Cleantech i ett energisystemperspektiv (CLEANS) - biogas i ett Sverige-Indien perspektiv

Erik Ahlgren

tillsammans med Shivika Mittal & P.R. Shukla

Chalmers & Indian Inst Management - Ahmedabad

Perspektiv på energi, Stocholm, 6-7 dec, 2017

GLOBAL CHANGE BIOLOGY
BIOENERGY

GCB Bioenergy (2015) 7, 1118–1135, doi: 10.1111/gcbb.12225

Bioenergy futures in Sweden – system effects of CO_2 reduction and fossil fuel phase-out policies

MARTIN BÖRJESSON[1], DIMITRIS ATHANASSIADIS[2], ROBERT LUNDMARK[3] and ERIK O. AHLGREN[1]

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Transportation Research Part D 32 (2014) 239–252

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Transportation Research Part D

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Biofuel futures in road transport – A modeling analysis for Sweden

Martin Börjesson [a,*], Erik O. Ahlgren [a], Robert Lundmark [b], Dimitris Athanassiadis [c]

Energy 48 (2012) 212–226

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Energy

journal homepage: www.elsevier.com/locate/energy

Cost-effective biogas utilisation – A modelling assessment of gas infrastructural options in a regional energy system

Martin Börjesson*, Erik O. Ahlgren

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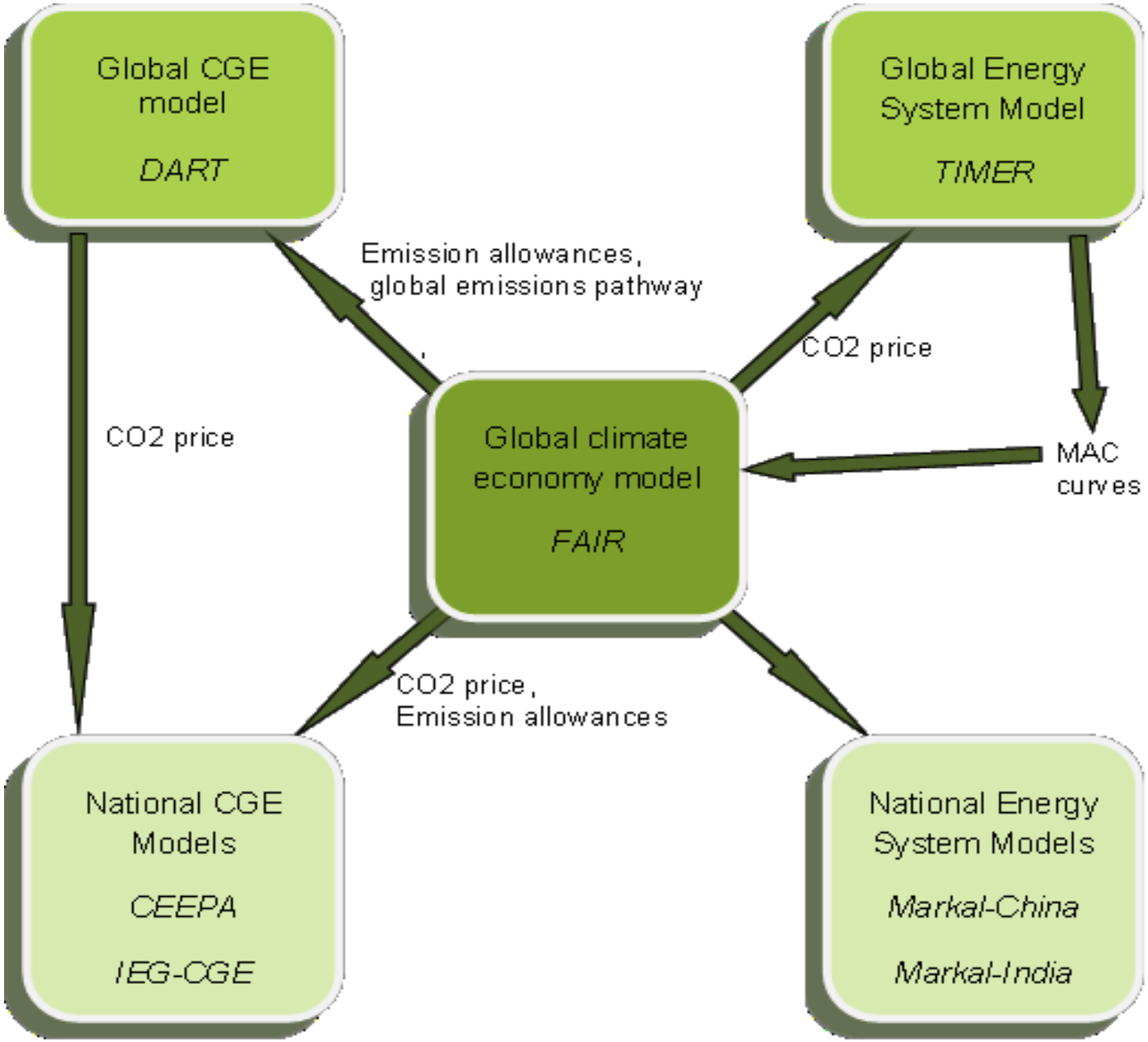
POEM –

Policy Options to engage Emerging Asian economies in a post-Kyoto regime

Collaborating partners

- Chalmers University of Technology, Sweden
- Netherlands Environmental Assessment Agency, The Netherlands
- Kiel Institute for the World Economy, Germany
- Indian Institute of Management - Ahmedabad, India
- Institute of Economic Growth, India
- Tshinghua University, China
- Beijing Institute of Technology, China


Global CGE model
DART
Global Energy System Model
TIMER
Emission allowances, global emissions pathway
CO2 price
CO2 price
Global climate economy model
FAIR
MAC curves
CO2 price, Emission allowances
National CGE Models
CEEPA
IEG-CGE
National Energy System Models
Markal-China
Markal-India

Mitig Adapt Strateg Glob Change
DOI 10.1007/s11027-014-9549-4

ORIGINAL ARTICLE

Multi-model comparison of the economic and energy implications for China and India in an international climate regime

Daniel J. A. Johansson • Paul L. Lucas • Matthias Weitzel • Erik O. Ahlgren • A. B Bazaz • Wenying Chen • Michel G. J. den Elzen • Joydeep Ghosh • Maria Grahn • Qiao-Mei Liang • Sonja Peterson • Basanta K. Pradhan • Bas J. van Ruijven • P. R. Shukla • Detlef P. van Vuuren • Yi-Ming Wei

Idé

… kan det svenska energisystemet och svenska styrmedel anpassas för att inte bara bidra till att uppnå ett nationellt mål (t.ex. reduktion av växthusgasemissioner i Sverige),

utan också (samtidigt), genom att stimulera en hemmamarknad för tekniker för vilka det kan finnas en jättemarknad i utvecklingsländer,

till priset av en viss kortsiktig kostnadsökning för att uppnå ett visst bestämt nationellt miljömål,

bidra till en långt större vinst genom export av grön teknik (vilken dessutom kan bidra till att uppnå miljöförbättringar i det utvecklingsland där tekniken implementeras, vilka ofta är av en större omfattning än de inhemska).

double (eller kanske *triple*) *dividend-tänkande*

Syfte

Kan hemmamarknaderna för energiteknik modifieras (*genom anpassningar av energi-, miljö- och klimatstyrmedel/riktade insatser*) för att skapa förbättrade förutsättningar för grön export (*energiteknik som efterfrågas specifikt i utvecklingsländer*) ?

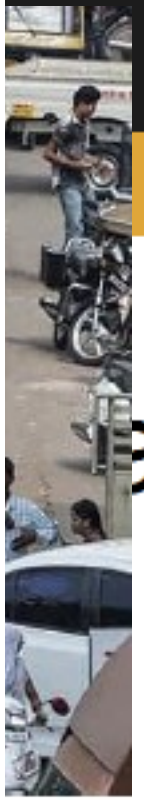
Vi ser på **biogasteknik**, utvecklingsländerna representeras av **Indien**.

Indien: sustainable & **inclusive** growth

Systemet

Starkt svensk intresse, myndighets- och näringslivsintresse, för teknikexport:

- **INNOVATIONS' ACCELERATOR INDIA – SWEDEN**



aj for

as

Scan

India and Sweden to work together on…

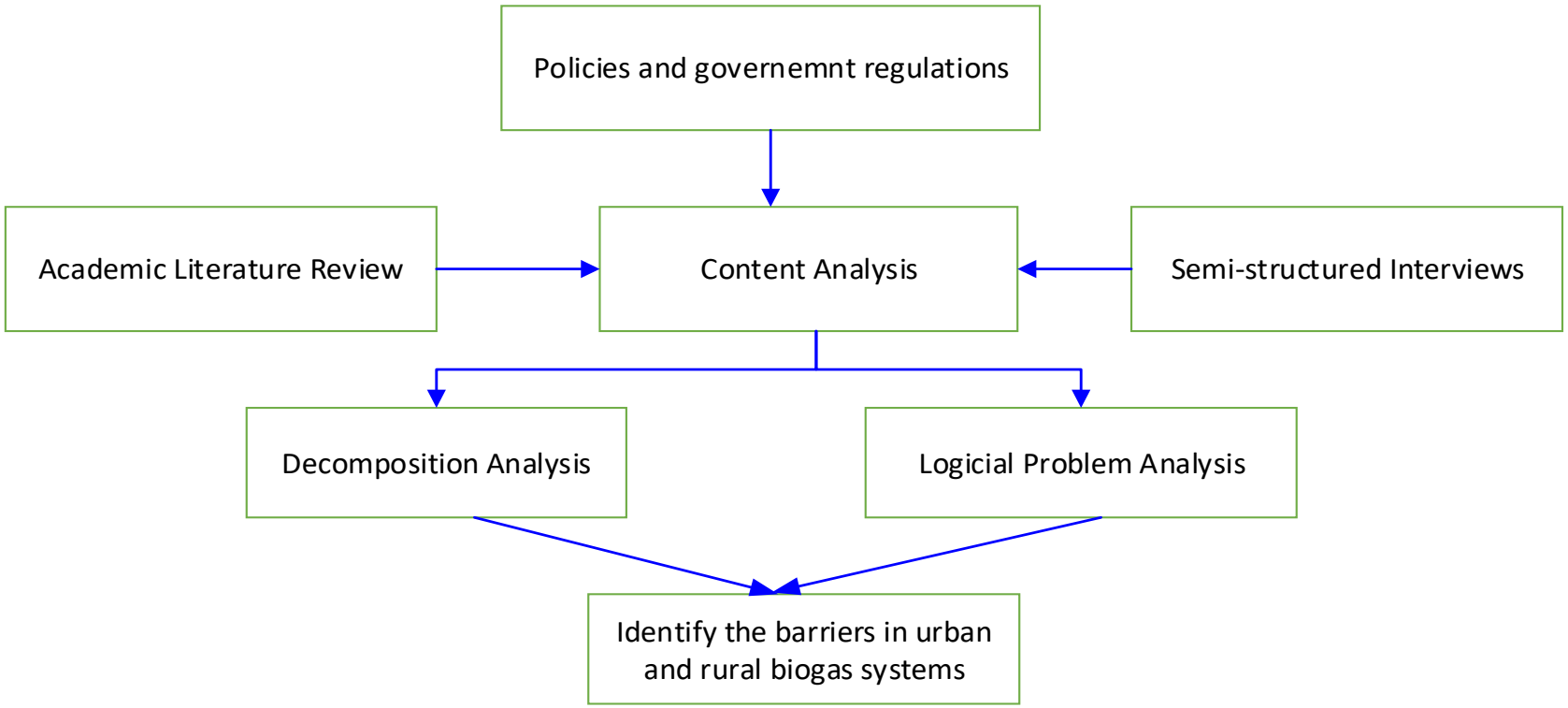
Metoder

- Kvantitativt
  - Modellering/Optimering
  - Potentialanalys
  - ……
- Kvalitativt
  - Barriärer
- **Indien** & Sverige

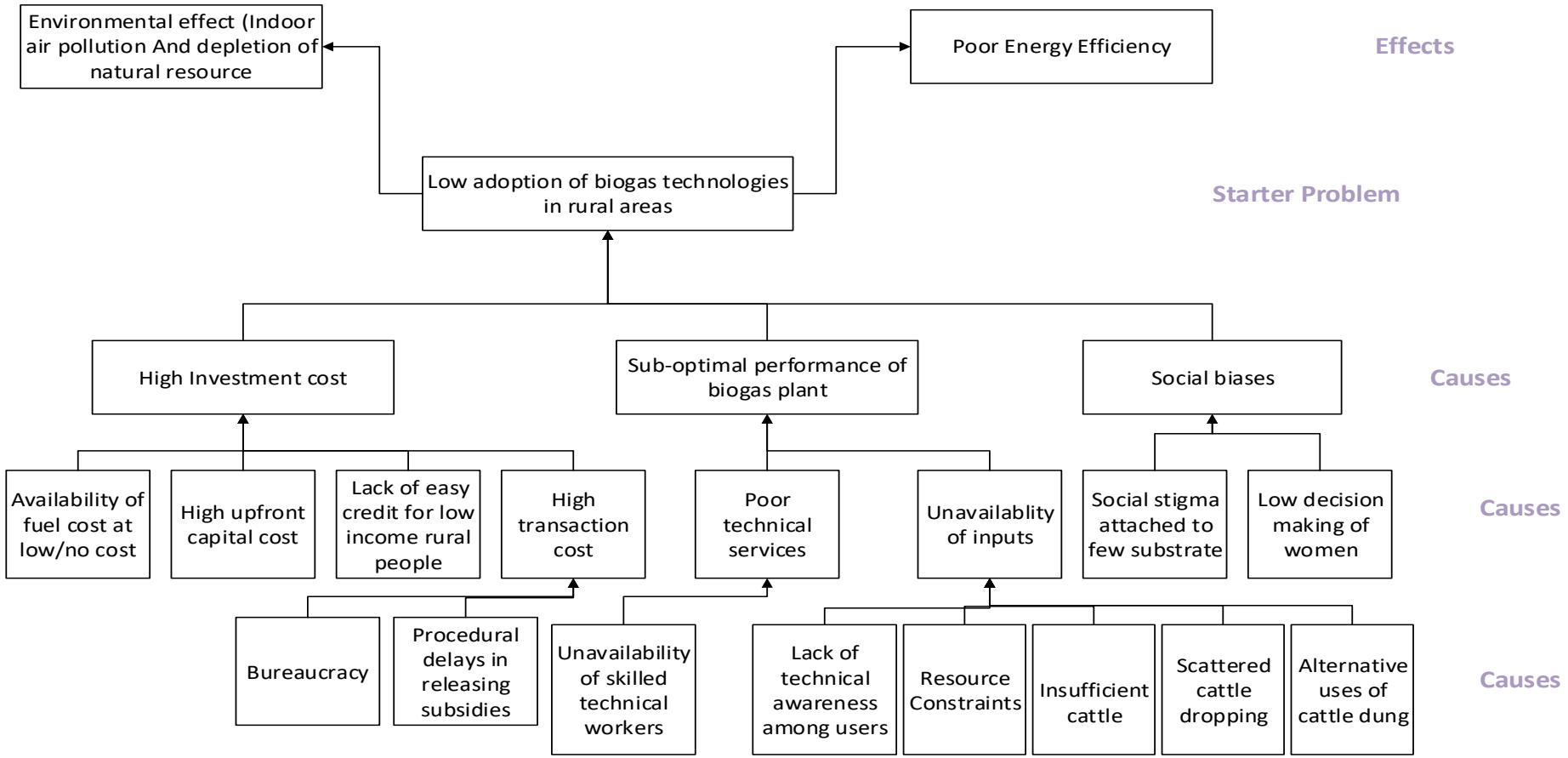
Biogas scales

- Small scale (Rural) —Domestic/family size/household biogas plants
  - Capacity range of 1–10 cubic meter biogas per day.
- Medium scale biogas plants
  - Capacity range of 100–1,000 cubic meter biogas per day
  - Cooperative biogas plants
    - Feed stocks from small dairies, vegetable and fruit markets, poultry farms, hostels, restaurants, etc.
  - Community biogas plants:
    - residents of a particular housing community and fed in a centralized digester for the biogas production
  - Institutional biogas plants:
    - People contributing the waste belong to an institution such as hospitals, hostels/mess
- Industrial scale biogas plants (Urban)
  - Capacity range is above 5000 cubic meter biogas per day

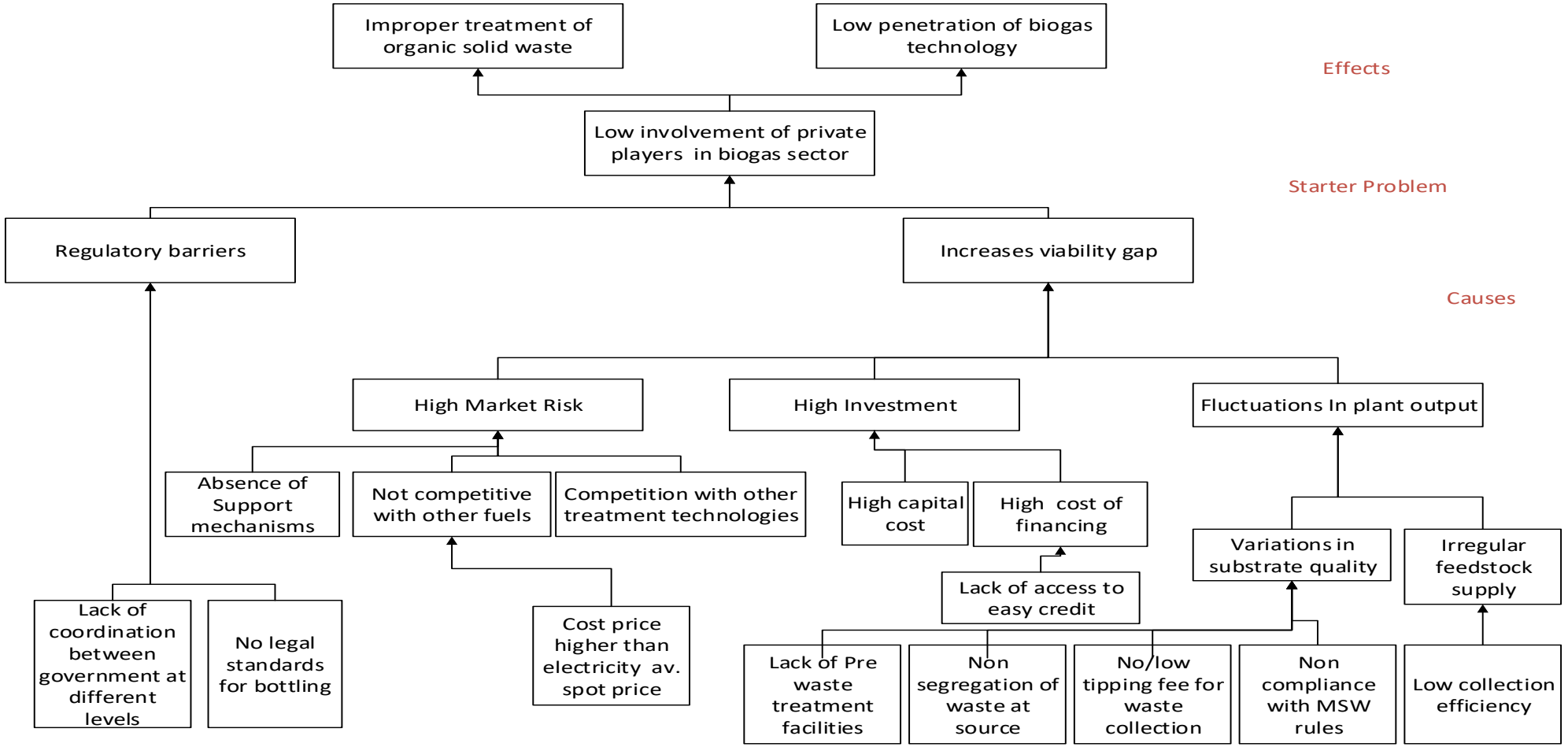
Approach


Policies and governemnt regulations
Academic Literature Review
Content Analysis
Semi-structured Interviews
Decomposition Analysis
Logicial Problem Analysis
Identify the barriers in urban and rural biogas systems

Barriers in rural areas



Barriers in urban areas



Barrier Comparison

Category	Barriers	Rural	Urban
Financial & Economical Barrier	High initial investment	✓	✓
	High transaction cost	✓	✓
	Lack of financing mechanism		✓
Market Barriers	Competition from other fuels	✓	✓
	Competition from alternative technologies/ uses	✓	✓
Social and cultural barrier	Social biases	✓	
	Gender participation	✓	
Regulatory and institutional barrier	Top down policy approach	✓	
	Limited urban municipal capabilities		✓
	Lack of coordination between different stakeholders	✓	✓
	Low private player involvement		✓
Technical & Infrastructural barriers	Lack of technical services	✓	
	Lack of waste treatment and storage facilities		✓
	Feedstock of poor quality		✓
	Unavailability of sufficient feedstock	✓	
Information	Lack of awareness about the policies, technology and its benefits	✓	

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Barriers to biogas dissemination in India: A review

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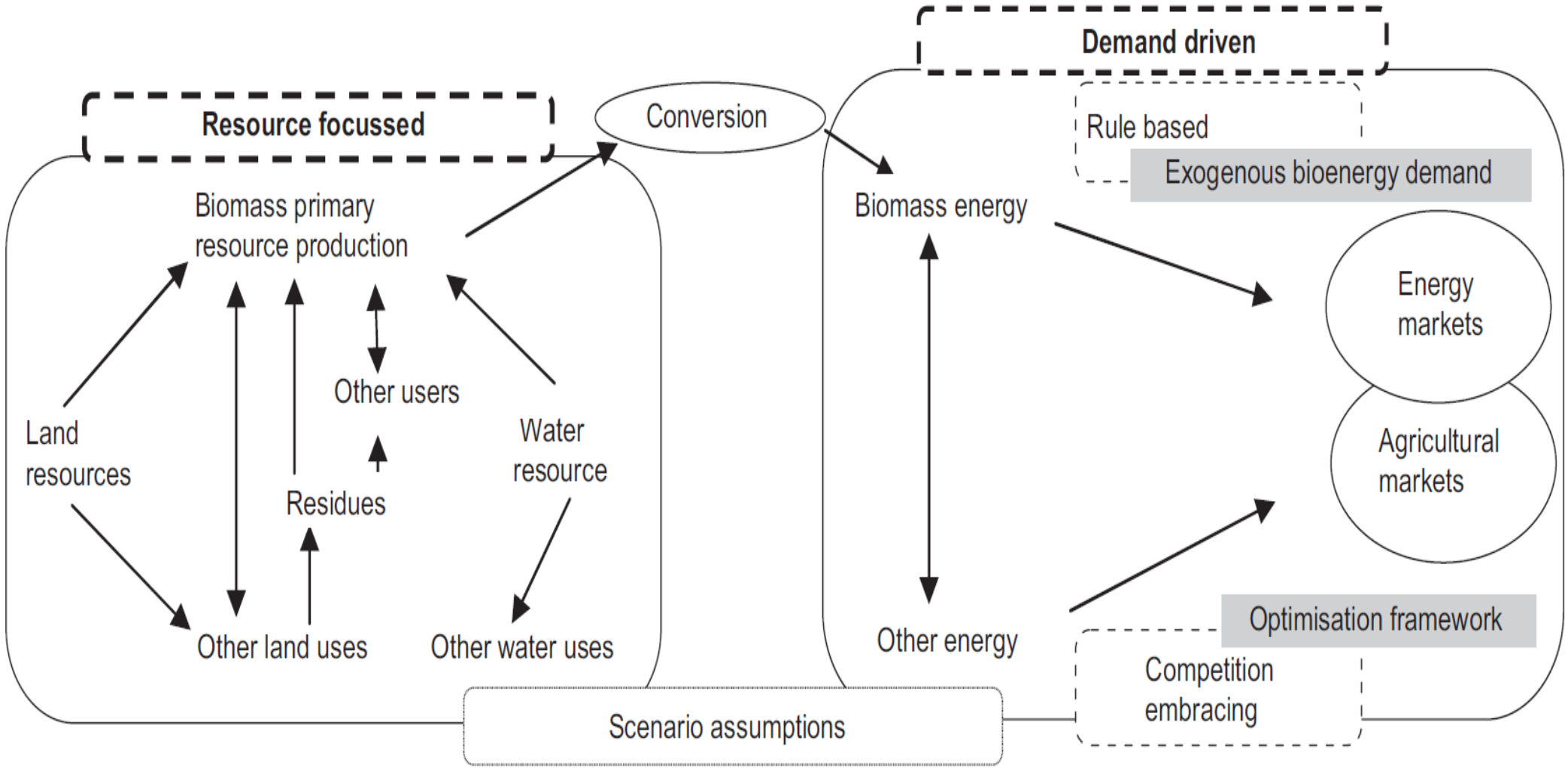

Demand driven
Resource focussed
Conversion
Rule based
Exogenous bioenergy demand
Biomass primary resource production
Biomass energy
Energy markets
Agricultural markets
Other users
Land resources
Water resource
Residues
Other land uses
Other water uses
Other energy
Optimisation framework
Competition embracing
Scenario assumptions

Slutsatser

- Ja, det går …

Methodology

Crop residues

$$CP_{i,t} = A_{i,t} * Y_{i,t}$$

$$GRA_{j,i,t} = CP_{i,t} * CPR_{i,j}$$

$$SRA_{j,i,t_{high}} = GRA_{j,i,t} * CE_t * (1 - DFR_i)$$

$$BP_{j,t} = \sum_j \sum_i SRA_{j,i,t} * DM_{i,j} * BY_{j,i}$$

Animal Dung

$$ADP_{i,t} = APOP_{i,t} * AD_i * 365$$

$$ABP_t = \sum_i ADP_{i,t} * AF_{i,t} * DM_i * BY_i$$

Municipal Solid wastes

$$GR_t = \frac{GR^*}{(1 + \exp(\alpha + \beta * GDPPC_t))}$$

$$OFMW_t = OF_t * GR_t * UPOP_t * 365$$

$$BP_t = OFMSW_t * DM * BY * CF_t$$

Sewage wastewater

$$WUc = 1.2521 * GDPPC^{0.4727}$$

$$SMWS_t = WUc_t * UPOP_t * CR$$

$$BP_t = SMWS_t * COD * RE * BY * TC_t$$

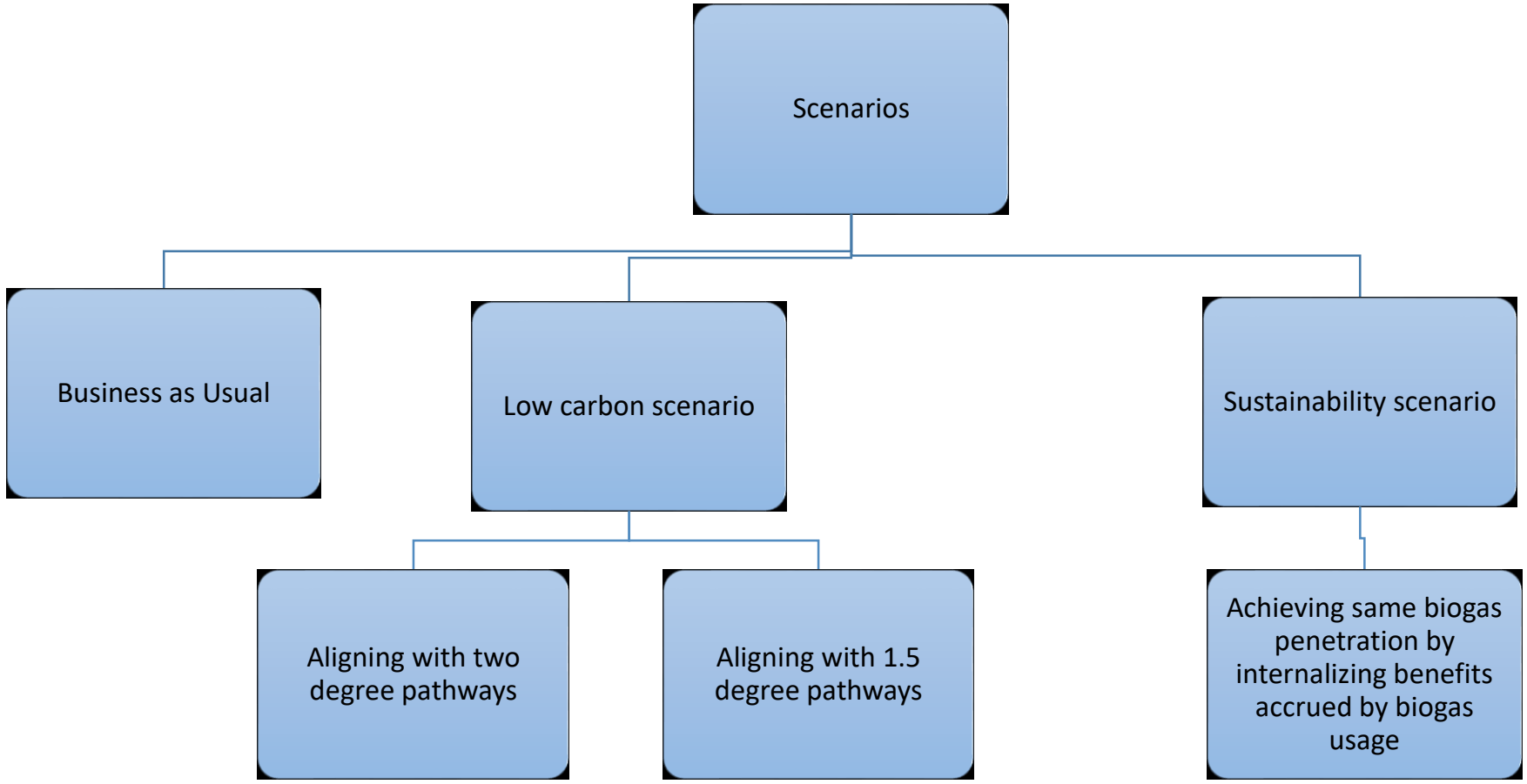
Energy Potential

Source	2015	2040
Crop residue	2.34	3.44
Animal Wastes	3182	7813
MSW	99	189.8
Sewage waste	21.9	65.7
Industrial effluents	43.8	95.63
Total (PJ)	3349	8167

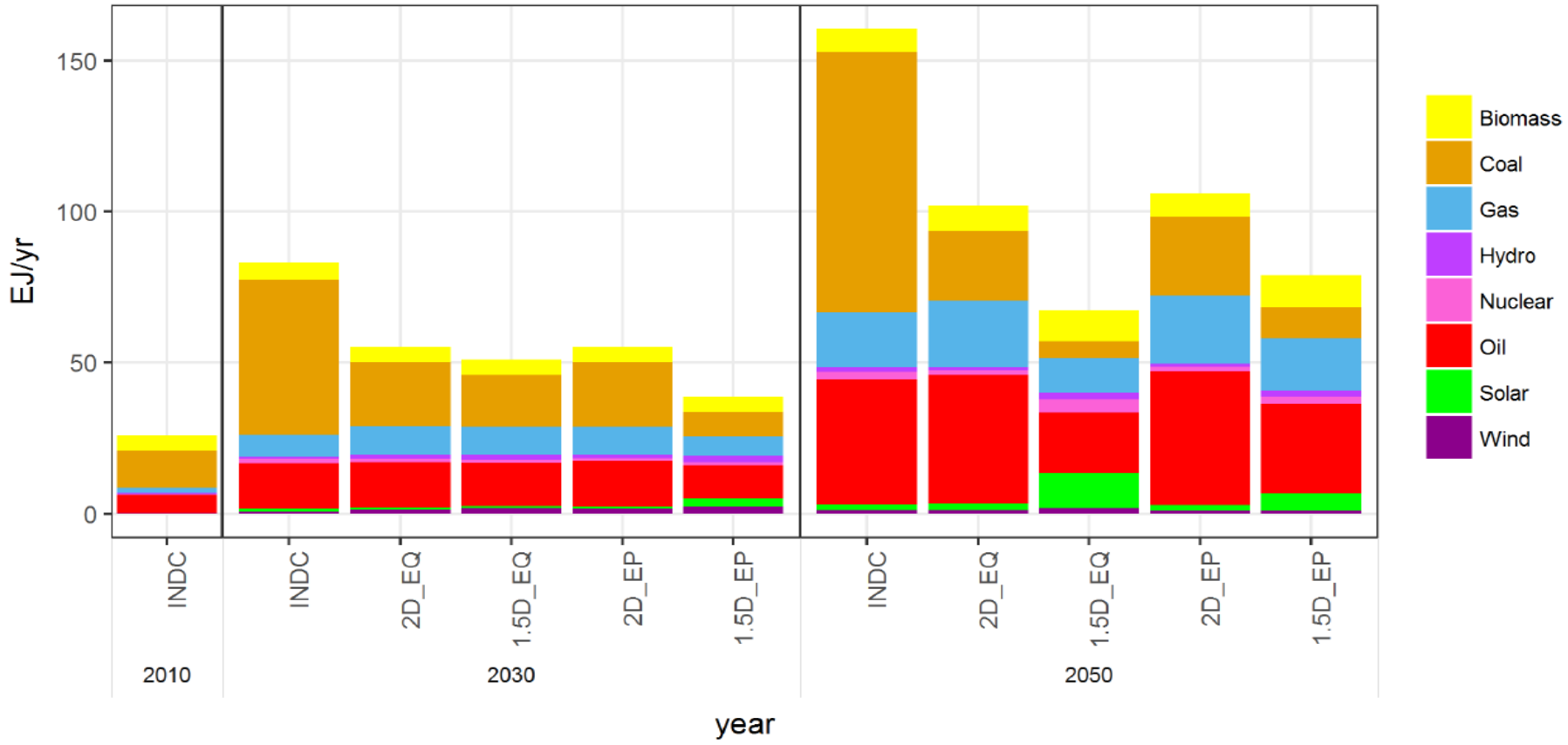
Research Objectives

- To identify the least cost pathways to increase the share of biogas in primary energy mix.
- To understand the competitive dynamics between biogas and other renewable energy technologies in power, transport and residential sector in low carbon and sustainable scenarios.
- To assess the implication of biogas penetration on system cost in low carbon and sustainable scenarios where the social benefits that can be accrued are internalized into the system.

Scenario Framework



Primary energy Mix



Long-term economic implications of 1.5°C scenario: A case study of India (Under review)

Benefits

Category	Benefits	Indicator	Reference
Immediate Benefits	Avoided GHG emission, nitrous oxide emission from chemical fertilizers.	Savings in terms of carbon tax,	[2]
	Health benefits	Reduction in household Health expenditure and household air pollution	[3, 4]
	Reduction in local air pollution		
	Greater energy security	Reduction in imported fuel quantity	[5, 6]
	Co–products like fertilizers	Difference between the monetary value of biogas slurry as farming fertilizer and replaced chemical fertilizers	[7]
	Land requirement	Difference between land required for landfills	
	Better Waste management		
Long term development benefits	Employment in rural sector	Strengthen the rural economy by creating new employment possibilities	
	Saved fuel collection time	Opportunity cost of time of women involved in fuel collection activity	
	Help to achieve SDGs	Promote gender equality and empower women, improving environmental sustainability (reducing demand of firewood) and eradicate poverty and hunger (creating jobs), Promote gender equality and empower women	[7]