Transforming Energy Systems, Reducing Emissions And Creating Jobs

ISEE Conference 2016

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UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Global Green Growth Institute

GLOBAL GREEN GROWTH:

Clean Energy Industrial Investments and Expanding Job Opportunities

Overall Findings

An Outline of the Presentation

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- What are the IPCC recommended emissions targets?
- What are the alternative pathways to meet those targets? (CO_2, energy system only in this study)
- What is the Core Argument of this study?
- What are the Industrial Policies for Clean Energy Transition?
- Country Specific Perspectives – Which countries we studied?
- Global Projections for 2030: What are the various scenarios?
- What are the options for reducing Carbon emissions without affecting growth?
- What are the Basic elements of our Program?
- What are the various prospects and concerns of this Program?
- What is the impact on employment?
- Country Specific Analysis: The Example of Indonesia

Emissions targets

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- As of 2010, total world GHG emissions amounted to 45,000 million metric tons (mmt).
- Of the 45,000 mmt of total GHG, about 82 percent are generated by energy-based sources. This includes 33,615 mmt in CO_2 emissions from energy sources, equaling about 75 percent.
- IPCC targets:

The total emissions will need to fall by 40 percent as of 2030, to 27,000 mmt and by 80 percent as of 2050, to 9,000 mmt.

Focus: Alternative pathways

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- Measures to reduce CO_2 emissions from energy based sources. With global population expected to rise to 8.4 billion by 2030, this means per-capita CO_2 emissions needs to be reduced from 4.6 mt in 2010 to 2.4 mt within 20 years.

- Examine policy frameworks (possible industrial policies) through which these targets can be met without inhibiting growth (specially of the developing countries) and expanding opportunities and well-being for their citizen.

Core Argument of the Study

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- The global economy can meet the IPCC emission reduction targets if most countries devote about 1.5 percent per annum of their economy's GDP to investments in:
  - Energy Efficiency (Building Retrofits, Industrial Efficiency, Grid upgrades)
  - Renewable Energy (Solar, Wind, Geothermal, Small scale hydropower, and bioenergy sources (excluding corn ethanol and other high-emissions bioenergy sources))
- Economies sustaining this level of annual investment can also:
  - Sustain economic growth at healthy rates while maintaining energy supply to undergird growth; and
  - Generate more jobs than maintaining or expanding existing fossil fuel sectors.

Industrial Policies

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- Governments need to play a leading role in adapting clean energy technology. UNIDO (2013, p. 124), *Industrial Developmental Report*:

  > "technological change rarely takes place in a vacuum, and often requires incentives. Success stories of new energy technologies are the product of forward-thinking ambitious government policies"

- Burning of fossil fuel will contract substantially in absolute terms throughout the globe (including discovery of new fossil fuel reserves and new technologies like 'fracking'):
  - Fossil fuel assets will experience a major decline
  - Workers will face job losses (economic policies needed to assist these workers with transitional support)

Country Specific Perspectives

- 5 countries: Brazil, Germany, Indonesia, South Africa, South Korea
- Economic growth with lower emissions is still possible if we can significantly reduce energy intensity and emissions intensity (via Kaya identity)

$$\frac{Emissions}{Population} = \frac{GDP}{population} \times \frac{energy\ consumption}{GDP} \times \frac{emissions}{energy\ consumption}$$

Table 1.1: Energy consumption and CO2 emissions levels for world and selected countries, 2010

	Energy consumption		CO_2 emissions	
	Total primary energy consumption	Per-capita energy consumption	Total CO_2 emissions	Per capita CO_2 emissions
	(Q-BTUs)	*(M-BTUs)*	*(mmt)*	*(mt)*
World	510.5	74	33,615	4.6
China	100.9	75.4	7,997	6.0
U.S.	98	316.9	5,637	18.2
Brazil	11.3	58	450.9	2.3
Germany	13.9	170.4	793.3	9.7
Indonesia	6.0	25.2	414.6	1.7
South Africa	5.6	111.8	473.2	9.5
ROK	10.8	218.2	581	11.7

Sources: U.S. Energy Information Administration, "International Energy Statistics," (for energy consumption and per capita emissions); World Bank (2014), "World Development Indicators," Table 3.9: Trends in greenhouse gas emissions (for total emissions).

Table 1.4: Determinants of per capita CO2 emissions levels by country, 2010: Level of development, energy intensity and energy mix

CO_2 Emissions/population = (GDP/population) x (Q-BTUs/GDP trillions) x (Emissions/Q-BTU)

	CO_2 emissions/ population	GDP/ population *($2005 PPP)*	Energy intensity ratio: Q-BTUs/ trillion dollars GDP	Emissions intensity ratio: CO_2 emissions/ Q-BTU
World	4.6 mt	$10,300	7.1 Q-BTUs	65.9 mmt
China	6.0 mt	$6,200	12.1 Q-BTUs	79.3 mmt
U.S.	18.2 mt	$50,000	6.2 Q-BTUs	57.5 mmt
Brazil	2.3 mt	$11,600	5.1 Q-BTUs	39.9 mmt
Germany	9.7 mt	$41,500	4.1 Q-BTUs	57.1 mmt
Indonesia	1.7 mt	$3,600	6.8 Q-BTUs	69.1 mmt
South Africa	9.5 mt	$7,500	14.6 Q-BTUs	84.5 mmt
ROK	11.7 mt	$22,000	9.8 Q-BTUs	53.8 mmt

Source: Authors' calculations based on Tables 1.1 and 1.2.

Global Projections for 2030: 3 Scenarios

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1. 2030 IEA Reference case:
   - No change in policy or significant cost reductions in Renewable Energy
2. 2030 IEA 'New Policies' case:
   - "broad policy commitments and plans that have already been implemented to address energy-related challenges as well as those that have been announced….";
   - "assumes only cautious implementation of current commitments and plans"
3. 2030 IEA 450/Low Carbon case:
   - "an energy pathway that is consistent with a 50 percent chance of meeting the goal of limiting the increase in average global temperature to 2°C compared with pre-industrial levels"

Table 1.3: Projected world CO2 emissions levels for 2030 by U.S. Energy Information Administration and OECD International Energy Agency

	2030 CO_2 emissions projections
U.S. Energy Information Administration (EIA) Reference case	41,468 mmt
OECD International Energy Agency (IEA)	
• Reference case	40,825 mmt
• New Policies case	36,493 mmt
• 450/Low Carbon case	24,663 mmt

Sources: Authors' compilation based on U.S. Energy Information Administration, "International Energy Outlook 2013."; International Energy Agency (2013) "World Energy Outlook 2013," Tables for Scenario Projections, pp. 574-575.

Options for Reducing Carbon Emissions

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1. Raise the economy's level of energy efficiency;
2. Among fossil fuel energy sources, increase the proportion of natural gas consumption relative to coal;
3. Invest in the development and commercialization of some combination of the following technologies:
   a. Clean renewables;
   b. Nuclear power; and
   c. Carbon capture and Sequestration (CCS) processes in generating coal, oil, and natural gas-powered energy.

Basic Elements of Our GGG Program

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- After intense review of these alternative approaches, our study found

a. Most critical and viable options are:

- Major Investments in Energy Efficiency
- Major Investments in Clean Renewables
  - Solar, wind, geothermal, small-scale hydro, low-emissions bioenergy.

b. **This is where the economies can devote ~ 1.5 percent of their GDP to drive down emissions**

- Major expansion of job opportunities through this investment project

Prospects for Energy Efficiency

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- **Buildings** (envelope, appliances, lighting, heating, etc.)
- **Industrial EE** (cross-cutting investments, such as CHP; and industry-specific)
- **Smart Grid and Grid upgrades**
- **Improvement in Public Transportation**

- **Rebound Effect:** Any 'rebound effect' that may emerge will not be large enough to counteract the significant benefits in terms of both cost savings and emission reductions.
- **Main Driver for EE:** Huge potential for saving on energy losses, especially in case of countries like South Africa.

Prospects for Clean Renewables

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- Problems:
  - Bioenergy and emissions
  - Bioenergy and food supply/prices
  - Large-scale vs. small scale hydro
- Opportunities:
  - Small-scale distributed energy systems
    - Rural electrification
- Main Driver for Clean Renewables: Prices and costs for Renewables is becoming increasingly favorable.

Major concerns

a) The question on how much expansion of clean energy can be accomplished through utilizing domestic resources versus relying on imports.

b) The extent to which countries currently rely on fossil fuels to both meet their energy consumption needs, and potentially, to also generate export earnings. How much loss in employment? (Indonesia and South Africa are currently major exporters of coal).

Job Creation Estimates

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Two sets of estimates of the employment impacts of large-scale clean energy projects:

1. Aggregate level of new employment generated through investments in various types of renewable energy and energy efficiency.

2. Disaggregate employment estimates according to four criteria:
   a. gender balance,
   b. self-employment versus wage employment,
   c. share of jobs in micro-enterprises versus large-enterprises, and
   d. the educational attainment levels associated with each type of job linked to clean energy activities.

Employment impacts- Methodology

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- Use input-output model
- Create RE and EE industries by weighting existing industries in I-O tables
- Estimate # of jobs (direct and indirect) for each $1 million spending in EE, RE, as well as contractions in FF
- Estimate # of jobs at the disaggregated employment creation: composition and educational profile of employment generated.

Table S.1: Summary of emissions reduction and employment expansion effects through 20-year country-specific clean energy investment projects

	Brazil	Germany	Indonesia	South Africa	ROK
Emissions reductions					
Year 20 per capita emissions	2.0 mt	5.5 mt	2.6 mt	8.7 mt	5.9 mt
Year 20 per capita emissions relative to 2010	-13.0%	-43.3%	+52.9%	-8.4%	-49.1%
Year 20 per capita emissions relative to 2030 BAU	-37.5%	-28.6%	-66.7%	-49.7%	-55.6%
Employment expansion					
Clean energy jobs per $1 million	37.4 jobs	9.5 jobs	103.3 jobs	66.2 jobs	15.1 jobs
Clean energy *minus* fossil fuel jobs per $1 million	16.2 jobs	1.9 jobs	81.3 jobs	33.1 jobs	1.5 jobs
Midpoint Year 20 employment through clean energy investments	806,000	352,000	1.8 million	398,000	276,000
Midpoint Year 20 employment as share of labor force	0.7%	0.9%	1.3%	1.9%	1.0%

Source: For emissions figures, Tables 1.4, 8.4 9.3, 10.5, 11.6, and 12.6. For employment figures, Tables 7.1, 7.5, 7.9, 7.13, 7.17, 8.7, 9.5, 10.7, 11.8, 12.8.

Country-Specific Analysis : Indonesia

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Table 10.1: Indonesia. Basic energy indicators, 2010

	Indonesia	World
Per capita GDP *(2005 $PPP)*	$3,600	$10,300
Total energy consumption *(Q-BTUs)*	6.0 Q-BTUs	510.5 Q-BTUs
Per capita energy consumption *(M-BTUs/population)*	25.2 M-BTUs	74.0 M-BTUs
Total CO_2 emissions *(mmt)*	414.6 mmt	31,502 mmt
Per capita CO_2 emissions *(mt of emissions/population)*	1.7 mt	4.6 mt
Energy intensity ratio *(Q-BTUs/$1 trillion GDP)*	6.8 Q-BTUs	7.1 Q-BTUs
Emissions intensity ratio *(CO_2 emissions/Q-BTUs)*	69.1 mmt	65.9 mmt

Source: See Tables 1.1 and 1.4.

Table 10.2: Indonesia. Energy consumption and emissions: 2010 actuals and alternative official projections

	2010 actuals	2030 BAU scenario	2030 "Low Carbon" scenario
Total energy consumption	6.0 Q-BTUs	25.8 Q-BTUs	19.7 Q-BTUs
Energy intensity ratio *(Q-BTUs/$1 trillion GDP)*[a]	6.8 Q-BTUs	11.2 Q-BTUs	8.6 Q-BTUs
Energy mix:			
Oil	39.1%	21.4%	25.7%
Coal	32.6%	52.0%	30.5%
Natural gas	19.2%	20.2%	30.4%
Nuclear	0.0%	0.0%	0.3%
High-emissions renewables	4.0%	2.5%	5.4%[b]
Clean renewables	5.1%	3.8%	7.9%
• Hydro	4.2%	2.7%	4.0%
• All others	0.9%	1.1%	3.9%[c]
Total CO_2 emissions	415 mmt	2,200 mmt	1,450 mmt
Emissions intensity ratio *(CO_2 emissions/Q-BTUs)*	69.2 mmt	85.3 mmt	73.6 mmt
CO_2 emissions per capita *(with population = 280 million)*	1.7 mt	7.8 mt	5.2 mt

Source: See Tables 1.1 and 1.4; Republic of Indonesia (2010), "Indonesia's Second National Communication to the United Nations Framework Convention on Climate Change"; EIA (2013b), "International Energy Outlook 2013."

Note: a) Calculations based on average annual GDP growth of 5 percent; b-c) Assumption is that clean bioenergy supplies 20 percent of all bioenergy under 2030 "low carbon" scenario.

Table 10.4: Indonesia. Cost assumptions and capacity expansion for clean renewables and energy efficiency investments

	Clean renewable energy	Energy efficiency
1) Cost assumptions	$125 billion per Q-BTU of capacity	$11 billion per Q-BTU of energy savings
2) Annual spending levels	$16 billion per year (= 1 % of midrange GDP)	$8 billion per year (= 0.5 % of midrange GDP)
CASE 1: No delay in implementing program: 20- year spending cycle		
3) Total spending with 20- year spending cycle[a]	$320 billion	$160 billion
4) Total capacity expansion or energy savings through 20 year spending cycle[b]	2.6 Q-BTUs of new capacity	14.6 Q-BTUs of energy savings
CASE 2: 3-year delay in implementing program: 17- year spending cycle		
5) Total spending with 17-year spending cycle[c]	$272 billion	$136 billion
6) Total capacity expansion or energy savings through 17- year spending cycled	2.2 Q-BTUs of new capacity	12.4 Q-BTUs of energy savings

Notes: a) Calculated as row 2 multiplied by 20; b) Calculated as row 3 divided by row 1; c) Calculated as row 2 multiplied by 17; d) Calculated as row 5 divided by row 1.

Source: Authors' calculations.

Table 10.5: Indonesia. Impact of clean energy investment relative to 2030 BAU scenario

	2030 BAU scenario	20-year clean energy investment *(Case 2: 3-year start-up delay)*
Total energy consumption	25.8 Q-BTUs	13.4 Q-BTUs *(with 12.4 Q-BTUs of energy-efficiency savings)*
Total clean renewable energy supply	1.0 Q-BTUs	3.2 Q-BTUs *(with 2.2 Q-BTUs of additional clean renewables)*
Total nuclear power supply	0.0	0.0
Total fossil fuel + High-emissions renewables	24.8 Q-BTUs	10.2 Q-BTUs
Total CO_2 emissions	2,200 mmt	714 mmt *(Based on 70 mmt average emissions per Q-BTU for fossil fuels)*
Total CO_2 emissions per capita *(with population = 280 million)*	7.9 mt	2.6 mt

Source: Authors' calculations.

Table 7.9: Indonesia. Employment creation through spending in alternative energy sectors, 2008

Jobs per $1 million

	Domestic content stable			Domestic content declines		
	Direct jobs	*Indirect jobs*	*Direct + indirect jobs*	*Direct jobs*	*Indirect jobs*	*Direct + indirect jobs*
Renewables						
Bioenergy	237.0	73.5	310.5	237.0	72.7	309.7
Hydro	29.4	46.5	75.9	24.9	45.3	70.2
Wind	19.6	60.1	79.7	18.1	59.2	77.3
Solar	18.9	44.5	63.4	17.4	43.4	60.8
Geothermal	18.4	46.2	64.7	18.1	44.9	62.9
Weighted average for renewables	64.7	54.2	118.8	63.1	53.1	116.2
Energy efficiency						
Building retrofits	36.3	61.7	97.9	36.3	60	96.3
Industrial efficiency	12.8	46.8	59.6	11.8	45.5	57.3
Grid upgrades	17.0	45.2	62.2	15.5	44.1	59.6
Weighted average for efficiency	25.6	53.8	79.4	25	52.4	77.3
Fossil fuels						
Coal	7.1	33.5	40.6	NA	NA	NA
Oil/natural gas	2.7	0.8	3.5	NA	NA	NA
Weighted average for fossil fuels	4.9	17.1	22.0	NA	NA	NA
Overall economy	155.1	27.2	182.2	NA	NA	NA

Source: See Appendix 3.

Table 7.11: Indonesia. Composition of employment generated through alternative energy sector spending, 2008

- Gender composition of workforce
- Wage vs. Self-Employment
- Micro vs. Non-Micro Enterprises
- Educational attainment levels (separate table below)

	Total employment	Female employment	Self-employment	Micro enterprise employment
	(Jobs per $1 million)	*(Percentage)*		
Renewables				
Bioenergy	310.5	37%	91%	NA
Hydro	75.9	31%	62%	NA
Wind	79.7	32%	65%	NA
Solar	63.4	29%	61%	NA
Geothermal	64.7	26%	64%	NA
Energy efficiency				
Building retrofits	97.9	22%	65%	NA
Industrial efficiency	59.6	32%	62%	NA
Grid upgrades	62.2	32%	60%	NA
Fossil fuels				
Coal	40.6	33%	63%	NA
Oil/natural gas	3.5	12%	22%	NA

Table 7.12: Indonesia. Educational profile of employment generated through alternative energy sector spending, 2008

	No education or less than primary level	Primary level	Secondary level	Tertiary level
	(Percentages)			
Renewables				
Bioenergy	15%	74%	10%	1%
Hydro	20%	53%	22%	5%
Wind	21%	52%	23%	5%
Solar	21%	48%	25%	6%
Geothermal	21%	52%	22%	5%
Energy efficiency				
Building retrofits	22%	54%	20%	5%
Industrial efficiency	20%	48%	26%	6%
Grid upgrades	20%	46%	28%	6%
Fossil fuels				
Coal	20%	52%	22%	6%
Oil/natural gas	13%	15%	51%	21%

Table 10.6: Indonesia. Employment impact of clean energy investments vs. fossil fuel spending

Figures are jobs in Year 1 of 20-year clean energy investment strategy

Assumptions for clean energy investments:

- **Total investment = 1.5 percent of GDP**
  - 67 percent clean renewables;
  - 33 percent energy efficiency
- **"Domestic Content Declines" scenario**
- **70 percent of investment for capacity creation/production**
- **30 percent for financing costs**

Indonesia labor force in 2011 = 115.9 million

	Clean energy investments	Fossil fuel spending	Net employment effects of clean energy investments
Direct + indirect total employment in Year 1	953,900	203,300	750,600
Direct + indirect employment as share of total labor force in Year 1	0.8%	0.2%	0.6%

Source: See Chapter 7 and Appendix 3.

Sources

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All tables, figures, and data in this presentation are drawn from:

Pollin, R., H. Garrett-Peltier, J. Heintz, S. Chakraborty, 2015. *Global Green Growth: Clean Energy Industrial Investments and Expanding Job Opportunities.* United Nations Industrial Development Organization and Global Green Growth Institute. Vienna and Seoul.

And the sources contained therein.

Thank you for your attention!

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