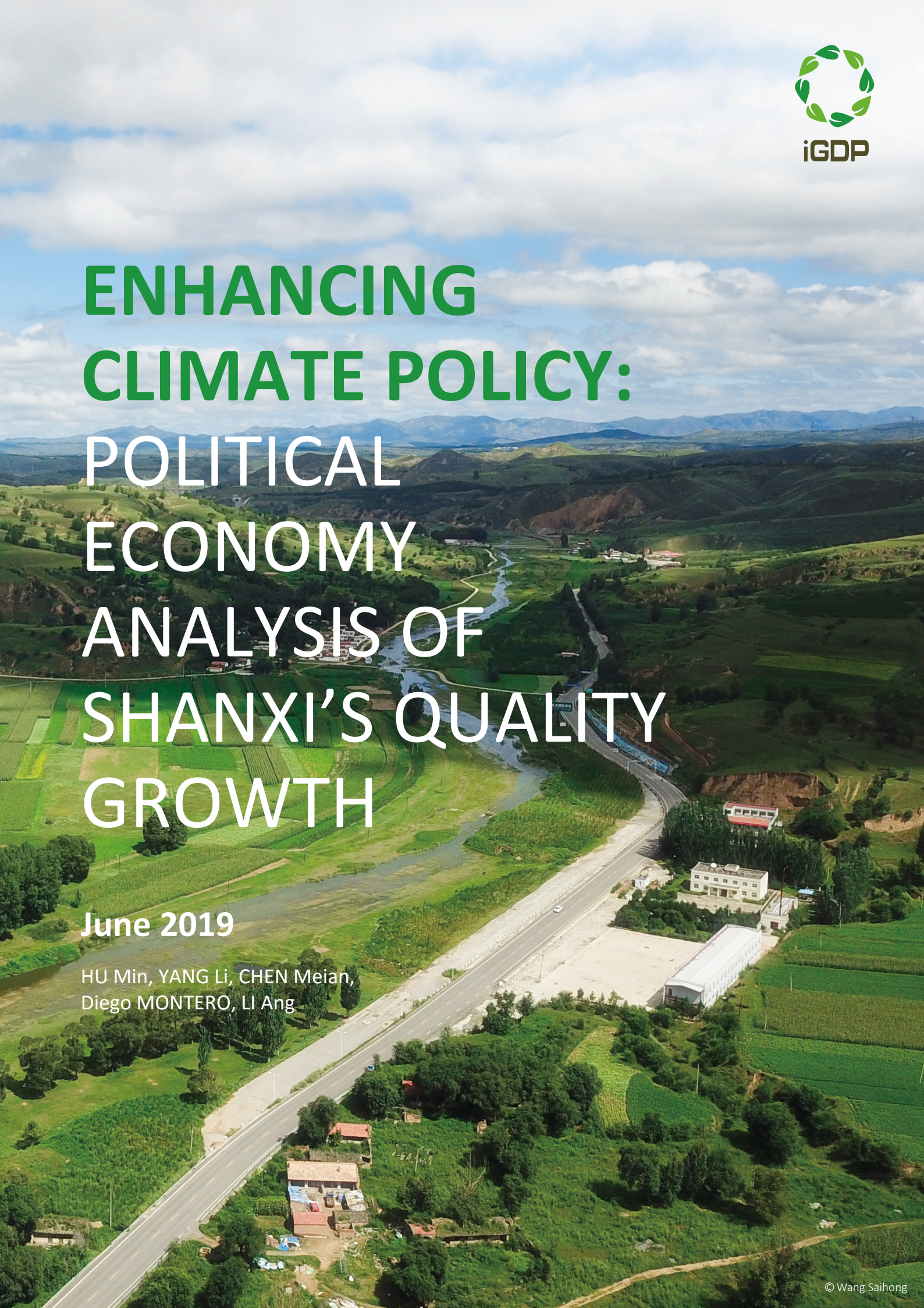

iGDP

ENHANCING CLIMATE POLICY: POLITICAL ECONOMY ANALYSIS OF SHANXI'S QUALITY GROWTH

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ABOUT iGDP

iGDP, innovative Green Development Program, is non-profit policy and strategy consultancy that focuses policy research and implementation on green and low-carbon development. Our goal is to strengthen China's low-carbon environmental policy design and implementation through interdisciplinary, systematic and empirical policy research. We work with all stakeholders to promote a zero-emissions future. The innovative Green Development Program was initiated by Energy Foundation China. It is the secretariat of China's Green and Low-Carbon Development Think Tank Partnership (GDTP), sits on China's Green Finance Association Experts Committee, and is a member of the North-East Asian Subregional Programme for Environmental Cooperation's Low-Carbon City Platform.

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Abbreviations & Acronyms

FYP	Five-year plan
GDP	Gross domestic product
GHGs	Greenhouse gases
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
LCOE	Levelized cost of energy
NDCs	Nationally determined contributions
OECD	Organization for Economic Co-operation and Development
PEA	Political Economy Analysis
SDS	Sustainable Development Scenario
TAPs	Two action plans, which refer to "Shanxi's Action Plan on Striving to Be a Pioneer in the National Energy Revolution", and "Action Plan on Implementation of the State Council's Guidance on Supporting Shanxi Province to Deepen Reform for Facilitating a Resources-based Economic Transition"
tce	Tonnes of coal equivalent

EXECUTIVE SUMMARY

China, the largest greenhouse gases (GHGs) emitter in the world, is shifting its development model to green growth to increase economic efficiency, fight air pollution and improve its overall domestic environmental quality. China is also an important proponent and champion of the *Paris Agreement*.

There are two narratives emerging from the progress that China has been making in its pursuit of green growth. In the first narrative, China has shown leadership in transitioning to a low carbon future. China's CO_2 emissions per unit of GDP have declined fast, around four times the global average, between 2000 and 2017 (Olivier & Peters, 2018). In the second narrative, however, continuous investment in coal fired power plants both domestically and outside its borders undermines China's decarbonization efforts, even as renewables become more competitive in energy markets. China's total CO_2 emissions continue to grow, contributing 46% of global total growth in 2017, a significant leap up from 27% in 2016. China's per capita CO_2 emissions level is already higher than the EU average. In addition, China is now the largest investor of coal-fired power plants in South-east Asia (Zhou, Gilbert, Wang, Cabré, & Gallagher, 2018).

Shanxi Province, the largest coal producing province and so-called "boiler house" of China, provides an extreme illustration of this double narrative. Shanxi's decade long drive to decouple its growth from the coal economy has been constantly torn between the competing policy priorities of delivering economic growth and breaking away from a resource-intensive development model. The region has not been able to unlock itself from a coal-centered economy. Coal-related industries contribute to over 70% of Shanxi's GDP, as well as around 50% of industrial value add in 2017. They also account for over 50% of tax revenue and around 50% of employment (Shanxi Statistics Bureau, 2018).

Encouragingly, Shanxi Province is continuing on the important endeavor to transition toward green and quality growth. In 2017, the State Council approved Shanxi's action plan to become "*A Pilot Region of Energy and Economic Transition Away from a Resources-Oriented Development Pattern*." And in 2019, the Central Comprehensive Deepening Reforms Commission of the Communist Party of China-approved Shanxi's action plan to become a "*Pioneer Region of China's Energy Revolution*". The two action plans (TAPs) outline a series of measures to reduce the province's coal dependence and present a comprehensive set of actions to have Shanxi shift toward a more sustainable development pathway. The successful implementation of the two TAPs would spur Shanxi's decarbonization and contribute to global climate mitigation efforts.

To ensure the success of the TAPs, this study uses a political economy analysis (PEA) lens to zoom into Shanxi's highly coal-dependent social and economic conditions to understand past transition efforts, estimate the TAPs climate impact and identify the policy gaps that need to be overcome to enhance the province's low carbon transition. The findings are the following:

- Shanxi's coal-centered economy causes serious pollution but has not led to expected levels of economic prosperity. Shanxi's economic performance has been falling behind other provinces. Its per capita GDP has not reached the national average since 1980 and even fell to the bottom in 2017, compared to other regions (Shanxi Statistics Bureau, 2018).

- Shanxi's efforts to control pollutant emissions, improve energy efficiency and reduce carbon intensity have fallen short as efforts to promote structural change in the local economy. While overall industrial energy efficiency has been improving, the share of heavy industry in the secondary sector increased from 81.3% in 1985 to 85.6% in 2000, and has remained over 90% since 2005. Shanxi's GDP carbon intensity is the highest of all provinces of China (Shanxi Statistics Bureau, 2019).

- Shanxi's energy-related CO_2 emissions, if all TAPs goals are fulfilled, would likely peak before 2030, with absolute CO_2 emissions from direct emissions growing close to 543 million tons, according to scenario analysis constructed in this study. Great uncertainties remain around the long-term emission trajectory of total CO_2 emissions due to lack of clarity about economic and social development changes going forward. The risk of continued climate impact lies in the fact that most programs and projects listed in the TAPs still focus on extending the coal industry value chain, and expanding the investment into the coal-fired power sector, which is already at over-capacity.

- Enhancing policies to decarbonize the economic structure is necessary in order to break the "trap" of a coal-centered economic pattern and address the risk of total CO_2 emissions rising. There is not enough evidence to show that Shanxi has implemented robust fiscal and tax policies to support the transition. Shanxi's fixed asset investments are still locked into the heavy industries (Shanxi Statistics Bureau, 2018).

Shanxi's political economy status indicates that while sectoral policy targets might deliver incremental progress in terms of higher energy efficiency or lower pollutant emissions, an overall improvement in terms of total emissions reduction and a cleaner economic structure could be a challenge if there are no stronger long-term, economy-wide climate goals in place. Necessary policies to meet the gap include but are not limited the following:

- Introduce an overarching target that includes but is not limited to coal in the provincial strategy as early as possible, for example the 14th Five Year Plan. One of the options worth exploring is an absolute emissions cap, as international experience shows that an emissions cap sets a long-term vision and market signal. It can provide clear targets for what should be achieved when a long-term strategy for low-carbon and green growth is laid out, and a clear indication of what is needed to mobilize investment in low carbon technology and infrastructure to meet these national carbon-reducing imperatives. This will need to be supported by an institutional arrangement that is empowered to execute coordination and enforcement.

- Develop actionable and measurable solutions shifting public and private investment from coal and energy intensive sectors to knowledge-driven, labor-driven and innovative industries. These include optimizing the operation of existing fiscal investment funds and establishing green finance pilots in Shanxi, as described in the TAPs.

Shanxi's transition to green growth is a highly complex issue involving multiple challenges and different facets, for example the labor-force transition from coal to clean industries and the environmental risks of closing down mining operations. Solutions should be packaged as a comprehensive policy framework with a multi-generational timeframe. Broadly speaking, strong climate policies could set long-term goals and financing mechanisms could help mobilize resources, jobs and development in a cleaner and greener direction. This will need to be supported by a strong institutional set-up and strong incentives for policy makers and regulators. In conclusion, to help Shanxi achieve a low-carbon transition, revolutionary policies aiming at a vision beyond coal are more critical than incremental policies tying to either extend the coal industry value chain, improve energy efficiency or reduce the environmental impact of coal industries.

"Green growth" has become ubiquitous in China's political pronouncements and building a "beautiful China" is now one of the country's five core development goals. Shanxi, riding the momentum of the energy revolution, has a window of opportunity to serve as an exemplar of China's green growth potential.


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THE PROBLEM: Coal Economy Continues as the Priority Despite the Global and National De-carbonization Trend

I. The Global Economy Is Undergoing De-Carbonization

The world's major economies are undergoing de-carbonization, driven by policies to address the climate change challenge. In December 2016, country leaders and their representatives signed the breakthrough Paris Agreement and agreed to tackle man-made global warming by acting together to prevent the global average temperature from rising above two degrees by the end of this century. Most of the leading economies have developed National Determined Commitments to reduce greenhouse gas emissions by decarbonizing their economic development.

Between 1971 and 2016, the world's average CO2 emissions per unit of GDP decreased from 0.69 kgCO2/US$[1] to 0.42 kgCO2/US$[2], a reduction of almost 39.1%. OECD countries have reduced their carbon intensity by 61%. To achieve the Paris Agreement goal, the world's average carbon intensity needs to decline 6.4% per year from now until 2050 (PwC, 2019).

After decades of development, the cost of renewable energy has declined over 90% and is becoming cheaper than fossil fuels. Many countries have adopted ambitious goals and policies, including feed-in-tariffs, to increase the share of renewable energy in the mix of primary energy sources. An International Renewable Energy Agency (IRENA) analysis shows that the global weighted-average levelized cost of electricity (LCOE) of onshore wind and solar PV in 2018 are now less expensive than any fossil fuel options (IRENA, 2019).

Table 1 Global weighted-average LCOE by key renewable power technologies

Technology	Levelized cost of electricity (2018 USD/kWh)		
	2010	2018	Change (%)
Onshore wind	0.085	0.056	-35%
Offshore wind	0.159	0.127	-20%
Solar PV	0.37	0.085	-77%
Concentrating solar power	0.34	0.185	-46%

Source: (IRENA, 2019)

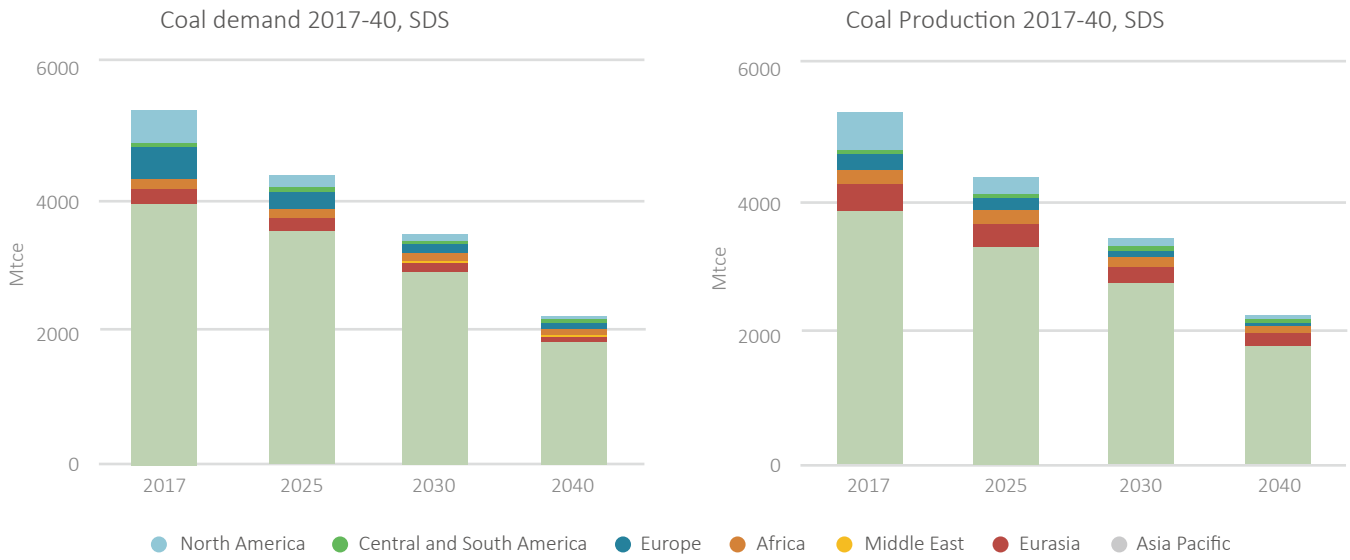
Coal-fired power plants are now less economically competitive, mainly due to tightened environmental regulation and a lower natural gas price in recent years. In China, if all coal-fired power plants that are scheduled to be built in the 13th FYP period were actually built, over 50% of the plants in Shanxi would not be profitable in 2020 (Caldecott et al., 2017). This imposes significant risks of stranded assets for the decades to come.

The high penetration of renewable energy is now not just an aspiration but a reality in many regions of the world. In May 2019, there were over 100 hours that the whole UK was powered by non-coal energy sources (Nicholls, 2019). In March 2018, Portugal's power sector generated more renewable energy than the country's total energy demand (Coren, 2018). China's Qinghai province, a region with more than five million people, powered itself 100% with renewable energy for seven days in 2017(Garfield, 2017).

As a result, the coal market is expected to face challenging growth prospects in the future. IEA projects that with the existing policies taken by many countries *in their Nationally Determined Contributions (NDCs)*, coal demand will likely remain the same in 2040 as in 2017 (IEA, 2019). If countries take actions that are more ambitious, global coal demand in 2040 will decline nearly 50% compared with 2017 to reach global carbon neutral goal by mid-century (IEA, 2019).

[1] 2010 price
[2] 2010 price

Figure 1 Coal production and demand projection in the Sustainable Development Scenario, 2017-2040



Source: IEA

Financial risk of investing in coal production is on the trend to increase. The world's leading mining companies including Rio Tinto and BHP have decided to exit the coal business (Biesheuvel, 2019; Hume, 2018). Forty percent of the world's top 40 banks have committed to stop investing in coal (Buckley, 2019). Power sector investment into coal continues to decline globally.

II. China's Political Commitment and Opportunities toward Green Growth

China has been continuously strengthening its national strategy for addressing climate change. Bringing "ecological civilization" to China is a core component of President Xi's political agenda and green growth is one of the five pillars in the current administration's platform. China aspires to step up as a world leader in low-carbon development as its works to mitigate its high levels of pollution and GHG emissions.

The report of the 19th National Congress of the Communist Party of China describes China as exercising leadership in international cooperation on climate change and states that the country has become an important participant, contributor and leader in global efforts to protect the environment and develop sustainably. Speeding up reform of the system for developing an ecological civilization and building a "beautiful China" are now long-term guiding principles in China's long-term national development. A vision and targets for "quality growth" and green growth towards 2030 and 2035 were set out at the 19th National Congress of the Communist Party of China in 2017.

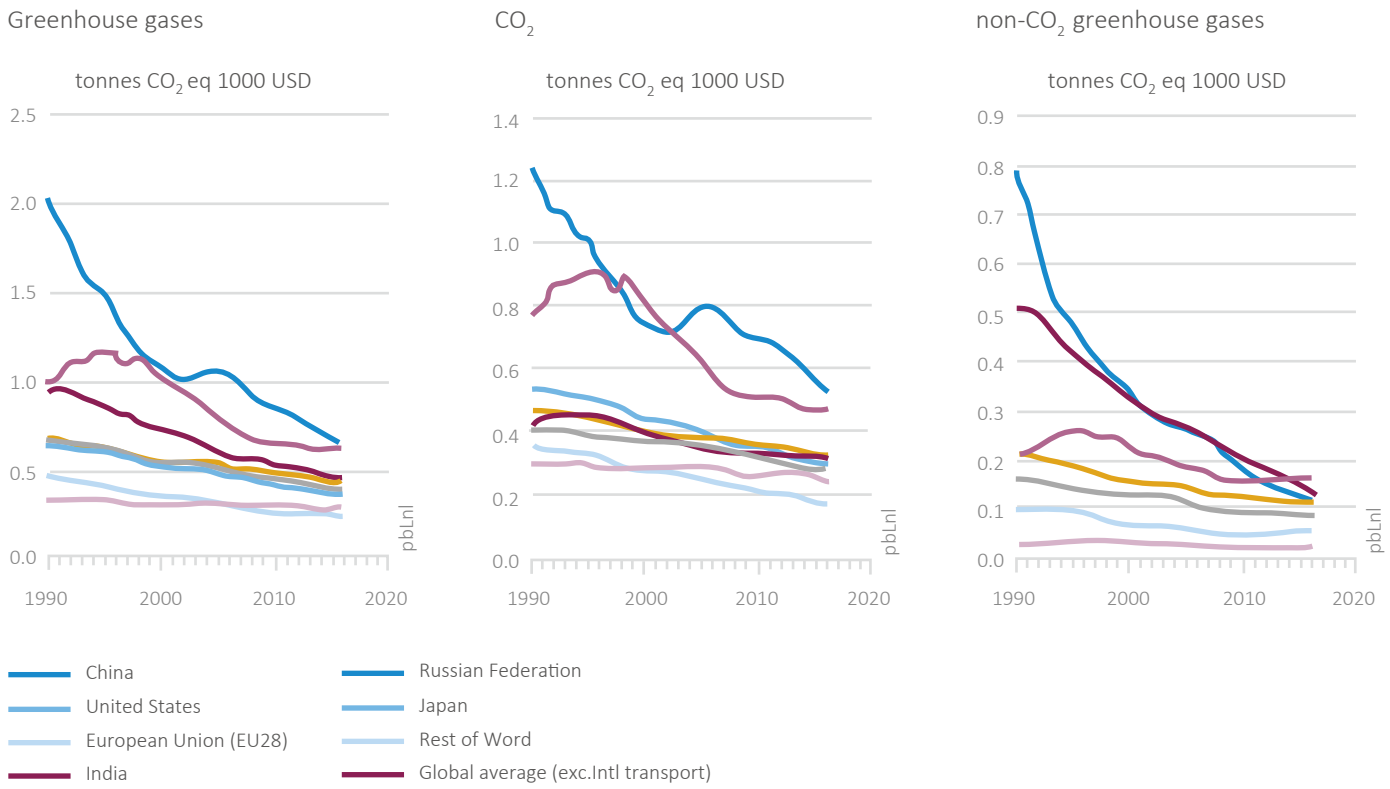
Table 2 Highlights of indicators for China's 2030/2035 development goals

2030 Goals	Description	National strategy
Quality Growth		
GDP	2035 Modernization Goal	19th CPC National Congress Report
Income	2035 Middle Developed Countries	Same as the above
Innovation	2035 Innovation-driven Country, Expenditure on R&D per GDP: 2.8%	Same as the above &*National Strategic Plan for Innovation Driven Development toward 2035*
Green Growth		
Clean Air	All cities annual average PM2.5 concentration meeting WHO guidelines	National Plan for Air Pollution control
Clean Water	The water quality in seven key basins reaching above average	National Plan for Water Pollution Control
Carbon Emissions	Peaking energy related CO2 emissions before 2030	National Determined Action of China, 2016

China's Nationally Determined Contribution (NDC) to the Paris Agreement commits to peak its carbon emissions around 2030 and states the country will strive to peak as early as possible. It also commits to carbon emissions per unit of GDP to be 60%-65% lower than in 2005, and for non-fossil energy to account for about 20% of primary energy consumption (NDRC, 2015).

China has made notable progress toward its global climate change commitment. China is now the world's leading renewable energy investor, possessing the largest solar and wind installed capacity. China has also greatly improved its carbon productivity. Its CO2 emissions per unit of GDP have declined fast, around four times the global average, between 2000 and 2017 (Olivier & Peters, 2018).

Figure 2 Emissions per US Dollar of GDP, at PPP 2011 prices



Source: PBL Netherlands Environmental Assessment Agency

This political momentum and policy progress can be attributed to China's domestic need to increase economic efficiency, fight air pollution and improve its overall environmental quality. At present, in the context of recent reforms of China's environmental protection management institutions, it has become particularly important to integrate and find synergies between policies that address climate change, pollution, and environmental management.

Table 3 China's Climate and Energy Goals

Policy Areas	Objectives	Nationally Binding	Local	National Strategies
Total CO_2 Emissions			A few city pilots	*N/A*
Total CO_2 Emissions Peak Year	Peak around 2030	Yes	Over 20 cities aiming at early peak	*NDC*
Carbon Intensity	In 2030, 60-65% lower than 2005 level	Yes	Yes	*NDC and the 13th FYP Guidelines*
Energy Intensity	In 2020, 15% lower than 2015 level	Yes	Yes	*The 13th FYP for Energy Development*
Total Energy Consumption	5 billion tons tce by 2020	No	Yes	*The 13th FYP for Energy Development*
Non-fossil Fuel Energy Share	15% in 2020 20% in 2030	Yes	Yes	*The 13th FYP for Energy Development*
Coal Use	4.1 Billion ton by 2020	Yes	Key Air Quality Regions	*The 13th FYP for Energy Development* *The Work Plan for Strengthening Coal Consumption Cap in Key Cities for Air Pollution Control*

Source: GDP Policy Mapping

III. Coal Consumption Continues to Grow and Worsen Social and Climate Risks

Despite the general effort to decarbonize the economy, China's coal consumption has continued to grow in recent years. This rising coal consumption is partly driven by efforts to boost the economy and the ongoing electrification of the energy system. China's per capita electricity use is still one quarter of the US level and half of the European level. Increased electricity demand to meet rising living standards is driving increased coal consumption for power generation (IEA, 2017).

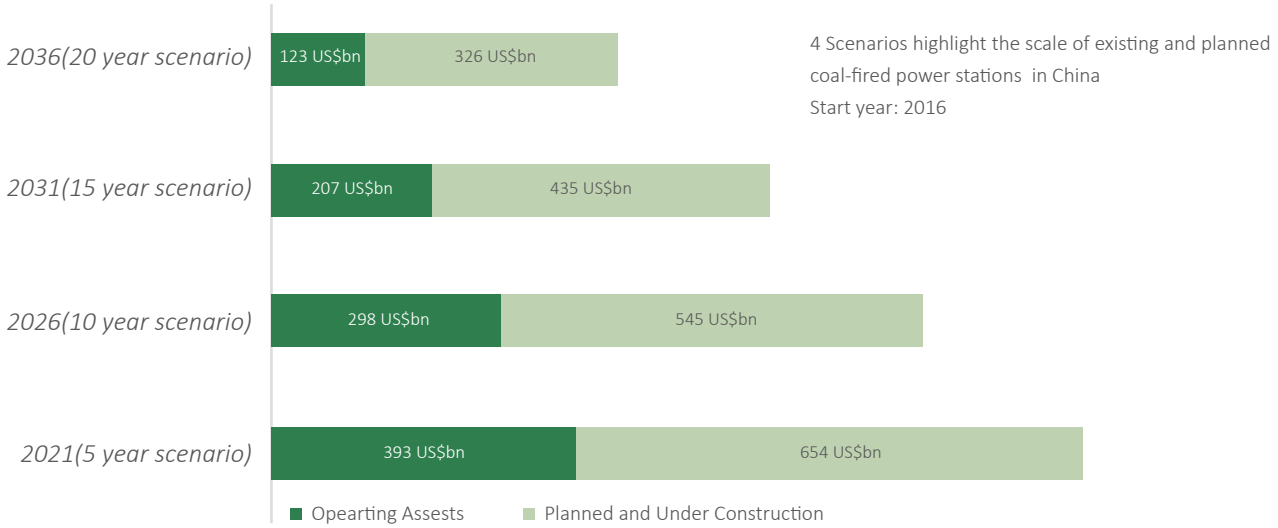
There is concern that this increasing demand for electricity will continue to be met by adding coal plants going forward. But experts argue that existing coal-fired power plant capacity is enough to meet this demand. China's power sector is characterized by overcapacity. The average utilization hours of thermal power was 4,165 hours in 2018 a record low. And the projection for 2020, based on the ongoing efforts to build new plants, could be 4,048 hours (China Electricity Council, 2018; Yuan, 2016). This makes the return on investment close to zero, or negative, and generation efficiency will remain low regardless of the advancement of technologies used for the new plants.

In the long term, China's coal demand is expected to flatten or decline. The IEA forecasts that China's total coal demand in 2040 will be much lower than in 2017. Between 2017 and 2040, coal consumption might oscillate between temporary increases and decreases, but the overall trend will be a decline with an average annual rate of 0.6% (IEA, 2019) .

Therefore, both existing and future investment in coal imposes high economic risk. According to a 2017 scenario analysis by the Oxford Smith School of Enterprise and the Environment (Caldecott et al., 2017), shown in Figure 3, China's stranded coal-fired assets are estimated to be as much as ¥3,086–7,201bn ($449–1,047bn) during the period of 2016-2056, equivalent to 4.1-9.5% of China's 2015 GDP with the ongoing planned investment in coal-fired power plants.

But other market signals are obscuring this message. The intensifying China-US trade war is threatening to limit China's access to natural gas and oil, making coal appear to be safe bet for policymakers pursuing energy security. If market signals are not robust enough to provide long-term certainty about coal's doomed future, China's comprehensive green growth policy system is likely to stall out.

Figure 3 Estimates of total asset stranding charges in US$bn

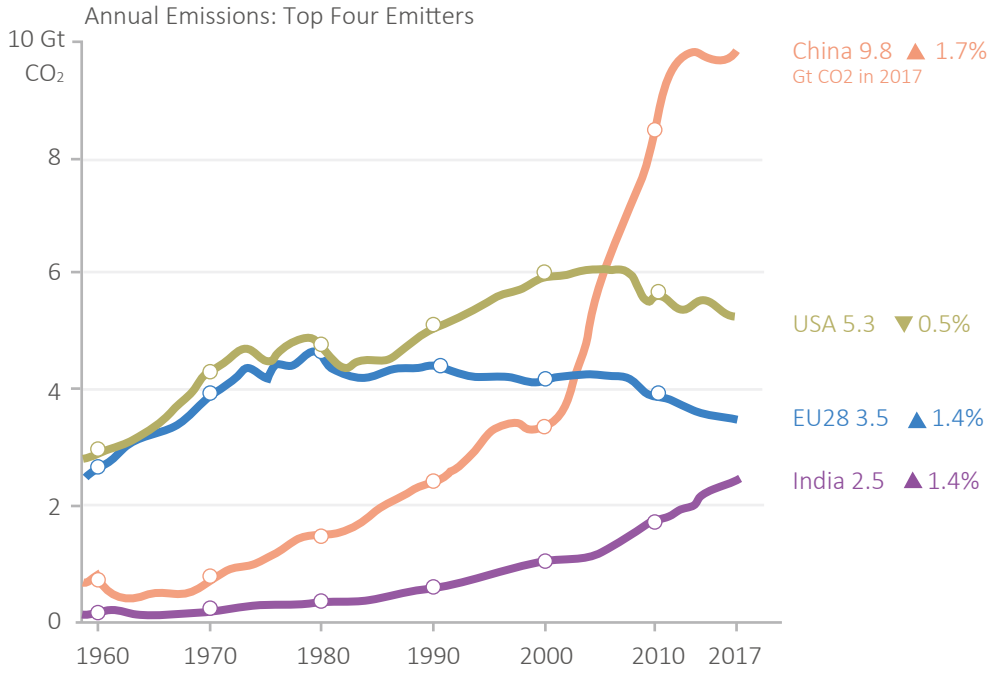


Source: (Caldecott et al., 2017)

IV. Urgency and Opportunities to Strengthen China's Climate Policies

While China is on track to achieve all the energy and environment targets in its strategic plans, there appears to be a lack of urgency with regard to total CO_2 emissions. China's CO_2 emissions continue grow, contributing 46% of global total growth in 2017, a significant leap up from 27% in 2016. China's per capita CO_2 emissions level is already higher than the EU average, and CO_2 emissions per unit of GDP remain higher than the global average (Global Carbon Project, 2018).

Figure 4 Annual emissions: top four emitters



Source: (Global Carbon Project, 2018)

To keep the global temperature rise within two degrees, the total global CO_2 emissions should start declining now. What matters most to climate safety is the level at which emissions will peak, not the peaking year. In other words, a peaking year goal alone is not enough for long-term sustainable and climate-safe development. China needs an absolute carbon cap.

China's environmental goals have been the main driver of improving energy efficiency, limiting coal use and reducing carbon emissions. But environmental policies can deliver a state in which energy efficiency and overall environmental quality are high while total carbon emissions still grow, as observed in developed countries. In addition, environmental and energy efficiency goals can have unintended consequences regarding carbon reduction efforts. For example, electric vehicle (EV) programs can help cities meet the clean air goals, but increase demand for electricity from fossil fuel sources. Though the long-term impact on climate might be positive, in the short term EV policies could create a surge in demand for electricity generated by a power system heavily dependent on coal as a primary fuel.

China has ramped up its air quality goals in past years in a "war on air pollution", but it has yet to address the climate challenge in this aggressive manner. For example, the requirement for cities to meet national air quality standards was first limited to "key regions" in the 2013 version Air Pollution Action Plan. In the new plan, issued in 2017, this goal was extended to all cities. The GDP per capita in Beijing, Shanghai and Shenzhen has reached the levels seen in developed countries, but there has not been a policy effort to limit CO_2 emissions in these regions comparable in strength to efforts to improve air quality.

POLITICAL-ECONOMIC ANALYSIS: Identifying the Policy Drivers and Gaps in Shanxi's Quality Growth

As China strives to decouple emission with economic growth, it is constantly torn between the competing policy priorities of delivering economic growth and breaking from a resource-intensive development model. Coal is at the center of China's (and to a large extent the world's) challenge to achieve green development.

Shanxi province has long been China's energy supplier. With abundant coal reserves, Shanxi's energy supply has been relied upon by the country to fuel its fast-growing economy, and over two-thirds of its coal production is consumed by other regions in China. Ameliorating the dependence on coal of Shanxi's economy would make a significant contribution to China's and the world's sustainable development goals.

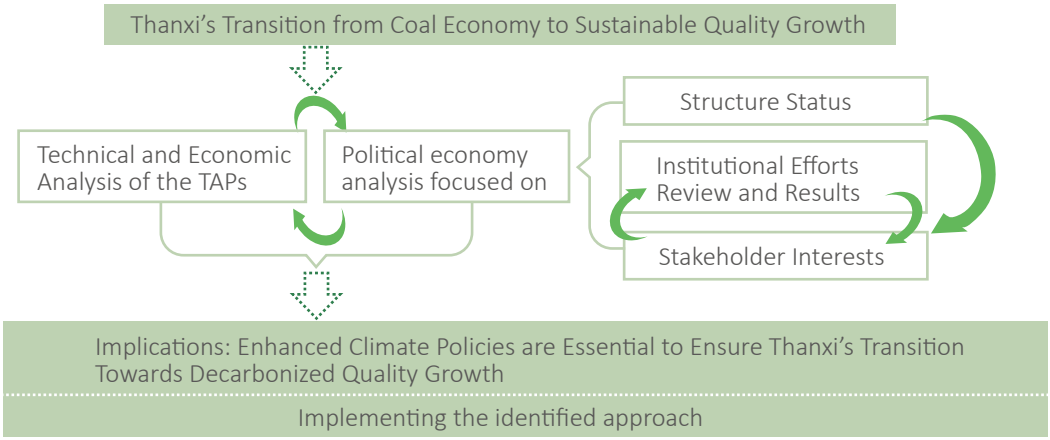
Shanxi's decades-long drive to improve its economic structure is typical among regional efforts in China. The province has announced a commitment to pursue economic growth by making itself into "*a pilot region*" of energy and economic transition away from a resources-oriented development pattern, a "*pioneer*" in China's energy revolution, and a "*new inland frontier*" of international economic collaboration by 2030. These efforts are primarily driven by the continuing need to promote economic development, an interest in mitigating the economic risk of having a coal-dependent economy, and the imperative to improve regional air quality, the latter two drivers of which are both central government priorities.

The central government has approved Shanxi's two action plans (TAPs) to implement the goal becoming "a pilot region of energy and economic transition" and "a pioneer in China's energy revolution". The TAPs present a comprehensive set of actions, intended for the shift into a more sustainable development pathway. This section reviews the history of Shanxi's transition efforts, identifying historical climate impacts and gaps in enforcement.

I. THE Political-Economic Analytical Framework

The political-economic analytical framework (PEA) for Shanxi province is presented in Problem-Driven Political Economy Analysis: The World Bank's Experience (*Fritz, Levy, & Ort, 2014*) . The PEA zooms into Shanxi's social and economic status, its highly coal dominated development pattern and the associated risks. By reviewing the policy efforts in past decades to diversify its growth pattern, the PEA reveals that although Shanxi has achieved its GDP energy intensity goals, this has not resulted in the additional policy aim of structural change in the local economy. The PEA also includes a preliminary stakeholder mapping based on the E3G Political Economy Mapping Methodology to understand the barriers and tests the hypothesis that introducing enhanced climate policy would help drive structural economic changes, reductions in coal investment and use, and thereby reductions in carbon emissions.

Figure 5 Political-economic analytical framework for Shanxi



Source: Based on (Fritz et al., 2014)
Note: This framework is customized for this study, based on the approach proposed in Problem-Driven Political Economy Analysis: The World Bank's Experience

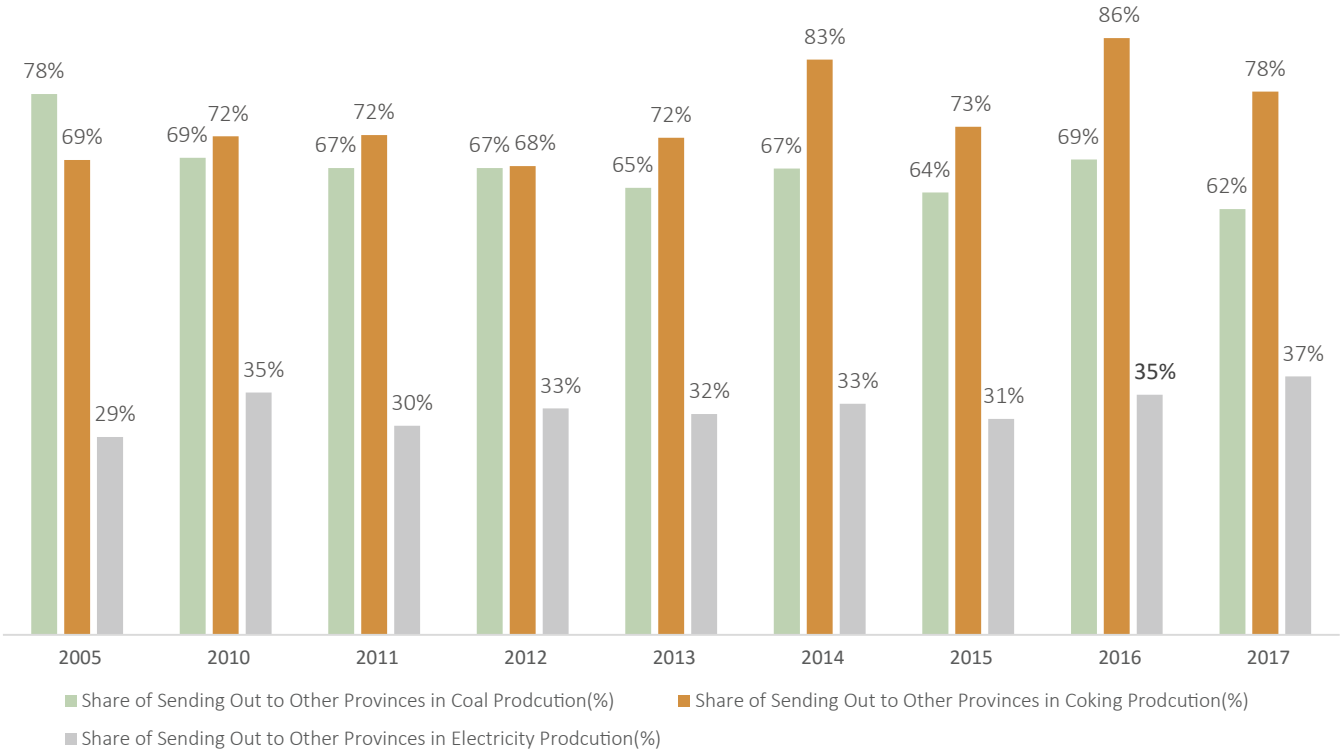
II. Social and Economic Structure Status

1. Shanxi Continuing to Lock into a Coal-centered Economy

Shanxi's economic development is highly energy-intensive due to the exploitation of its substantial coal endowment. Shanxi possesses China's first and third largest endowments of coal-bed methane and coal, respectively, and its economy is centered on coal related industries, including coal exploitation, coal power generation, coking, and metallurgical industries, as well as other coal chemical industries. These sectors contribute to over 70% of Shanxi's GDP, as well as around 50% of industrial value add in 2017. They also account for over 50% of tax revenue and around 50% of employment (Shanxi Statistical Bureau, 2019).

Shanxi has been known as China's "boiler house" for its role providing energy products to fuel the economic development of the country. Shanxi produced 18.3 billion tons of coal between 1949 and 2018. Over two-thirds of this coal was consumed in other regions of China. In 2017, Shanxi provided 62% of coal production, 78% of coke production and 37% of electricity generation to other regions of China (Shanxi Statistical Bureau, 2019).

Figure 6 Share of Shanxi's energy produced for consumption outside Shanxi



Shanxi's economic role as an energy product provider is likely to persist in the foreseeable future. While this has made Shanxi an important role in national energy security, this coal-based economy has also been the cause of the economic challenges and environmental degradation that the province faces today.

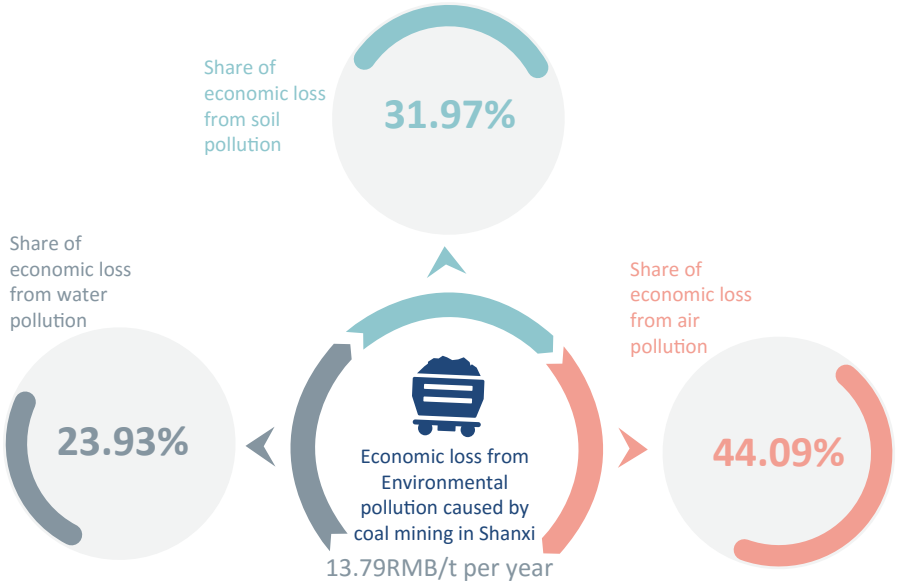
2. Shanxi's Coal-Centered Economy Has Caused Serious Pollution

In 2017, Shanxi's primary energy source mix included only 0.83% natural gas (including coal bed methane), 2% oil and 1.23% renewables. The remaining 97.94% was occupied by coal, much higher than the national level of 68% (Shanxi Statistics Bureau, 2018).

Over two thirds of Shanxi's energy is consumed by heavy industry- 12% by coke, 13% by chemicals, 25% by metal, and 27% by coal exploitation (Shanxi Statistics Bureau, 2018).. Shanxi's energy efficiency, though much improved overall, is only half of the national

average, and one fourth of the global average. In 2018, of the twenty cities with the worst air quality performance in China, six were in Shanxi Province (Xinhua Net, 2019). According to a study by Shanxi Academy of Environmental Sciences (Dang, Jia, Xu, & Xu, 2012), In 2003, the economic cost from environmental pollution and ecological damage of coal mining in Shanxi Province was 63.79 yuan/ton, of which economic loss of environmental pollution is 13.78 yuan/ton, and the cost of ecological damage is 50.00 yuan/ton. Accordingly, it is estimated that the economic losses caused by the coal industry amounted to around 7% of Shanxi's GDP in 2018.

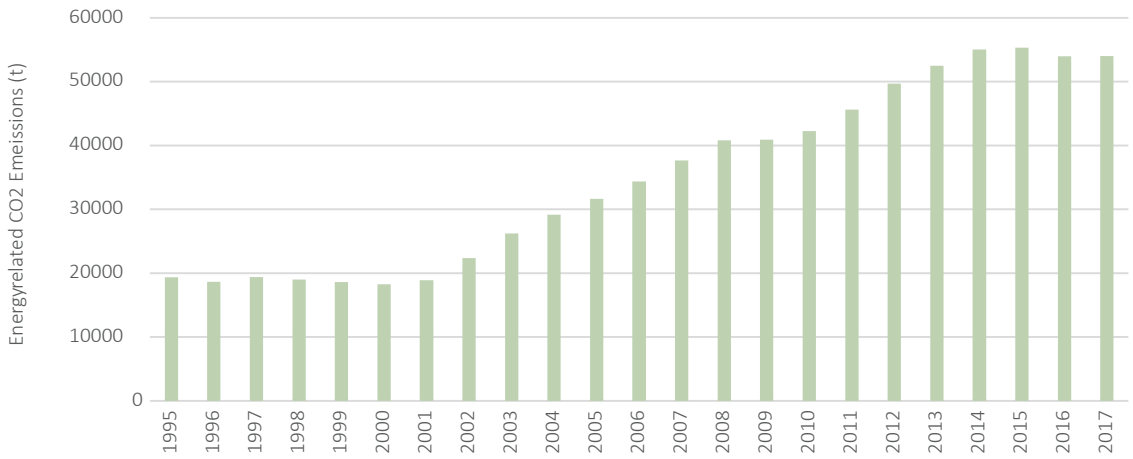
Figure 7 Economic losses from Shanxi's coal mining



Source: (Dang et al., 2012)

Shanxi is one of the largest GHG emitting provinces in China. Its total CO_2 emissions ranked seventh in 2012, with 466 Million tons of direct emissions. Shanxi's per capita CO_2 emissions grew from 6 tons in 1996 to 14 tons in 2017, far above the national average[3]. Approximately 80% of Shanxi's carbon emissions come from the industrial sector. Shanxi's total CO_2 emissions reached a plateau in 2014 and 2015, fell in 2016, and then started to rise again in 2017. This dip was partly due to the economic slowdown and "air pollution war"-driven efforts to cut industrial overcapacity.

Figure 8 Shanxi's energy related CO_2 emissions, 1995-2017



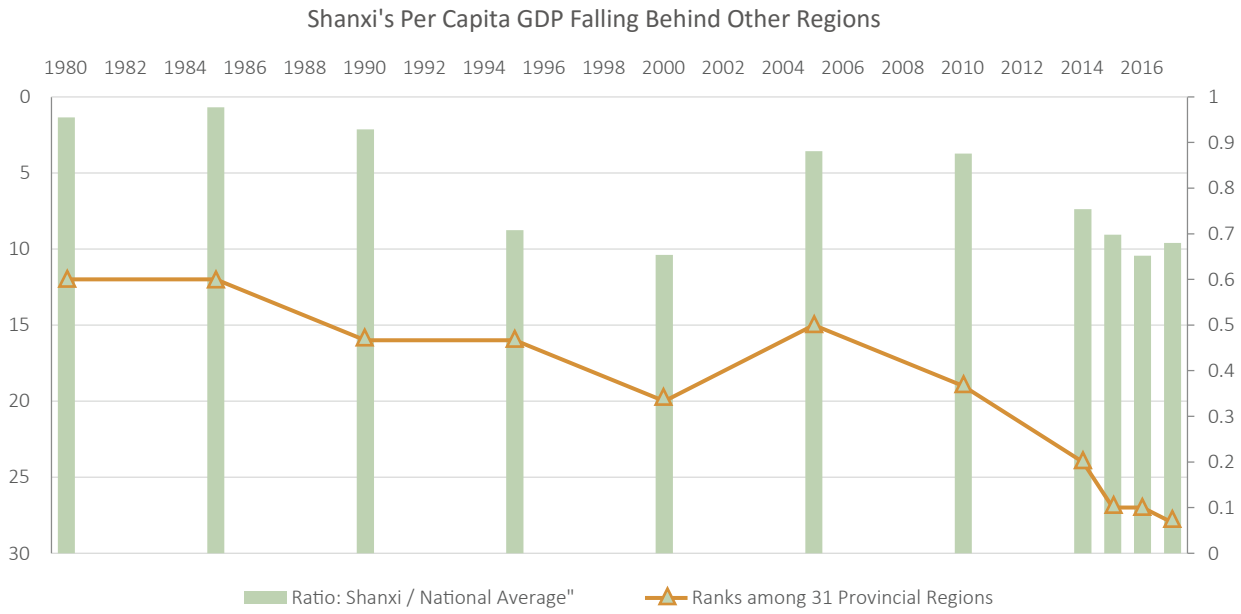
Source: calculated by iGDP

[3] calculated by iGDP

3. Shanxi's Economic Importance within China has Declined

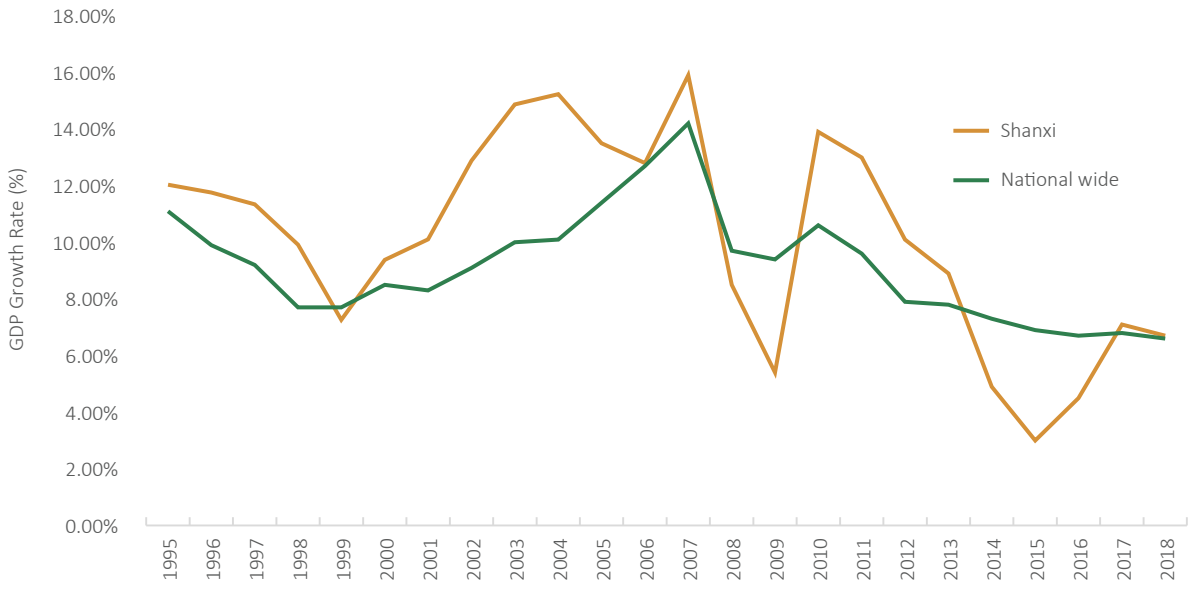
Since 1980, Shanxi's economic performance has been falling behind compared to other provinces. Its GDP growth rate was at the bottom among all provinces in China in 2014. It bounced up to number 24 in 2017, but has been struggling to catch up with the national average growth rate. Shanxi's per capita GDP in 2017 was approximately USD 6000, lower than China's national average of USD 8800. Shanxi's GDP share accounts for 2.39% of the national total, however this number dropped to 1.81% in 2017.

Figure 9 Shanxi's economic position in China (1980- 2017)



Source: China Statistical Yearbooks

Figure 10 Shanxi's GDP growth rate vs. national average



Source: China Statistical Yearbooks

Shanxi's coal dependence makes its economy unstable. Its economic performance is heavily influenced by coal and coke demand, which is driven by national economic conditions, especially developments in heavy industry and manufacturing. The cyclical fluctuations in Shanxi's economy are also wider than the national average and particularly sensitive to coal prices and overall economic growth.

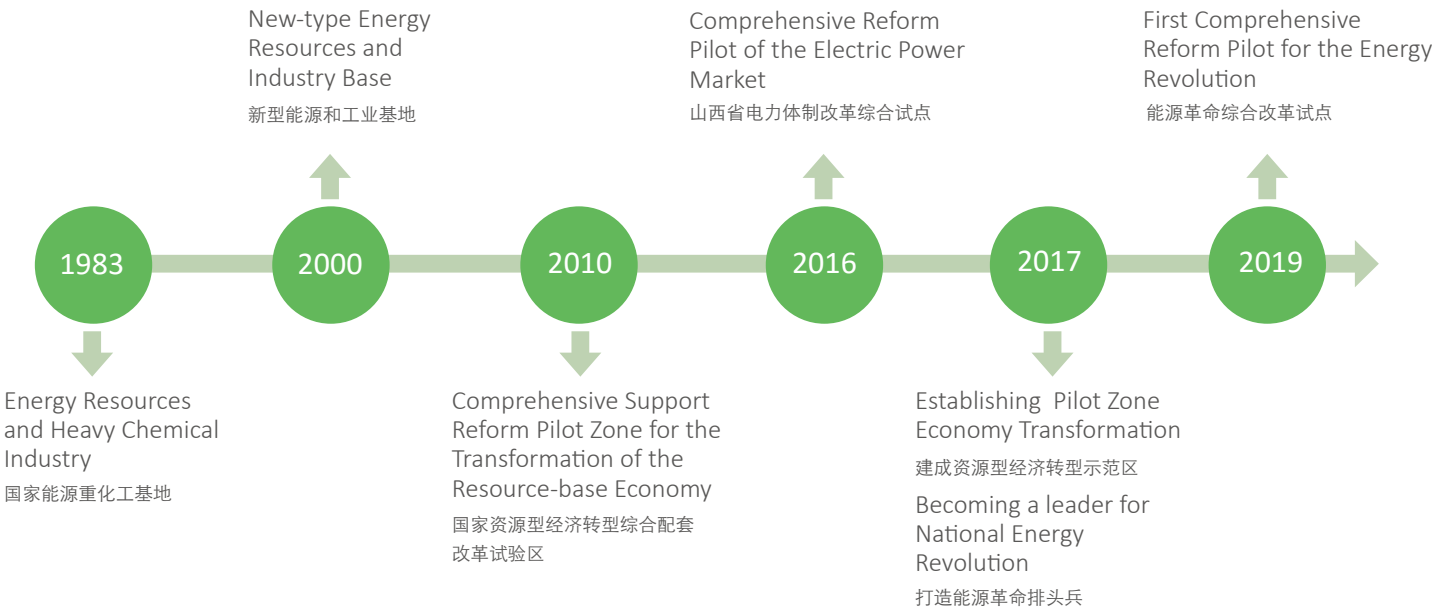
III. Institutional Efforts Review and Results

1. Shanxi's Efforts to Decouple its Economy from Coal

Shanxi has made a great effort to diversify its economic structure. The goal of its long-term development strategy has been to increase the service industry share and reduce the heavy industry share. Shanxi has also set ambitious green growth goals to improve the environmental quality of the region.

Over the last decade, Shanxi has participated in numerous national pilot programs that aim to transform its energy-intensive economy. It joined the national circular economy pilot program in 2007, focusing on energy saving and pollution reduction as well as the development of emerging industries. In 2010, Shanxi became a comprehensive support reform pilot for the transformation of its resources-based economy, aiming to deepen reform, optimize the local economic structure and enhance its technological advancement. In 2016, Shanxi became the pilot for national electricity market reforms, working on increasing electricity exports and developing a market-based electricity system to promote energy efficiency. In 2017, Shanxi also received national policy support for developing a pilot zone for transforming its resource-based economy. In this effort, the province aimed to promote industrial restructuring, adjust both the supply and demand-sides of energy system, and cultivate the development of emerging industries. Most recently, Shanxi has become the first pilot for energy revolution in 2019, which is expected to explore practices on energy transformation for national scale-up.

Figure 11 Shanxi's efforts to green the economy between 1983-2019



Source: iGDP Policy Mapping

Shanxi has also developed a range of policies to shift away from its energy-intensive economy. As illustrated in Table 4 below, Shanxi has formulated and implemented a variety of policies and actions to adjust its economic development path during the 13th FYP period.

Table 4 Key policies and actions issued by Shanxi during the 13th FYP

Policy Documents	Key Policy Indicators
"Action Plan for Shanxi to Become an Energy Revolution Pioneer"	• Energy consumption control/ Coal consumption cap. • Carbon intensity reduction. • The development of renewable energy and coal bed methane. • The high efficient and clean utilization of coal. • The energy system restructuring. • The development of renewable energy industries. • The development of smart energy system. • Technological advancement in the energy system. • The development of new driving forces for the economy.
"Shanxi's Social and Economic Development for the 13th FYP"	• Carbon intensity reduction. • Energy intensity reduction. • The share of renewable energy in the primary energy consumption. • Land use control/ Water use control. • Water quality /Air quality/ Major pollutants emission control, • Promote green mining technology and a grading commercial coal utilization system by quality. • Promote the ultra-low emission transformation of coal-fired generating units. • Strictly implement the approval of ultra-low emission standards for new generating units. • Establish and improve the trading mechanism of electricity market. • Explore a price mechanism that keeps the equal quality and quantity of coal-bed methane and natural gas.
"The Development of Shanxi's Circular Economy for the 13th FYP"	• Make special plans for the development of low calorific value (low CV) coal-based power generation program, comprehensive utilization of coal gangue, comprehensive utilization of fly ash, comprehensive energy saving and utilization. • Promote air-cooled, high-parameter supercritical, ultra-supercritical coal-fired generating units. • Implement ultra-low emission of coal-fired generating units. • Accelerate the construction of statistical monitoring and accounting system for energy, mineral resources, water and atmosphere and an online monitoring system for energy consumption of key energy-intensive enterprises.
"The Development of Shanxi's Circular Economy for the 13th FYP"	• Set strict environmental impact assessment system. • Implement pollution emissions permit system. • Implement ultra-low emission standards I for newly conventional coal-fired generating units and ultra-low emission standards II for low-calorific value coal-fired generating units. • Transform the existing coal-fired units with a capacity of 300,000 kilowatts and above with the ultra-low emission. • Eliminate yellow label cars. • Implement Class A emission standard for wastewater plants. • Establish a soil environmental quality database. • Set the ecological protection red line.
"Shanxi's Three-Year Action Plan to Win the Battle for a Blue Sky"	• Restrict market entry for energy-intensive, high pollution and resource-intensive industries. • Use pollutant emissions data from CEMS (continuous emission monitoring system) for law enforcement.

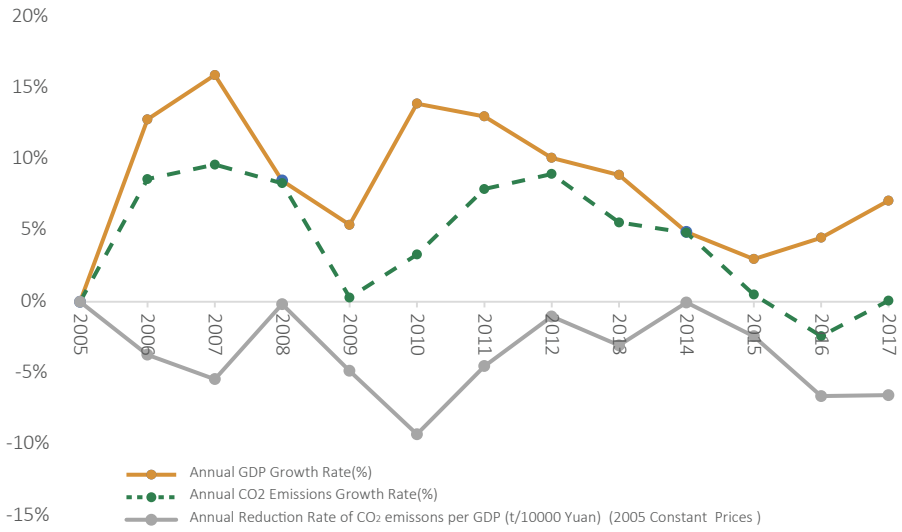
Source: iGDP's Policy Mapping

For instance, Shanxi has set targets of carbon intensity reduction, an energy consumption cap and energy intensity reduction to manage carbon emissions and energy consumption in general. Meanwhile, the province has developed a set of policies targeting its coal-based energy system and industrial structure. These are centered on improving energy efficiency and saving energy within the traditional energy system, such as developing ultra-supercritical coal-fired generating units, implementing ultra-low emission standards for new conventional coal-fired generating units, as well as a grading commercial coal utilization systems by quality. These policies focus on energy consumption control in key energy-using enterprises in energy-intensive sectors.

2. Progress Achieved but Economic Structure Remains Energy Intensive

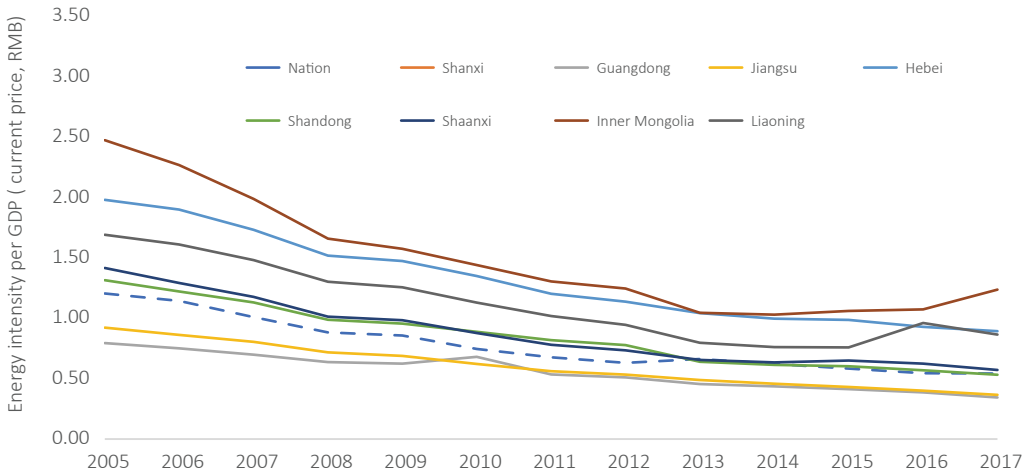
Shanxi has achieved most of its energy and environmental targets, including improving energy efficiency and reducing carbon intensity, in the 11th and 12th FYP periods. Yet the province is still struggling with clean development. From 2005 to 2017, Shanxi's carbon emission per unit of GDP declined 4% annually. Shanxi's GDP carbon intensity declined 5.26% and 4.42% in 2016 and 2017 respectively, reaching the annual objectives (Shanxi Statistical Bureau, 2019). However, compared with other regions of China, Shanxi's carbon intensity remains the highest of all provinces of China. Its energy efficiency, though much improved overall, is only half of the national average, and one fourth of the global average.

Figure 12 Shanxi's GDP growth rate and carbon intensity reduction trend (2005-2017)



Source: Calculated by iGDP

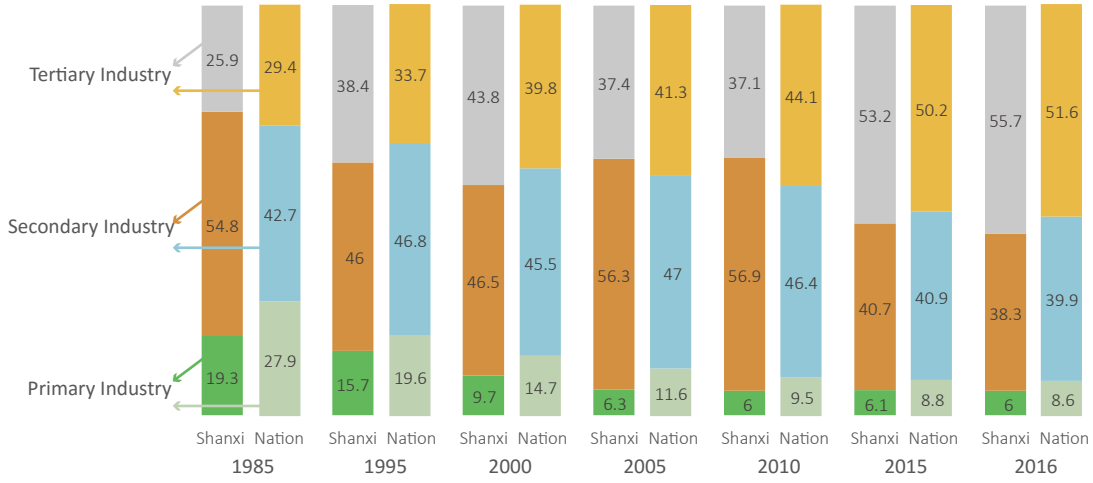
Figure 13 Shanxi's energy intensity compared with other regions and the national average



Source: Calculated by iGDP

Shanxi's overall economic structure improvement seems able to catch up with the national average, following the policy goal to increase the service industry's share in the overall economy. However, Shanxi saw a sharp decline of this share between 2000 and 2010, from 43.8% to 37.1%. This trend was reversed from 2010 to 2016, going from 37.1% to 53.2%, partly because of the economic downturn's impact on secondary industry (Shanxi Statistical Bureau, 2019). Experts argued this reversal was not a result of economic structure optimization efforts, but a result of heavy industry's decline due to the global economic downturn (Han, 2018).

Figure 14 Shanxi's economic structure

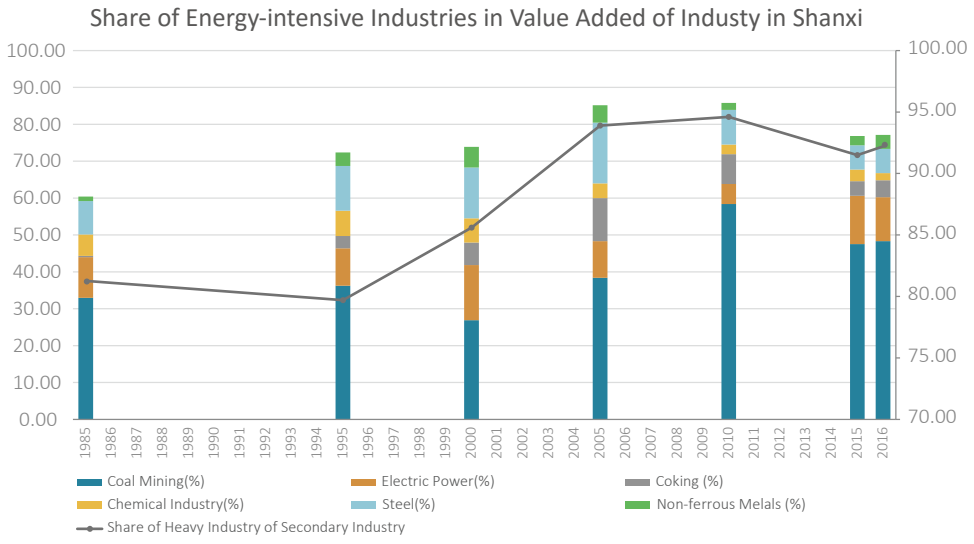


Source: (Shanxi Statistical Bureau, 2019)

Despite these strategic efforts since the 1990s, Shanxi's secondary industry has become heavier overall. The share of heavy industry in the secondary sector increased from 81.3% in 1985 to 85.6% in 2000, and has remained over 90% since 2005. It reached 94.6% in 2010 (Shanxi Statistical Bureau, 2019). The province's long-term endeavor of establishing a more diverse and sustainable economic development pattern has yet achieved the intended results.

As China's largest energy products supplier, Shanxi has also tried to increase the portion of high value products within existing heavy industries, for example, from selling coal to selling electricity. However, among its largest sectors, coal production's contribution to overall industry value add rose from 26.9% in 2000 to 48.3% in 2016, while electricity's share remained around 11% from 1985 to 2016. The shares for iron & steel products and non-ferrous metals, with higher value add, have dropped (Shanxi Statistical Bureau, 2019).

Figure 15 The share of heavy industry in Shanxi



Source: Shanxi Statistical Bureau, 2019

IV. Mapping Stakeholder Interests

1. Local Leaders Lack Incentives to Pursue Climate Goals

This stakeholder interests mapping exercise analyzed views published on media platforms and interviewed central and Shanxi provincial government officials and policy advisors, coal and green industry representatives, and members of the public. The methodology employed was a simplified approach based E3G's Political Economy Mapping Methodology (PEMM). The mapping focused on two questions: what are the priorities for every stakeholder group, and who are the champions for key policy goals.

The chart below shows the result of the stakeholder interests mapping. The interviewees were asked to identify two priority areas, assuming central government willingness to support each priority. The shade of the circle shows the extent to which the stakeholder prioritized such policy. If the circle is darker than the others, which means the stakeholder prioritized this policy over others.

The main findings of this interests mapping have already been included in the "structure context" in the above section. They are the following:

- Shanxi's decision makers' priority is still economic growth. Shanxi's GDP growth rate in 2018 was able to catch up with the national average, showing that the attention that senior national leaders have been paying to Shanxi's development is paying off. The TAPs are seen as an opportunity to grow the economy while fitting into the national priority of building an eco-civilization.

- Environment also appears as a priority in Shanxi because of the strong push from the central government to reduce air pollution. Shanxi's Fen-Wei air basin was identified as the new key pollution management region due to failing to meet air quality goals. The Shanxi government is under pressure to change that.

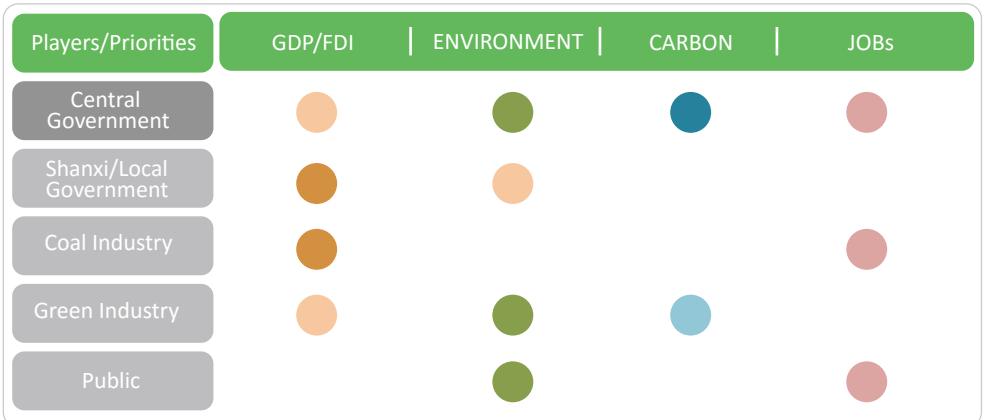
- Providing jobs is important but not an urgent priority at the moment, since it is mainly the responsibility of lower level governments and industry leaders. Society seems resilient enough to tackle this challenge, which outside experts often consider the most pressing challenge of the green transition.

- To simplify the analysis, it is assumed that central government would put same level of weight on all policy goals though we understand there are differences among them.

- To business focusing on renewable energy or pollution control, carbon and environmental policies are overall equally important. Carbon policy per se is not that critical, it is instead specific sectoral policies that are more relevant to industry.

- Concerning public opinion, a very limited scale survey shows that there is an awareness gap regarding climate change. Phasing out coal is something people cannot imagine as a short-term scenario.

Figure 16 Priorities of stakeholders



This stakeholder mapping suggests that there is lack of incentive at the local level to tighten up climate policies. Most decision makers in Shanxi prioritize GDP and employment over environment and climate change. Therefore climate policy should be introduced at the central government level with mandatory targets to the local level. There is potential for the public and business community to be mobilized for a larger role.

2. Investment and Tax Policies Not Effectively Driving Change

Investment and tax policies are signals of whether government is prioritizing quality and green growth in their macroeconomic policymaking.

Shanxi's fixed asset investments have been locked into the coal mining and heavy chemical industries. Industrial fixed assets investment expenditure accounts for a high proportion of the total fixed asset investment expenditure, and has historically been dominated by the four major resource-related industries (coal mining, coking, metallurgy and electricity). The sources of investment in the four major industrial fixed assets are mainly from self-raised funds, accounting for more than 70% of investments (Shanxi Statistical Bureau, 2019). Shanxi's resource-intensive industries find it easier to attract investment due to low development costs and short-term high rates of return. This weakens investments into high value-added regions of the industrial chain.

Resource taxes and environmental taxes are the two primary economic tools to shape investment behavior and drive green growth in Shanxi. The effect of both taxes needs to be improved. In 2017, Shanxi's resource tax was about 27.3 billion yuan, becoming the largest local tax in Shanxi Province, accounting for 31% of Shanxi's local tax revenue (Shanxi Statistical Bureau, 2018). Spending the resources tax revenue wisely is a critical means of getting out of resources trap. Due to a lack of data to track expenditures, this project is not able to provide a thorough analysis of these behaviors. Indirect evidence captured in this study, however, suggests that Shanxi has not made a significant effort to place fiscal investment into "low-carbon" industries.

Compared with resource taxes, the role of Shanxi Province's environmental tax is limited. Its revenue in 2017 was only around 1.9 billion yuan, less than one tenth of the resources tax revenue. Experts suggest that including a carbon tax into the environmental tax system would help drive a green growth transition.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OPPORTUNITIES AND CHALLENGES IN SHANXI'S ONGOING ENERGY REVOLUTION EFFORTS

I. Opportunities: Transition Goals of the Two Action Plans (TAPs)

The *Two Action Plans*[4] issued by Shanxi's government in 2017 have set a series of goals to decarbonize the economic structure, improve energy efficiency and reduce coal dependence from now through 2030. Backed by President Xi, the political status of these actions is very high. After several years of struggling with economic growth, Shanxi is keen to grasp this opportunity to achieve economic growth and sustainable development.

Table 5 Development goals set in the two action plans

Indicators	2020	2025	2030
Service Industry Share	50%		
The Share of Strategic Industry of total GDP	National average		
Total Energy Consumption	240 Million tce	Growth rate lower than national average	Growth rate lower than national average
Coal Production	900 Million tce		
Coal Production Industry Share of total GDP	11.5%	10.3%	8%
Coal Wash Rate	80%		90%
Share of Coal of total Primary Energy	80%	Above national average	Above national average
Coal Production Capacity	1.35Billion tons	1.25 Billion tons	1.15 Billion tons
The Share of Renewable Energy Installed Capacity of total capacity	35%	40%	45%
Coal-bed Methane Production Capacity	40 billion M^3		45-50 billion M^3
Coal-bed Methane Production			35Billion M^3
Energy Intensity	15%-18% reduction,	1-3% above National average level	World leading level
Carbon Intensity Reduction	40%—45% against 2005 Level		
Carbon Peaking Target			CO_2 peaking before 2030
Coal Power Generation Carbon Intensity of Big Power Generator[5]	550g/kwh		World leading level
The share of R&D expenditure of total GDP	Reaching national average	Above national average	Above national average
Electricity Transmission to other regions	6 Billion	Steady growth	Steady growth
Coal-bed Methane Transmission to other regions		Big growth	Big growth

[4] Refers to "Shanxi's Action Plan on Striving to Be a pioneer in National Energy Revolution", and "Action Plan on Implementation of State Council's Guidance on Support Shanxi Province to Deepen Reform for Facilitating Resources-based Economic Transition"

[5] National level: The average coal consumption of coal-fired power plants is reduced from 318 grams of standard coal/kWh in 2015 to 312 grams of standard coal/kWh; in 2015, the average coal-fired power consumption of power plants of 6000 kW and above in Shanxi Province was 301 grams of standard coal/ kWh; power consumption coal consumption is 326 grams of standard coal / kWh, higher than the national average by 4 grams of standard coal / kWh and 11 grams of standard coal / kWh respectively.

II. Shanxi's Emission Trajectory

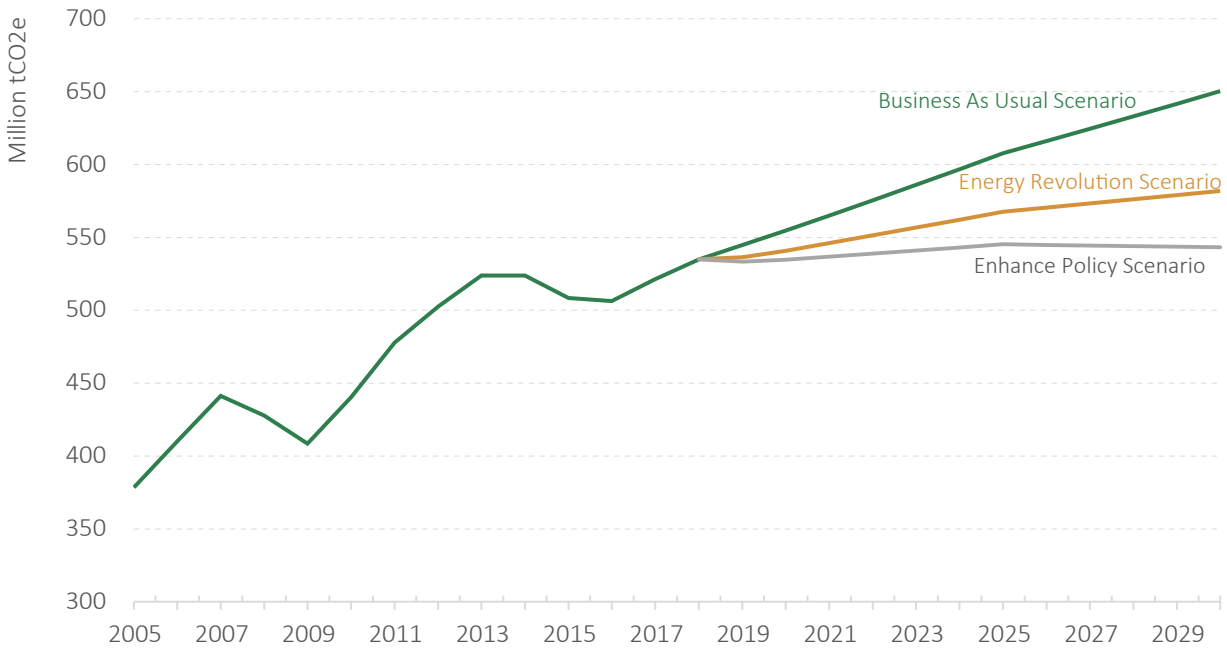
To project Shanxi's CO_2 emissions trend through 2030, this report developed three scenarios based on policy goals defined in the TAPs and potential economic growth pathways. Underlying assumptions include different sets of ambitious targets in Shanxi policy going forward, covering GDP growth rate, industrial structure and the energy structure.

Table 6 Descriptions fo three scenarios

	Business as Usual (BAU)	Energy Revolution Scenario (ER)	Enhanced Carbon Policy Scenario(ECP)
Macro-economic growth	Same assumptions During the 14 FYP, maintain average growth rate of 2016-2017, and slowly reduce to a middle-high level in the period of 15 FYP, but with higher than national average for facilitating Shanxi economic and social development towards post-industrialization 2021-2035: 6.5%; 2026-2030: 6%		
Energy Intensity	Keep current change trend for industrial structure and energy efficiency technology	Continually facilitate change of industrial structure and energy efficiency technology based on the required efforts from the TAPs	Adopting all the goals and measures in the ER scenario. Meanwhile, implement more stringent energy efficiency, and emphasize rapid increase in the share of manufacturing sector, and the share of tertiary sector.
Energy Structure	Keep current change trend for change of energy structure	Facilitate the substitution of coal with cleaner fossil fuels (e.g. coalbed methane, and natural gas), steadily develop renewable	Facilitate the substitution of coal with cleaner fossil fuel (e.g. Coalbed Methane, and natural gas), Steadily develop renewable

The TAPs set goals similar to the national average. Shanxi's energy-related CO2 emissions, if all TAPs goals are fulfilled, would likely peak before 2030, with absolute CO2 emissions from direct emissions growing close to 543 million tons. Only when Shanxi sets more ambitious goals than the national average will it be able start to plateau its carbon emissions before 2030. These enhanced actions could include reducing the carbon intensity level to the national average as early as possible, mainly through improving energy efficiency significantly faster than the national average rate. This means dramatically decarbonizing the growth of secondary industries, which would remain the primary growth engine of Shanxi. Increasing the non-fossil fuel energy consumption share to the national average could be another important option, however this could only be achieved through investment or purchasing renewable energy from other regions. The social and economic cost and political feasibility for this approach is unclear and cannot be answered by this analysis.

Figure 17 Shanxi carbon emission projections



Source: GDP analysis

III. Risks: Climate Impact of the TAPs Could be Enhanced

There is a lot of uncertainty about how Shanxi's economic development will evolve in the next decades, and this will shape Shanxi's carbon emissions trajectory. The scenario analysis shows a direction but does not provide solid estimates of emissions without further data about the economic growth pattern. The TAPs have introduced a list of projects and programs that Shanxi will develop in future. The climate impact of these actions is assessed as unclear to risky.

This report finds that risk lies in the fact that most programs and projects focus on (1) extending the coal industry value chain, and (2) expanding the market for the coal-fired power sector, which is already at over-capacity. If all projects are implemented successfully, we could see a transition from selling coal to selling coal-generated electricity, and from selling electricity to sell high-energy intensive industrial products, as well as to sell coal-chemical products.

There are also plans to promote the renewable energy industry and knowledge industry. The actions have not yet been fully developed and it is not clear how well they will be implemented.

In conclusion, the TAPs aim to boost economic development in Shanxi through energy intensive industry development, however there is high risk that their climate impact will be great in the absence of enhanced climate policies.

Table 7 Key programs and projects in the two action plans

Sector	Programs	Projects
Coal Mining 煤炭生产	Upgrade of Advanced Production Capacity 先进产能提升	Construction of Three Major Based in Shanxi Northern, Middle and Eastern areas 建设晋北、晋中、晋东三大煤炭基地
	Resources Comprehensive Utilization 资源综合利用	Construction of National Industrial Solid Waste Comprehensive Utilization Base in Suzhou 朔州国家工业固废综合利用基地建设
Electricity 电力	Coal-Electricity Integration 煤电一体化	Construction of Three Major Coal Power Based in Shanxi Northern, Middle and Southeastern Areas 建设晋北、晋中、晋东南三大煤电基地
Metallurgical Industry 冶金	Coal-Electricity-Aluminum-Material Integration 煤-电-铝-材一体化改革试点	Aluminum Processing Base with the capacity over Million tons in Luliang and Yuncheng 吕梁、运城百万吨铝加工基地
Coal Chemical Industry 煤化工	Coal Deep Processing 煤炭深加工	Production of Olefin, Aromatics, Ethylene Glycol and Other Materials from Coal (Methanol) 煤（甲醇）制烯烃、芳烃、乙二醇等材料
		Fine Chemicals and Synthetic Materials from Deep Processing of Coal 煤炭深加工精细化学品和合成材料
		Luan Group's Construction of National Demonstration Project for the Integration of Oil, Chemical and Electric heating from Clean Utilization of High-sulfur coal 潞安高硫煤清洁利用油化电热一体化国家示范项目
Coalbed Methane 煤层气	Acceleration Project for Coalbed Methane Industry 煤层气产业提速工程	Construction of Demonstration Base for Comprehensive Utilization of Mineral Resources from Tashan's Extra-thick Coal Steam in Datong 山西大同塔山特厚煤层等矿产资源综合利用示范基地建设
		Promotion of 14 Planned Mining Areas at or above Provincial Level in Jinzhong, and Qingyuan, Gu counties. 推进晋中、沁源-古县等14个省级以上规划矿区建设
New Energy 新能源	Development Project for Wind Power 风力发电壮大工程	Construction of Wind Power Base in Shanxi Northern Area 晋北风电基地建设
		Pilots for Building Heating from Wind power in three cities of Shanxi Northern area 北部三市风电供暖工程试点

	Promotion Project for PV power 光伏发电提升工程	Leading Technology of Photovoltaic Power Generation in Datong and Yangquan 大同、阳泉光伏领跑技术基地建设
		Construction of Three Batches for National Third Batch of Photovoltaic Leading Technology Base 争取全国第三批光伏“领跑技术基地”建设
Automobile Manufacture 汽车制造	Promotion Project of New Energy Vehicle 新能源汽车提升工程	Electric Vehicle Industrial Base in Taiyuan, Jincheng, Changzhi, Jinzhong, Yuncheng 太原、晋城、长治、晋中、运城电动汽车产业基地
		Methanol Automobile Industry Base in Jinzhong, Changzhi 晋中、长治甲醇汽车产业基地
		Gas Automobile Industry Base in Taiyuan, Yuncheng, Datong 太原、运城、大同燃气汽车产业基地
Energy Equipment Manufacture 能源装备制造	Quality Upgrading Project 提质工程	Construction of Coal-bed Methane Equipment Manufacturing Base in Taiyuan, Jincheng 太原、晋城煤层气装备制造业基地
		Industrial Zone for Solar Energy Integration in Jinneng Group and Luan Group 晋能、潞安太阳能一体化工业园区建设
Big Data 大数据	Application Project of Big Data Application 大数据应用工程建设	Information Platform for Coal Regulatory in Shanxi 山西省煤炭监管信息平台
		Big Data Platform for China's (Taiyuan) Coal trading Center 中国（太原）煤炭交易中心大数据平台
		Shanxi's Data Center for Energy Cloud 山西“能源云”数据中心

POLICY RECOMMENDATIONS

Shanxi's political economy status indicates that while sectoral policy targets might deliver incremental progress in terms of higher energy efficiency or lower pollutants emissions, an overall improvement in terms of total emissions reduction and a cleaner economic structure could be a challenging goal if there is no stronger climate policies in place.

There is a need to set more stringent long-term, economy-wide climate goals. An absolute carbon cap is an important approach to enhancing existing climate targets to decarbonizing economic growth patterns throughout China's provinces. Without such a goal, a change in investment behavior toward green growth projects will likely not happen. Even with existing robust environmental policies and clean energy development objectives, the climate impact of Shanxi and China's future economic growth remains unclear. An absolute carbon cap, mandatory or voluntary, can play the core role. It can provide clear targets for what should be achieved when a national long-term strategy for low-carbon and green growth is laid out, and provide a clear indication of what is needed to mobilize investment in low carbon technology and infrastructure to meet these national low-carbon imperatives.

Policy solutions guiding fiscal investment need to be prioritized in political agenda to address the challenges that remain on new economic growth engine and employment opportunities. The primary approach is to explore actionable and measurable solutions shifting the investment from coal and energy incentive sectors to knowledge-driven, labor-driven and innovative industries. This theory of change was outlined in the book "*Escaping The Resource Curse* (Humphreys, Sachs, Stiglitz, Soros, & Humphreys, 2007) as "a revenue management law for income" from exploiting resources. In Shanxi, the solutions include approaches to increase resources tax income, programs to set long-term fiscal investment fund using coal revenue, and actions to implement green finance policies principals. There are promising policy signals in the TAPs, which commit to set green finance pilots in Shanxi. This would have profound impact on Shanxi's quality growth.

Challenges on employment and new economic growth driver might be great but at the same time bringing magnificent opportunities. At the center of the solutions should be a comprehensive policy system and need persist efforts even cross generations. Strong climate policies set the long-term goal and financing mechanism could help mobilize resources, jobs and development toward a cleaner and greener direction. This will need to be supported by a strong institutional set-up and strong incentives for policy makers and regulators.

In conclusion, to help Shanxi achieve the transition from coal industries, revolutionary policies aiming at a vision beyond coal are more critical than incremental policies tying to either extend the coal industry value chain or improve energy efficiency or environmental impact within coal industries. As an energy expert mentioned during the interview, Shanxi would be finally on track for green and quality growth, when the top 10 items of Shanxi governor's daily agenda does not consist of coal related issues.

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