IMPROVEMENT OF ENERGY EFFICIENCY AS A RESEARCH AND BUSINESS OPPORTUNITIES

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ENERGY SUPPLY & DEMAND

- Geology and location → resources
- Values, climates, and incomes →consumption patterns
- Well-structured, open, and transparent markets → supply and demand via prices over time
- Inertia → a by-product of the long lead times in developing and implementing energy production and consumption technologies

EFFECT OF ENERGY AVAILABILITY

- the quality of life
- material welfare
- health
- employment,
- income

ENERGY SUPPLY AND USE INFLUENCES THE NATURAL ENVIRONMENT AND HUMAN HEALTH

- ✓ vary from damage to local ecosystems
- ✓ water availability and quality
- ✓ air pollution
- ✓ the global impact of greenhouse gas emissions and ocean pollution

ENERGY & ENVIRONMENT

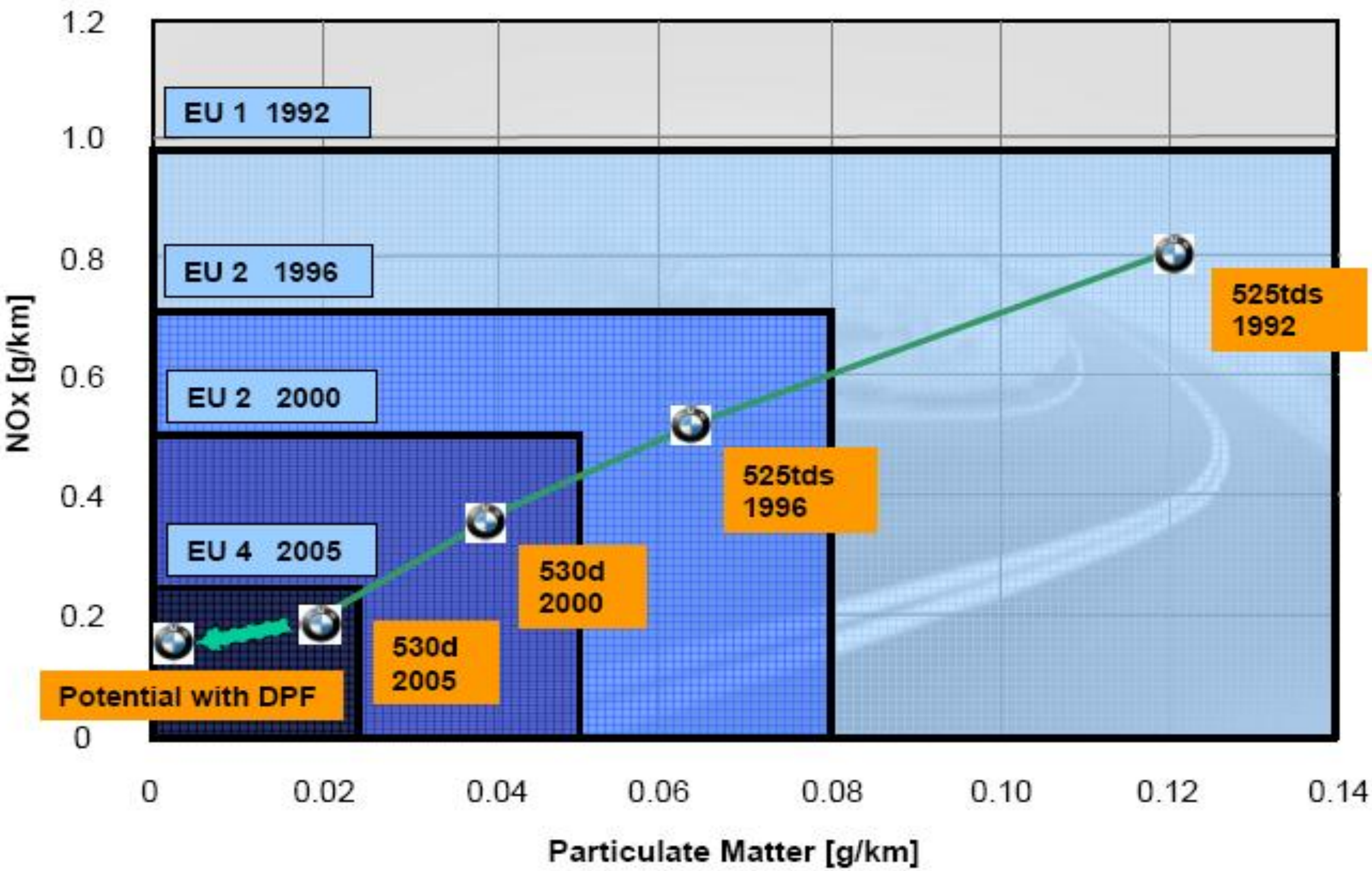
- Increasing emissions of GHGs from human activity → marked increase in atmospheric GHG concentrations.
- Energy sector is the largest contributor to climate change (produces 60 % of GHG).
- There is no adequate restraint to climate change without solutions from the energy sector.

World Major CO2 Emission, 2006 (Energy Sector)

No.	Country	Million Ton
1	China	6,017.69
2	USA	5,902.75
3	Russia	1,704.36
4	India	1,293.17
5	Japan	1,246.76
6	Germany	857.60
7	Canada	614.33
8	United Kingdom	585.71
9	South Korea	514.53
22	**Indonesia**	**280.36**

Source: www.eia.doe.gov, 2008

European Emission Target



MAJOR AREAS OF COP 15 ACTION

(a) a shared vision for long-term cooperation, including a long-term global goal for emission reductions.

(b) enhanced national and international action on mitigation of climate change.

(c) enhanced action on adaptation.

(d) enhanced action on technology development and transfer.

(e) enhanced action on the provision of financial resources and investment.

Engineering efficiency

- Engineering efficiency : amount of useful work output that a process or a piece of equipment performs with a unit of energy input.

- It is expressed in units of physical output per unit of energy, or as a percentage of the input energy that is converted into useful output.

- Engineering efficiency is used to emphasize the engineering performance of equipment and processes.

ENERGY INTENSITY

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ENERGY INTENSITY

- Energy intensity : the amount of primary energy supply or final energy use to produce economic variable such as GDP.

  - The smaller the energy intensity, the more efficient energy is used to produce certain GDP.

- Energy intensity focuses on the energy use of entire industries or countries.

ENERGY INTENSITY

- It is expressed in units of energy per unit of physical or monetary output.
- It encompasses the effects of both engineering efficiency and industrial structure.
- Industrial structure refers to the mix of plants and facilities in the industry or country, and manifests itself in the mix of raw materials, intermediate products, and finished goods that are produced.

ENERGY INTENSITY

- A country can lower its energy intensity by installing more energy efficient equipment and processes and/or shifting its industrial base away from heavy, processing industries toward light, fabricating ones.

- Processing raw materials, such as steel and petrochemicals production, generally requires much more energy per unit of output than does fabricating finished goods, such as computer and automobile manufacture.

ENERGY EFFICIENCY IMPROVEMENT

- It means: a reduction in the energy used for a given energy service (heating, lighting, etc.) or level of activity.
- It encompasses all changes that result in a reduction in the energy used for a given energy service.
- Reduction of energy consumption is not necessarily associated to technical changes, since it can also result from a better organization and management or improved economic efficiency in the sector .

ENERGY EFFICIENCY IMPROVEMENT

- Energy efficiency is not just a technical matter, it is also a matter of efficient services: making a phone call instead of a physical visit, recycling bottles, reducing heat at night, using timber instead of concrete for house construction.

- Such improvements may exist at the micro-level but may not be directly visible at the macro-level.

- Assessing energy efficiency also means measuring the overall impact of all the improvements at the micro-level on the evolution of the energy consumption.

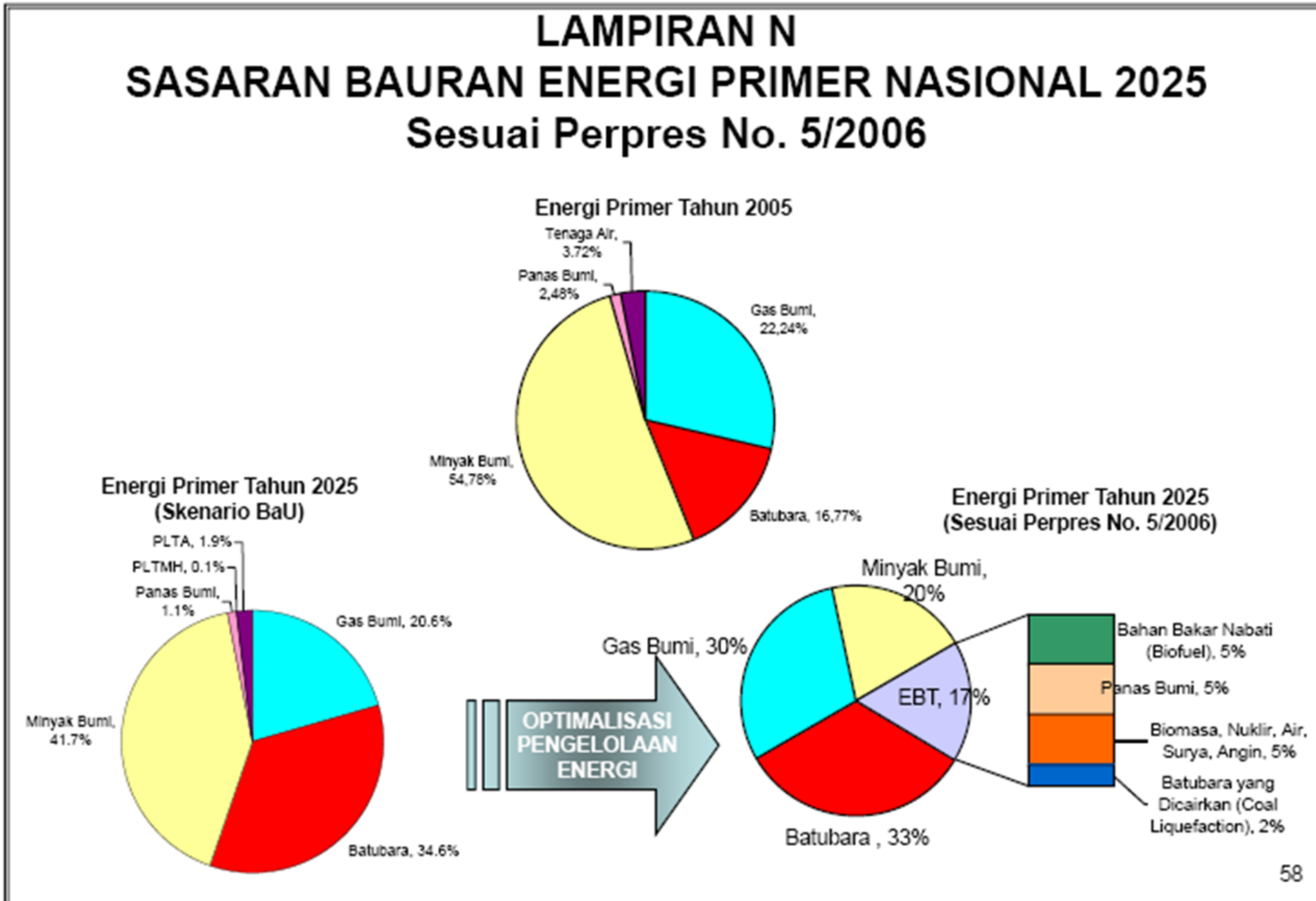
GDP and Energy Indicator (Growth)

Year	Growth (%)				
	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007
GDP at Constant Price 2000	4.72	5.03	5.69	5.51	6.32
GDP Nominal	8.07	14.01	20.84	20.37	18.50
GDP Nominal Per Capita	6.43	12.66	20.28	18.57	16.69
Population	1.54	1.20	0.47	1.52	1.55
Number of Households	2.87	2.88	-5.38	1.49	0.84
Primary Energy Supply	2.87	3.30	5.77	0.34	6.11
Final Energy Consumption Per Capita	1.30	2.08	5.28	-1.16	4.49
Final Energy Consumption	-1.79	9.58	4.32	-0.24	7.03

Population and Employment

Year	Population (Thousand People)	Labor Force (Thousand People)	Household (Thousand Household)	Unemployment (Thousand People)
2000	205,843	95,651	52,005	5,813
2001	208,647	98,812	54,314	8,005
2002	212,003	99,564	55,041	9,132
2003	215,276	100,316	56,623	9,531
2004	217,854	103,973	58,253	10,251
2005	218,869	105,802	55,119	10,854
2006	222,192	106,389	55,942	10,932
2007	225,642	109,941	56,411	10,011

ENERGY POLICIES



Share of Final Energy Consumption by Sector (%)

Year	Industry	Household	Commercial	Transportation	Others
2000	41.18	18.78	4.10	29.71	6.24
2001	40.63	18.36	4.13	30.58	6.31
2002	40.07	17.99	4.22	31.48	6.23
2003	37.72	18.76	4.44	33.06	6.02
2004	37.29	17.51	4.63	34.44	6.12
2005	40.50	16.49	4.59	33.03	5.39
2006	43.33	15.69	4.60	31.57	4.81
2007	44.82	15.21	4.59	31.06	4.32

Note: Commercial Energy (excluded biomass)

Share of Final Energy Consumption by Type (%)

Year	Coal	Natural Gas	Fuel	LPG	Electricity
2000	7.3	17.6	63.6	1.7	9.8
2001	7.3	16.2	64.7	1.6	10.2
2002	7.6	16.0	64.1	1.7	10.5
2003	6.5	16.0	64.6	1.8	11.2
2004	5.9	15.8	65.3	1.7	11.3
2005	11.7	15.3	59.9	1.5	11.6
2006	15.8	14.8	55.4	1.7	12.3
2007	20.3	13.3	52.2	1.8	12.4

Note: Commercial Energy (excluded biomass)

Energy Subsidy

- Fuel and electricity subsidy, is still needed due to the relatively low purchasing power of the people and to accelerate economic development. Subsidy will be continuously decreased and diverted from price subsidy to direct subsidy in order to provide subsidy to the right target.

- Subsidy allocation is determined by the volume of subsidized fuel and world crude oil prices; the higher the crude oil price, the bigger the subsidy. The government will continue to decrease subsidized fuel which is then substituted with other sources of energy, such as LPG and coal briquettes.

- In 2005, petroleum fuel subsidy was recorded at 95.6 billion Rupiah, decreasing to 60.5 billion Rupiah in 2006 and 43.4 billion Rupiah in 2007, following decreasing use of subsidized fuel. Electricity subsidy in 2005 amounted to 10.5 billion Rupiah, increasing to 27.5 billion Rupiah in 2006, which then decreased to 25.8 billion Rupiah in 2007.

SUBSIDIES OF FUEL, LPG AND ELECTRICITY

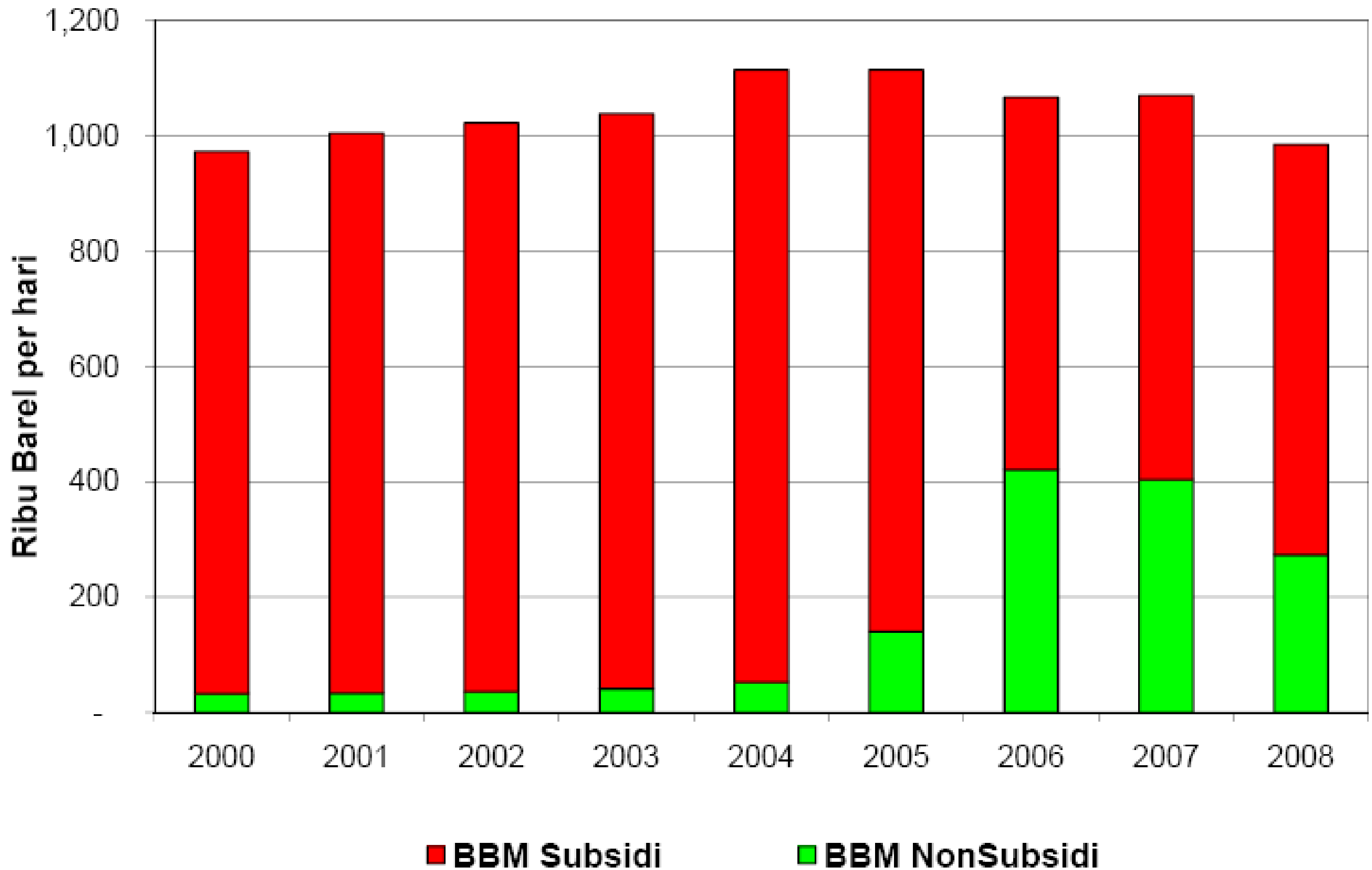
	2004	2005	2006	2007	2008
Total	62,49	114,00	98,11	121,27	200,30
Listrik	3,31	10,65	33,9	37,48	60,29
BBM/LPG	59,18	103,35	64,21	83,79	140,01

RENCANA DAN REALISASI
SUBSIDI BBM/LPG DAN LISTRIK TAHUN 2008

(Miliar Rp)

URAIAN	RENCANA	REALISASI
Premium	44.048,54	41.958,18
Minyak Tanah	37.949,12	48.202,00
Solar	32.649,00	44.248,37
BBM	**114.646,65**	**134.409,56**
LPG	9.565,27	5.597,03
Listrik	61.010,00	60.290,00
TOTAL	**185.221,92**	**200.296,59**

PASOKAN BBM DOMESTIK



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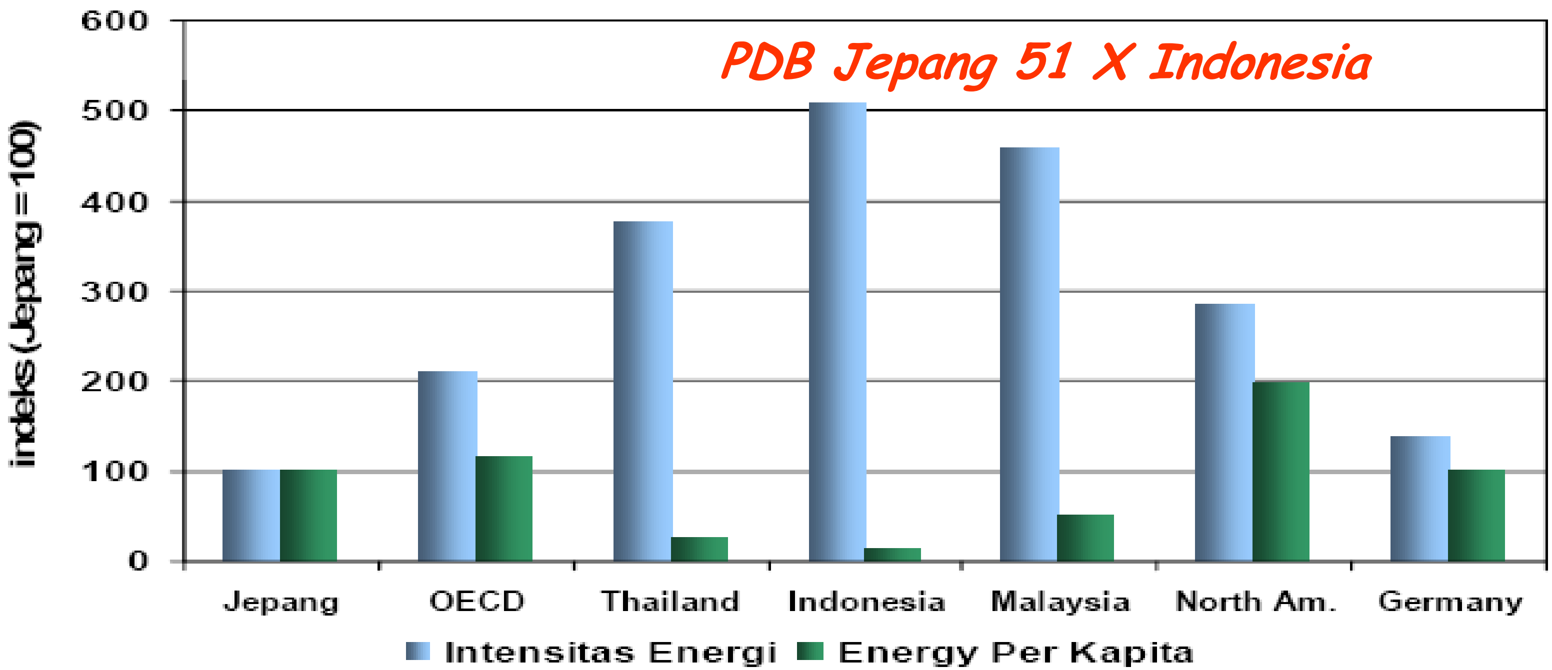
KONSUMSI ENERGI PER KAPITA VS INTENSITAS ENERGI



- *Intensitas Energi*
  (toe per juta US$ PDB)
  - *Jepang : 92,3*
  - *Indonesia : 470*
- *Konsumsi Energi per Kapita*
  (toe per kapita)
  - *Jepang : 4,14*
  - *Indonesia : 0,467*

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CARBON DIOXIDE EMISSION

- Carbon Dioxide (C02) emission from the energy sector increased by 5% in average over the last couple of years in line with an increase of energy use. C02 emission in 2000 reached 244.31 millions tons and increased to 323.04 millionstons in 2007.

- Carbon dioxide emission from the industry and electricity generation sectors in 2000 reached 81.44 millions tons and 59.8 millions tons respectively and increased to 117.06 millions tons and 93.63 millions tons. The same trend is also shown in the household and commercial sectors as well as transportation sectors.

Energy Efficiency/CO2 Indicators[1)]	Units	2000	2007	World	Japan
Key indicators					
Primary energy intensity (at purchasing power parities (ppp))	koe/$05p	0.225	0.192	0.180	0.126
Primary energy intensity excluding traditional fuels (ppp)	koe/$05p	0.151	0.136	0.162	0.125
Primary energy intensity adjusted to EU structure (ppp)	koe/$05p	0.193	n.a.	0.106	0.098
Final energy intensity (at ppp)	koe/$05p	0.162	0.132	0.113	0.077
Final energy intensity at 2005 GDP structure[3)] (ppp)	koe/$05p	0.162	0.132	0.077	0.077
Final energy intensity adjusted to EU economic structure (ppp)	koe/$05p	0.138	n.a.	0.076	0.070
CO2 intensity (at ppp)	kCO2/$05p	0.406	0.377	n.a.	0.284
CO2 emissions per capita	tCO2/cap	1.330	1.580	n.a.	9.27

[1)] CO2 from fuel combustion [2)] incl. autoproducers [3)] by main sector

Energy Efficiency/CO_2 Indicators[1)]	Units	2000	2007	World	Japan
Industry					
Energy intensity of industry (to value added) (at ppp)	koe/$05p	0.098	0.093	0.116	0.088
Energy intensity of manufacturing (at ppp)	koe/$05p	0.155	0.141	0.172	0.120
Unit consumption of steel	toe/t	0.590	0.220	n.a.	0.38
CO_2 intensity of industry (to value added) (at ppp)[2)]	kCO_2/$05p	0.230	0.264	n.a.	0.259
CO_2 emissions of industry per capita [2)]	tCO_2/cap	0.350	0.480	n.a.	2.53

Energy Efficiency/CO2 Indicators[1)]	Units	2000	2007	World	Japan
Transport					
Energy intensity of transport to GDP (at ppp)	koe/$05p	0.032	0.025	0.033	0.022
CO2 intensity of transport to GDP (at ppp)	kCO2/$05p	0.095	0.074	n.a.	0.057
CO2 emissions of transport per capita	tCO2/cap	0.310	0.310	n.a.	1.88

Energy Efficiency/CO2 Indicators[1)]	Units	2000	2007	World	Japan
Residential, service and agriculture sectors					
Energy intensity of households (to private consumption) (at ppp)	koe/$05p	0.122	0.091	0.053	0.020
Average electricity consumption of households per capita	kWh/cap	148	208	681	2250
Average electricity consumption per household	kWh/hh	583	781	2834	6068
Average electricity consumption of electrified households	kWh/hh	799	813	n.a.	6068
Energy intensity of service sector (to value added) (at ppp)	koe/$05p	0.011	0.010	0.020	0.024
Electricity intensity of service sector (to value added) (at ppp)	kWh/$05p	56	72	121	130

Energy Efficiency/CO2 Indicators[1)]	Units	2000	2007	World	Japan
Residential, service and agriculture sectors					
Unit consumption of services per employee	toe/emp	0.080	0.090	n.a.	1.51
Unit electricity consumption of services per employee	kWh/emp	402	644	n.a.	8280
Energy intensity of agriculture (to value added) (at ppp)	koe/$05p	0.020	0.015	0.043	0.061
CO2 intensity of households (to private consumption) (at ppp)	kCO2/$05p	0.069	0.038	n.a.	0.026
CO2 emissions of residential sector per household	tCO2/hh	0.560	0.390	n.a.	1.32
CO2 intensity of service sector (to value added) (at ppp)	kCO2/$05p	0.015	0.010	0.023	0.034
CO2 emissions of service sector per employee	tCO2/emp	0.110	0.090	n.a.	2.14
CO2 intensity of agriculture (to value added) (at ppp)	kCO2/$05p	0.060	0.046	0.102	0.179
CO2 emissions of agriculture sector per capita	tCO2/cap	0.030	0.030	0.07	0.09

Energy Efficiency/CO2 Indicators[1)]	Units	2000	2007	World	Japan
Transformation sector					
Overall efficiency of energy transformations	%	69.3	66.4	67.4	70.9
Efficiency of total electricity generation	%	43.2	40.5	38.4	42.2
Rate of electricity transmission-distribution losses	%	10.9	11.2	8.7	4.6
Efficiency of thermal power plants	%	38.9	38.0	34.3	43.5

Energy Efficiency/CO2 Indicators[1)]	Units	1990	2007	World	Japan
Diffusion of energy/CO2 efficient technologies and practices					
Per capita installed capacity of solar water heaters	m^2/1000inhab	n.a.	n.a.	n.a.	55.7
Share of biofuels in road transport energy consumption	%	n.a.	n.a.	1.8	n.a.
Share of biomass in industry energy consumption	%	43.4	18.0	8.1	2.0
Share of renewables in electricity generating capacity	%	18.2	12.9	23.4	18.9
Share of renewables in gross electricity consumption	%	23.5	10.2	23.4	9.5

GDP and Energy Indicator (Nominal)

	Unit	2002	2003	2004	2005	2006	2007
GDP at Constant Price 2000	Trillion Rupiahs	1,506	1,577	1,657	1,751	1,847	1,964
GDP Nominal	Trillion Rupiahs	1,863	2,014	2,296	2,774	3,339	3,957
GDP Nominal per	Thousand Rupiahs	8,789	9,354	10,538	12,676	15,030	17,538
Population	Thousand	212,003	215,276	217,854	218,869	222.192	225,642
Number of Households	Thousand	55,041	56,623	58,253	55,119	55,942	56,411
Primary Energy Supply	Thousand BOE	799,845	822,761	849,907	898,919	901,968	957,107
Primary Energy Supply per Capita	BOE / capita	3.77	3.82	3.90	4.11	4.06	4.24
Final Energy	Thousand BOE	481,185	472,567	517,854	540,206	538,883	576,764
Final Energy Consumption per Capita	BOE / capita	2.27	2.20	2.38	2.47	2.43	2.56

KAPASITAS DAN PRODUKSI ENERGI ALTERNATIF

URAIAN	SATUAN	2004	2005	2006	2007	2008
Panas Bumi	KW	807.000,0	852.000,0	852.000,0	982.000,0	1.052.000,0
PLTS	KW	-	110,3	1.629,3	3.658,3	5.522,3
PLTB	KW	-	80,0	320,0	815,0	1.015,0
PLTMH & Pikohydro	KW	-	214,0	928,0	2.092,0	3.027,0
TOTAL	KW	807.000,0	852.404,3	854.877,3	988.565,3	1.061.564,3

PRODUKSI BAHAN BAKAR NABATI

URAIAN	SATUAN	2004	2005	2006	2007	2008
Biofuel (Per Tahun)	Ribu KL	3,3	122,5	471,5	1.722,2	2.558,7
- Bio diesel	Ribu KL	0,8	120,0	456,6	1.550,0	2.329,1
- Bio etanol	Ribu KL	2,5	2,5	12,5	135,0	192,4
- Bio oil	Ribu KL			2,4	37,2	37,2

Pembangunan Listrik Pedesaan

No	Jenis Pembangkit	Satuan	2006	2007	2008
1	PLTMH	kW	714	1169	1845
2	PLTS	kWp	1519	2029	1864
3	PLTS Terpusat	kWp	-	102	240
4	PLTB	kW	240	735	200
6	Jaringan Tegangan Menengah	kms	1279	1249	1306
7	Jaringan Tegangan Rendah	kms	1640	1475	1323

(Sumber: Kinerja ESDM 2008)

APPROACH TO ENERGY EFFICIENCY

1. Reduction of demand through enforcement, regulatory action, or economic measures.
2. Use analternative method, process, to achieve the desired end result with greater eficiency.
3. Subtitute one fuel or energy source for another.

Introduction

The "Company Energy Efficiency Methodology" (Methodology) has been developed for **Asian industrial companies** to help them **improve energy efficiency** through Cleaner Production.

Gerlap

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Benefits

Benefits from energy efficiency are ***reduced risks*** and ***increased profits*** for companies through:

- Reduced operating costs
- Reduced impact from rising energy prices and blackouts
- Improved productivity and product quality
- Improved reputation with customers, government and public
- Improved staff health, safety and morale
- Improved compliance with legislation and ISO 14001 targets
- Improved environmental performance

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The Methodology

Company Energy Efficiency methodology

Is tailored to energy-intensive industrial companies in developing Asian countries

Focuses on energy, which is less visible than waste, water and raw materials

Explains not only what should be done in theory, but also how it is done in practice because all companies are different.

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The Methodology is based on:

Company Energy Efficiency methodology

The Cleaner Production (CP) strategy: prevention of waste, systematic approach, integrated into business processes and aimed at continuous improvement

Several existing CP and energy audit methodologies

Real practice experience from energy assessments carried out as part of the GERIAP project in more than 40 Asian industrial companies

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How to use the methodology

Company Energy Efficiency methodology

Companies can improve their energy efficiency through a *6-step Cleaner Production approach*

Under each step there are several ***tasks***. Each task describes what a company should do as a minimum.

•Company examples that explain how the task was applied at different companies and lessons learnt

•Worksheets to assist you in completing the task, and which are editable and printable

<u>Remember: the ultimate purpose is to keep improving energy efficiency, and this methodology can help companies do this.</u>

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WORLD ENERGY POLICY TO ENERGY EFFICIENCY

- ✓ **More efficient and less costly distribution and utilization of electricity because electricity is a key energy carrier used in all sectors with a wide-range of technologies.**
- ✓ **Efficient and economical distributed electric-power production to ensure at least 500 kWh per person per year to the rural populations of the world by 2020, and 1,000 kWh by 2050, consistent with the 2000 WEC Millennium Statement.**
- ✓ **Alternative fuels and means for transportation will meet the growing concern-also pointed out in the 2003 WEC study, *Drivers of the Energy Scene*-about the ability of petroleum to meet increasing global transportation needs at affordable prices.**

- More efficient power systems for automobiles and trucks that also reduce emissions.
- Improved use of raw forest materials to produce energy more efficiently in the paper and pulp industry.
- Reducing consumption of raw materials and decreasing emissions in the production of iron and steel.
- Improved energy efficiency of the aluminum production process to reduce CO_2 emissions.

GOOD PRACTICE OF ENERGY EFFICIENCY (PROCEL)

	1986/ 2003	2004	2005	2006	2007
Total Investment (BRL[9] million)	666.08	94.15	98.02	113.24	52.78
Energy Saved (billions kWh/year)	17.22	2.373	2.158	2.845	3.930
Peak Demand Reduction (MW)	4,633	622	585	772	1,357
Equivalent Power Plant (MW)	4,033	569	518	682	942
Postponed Investment (BRL billion)	10.65	2.50	1.77	2.23	2.76

BONUS-MALUS FOR NEW CARS IN FRANCE

Bonus applies to new vehicles purchased from 5 December 2007 and depends on the level of CO_2 emissions:

- € 5,000 for emitting less than 60 g CO_2/km
- € 1,000 for emitting less than 100 g CO_2/km
- € 700 for emitting 101 - 120 g CO_2/km
- € 200 for emitting 121 - 130 g CO_2/km

The penalty applies to new vehicles purchased as of 1 January 2008 emitting more than 160 g CO_2/km:

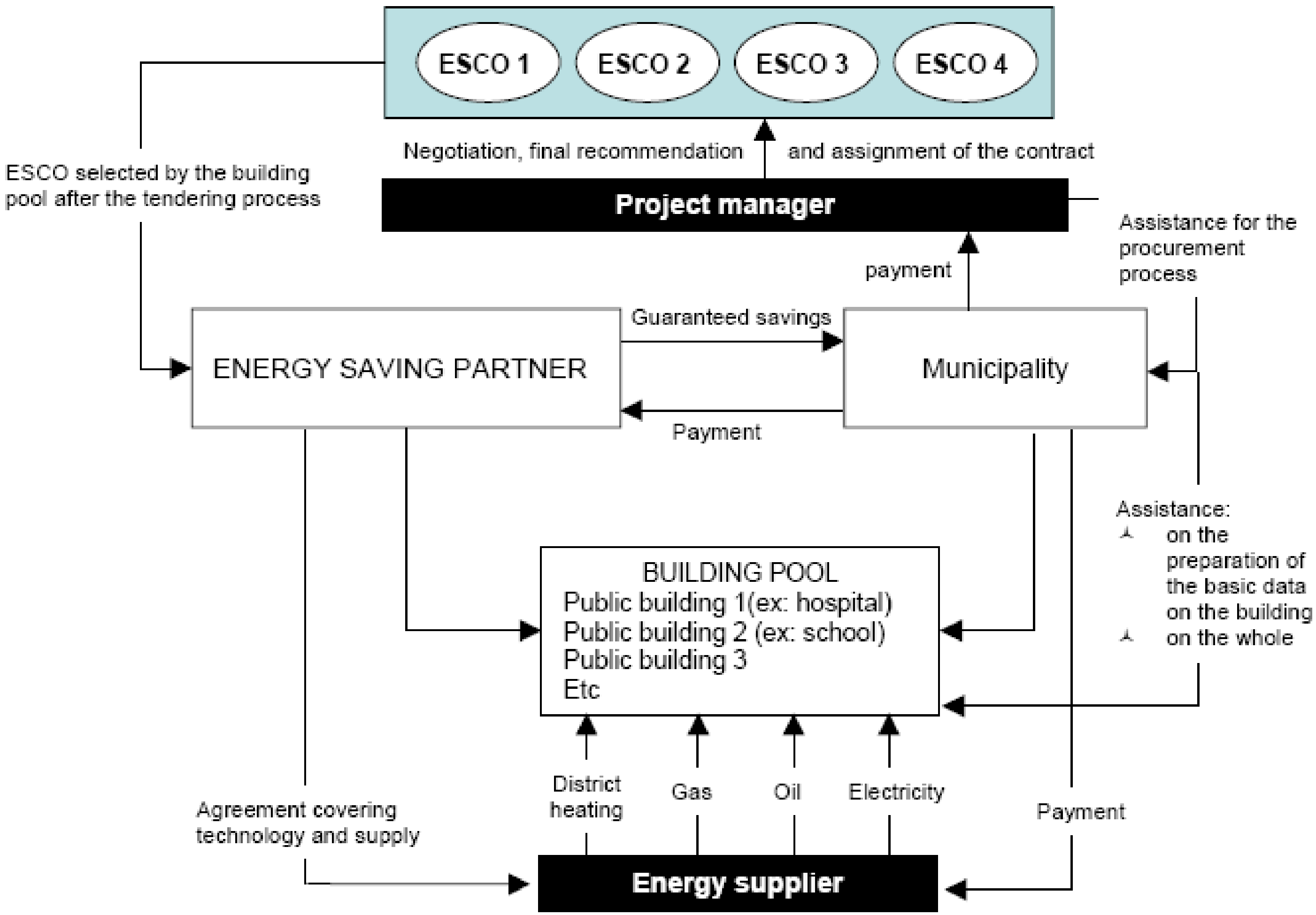
+ € 200 for emitting 161 - 165 g CO_2/km

+ € 750 for emitting 166 - 200 g CO_2/km

+ € 1,600 for emitting 201 - 250 g CO_2/km

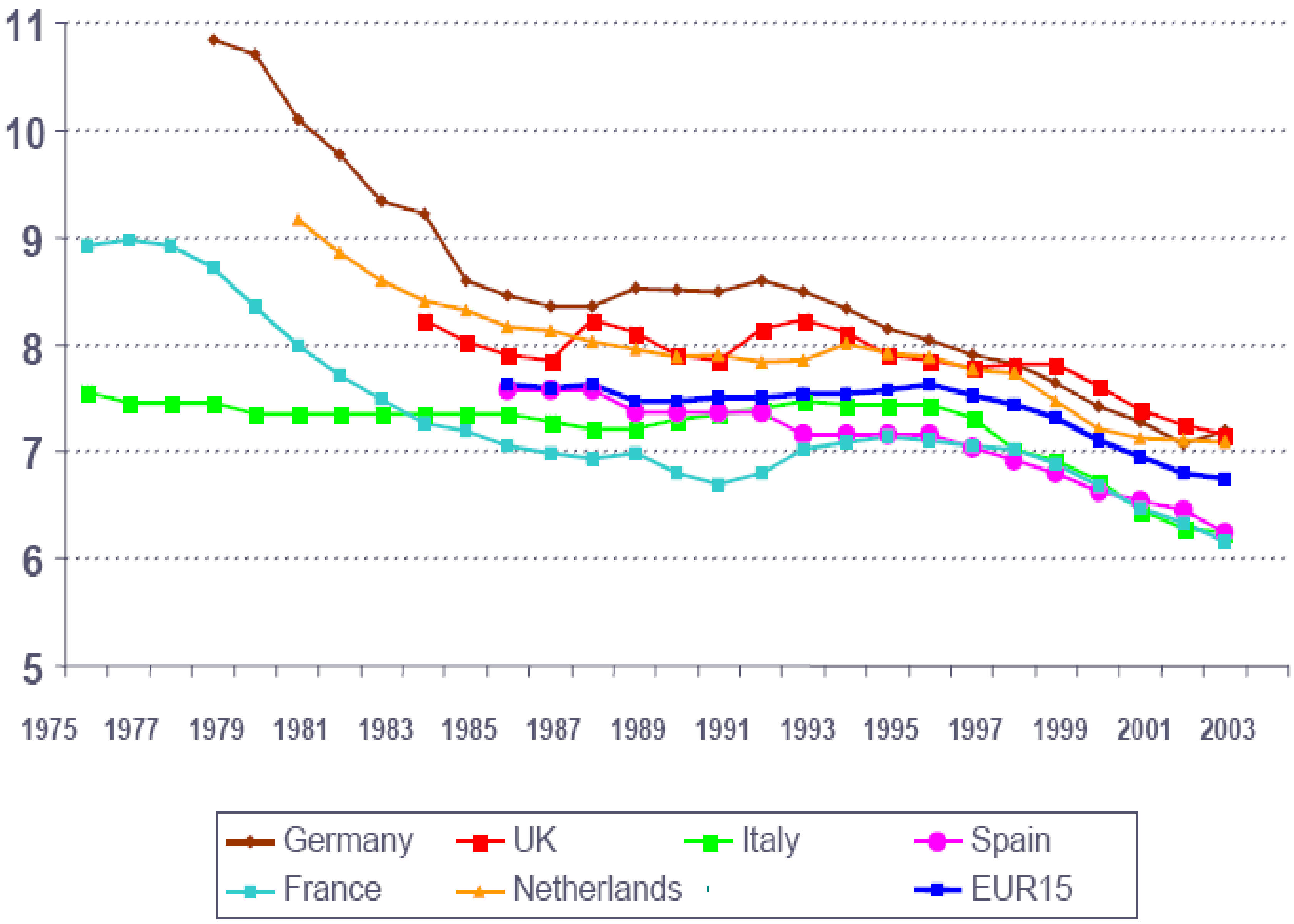
+€ 2,600 for emitting over 250 g CO_2/km

Energy Performance Contracting (EPC) between consumer and Energy Service Company (ESCO)



Improvement of Engine Technology

Technology	Average Increase Efficiency
Engine Technologies	
Variable Valve Timing & Lift improve engine efficiency by optimizing the flow of fuel & air into the engine for various engine speeds.	**5%**
Cylinder Deactivation saves fuel by deactivating cylinders when they are not needed.	**7.50%**
Turbochargers & Superchargers increase engine power, allowing manufacturers to downsize engines without sacrificing performance or to increase performance without lowering fuel economy.	**7.50%**
Integrated Starter/Generator (ISG) Systems automatically turn the engine on/off when the vehicle is stopped to reduce fuel consumed during idling.	**8%**
Direct Fuel Injection (w/ turbocharging or supercharging) delivers higher performance with lower fuel consumption.	**11-13%**
Transmission Technologies	
Continuously Variable Transmissions (CVTs) have an infinite number of "gears", providing seamless acceleration and improved fuel economy.	**6%**
Automated Manual Transmissions (AMTs) combine the efficiency of manual transmissions with the convenience of automatics (gears shift automatically).	**7%**



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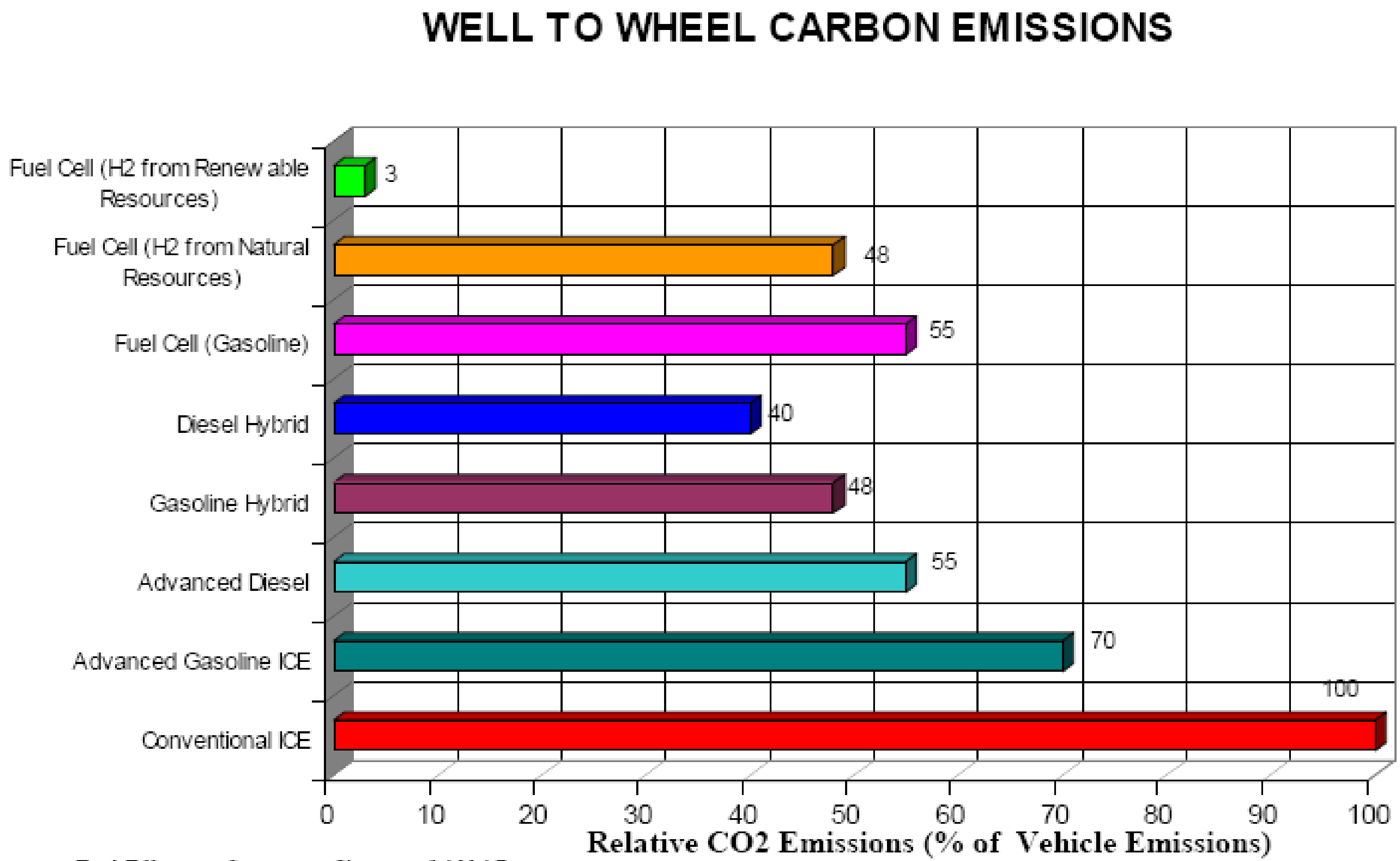
Technology Options to meet CO_2 Norms



KEY ISSUES FOR ENERGY EFFICIENCY RESEARCH (Economic Issues)

- ✓ Improvement in existing technology and new applications for developments.
- ✓ New components, subsystems, and systems for energy-intensive process.
- ✓ Improvements and major new developments in transportation
- ✓ In all areas of intensive electricity use, the identification of preferred systems from the point of view of utilities and energy costumers is required.
- ✓ More efficient technologies for direct-fired process heat application requiring oil or natural gas are required.
- ✓ Special emphasis on improve methods for heat recovery-particularly heat exchange technology- is needed.

ENERGY EFFICIENCY RESEARCH (Programmatic and institutional issues Issues)

- ✓ Identification of energy user's needs in the residential, commercial, industrial, and transportation sectors.
- ✓ The interplay between energy management and load management, and the balancing of the two.
- ✓ The relative emphasis between research and development, demonstration, and testing programs need to be defined.
- ✓ The various roles of government agencies, the utilities, and cooperation with equipment manufacturers and suplliers must be established.
- ✓ Recommendations must be made for reasonable, balanced regulatory actions, rather than one-sided laws which attempt to solve one problem by creating two others.

Projects should first be screened to determine conpliance with evaluation criteria :

- Does the proposed project satisfy an industry or a public need?
- Does it have a favourable impact on utilities or end-users?
- Should it involve research and development or demonstration or testing?
- Who should carry it out?
- Will it lead to identification of “preferred systems” in the area of energy use which is involved?

UK Energy Research Centre

- Demand Reduction
- Future Sources of Energy
- Energy Infrastructure and Supply
- Energy Systems and Modeling
- Environmental Sustainability
- Materials for Advanced Energy Systems
- Cross-cutting Research Activity

Renewable Energy Centres Agency (EUREC)

- ✓ solar buildings
- ✓ Wind, photovoltaics , biomass, small hydro
- ✓ solar thermal power stations
- ✓ ocean energy
- ✓ solar chemistry and solar materials
- ✓ hybrid systems
- ✓ integration of renewable energy in the energy infrastructure

PROSPECT FOR RESEARCH AND BUSINESS

- ✓ Measuring instrument with a lower price (power analyzer, thermal image analyzer, fuel consumption meter)
- ✓ Lower price control equipment (temperatur, speed, light)
- ✓ Gas analyzer (combustion and ambient)
- ✓ Energy simulator software (process industry, driving simulator)
- ✓ Energy efficiency data base (energy efficient benchmarking)
- ✓ New or improved methods for energy efficiency enhancement (cooking, pumping, cleaning)
- ✓ Proven equipment to enhanced energy efficiency (vehicles, stoves, electricity appliances)
- ✓ Boiler, fan, pump, turbine, heat exchangers, lamp)

PROSPECT FOR RESEARCH AND BUSINESS

- ✓ Energy efficiency data base (energy efficient benchmarking)
- ✓ Analysis and determianation of Emission Factors
- ✓ Fuel price structure (subsidy and non subsidy)
- ✓ Regional fuel quota for a province or municipal
- ✓ Energy Efficiency Training
- ✓ Energy audit Training
- ✓ Traing and Sertification for Energy Managers
- ✓ Renewable energy

CONCLUDING REMARKS

- The main reason for the introduction of energy efficiency policies related to long-term issues is global warming, but also, to some extent, the looming depletion of oil and gas resources around 2030-2050.

- In non-OECD countries, energy efficiency is also a way to alleviate the investment constraints on the supply side.

- Since 2000, with the sharp increase in the price of oil, many countries, especially the less developed ones, are again facing macroeconomic constraints.

CONCLUDING REMARKS

- At the domestic level, governments should incorporate energy efficiency into all main public sector policies (land planning, transport infrastructure, social housing policy, urban planning).

- The infrastructure investment decisions should incorporate the possibility of growing energy prices and constraints on CO_2 emissions.

- The mitigation of the transport sector's CO_2 emissions is highly relevant.

- This could be done through a value of carbon being included in public decisions to direct consumer choices toward energy efficient solutions (a low initial value but growing regularly).

THANKS FOR YOUR ATTENTION

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REFERENCES

1. **A. Thumann and W. J. Younger**. *Handbook of Energi Audits*, 7th ed., The Fairmont Press, Inc., Lilburn, USA, 2007.
2. **T. Amstrong et al**. *Energy Audit Manual New Zealand*, Energy Efficiency and Conservation Authority, Wellington, 2007.
3. **S. A. Parker and W. D. Hunt**. Strategic Energi Management Plan for Fort Buchanan, Puerto Rico, U. S. Dept. Of Energy, October 2001.
4. **A. P. Rossiter and B. P. Jones**. *Energy Management and Efficiency for the Process Industries,* American Institute of Chemical Engineers and John Wiley & Sons, Inc. Hoboken, New Jersey, 2015.
5. **Badan Pengkajian Industri Hijau dan Lingkungan Hidup, Kementerian Perindustrian RI**. *Pedoman Teknis Audit Energi dalam Implementasi Konservasi Energi dan Pengurangan Emisi CO2 di Sektor Industri* (Fase 1), Jakarta, 2011.
6. **Departemen Penelitian dan Pengaturan Perbankan, Otoritas Jasa Keuangan (OJK)**. Buku Pedoman Pembiayaan Efisiensi Energi di Industri untuk Lembaga Jasa Keuangan, OJK, Jakarta, 2015.
7. **Awaludin, W. Panuntun, W.S. Alam, N. Sinaga**. *Pemilihan Mesin Penggerak Generator Pada Sistem Pembangkit Listrik Tenaga Biogas (PLTBG)*, Seminar Nasional Teknik Kimia, Jurusan Teknik Kimia FT Undip, 2003.
8. **Sinaga, Nazaruddin, R. Ismail, R. Perangin-angin dan O. A. Wicaksono**. *Pembangkitan Listrik Menggunakan Bahan Bakar Biogas dari Hasil Fermentasi Kotoran Ternak*, Seminar Nasional Teknik Kimia, Jurusan Teknik Kimia FT Undip, 2003.
9. **Sinaga, Nazaruddin, A. Suwono, Sularso, and P. Sutikno**. *Simulation of Fin Arrangement Effect on Performance of Staggered Circular Finned-Tube Heat Exchanger*, Proceeding, International Conference on Fluid and Thermal Energy Conversion, Bali, 2003
10. **Sinaga, Nazaruddin, A. Suwono, Sularso, and P. Sutikno**. *Kaji Numerik dan Eksperimental Pembentukan Horseshoe Vortex pada Pipa Bersirip Anular*, Prosiding, Seminar Nasional Teknik Mesin II, Universitas Andalas, Padang, Desember 2003
11. **Sinaga, Nazaruddin, A. Suwono dan Sularso**. *Pengamatan Visual Pembentukan Horshoe Vortex pada Susunan Gormetri Pipa Bersirip*

Anular, Prosiding, Seminar Nasional Teknik Mesin II, Universitas Andalas, Padang, Desember 2003.

12. **Sinaga, Nazaruddin**. *Perancangan Mixer Biogas-Udara Untuk Mesin Diesel Dual Fuel Pembangkit Listrik Tenaga Biogas*, Majalah Teknik, Tahun ke XXV, Edisi I, 2005.
13. **Sinaga, Nazaruddin**. *Analisa dan Pemilihan Mesin Untuk Mesin Dual Fuel Campuran Biogas-Solar*, Majalah Rotasi, Jurusan Teknik Mesin FT Undip, Vol. 7 No. 2, April, 2005.
14. **Sinaga, Nazaruddin**. *Perancangan Conversion Kit Untuk Modifikasi Mesin Diesel Dual Fuel Pembangkit Listrik Tenaga Biogas*, Jurnal Ilmiah Nasional Efisiensi dan Konservasi Energi, Jurusan Teknik Mesin, FT Undip, Vol. 1 No. 1, September, 2005.
15. **Sinaga, Nazaruddin**. *Peluang dan Strategi Penghematan Energi Sektor Transportasi di Indonesia*, Prosiding, Seminar Nasional Efisiensi dan Konservasi Energi (FISERGI) 2005, Jurusan Teknik Mesin FT Undip, ISSN 1907-0063, Desember, 2005.
16. **Sinaga, Nazaruddin**. *Pengaruh Parameter Geometri dan Konfigurasi Berkas Pipa Bersirip Anular Terhadap Posisi Separasi di Permukaan Sirip*, Jurnal Ilmiah Poros, Jurusan Teknik Mesin FT Universitas Tarumanegara, Vol. 9 No. 1, Januari, 2006.
17. **Sinaga, Nazaruddin**. *Energy Efficiency As Research and Business Opportunity*, Proceeding, International Workshop on Improvement of UNDIP Research Ability and Networking to Stimulate Sustainable Energy, Grand Candi Hotel, Semarang, October 2009.
18. **Cahyono, Sukmaji Indro, Gwang-Hwan Choe, and Nazaruddin Sinaga**. *Numerical Analysis Dynamometer (Water Brake) Using Computational Fluid Dynamic Software*. Proceedings of the Korean Solar Energy Society Conference, 2009.
19. **Sinaga, Nazaruddin**. *Energy Efficiency On Boiler And Pump Systems*, Technical Papers, International Workshop on Energy Audit Diponegoro University, Casindo Project, Semarang, August 2010 .
20. **Sinaga, Nazaruddin**. *Pengaruh Model Turbulensi Dan Pressure-Velocity Copling Terhadap Hasil Simulasi Aliran Melalui Katup Isap Ruang Bakar Motor Bakar*, Jurnal Rotasi, Volume 12, Nomor 2, ISSN:1411-027X, April 2010.
21. **I. N. Widiasa, N. Sinaga dan D. Ariyanti**. *Improving Performance Of Low Pressure Reverse Osmosis Systems By Intermittent Autoflushing*, Jurnal Teknik Kimia Indonesia Vol. 9 No. 1, April 2010.

22. **Priangkoso, Tabah dan N. Sinaga**. *Tinjauan Beberapa Model Mekanistik Tingkat Konsumsi Bahan Bakar Untuk Diterapkan Pada Program Simulator Mengemudi Hemat Energi Smart Driving*, Prosiding, Seminar Nasional Sains dan Teknologi ke-2, Fakultas Teknik Universitas Wahid Hasyim Semarang, Juni 2011.
23. **Mrihardjono, Juli dan N. Sinaga**. *Pengujian Model Driving Cycle Kendaraan Honda City Berbahan Bakar Premium*, Majalah Gema Teknologi, Volume 16, Nomor 3, April - Oktober 2011, ISSN : 0852 0232.
24. **Sinaga, Nazaruddin dan Tabah Priangkoso**. *Tinjauan/Review Model Empirik Konsumsi Bahan Bakar Kendaraan*, Journal Momentum, Vol. 7, No. 1, April 2011.
25. **Supriyo dan N. Sinaga**. *Perencanaan Daya Pendingin pada Dinamometer Arus Eddy*, Eksergi, Jurnal Teknik Eergi POLINES, Volume 7, Nomor 3, ISSN : 0216-8685, September 2011.
26. **Supriyo dan N. Sinaga**. *Perancangan Dinamometer Arus Eddy Kapasitas 250 KW*, Majalah Eksergi, Volume 7, Nomor 3, ISSN : 0216-8685, September 2011.
27. **Sinaga, Nazaruddin**. *Pengujian Teknik Mengemudi Hemat Energi pada Kendaraan Penumpang untuk Mendukung Program Smart Driving di Indonesia*, Prosiding, Seminar Nasional Teknik Mesin X (SNTTM X), Jurusan Teknik Mesin, Fakultas Teknik Universitas Brawijaya, Malang, November 2011.
28. **Yunianto, Bambang dan N. Sinaga**. *Peningkatan Efisiensi Pembakaran Tungku Kayu Bakar Tradisional Dengan Modifikasi Disain*, Prosiding, Seminar Nasional Teknik Mesin X (SNTTM X), Jurusan Teknik Mesin, Fakultas Teknik Universitas Brawijaya, Malang, November 2011.
29. **Sinaga, Nazaruddin, T. Priangkoso, D. Widayana dan K. Abdurrohman**. *Kaji Eksperimental Pengaruh Beberapa Parameter Berkendaraan Terhadap Tingkat Konsumsi Bahan Bakar Kendaraan Penumpang Kapasitas Silinder 1500-2000cc*, Prosiding, Seminar Nasional Teknik Mesin X (SNTTM X), Jurusan Teknik Mesin, Fakultas Teknik Universitas Brawijaya, Malang, November 2011.
30. **Sinaga, Nazaruddin dan B. Prasetiyo**. *Kaji Eksperimental Karakteristik Sebuah Dinamometer Sasis Arus Eddy*, Eksergi, Jurnal Teknik Energi POLINES, Volume 8, Nomor 2, Mei 2012, ISSN : 0216-8685.

31. **Sinaga, Nazaruddin dan A. Dewangga**. *Pengujian Dan Pembuatan Buku Petunjuk Operasi Chassis Dinamometer Tipe Water Brake*, Majalah Rotasi, Volume 14, Nomor 3, Juli 2012, ISSN:1411-027X.
32. **Sinaga, Nazaruddin**. *Smart Driving : Menghemat Bahan Bakar, Meningkatkan Kualitas Emisi Dan Menurunkan Resiko Kecelakaan*, Makalah, Seminar Astra – Jurusan Teknik Mesin Undip, Jurusan Teknik Mesin FT UNDIP, November 2012.
33. **Sinaga, Nazaruddin dan Mulyono**. *Kaji Eksperimental Dampak Pemakaian Pertamax Dan Pertamax-Plus Terhadap Emisi Gas Buang Pada Sepeda Motor*, Prosiding, Seminar Nasional Unit Penelitian dan Pengabdian Kepada Masyarakat Politeknik Negeri Semarang 2013, ISBN : 978-979-3514-66-6, Halaman 168-172.
34. **Sinaga, Nazaruddin, dan M. H. Sonda**. *Pemilihan Kawat Enamel Untuk Pembuatan Selenoid Dinamometer Arus Eddy Dengan Torsi Maksimum 496 Nm*, Eksergi, Jurnal Teknik Energi Vol 9 No.1 Januari 2013.
35. **Sinaga, Nazaruddin dan S. J. Purnomo**. *Hubungan Antara Posisi Throttle, Putaran Mesin dan Posisi Gigi Terhadap Konsumsi Bahan Bakar pada Beberapa Kendaraan Penumpang*, Eksergi, Jurnal Teknik Energi, Vol.9 No. 1, Januari 2013.
36. **Sinaga, Nazaruddin**. Pelatihan Teknik Mengemudi Smart Driving Untuk Menurunkan Emisi Gas Rumah Kaca Dan Menekan Biaya Transportasi Angkutan Darat, Prosiding, Seminar Nasional Teknik Mesin XII (SNTTM XII), Fakultas Teknik Universitas Lampung, Oktober 2013.
37. **Sinaga, Nazaruddin, S. J. Purnomo dan A. Dewangga**. *Pengembangan Model Persamaan Konsumsi Bahan Bakar Efisien Untuk Mobil Penumpang Berbahan Bakar Bensin Sistem Injeksi Elektronik (EFI)*, Prosiding, Seminar Nasional Teknik Mesin XII (SNTTM XII), Fakultas Teknik Universitas Lampung, Oktober 2013.
38. **Yunianto, Bambang dan N. Sinaga**. Pengembangan Disain Tungku Bahan Bakar Kayu Rendah Polusi Dengan Menggunakan Dinding Beton Semen, Majalah Rotasi, Volume 16, Nomor 1, Januari 2014, ISSN:1411-027X.
39. **Sinaga, Nazaruddin dan Y.N. Rohmat**. *Perbandingan Kinerja Sepeda Motor Berbahan Bakar Lpg Dan Bensin, Prosiding, Seminar Nasional Teknologi Industri Hijau*, Semarang 21 Mei 2014, Balai Besar Teknologi Pencegahan Pencemaran Industri (BBTPPI) Semarang, BPKIMI, Kementrian Perindustrian, Mei 2014.

40. **Syachrullah, L.I, dan N. Sinaga**. *Optimization and Prediction of Motorcycle Injection System Performance with Feed-Forward Back-Propagation Method Artificial Neural Network (ANN)*, Prosiding, Seminar Nasional Perkembangan Riset dan Teknologi di Bidang Industri ke-2, Fakultas Teknik Universitas Gajah Mada Yogyakarta, Juni 2014.
41. **Paridawati dan N. Sinaga**. *Penurunan Konsumsi Bahan Bakar Sepeda Motor Sistem Injeksi Menggunakan Metode Optimasi Artificial Neural Network Dengan Algoritma Back-Propagation*, Prosiding, Seminar Nasional Perkembangan Riset dan Teknologi di Bidang Industri ke-2, Fakultas Teknik Universitas Gajah Mada Yogyakarta, Juni 2014.
42. **Nazaruddin Sinaga, Abdul Zahri.** *Simulasi Numerik Perhitungan Tegangan Geser Dan Momen Pada Fuel Flowmeter Jenis Positive Displacement Dengan Variasi Debit Aliran Pada Berbagai Sudut Putar Rotor*, Jurnal Teknik Mesin S-1, Vol. 2, No. 4, Tahun 2014.
43. **Haryanto, Ismoyo, MSKTS Utomo, N. Sinaga, C. A. Rosalia dan A. P. Putra**. *Optimization Of Maximum Lift To Drag Ratio On Airfoil Design Based On Artificial Neural Network Utilizing Genetic Algorithm*, International Journal on Applied Mechanics and Materials Vol. 493, pp 123-128, 2014.
44. **M. Rifal dan N. Sinaga**. *Impact of Methanol-Gasoline Fuel Blend on The Fuel Consumption and Exhaust Emission of an SI Engine*, Proceeding, The 3rd International Conference on Advanced Materials Science and Technology (ICAMST 2015), Universitas Negeri Semarang, April 2015.
45. **Sinaga, Nazaruddin dan Mulyono**. *Studi Eksperimental Karateristik Kinerja Sepeda Motor Dengan Variasi Jenis Bahan Bakar Bensin*, Majalah Eksergi, Volume 11, Nomor 1, ISSN:0216-8685, Halaman 1-6 Januari 2015.
46. **Septianto, Fajar, A. Widodo dan N. Sinaga**. *Analisa Penurunan Efisiensi Motor Induksi Akibat Cacat Pada Cage Ball Bantalan*, Jurnal Teknik Mesin S-1, Vol. 4, No. 4, Tahun 2015.
47. **Syahrullah, L. I. dan N. Sinaga**. *Optimization and Prediction of Motorcycle Injection System Performance with Feed-Forward Back-Propagation Method Artificial Neural Network (ANN)*, American Journal of Engineering and Applied Sciences, Volume 9, Issue 2, ISSN: 1941-7039, Halaman 222-235, Februari 2016.
48. **Rojak, Amirur dan N. Sinaga**. *Pengaruh Penggunaan Bahan Bakar LGV Pada Mobil Penumpang 1200 CC Dan 1500 CC Terhadap Kebutuhan Udara Dan Bahan Bakar*, Politeknosains, Volume XV, Nomor 1, ISSN: 1829-6181, Maret 2016.

49. **Fajrin, D. H. dan N. Sinaga**. *Efek Variasi Kandungan Air Terhadap Kerja Gas Engine Cooler Suatu PLTB Limbah Organik Pasar Induk*, Politeknosains, Volume XV, Nomor 1, ISSN: 1829-6181, Maret 2016.

50. **Khudhoibi dan N. Sinaga**. *Pengaruh Engine Remap Terhadap Beberapa Parameter Operasi Mobil Berbahan Bakar LGV*, Jurnal Ilmiah Momentum, Volume 12, Nomor 1, ISSN : 0216-7395, April 2016.

51. **Rifal, Mohamad dan N. Sinaga**. *Impact of Methanol-Gasoline Fuel Blend on The Fuel Consumption and Exhaust Emission of an SI Engine*, AIP Conf. Proc. 1725, 020070-1–020070-6; Published by AIP Publishing, 978-0-7354-1372-6, Maret 2016.

52. **Sinaga, Nazaruddin dan A. S. B. Nasution**. *Simulasi Pengaruh Komposisi Limbah Cair Pabrik Kelapa Sawit (Pome) Terhadap Kandungan Air Biogas dan Daya Listrik yang Dihasilkan Sebuah Pembangkit Listrik Tenaga Biogas*, Eksergi, Jurnal Teknik Energi POLINES, Vol. 12 No. 3, September 2016.

53. **Sinaga, Nazaruddin dan D. Alcita**. *Perbandingan Beberapa Parameter Operasi Mesin Mobil Injeksi Terhadap Penggunaan Bahan Bakar Bensin dan Campuran Metanol-Bensin M15*, Eksergi, Jurnal Teknik Energi POLINES, Vol. 12 No. 3, September 2016.

54. **Fatichuddin, Mochamad dan N.Sinaga**. *Pengaruh Komposisi Air Terhadap Kebutuhan Daya Kompresor Pada Sistem Pembangkit Listrik Biogas Dari Limbah Tandan Kosong Kelapa Sawit*, Jurnal Ilmiah Momentum, Vol. 12 No. 2, Oktober 2016.

55. **Nazaruddin Sinaga**. *Perancangan Awal Conventer Kit LPG Sederhana untuk Konversi Mesin Bensin Skala Kecil*, Eksergi, Jurnal Teknik Energi POLINES, Vol. 13, No. 1, Januari 2017.

56. **Nazaruddin Sinaga**. *Kaji Numerik Aliran Jet-Swirling Pada Saluran Annulus Menggunakan Metode Volume Hingga*, Jurnal Rotasi Vol. 19, No. 2, April 2017.

57. **Nazaruddin Sinaga dan M. Rifal**. *Pengaruh Komposisi Bahan Bakar Metanol-Bensin Terhadap Torsi Dan Daya Sebuah Mobil Penumpang Sistem Injeksi Elektronik 1200 CC*, Jurnal Rotasi Vol. 19, No. 3, Juli 2017.

58. **Nazaruddin Sinaga**. *Analisis Aliran Pada Rotor Turbin Angin Sumbu Horisontal Menggunakan Pendekatan Komputasional*, Eksergi, Jurnal Teknik Energi POLINES, Vol. 13, No. 3, September 2017.

59. **Nazaruddin Sinaga.** *Perancangan dan Pembuatan Data Logger Sederhana untuk Dinamometer Sasis Sepeda Motor*, Jurnal Rotasi, Vol. 20, No. 1, Januari 2018.

60. **Mohamad Rifal dan Nazarudin Sinaga**. *Kaji Eksperimental Rasio Metanol-Bensin Terhadap Konsumsi Bahan Bakar, Emisi Gas Buang, Torsi Dan Daya*, Gorontalo Journal of Infrastructure and Science Engineering, Vol 1 (1), April 2018, pp. 47-54.

61. **Nazaruddin Sinaga, Maizirwan Mel, Rezeki Pakpahan, Nor Azwadi Che Sidik**. *Influence of Volatile Fatty Acid Concentration on Biogas Production in Synthropic Anaerobic Digestion*, Journal of Advanced Research in Biofuel and Bioenergy, Vol. 1 No. 1, June 2018

62. **Sinaga, N., Nasution, S.B., Mel, M**. *Process Optimization of Biogas Production From Palm Oil Mill Effluent: A Case Study of a Crude Palm Oil Factory in Muaro Jambi, Indonesia*, Journal of Advanced Research in Fluid Mechanics and Thermal Sciences, Vol. 49, Issue 2, pp. 155-169 , September 2018, ISSN: 2289-7879

63. **Nurjehan Ezzatul Ahmad, Maizirwan Mel, Nazaruddin Sinaga**. *Design of Liquefaction Process of Biogas Using Aspen HYSYS Simulation*, pp. 10-15, Journal of Advanced Research in Biofuel and Bioenergy, Vol. 2 No.1, September 2018.

64. **Nugroho, A., Sinaga, N., Haryanto, I**. *Performance of a Compression Ignition Engine Four Strokes Four Cylinders on Dual Fuel (Diesel-LPG)*, Proceeding, The 17th International Conference on Ion Sources, Vol. 2014, 2018, 21 September 2018, AIP Publishing.

65. **Nazaruddin Sinaga, P. Paryanto, Susilo A. Widyanto, R. Rusnaldy, Alexander Hetzner, and Jorg Franke.** *An Analysis of the Effect of Gravitational Load on the Energy Consumption of Industrial Robots*, 6th CIRP Global Web Conference, Procedia CIRP 78 (2018), pp. 8 – 12, September 2018.

66. **Syaiful, Sinaga, N., Wulandari, R., Bae, M.W**. *Effect of Perforated Concave Delta Winglet Vortex Generators on Heat Transfer Augmentation of Fluid Flow Inside a Rectangular Channel: An Experimental Study*. International Mechanical and Industrial Engineering Conference 2018 (IMIEC 2018), MATEC Web of Conferences Vol.204 , 2018 , 21-Sep-18 , EDP Sciences 12 , ISSN: 2261-236X

67. **Muchammad, M., Sinaga, N., Yunianto, B., Noorkarim, M.F., Tauviqirrahman, M.** *Optimization of Texture of The Multiple Textured Lubricated Contact with Slip*, International Conference on Computation in Science and Engineering, Journal of Physics: Conf. Series 1090-

012022, 5 November 2018, IOP Publishing, Online ISSN: 1742-6596 Print ISSN: 1742-6588.

68. **Nazaruddin Sinaga, B. Yunianto, Syaiful, W.H. Mitra Kusuma**. *Effect of Addition of 1,2 Propylene Glycol Composition on Power and Torque of an EFI Passenger Car Fueled with Methanol-Gasoline M15*, Proceeding of International Conference on Advance of Mechanical Engineering Research and Application (ICOMERA 2018), Malang, October 2018.

69. **Nazaruddin Sinaga, Mohammad Tauiviqirrahman, Arif Rahman Hakim, E. Yohana.** *Effect of Texture Depth on the Hydrodynamic Performance of Lubricated Contact Considering Cavitation*, Proceeding of International Conference on Advance of Mechanical Engineering Research and Application (ICOMERA 2018), Malang, October 2018.

70. **Syaiful, N. Sinaga, B. Yunianto, M.S.K.T. Suryo**. *Comparison of Thermal-Hydraulic Performances of Perforated Concave Delta Winglet Vortex Generators Mounted on Heated Plate: Experimental Study and Flow Visualization*, Proceeding of International Conference on Advance of Mechanical Engineering Research and Application (ICOMERA 2018), Malang, October 2018.

71. **Nazaruddin Sinaga, K. Hatta, N. E. Ahmad, M. Mel**. *Effect of Rushton Impeller Speed on Biogas Production in Anaerobic Digestion of Continuous Stirred Bioreactor*, Journal of Advanced Research in Biofuel and Bioenergy, Vol. 3 (1), December 2019, pp. 9-18.

72. **Nazaruddin Sinaga, Syaiful, B. Yunianto, M. Rifal**. Experimental and Computational Study on Heat Transfer of a 150 KW Air *Cooled Eddy Current Dynamometer*, Proc. The 2019 Conference on Fundamental and Applied Science for Advanced Technology (Confast 2019), Yogyakarta, Januari 21, 2019.

73. **Nazaruddin Sinaga**. *CFD Simulation of the Width and Angle of the Rotor Blade on the Air Flow Rate of a 350 kW Air-Cooled Eddy Current Dynamometer*, Proc. The 2019 Conference on Fundamental and Applied Science for Advanced Technology (Confast 2019), Yogyakarta, Januari 21, 2019.

74. **Ahmad Faoji, Syaiful Laila, Nazaruddin Sinaga**. *Consumption and Smoke Emission of Direct Injection Diesel Engine Fueled by Diesel and Jatropha Oil Blends with Cold EGR System*, Proc. The 2019 Conference on Fundamental and Applied Science for Advanced Technology (Confast 2019), Yogyakarta, Januari 21, 2019.

75. **Johan Firmansyah, Syaiful Laila, Nazaruddin Sinaga**. *Effect of Water Content in Methanol on the Performance and Smoke Emissions*

of Direct Injection Diesel Engines Fueled by Diesel Fuel and Jatropha Oil Blends with EGR System, Proc. The 2019 Conference on Fundamental and Applied Science for Advanced Technology (Confast 2019), Yogyakarta, Januari 21, 2019.

76. **Syaiful, Anggie Restue, Saputra, Nazaruddin Sinaga**. *2-D Modeling of Interaction between Free-Stream Turbulence and Trailing Edge Vortex*, Proc. The 2019 Conference on Fundamental and Applied Science for Advanced Technology (Confast 2019), Yogyakarta, Januari 21, 2019.

77. **Anggie Restue, Saputra, Syaiful, and Nazaruddin Sinaga**. *2-D Modeling of Interaction between Free-Stream Turbulence and Trailing Edge Vortex*, Proc. The 2019 Conference on Fundamental and Applied Science for Advanced Technology (Confast 2019), Yogyakarta, January 21, 2019.

78. **Sinaga, Nazaruddin, M. Mel, D.A Purba, Syaiful, and Paridawati**. *Comparative Study of the Performance and Economic Value of a Small Engine Fueled with B20 and B20-LPG as an Effort to Reduce the Operating Cost of Diesel Engines in Remote Areas*, Joint Conference of 6th Annual Conference on Industrial and System Engineering (6th International Conference of Risk Management as an Interdisciplinary Approach (1st ICRMIA) 2019 on April 23-24, 2019 in Semarang, Central Java, Indonesia.

79. **Sinaga, Nazaruddin, B. Yunianto, D.A Purba, Syaiful and A. Nugroho**. *Design and Manufacture of a Low-Cost Data Acquisition Based Measurement System for Dual Fuel Engine Researches*, Joint Conference of 6th Annual Conference on Industrial and System Engineering (6th International Conference of Risk Management as an Interdisciplinary Approach (1st ICRMIA) 2019 on April 23-24, 2019 in Semarang, Central Java, Indonesia.

80. **Y Prayogi, Syaiful**, **and N Sinaga**. *Performance and Exhaust Gas Emission of Gasoline Engine Fueled by Gasoline, Acetone and Wet Methanol Blends*, International Conference on Technology and Vocational Teacher (ICTVT-2018), IOP Conf. Series: Materials Science and Engineering 535 (2019) 012013 doi:10.1088/1757-899X/535/1/012013.

81. **E. Yohana, B. Farizki, N. Sinaga, M. E. Julianto, I. Hartati**. *Analisis Pengaruh Temperatur dan Laju Aliran Massa Cooling Water Terhadap Efektivitas Kondensor di PT. Geo Dipa Energi Unit Dieng*, Journal of Rotasi, Vol. 21 No. 3, 155-159.

82. **B. Yunianto, F. B. Hasugia, B. F. T. Kiono, N. Sinaga**. *Performance Test of Indirect Evaporative Cooler by Primary Air Flow Rate Variations*, Prosiding SNTTM XVIII, 9-10 Oktober 2019, 1-7.