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A model case of economic assessment

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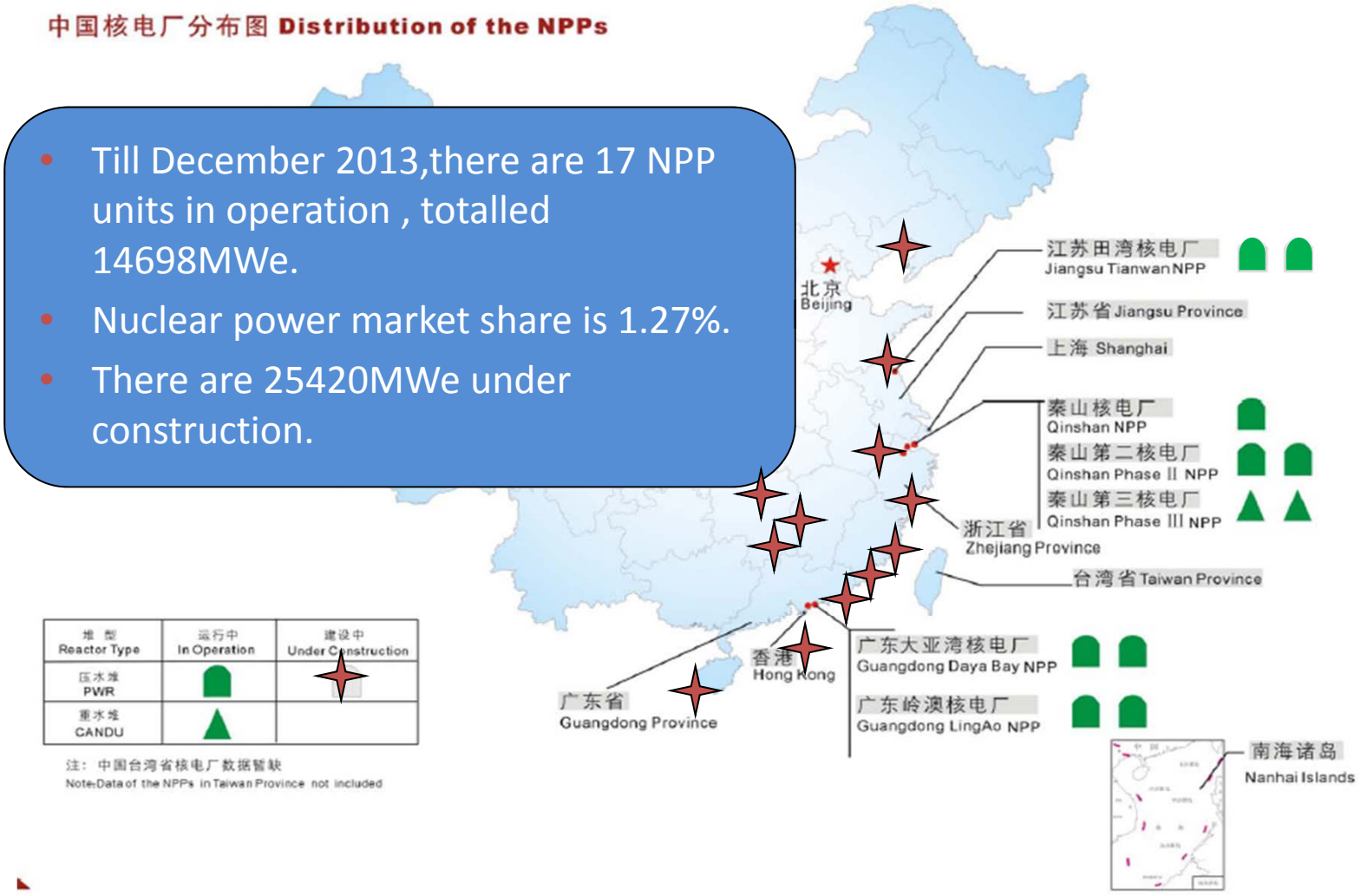
中国核电厂分布图 Distribution of the NPPs

- Till December 2013,there are 17 NPP units in operation , totalled 14698MWe.
- Nuclear power market share is 1.27%.
- There are 25420MWe under construction.



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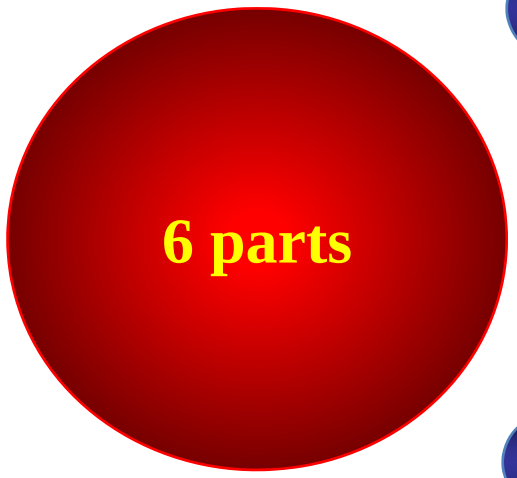

1. Methodology
2. Basic parameters of the case
3. Estimation of the case
4. Production cost and financial assessment
5. Sensitivity analysis
6. Conclusion

This report estimates a nuclear power plant and makes economic analysis based on INPRO methodology.

Firstly, we look at the cost estimation:

- The cost is estimated based on two nuclear power plants' investments which are the similar type with this model case.
- This estimation is the price to construct a ×AP× type nuclear power plant in China.

Secondly, economic analysis including:

- Calculating production cost and analyzing cost composition.
- Calculating sales price based on specific conditions.
- Calculating figures of merit to make financial assessment.
- Making a sensitivity analysis about how three factors influencing sales price.

The change rate from RMB to US dollar is 6.2.

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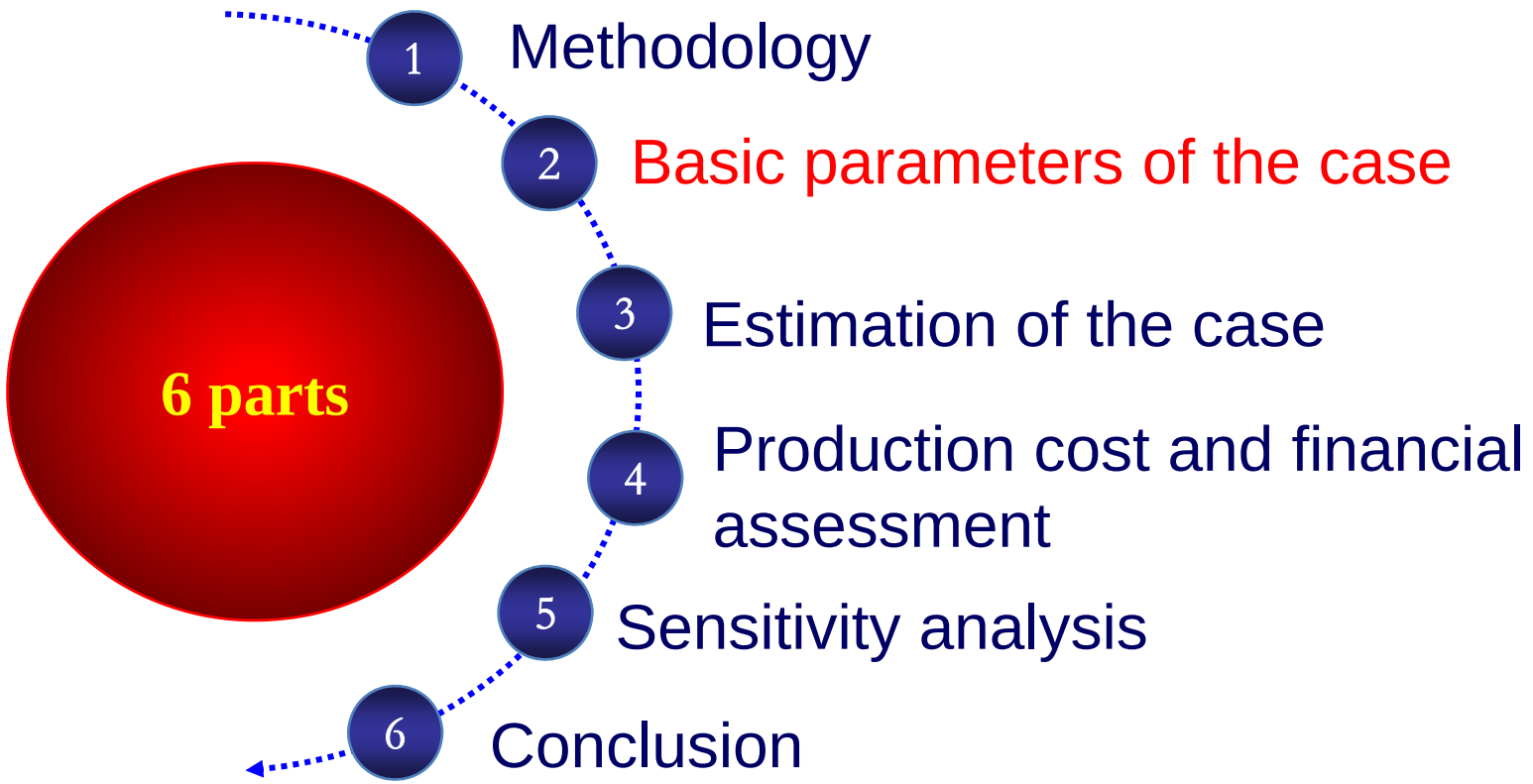
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This is a two units nuclear power plant that is established besides a sea, so cooling tower is not needed. Basic parameters of this nuclear power plant are shown in the table:

Items	
Units amount	2
Single unit capacity	1250MWe
Heat efficiency	36.8%
Load factor	80%
Station service power consumption rate	7.5%
Construction duration	63 months
Economic operation duration	30 years

There are some points to take notice:

- Days for construction is 63 months for each unit. The second unit starts constructing 9 months after the first unit starts.
- At the first year of operation, load factor is 67% distinguishingly.

Finally, the estimation reference date is December 2013.

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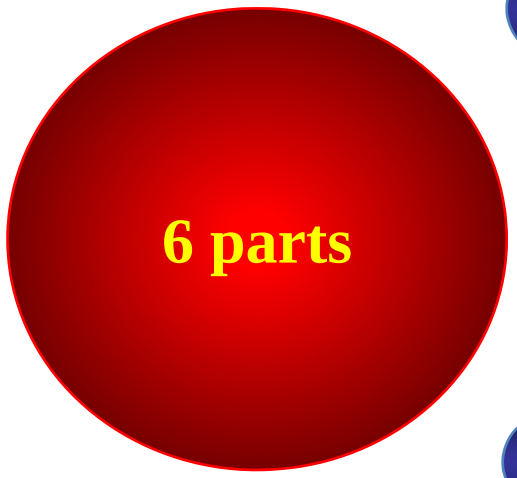

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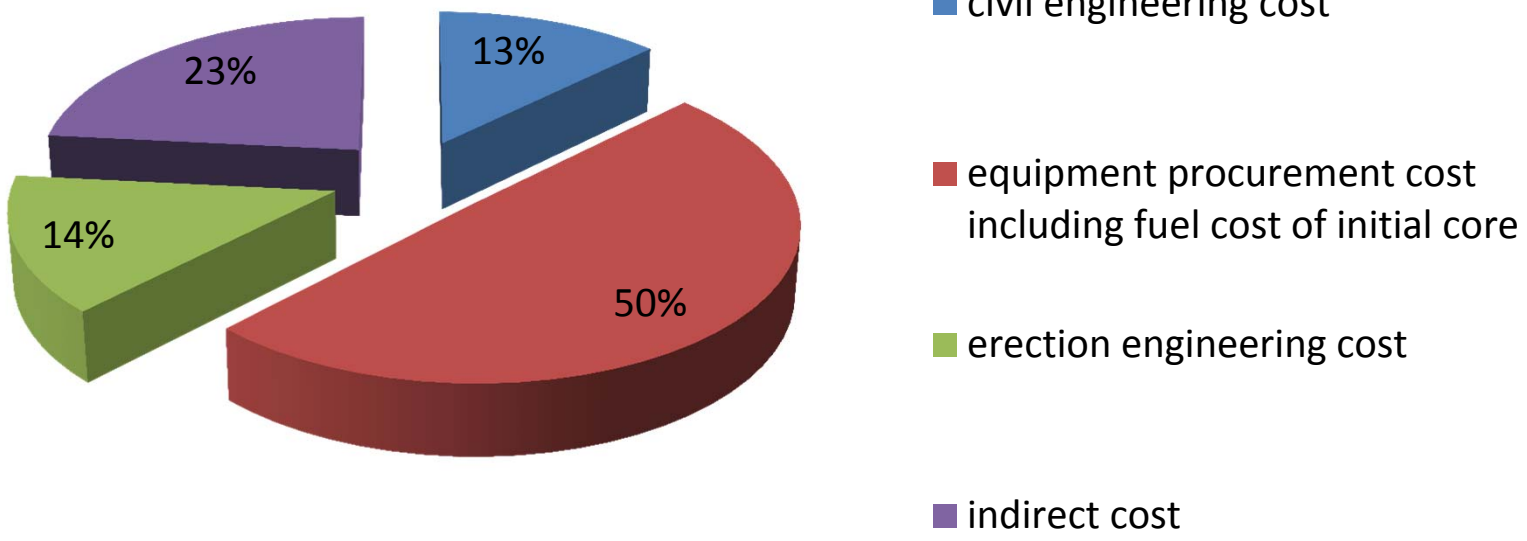
- Estimation of the case(1)
- Here we estimate the overnight cost including civil and erection cost, equipment procurement cost including fuel cost of initial core, indirect cost like land expense, management cost, exploration survey cost and engineering design cost, technical service cost, operation preparation cost, contingency, etc.
- Based on two similar type of nuclear power plant's investments, an approximate estimate is made.

- Estimation of the case(2)
- The two units of 2500 MWe nuclear power plant cost is shown in the table:

Items(2*1250MWe)	Million US$
Civil engineering cost	730
Equipment procurement cost including fuel cost of initial core	2846
Erection engineering cost	820
Indirect cost	1343
Total	5739

- Estimation of the case(3)



- Estimation of the case(4)
- Assume this project is started at the year of 201×. Construction investment schedule is as following:

Year	201×	201×+1	201×+2	201×+3	201×+4	201×+5	201×+6
Ratio(unit 1)	6%	12%	7.8%	8.4%	9%	10.2%	6.6%
Ratio(unit 2)		8%	5.2%	5.6%	6%	6.8%	8.4%
Total	6%	20%	13%	14%	15%	17%	15%

Ratios of unit1 and unit2 are both the ratio of total overnight cost .

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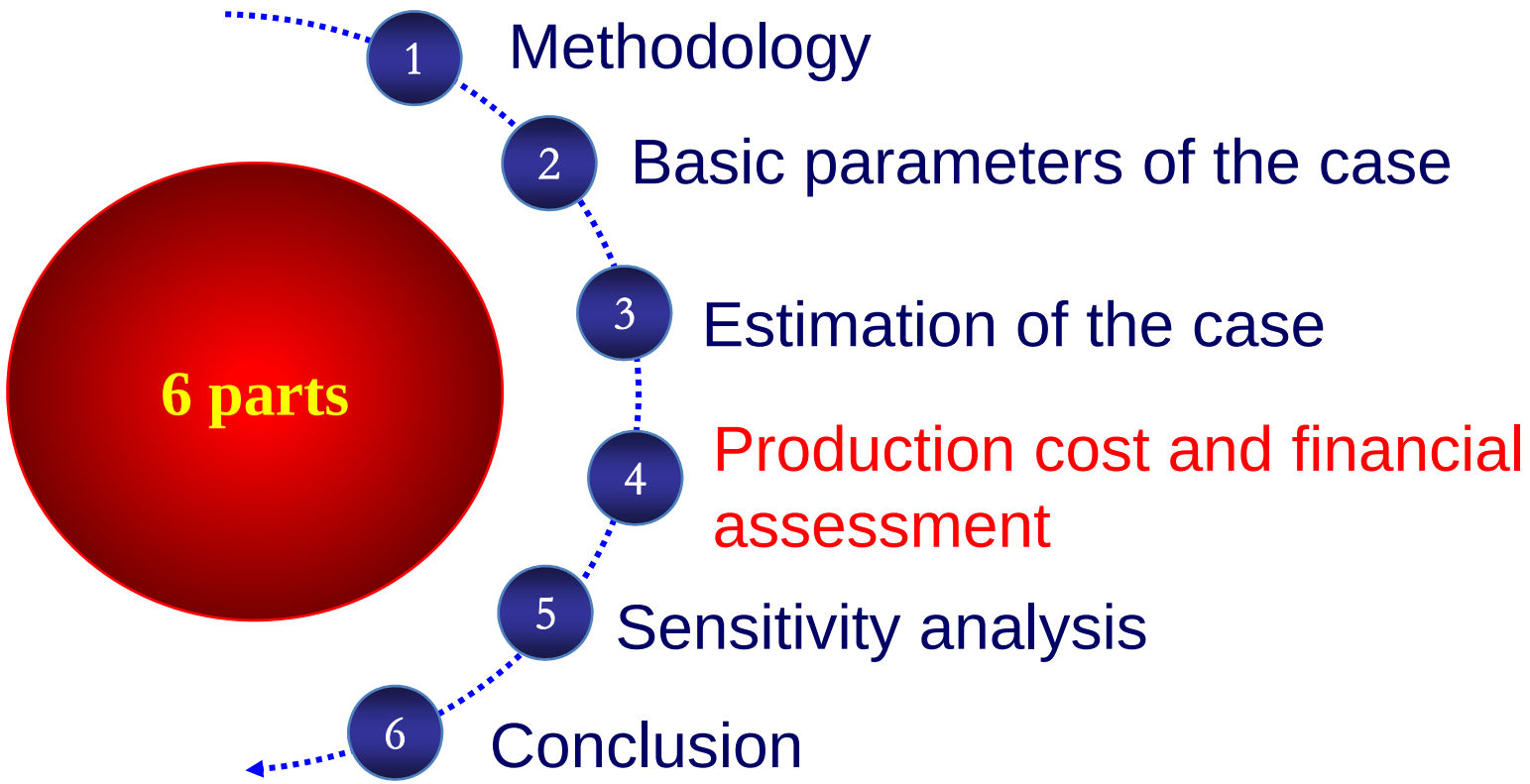
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- Production cost (1)
- Assume there is a new company established to build and operate the nuclear power plant. The capital cost is 20% of the total investment cost of the project(total investment cost of the project is overnight cost plus the interest of the amount of fund shortage).
- There are two financing channels with 4% interest rate(16% of the shortage is raised in this way)and 6.7% interest rate (84% of the shortage is raised in this way).

- Production cost (2)
- Other relative parameters are shown as following:

Items	
Economic operation duration	30 years
Fixed assets proportion	95%
Intangible assets proportion	5%
Residual value proportion	2%
Depreciation life*	25 years
Amortization life	5 years

*Using straight-line depreciation.

• Production cost (3)

- Operation expenditures are as following:

Items	Million US$/year
Fuel cost	148
Spent fuel disposal cost *	69
Material cost	19
Maintenance cost	74
Labor cost*	28
Decommissioning cost	21
Insurance cost	Is calculated by net value of fixed assets multiply by 0.25%

* Spent fuel disposal cost is happened at the sixth operation year.

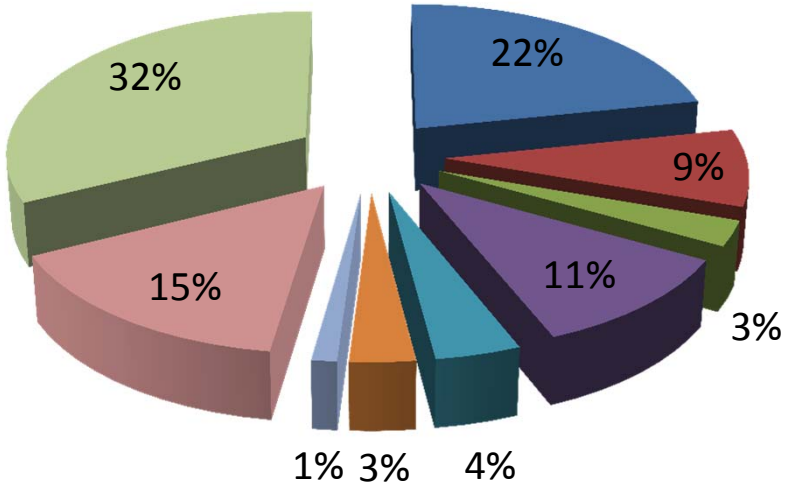
* There are 800 persons working in the nuclear power plant.

• Production cost (4)

- Then we get the total production cost in whole economic operation life:

Items	Million US$
Fuel cost	4377
Spent fuel disposal cost	1726
Material cost	568
Maintenance cost	2165
Labor cost	815
Decommissioning cost	625
Insurance cost	242
Financial cost	3089
Depreciation of fixed assets and Amortization expenses	6520
Total	**20128**

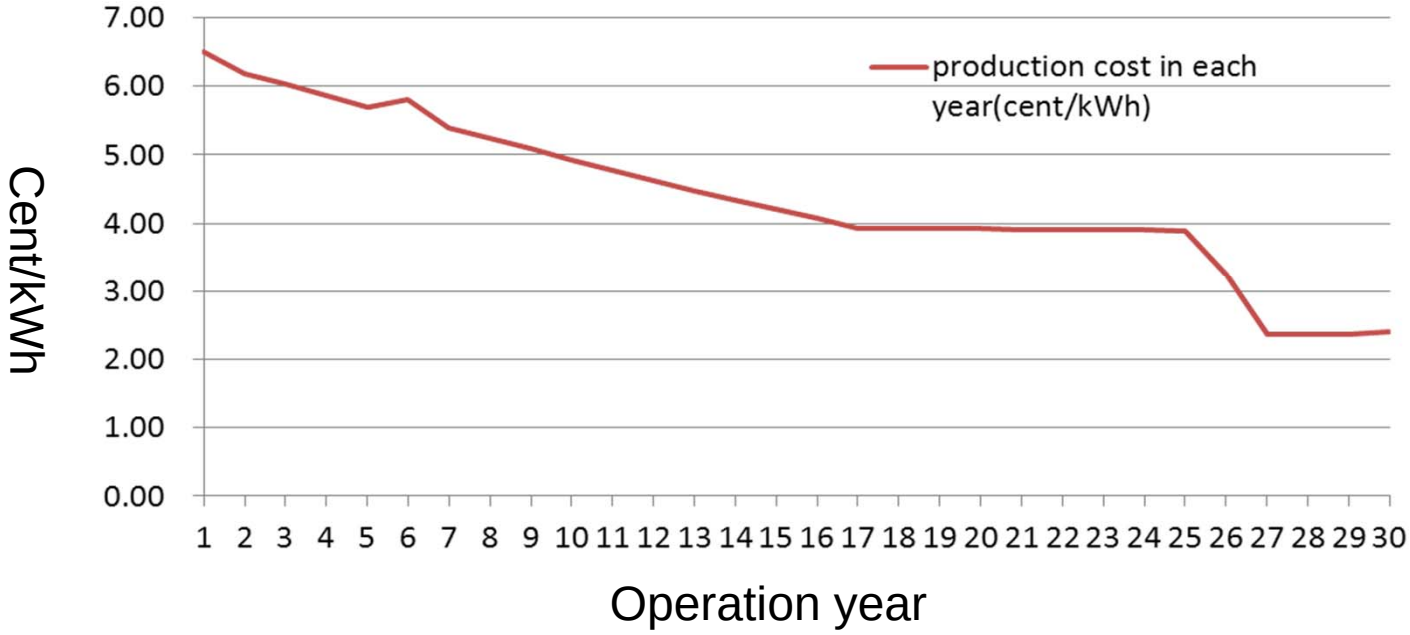
- Production cost(5)



- Fuel cost
- Spent fuel disposal cost
- Material cost
- Maintenance cost
- Labor cost
- Decommissioning cost
- Insurance cost
- Financial cost
- Depreciation of fixed assets and Amortization expenses

• Production cost (6)

- Production cost in each year



- The average cost is 4.33 cent/kWh.
- The maximum cost is 6.49 cent/kWh.

- Financial assessment(1)
- Parameters in operation period:
  - output tax rate:17%
  - input tax rate for water purchase:13%
  - input tax rate for material purchase:17%
  - urban maintenance & construction tax rate:7%(it is based on the output tax)
  - extra charges of education funds:5%(it is based on the output tax)
  - income tax rate:25%
  - accumulation fund rate:10%

• Financial assessment(2)

- Based on all the above prerequisite, we calculate power sales price when internal rate of return is 9%. And with other figures of merit, we can see in the table:

Items	
Sales price	7.14 cent/kWh
Repayment period of investment	16.25 years
NPV	16.80 million US$
ROI	5.64%

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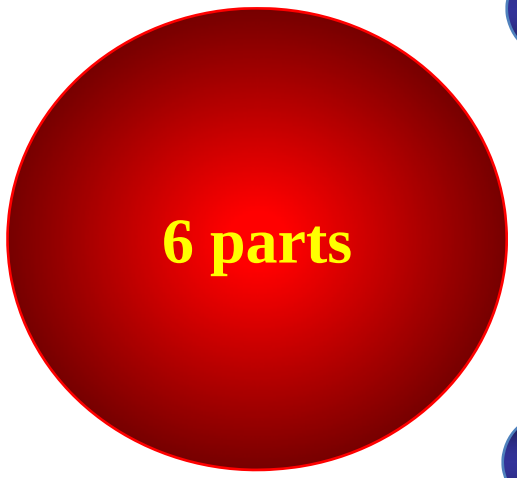

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• Sensitivity analysis

- Here we make a sensitivity analysis, chiefly study on the impact of capital cost, load factor and fuel cost to sales price.

Factors	Rate of change(%)	Sales price(cent/kWh)	Sales price change rate(%)	Sensitivity Coefficient
Model case	0	7.14	0	0
Capital cost	-5	6.87	-3.75	0.75
Capital cost	5	7.41	3.75	0.75
Load factor	-5	7.44	4.18	-0.84
Load factor	5	6.87	-3.78	-0.76
Fuel cost	-5	7.09	-0.74	0.15
Fuel cost	5	7.20	0.74	0.15

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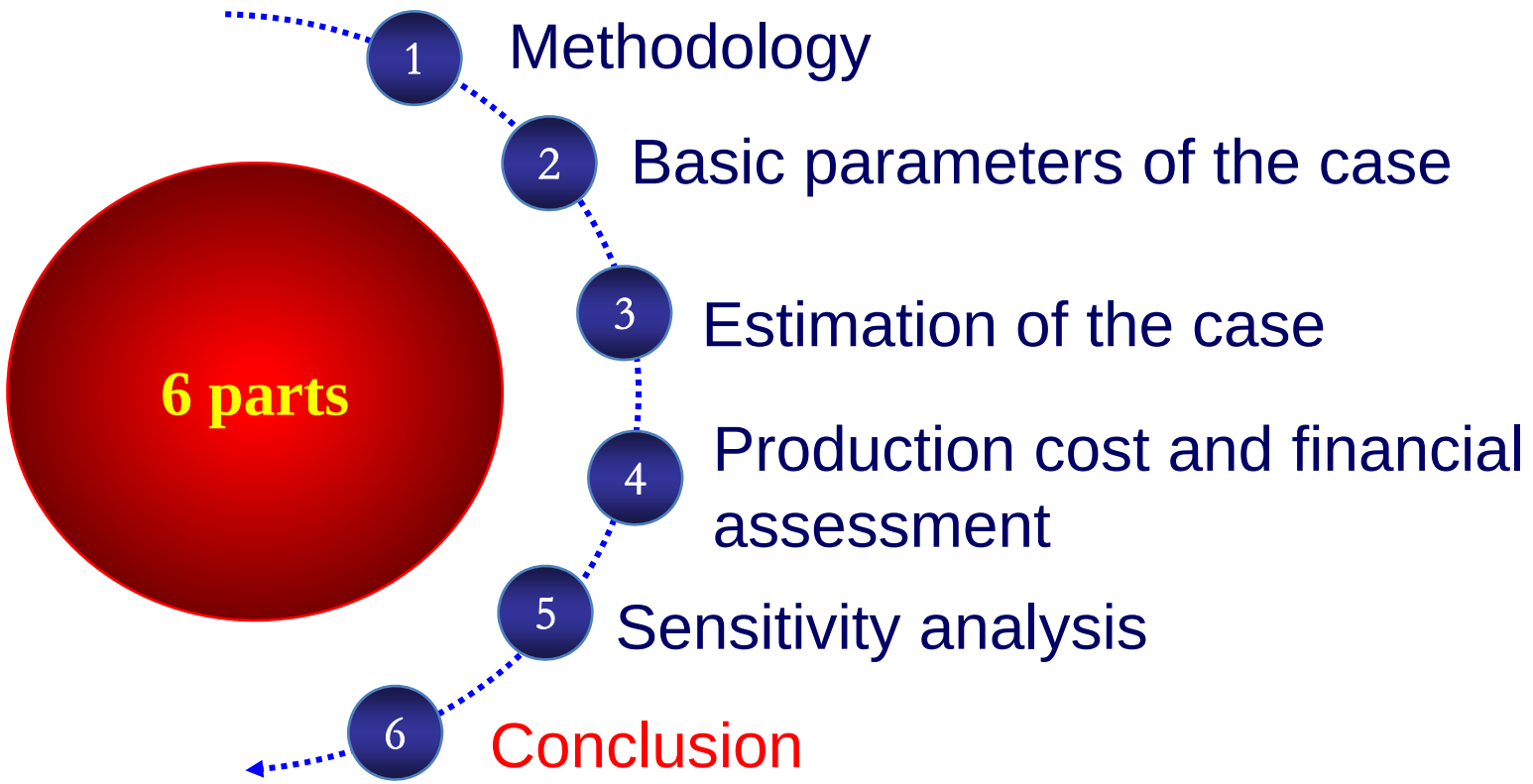
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• Conclusion

Overnight cost

In the overnight cost, equipment procurement cost including fuel cost of initial core is the most important part.

Production cost

In the total production cost, depreciation of fixed assets and amortization expenses, fuel cost occupy more proportion.

Financial assessment

As NPV>0，this project is economically feasible.

Sensitivity analysis

The sensitivity analysis shows that, load factor and capital cost have a more influence on the power sales price.

Thank you for attention!