

**Acquisition of technological capabilities through the  
Clean Development Mechanism: Some quantitative  
explorations**

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# Layout of Presentation

- Introduction
- Objective
- Technology acquisition, absorption and capability building :  
Theoretical framework
- Review of Literature
- Methodology, Data base
- The Model
- Estimates & conclusion

# The context

- Post Kyoto protocol : future of CDM uncertain
- Intense worldwide debate on the usefulness of CDM
- The present study contributes to this debate.
- Explores the contribution of CDM in building capabilities of developing countries in green technologies with a particular focus on Indian manufacturing firms.

# Objectives

- Distinguishes between technology acquisition, technology absorption and technological capabilities
- Focuses on absorption and capabilities
- investigates the role of CDM in technology absorption and building technological capabilities in Indian manufacturing in terms of
  - R&D efforts (an indicator of absorption), and
  - Firms' performance indicators

# Theoretical framework:

## 1. Technology matters

- New growth theories' approach
  - Human skills an important determinant of growth
- Evolutionary approach ( inter alia, Nelson and Winter 1982; nelson, 1993; and Lundvall 1992)
  - Firm level heterogeneity in technological capabilities an important determinant of performance

## **2. Technology acquisition a necessary condition for tech capabilities in developing countries**

- **Developed countries:** Technological capabilities are organically developed through own R&D
- **Developing countries:** Distinction between
  - technology creation,
  - technology acquisition, and
  - technology learning and technological capabilities
- **Three major modes of technology imports :**
  - Imports of capital goods (embodied),
  - technology licensing (Disembodied) and
  - FDI (disembodied)

### **3. Tech acquisition is not a sufficient condition for tech capabilities**

- The relationship is ambiguous.
- FDI: latest technologies acquired through FDI but may not have spillover effects to upgrade domestic firms' capabilities; Subsidiaries may remain dependent on parents);
- technology licensing: Market acquisition: may have substitution or complementary effects
- Imports of capital goods: may induce incremental changes.
- Several firms and country specific factors affect the impact of technology acquisition on local R&D and tech building

# CDM and technology transfer

- CDM implies technology transfers through three mechanisms
  - FDI if equity stake by foreign partners
  - Technology licensing if contractual
  - Capital goods imports if unilateral

# **But does that mean upgrading in green technologies ?**

Two hypotheses

- H1: CDM involvement strengthens technological capabilities of domestic firms in terms of R&D efforts.
- H2: CDM involvement results in enhancement of firms' performance.

# Strong possibility of technology transfers through CDM

- CDM: project based
- Eligibility criteria: sustainable growth and additionality
- Rules and processes
- Implemented through the CDMA
- Additonality criterion and its strict implementation has strong implication for technology transfer

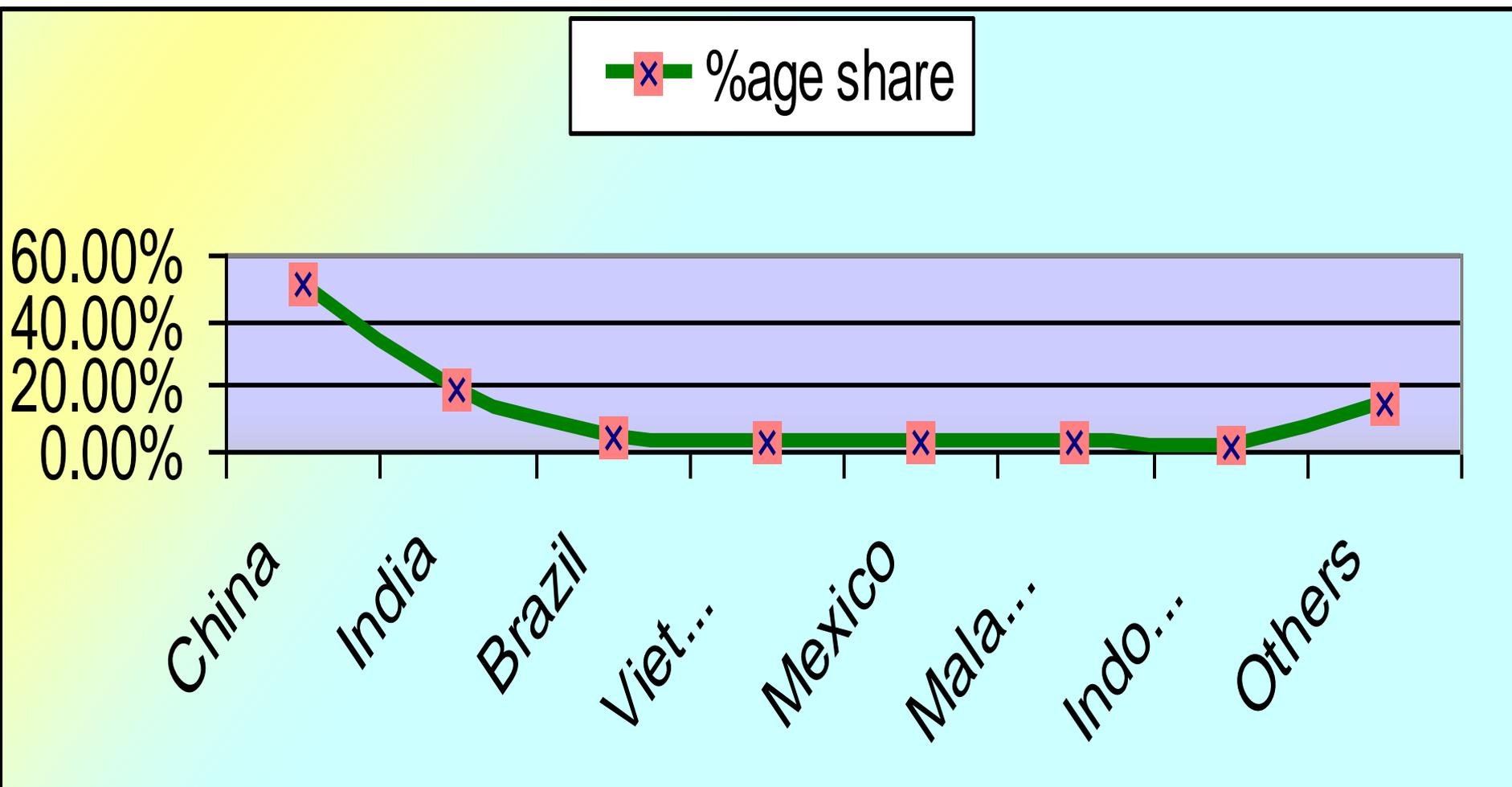
# Our interviews: Mixed reactions

- No technology transfer, purely indigenous technology but in the process new technologies developed indigenously
- Developed countries are unwilling to share for the fear of spill overs.
- Suppliers in the value chain might be undertaking R&D
- DCs have moved on to least developed countries for CERs purchase :Political economy of CDM
- **GIZ** : Undertaking a vast study for the development effects of CDM but technology components is ignored,
- **Policy makers** have a positive view of CDM; Keen to know the results.

# Global CDM projects

- Total projects initiated 6079 by March 2011
- Investment: \$143 billion
- Total projects registered: 4730 by October, 2012
- India : 860 by June end 2012.

# Where does India stand in global CDM projects?

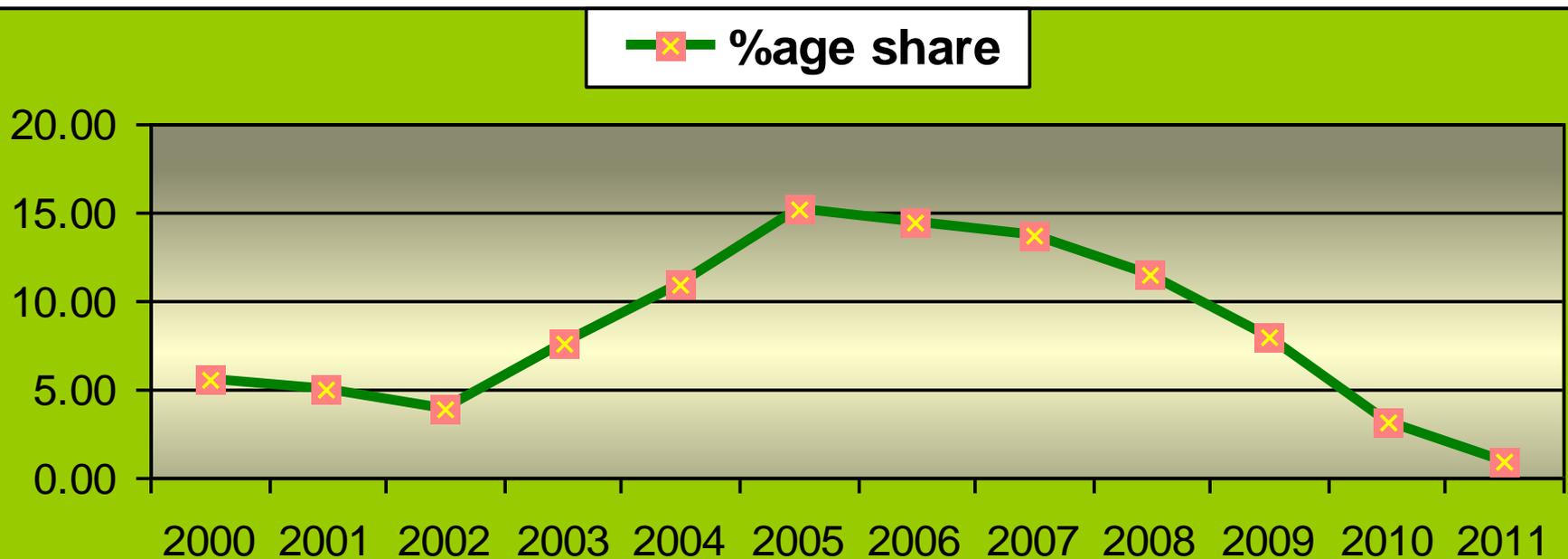


## Growth of CDM projects in India:

India's total number of CDM projects registered from 2000 to 2011.

Slow down in the number of CDM projects:

- Global slow down.
- Fall in the international prices of CERs.
- EU focus of obtaining CERs from least developed countries instead of the major CDM countries.

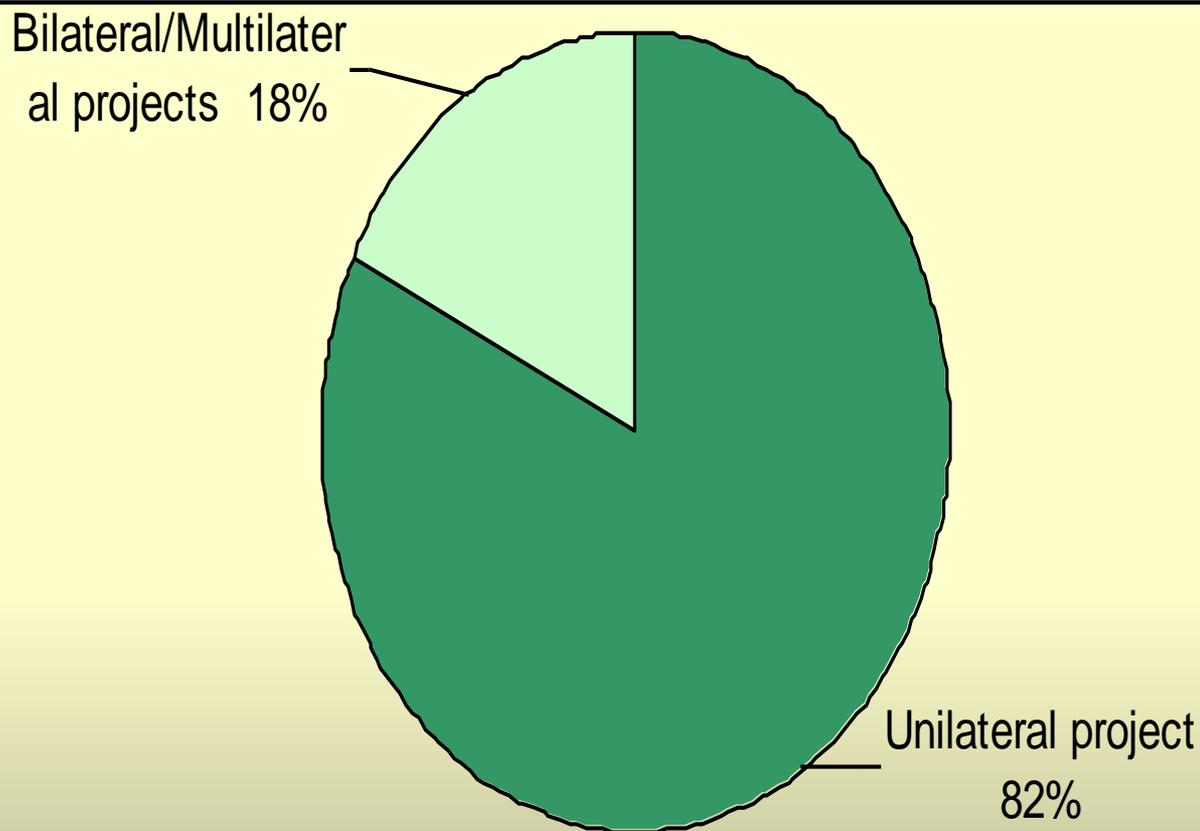


Source: IGES CDM Project Database

# Distribution by types of projects in India: Registered CDM Projects 31 May 2012.

	No. of Projects	Avg. Annual Emission Reductions (t-CO2)	Amount of Issued CERs t-CERs)	Review Requested	Rejected
<b>Wind Power</b>	<b>290</b>	<b>32,507</b>	<b>13,255,604</b>	<b>60</b>	<b>8</b>
<b>Biomass</b>	<b>191</b>	<b>38,850</b>	<b>10,194,695</b>	<b>65</b>	<b>16</b>
<b>Hydro Power</b>	<b>93</b>	<b>82,775</b>	<b>3,657,286</b>	<b>24</b>	<b>5</b>
Energy efficiency	79	108,702	1,486,622	21	9
Waste gas/heat utilization	73	74,834	12,991,240	34	9
Fuel switch	23	372,162	9,801,005	8	0
Cement	17	114,708	1,382,047	2	4
<b>Biogas</b>	<b>19</b>	<b>30,269</b>	<b>786,306</b>	<b>4</b>	<b>0</b>
Methane avoidance	14	76,770	66,392	3	0
A forestation & reforestation	7	72,246	0	1	0
HFC reduction/avoidance	7	1,577,424	87,702,841	2	0
<b>Other renewable energies</b>	<b>10</b>	<b>20,647</b>	<b>0</b>	<b>2</b>	<b>0</b>
N2O decomposition	5	406,915	354,329	3	0
Transportation	4	207,362	82,317	0	0
Methane recovery & utilization	2	94,254	88,873	0	0
PFC reduction	1	433,551	33,624	0	0
<b>Total</b>	<b>835</b>	<b>79,037</b>	<b>141,883,181</b>	<b>229</b>	<b>51</b>

# Unilateral vs Bilateral/ Multilateral projects in India: technology licensing and equipment acquired important modes of technology acquisition



Source: IGES CDM Project Database

# CDM and technology transfers: Literature review

Two broad categories of studies:

- Those that do not differentiate between technology acquisition and absorption: PDD based studies
  - Country-based/Inter-country
  - Focus on determinants of TT
- Those that make distinction between the two:
  - Survey based: Doranova, 2009;
  - Original CDM document based : Das 2011

- **Das (2011):** identified 3 categories of technology learning : new tech development, in-house efforts, **training**: qualitative analysis
- **Doranova (2009)** identified technological learning at three levels: **Basic level**, **Intermediary level**, **Advanced level**:
- **Hansen (2011):** CDM not directly entails technology and knowledge acquisition
- **Wang (2009):** updated machinery and raw material in a firm have significant effect on the development of technologies through CDM projects.
- **FICCI (2012):** shows CDM do not contribute to technology transfer in India, neither in the unilateral or bilateral/multilateral projects.

## **No quantitative analysis**

- Little analysis of the impact of CDM involvement on firms behaviour in terms of R&D efforts or their performance.
- To the best of our knowledge, this is the first study in this direction.

# Our hypothesis and Methodology

**H1: CDM project leads to increased R&D efforts by the implementing firms.**

## **Methodology:**

- Difference in differences (DID) technique on a panel data use to measure the effect of implementing a CDM project on R&D efforts of the firms.
- DID method compares the difference in the performance between the periods prior to CDM-adoption (pre-period) and after CDM adoption (post-period) and with the difference between CDM and non-CDM firms.

# Difference-in -Difference

- CDM Firms (treated firms) : firms that have implemented large and/ multiple CDM projects and

- Non CDM firms (the comparison group): Firms that have implemented a single small project.



The model

$$Y_{it} = \alpha + \alpha_1 \text{CDM} + \alpha_2 \text{CDM} * \text{td} + \alpha_3 \text{td} + \sum \alpha_i \text{CONTROLS} + e$$

- Where  $Y_{it}$  is the dependent variable

# The dependent variables

Two indicators of R&D efforts are considered for the analysis:

- R&D intensity: R&D expenditures normalized by sales
- Environment expenditure intensity: Expenditures incurred on environment expenditure normalized by sales.

# Independent variables

## *Main variables:*

CDM: A dummy that takes value 1 for firms implementing large/multiple projects and 0 for those implementing a single small project.

td: classifies each year as pre or post CDM period for all firms based on their year of CDM activity. It assumes value 1 in the post CDM years and 0 in the pre CDM years.

CDM\*td: the DID coefficient (interaction dummy that multiplies the dummies CDM<sub>it</sub> and t<sub>dt</sub>). Its coefficient would measure the difference in differences estimator of the CDM effect on the acquiring firms.

## Control variables:

PBT intensity: Profits before tax normalized by sales

Sales: log of sales

GFA: Gross fixed assets to sales ratio

Ititeprofes Intensity: IT expenditures –sales ratio

Man intensity: Managerial salary-sales ratio

EXP intensity: exports-sales ratio

# Data Sources:

## Data from two sources

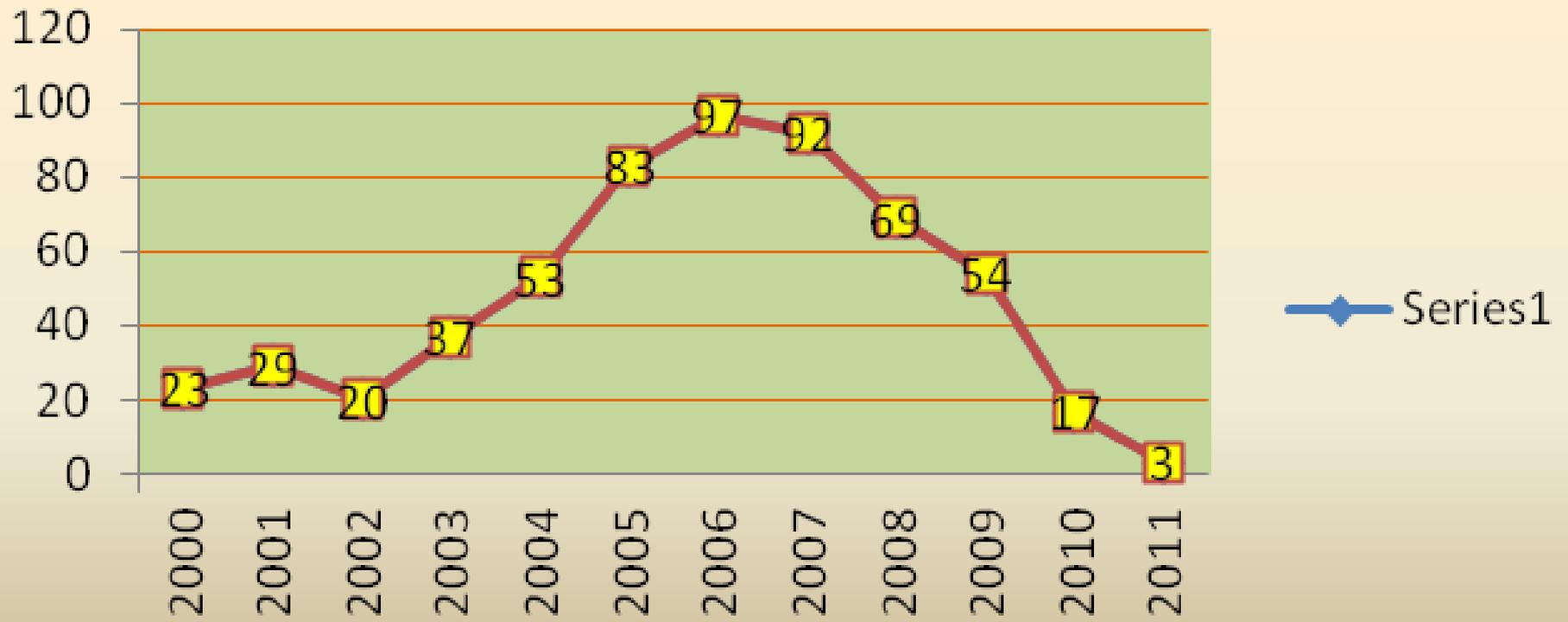
- CDM database of the Institute for Global Environment Strategies (IGES)
- Centre for Monitoring Indian Economy's PROWESS database of large and medium Indian companies.

## Building CDM database for the study :

- Information from IGES for all 835 projects registered in India.
- Identified 584 renewable energy projects involving 576 host firms.
- Merging host firms taken from IGES into PROWESS database with more 40 variables, to create a panel dataset for the years 2001 to 2012.

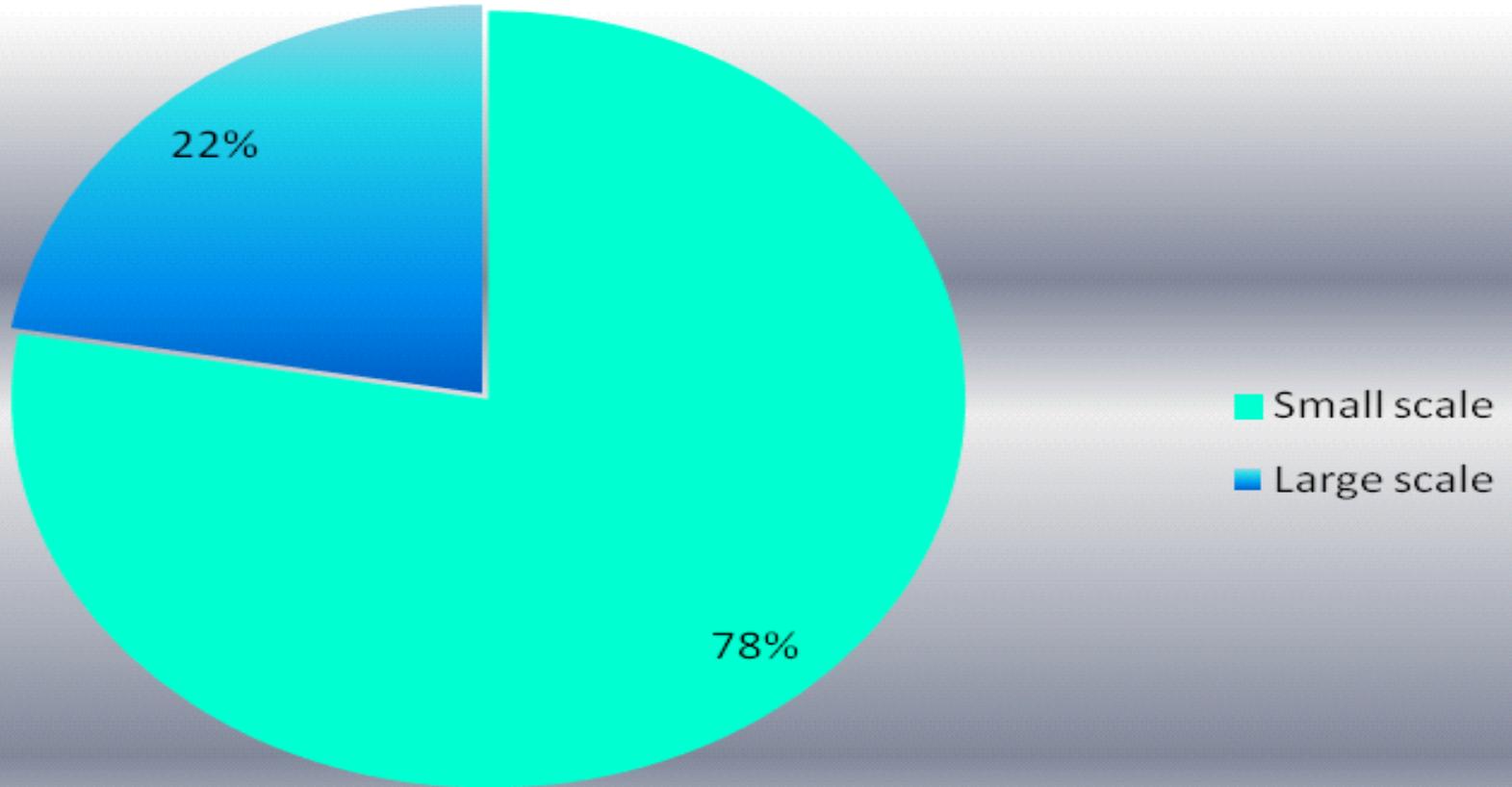
# Renewal energy projects

## 1. Growth of CDM projects in renewable energy:



Source: PROWESS, IGES

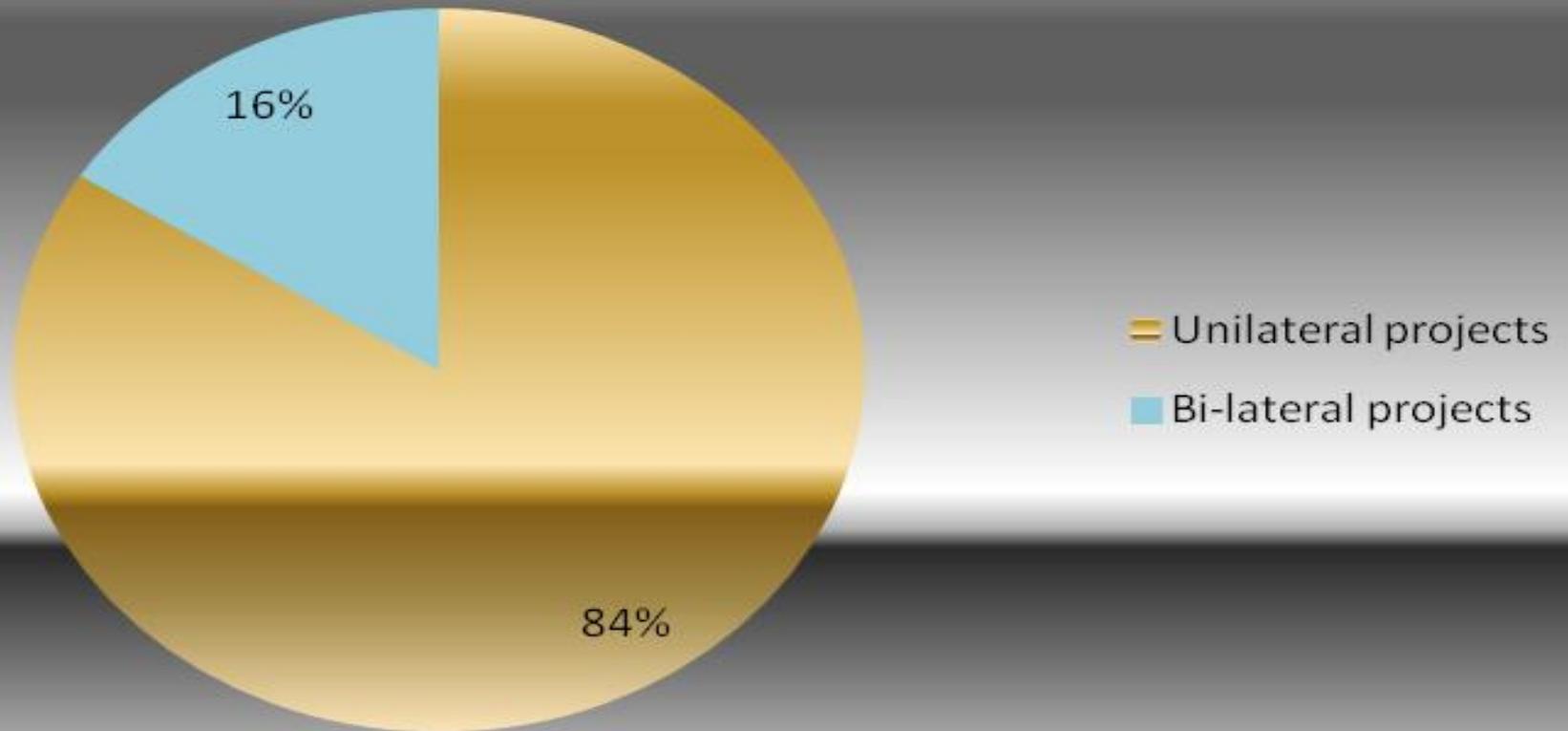
# Renewal energy projects 2, SCALE



Source: PROWESS, IGES

# Renewal energy projects

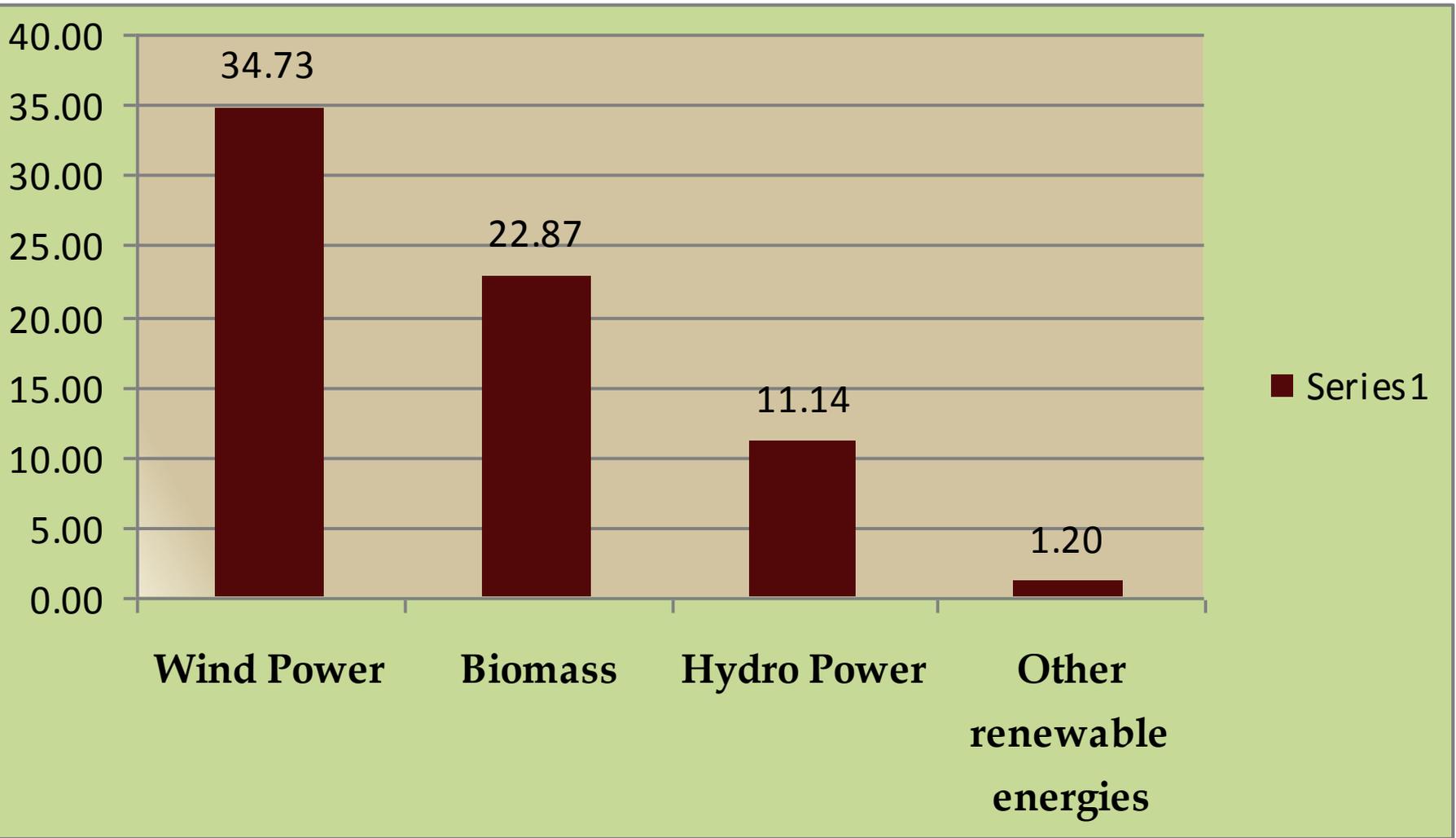
## 3. Financing patterns



Source: PROWESS, IGES

# Renewal energy projects

## 4. Composition by category



Source: PROWESS, IGES

# Estimation Results with R&D intensity as dep variable

<b>Variables tested</b>	
<b>Capital intensity</b>	<b>Insignificant</b>
<b>Size ( log of sales)</b>	<b>Insignificant</b>
<b>CDM*td</b>	<b>Insignificant</b>
<b>Intensity of IT professionals ( Management attitude)</b>	<b>Significant positive</b>
<b>Profit sales ratio</b>	<b>Insignificant</b>
<b>Dummy for CDM</b>	<b>Insignificant</b>
<b>Dummy for CDM implementation years</b>	<b>Insignificant</b>
<b>Management intensity</b>	<b>Insignificant</b>
<b>Export-Intensity (Outward orientation)</b>	<b>Significant positive</b>

# Estimation results: environmental expenditure intensity

	NPB: 155
Variables tested	
Capital intensity	Insignificant
Size ( log of sales)	
CDM*td	Significantly negative
<b>Intensity of IT professionals</b>	
Profit sales ratio	
Dummy for CDM	Significantly positive
Dummy for CDM implementation	
Management intensity	
<b>export_Intensity</b>	

# Conclusion

- CDM implementation may not have significant impact on R&D efforts of implementing firms.
- CDM implementing firms appear to substitute their environment related expenditures by CDM projects. Thus, seek to convert the challenges of technology transfer into opportunities
- CAVEATS:
  - Preliminary results only
  - Substantially more work is required for generating robust results

# Major Issues to discuss

- Do you agree with the conclusions?
- Can CDM be treated as a mechanism of technology transfer?
- If not, why?
- Are we missing the boat in capturing green tech markets because R&D is given a low priority by Indian companies?
- Are developed countries reluctant to share their technologies?
- What has been the Chinese experience?
- Which aspects of the firms' conduct and performance should be considered to evaluate the impact of CDM implementation?
- Can we say that CDM has helped in technology diffusion and not technology learning?
- Does carbon price fall mean the potential death of this tool?
- Should it be replaced by other instruments?

**Thank You**