Energy Security and Energy Justice in Transnational Grids

Sharlissa Moore, Assistant Professor
James Madison College/ Civil & Environmental Engineering

MICHIGAN STATE UNIVERSITY

CIVIL & ENVIRONMENTAL ENGINEERING

Introduction

Despite policy discourses about achieving energy independence, there are numerous examples of increasing cross-border transmission lines and regional integration worldwide. For example, the Southern African Power Pool connects 12 countries in sub-Saharan Africa, the Gulf Cooperation Council Interconnection Authority connects six countries in the Middle East, Nordpool connects Nordic countries and the Baltic states, and the ASEAN Power Grid seeks to interconnect nine countries in Southeast Asia. Moreover, ambitious visions for interconnected grids, such as Desertec, the Asian Supergrid, and the Global Energy Interconnection Development and Cooperation Organization (GEIDCO) imagine deeply interconnected grids to provide for a scale-up renewable electricity. Some of these projects are envisioned to cross countries with large power and wealth disparities, demanding analysis by social scientists to better understand the impacts.

This research asks:

- What can be learned from cross-comparative research on grid interconnection?
- What are the benefits and drawbacks of increasing grid integration on energy security and energy justice?

A database of 34 existing and planned grid integration projects, encompassing hundreds of cross-border lines worldwide has been developed using extensive literature review and document analysis, with a goal of including all projects and visions.

Evaluation is in progress of the energy security issues and energy justice issues stemming from transnational or international grid projects.

Literature Overview

Much of the existing literature on grid integration focuses on techno-economic benefits or on single case studies, with an emphasis on Europe.

Topic	What the literature provides
Existing grid integration	• Electricity is not as freely traded as primary energy sources are (Oseni & Pollitt, 2016). • Electricity exports worldwide only account for 3% of generation (ibid).
Technological benefits to regional integration	• To address increase renewable energy adoption through international trade, avoiding curtailment and load shedding (Cottier & Espa, 2017) • To improve diversification of supply (Karova, 2011) • To export excess power (Oseni & Pollitt, 2016)
Market benefits to integration	• Benefits reflect the proffered benefits of deregulation (Hoven & Froschauer, 2004) • To lower electricity prices through competition and efficiency (Oseni & Pollitt, 2016) • To improve consumer choice of supply (Brunekfreeft et al. 2005)
Geopolitical concerns	• Geopolitical risk is lowered since electricity cannot be stockpiled (Lilliestam, 2014) • Economic benefits are necessary but not sufficient. Domestic interests could limit trade (Robinson, 2017) • Cybersecurity could be a concern (Zeniewski et al., 2013)
Literature Gaps	• Little cross-comparative work has been done across multiple case studies • Most literature makes a techno-economic case for integration and does not consider the impacts on energy justice and energy security • The environmental impacts of grid integration have been insufficiently explored

Overview of Database by Region

Africa

- 5 Regional Power Pools
- All continental African countries involved
- Southern African Power Pool most advanced
- Central African Power Pool is the smallest in terms of capacity & interchange
- Morocco is connected to Spain
- Strong focus on hydroelectricity scale-up, except in North Africa

African Power Pools
Source: Pollet et al., 2015

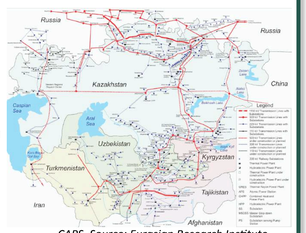
North and South Asia

- 8 projects
- 2 planned power pools (ASEAN & SAARC)
- China connected bilaterally with six countries; India with three
- Iran exports oil-fired electricity to 7 countries
- Vision for an Asia Supergrid with massive export of wind and solar envisioned from the Gobi Desert
- Strong focus on hydroelectricity (e.g., Mekong River Dams)

Asia Supergrid Vision
Source: Japan Renewable Energy Foundation

Central Asia

- Central Asia Unified Power System (CAPS) built in the Soviet Era; only power pool worldwide that is breaking up
- 2 visions for Central Asia to provide increased access in Afghanistan & Pakistan (TUTAP project & CASA-1000)
- Strong focus on hydroelectricity



CAPS. Source: Eurasian Research Institute

Middle East

- Gulf Cooperation Council Interconnection Authority interconnected for reliability but considering deeper interconnection
- $1.6 billion HVDC link planned between Egypt and Saudi Arabia

هيئة الربط الكهربائي
لدول مجلس التعاون لدول الخليج العربية
Gulf Cooperation Council Interconnection Authority

Europe

- ENTSO-E 10-year network development plan for an integrated European market
- Nordpool: Most developed power pool in the world
- North Sea Transnational Grid vision would integrate 30-60 GW of offshore wind
- Energy Community of South East Europe lightly interconnected
- Greater focus on renewables compared to other regions

European Network of Transmission System Operators for Electricity Logo

North America

- First cross-border transmission line in the world, Niagara Falls, 1901
- Canada-US: 30 interconnections, focused on hydroelectricity export
- U.S.-Mexico: only 9 lines, 944 MW capacity
- Wind farm in Mexico began exporting to California in 2015

U.S.-Canada Grid Interconnection map
Source: U.S. Energy Information Administration

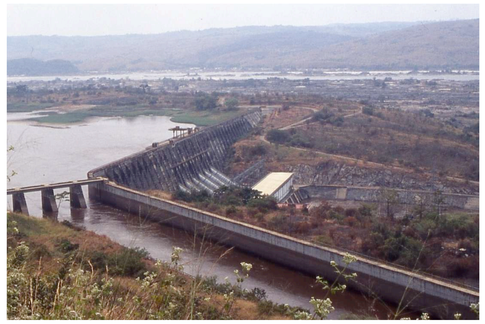
South America

- Central American Electrical Interconnection System (SIEPAC) is the most advanced
  - Obama-era State Department Project "Connecting the Americas 2022" supported SIEPAC
- Guatemala-Mexico linked completed in 2009
- Integration in MERCOSUR is largely limited to large cross-border dams
- Decision to integrate the Andean Community was made in 2002, but limited progress has been made
- Feasibility studies conducted for Caribbean island integration
- Strong focus on hydroelectricity

SIEPAC grid map. Source: SIEPAC

General Initial Findings

- **Integration is limited in capacity but extensive in reach:** Nearly all countries worldwide are involved in transnational electricity integration projects
- **Hydropower expansion dominates:** The vast majority of these projects focus on the expansion of hydroelectric power, not on solar or wind
- **Electricity integration is growing worldwide**, with the exception of the Central Asian Power System, which is disconnecting
- **Regional economic communities** facilitate electricity integration worldwide
- **Domestic integration also growing** in many countries
  - Examples include China, the U.S., Afghanistan, Kazakhstan



Inga I Dam in DRC. Grid integration could increase investment in large-scale dam dams by creating new markets. (Creative Commons)

Energy Justice Initial Findings

Capabilities Justice

- Project rhetoric often focuses on increasing electrification but in reality integration allows for export of surplus electricity instead of increasing access.
  - China's GEIDCO vision is an outlier, as is the TUTAP project to increase access in Afghanistan & Pakistan

Distributive justice

- Most power pools are currently focused on increasing the construction of hydroelectric dams, which result in the displacement of populations, significant food-energy-water nexus implications, and lack of supply diversity e.g., Mekong River Dams & ASEAN
- Countries that or poor and/or lack access are focused on export e.g., DRC, Lao PDR, Ethiopia, Paraguay
- Some cross-border project focus on power capacity for resource extraction rather than access e.g., Grand Inga dam vision (DRC)

Procedural justice

- Decisions are currently made through existing regional trade associations, such as MERCOSUR, COMESA etc.
- Vision for a global grid requires massive collection and coordination of big data, as well as standards. Who gets to participate?

Energy Security Initial Findings

- ***Independence vs. interdependence***: Energy security has been framed as independence in some regions (e.g., Central Asian countries) but defined more broadly in other regions (e.g., African power pools)
  - Security benefits can be achieved with respect to reliability and, in some cases, sustainable development
- ***Financial security***: Significant non-payment is seen in some cases, e.g.,
  - Iraq owes Iran $800 million
  - Zimbabwe owes S. Africa & Mozambique $43 million
- ***Energy weapon***: Mutual interdependence provides security benefits but can only be achieved at high levels of integration
  - Lopsided dependencies could turn electricity into a weapon
  - However, there are surprisingly few examples of this
- ***Cybersecurity***: Large projects such as GEIDCO depend on big data and pose cybersecurity questions that have largely gone unexplored
- ***Institutional arrangements***: How much future control would regional transmission systems operators or regional regulators have?

Vision for a Global Grid

Source: GEIDCO

Global Energy Interconnection Development and Cooperation Organization (GEIDCO)

Status:
Vision

Implementing Organization:
State Grid Corporation of China

国家电网公司 STATE GRID CORPORATION OF CHINA

Brief History:

- First proposed by Buckminster Fuller in the 1960s
- Reflects principles of the "Desertec" vision promoted since early 1900s
- Proposed at the UN Sustainable Development Summit in 2015 by Chinese President Xi Jinping
- Reached 265 member organizations worldwide in 2017

Targets:

- Build clean energy bases in the Arctic and Equator
- **2030:** Integrate Africa-Europe, Asia-Europe, and Asia-Africa
- **2040:** Integrate North America- South America, Oceania-Asia, and Asia-North America
- **2050:** Europe-North America integration, with a "backbone grid and intercontinental interconnection channel between various clean energy bases

Summary of vision:

- *"Two replacements"*
  - Replace fossil fuel generation with renewables
  - Replace internal combustion engine with electric vehicles
- *"One increase"*
  - Achieve total global access to electricity
- *"One restore"*
  - Restore the use of fossil fuels as a basic industrial material only

GEIDCO envisions Interconnected continents by 2050
Source: GEIDCO

Next Steps

- Finish additional database entries
- Conduct interviews to aid in verifying the database information
- Expand cross-comparative work

References

Many thanks to Courtney Bourgoin and Emily Fluent for their help with this project.

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