

Political coordination of multi-participants in solar photovoltaic's policymaking process in China

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1. Overview

With energy shortages of fossil fuel consumption being exacerbated, an improved energy system from fossil fuels to renewable energy is critical to achieving net-zero emissions. While solar photovoltaic (PV) has become the cheapest way to generate large-scale electricity [1], how to optimise solar PV remains a critical issue for countries, especially developing countries, to make support policies.

Primary research on solar PV emphasised economic profits, focusing on business models, solar PV firms' performance and market development (e.g., massive production, global trade). [2]–[5] They usually ignored political interaction among enterprises, governments and society. Moreover, policy studies on solar PV emphasised the effectiveness of support policies (e.g., demand-pull policies, technology policies and subsidy policies) by building quantitative models.[6]–[10] A few discussed solar PV's policymaking process. Limited by interviews and other qualitative methodologies, previous research discussed political challenges [11], ignoring political coordination.

Therefore, the purpose of this paper is to apply quantitative methodologies and systematically investigate the evolution of political coordination of multi-participants and their relationship in China, which has made a significant contribution to renewable energy development with continuous supportive policies.

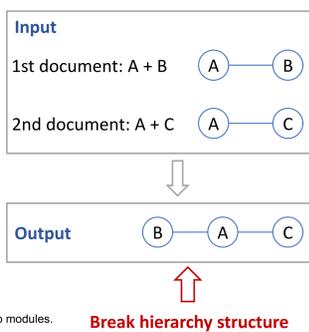
2. Methods

This research combined network analysis (M1) and policy document similarity analysis (M2) by tracing solar PV's policymaking documents in China (issued during 1994–2020). We collected 413 policy documents during the period that mentioned "solar PV" from State Council Policy Document Library and other departmental websites by searching the keywords "renewable energy", "solar energy", "solar PV".

In M1, SPV's policy participant network of China's central government is visualised by nodes (policy actors) and lines defined by political interactions with jointly issued documents. This paper also divided policy participants in solar photovoltaic issues into different based on the modularity calculation of social network analysis.

Methodology 1: Social Network Analysis

Sample Size	N = 413
No. of departments	41 Departments ¹
Sampling Method	Departments issuing relevant documents
No. of stages	4 stages (1994–2009, 2010–2014, 2015–2016, 2017–2020) ²
Type of Network	Undirected network with "+"
Drawing Method	Force-directed graph drawing ³ with NetworkX package on Python, Modularity ⁴ , Force Atlas 2 ⁵



¹ Including NPC, NDRC and other departments and national organizations.
² This division is based on the research of Gao (2020).
³ Force-directed graph drawing algorithms are a class of algorithms for drawing graphs in an aesthetically-pleasing way.
⁴ Modularity is a measure of the structure of networks or graphs which measures the strength of division of a network into modules.
⁵ ForceAtlas2 is a continuous graph layout algorithm for handy network visualization designed for the Gephi Software.

In M2, we analysed and compared policy document similarity of 12 Five-Year Plans (FYPs, from 10th to 13th) in three series, including FYPs for national economic and social development, FYPs for energy development, and FYPs for renewable energy development.

Methodology 2: Policy Document Similarity Analysis

Table 1 Documents' List for Data Analysis

No. of documents	12
Sampling	NFPYs ¹ , EFYPs ² , REFYPs ³
Documents Series	10 th (2000–2005), 11 th (2006–2010), 12 th (2011–2015), 13 th (2016–2020)

Table 2 The List of Department Issued Five-Year Plan

Compared Sections	Compared Editions of the Five-Year Plan			
	10 th (2001–2005)	11 th (2006–2010)	12 th (2011–2015)	13 th (2016–2020)
NFPY ¹	2001.03.15 NPC	2006.03.14 NPC	2011.03.26 NPC	2016.03.16 NPC
EFYP ²	2001.05.26 NDRC	2007.04.11 NDRC	2013.01.01 SC	2016.12.16 NDRC-NEA
REFYP ³	2001.10.10 MOFCOM	2008.03.03 NDRC	2012.07.06 NDRC	2016.12.10 NDRC

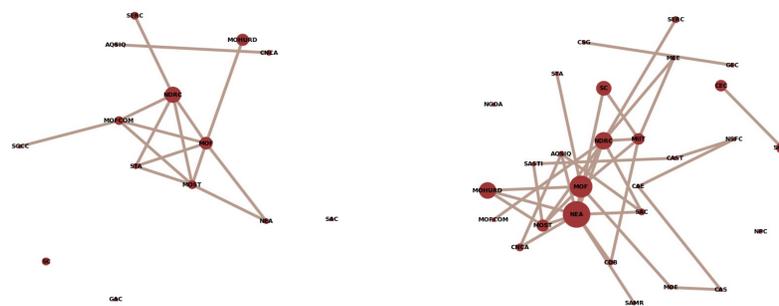
MOFCOM: Ministry of Commerce
 NPC: National People's Congress
 SC: State of Council
 NEA: National Energy Agency
 NDRC: National Development and Reform Commission

¹ NFPY: Five-Year Plan for National Economic and Social Development.
² EFYP: Five-Year Plan for Energy Development.
³ REFYP: Five-Year Plan for Renewable Energy Development.

Before issuing policy documents, Chinese government usually holds seminars/meeting to gather stakeholders together to discuss important issues. **Five-Year Plan is a typical case.**

3. Results

In M1, we found that policy participants tend to make joint documents with ones at the same administrative level. Driven by complex systems, solar PV are jointly shaped by multi-participants, including administrative departments, industrial organisations/state-owned enterprises and research institutes/think tanks.

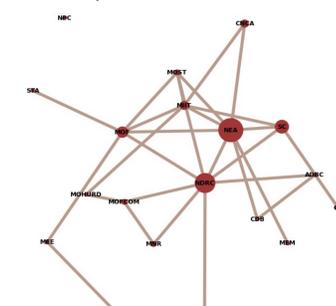


Stage 1 (1994–2009): Sporadic stage

Limited actors participated in. The joint releases are few.

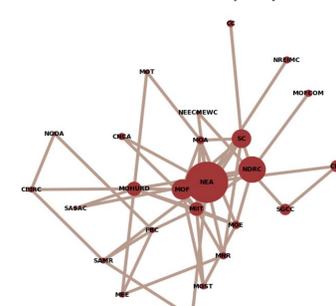
Stage 2 (2010–2014): Bold stage

Different actors tended to release documents jointly.



Stage 3 (2015–2016): Burst Stage

A lot of joint policies released by multi-actors.

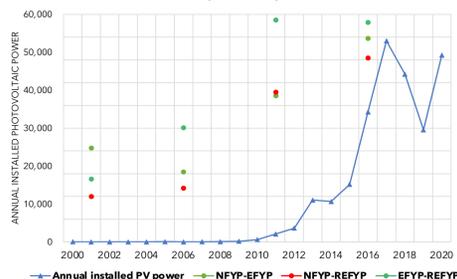


Stage 4 (2017–2020): Reintegration stage

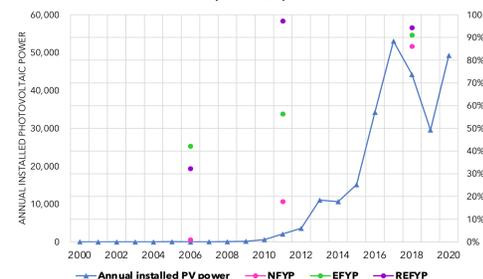
Policy coordination were enhanced more.

In M2, we also found that policy participants tend to follow policy decisions at a higher administrative level or, especially, political coordination of the National People's Congress (NPC), State Council (SC), and NDRC. The more participation of higher administrative departments, the more continuous national goals are made, the more comprehensive policy is.

Policy similarity in different series of Five-Year Plans (10th–13th)



Evolution of policy similarity of Five-Year Plans (10th–13th)



4. Conclusions

This study systematically illustrates the dynamics of political coordination driven by changes in policy participants and their interactions. With the domestic solar PV systems development, political coordination has been developed continuously under a complex energy system. Policymaking changes are jointly shaped by national goals, participation of actors, industry changes. Thus, the government could explore the possibility of trans-departmental political coordination in the policymaking process of the energy transition. Moreover, the national goal is another critical tool for the government to promote political coordination in the face of a complex energy system.

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