Extractive Industries & Climate Change

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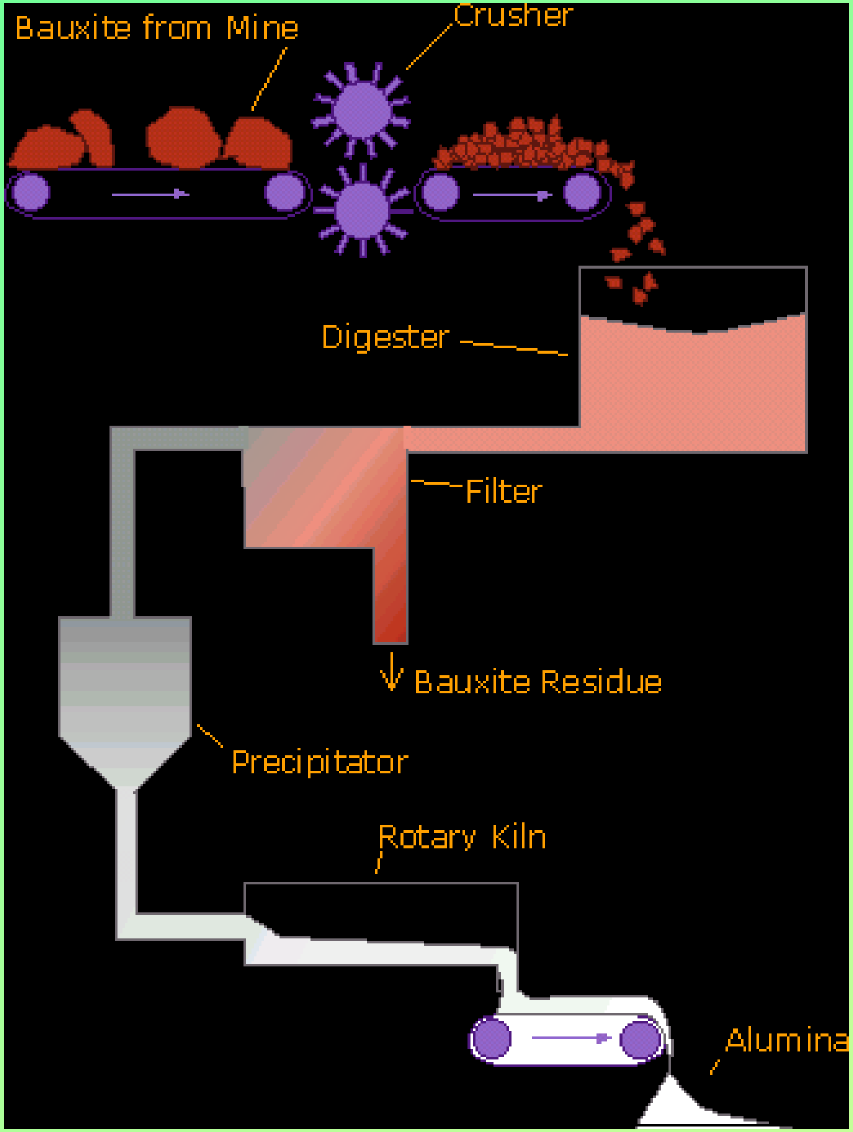
mines minerals & PEOPLE (mm&P)

Focus of Presentation

- Extractive I*ndustry is very large and wide spread*
- *This presentation focuses on Aluminium life cycle as we are in for massive expansion*
- *And since coal is the key source of energy we shall dwelve into it…*



Bauxite from Mine
Crusher
Digester
Filter
Bauxite Residue
Precipitator
Rotary Kiln
Alumina

Extraction

The aluminium-bearing minerals in bauxite –Gibbsite, Boehmite and Diaspore - are selectively extracted from the insouble components (mostly oxides) by dissolving them in a solution of sodium hydroxide (caustic soda):

Gibbsite: $Al(OH)_3 + Na^+ + OH^- \text{---}> Al(OH)_4^- + Na^+$

Boehmite and Diaspore: $AlO(OH) + Na^+ + OH^- + H_2O \text{---}> Al(OH)4^- + Na^+$

Bayer Process

The process of producing pure alumina from bauxite (the Bayer Process) has changed very little since the first plant was opened in 1893. The Bayer process can be considered in three stages:

Precipitation and Calcination

Precipitation

Crystalline aluminium trihydroxide (Gibbsite), conveniently named "hydrate", is then precipitated from the digestion liquor:

$Al(OH)_4^- + Na^+ \text{--->} Al(OH)_3 + Na^+ + OH^-$

This is basically the reverse of the extraction process, except that the product's nature is carefully controlled by plant conditions, including seeding or selective nucleation, precipitation temperature and cooling rate. The "hydrate" crystals are then classified into size fractions and fed into a rotary or fluidised bed calcination kiln. Undersize particles are fed back into the precipitation stage.

Calcination

"Hydrate", is calcined to form alumina for the aluminium smelting process. In the calcination process water is driven off to form alumina:

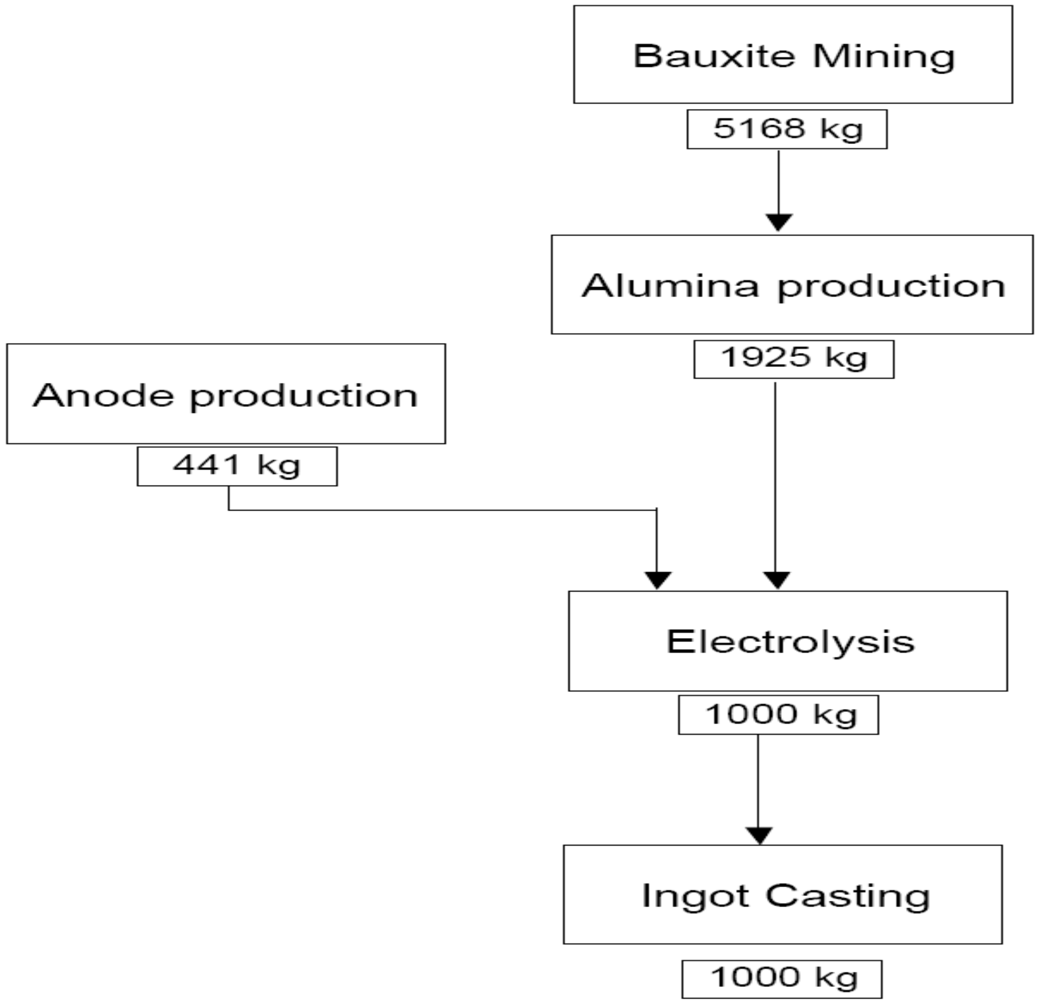
$2Al(OH)_3 \text{--->} Al_2O_3 + 3H_2O$

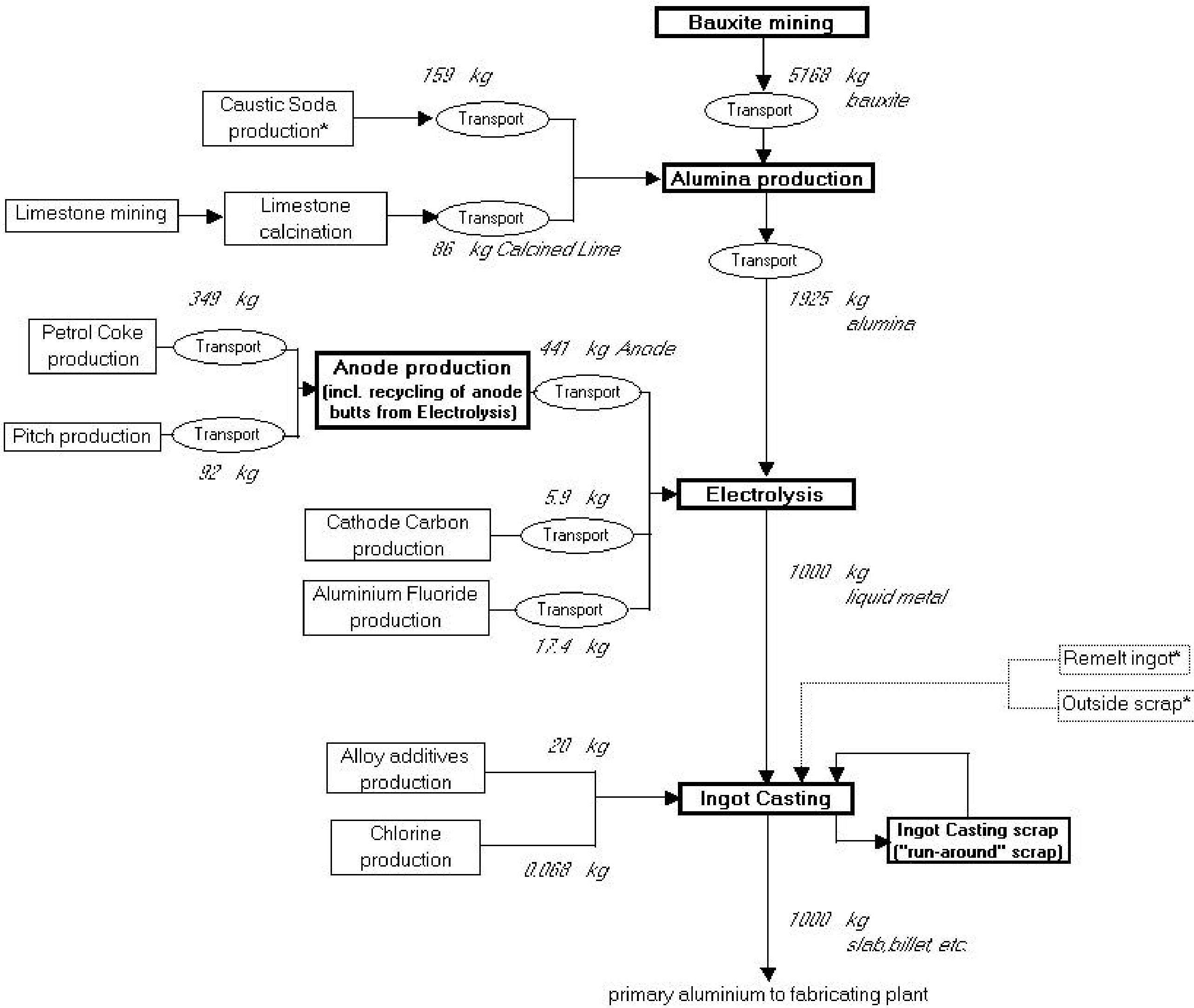
The calcination process must be carefully controlled since it dictates the properties of the final product.

Inputs per ton of Bauxite in Mining

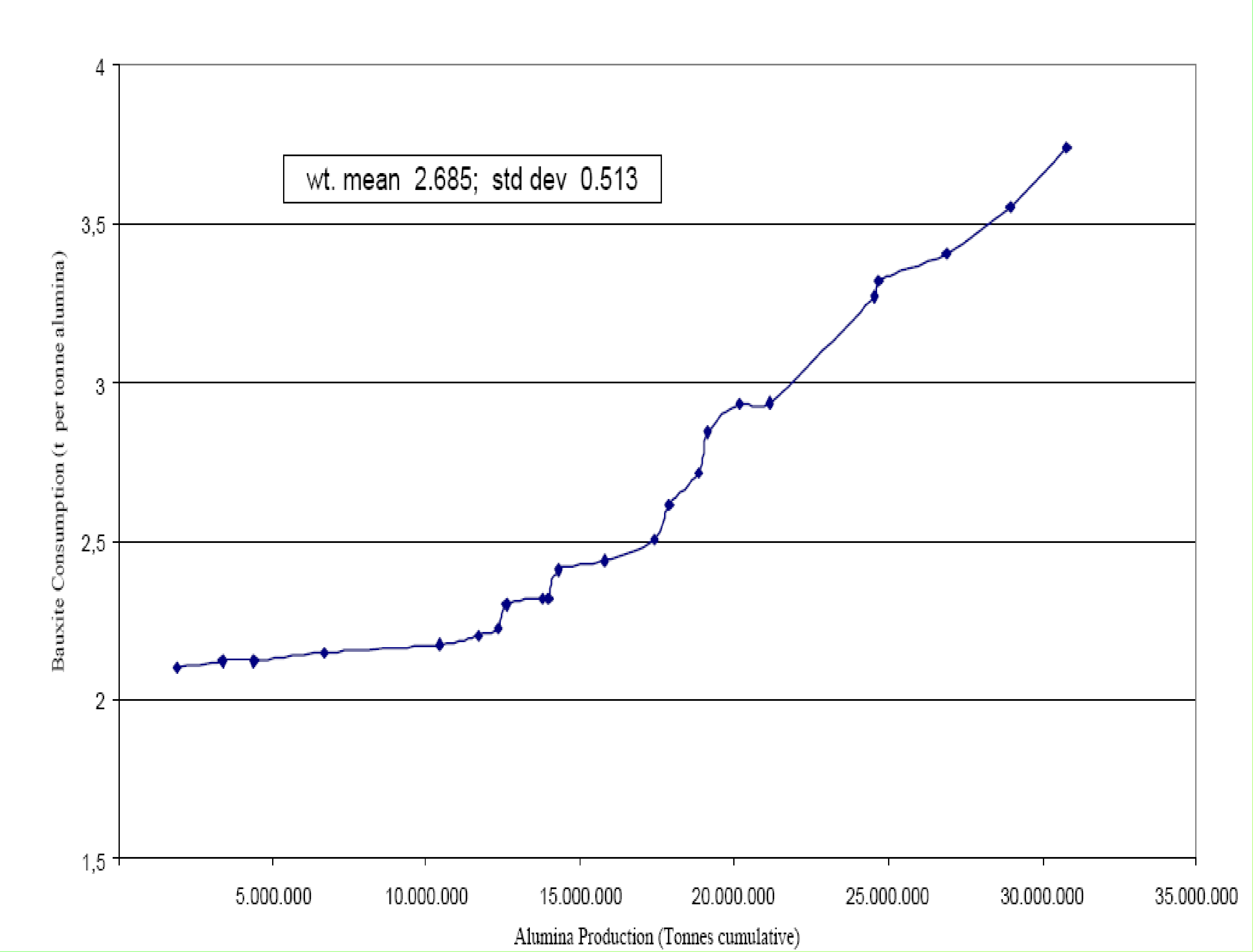
	Selected	2 Australian mines		9 mines (Aachen)		N.American LCI 1998	
Inputs							
Diesel	2 kg/t*	0.90	kg/t	0.67 – 1.8	kg/t	4.37	kg/t
Other oil	-	(1.16 kg/t medium fuel oil, 0.27 kg/t gasoline)>				1.43	kg/t
Electricity	-	0.002	kWh/t			0.4	kWh/t
Fresh water	-	0.031	m3/t				
Outputs							
Particulates	2.35 kg/t*			0.002–0.005	kg/t	2.35	kg/t
Solid waste	136 kg/t*					136	kg/t

*per t of bauxite output


Bauxite Mining
5168 kg
Alumina production
1925 kg
Anode production
441 kg
Electrolysis
1000 kg
Ingot Casting
1000 kg



* input from remelt or recycled aluminium ("cold metal") is excluded as not representative for primary aluminium (see para. 2.3 reference flow)


wt. mean 2.685; std dev 0.513
Bauxite Consumption (t per tonne alumina)
4
3,5
3
2,5
2
1,5
5.000.000
10.000.000
15.000.000
20.000.000
25.000.000
30.000.000
35.000.000
Alumina Production (Tonnes cumulative)

IAI LCS 2000

Inventory data for 1000 kg Primary Aluminium

INPUTS

Process	Bauxite mining	Alumina production	Anode production	Electrolysis	Ingot Casting	Total	
Raw materials							
Bauxite	5168					**5168**	kg
Caustic Soda		159				**159**	kg
Calcined Lime		86				**86**	kg
Alumina						*1925*	*kg*
Petrol Coke			349			**349**	kg
Pitch			92			**92**	kg
Anode						*441*	*kg*
Aluminium Fluoride				17,4		**17,4**	kg
Cathode Carbon				6,1		**6,1**	kg
Aluminium (liquid metal)						*1000*	*kg*
Alloy additives					20	**20**	kg
Chlorine					0,068	**0,068**	kg
Cast Ingot						*1000*	*kg*
Other raw material inputs							
Fresh Water		6,4	0,5	2,95	3,15	**13,0**	m3
Sea Water		6,5	0,001	20,8	0,2	**27,5**	m3
Refractory materials			5,5	6		**11,5**	kg
Steel (for anodes)			1,4			**1,4**	kg
Steel (for cathodes)				5,5		**5,5**	kg
Fuels and electricity							
Coal		185	0,9			**186**	kg
Diesel Oil	10,3	1,2	1,4		0,1	**13,0**	kg
Heavy Oil		221,4	6,2		10	**238**	kg
Natural Gas		233	23		52	**308**	m3
Electricity		203	62	15365	81	**15711**	kWh

Coal Deposits in India

Example of Coal

- Mining Methods
  - Underground — Recovery Factor
    - Room and Pillar — 35%
    - Long Wall — 60 – 70%
  - Surface
    - Contour or Strip — 80 – 90%

Occupational Hazards

- Underground
  - Fires, Explosions, Subsidence
    - 30 non-fatal but disabling accidents per mT and
    - 1 death per 2.5 mT
  - Surface
    - Pollutants including Noise
    - 5.5 non-fatal but disabling accidents per mT
    - 1 death per 10 mT

…Occupational Hazards

- 25 percent of coal mine workers suffer from Coal-Workers Pneumoconiosis
- CWP correlated with Vanadium, Radon 220 and 222
- Greater than 90 dB noise levels for almost 60% of the employees

Several other accompanying and induced diseases impair fuel producers

Impact on Land

- Land required depends on the Geological occurrence and the surface environment however on an average 6-9 hectares per million tonne is destroyed
- Problems in Densely settled lands
- Areas impacted by Coal Fires
- Problems of remote forests and tribal communities
- Reclamation costs are being estimated at atleast 4% of the coal production costs.

The Shift in Coal Production

Year	Opencast Mines	Underground Mines
1975-76	28.44	71.25
1979-80	29.50	65.50
1982-83	55.82	75.80
1987-88	100.84	75.88
1990-91	142.29	69.32
1993-94	172.16	73.98
1994-95	182.53	71.97
1995-96	198.27	71.89
1996-97	215.13	70.95
1997-98	228.14	69.02
1998-99	224.51	67.76
1999-00	233.21	66.82
2000-01	243.53	66.09

Impacts on Water

- Requirements for Dust Control, Fire Protection and Coal Washing
  - 65 to 120 litres/tonne for underground about one third of this for surface and 33 litres/tonne for washing
  - Long term effects on groundwater
  - Acid mine drainage as most mines also have soluble salts

Methods are inadequate

- Land Reclamation
  - Not easy in tropical climates
  - Difficulty in grading land, Restoration of soil
  - Local weather and endemic vegetation conditions
- Water Treatment
  - Drainage controls, special disposal systems for sulphur bearing materials, sealing abandoned mines, chemical treatment

Disposal of Wastes

- Solid and Liquid Wastes are coarse and fine refuse which leads to acid production and weathering
  - In processing and disposal itself
    - 0.2 deaths per mT of coal input to plant
    - 1.3 disabling injuries per mT
  - Estimated 0.08 deaths and 5.2/ GW (e)y

Impacts during Processing

- Physical separation alone is done and only 40 to 50 percent of sulphur is removed
- Amount of pollutants depends on the amount, chemical and physical properties and the product to be prepared eg sizing, grading etc
- Air pollution in the drying stages and hot combustion gases creating
  - Coal Dust, Ash, Carbon Oxides, Nitrogen Oxides, Sulphur Oxides
- Liquid pollutants – black water in washing for which closed-water circuits are being promoted

Who’s paying the costs?

- Local Communities
- Workers
- Local Environment
- Ecosystem

The beneficiaries

- Investors and Investment Bankers
- Owners and Managers
- Politicians and Contractors
- Consultants
- Reclaimers!

CONFRONTING THE REALITY

- PEOPLE ALL OVER HAVE BEEN MISLED BY FALSE INFORMATION FROM THE INDUSTRY AND PROMOTING GOVERNMENTS

- INDUSTRY WANTS TO TALK ON GENERAL ISSUES AND DESISTS FROM ANY COMMITMENTS ON MINING SPECIFIC ISSUES

- ATLEAST REACH RIGHT INFORMATION TO THE COMMUNITIES!

India's Emissions

Greenhouse gas sources and sinks	CO_2 emissions	CO_2 removals	CH_4	N_20	NO_x	CO	CO_2 equivalent ($CO_2+CH_4+N_2O$)[c]
1. Energy and transformati on industries	508,600				2,684[d]	3,493[d]	508,600
Total national emissions and removals	585,185	-50,900	18,477	255	3,193	18,003	1,001,352

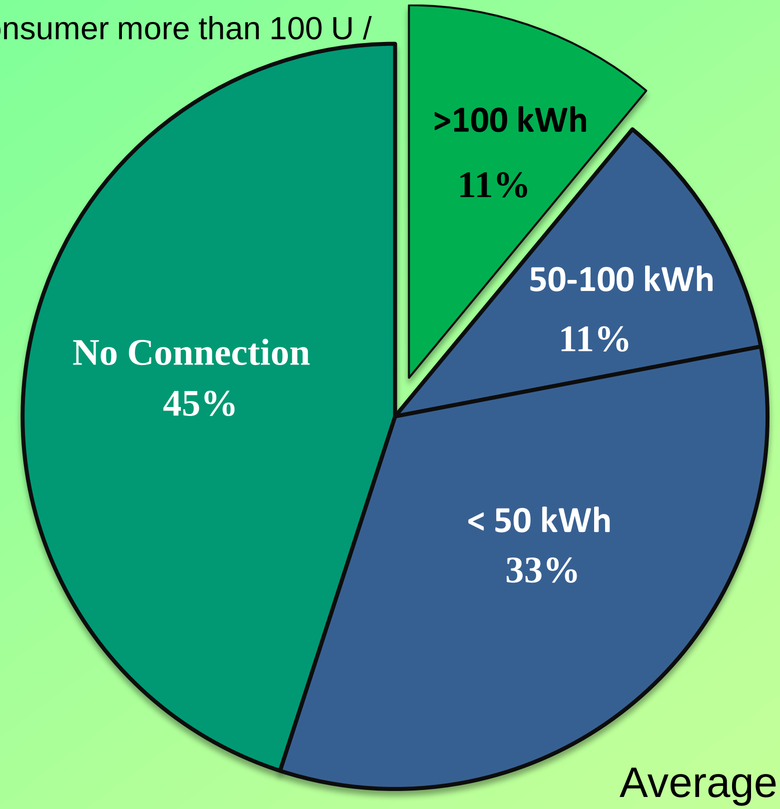
Hiding behind others emissions!

Table: Carbon Dioxide Emission in USA, China, India

Name of the Country	Total Emission in Million Tones/ Year			Per Capita Emission in Tones/Year		
	1990	2002	2005	1990	2002	2005
China	2241	3376	5323	1.95	2.63	4.07
United States of America	5001	5763	5957	20.00	20.03	20.14
India	575	1015	1163	0.69	0.98	1.07

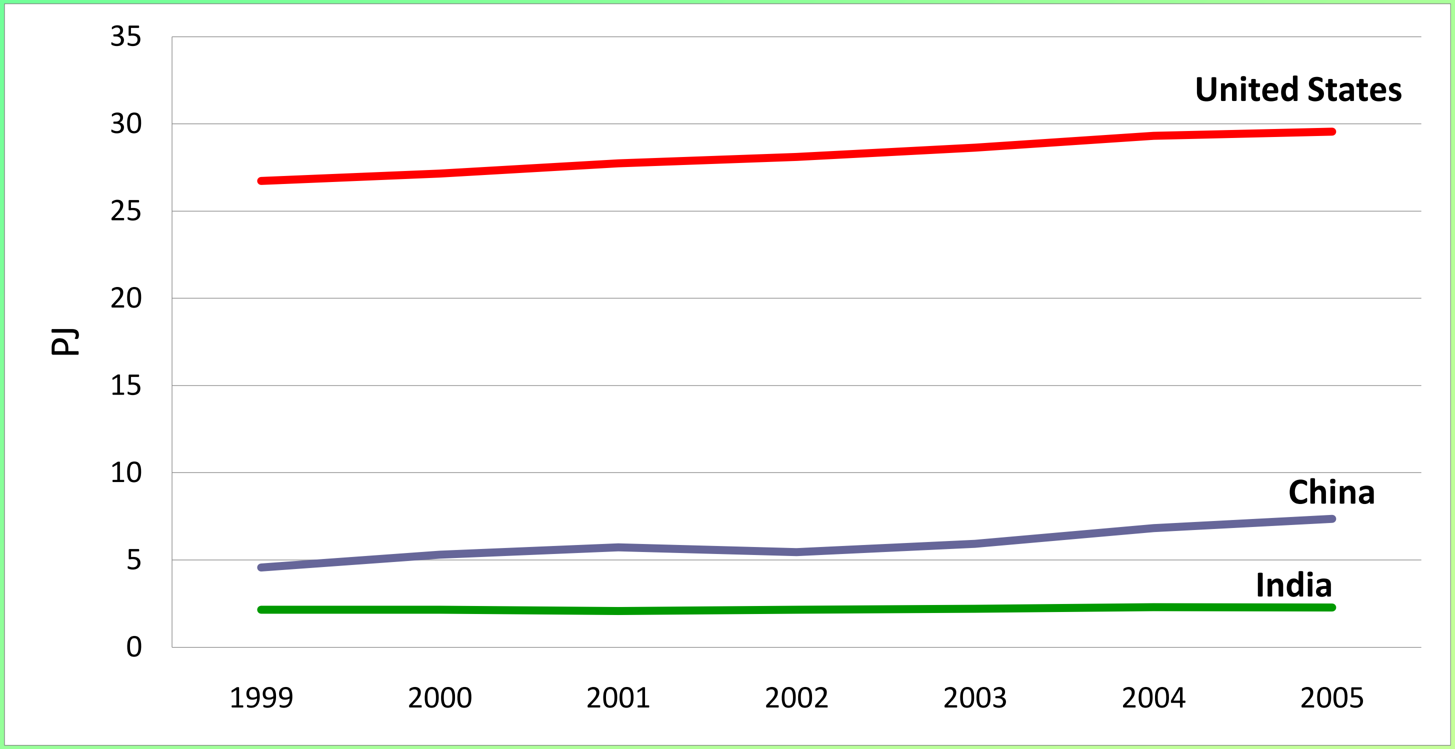
Residential Sector Energy Use and Poverty

Only 11% of Indian households consumer more than 100 U / month



Average US Household consumes **900** units monthly

Transportation Sector Energy Demand



India's total Oil demand is lower than the incremental growth of Oil demand in the US between 1999-2005

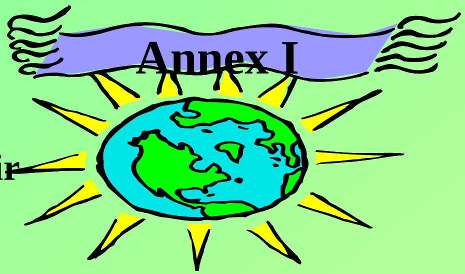
Source: Energy Information Administration, USDOE

Annex I countries

UN Framework Convention on Climate Change
signed by 154 states

Annex I countries
(industrialised countries)

commited themselves to reduce their GHG emissions



Non-Annex I countries
(developing countries)

The Kyoto Protocol (III)

What is it about ?

└ answers to this challenge

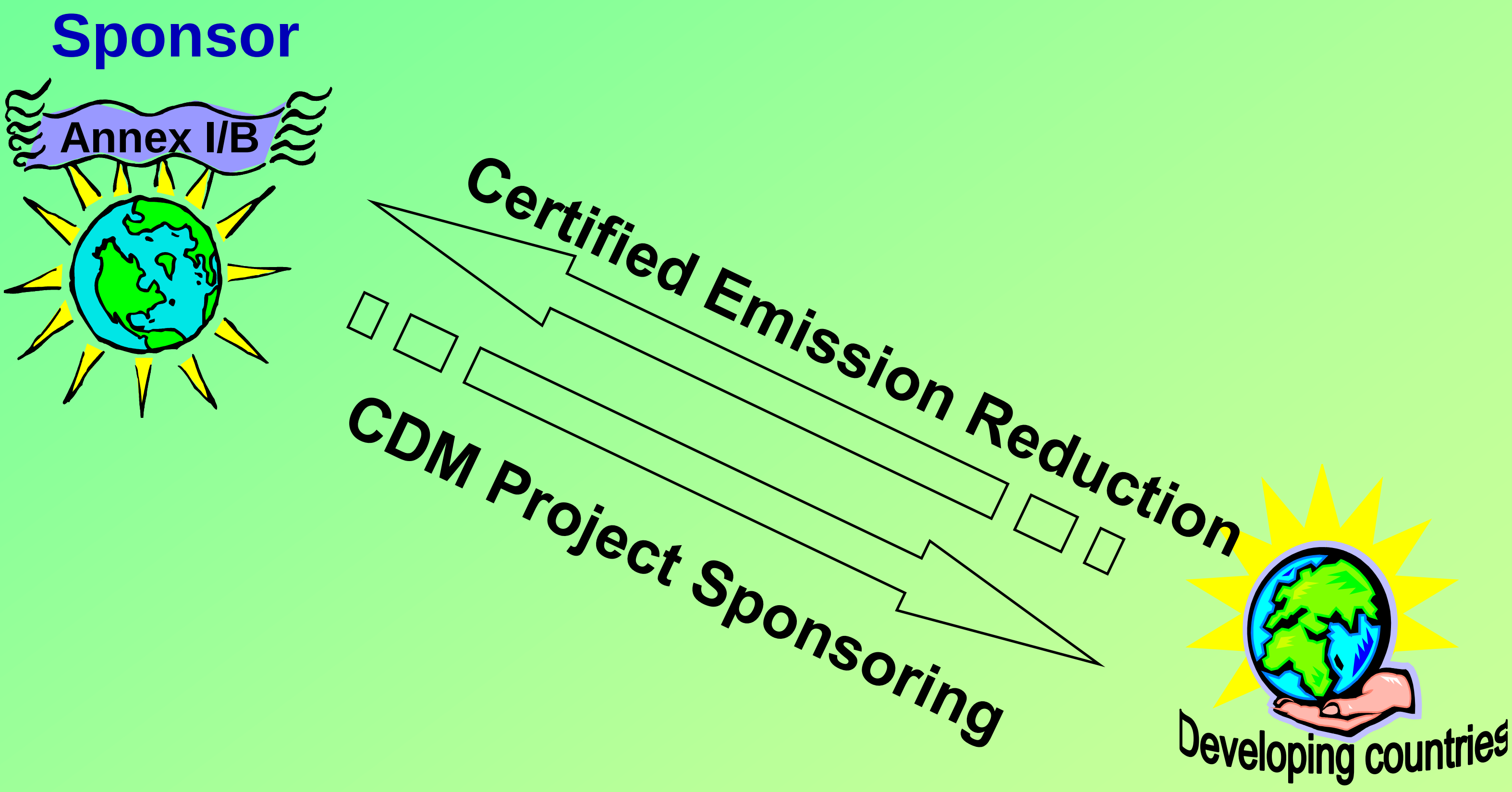
Identifies three mechanism to supplement national actions to achieve real, long-term, measurable and cost-effective GHG reductions:

- **Clean Development Mechanism (CDM)**
- **Joint Implementation (JI)**
- **International Emission Trading**

Clean Development Mechanism - CDM (I)

What is it about ?

└ the 3 Kyoto mechanisms



Clean Development Mechanism - CDM (II)

What is it about ?
└ the 3 Kyoto mechanisms

Criteria to be fulfilled to receive Certified Emission Reductions:

- Assist host-country to achieve sustainable development
- Assist sponsor in achieving compliance with part of their emission reduction commitment
- Voluntary participation approved by the parties
- Real, measurable and long-term benefits related to the mitigation of climate change
- Reductions in emissions that are additional to any that would occur in the absence of the certified project activity

TRADABLE UNITS

- Same representation

- Certified Emission Reduction Units (CER)

1 CER = 1 Tonne CO_2 equivalents

TRADABLE UNITS

- Same representation

In India on the Average

1MWh of Power = 0.8 t CO_2

So saving of 1MWh will get you
1MWHx24x365x0.8 CERs per year

Current rate of CER= Euro 18

So yearly income=Rs.1x24x365x.8x18x62

= Rs. 7820928/-

Emission factors for various Fuels

- The emission factors are given for different units, to aid interpretation. Users should be able to find appropriate fuel consumption data in one of the units mentioned. Once this is done, fuel consumption is multiplied by the appropriate factor.

Refined Petroleum Products	***tCO2/ KWh***	***tCO2/ tonne***
Coal	0.0003413	1.84
Gasoline	0.0002496	3.07
Natural Gas	0.0002020	2.93
Gas/Diesel Oil	0.0002667	3.19
Residual Fuel Oil	0.0002786	3.08
LPG	0.0002271	2.95
Jet Kerosene	0.0002575	3.17
Lubricants	0.0003631	2.92
Refinery Feedstock	0.0002641	3.25

THE SITUATION

- LOCAL COMMUNITIES ARE CONSTRAINED AND BOUND AT MULTIPLE LEVELS THROUGH VARIOUS INSTRUMENTS
  - ECONOMIC
  - SOCIAL
  - CULTURAL

In the new Construct

- Want money for improving any of the polluting process
- Want to claim credits for selling technologies which are marginally better
- Make money by changing the issue of discourse
- Make money by making the assessment very complicated

THE EXPECTATION

- THE PURPOSE AND GOAL OF EVERY EFFORT HAS TO BE WELFARE OF THE PEOPLE
- SECTORAL ANALYSIS HELPS ONLY IN IMPROVING OUR UNDERSTANDING
- WE NEED TO DEFINE THE DEVELOPMENT THAT THE COMMUNITIES ARE ASPIRING

Harmfuls in the Extractive Industries

- Radionuclides
- Toxic Heavy Metals
- Polynuclear Aromatic Hydrocarbons
- Nitrogen Oxides
- Sulphur Oxides
- Carbon Oxides causing impacts that are
  - Carcinogenic, Mutagenic, Teratogenic and even Genotoxic

Impacts of Fuel Industry

- Colossal socio-economic Changes
- Irreversible Environmental Damage
- Direct and Indirect impacts through the Fuel Cycle
- Climate Modification

Issues

- So far the focus has been on
  - Occupational health
  - Safety
  - Direct impacts on physical environment
- Long term socio-economic and environmental consequences requires knowledge about
  - Quantity and types of pollutants
  - Dispersion Patterns
  - Ecological Pathways
  - Relationship to Human Ecosystems
  - Extent of damage, risks and synergetic effects

We Need

- Green Power
- Green Work and Occupation
  - Implies we need
    - More and Efficient Use of Renewables
    - Decentralised Energy Options
    - Demand Side Management
    - Protecting Biodiversity
- AND NOT MERE GDP GROWTH!!!!