## One Step Ahead, Two Steps Backwards: Energy Transitions and Coal in Developing Countries

#### Rafia Zaman<sup>1, 2</sup>, Christian Hofer<sup>1</sup>, Thomas Brudermann<sup>1\*</sup>

(1) University of Graz, Austria(2) Khulna University, Bangladesh







### Low-carbon Energy Transition: A Global Agenda

- Climate change mitigation targets require systemic reconfiguration and socio-technical transitions
  - Renewable share in global electricity mix 25% by 2040
  - Powering Past Coal Alliance
- Collective action is required
  - Members of coal phase-out agreement account for only 3% of global coal consumption



## Systemic Coal Lock-in

Coal as 'Fuel-of-Choice' in the Global South (BP, 2018)

- 30% in 2040'es global electricity mix
- Slight (relative) decline from 2017 level (38%)

#### **Electricity Access Outlook (IEA, 2017)**

Middle East (93%)	Developing Asia (89%)	Sub-Saharan Africa (43%)		
	Target: 99%	Target: 59%		
	Increasing electricity coverage by 2030 through coal power			

## **Research objectives**

- Who is financing the coal extension?
- Interrelations between "phase-out" and "phase-in" of coal?
  - (beyond the scope of this presentation)
- International money flows for coal projects between donor and recipient countries
  - Bipartite network analysis based on secondary database
  - Unit of Analysis: recipient countries in Asia and Africa (and Middle-East)

## **Data Source**

- NRDC (Natural Resources Defense Council) Consolidated Coal and Renewable Energy Database of 2017
  - Comprehensive data on international investments for coal power plant projects by G20 public financing institutions announced between January 2013 and August 2017
  - Data collected from various sources (official sources, newspaper reports, sometimes estimates)
- Limitations
  - Exhaustive list, but incomplete data
  - Non-disclosed investment data for several projects (especially in early planning stages)

## Method

- (Bipartite) Network analysis (Borgatti & Halgain, 2014; Latapy et al., 2008)
- Graphical visualization: Bipartite Network of investment flows

**Degree of Centrality**: indicates which donor countries  $(V_1)$  have a central role in the network in terms of investment flow in the receiving countries  $(V_2)$ 

**Clustering Coefficient:** local density measure, cc.(u,v) captures the correlation (0 to 1) between two nodes; it indicates the extent to which a donor country (*u*) invests into a country (*v*), which is also receiving funds from the donor's neighbor country (*N*).

)

$$d_i^* = \frac{d_i}{n_2}; i \in V_1 \quad \text{Equation (1)} \quad cc.(u) = \frac{\sum_{v \in N(N(u))} cc.(u,v)}{|N(N(u))|} \quad \text{Equation (3)}$$

$$d_j^* = \frac{d_j}{n_1}; j \in V_2 \quad \text{Equation (2)} \quad cc.(u,v) = \frac{|N(u) \cap N(v)|}{|N(u) \cup N(v)|} \quad \text{Equation (4)}$$

# Results

## Top Donors and Recipients (Asian projects)

Top 3 Donors (93% of total investment outflows)	<b>Top 3 Recipients</b> (83% of total investment inflows)
China	Indonesia
(45%; ~20 billion US\$)	(40%; ~18 billion US\$)
Japan	Bangladesh
(38%; ~17 billion US\$)	(22%; ~10 billion US\$)
South Korea	Vietnam
(10%; ~5 billion US\$)	(21%; ~10 billion US\$)

## The 'full' picture

Top 3 Donors (93% of total investment outflows)	Top 3 Recipients (83% of total investment inflows)
China	Indonesia
(45%; ~20 billion US\$)	(40%; ~18 billion US\$)
Japan	Bangladesh
(38%; ~17 billion US\$)	(22%; ~10 billion US\$)
South Korea	Vietnam
(10%; ~5 billion US\$)	(21%; ~10 billion US\$)



## **Asian Recipients**

#### Investments in Billion-\$ (Number of projects)



## Network Analysis: Coal in Asia

High investment diversity (low CC)

	Investments		Network			
Donors	Project volume (mio. US\$)	No. of projects	No. of receiving countries	Degree Centrality	Clustering Coefficient	
China	20,217.3	55	11	0.733	0.202	
Japan	16,895.8	43	7	0.467	0.295	
South Korea	4,670.3	21	5	0.333	0.321	
India	1,600.0	2	2	0.133	0.450	
ADB	1,050.5	2	2	0.133	0.278	
Germany	335.7	7	4	0.267	0.205	
World Bank	147.0	1	1	0.067	0.000	
Russia	20.0	2	2	0.133	0.341	
Low investment diversity (high CC)						

R. Zaman, C. Hofer, T. Brudermann

## Top Donors and Recipients (Africa)

Top 3 Donors (94% of total investment outflows)	Top 3 Recipients (73% of total investment inflows)
China	Zimbabwe
(68%; ~7 billion US\$)	(35%; ~3.4 billion US\$)
Japan	Morroco
(18%; ~2 billion US\$)	(21%; ~2.1 billion US\$)
South Korea	South Africa
(8%; ~1 billion US\$)	(16%; ~1.5 billion US\$)

Top 3 Donors	Top 3 Recipients
(94% of total	(73% of total
investment outflows)	investment inflows)
China	Zimbabwe
(68%; ~7 billion US\$)	(35%; ~3.4 billion US\$)
Japan	Morroco
	territe and the second
(18%; ~2 billion US\$)	(21%; ~2.1 billion US\$)
(18%; ~2 billion US\$) South Korea	(21%; ~2.1 billion US\$) South Africa

#### World Bank Senegal The 'full' picture Germany Israel South Africa South Africa Tanzania China Zimbabwe India Mozambique Japan ADB

South Korea

Botswana

MENA

countries

Zambia

Nigeria

United Arab Emirates

Malaw

Ghana

Morocco

Egypt

Kenya

# African (and Middle-East) Recipients



Investments in Billion-\$ (Number of projects)

## Network Analysis: Coal in Africa

		Central PlayersDiverse InvestmPortfolio (Lower				<u>estment</u> ower CC)
		Investments		Network		Ť
Donors	Project volume (mio. US\$)	No. of projects	No. of receiving countries	Degree Centrality	Clustering Coefficient	
China	6,602.8	27	11	0.688	0.129	
Japan	1,790.3	7	3	0.188	0.333	
South Korea	754.0	4	3	0.188	0.292	
South Africa	150.0	2	1	0.063	0.091	
Germany	141.5	2	2	0.125	0.083	
India	112.0	4	2	0.125	0.255	
AfDB	100.0	2	2	0.125	0.222	
World Bank	40.8	2	2	0.125	0.000	

#### Similar Investment Portfolio (Higher CC)

#### China, EU Reaffirm Strong Commitment to Paris Agreement



UN Climate Change News, 17 July 2018 – China and the European Union reaffirmed their commitment to the Paris Agreement in a joint statement on Monday after the 20th EU-China Summit held in Beijing.

WORLD NEWS

NOVEMBER 8, 2016 / 2:10 PM / 2 YEARS AGO

# 📙 The Korea Herald

### S. Korea confirms commitment to Paris UN climate meeting

By Yonhap

# Japan ratifies Paris Agreement after the pact enters into force

## **Key Findings**

- China, Japan, and South Korea are dominant investors and technology transferees in the upcoming coal power plants of Asia and Africa
  - As by investment volume and network analysis
- Emerging Asian economies (Indonesia, Vietnam, Bangladesh) as key targets

• Hardly any investment (divestment) from the developed western world (including USA, Russia, EU, multilateral donor banks).

## Discussion: Investment Rationale

- Currently low CO<sub>2</sub> emitting status of recipient countries, e.g. Bangladesh (0.2%), Indonesia (1.5%), Vietnam (0.6%), African countries (3.6%)
- HELE Investment as Paris Climate Change Mitigation strategy
  - 'High Efficiency Low Emission' technologies (USC, A-USC, CCS) with capacity of at least 20% carbon emission reduction.

- 'Development aid'?
  - Value creation or hyprcrisy?

## An unsustainable transition?



## Conclusions: A dilemma yet to be solved

- Energy service security at the expense of negative environmental externalities
- Energy justice vs. Climate justice:
  - Proponent view: Advanced coal technology as a ,solver' in the climate agreement
  - Opponent view: carbon-constrained development pathways for developing countries

# Thank you!

UNIVERSITY OF GRAZ INSTITUTE OF SYSTEMS SCIENCES, INNOVATION AND SUSTAINABILITY RESEARCH



Dr. Thomas Brudermann Assistant Professor

Merangasse 18/1, 8010 Graz, Austria phone +43 (0)316/ 380-7336 e-mail Thomas.Brudermann@uni-graz.at homepage.uni-graz.at/thomas.brudermann/