Using Life Cycle Thinking to Promote Sustainability in Emerging Economies

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SEE 2018, 30 November 2018, Bangkok
Life Cycle Thinking - Pathway of Thailand

1990
GT/CT Projects in industry

1993
LCA Pilot Projects

1997-1999
Life Cycle Network
- Thai LCA Network
- LCA in academics

2000
LCA/Eco-Design Capacity Building
- Supported by JP government.

2002

2007-2009
National LCI DB
- MoU 5 Orgs – MoU-FTI-TEI-NSTDA-TRF

LCA Applications (+ in Policy)
- National Carbon Footprint
- Eco-Product Directory

2009

2012
LCA Agrifood Asia Network

2013-2015
Sustainable Development
- National committee on SD
- Water Footprint
- Env. Footprint,
- Green GDP, SAFA
- SCP/SD indicators

2015-present
- Full GT/LCA for SDGs/SCP
- Sustainable Industry/Agriculture/Tourism/City..

2012-2015
- National LCI DB - 2
- Water Footprint, PEF
- Sust. Ass./SCP/SEEA

2000
1
LCT

2007-2009
Cap Bldg

2009
3
Appl

2015-present
4
SDGs

1
LCT
2
Cap Bldg
3
Appl
4
SDGs

Courtesy: Dr Thumrongrut Mungcharoen, NSTDA
LCA APPLICATIONS AND RESEARCH

DEVELOPMENT OF THE NATIONAL LCI DATABASE
Thai National LCI Database Development Pathway

Thai LCI Database

- Capacity building of human resource on LCA

2002

First Thai LCI Database Master Plan

2005

Thai National LCI Database

- Promotion of LCA applications are the main goal to support the use of LCI database.

2010

Quality Improvement

- Developing data collection and analysis tools

2015

LCA Applications

- GHG LC-Emission Factors for National CF Label, CFP/CFO/CFR, WF, EcoProducts, SPP, EcoEfficiency, Green GDP, LCA in policy, SDGs, etc.

2004

- Thai LCI Database @ MTEC

2007

Master Plan

- Establish the Thai National LCI database (MOI, MTEC, TRF, TEI, FTI)

2013

- Data quality concerned, LCI and documentations are improving

Software Development

Courtesy: Dr Jitti Mungkalasiri, MTEC
Thai National LCI Database

Thai National LCI Database (Master Plan, Dec. 2004)

Infrastructure
- Energy, Utilities and Transportation
  - Coal, Natural Gas
  - Petroleum (gasoline, diesel, jet fuel, gas oil)
  - Biofuels
  - Electricity grid
  - Transportation system
  - Water supply (surface/ground)

Industry Materials
- Plastics (PS, PE, PP, etc.)
- Non-ferrous metals
- Ferrous metals
- Aluminum, Copper
- Fibers
- Synthetic rubber (SBR, BR)
- Pulp & Paper
- Petrochemicals (7)

Commodity Chemicals
- NaOH
- H2SO4
- HCl
- Cl2
- Lime
- Na2CO3
- Sulfur
- Fertilizer/ Pesticide

Agriculture
- Cassava
- Rice
- Sugar cane
- Corn
- Cotton
- Natural rubber
- Vegetable oil
- livestock
- Animal feed

Recycle and Waste Management
- Recycle
- Landfill
- Anaerobic digestion
- Incineration

Building and Construction Materials
- Steel/ Gypsum
- Cement
- Glass
- Wood
- Tiles

Energy, Utilities and Transportation
- Coal, Natural Gas
- Petroleum (gasoline, diesel, jet fuel, gas oil)
- Biofuels
- Electricity grid
- Transportation system
- Water supply (surface/ground)

Recycle
- Landfill
- Anaerobic digestion
- Incineration

MOU since 30 Mar. 2007 (renewed every 2 years)
- MOU with JRC/EU 22 Aug. 2007
- join UNEP/SETAC LC initiative
- Technical Support by Japanese Government through GPP
- Financial Support by Thai Government

Thai National LCI Database (@ Feb 2015) -> GHG emission factor

WEBSITE
Thai LCA Software
Thai LCI Data for Research
LCI Databases exchange with other Countries

NATIONAL LCI DATABASE
1,300

TOTAL (G+G.146, C+G.552) 1,300

MTEC
a member of NSTDA

MOU with JRC/EU 22 Aug. 2007
join UNEP/SETAC LC initiative
Technical Support by Japanese Government through GPP
Financial Support by Thai Government
Partners in Thailand

Office of Natural Resources and Environmental Policy and Planning.

Department of Mineral Fuels

Land Transportation

Petroleum Institute of Thailand

Courtesy: Dr Thumrongrut Mungcharoen, NSTDA
Thai-LCA applications

Thailand joins the Global LCA Data network (GLAD)
- UN Environment

Steering Committee

Brazil MMA CNIS EC DG-ENV DG-JRC France Ademe
Germany Italy Japan Malaysia Mexico
Naturverordnet MTEC BAFU USDA UN Environment

Life Cycle Initiative

GLOBAL LCA data access

More than 800 databases are domestically available

Footprint Family: CF, WF, etc.

Eco Product Directory

LCA Data

Green Public Procurement

Policy Justification

Sust. Assess.

...Green GDP, Green public procurement, Ecolabel, Resource efficiency, Circular economy, Sustainable development goals...

Courtesy: Dr Jitti Mungkalasiri, MTEC
LCA APPLICATIONS AND RESEARCH
LCA Applications & Initiatives

1. Carbon Footprint (since 2009)
   - GHG emission factors
   - Assessment Tools
   - LCA Inventory data
   - LCA, Eco-Design

2. EcoProducts Directory (since 2009)
   - Life Cycle Thinking
   - GHG emission factors
   - Assessment Tools
   - LCA Inventory data
   - LCA, Eco-Design

3. Green Public Procurement (since 2012)
   - Life Cycle Thinking
   - GHG emission factors
   - Assessment Tools
   - LCA Inventory data
   - LCA, Eco-Design

4. Sustainability assessment (Biofuels, AgriFood,..) (since 2006)
   - Life Cycle Thinking
   - GHG emission factors
   - Assessment Tools
   - LCA Inventory data
   - LCA, Eco-Design

5. Policy Justification (since 2012)
   - Life Cycle Thinking
   - GHG emission factors
   - Assessment Tools
   - LCA Inventory data
   - LCA, Eco-Design

6. Water/Environmental Footprint (since 2010)
   - Life Cycle Thinking
   - GHG emission factors
   - Assessment Tools
   - LCA Inventory data
   - LCA, Eco-Design

7. SCP-SD Indicators/Institutional framework (since 2013)
   - Life Cycle Thinking
   - GHG emission factors
   - Assessment Tools
   - LCA Inventory data
   - LCA, Eco-Design

• Food vs. Feed vs. Fuel ?
• Green GDP/Green Industry
• Eco-efficiency/ Factor X
• Adder/ Externalities ?
• Env. Tax, etc.

Sugar cane/ Molasses/ Cassava/ Oil palm/ Jatropha

Courtesy: Dr Thumrongrut Mungcharoen, NSTDA
LCA-based labels in Thailand

Type 1
Ecolabel based on LCT

Type 2
Carbon footprint label based on LCA

Type 3
Company labels
LCA APPLICATIONS AND RESEARCH

CARBON FOOTPRINT
Carbon Footprint Labels

100g

2,872 products
537 companies

514 products
75 companies

29 products
12 companies

113 fabric str.
27 companies

34 products
21 companies

COOL mode

CO₂ UPCYCLE
Life Cycle Initiatives for Municipalities in Thailand:
Carbon Footprint for Organization and City Carbon Footprint

- **North**: 45 Municipalities
- **Northeast**: 34 Municipalities
- **Central**: 22 Municipalities
- **East**: 4 Municipalities
- **South**: 22 Municipalities

**Regional Distribution of CFO and CCF from 2011 to 2017**

- Carbon Footprint for Organization (CFO) from 2011 to 2017: **127 Municipalities**
- City Carbon Footprint (CCF) from 2014 to 2017: **71 Municipalities**
- CFO & CCF in 2018: **23 Municipalities**

Courtesy: Dr. Trakarn Prapaspongsa, MU

Research Unit for Energy Economic and Ecological Management Science and Technology Research Institute, Chiang Mai University
City Carbon Footprint (CCF) of 23 Municipalities (M) in Thailand in 2018

<table>
<thead>
<tr>
<th>Municipality Size</th>
<th>Average GHG Emission (t CO₂eq/person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Scale</td>
<td>6.93</td>
</tr>
<tr>
<td>Medium Scale</td>
<td>4.84</td>
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<tr>
<td>Small Scale</td>
<td>6.50</td>
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<table>
<thead>
<tr>
<th>Municipality Size</th>
<th>Average GHG Emission (t CO₂eq/household)</th>
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</thead>
<tbody>
<tr>
<td>Large Scale</td>
<td>29.56</td>
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<tr>
<td>Medium Scale</td>
<td>11.78</td>
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<tr>
<td>Small Scale</td>
<td>16.82</td>
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<table>
<thead>
<tr>
<th>Municipality Size</th>
<th>Average GHG Emission (t CO₂eq/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Scale</td>
<td>73,389.70</td>
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<tr>
<td>Medium Scale</td>
<td>13,234.01</td>
</tr>
<tr>
<td>Small Scale</td>
<td>8,331.17</td>
</tr>
</tbody>
</table>
LC-Water Footprint Activities in Thailand

• 2010-2011: policy research: study how to use STI to support WF (by NSTDA)

• 2012: (12-16 Nov.) NSTDA nominated Prof. Shabbir Gheewala as the Thai representative to the “Train the Trainers on CF & WF” in Paris organized by the UNEP-SETAC LC Initiative

• 2013: (2-3 July) NSTDA (with the support by UNEP) organized “Train the Trainers on WF” at NSTDA. Lecturers are Stephan Pfister (ETH Zurich) & Shabbir (batch 1: 35 trainees)

• 2014: (15-16 Oct.) NSTDA organized “Train the Trainers on WF” using lecturers of batch 1 (top 3) (batch 2: 40 trainees)

• 2015: (29 July) NSTDA provided lecturer for Water Institute for Sustainability, FTI “Train the Trainers on WF” (batch 3: 30 trainees)

• @ present: several research works on WF (supported by TRF, ARDA, NSTDA,..)

Water Stress Index of 25 watersheds in Thailand (Source: S. Gheewala)
Water stress index and its application for water scarcity footprint calculation in Thailand
So many labels ... 

Who are the buyers?
Green Product Procurement in Thailand

**GPP Phase I**
2008-2011
- MoNRE assigns PCD to implement GPP
- 170 departments join
- 14 products and 3 services listed

**GPP Phase II**
2013-2016
- More govt. organisations and private sector join
- 17 products and 5 services

**GPP Phase III**
2017-2021
- Local administrative orgs., universities and more private enterprises
- 19 products and 5 services
LCA APPLICATIONS AND RESEARCH

LCSA – FOOD AND FUEL
Life Cycle Environmental Sustainability Assessment of Oil Palm Plantations in Thailand

- **Life Cycle Inventory Data Collection**
  - Independent Smallholders
  - Group of Smallholders
  - Mini Estates
  - Mills with plantation

- **Sustainability Assessment**
  - Life cycle inventory
  - LC-GHG emissions (Carbon Footprint)
  - Water requirement, footprint and impact potential
  - Water requirement, footprint and impact potential
  - Land use and HCV areas

- **Outputs**
  - Identification of environmental hotspots and recommendations for supporting sustainable oil palm production
  - Data for supporting Thailand National LCI Database of Oil palm plantations (Province/Region levels)
  - Environmental sustainability indicators and baseline data for oil palm plantation in Thailand for supporting certification of RSPO and/or other sustainability standards
Sustainability Assessment of Sugarcane Complex for Enhancing Competitiveness of Thai Sugarcane Industry

**Life cycle of sugarcane systems**

- Land use for sugarcane plantation
- Sugarcane cultivation & Harvesting
- Sugar milling
  - Agr. residues
  - Bagasse
  - Cane juice
  - Filter cake
  - Wastewater
  - Bio-electricity generation
  - Sugar processing
  - Waste/By-products utilizations
  - Molasses
  - Bio-ethanol production
- Bio-electricity
- Sugar
- Bio-ethanol
- Value-added products

**Scenarios for sustainability assessment**

- LUC scenarios for sugarcane plantation in Thailand
- Comparative assessment for different agricultural practices, varieties, yields
- Comparative assessment for different production systems and different by-products utilization systems. The scope of impact assessment includes:
  1. GHG emissions
  2. Water use
  3. Eutrophication
  4. Acidification
  5. Eco-toxicity
  6. Human-toxicity
  7. Photo-chemical oxidation
  8. Socio-economic impact
  9. Other aspects related to BSI, GBEP

- Sustainability indicators & Baseline data for Thai sugarcane industry
- Life cycle GHG emission method and GHG emission factors for the Thai sugarcane industry
- Roadmap for sustainable sugarcane bioenergy production in Thailand
LCA APPLICATIONS AND RESEARCH

GREEN GDP
Green GDP is one of the indicators used to assess Sustainable Development. To integrate environmental and social impacts into traditional economic GDP

Why Green GDP?

- Limitation of GDP has as an indicator of economic performance and social progress
- Need more comprehensive macroeconomic indicator consistent with the concept of Sustainable Development
- Green GDP can integrate environmental statistics into national accounts and reflect a country’s ability to manage its economics and resources

What is Green GDP?

*Green GDP is an indicator of economic growth with the consequences* on that growth factored into the traditional GDP

**Economic & Social:** Traditional GDP

**Environment & Social:** Environmental Consequences

- e.g. Resource depletion, environmental degradation, protective or restorative environmental initiatives

Courtesy: Dr Viganda Varabunthoonvit, KU
Green GDP is a Joint KPI between ministries for Sustainability Growth

Start from Green GDP of Industrial Sector to incorporate and develop

- Green GDP Timeline in Thailand

  • Policy justification and Decoupling indicator
    - SD Index/Green GDP
  • Joint KPIs
    - Sustainable growth indicator is Green GDP
  • BIOTEC: Green GDP of Agricultural sector based on SEEA concept
  • VGREEN KU: Green GDP of Agri sector by using EIO-LCA (Agri)

  2012

  • Convert physical value in Thai National LCI Database to monetary value for Green GDP Calculation
  • Need to research for “Green GDP”
    - Calculation method

  2013

  • CMU and KU: Green GDP for Industrial Sector
    (petroleum refinery, paper and sugar)

  2014

  • Green GDP Critical Review
  • Monitoring and Update
    - Petroleum Refinery
    - Upstream Petrochemical
    - Sugar
    - Mining
    - Cement
    - Rubber

  2015

  • Convert physical value in Thai National LCI Database to monetary value for Green GDP Calculation

  2016

  • Monitoring/Update
    - Petroleum Refinery
    - Upstream Petrochemical
    - Sugar
    - Mining
    - Cement
    - Rubber

  2017

Coverage: Dr. Viganda Varabuntoonvit, KU
Overall Green GDP Calculation Based on SEEA and LCA Concept

Inventory data will be collected from each ministry and convert to monetary term

**Green GDP Workflow**

1. **Gross Domestic Product (Sector level)**
   - NESDB GDP at current market price

2. **Study Process**
   - Defined Goal and Scope
   - Life Cycle Inventory Analysis (LCI)
   - Life Cycle Impact Assessment
   - Interpretation

3. **Physical Units**
   - Direct Emissions (GtoG)
   - Review/request data each of ministry

**Monetary Terms**

- MAC$_T^*$: Marginal Abatement Cost (Technology base)
- MAC$_E^{**}$: Marginal Abatement Cost (Extraction base)
- Damage cost
- Degradation cost
- Depletion cost

**Green GDP of Each Sector**

Courtesy: Dr Viganda Varabunthoonvit, KU
LCA APPLICATIONS AND RESEARCH

GREEN INDUSTRY
ECO FACTORY Roadmap

2014
- Std requirements V 1.0
- 2 Pilot cases
- 12 Auditors

2015
- Implementation

2016
- MoU with MoI, equivalent to GI4

2017
- MoU with IEAT

2018
- Std requirements V 2.0
- 166 certified factories

www.ecofactory.fti.or.th

Courtesy: Dr Rattanawan Mungkung, KU
Green Industry Mark

Green Industry Performance (Firms)

<table>
<thead>
<tr>
<th>Level</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>Total</th>
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<td>1</td>
<td>316</td>
<td>1,172</td>
<td>4,407</td>
<td>5,637</td>
<td>4,328</td>
<td>809</td>
<td>16,669</td>
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<tr>
<td>2</td>
<td>227</td>
<td>705</td>
<td>1,733</td>
<td>764</td>
<td>986</td>
<td>447</td>
<td>4,862</td>
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<td>3</td>
<td>507</td>
<td>603</td>
<td>882</td>
<td>659</td>
<td>730</td>
<td>384</td>
<td>3,765</td>
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<td>4</td>
<td>-</td>
<td>30</td>
<td>20</td>
<td>1</td>
<td>42</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>8</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>1,050</td>
<td>2,510</td>
<td>7,042</td>
<td>7,066</td>
<td>6,094</td>
<td>1,648</td>
<td>25,410</td>
</tr>
</tbody>
</table>

Courtesy: Dr Rattanawan Mungkung, KU
LCA APPLICATIONS AND RESEARCH

THAI ECOLOGICAL SCARCITY
Several impacts of Thai Eco Factors developed from the national policies

Emission to air
- Greenhouse gases
- Ozone-depleting substances
- Acidifying gases
- Photochemical Ozone Creation
- Paticulate matters
- Carcinogenic substances
- Heavy metals to air

Emissions to surface waters
- Nutrient emissions
- Heavy metals to freshwater

Emissions to soil
- Pesticide

Emissions to groundwater
- Nitrate

Wastes
- Deposited solid waste

Resources
- Primary energy
- Land use
- Metal mineral
- Non-metal mineral
- Freshwater

NATIONAL POLICY TARGETS
Energy plans: AEDP, EEP
Climate Change Master Plan
Environmental Quality Management Plan
Water / Air / Soil / ground water Quality Standards
Solid waste management target
Montreal Protocol on ODS
Forest Conservation target
..... etc.

2011

Courtesy: Dr Naruetep Lecksiwilai, JGSEE
LCA APPLICATIONS AND RESEARCH

FOOD, FUEL AND CLIMATE CHANGE
Research Network for LCA and Policy on Food, Fuel and Climate Change

- Development of capacity and human resources for LCA in Thailand
- Policy recommendations on food and fuel issues vis-à-vis climate change
- Commitment to continue activities on LCA of the researchers and partners

**Production Systems**

- Feedstocks:
  - Rice
  - Cassava
  - Sugar cane
  - Oil palm
  - Rubber

- Products:
  - Food
  - Fuel
  - Bio-refinery products

**Policies**

- Climate change mitigation
- Efficient resources use
- Ensuring food security
- Enhancing energy security
- Towards Green Economy & Poverty reduction
- Support country’s SCP

**Resources**

- Land
- Energy
- Chemical
- Water

**Tools used**

- Consequential LCA, Social LCA, Cost Benefit Analysis
NSTDA Research Chair Grant 2016
Network for Research and Innovation for Trade and Production of Sustainable Food and Bioenergy
LCA IN THAILAND
Promoting Sustainability in Emerging Economies via Life Cycle Thinking

November 2017, Issue 11, Pages 1641-1891

- Guest editors from Thailand

- 9 out of 18 papers are from Thailand
  - Thai national life cycle inventory readiness for product environmental footprint
  - Consequential and attributional environmental assessment of biofuels: implications of modelling choices on climate change mitigation strategies
  - Budget constraint and the valuation of environmental impacts in Thailand
CONFERENCES CONTACTS

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11th International Conference
LIFE CYCLE ASSESSMENT
FOOD 2018
17-19 OCTOBER | BANGKOK, THAILAND

www.lcafood2018.com
lcafood2018@gmail.com
Promoting sustainability in emerging economies via life cycle thinking

» Starting from the idea of cleaner production

» Introducing the importance of life cycle thinking through various tools
  — Ecolabeling, EPDs, Green public procurement

» Development of National LCI Database

» Application of life cycle-based tools in industry and policy-making

» Aligning national goals with international movements