BENCHMARKING OF PRODUCTION COST

Theoretical & Practical Considerations For Power System Planning

Training course on Power System Planning and Environmental Impact Assessment

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by Tuan A. NGUYEN

Innovation Energie Développement

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What is benchmarking

- Benchmarking :
  - A tool or a study to help you to improve your business by comparing the performance of systems.
  - The process of identifying, understanding, and adapting outstanding practices from other organizations to help your organization improve its performance.
- Highly respected practice in the business and in sciences. It is an planning activity that looks outwards to find best practice and high performance and then measures actual business operation against those goals.
- When comparing benchmark results, it is important to know exactly what the benchmarks are designed to compare.
- A benchmark of fuel efficiency, for example, may be irrelevant to the system if the power plant uses different fuel specifications from those used in the benchmark.

Benchmark – who is right ?

Benchmarking of electricity production costs

- Cost reductions become a vital issue, a key objective of many electric power utilities to be competitive in the light of deregulation process
- Quite disparate production cost between utilities
- In order to reduce production cost to serve as operation objective, the management need a way of assessing their performance in concrete indicators
- So many factors affect the overall system performance ➔production cost : system configuration, load curves, regulation and taxes in places, environment, fuels…, as well as socio-cultural factors…

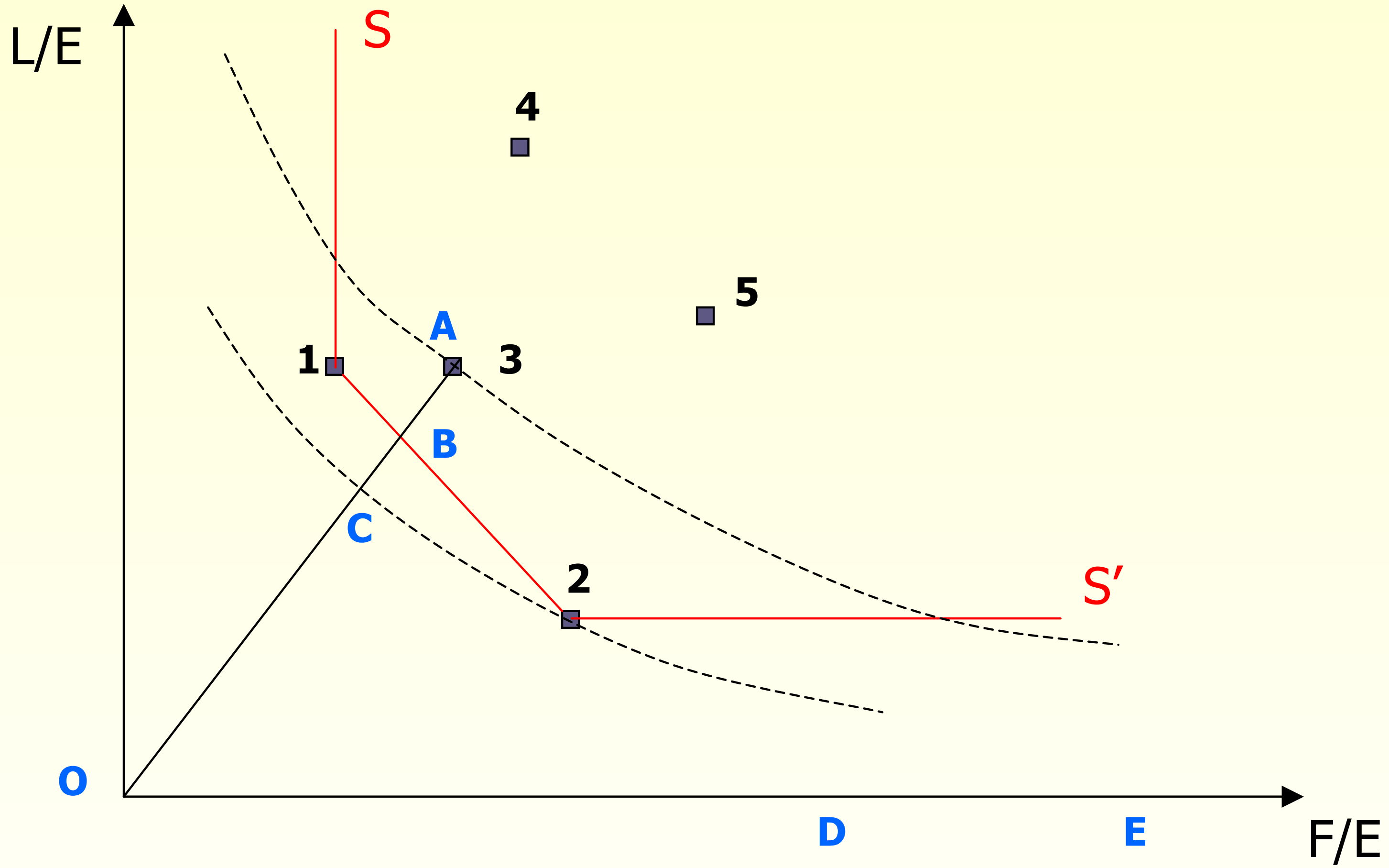
Benchmarking of production costs

- To measure production performance in power industries, there are many technical, economic indicators, as well as financial indices :
  - specific fuel consumption,
  - thermal efficiency,
  - outage day,
  - labour operation efficiency,
  - capital cost or operational efficiency
- Although each individual indicator can be used to gauge that an utility A performs better than an utility B in that aspect, we would not draw the overall conclusion or determine the extent to which utility is superior or inferior based on each individual factor.
- In practice, power production means are so different also the relative method of calculation of each factor. As such, without a normalised set of indicators, it is impossible to make an overall comparison among utilities ➔ How the utilities can improve theirs performances ?

Theoretical considerations

- The measurement of efficiency in power sector is complicated by it nature : so many variable endogenous and exogenous
- Farell (1957) introduced a measure of overall efficiency, divided into two categories:
  - Technical efficiency which measures the ability of an utility to obtain maximum output from a given set of inputs;
  - Allocative (price) efficiency measures the ability of an utility to use the input in optimal proportions given their respective prices and the production technology

Best practice efficiency diagram



Technical efficiency

- Point B represents an efficient firm using the two factors in the same ratio as A, but it uses only fraction OB/OA as much of each factor → It could be thought of as producing OA/OB time as much output from the same inputs
- OB/OA is technical efficiency of the firm 3

Allocative (price) efficiency

- Farrel (1957) defines the allocative (price) efficiency of observation 3 as the ratio OC/OB
- Thus if the plant is facing the input prices that plant 3 is facing → the point B is technically efficient
- However, the point B is not allocatively efficient since input costs could be reduced by moving from point B to point 2
- The proportion by which costs could be reduced by moving from point B to point 2 is OC/OB

Practical price efficiency

- The analysis will focus on the price paid for the fuels of the thermal power plants. The information obtained from the utility regarding the prices paid and the contractual arrangements will be compared with the corresponding information obtained from other utilities in the region.
- The comparison will indicate whether other utilities paid lower prices and, if so, why

Efficiency measures

- Fuel efficiency F/Y (kg/MWh)
- Labour efficiency L/Y (person hours/MWh)
- Material efficiency M/Y (€/MWh)
- Capital efficiency K/Y (MW/MWh)
- Divers efficiency D/Y (€/MWh)

Unit cost as single efficiency measure

- $UC = (Pf * F/Y) + (Pl * L/Y) + (Pm * M/Y) + (Pk * K/Y) + (Pd * D/Y)$
  - Where Pf, Pl, Pm, Pk, Pd : the unit prices of F, L, M, K et D.
- $VC = UC – (Pk * K/Y+Pd*D/Y)$.
  - Where VC is variable unit cost (equal to the unit cost minus the capital cost.
- Problem : Unit cost of a plant relative to the lowest unit cost is not a satisfactory indicator of efficiency because input prices are exogenous factors → Best practice benchmarking BE

Best practice benchmarking BE

- $BE_i = \text{minimum} (BE_{ij} = [(Pf_i * F_j/Y_j) + (Pl_i * L_j/Y_j) + (Pm_i * M_j/Y_j) + (Pk_i * K_j/Y_j) + (Pd_i * D_j/Y_j)]$
  - *Where j = 1,2,...j : the number of comparable observations in other systems*
- The best practice efficiency for plant i is defined as the ratio of the best practice unit cost for the i plant to the actual unit cost
- $E_i = BE_i / CU_i$
  - Where Ei = 1 ➔ full efficiency
  - Ei<1 ➔ Unit cost for plant i could be reduced to Ei x CUi = BEi if the plant could adopt the best practice technological coefficients

Case study – Benchmarking of production cost

- The performance comparison focuses on production-related areas such as
  - fuel costs,
  - fuel efficiency of power plants,
  - availability of power plants,
  - power purchases,
  - supply quality,
  - losses,
  - staff productivity,
  - maintenance policy and costs,
  - dispatching and spinning reserve policy, etc.
  - In addition, the comparison covers activities of the customer service department and
  - DSM measures.

1) Production park

- Regroup by comparable type
  - Types of machines
  - MCR (Maximum Continuous Rating)
  - Utilisation mode
  - Fuel
- Descriptive Indicators
  - Sources and power
  - Production share
  - Property

2) Fuel and lub oil purchase

- Indicator
  - Unit price
- Explanatory Indicator
  - Quantity
  - Specifications (sulphur)
  - Conditions of transport
  - Taxes

3) Energy efficiency par group

- <u>Performance indicators</u>
  - g/kWh real
  - g/kWh corrected (either by ICP real or by 1,046)
  - BTU/kWh
  - g/kWh net of plant
  - gr. oil/ kWh
- <u>Explanatory Indicators</u>
  - Proportion HFO/DO
  - Cycle start - stop
  - Working hours
  - Average utilisation capacity
  - Thermal and electric auxiliaries

4) Operation

- Performance Indicators
  - Agents /machine
  - Agents /MW
- Explanatory Indicators
  - Total number of personnel
  - Annual working hours
  - Hours-agents/working hours

5) Availability

- <u>Performance Indicator</u>
  - Kdh et Kd
  - Tripping number per 1000h working
- <u>Explanatory Indicators</u>
  - Scheduled outage hours per machine et per MW
  - Non scheduled outage hours per machine et per MW

6) Maintenance

- Performance Indicators
  - Agent/machine
  - Agent/MW
- Explanatory Indicators
  - Comparative table of agent/machine, Scheduled maintenance hours/machine, non scheduled maintenance hours/ machine)

7) IPP

- <u>Performance Indicator</u>
  - Cost of power purchase

8) Dispatching

- Performance Indicator
  - Difference compared with ideal local
  - Difference compared with technical ideal
- Explanatory Indicators
  - Pie chart
  - ratio Minimum maximum

9) DSM

- Performance Indicator
  - Cost of kW saved
  - Cost of kWh saved
- Explanatory Indicator
  - Avoided kW
  - participation of the utility
  - Other participations

10) Tariffs

- Indicator
  - Average revenue per kWh sold

11) Customer Services

Performance indicators

- Costs per customer
- Costs per kWh sold

Explanatory Indicators

- agents/customer
- consumption
- Unit consumption

12) Losses

- Performance indicators
  - Total losses / injected kWh
- Explanatory indicators
  - Technical losses estimation
  - Non-technical losses

13) Quality of supply

- <u>Performance indicators</u>
  - criteria B Production
- <u>Supplementary indicator</u>
  - criteria B total
- [(Number of affected LV cust. + Subscribed wattage of affected MV cust.) * Duration of outage] / [Total number of LV customers + Total subscribed wattage of MV customers]

14) Environment

- Performance Indicator
  - emissions of SO_2, NO_x / MWh
- Comparative comments on regulatory and experiments

15) O&M production costs (excluding fuel and oil costs)

- Performance Indicators
  - Cost per kWh sent out by the company
- Explanatory indicators
  - Salaries in % of cost
  - Number of employees per plant, divided into Operation, Maintenance, Support & Management
  - Average salary/ employee
  - Material and subcontracts costs
  - O&M costs based on identical salaries and identical working hours

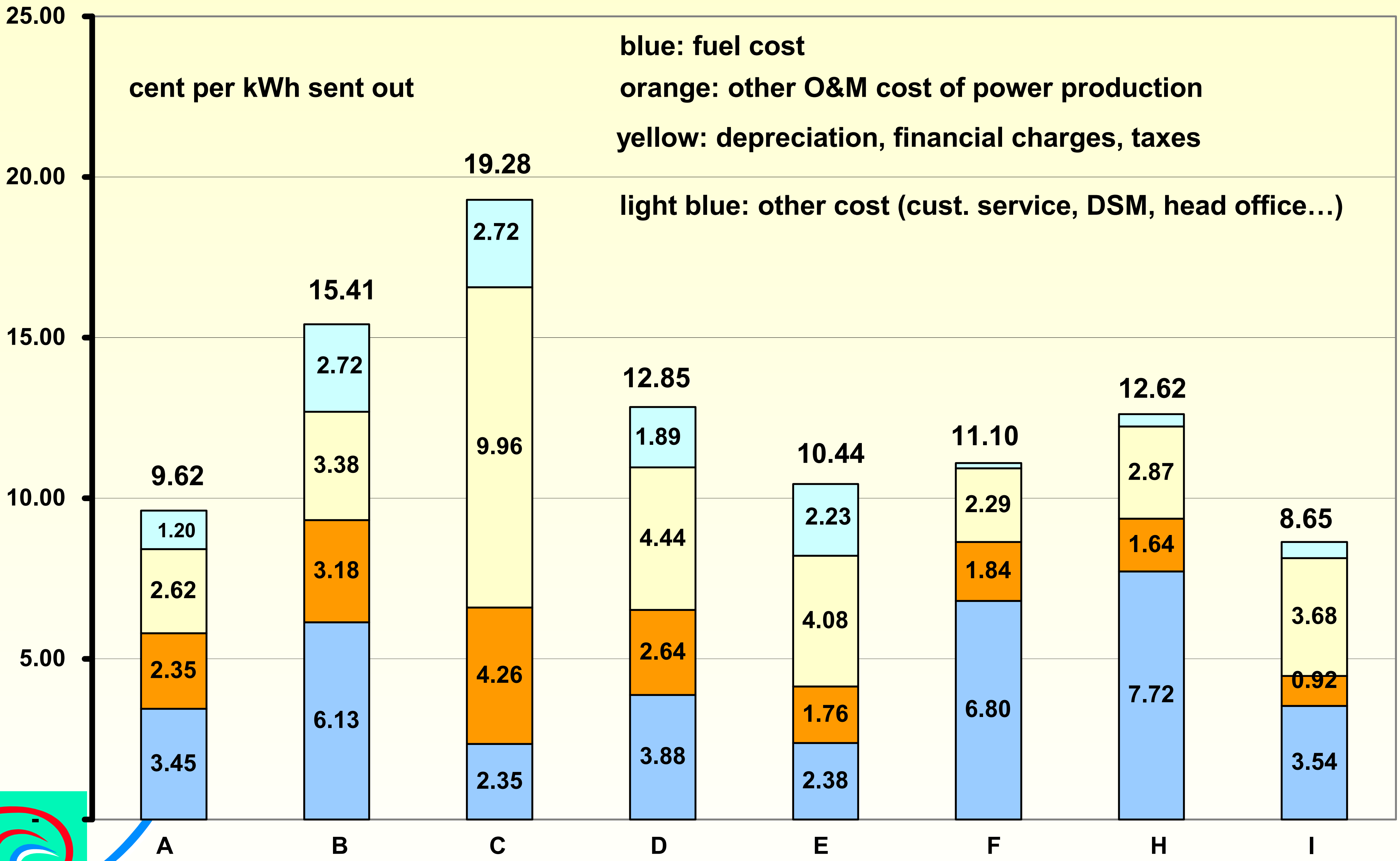
16) Depreciation, Financial charges and Taxes

- Indicators
  - Depreciation per kW installed
  - Depreciation per kWh
  - Financial charges per kW installed
  - Financial charges kWh
  - Taxes (professional, property and pollution)

17) Production Cost

- Performance Indicators
  - Utility's production cost per kWh sent out (without IPP, and with IPP)
- Explanatory Indicators
  - Fuel cost /kWh
  - O&M cost /kWh
  - Finance charges/kWh
  - Other cost /kWh (Customer services,DSM, Other costs)

Production cost – comparative study of 8 systems



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