



**TNB RESEARCH**

*Energizing Research, Enlivening Innovation*

## RENEWABLE ENERGY SITUATION IN MALAYSIA

### Carbon Footprint of Renewable Energy for ASEAN Countries



**AIST**

الهيئة  
NSTDA



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# Presentation Outline

#	Item
1	Renewable Energy Development in Malaysia
2	Renewable Energy: Government Policies
3	National Climate Action
4	MYRER 2035
5	Research and Development

# Renewable Energy Development in Malaysia

8<sup>TH</sup> Malaysia  
Plan (2001 -  
2005)

- RE as the 5th Fuel
- Implied 5% RE in energy mix

9<sup>th</sup> Malaysia  
Plan  
(2006 – 2010)

- **Targeted RE capacity to be connected to power utility grid:**
  - 300 MW – Peninsular Malaysia; 50 MW - Sabah
- **Targeted power generation mix:**
  - 56% natural gas, 36% coal, 6% hydro, 0.2% oil,
  - 1.8% Renewable Energy
- Carbon intensity reduction target: 40% lower than 2005 levels by 2020

RE as of 31<sup>st</sup>  
December  
2011

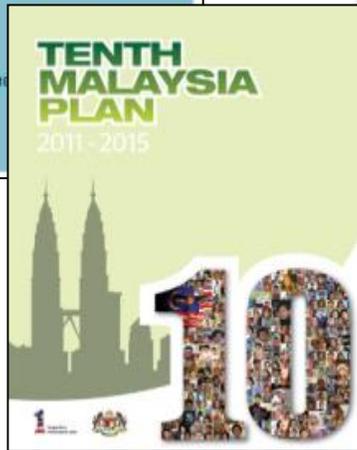
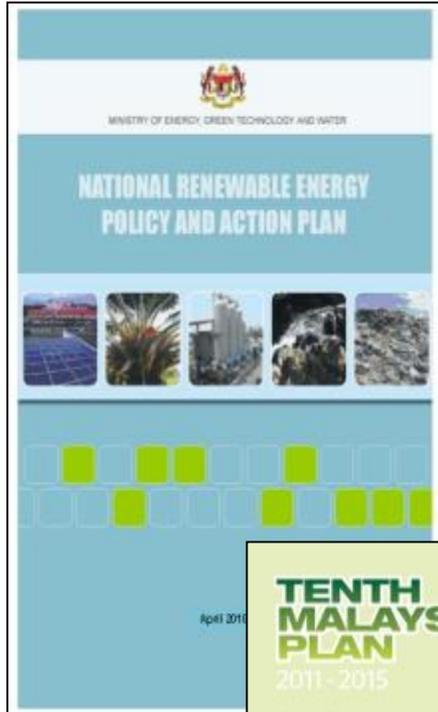
- Connected to the utility grid (as of 2011): **68.45 MW (20% from 9<sup>th</sup> MP target)**
- Off-grid: >430MW (private palm oil millers and solar hybrid)

Source:



# Renewable Energy: Government Policies

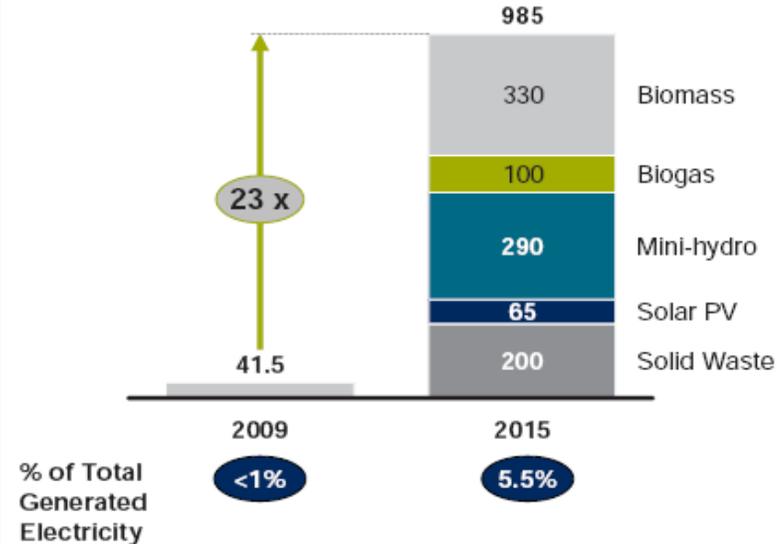
- 2<sup>nd</sup> April 2010: National Renewable Energy Policy & Action Plan approved by GOM
- 10<sup>th</sup> Jun 2010: 10<sup>th</sup> Malaysia Plan (chapter 6)
- 15<sup>th</sup> Oct 2010: National Budget 2011 (paragraph 34)
- 25<sup>th</sup> Oct 2010: Economic Transformation Programme (chapter 6)
- April 2011: Bill was passed in the Parliament, gazetted in June 2011
- 1<sup>st</sup> Dec 2011: RE Act was enforced



Renewable energy will increase from <1% in 2009 to 5.5% of Malaysia's total electricity generated by 2015

Moving towards renewable energy replaces the need for fossil-fuel power plants

Planned increase in renewable energy capacity  
MW



RE investments will receive a huge push through FIT

- Introduction of Feed-in Tariff (FiT) of 1% to be incorporated into the electricity tariffs of consumers
- Establishment of a Renewable Energy Fund from the FiT to be administered by a special agency under KeTTHA
- This provides an annual CO<sub>2</sub> avoidance of 3.2 million tonnes

Majlis Tindakan Perubahan Iklim Malaysia



Bilangan 2/2021

11 Oktober 2021 (Isnin)

- NDC update (2021): Reduction of 45% carbon intensity based on GDP by 2030 compared to 2005 level
- Net-zero GHG Emission the earliest by 2050
- Establishment of **GHG Inventory Centre**
- Government fleets using non-ICE by 2030
- Development of the **Domestic Emissions Trading Scheme (DETS)**
- National Guidance on International VCM

# Malaysia Renewable Energy Roadmap

In 2021, the Ministry of Energy and Natural Resources of Malaysia (KeTSA) set a target to reach 31% of RE share in the national installed capacity mix by 2025. This target supports Malaysia's global climate commitment is to reduce its economy-wide carbon intensity (against GDP) of 45% in 2030 compared to 2005 level. Realization of the Government's vision is crucial in supporting the nation to achieve its Nationally Determined Contributions (NDC) targets.

## Objective

To formulate strategies in achieving the national RE target:

S1	29% capacity mix	32% capacity mix	S2	31% capacity mix	40% capacity mix
	2025	2035		2025	2035

## Roadmap Document Outline

Sec	Content	Remarks
1	<b>Introduction</b>	Definition, Objectives & Scope, Guiding Principle, NDCs, Scenarios
2	<b>Global &amp; Regional Context</b>	RE Past Trends & Future Prospects
3	<b>Malaysia's Energy &amp; Power Landscape</b>	Current state, Total Primary Energy Supply
4	<b>Status of RE in Malaysia</b>	Baseline, RE Programmes, Challenges
5	<b>RE Capacity in 2035</b>	2025 & 2035
6	<b>Strategic Framework &amp; Initiatives</b>	Strategic pillars and enablers
7	<b>RE Transition Impact</b>	Technical, Social & Economics



Source:



# Technical Potential of RE in Malaysia

Based on agreed methodology and inputs received from engagement sessions

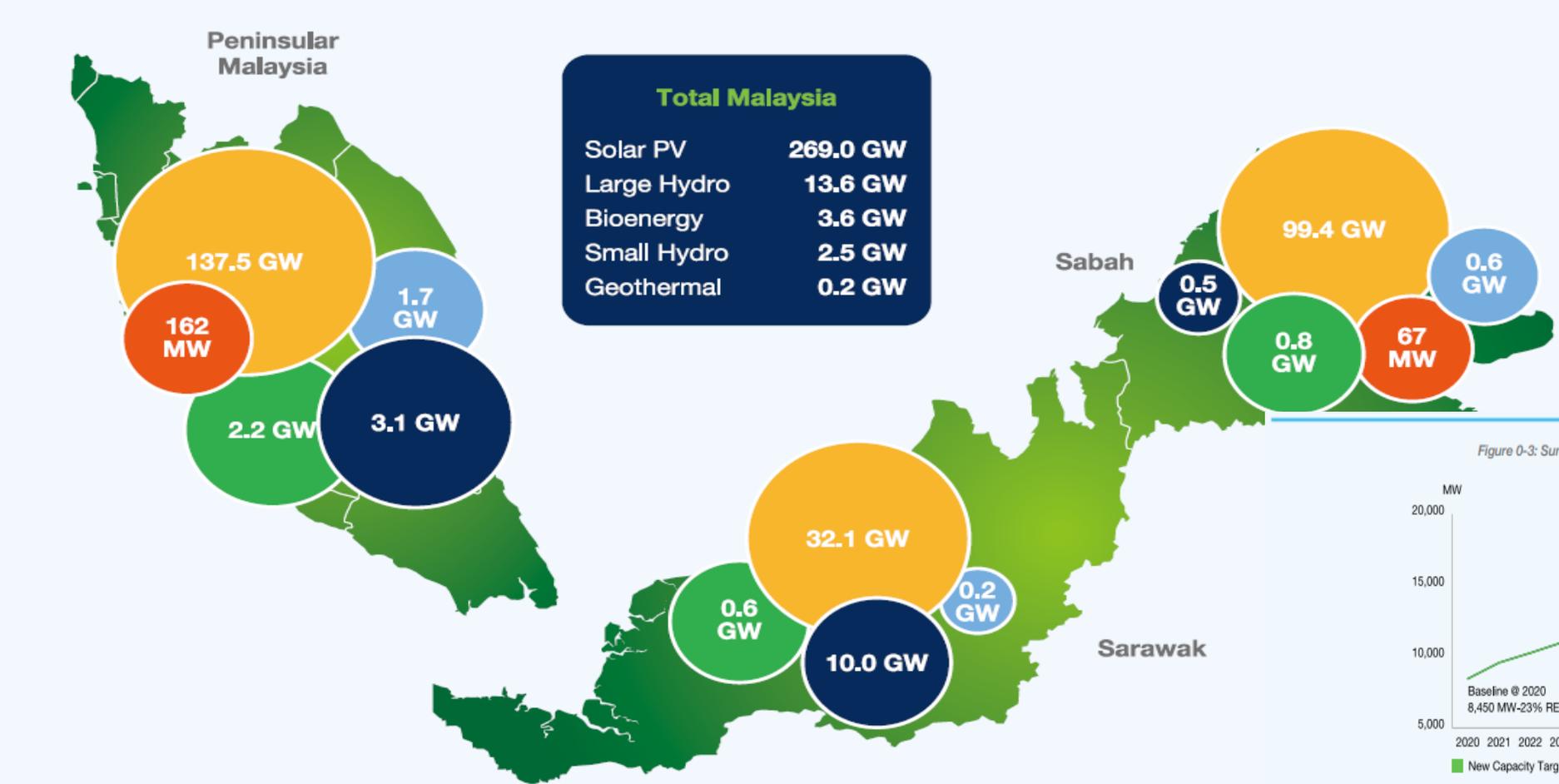


Figure 0-3: Summary of RE capacity evolution and RE share in the MyRER

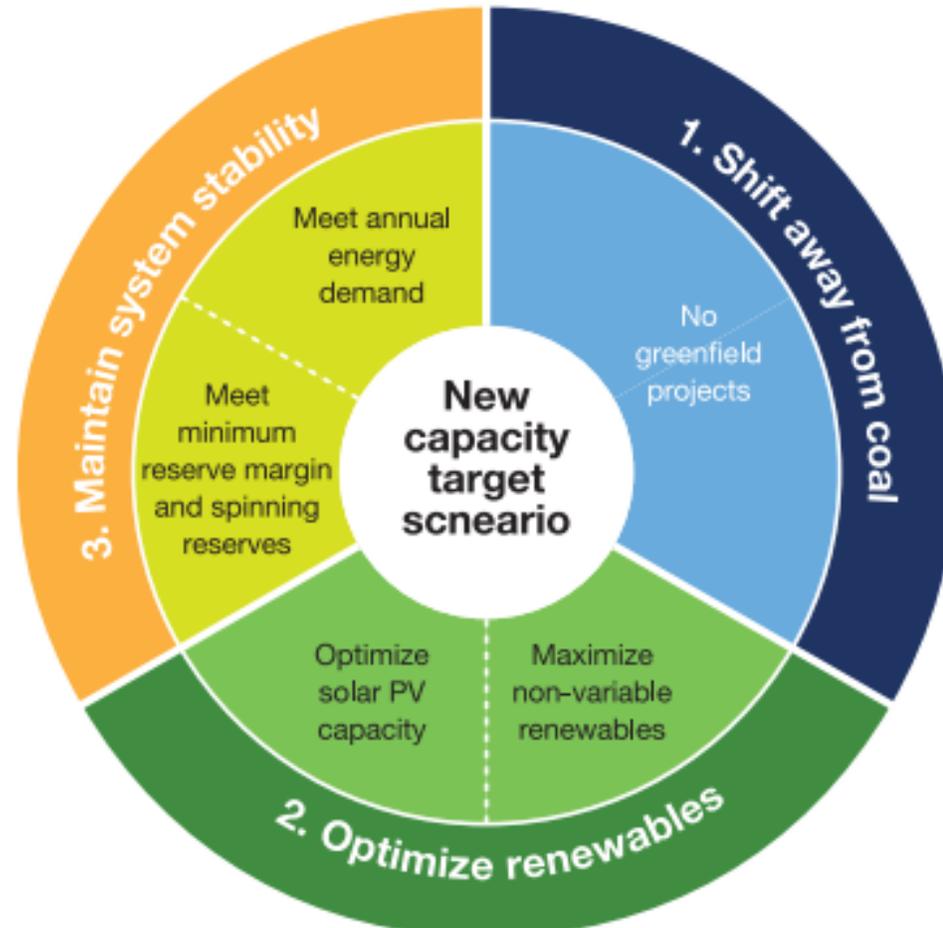


- Solar PV (includes ground mounted, rooftop and floating installation)
- Bioenergy (includes agriculture, animal and municipal & hazardous waste)
- Small hydro (system size up to 100 MW)
- Large hydro (system size > 100 MW)
- Geothermal

# Strategies for New Capacity Target 2035 scenario

## Maintain system stability

- Meet total annual energy demand
- Ensure at least 20% reserve margins over peak demand
- Ensure sufficient spinning reserves
- Mitigate VRE intermittency through battery storage



## Shift away from coal

- No greenfield coal projects and reduce reliance on coal in capacity mix

## Optimize renewables

- Maximize capacity from remaining potential of non-variable (biomass, biogas, small hydro, geothermal) resources
- Optimize solar PV capacity to displace coal generation

# Strategic Framework has been formulated in driving the renewable energy growth

## Five (5) pillars towards realizing the national RE target

# Vision

Achieve 31% RE in the national capacity mix by 2025 and enhance decarbonization of the electricity sector through 2035 while ensuring price affordability, system stability and environmental sustainability

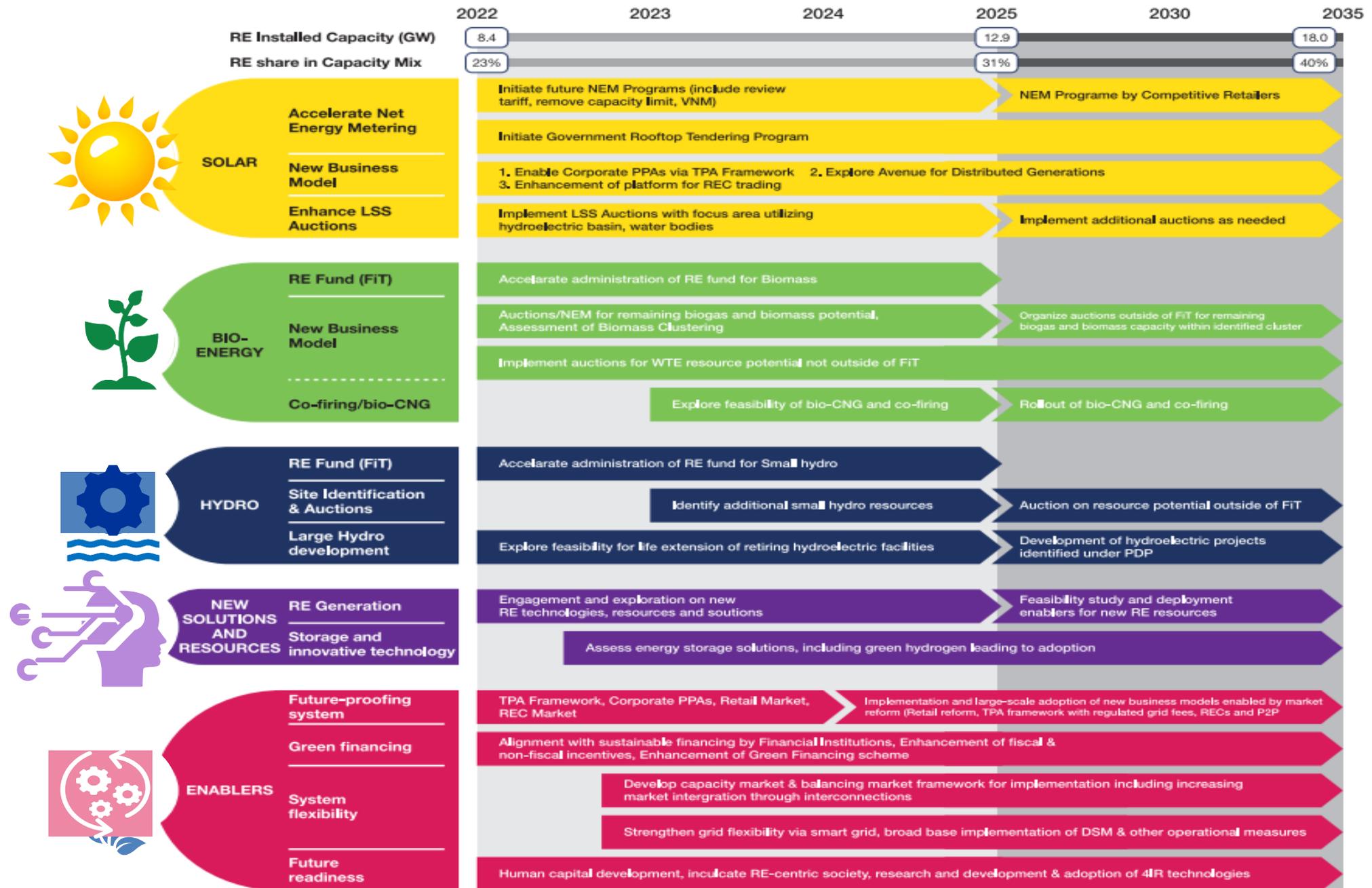
### Technology specific pillars

 <b>SOLAR</b> Accelerate rooftop PV deployment and rollout large scale solar to create new business models	 <b>BIO-ENERGY</b> New business models to leverage bio-energy resources	 <b>HYDRO</b> Leverage full hydro potential	 <b>NEW SOLUTIONS AND RESOURCES</b> (post-2025) Explore development and demonstration of new energy technologies
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### Enabling initiatives



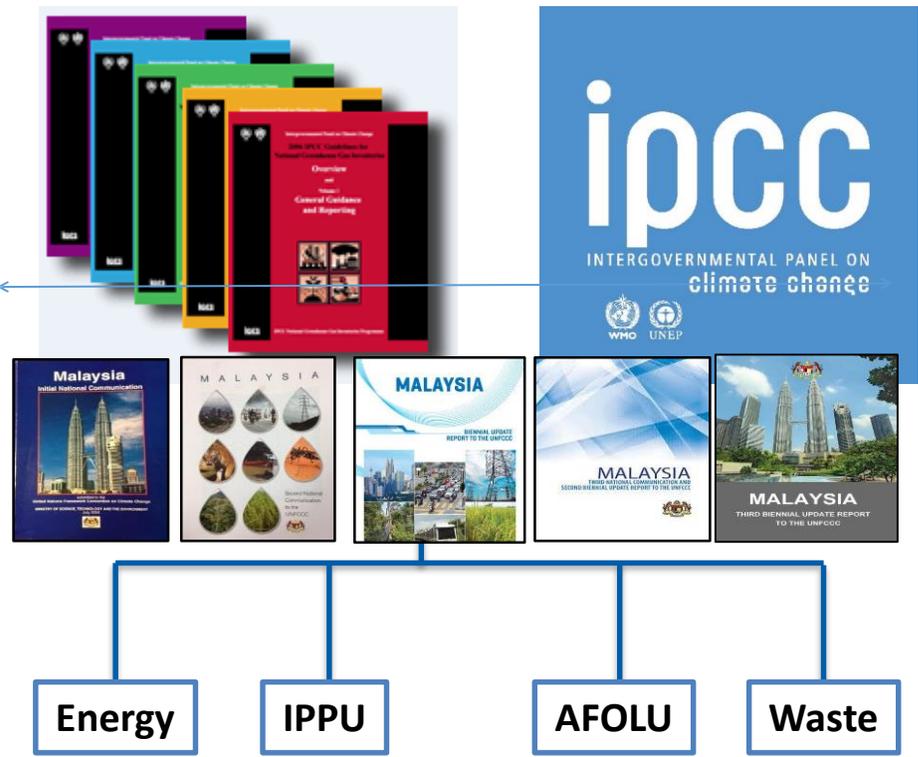
- 5.1 Leverage future-proofing electricity market for RE opportunities
- 5.2 Improve access to financing
- 5.3 Build future readiness
- 5.4 Increase system flexibility



## Background - GHG Inventory Levels and Other emissions assessment

- Accounting based on Country, Organization, Project, Product
- Direct emissions measurement from plant

### Country Level Accounting: GHG Inventory and National Communication



### Corporate Level Accounting: GHG Emission Report/ Carbon Footprint



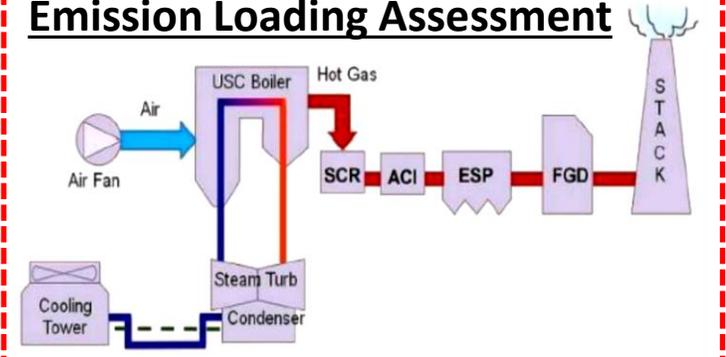
### Product Accounting: GHG Emission Report



### Project Level Accounting: GHG Emission Monitoring

### Power Plant Emission Monitoring System

Example of pollution control system and monitoring system for coal fired power plant

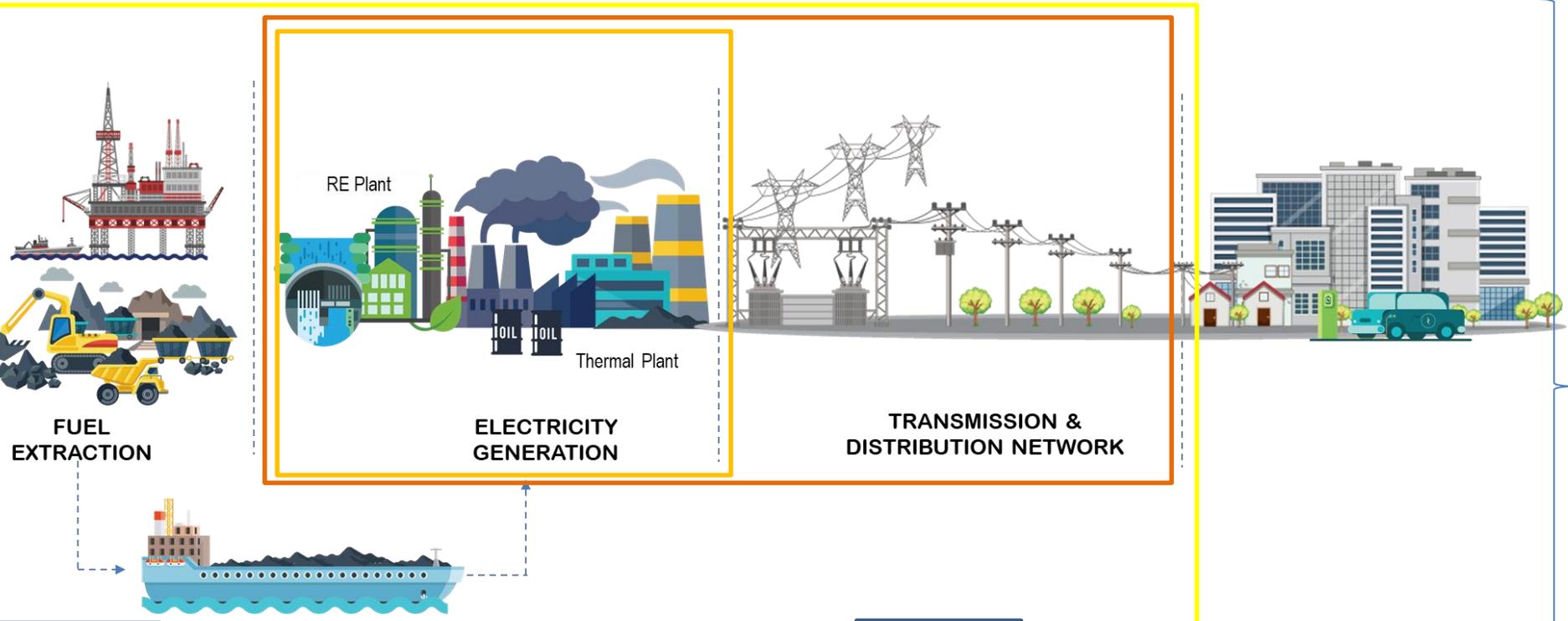


- Sulphur Oxide (SO<sub>x</sub>)
  - Nitrogen Oxide (NO<sub>x</sub>)
  - TSP (Total Suspended Particles)
  - PM (Particulate Matter) PM<sub>10</sub>, PM<sub>2.5</sub>
  - Opacity
  - Oxygen
  - Flow rate
  - Temperature
- Continuous Emission Monitoring System: CEMS



# Background – Emissions Assessment and Application of Emission Factor

**Emissions = Activity Data x Emission Factor**



**NATIONAL GHG INVENTORY**

**GHG MITIGATION PROJECT**

Renewable energy

Energy efficiency

Electric vehicle

**ORGANIZATION CARBON FOOTPRINT**

Scope 1: Direct emissions – Owned and Control

Scope 2: Indirect energy related emissions

Scope 3: Other indirect emissions – Value Chain

**PRODUCT CARBON FOOTPRINT & LIFE CYCLE ASSESSMENT**

**EF Fuel** TABLE 2.2 DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE ENERGY INDUSTRIES (kg of greenhouse gas per TJ on a Net Calorific Basis)

Fuel	CO <sub>2</sub>			CH <sub>4</sub>			N <sub>2</sub> O		
	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Crude Oil	73 300	71 100	75 500	r 3	1	10	0.6	0.2	2
Orimulsion	r 77 000	69 300	85 400	r 3	1	10	0.6	0.2	2
Natural Gas Liquids	r 64 200	58 300	70 400	r 3	1	10	0.6	0.2	2

**EF Grid** Table 1: Life-Cycle Emissions Intensities of Electricity Generation Sources (in gCO<sub>2</sub>e/kWh)

Coal	1,001
Natural Gas	469
Solar PV	46
Large-Scale Solar	22
Hydroelectric	4
Biomass	18

Emission Factor - Source: IPCC (2006 and 2011)



## Project Information

**Start Date : 1 August 2017**  
**End Date :30 Sept 2020**  
**Fund: AAIBE and Seeding Fund, TNB**

## Objectives

- i. To analyze the emission factor of major greenhouse gases, GHG (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O) from power plants in Malaysia.
- ii. To establish GHG Emission Factors Guidelines for the power industries and regulators on GHG emissions assessment.
- iii. To analyse and benchmark the GHG emission factor with other published emission factors.
- iv. To conduct and analyze the GHG emissions assessment from the power plants

## Output

- NATIONAL GHG EMISSION FACTOR (EF) FOR COAL AND NATURAL GAS**

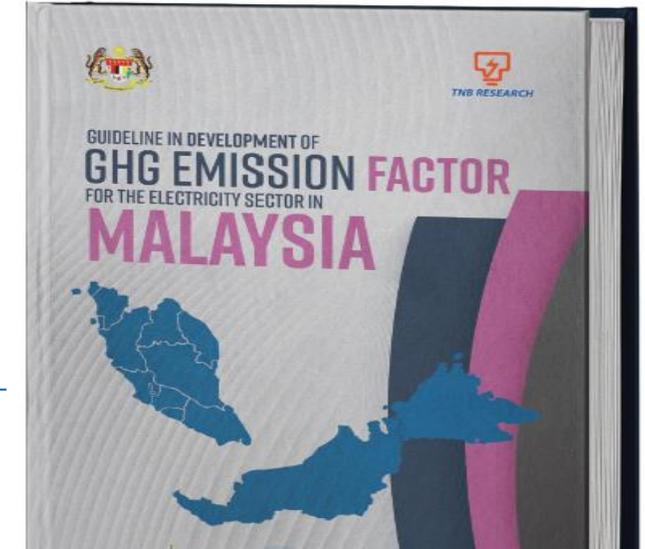
Year	Fuel		CO <sub>2</sub> [kgCO <sub>2</sub> /TJ]	IPCC CO <sub>2</sub> [kgCO <sub>2</sub> /TJ]
2017	Coal	Bituminous	93,224	94,600
		Sub-bituminous	96,714	96,100
		Lignite	103,692	101,000
	Natural Gas		49,519	56,100
2018	Coal	Bituminous	93,078	94,600
		Sub-bituminous	96,679	96,100
		Lignite	101,720	101,000
	Natural Gas		50,023	56,100
2019	Coal	Bituminous	93,089	94,600
		Sub-bituminous	96,260	96,100
		Lignite	105,116	101,000
	Natural Gas		50,911	56,100

Fuel		CH <sub>4</sub> [kgCH <sub>4</sub> /TJ]	IPCC CH <sub>4</sub> [kgCH <sub>4</sub> /TJ]	N <sub>2</sub> O [kgN <sub>2</sub> O/TJ]	IPCC N <sub>2</sub> O [kgN <sub>2</sub> O/TJ]
Coal	Bituminous	0.10	1.0	0.70	1.5
	Sub-bituminous	0.09		0.95	
	Lignite	0.04		0.56	
Natural Gas		0.09	1.0	0.43	0.1



## Output

- NATIONAL GHG EF GUIDELINES AND GHG EF DATABASE SYSTEM FOR THE ELECTRICITY SECTOR IN MALAYSIA**



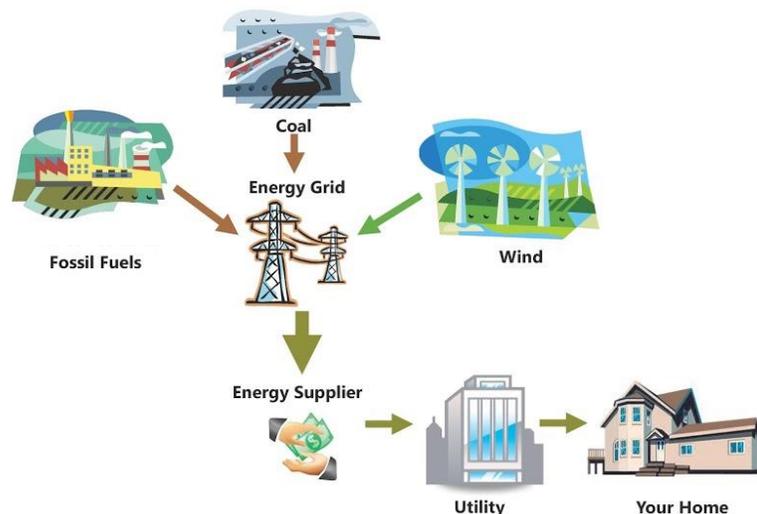
## Project Information

**Start Date : March 2021**

**End Date :March 2023**

**Fund: AAIBE and Seeding Fund, TNB**

## Overall Project Approach



**LCA Approach – AD and EF**

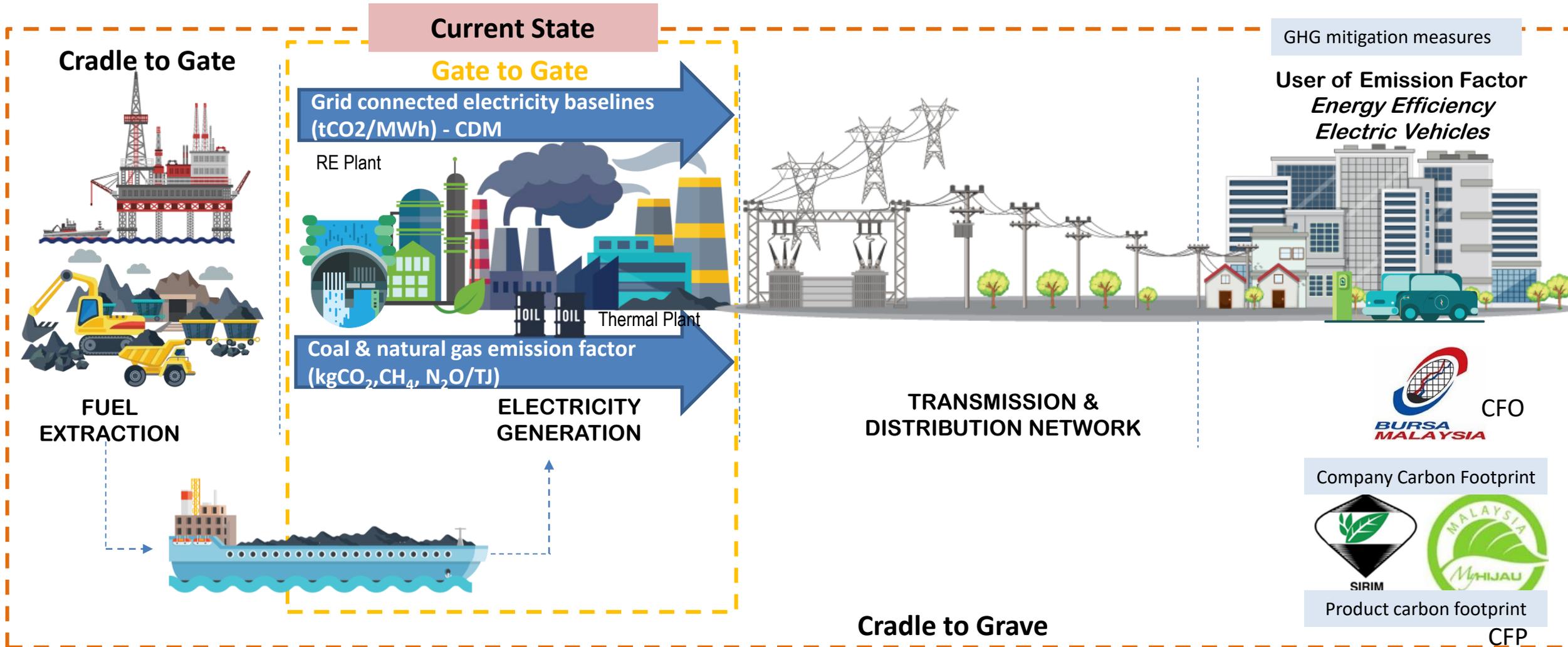
## Objectives

- i. To develop national and source specific emission factor for power generation in Malaysia for thermal and RE plants which include transmission & distribution system.
- ii. To develop and assess the life cycle impact of fuel and renewable energy of the electricity system in Malaysia. This includes the types of emission factor to be applied for particular application.
- iii. To expand and extend existing emission database, their underlying data, and their methodologies, to be able to incorporate the country electricity system emission factors.
- iv. To verify emission estimates in order to improve inventories and their underlying emission factors, and to improve credibility.

## Deliverables

- 1. Report on the review of national emission factor which include GHG and other pollutants for the development of National Emission Factor.**
- 2. Life cycle assessment of the fossil fuel and renewable energy electricity system to the grid.**
- 3. Development of National Electricity System Emission Factor of fossil fuel and renewable energy for grid application.**
- 4. Database of the national electricity system of Emission Factor**

# NATIONAL ELECTRICITY EMISSION FACTOR



Project to quantify emission factor and the level of emissions resulting from each process in the entire life cycle.

# Emission Factor Assessment (Cradle to Grave)

## Renewable energy power plants



### UPSTREAM PROCESSES

### ELECTRICITY GENERATION

### TRANSMISSION & DISTRIBUTION NETWORK

- i. Solar*
- Raw Materials Extraction
  - Materials Production and Transportation
  - Module Manufacture
  - Plant component manufacture
  - Plant Construction

- ii. Biomass*
- Biomass (EFB/PKS) harvest
  - processing
  - transport
  - Plant construction
  - Plant component manufacture

- iii. Biogas*
- production of raw materials-POME/landfill gas (biogas composition & properties)
  - transportation of raw materials
  - Plant construction
  - Plant component manufacture

- power plant operations (electricity generation, plant efficiency)
- (-) electricity used by plant
- chemical usage
- generated wastes

- Electricity transmitted [GWh]
- T&D losses [%] & [kWh]

Plant De-commissioning & disposal

**Stage 1**  
Total pollutants & GHG emissions per kg solar, biomass, biogas

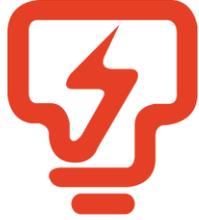
**Stage 2**  
Total pollutants & GHG emissions per MWh generated from solar, biomass, biogas

**Stage 3**  
Total pollutants & GHG emissions per MWh delivered to:  
 ○ National electricity grid with loss in T&D  
 ○ National electricity grid without loss  
 Based on fuel mix.  
 Result calculated for cradle-to-gate and gate-to-gate of 1MWh of electricity

**Stage 4**  
Total pollutants & GHG emissions per kg solar, biomass, biogas

# Way Forward

- i. Common understanding and methodology on carbon footprint for the assessment of renewable energy – application of LCA approach
- ii. Develop a database on specific emission factor of each life cycle –
  - Extraction
  - Transportation
  - Operation/Process
  - Disposal
- iii. Develop a guideline on the approach and methodology for carbon footprint and LCA from ASEAN countries
- iv. Joint Publication



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# Thank You

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