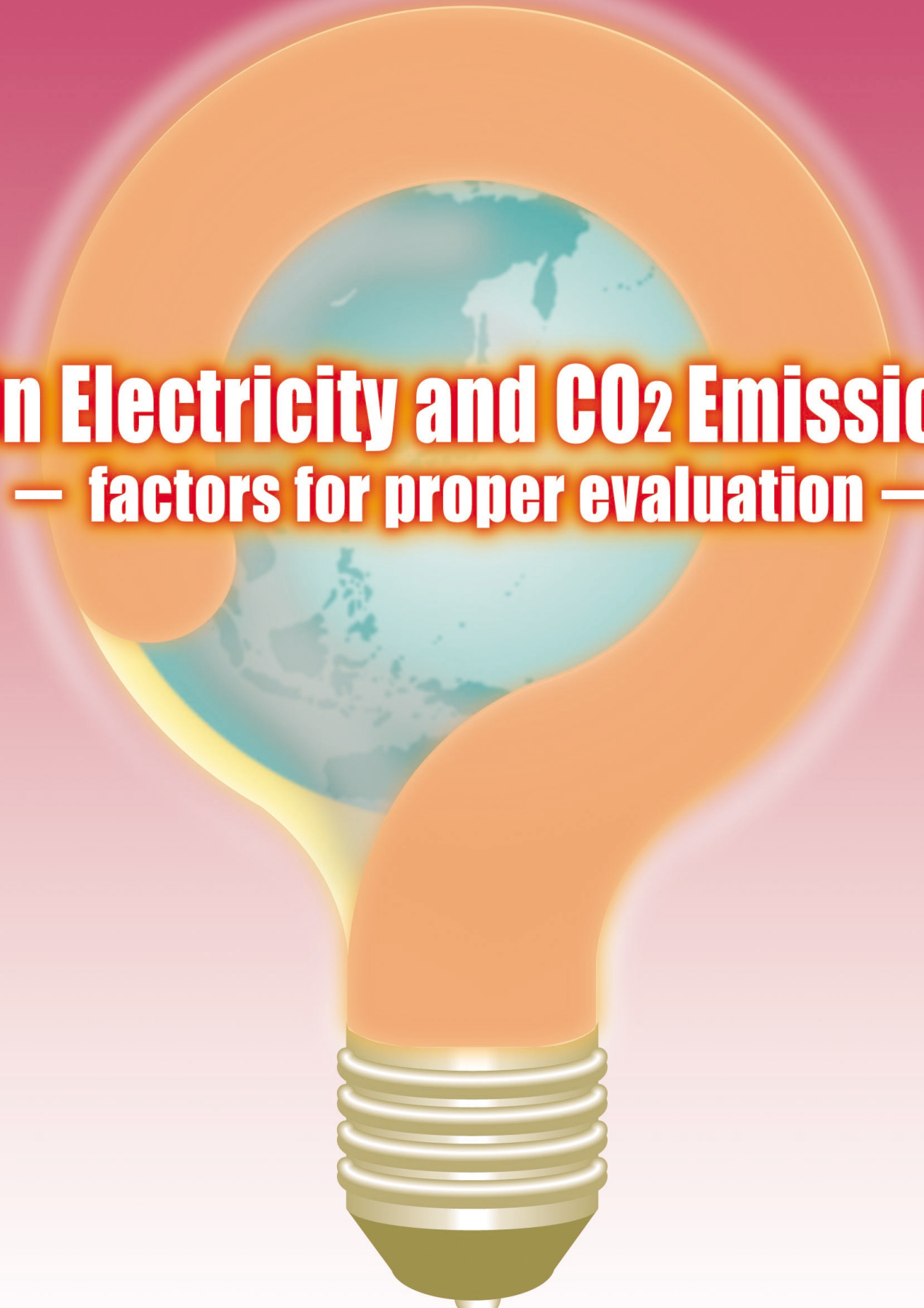


A large, glowing orange lightbulb is centered on the page. Inside the bulb, a blue and green globe of the Earth is visible. The background is a gradient of pink and purple. The text is overlaid on the globe.

On Electricity and CO₂ Emission

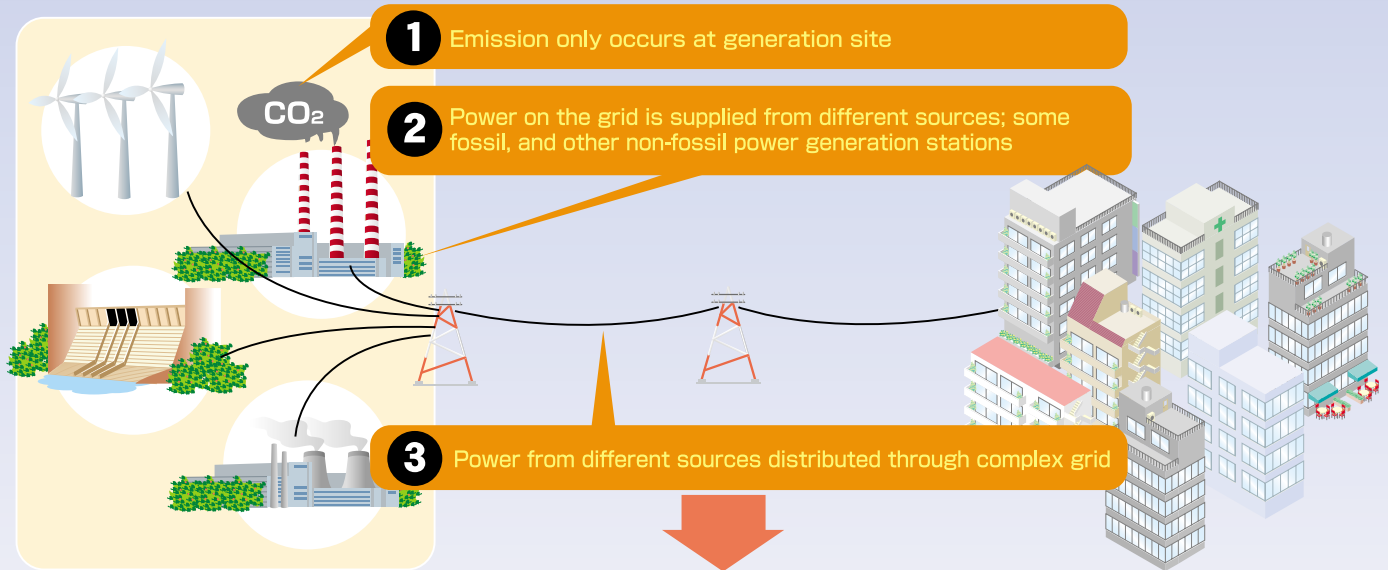
— factors for proper evaluation —

The Japan Gas Association

Estimating and evaluating CO₂ emission and its reduction from electricity use

Estimation of CO₂ emission should be made on the demand side so that it gives incentives to users to achieve greater energy saving

—Why it is difficult to calculate emission and its reduction from power use —



An appropriate choice of factor must be made for calculation of CO₂ emission and its reduction from power use

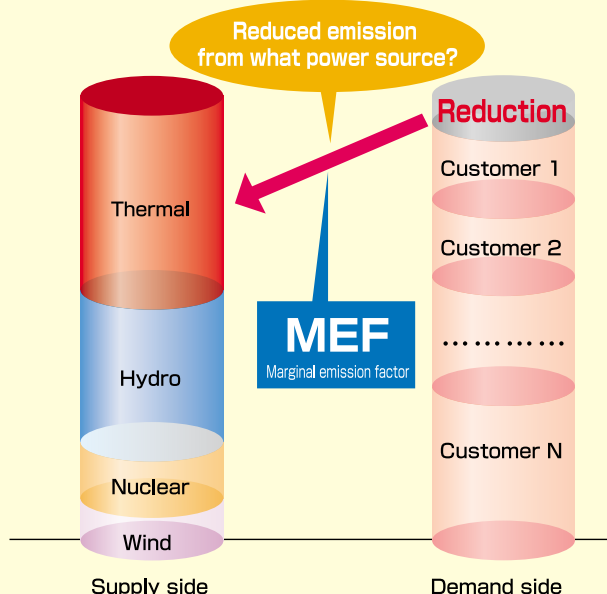
CO₂ emission from power use and reduced CO₂ emission from power conservation can be estimated using the following formulae

$$\text{a. [CO}_2\text{ emission reduction (kg-CO}_2\text{)] = [Power reduction (kWh)] \times [\text{CO}_2\text{ emission factor (kg-CO}_2\text{/kWh) of power displaced]}$$

$$\text{b. [CO}_2\text{ emission (kg-CO}_2\text{)] = [Power consumption (kWh)] \times [\text{CO}_2\text{ emission factor (kg-CO}_2\text{/kWh) of power]}$$

For estimating reduced emission from power generation(a), the '**MARGINAL EMISSION FACTOR**' (MEF) should be used. The '**AVERAGE EMISSION FACTOR FOR ALL TYPES OF POWER SOURCE**' (AEF) is sometimes used to calculate emission(b).

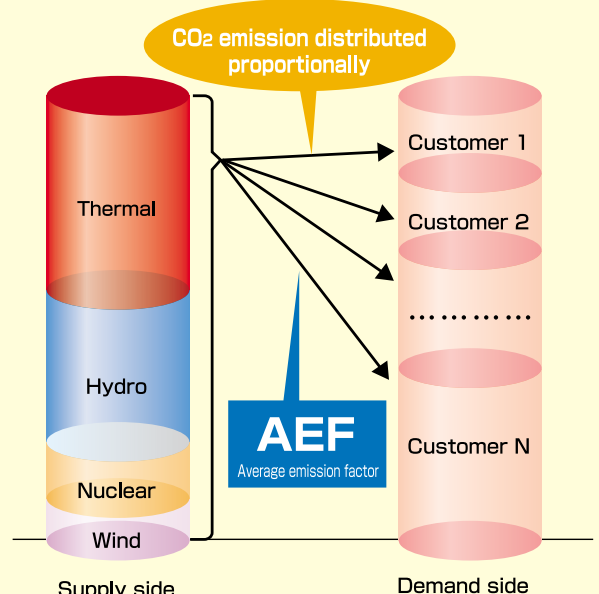
Estimating reduced emission through power saving



Estimating reduced CO₂ emission by power saving must be made using the marginal emission factor (MEF).

MEF: emission factor of a power source displaced or whose construction is delayed due to power saving projects

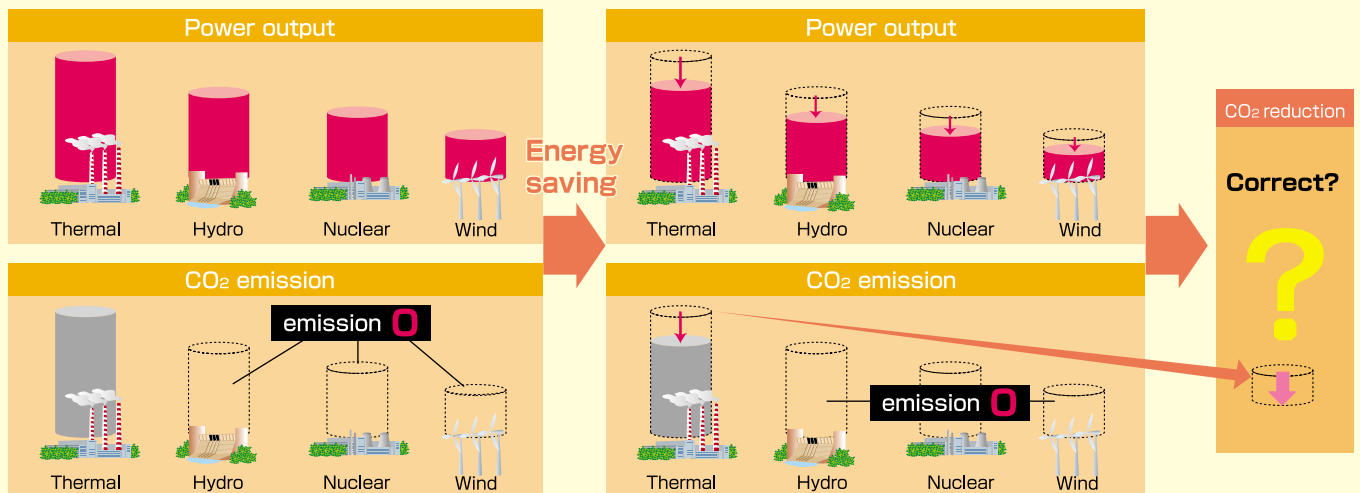
Estimating emission



The average emission factor for all types of power source (AEF) is used to estimate emission.

Total emission is distributed proportionally to all demand sectors using AEF.

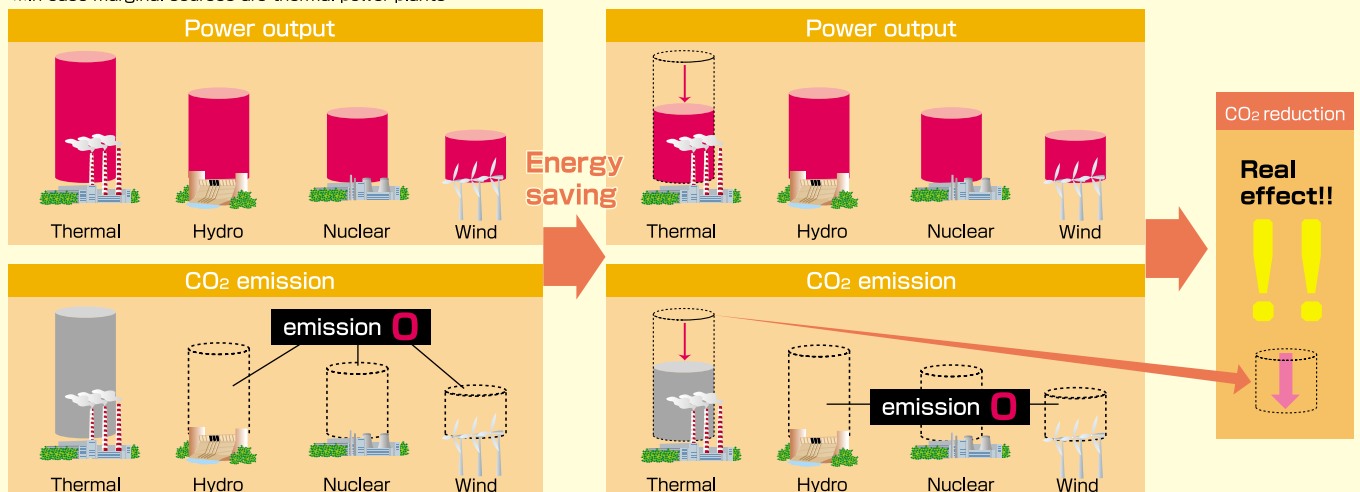
Using AEF when evaluating reduced CO₂ emission through energy saving means that power output from all sources is reduced at an equal rate.



Evaluating reduced CO₂ emission using AEF underestimates the CO₂ reduction achieved through energy saving and newly built renewable power sources.

To properly evaluate the effects of energy saving, the MEF corresponding to the power source displaced or avoided must be used.

※In case marginal sources are thermal power plants

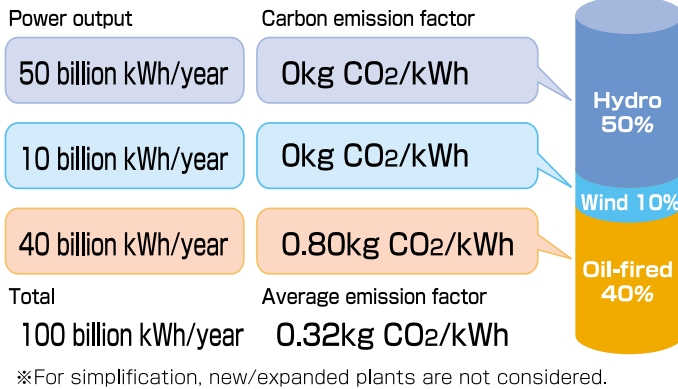


MEF properly estimates the effects of CO₂ reduction by energy saving and renewable power sources.

AEF is not an appropriate factor for estimating the effects of energy saving and GHG reduction efforts. It is counter-productive to promoting reduction of GHG emission. To avoid such an outcome, it should be appropriate to use a MEF to estimate reduced CO₂ emission by power saving.

Case studies

Assumption for hypothetical grid



Using MEF

Among existing plants, hydro and wind power plants are considered must-run plants because they require low operational costs.

Therefore, the avoided generating capacity is estimated from the capacities of the existing **oil-fired thermal plants**. 【MEF=0.80kg-CO₂/kWh】

Using AEF

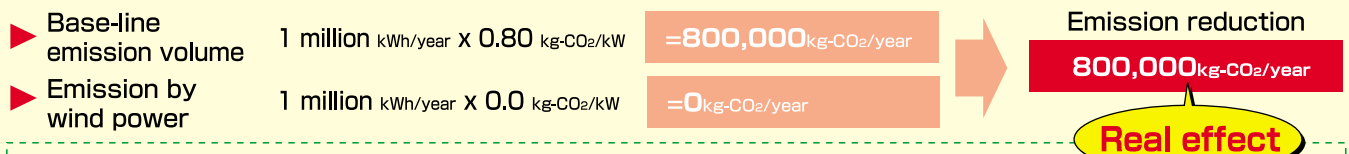
Avoided capacity is equally divided among thermal, hydro, wind, etc. that are connected to the grid. 【AEF=0.32kg-CO₂/kWh】

Calculation of CO₂ reduction measures and their effects

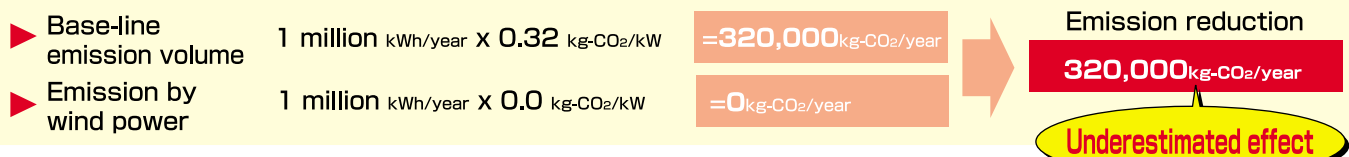
Case 1

Amount of CO₂ emission reduced through installation of 1 GWh wind power connected to the grid

Using MEF



Using AEF



Case 2

A business connected to the grid having 10MWh demand and 36,000MJ thermal demand per year

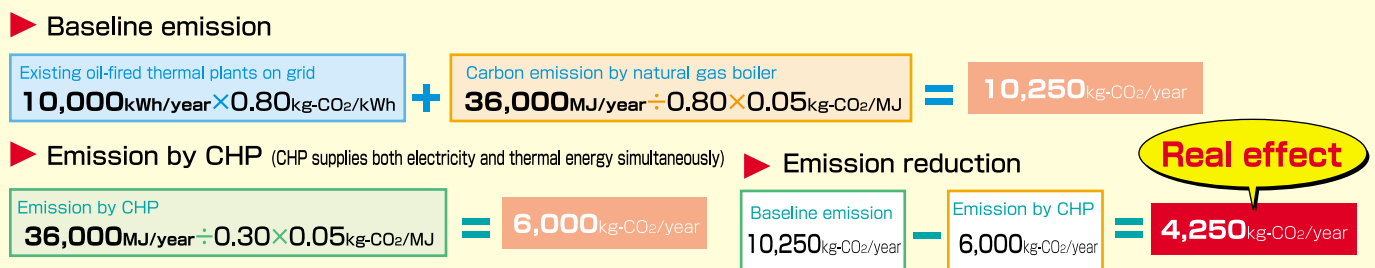
Current

Power purchased from the grid and thermal energy supplied by a natural gas-fired boiler whose efficiency is 80%
(emission factor of natural gas at 0.05kg-CO₂/MJ)

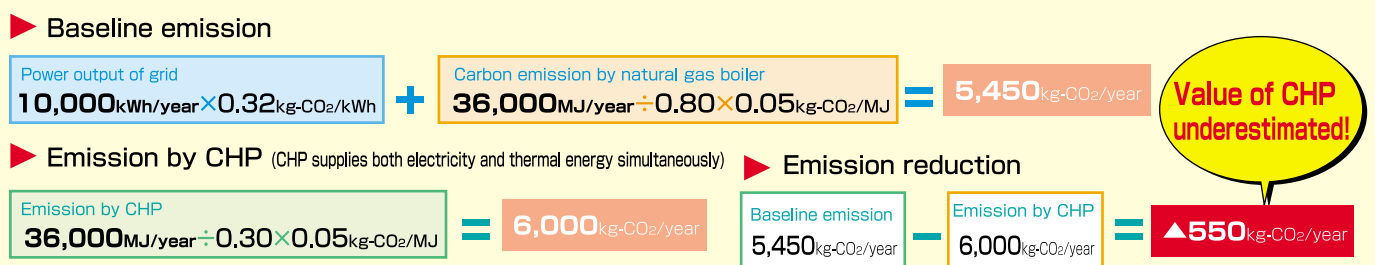
CO₂ reduction measures

Install CHP –30% energy efficiency and 30% waste heat recovery rate– to supply total power and thermal needs
【CHP : Combined Heat & Power】

Using MEF

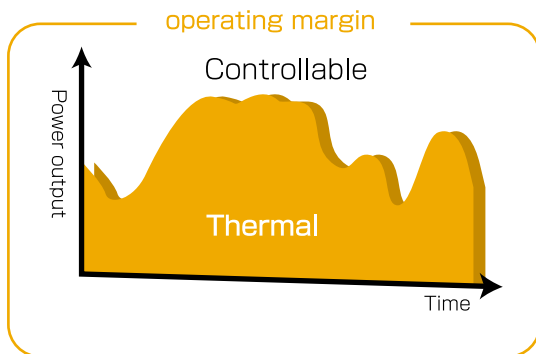


Using AEF



Rationale behind MEF

Reduction of power demand does not equally influence all power generation sources. Rather, it has effects on both existing and planned power generation sources. These sources are called 'operating margin' and 'build margin', respectively.



Operating margin (Influence on certain existing types of power)

In many countries, the base-load power plants constitute the core of power supply. In addition to these sources (must-run plants*), there are additional plants operated to meet changes in power demand. The must-run plants are least affected by changes in power demand. Operating margin, therefore, refers to a factor of emission from power sources excluding such must-run plants as nuclear and renewable.

$$\text{[Operating margin]} = A/B$$

A=Total CO₂ emission from all plants excluding must-run plants connected to the grid (Example: Plants excluding nuclear, hydro, and wind, etc.)

B=Power output from all plants excluding must-run plants connected to the grid

Build margin (Influence on power build-up and plant expansion)

Changes in power demand affects plans for building new power sources. Some countries or regions have a priority on new constructions on the basis of their fuel choices and policy directions. In case of a delay of a build-up program, those plants of high-priority energy sources are the last to be delayed or avoided. This is an element that needs to be considered in reduction of CO₂ emission.

$$\text{[Build margin]} = C/D$$

C=estimated amount of CO₂ emission from delayed or avoided generation plants connected to the grid

D= amount of power generated from delayed or avoided plants connected to the grid

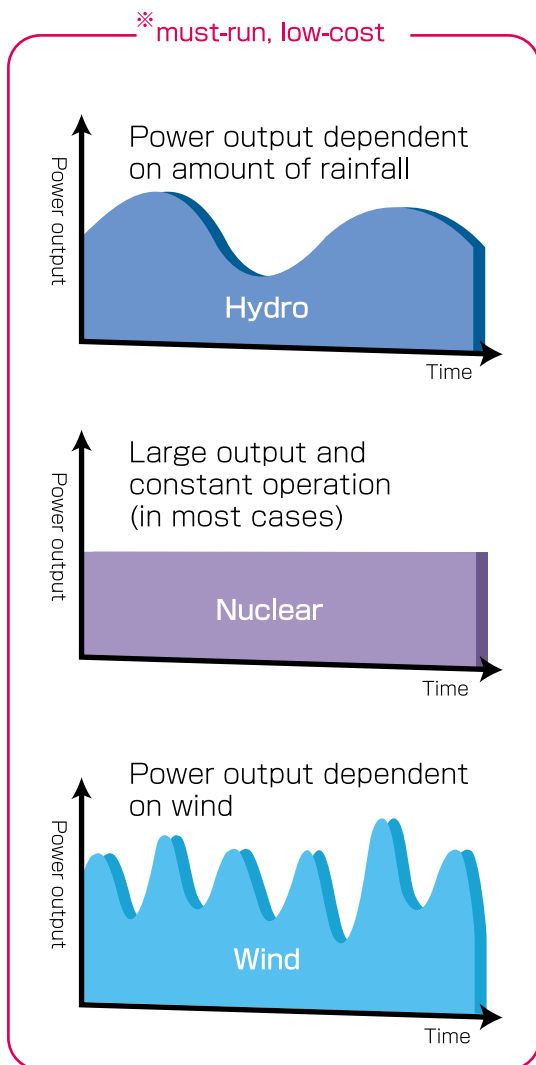
In case of a difficulty in identifying planned power sources, there is an alternative method to estimate the effect on the basis of the existing facilities.

Combined margin (operating margin and build margin combined)

Because of difference in background, including energy policy, grid characteristics, market conditions and other factors, it could be appropriate to combine the operating and build margins in determining a combined margin.

$$\text{[Combined margin]} = \lambda \text{ [Operating margin]} + (1 - \lambda) \text{ [Build margin]}$$

$$(0 \leq \lambda \leq 1)$$



Japanese gas utilities are committed to reduce CO₂ emission through improving their operations while helping their customers with efficient gas utilization. Our efforts in promoting CHP go perfectly in line with our commitment to the global environment. It is an excellent energy-saving equipment which generates electricity and utilizes waste heat for thermal application simultaneously. We are, however, deeply concerned about the use of AEF for estimating CHP's contribution to reducing CO₂ emission as it does not properly recognize the positive effects of CHP.

This material has been prepared based on our belief that an erroneous method for evaluating CO₂ reduction effects be corrected and that CHP, renewable energy sources, and energy saving be further enhanced so that greater CO₂ reduction would be achieved in the future.

For inquiries regarding this subject, please contact:

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