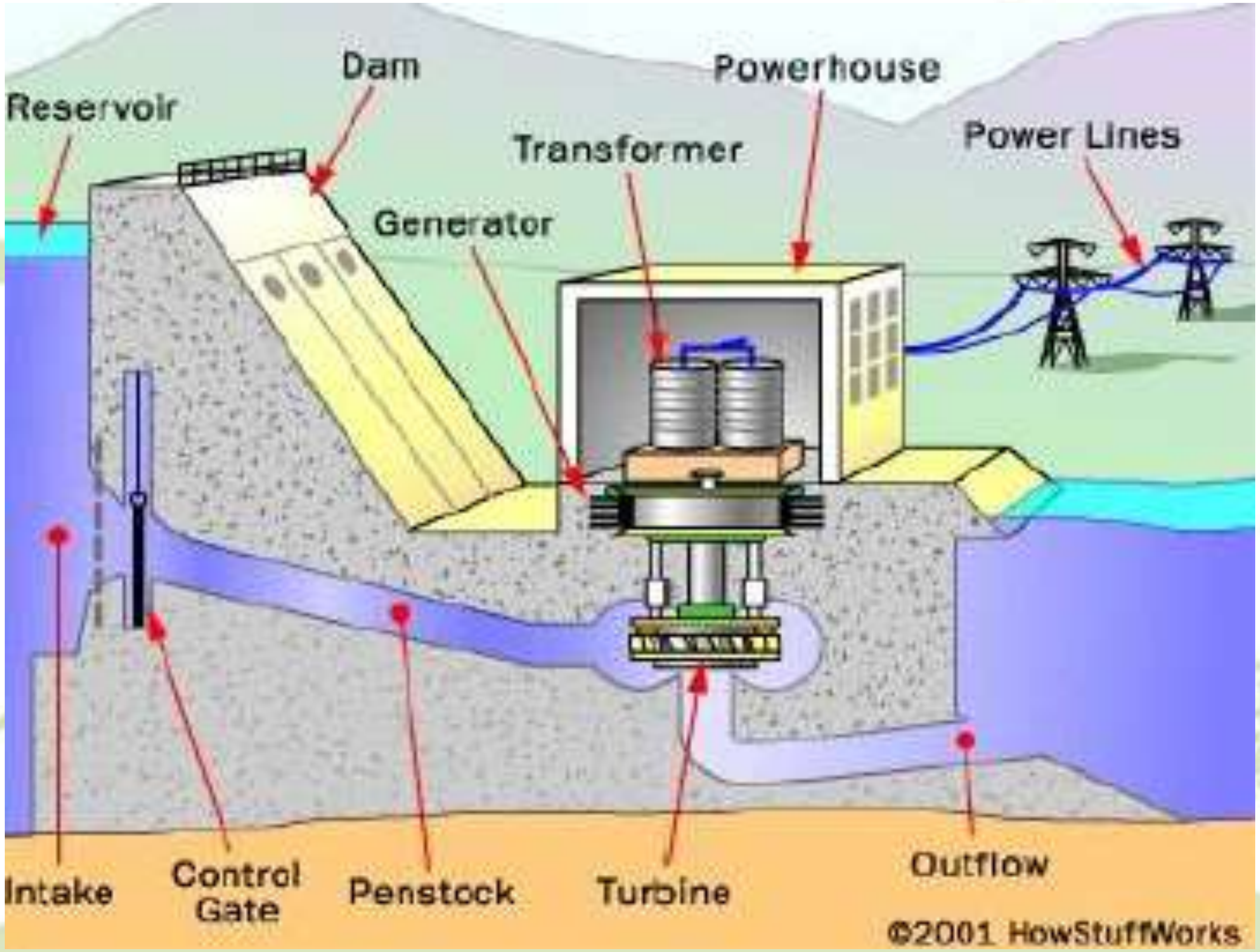
1. Panas bumi (*geothermal energy*) merupakan salah satu sumber energi paling bersih. Jauh lebih bersih dari sumber energi fosil yang menimpulkan polusi atau emisi gas rumah kaca.
2. Energi Geothermal ramah lingkungan yang tidak menyebabkan pencemaran (baik pencemaran udara, pencemaran suara, serta tidak menghasilkan emisi karbon dan tidak menghasilkan gas, cairan, maupun meterial beracun lainnya).
3. Panas bumi (*geothermal energy*), dibandingkan dengan energi alternatif lainnya seperti tenaga surya dan angin, bersifat konstan sepanjang musim. Di samping itu energi listrik yang dihasilkan dari geothermal tidak memerlukan solusi penyimpanan energi (*energy storage*) karena dapat dihasilkan sepanjang waktu.
4. Untuk memproduksi energi geothermal membutuhkan lahan dan air yang minimal, tidak seperti misalnya pada energi surya yang membutuhkan area yang luas dan banyak air untuk pendinginan.

Kekurangan PLT Panas Bumi

1. Biaya modal yang tinggi. Pembangunan pembangkit listrik geothermal memerlukan biaya yang besar terutama pada eksploitasi dan pengeboran.
2. Pembangkit listrik tenaga panas bumi hanya dapat dibangun di sekitar lempeng tektonik di mana temperatur tinggi dari sumber panas bumi tersedia di dekat permukaan

Prinsip kerja PLTA

Pembangkit Listrik Tenaga Air (PLTA) adalah salah satu pembangkit yang memanfaatkan aliran air untuk diubah menjadi energi listrik. Pembangkit listrik bekerja dengan cara merubah energi air yang mengalir (dari bendungan atau air terjun) menjadi energi mekanik (dengan bantuan turbin air) dan dari energi mekanik menjadi energi listrik (dengan bantuan generator). Kemudian energi listrik tersebut dialirkan melalui jaringan-jaringan yang telah dibuat, hingga akhirnya energi listrik tersebut sampai ke konsumen.



Kelebihan PLTA

1. Kapasitas daya keluaran PLTA relatif besar dibandingkan dengan pembangkit energi terbarukan lainnya.
2. PLTA umumnya memiliki umur yang panjang, yaitu 50-100 tahun.
3. Bendungan yang digunakan biasanya dapat sekaligus digunakan untuk kegiatan lain, seperti irigasi atau sebagai cadangan air dan pariwisata.

Kekurangan PLTA

1. Mebutuhkan inventasi yang besar.
2. Membutuhkan lahan yang luas untuk membuat pusat listrik yang berkapasitas besar.

Prinsip kerja PLTBm

Prinsip kerja sistem pembangkit energi biomassa pada gambar di samping yaitu, pertama pada sebuah tungku yang menggunakan bahan bakar sampah kemudian digunakan untuk memanaskan kompor atau tungku yang diatasnya terdapat ketel sebagai tempat air, diaman pada bagian atas ketel tersebut terdapat saluran pipa sebagai keluaran dari proses pemanasan air berupa uap air, uap air yang keluar dari ketel tersebut akan mendorong dan memutar turbin kemudian akan memutar generator sebagai pembangkit listrik

Kelebihan PLTBm

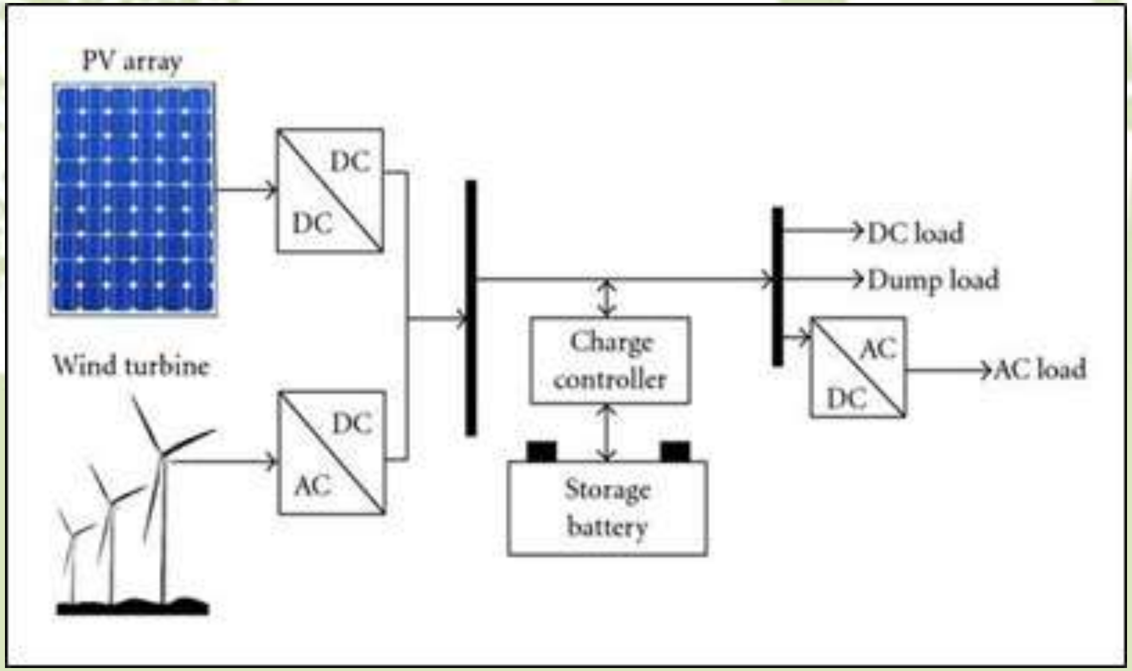
1. Biomassa merupakan sumber energi terbarukan (tanaman dapat tumbuh kembali pada lahan yang sama).
2. Biomassa dapat membantu mengurangi impor bahan bakar asing dan membantu meningkatkan kemandirian energi negara (biomassa digunakan untuk mengurangi kebutuhan bahan bakar fosil seperti batubara, minyak dan gas alam).
3. Peningkatan penggunaan biomassa dari limbah dapat menyebabkan polusi jauh lebih sedikit di dunia (dengan mengkonversi sampah menjadi sumber energi yang berguna).

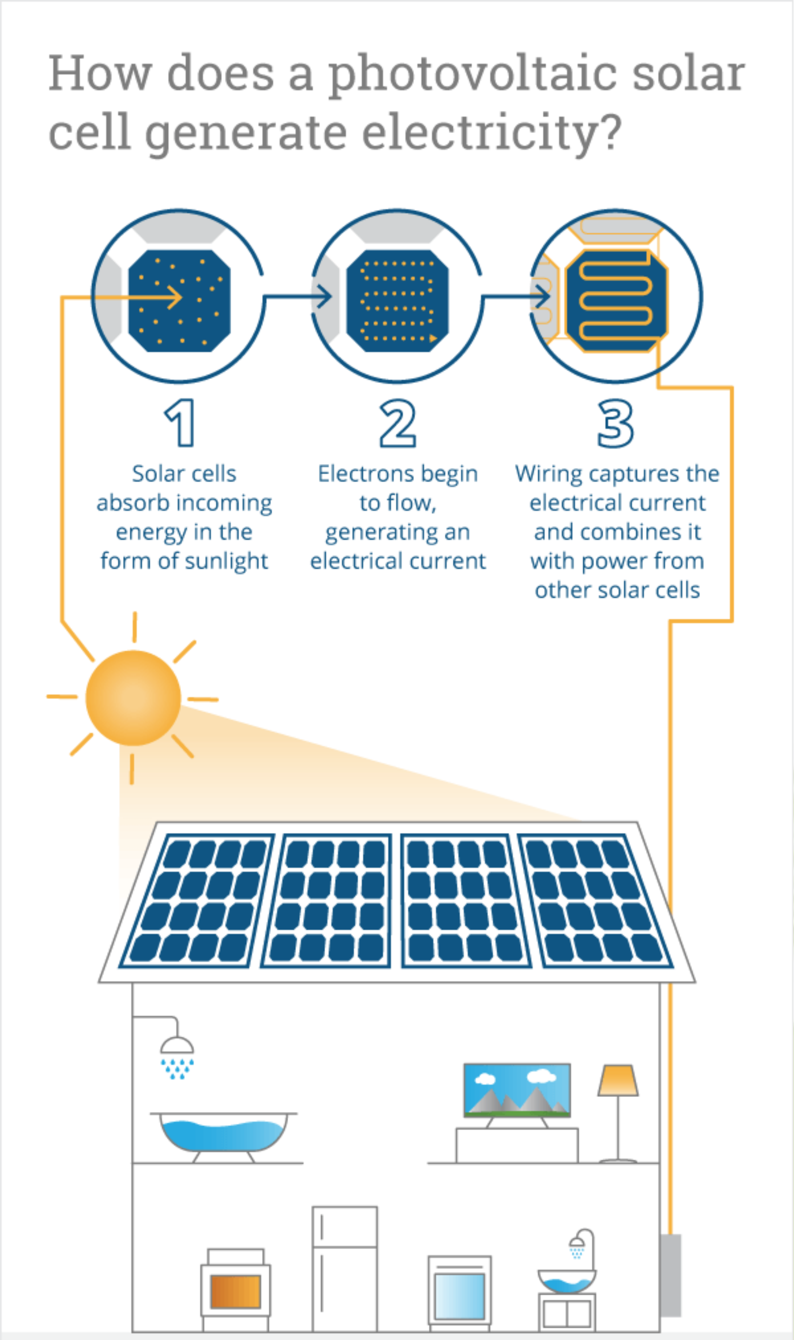
Kekurangan PLTBm

1. Menggunakan banyak lahan untuk biomassa dapat menyebabkan berkurangnya lahan untuk menanam tanaman pangan yang dapat meningkatkan kelaparan di dunia.
2. Banyak teknologi yang digunakan untuk mengkonversi biomassa menjadi bentuk energi yang berguna masih tidak cukup efisien dan membutuhkan biaya yang signifikan.

Prinsip kerja PLTS

PLTS adalah suatu pembangkit listrik yang menggunakan sinar matahari melalui sel surya (*photovoltaic*) untuk mengkonversikan radiasi sinar foton matahari menjadi energi listrik. Sel surya merupakan lapisan-lapisan tipis dari bahan semikonduktor silikon (Si) murni, dan bahan semikonduktor lainnya. PLTS memanfaatkan cahaya matahari untuk menghasilkan listrik DC, yang dapat diubah menjadi listrik AC apabila diperlukan, oleh karena itu meskipun cuaca mendung, selama masih terdapat cahaya, maka PLTS tetap dapat menghasilkan listrik



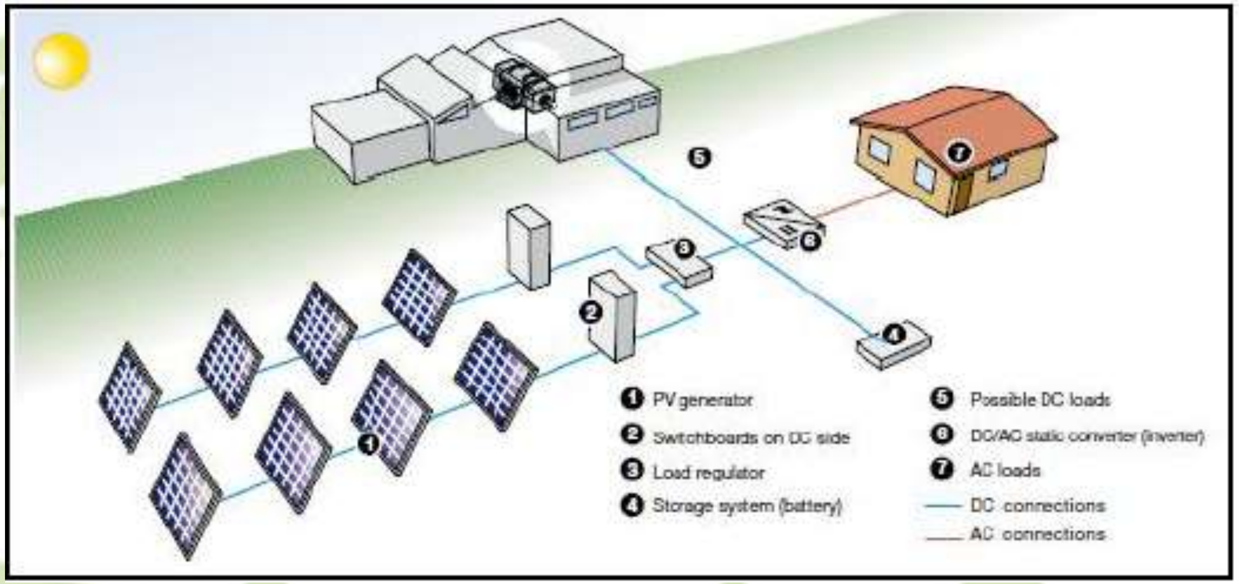


Prinsip kerja PLTS

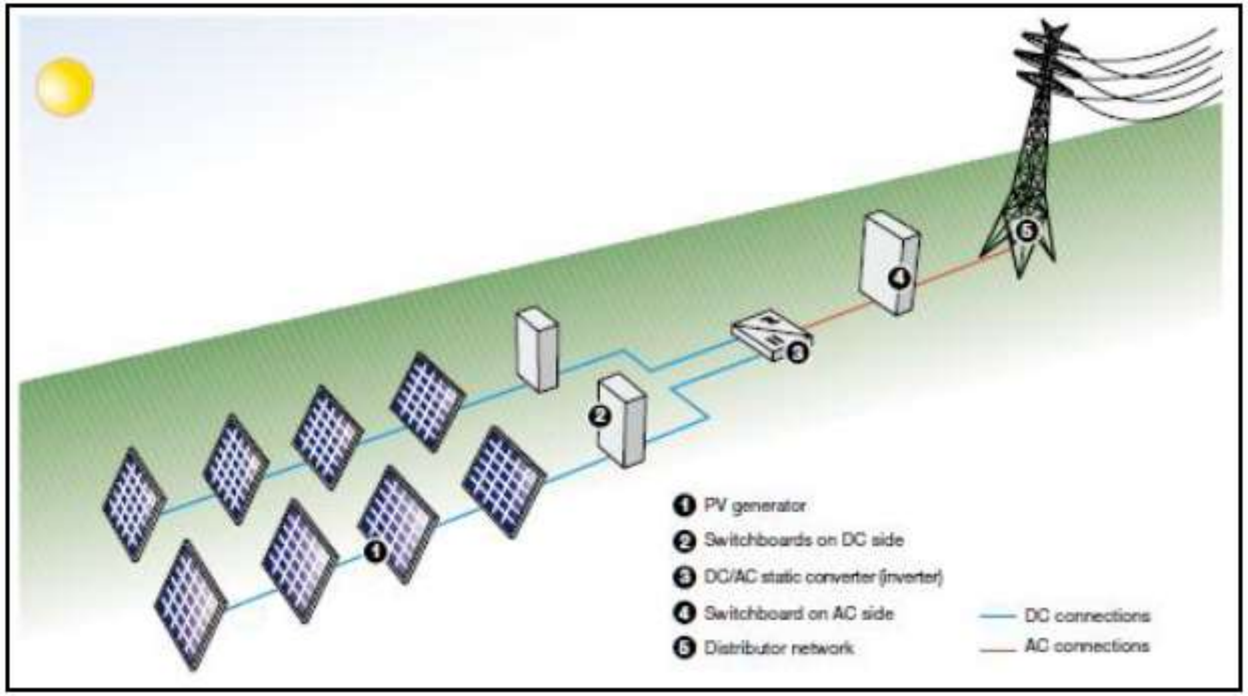
Berdasarkan aplikasi dan konfigurasinya, secara garis besar PLTS diklasifikasikan menjadi dua yaitu:

1. PLTS Terpusat *(Off-Grid)*
2. PLTS Terinterkoneksi *(On-Grid)*

PLTS Terpusat *(Off-Grid)*



PLTS Terinterkoneksi *(On-Grid)*



Kelebihan PLTS

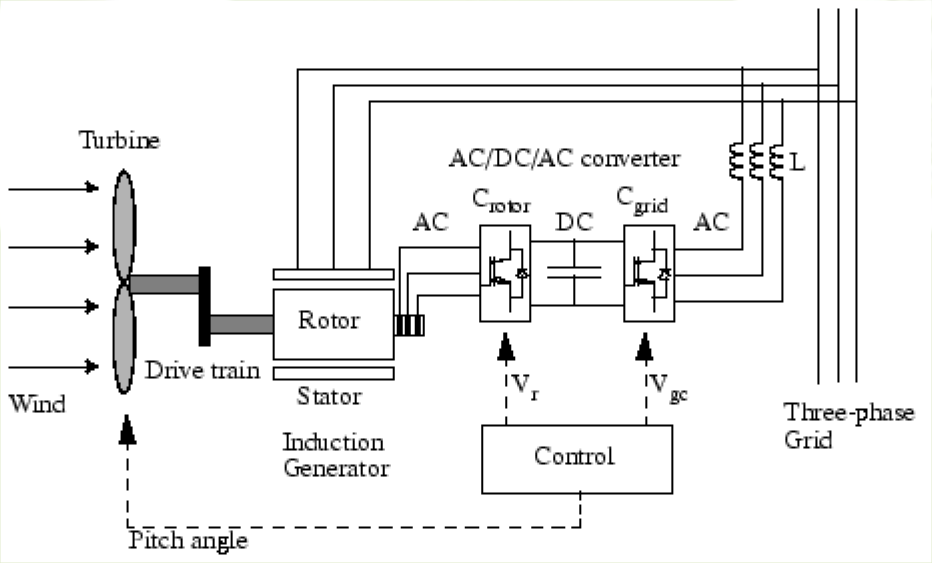
1. Ramah Lingkungan
2. Hanya membutuhkan sedikit perawatan

Kekurangan PLTS

1. Daya yang dihasilkan berkurang ketika mendung
2. Besarnya biaya pembangunan

Prinsip kerja PLT Angin (PLTB)

Secara umum prinsip dasar kerja dari turbin angin adalah mengubah energi mekanis dari angin menjadi energi putar pada kincir, lalu putaran kincir digunakan untuk memutar generator, yang akhirnya akan menghasilkan listrik.
AC/DC/AC converter + control device diperlukan untuk menstabilkan tegangan listrik yang fluktuatif, karena kecepatan angin yang selalu berubah-ubah tiap waktu.



Kelebihan PLTB

1. Berasal dari sumber energi baru terbarukan
2. Ramah lingkungan
3. Pembangunan turbin angin tidak memerlukan banyak ruang

Kekurangan PLTB

1. Membutuhkan anggaran biaya yang besar
2. Sumber daya yang mengikuti arus dan waktu

Prinsip kerja PLT Gelombang Laut

Dalam PLT gelombang laut, teknologi yang umum digunakan adalah oscilatting water column (OWC). Disain ini biasanya ditempatkan pada kedalaman laut mulai dari perairan dangkal hingga kedalaman 50 m (150 kaki) dengan memiliki lebar 35 m dan panjang 18 m (EPRI,2007). Turbin yang digunakan pada teknologi OWC juga memiliki desain khusus, yaitu dapat berputar dengan arah yang sama dari arah manapun udara memutar turbinnya.

Terdapat 2 prinsip kerja pada OWC.

1. Saat aliran udara keluar
2. Saat aliran udara masuk

Aliran Udara Keluar

Aliran Udara Masuk

Prinsip kerja PLT Gelombang Laut

Prinsip Kerja OWC
Aliran Udara Keluar

1. Permukaan gelombang laut naik, sehingga menyebabkan udara di dalam chamber bergerak naik karena ada tekanan dari gelombang laut.
2. Setelah itu udara ini mengalir menuju ruangan generator, dimana aliran udara ini menyebabkan turbin berputar.
3. Setelah melewati turbin, udara bertekanan ini mengalir melewati keluar dari OWC.

Prinsip Kerja OWC
Aliran Udara Masuk

1. Turunnya permukaan gelombang laut sehingga menyebabkan udara dari luar masuk ke ruang generator.
2. Setelah itu udara ini mengalir menuju ruangan generator, dimana aliran udara ini menyebabkan turbin berputar
3. Kemudian setelah melewati turbin, udara bertekanan ini mengalir kedalam chamber diikuti dengan turunnya permukaan air laut

Kelebihan

1. Berasal dari sumber energi baru terbarukan
2. Ramah lingkungan
3. Cocok digunakan di Indonesia yang memiliki garis pantai yang luas

Kekurangan

1. Membutuhkan anggaran biaya yang besar
2. Dibutuhkan gelombang laut yang continue, karena ada tidaknya gelombang laut mempengaruhi listrik yang dihasilkan

Thank You

Technology & Sustainability

Dr. Ni'matuzahroh

Aisyah Dewi Muthi'ah S.T M.T MBA

Shofa Aulia Aldhama,S.T.,M.T.

Humanity and Technology

- Saat ini teknologi berinteraksi dengan hampir setiap aspek kehidupan manusia,
- Teknologi sebagai kompetensi manusia sedang mengalami periode pertumbuhan revolusioner yang cepat,
- Saling ketergantungan inilah yang menciptakan hubungan yang kuat diberbagai bidang keilmuan,
- Implikasi dari adanya hubungan yang kuat ini menjadi modal penting bagi keberlanjutan lingkungan yang kita tinggali.

right direction?

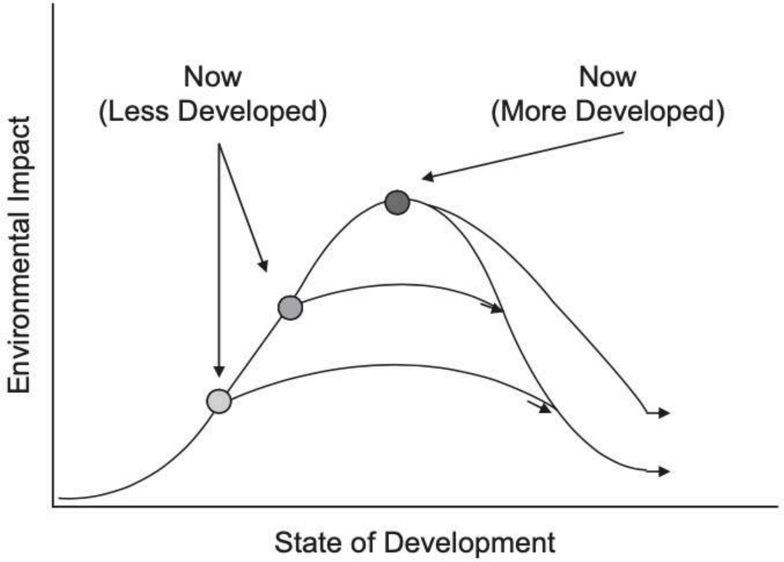


Figure 1.2

A schematic diagram of the typical life cycle of the relationship between the state of technological development of society and its resulting environmental impact.

TABLE 3.1 Relating Current Environmental Problems to Industrial Responses to Yesterday's Needs

Yesterday's need	Yesterday's solution	Today's problem
Nontoxic, nonflammable refrigerants	Chlorofluorocarbons	Ozone hole
Automobile engine knock	Tetraethyl lead	Lead in air and soil
Locusts, malaria	DDT	Adverse effects on birds and mammals
Fertilizer to aid food production	Nitrogen and phosphorus fertilizer	Lake and estuary eutrophication

Why did this happen?

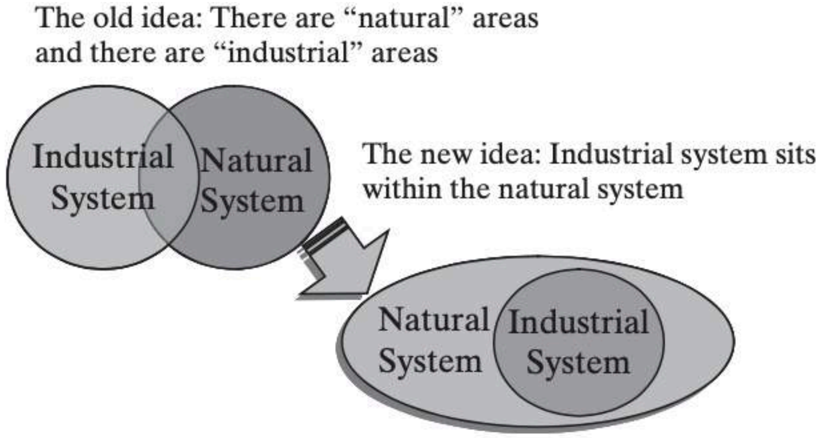
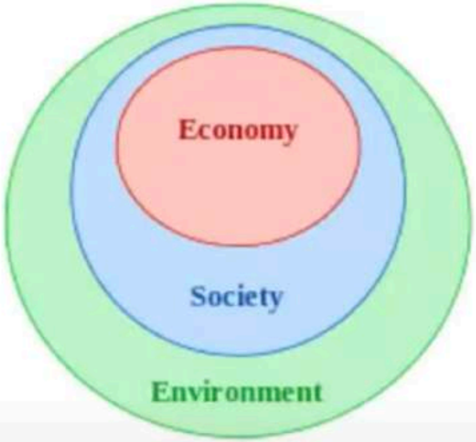


Figure 3.1

The transformation from natural and industrial systems as essentially independent entities to the realization that the industrial system is embedded within the natural system.

Sustainability Concept?



A diagram indicating the relationship between the "three pillars of sustainability" in which both economy and society are constrained by environmental limits

Scott Cato, M. (2009). "Green economics"

"Pemenuhan kebutuhan kita sendiri tanpa mengorbankan kemampuan generasi mendatang untuk memenuhi kebutuhan mereka sendiri"

Planetary Boundaries: A safe Operating Space for Humanity (Rockstrom, et all, 2009)

Industrial Revolution - Pressure to the environtment

"Life Style harus berubah : Cara produksi-konsumsi"

We couldn't control what we can't measure

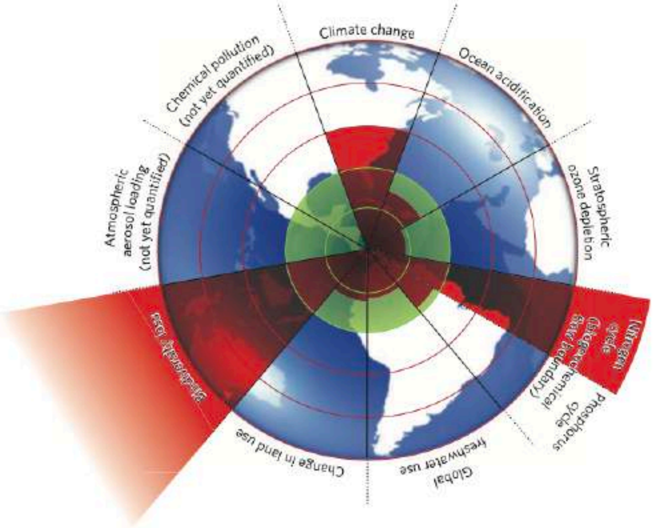


Figure 1 | Beyond the boundary. The inner green shading represents the proposed safe operating space for nine planetary systems. The red wedges represent an estimate of the current position for each variable. The boundaries in three systems (rate of biodiversity loss, climate change and human interference with the nitrogen cycle), have already been exceeded.

PLANETARY BOUNDARIES

Earth-system process	Parameters	Proposed boundary	Current status	Pre-industrial value
Climate change	(i) Atmospheric carbon dioxide concentration (parts per million by volume)	350	387	280
	(ii) Change in radiative forcing (watts per metre squared)	1	1.5	0
Rate of biodiversity loss	Extinction rate (number of species per million species per year)	10	>100	0.1–1
Nitrogen cycle (part of a boundary with the phosphorus cycle)	Amount of N_2 removed from the atmosphere for human use (millions of tonnes per year)	35	121	0
Phosphorus cycle (part of a boundary with the nitrogen cycle)	Quantity of P flowing into the oceans (millions of tonnes per year)	11	8.5–9.5	-1
Stratospheric ozone depletion	Concentration of ozone (Dobson unit)	276	283	290
Ocean acidification	Global mean saturation state of aragonite in surface sea water	2.75	2.90	3.44
Global freshwater use	Consumption of freshwater by humans (km^3 per year)	4,000	2,600	415
Change in land use	Percentage of global land cover converted to cropland	15	11.7	Low
Atmospheric aerosol loading	Overall particulate concentration in the atmosphere, on a regional basis		To be determined	
Chemical pollution	For example, amount emitted to, or concentration of persistent organic pollutants, plastics, endocrine disrupters, heavy metals and nuclear waste in, the global environment, or the effects on ecosystem and functioning of Earth system thereof		To be determined	

FAKULTAS TEKNOLOGI MAJU DAN MULTIDISIPLIN

Life Cycle Assessment (LCA)

Background

Paradigma Lama

“ Produk dirancang untuk memenuhi ekspektasi pengguna. Faktor-faktor yang dipertimbangkan dalam desain produk antara lain fungsi, kualitas, biaya, ergonomis, dan keamanan”

tidak ada pertimbangan yang diberikan secara khusus pada **aspek lingkungan !!!**

Background (2)

Paradigma baru

"Mulai sadar pentingnya mempertimbangkan faktor dan dampak lingkungan dalam mendesain sebuah produk".

- Suatu produk tidak dapat dirancang, diproduksi dan dipasarkan tanpa adanya **material bahan baku, transportasi, dan energi.**
- **Identifikasi** dampak yang ditimbulkan merupakan proses yang rumit.
- Oleh karena itu, perlu metode analisa yang **sistematis** untuk menilai **lingkungan** dari seluruh **siklus hidup** produk.
- Konsep **Life Cycle Assessment (LCA).**

Sejarah *Life Cycle Assesment*

1969

Coca-cola company,USA

1972-1973

Mulai Berkembang di negara Eropa (Inggris, Jerman, Swedia)

1996

Standar International untuk LCA yaitu ISO 14040:1996

Pengertian *Life Cycle Assesment*

- *LCA is a method used to evaluate **the environmental impact of a product** through its **life cycle** encompassing extraction and processing of the raw materials, manufacturing, distribution, use, recycling, and final disposal. [1]*
- *LCA is a technique to assess the **environmental aspects and potential impacts** associated with a **product, process, or service**. [2]*
- *LCA is best known for **quantitative analysis** of **environmental aspects** of a product **(product system)** over all **its life cycle stages**. [3]*

1) lgin, Mehmet Ali; Surendra M. Gupta (2010). "Environmentally Conscious Manufacturing and Product Recovery (ECMPRO): A Review of the State of the Art". Journal of Environmental Management. 91 (3): 563–591.
2) EPA NRMRL Staff (6 March 2012). "Life Cycle Assessment (LCA)". EPA.gov. Washington, DC. EPA National Risk Management Research Laboratory (NRMRL). Archived from the original on 6 March 2012. Retrieved 8 December 2019.
3) Life Cycle Assessment Best Practices of ISO 14040 Series

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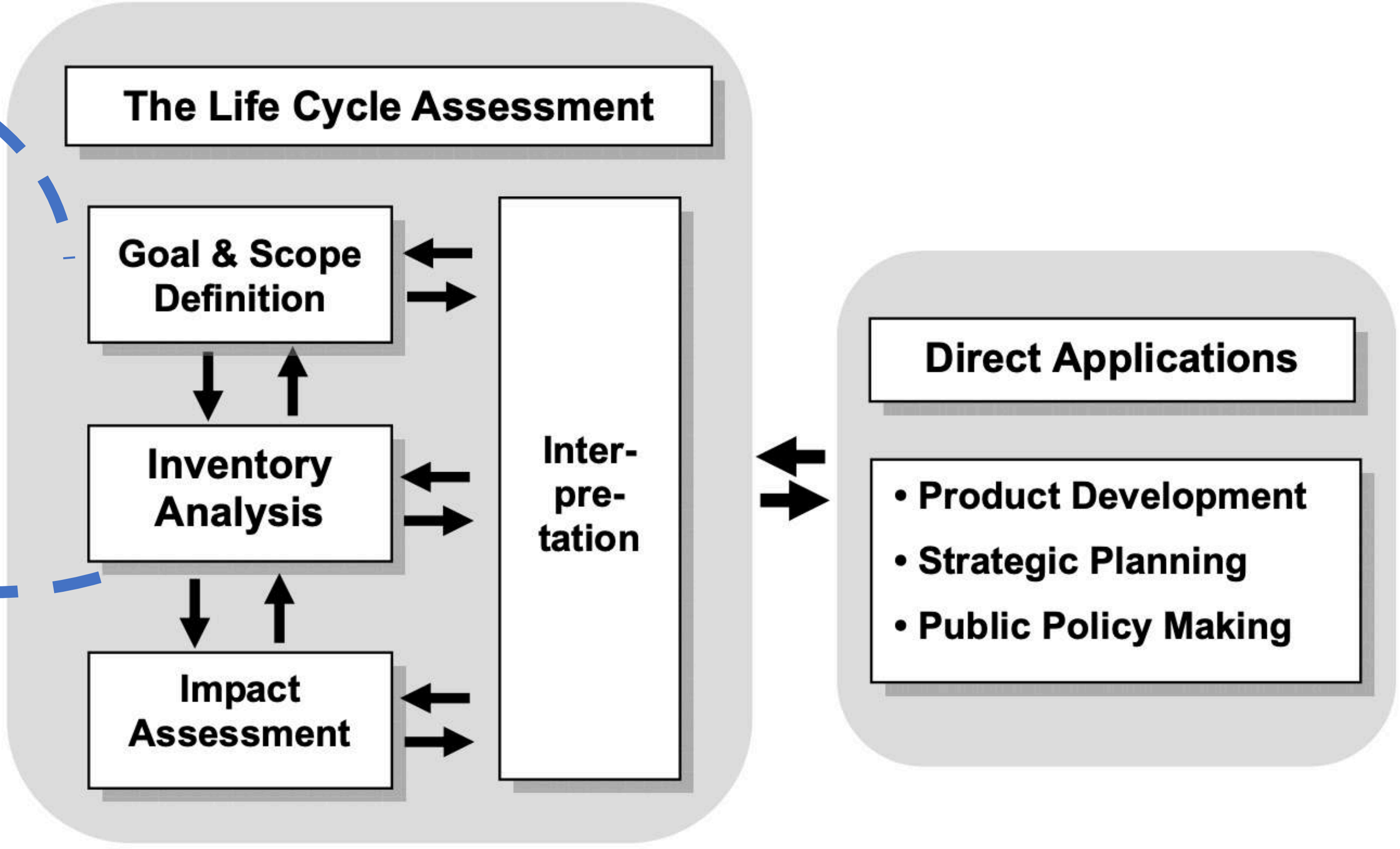
Four Phases of LCA

Menetapkan tujuan assessment dan menentukan *system boundaries*

Life Cycle Inventory (LCI) adalah proses mengukur kebutuhan bahan mentah dan energi, emisi atmosfer, emisi lahan, emisi air, penggunaan sumber daya, *other releases* selama siklus hidup suatu produk atau proses.

Pada Fase *Life Cycle Asessment* (LCAI) bertujuan untuk mengevaluasi potensi dampak lingkungan dan kesehatan manusia akibat aliran elementer yang sudah ditentukan pada fase LCI.



LCA *Impact*

Membahas **aspek lingkungan** dan **dampak lingkungan potensial** (ex: penggunaan sumber daya dan konsekuensi lingkungan dari emisi yang ditimbulkan) disepanjang **siklus daur-hidup** produk, mulai akusisi bahan baku, penggunaan, pengolahan akhir, daur ulang dan pembuangan akhir *(cradle-to-grave)*

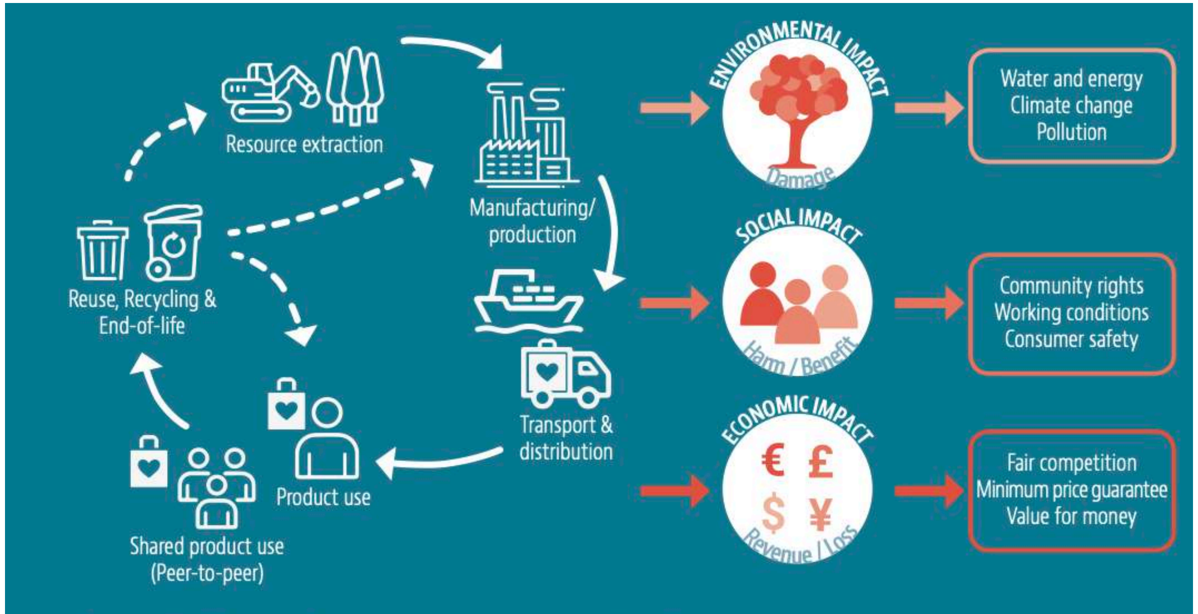
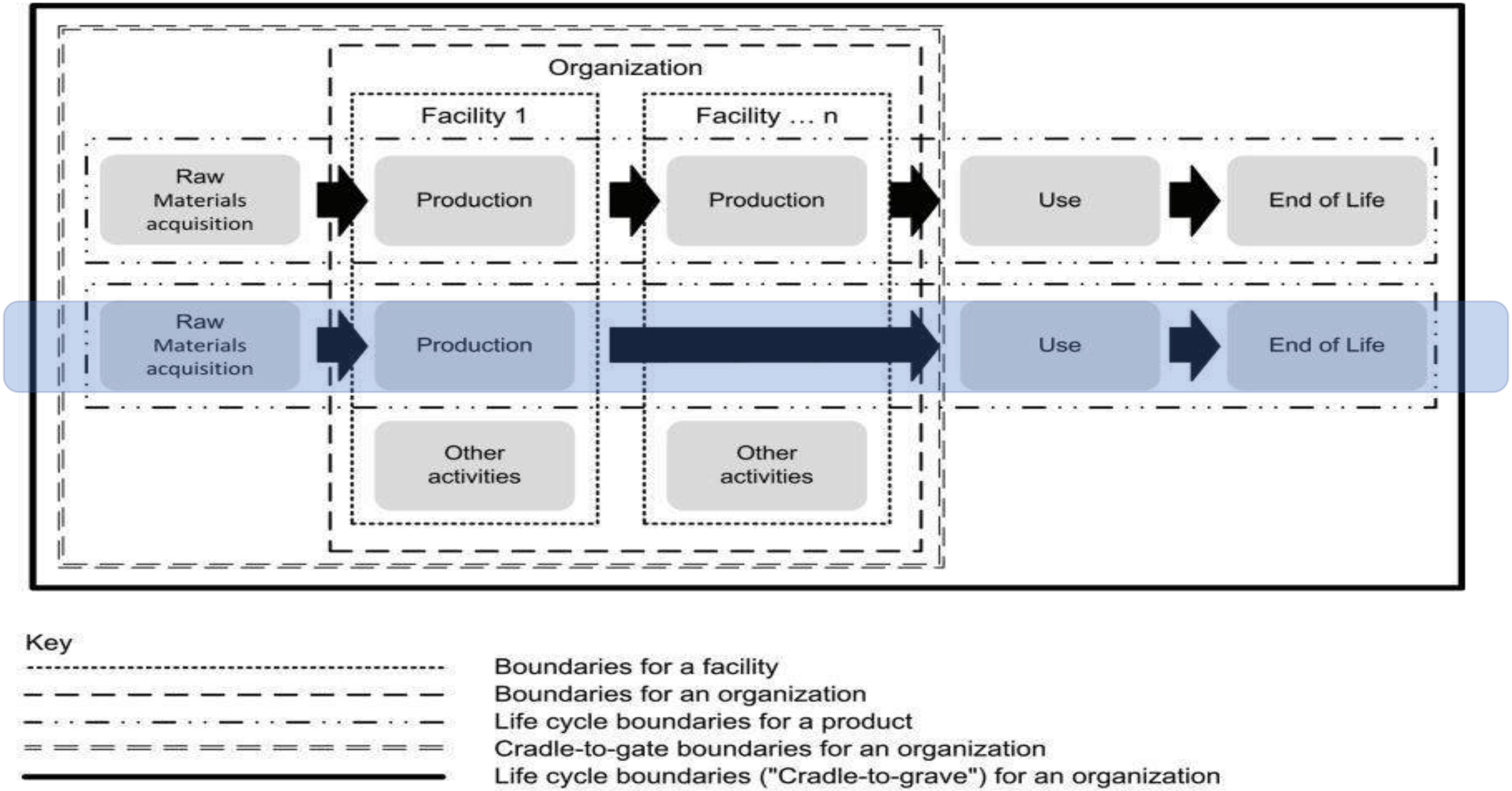


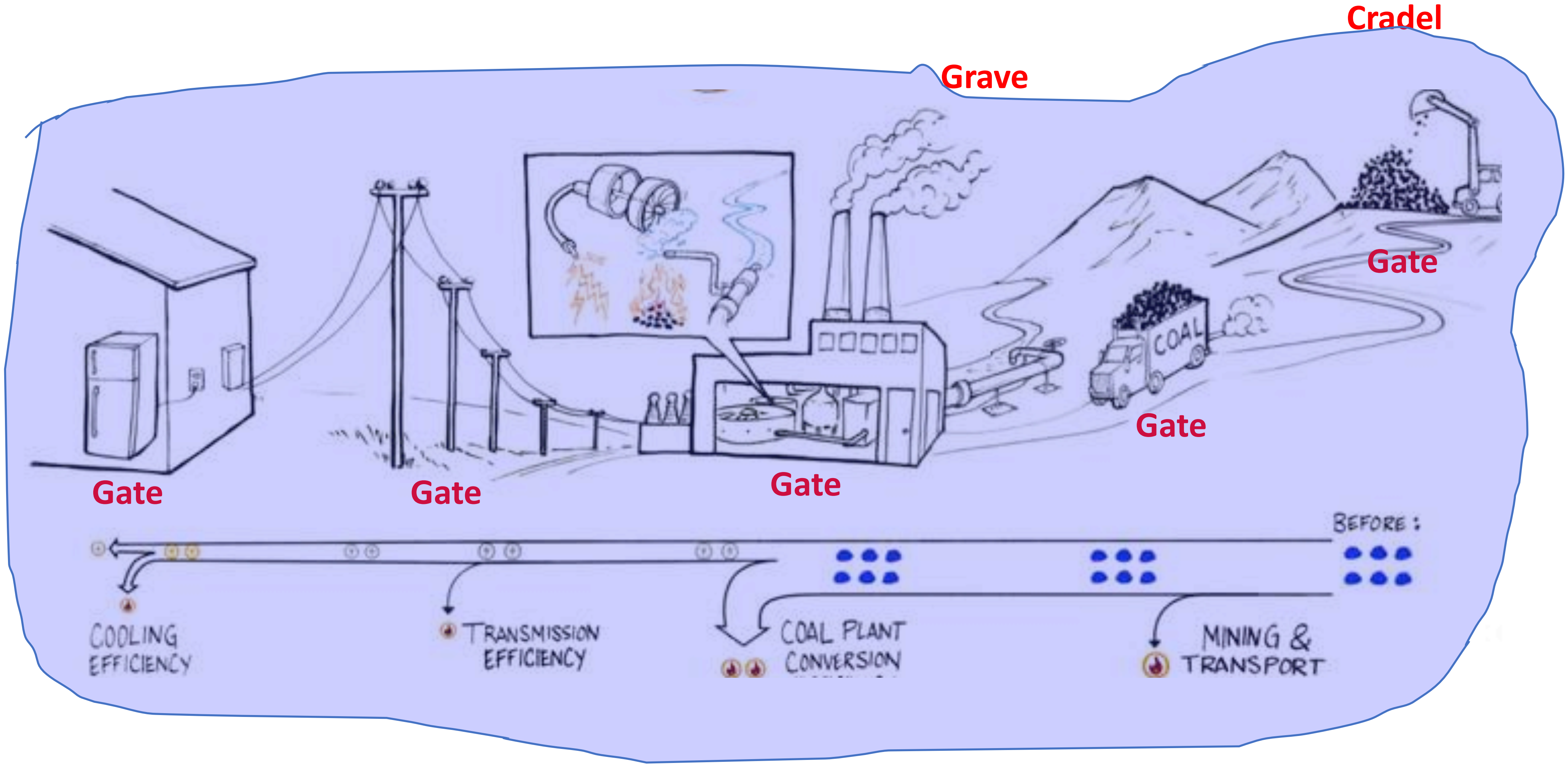
Figure 4: The life cycle of a consumer product and examples of environmental, social and economic impacts & benefits

Batasan sistem Perusahaan VS Produk



ISO 14040

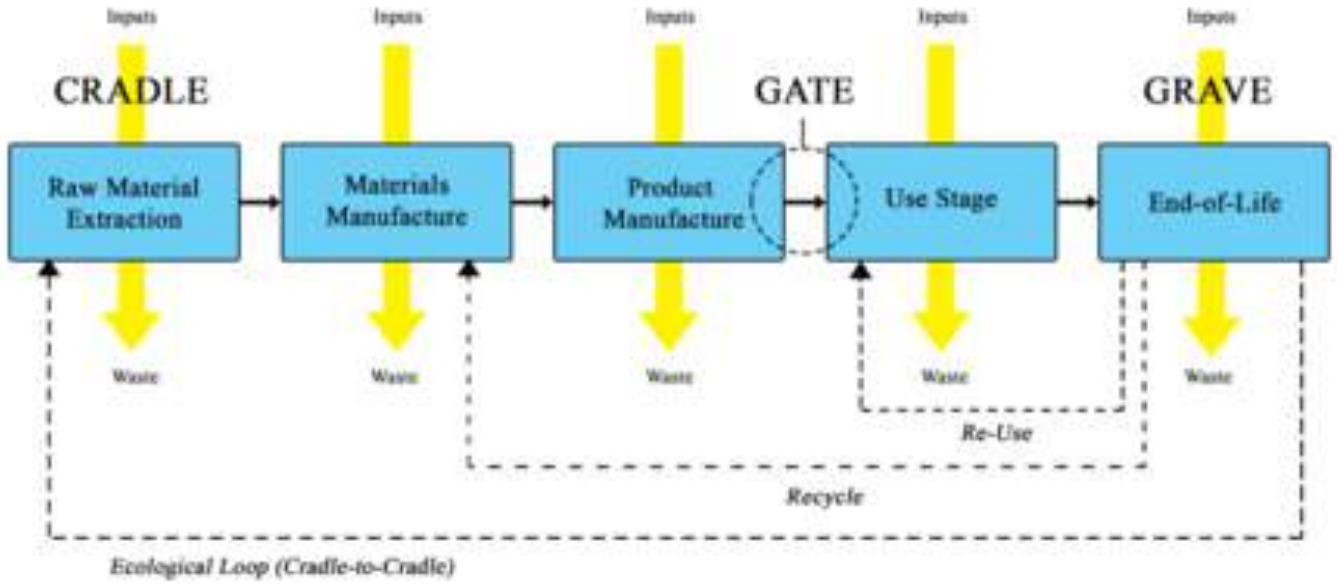
Sistem Produk: Listrik Batubara



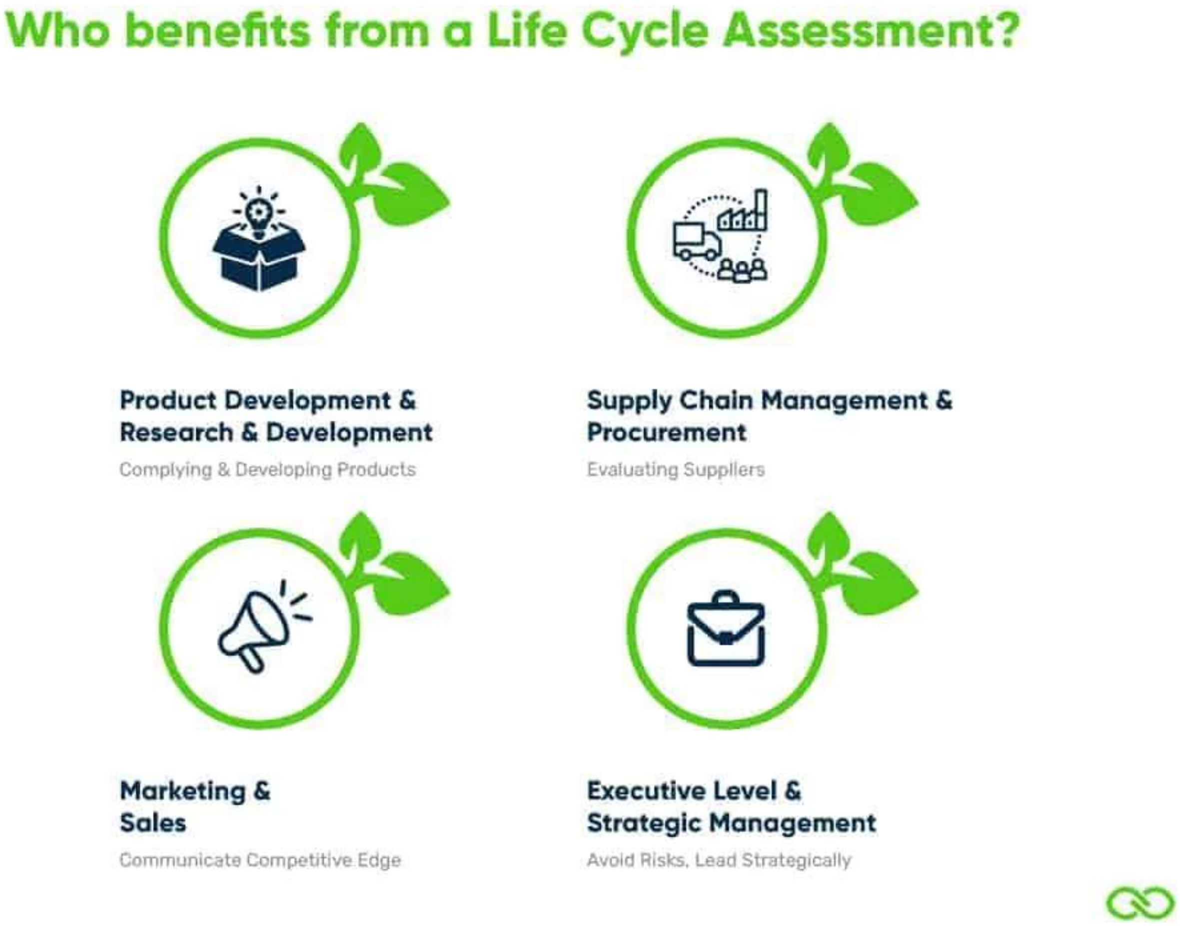
Antropogenik: Sumber Pencemaran yang tidak alami karena ada campur tangan manusia atau aktifitas manusia

Menghitung **Dampak**

Perhitungan dampak lingkungan (kinerja-lingkungan) : **outputnya apa** dan **dimana**?

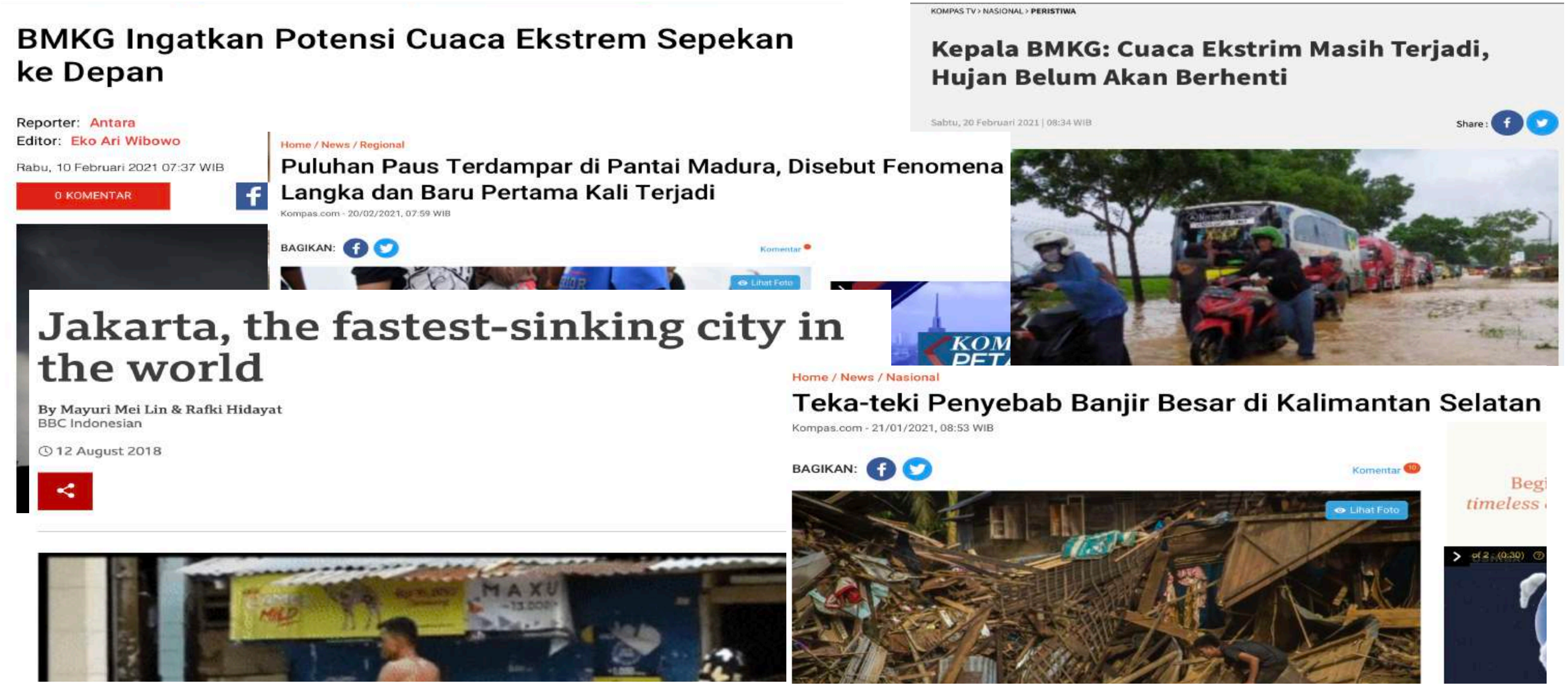


Hotspot: bagian dari sistem produk yang memberikan kontribusi besar terhadap dampak secara total

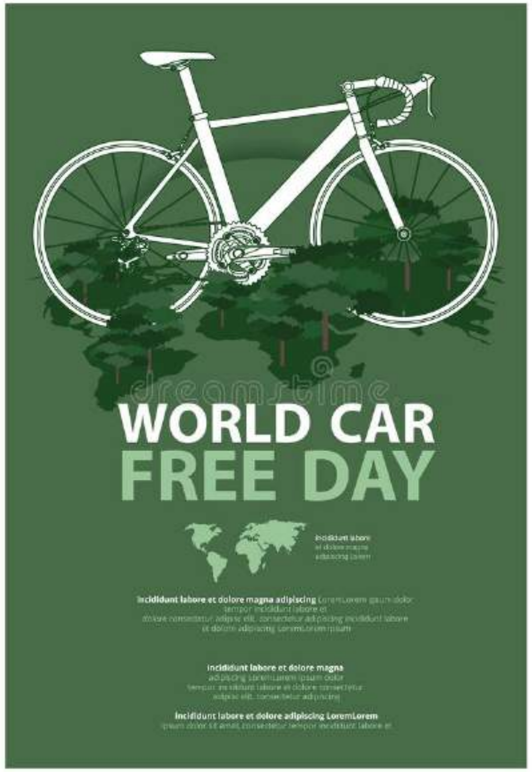


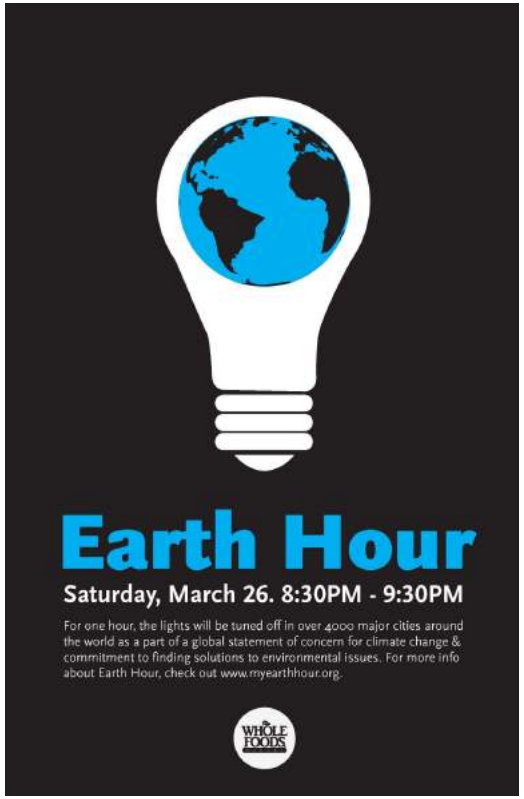
LCA *benefits*

Faktor Pendorong Penerapan LCA



Public Awareness





Public Awareness

Global Trade

International Buyers require **environtmental product labeling** and **declaration.**

supply chain dan **competitiveness**

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Certification

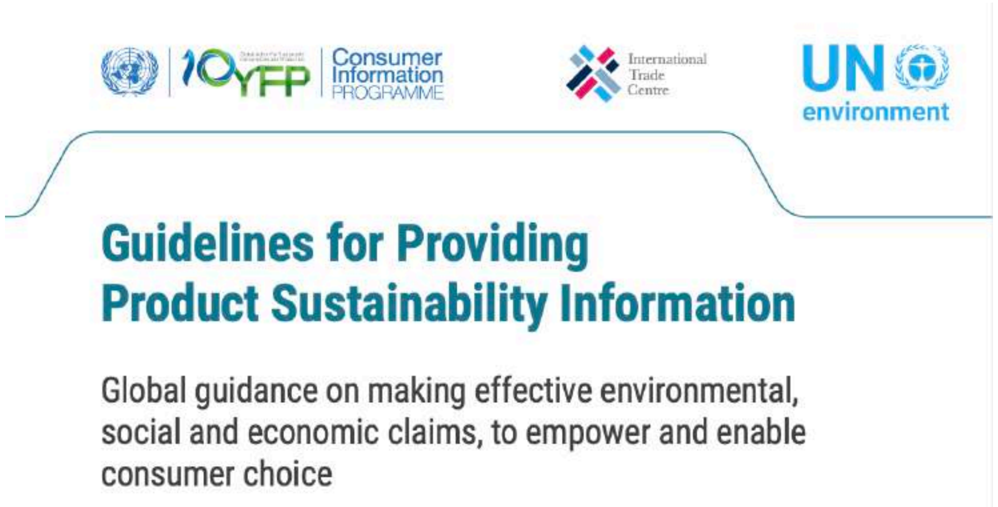
Label

Product Guarantee

Product Competitiveness

Consumer Choice

Informasi produk di tingkat konsumen


Consumer Information PROGRAMME

International Trade Centre

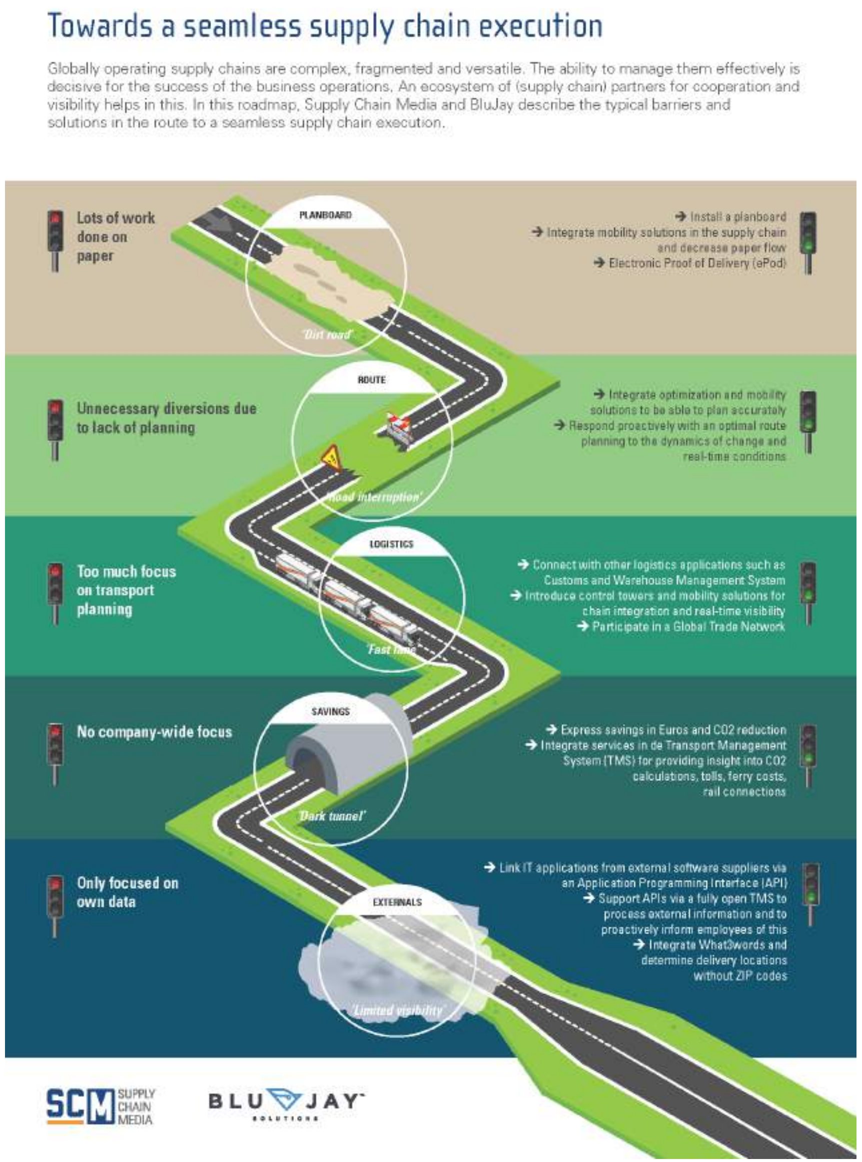
UN environment

Guidelines for Providing Product Sustainability Information

Global guidance on making effective environmental, social and economic claims, to empower and enable consumer choice

Supply Chain LCA

- Dalam konsep LCA apabila ingin *minimize* dampak dari *cradle to grave*, kita harus mempunyai konsep SC yang jelas, seperti mencari jalur yang meminimumkan dampak, integrasi moda transportasi, pemilihan mitra supplier dan distributor dll.
- Customer akan melihat performance lingkungan dari produk-produk yang diperjual belikan.



Pertanyaan LCA: Pisang mana yang lebih ramah lingkungan?

0.7 $KgCo_2$-eq/kg banana

0,2 – 1, range nilai emisi

0.5 $KgCo_2$-eq/kg banana

0,3 – 1, range nilai emisi

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Bagaimana di Indonesia?

NEWS

Global Sustainability Standards Symposium, 3rd May 2017

by adminapri / May 3, 2017 / 0 comments

APRI attended Global Sustainability Standards Symposium. This event was held on 3rd May 2017 at Kartini Hall, Jakarta. This Event was hosted by the ISEAL Alliance, United Nations Industrial Development Organization (UNIDO), the Indonesia Chamber of Commerce and Industry (KADIN) and the Indonesia Ministry of Industry.

The Global Sustainability Standards Symposium is a platform for provocative conversations about the challenges businesses are facing in terms of strengthening competitiveness and accessing new markets, with a particular focus on how sustainability standards can play a role. In 2017, the Symposium will focus on Southeast Asia and explore the theme of **sustainable value chains**. It will examine the common challenges faced by multiple sectors including fisheries, palm oil, cocoa and forestry, as well as the widespread economic, social and environmental benefits of incorporating responsible practices into value chains.

Around 200 business and sustainability leaders and experts join with this event to discuss how standards can be useful tools to help companies operationalise sustainability while improving their resilience and competitiveness in international markets. Hear from experts based in Europe, the US and other markets on their use of standards and certification, and network with others working in Southeast Asia.

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Bagaimana di Indonesia?

Bagaimana di Indonesia?

Tantangan penerapan LCA di Indonesia

Weakness & Uncertainty:

- Gaps between model and reality
- Lack of data availability
- Regionalized data
- Characterization factors-local impact

Tantangan penerapan LCA di Indonesia (2)

Benefit:

- Identify environtmental performance (quantitative)
- Identify hotspot – improvement quality
- Avoid burden shifting
- Product comparison

Referensi

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- *United Nations Environment Programme (2017). Guidelines for Providing Product Sustainability Information: "Global guidance on making effective environmental, social and economic claims, to empower and enable consumer choice", ISBN: 978-92-807-3672-4,*
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Thank You

Drone and its application

Rizki Putra Prastio, S. Si. M. T.

TABLE OF CONTENTS

1 Remote Sensing

2 Image Processing

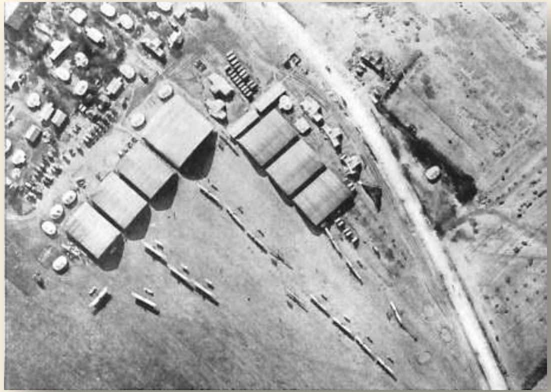
3 Aerial Imagery Collection

1

Remote Sensing

Remote Sensing

The process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft) (usgs.gov)



Used in WWII to search camouflaged military vehicles

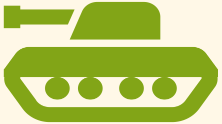
How does it work?

Vegetation vs metals vs water vs soil

Vegetation canopy and other materials have different near-infrared reflectivity.

↓

Main feature

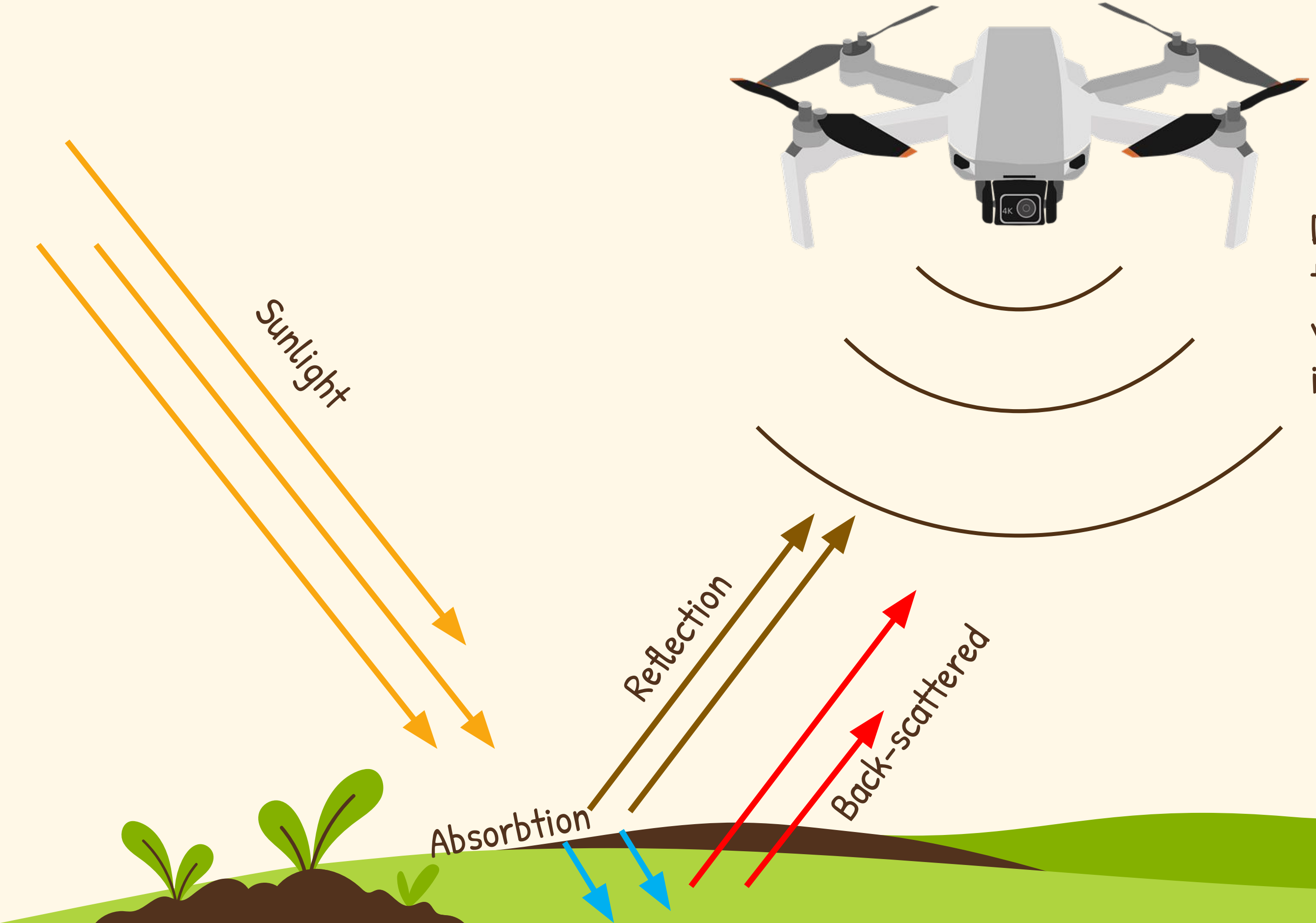


Series of landsat satellite was launched in 1970's an

Spatial resolution
1.0-30 m
(too low)

Temporal resolution
days - months

Obscured by clouds, particularly in equator

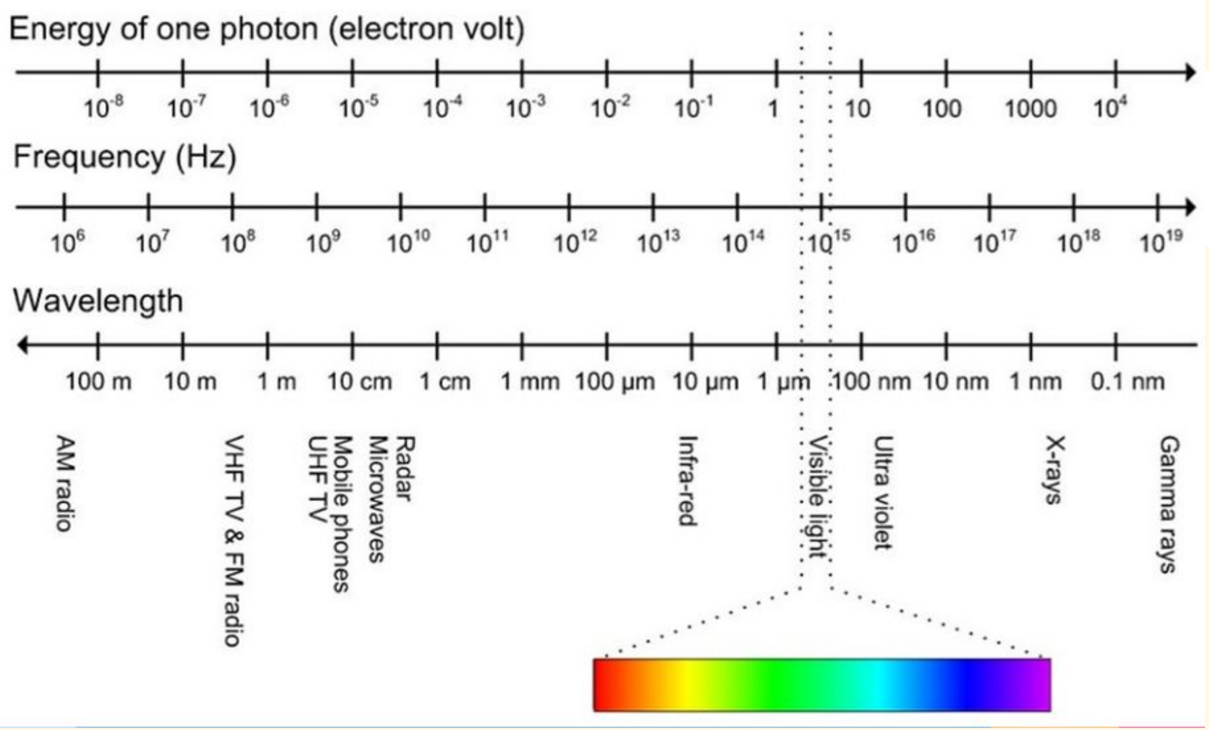


Drone can carry various sensors that allows us to measure some variables simultaneously. For instance:

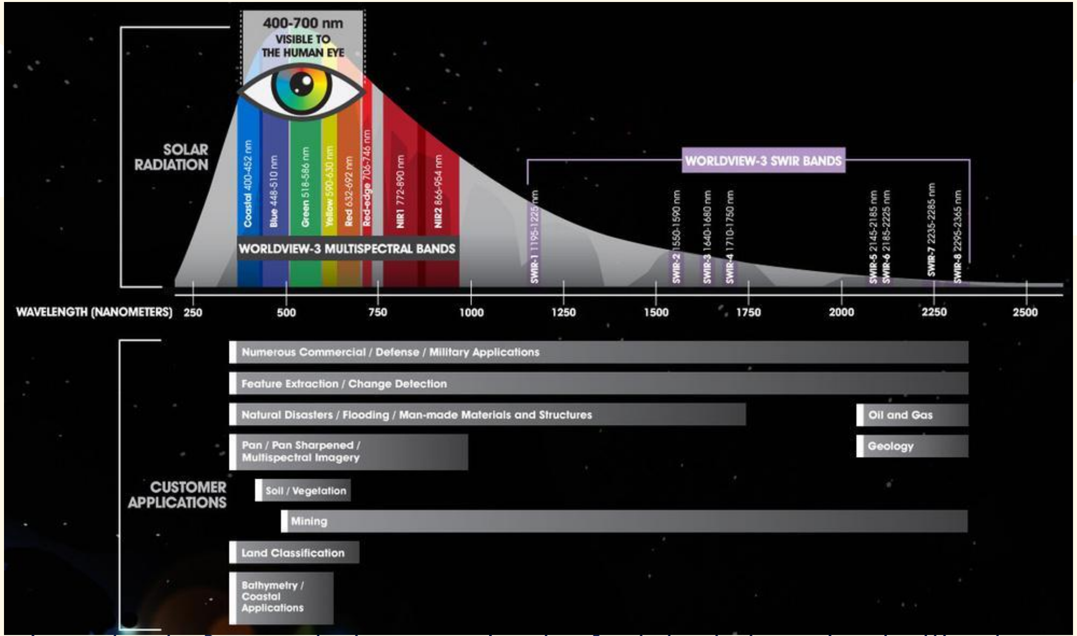
- Electromagnetic radiation.
- Distance.

2

Aerial Imagery Collection



The visible region (captured by the human eye) is around 400-700 nanometers.



Multispectral imaging combines two to five spectral imaging bands of relatively large bandwidth into a single optical system. A multispectral system usually provides a combination of visible (0.4 to 0.7 µm), near-infrared (NIR; 0.7 to 1 µm), short-wave infrared (SWIR; 1 to 1.7 µm), mid-wave infrared (MWIR; 3.5 to 5 µm) or long-wave infrared (LWIR; 8 to 12 µm) bands into a single system. — Valerie C. Coffey

What is multispectral imaging used for?

In the picture, it is clear that there are striking color differences in the mountains, sea, urban areas, and others. Marine sediments along the Madura Strait, for example, are clearly visible. In general, red color indicates shady vegetation, and dark color is aquatic (sea, river lakes). Moreover, the figure is the result of the three combination of spectrums, i.e., NIR, green, and red.

Examples of multispectral image processing results; East Java region photographed by LANDSAT 1 on September 27, 1972

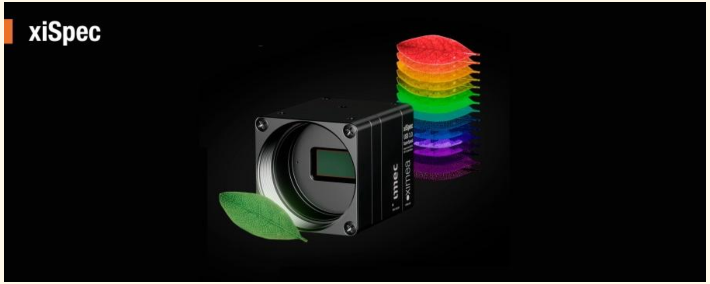
Sensor types

Visible light camera

(400 nm – 700 nm)

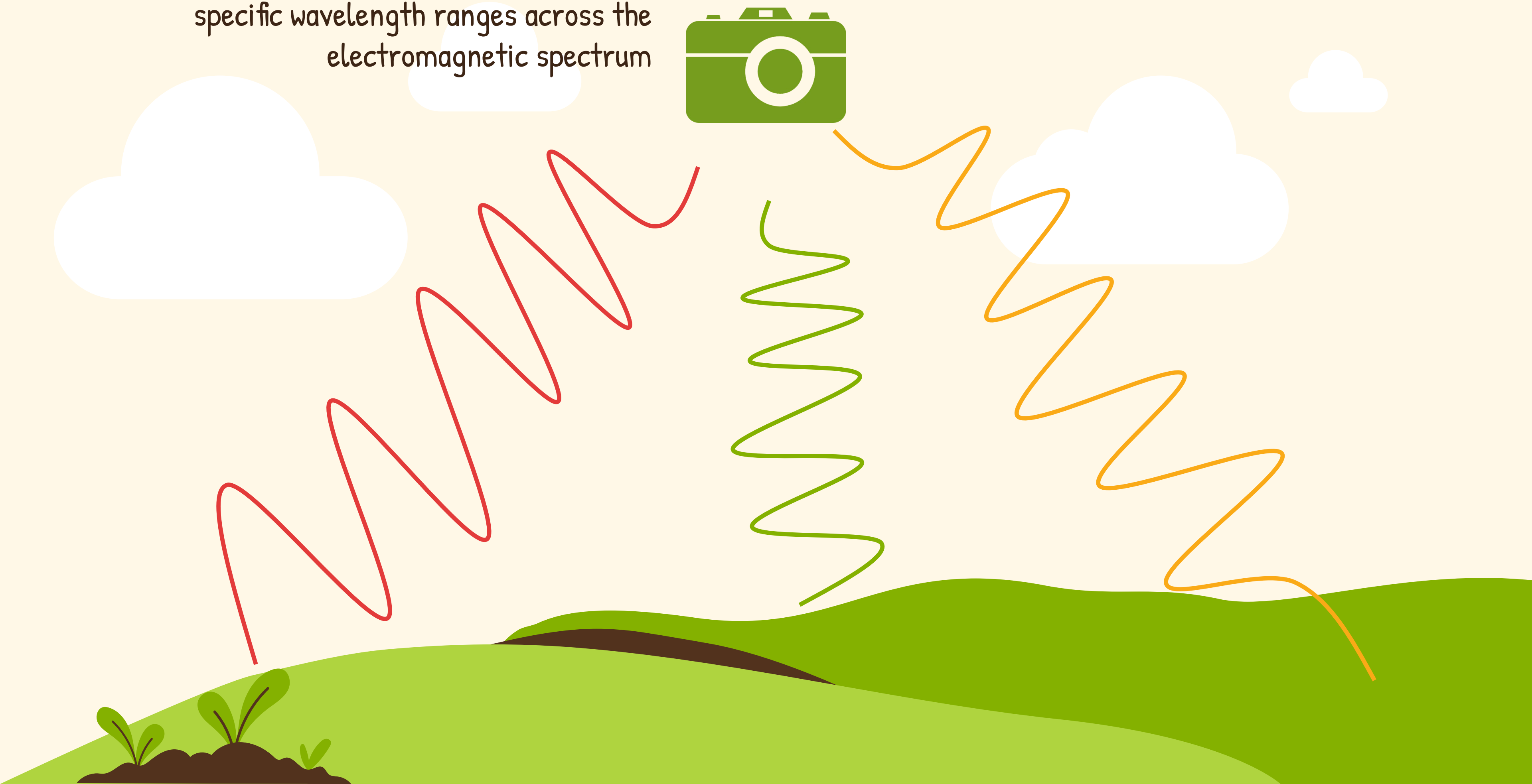
IR camera

Hyperspectral camera (> 10 spectral bands)



Multispectral camera

Multispectral camera: captures image data within specific wavelength ranges across the electromagnetic spectrum



3

Image Processing

Multispectral camera:
Consists of 6 cameras packed in a single structure.

1. RGB (color) camera
2. Blue : 450 nm ± 16 nm
3. Green : 560 nm ± 16 nm
4. Red : 650 nm ± 16 nm
5. Red Edge (RE) : 730 nm ± 16 nm
6. Near-Infrared (NIR) : 840 ± 26 nm

RGB (color) camera

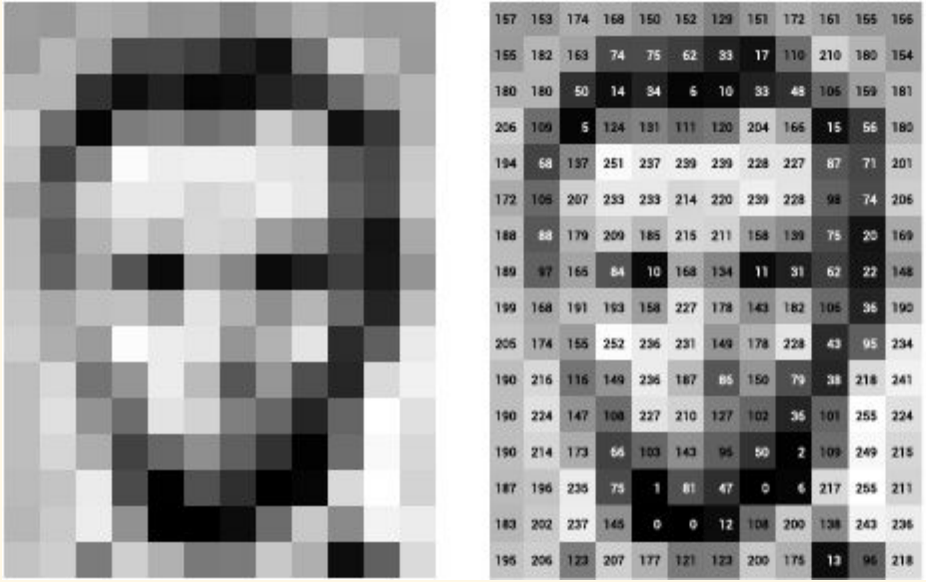
Blue

Green

Red

Red Edge

NIR



157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

An image is comprised of individual pixels. Each pixel also has its own value

We can perform certain operations to those pixels to get some useful information from it.

Source: https://ai.stanford.edu/~syyeung/cvweb/tutorial1.html

NDVI

The normalized difference vegetation index (NDVI) is a widely-used metric for quantifying the health and density of vegetation using sensor data

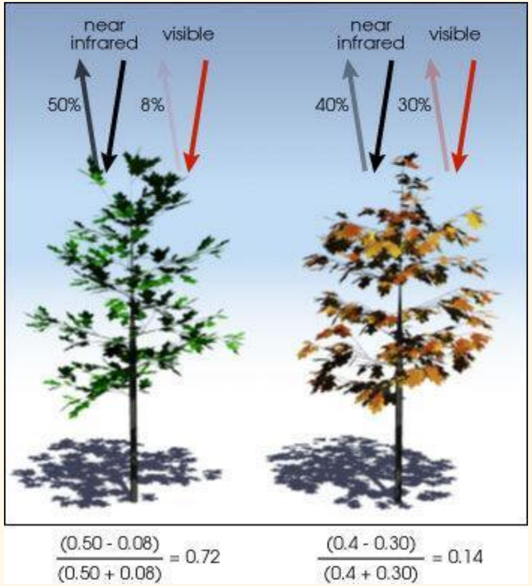


Illustration by Robert Simmon

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

Healthy vegetation (chlorophyll) reflects more near-infrared (NIR) and green light compared to other wavelengths. When you have high NDVI values, you have healthier vegetation. When you have low NDVI, you have less or no vegetation

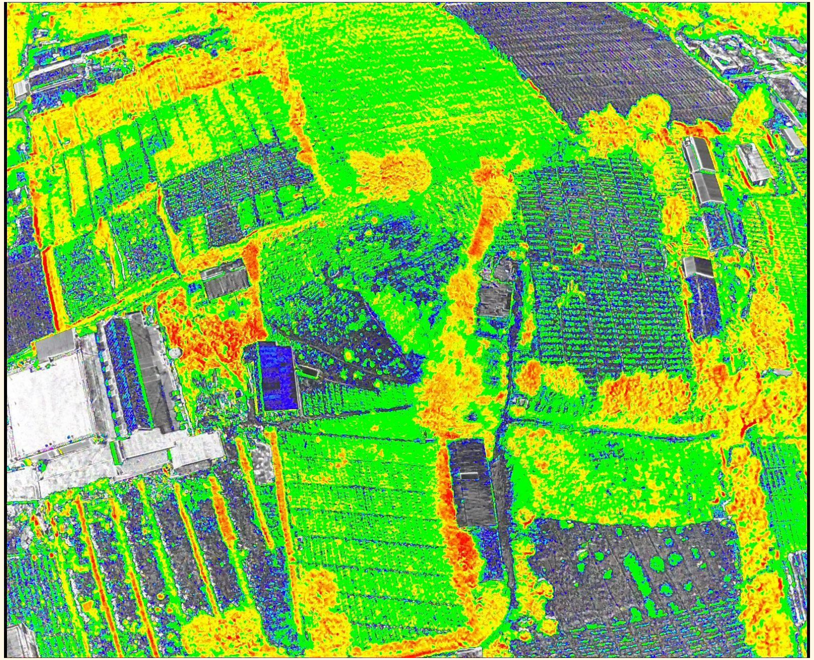
NDVI

−

+

Result

RGB (color) camera



NDVI

ENHANCED NORMALIZED DIFFERENCE VEGETATION INDEX (ENDVI)

Developed to improve NDVI by optimizing the vegetation signal in areas with a high leaf area index (LAI)

ENDVI = 2.5 * (NIR - Red)/(NIR + 6*Red - 7.5*Blue + 1)

GREEN NORMALIZED DIFFERENCE VEGETATION INDEX (GNDVI)

It is similar to NDVI except that instead of the red spectrum it measures the green spectrum.

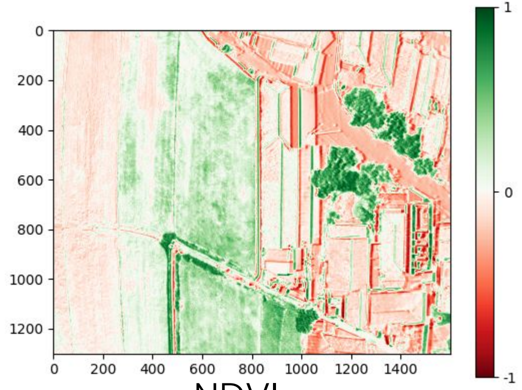
Compared to the NDVI index, it is more sensitive to chlorophyll concentration

GNDVI = (NIR - Green)/(NIR + Green)

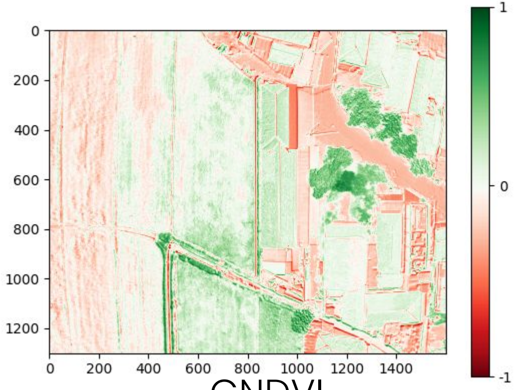
RGB (color) camera

Red

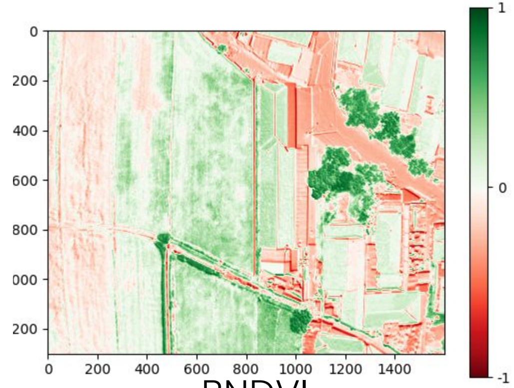
NIR



NDVI

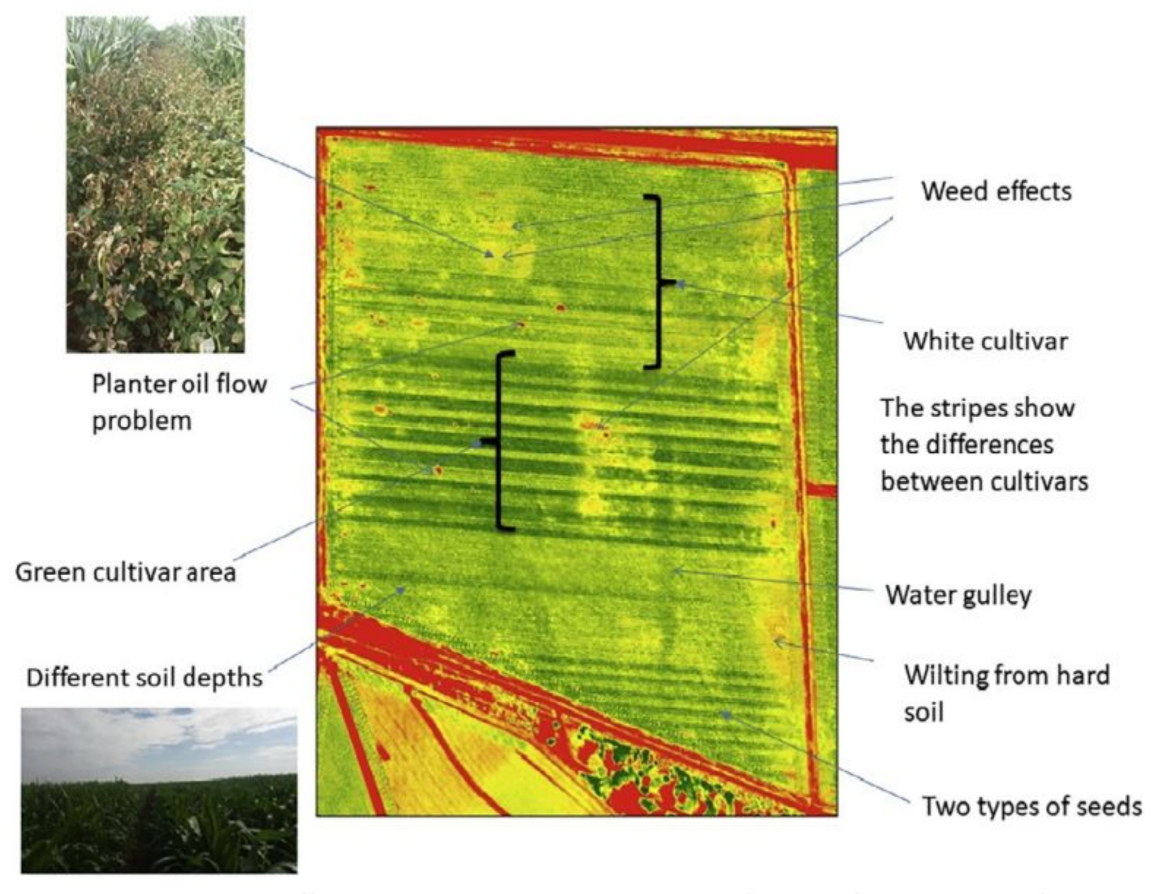


GNDVI

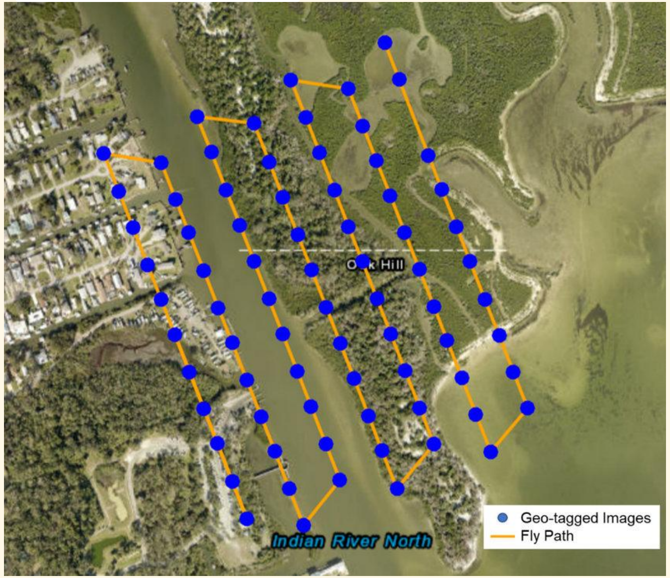


BNDVI

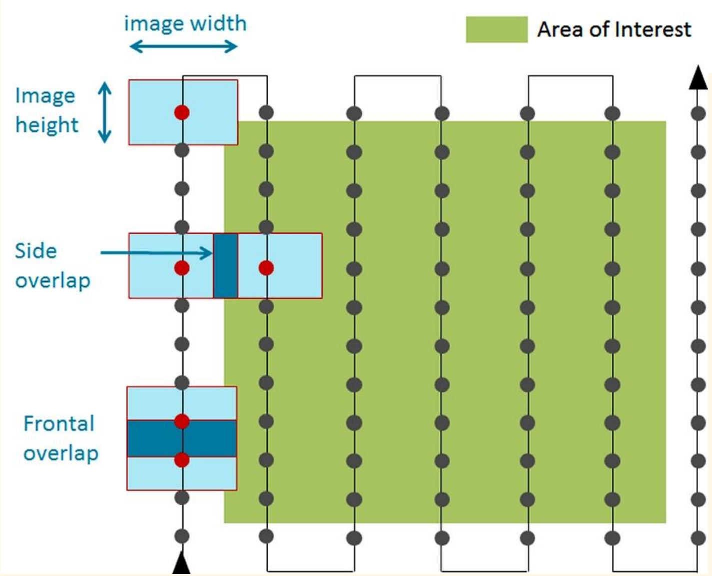
Index	Calculation Formula	Reference	Comment
NDVI	$NDVI = \frac{NIR-RED}{NIR+RED}$	Rouse et al. [21]	normalized vegetation index
GNDVI	$GNDVI = \frac{NIR-Green}{NIR+Green}$	Gitelson et al. [9]	Green normalized vegetation index
BNDVI	$BNDVI = \frac{NIR-Blue}{NIR+Blue}$	Wang Fu-ming et al. [3]	Blue normalized vegetation index
GRNDVI	$GRNDVI = \frac{NIR-(Green+Red)}{NIR+(Green+Red)}$	Wang Fu-ming et al. [3]	Green and Red normalized vegetation index
GBNDVI	$GBNDVI = \frac{NIR-(Green+Blue)}{NIR+(Green+Blue)}$	Wang Fu-ming et al. [3]	Green and Blue normalized vegetation index
RBNDVI	$RBNDVI = \frac{NIR-(Red+Blue)}{NIR+(Red+Blue)}$	Wang Fu-ming et al. [3]	Red and Blue normalized vegetation index
A_{NDVI}	$A_{NDVI} = \sum_{r_{m1}}^{r_{m2}} \sum_{r_{n1}}^{r_{n2}} \frac{NIR_m-Red_n}{NIR_m+Red_n}$	this paper	accumulative normalized vegetation index


Weed effects
White cultivar
The stripes show the differences between cultivars
Water gulley
Wilting from hard soil
Two types of seeds
Planter oil flow problem
Green cultivar area
Different soil depths

3D mapping



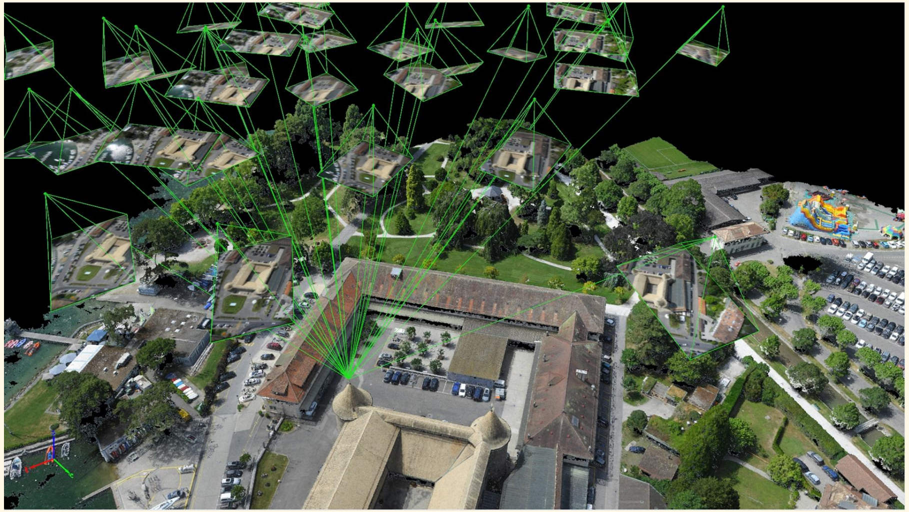
Yang, Bo & Hawthorne, Timothy & Torres, Hannah & Feinman, Michael. (2019). Using Object-Oriented Classification for Coastal Management in the East Central Coast of Florida: A Quantitative Comparison between UAV, Satellite, and Aerial Data. Drones. 3. 60. 10.3390/drones3030060.



Mining.com

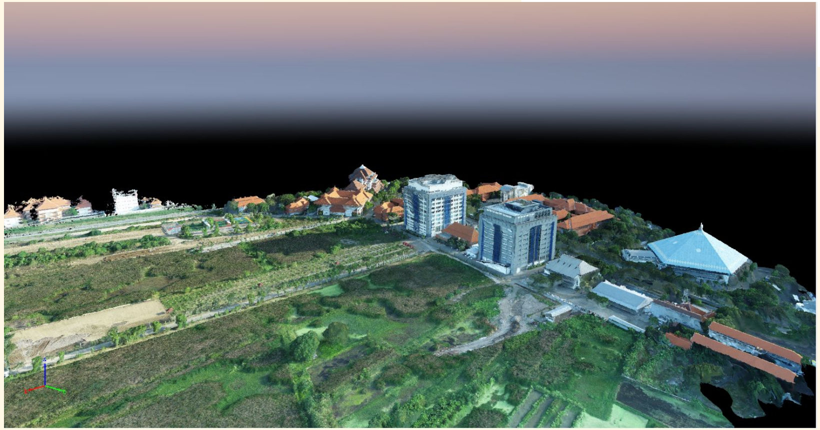
The drone will take hundreds or thousands of overlapping aerial photos as it flies over the area of interest.

3D mapping

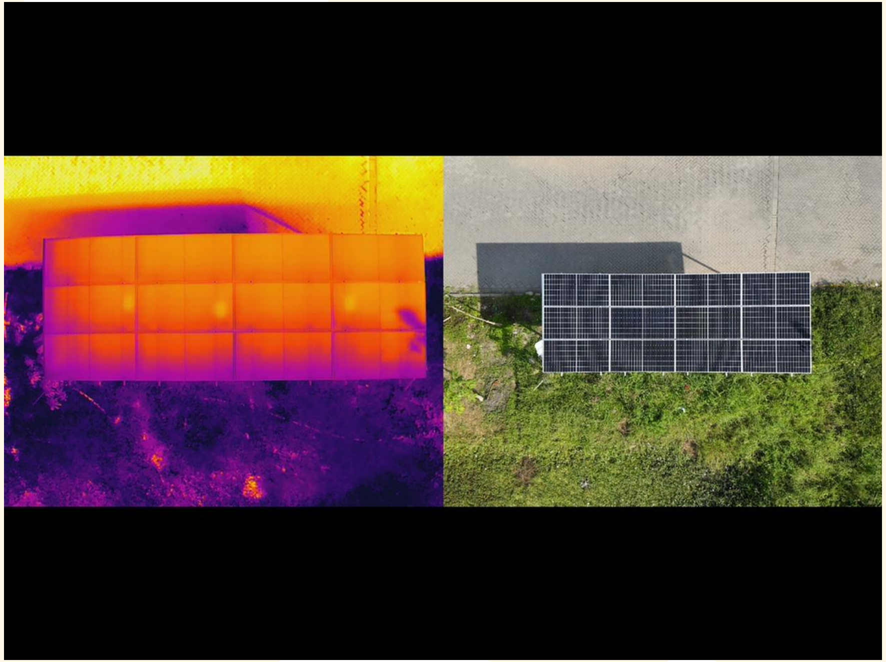


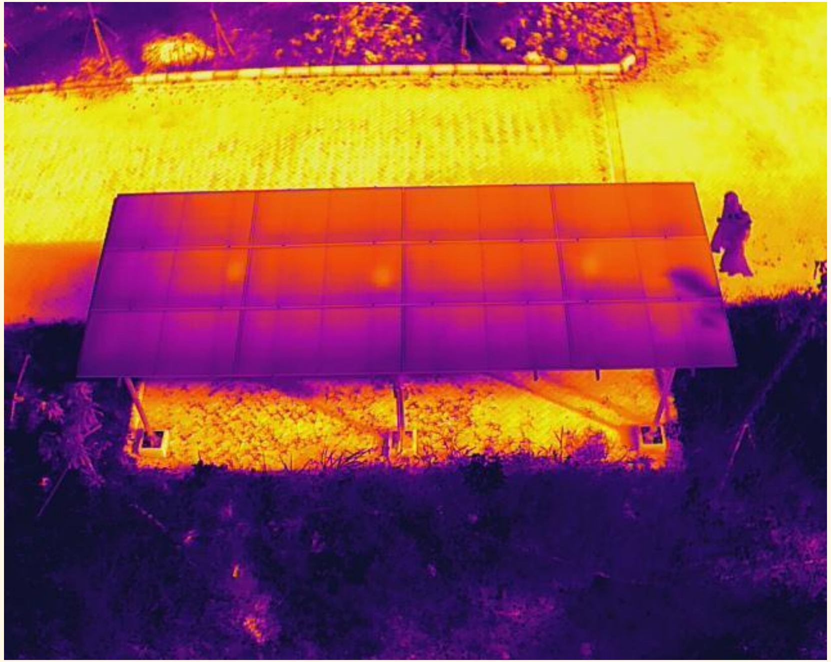
pix4d

3D mapping



Hot spot finder





Environmental Management System

ISO 14000 Family

WHAT IS ISO?

It's all in the name

Because 'International Organization for Standardization' would have different acronyms in different languages (IOS in English, OIN in French for Organisation internationale de normalisation), our founders decided to give it the short form ISO. ISO is derived from the Greek **'isos'**, meaning **equal**. Whatever the country, whatever the language, we are **always ISO**

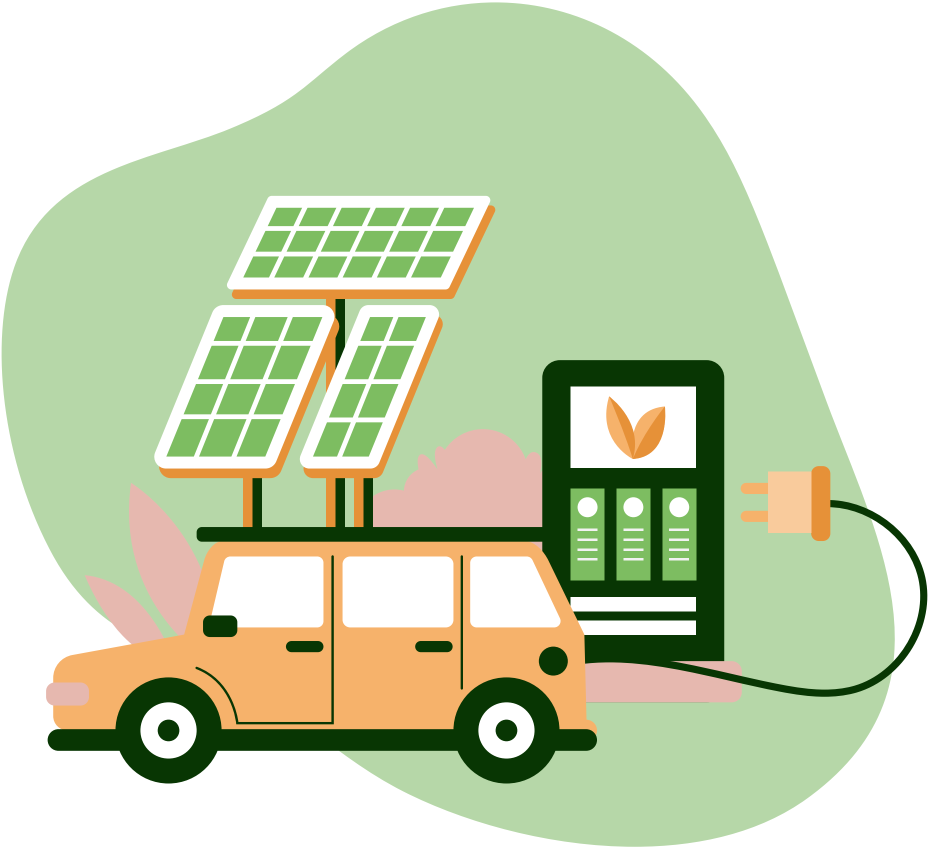
ISO is an independent, non-governmental international organization with a membership of **167 national standards bodies.**

Through its members, it brings together experts to **share knowledge** and **develop voluntary, consensus-based, market relevant** International Standards that support innovation and provide solutions to global challenges.

ISO standards are internationally agreed by **experts**
Think of them as a formula that describes **the best way of doing something**

*It could be about **making a product, managing a process, delivering a service** or **supplying materials** – standards cover a huge range of activities. Standards are the distilled wisdom of people with expertise in their subject matter and who know the needs of the organizations they represent – people such as manufacturers, sellers, buyers, customers, trade associations, users or regulators

When things don't work as they should, it often means that standards are absent.



For instance...

Quality Management Standards

to help work more efficiently and reduce product failures.

Environmental Management Standards

to help reduce environmental impacts, reduce waste and be more sustainable.

Health and Safety Standards

to help reduce accidents in the workplace.

For instance...

Energy Management Standards

to help cut energy consumption.

Food Safety Standards

to help prevent food from being contaminated.

IT Security Standards

to help keep sensitive information secure.

24552

International Standards covering almost all aspects of technology and manufacturing

167

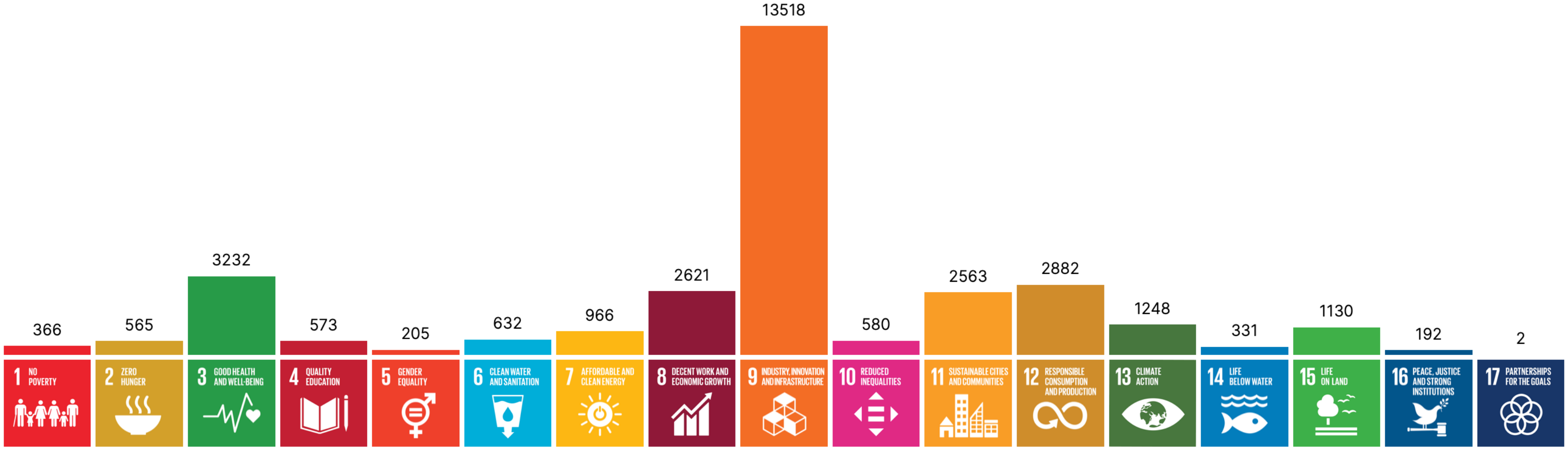
Members representing ISO in their country

809

Technical committees and subcommittees to take care of standards development

ISO contributes to all of the Sustainable development goals

Here you can see the number of ISO standards that apply to each Goal.



Developing Standards

Like a symphony, it takes a lot of people working together to develop a standard. ISO's role is similar to that of a conductor, while the orchestra is made up of independent technical experts nominated by our members

Key Principles in ISO Standard Development . . .

ISO does not decide when to develop a new standard, but responds to a request from industry or other stakeholders such as consumer groups

Respond to a need in the market

ISO standards are developed by groups of experts from all over the world, that are part of larger groups called technical committees

Based on global expert opinion

The technical committees are made up of experts from the relevant industry, but also from consumer associations, academia, NGOs and government

Developed through a multi-stakeholder process

Developing ISO standards is a consensus-based approach and comments from all stakeholders are taken into account

Based on a consensus

Benefits of standards

ISO was founded with the idea of answering a fundamental question: what's the best way of doing this?

Better business, better regulation, better products and services

ISO 14000 Family Environmental Management

An environmental management system helps organizations **identify, manage, monitor** and **control** their environmental issues in a **holistic manner**

For companies and organizations of any type that require practical tools to manage their environmental responsibilities

...

What does it do and who is it for?

It maps out a framework that **a company** or **organization** can follow to set up an **effective environmental management systems.** Designed for **any type of organization**, regardless of its activity or sector, it can provide assurance to company management and employees as well as external stakeholders that **environmental impact** is being **measured** and **improved.**

• • •

What do the standards in the ISO 14000 family cover?

ISO 14001 provides requirements with guidance for use that relate to **environmental systems**. Other standards in the family focus on specific approaches such as **audits, communications, labelling and life cycle analysis**, as well as **environmental challenges** such as climate change

The ISO 14000 family of standards are developed by ISO **Technical Committee ISO/TC 207** and its various **subcommittees**. For a full list of published standards in the series see their **standards catalogue**

Can an organization be ISO 14001 certified?

There are more than **300,000 certifications** to ISO 14001 in **171 countries** around the world. ISO also created a short document where you can find out more, not only on certification, but a wide range of **benefits of ISO 14001**

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Please keep this slide for attribution

Thanks!

Do you have any questions?

Green Data Centers: Trends, Infrastructures, Challenges

Muhammad Noor Fakhruzzaman, S.Kom., M.Sc.

References

- https://news.microsoft.com/innovation-stories/project-natick-underwater-datacenter/
- https://www.datacenterdynamics.com/en/opinions/sustainable-data-centers-5-key-questions/
- https://www.saveonenergy.com/learning-center/post/how-to-make-data-centers-more-eco-friendly/
- https://datacenterlight.ch/en-us/cms/hydropower/
- https://docs.media.bitpipe.com/io_10x/io_102267/item_1306461/Focus_Green_datacentre.pdf

Introduction

- Green data center = Pusat data dan sistem didalamnya yang menggunakan energi ramah lingkungan
- Meningkatnya penggunaan cloud server = data center bermunculan di seluruh dunia = Memakan banyak energi
- Sehingga diperlukan data center yang ramah lingkungan

Outline

- Power source dari Renewable Energy
- Pendinginan perangkat yang hemat energi
- Green Cloud Computing

Data Center Power Source

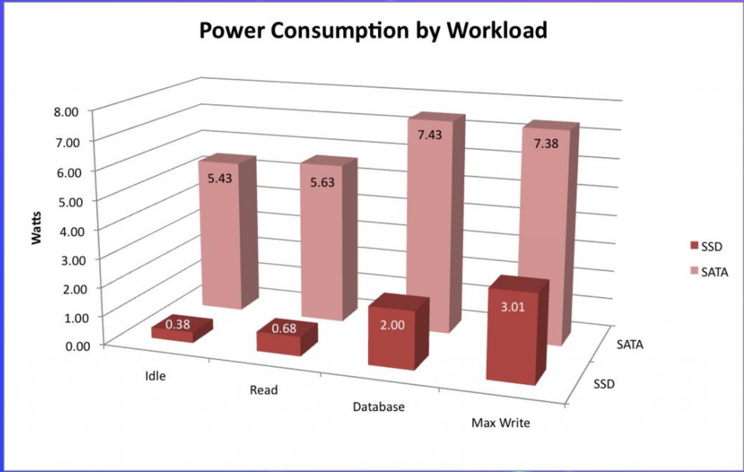
- Hydropower
  - Data center Light di Swiss terletak di Alpen. Ditenagai aliran sungai Linth 99%
- Solar Power
  - Belum bisa >90% solar power karena daya-nya yang kecil

Diskusi singkat

- Bisa kah renewable energy menyuplai seluruh kebutuhan listrik data center se-dunia?
- Bagaimana cara agar solar power mampu menyuplai tenaga ke data center?

Low-powered Computers

- HDD vs SSD
- Energy Efficient Servers
  - Menggunakan manajemen smartphone, balancing idle/processing
- Modular Servers
  - Datacenter portable sesuai kebutuhan
- Low Power Cooling Systems



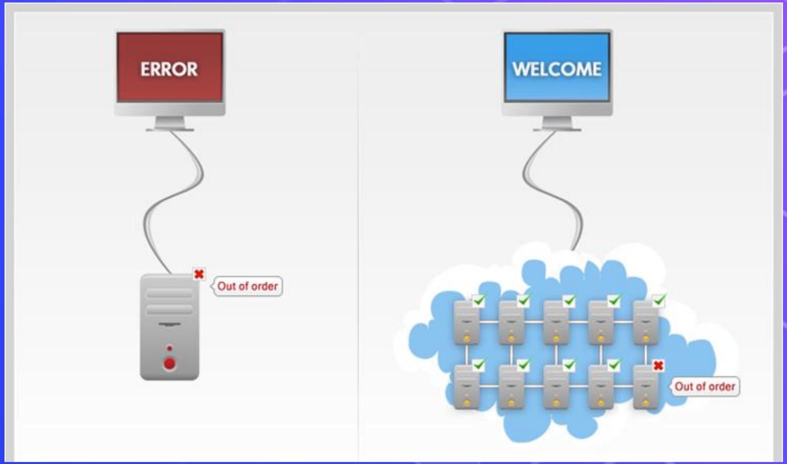
Green Cooling Systems

What do you think?

- Hydro-cooling
- Evaporative cooling
- Free-air cooling

Green Cloud Computing

- Product longevity
- Algorithmic efficiency
- Resource allocation
- Virtualization
- Power management
- Artificial Intelligence

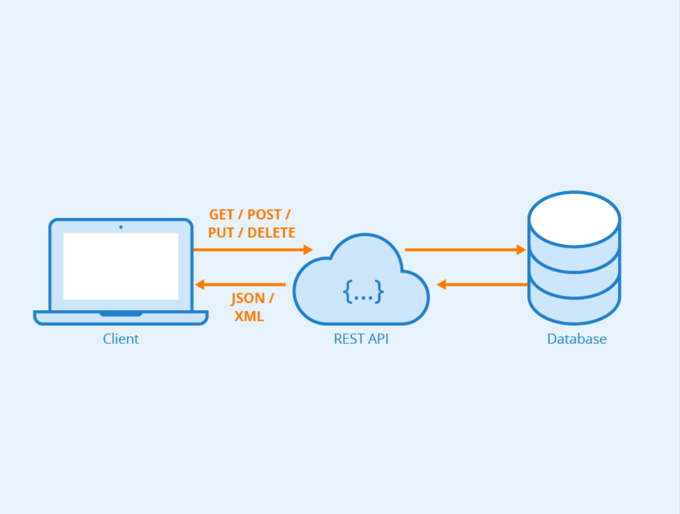


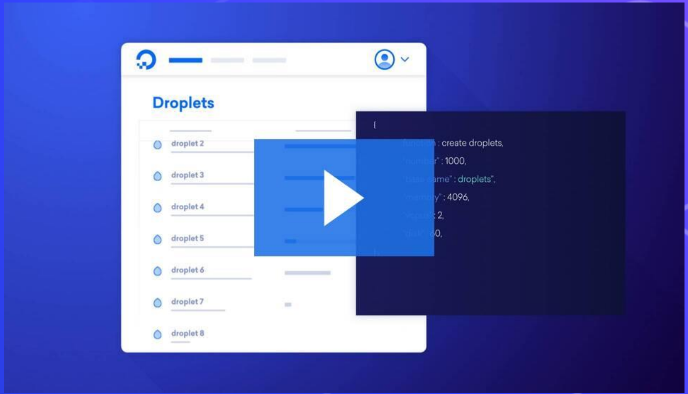
Why cloud?

- Cloud menggunakan resourcenya secara optimal
- Cloud server terdistribusi sesuai lokasi dan kebutuhan pengguna
- Penyedia Cloud service (AWS, Azure, Digital Ocean) menggunakan energi terbarukan

Cloud usage

- High Performance Computing
  - Machine learning
  - AI as a service
- Cloud storage
  - Hemat penyimpanan lokal
  - Reduce redundancy
- Highly Accessible
  - Dapat diakses dimana saja
  - Menggunakan device apa saja

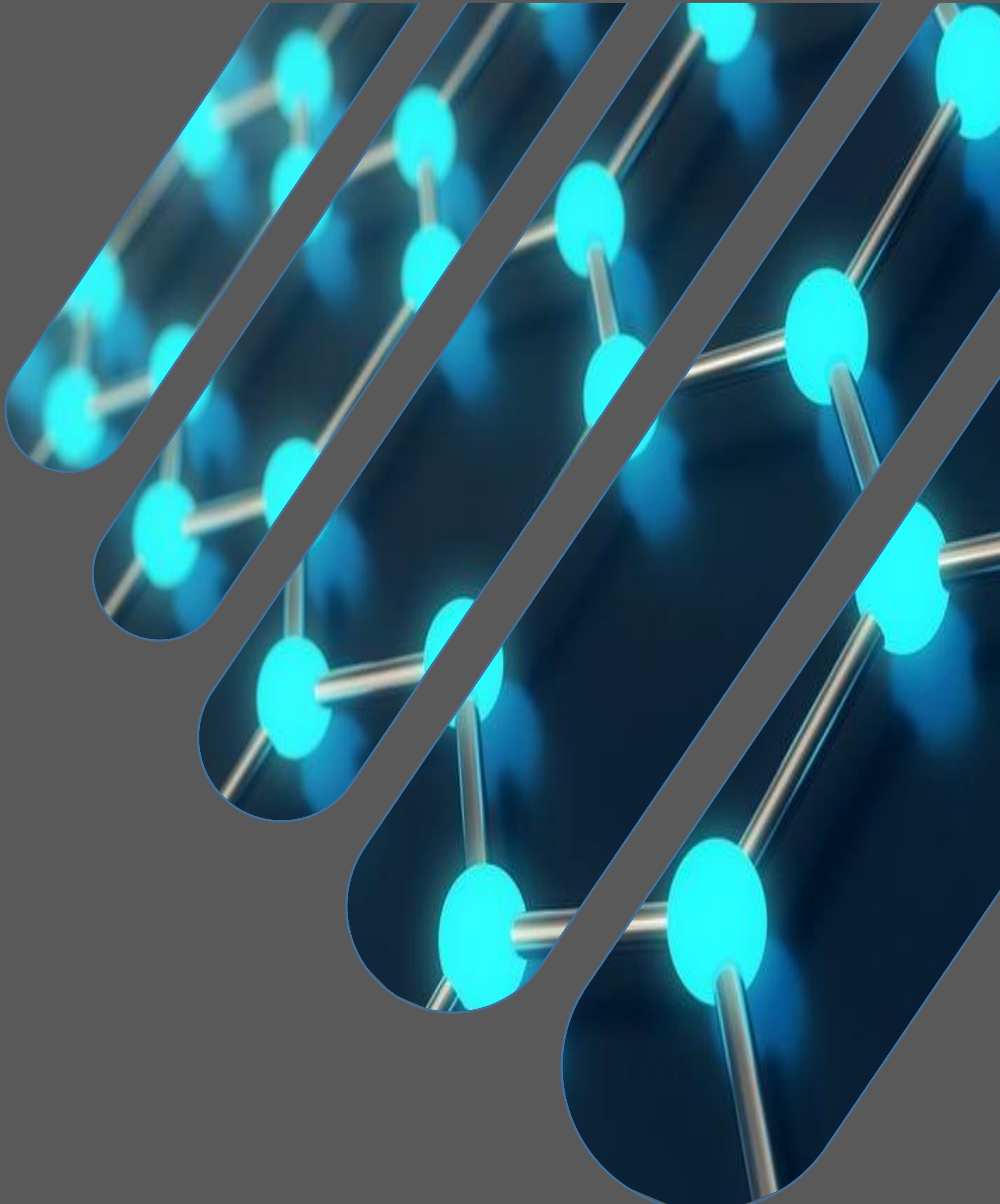




[About](#)

Questions / Comments?

TEKNOLOGI HIJAU DALAM MANUFAKTUR NANOMATERIAL



Tahta Amrillah, PhD
Ilma Amalina, PhD

Outline:

Introduction

Green synthesis of Nanoparticles

Nanomaterials for Green Technology

Outline:

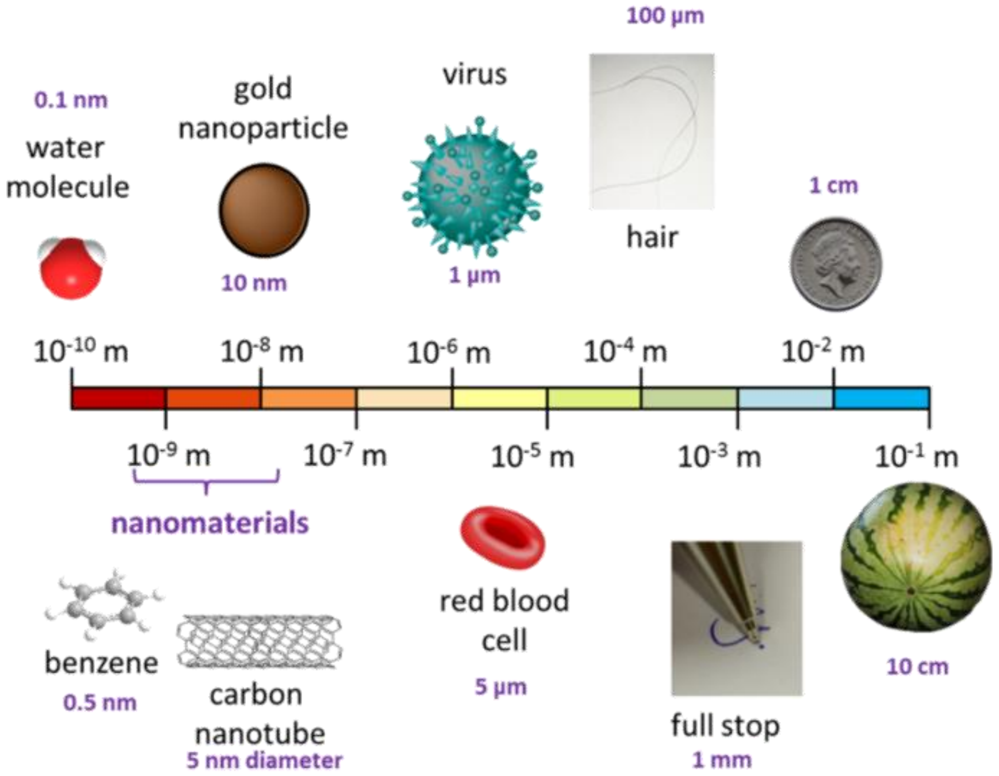
Introduction

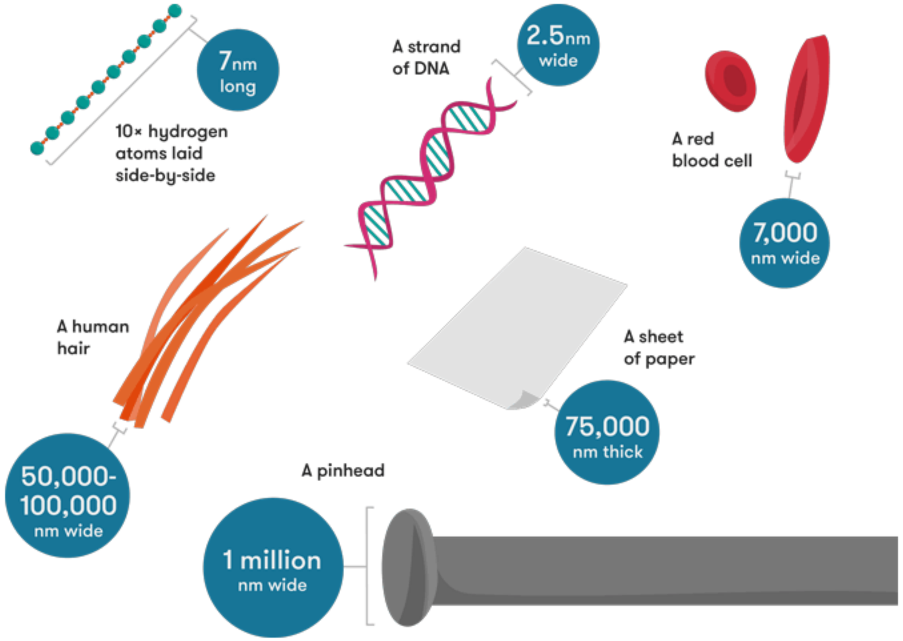
Green synthesis of Nanoparticles

Nanomaterials for Green Technology

What is nanotechnology?

- Nanotechnology is the study and the manipulation of matter at length scales of the order of a few nanometers (100 atoms or so) to produce useful materials and devices.

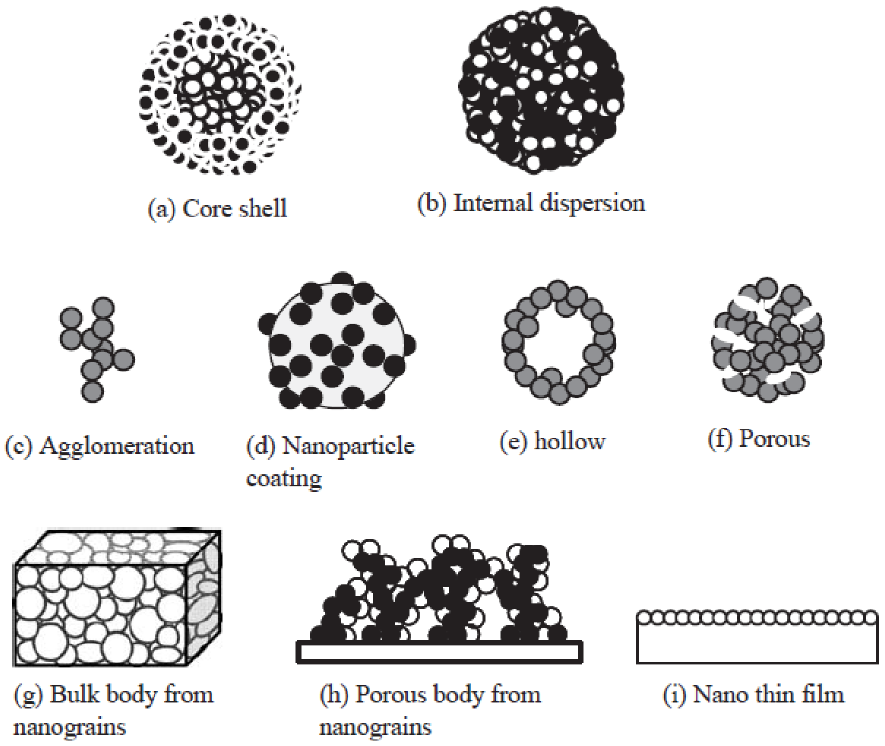




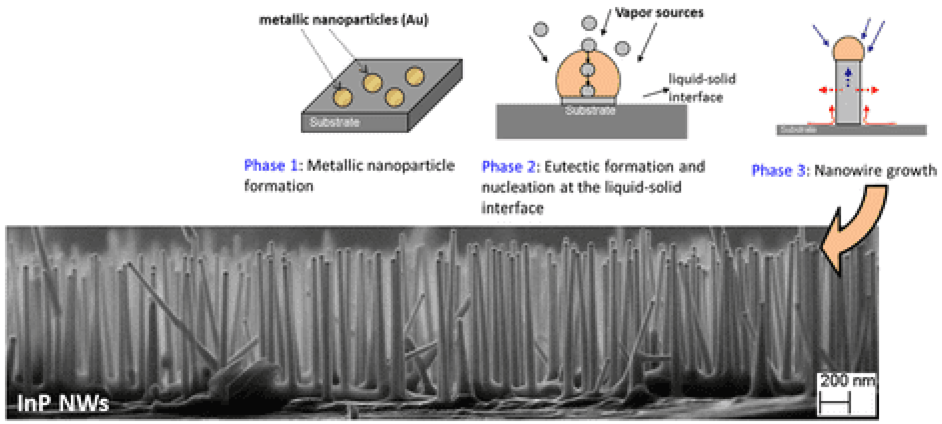
Binns, C.,2010. Introduction to Nanoscience and Nanotechnology. New Jersey: John Wiley & Son, Inc.
https://chembam.com/definitions/nanotechnology/
https://www.science.org.au/curious/nanoscience

What is nanotechnology?

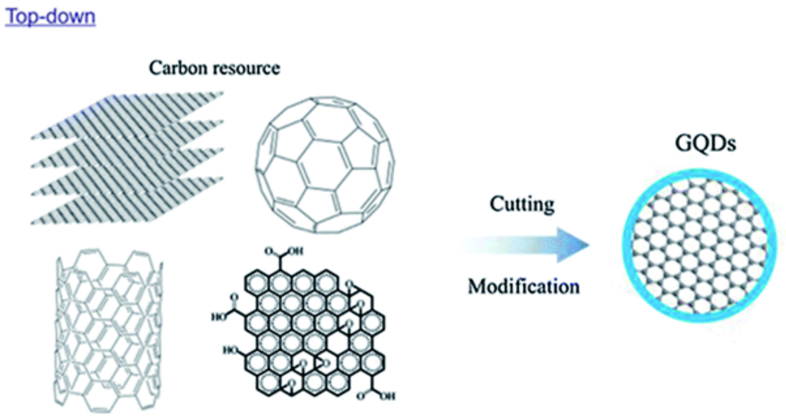
Low dimensional materials: quantum dot (0D), nanowire (1D), and thin-film (2D), nanoparticle (3D)



Nanoparticle Technology Handbook, Hosokawa, et al. Elsevier

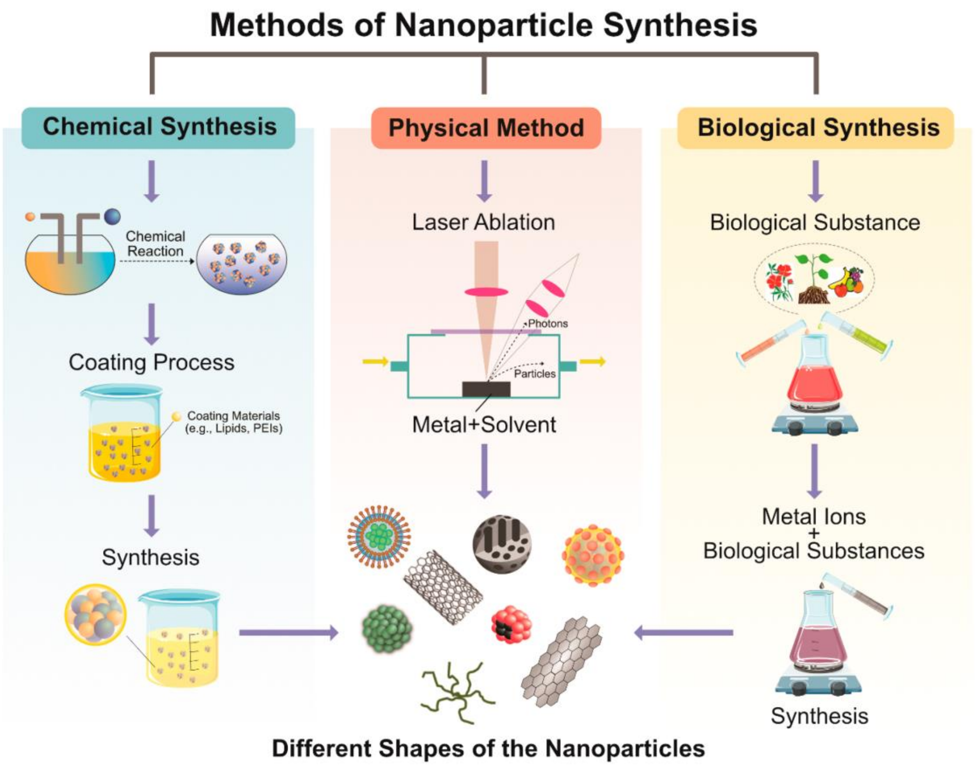


https://antoniopolimeni-physics.weebly.com/semiconducting nanowires.html

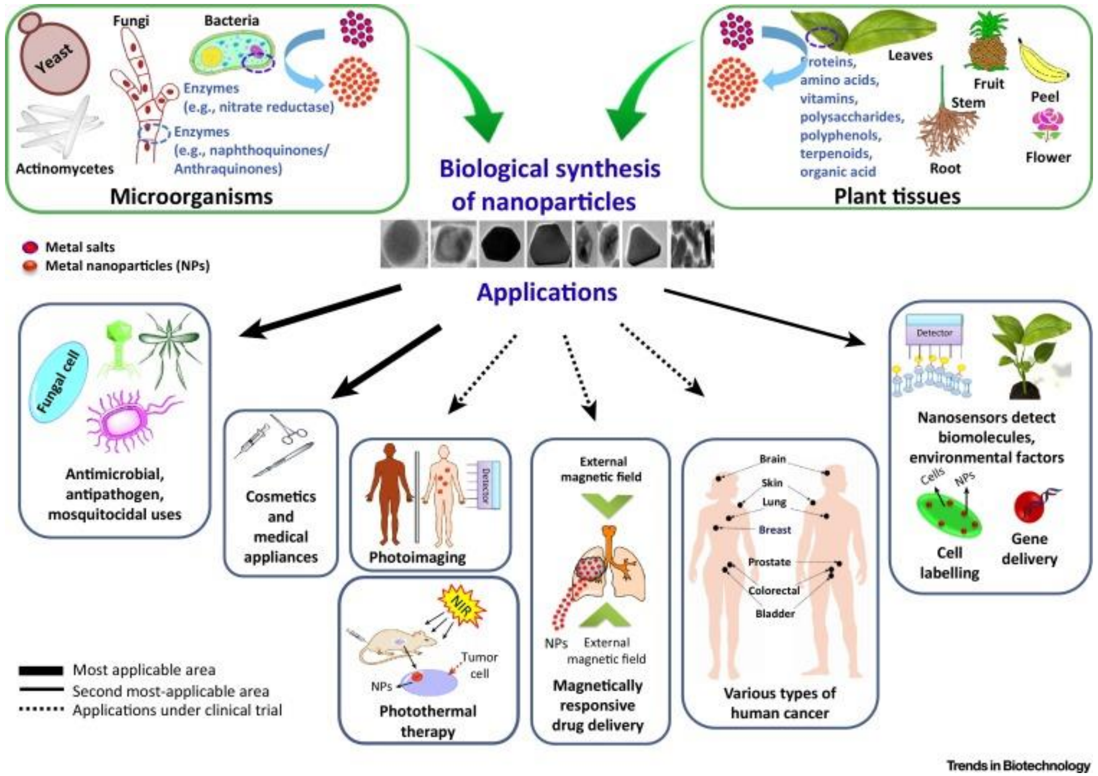


https://doi.org/10.1039/D0RA03938A

What is nanotechnology?

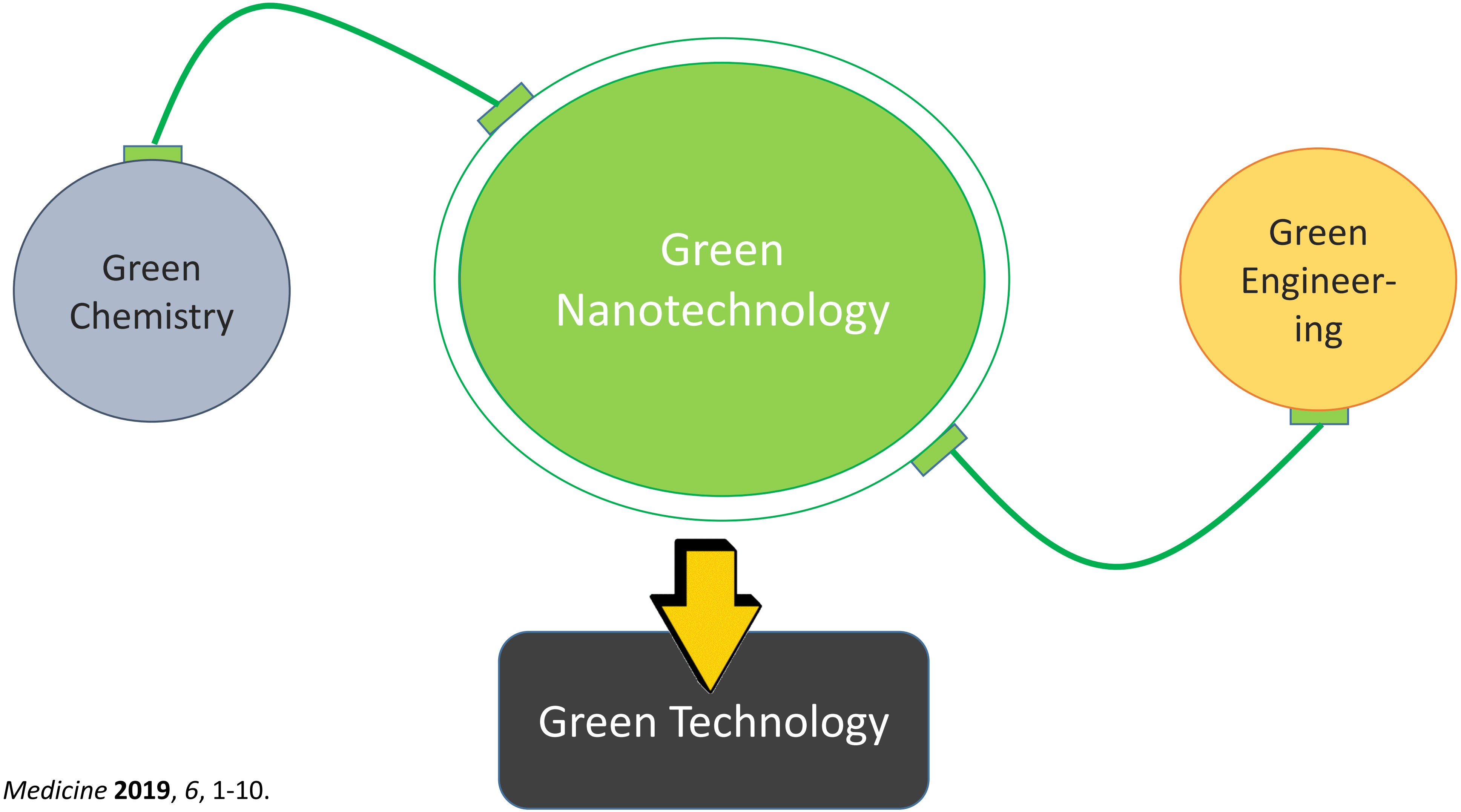


https://doi.org/10.3390/nano9121719



https://doi.org/10.1016/j.tibtech.2016.02.006

What is green nanotechnology?



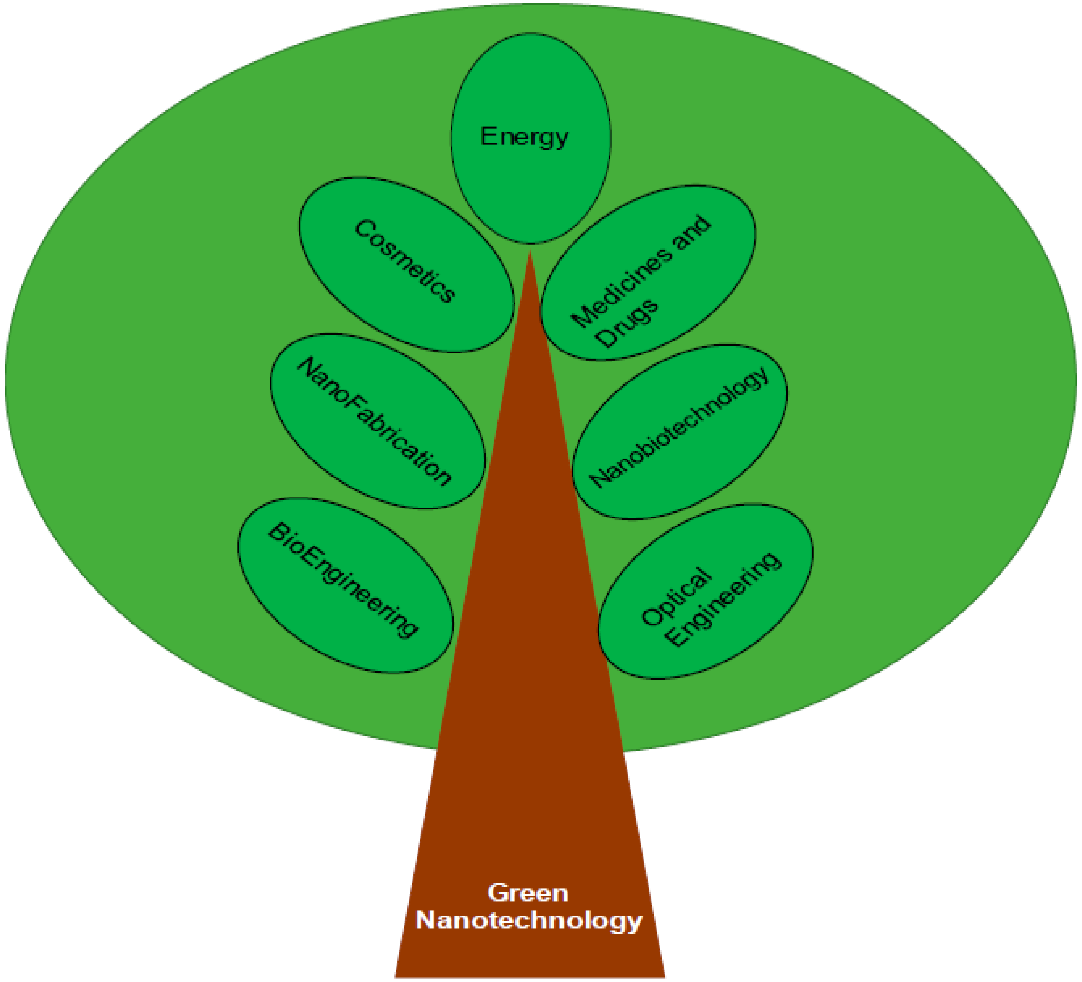
Verma, A., *et al*. *Medicine* **2019**, *6*, 1-10.

What is green nanotechnology?

CONTRIBUTES TO:	GREEN NANOTECHNOLOGY	CLEAN PRODUCTION PROSES:
ENVIRONMENTAL SUSTAINABILITY	is the study of how nanotechnology can benefit environment, such as by using less energy during manufacturing process, the ability to recycle products after use, or using eco-friendly materials.	SYNTHESIS NANOMATERIAL USING SUNLIGHT
NO HARM TO HUMAN HEALTH		SYNTHESIS NANOMATERIAL USING WASTE
NO HARM TO ENVIRONMENT		BIOSYNTHESIS NANOMATERIAL

Verma, A., *et al. Medicine* **2019**, *6*, 1-10.

Green Nanotechnology Applications:



- Nanoparticles could be used to remove industrial pollutants in contaminated air, soil and groundwater
- Nanofilters might be used to purify water and to desalinate water at an affordable cost
- Make solar cells much more cost efficient
- Save fuel
- Reduce materials used for production
- Reduce pollution from energy generation
- Help conserve fossil fuels
- Enhance battery life (less material use and waste)

Verma, A., *et al*. *Medicine* **2019**, *6*, 1-10.
Dhingra, R., *et al*. *Sustainability* **2010**, *2*, 3323-3338.

Green Chemistry for Nanomanufacturing Process Principles:

- Prevent waste
- Design safer chemical and products
- Design less hazardous chemical synthesis
- Use renewable feedstocks
- Use catalyst, not stoichiometric reagents
- Avoid chemical derivatives
- Maximise atom economy
- Use safer solvent and reaction conditions
- Increase energy efficiency
- Design chemicals and products to degrade after use
- Analyse in real time to prevent pollution
- Minimise the potential for accidents

Green Chemistry for Nanomanufacturing Process Principles:

Green Chemistry Principles

- P1. Prevent waste
- P2. Atom economy
- P3. Less hazardous chemical synthesis
- P4. Designing safer chemicals
- P5. Safer solvents/reaction media
- P6. Design for energy efficiency
- P7. Renewable feedstocks
- P8. Reduce derivatives
- P9. Catalysis
- P10. Design for degradation/Design for end of life
- P11. Real-time monitoring and process control
- P12. Inherently safer chemistry

Designing Greener Nanomaterial and Nanomaterial Production Methods	Practicing Green Nanoscience
Design of safer nanomaterials (P4,P12) →	Determine the biological impacts of nanoparticle size, surface area, surface functionality; utilize this knowledge to design effective safer materials that possess desired physical properties; avoid incorporation of toxic elements in nanoparticle compositions
Design for reduced environmental impact (P7,P10) →	Study nanomaterial degradation and fate in the environment; design material to degrade to harmless subunits or products. An important approach involves avoiding the use of hazardous elements in nanoparticle formulation; the use of hazardless, bio-based nanoparticle feedstocks may be a key.
Design for waste reduction (P1,P5,P8) →	Eliminate solvent-intensive purifications by utilizing selective nanosyntheses - resulting in greater purity and monodispersity; develop new purification methods, e.g. nanofiltration, that minimize solvent use; utilize bottom-up approaches to enhance materials efficiency and eliminate steps
Design for process safety (P3,P5,P7,P12) →	Design and develop advanced syntheses that utilize more benign reagents and solvents than used in "discovery" preparations; utilize more benign feedstocks, derived from renewable sources, if possible; identify replacements for highly toxic and pyrophoric reagents
Design for materials efficiency (P2,P5,P9,P11) →	Develop new, compact synthetic strategies; optimize incorporation raw material in products through bottom-up approaches, use alternative reaction media and catalysis to enhance reaction selectivity; develop real-time monitoring to guide process control in complex nanoparticle syntheses
Design for energy efficiency (P6,P9,P11) →	Pursue efficient synthetic pathways that can be carried out at ambient temperature rather than elevated temperatures; utilize non-covalent and bottom-up assembly method near ambient temperature, utilize real-time monitoring to optimize reaction chemistry and minimize energy costs

Hutchison, J. E. *ACS Nano* **2008**, *2*, 3, 395-402
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Outline:

- Introduction
- Green synthesis of Nanoparticles
- Nanomaterials for Green Technology

Green Synthesis of Nanoparticles (NPs)

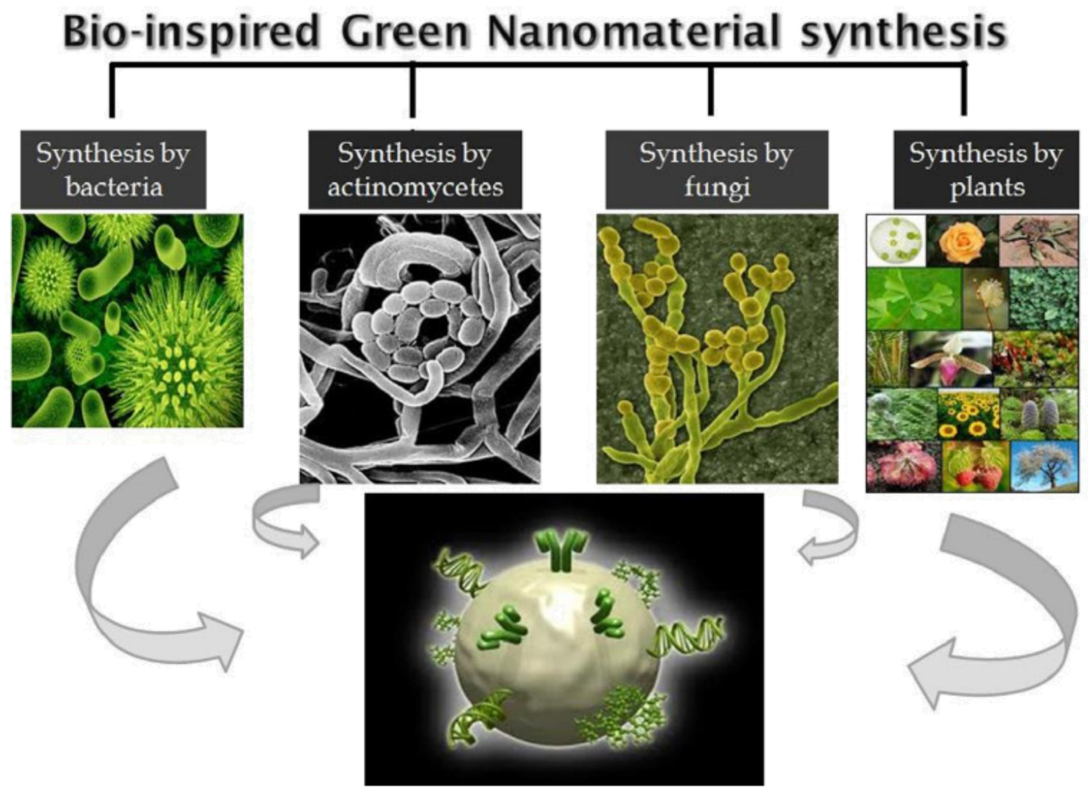
1. BIOSYNTHESIS OF NPs

a. Use of bacteria and actinomycetes

b. Use of fungi

c. Use of plants

d. Use of virus



Nath, D., Banerjee, P. *Environmental Toxicology and Pharmacology* **2013**, *36*, 997-1014

Green Synthesis of Nanoparticles (NPs)

1. BIOSYNTHESIS OF NPs → Metal NPs

a. Use of bacteria and actinomycetes
- Synthesis of gold, silver, cadmium NPs
- *Escherichia coli*, *Pseu-domonas stutzeri*, *Pseudomonas aeruginosa*, *Plectonema boryanum*, *Salmonells typlus*, *Staphylococcuscurrens*, *Vibriocholerae, Thermomonospora* sp., *Rhodococcus* sp

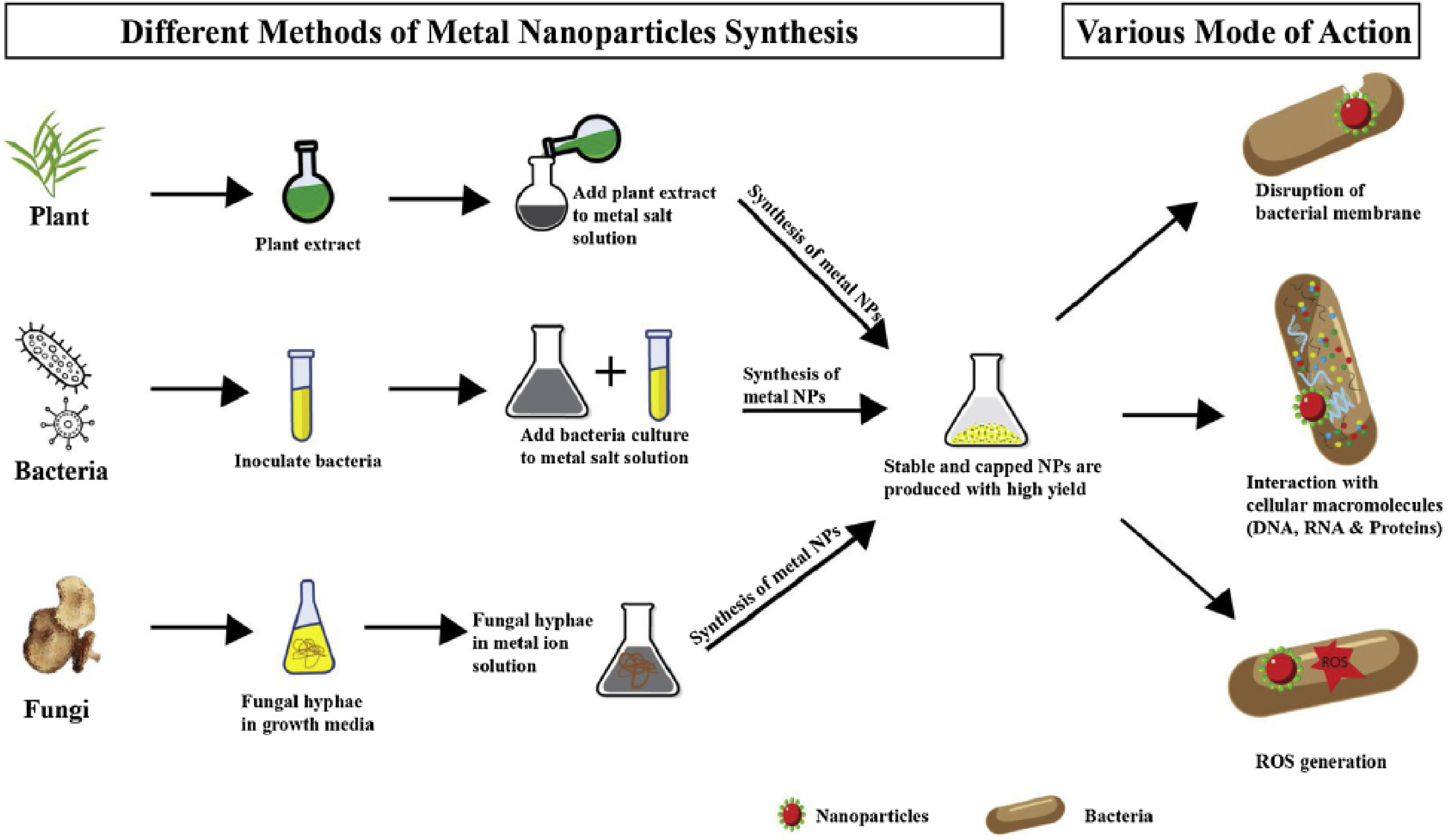
b. Use of fungi
- Synthesis of gold, cadmium, antimony, silver
- *Verticillium luteoalbum, Saccharomyces cerevisiae, Pennicillium fellutanum, Rhizopus oryzae, Aspergilus flavus*

c. Use of plants
- Synthesis of gold, silver, zinc, copper, palladium, platinum, titanium, iron, selenium, lead, indium
- Various plants sources

d. Use of viruses
- Viruses can be used to synthesise nanoconugates and nanocomposites with metal NPs
- Ex: synthesis of semiconductor nanocrystal

Gahlawat, G., Choudhury, A. R., RSC. Adv., 2019, 9, 12944-12967; Nath, D., Banerjee, P. *Environmental Toxicology and Pharmacology* **2013**, *36*, 997-1014; Verma, A., *et al*. *Medicine* **2019**, *6*, 1-10.

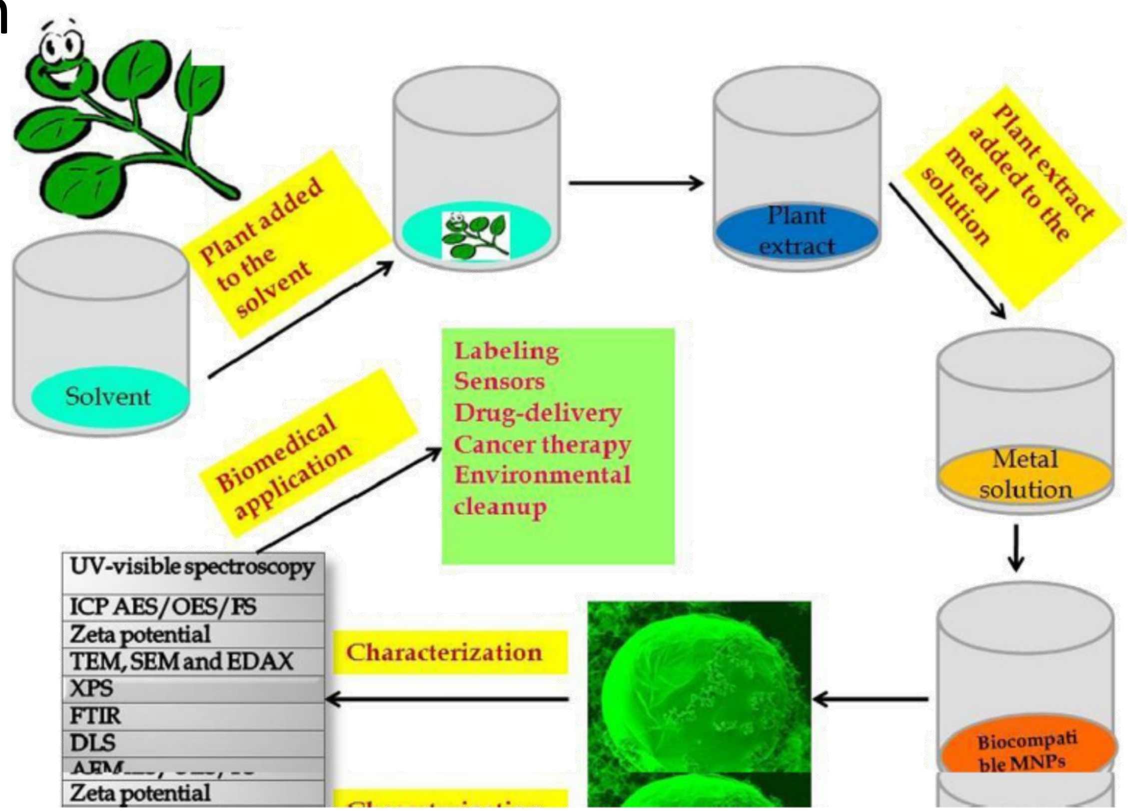
Green Synthesis of Nanoparticles (NPs)

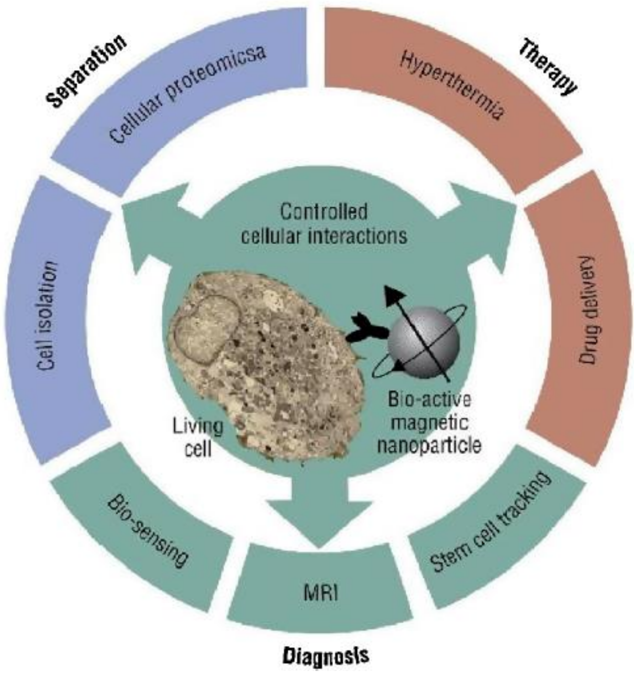


Singh, A., *et al*. *Biotechnology Report* **2020**, *25*, 1-11.

Green Synthesis of Nanoparticles (NPs)

- Plants: easily available, safe to handle, environmentally friendly and have the potential for biological reduction of metallic ions and hyper-accumulation





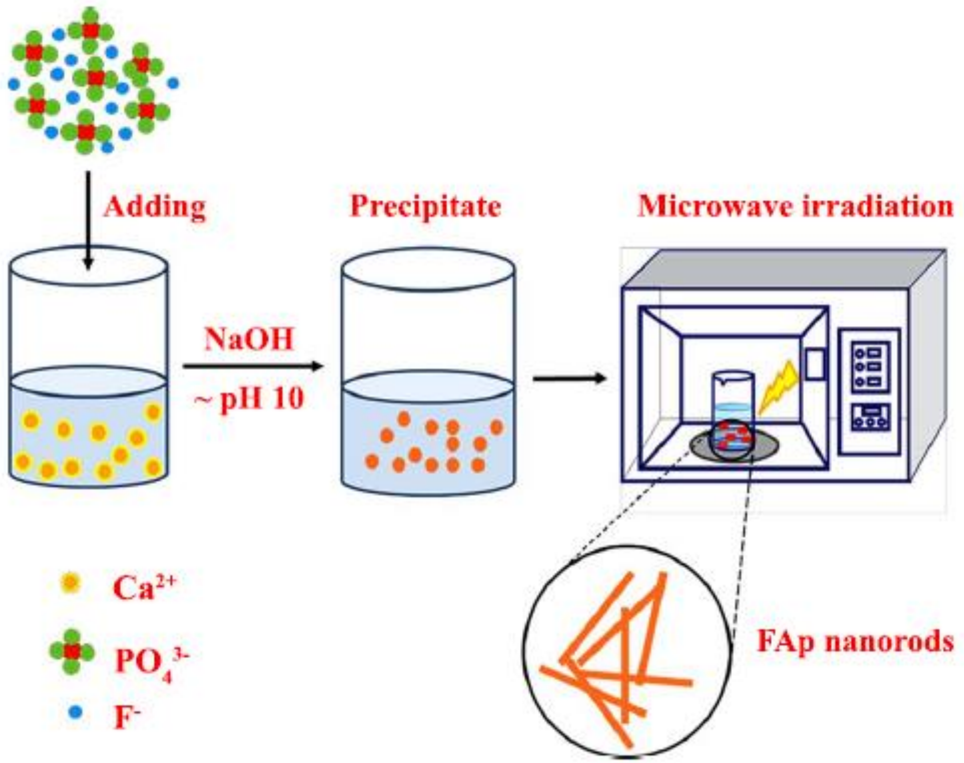
Nath, D., Banerjee, P. *Environmental Toxicology and Pharmacology* **2013**, *36*, 997-1014
Verma, A., *et al*. *Medicine* **2019**, *6*, 1-10.

Green Synthesis of Nanoparticles (NPs)

2. MICROWAVE ASSISTED-METHOD

- Use of microwave-assisted method → reduce energy consumption and pollution, shorter reaction time, and high yield
- Microwave-assisted method to synthesis metal NPs, nanocomposites and biomass nanocomposites
- Biomass nanocomposites:

- Cellulose nanocomposites → cellulose-hydoxiapatite nanocomposites, cellulose-$CaCO_3$, cellulose-Ag/AgCl

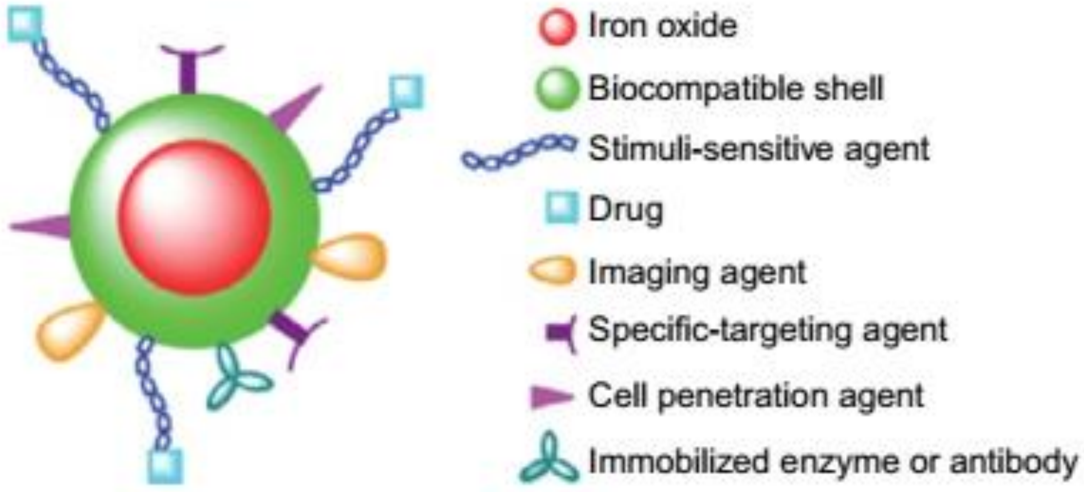


Basiuk, V. A., Basiuk, E. V., **2015**, *Green Processes for Nanotechnology*, Springer: London
Girija, E. K., *et al*. *Current Physical Chemistry* **2019**, *9*, 80-93.

Green Synthesis of Nanoparticles (NPs)

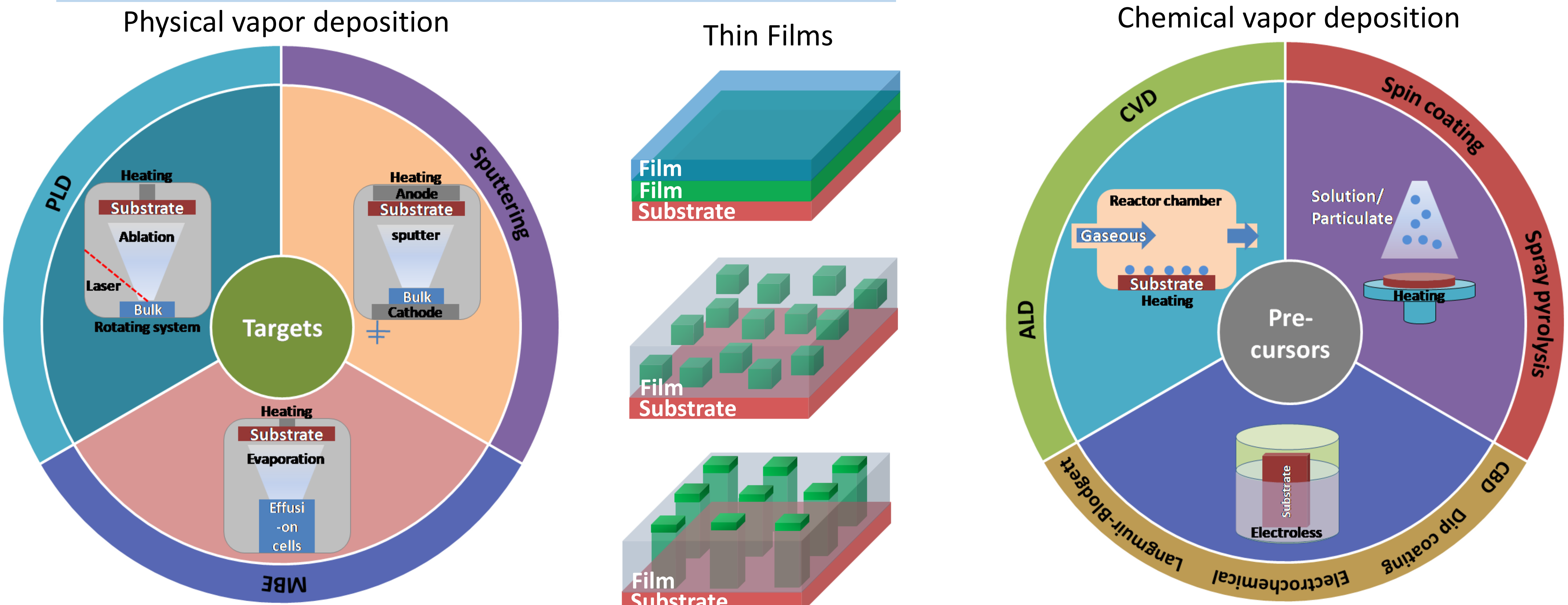
3. ENHANCE BIOCOMPATIBILITY OF NPs

- Not every nanomaterials biocompatible (i.e. non-toxic and compatible with human body), therefore it required to enhance the biocompatibilty of those materials
- Making a nanocomposite with biocompatible materials, such as hydroxiapatite, dextran and protein corona using green synthesis of NPs



Green Synthesis of Thin Films

4. PHYSICAL VAPOR DEPOSITION

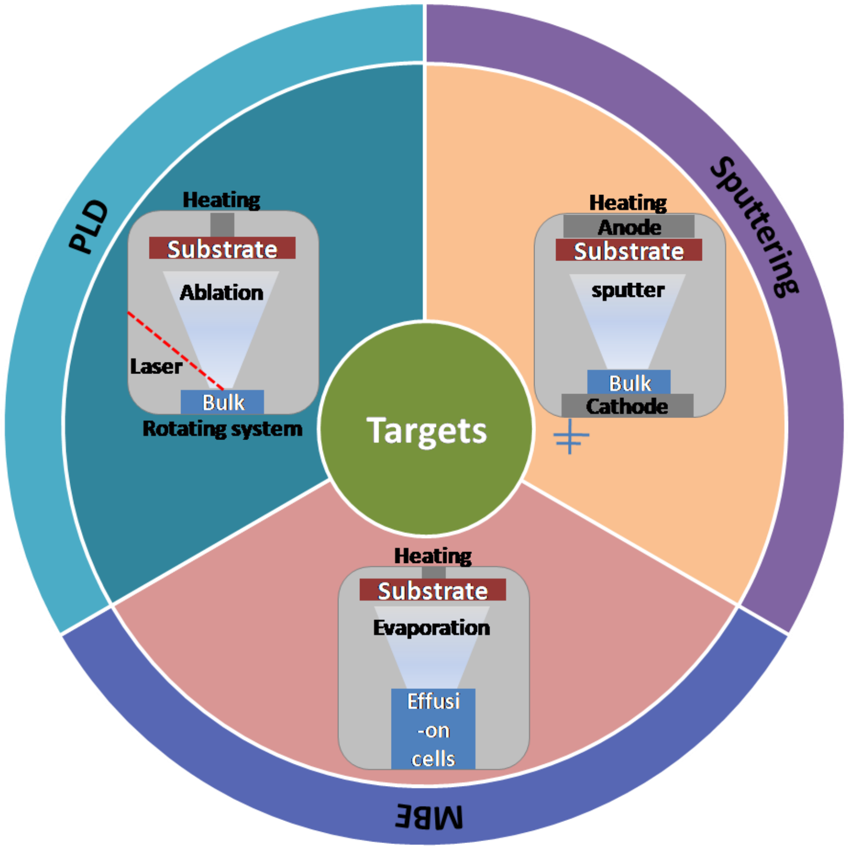


Amrillah, et al. (unpublished)

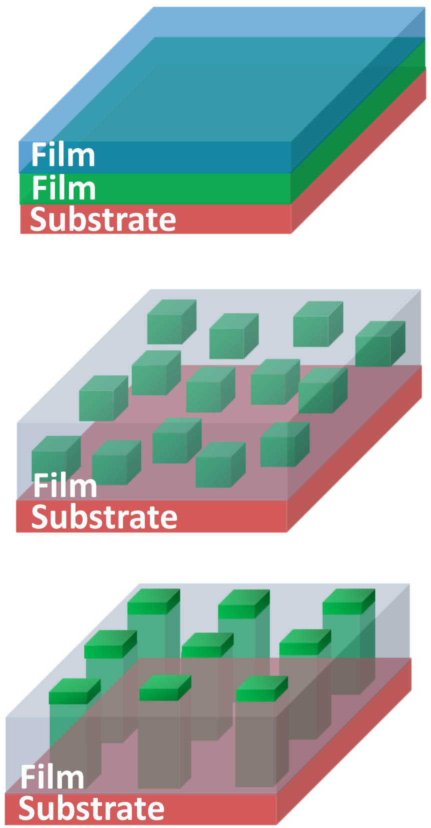
Green Synthesis of Thin Films

4. PHYSICAL VAPOR DEPOSITION

Physical vapor deposition

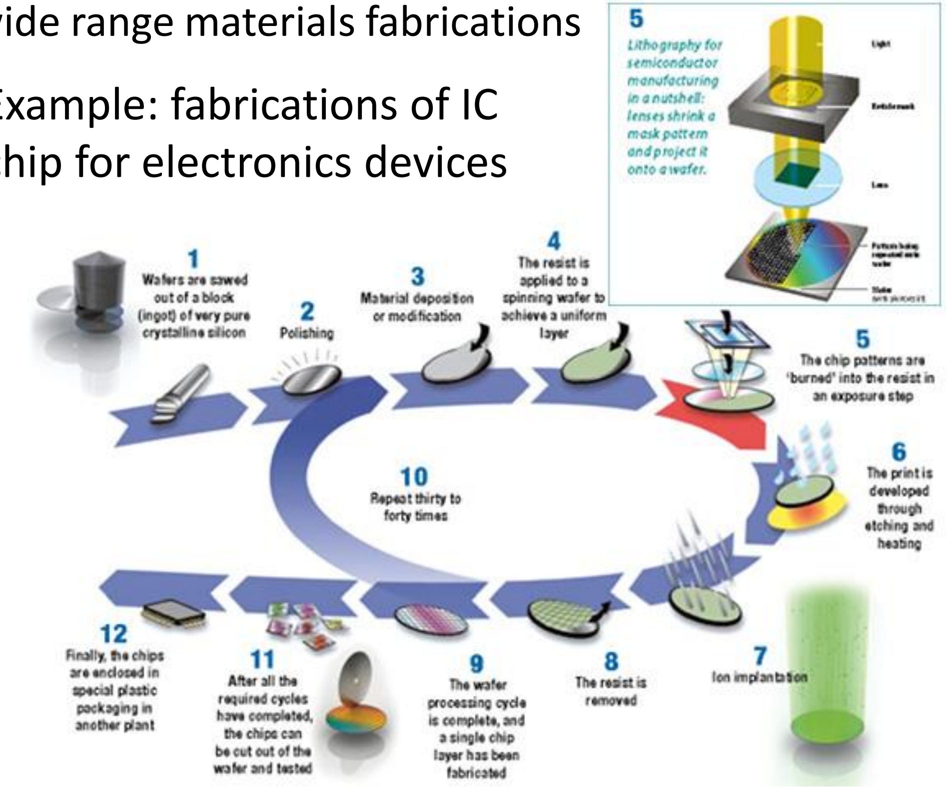


Thin Films



- No need chemical solvent (precursors)
- Less chemical waste
- Dry fabrications
- Less toxic compound
- Fast and convenient thin film deposition
- wide range materials fabrications

Example: fabrications of IC chip for electronics devices



Amrillah, et al. (unpublished)

https://bits-chips.nl/artikel/asml-for-beginners/

Outline:

Introduction

Green synthesis of Nanoparticles

Nanomaterials for Green Technology

Nanomaterials for Green Technology

- Examples:
  - Catalyst for water purification; TiO_2, ZnO, Fe_2O_3, etc.
  - Nanomaterial in agriculture and aquaculture; SiO_2, TiO_2, and carbon nanotubes, zeolites, hydrogel
  - Energy conversion and solar cells; Thin films (Cu-based, Zn-based), DSSC, Perovskite, PEC, Tandem solar cells

Nanomaterials for Green Technology

- Examples:
  - Catalyst for water purification; TiO_2, ZnO, Fe_2O_3, etc.
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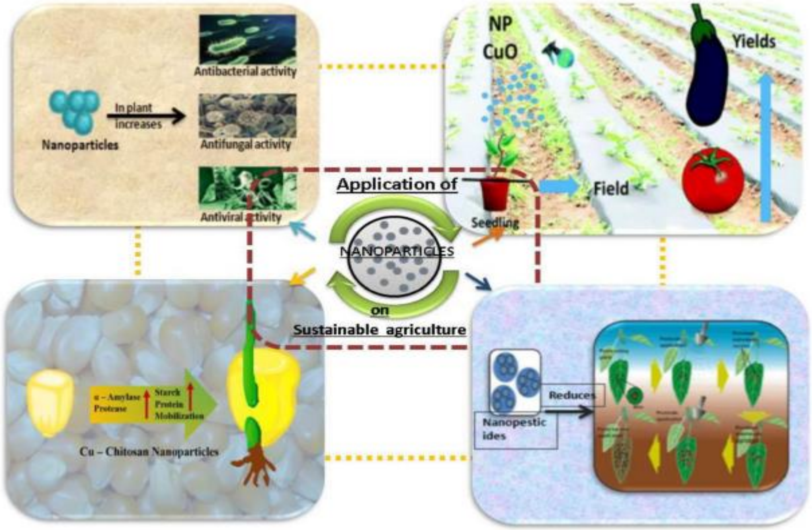

doi: 10.3389/fmicb.2017.01014

- Increase the plant productivity using nanopesticides and nanofertilizers;
- Improve the quality of the soil using nanozeolites and hydrogels (water holding capacity);
- Stimulate plant growth using nanomaterials (SiO_2, TiO_2, and carbonnanotubes) to absorb enviromental contaminant;
- Provide smart monitoring using nanosensors by wireless communication devices.

Nanomaterials for Green Technology

- Examples:
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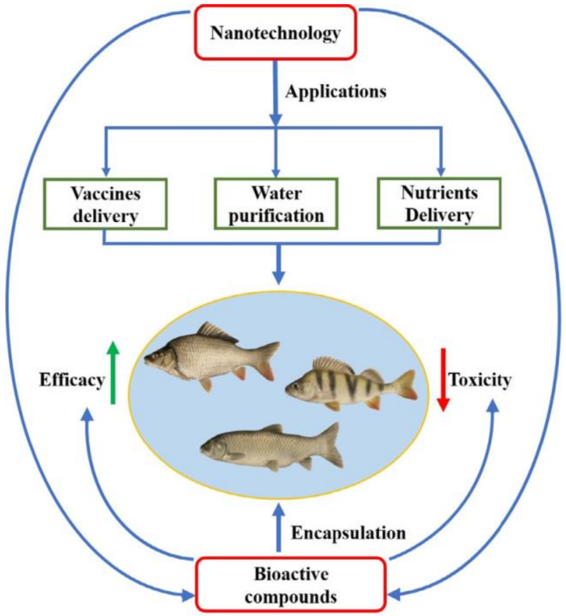

- Water purification using nanomaterials catalyst such as TiO_2, ZnO, Fe_2O_3, ect.;
- The use of vaccines to protect the host (fish, crab, shrimp, etc.) from the infections of pathogens using nano-Chitosan, nano-curcumin
- A Nutrients using nanomaterials such as Zn, Cu, Mn nanoparticles. Example: MnO NPs significantly promoted growth and antioxidant defence system of freshwater prawn

Reviews in Aquaculture, 1–18 (2019)

Nanomaterials for Green Technology

- Examples:
  - Catalyst for water purification; TiO_2, ZnO, Fe_2O_3, etc.
  - Nanomaterial in agriculture and aquaculture; SiO_2, TiO_2, and carbon nanotubes, zeolites, hydrogel
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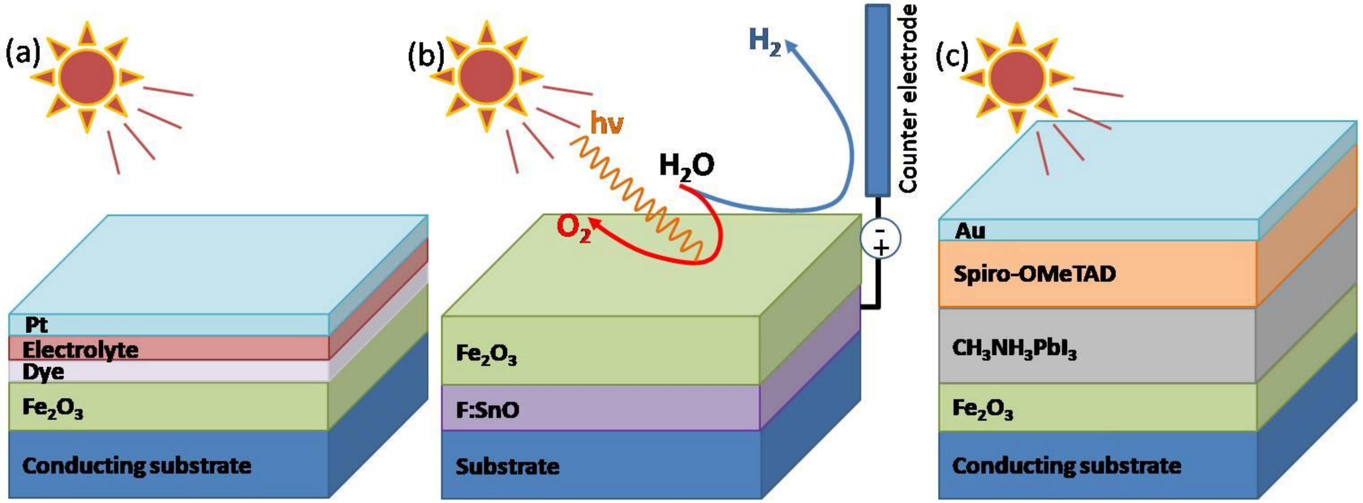
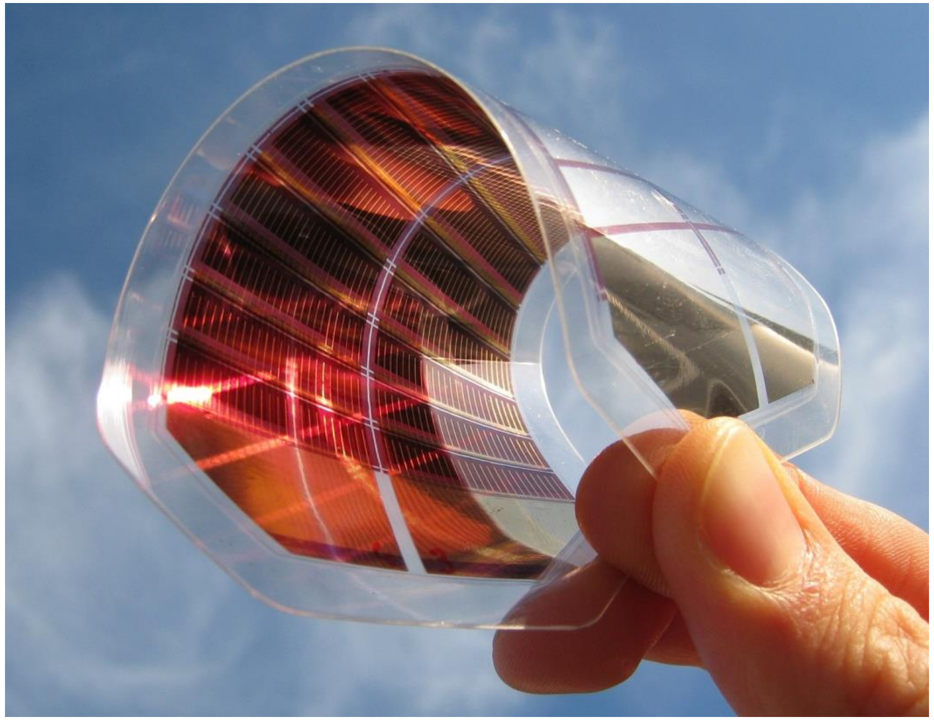


DSSC PEC Perovskite

Amrillah et al., (unpublished)

- Solar conversion to electrical power
- Types according to the physical mechanism:
  - Photo-electrochemical cell (PEC)
  - Dye sensitized solar cell (DSSC)
  - Perovskite solar cell
  - Thin film or wafer solar cell
    - c-Si
    - a-Si
    - CIGS, etc.

Energy Conversion Devices and Solar cell



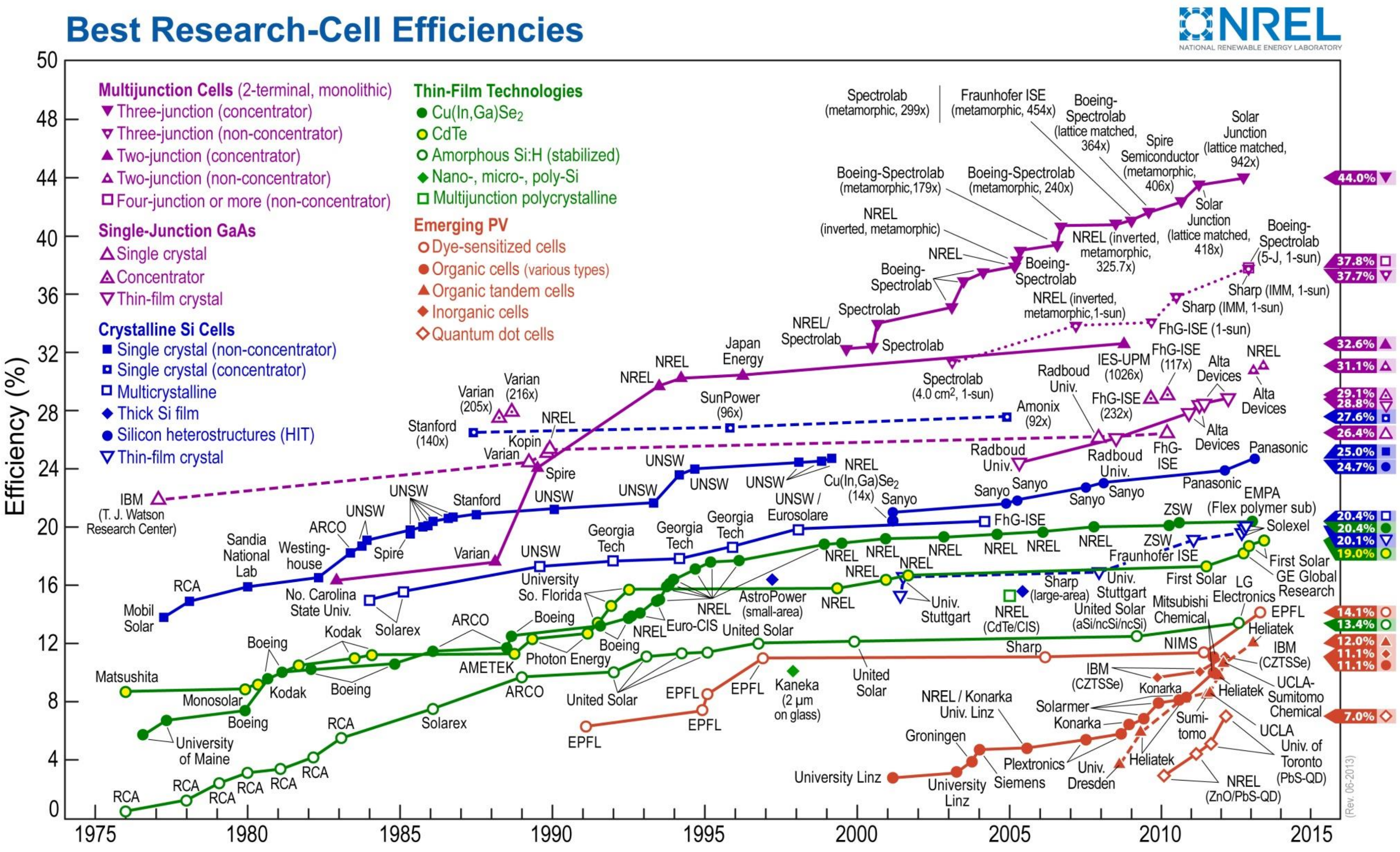
Paper printed flexible solar cells

https://inhabitat.com/paper-thin-printed-solar-cells-could-provide-power-for-1-3-billion/

History

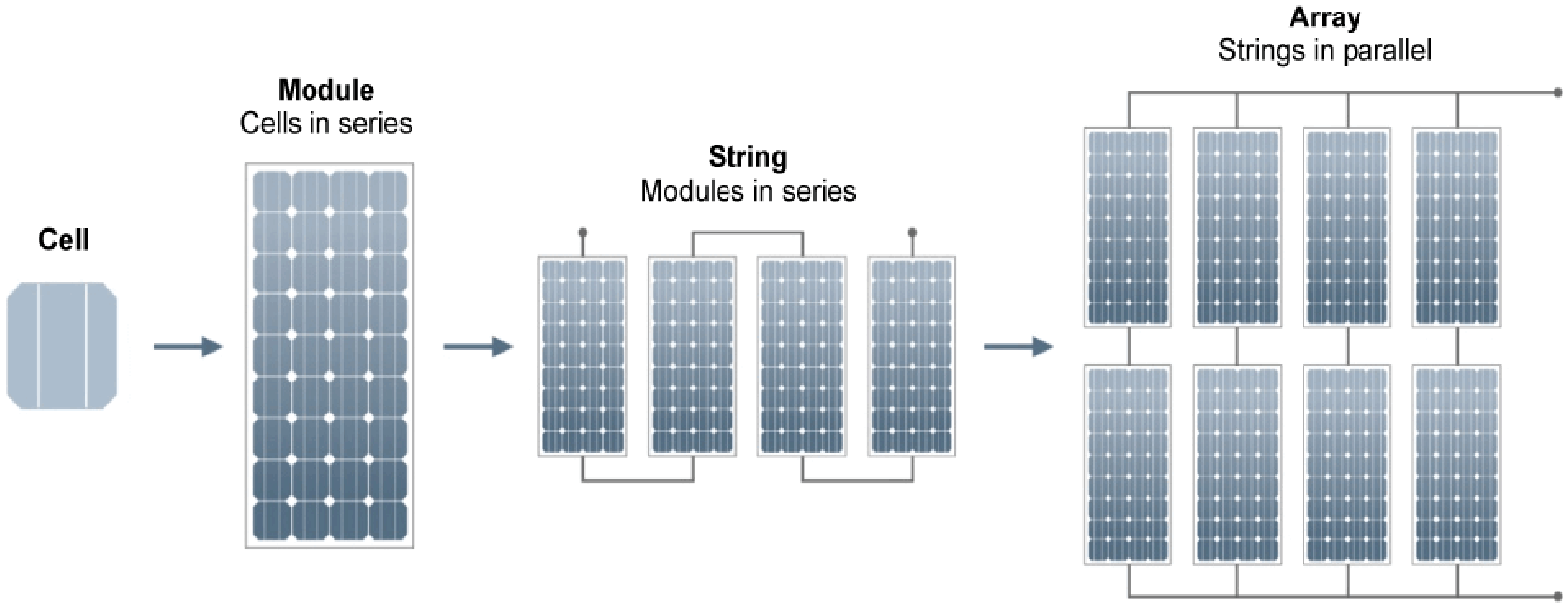
- 1888 – Russian physicist Aleksandr Stoletov built the first cell based on the outer photoelectric effect discovered by Heinrich Hertz in 1887.
- 1905 – Albert Einstein proposed a new quantum theory of light and explained the photoelectric effect in a landmark paper, for which he received the Nobel Prize in Physics in 1921.
- 1941 – Vadim Lashkaryov discovered *p*-*n*-junctions in Cu_2O and Ag_2S protocells.
- 1946 – Russell Ohl patented the modern junction semiconductor solar cell, while working on the series of advances that would lead to the transistor.
- 1948 - *Introduction to the World of Semiconductors* states Kurt Lehovec may have been the first to explain the photo-voltaic effect in the peer reviewed journal Physical Review.
- 1954 – The first practical photovoltaic cell was publicly demonstrated at Bell Laboratories. The inventors were Calvin Souther Fuller, Daryl Chapin and Gerald Pearson.
- 1954 – now, solar cells into the markets

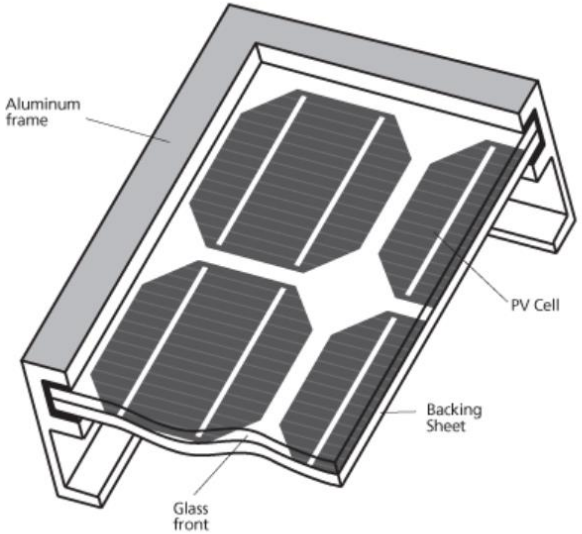
Energy Conversion Devices and Solar cell



Energy Conversion Devices and Solar cell

Solar cells in the markets

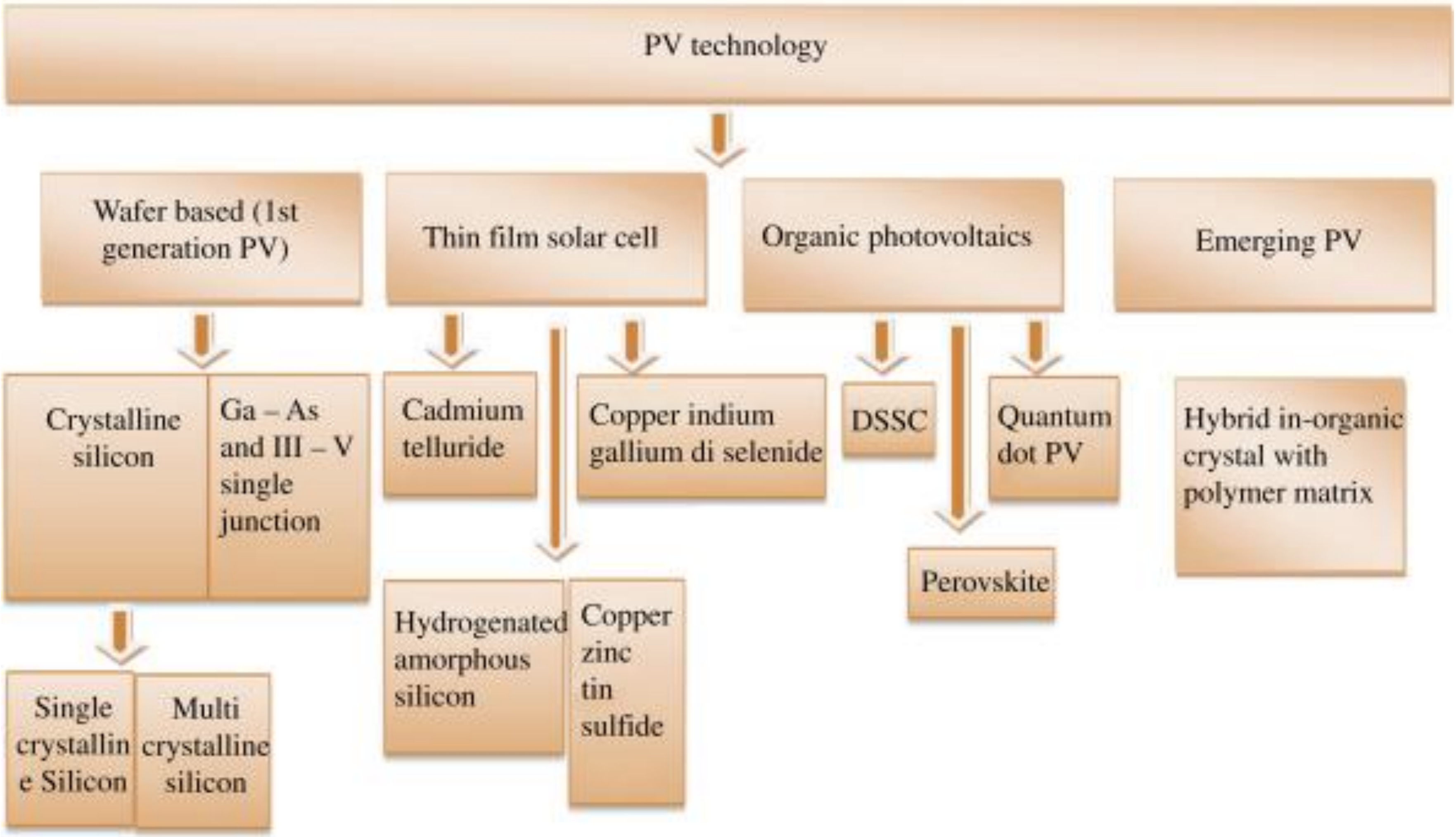




https://samlexsolar.com/learning-center/solar-cell-module-array.aspx

- Those are silicon based solar cell which have been widely used by human nowadays
- They are connected differently
- The cells are very thin and fragile so they are sandwiched between a transparent front sheet, usually glass, and a backing sheet, usually glass or a type of tough plastic. An aluminum frame is fitted around the module to enable easy fixing to a support structure

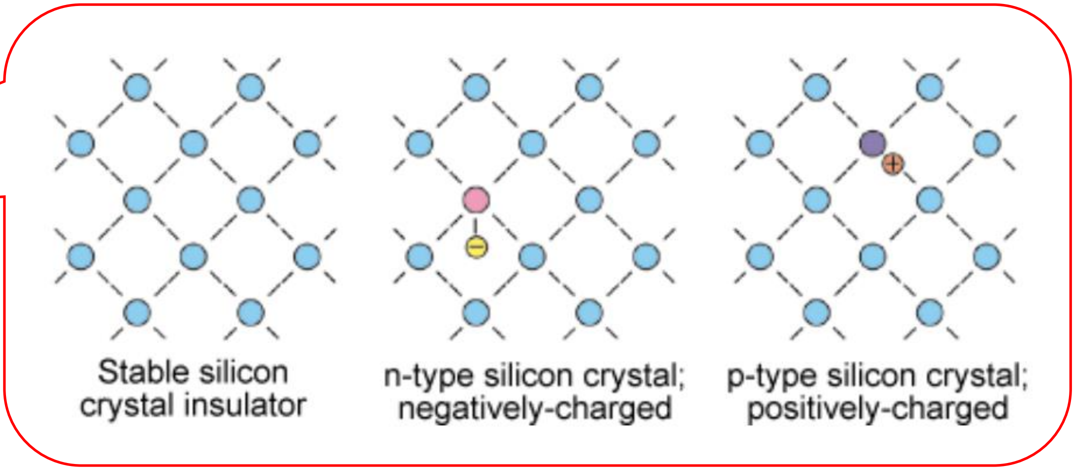
Energy Conversion Devices and Solar cell

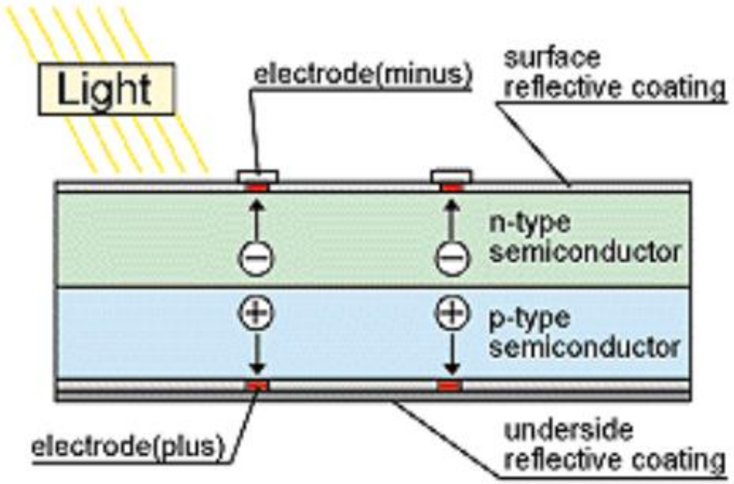


https://doi.org/10.1016/B978-0-12-813351-4.00043-2

Energy Conversion Devices and Solar cell

Wafer based solar cell
Thin film solar cell
DSSC
Perovskite solar cell
Tandem solar cell



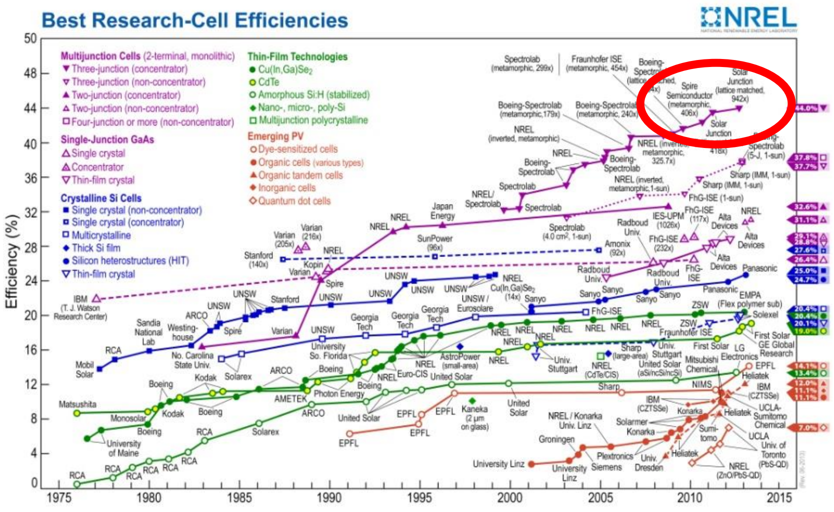


https://global.kyocera.com/prdct/solar/spirit/about_solar/cell.html

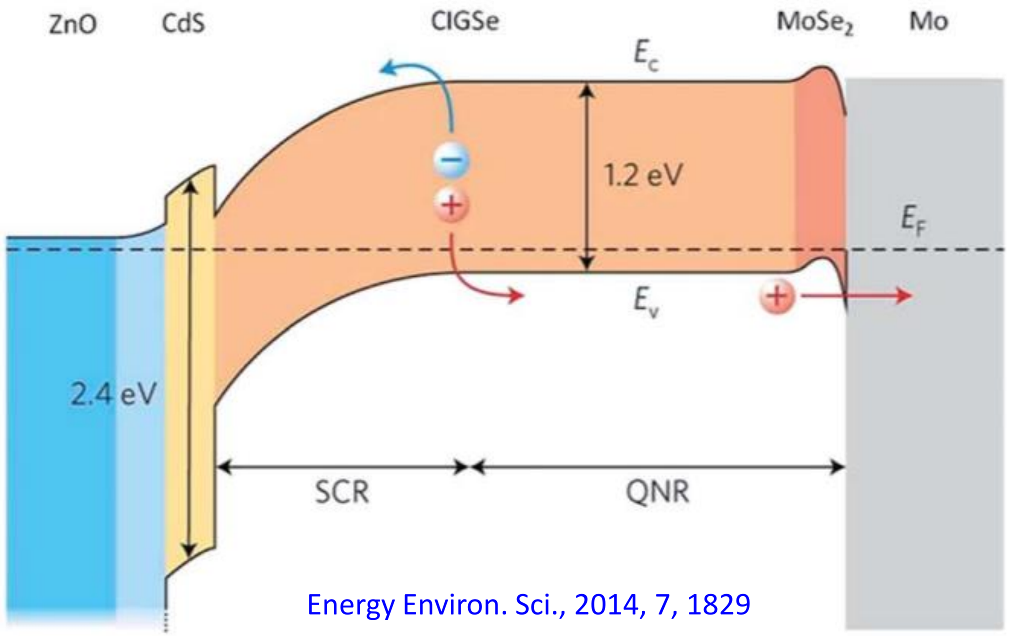
- Silicon atoms have four "arms." Under stable conditions, they become perfect insulators.
- Silicon with a surplus electron, a negative charge will occur when sunlight (photons) hits the surplus electron - conducts electricity namely **n-type semiconductor**.
- Silicon with the lack one electron results in a hole with an electron missing - carry a positive charge. This is called a **p-type semiconductor**.
- When p-type and n-type semiconductors was combined, the p-type, with one less electron, attracts the surplus electron from the n-type to stabilize itself. Thus the electricity is displaced and generates a flow of electrons - electricity.
- When sunlight hits the semiconductor, an electron springs up and is attracted toward the n-type semiconductor. This causes more negatives in the n-type and more positives in the p-type, thus generating a higher flow of electricity. This is the photovoltaic effect.

Energy Conversion Devices and Solar cell

- Wafer based solar cell
- **Thin film solar cell**
- DSSC
- Perovskite solar cell
- Tandem solar cell



Tandem solar cell has relatively higher than single junction sola cell



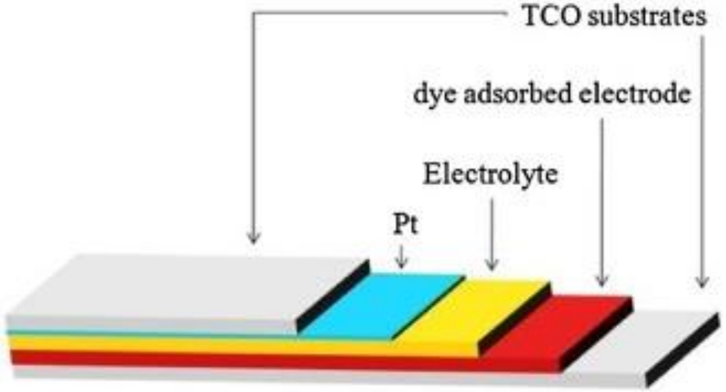
Energy Environ. Sci., 2014, 7, 1829

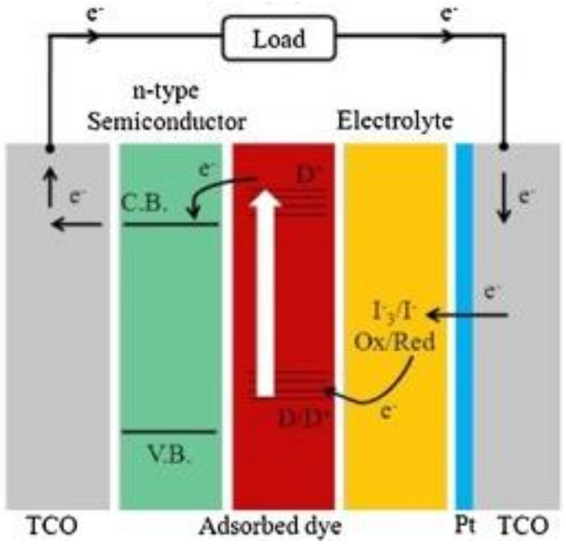
- Why it called thin-film solar cell? Because it required a substrate as a template to grow the layer (thin film). The solar cell also consist with many layer (top and bottom electrode layer, widow layer, p-type and n-type layers, substrates).
- In principle, it is similar to wafer based solar cell; combining n-type and p-type semiconductor; electron flow from n-type to p-type induce an electricity.
- Nevertheless, the p-type semiconductor layer such as CIGS can absorb photon larger than Si, therefore it can increase the solar cell efficiency and induce larger voltage over Si cell.

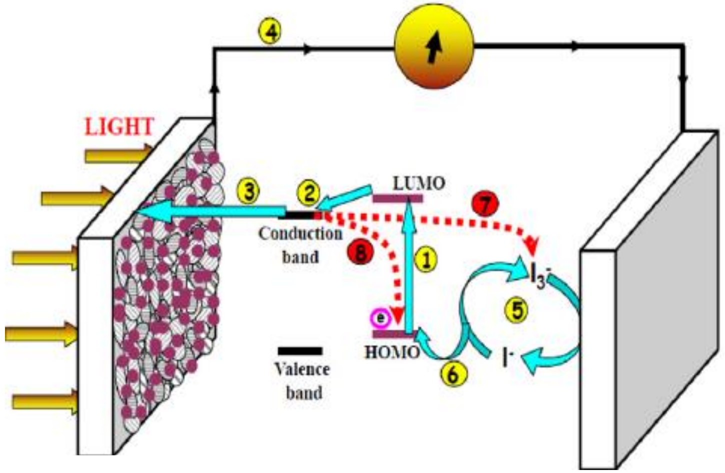
Energy Conversion Devices and Solar cell

- Wafer based solar cell
- Thin film solar cell
- **DSSC**
- Perovskite solar cell
- Tandem solar cell

Optik 169, 2018, 214-223





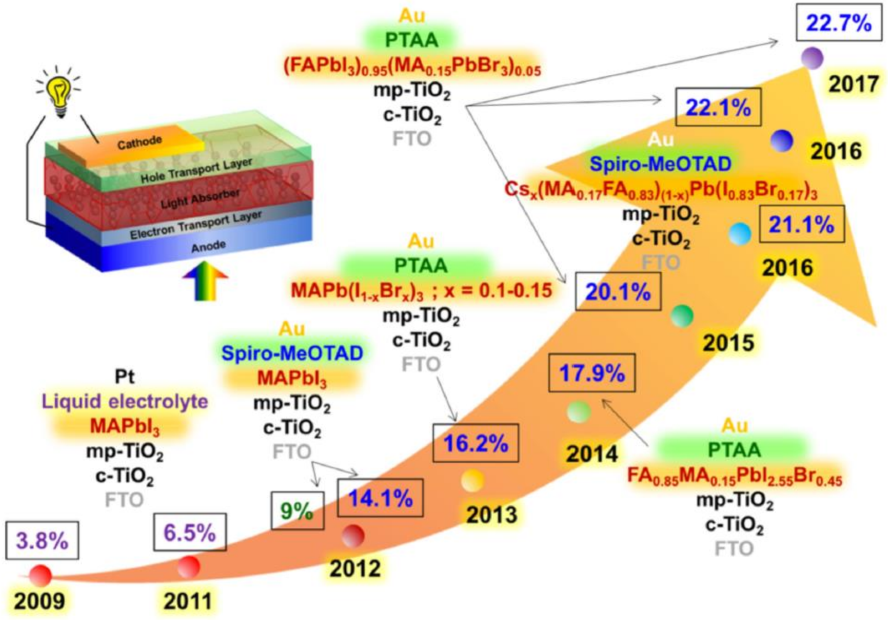


Renew. Sust. Energy Rev. (2016) 356–376

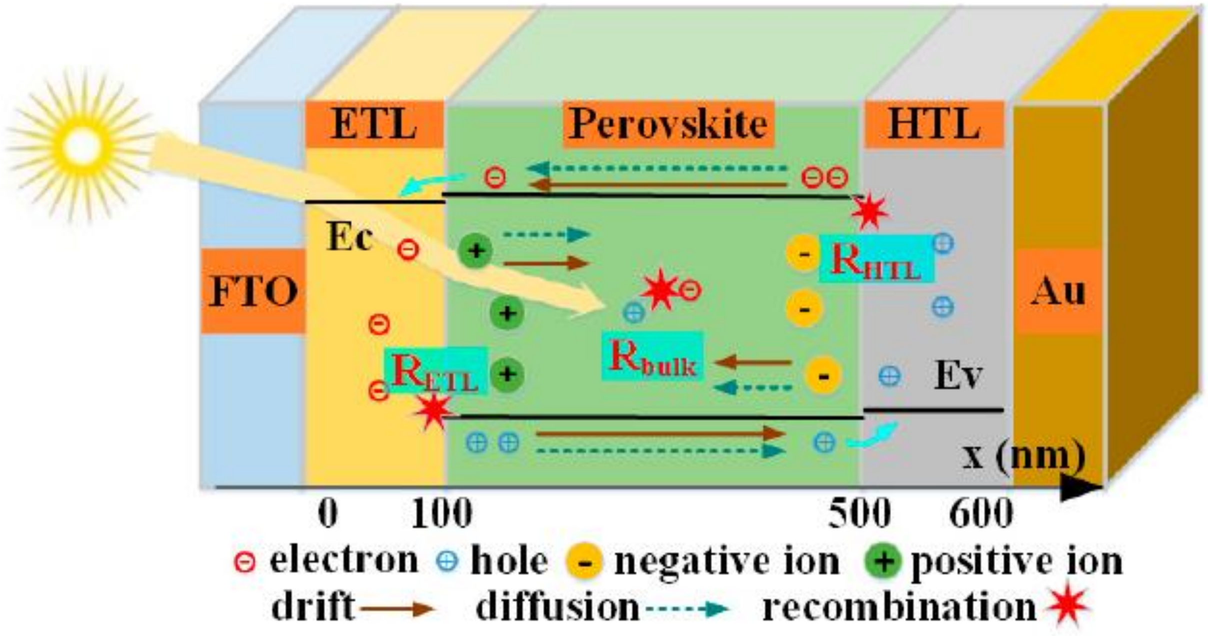
1. Photo-excitation of electron in dye
2. Injection of electron from dye to the conduction band of zinc oxide
3. Transfer of electron from metal oxide to transparent conducting glass substrate
4. Conduction of electron from photo-anode to cathode
5. Reduction of tri-iodide to iodide
6. Oxidation of iodide to tri-iodide and regeneration of dye
7. Recombination of photo-excited electron with the oxidized dye
8. Recombination of photo-excited electron with the oxidized tri-iodide

Energy Conversion Devices and Solar cell

Wafer based solar cell
Thin film solar cell
DSSC
Perovskite solar cell
Tandem solar cell



doi: 10.3389/fenrg.2018.00128

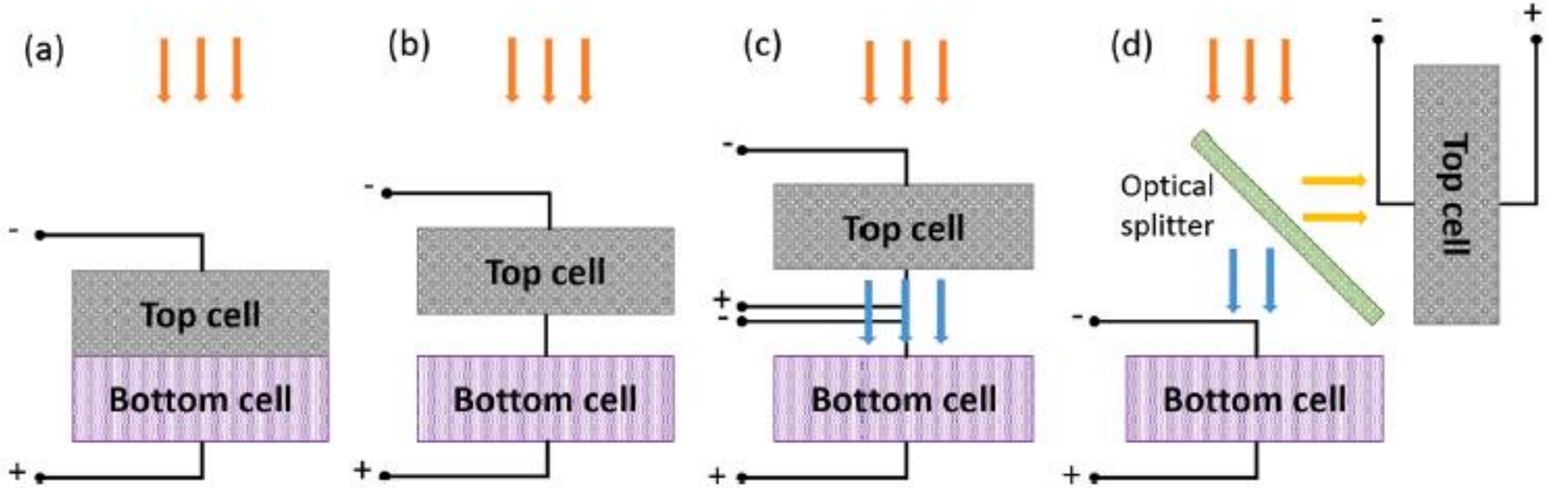


Photonics 2020, 7, 47; doi:10.3390/photonics7030047

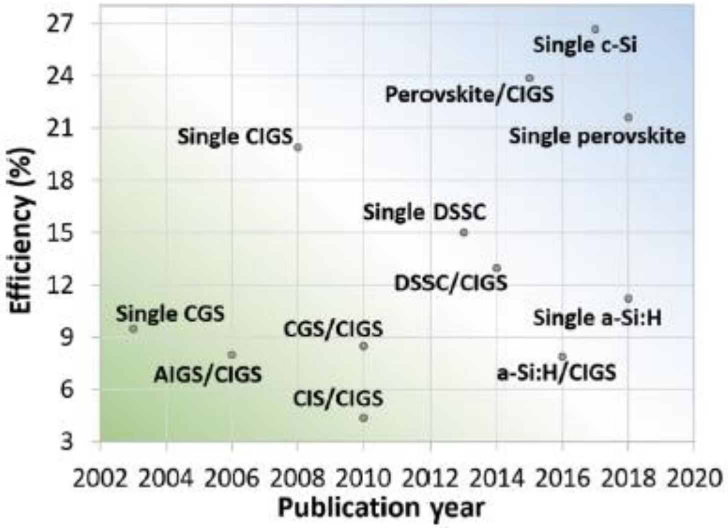
- During exposure to sunlight, the **perovskite** layer firstly absorbs photons to produce excitons (electron-hole pairs). Due to the difference in the exciton binding energy of the **perovskite** materials, these excitons can form free carriers (free electrons and holes) to generate a current or can recombine into excitons
- Perovskite solar cell is one of solar cells that exhibit large solar conversion efficiency

Energy Conversion Devices and Solar cell

Wafer based solar cell
Thin film solar cell
Organic solar cell
DSSC
Perovskite solar cell
Tandem solar cell



Architectures of tandem solar cells. (a) 2-T monolithic, (b) 2-T mechanically stacked, (d) 4-T mechanically stacked, and (d) 4-T spectrum-split



Solar Energy 207 (2020) 1146–1157

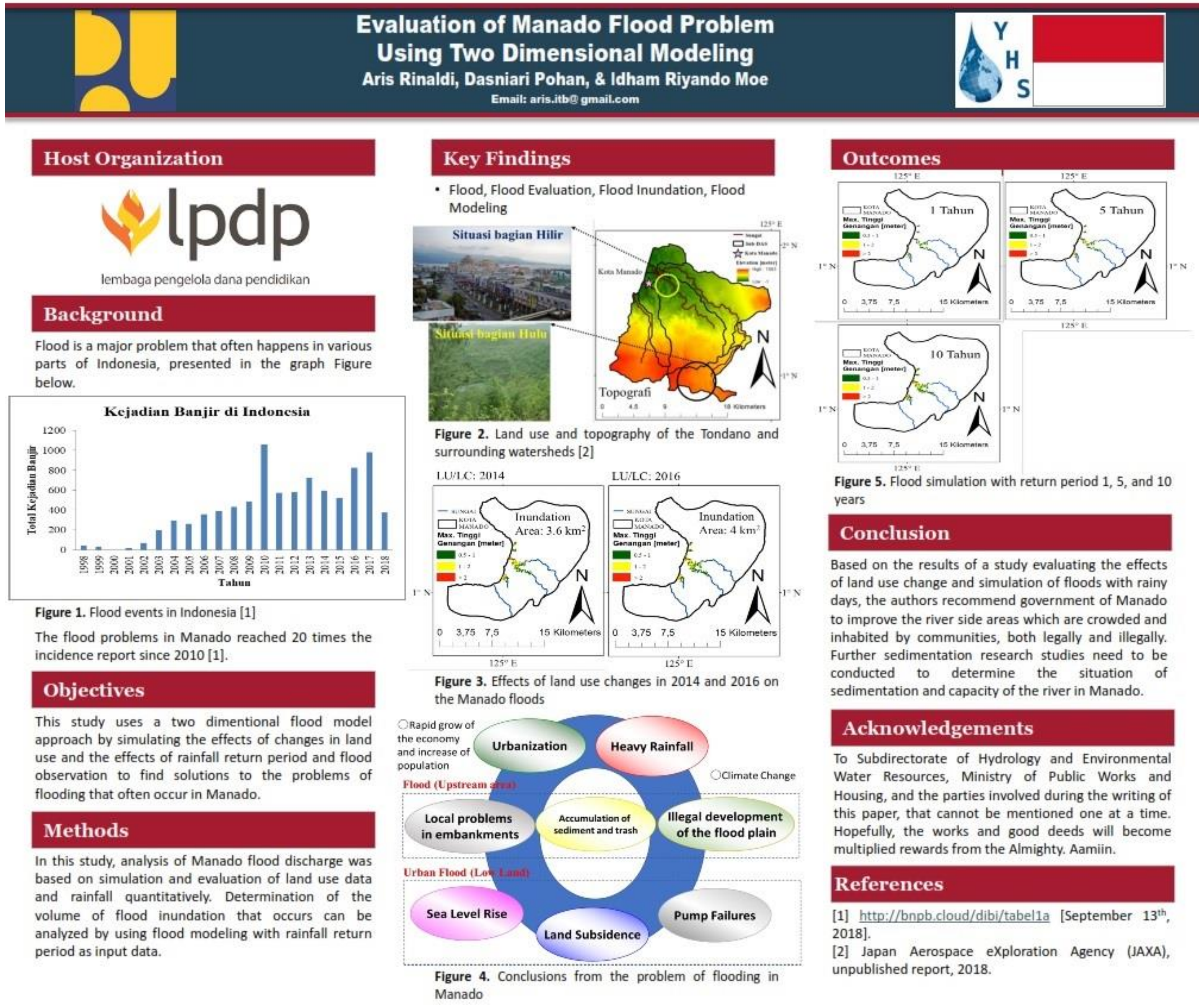
- Tandem solar cells; CIGS/DSSC, Si/DSSC, Si/CIGS, CIGS/perovskite, etc.
- Tandem solar cells was made to enhanced the efficiency of sola cells. The combination of two different solar cells can sort the light to match efficiently with the solar cells characteristic, overcome the Shockley–Queisser limit of single-junction devices and induce larger voltage
- The architecture of tandem solar cells is important to obtain high efficiency solar cells

Assignment

- Membuat 1 poster dari mereview 1 artikel atau lebih (sesuai dengan materi)
- Isi poster (urutan dan isi di sesuaikan menurut keinginan masing-masing), secara umum isi poster sebagai berikut:
  - Judul
  - Nama dan NIM, affiliasi (asal jurusan – kampus – alamat kampus)
  - Abstract
  - Isi (pendahuluan, experiment, hasil, kesimpulan)
  - Referensi
- Format poster: Pdf ukuran kertas A4, kemudian file di namakan sesuai NIM anggota kelompok (di urut dari NIM yang terkecil)
- 1 kelompok beranggotakan 2 atau 3 orang (sesuai urutan NIM; di cari/buat sendiri)
- Dikumpulkan maksimal satu minggu setelah perkuliahan, di upload melalui AULA. Jika telat, nilai dikurangi sesuai hari keterlambatan (5 point per hari)
- Bahasa Indonesia/Inggris (di sarankan berbahasa Inggris)
- Estetika (50%) dan isi poster (50%) menjadi bahan penilaian

Assignment (contoh)

http://litabmas.stikes-ppni.ac.id/berita/isi-dalam-poster-ilmiah



http://arishms.com/2019/03/festival-poster-ilmiah-sarasehan-lpdp-2019/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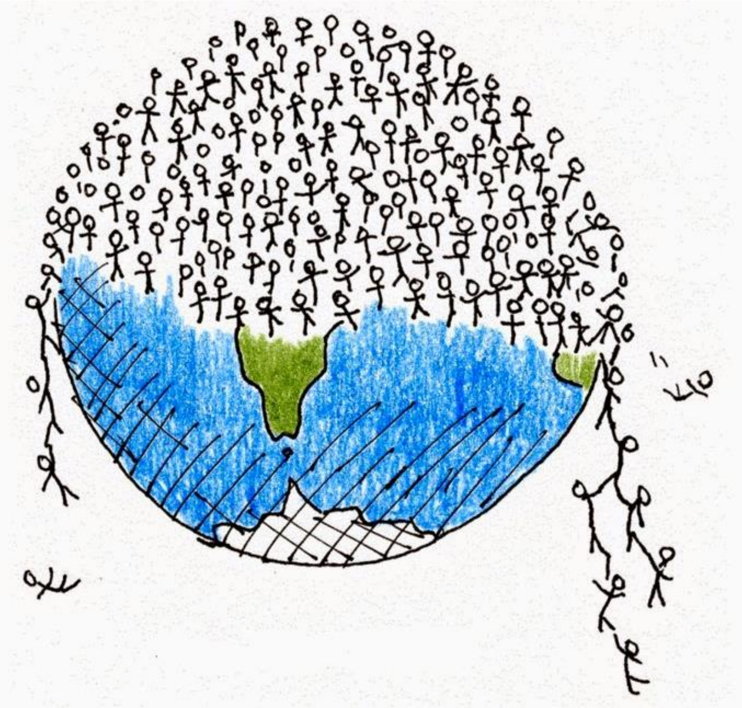
Data Geospasial & Sistem Informasi Geografis

Ika Qutsiati Utami, S.Kom., M.Sc.
Mata Kuliah Teknologi Hijau
Program Studi S1 Teknologi Sains Data
Fakultas Teknologi Maju dan Multidisiplin Universitas Airlangga

Bahan Kajian

1. Penyelesaian Masalah dengan Metode Geospasial
2. Bidang Ilmu Geoinformatika
3. Konsep dan Peran Pola Pikir Geospasial
4. Sistem Informasi Geografis (SIG)
5. Peranan Sistem Informasi Geografis (SIG) dalam Aspek Lingkungan

Latar Belakang



Peningkatan populasi

Pembangunan Infrastruktur

KETIDAKSEIMBANGAN LINGKUNGAN

UU No.4 Tahun 2011 tentang Informasi Geospasial (Pasal 1-4)

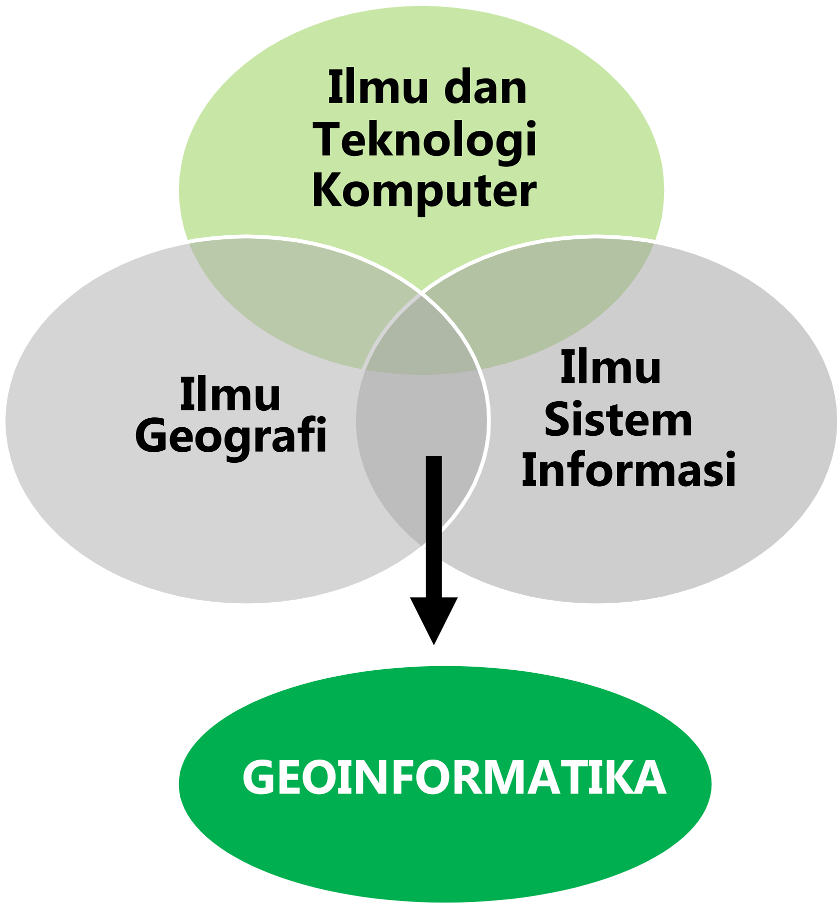
1. **Spasial** adalah aspek keruangan suatu objek atau kejadian yang mencakup lokasi, letak, dan posisinya.
2. **Geospasial** atau ruang kebumian adalah aspek keruangan yang menunjukkan lokasi, letak, dan posisi suatu objek atau kejadian yang berada di bawah, pada, atau di atas permukaan bumi yang dinyatakan dalam sistem koordinat tertentu.
3. **Data Geospasial** adalah data tentang lokasi geografis, dimensi atau ukuran, dan/atau karakteristik objek alam dan/atau buatan manusia yang berada di bawah, pada, atau di atas permukaan bumi.
4. **Informasi Geospasial** adalah data geospasial yang sudah diolah sehingga dapat digunakan sebagai alat bantu dalam perumusan kebijakan, pengambilan keputusan, dan/atau pelaksanaan kegiatan yang berhubungan dengan ruang kebumian.

Solusi:
Metode Geospasial

Bidang Ilmu Geoinformatika

Geoinformatika adalah bidang ilmu dengan irisan dari:

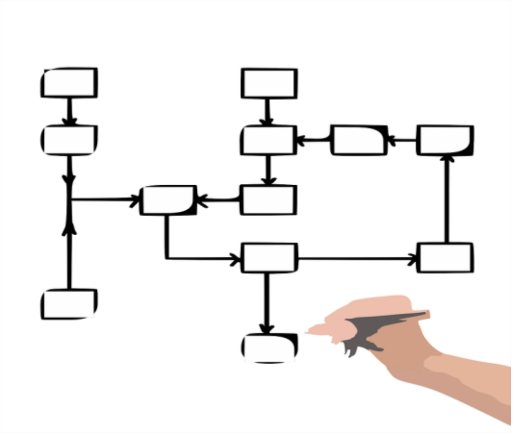
1. Keillmuan sistem informasi
2. Ilmu komputer dengan semua infrastrukturnya
3. Ilmu geodesi guna menjawab permasalahan kebumian yang semakin kompleks dengan ukuran data yang semakin besar.



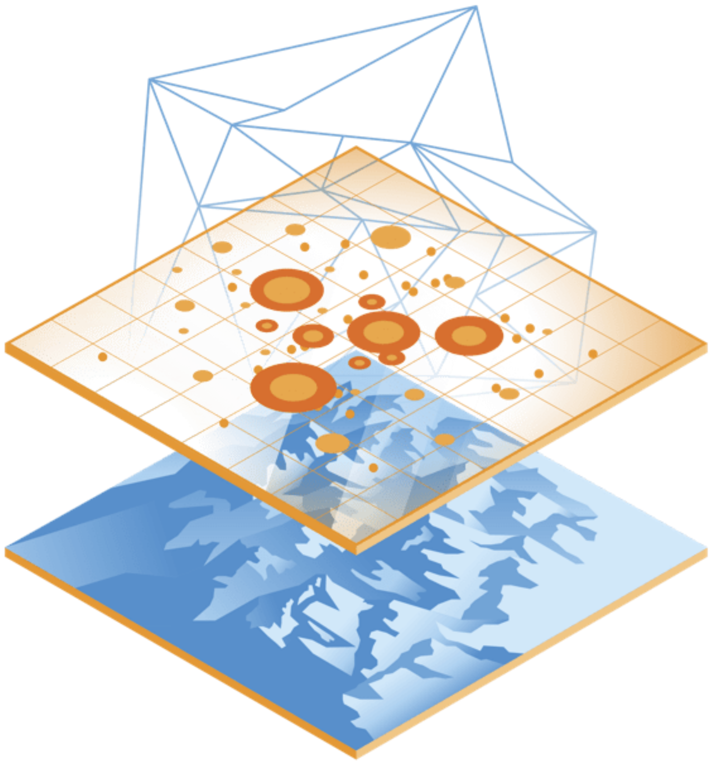
Bidang Ilmu Geoinformatika

Geoinformatika adalah ilmu dengan kajian yang komprehensif, mulai dari:

1. Akuisisi data geospasial dan penyimpanan data
2. Pemodelan dan presentasi dari informasi geospasial
3. Analisis dan perencanaan spasial
4. Pengembangan algoritma dan sistem basisdata geospasial



3 Dimensi Kajian Geoinformatika



1. **Lokasi (*Longitude, Latitude, Altitude*)**
   Mengetahui dimana suatu peristiwa terjadi

2. **Waktu**
   Variabel penting dalam proses pengambilan kebijakan (jangka pendek/pendek/menengah)

3. **Skala**
   Skala atau level detil dari informasi geografis yang disajikan guna menentukan akurasi dan presisi data

Manfaat Geoinformatika

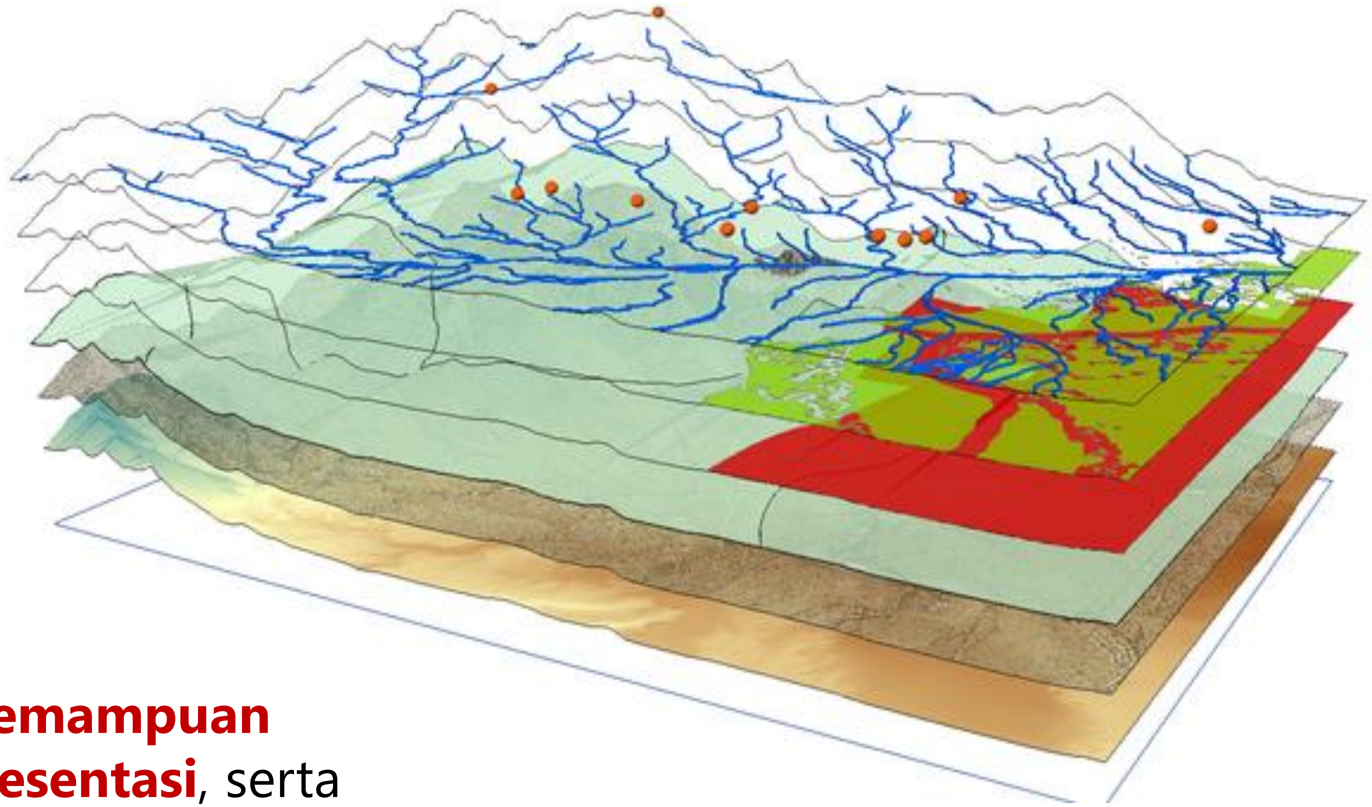
1. Ilmu geoinformatika berperan penting dalam **menemukan pengetahuan baru** melalui integrasi dan analisis data-data geospasial.

2. Geoinformatika memberikan **solusi berupa kerangka kerja yang sistematis** dalam pengelolaan data-data geospasial.

3. Membantu ilmuwan kebumian dalam **menghadapi situasi yang semakin kompleks**, seperti perubahan iklim, bencana alam, dan pengelolaan wilayah dan sumber daya alam.

Pola Pikir Geospasial

Pola pikir berbasis **"Lokasi dan Ruang"**



Pola pikir ini termasuk didalamnya **kemampuan kognitif akan ruang, alat, dan representasi**, serta kemampuan melakukan proses dan analisis

Metode Pemecahan Masalah dengan Pola Pikir Geospasial

1. **Formulasi permasalahan melalui cara spasial**
2. **Runut dan logis mengumpulkan, menyimpan, mengelola, menganalisis, dan menampilkan informasi geografis**
3. **Merepresentasikan data melalui model data geospasial**
4. **Memberikan solusi dengan upaya yang meliputi identifikasi, analisis komprehensif, manipulatif**
5. **Proses transfer melalui peta digital dengan kaidah kartografi**
6. **Generalisasi dan transfer proses pemecahan masalah kepada khalayak luas**

Pentingnya Pola Pikir Geospasial

Kita perlu memahami fenomena-fenomena yang terjadi di muka bumi, memecahkan permasalahannya dan mengkomunikasikannya dengan berbagai pihak agar **tercapai keseimbangan dan keberlanjutan hidup yang lebih baik.**

Sistem Informasi Geografis

GIS (*Geographical Information System*) adalah teknologi baru yang pada saat ini menjadi alat bantu (*tools*) yang sangat esensial dalam menyimpan, memanipulasi, menganalisa dan menampilkan kondisi – kondisi alam dengan bantuan data atribut dan spatial.

1. **GIS menggunakan data spasial yang terintegrasi.**
2. **GIS dapat digunakan sebagai alat bantu interaktif** yang menarik untuk meningkatkan pemahaman mengenai konsep lokasi, ruang, kependudukan, dan unsur-unsur geografi yang ada dipermukaan bumi.
3. **GIS memiliki kemampuan menguraikan unsur-unsur** yang ada dipermukaan bumi kedalam beberapa faktor data spasial.
4. **GIS memiliki kemampuan yang sangat baik dalam memvisualisasikan data spasial**.

3 Komponen Kunci Sistem Informasi Geografis

1. **Sistem Komputer**

   Perangkat keras (*hardware*), perangkat lunak (*software*) dan prosedur untuk penyusunan input data, pengelolahan, analisa, pemodelan dan visualisasi data geospasial.

2. **Data Geospasial**

   Peta digital, foto udara, citra satelit, tabel statistik dan dokumen lain yang berhubungan.

3. **Pengguna**

   Bertugas untuk memilih informasi yang diperlukan, membuat standar, update data, analisa output, dan perencanaan aplikasi

Peran Sistem Informasi Geografis

1. **Bidang sumber daya alam dan lingkungan**
2. **Bidang perencanaan**
3. **Bidang kelistrikan**
4. **Bidang telekomunikasi**
5. **Bidang kependudukan atau demografi**
6. **Bidang pariwisata**

GIS dalam Penanggulangan Bencana

Penanggulangan bencana harus didukung oleh suatu sistem informasi yang memadai untuk:

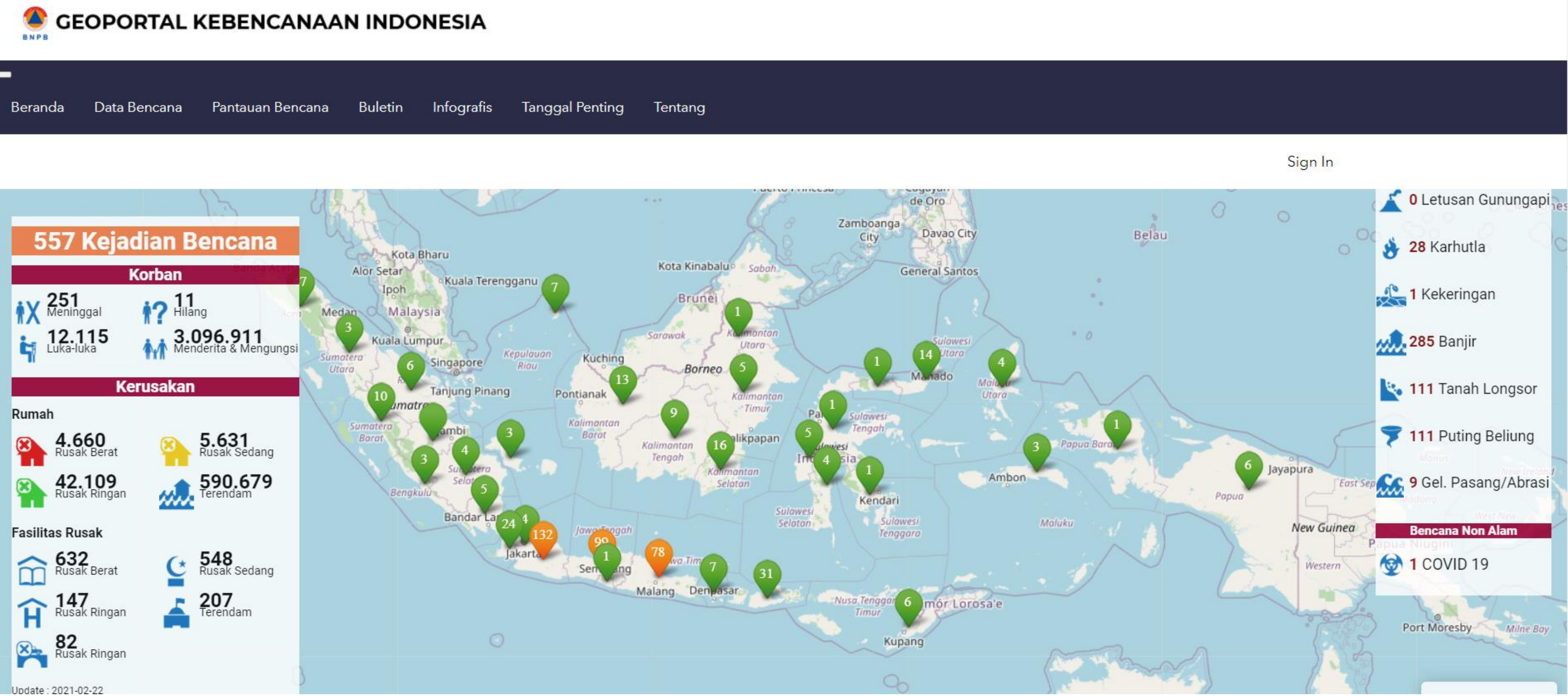
1) Meningkatkan kemampuan perencanaan logistik penanggulangan bencana
2) Mendukung pelaksanaan distibusi barang bantuan penanggulangan bencana
3) Mendukung proses pelaporan aktivitas distibusi barang bantuan penanggulangan bencana
4) Memberikan informasi secara lengkap dan aktual kepada semua pihak

Output: tabel, grafik, peta (rute transportasi), jenis dan jumlah komoditi yang diperlukan didaerah terjadinya bencana, jenis dan jumlah komoditi yang akan didistribusikan kedaerah terjadinya bencana.

GEOPORTAL KEBENCANAAN INDONESIA

Beranda Data Bencana Pantauan Bencana Buletin Infografis Tanggal Penting Tentang

Sign In

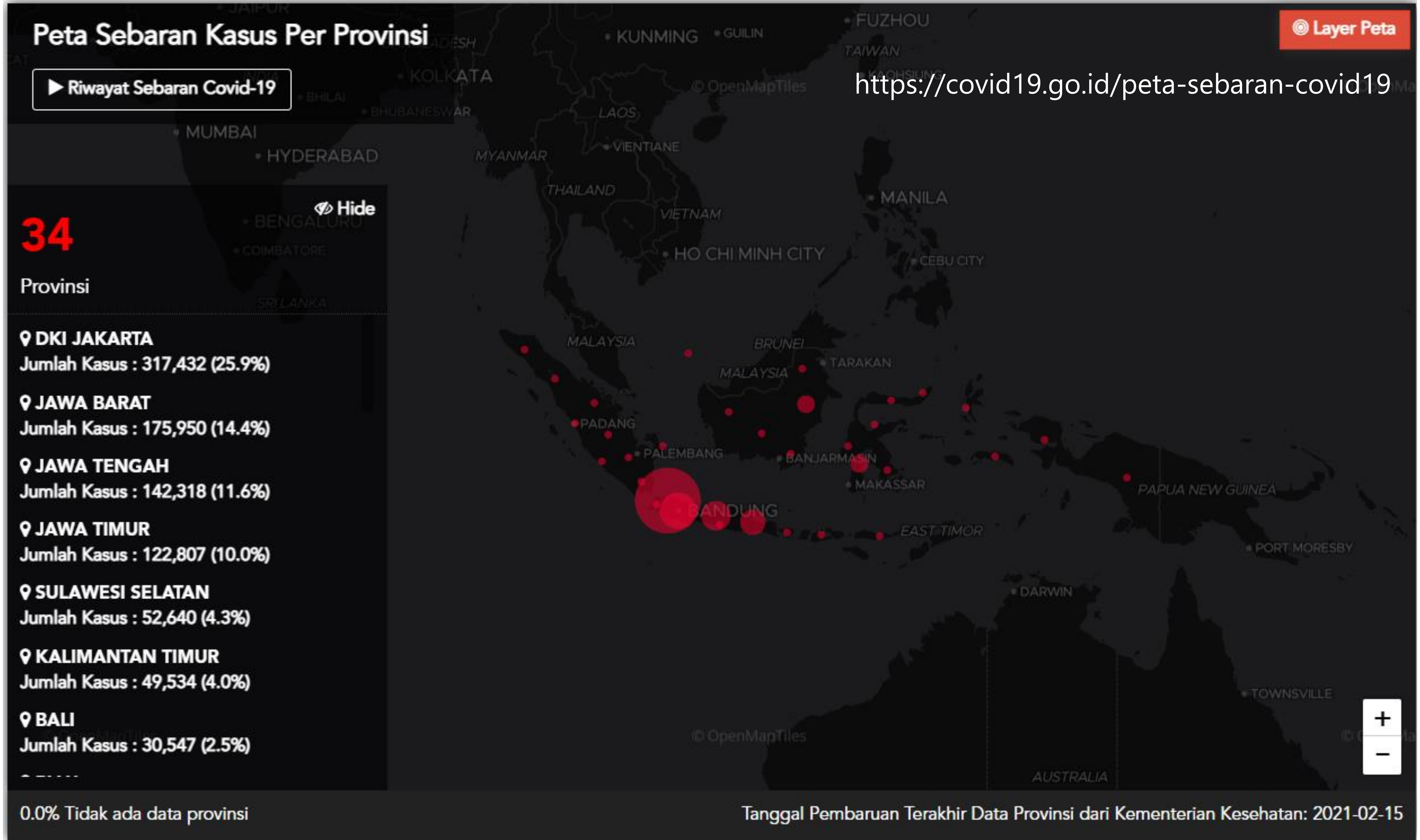

BNPB
GEOPORTAL KEBENCANAAN INDONESIA
Beranda
Data Bencana
Pantauan Bencana
Buletin
Infografis
Tanggal Penting
Tentang
Sign In
557 Kejadian Bencana
Korban
251 Meninggal
11 Hilang
12.115 Luka-luka
3.096.911 Menderita & Mengungsi
Kerusakan
Rumah
4.660 Rusak Berat
5.631 Rusak Sedang
42.109 Rusak Ringan
590.679 Terendam
Fasilitas Rusak
632 Rusak Berat
548 Rusak Sedang
147 Rusak Ringan
207 Terendam
82 Rusak Ringan
Update : 2021-02-22
0 Letusan Gunungapi
28 Karhutla
1 Kekeringan
285 Banjir
111 Tanah Longsor
111 Puting Beliung
9 Gel. Pasang/Abrasi
Bencana Non Alam
1 COVID 19

GIS dalam Penanganan Covid-19

1) Data jumlah kasus yang terjadi
2) Data masyarakat yang mengalami dampak virus
3) Data lembaga kesehatan dan layanan publik
4) Data daerah yang terdampak virus (zona merah, kuning, hijau)
5) Menentukan daerah PSBB
6) Menentukan daerah penerapan *new normal*

Output: data dan pemetaan (website dan aplikasi)

https://covid19.go.id/peta-sebaran-covid19



Kesimpulan

Data geospasial dan GIS berperan dalam:

1. Menjaga keseimbangan lingkungan dengan menyajikan informasi yang tepat dan akurat
2. Pengelolaan sumber daya alam
3. Membantu pemerintah dan masyarakat dalam hal pengambilan strategi untuk pembangunan nasional

Referensi

1. Fatwa Ramdani, Pengantar Ilmu Geoinformatika, 2017.
2. Dr. Ir. Ahmad Perwira Mulia Tarigan, M.Sc (Peneliti Bidang Geospasial, Ketua ISI (Ikatan Surveyor Indonesia) Wilayah Sumut/
3. Ahyudin, Peran Masyarakat Dalam Penanganan Bencana, 2005.
4. Website BPBD Kabupaten Bogor, dapat diakses di https://bpbd.bogorkab.go.id/.

Diskusi

1. Bagaimana data geospasial dan sistem informasi geospasial berperan dalam menjawab isu-isu lingkungan?
2. Jelaskan contoh lain penerapan data geospasial, informasi geospasial dan sistem informasi geospasial pada bidang yang berbeda (selain yang telah dijelaskan dalam PPT)!

Terima kasih

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[TNM102] TEKNOLOGI HIJAU

Green Healthcare Systems & Implementasi Robotika – AI 2

Tim Dosen Teknologi Hijau

Teknik Robotika dan Keceradasn Buatan

Topik kali ini...

01 *Green Healthcare Systems*

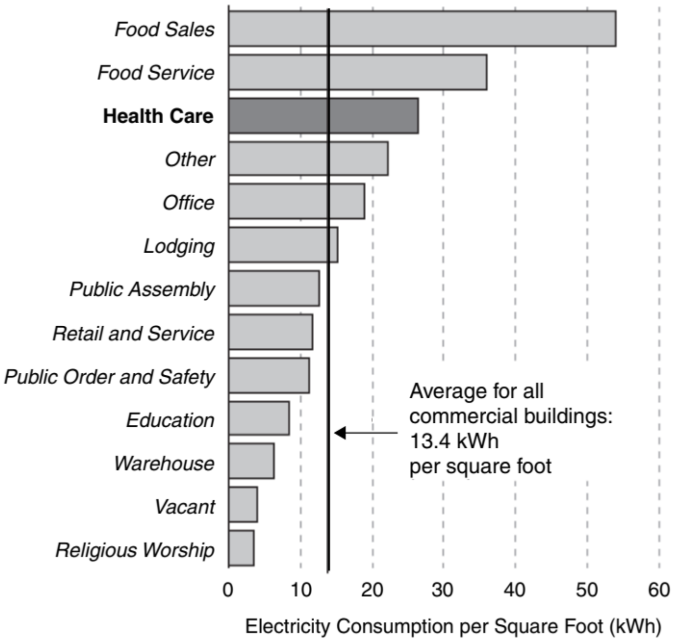
02 *Drone in Agriculture*

03 *Connected Autonomous Vehicle (CAV) Impact on Energy Saving*

01

Green Healthcare Systems

Mengapa Butuh *Green Healthcare System?*



Fakta (WHO, 2011)

- Dari total sampah yang dihasilkan oleh kegiatan kesehatan, sekitar 80% merupakan sampah umum.
- 20% sisanya dianggap bahan berbahaya yang mungkin menular, beracun atau radioaktif.
- Setiap tahun diperkirakan 16.000 juta suntikan diberikan di seluruh dunia, tetapi tidak semua bekas jarum suntik dibuang dengan benar.
- Limbah layanan kesehatan mengandung mikroorganisme yang berpotensi membahayakan, pasien rumah sakit, petugas kesehatan, dan masyarakat umum.

Green Healthcare Systems

Green healthcare systems **berarti suatu integrasi komponen pelayanan kesehatan yang menggabungkan praktik ramah lingkungan ke dalam pelayanan kesehatan.**

Lokal

(dalam lingkup rumah sakit, fasilitas riset, atau klinik)

- Memilih agen pembersih yang ramah lingkungan
- Membatasi penggunaan pestisida

Komunitas

- Mengurangi jejak ekologi yang berbahaya dari rumah sakit (seperti adanya infrastruktur pejalan kaki, mengurangi pengemasan, menggunakan produk *biodegradable*)

Global

- Mengurangi degradasi lingkungan seperti membeli makanan atau supply dari sumber local untuk mengurangi emisi gas rumah kaca yang berkontribusi ke perubahan iklim.

Komponen Utama *Green Healthcare System*

Leadership
Prioritize environmental health as a strategic imperative

Chemicals
Substitute harmful chemicals with safer alternatives

Waste
Reduce, treat and safely dispose of healthcare waste

Energy
Implement energy efficiency and clean, renewable energy generation

Water
Reduce hospital water consumption and supply potable water

Transportation
Improve transportation strategies for patients and staff

Food
Purchase and serve sustainability grown, healthy food

Pharmaceuticals
Prescribe appropriately, safely, manage and properly dispose of pharmaceuticals

Building
Support green and healthy hospital design and construction

Purchasing
Buy safer and more sustainable products and materials

Courtesy: Youtube.com

02

Drone in Agriculture

Komponen dalam *drone*

Remote Sensing

Penginderaan jauh

Aerial Image Collection

Pengambilan gambar dari udara dengan berbagai sensor

Image Processing

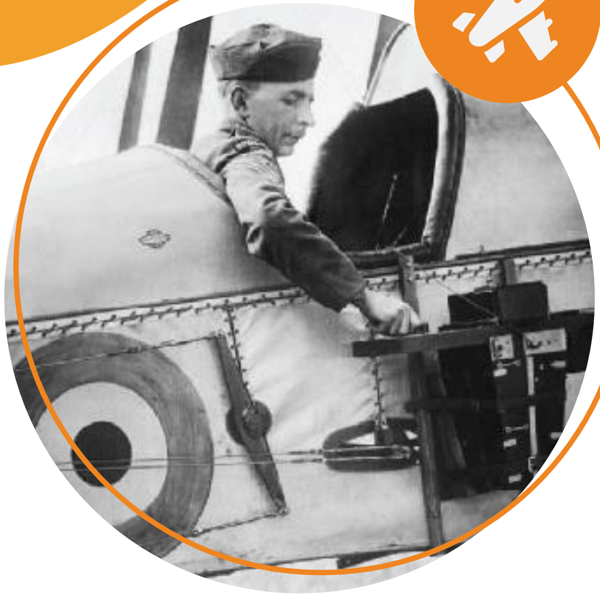
Pengolahan citra digital untuk mendapatkan informasinya.

Implementasi

Pemanfaatan drone dalam agrikultur

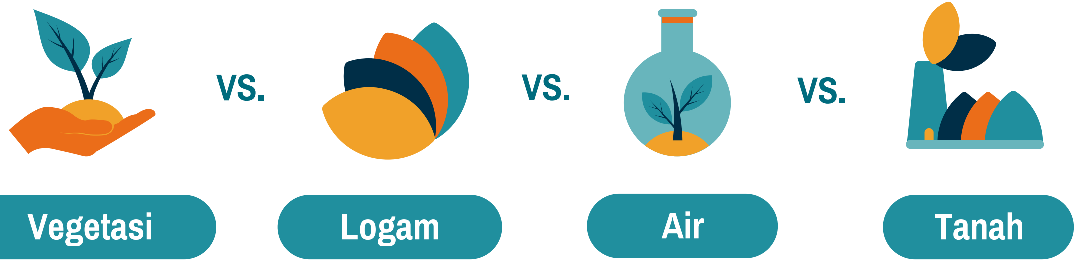
Remote Sensing

Aktivitas mendeteksi dan memonitor karakteristik fisik suatu area dari jarak jauh.



Digunakan pada PDII untuk menemukan kendaraan militer yang disamarkan

Mengapa *Remote Sensing*?



PRINSIP DASAR

Mendeteksi perbedaan reflektivitas gelombang inframerah dekat antara vegetasi dan material lain

Remote sensing: Satelit

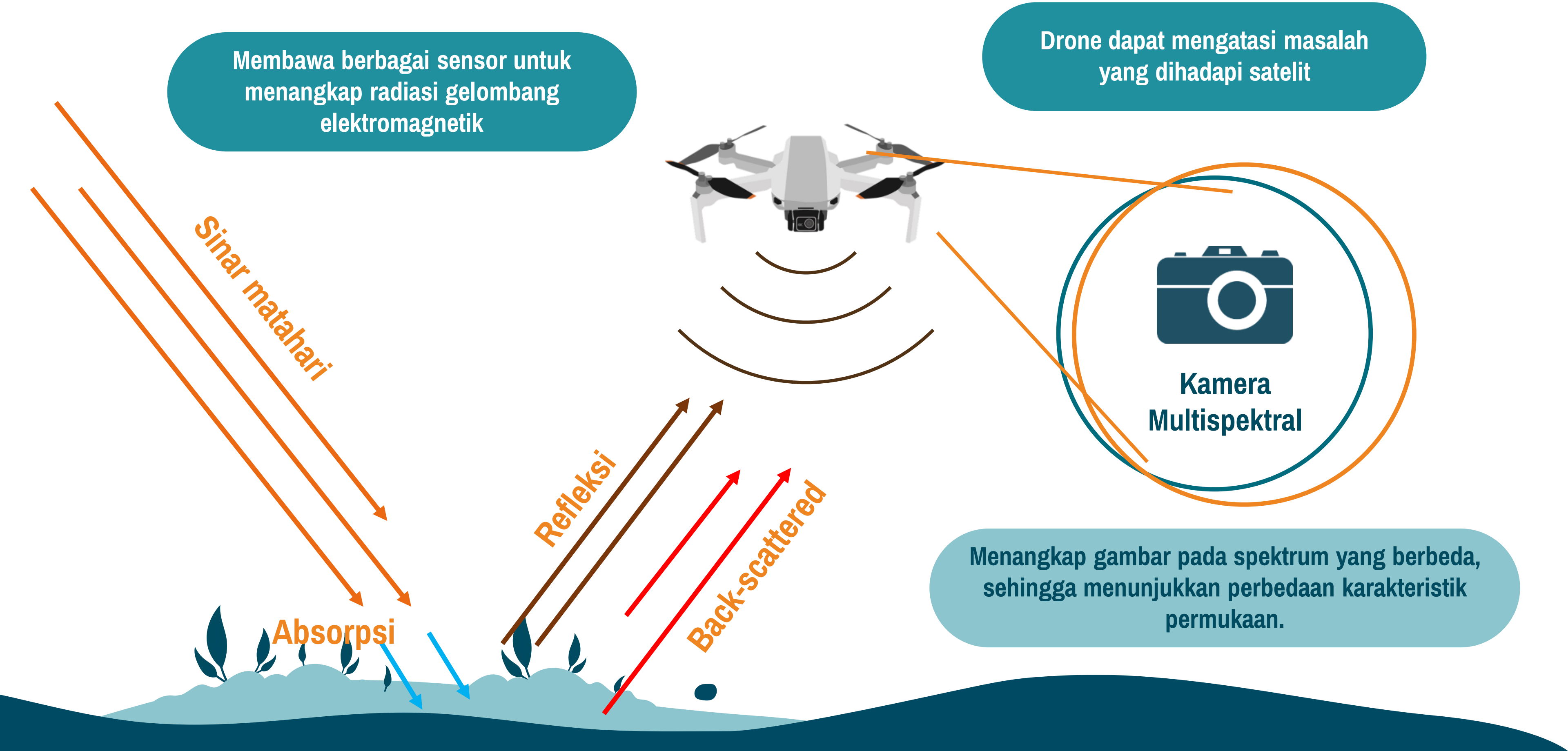
Rangkaian satelit landsat diluncurkan pada tahun 1970 an

Terganggu awan terutama daerah equator

Resolusi spasial 1.0-30 m (terlalu kasar)

Resolusi temporal hari - bulan

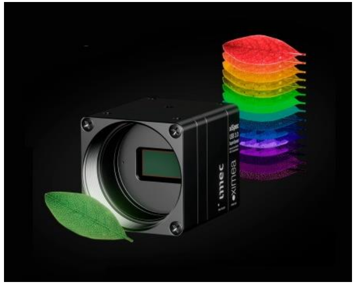
Satelit kurang baik untuk digunakan penginderaan jauh dalam bidang agrikultur


Membawa berbagai sensor untuk menangkap radiasi gelombang elektromagnetik
Drone dapat mengatasi masalah yang dihadapi satelit
Sinar matahari
Kamera Multispektral
Refleksi
Back-scattered
Absorpsi
Menangkap gambar pada spektrum yang berbeda, sehingga menunjukkan perbedaan karakteristik permukaan.

TIPE SENSOR

Aerial Imagery Collection

Visible light camera
(400 nm – 700 nm)



Hyperspectral camera
(> 10 spectral bands)

IR camera

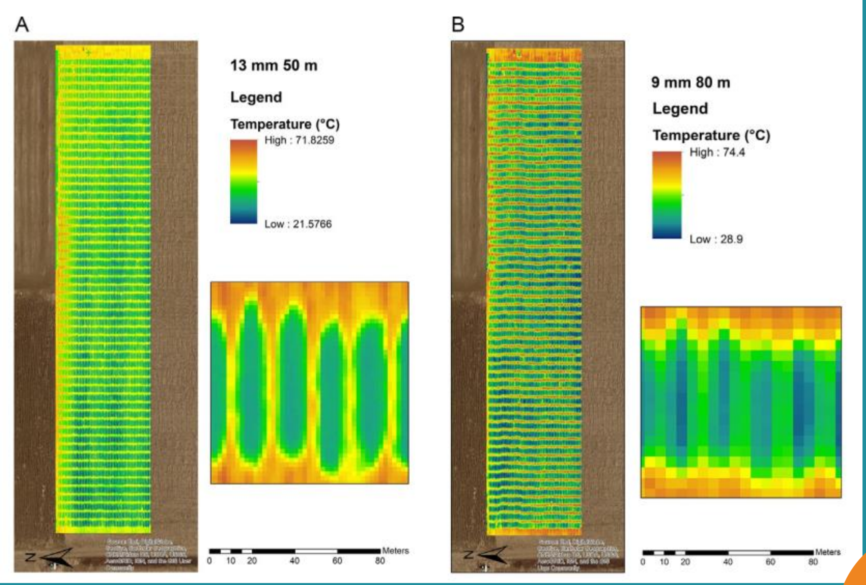
Multispectral camera

Aerial Imagery Collection

Thermal camera
(gambar berdasarkan suhu objek)

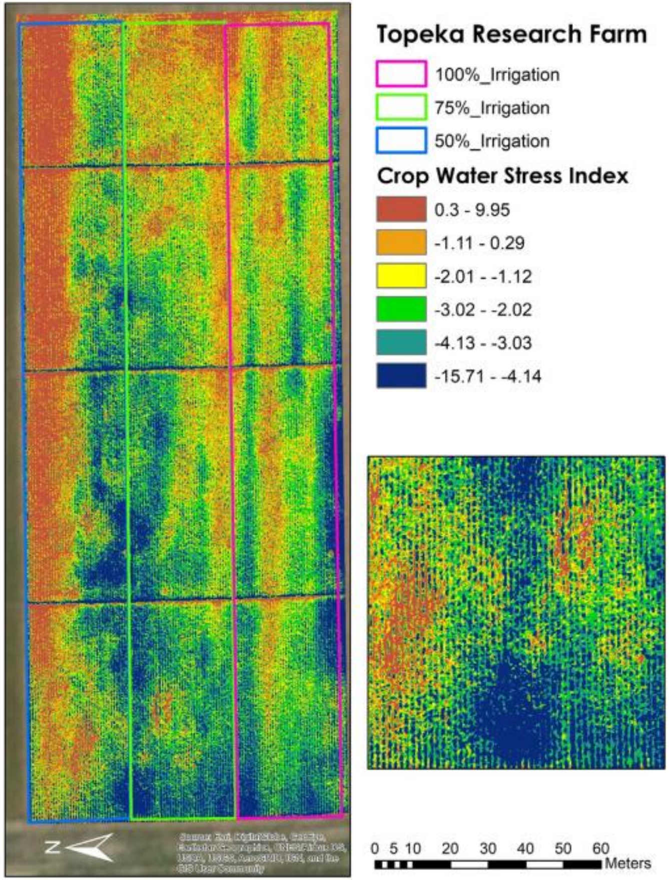
LiDAR
(memberikan informasi jarak dari sensor ke objek)

Image Processing

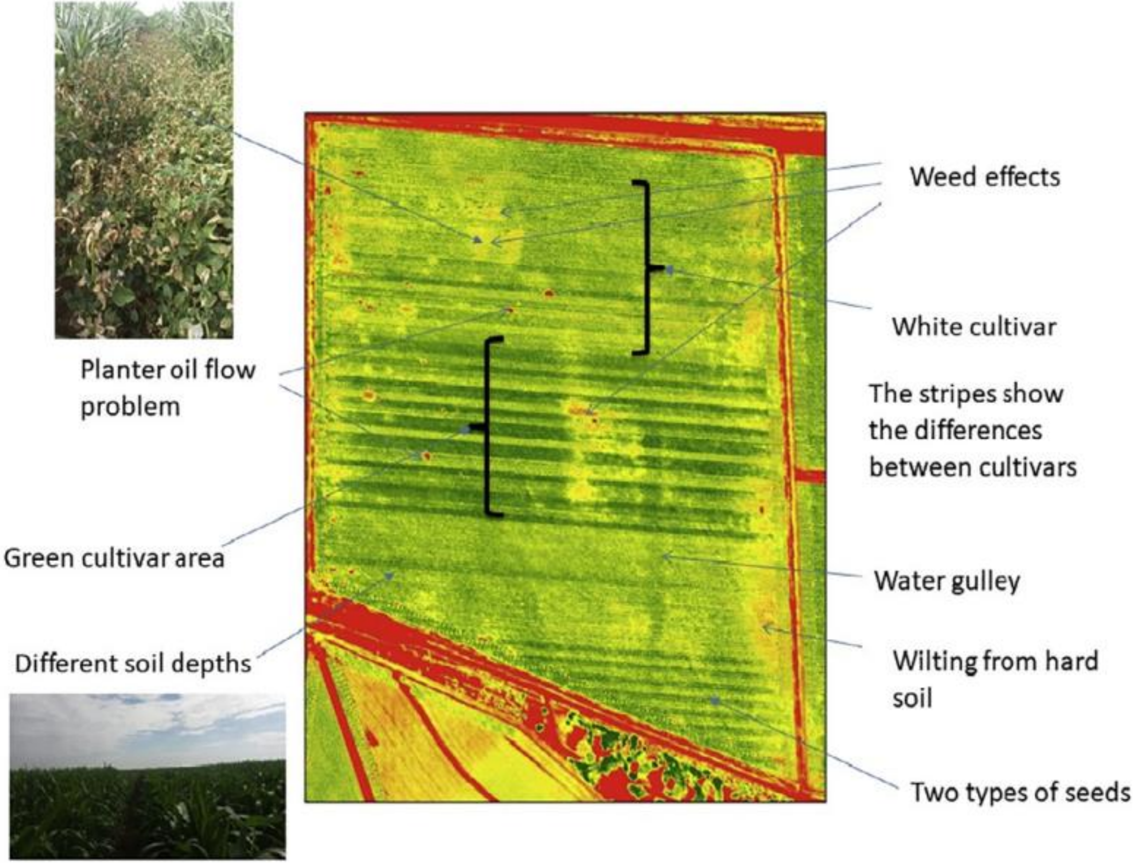


Proses pengolahan data numerik hasil pemetaan untuk menampilkan citra yang mudah diinterpretasikan

Citra dari kamera diolah untuk menghasilkan citra yang dapat memberikan arti.

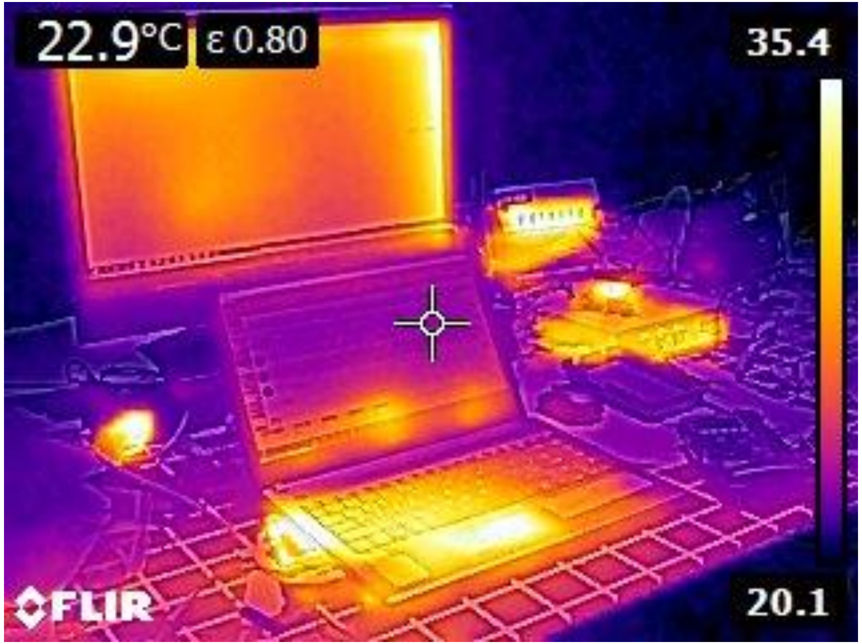


Topeka Research Farm
100%_Irrigation
75%_Irrigation
50%_Irrigation
Crop Water Stress Index
0.3 - 9.95
-1.11 - 0.29
-2.01 - -1.12
-3.02 - -2.02
-4.13 - -3.03
-15.71 - -4.14
N
0 5 10 20 30 40 50 60
Meters



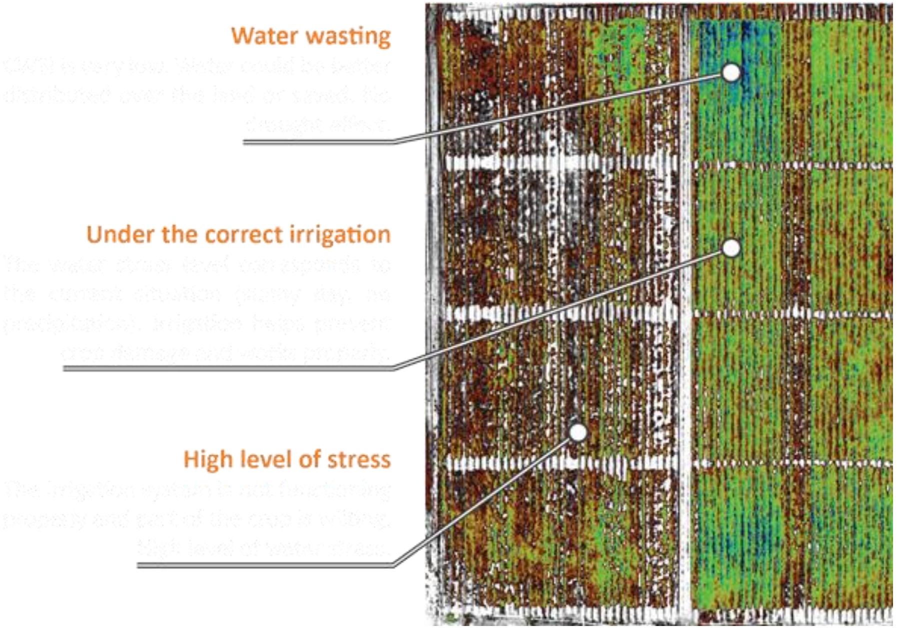
Planter oil flow problem
Green cultivar area
Different soil depths
Weed effects
White cultivar
The stripes show the differences between cultivars
Water gulley
Wilting from hard soil
Two types of seeds

Visible light camera + thermal camera



Visible light camera

Implementasi: *Water Management*

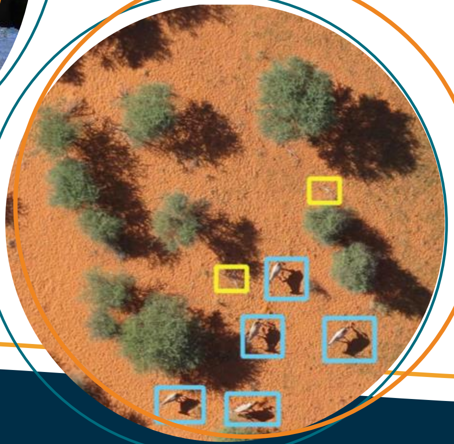


- Ketersediaan air untuk irigasi terbatas.
- Drone dengan sensor khusus dapat melihat distribusi air pada lahan pertanian.
- Pemanfaatan air menjadi lebih efektif dan efisien.

Implementasi: *Reforestation*

Dapat dimanfaatkan untuk menebar benih pohon.

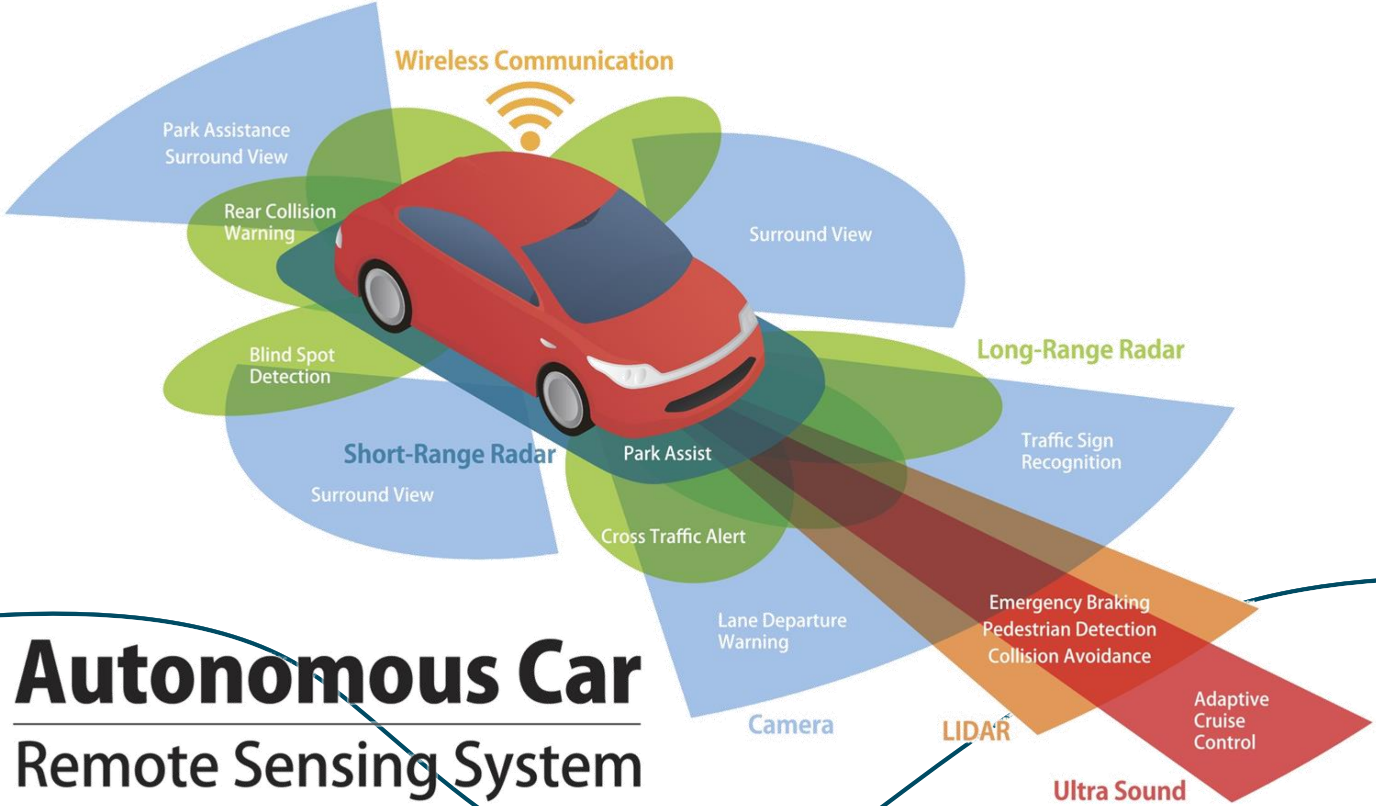
Implementasi: *Wildlife Conservation*



- Dapat dimanfaatkan untuk memonitor populasi hewan liar.
- Sarana pengawasan dari pemburu

03

Connected Autonomous Vehicle (CAV) Impact on Energy Saving



Wireless Communication
Park Assistance
Surround View
Rear Collision
Warning
Surround View
Long-Range Radar
Blind Spot
Detection
Traffic Sign
Recognition
Short-Range Radar
Park Assist
Surround View
Cross Traffic Alert
Emergency Braking
Pedestrian Detection
Collision Avoidance
Lane Departure
Warning
Adaptive
Cruise
Control
Camera
LIDAR
Ultra Sound
Autonomous Car
Remote Sensing System

Connected Autonomous Vehicle (CAV)

Bentuk terintegrasi dari AV yang memanfaatkan teknologi untuk berkomunikasi antara satu dengan lainnya termasuk sinyal lalu lintas, tanda, atau mengambil data dari *cloud* untuk meningkatkan keamanan dan alur lalu lintas.

Courtesy: Youtube.com

Berdasarkan penjelasan sebelumnya...

“Apakah teknologi AV dapat menghemat konsumsi energi? Mengapa?”

UNLEASH YOUR OPINION !

RAISE HAND

4 Kategori Dampak CAV

Travel demand change category

01

Driving detail category

02

Multi-vehicle operation category

03

Power train & energy resource category

04

Travel Demand Change

- Better route choice
- Newly Induced Trips from underserved area/population
- Shared Automated Vehicle
- Long Distance Travel with CAV

Driving Details

Faster Travel

Karena kemampuan mengemudi yang otonomi

Smoother Driving Cycle

Karena pengendalian telah diatur sedemikian hingga mengurangi ketidak teraturan

Computer & Sensor Power Demand

Karena CAV membutuhkan integrasi banyak sensor dan proses komputasi yang kompleks

Multi-Vehicle Operation

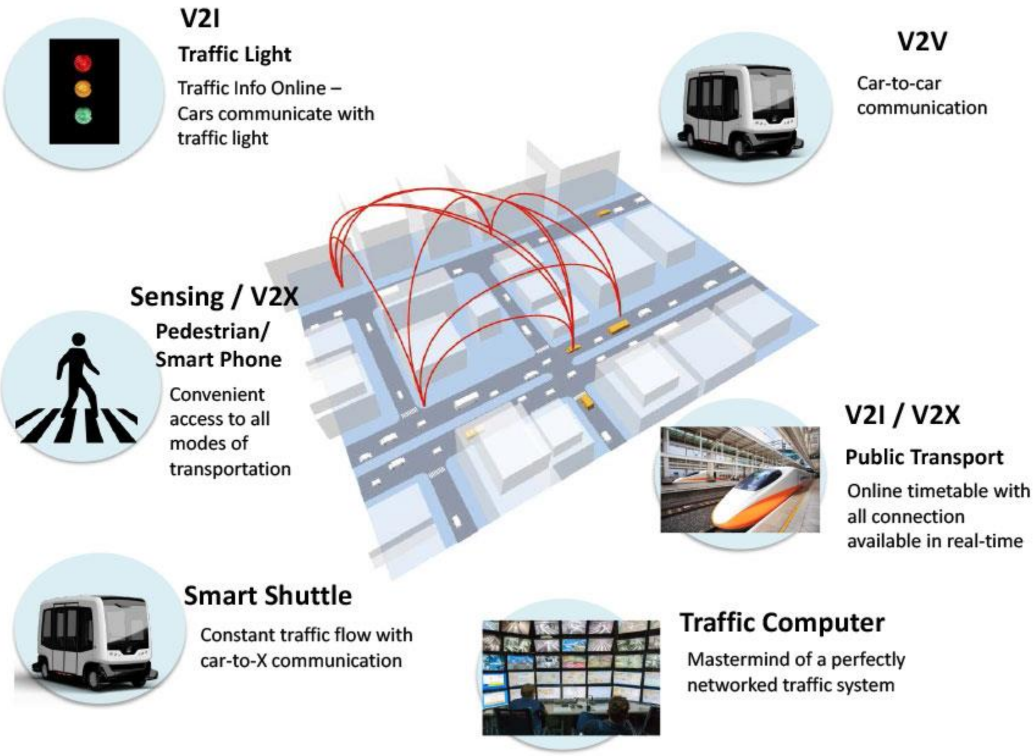
V2I and Connected Intersection

Interkoneksi antara kendaraan dengan komponen sistem lalu lintas lain.

V2V and Platooning

Koneksi dan interaksi antar kendaraan

V2I & Connected Intersection

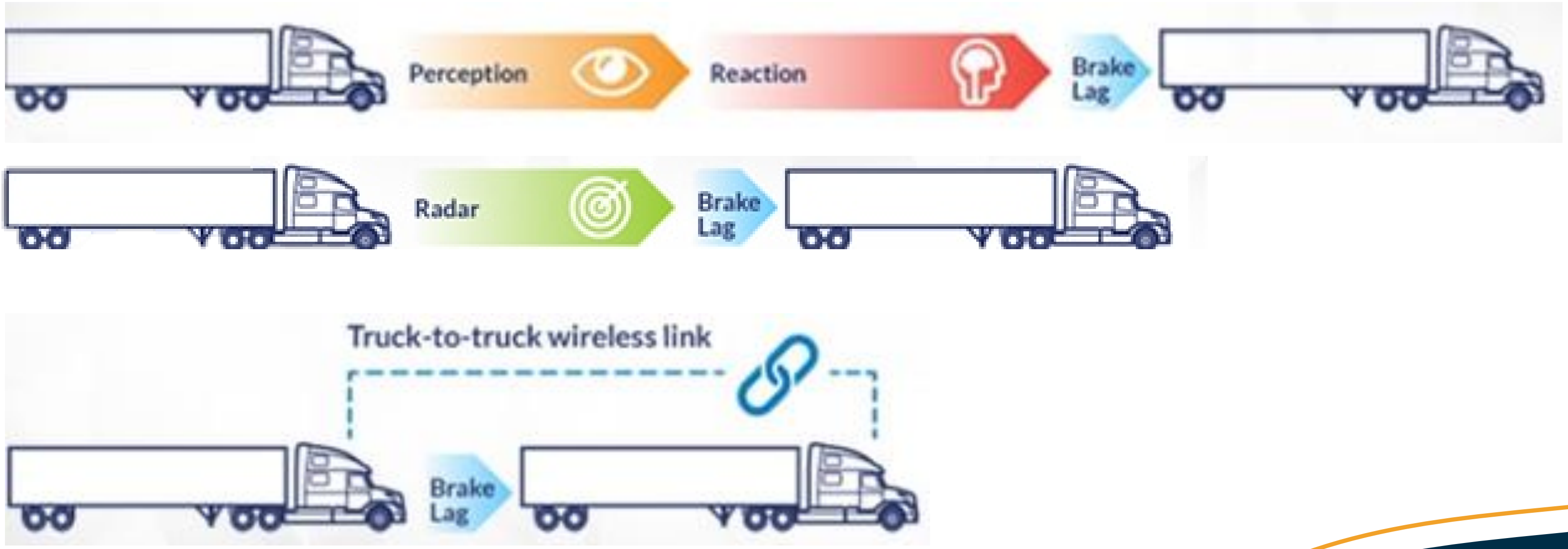


V2V & *Platooning*

Manual Driving

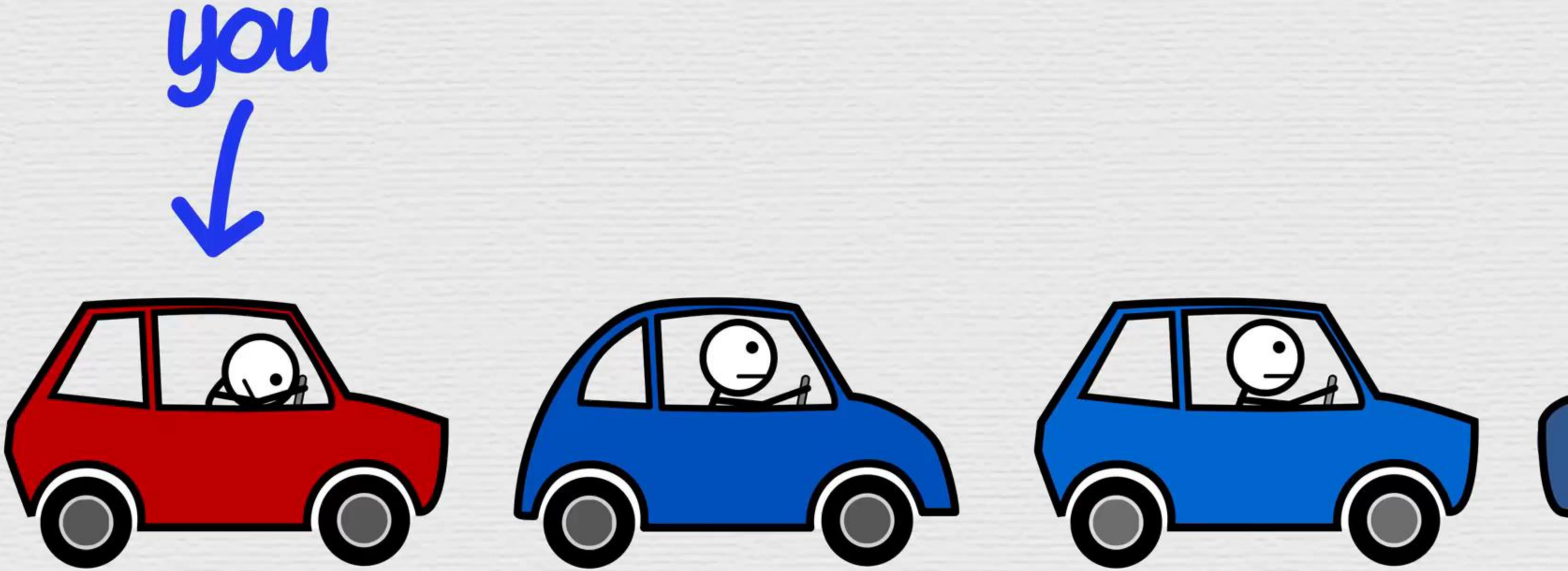
Radar-based Collision Mitigation System

Platooning System

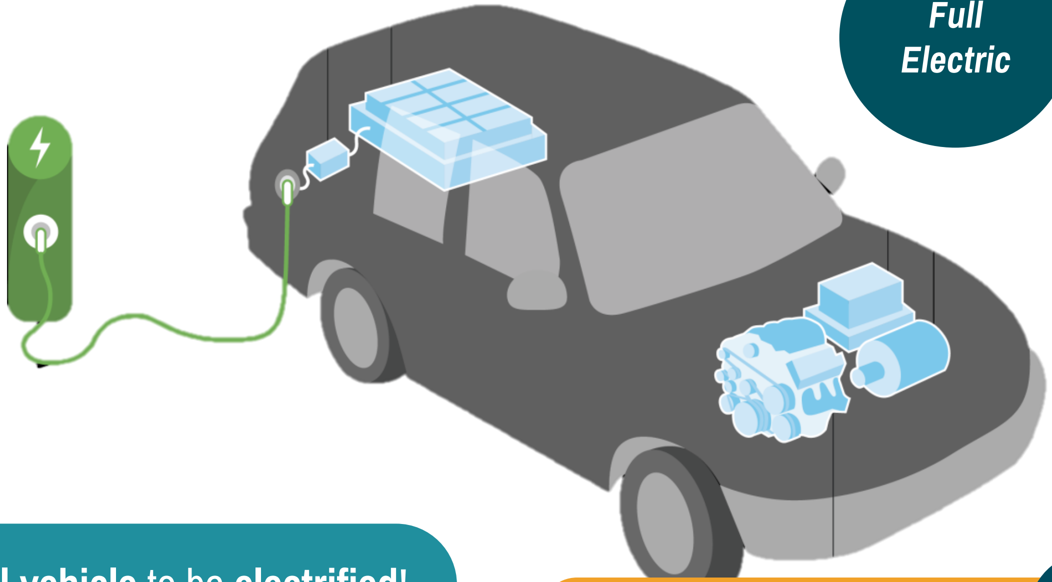


LET'S TAKE A LOOK NEXT VIDEO...

Courtesy: Youtube.com



Power Train & Energy Source



Full Electric

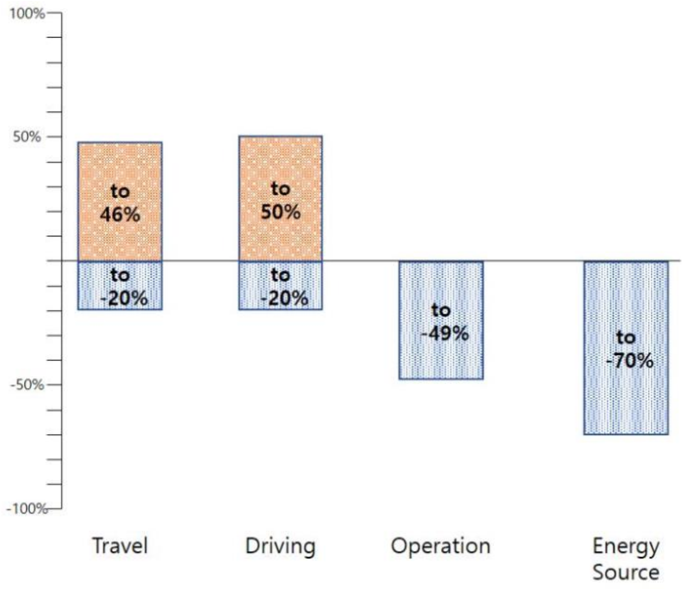
Hybrid electric

CAV will lead **all vehicle** to be **electrified**!

UNLEASH YOUR OPINION !

RAISE HAND

Prediksi Penggunaan Energi AV



Category	Impacts	Description	Energy Impacts
Travel Demand Changes	Better Route Choices	Route choice based on real-time traffic data from connected environment	-5% to -20%
	New Trips from Under-served Populations	Motorized trips by limited drivers & non-drivers	+10% to +14%
	Shared Automated Vehicles – Empty Driving	SAVs traveling to next passenger, empty	+6% to +14%
	More Long-distance Travel	Longer distance travel caused from lower driving task of CAVs	+6% to +18%
Driving Details	Faster Travel from Improved Driving Skills	Fast & throughput-efficient driving cycle	+7% to +30%
	Smoother Driving Cycle	More fuel-efficient driving cycles	-10% to -20%
	Computer & Sensor Power Demands	Energy for sensors, on-board computing, vehicle control & navigation	+4% to +15%
Multi-vehicle Operation	V2V & Platooning	Vehicle-to-vehicle connectivity & platooning	-2% to -19%
	Shared AVs & Ride-Sharing	Fuel savings from vehicle right-sizing & dynamic ride-sharing (DRS)	-5% to -12%
	V2I & Smart Intersections	Vehicle-to-infrastructure connectivity & smart intersection	-6% to -30%
Powertrain Energy Source	Plug-in Electric & Hybrid Electric Vehicles	Drivetrain shifts from gasoline to electricity	-30% to -70%

Conclusions

- An Important perspective **to anticipates the increasing of energy consumption instead of reduction because of CAV**.
- Energy consumption decrease because of CAV without EVs is approximately 11%, while it reaches a 55% decrease when all the CAVs are EVs.

Referensi

Green Healthcare Systems

Jazla Fadda, "Green Healthcare System: Main Features in Supporting Sustainability of Healthcare System—A Review", Green Buildings and Renewable Energy, Springer, 2020.

Drone in Agriculture

Deon van der Merwea,∗, David R. Burchfieldb, Trevor D. Wittb, Kevin P. Pricec, Ajay Shardad, "Drones in Agriculture", Book Chapter : 1, 2020.

Autonomous Vehicle Impact on Energy Consumption

J. Lee and K. Kockleman, "Energy Implications of Self-Driving Vehicles", 98th Annual Meeting of the Transportation Research Board, 2020. Available: https://www.caee.utexas.edu/prof/kockelman/public_html/TRB19EnergyAndEmissions.pdf.

Tugas

Cek e-Learning UNAIR (AULA) untuk detail lebih lanjut.

Thanks!

Do you have any questions?

Nanotechnology for Environmental Purposes

- Nanomaterial for Photocatalysis -

Dr. Eng. Chitiphon Chuaicham

Special Assistant Professor

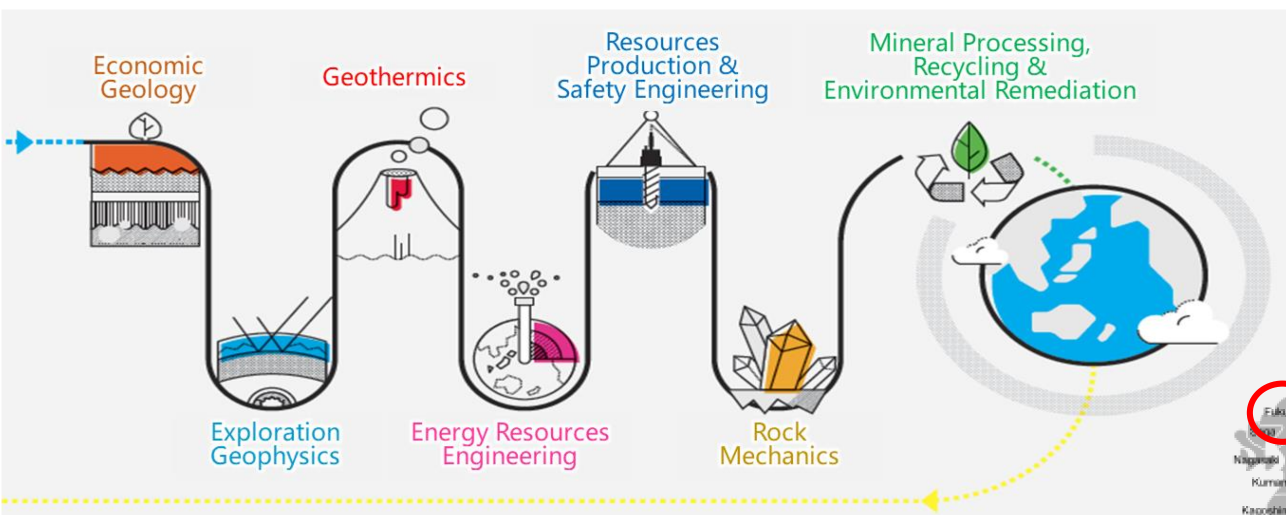
Department of Earth Resources Engineering
Kyushu University
Japan

Video conferencing with Universitas Airlangga, June 8th, 2021

Kyushu University

Department of Earth Resources Engineering, Kyushu University, Japan

QS World Ranking 36th (Mineral & Mining Engineering)



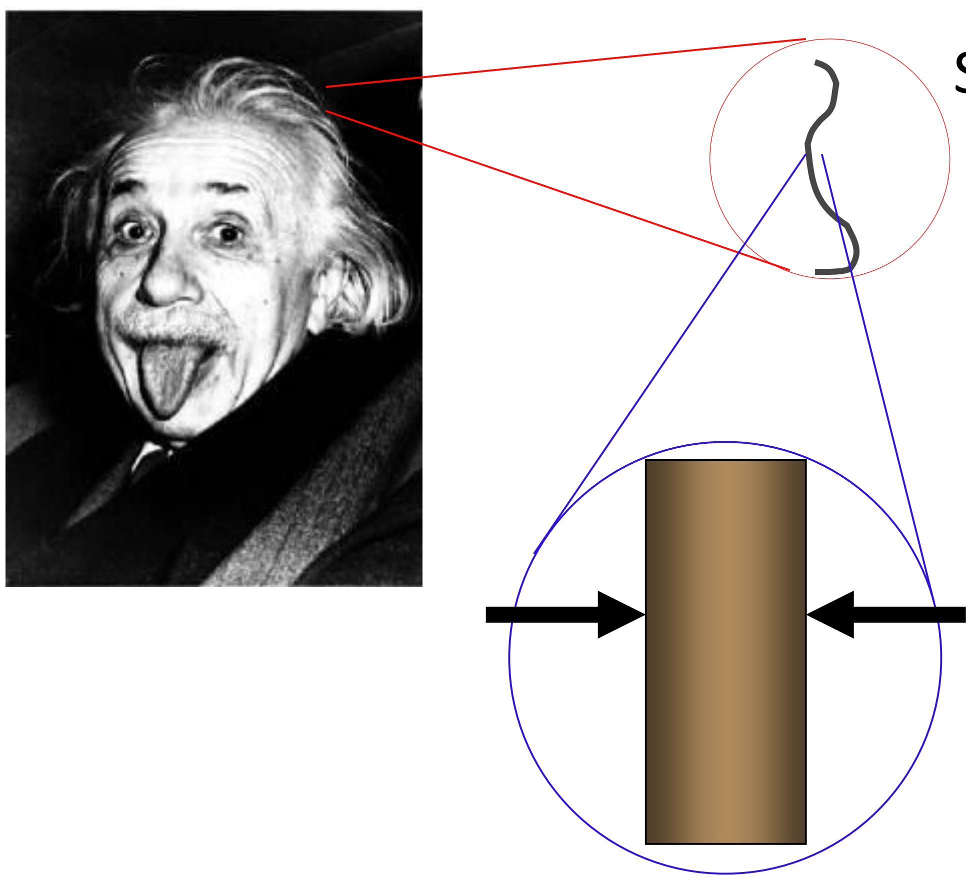
What is nanotechnology?

Nanotechnology is the understanding and control of matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications.

1 nanometer = 1 billionth of a meter

$= 1 \times 10^{-9}$ m

How small are nanostructures?



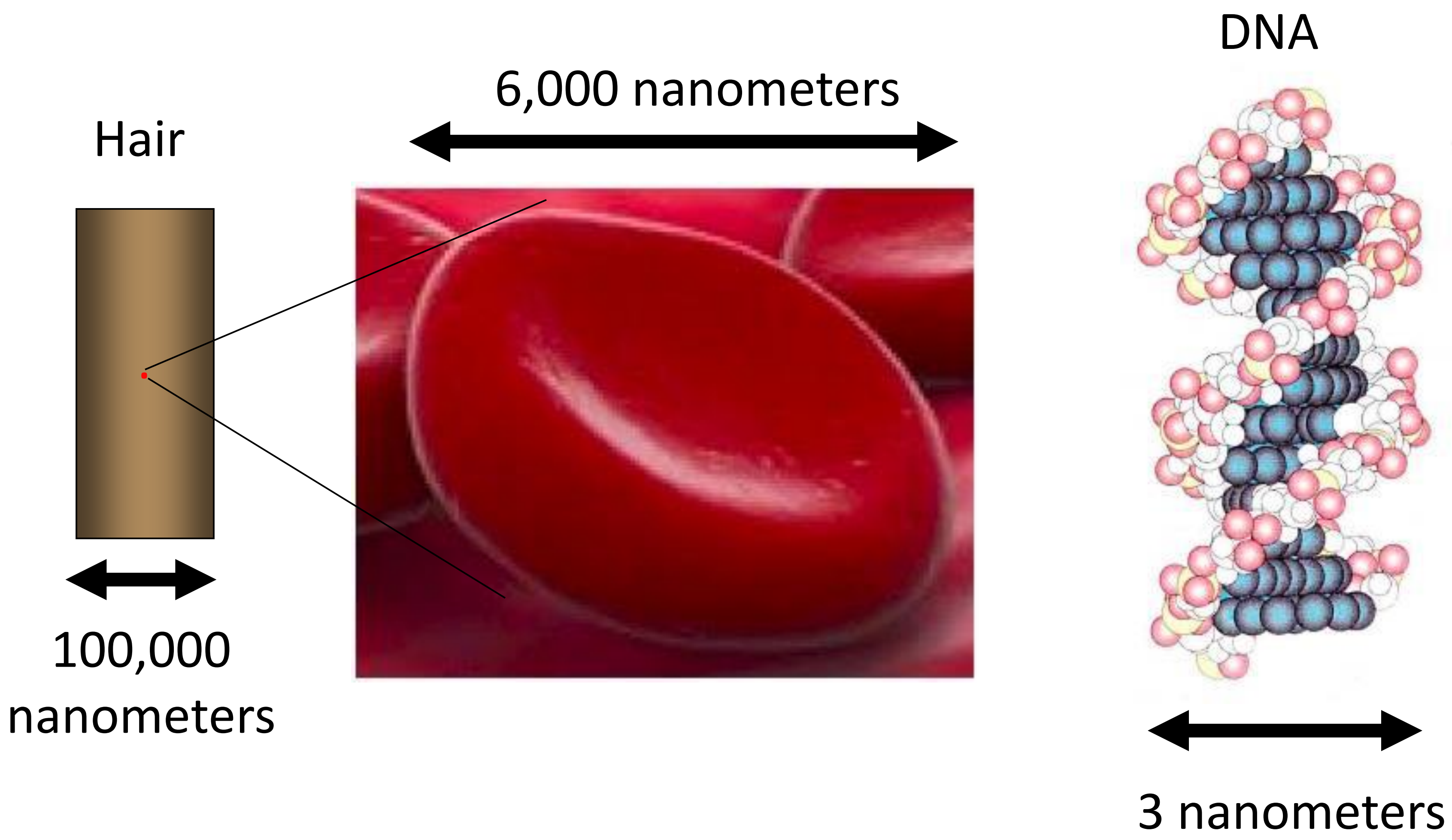
Single Hair

Width = 0.1 mm

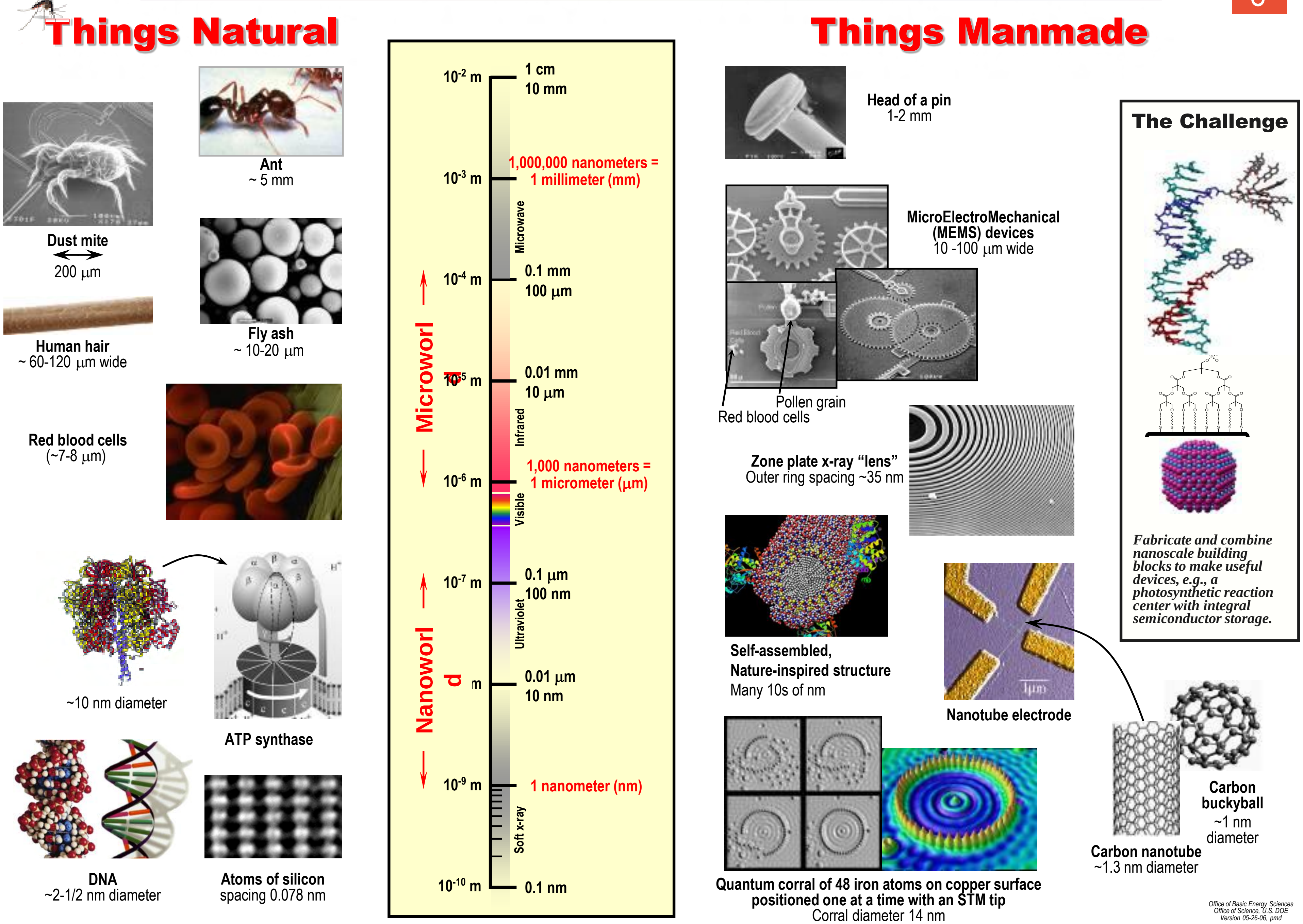
= 100 micrometers

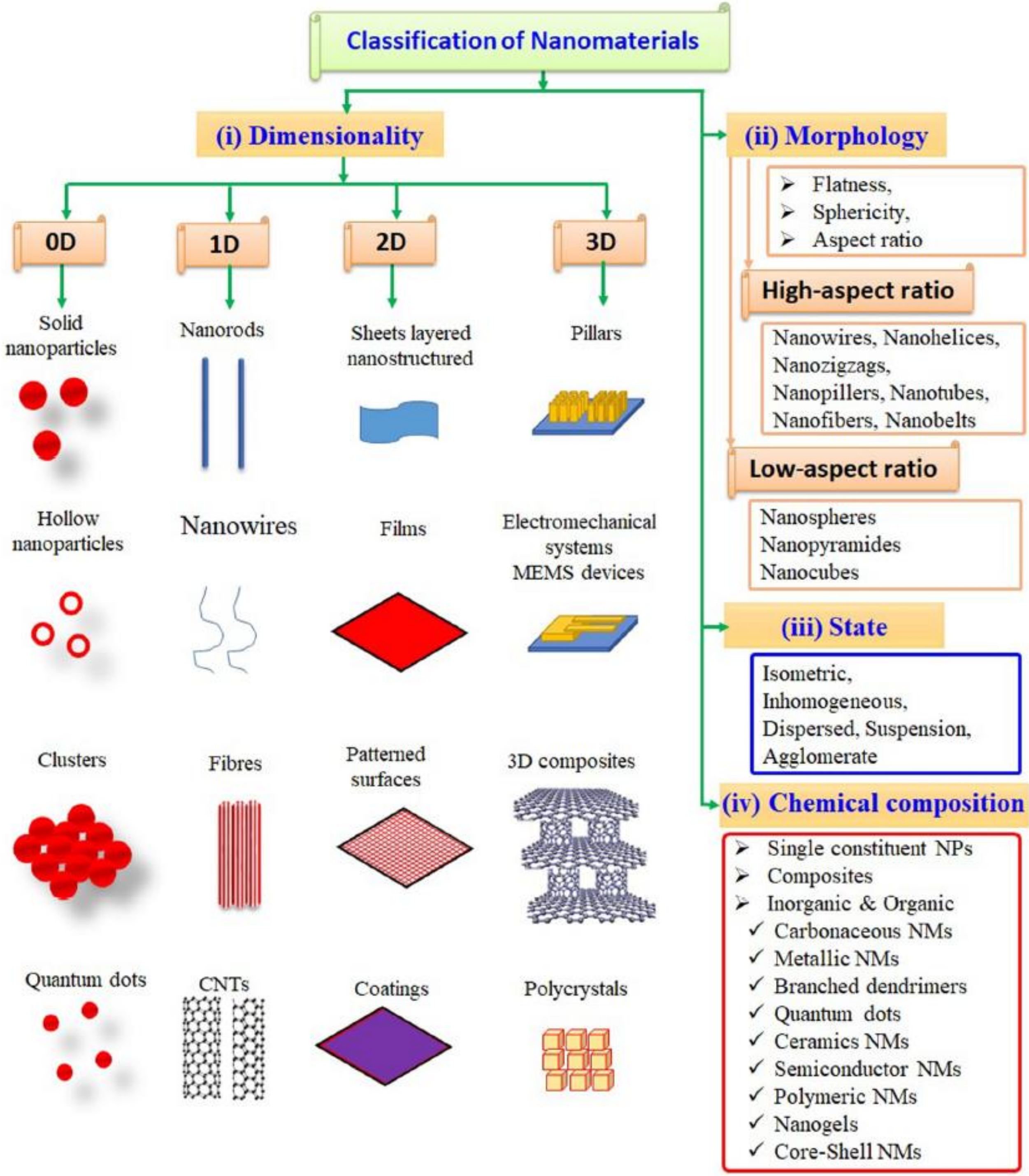
= 100,000 nanometers !

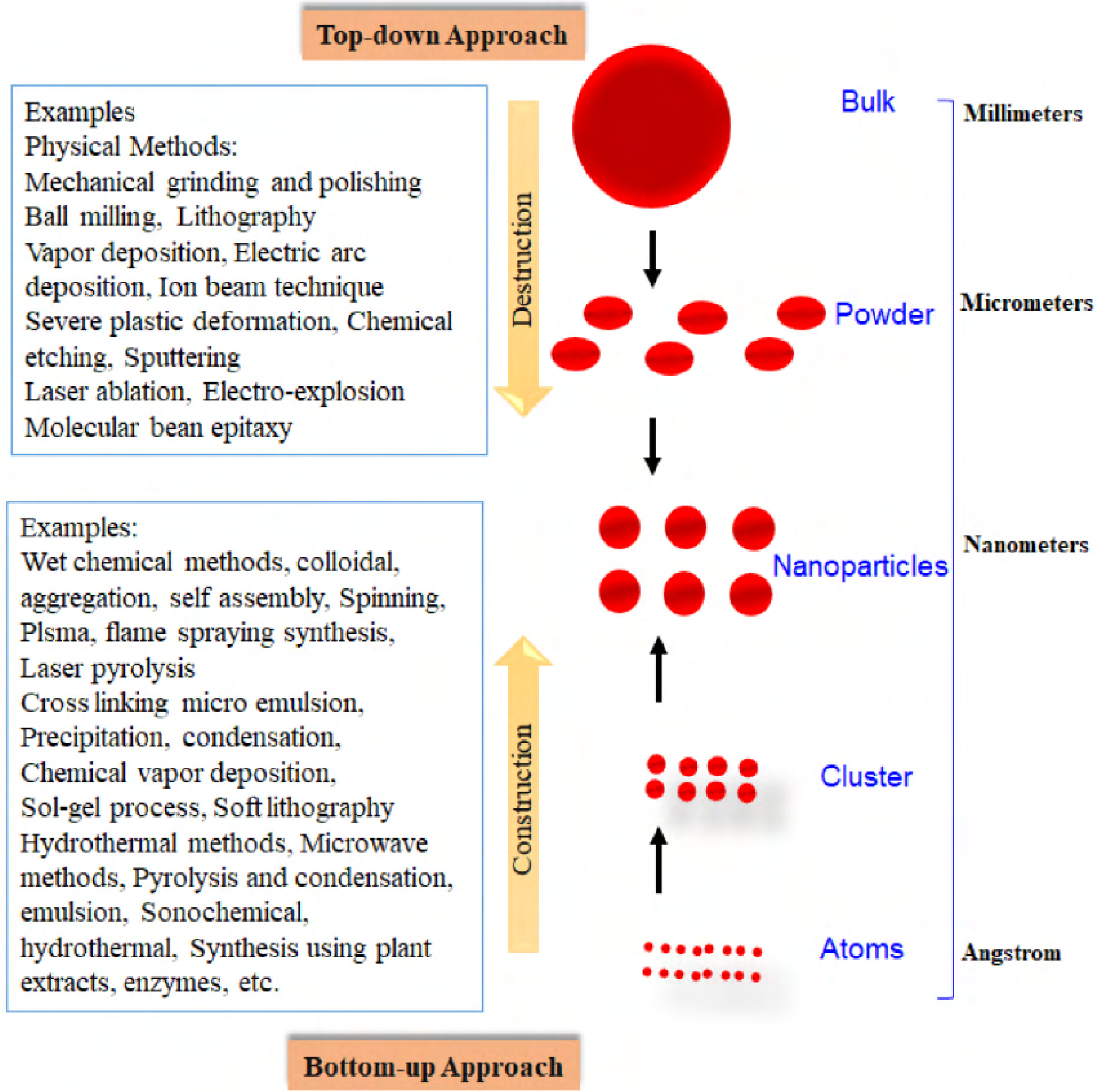
Smaller still



The Scale of Things – Nanometers and More




Classification of Nanomaterials
(i) Dimensionality
0D
1D
2D
3D
Solid nanoparticles
Nanorods
Sheets layered nanostructured
Pillars
Hollow nanoparticles
Nanowires
Films
Electromechanical systems MEMS devices
Clusters
Fibres
Patterned surfaces
3D composites
Quantum dots
CNTs
Coatings
Polycrystals
(ii) Morphology
Flatness,
Sphericity,
Aspect ratio
High-aspect ratio
Nanowires, Nanohelices, Nanozigzags, Nanopillers, Nanotubes, Nanofibers, Nanobelts
Low-aspect ratio
Nanospheres
Nanopyramides
Nanocubes
(iii) State
Isometric,
Inhomogeneous,
Dispersed, Suspension,
Agglomerate
(iv) Chemical composition
Single constituent NPs
Composites
Inorganic & Organic
Carbonaceous NMs
Metallic NMs
Branched dendrimers
Quantum dots
Ceramics NMs
Semiconductor NMs
Polymeric NMs
Nanogels
Core-Shell NMs


Top-down Approach
Examples
Physical Methods:
Mechanical grinding and polishing
Ball milling, Lithography
Vapor deposition, Electric arc deposition, Ion beam technique
Severe plastic deformation, Chemical etching, Sputtering
Laser ablation, Electro-explosion
Molecular bean epitaxy
Destruction
Bulk
Millimeters
Powder
Micrometers
Nanoparticles
Nanometers
Cluster
Atoms
Angstrom
Construction
Examples:
Wet chemical methods, colloidal, aggregation, self assembly, Spinning, Plsma, flame spraying synthesis, Laser pyrolysis
Cross linking micro emulsion, Precipitation, condensation, Chemical vapor deposition, Sol-gel process, Soft lithography
Hydrothermal methods, Microwave methods, Pyrolysis and condensation, emulsion, Sonochemical, hydrothermal, Synthesis using plant extracts, enzymes, etc.
Bottom-up Approach

Why do we want to make things at the nanoscale?

- To make better products: smaller, cheaper, faster and more effective. (Electronics, catalysts, water purification, solar cells, coatings, medical diagnostics & therapy, and more -- a sustainable future!)

- To discover completely new physical phenomena to science and technology. (Quantum behavior and other effects.)

Materials

Nanomaterials

- Nanomaterials (NMs) are chemical substances or materials that are of size, at least in one dimension, in nanoscale 1-100 nm
- Cannot be seen by simple microscope, or naked eye. Advanced microscopic techniques are used.
- Large surface to volume ratio leads to better performance such as in catalysis, solar veils, gas sensors
- High percentage of atoms or molecules on the surface which leads to unique properties
- Surface forces are very important
- Metal nanoparticles have unique scattering properties
- Semiconductor nanoparticles may exhibit confined energy states in the electronic band structure
- Their chemical and physical properties are unique and change by size and shape
- NMs properties can be 'tuned' by varying the size of the particle (e.g. changing the fluorescence colour so a particle can be identified)
- NMs complexity offers a variety of functions to products
- Adsorption and absorption of molecules (gas or liquid phases) are high and fast
- Examples are nanosilica, nanotitania, nanoalumina, etc.

Bulk materials

- Bulk materials are particles that have their size above 100 nm in all dimensions
- Can be seen by simple microscope, or naked eye.
- Low surface to volume ratio leads to better performance such as in catalysis, solar veils, gas sensors
- Low percentage of atoms or molecules on the surface which leads to their properties
- Bulk forces are not as important as surface forces
- Metal bulk have normal scattering properties
- Semiconductor bulk may not exhibit confined energy states in the electronic band structure
- Their chemical and physical properties cannot be tuned
- Adsorption and absorption of molecules (gas or liquid phases) are low and slow
- Examples includes sand, cement, alumina, ore, salts, etc.

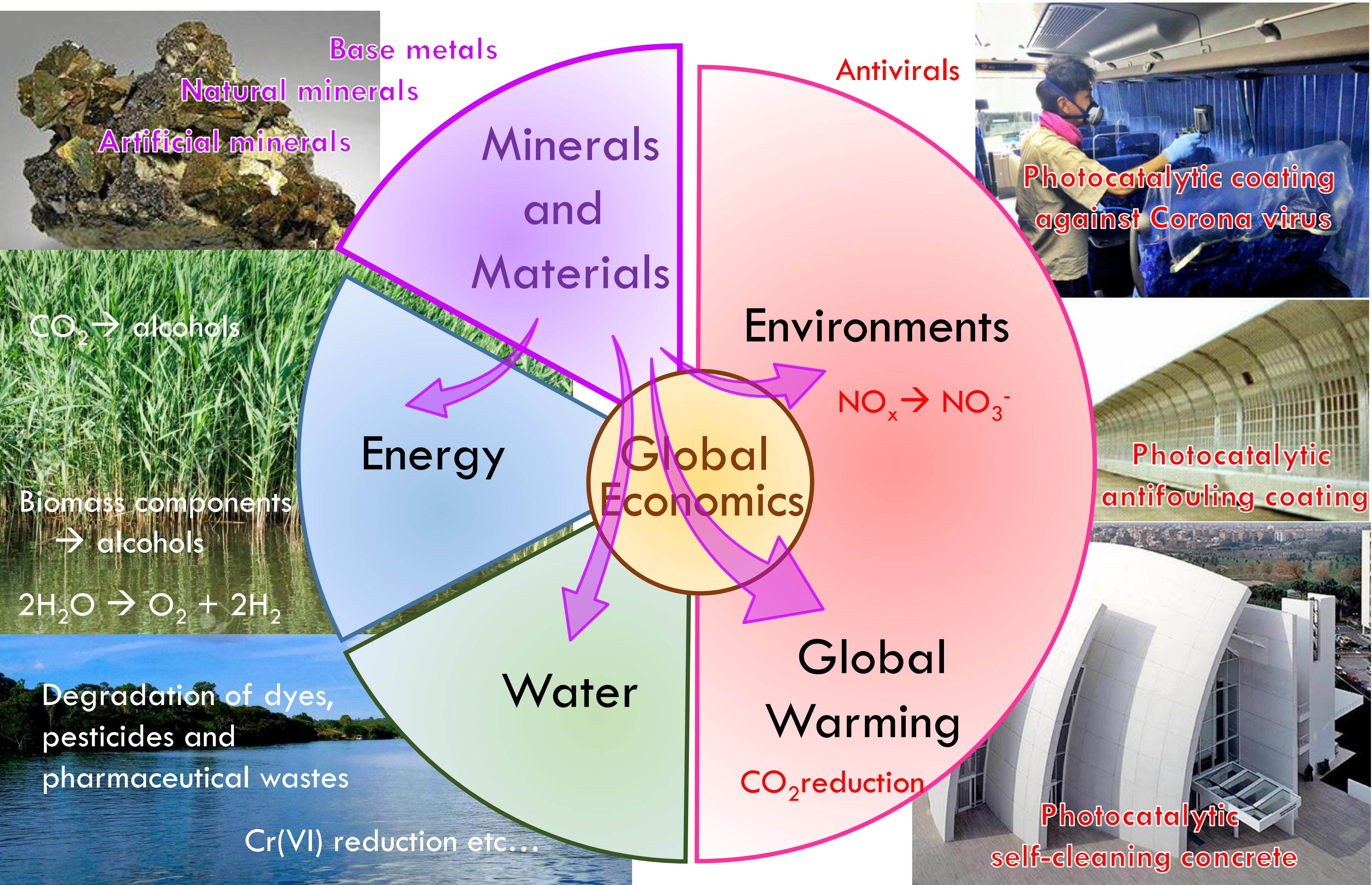
What Will Nanomaterials Do For Society?

Since the 1980's **electronics** has been a leading commercial driver for nanotechnology R&D, but other areas (**materials**, **biotech**, **energy**, and others) are of significant and growing importance.

Some applications of nanotechnology has been around for a *very* long time already:

- **Stained glass windows** (Venice, Italy) - gold nanoparticles
- **Photographic film** - silver nanoparticles
- **Tires** - carbon black nanoparticles
- **Catalytic or photocatalyst converters** - nanoscale coatings of platinum and palladium

Photocatalysis



Anti fogging, Self-Cleaning

When the original building materials are coated with a photocatalyst, a protective film of titanium provides the self-cleaning building by becoming antistatic, super oxidative, and hydrophilic.

Air Purifying Effect, Deodorizing effect

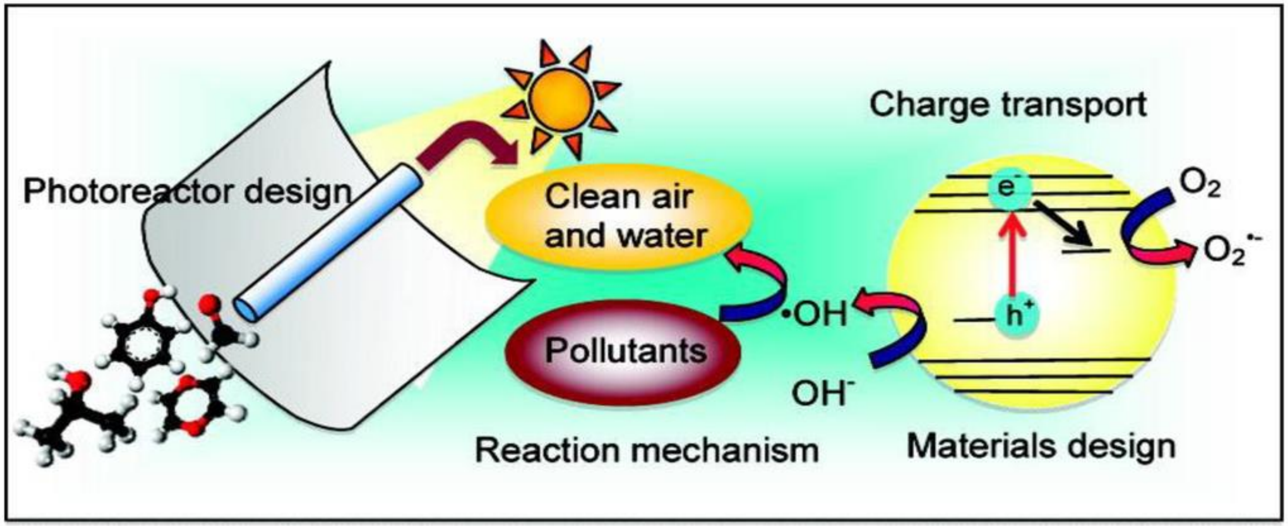
- The hydroxyl radicals accelerate the breakdown of any Volatile Organic Compounds by destroying the molecular bonds.
- This will help combine the organic gases to form a single molecule that is not harmful to humans thus enhance the air cleaning efficiency.

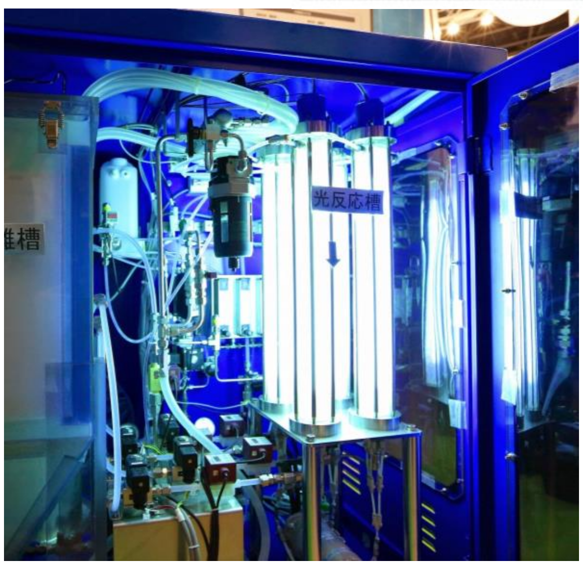
Water Purification

- Photocatalyst coupled with UV lights can oxidize organic pollutants into nontoxic materials, such as CO_2 and water and can disinfect certain bacteria.

- This technology is very effective at removing further hazardous organic compounds (TOCs) and at killing a variety of bacteria and some viruses in the secondary wastewater treatment.

Photocatalytic treatment of toxic pollutant





Photocatalytic Water Purification Technology

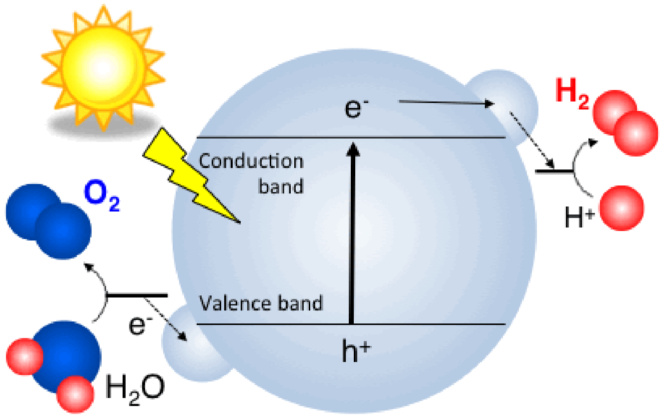
What is a photocatalysis?

Photo	Catalysis
Energy in the from of light	Process where a substance involves in altering the rate of a chemical transformation

- **Photocatalysis** can be defined as "Catalysis driven acceleration of a light-induced reaction".

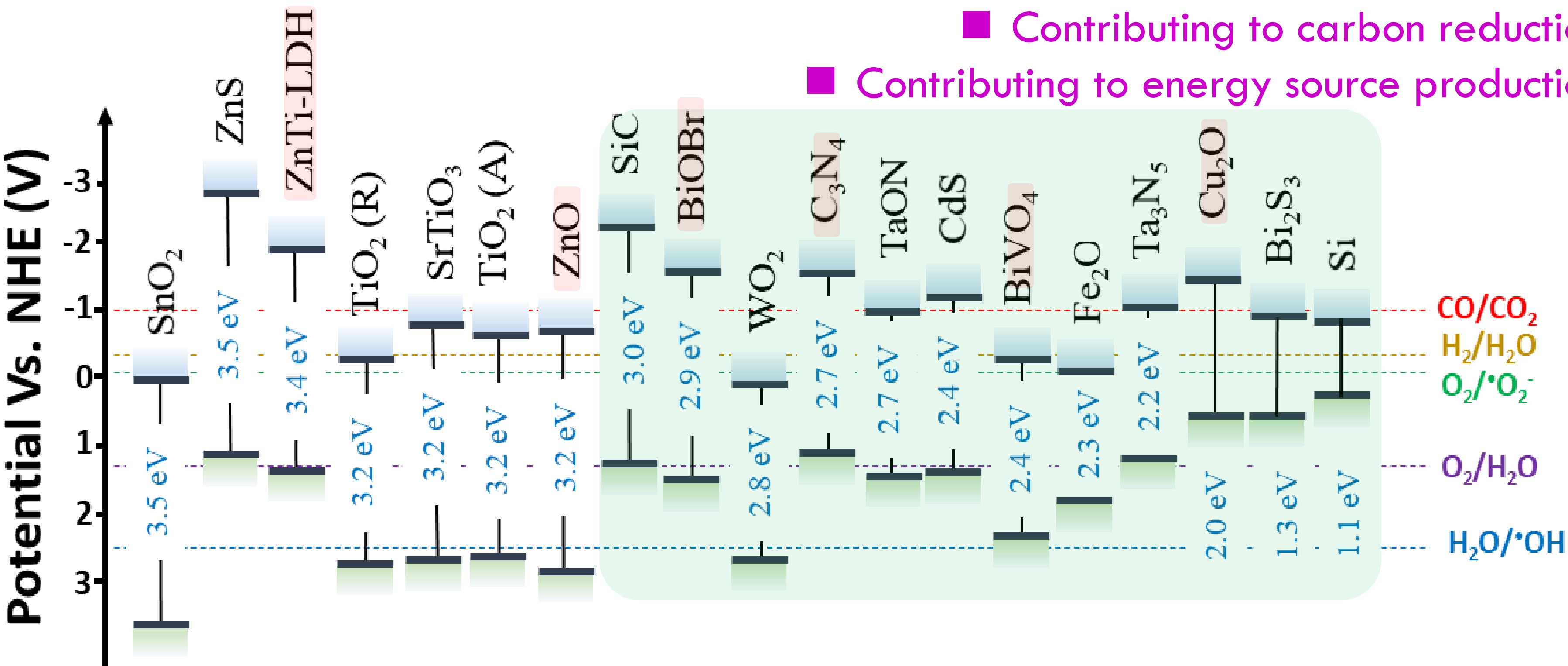
- **photocatalyst** is a material which absorbs light to bring it to higher energy level and provides such energy to a reacting substance to make a chemical reaction occur.

*Fujishima and Honda, Nature, **1972**, 238, 37-38.*



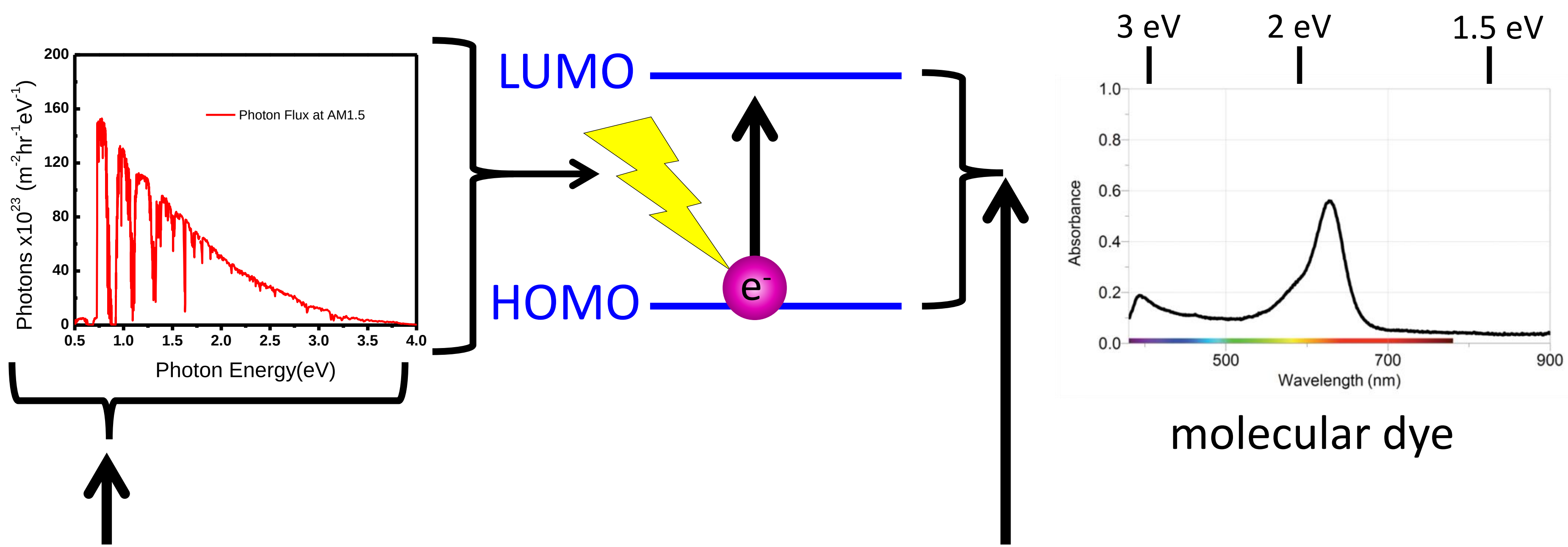
i) light absorption (optical)
ii) charge separation and transport (physicochemical)
iii) surface chemical reaction (physical)

- Visible light driven
- Highly available
- Recyclability
- Contributing to carbon reduction
- Contributing to energy source production



Molecular Photocatalysts

- Molecular photocatalysts have distinct energy levels.

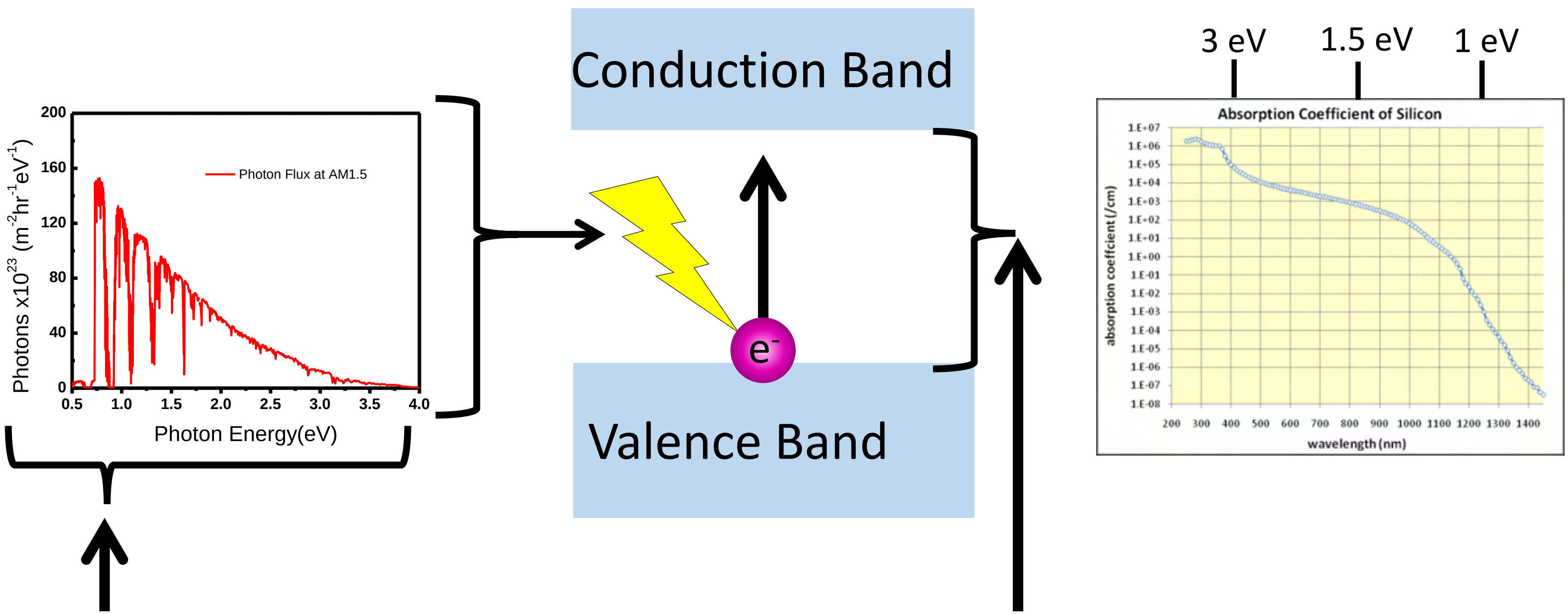


This photon energy needs to match this energy gap.

- Molecular photocatalyst only absorb efficiently at one wavelength.

Semiconductor Photocatalysts

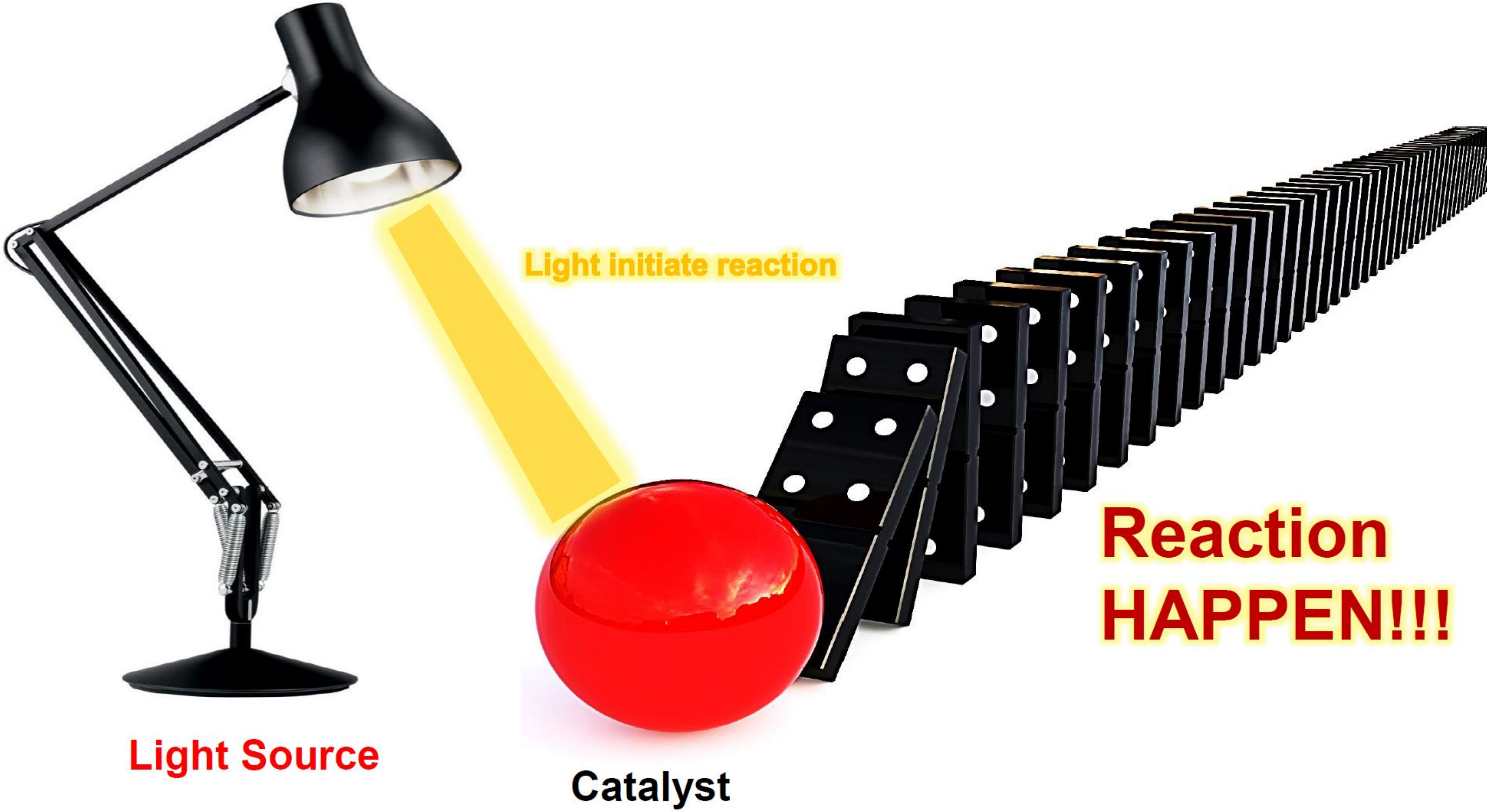
- Semiconductors have bands rather than distinct levels.



This photon energy needs to roughly this energy gap.

- Semiconductors can absorb a much broader range of light.

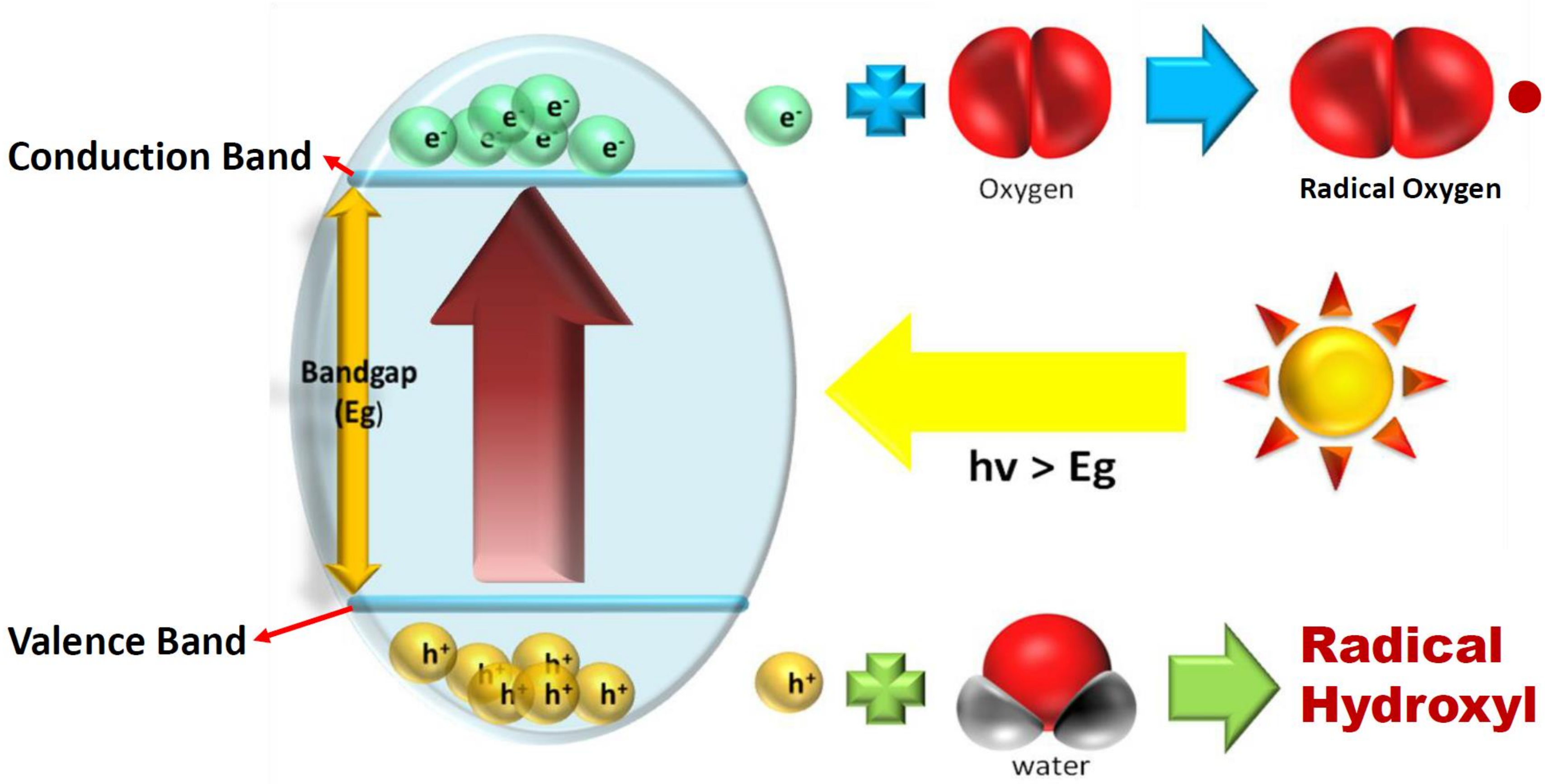
Principle of photocatalytic reaction



How photocatalyst works?

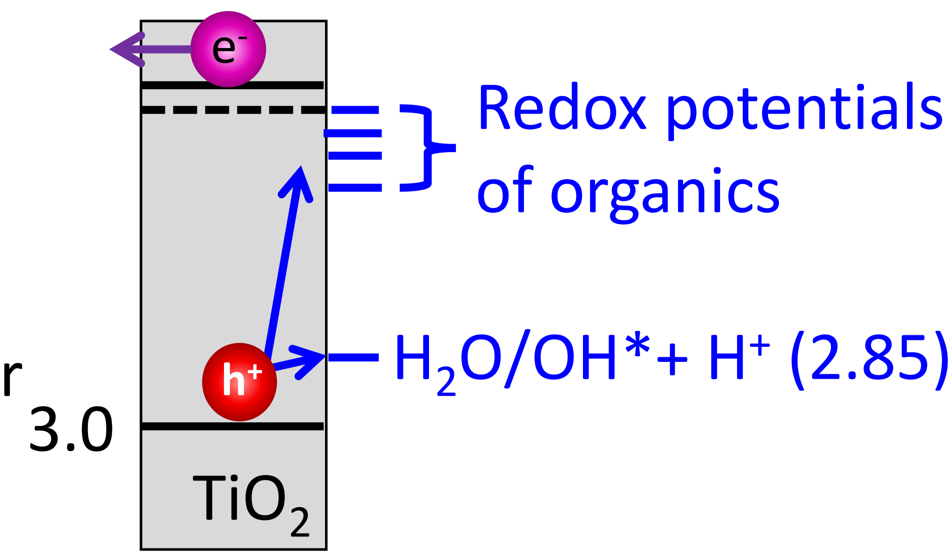
PHOTOCATALYST reaction make radical hydroxyl (OH^-) and radical O_2 with very strong Oxidation POWER

Mechanism of radical production



Pollutant Removal

- Often there is organic pollutants that need to be removed for drinking or sanitation purposes.
- Most of these are very easy to oxidize with n-type semiconductors.
- Oxides are especially nice because they can produce OH radicals from water.
- OH radicals are highly oxidative and can migrate into solution.
- Thus either the photo-hole or the radical can oxidize the pollutant.

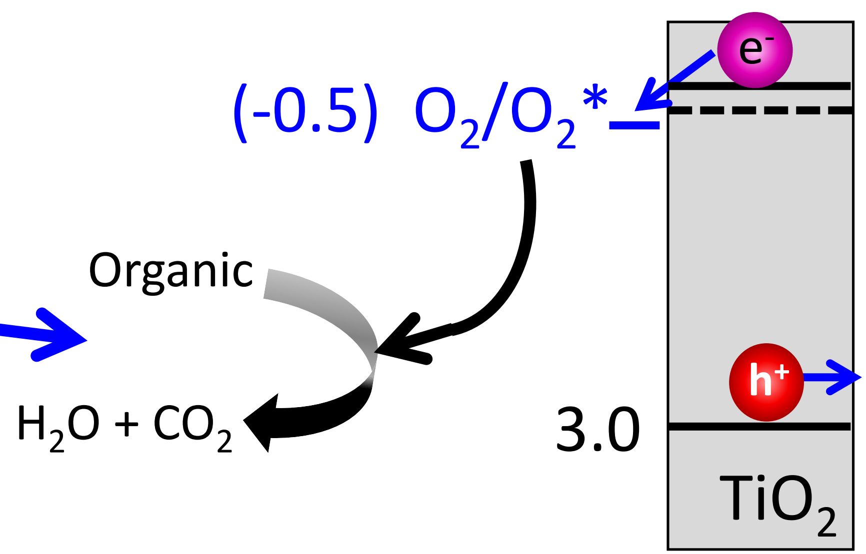


All potentials are vs. NHE

Pollutant Removal

- While the hole oxidizes, *what does the electron do*?
- If there is oxygen in the system, which there always is, the electron can reduce the oxygen to form a superoxide (or oxygen radical.)
- Oxides are especially nice because they can produce OH radicals from water.

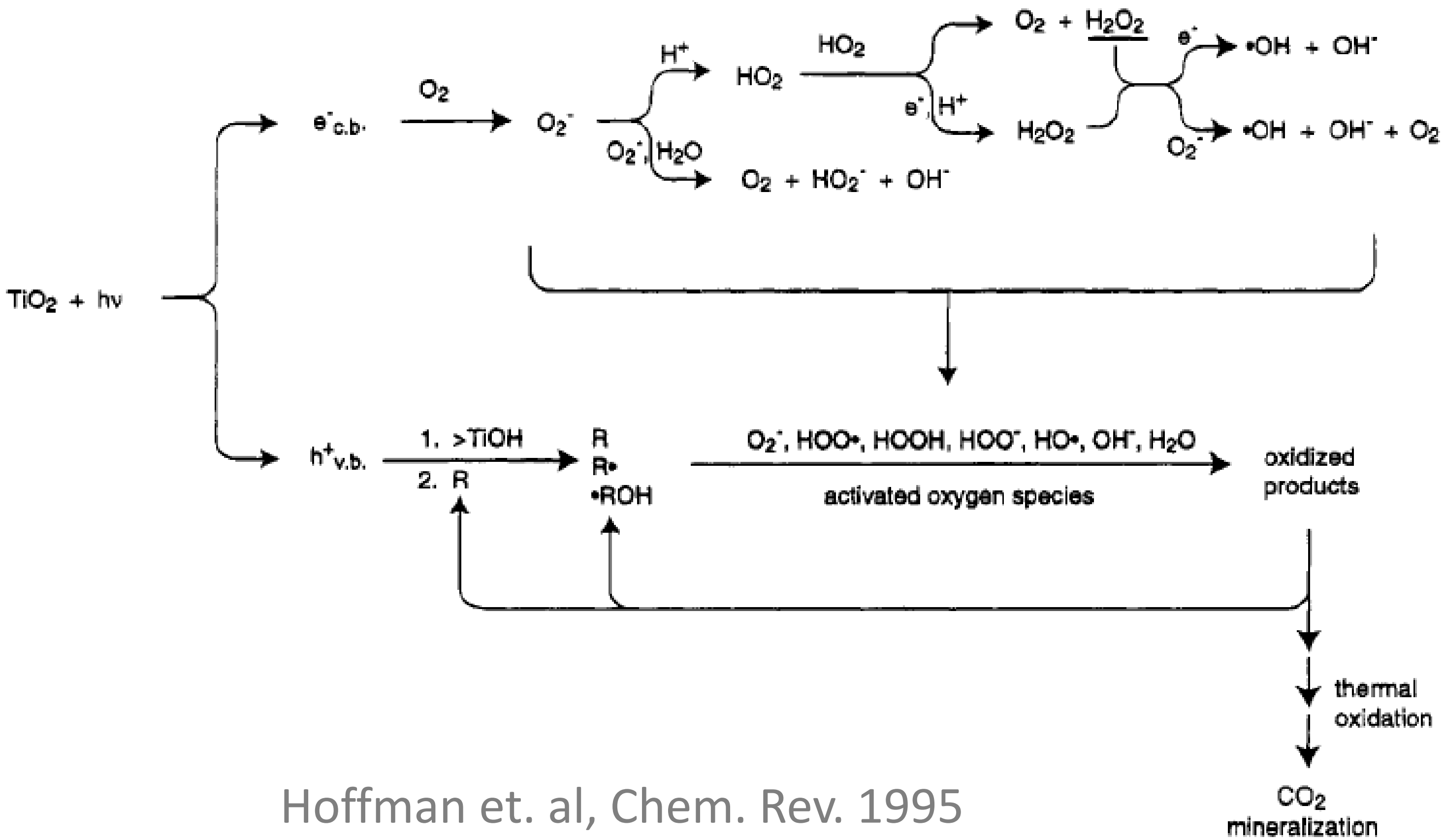
How does this reaction happen



All potentials are vs. NHE

Pollutant Removal

- Here is a more detailed mechanism for electron and hole degradation reactions for TiO_2
- Radicals react very fast, thus it is hard to analyze mechanisms.



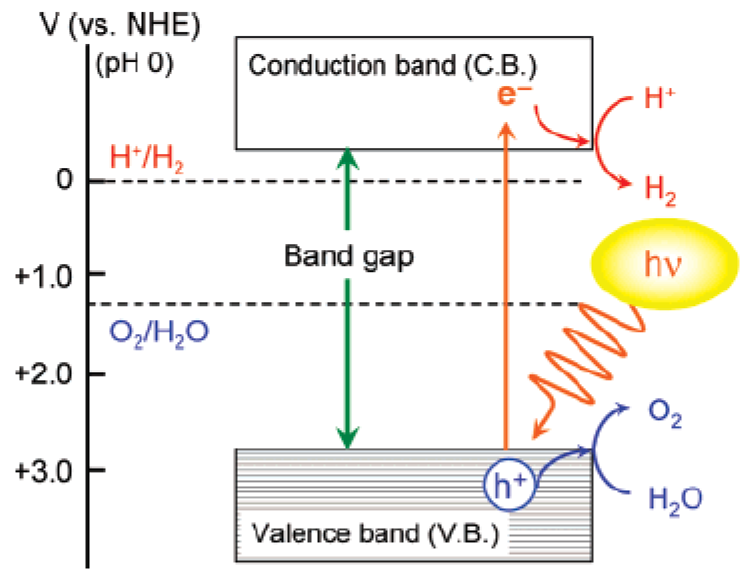
Hoffman et. al, Chem. Rev. 1995

Photocatalyst material requirements

- **Band gap**: Band gap>1.23eV and sufficiently small to make efficient use of solar spectrum (~<3eV). Band levels suitable for water splitting.

- **High Crystallinity**: Defects can act as recombination sites.

- **Long term stability**: Charge transfer used for reaction and not corrosion.

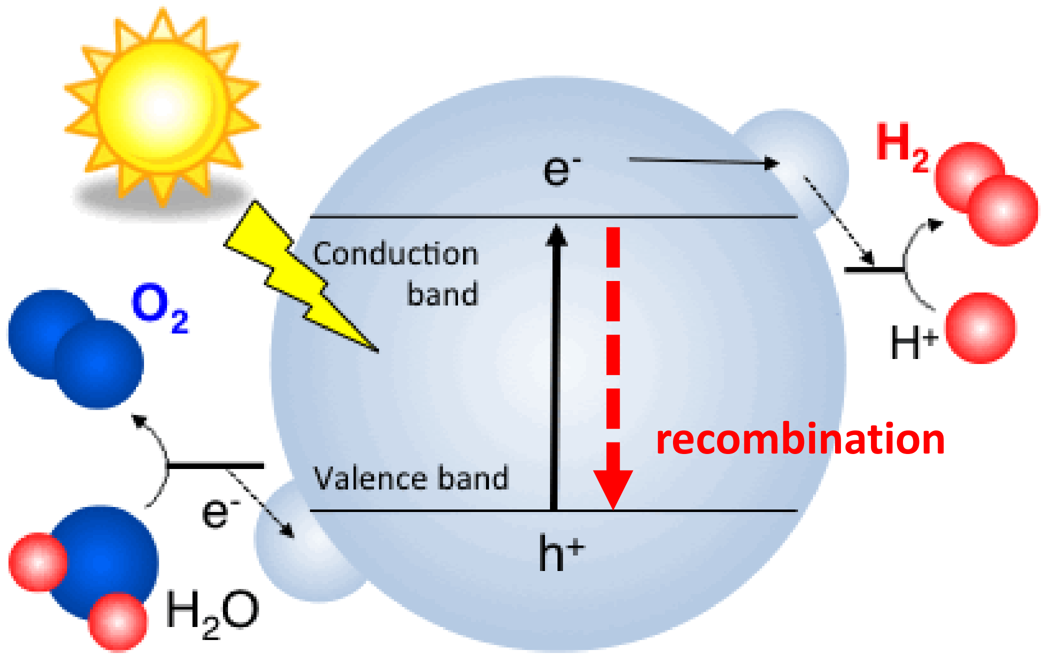


Domen et al. New Non-Oxide Photocatalysts Designed for Overall Water Splitting under Visible Light. *J. Phys. Chem. 2007*

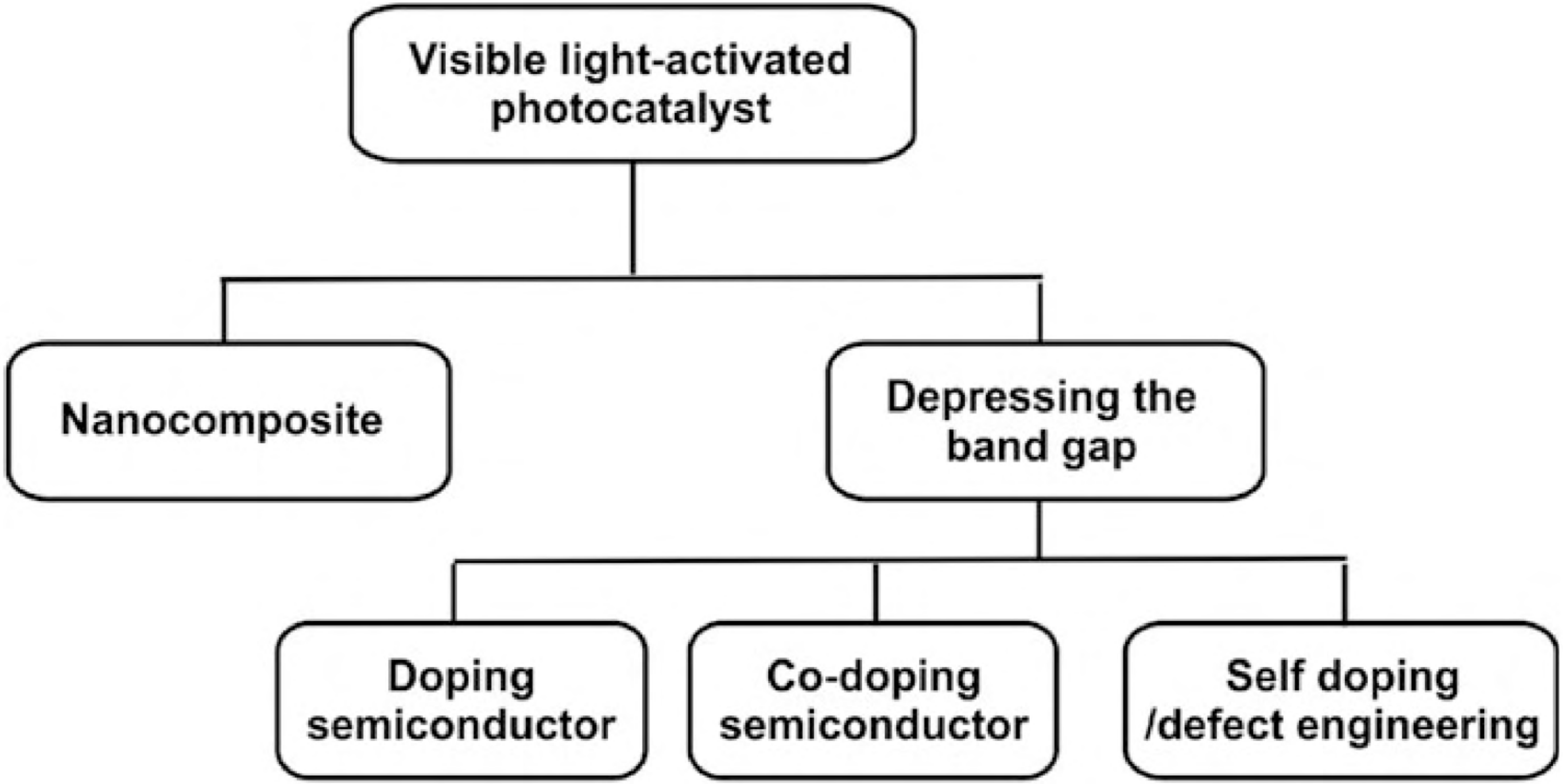
Breaking photocatalysis down to the fundamentals

- A photon forces an electron to a higher energy level.

- The electron needs to get to the surface and react before it falls back down into it's initial/lower energy level.

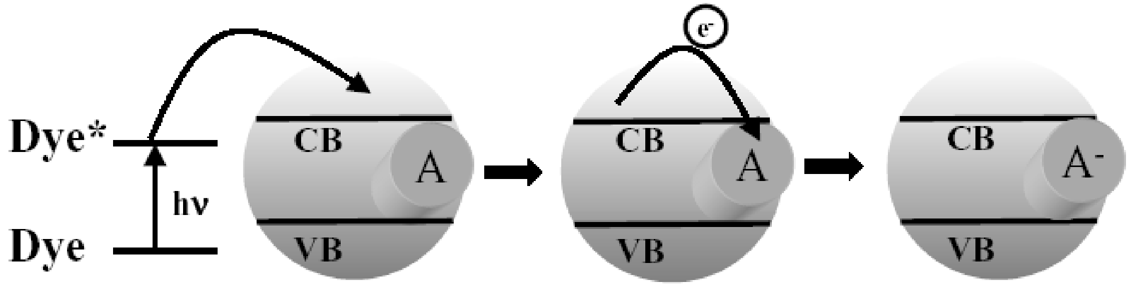


Why Materials Such as Nanoparticles, Nanocomposites, Etc. Need to Be Developed for the Visible Light-Induced Photocatalysis?

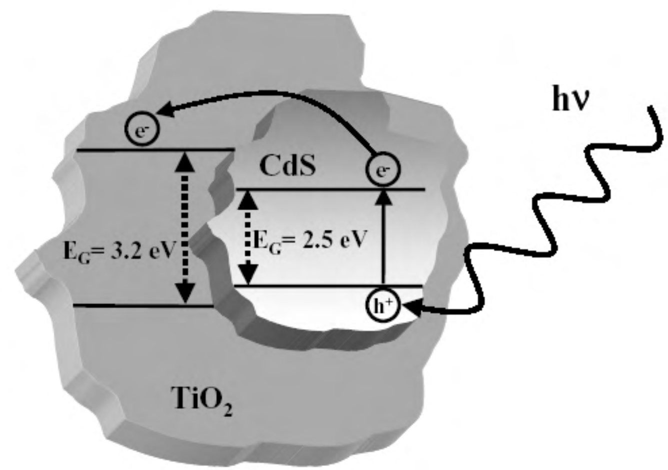


Energy band engineering

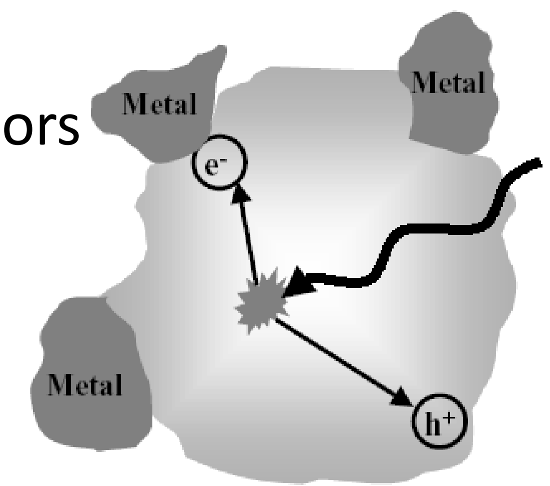
- Doping N, S, C, metals → strategies to raise the VB maximum
- Dye surface sensitizatior



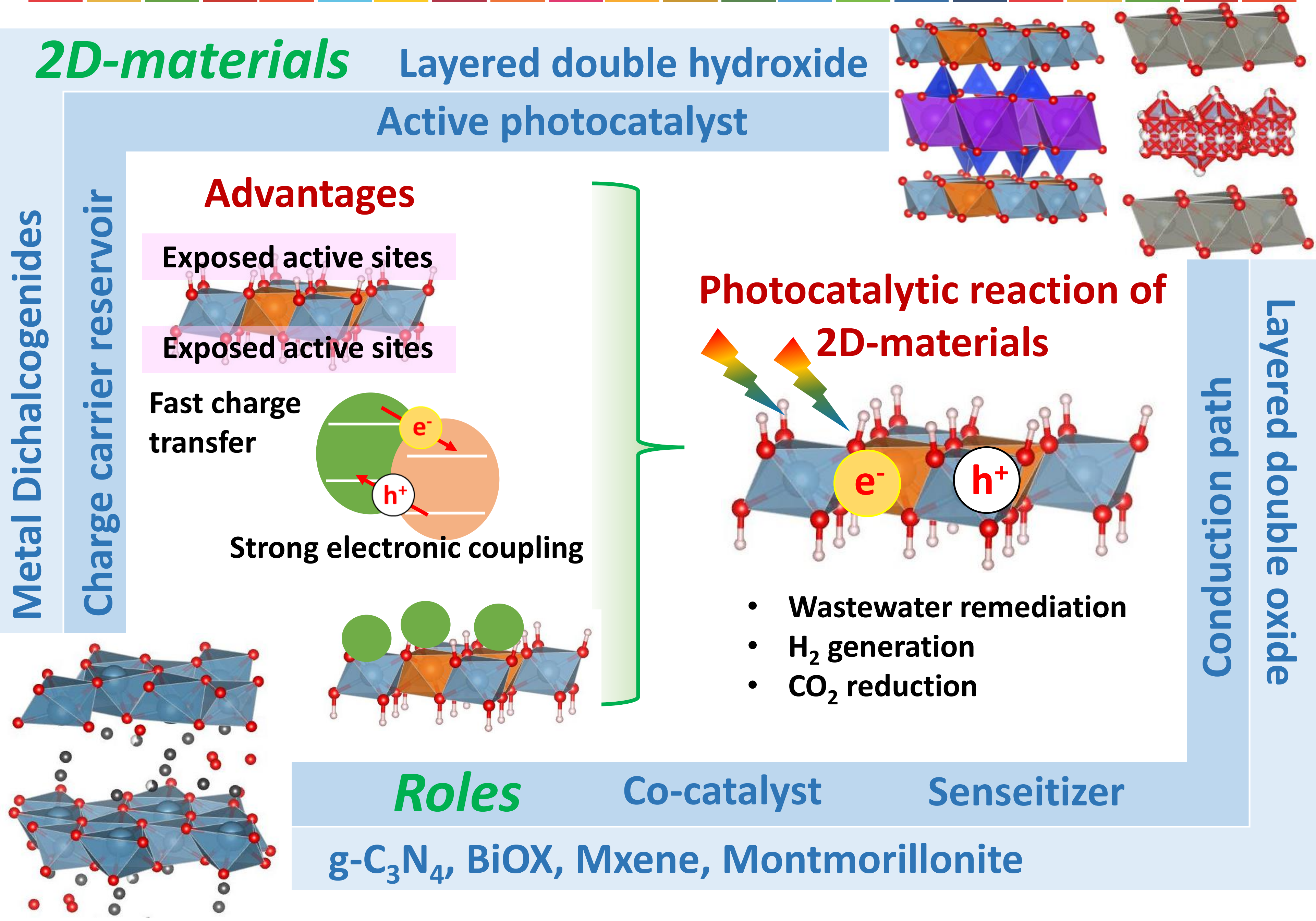
- Surface modification to increase stability



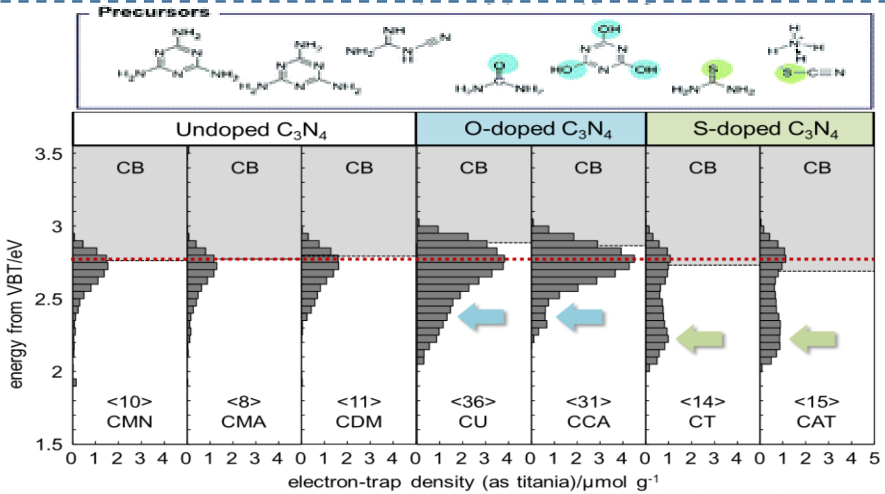
- Coupled semiconductors
- Novel semiconductor containing 3d metals.

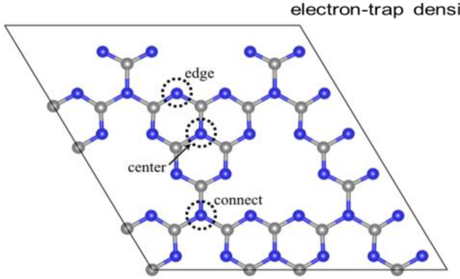


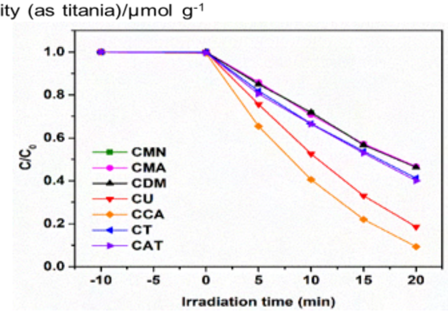
Miao Zhang et al, Angew. Chem. Int. Ed. 2008, 47, 9730 –9733


2D-materials
Layered double hydroxide
Active photocatalyst
Metal Dichalcogenides
Charge carrier reservoir
Advantages
Exposed active sites
Exposed active sites
Fast charge transfer
e$^-$
h$^+$
Strong electronic coupling
Photocatalytic reaction of 2D-materials
e$^-$
h$^+$
• Wastewater remediation
• H_2 generation
• CO_2 reduction
Conduction path
Layered double oxide
Roles
Co-catalyst
Senseitizer
g-C_3N_4, BiOX, Mxene, Montmorillonite

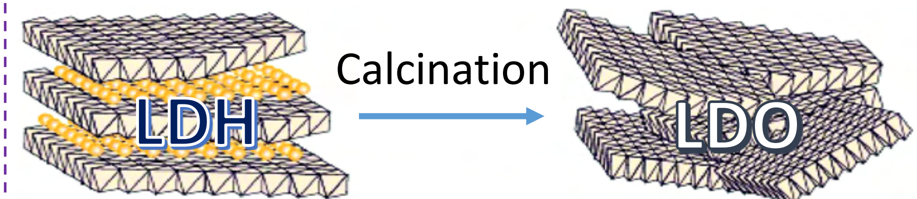
2D-photocatalysts

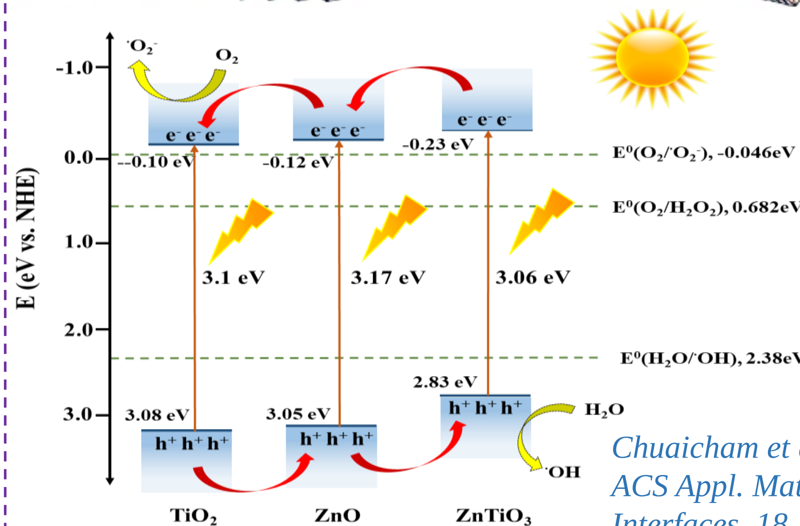






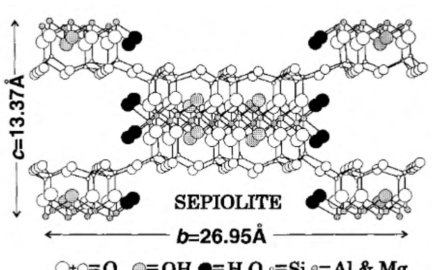
Chuaicham et al. 2020, Chem Commun, 56, 3793.

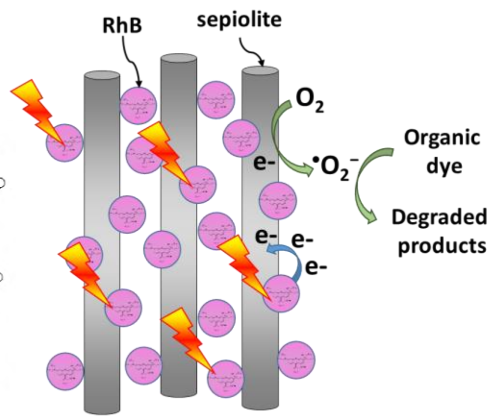




Chuaicham et al. 2020, ACS Appl. Mater. Interfaces, 18, 8, 9169.

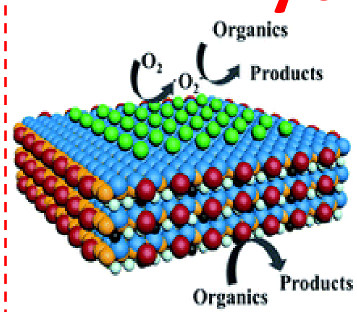
Chuaicham et al. 2019, Catalyst, 9(3), 235.

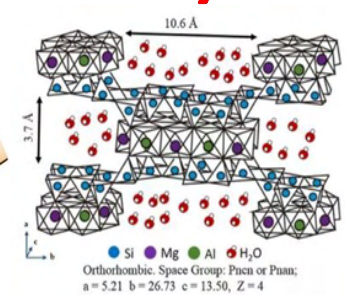




Sepiolite covered with cationic organic dyes
(Dye-sensitized photocatalyst)

2D-hybrid photocatalysts

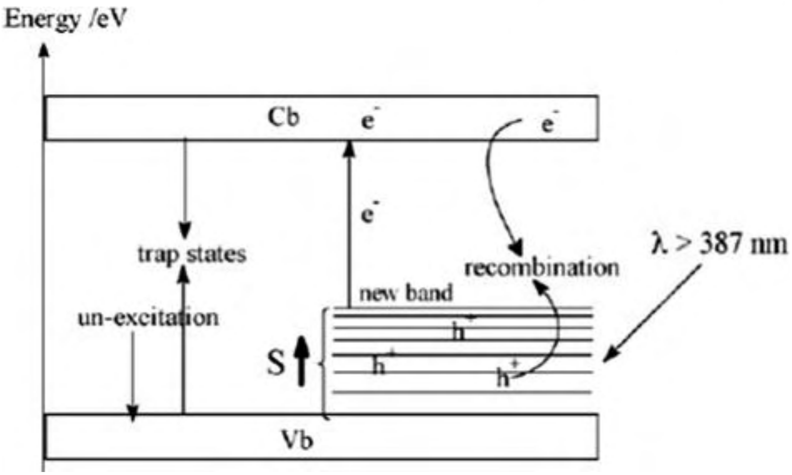




2D-Photocatalysts

Clay minerals

Heteroatom doping

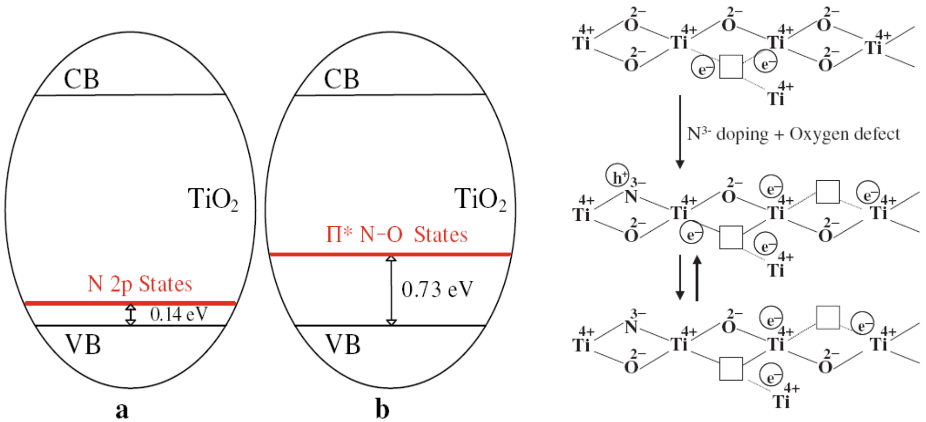


Mechanism of photocatalytic activity of TiO_2 doped with S

S.X. Liu, X.Y. Chen, J. Hazard. Mater. 152, 48–55 (2008)

Successful example of band-edge control for the utilization of visible light → mechanism under debate.

- Hybridization of the N-related states with the host VB;
- N-doping in TiO_2 is accompanied by formatin of Ti^{3+} via donor-type deffects



K. HASHIMOTO et al. Jpn. J. Appl. Phys., Vol. 44, No. 12 (2005)

- Doping with N, C, S narrows the bandgap by less than 0.3 V.
- Significant extension of visible light absorption via anion doping **remains a big challenge**.

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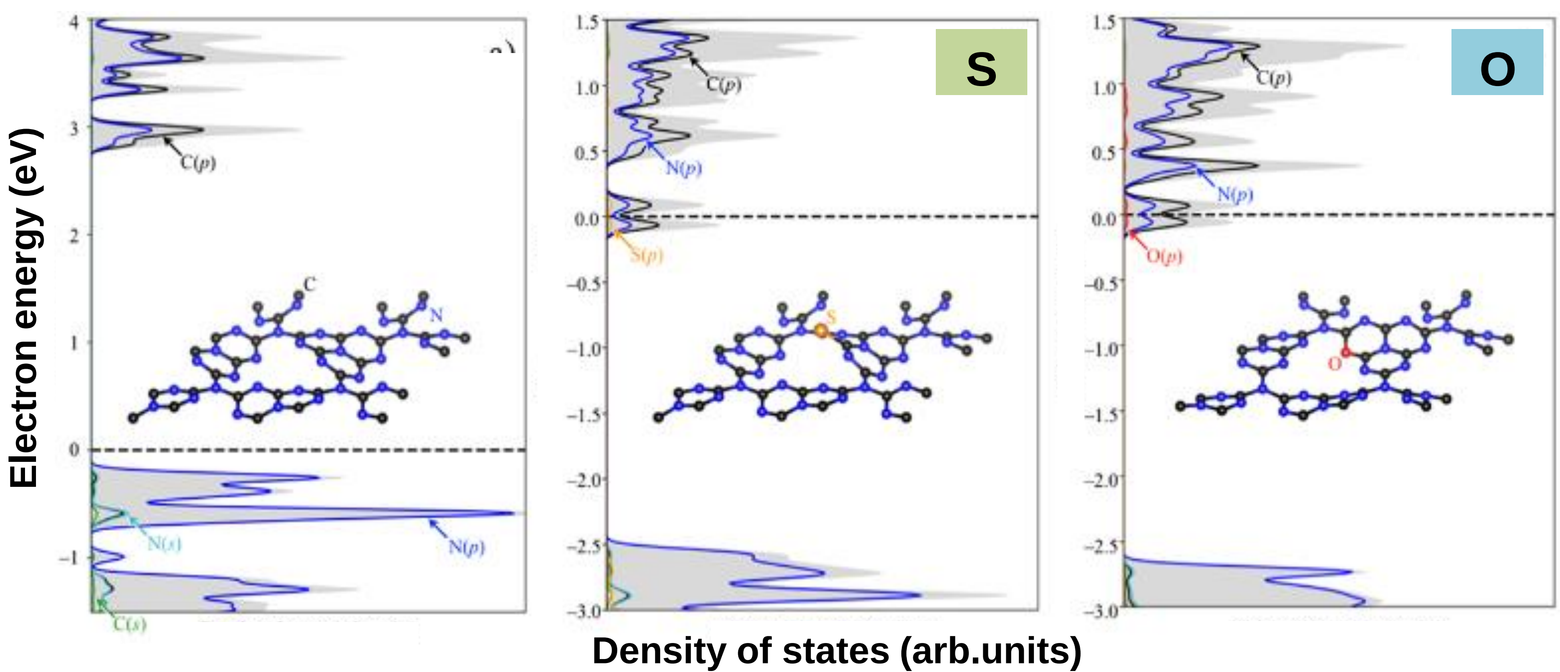
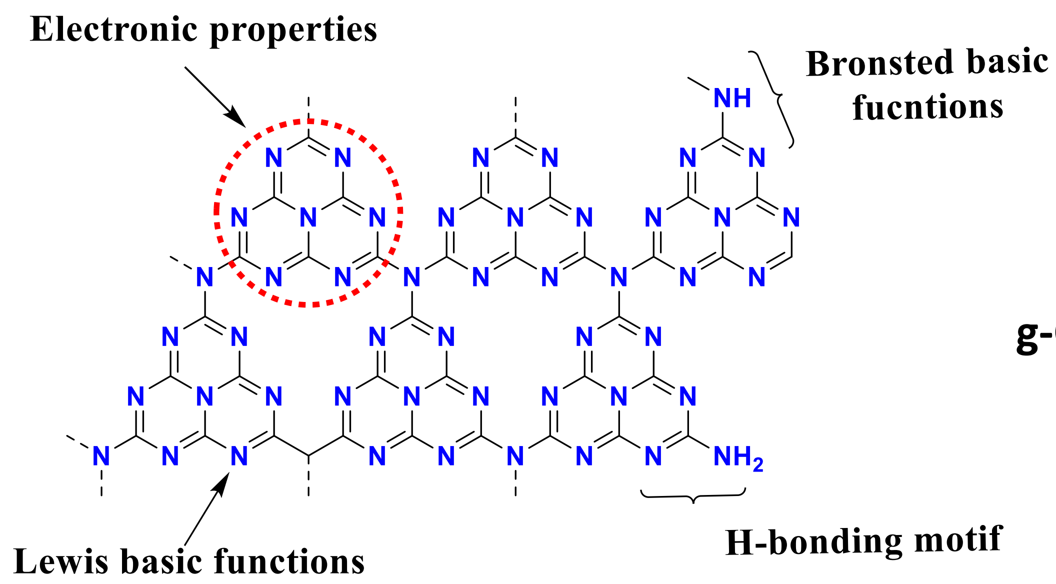
Energy-resolved distribution of electron traps for O/S-doped carbon nitrides by reversed double-beam photoacoustic spectroscopy and the photocatalytic reduction of Cr(VI)†

Chitiphon Chuaicham,[a] Sekar Karthikeyan,[a] Radheshyam R. Pawar,[a] Yihuang Xiong,[b] Ismaila Dabo,[b] Bunsho Ohtani,[c] Yoonyoung Kim,[de] Jun Tae Song,[de] Tatsumi Ishihara[de] and Keiko Sasaki*[ac]





$g\text{-}C_3N_4$

Advantages

1. Strong reduction ability
2. Active in visible light
3. Abundance
4. Easy fabrication
5. 2D layered structures
6. Non-toxicity
7. High stability

Challenges

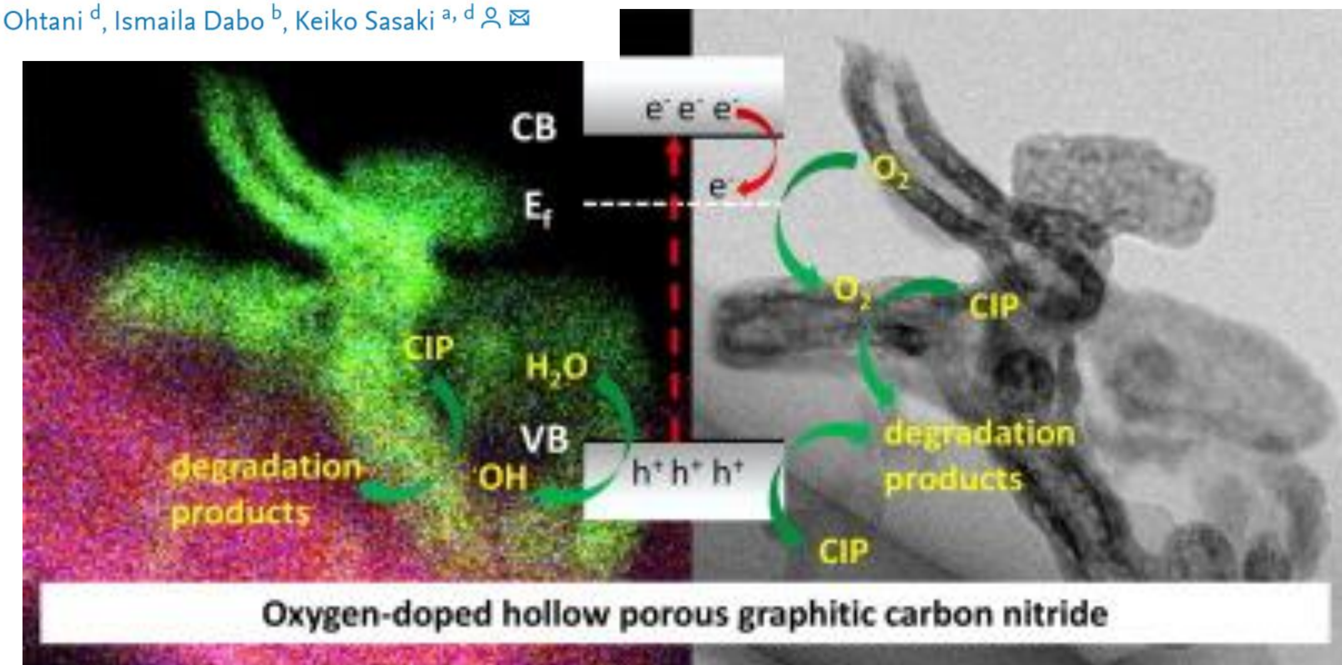
1. Small surface areas/ active sites
2. High surface inertness
3. Insufficient visible absorption
4. Slow reaction kinetics
5. Fast charge recombination
6. Moderate oxidation ability
7. Low charge carrier mobility

J. Wen et al., Applied Surface Science 2017, 391, 72–123

Chemical Engineering Journal
Available online 27 May 2021, 130502
In Press, Journal Pre-proof

Single-step synthesis of oxygen-doped hollow porous graphitic carbon nitride for photocatalytic ciprofloxacin decomposition

Chitiphon Chuaicham [a], Karthikeyan Sekar [a], Yihuang Xiong [b], Vellaichamy Balakumar [a], Yanisa Mittraphab [c], Kuniyoshi Shimizu [c], Bunsho Ohtani [d], Ismaila Dabo [b], Keiko Sasaki [a, d]



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Full Length Article

A promising Zn-Ti layered double hydroxide/Fe-bearing montmorillonite composite as an efficient photocatalyst for Cr(VI) reduction: Insight into the role of Fe impurity in montmorillonite

Chitiphon Chuaicham [a,*], Yihuang Xiong [b], Karthikeyan Sekar [a], Weinan Chen [b], Li Zhang [a], Bunsho Ohtani [c], Ismaila Dabo [b], Keiko Sasaki [a,c,*]

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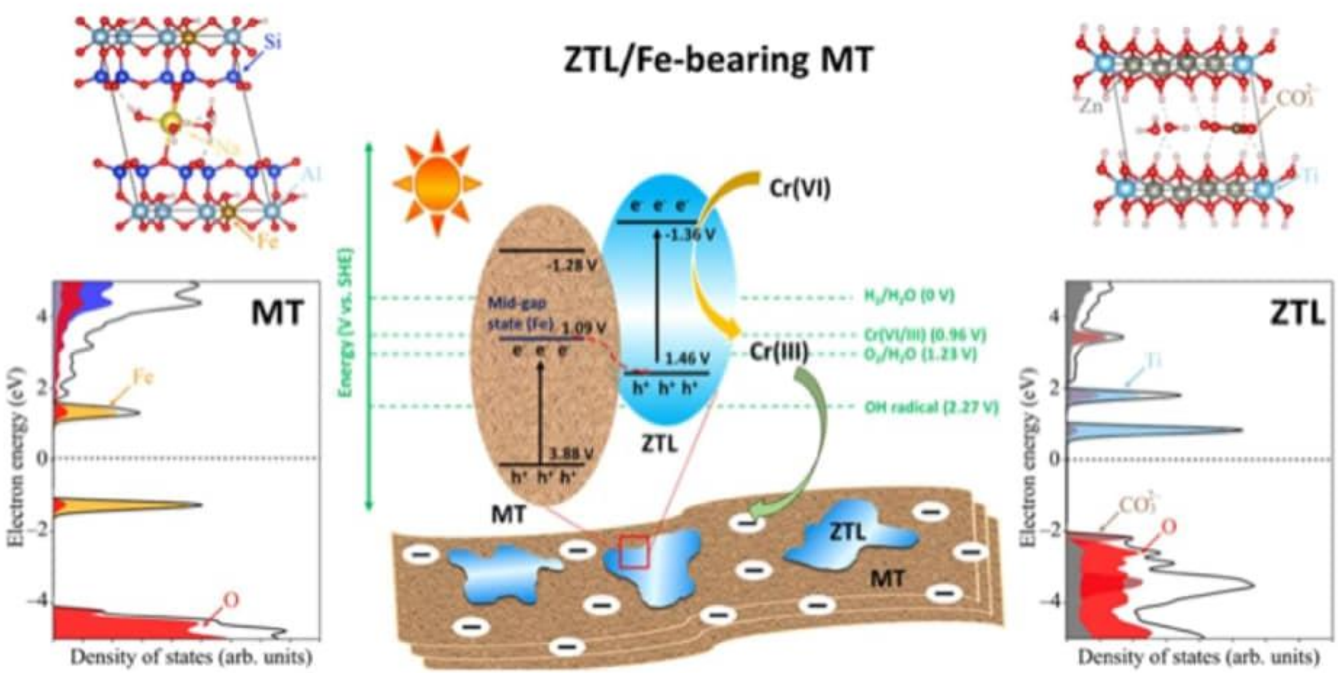
[b] Department of Materials Science and Engineering, The Pennsylvania State University, University Park, PA 16802, United States
[c] Institute for Catalysis, Hokkaido University, Sapporo 001-0021, Japan



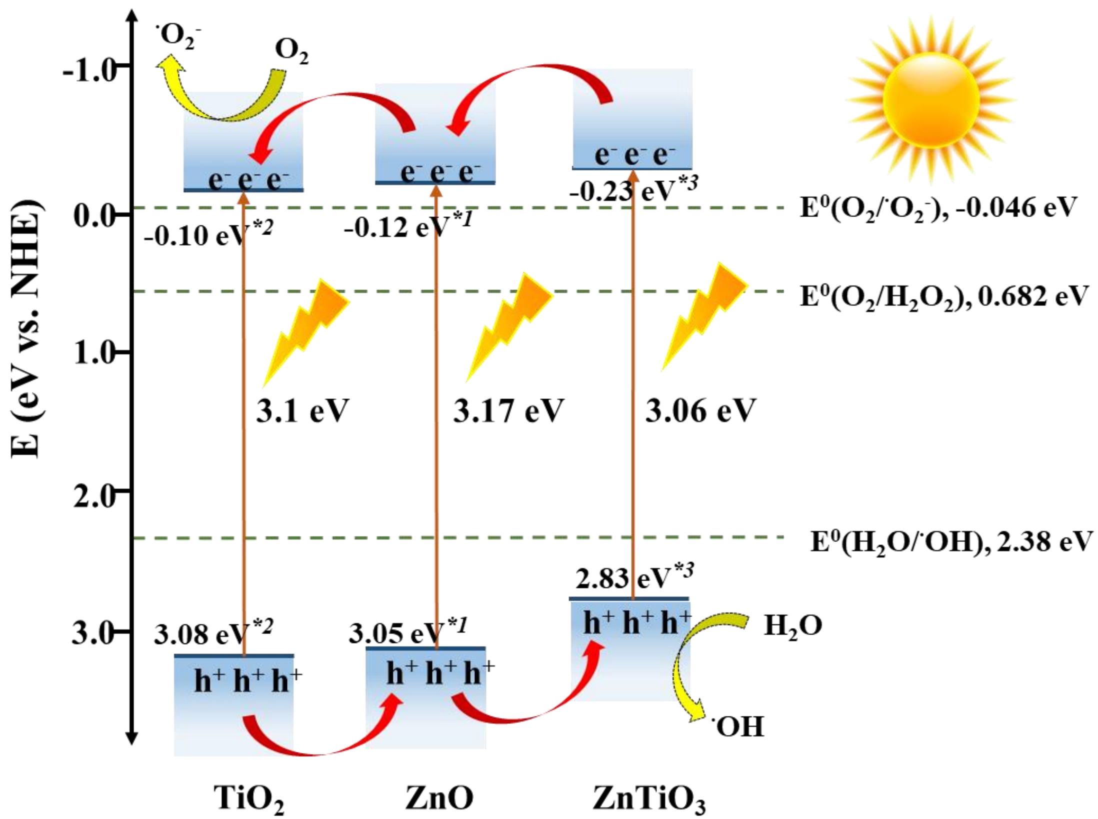
ACS APPLIED MATERIALS & INTERFACES

www.acsami.org Research Article

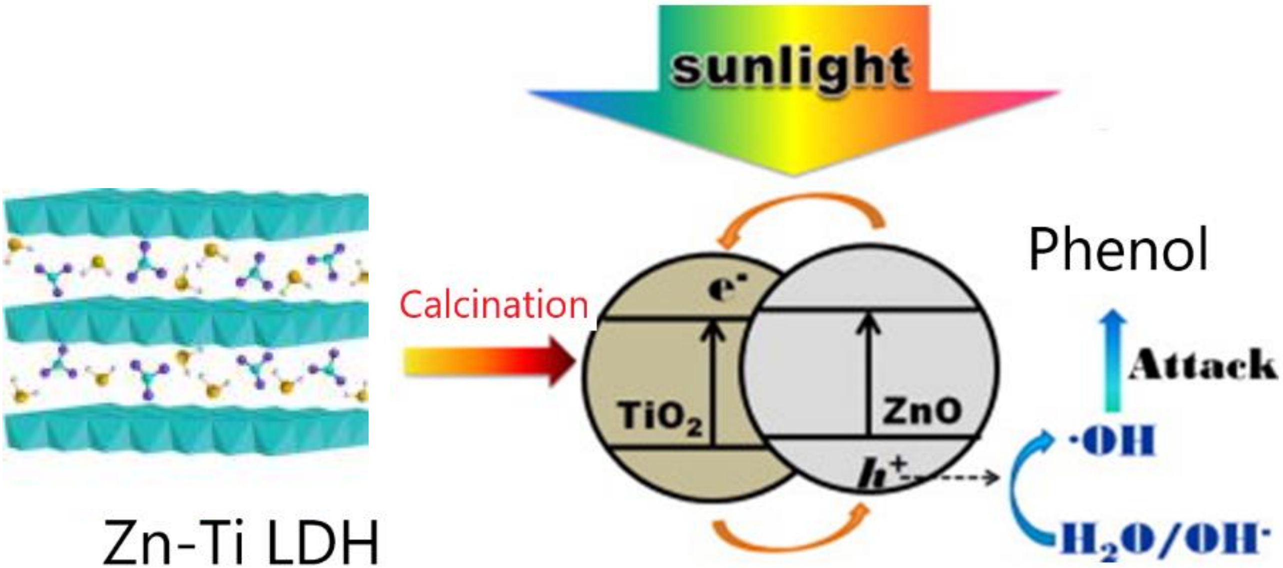
Importance of $ZnTiO_3$ Phase in ZnTi-Mixed Metal Oxide Photocatalysts Derived from Layered Double Hydroxide

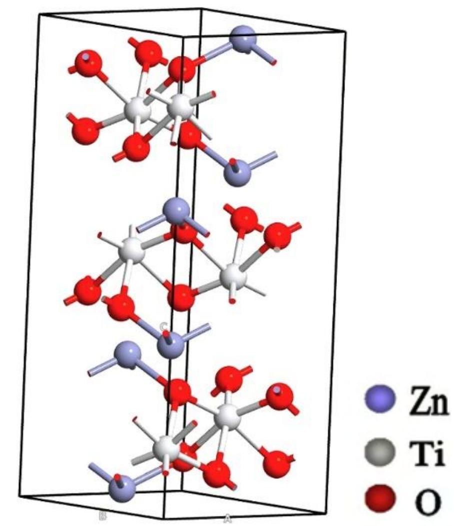
Chitiphon Chuaicham, Sekar Karthikeyan, Jun Tae Song, Tatsumi Ishihara, Bunsho Ohtani, and Keiko Sasaki*

Cite This: https://dx.doi.org/10.1021/acsami.9b18785 Read Online



Mixed metal oxide (MMO) derived from LDH





Topotactic transformation from LDHs to MMO

$ZnTiO_3$

- High dispersion of immobilized semiconductor nanoparticles
- High specific surface area
- Possible synergistic effects between the components of MMO

- Reducing recombination process and change band gap to enhance the optical response in the UV to visible light range.

Niasari et al., 2016

$ZnTiO_3$ might be grafted on MMO.

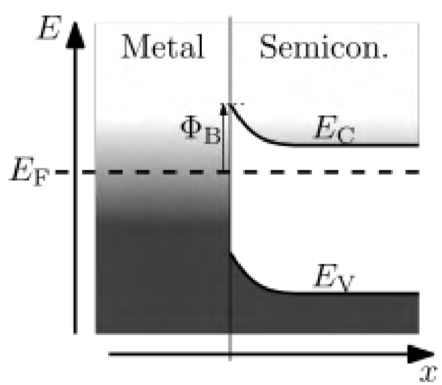
Objectives

To study the surface structure and properties of ZnTi-mixed metal oxide (ZTM) derived from ZnTi-layered double hydroxide.

Metal NPs enhances photocatalytic activities

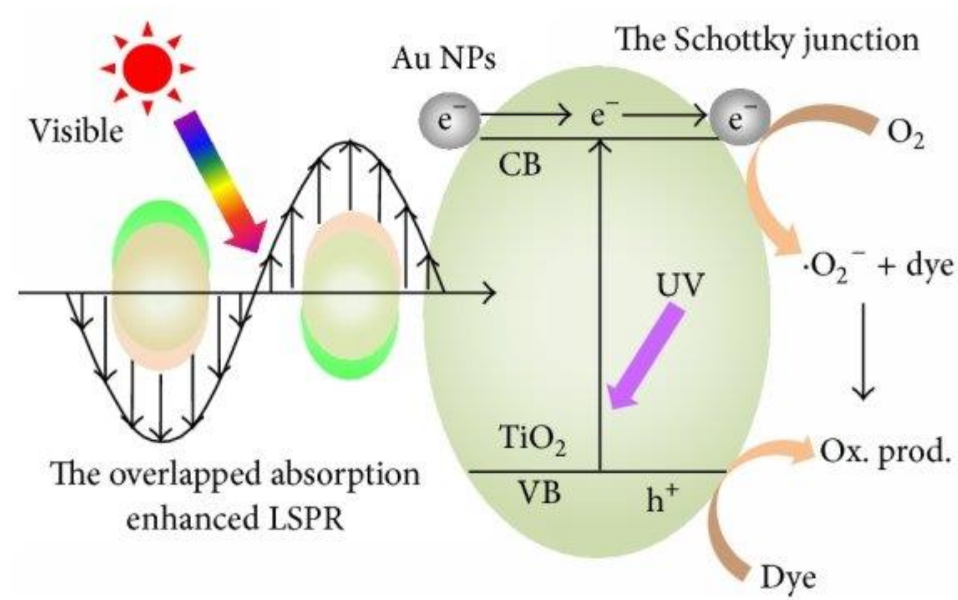
Schottky barrier

Band diagram for *n*-type semi-conductor Schottky barrier at zero bias (equilibrium) with graphical definition of the **Schottky barrier height**, Φ_B, as the difference between the interfacial conduction band edge E_C and Fermi level E_F to improve charge separation.



Co-catalyst

Itself is not a catalyst, but works together with catalysts to improve the light absorption through the surface plasmon resonance for improvement in photocatalytic efficiency.



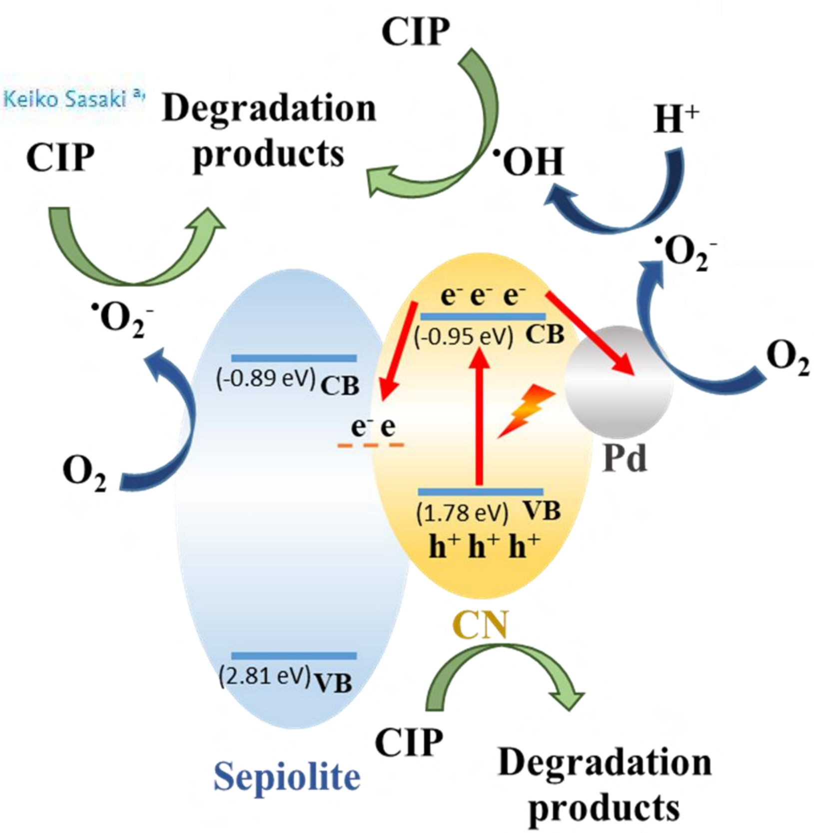
Localized Surface Plasmon Resonance

Localized Surface Plasmon Resonance (LSPR) is a charge density oscillation confined to metallic nanoparticles (so-called plasmonic nanostructures) under resonance with specific wavelengths of the incident electromagnetic field and which results in the enhancement of local and far electromagnetic fields.

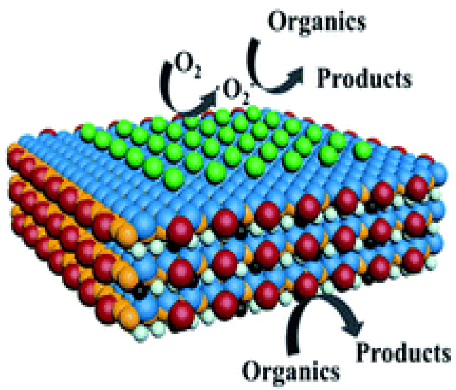
ELSEVIER
Journal of Colloid and Interface Science
Available online 26 May 2020
In Press, Journal Pre-proof

Fabrication and characterization of ternary sepiolite/g-C_3N_4/Pd composites for improvement of photocatalytic degradation of ciprofloxacin under visible light irradiation

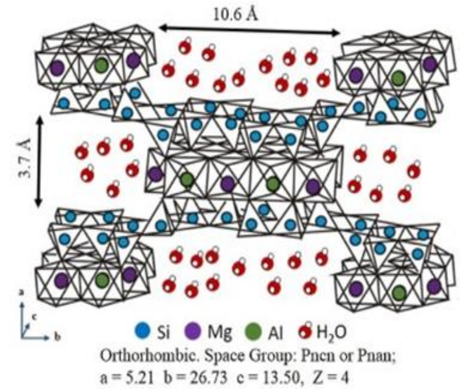
Chitiphon Chuaicham [a], Radheshyam Rama Pawar [a], Sekar Karthikeyan [a], Bunsho Ohtani [b], Keiko Sasaki [a, b]



2D-hybrid photocatalysts



2D-Photocatalysts

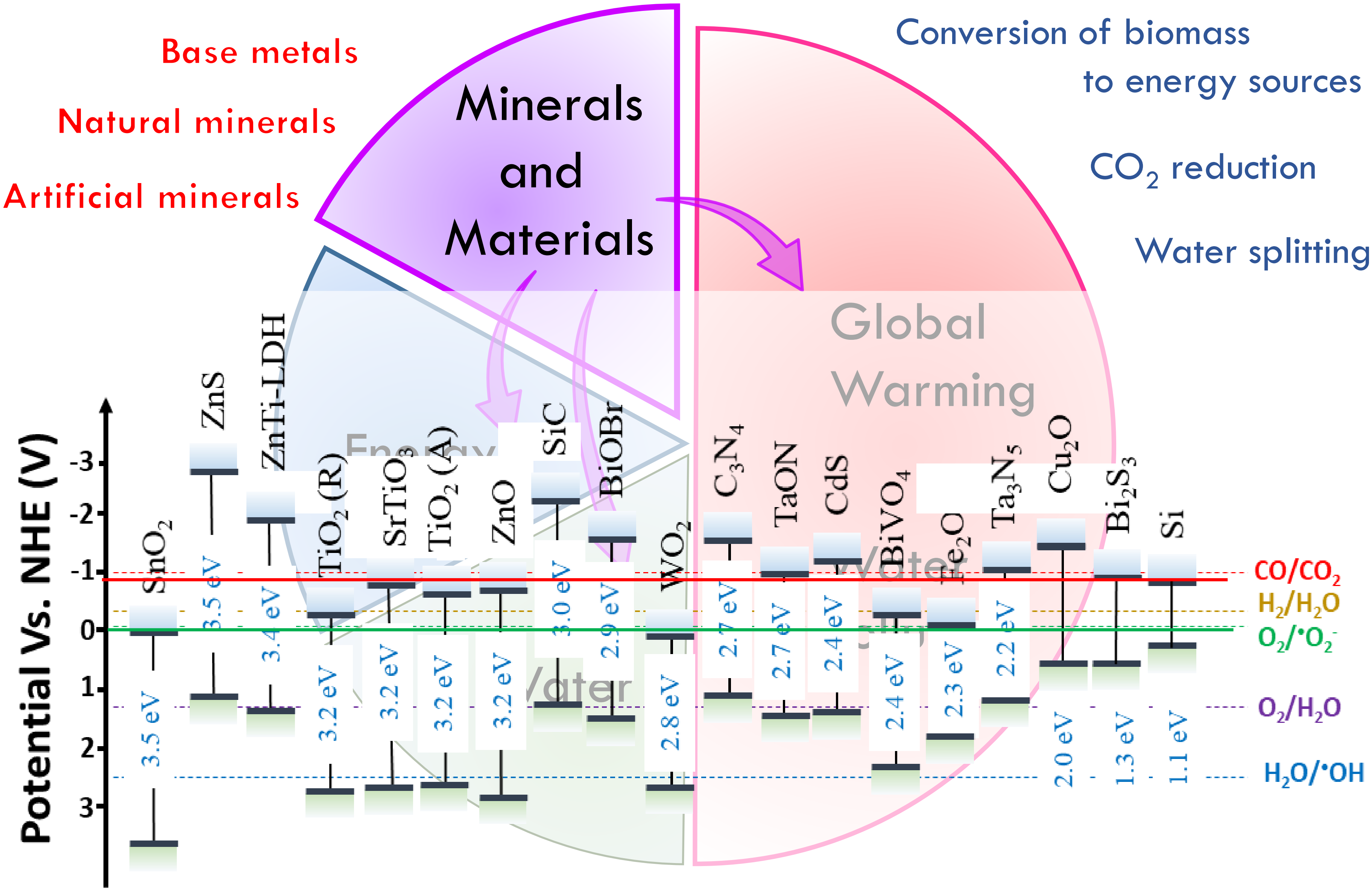


Clay minerals

- Main visible light-active **photocatalyst.**
- Generation of **electron-hole pairs**, leading to production of **active-species** for decomposition of organic pollutants.

- Avoid the **recombination** of photogenerated charge carriers.
- Provide the **growing site** for the main photocatalyst.

Solar light driven chemical conversion



Thank you for your attention.

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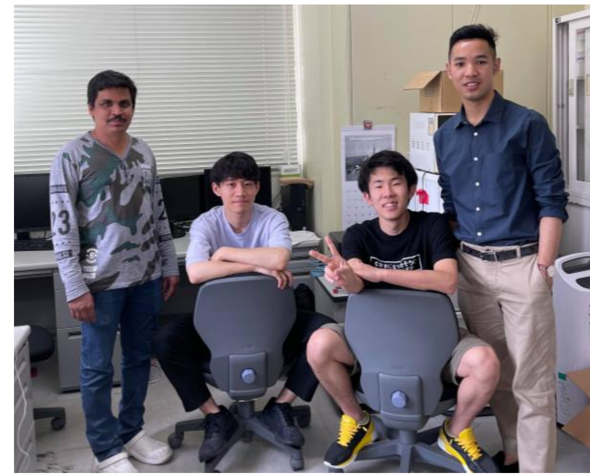
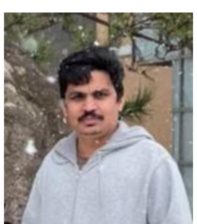
Kyushu Univ



Collaborators



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Karthik Sekar
Kyushu Univ (PDF)

Ismaila Dabo
Penn State

Bunsho Ohtani
Hokkaido Univ