UNIDO-MAEESTA

SOLAR HEAT FOR INDUSTRIAL PROCESSES (SHIP) INTEGRATION FOR ENERGY RESOURCE CONSERVATION

Case Study in Palm Oil Refining and Oleochemical Industry

ISEC – 2nd International Sustainable Energy Conference 2022

Ahmad Zafuan Mohamed Kassim

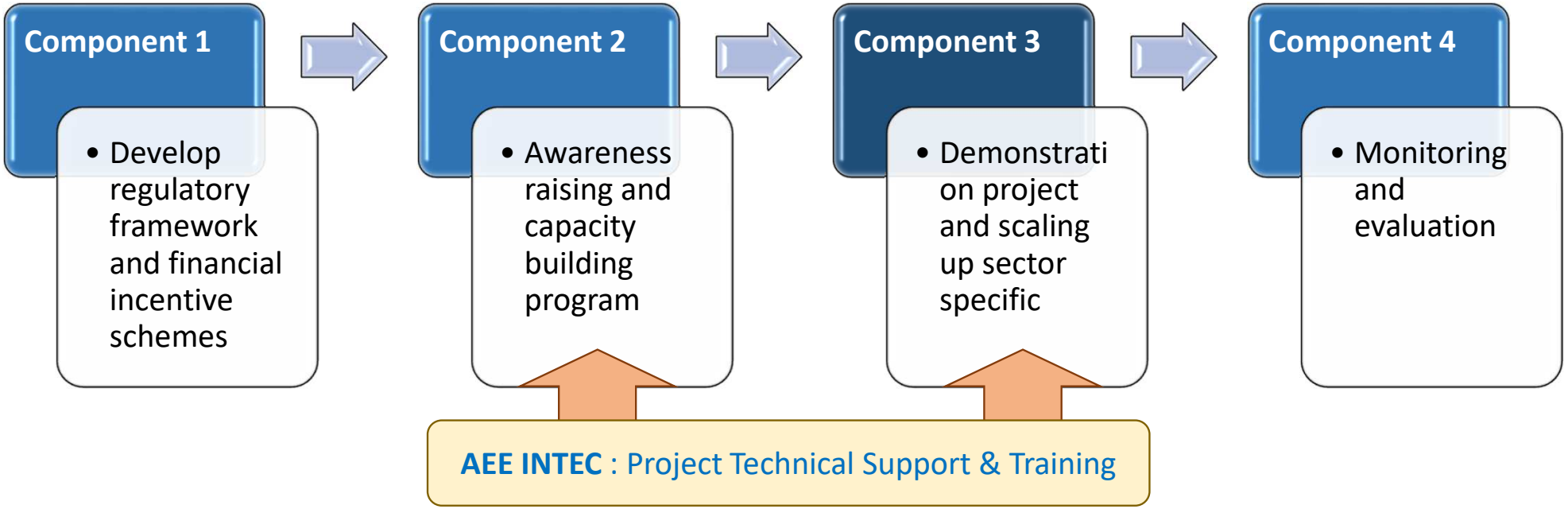
National Expert
UNIDO-MAEESTA Project

National Project

Implementing Agency	**United Nations Industrial Development Organization, UNIDO**
Project Funding	**Global Environment Facility, GEF**
Executing Agency	**SIRIM**
Stakeholders	**MOSTI, KETSA, EPU, ST, SEDA, MGTC, MITI, MIDA, SME Corp, SERI, FMM**

National Project

GHG Emissions Reductions in Targeted Industrial Sub-Sectors Through Thermal Energy Efficiency and Application of Solar Thermal Systems in Malaysia



SOLAR HEAT FOR INDUSTRIAL PROCESSES (SHIP) INTEGRATION FOR ENERGY RESOURCE CONSERVATION

Case Study in Palm Oil Refining and Oleochemical Industry

Ahmad Zafuan Mohamed Kassim, Luk Chau Beng, Sanjaya Man Shrestha
***UNIDO-MAEESTA National Project**, SIRIM Complex, Section 2, 40700 Shah Alam, Selangor, Malaysia*

Haslenda Hashim, Zarina Ab Muis, Ho Wai Chin, Nor Alafiza Yunus, Muhammad Imran Ismail
***Process System Engineering Centre (PROSPECT), Universiti Teknologi Malaysia (UTM),** 81310 Johor, Malaysia*

Cheng Kai Chong, S Sadish Kumar Surendran Pillay
***IOI Pan-Century Edible Oils Sdn. Bhd**, Pasir Gudang, Johor, Malaysia*

Wolfgang Gruber-Glatzl, Jürgen Fluch
***AEE – Institute of Sustainable Technologies**, Gleisdorf, Austria*

Project Background

Currently in Malaysia…

- Thermal energy efficiency (demand-side) – **not yet regulated**

- **Renewable Energy Act 2011** – focus on Feed-in Tariff (Fit) for **electricity generation** from the specified renewable energy resources and technology
  - ✓ Biogas
  - ✓ Biomass
  - ✓ Small hydropower
  - ✓ Solar Photovoltaic

Energy Efficiency and Conservation Act (EECA) – bill to the Parliament for debate

- *Targeted 2022-2023*

Project Background

In March 2019… we develop **Project Ecosystem** for Solar Thermal Demonstration Project Development

Related Federal Agencies

SEDA : Sustainable Energy Development Authority
- Authority for RE Act 2011

EC : Energy Commission
- Energy (electricity & gas) regulator
- In near future **Thermal Energy** – (based on EECA)

MGTC : Malaysia GreenTech
- Green procurement development & database

MIDA : Malaysia Investment Development Authority
- Green investment tax – *based on the green procurement*

Related State Agencies

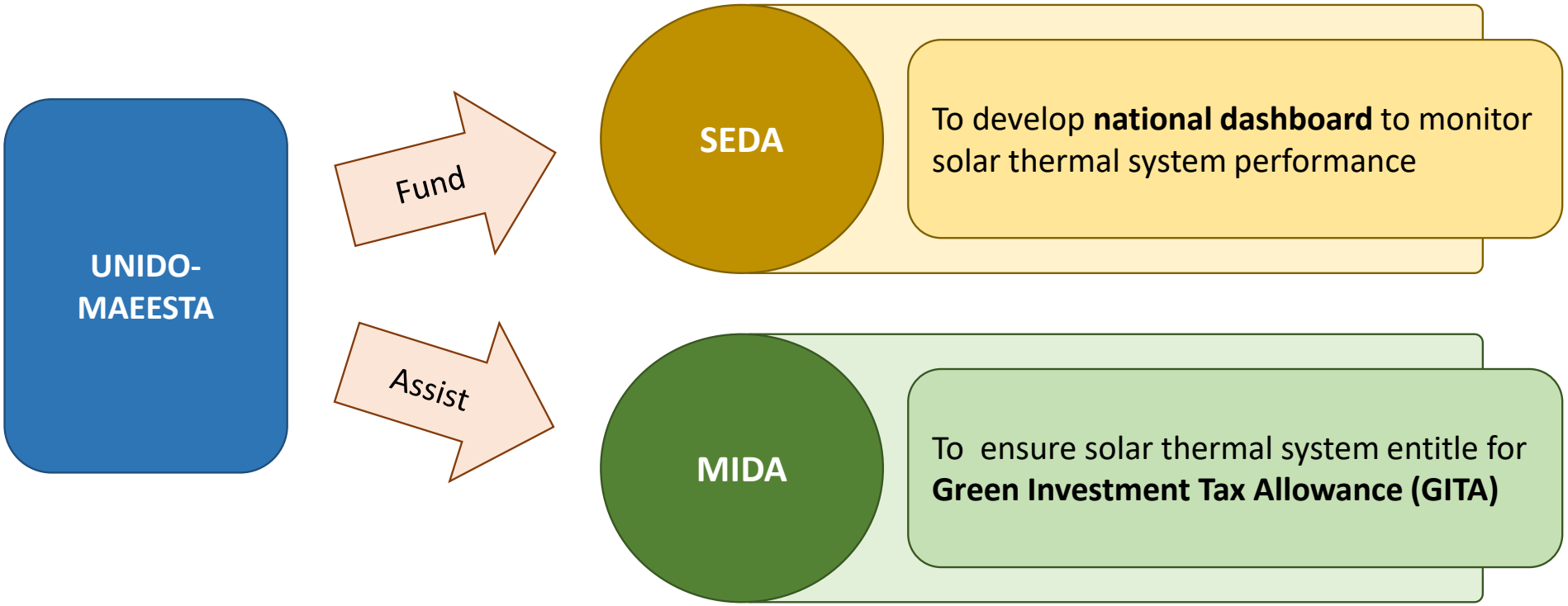
Selangor
- Invest Selangor Berhad (ISB)

Sarawak
- Sarawak Economic Development Corporation (SEDC)

Johor
- Iskandar Regional Development Authority (IRDA)

Terengganu
- *Entrepreneur Development Foundation (YPU)*
- *East-Cost Economic Regional Development Authority (ECERDC)*

Project Background



One of the success factors for this project (a case study)

Project Background

February 2020 : **5 Project Approved**

(Before Covid19 Pandemic)

Company	Industry	State
Company A	Bulking Storage	Selangor
Company B	Medical Glove	Terengganu
Company C	Animal Feed	Terengganu
Company D	Food Ingredients	Johor
Company E	Resort	Sarawak

Current : **2 Project Proceed**

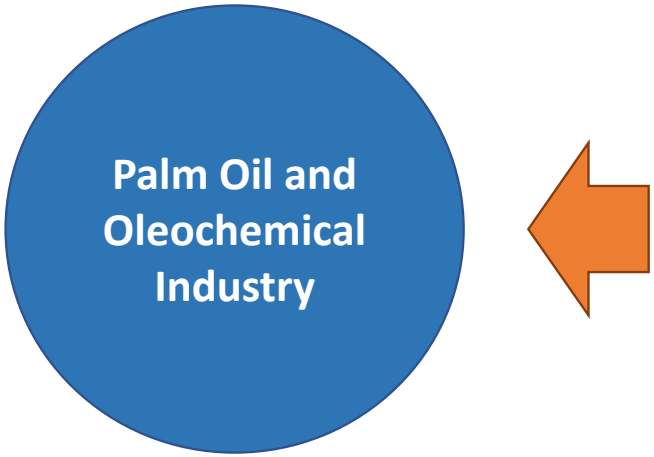
(Current Covid19 Pandemic condition)

Company	Industry	State
Company D	Food Ingredients	Johor

+

Company	Industry	State
Company F	Oleochemical	Johor

Palm Oil and Oleochemical Industry



Sustainability Certifications in the Palm Oil Industry

- **Roundtable on Sustainable Palm Oil (RSPO)**
- **Malaysia Sustainable Palm Oil (MSPO)**
- Indonesia Sustainable Palm Oil (ISPO)
- International Sustainability and Carbon Certification (ISCC)
- Roundtable on Sustainable Biomaterials and Sustainable Agriculture Networks (RSBSAN)

Sustainability Report – compulsory for Public Listed Company

UNIDO-MAEESTA *: we are collaborating with UTM to approach* ***Company F*** *(oleochemical industry)*

This project was developed based on the ***triple helix work integration model*** *: Industry, Government & University*

Palm Oil and Oleochemical Industry

PROJECTIONS FOR THE OIL PALM INDUSTRY

	2006-2010	2011-2015	2016-2020	2006-2020	2006-2020
	(RM billion)				Average Annual Growth (%)
Investments	5.9	8.6	11.6	26.1	8.2
Investments per year	1.2	1.7	2.3	1.7	n.a.[1]
Exports (end period)	40.5	59.6	78.8	78.8	7.6

Third Industrial Master Plan (IMP3) 2006-2020 by MITI : Palm-Oil Based Industry

Malaysia currently produces 28% of the world's palm oil and export and export 33% of it.

(Ismail et al, 2020)

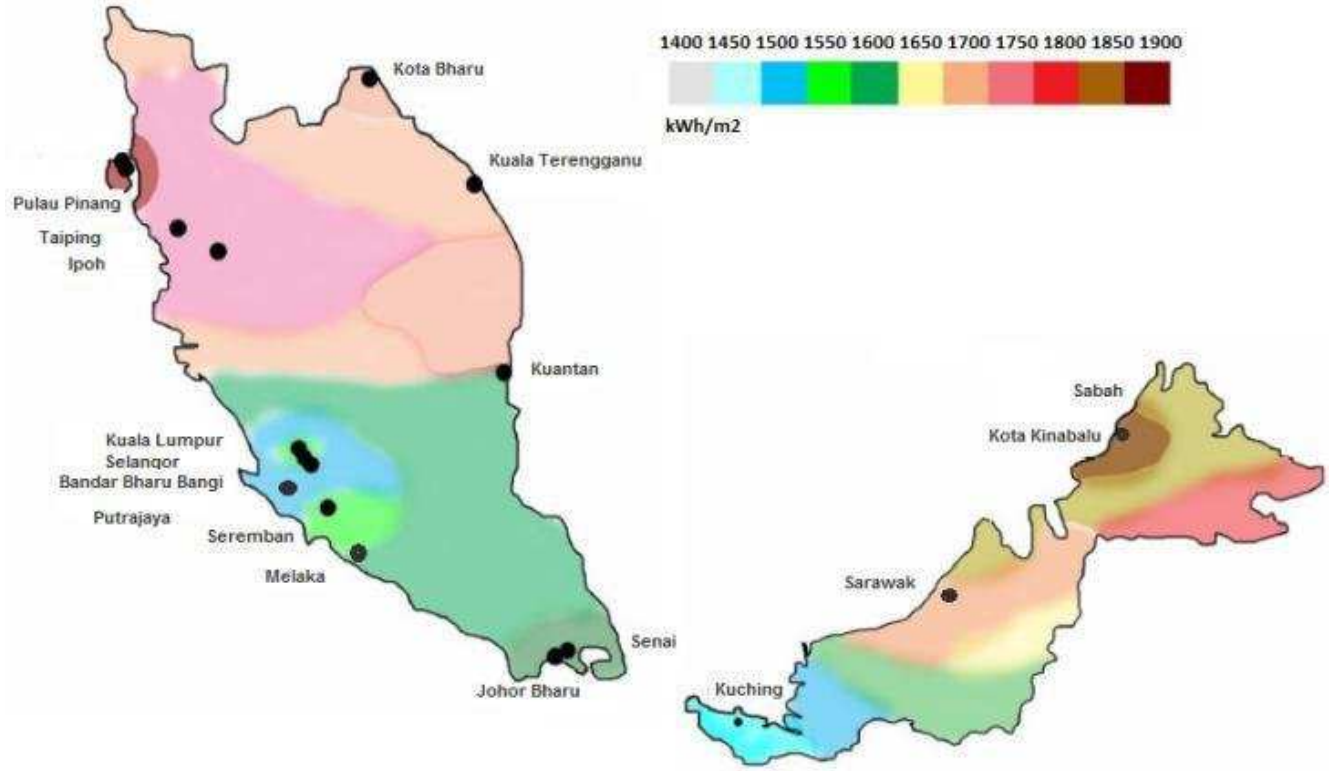
Solar Heat for Industrial Processes (SHIP)

The annual average solar irradiation level (kWh/m$^{2)}$ in Malaysia

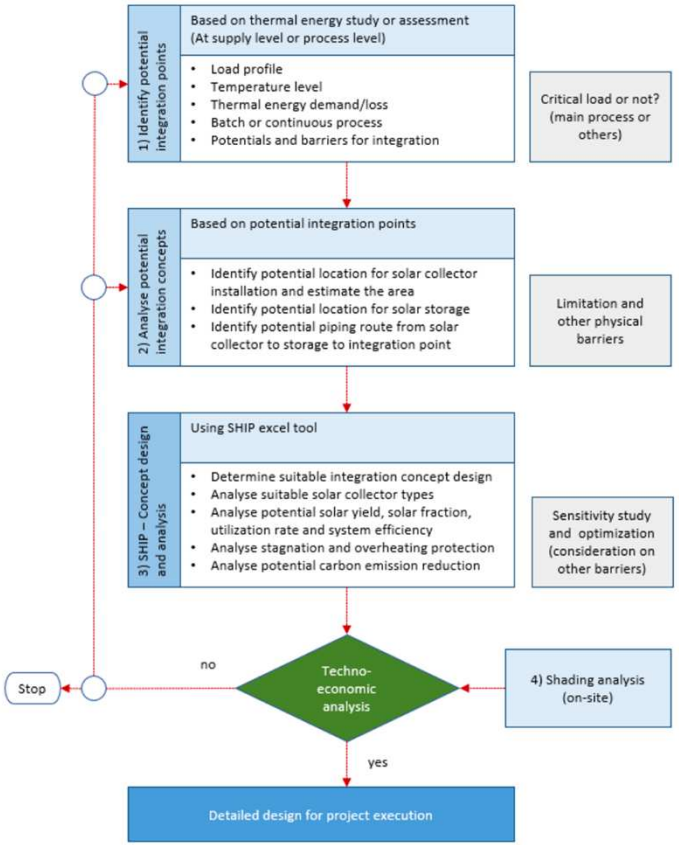
Malaysia has great achievement on **solar PV installation projects**

Total installed capacity at the end of 2019 was about 1.2 GW

https://cleanenergynews.ihsmarkit.com/research-analysis/malaysia-to-rely-on-annual-tenders-to-achieve-7-gw-renewable-t.html



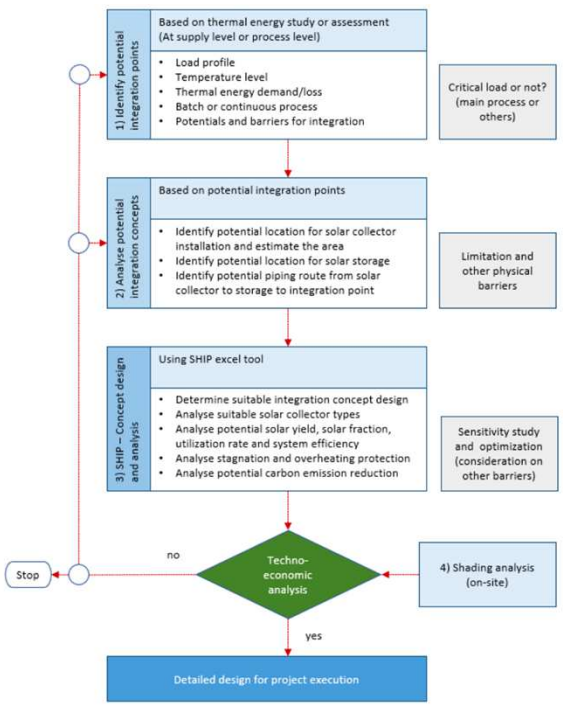
Methodology



Main reference - documents:

- Hassine, I.B., Helmke, A., Heß, S., Krummenacher, P., Muster, B., Schmitt, B., Schnitzer, H., (2015). ***Integration Guideline. IEA SHC Task 49***
- Schmitt, B. (2016). ***Classification of industrial heat consumers for integration of solar heat***. Energy Procedia, 91, 650-660
- Baniassadi, A., Momen, M., Amidpour, M., Pourali, O., (2018). ***Modelling and design of solar heat integration in process industries with heat storage***. Journal of Cleaner Production, 170, 522-534

Methodology – Process 1



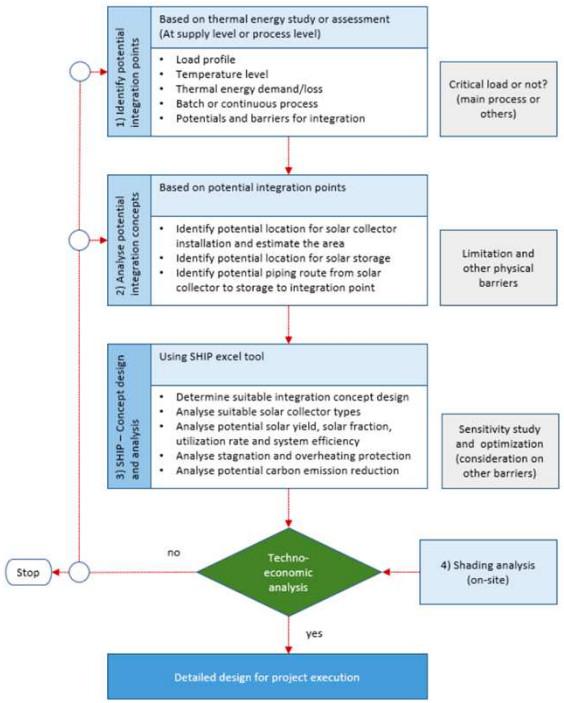
Identify potential integration points

Based on thermal energy study or assessment
(at supply level or process level)

- Load profile
- Temperature level
- Thermal energy demand/loss
- Batch or continuous process
- Potentials and barriers for integration

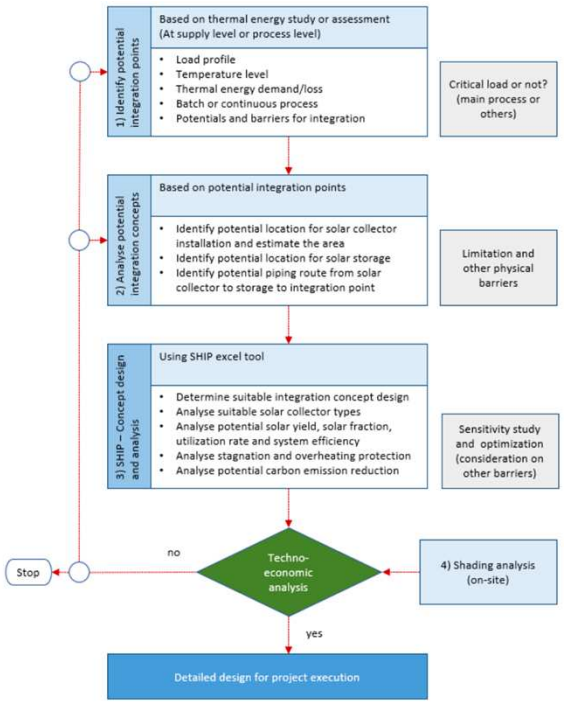
Critical load or not?
(Main process or others)

Methodology – Process 2



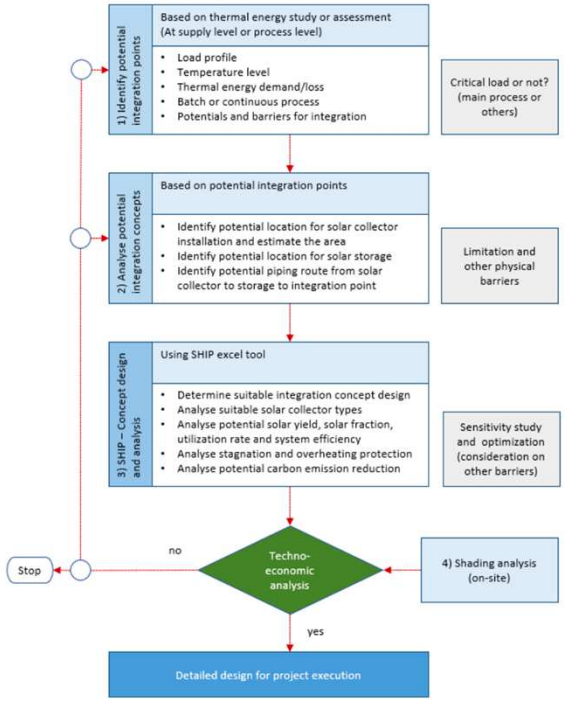
Analyse potential integration concepts
Based on potential integration points
• Identify potential location for solar collector installation and estimate the area • Identify potential location for solar storage • Identify potential piping route from solar collector to storage to integration point
Limitation and other physical barriers

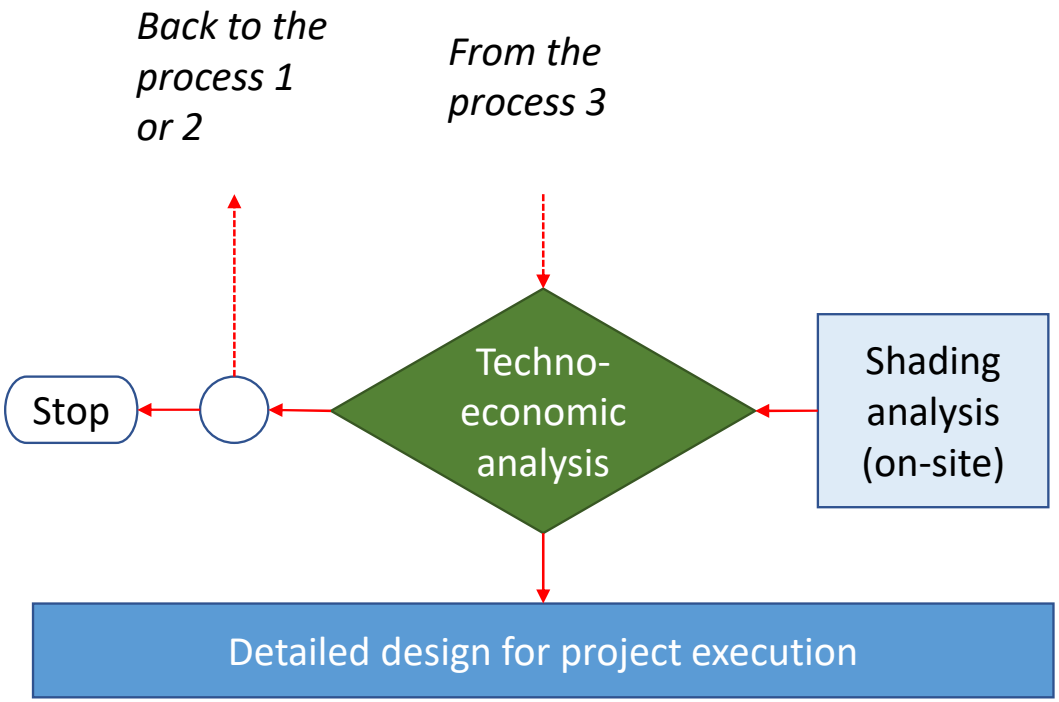
Methodology – Process 3



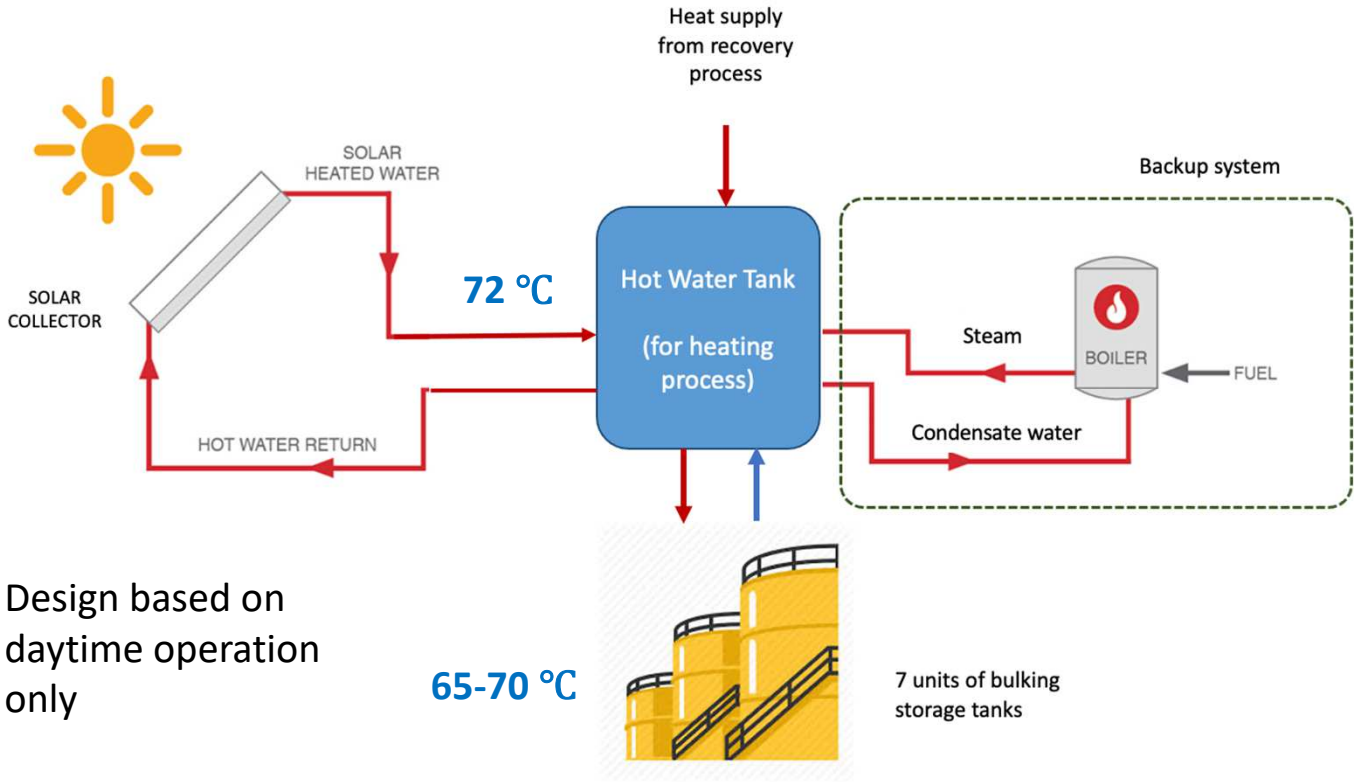
SHIP – Concept design and analysis
Using SHIP excel tool
• Determine suitable integration concept design • Analyse suitable solar collector types • Analyse potential solar yield, solar fraction, utilization rate and system efficiency • Analyse stagnation and overheating protection • Analyse potential carbon emission reduction
Sensitivity study and optimization (consideration on other barriers)

Methodology – Process 4





Case Study – Proposed SHIP Integration



Design based on daytime operation only

Currently:
The heating system using steam boiler (NG) – heating all 7 bulking storage tanks

Proposed:
SHIP integration to the new hot water tank for heating all 7 bulking storage tanks. Backup with existing boiler including heat recovery

<u>Two major limitations:</u>

- Rooftop area: 1,360 m^2 (*rooftop may change*)
- Budgetary allocation : RM 680k (EUR142k)

Case Study : SHIP Design & Analysis

Scenarios		1	2	3	4	5	6	7	8
Scenario Name	Case	Case 4	Case 4	Case 4	Case 4	Case 4	Case 4	Case 4	Case 4
		FPC 1	ETC 1	ETC 2	FPC 2	ETC 3	ETC 4	ETC 5	FPC 3
KPIs technical design		COLLECTOR FOR REFERENCE ONLY		SUPPLIER A		SUPPLIER B	SUPPLIER C	SUPPLIER D	
Solar yield	[MWh/a]	267	236	224	237	273	239	123	251
Spec. solar yield	[kWh/m².a]	799	940	941	748	867	915	545	701
Solar heat delivery	[MWh/a]	251	223	212	223	258	226	117	236
Spec. solar heat delivery	[kWh/m².a]	750	888	892	706	819	865	517	659
Installed aperture area	[m²aperture]	334	251	238	316	315	262	226	358
Installed gross area	[m²gross]	360	271	378	338	359	371	360	375
Installed storage volume	m³	29	18	11	21	17	16	-	26
Solar fraction	[%]	53%	47%	45%	47%	54%	48%	25%	50%
Utilization rate	[%]	45%	53%	53%	42%	48%	51%	30%	39%
Input costs									
Investment Costs	[MYR]	RM 880,106	RM 652,039	RM 864,244	RM 805,895	RM 841,052	RM 864,900	RM 792,000	RM 904,243
Subsidy of initial investment	[% of investment]	35%	35%	35%	35%	35%	35%	35%	35%
Annual O&M costs	[% of investment]	2%	2%	2%	2%	2%	2%	2%	2%
Residual value	[% of investment]	1%	1%	1%	1%	1%	1%	1%	1%
Cost of substituted final energy	[MYR/MWh]	220	220	220	220	220	220	220	220
Efficiency of existing system	[%]	70%	70%	70%	70%	70%	70%	70%	70%
Discount Rate	[%]	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Yearly reduction of yield	[%]	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
Project Lifetime	[a]	20	20	20	20	20	20	20	20
		RM 2,444	*RM 2,403*	*RM 2,286*	*RM 2,388*	*RM 2,342*	*RM 2,333*	*RM 2,200*	*RM 2,411*
Economic KPIs									
Annual final energy savings	[MYR/a]	78,749	70,017	66,739	70,124	81,106	71,112	36,678	74,020
Simple payback	[years]	9.2	7.3	11.2	9.6	8.4	10.3	24.3	10.3
LCOH	[MYR/MWh]	112	93	129	115	104	121	216	122
NPV	[MYR]	- 97,596	20,060	- 179,625	- 105,064	- 46,965	- 145,560	- 358,301	- 154,772

Conclusion

- Based on the constant load profile and the high solar irradiation throughout the year, solar fraction of up to 53% can be achieved.
- Economic performance is very promising compared to actual energy costs and the expected further increase in the upcoming years.
- SHIP is significant to be applied in the palm oil and oleochemical industry for cost reduction of the fossil fuel (boiler application) and decarbonisation strategy.
- This will influence the future potential **revision and formulation of renewable energy policy (RE Act 2011) to consider solar thermal technology application for heat generation** in industry and building sectors.

Thank You Very Much

Ahmad Zafuan Mohamed Kassim
National Expert

Energy Efficiency & Solar Thermal
UNIDO-MAEESTA Project

+60 19 242 8511

A.MOHAMEDKASSIM@unido.org

www.maeesta.com