THE KYOTO MECHANISMS AND THE DIFFUSION OF RENEWABLE ENERGY TECHNOLOGIES IN THE BRICS

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OUTLINE

- Introduction
- Motivation
- Research question/introduction
- Analytical framework
- Use of renewable energy in BRICS countries
- Kyoto mechanisms (CDM and JI)
- Discussion on impact of Kyoto mechanisms on diffusion of renewable technology

- Future areas of research

MOTIVATION

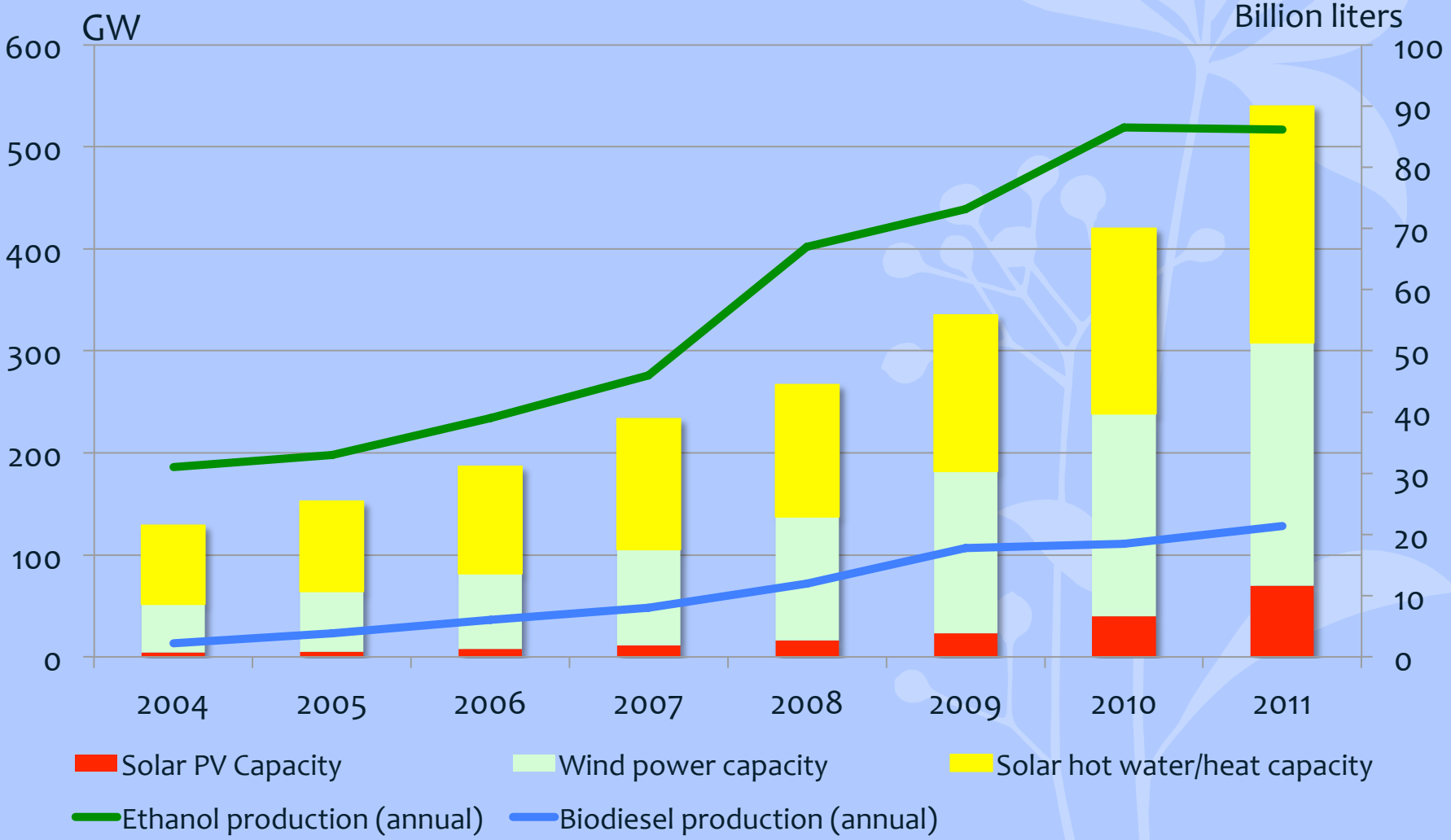
- Importance of sustainable development
- Environmental impact of the emerging economies (BRICS)

  How to avoid the inverted Environmental Kuznets curve?
- International agreements aimed at establishing alternative forms of governance

  -Less based on regulation and command-and-control under globalizing world

  -Kyoto Mechanisms tries to promote collaboration among countries (CDM, JI) to diffuse technology in an aim to reduce emissions
- The role of international on the emergence of new technological systems of renewable energy

RENEWABLE ENERGY PRODUCTION IS IN INCRESE



RENEWABLE ENERGY CAPACITY IN BRICS IS IN INCREASE

Ranking of Production Capacity by Energy Type

	2006	2010	2006	2010
	RENEWABLE ENERGY*		SOLAR PV **	
1	China	China	Germany	Germany
2	US	Germany	Japan	Spain
3	Germany	US	US	Japan
4	Spain	Spain	Spain	Italy
5	India	India	Netherlands	US
	WIND POWER		SOLAR THERMAL	
1	Germany	China	China	China
2	Spain	US	Turkey	Turkey
2	US	Germany	Germay	Germany
4	India	India	Japan	Japan
5	Denmark	Spain	Israel	Greece
	BIOMASS		ETHANOL PRODUCTION	
1	US	US	US	US
2	Brazil	Brazil	Brazil	Brazil
2	Philippines	Germany	China	China
4	Sweden	China	Germany	Canada
4	Finland	Sweden	Spain	France
4	Germany		BIO DIESEL PRODUCTION	
			Germany	Germany
			US	Brazil
			France	Argentina
			Italy	France
			Czech Republic	US

REN 21, 2008, 2012 report. * excluding hydro power, ** connected to grid only

RESEARCH QUESTION

Have the Kyoto mechanisms stimulated the diffusion of sustainable energy technologies in BRICS?

THEORY ON DIFFUSION OF INNOVATION BY ROGERS (1995)

A process involved in transmission of new technological knowledge/innovation communicated through certain channels (i.e. commercialization channels etc.) over time *among actors* ***in a socio economic system.***

This would involve:

-Complexity

-Dynamics

-Diversity

Because diffusion of technology/innovation is co- evoltive process between society and technology.

In the way the technology/innovation is diffused.

POTENTIAL FACTORS THAT MAY AFFECT DIFFUSION PROCESS: INDEPENDENT VARIABLES

-Characteristics of national potential adopters

- cost/benefit calculation of individual
- search & evaluation capacity
- International exposure (trade and FDI)
- culture/awareness
- Innovation capability at national and individual level

-National natural endowments

- determine selection of technology (wind, solar, bio etc)
- determine return from existing energy sources
- determine shadow cost of new technology

-National Economic and social development

- affect the awareness of adopters and influence the personal choices

POTENTIAL FACTORS THAT MAY AFFECT DIFFUSION PROCESS : ASSUMPTIONS

-National Policies

National institutional framework

Public policy

-Science & Technology Development

Technological level of the country

Degree of influence on technology

-Suppliers of Technology

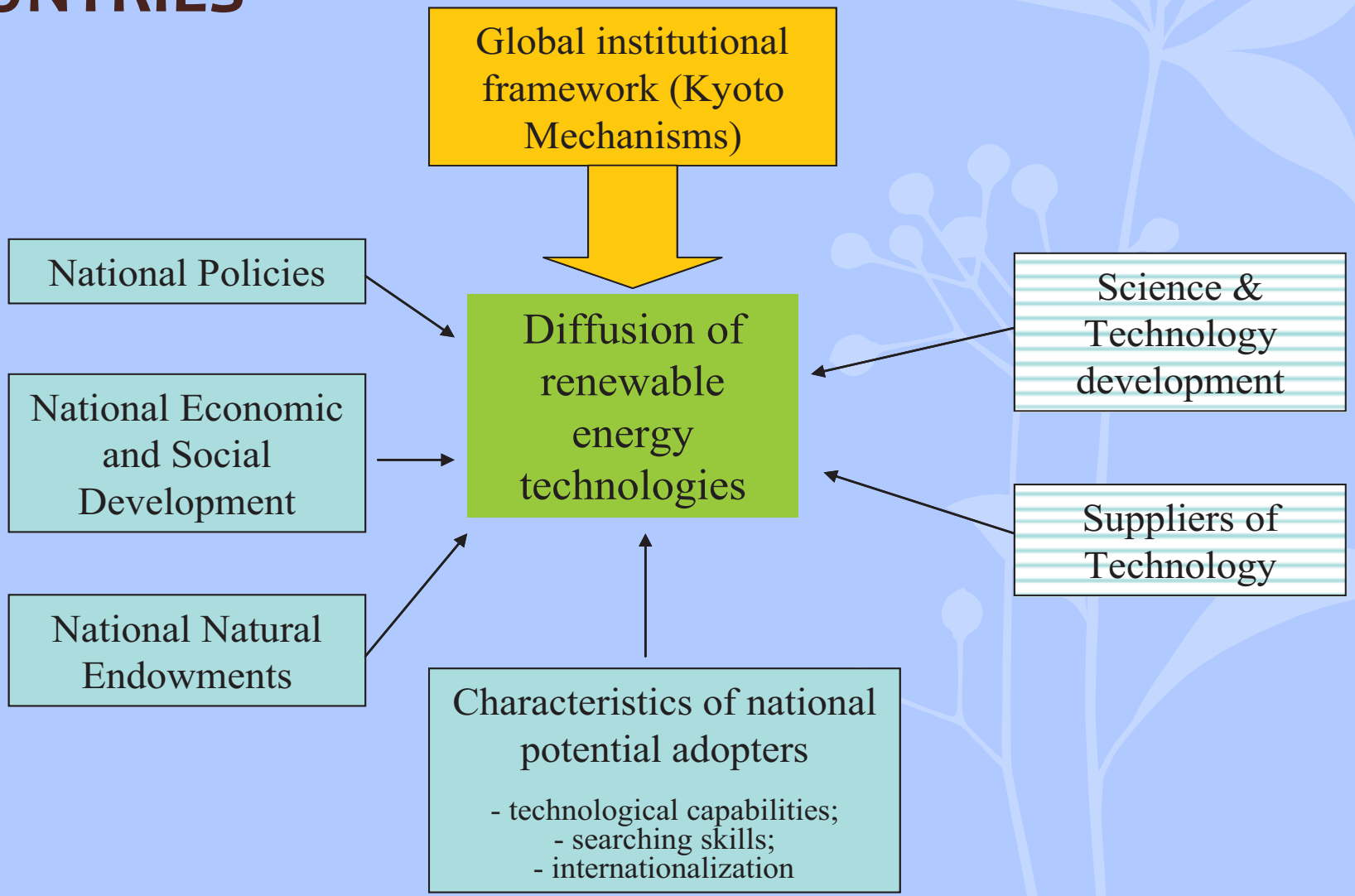
EXOGIOUS VARIABLE?

NEW FACTOR

-Global institutional framework

Kyoto mechanism (CDM and JI)

ANALYTICAL FRAMEWORK DIFFUSION OF RENEWABLE ENERGIES IN BRICS COUNTRIES



METHODS OF ANALYSIS: OPERATIONALIZATION (1)

1. EXAMINE PATTERNS OF DIFFUSION OF RENEWABLE ENERGY TECHNOLOGIES IN BRICS COUNTRIES

- Use WBI data to examine the evolution of renewable energy use between 1987-2006
  - -Share of renewable energy sources in total energy
  - -Reliance on biomass sources on total share of combustible renewables and waste
  - -Share of capacity of annual production of modern renewable energy

Using above as proxy of Diffusion of renewable energy technology

METHODS OF ANALYSIS: OPERATIONALIZATION OF FACTORS(2)

2. KYOTO MECHANISM CDM and JI

-Proportion of CDM and JI in BRICS

-Area of CDM and JI implemented and its association with renewable energy

METHODS OF ANALYSIS: OPERATIONALIZATION OF FACTORS(3)

3. EXAMINE THE FACTORS FACILITATE DIFFUSION

(1)Characteristics of national potential adopters

a. Internationalization of national business

- FDI and ISO certification
- Export as import capacity and royalties paid abroad % GDP

b. National technological capabilities

- High tech export
- R&D expenses in GDP
- Royalties received on GDP
- Number of scientific papers and patents per 1000 population

c. National search capabilities

- Expenses per student in tertiary education
- Availability of computer, communication on services

METHODS OF ANALYSIS: OPERATIONALIZATION OF FACTORS(3)

(2) National natural endowments

- Fossil resources
- Water resources
- Forest resources

(3)Economic and social development

- GDP per capita
- GDP industry
- GDP Agriculture

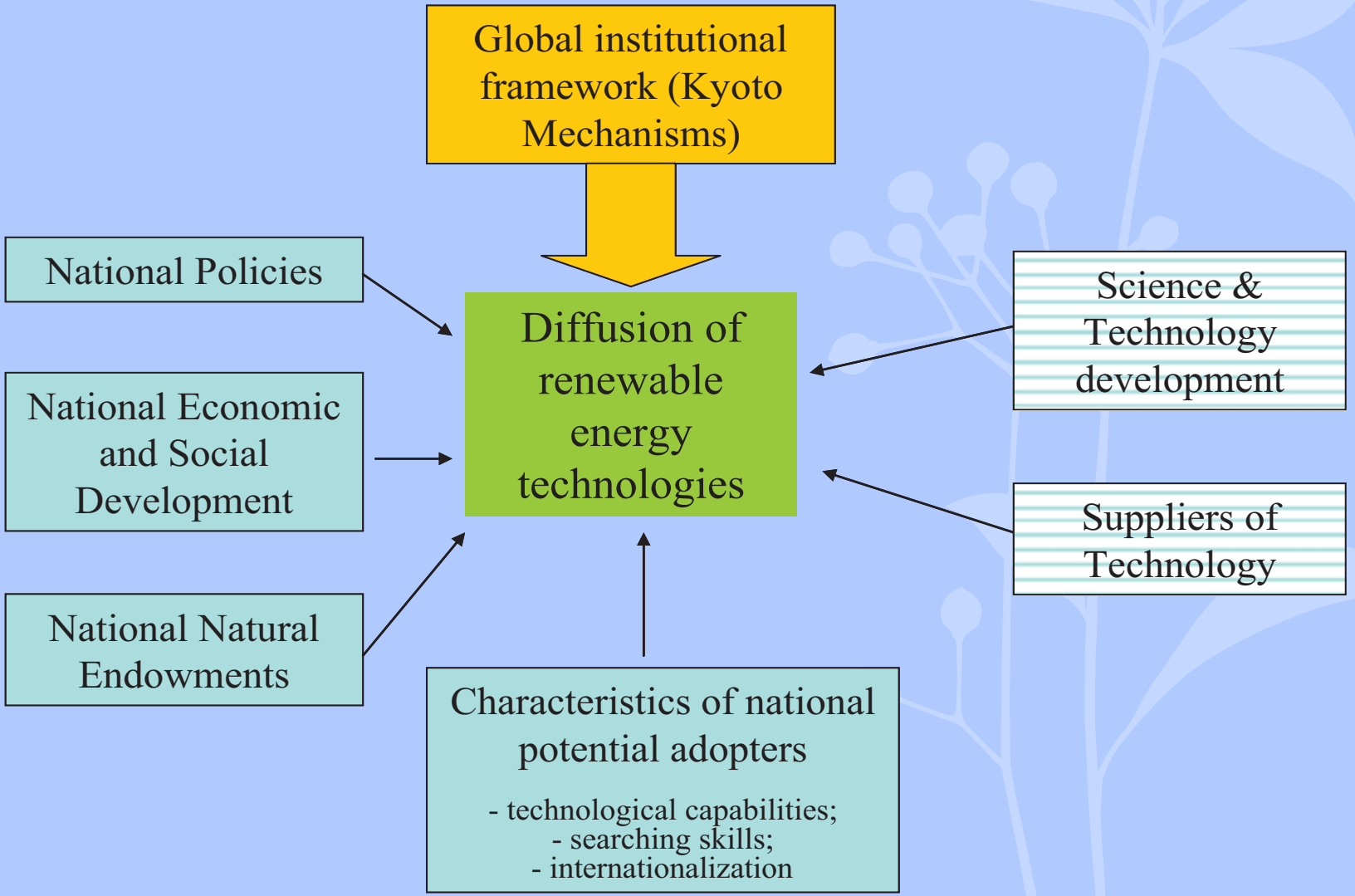
(4)National Policies

- Investment in energy with private GDP
- Investment in energy

(5)Kyoto mechanisms

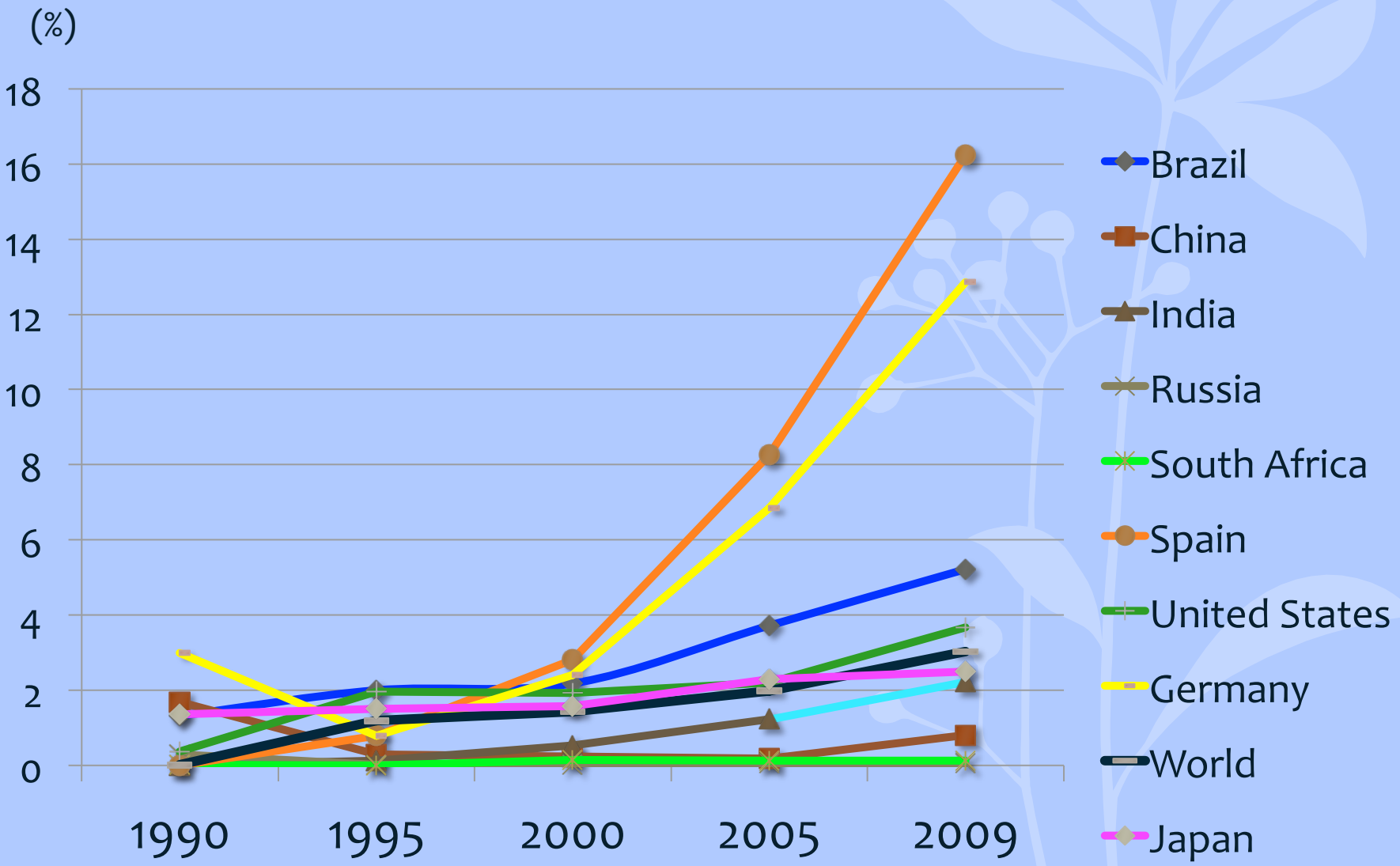
- Number of CDM and IJ projects

Conceptual/analytical framework
Diffusion of renewable energies in BRICS countries



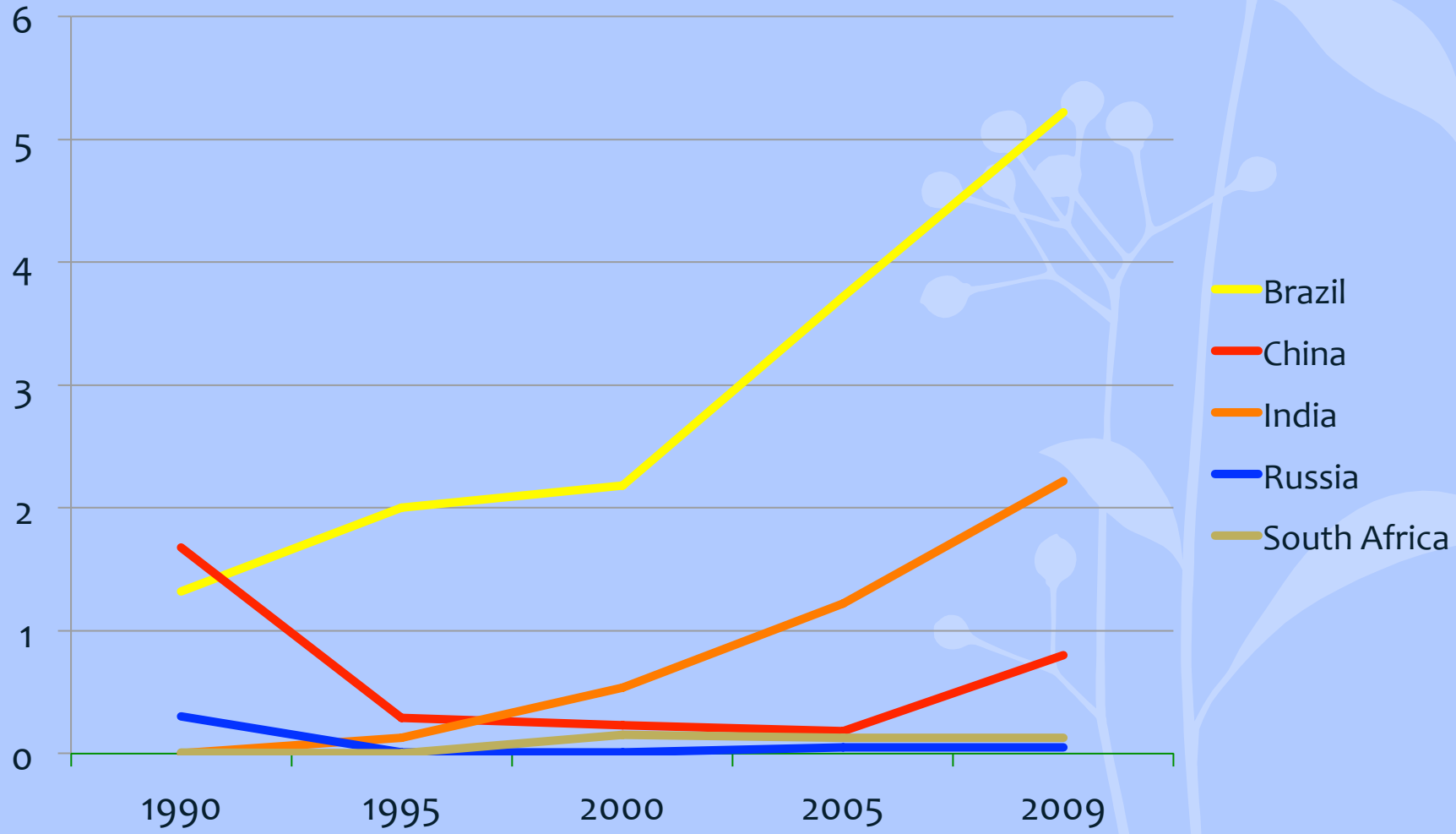
EXAMINE PATTERNS OF DIFFUSION OF RENEWABLE ENERGY TECHNOLOGIES IN BRICS COUNTRIES

SHARE OF RENEWABLE ENERGY IN TOTAL ENERGY PRODUCTION (EXCLUDING HYDRO ENERGY)

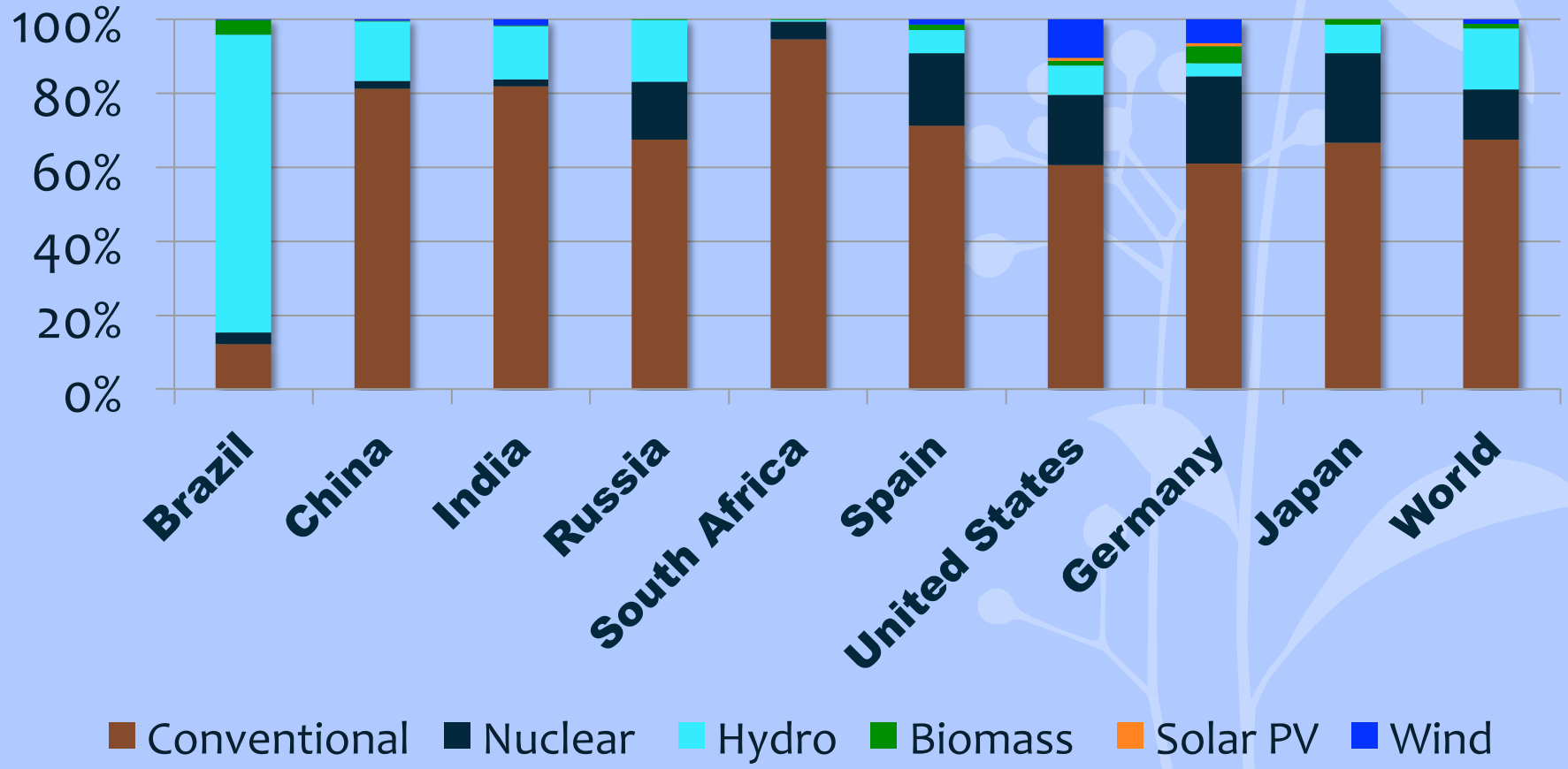


World bank indicators, 2011

SHARE OF RENEWABLE ENERGY IN TOTAL ENERGY PRODUCTION (EXCLUDING HYDRO ENERGY) BRICS only

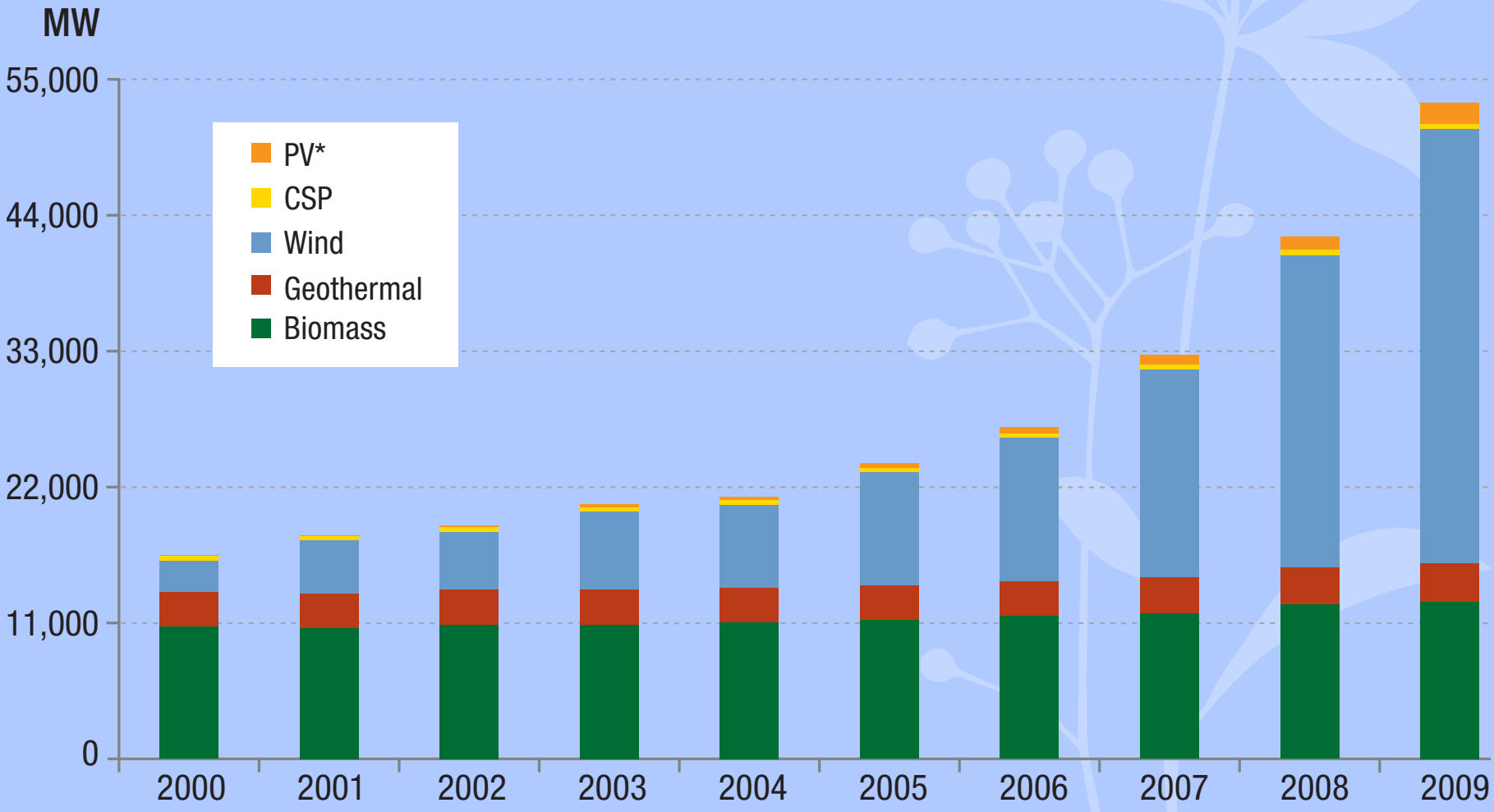


COMPOSITION OF ELECTRICITY GENERATION IN BRICS 2008



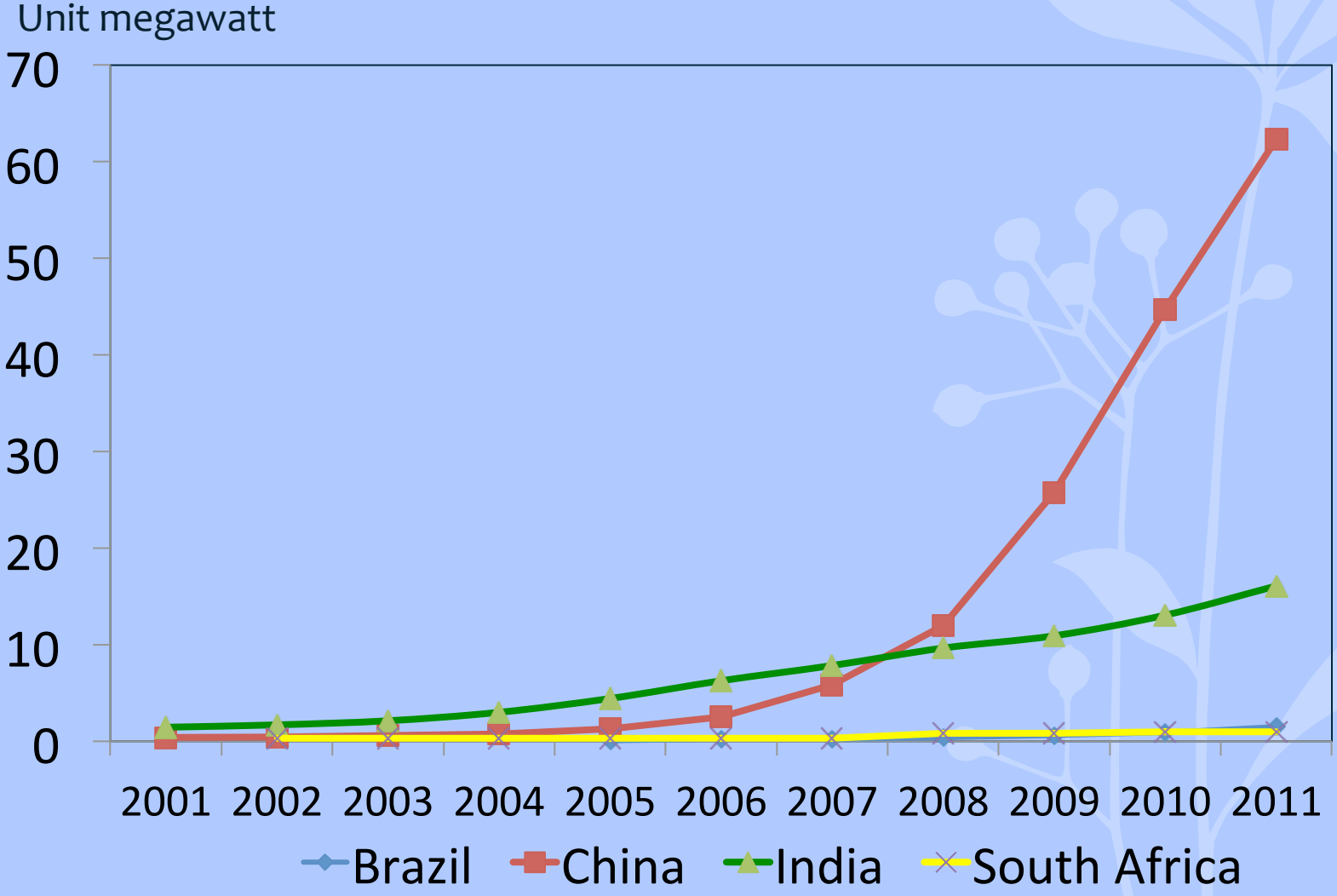
International Energy Agency (IEA), 2009, and Energy production source, 2011

RENEWABLE ELECTRICITY GENERATING CAPACITY BY SOURCE (EXCLUDING HYDROPOWER)



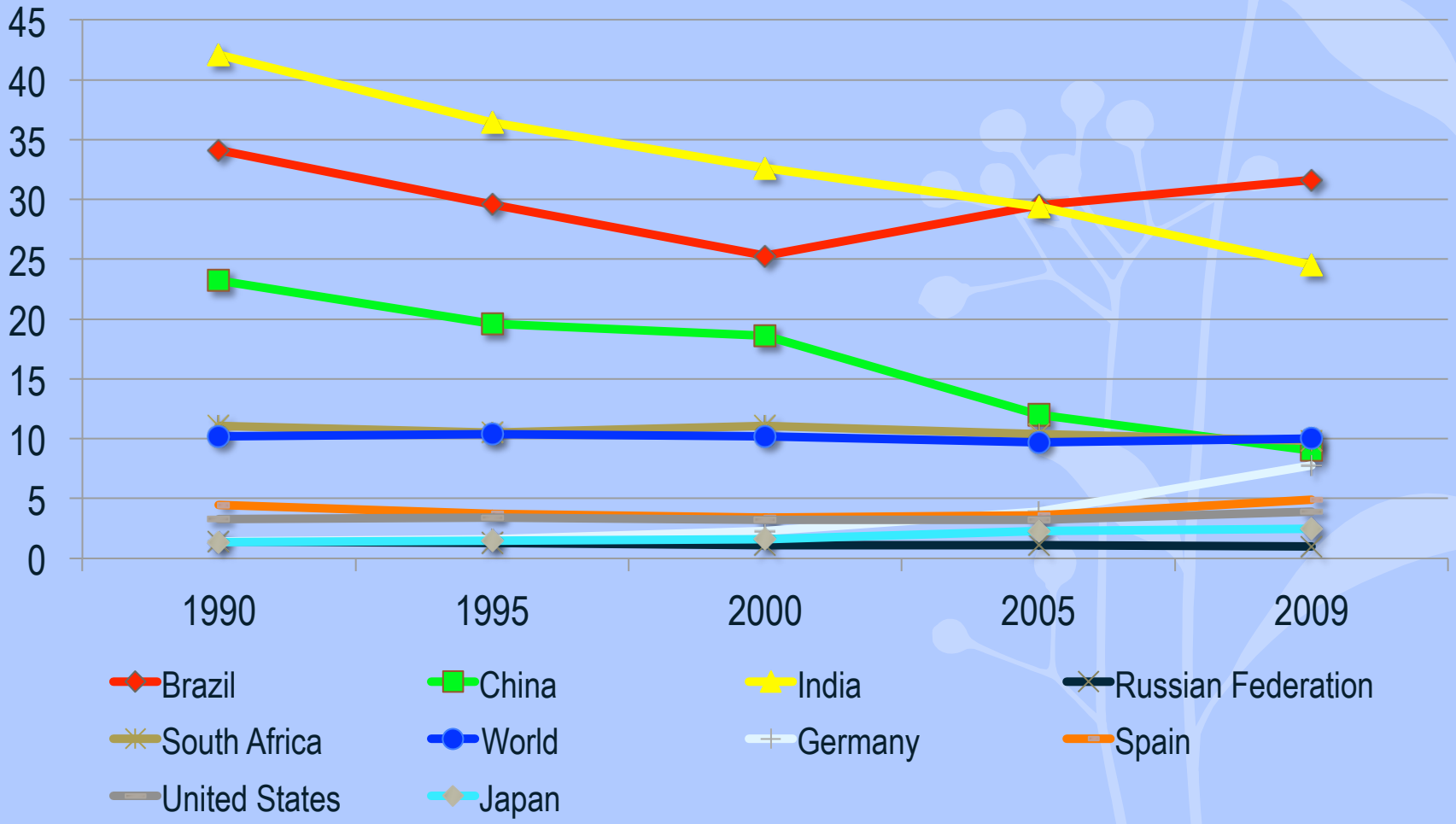
source: IEA, AWEA, SEIA, GEA

Wind energy capacity among BRICS



Source: GWEC 2011 and REN21, 2011, 2012

PATTERN OF DIFFUSION OF RENEWABLE IN BRICS (2)
% OF COMBUSTIBLE RENEWABLES AND WASTE OF TOTAL



World Bank Indictors, 2010

SUMMARY OF ANALYSIS 1

-Renewable energy production is in increase although proportion is still small.

-Fast growing renewable energy are: Wind and Solar PV

But Solar PV capacity is still very small proportion in BRICS countries

-Trend in capacity of renewable energy is diverse.

Wind energy growth is observed in China and India

Biomass energy is in decrease in China and India while it is in increase in developed countries such as Germany and Spain.

Brazil decreased its proportion in biomass energy but increased again in recent years

-It is possible the diverse factors may be influencing its diffusion process

KYOTO MECHANISM: AREAS IN WHICH CDM AND JI IMPLEMENTED IN BRICS

NUMBERS OF CDM AND JI PROJECTS IN BRICS

	2004	2005	2006	2007	2008	2009*	Total
Brazil	18	86	79	62	100	16	361
China	2	25	221	680	667	171	1766
India	11	198	268	304	375	95	1251
South Africa	1	6	9	7	4	2	29
Russia			12	43	37	7	99
Total CDM	60	473	837	1409	1561	393	4733
Total JI			23	84	84	13	204

* May 2009; Note: CER- certified emissions reduction

JI PROJECT IN RUSSIA

	% total JI projects	% JI projects hosted in Russia
Fugitive	33%	**33%**
EE (efficiency energy) supply side	11%	2%
Biomass energy	10%	**10%**
Fossil fuel switch	10%	**10%**
Landfill gas	8%	**8%**
N2O	7%	**7%**
Energy distribution	5%	5%
Hydro	4%	4%
HFCs	3%	3%
EE industry	2%	**11%**
Coal bed/mine methane	2%	2%
Biogas	1%	1%
Cement	1%	1%
CO2 capture	1%	1%
PFCs	1%	1%
Total number of projects	204	99

PROJECT IN PIPELINE FOR BRICS COUNTRIES

	Brazil	China	India	South Africa	World
Hydro	21%	47%	10%	7%	27%
Biomass energy	32%	4%	27%	14%	15%
Wind	3%	19%	24%	0%	15%
EE own generation	3%	15%	10%	3%	9%
Landfill gas	11%	3%	2%	21%	8%
Biogas	2%	2%	3%	10%	6%
Agriculture	16%	0%	0%	0%	5%
EE industry	1%	1%	12%	3%	4%
Fossil fuel switch	5%	2%	4%	14%	3%
N2O	1%	2%	0%	14%	1%
Coal bed/mine methane	0%	4%	0%	7%	1%
EE supply side	1%	1%	2%	0%	1%
Cement	0%	0%	2%	0%	1%
Reforestation	1%	0%	1%	0%	1%
Fugitive	1%	0%	1%	3%	1%
Solar	0%	0%	0%	0%	1%
Others	2%	1%	2%	3%	2%
Total number of projects	361	1766	1251	29	**4733**

CHARACTERISTICS OF THE CDM AND JI PROJECTS IN EACH BRICS COUNTRY 1

- **Russia:** more projects on energy efficiency in manufacturing and less on the supply side.
- **Brazil:** more projects on biomass energy, energy efficiency in agriculture (also landfill gas, and fossil fuel switch).
- **China:** more projects on coal mine and hydro technologies (also energy efficiency).
- **India:** more projects on energy efficiency in manufacturing and services, cement, as well as on biomass and wind technologies.

CHARACTERISTICS OF THE CDM AND JI PROJECTS IN EACH BRICS COUNTRY 2

-**South Africa:** more projects on energy efficiency of households, N2O, coal mining, fossil fuel switch and landfill gas.

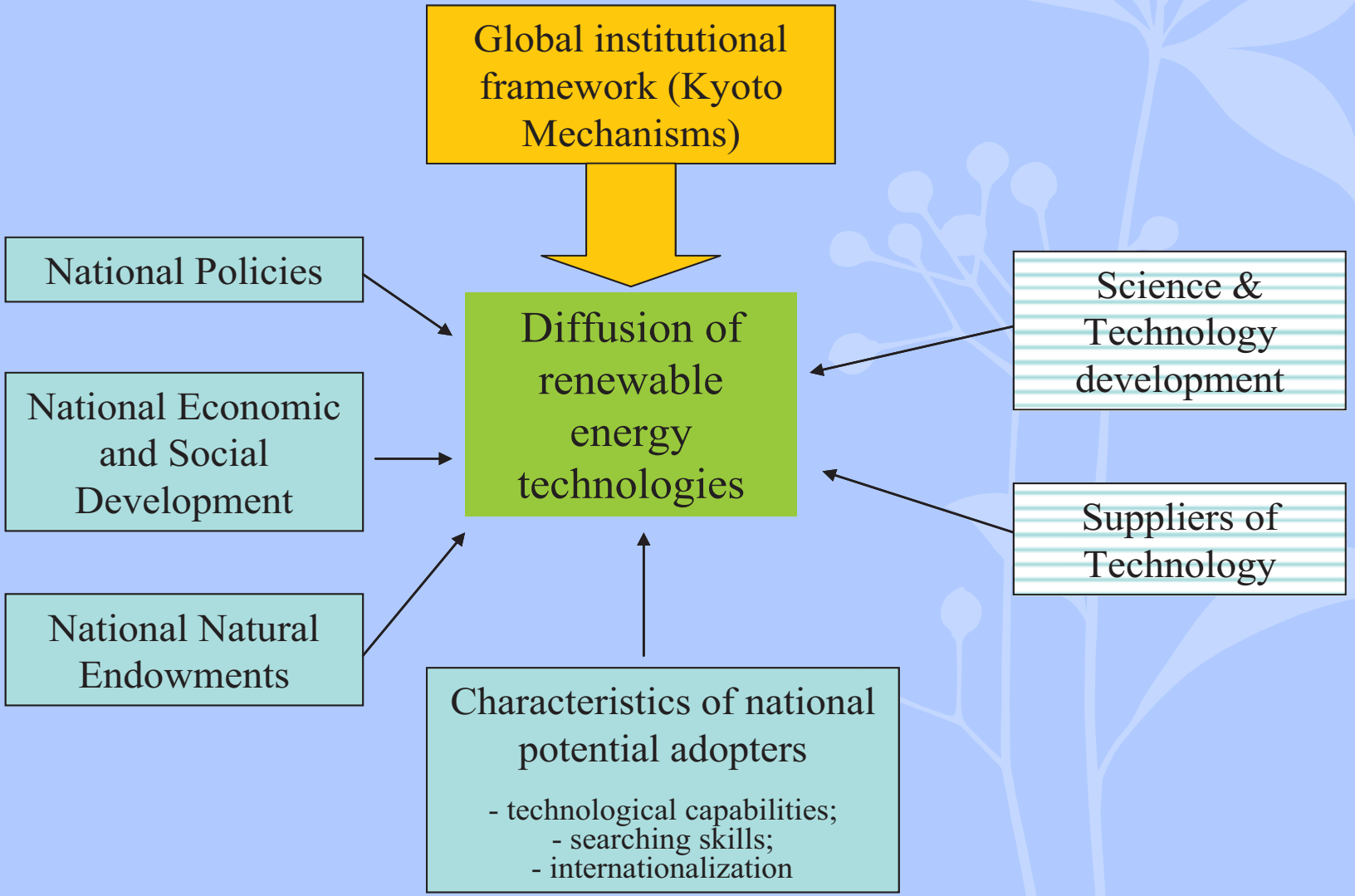
-JI : focus on brown issues, fuels energy efficiency on the supply side

-CDM: Hydro, biomass, wind energy efficiency own generation, biogas and agriculture

-Technological focus/specialization of host country seem to determine the areas of CDM

EXAMINE FACTORS THAT MAY FACILITATE DIFFUSION OF RENEWABLE ENERGY IN BRICS

Conceptual/analytical framework
Diffusion of renewable energies in BRICS countries



Characteristics of national potential adopters

		% Renewable sources on total energy sources	% Fossil fuel energy consumption on total	GDP per unit of energy use*
International isation of national business	Export as import capacity and royalties paid aborad% GDP	-	+	
National technological capabilities	High-technology exports; R&D expenditure as % of GDP; Patent redidents per 1000 people; Researchers and technicains in R&D, Royalties received as % of GDP, Scientific papers per 1000 people	-	+	
National searching capabilities	Expenses per student in tertiary education	+		
	% of computer, communications on services	+	-	+

National Natural endowment & National Economic and Social Development

National Natural endowments	% Renewable sources on total energy sources	% Fossil fuel energy consumption on total	GDP per unit of energy use*
Fossil resources	-	+	-
Water resources		-	
Forest resources	+		
National economic and Social Development			
GDP per capita	-	+	-
Vehicles & computers	-	+	
GDP share of industry	-	+	-
GDP share of agriculture	+	-	-

National Policies & Kyoto Mechanisms

	% Renewable sources on total energy sources	% Fossil fuel energy consumption on total	GDP per unit of energy use*
National policies Investment in energy with privates % GDP	+	-	+
KYOTO Mechanism Number of CDM and JI projects**		-	+

SUMMERY OF ANALYSIS 3

- Capability of adopter are associated with level of diffusion of renewable technologies and the efficient use of energy.
- The degree of internationalization of national business have negative impact to environment (more growth than environment)
- National technological capabilities of BRICS measured by various indicators (high tech exports, R&D expenditure and royalties as % of GDP etc) are negatively associated with the development of sustainability but positively correlated with reliance on fossil fuels confirming the earlier statement.
- Above also suggest that most of the BRIC's R&D efforts goes to advances in energy intensive industries/technologies
- Natural resource endowments seem to have created diversity in the way technology is diffused.
- National economic and social development also shows the economic growth positively associated with fossil fuels
- CDM and JI project positively correlated with increased output per unit of energy use and consequently to more efficient economic use of fuel energy.
- CDM and JI is not associated with the use of renewable sources of energy

DISCUSSION BASED ON ABOVE RESULTS

First observation indicated following points:

- Heterogeneity across BRICS in intensity and composition of use in renewable energy.
- BRICS are not necessarily lagged behind in its use of renewables but may need to modernize the technology
- Diffusion pattern also differs among energy types. Ie. Solar PV is not diffused among BRICs

Second set of observation indicated following points:

- JI and CDM is concentrated in the very few countries—namely China, India and Russia
- Areas of project varies across countries but usually employs matured technology and not necessarily the most sustainable technology
- Much of these areas are influenced by locally available resources and technology.
- JI and CDM seem to exploit already existing and widely used technology in host countries and often less sustainable variants of renewable energy technology.

Third set of observation indicated following points:

- BRICS countries' socio economic factors are positively correlated with use of fossil fuels indicating that there is strong tendency to move towards existing form of production and consumption of energy when economy is active
- May encourage developed countries to go for 'low hanging fruits' to diffuse 'old' and 'cheaper' variant of environmental technology than most sustainable one.

- Raises questions on effectiveness of Kyoto mechanisms in diffusing renewable technology.

LIMITATION OF THIS RESEARCH

- Simplified understanding of Policy issues in BRICS countries
- Manufacturing capacity was not covered fully
- Innovation/technological capability in BRICs countries are not covered
  - Technological capability in BRICS: considered exogenous may no longer correct.
- Selection and choices of socio economic indicator can be fine tuned.

CONCLUSION

Research question

Have the Kyoto mechanisms stimulated the diffusion of sustainable energy technologies in BRICS?

Renewable energy production capacity is in increasing trend for BRICS countries

The type and speed of its growth--diffusion process-- is diverse and strongly influenced by various factors. However, the economic growth and international exposure still seem to increase the use of fossil fuels.

Kyoto Mechanism CDM, JI may stimulate the diffusion of already existing renewable technologies but it does not seem to 'transfer' technology to further mitigate climate change.

The emerging countries need to make effort in creating certain level of policy environment, technological capability in addition to natural endowment in emerging area of renewable energy technology.

FURTHER AREAS OF RESEARCH

- National Policies of BRICs countries
  - Its relation ship with creation process of
    - manufacturing capability
    - Technological/ Innovation capability

  Involvement of developed countries

- Relationship between
  - Manufacturing capability
  - Technological/innovation capability
  - Market conditions

- Trajectory of innovation with regards to cost competitive market demand (strong demand from emerging countries)