

Synergistic effect of regional energy transformation and air pollution control

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Introduction

- Guangdong contributes over 10.6% of China's GDP and consumes 7% (301 million tons of coal equivalents) of China's energy in 2015.
- China proposes three-year plan on defending the blue sky to significantly reduce PM2.5 emission. At the same time, the Guangdong Provincial Government proposed to implement the total energy consumption total value and energy intensity control, carbon emission intensity control.
- Control measures for energy, carbon emissions and air pollutants in Guangdong Province promote energy transformation in Guangdong Province.

Future Scenario

- All the datasets are converted to the base year of 2015.
- The projections on population and GDP are based on the 12th five-year economic development plan and research assumptions.

Table.1 Key assumptions

	2015	2015-2030
Population (million)	108.5	0.5%
GDP (million Yuan)	72812.55	7%

Table.2 Scenario setting

No.	Scenario	Description
1	BaU	The baseline scenario, according to the trend of 2015 development, does not consider health effects, as a reference scenario, it does not actually exist.
2	BaU_RE	In the renewable energy scenario, high-renewable energy and coal-fired replacement will be completed by 2030. By 2020, Gas power generation 23GW, Wind power generation 18GW, hydro power generation 7.28GW, Nuclear power generation 16GW, Solar power generation and other 7.4GW. By 2030, Gas power generation 37GW, wind power generation 40GW, hydro power generation 11GW, Nuclear power generation 21GW, Solar power generation 13.6GW
3	INDC_wo	The INDC scenario, Renewable power as same as BAU_RE, to 2030 Guangdong carbon emission intensity will reduced by 60-65% compared to 2005, the future air pollutant control strategy is consistent with 2015.
4	INDC_wi1	Completion of the national INDC target, air pollutant control strategy is gradually improved, PM2.5 is effectively controlled, 10% lower than in 2015 by 2020, and 20% lower than 2015 by 2030.
5	INDC_wi2	Completing the national INDC target and formulating stricter air pollutant control policies, PM2.5 is further controlled. In 2020, it will 20% lower than in 2015. By 2030, the most stringent air pollutant control technology will be adopted.

Methods

1.GAINS Model:

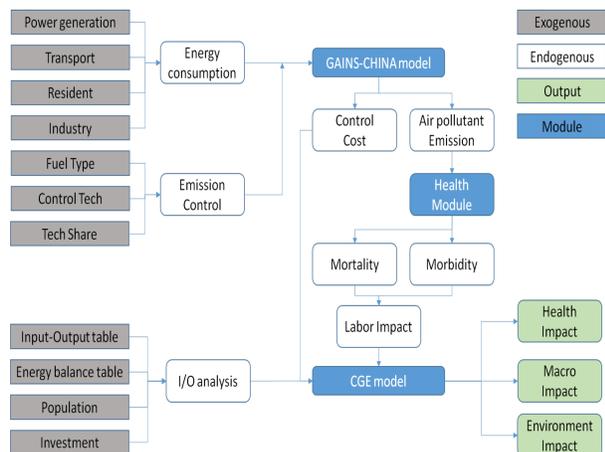
GAINS model outputs Annual PM2.5 concentration and control cost in various scenarios

2.Health Impact Module:

Quantifies morbidity and mortality as well as derived medical expenditure, work time loss and premature death.

3.ICAP/GD-CGE Model:

Worktime loss and premature death are input as labor impact disturbance variables to CGE model which could simulate the macro impact and health impact.



Results

1.Power sector structural transformation

By 2020, coal-fired power generation in Guangdong Province will account for about 44%. Secondly, nuclear power and gas power account for 21%, wind power accounts for 7%, hydropower accounts for 5%, solar energy and other accounts for 1%, renewable energy accounts for 13%, and clean energy power accounts for 34%. By 2030, coal-fired power generation in Guangdong Province will account for about 33%. Secondly, gas power accounts for 31%, nuclear power accounts for 21%, wind power accounts for 9%, hydropower accounts for 3%, solar energy and other accounts for 2%, renewable energy accounts for 14%, and clean energy power accounts for 35%. (Fig.1)

2.PM2.5 concentration

BaU_RE will have a PM2.5 concentration of approximately 36 $\mu\text{g}/\text{m}^3$ by 2020 and approximately 34 $\mu\text{g}/\text{m}^3$ by 2030. The INDC_wo scenario will have a PM2.5 concentration of approximately 33.3 $\mu\text{g}/\text{m}^3$ in 2020 and a decrease of 31.4 $\mu\text{g}/\text{m}^3$ in 2030. The INDC_wi1 scenario is about 31.3 $\mu\text{g}/\text{m}^3$ at 2020 PM2.5 and 27.8 $\mu\text{g}/\text{m}^3$ at 2030. The INDC_wi2 scenario will have a PM2.5 concentration of approximately 27.9 $\mu\text{g}/\text{m}^3$ by 2020 and a decrease of 26.5 $\mu\text{g}/\text{m}^3$ by 2030. (Fig.2)

3.Macro Impact:

In 2030, the INDC_wo scenario has a GDP loss of 0.3% compared to the base scenario. Residents income loss 0.5%. Compared with the INDC_wo scenario, INDC_wi1 scenario GDP increased by 4.9 billion yuan, and residents' income increased by 4.1 billion yuan, INDC_wi2 scenario GDP increased by 8 billion yuan, and resident income increased by 6.6 billion yuan. (Fig.3)

4.Benefit/cost

By 2020, air pollution control costs are lower than GDP growth. By 2030, the INDC_wi2 scenario with a more stringent air pollution control strategy will result in GDP growth greater than governance costs, The benefit/cost ratio will reach 0.76 and 1.18 by 2030, respectively. (Fig.4)

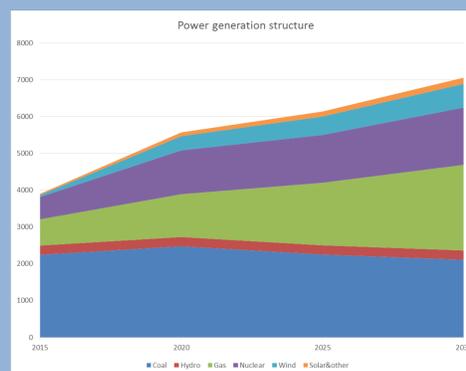


Fig.1 Power generation structure

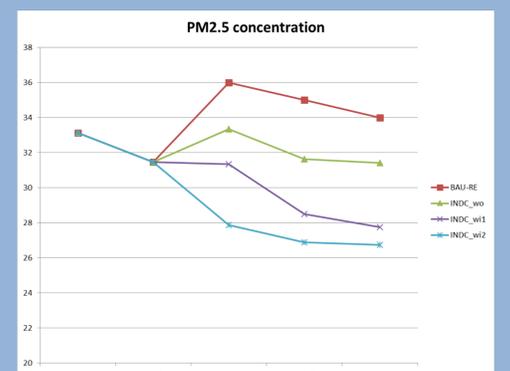


Fig.2 PM2.5 concentration

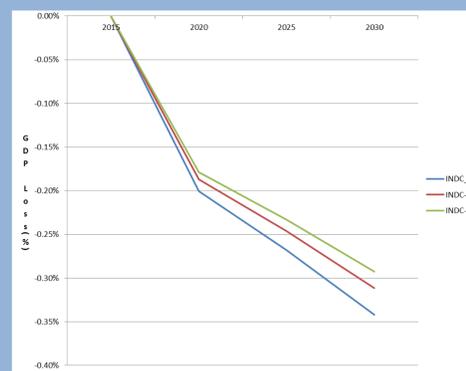


Fig.3 GDP Impact (%)

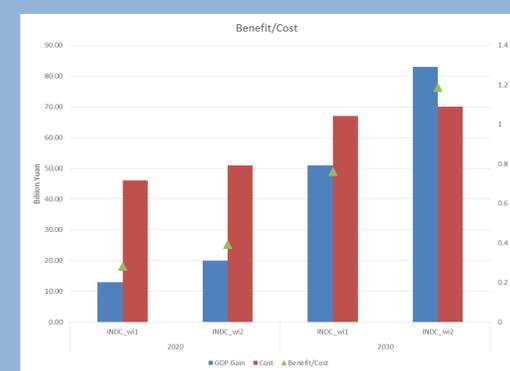


Fig.4 Benefit&Cost

Conclusion

References :

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1. By 2030, Guangdong's renewable energy power generation accounts for 14%, and clean energy power generation accounts for 35%.
2. Through the strict air pollutant control strategy, the PM2.5 concentration in the INDC_wi1 and INDC_wi2 scenarios will drop to 27.8 $\mu\text{g}/\text{m}^3$ and 26.5 $\mu\text{g}/\text{m}^3$ by 2030.
3. Considering the health impact, the INDC_wo scenario reduces GDP by 0.35% compared to the baseline scenario, but by increasing the air pollutant control strategy, it can increase Guangdong's GDP 8 billion Yuan, and resident income increased by 6.6 billion Yuan.
4. By 2030, the GDP increase in the INDC_wi2 scenario with a more stringent air pollutant control strategy will be higher than the control cost, the benefit/cost will be 1.18.