

Evaluation of Environmental Impacts of Polycrystalline Silicon Solar Cell PP. by Using LCA Aspect

Sate Sampattagul, Muanjit Chamsilpa, Tanongkiat Kiatsiriroat,
Yucho Sadamichi and Seizo Kato

Department of Mechanical Engineering, Faculty of Engineering,
Chiang Mai University, Chiang Mai 50200, Thailand.

Department of Mechanical Engineering, Faculty of Engineering, Mie University,
1515 Kamihama-cho, Tsu, Mie 514-8507, JAPAN

*Corresponding author *E-mail: sate@eng.cmu.ac.th*



Outline of Presentation

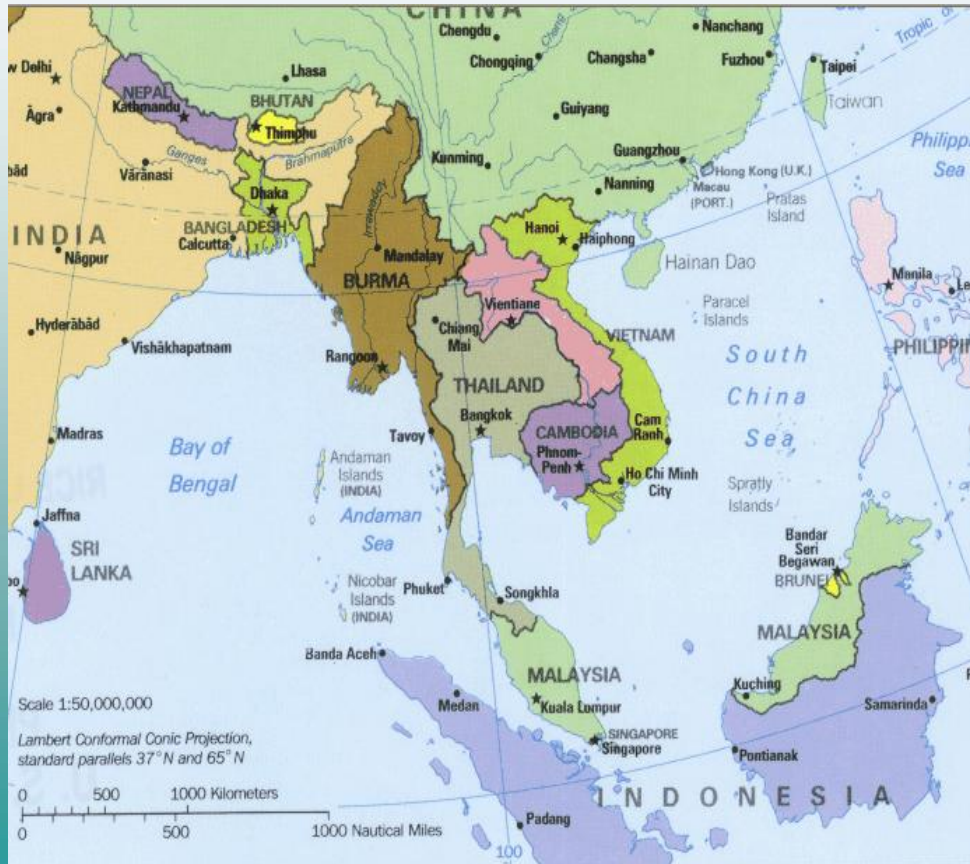
1. Background

2. Research and Results

- Research Background
- Methodology
- Results and Conclusions



Basic Information of Thailand



Data	Thailand
Population	64.3 million
Size (Land area)	0.51 million km ²
GDP per capita	US\$ 2,012 /capita
Per capita primary energy	0.98 [TOE/capita]
Per capita CO ₂ emission	2.8 ton-CO ₂ /capita
Per capita electricity	1,058 [kWh/capita]





- about
- news/ events
- forum/ webboard
- download
- links



Welcome to Thai LCA Network

WHAT'S NEW

- LCA-nyt Brief in English ([Download here](#))
- We are pleased to invite you to participate in the big event of Thai LCA Society, The International Conference on Green and Sustainable Innovation, ICGSI 2006 (November 29 - December 1, 2006) . We are waiting for your participation !!! For more information <http://eng.cmu.ac.th/icgsi>
- [LCA Thai Manual Line by TEI](#)

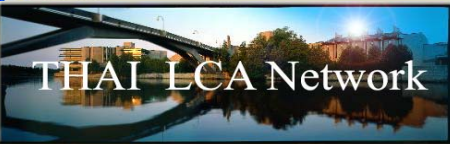
EVENTS

- **Workshop on Design for X** June 22nd, 2006
ARCH computer room, Kasetsart University, Bangkok

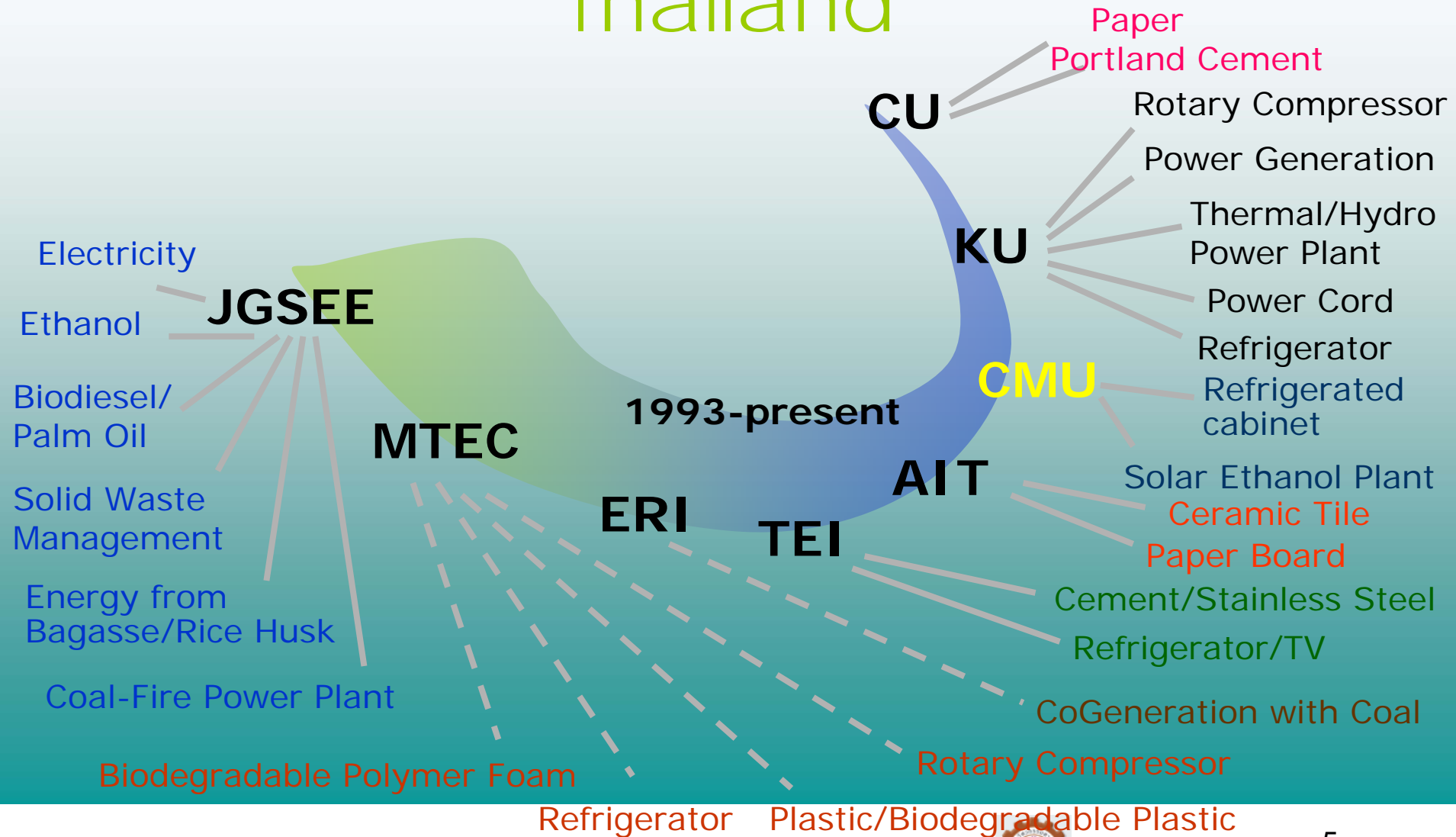
Agenda

08:45-09:15 Registration

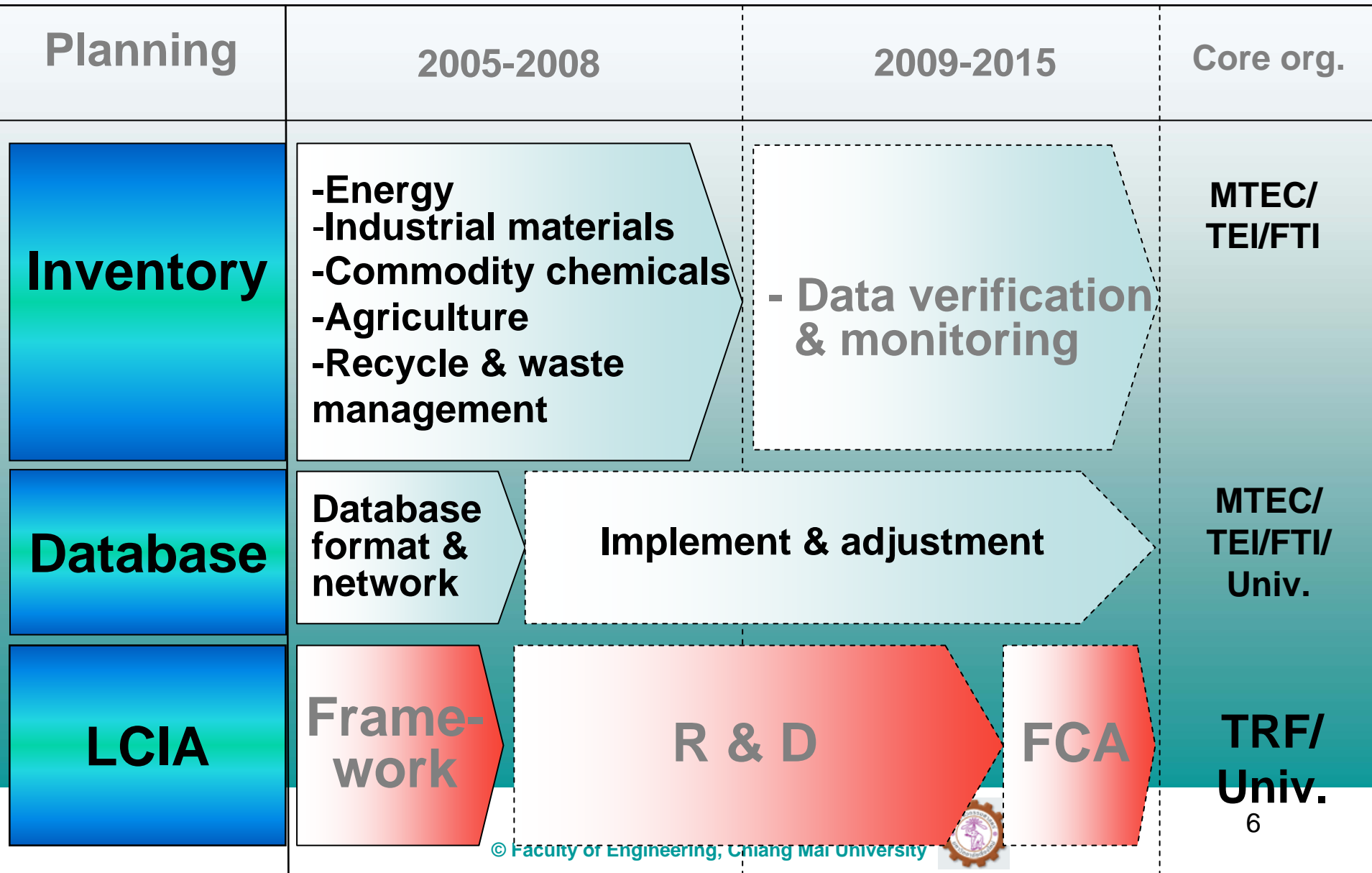
BANNER & LINKS



Current status of LCA reports in Thailand



Roadmap of LCA Database in Thailand



2006

ICGSI
International Conference on
Green and Sustainable Innovation

International Conference on Green and Sustainable Innovation 2006

"Integrated approaches for
sustainable society"

November 29th – December 1st, 2006
Amari Rincome Hotel
Chiang Mai, Thailand
<http://eng.cmu.ac.th/icgsi>

Call for Paper
Abstract Submission : August 15th, 2006

Hosted by:
Energy Management and Conservation Center (EMAC),
Department of Mechanical Engineering,
Faculty of Engineering, Chiang Mai University (CMU)
National Metal and Materials Technology Center (MTEC)



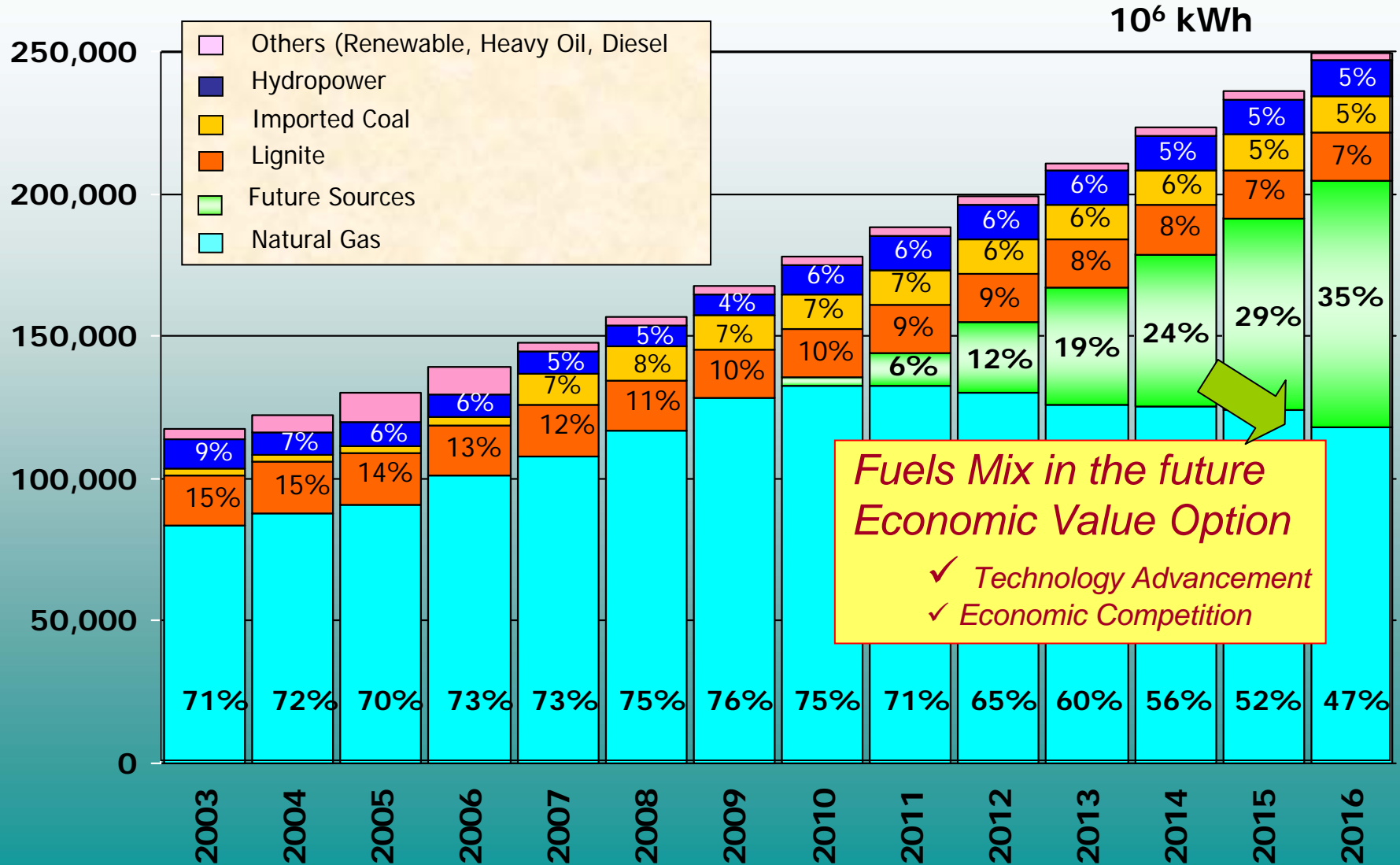
LCA of Polycrystalline Solar Cell Power Plant



Background



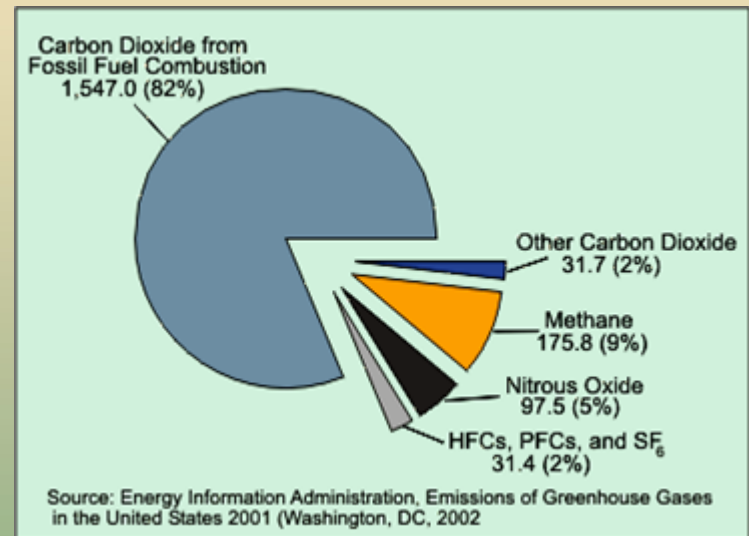
Energy Sources for Power Generating



Environmental Aspects

Severe Environmental Impacts

- **Global Warming**
- **Greenhouse Effect**
- **Ozone Layer Depletion**
- **Natural Resource Depletion**
- **Others**



From Problem Aspects to a Remedy.

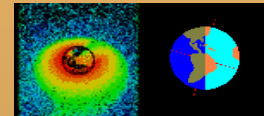
**Energy
Crisis**

**Renewable
Energy**

**Environmental
Impacts**

**Cleaner
Energy**

- **Solar Energy**
- **Solar Cell**
- **Power Plant**



Polycrystalline Solar Cell Power Plant in Mae Hong Son, TL

General Information

- Mae Hong Son : Northern province of Thailand
- Natural Resources/Environmental Conservation
- Electrical Generation ; 1. Diesel Power Plant 2. Hydro Power Plant
- Electricity demand increasing continuously
- 2 choices to increase electricity supply;
 - 1). Diesel Power Plant
 - 2). Solar Cell Power Plant



MAE HONG SON PROVINCE



Step 1 : Goal & Scope Definition

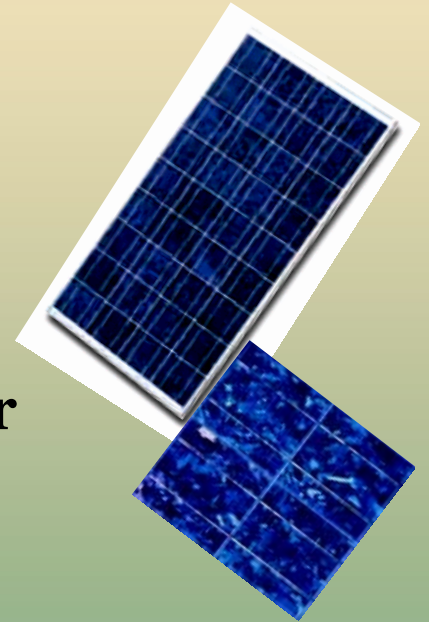
- 1. To analyze and estimate the numerical environmental loads of the solar cell power plant system.**
- 2. To evaluate the consolidated impacts over its life cycle.**
- 3. To create proposals for more eco-improvement strategies toward environmental conscious product policy.**



Step 1 : Goal & Scope Definition

Functional Unit Definition

- Polycrystalline solar modules system
- Capacity 3 kW
- Efficiency 14%
- Electricity generation rate 3,942 kWh/year
- Life span 30 years



Step 1 : Goal & Scope Definition

Energy & Materials Input

Manufacturing

Transportation

Use

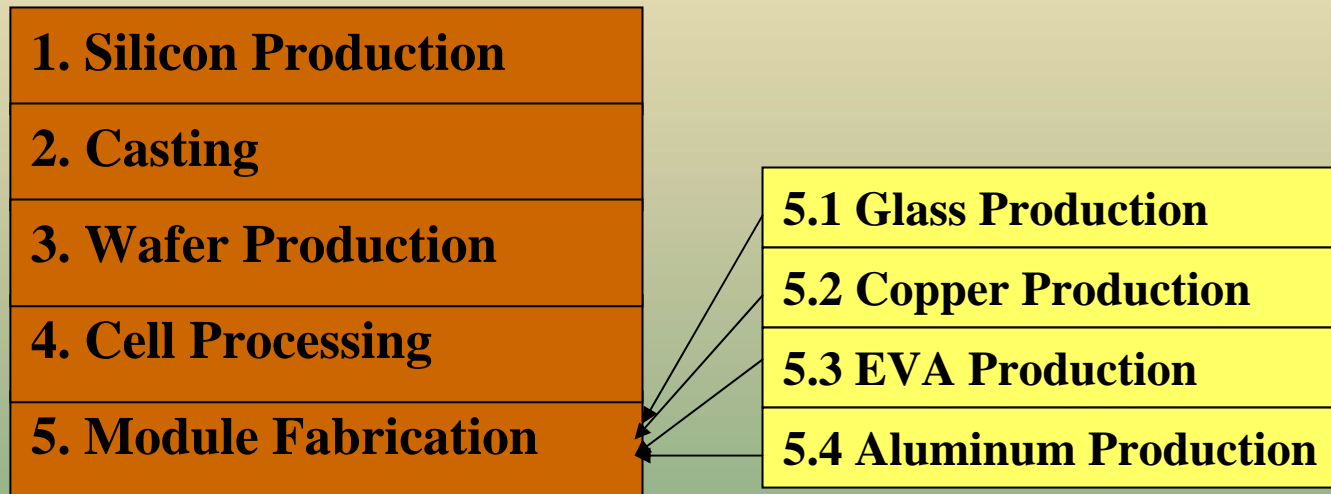
Environmental Impacts & Product

System Boundary



Step 2 : Life Cycle Inventory (LCI)

Polycrystalline Silicon Manufacturing Phase



Step 2 : Life Cycle Inventory (LCI)

Example : LCI of Materials

PV Parts	Materials	Amount	Unit
PV panel	Silicon	31.8	kg/unit
	Glass	239.4	kg/unit
	Aluminum	57.0	kg/unit
	Copper	2.7	kg/unit
	Filling material	32.7	kg/unit
	Theodora	4.5	kg/unit
	Butyl rubber	3.3	kg/unit
Mount	Crude steel	150.0	kg/unit
	Insulation	90.0	kg/unit
Controller	Crude Steel	15.0	kg/unit
	Copper	9.0	kg/unit
	Insulation	6.0	kg/unit



Step 2 : Life Cycle Inventory (LCI)

Use Phase : Electrical Generation at the Power Plant

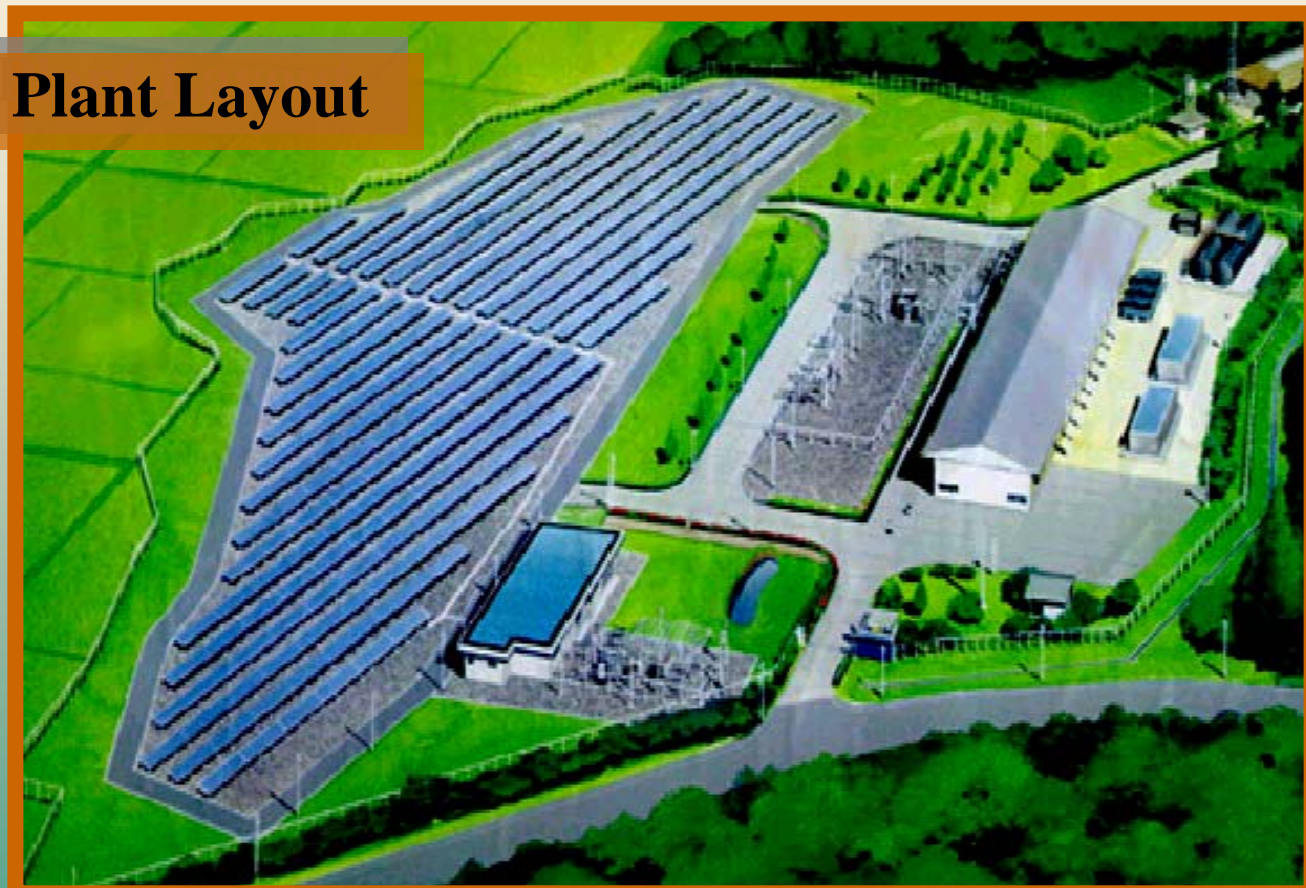
-The system consists of;

- 1. Solar Modules**
- 2. Controlled System**
- 3. Distribution System**
- 4. Inverters/Converters**
- 5. Battery Storages**

- Solar Module system was firstly selected to study.



Power Plant Layout



Solar Cell Modules



Power Plant Building



System Controllers



Inverters & Converters



Battery Storages



Step 3 : Life Cycle Impact Assessment (LCIA)



Loader and Receiver Balance Theory

Loader: Giving allowable environmental load



Receiver: Received allowable environmental load

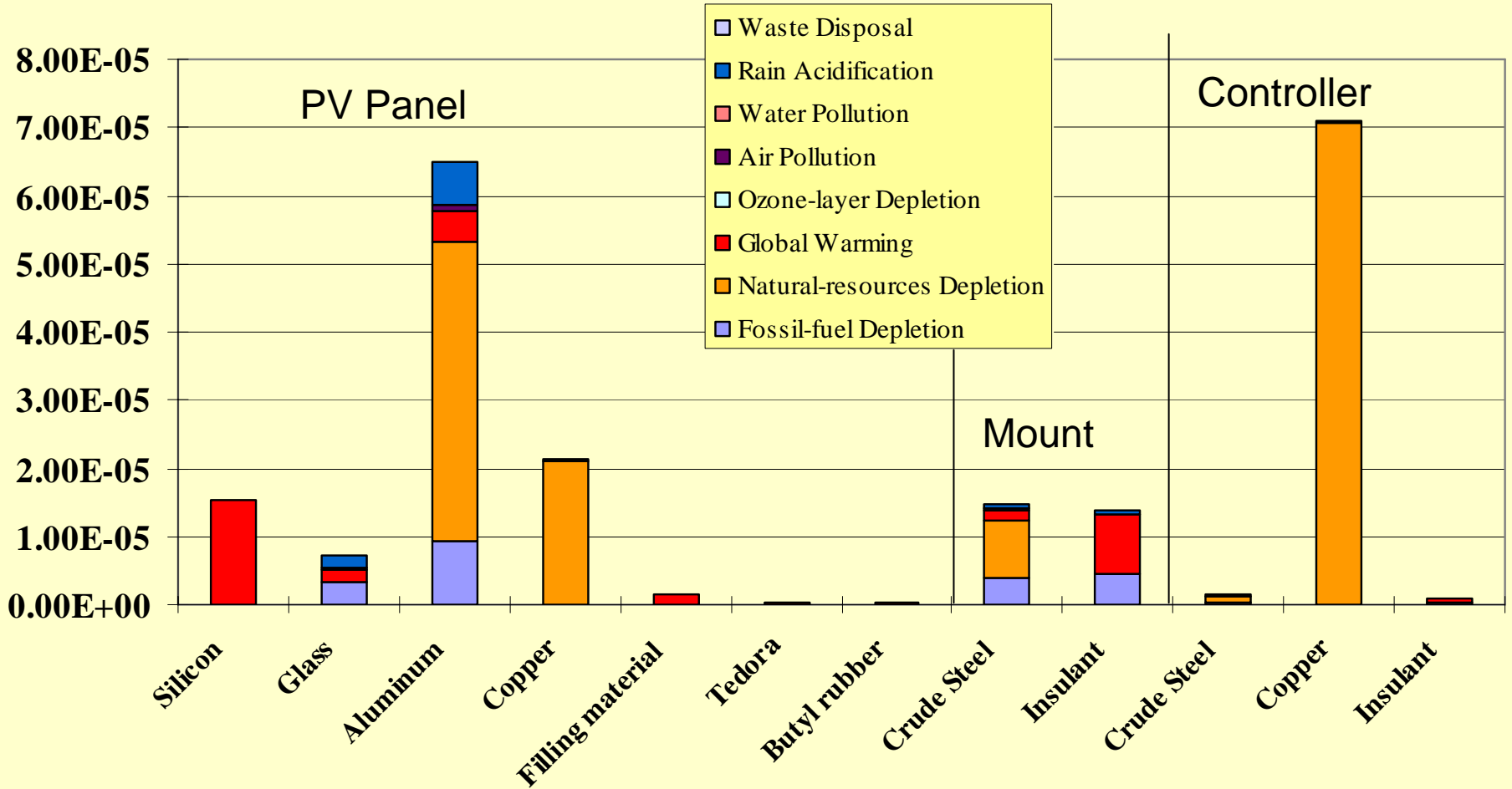
P_i [kg, kWh, m³, ..., etc.]

MEV_i [NETS]

$$P_i \text{ [kg, kWh,...]} \times ELM_i \left[\frac{\text{NETS}}{\text{kg, kWh,...}} \right] = MEV_i \text{ [NETS]}$$

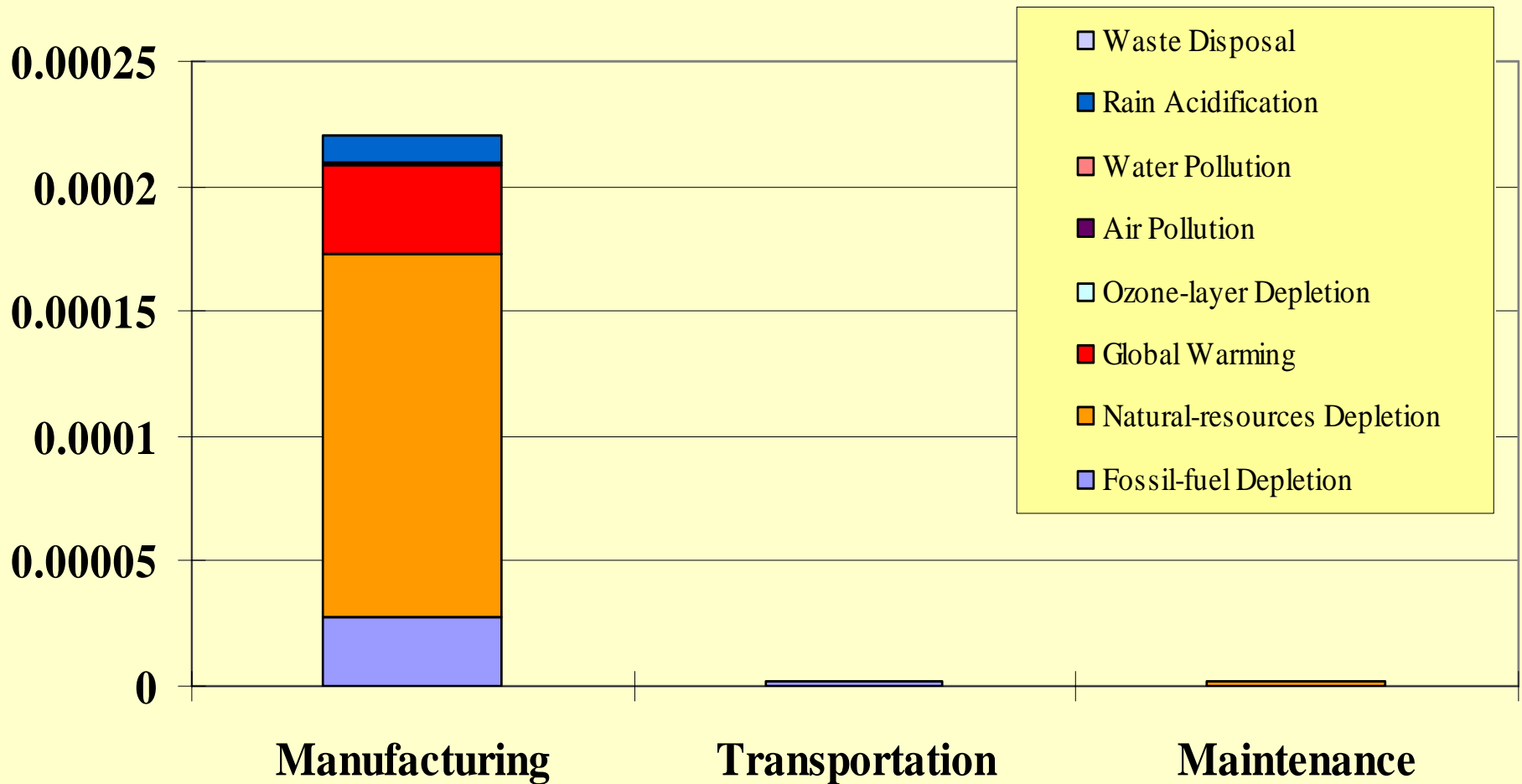
	Environmental load factors	No.	Consolidated standardization values
Global Scale	Depletion of fossil fuel	4	Proven Reserve
	Global warming	43	GHG emissions, GWP
	Ozone layer depletion	24	Emission of CFCs, ODP
	Air and Water pollution	Many	WHO regulation values
District Scale	Acid rain	7	[H+] Concentration in rain
	Waste problem	2	Amount of residuals in disposal





Eco-Load at Manufacturing Stage





Results of LCA-NETS

Conclusions

- **LCA-NETS** method can be used to evaluate the environmental impacts of polycrystalline solar cell power plant in Thailand.
- At the primary loop of LCA study, 98% of the environmental impacts come from the manufacturing phase.
- Detail LCA that cover all stages should be done to enhance the potential of solar cell product and minimize the life cycle environmental impacts for a better sustainable future.



The end of Presentation

Thank you for your attention.

SUSTAINABLE**ENERGY**

SUSTAINABLE**ENVIRONMENT**

SUSTAINABLE**DEVELOPMENT**

