

# RENEWABLE ENERGY

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# Outline

- ▶ Overview of renewable energy
- ▶ Biogas
- ▶ Photovoltaic system

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- ▶ Biogas
- ▶ Photovoltaic system

# Overview of renewable energy

## ► What is renewable energy

Renewable energy is energy which can be obtained from natural resources that can be constantly replenished.

# Overview of renewable energy

- ▶ When can energy be called 'Renewable'?
  - When its' source cannot run out (like the sun) or can easily be replaced (like wood, as we can plant trees to use for energy)
  - When their sources are carbon neutral. This means they do not produce Carbon compounds (such as other greenhouse gases).
  - When they do not pollute the environment (air, land or water)

# Overview of renewable energy

## ► Type of renewable energy



bioenergy



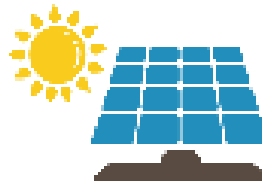
geothermal energy



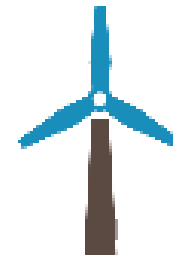
hydropower



ocean energy



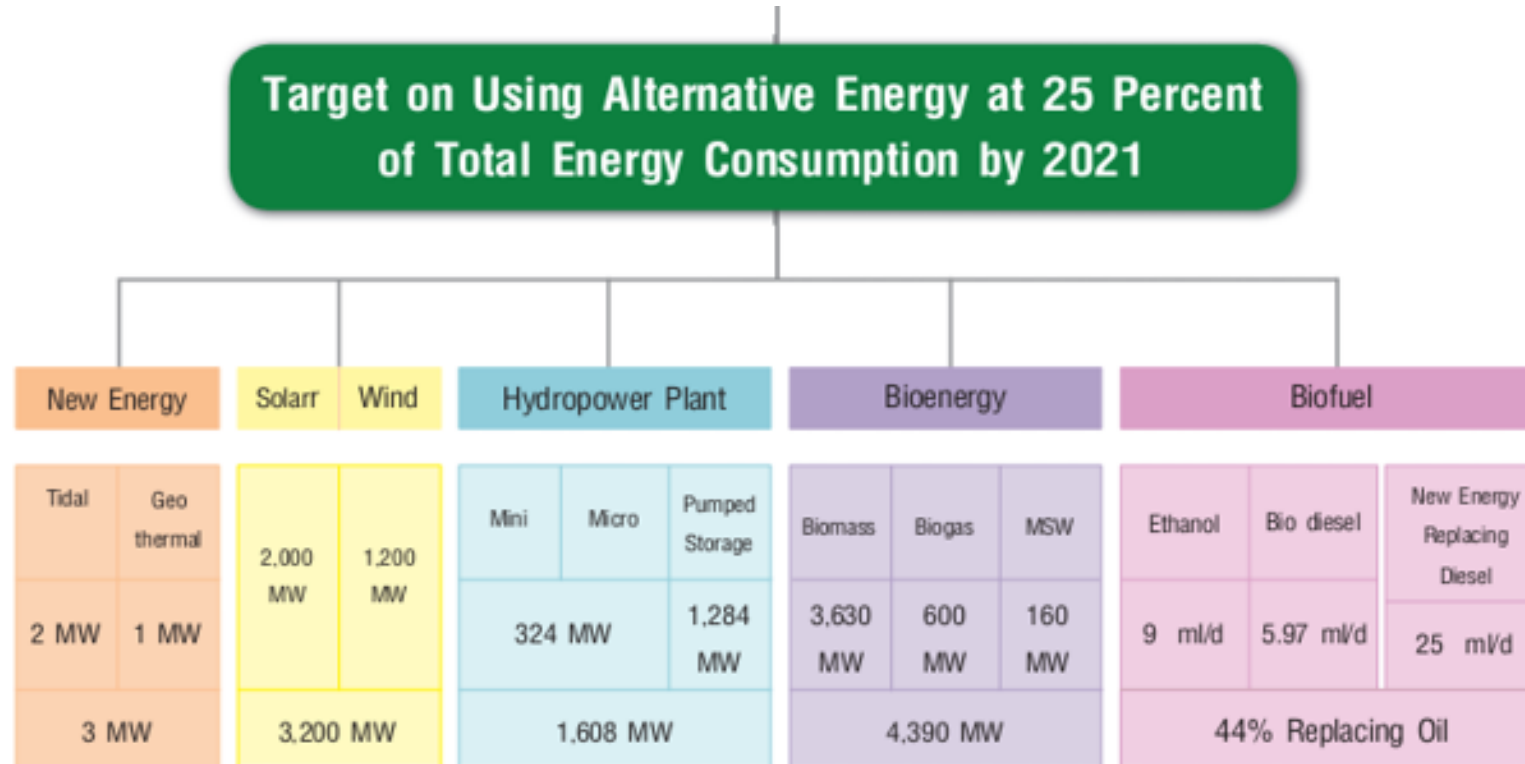
solar energy



wind energy

# Overview of renewable energy

## ► Thailand policy



# Outline

- ▶ Overview of renewable energy
- ▶ **Biogas**
- ▶ Photovoltaic system



# Biogas

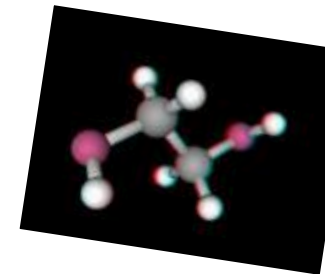
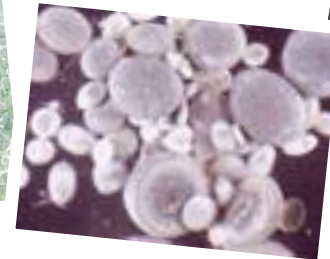
## ► What is biogas

The term 'biogas' is commonly used to refer to a gas which has been produced by the biological breakdown of organic matter in the absence of oxygen. The gases methane, hydrogen and carbon monoxide can be combusted or oxidized with oxygen and the resultant energy release allows biogas to be used as a fuel.

# Biogas

## ► Wastewater treatment technology

- Physical
- Chemical
- microorganism



# Biogas

## ► Biological waste treatment

- Aerobic Microorganism
- Anaerobic microorganism

# Biogas

## ► Aerobic process

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Organic matters + O<sub>2</sub> + Aerobic Microorganism → Sludge + CO<sub>2</sub> + Treated Water

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**ENERGY**



# Biogas



**Aerated Lagoon**

# Biogas

## ► Anaerobic process

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Organic Matters + Anaerobic Microorganism → Sludge +  $\text{CH}_4$  + Treated Water

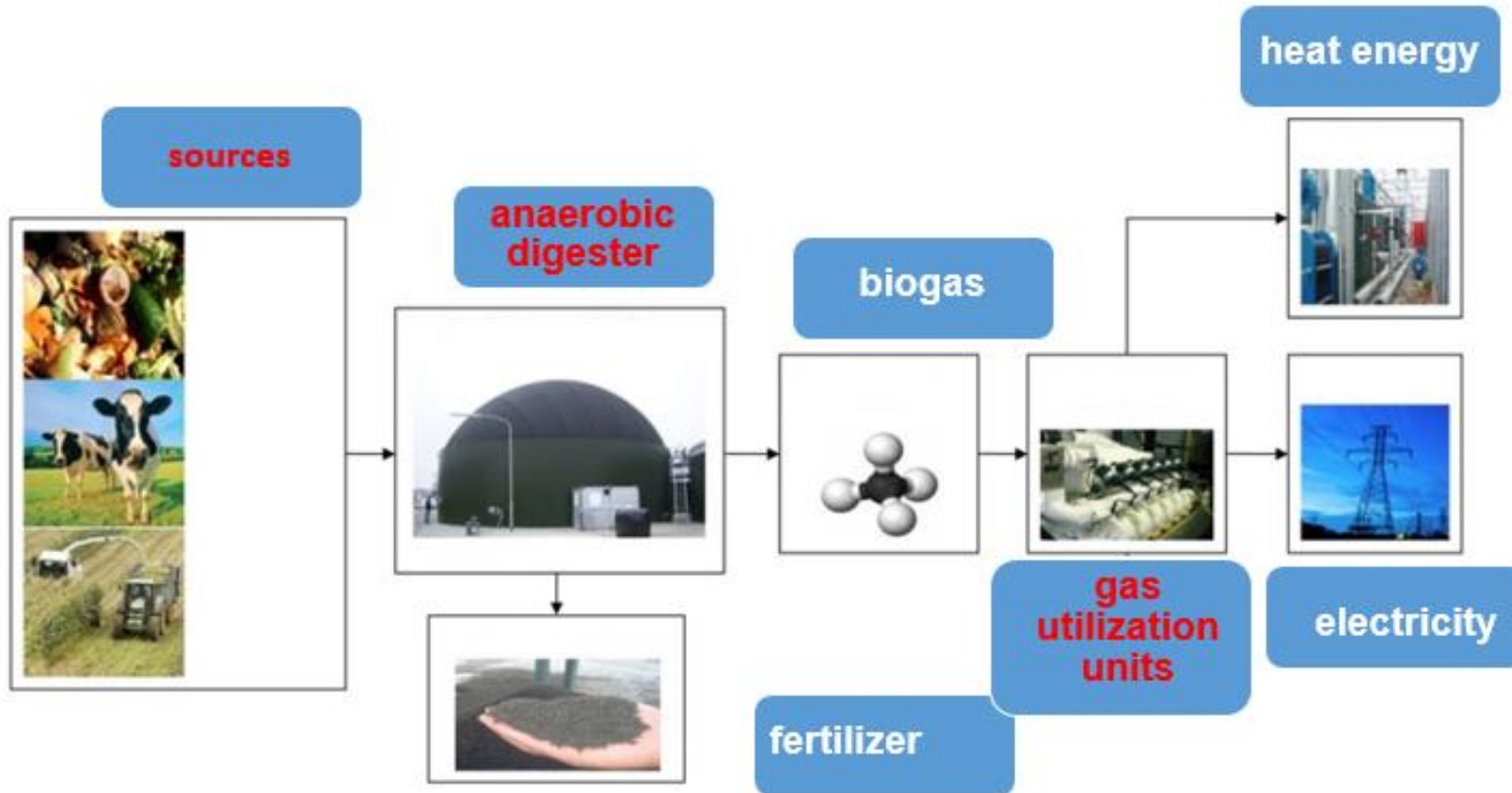
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**BIOGAS**  
“RENEWABLE ENERGY”

# Biogas

## ► Overview of biogas system



Source : modified from <http://www.e-invest-ltd.com/>



# Biogas

## ▶ Source

### ▶ Animal waste

- ▶ swine, chicken and cattle

### ▶ Industrial wastewater

- ▶ food processing
- ▶ palm oil
- ▶ starch
- ▶ ethanol

etc.

### ▶ Municipal Solid Waste (MSW)





# Biogas

- ▶ Aerobic digester
  - ▶ Chanel digester
  - ▶ Fixed dome
  - ▶ CSTR (new project)



# Biogas

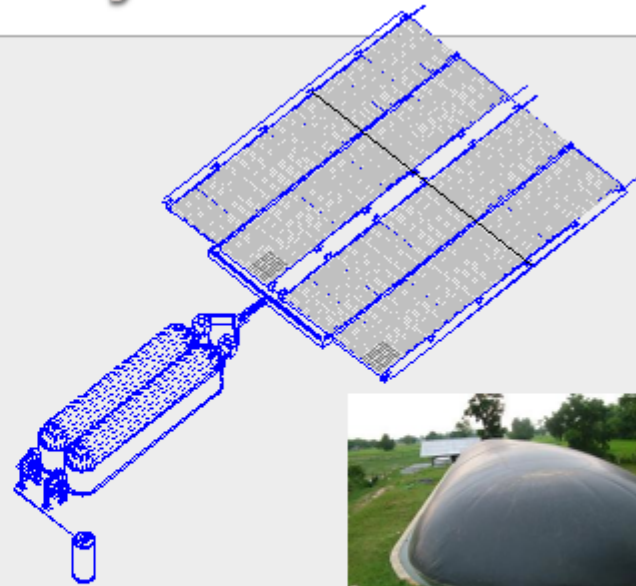
## ► Chanel digester

### ERDI's CMU-CD System

#### Channel Digester

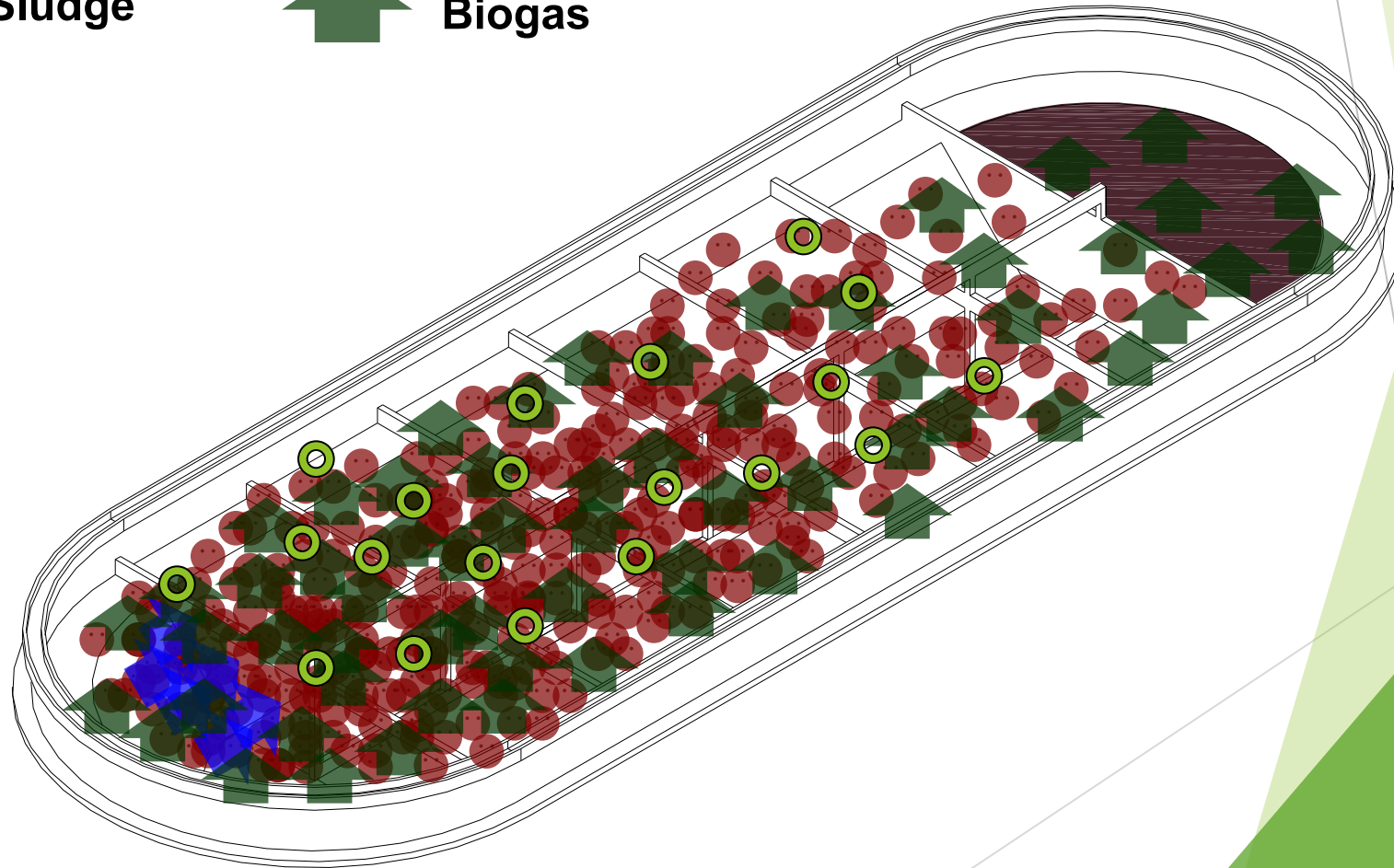
- 100 – 2,500 m<sup>3</sup>
- Loading 8 pigs (60kg) / m<sup>3</sup>
- HRT 5-7 days
- Simple Maintenance
- Sludge sun drying bed

*Approx. US\$ 100 - 150 US\$ / m<sup>3</sup>*



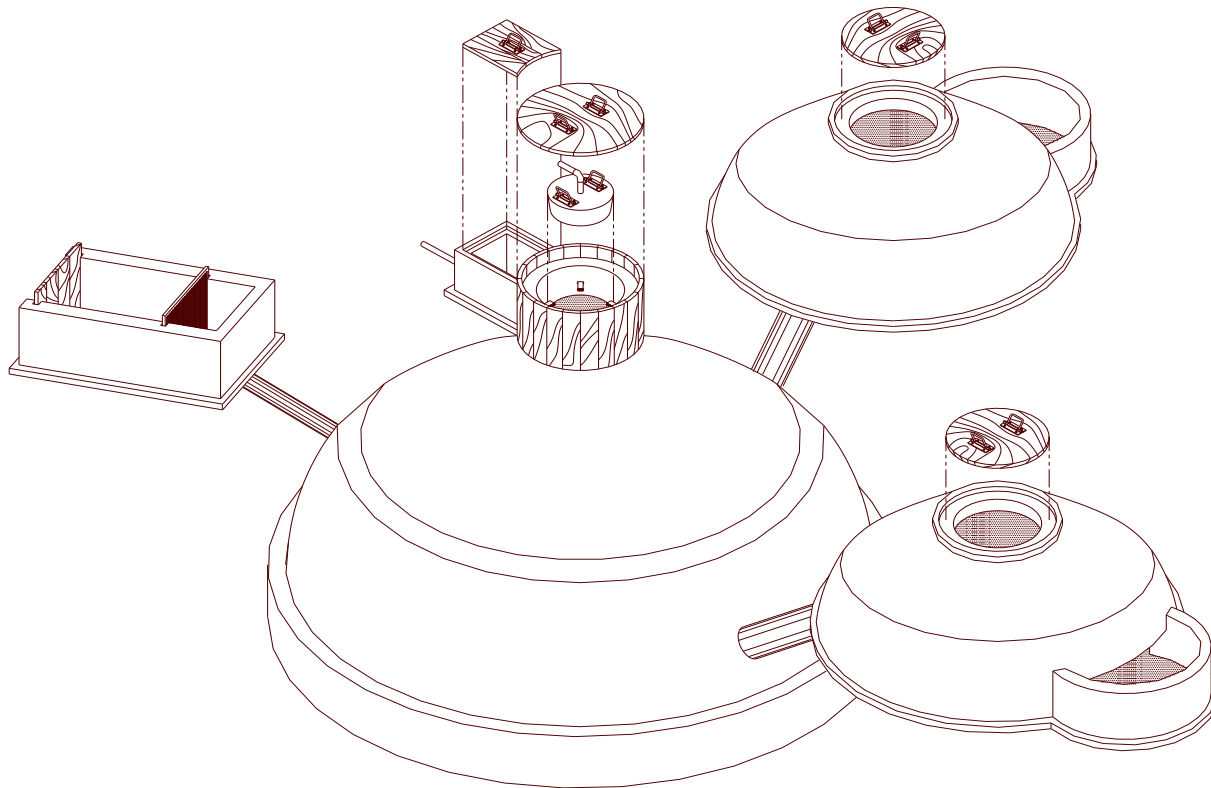
**Production Capacity 0.8 m<sup>3</sup> biogas/ system m<sup>3</sup> / day at full load**

# Channel Digester : CD



# Biogas

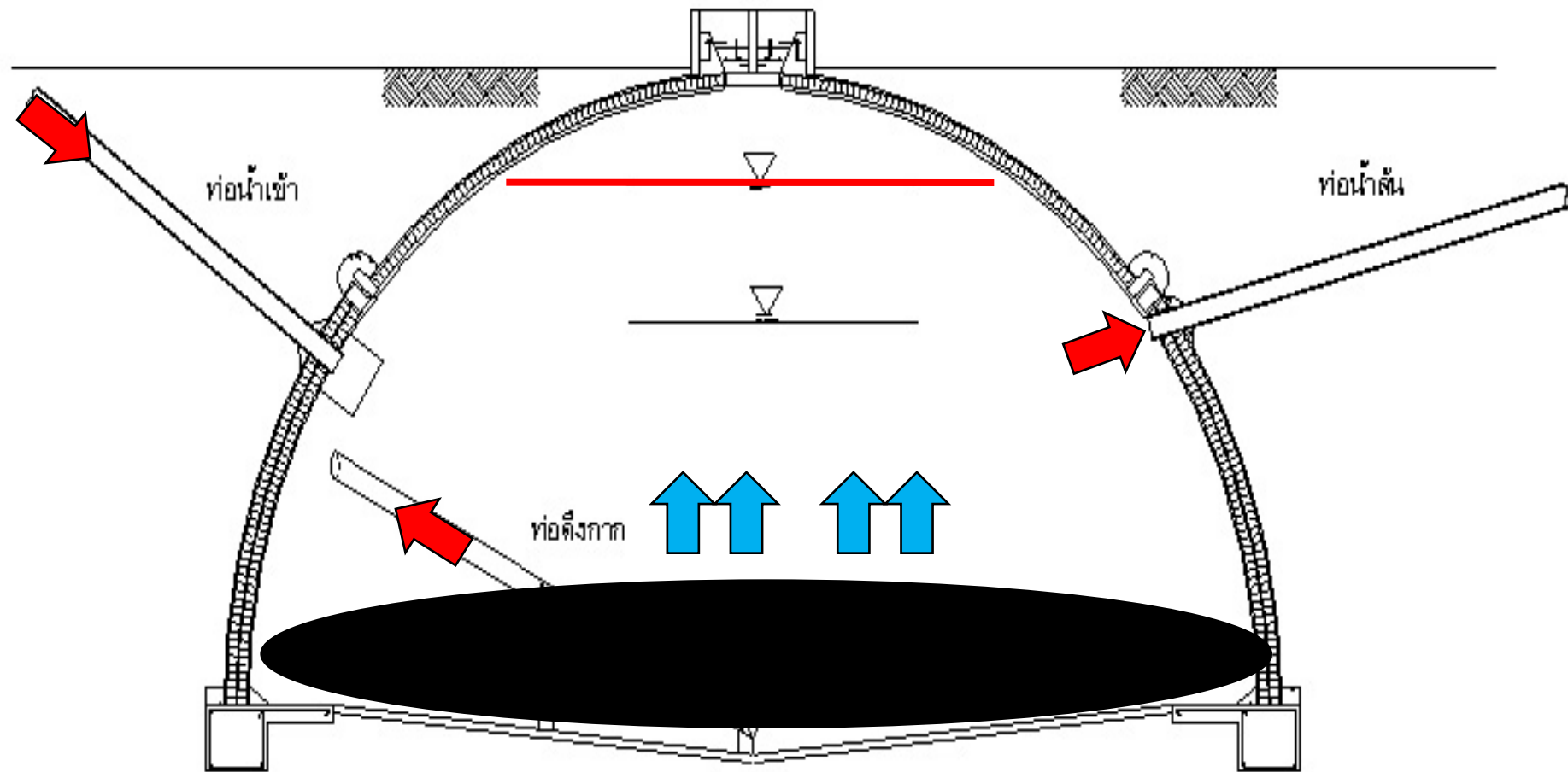
## ► Fixed dome



Isometric Fixed Dome  
Standard 12 m<sup>3</sup>

# Biogas

## ► Fixed dome

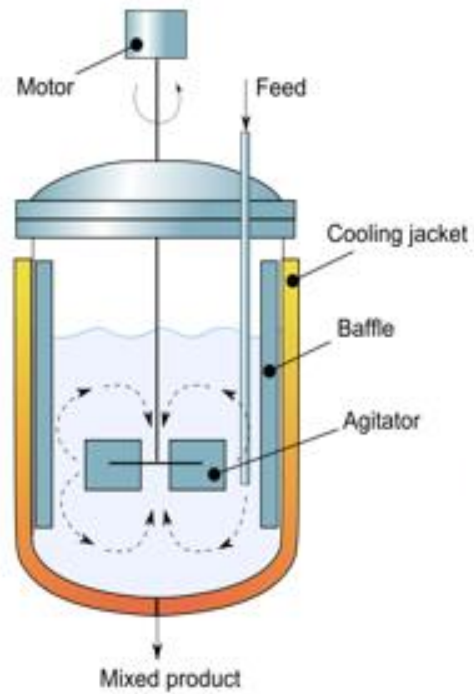


บ่อหมักไร้อากาศแบบ Fixed Dome ขนาด 100 ลบ.ม.



# Biogas

- ▶ CSTR : Continuous stirred-tank reactor



# Biogas

- ▶ CSTR : Continuous stirred-tank reactor



Energy crop



An **energy crop** is a plant grown as a low cost and low maintenance harvest used to make biofuels, or directly exploited for its energy content.

# Biogas

- ▶ CSTR : Continuous stirred-tank reactor



CSTR in Ratchaburi  
(Thailand)



CSTR in Homburg Efze  
(Germany)



# Biogas

## ▶ Benefit from biogas system

### ▶ Environment

- ▶ Wastewater treatment (~ 70%COD removed)

- ▶ Reduces odor problem

- ▶ Reduces GHG emission

### ▶ Social

- ▶ Enhances quality of life of the communities nearby

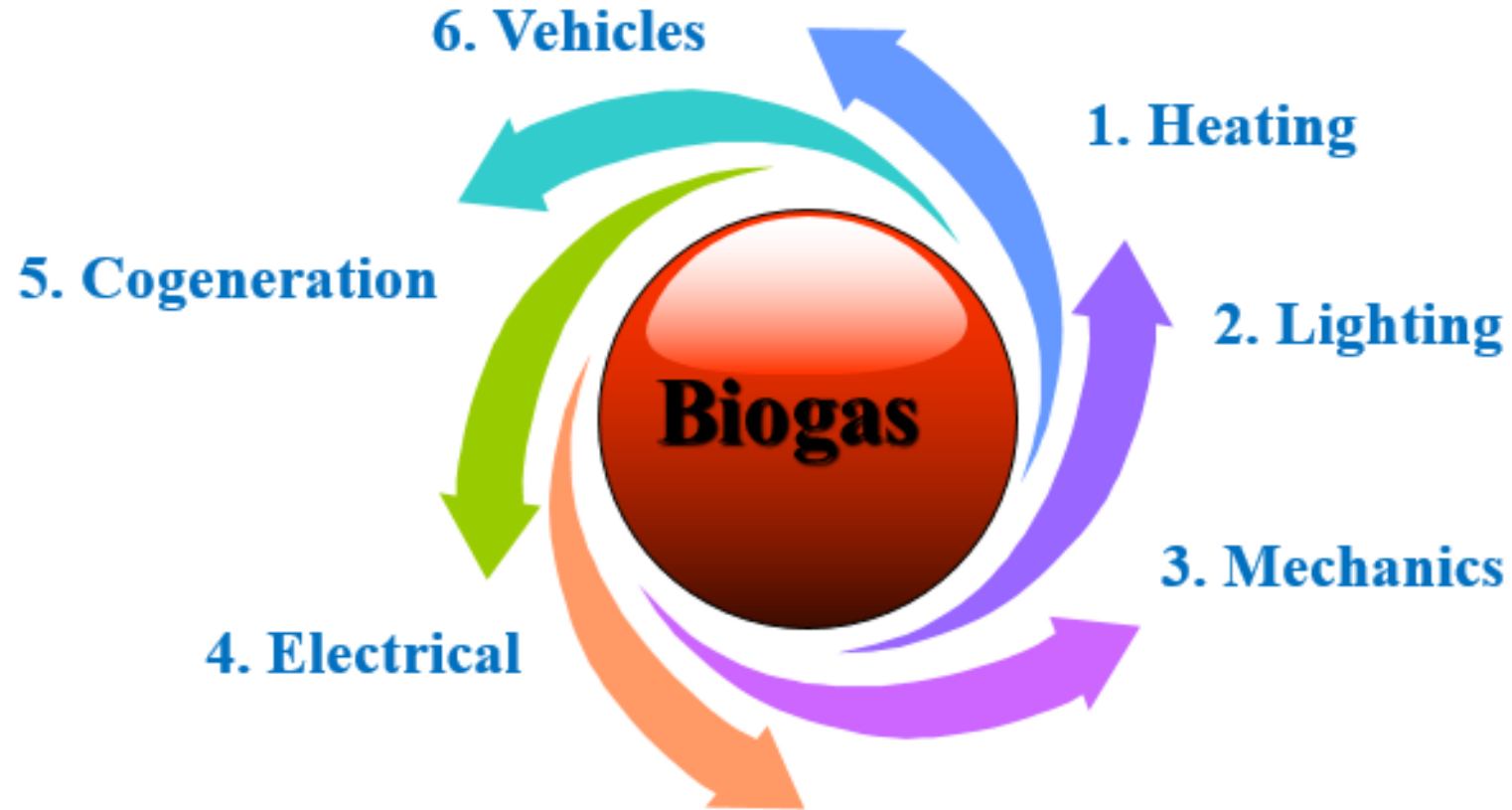
- ▶ Enhances the relationship between business owners and the communities

# Biogas

- ▶ Benefit from biogas system
  - ▶ Economy
    - ▶ Reduces fossil fuel imported
    - ▶ Benefits from CDM
    - ▶ Promotes agricultural sector

# Biogas

## ► Biogas utilization



# Biogas

## ► Biogas utilization - biogas property

ปริมาณมีเทน (CH <sub>4</sub> )	65 – 70 %
ปริมาณคาร์บอนไดออกไซด์ (CO <sub>2</sub> )	30 – 35 %
ปริมาณไฮโดรเจนซัลไฟด์ (H <sub>2</sub> S)	1,000 ppm
ค่าความร้อนทางต่ำ	24.48 MJ/m <sup>3</sup>
ความเร็วเปลวไฟ	25 cm/s
อัตรา A/F ในทางทฤษฎี	6.19 m <sup>3</sup> a/m <sup>3</sup> g
อุณหภูมิเผาไหม้ในอากาศ	650 °C
อุณหภูมิจุดติดไฟของ CH <sub>4</sub>	600 °C
ค่าความจุความร้อน (Cp)	1.6 kJ/m <sup>3</sup> -°C
ค่าความหนาแน่น (ρ)	1.15 kg/m <sup>3</sup>

# Biogas

## ► Biogas utilization

1 cubic meter of biogas (5.5 kcal) is equal to

<b>LPG</b>	<b>0.46</b>	<b>kg</b>
<b>Benzene</b>	<b>0.67</b>	<b>liter</b>
<b>Diesel</b>	<b>0.60</b>	<b>liter</b>
<b>Wood</b>	<b>1.50</b>	<b>kg</b>
<b>Electricity</b>	<b>1.20-2.40</b>	<b>kWh</b>

# Biogas

## ► Biogas utilization

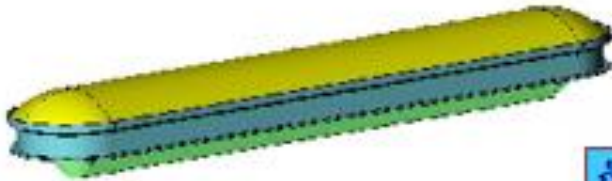
Lower Explosive Limit หรือ LEL = 5 %

Upper Explosive Limit หรือ UEL = 15 %

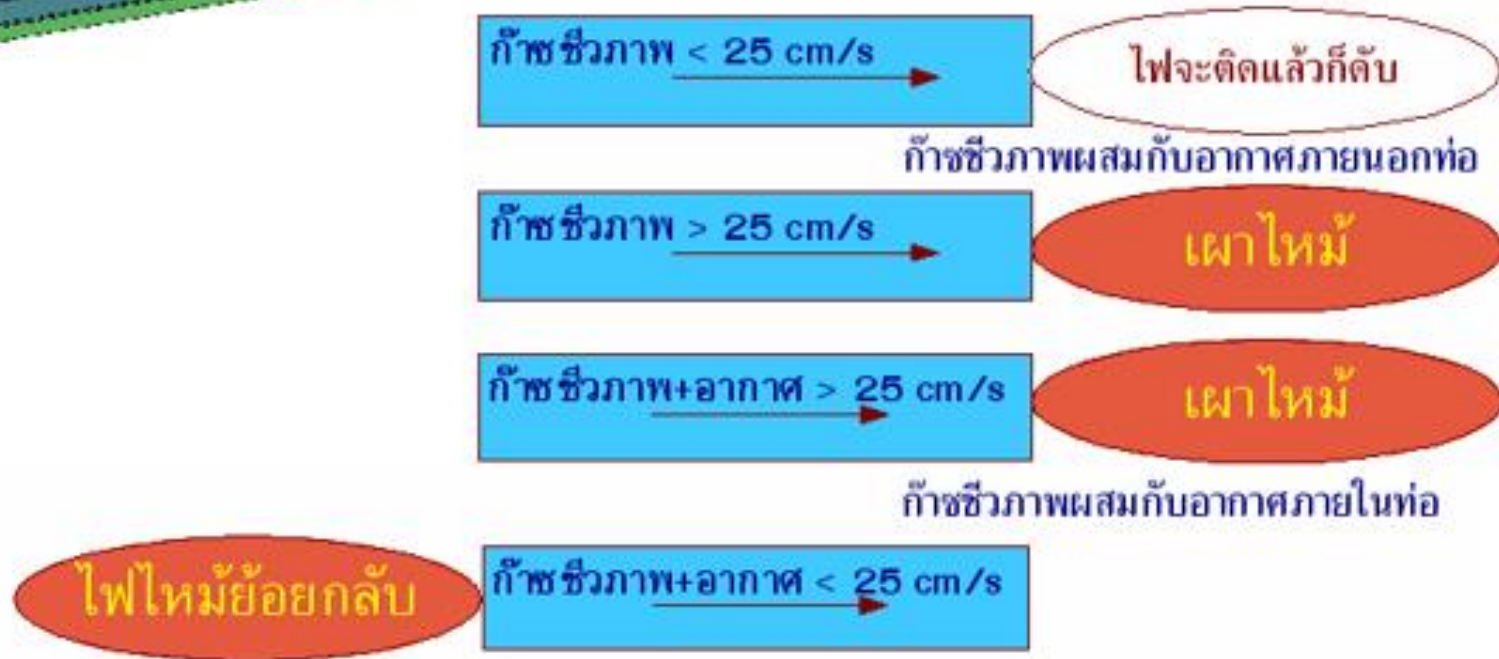
# Biogas

## ► Biogas utilization

ระบบหมักแบบไร้อากาศ



รูปแบบการเผาไหม้ :



# Biogas

- ▶ Biogas utilization - heating



เตาหุงต้มใน  
ครัวเรือน



หัวกก  
ลูกสุกร



เครื่องกำเนิดไอน้ำ  
(Boiler)



# Biogas

- ▶ Biogas utilization - lighting



ตะเกียง

# Biogas

## ► Biogas utilization - mechanics



# Biogas

## ► Biogas utilization - electricity



# Biogas

## ► Biogas utilization - electricity

### Induction Generator

- ผลิตเฉพาะ กระแส (Ampere) ส่วนความถี่ (Frequency) และความต่างศักย์ (Volt) ต้องต่อร่วมกับระบบของการไฟฟ้า (กฟน., กฟภ.) เสมอ
- เมื่อไฟของการไฟฟ้าดับก็จะดับด้วย
- ระบบควบคุมไม่ซับซ้อน ราคาถูก

### Synchronous Generator

- ผลิตได้ทั้งกระแส (Ampere) ความถี่ (Frequency) และความต่างศักย์ (Volt)
- ใช้ร่วมกับการไฟฟ้า (กฟน., กฟภ.) ได้โดยต้องมีชุดขนาน (Sync.)
- สามารถติดตั้งในพื้นที่ที่ไม่มีไฟของการไฟฟ้าได้
- ระบบควบคุมมีความซับซ้อน ราคาค่อนข้างแพง



# Biogas

- ▶ Biogas utilization - electricity



# Biogas

## ► Biogas utilization - CBG

ระบบก๊าซชีวภาพ



ระบบปรับปรุง  
คุณภาพก๊าซ



ระบบเพิ่มความดัน  
ก๊าซ 200 บาร์เกจ



สถานีเติมก๊าซและ  
ยานยนต์  
(CNG, CBG)



ระบบส่งก๊าซ



# Biogas

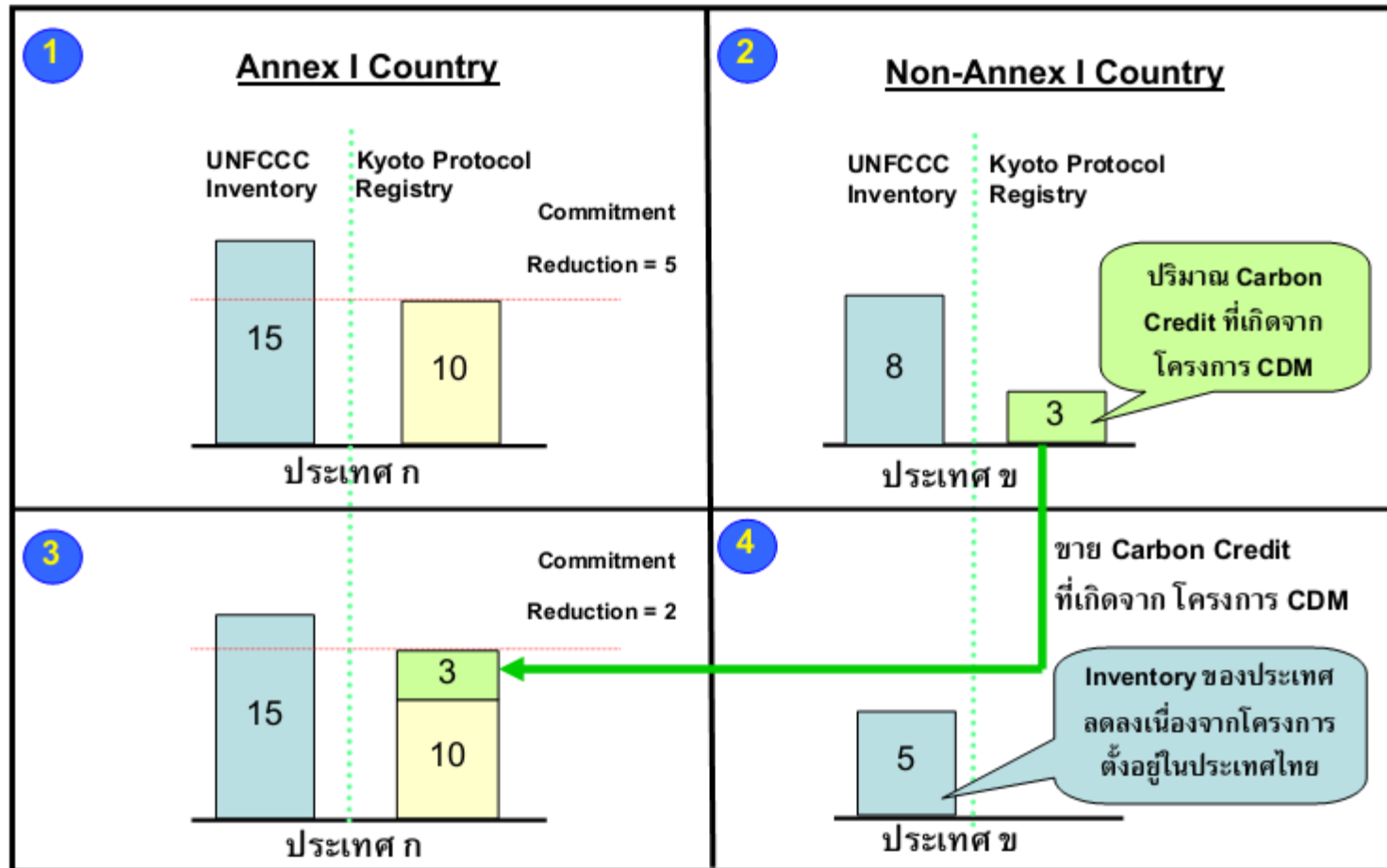
## ► Biogas utilization - CBG



# Biogas

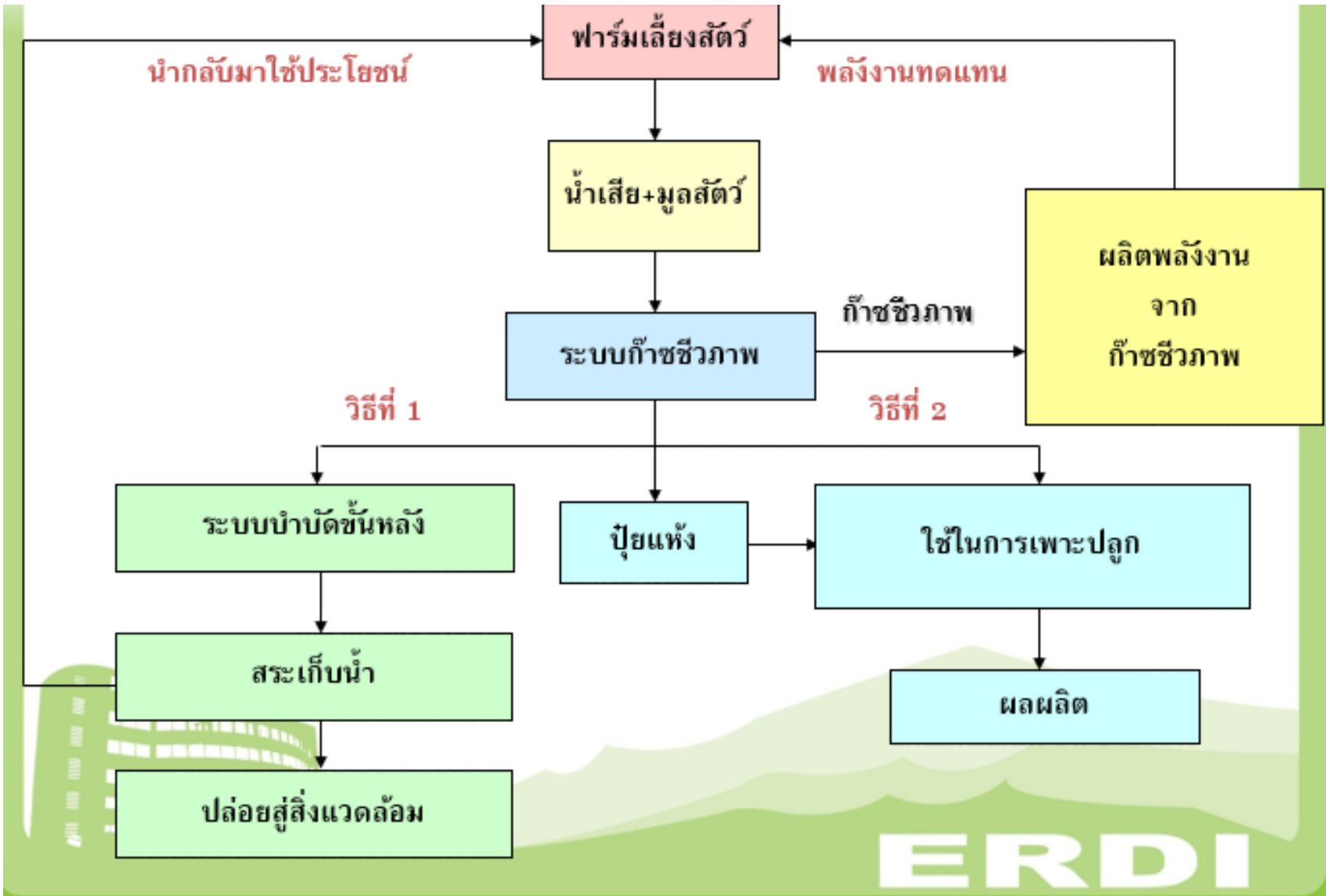
## ► Biogas utilization - Clean Development Mechanism (CDM)

### การลดก๊าซเรือนกระจกตามพันธกรณีผ่าน CDM





# Biogas- Case study



# Outline

- ▶ Overview of renewable energy
- ▶ Biogas
- ▶ Photovoltaic system

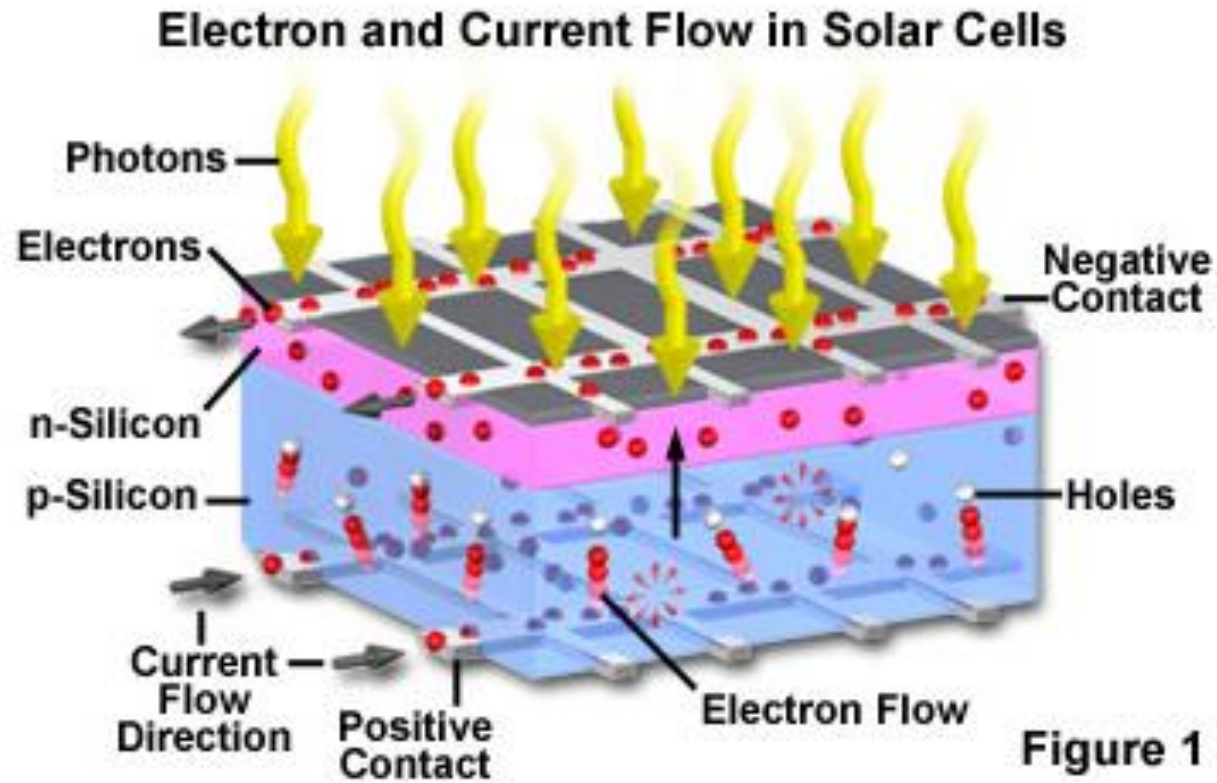
# Photovoltaic system

## ▶ What is PV

- ▶ Photovoltaics (**PV**) is a method of generating electrical power by converting sunlight into direct current electricity using semiconducting materials that exhibit the **photovoltaic** effect. A **photovoltaic** system employs solar panels composed of a number of solar cells to supply usable solar power.

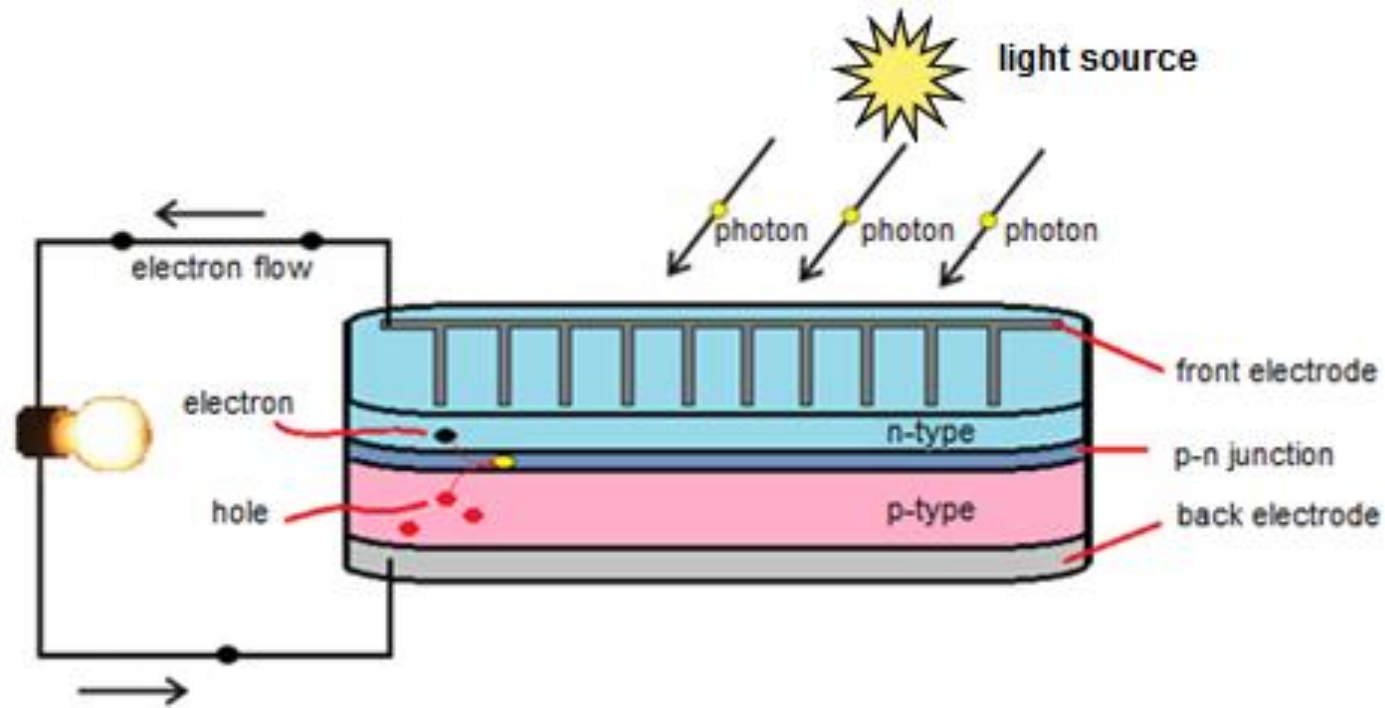
# Photovoltaic system

## ► How it work




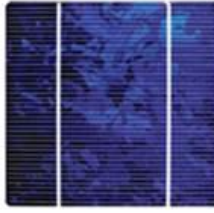

# Photovoltaic system

## ► How it work



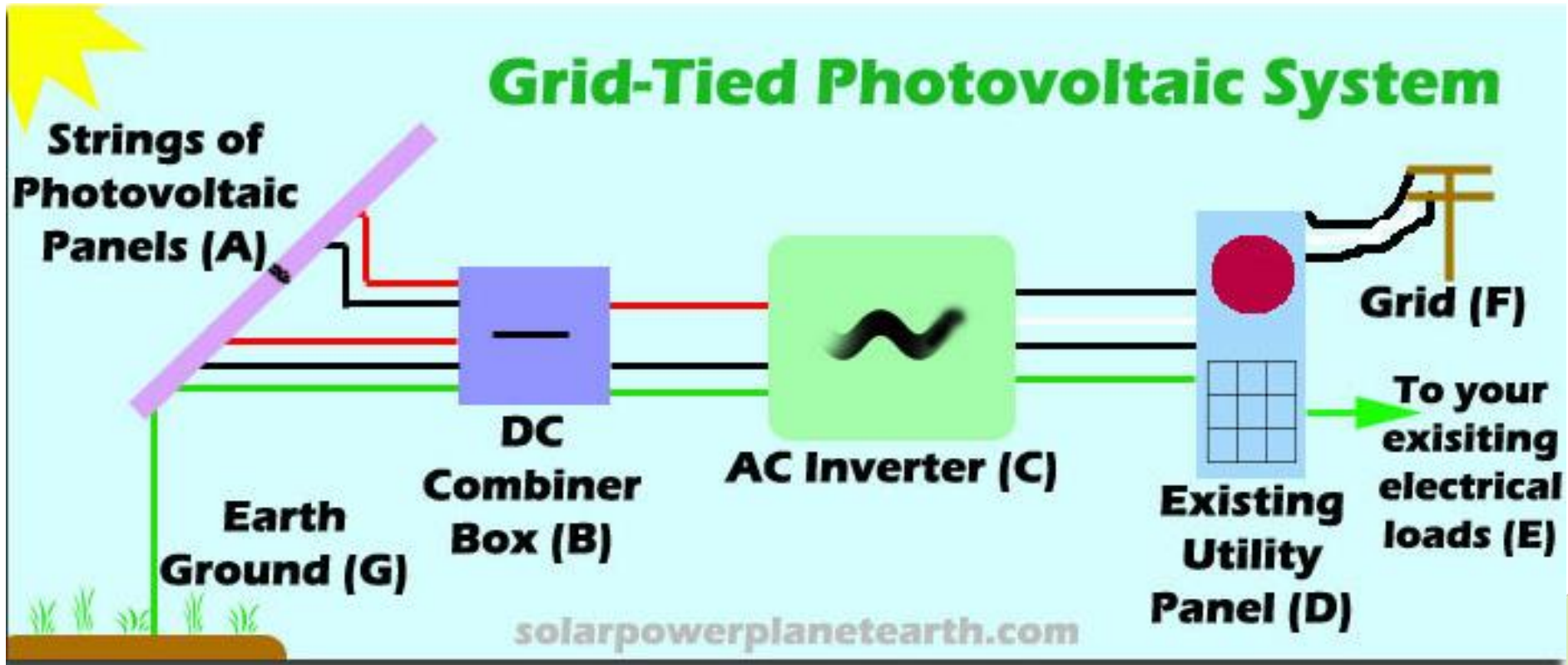
# Photovoltaic system

## ► Type of cell

Solar cell technology	Characteristics
 <p>Monocrystalline</p>	Structure: Formed from single crystal of silicon Typical Module Efficiency: 13% - 20% Typical Module Price /Wp: <a href="#">Rs.75 – Rs.100</a>
 <p>Polycrystalline</p>	Structure: Formed from multiple crystals of silicon Typical Module Efficiency: 14% - 16% Typical Module Price/Wp: <a href="#">Rs.50 – Rs.75</a>
 <p>Thin film</p>	Structure: Formed from amorphous silicon Typical Module Efficiency: 6% - 12% Typical Module Price/Wp: <a href="#">Rs.40 – Rs.55</a>

# Photovoltaic system

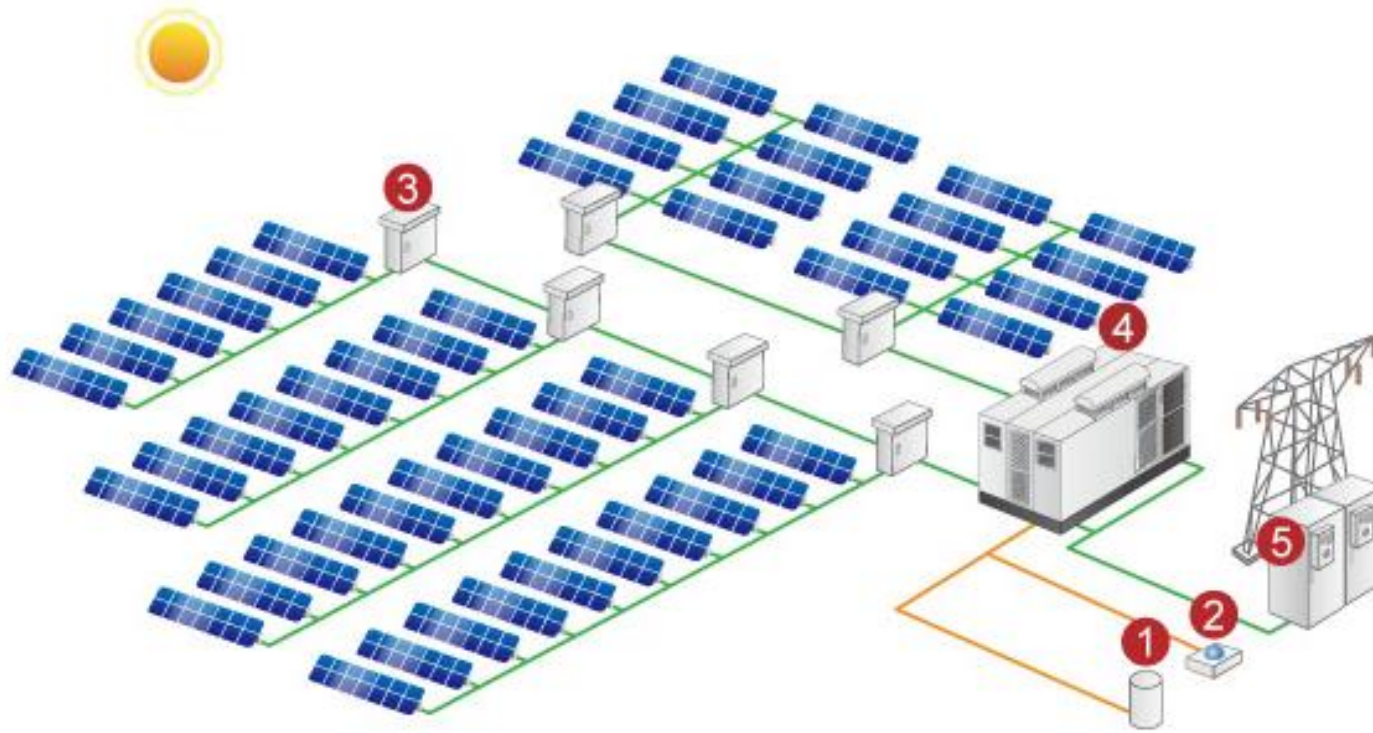
- Application - Grid-connected PV Systems





# Photovoltaic system

## ► Application - Grid-connected PV Systems





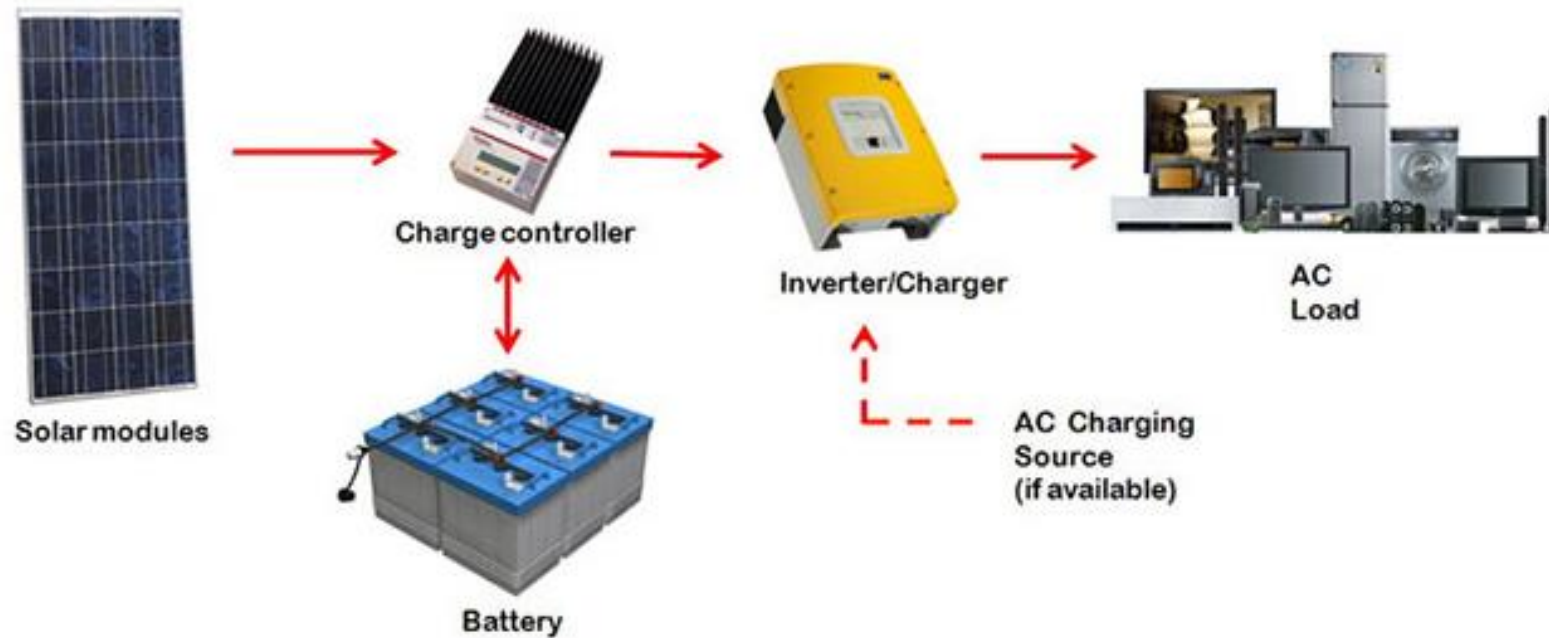
# Photovoltaic system

## ► Application - Grid-connected PV Systems



# Photovoltaic system

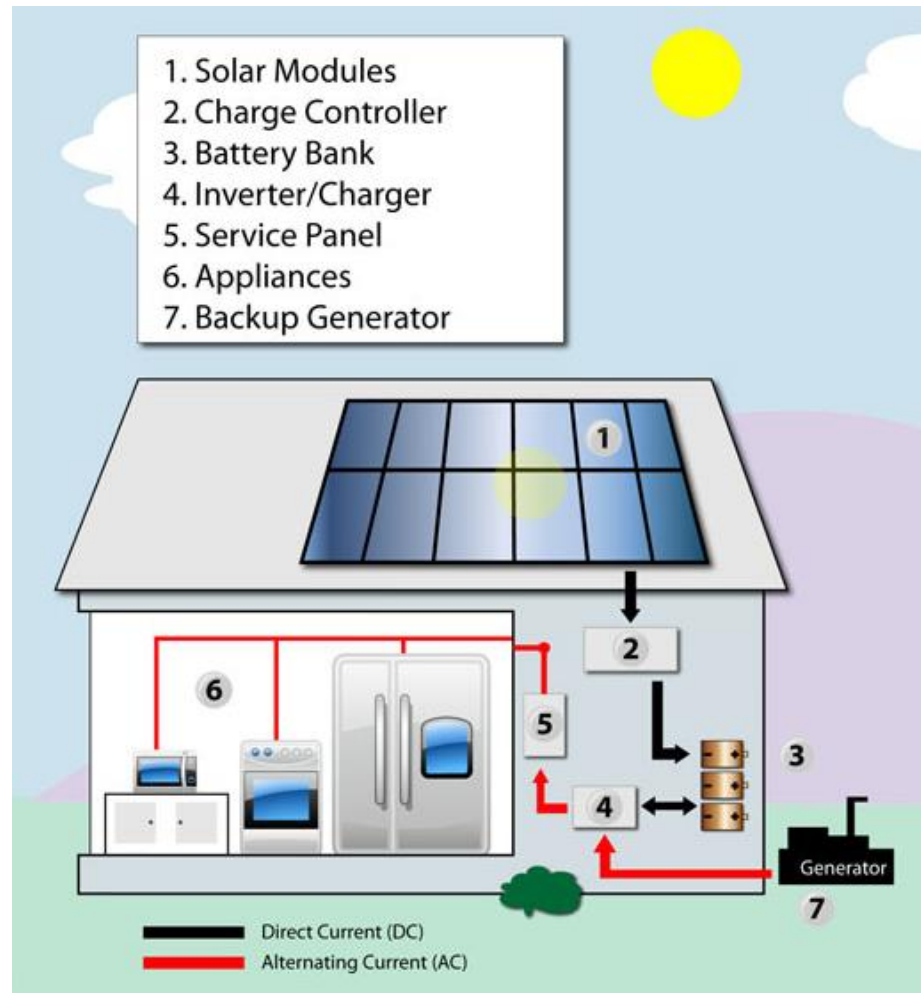
## ► Application - Off-grid PV Systems





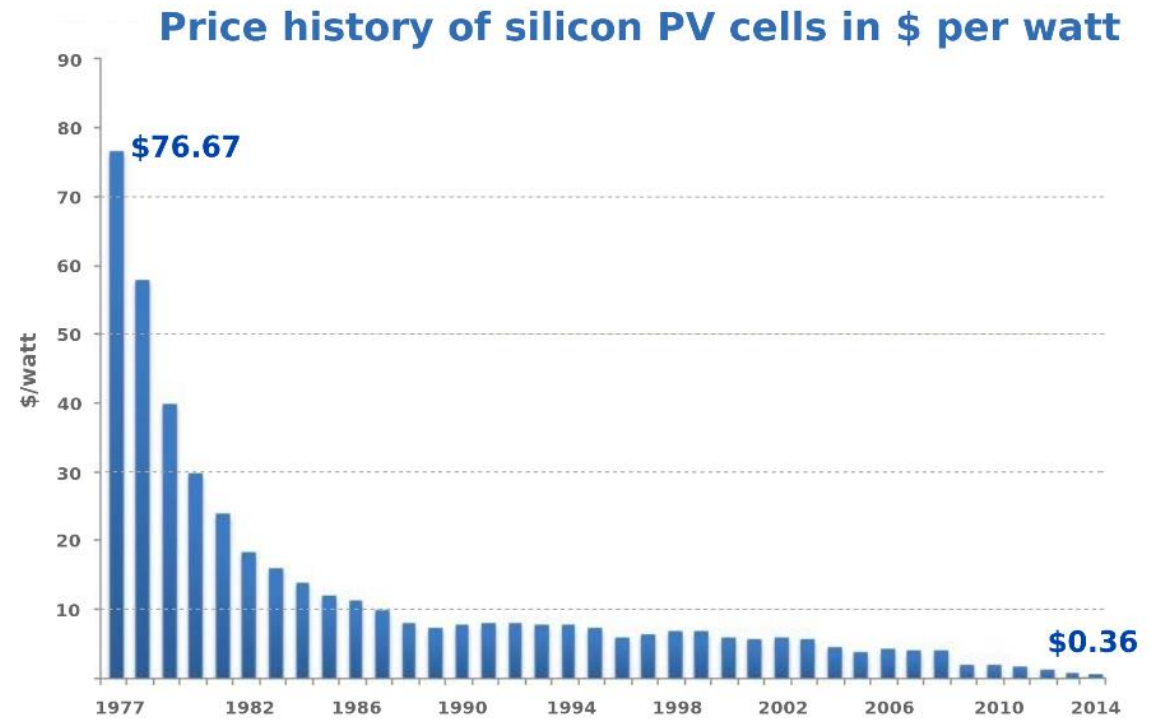
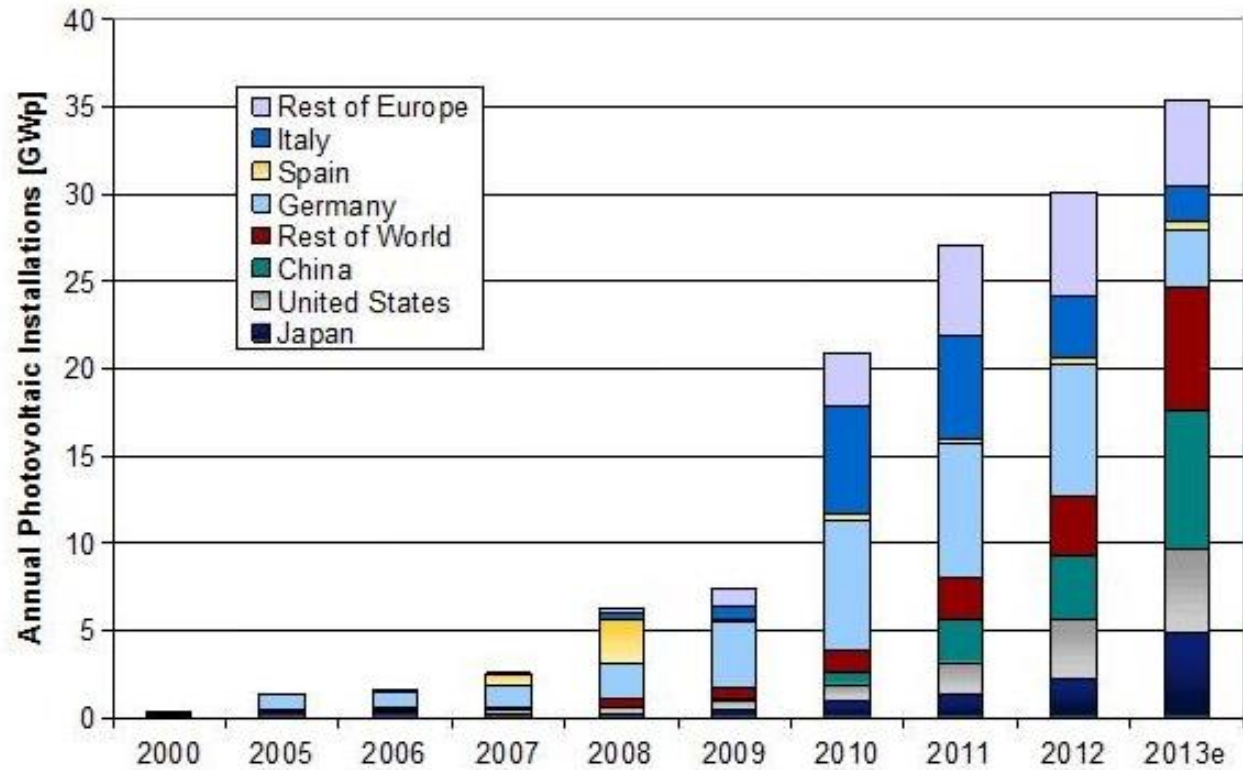
# Photovoltaic system

## ► Application - Off-grid PV Systems



# Photovoltaic system

## ► trend



Source: Bloomberg, New Energy Finance & pv.energytrend.com

# Photovoltaic system

## ▶ Conclusion - Challenges for the Future

- ▶ Price decrease ,but installation increase
- ▶ Focal area Asia, are starting or continuing to develop
- ▶ PV can become a major source of electricity in the world

# Thank you & Question

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