AIM's Contribution to Indonesia LTS

Rizaldi BOER

Centre for Climate Risk and Opportunity Management – Bogor Agricultural University

Retno Gumilang DEWI and Ucok SIAGAN

Center for Research on Energy Policy – Institut Teknologi Bandung

COP 27 Side Event

12 November 2022

LTS for Low Carbon and Climate Resilience (LCCR)
July 2021

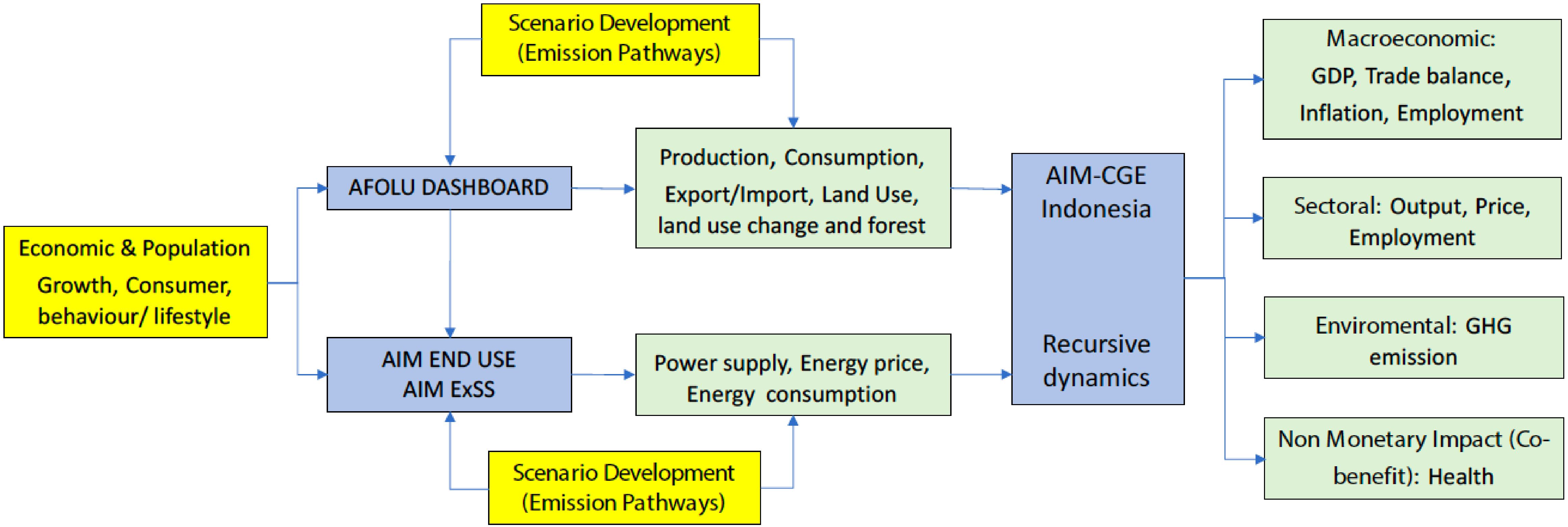
Enhanced NDC RI 2030
(September 2022)

INDONESIA
NDC 2030 & LTS LCCR 2050

INDONESIA NZE
(NET ZERO EMISSION)
2060

Under Prepaparation

Designing Indonesian LTS for LCCR 2050



Source: Indonesian LTS (2021)

AIM Contribution in the Development of Long Term Strategy for Decarbonization AFOLU Sector in Indonesia

MoEF and MoA

Development of AFOLU Dashboard based on AIM AFOLU A and AFOLU B

MoA, MoEF, MEMR, and MoI

Policy Dialogue on DDP

MoEF, and MoA

LTS LCCR 2050 (2021)
Road Map NDC 2030 (2019)
2nd NDC/NZE 2060

Education & Capacity Buildings

Master Degree Theses and Academic Publications (DD modelling)

Countries' DDPP research team

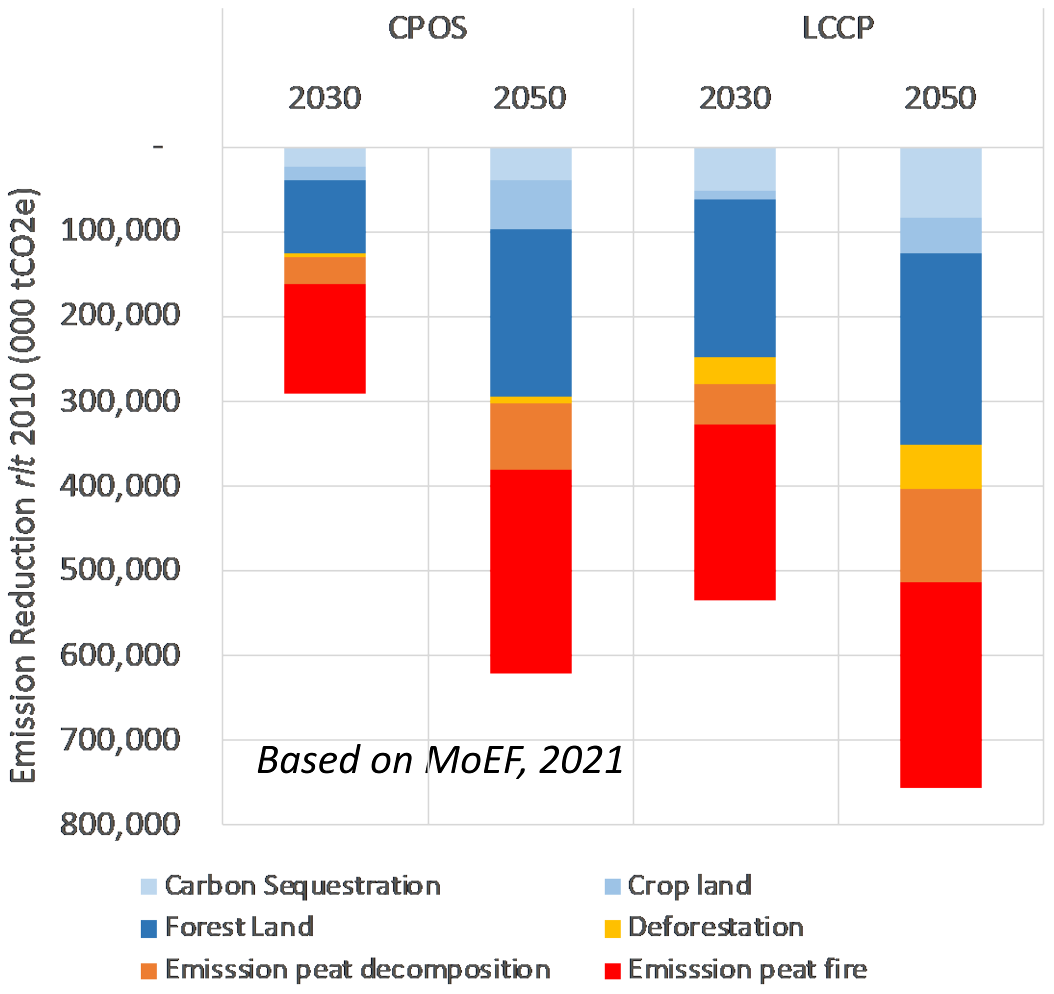
Cross Countries Science Annual Meeting

LTS-FOLU Net Sink 2030

Actions	Targets
Avoiding DD	Reducing deforestation not more than 2 Mha in the period 2020-2050, protecting primary forest in the concessions to about 2.3 Mha
SFM	Implementation of SFM reaches 9.46 Mha in 2050
Peat Management	Restoration of peatland reaches 4.22 Mha and improved water management 1.04 Mha in 2050
Timber Pl & Affn/Refn	Establishment of timber plantation reaches 12.8 Mha and land rehabilitation 10.6 Mha in 2050
Agriculture	Maintaining 3.75 million ha of rice fields in Java; increased land use efficiency (IP rice in Java to 2.2 and outside Java to 1.9; productivity of food crops increased by 27% and 50% compared to the present, and oil palm increased productivity almost 2 times today with a total area of 17.2 million ha; mixed agriculture- Integration of livestock with plantations reach 4.91 million ha in 2050, Reducing food loss from 71 kg/cap/year (2010) to 34 kg/cap/year (205) and food waste in 2050 is less than 76 kg/cap/year

Key Mitigation Policies:

- Forest & peatland moratorium; Social forestry; Multi-business policy
- Mandatory Certification for Forest Concessions and palm oil
- Incentive and disincentive policies
- Indonesian Environmental Fund
- Public campaigns
- HR improvement, Law enforcement
- Monitoring and Evaluation



AIM Contribution in the Development of Long Term Strategy for Decarbonization Energy Sector in Indonesia

AIM ExSS, AIM End Use, and AIM CGE

National Energy Council (DEN)

Update of National Energy Policy (KEN) (Under Preparation)

MoEF, MEMR, and MoI

LTS LCCR 2050 (2021)
Road Map NDC 2030 (2019)
NZE 2060 (Under Preparation)

Sub-National

Low Carbon Development Strategy of DKI Jakarta, Bali and West Java Province

Education & Capacity Buildings

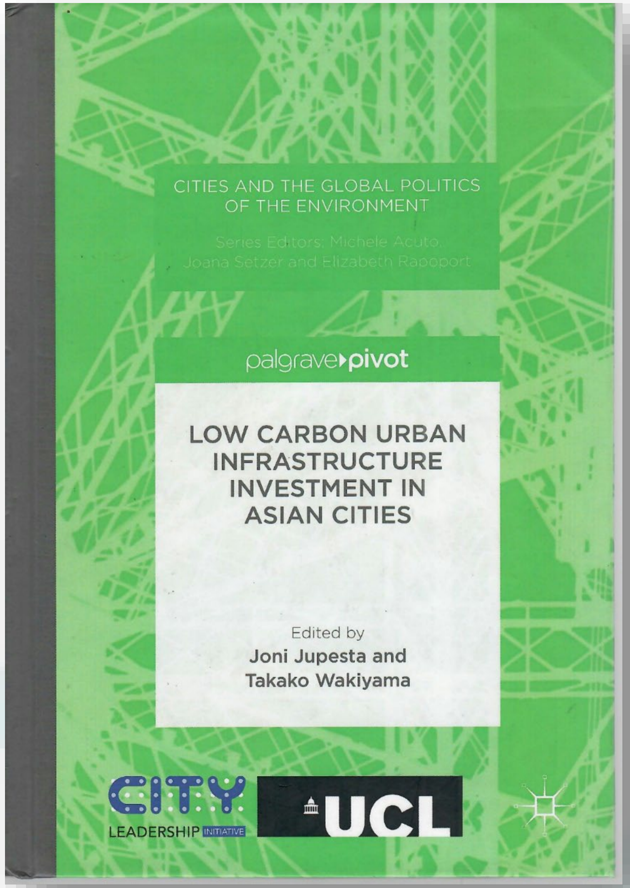
Master Degree Theses and Academic Publications

$ Company / Business

Decarbonization Road Map in Oil and Gas, Nickel, Lead/Tin, Gold Mining, Pulp and Paper

Energy Modeling (The Latest Works)

- ❑ Indonesia NZE 2060 Road Map (AIM ExSS-EndUse)
- ❑ Indonesia LTS LCCR Road Map (AIM ExSS-EndUse)
- ❑ Indonesia NDC 2030 Road Map (AIM ExSS-EndUse)
- ❑ DKI Jakarta 2050
- ❑ West Java Province 2050
- ❑ Bali Province 2050


CITIES AND THE GLOBAL POLITICS OF THE ENVIRONMENT
Series Editors: Michele Acuto, Joana Setzer and Elizabeth Rapoport
palgrave pivot
LOW CARBON URBAN INFRASTRUCTURE INVESTMENT IN ASIAN CITIES
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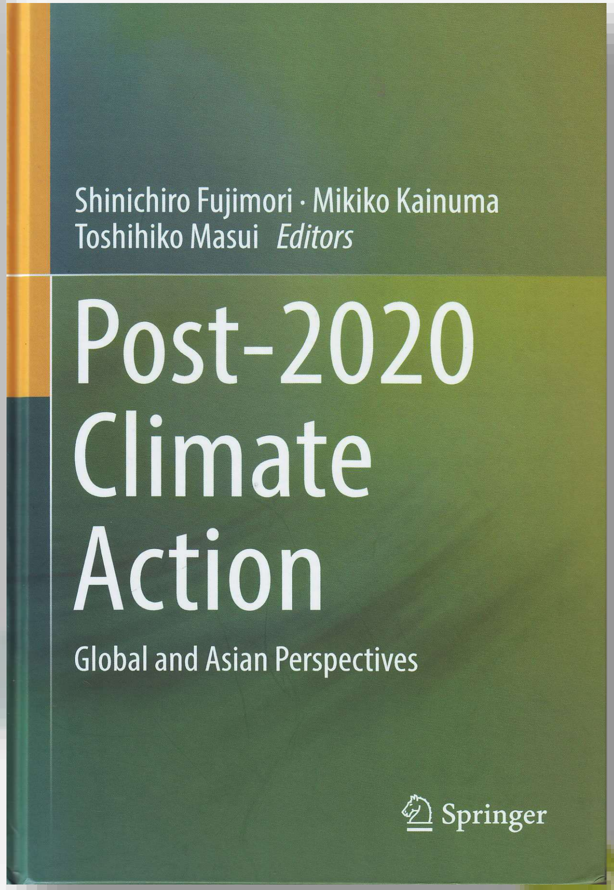
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EMISI GAS RUMAH KACA


AIM
Low Carbon Society Scenario Toward 2050
INDONESIA
Energy Sector
IGES
NIES
MIZUHO
February, 2010
Institut Teknologi Bandung (ITB) - Indonesia
Institute for Global Environmental Strategies (IGES) - Japan
Kyoto University - Japan
National Institute for Environmental Studies (NIES) - Japan
Mizuho Information & Research Institute - Japan

Jakarta, 27 February 2020

CREP-ITB IGES Institute for Global Environmental Strategies NIES National Institute for Environmental Studies, Japan AIM ASIA-PACIFIC INTEGRATED MODEL

Challenges and Opportunities in Enhancing Power Sector Contribution to Achieve NDC Target and Paris Agreement (Long-Term Strategy)

Retno Gumilang Dewi, Gissa, Sarah, Iwan, and Bintang
Center for Research on Energy Policy
INSTITUT TEKNOLOGI BANDUNG

CREP - ITB

Preliminary Study

LONG-TERM STRATEGY To ACHIEVE

DKI JAKARTA's LOW CARBON SOCIETY 2050

This Study is Supported by : CREP-ITB IGES Institute for Global Environmental Strategies NIES National Institute for Environmental Studies, Japan AIM ASIA-PACIFIC INTEGRATED MODEL

6

This Study is Supported by : ITB IGES Institute for Global Environmental Strategies NIES National Institute for Environmental Studies AIM ASIA-PACIFIC INTEGRATED MODEL

LONG-TERM STRATEGY:

West Java's Low Carbon Society 2050

By Retno Gumilang Dewi & Ucok Siagian
Gissa N Sevie, Iwan Hendrawan, Rias Parinderati, Rien Rakhmana, Sarah

CREP-ITB NIES National Institute for Environmental Studies, Japan AIM ASIA-PACIFIC INTEGRATED MODEL

The Potential of Renewable Based Power Plant Development Towards Bali Green and Independent Electricity Supply

RG Dewi[1,2], UWR Siagian[1,3], GN Sevie[1], I Hendrawan[1], R Parinderati[1] and R Rakhmana[1]

[1] Center for Research on Energy Policy, Institut Teknologi Bandung, Indonesia
[2] Chemical Engineering Department, Institut Teknologi Bandung, Indonesia
[3] Petroleum Engineering Department, Institut Teknnologi Bandung, Indonesia

27-28th October 2020

Medan International Conference on Energy and Sustainability - MICES 2020

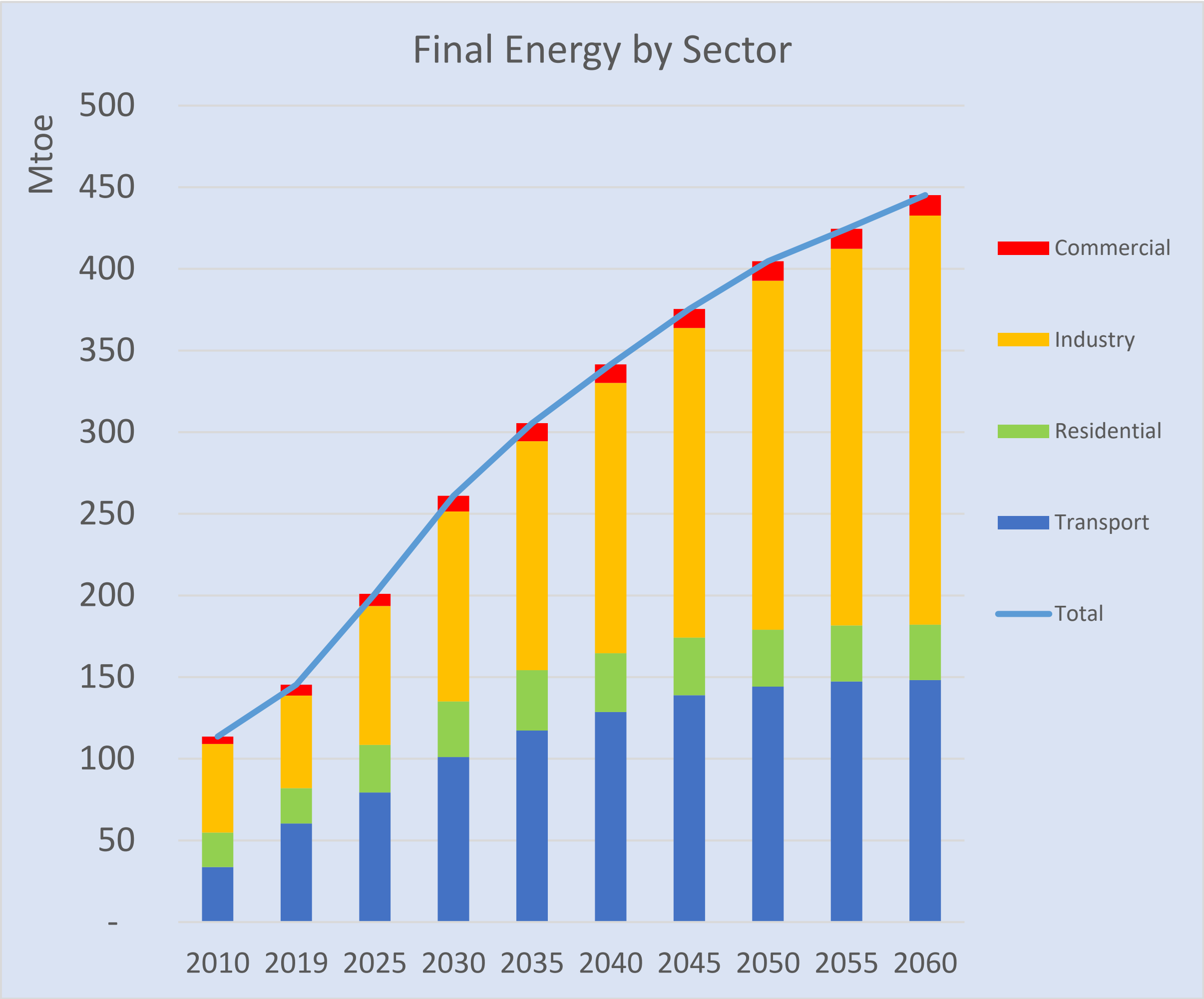
"Energy, Covid-19, and The Changing World"

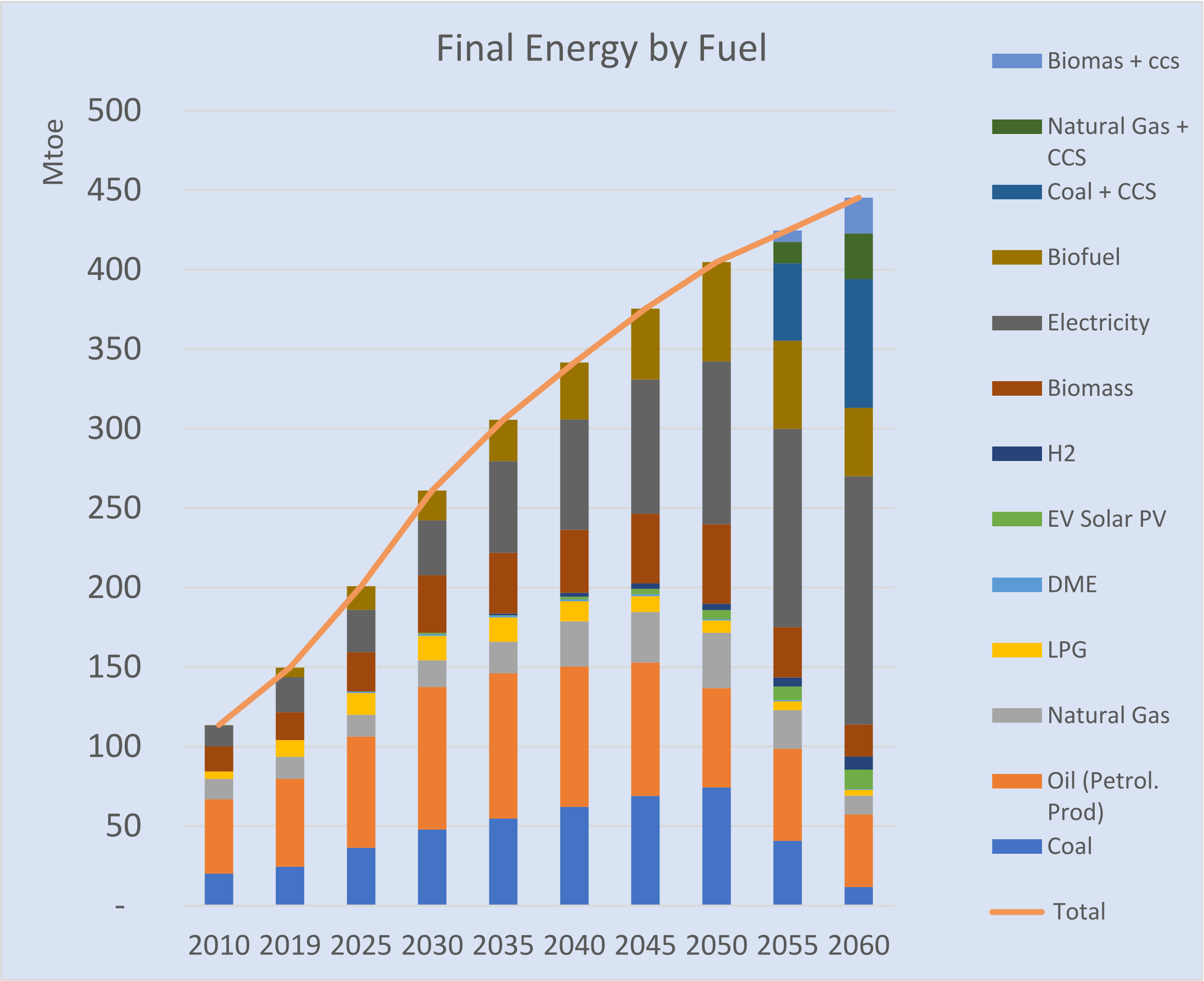
Organized by: IKATAN ALUMNI ITB DAERAH SUMATERA UTARA

Supported by: ECADIN ENERGY ACADEMY INDONESIA

Latest Modeling of Indonesia NZE 2060
(National Energy Council)

Final Energy Demand

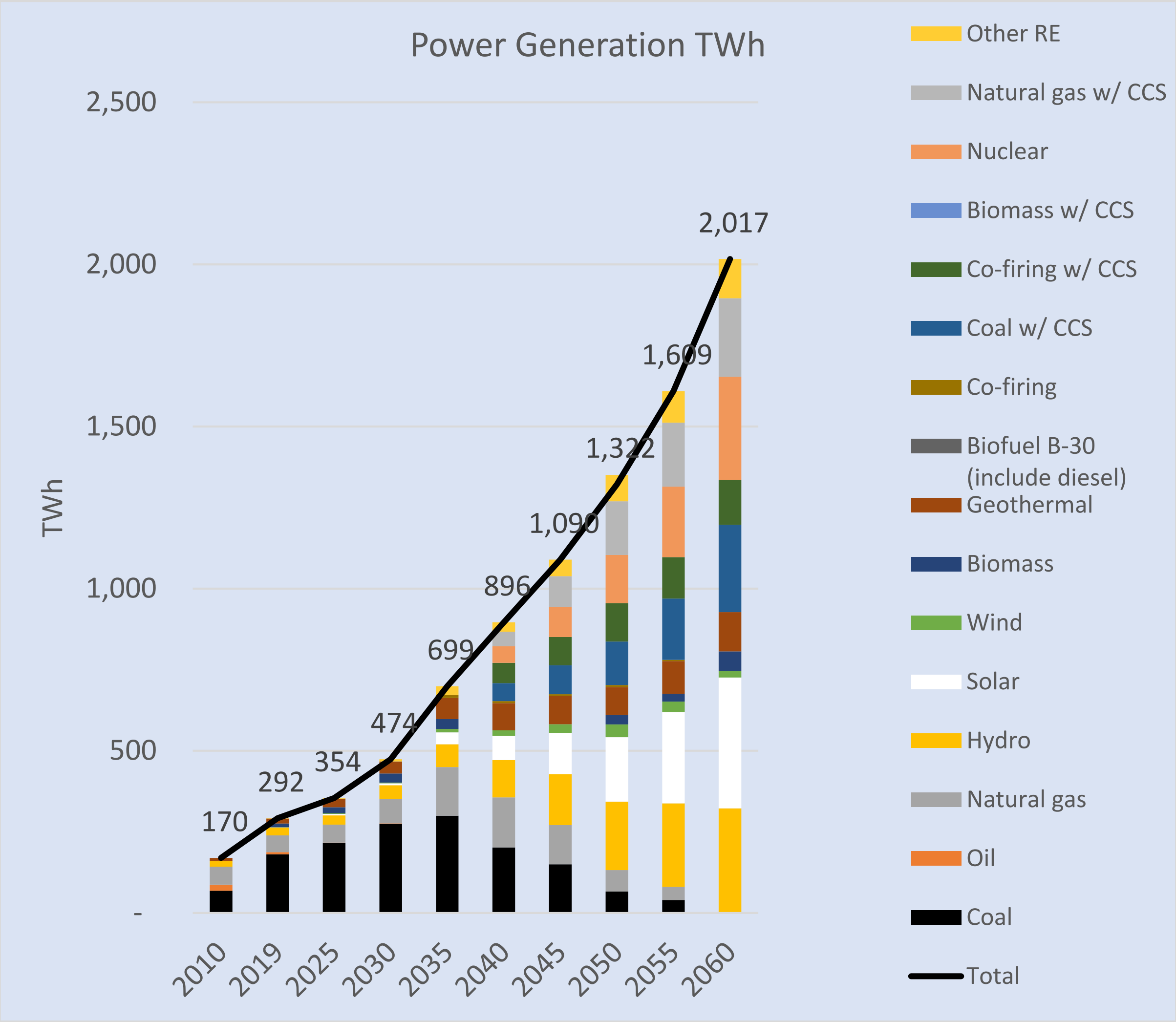


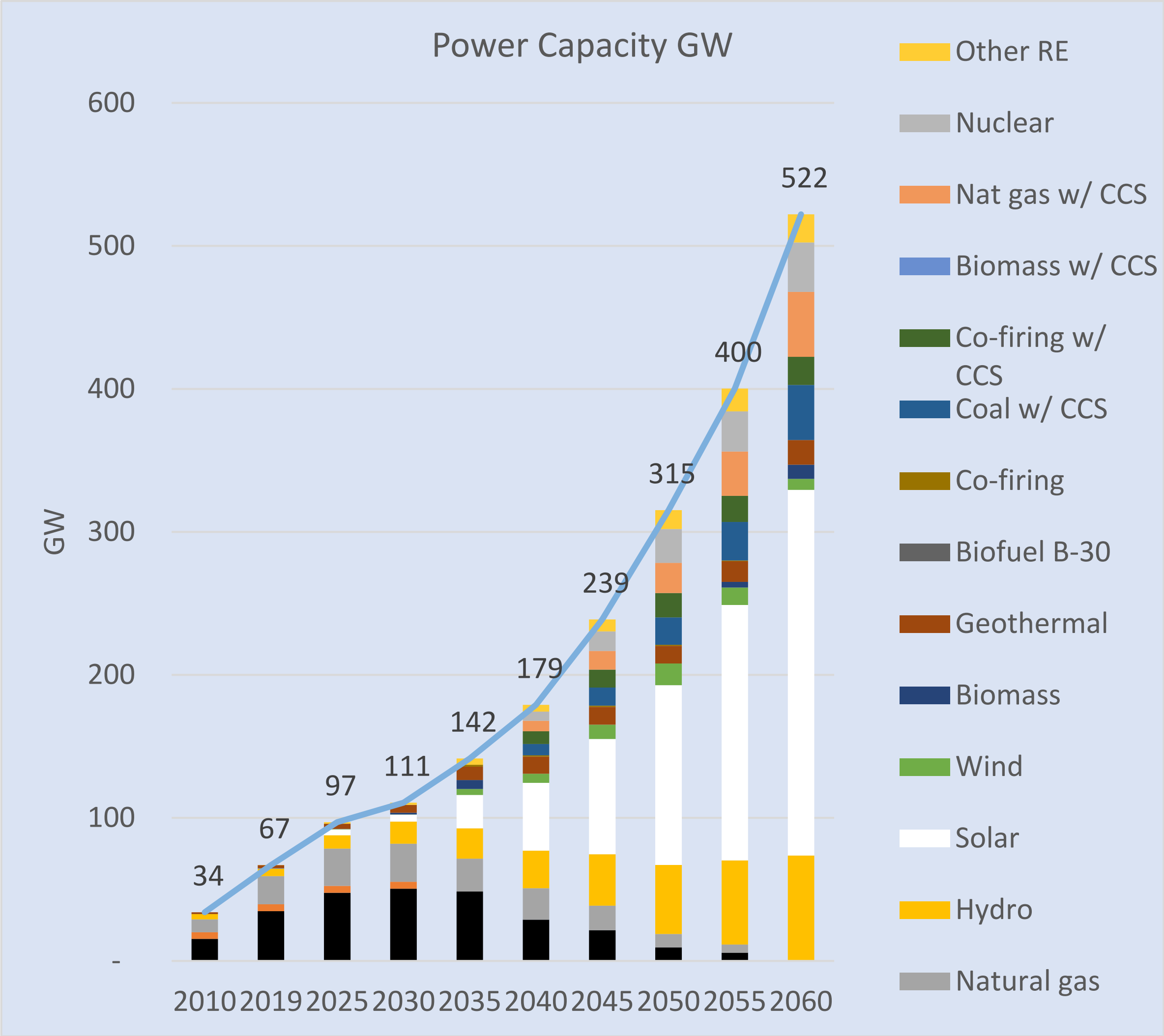


2020-2060 Average demand growth 2.2% per year

	2010	2019	2030	2040	2050	2060
Share of Elect.	12%	16%	14%	22%	28%	40%

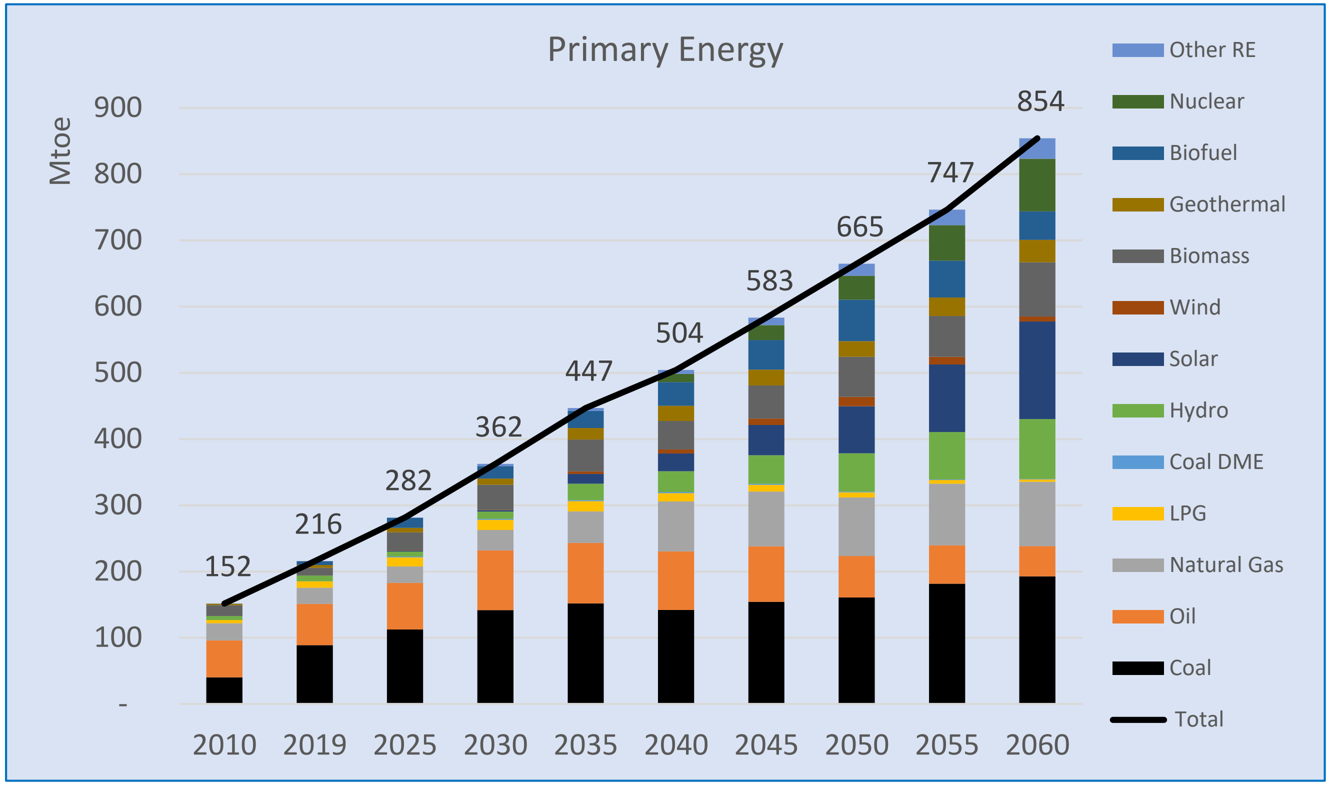
Electric Power Generation Mix

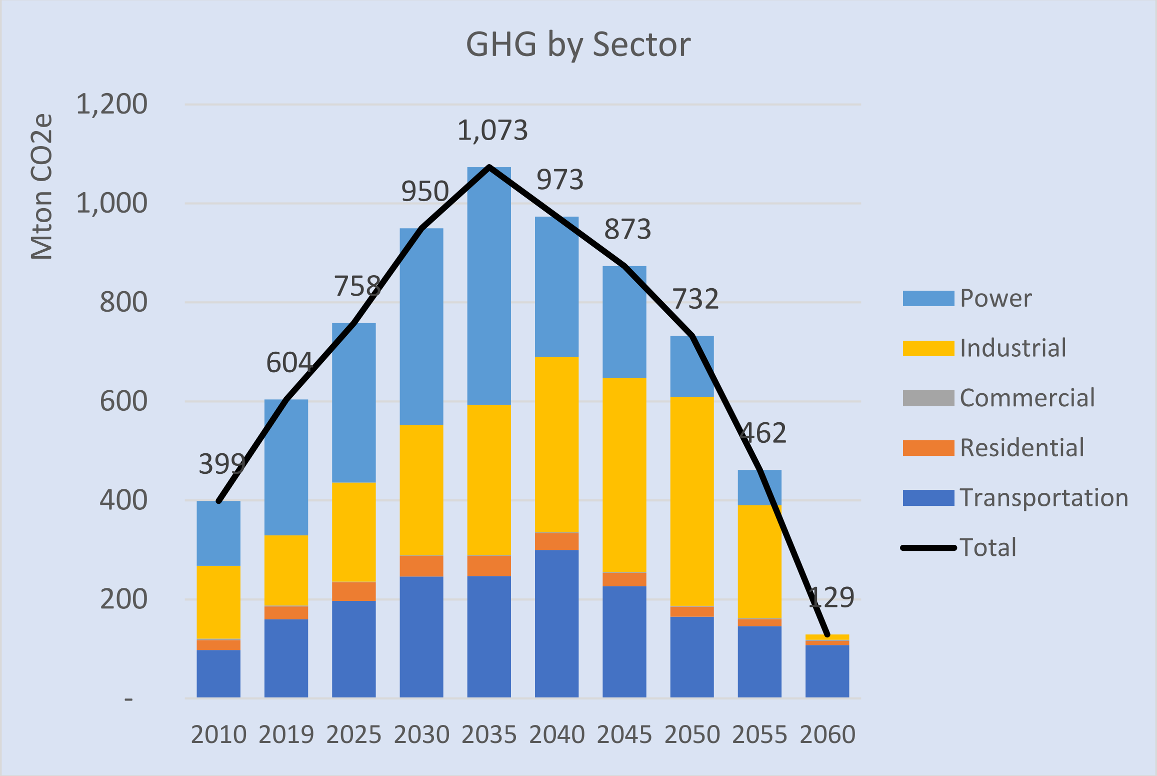




	2019	2025	2030	2035	2040	2045	2050	2055	2060
Share of RE	17%	24%	26%	36%	43%	46%	54%	57%	60%

Primary Energy Supply and GHG Emissions





Primary Energy	2010	2019	2030	2040	2050	2060
Toe/cap/year	0.65	0.80	1.11	1.39	1.72	2.12

	2019	2025	2030	2035	2040	2045	2050	2055	2060
Share of RE	14%	23%	25%	31%	38%	44%	54%	58%	63%

Sector	2010	2020	2030	2040	2050	**2060**
Energy	453	638	1030	960	572	**129**
IPPU	35	55	62	55	50	**45**
Agriculture	84	88	94	98	102	**101**
FOLU	470	98	-140	-246	-304	**-362**
Waste	89	139	198	170	120	**87**
Net Emissions	1,131	1,018	1,244	1,037	540	**0**

THANK YOU

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and ucokwrs@tm.itb.id

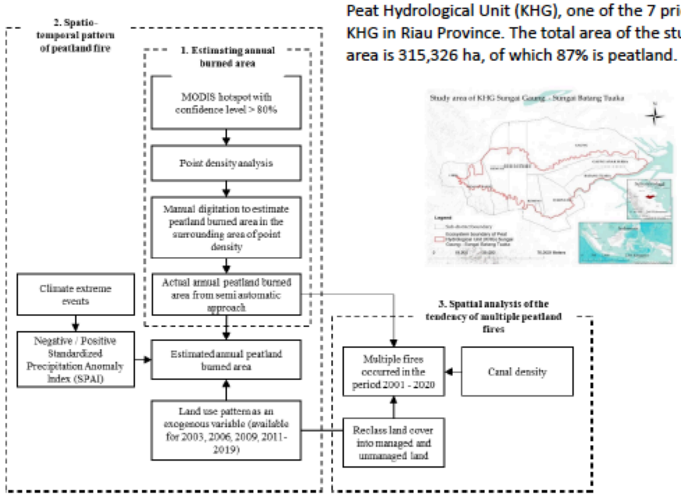
Peatland fire regime across a peat hydrological unit, Riau, Indonesia

Annuri Rossita[1], Rizaldi Boer[1], Lars Hein[2], Dodik Ridho Nurrochmat[1], Akhmad Riqqi[3]
[1]Bogor Agricultural University, Indonesia; [2]Wageningen University, Netherlands; [3]Bandung Institute of Technology, Indonesia

Introduction

- Peatland is one of the most valuable ecosystems providing multiple ecosystem services, amongst is carbon regulating as the most fundamental services
- IPCC AR6 statement of "GHG emission increased is unequivocally caused by human activities" were reciprocal with peatland case, where most of the ecosystem has been artificially modified to support dryland cultivation and alter the peatland natural trait, from carbon sink to carbon source.
- In Indonesia, where peatland stretched for approximately 8% of the country's land, the carbon dynamics of the ecosystem will determine the route of the national emission. Indonesia's commitment to aim for net-zero emission in 2060 or sooner will only be feasible if the forestry sector reaches net-sink in 2030 and zero peat fire starting in 2025.
- Peat fire per se has been the most concerning peatland disturbance as it varied temporally and complicates by its connection with the biophysical parameters (e.g., peat soil, land cover, etc.).
- Many studies have an emphasis on the role of excessive draining to hydrological change and fire vulnerability; however, there is still no study that presents the impact of draining on different land management from an annual basis data. This study aimed to fill this gap.

Method



The study is conducted in Gaung-Batang Tuaka Peat Hydrological Unit (KHG), one of the 7 priority KHG in Riau Province. The total area of the study area is 315,326 ha, of which 87% is peatland.

Results

Main result 1:

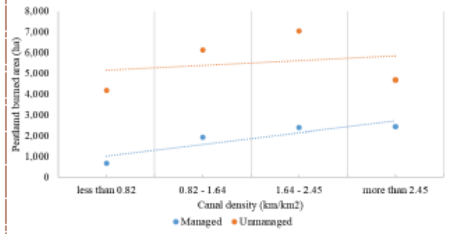
Of all land covers, unmanaged land, particularly in wet shrub and bare ground, has the highest total burned area.

Land-use type	Burned area (ha) 2003	2006	2009	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total burned area (ha)
Primary swamp forest								25				11	35
Forest plantation				812	103	38	17	55			2	285	1,373
Estate crop						588	401	779	29	1	871	3,319	5,907
Bare ground		457	162	34	50	53	965	2,147		4	1	478	4,350
Secondary swamp forest	453	698	391	65	12	126	354	176			59	965	3,277
Wet shrub	10	504	1,886	1,128	1,320	859	1,108	1,471	0	40	885	4,018	13,401
Dryland agriculture		20					1					45	65
Mixed dryland agriculture		68					13	30		5	17	889	1,013
Paddy field		17		47			1					25	90
Total burned area (ha)	463	1,756	2,440	2,088	1,725	1,583	2,850	4,683	29	50	1,834	10,033	29,492
Annual rainfall (mm)	2,637	2,696	2,685	2,886	2,702	2,585	2,416	2,084	2,675	2,734	2,589	2,245	
SPAI[1]	0.49	0.79	0.33	1.78	0.82	0.27	-0.64	-2.27	0.68	0.98	0.30	-1.50	

[1]SPAI refers to a standardized annual precipitation anomaly index.

Main result 2:

Draining impact positively correlates with peatland burned area. However, the impact of the draining on unmanaged land is stronger than in managed land.



Main result 3:

Recurrent peatland fire intensively occurred during extreme dry years (positive IOD and/or El-Nino).

Peat fire frequency	Peatland fire identified as unmanaged land all year (ha)	Total burned area
7	8.4	8.4
6	33.3	44.1
5	135.5	269.2
4	355.0	816.0
3	927.7	1,621.6
2	1,583.2	4,484.7

Area identified as unmanaged land for years is found to experienced recurrent fire more compared to other LUC patterns.

Discussion

- Currently, the peatland ecosystem is dominated by the extent of unmanaged land, particularly unproductive areas (e.g., wet shrub and bare ground). Utilizing and supervising this land via a sustainable land-management strategy could reduce fire vulnerability and lower the possibility of recurrent fires event in the future.
- The government of Indonesia has developed social forestry scheme as one of the transformative policies toward net-sink that can be used for the peatland case. The scheme legally grants land access to the community for utilizing the unproductive land. Under the legality status, the community can receive government support (e.g., incentive, capacity building) to increase land economic value.
- The stronger impact from excessive draining to the burned area in unmanaged land indicates the urgency to rewet these areas, particularly in the intact ecosystem with less human activity, where hydrological restoration is likely to be more efficient. In the managed land with dense canal density with the low success of peatland rewetting, mixed-agroforestry farming is the most feasible option to maintain soil moisture by minimizing peat soil to radiation exposure.

Conclusions

- The significant impact of extensive peat drainage underscores the need for peatland rewetting (restoration) to reduce the possibility of multiple fires, particularly in unmanaged land.
- Due to a significant burned area occurs on unproductive land (e.g., wet shrub and bare ground), utilization of this land for production purposes—in particular when combined with rewetting and paludiculture—could reduce fire vulnerability considerably.
- As peatland has been occupied by multi actors (e.g., private sector, smallholder, regional government, etc.), integrated peatland management requires equal participation from both party and non-party actors. The presence of an incentive scheme that makes the environmental benefit apparent economically is key to upscale the peatland restoration work and reach the zero-peat fire ambition.

Acknowledgment:
The authors thank the Ministry of Research and Technology of the Republic of Indonesia for the research funding, and the Ministry of Environment and Forestry for the supporting data in this research.

Assessment of the energy efficiency and GHG emission reduction potential in Indonesia's Iron and Steel Industry based on AIM/EndUse model

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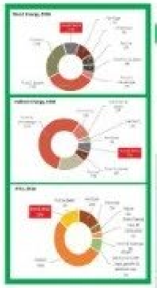
National Institute for Environmental Studies

Introduction

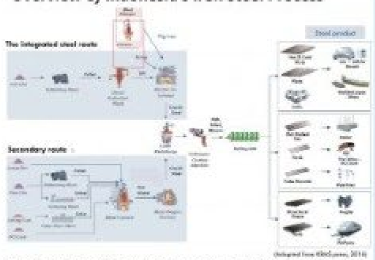
Background & Problem Identification



The intensive use of energy in the steel industry makes this sector as one of the main contributors of GHG emissions in Indonesia's industrial sector that not only from **energy use**, which includes stationary fuel combustion (direct) and purchased electricity (indirect), but also from **IPPU**.

The study presented an analysis of the effectiveness of mitigation efforts on potential energy saving and GHG emission reduction from energy and IPPU activities that has never been done in the studies that focus on the bottom-up modeling for the iron steel industry.

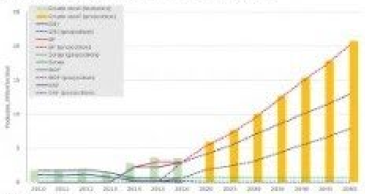
Overview of Indonesia's Iron Steel Process



Steel is produced by two main routes namely, integrated steel route and secondary route.

"Besides integrated and secondary routes, Indonesia has operated the iron-making Blast Furnance technology in 2019, which the pig iron from Blast Furnance will be integrated to EAF"

Future Indonesia's Steel Production



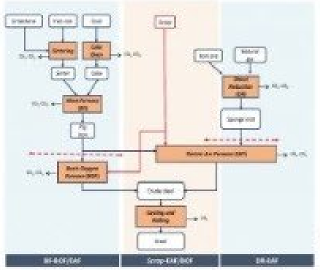
Histories (2010-2016)

Indonesia's steel production process based on Direct Reduction (DR) and scrap that integrated with EAF. In 2014, Indonesia has developed Blast Furnace that integrated with Basic Oxygen Furnace (BOF), meanwhile the DR has not operated since 2016.

Projection (2020-2050)

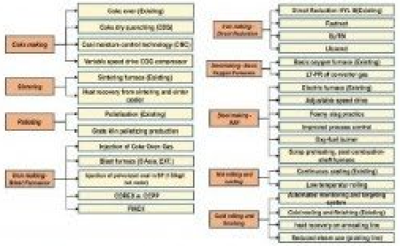
- Indonesia has developed BF-EAF since 2019
- There is no addition of scrap since 2020 to 2050 (stagnant)
- The goverment's target for building of 10 MillionTon of steel (2025), that assumed to be achieved by BF that integrated with BOF and EAF in 2030.
- Beyond 2030, it assumed that the averange development of BF to BOF is 1.2 MillionTon per 5 year and BF to EAF 1.5 MillionTon per 5 year

Possible Mitigation Options in the Steel Production Process



1. Adjusting the production structure

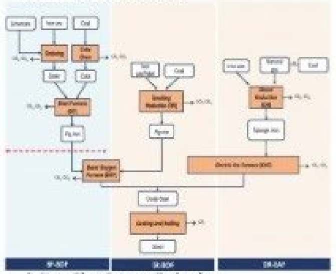
Increasing material efficiency with the scrap utilization in both BF-BOF and EAF routes that eliminate the needs of previous processes (coking, sintering, blast furnace, direct reduction) to producing iron that consumes a large amount of fuel and reductant



2. Promoting Low Carbon Technology

Promoting low carbon technology to increase energy efficiency in iron steel production process

In this study, there are 51 technologies related process iron steel industry that will be evaluated in the AIM/End-Use model. The selected technology based on cost effectiveness apraouch as shown in the picture above



3. Non- Blast Furnace Technology

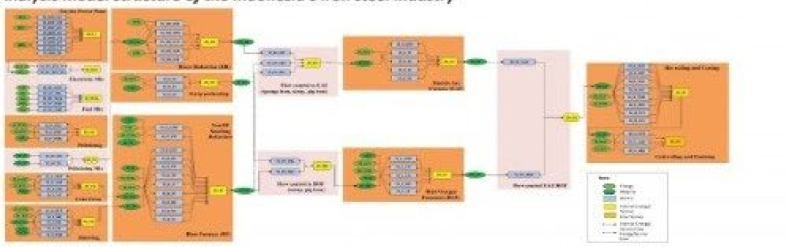
Promoting non-blast furnace technology (such as: smelting reduction & Coal/Natural gas based Direct reduction)

Acknowledgement

Contributions from Mizuho Japan, NIES Japan, the Ministry of Environment and Forestry, Chemical Engineering Department-ITB and CREP-ITB in the preparation of this study were greatly appreciated

Methodology & Assumption

Analysis model structure of the Indonesia's iron steel industry



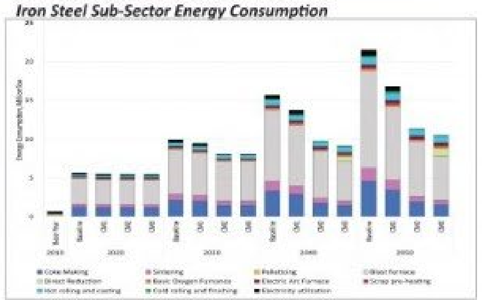
- Model simulation was used to deliver an outlook and evaluate scenarios related to GHG emissions reduction, and energy efficiency potentials in Iron steel sectors. The modelling tool used **AIM/End-use (The Asian-Pacific Integrated Model)** with GAMS (General Algebraic Modelling System) v 23.3 as the calculation software and solver

Model Scenarios

Parameters	BaU	CM1	CM2	CM3
Build upon	none	BaU	CM1	CM2
GDP growth	5.5%	5.5%		
Economic structure	Economic structure in 2030 & 2050 are the same as that of 2010			
Share of energy in power	Share of energy in 2030 & 2050 are the same as that of 2010	Following NDC scenario unconditional	Following NDC scenario unconditional	Following NDC scenario unconditional
Increasing material efficiency (Scrap)	No addition of scrap since 2020 to 2050	[illegible]	[illegible]	[illegible]
Efficiency improvement of BAT compared to existing device	Efficiency of equipment in 2030 & 2050 are the same as that of 2010	Efficiency of equipment in 2030 & 2050 are the same as that of 2010	10-40%	10-80%
Non-Blast Furnace Technology	DR process is non-active since 2016 to 2050	DR process is non-active since 2016 to 2050	[illegible]	[illegible]

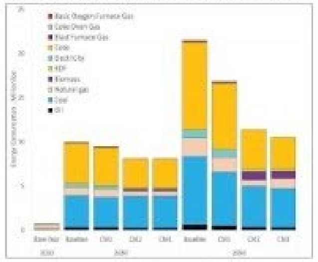
Result & Discussions

Iron Steel Sub-Sector Energy Consumption

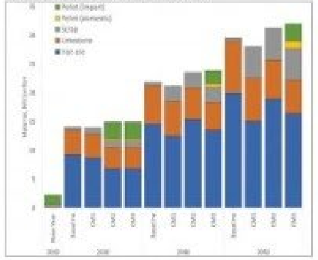


The potential energy savings that can be obtained if the iron steel development of each scenario can be achieved is 4.68 Mtoe (CM1 scenario), 10.12 Mtoe (CM2 Scenario), and 10.99 Mtoe (CM3 Scenario) in 2050 or equal to the percentage of energy savings compared to the baseline 21.8%, 47.1%, and 51.1% respectively

Energy consumption by type of energy, 2010-2050

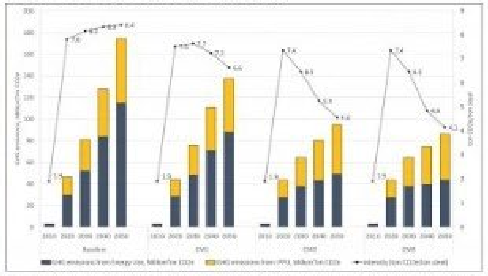


Material consumption , 2010-2050



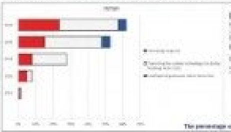
In the baseline scenario, the use of fuels is still dominated by natural gas followed by electricity due to the steel production process through DR-EAF (2010). This situation is expected to change, the share of coke and coal will significantly increase along with steel production increases through BF technology in 2030 and 2050. Under CM scenario, the utilization of scrap, maximizing energy efficiency, and reactivate Direct Reduction effectively reduces coke and coal consumption.

Iron Steel Sub-Sector GHG Emissions



The increasing steel production capacity using BF technology cause a significant increase of GHG emissions intensity level from 1.9 tonsCO_2e/ton of steel (2010) to 8,4 tonsCO_2e/ton of steel in 2050. Therefore, the implementation of mitigation scenario shows the changing trends for GHG emissions intensity.

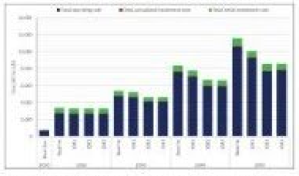
The Effectiveness of Each Mitigation Actions in GHG Emissions Reduction



Energy: Low carbon technology promotion is the main driver for GHG emissions reduction from energy sector.

IPPU: Scrap utilization will obtain the most significant emissions reduction from IPPU sector, followed by promoting low carbon technology (smelting reduction), and direct reduction.

Mitigation Cost



In general, mitigation actions show a decrease in total costs (Total operating cost, Total annualized investment cost, and Total initial investment cost), except in the CM3 scenario. In the CM3 scenario, reactivate coal/Natural gas based Direct Reduction will increase total cost from 8552 to 8598 Million US$ in 2050.

Concluding Remarks

1. The effectiveness of each mitigation actions reveals that energy savings and emission reduction from energy will rely mostly on promoting low carbon technologies (including smelting reduction). In the sector IPPU, some strategies focused on the scrap utilization in BOF and EAF will obtained the most significant emissions reduction due to reducing the consumption of pig iron, this also has an impact on the reduced need for coke as a reductant. Therefore, the increased use (up to 20% of obsolete scrap) in the BF-BOF route can become an interesting option for Indonesia iron and steel industry
2. Reactivate coal/Natural gas based Direct Reduction technology with a production capacity of 3 MillionTon DRI in 2050, provides a significant reduction in emissions opportunities of 8.7 MtCO_2e. with an additional cost from from 8552 to 8598 Million US$ in 2050.

The 26[th] AIM International Workshop, September 3-4, 2020

AIM ASIA-PACIFIC INTEGRATED MODEL

National Institute for Environmental Studies

Explore Mitigation Potential in Indonesia's Power Sub-sector Toward 2030 & 2050

Retno Gumilang Dewi[*1,2], Ucok WR Siagian[1,3], Gissa N Sevie[1,2], Sarah Sitorus[1], Bintang B Yuwono[1], dan Iwan Hendrawan[1]
[1]Center for Research on Energy Policy, [2]Chemical Engineering Department, [3]Petroleum Engineering Deparment
Institut Teknologi Bandung, INDONESIA

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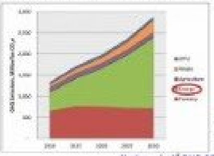
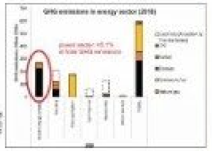
1 Introduction

Background & Problem Identification

NDC 2030: "The Government of Indonesia (GOI) is committed to reduce the national GHG emissions level in 2030 by **29%** below the baseline emissions level (unconditional) and further up to **41%** (conditional) if there is international



The projection showed that energy sector (58,2%) will surpass the LULUCF (24,9%) in 2030.



(Indonesia 1[st] BUR,2016)

Question?

- Whether the potential for reducing GHG emissions in mitigating uncoditional NDC (CM1) by 204 million tons CO_2e and conditional (CM2) by 245 million tons CO_2e can still be increased and how much potential can be maximized?
- In addition to the GHG emission reduction target in 2030 in the NDC, Indonesia also set a GHG emission reduction target in 2050 on the Long-Term Strategy (LTS) to be able to contribute to global efforts to prevent global temperatures from exceeding 1.5°C (Paris Agreement), how significant is the contribution of the power sector?

2 Methodology & Assumption

An analysis of the ability to increase the GHG emissions mitigation potential of the power sub-sector is carried out using two approaches, namely the AIM-EndUse model and the AIM-ExSS (Extended Snapshoot) model which is operated using the General Algebraic Modeling System GAMS (General Algebraic Modeling System) v 23.3

• Model Scenarios

Parameters	Baseline	CM1	CM2	CM3
GDP growth	5.5%			
Economics structure	Economic structure in 2030 & 2050 is still the same as that of 2010			
Electricity production	2010-2018: Inventory data from DIK ESDM 2019-2028: RUPTL (2019-2028) 2028-2030: Interpolation 2030-2050: based on assumption electricity per capita of 6%			
Share of energy in power	Share of energy in 2030 is the same as that of 2010	Following RUPTL	Following RUPTL and more renewables	Refer to RUPTL and maximizing share of renewables (based on the availbility of renewable energy constraint[1])
Renewable energy	No additions of renewable energy generation since 2010	Geothermal, hydro, solar & wind, biomass, biofuel	Geothermal, hydro, solar & wind, biomass, biofuel	Geothermal, hydro, solar & wind, biomass, biofuel, cofiring (more biomass for existing coal fired plant since 2030), begin to use nuclear energy in 2040
Efficiency improvement in coal-fired plant	Energy efficiency in 2030 & 2050 are the same as that of 2010	Implementation of low carbon technology: USC, SC	Implementation of low carbon technology: USC, SC, IGCC	Implementation of low carbon technology: USC, SC, IGCC
Advanced technology				CCS is integrated with coal fired and biomass plants (BECCS)

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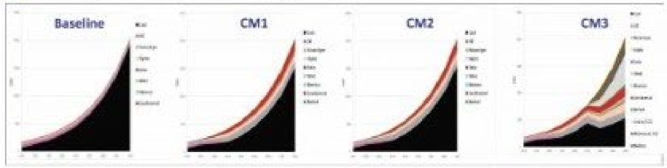
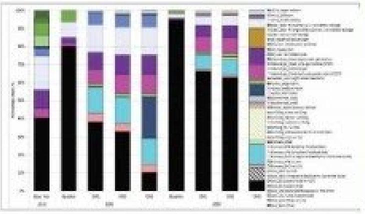
- [1] Constrain the availability of EBT fuel in 2050 based on data on the potential of EBT in Indonesia and the percentage of study results from Indonesia 2050 Pathway Calculator-KESDM

Power Sector Development Scenario

A. Electricity projection for each type of energy, 2010-2050



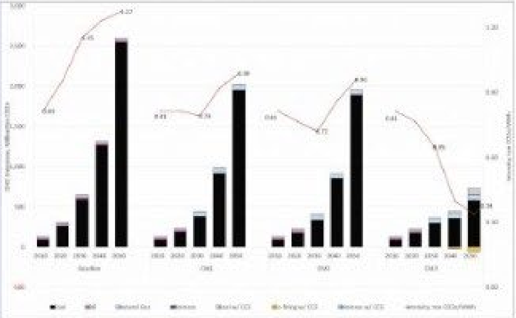
B Electricity projection for each type of technology, 2010 & 2050



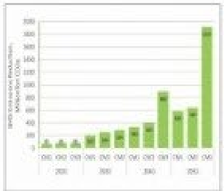
- In the baseline scenario, the total electricity production is targeted at 2041 TWh (2050) which is assumed to be mostly produced by coal-fired power plants, which is 94.5% of total electricity production while the contribution of renewable energy plants is still relatively small around 1.3%.
- In the ex-tenteded NDC scenarios (CM1 and CM2), national electricity production is still dominated by the coal-fired power plant. However, the portion will decrease to 1,542 TWh (75.6%) and 1,516 (74.3%) of total electricity production in 2050, respectively.
- In the more ambitious mitigation scenario (CM3), there is a shift of coal power plants dominance by renewable energy generation (36.30%) and CCS technology that integrated with coal & biomass/BECCS (31.58%) in 2050.

Technology mix in the skenario CM3 that will be drastically changed when compared to the baseline in 2050. The conventional coal generation technology (sub-critic) will decrease significantly from the 94.5% (baseline) to 5.45%, while clean coal technology (Super/Ultra Super Critical,

- *Power Sub-sector GHG Emissions, 2010-2050*



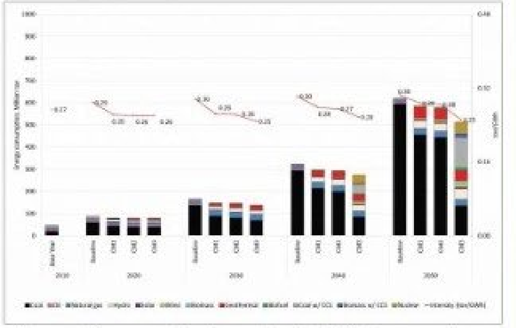
Without mitigation intervention, Intensity in the baseline scenario has increasing trend from 0.81 tCO2e/MWh(2010) to 1.27 tCO2e/MWh (2050). Meanwhile, the CM1 and CM2 scenario intensity has decreasing trend until 2030. However, the year above 2030, renewable energy domination over electricity supply demand will not be significant compared to the increasing number of coal-fired power plant. On the contrary, the application of CSS integrated with coal and biomass/BECCS power plant able to positively reduce the intensity up to 0.34 tCO2e/MWh or declining 73.6% intensity level of baseline scenario in 2050



- The reduction in GHG emissions in the unconditional mitigation NDC scenario can be increased from 204 million tons of CO_2e to 284 million tons of CO_2e in 2030. Above 2030, mitigation efforts carried out increasingly intense include:

i) Utilizing clean coal technology
ii) Increasing the mix of renewable energy
iii) Application of integrated CCS technology in coal and biomass/ BECCS
iv) An increase in the composition of biomass for co- firing from 5% to 20% in 2050,

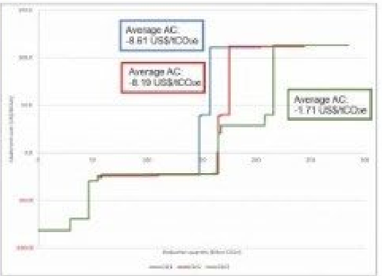
- *Primary energy consumption, 2010-2050*



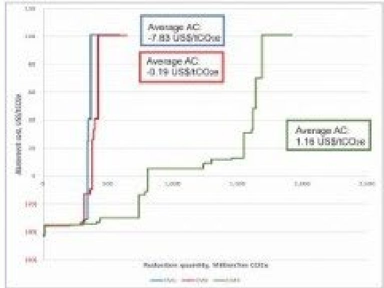
- The potential energy savings that can be obtained if the power sub-sector development of each scenario can be achieved is 18.7 Mtoe (CM1 scenario), 19.4 Mtoe (CM2 Scenario), and 27.6 Mtoe (CM3 Scenario) in 2030 or equal to the percentage of energy savings compared to the baseline 11.2%, 11.7% and 16.5%, respectively. In 2050, the potential energy savings compared to the baseline 5.9%, 6.9% and 17.6%, respectively.

Result & Discussions 3

- *Abatement Cost Curve*



- Under CM1, CM2 and CM3 power sector could achieve emission reduction target of 203 Million tons of CO2e, 243 Mton CO2e and 284 Mton CO_2e (compared to the baseline scenario). This reduction could be achieved with negative average abatement



- Under CM1, CM2 and CM3, power sector could achieve 21.6%, 24.6% and 23.6% emission reduction target (compared to the baseline scenario). This reduction could be achieved with negative average abatement cost. Meanwhile, greater carbon reductions (CM3; i.e.,73.6% reduction) could be achieved with a slight increase in average abatement costs

Concluding Remarks 4

- In 2030, the GHG emissions reduction target that in line with unconditional NDC Indonesia mitigation scenario is 203 million tons of CO_2e. However, there is still room for improvement in potential for GHG emissions reductions by 284 million tons of CO_2e, with an increase of avarage mitigation cost from -8.61 US$/tCO₂e to -1.71 US$/tCO₂e. This potential of GHG emissions reduction can be included in conditional & unconditional NDC Indonesia.
- For the long-term strategy (2050), there are still more aggressive mitigation technology choices needed in reducing GHG emissions, such as BECCS technology (bioenergy and CCS) as part of achieving the target of the EBT mix (new and renewable energy) in 2050 as mandated by the National Energy Policy (KEN).

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1. Republic of Indonesia, "Indonesia: First Nationally Determined Contribution," no. November, p. 18, 2016, [Online]. Available: http://www4.unfccc.int/ndcregistry/PublishedDocuments/Indonesia First/First NDC Indonesia_submitted to UNFCCC Set_November 2016.pdf.
2. ESDM, "Sektor Pasokan Energi Pembangkit dari Energi Baru (Indonesia 2050 Pathway Calculator)," *Mini Pap.*, 2015.

Acknowledgement

Contributions from, Mizuho Japan, NIES Japan, the Ministry of Environment and Forestry, the Ministry of Energy and Mineral Resources, PLN Indonesia, and CREP-ITB in the preparation of this study were greatly appreciated

Assessment of the energy efficiency and GHG emission reduction potential in Indonesia's Iron and Steel Industry based on AIM/EndUse model

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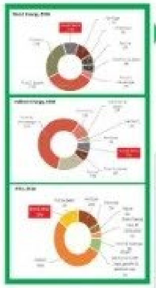
National Institute for Environmental Studies

Introduction

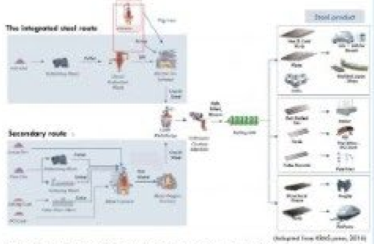
Background & Problem Identification



The intensive use of energy in the steel industry makes this sector as one of the main contributors of GHG emissions in Indonesia's industrial sector that not only from **energy use**, which includes stationary fuel combustion (direct) and purchased electricity (indirect), but also from **IPPU**.

The study presented an analysis of the effectiveness of mitigation efforts on potential energy saving and GHG emission reduction from energy and IPPU activities that has never been done in the studies that focus on the bottom-up modeling for the iron steel industry.

Overview of Indonesia's Iron Steel Process

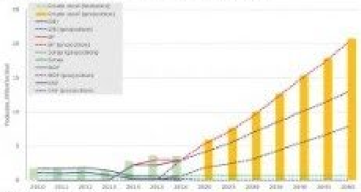


(Adopted from IISIA, 2016)

Steel is produced by two main routes namely, integrated steel route and secondary route.

"Besides integrated and secondary routes, Indonesia has operated the iron-making Blast Furnance technology in 2019, which the pig iron from Blast Furnance will be integrated to EAF"

Future Indonesia's Steel Production



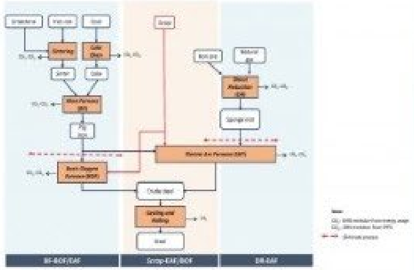
Histories (2010-2016)

Indonesia's steel production process based on Direct Reduction (DR) and scrap that integrated with EAF. In 2014, Indonesia has developed Blast Furnace that integrated with Basic Oxygen Furnace (BOF), meanwhile the DR has not operated since 2016.

Projection (2020-2050)

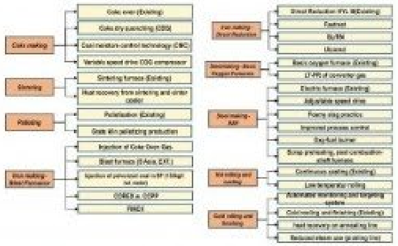
- Indonesia has developed BF-EAF since 2019
- There is no addition of scrap since 2020 to 2050 (stagnant)
- The goverment's target for building of 10 MillionTon of steel (2025), that assumed to be achieved by BF that integrated with BOF and EAF in 2030.
- Beyond 2030, it assumed that the averange development of BF to BOF is 1.2 MillionTon per 5 year and BF to EAF 1.5 MillionTon per 5 year

Possible Mitigation Options in the Steel Production Process



1. Adjusting the production structure

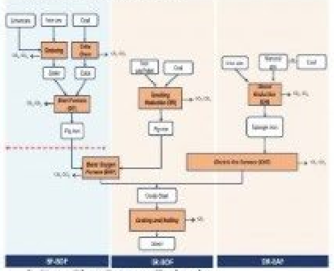
Increasing material efficiency with the scrap utilization in both BF-BOF and EAF routes that eliminate the needs of previous processes (coking, sintering, blast furnace, direct reduction) to producing iron that consumes a large amount of fuel and reductant



2. Promoting Low Carbon Technology

Promoting low carbon technology to increase energy efficiency in iron steel production process

In this study, there are 51 technologies related process iron steel industry that will be evaluated in the AIM/End-Use model. The selected technology based on cost effectiveness appraouch as shown in the picture above



3. Non- Blast Furnace Technology

Promoting non-blast furnace technology (such as: smelting reduction & Coal/Natural gas based Direct reduction)

Acknowledgement

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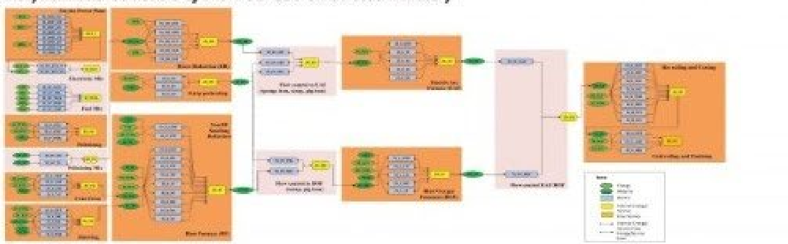
Methodology & Assumption

Analysis model structure of the Indonesia's iron steel industry



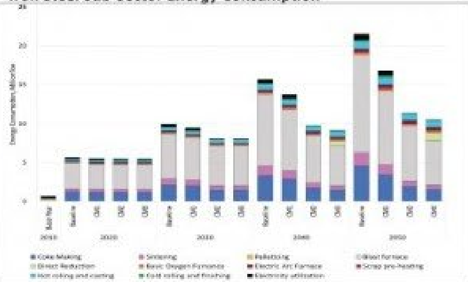
- Model simulation was used to deliver an outlook and evaluate scenarios related to GHG emissions reduction, and energy efficiency potentials in Iron steel sectors. The modelling tool used **AIM/End-use (The Asian-Pacific Integrated Model)** with GAMS (General Algebraic Modelling System) v 23.3 as the calculation software and solver

Model Scenarios

Parameters	BaU	CM1	CM2	CM3
Build upon	none	BaU	CM1	CM2
GDP growth	5.5%	5.5%		
Production structure	Economic structure in 2030 & 2050 are the same as that of 2016			
Share of energy in power	Share of energy in 2030 & 2050 are the same as that of 2030	Following NDC scenario unconditional	Following NDC scenario unconditional	Following NDC scenario unconditional
Increasing material efficiency (Scrap)	No addition of scrap since 2020 to 2050	[illegible]	[illegible]	[illegible]
Efficiency improvement of BAT compared to existing device	Efficiency of equipment in 2030 & 2050 are the same as that of 2016	Efficiency of equipment in 2030 & 2050 are the same as that of 2016	10-80%	10-80%
Non-Blast Furnace Technology	DR process is non-active since 2016 to 2050	DR process is non-active since 2016 to 2050	[illegible]	[illegible]

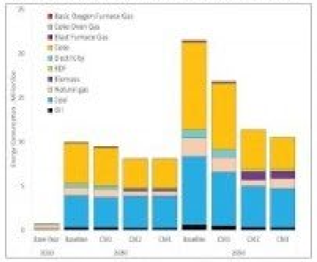
Result & Discussions

Iron Steel Sub-Sector Energy Consumption

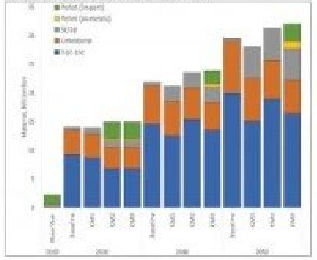


The potential energy savings that can be obtained if the iron steel development of each scenario can be achieved is 4.68 Mtoe (CM1 scenario), 10.12 Mtoe (CM2 Scenario), and 10.99 Mtoe (CM3 Scenario) in 2050 or equal to the percentage of energy savings compared to the baseline 21.8%, 47.1%, and 51.1% respectively

Energy consumption by type of energy, 2010-2050

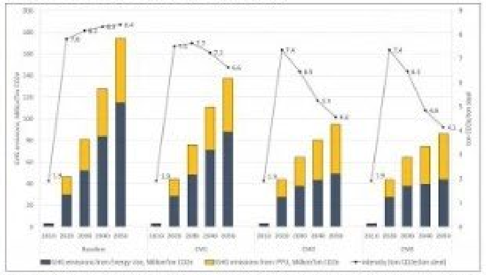


Material consumption , 2010-2050



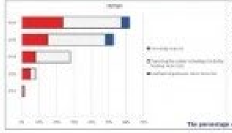
In the baseline scenario, the use of fuels is still dominated by natural gas followed by electricity due to the steel production process through DR-EAF (2010). This situation is expected to change, the share of coke and coal will significantly increase along with steel production increases through BF technology in 2030 and 2050. Under CM scenario, the utilization of scrap, maximizing energy efficiency, and reactivate Direct Reduction effectively reduces coke and coal consumption.

Iron Steel Sub-Sector GHG Emissions

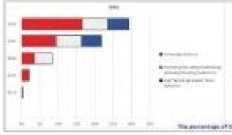


The increasing steel production capacity using BF technology cause a significant increase of GHG emissions intensity level from 1.9 tonsCO2e/ton of steel (2010) to 8,4 tonsCO2e/ton of steel in 2050. Therefore, the implementation of mitigation scenario shows the changing trends for GHG emissions intensity.

The Effectiveness of Each Mitigation Actions in GHG Emissions Reduction

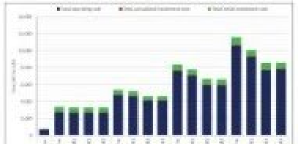


Energy: Low carbon technology promotion is the main driver for GHG emissions reduction from energy sector.



IPPU: Scrap utilization will obtain the most significant emissions reduction from IPPU sector, followed by promoting low carbon technology (smelting reduction), and direct reduction.

Mitigation Cost



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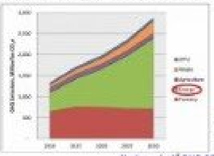

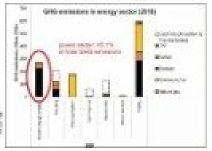

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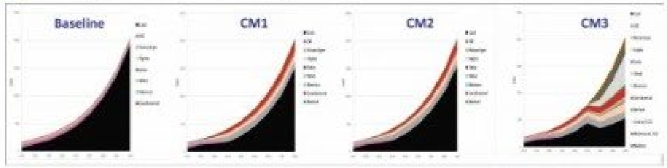

- In the baseline scenario, the total electricity production is targeted at 2041 TWh (2050) which is assumed to be mostly produced by coal-fired power plants, which is 94.5% of total electricity production while the contribution of renewable energy plants is still relatively small around 1.3%.
- In the ex-tenteded NDC scenarios (CM1 and CM2), national electricity production is still dominated by the coal-fired power plant. However, the portion will decrease to 1,542 TWh (75.6%) and 1,516 (74.3%) of total electricity production in 2050, respectively.
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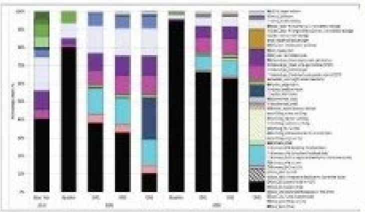
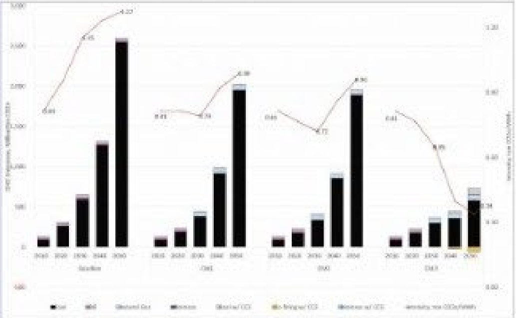
B. Electricity projection for each type of technology, 2010 & 2050

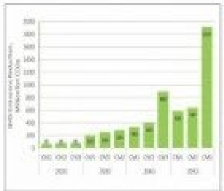


Technology mix in the skenario CM3 that will be drastically changed when compared to the baseline in 2050. The conventional coal generation technology (sub-critic) will decrease significantly from the 94.5% (baseline) to 5.45%, while clean coal technology (Super/Ultra Super Critical,

• *Power Sub-sector GHG Emissions, 2010-2050*



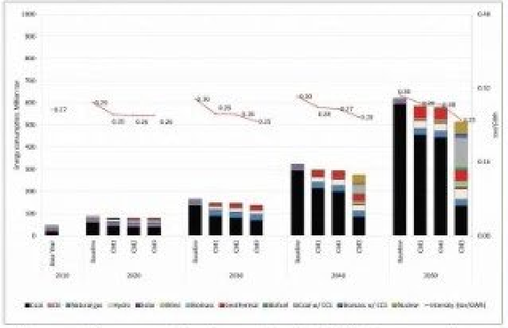
Without mitigation intervention, Intensity in the baseline scenario has increasing trend from 0.81 tCO2e/MWh(2010) to 1.27 tCO2e/MWh (2050). Meanwhile, the CM1 and CM2 scenario intensity has decreasing trend until 2030. However, the year above 2030, renewable energy domination over electricity supply demand will not be significant compared to the increasing number of coal-fired power plant. On the contrary, the application of CSS integrated with coal and biomass/BECCS power plant able to positively reduce the intensity up to 0.34 tCO2e/MWh or declining 73.6% intensity level of baseline scenario in 2050



- The reduction in GHG emissions in the unconditional mitigation NDC scenario can be increased from 204 million tons of CO_2e to 284 million tons of CO_2e in 2030. Above 2030, mitigation efforts carried out increasingly intense include:

i) Utilizing clean coal technology
ii) Increasing the mix of renewable energy
iii) Application of integrated CCS technology in coal and biomass/ BECCS
iv) An increase in the composition of biomass for co- firing from 5% to 20% in 2050,

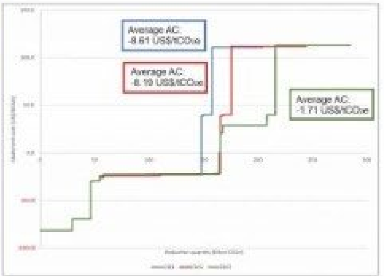
• *Primary energy consumption, 2010-2050*



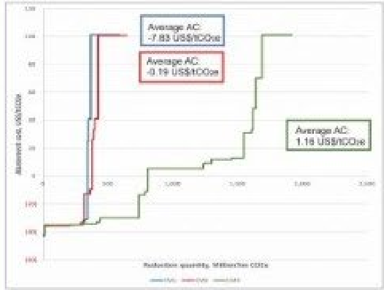
- The potential energy savings that can be obtained if the power sub-sector development of each scenario can be achieved is 18.7 Mtoe (CM1 scenario), 19.4 Mtoe (CM2 Scenario), and 27.6 Mtoe (CM3 Scenario) in 2030 or equal to the percentage of energy savings compared to the baseline 11.2%, 11.7% and 16.5%, respectively. In 2050, the potential energy savings compared to the baseline 5.9%, 6.9% and 17.6%, respectively.

Result & Discussions 3

• *Abatement Cost Curve*



- Under CM1, CM2 and CM3 power sector could achieve emission reduction target of 203 Million tons of CO2e, 243 Mton CO2e and 284 Mton CO_2e (compared to the baseline scenario). This reduction could be achieved with negative average abatement



- Under CM1, CM2 and CM3, power sector could achieve 21.6%, 24.6% and 23.6% emission reduction target (compared to the baseline scenario). This reduction could be achieved with negative average abatement cost. Meanwhile, greater carbon reductions (CM3; i.e.,73.6% reduction) could be achieved with a slight increase in average abatement costs

Concluding Remarks 4

- In 2030, the GHG emissions reduction target that in line with unconditional NDC Indonesia mitigation scenario is 203 million tons of CO_2e. However, there is still room for improvement in potential for GHG emissions reductions by 284 million tons of CO_2e, with an increase of avarage mitigation cost from -8.61 US$/$tCO_2e$ to -1.71 US$/$tCO_2e$. This potential of GHG emissions reduction can be included in conditional & unconditional NDC Indonesia.
- For the long-term strategy (2050), there are still more aggressive mitigation technology choices needed in reducing GHG emissions, such as BECCS technology (bioenergy and CCS) as part of achieving the target of the EBT mix (new and renewable energy) in 2050 as mandated by the National Energy Policy (KEN).

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