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# Green IT by all parties

March 4, 2010

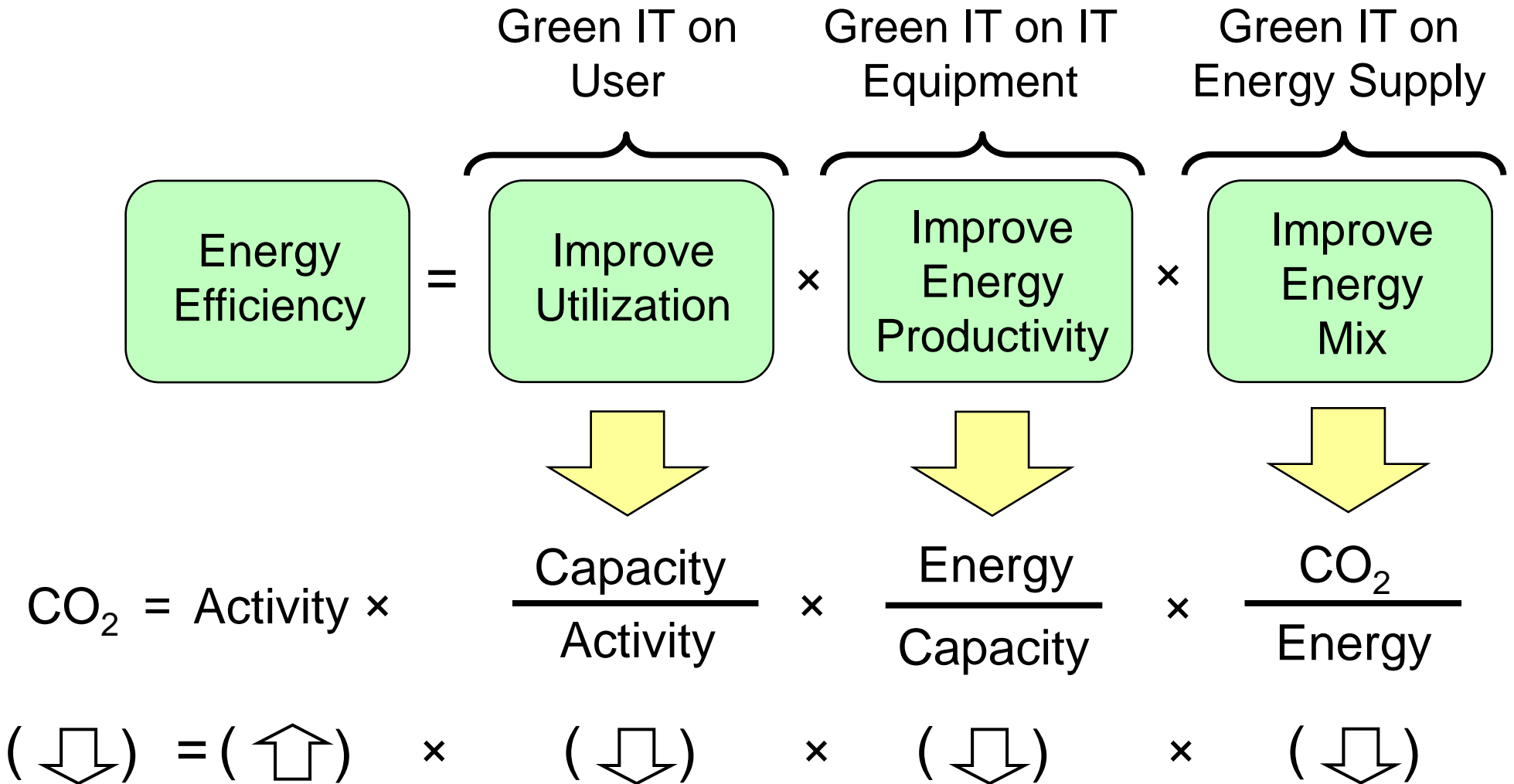
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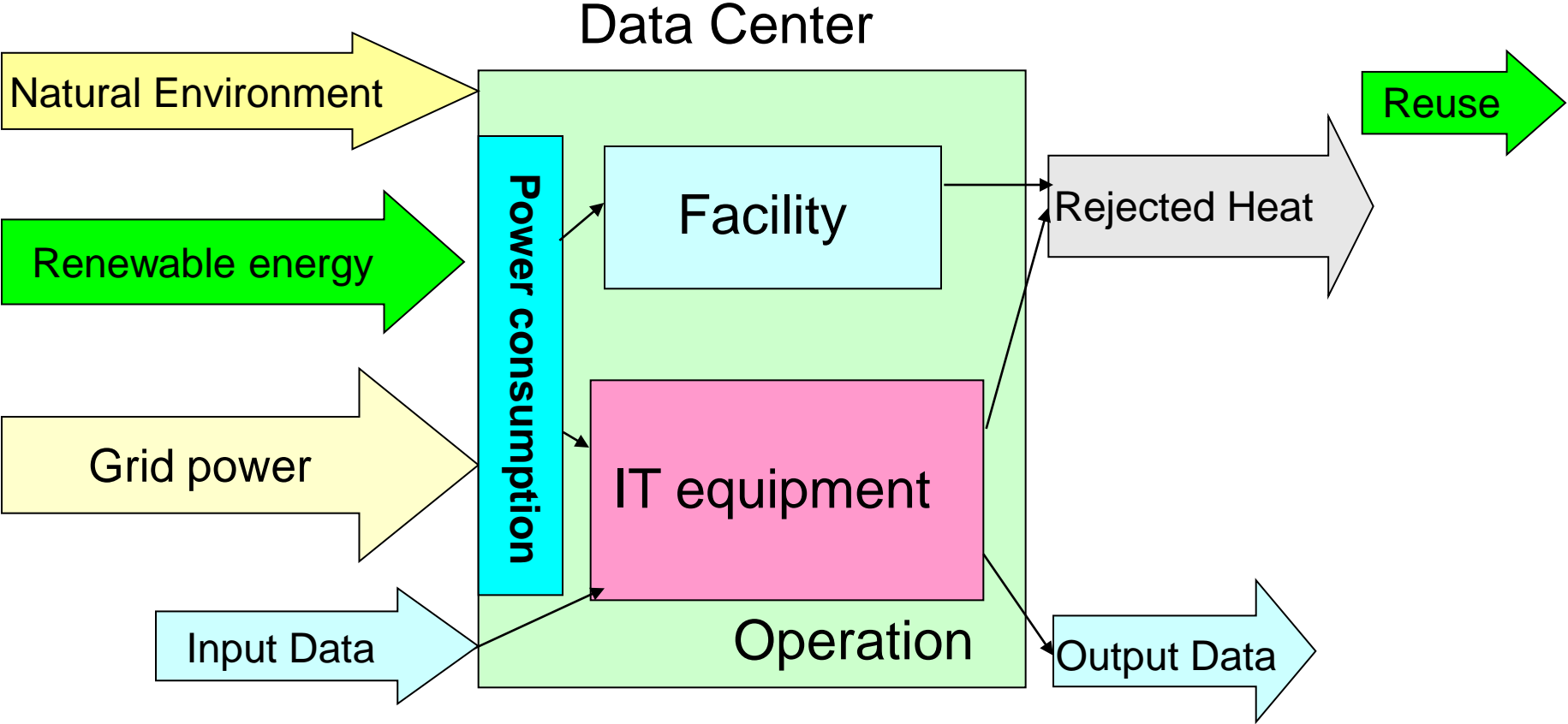
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# 0. Energy Efficiency with all related parties

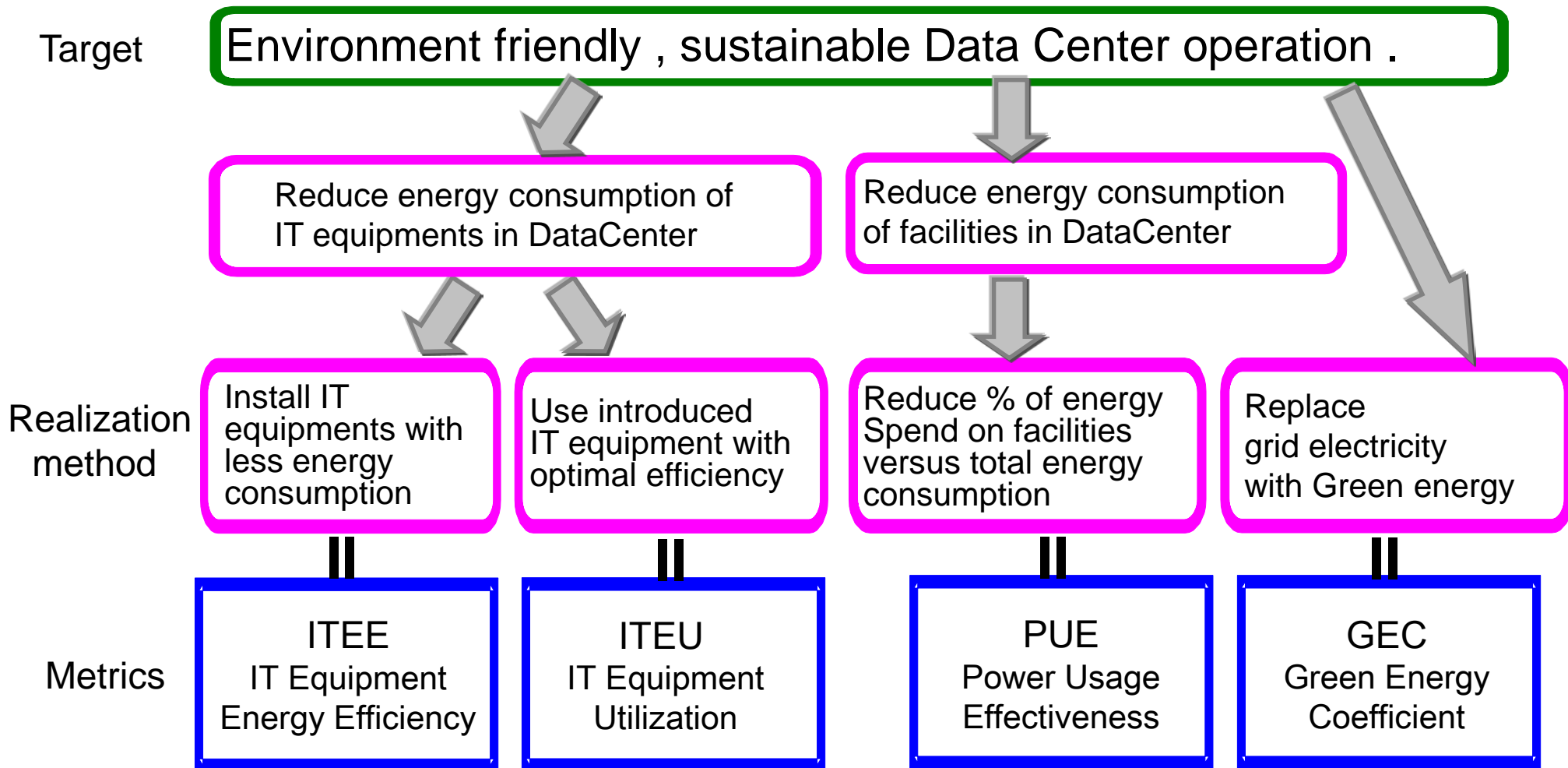


# 1.0 Data Center and its related parties



# 1.1 Green IT for Data Center and its metrics

To improve energy efficiency of Data Center as a whole with all related parties



# 1.2 Definition of 4 sub-metrics proposed

Sub-metric Name	Calculation formula	Action for Energy Conservation by each
<b>1. ITEU (IT Equipment Utilization)</b>	= IT equipment utilization in DC	<ul style="list-style-type: none"> <li>• Effective use of existing IT equipment by user</li> </ul>
<b>2. ITEE (IT Equipment Energy Efficiency)</b>	$= \frac{\Sigma (\text{IT equipment rated capacity})}{\Sigma (\text{Rated Power Consumption of IT equipment})}$	<ul style="list-style-type: none"> <li>• Development &amp; Installation of energy saving IT equipment</li> </ul>
<b>3. PUE (Power Usage Effectiveness)</b>	$= \frac{\text{DC Total energy Consumption}}{\text{Total energy consumption of IT equipment}}$	<ul style="list-style-type: none"> <li>• Energy savings in facility, Infrastructure</li> </ul>
<b>4. GEC (Green Energy Coefficient)</b>	$= \frac{\text{Green Energy by DC}}{\text{DC Total Energy Consumption}}$	<ul style="list-style-type: none"> <li>• Installation of photovoltaic system</li> </ul>

Note) DC : Data Center

# 1.3 Total Energy Efficiency Metric: DPPE

## DPPE (Datacenter Performance Per Energy)

DPPE means work production per carbon energy in a Data Center.

It is possible to calculate DPPE from 4 sub-metrics, ITEU, ITEE, PUE, and GEC.

$$DPPE = \frac{\text{DataCenter Work}}{\text{Carbon Energy}} = \frac{\text{IT equipment work rate} \times \text{IT equipment work Capacity}}{\text{DC Total energy} - \text{Green energy}}$$

$$= \text{ITEU} \times \text{ITEE} \times \text{PUE} \times \text{GEC}$$

**ITEU**

IT equipment utilization

**ITEE**

$\frac{\text{IT equipment work capacity}}{\text{IT equipment energy}}$

**PUE**

$\frac{\text{IT equipment energy}}{\text{DC energy}}$

**GEC**

$\frac{\text{DC energy}}{\text{DC energy} - \text{Green energy}}$

Note) DC power: Total power consumption of Data Center

## 2.1 ITEU (IT Equipment Utilization)

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ITEU is a sub-metric to promote reduction in energy consumption by Improving utilization rate of IT equipment and reduction of surplus equipment investment.

It is an metric to evaluate efforts in design and operation of IT equipment in a Data Center.

### Metric:

$$\text{ITEU} = \frac{\text{Total measured energy (kWh) of all IT Equipment}}{\text{Total specification energy (kWh)(nameplate power rating) of all the IT Equipment}}$$

### Comment:

Agreement was achieved with TGG concerning the calculation method of the metric.

## 2.2 ITEE (IT Equipment Energy Efficiency)

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ITEE represents an average of rated energy efficiency specific to the IT equipment. It is an metric showing efforts to procure energy saving IT equipments . It represents energy efficiency of IT equipments in whole Data Center comprehensively with a single metric.

### Metric:

$$\text{ITEE} = \frac{\text{Total IT Equipment rated Work capacity}}{\text{Total rated energy (kWh) of all the IT Equipment}}$$

Total IT equipment rated Work capacity =

$$\alpha \cdot \Sigma \text{ server capacity} + \beta \cdot \Sigma \text{ Storage capacity} + \gamma \cdot \Sigma \text{ NW capacity}$$

### Comment:

This is a weighted average of rated energy efficiency of all IT equipment in a DataCenter.



## 2.3 PUE (Power Usage Effectiveness)

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PUE ( I/DCiE )by TGG is used for energy saving metrics for Data Center facility, or infrastructure. Specific measurement method is under consultation with TGG currently.

### Metric:

$$\text{PUE} = \frac{\text{DC Energy Consumption (kWh)}}{\text{Energy Consumption of IT Equipment (kWh)}}$$

### Comment:

measurement should be by energy, not by power.

measurement period should be one year.

measurement point should be PDU.

## 2.4 GEC (Green Energy Coefficient)

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Provide ratio of renewable energy generated on-site to total energy consumed

### Metric:

$$\text{GEC} = \frac{\text{Total Measured Green Energy (kWh)}}{\text{Total Measured DC Energy Consumption (kWh)}}$$

### Comment:

- Because GEC is an metric for encouraging Data Center operators to use renewable energy, Green energy purchased from external organization is not included in this metrics.
- Agreement was achieved with TGG on teleconference in December 2009.

## 2.5 DPPE (Data Center Performance per Energy)

DPPE can be calculated using four sub-metrics as a product.

**Metric:**

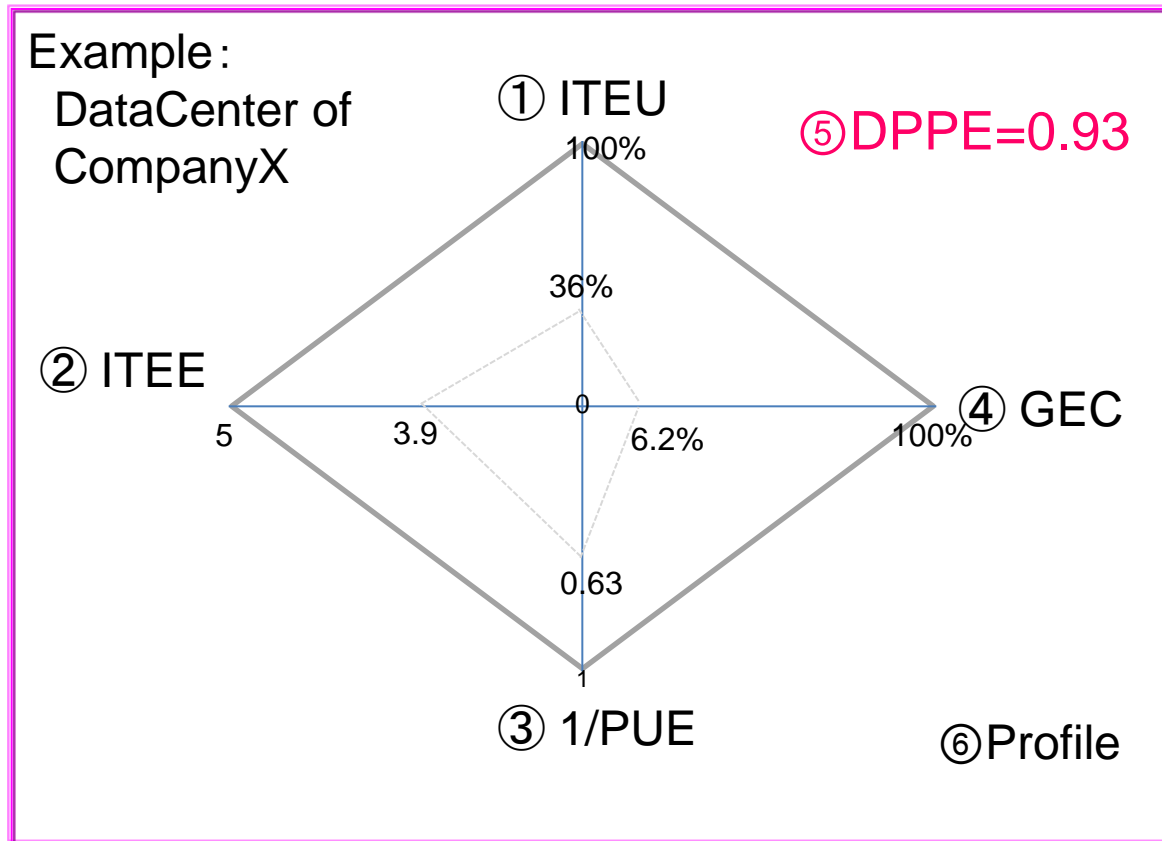
$$\text{DPPE} = \text{ITEU} \times \text{ITEE} \times \frac{1}{\text{PUE}} \times \frac{1}{1 - \text{GEC}}$$

**Comment:**

- The purpose of expressing DPPE as a product of each sub-metric is to calculate DC capacity per non-green power.
- Because DPPE becomes infinite when  $\text{GEC}=1$ , the maximum value for GEC should be limited to 0.8 when calculating DPPE.

# Data Center evaluation method (Example)

Express in Spider Chart



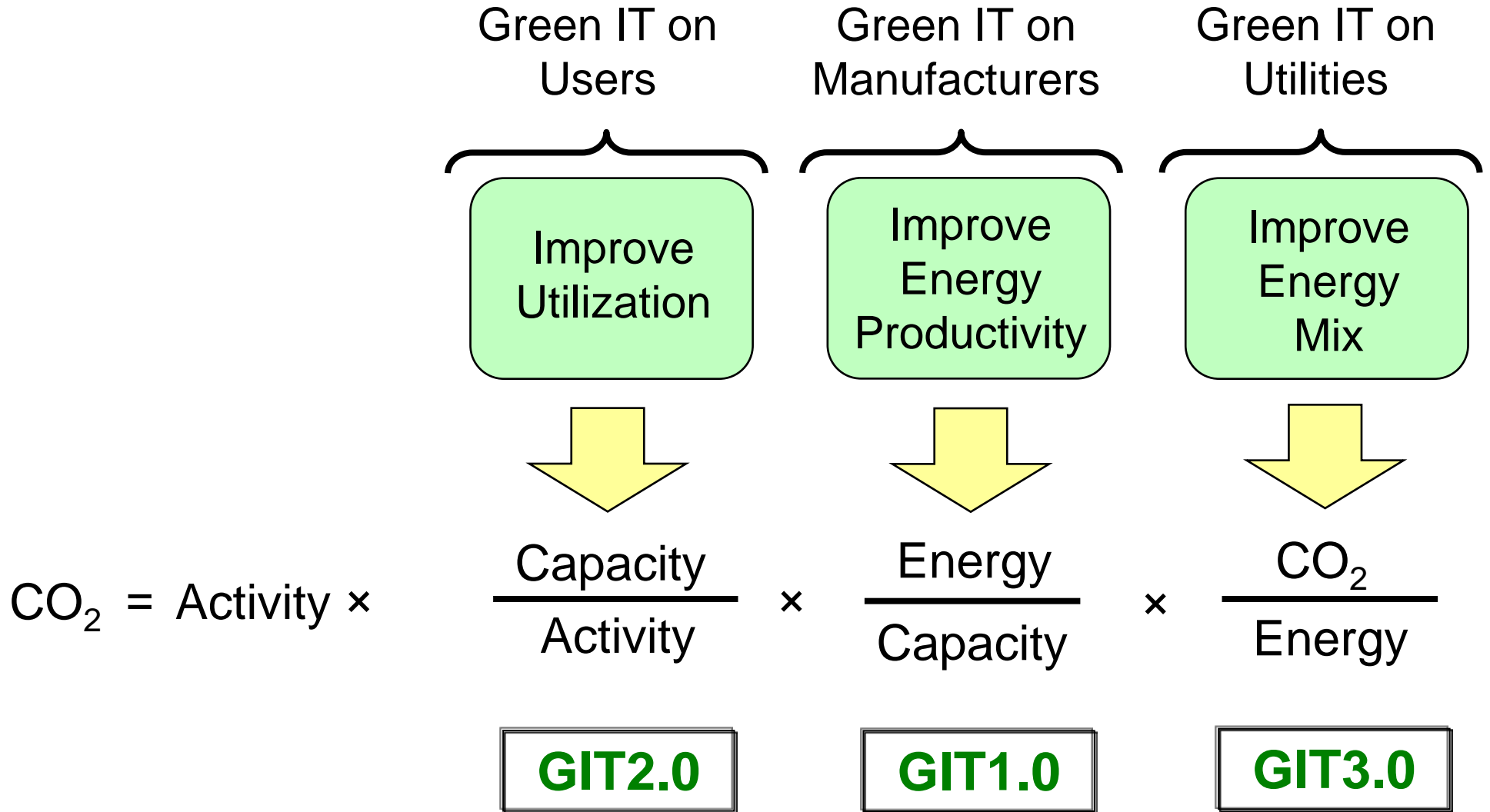
## ⑥ Profile

Information including

- Grade, Tier  
(Operation rate is decreasing with more stand-by equipments. )
- Scale  
(The structure is totally different between data center with just 1 unit of server and the center with 10000 units of servers. )
- Application  
(Housing, hosting, cloud)
- Year of measurement

are necessary.

# 3. Effective Green IT with broader participants



# NRI

未来創発

**Dream up the future.**

**野村総合研究所**  
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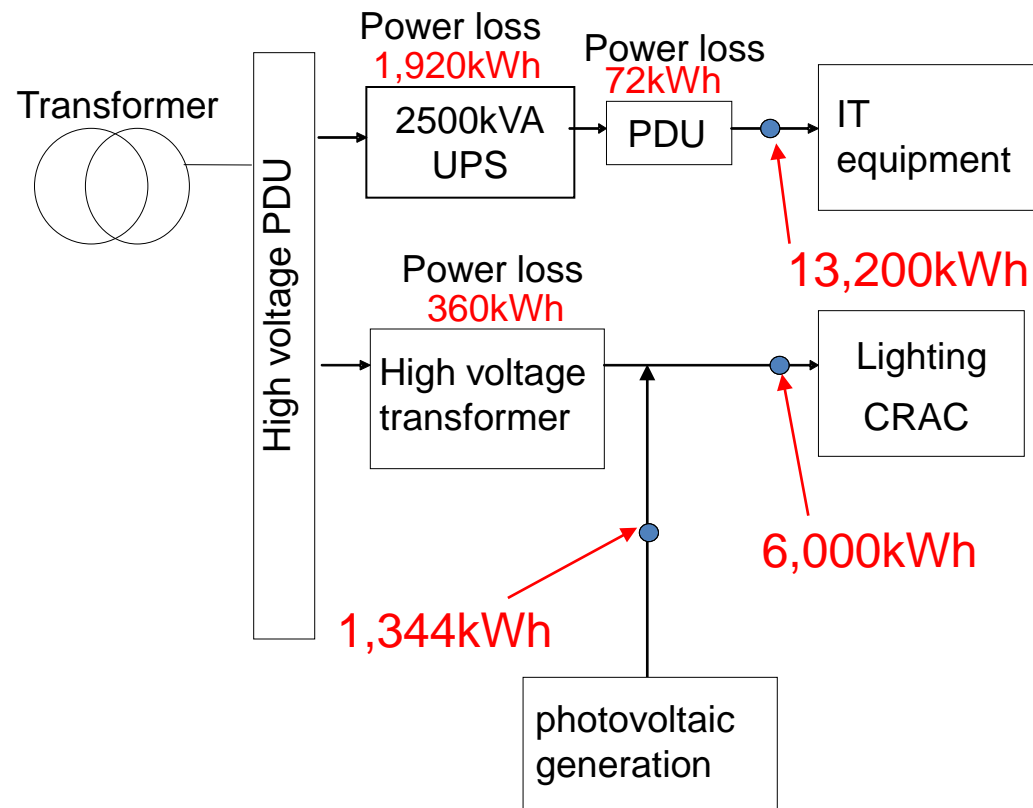
# Example of Data Center

Reference : Data Center of Company X used in Calculation Example

## (1) Building scale of Data Center

Item	Specification
Machine room area	1,200m <sup>2</sup>
# Racks installed	300 Racks
# Racks operating	250 Racks
UPS Capacity	2500 kVA×2

## (2) Power system chart Data CenterX



## (3) IT Equipment (in operation)

Server 420 units  
 Storage 42 sets  
 NW Equip. 84 sets

# ITEE (IT Equipment Energy Efficiency)

Use “Rated Energy Efficiency” adopted in Japanese Energy Conservation Law (for alignment with Top Runner Standard)

- Servers: Watt/MTOPS (composite theoretical performance)
- Storage: Watt/Gbyte (memory capacity)
- Networking : Watt/Gbps (throughput - not yet decided)

$$\text{ITEE} = \frac{\alpha \cdot \Sigma (\text{GTOPS}') + \beta \cdot \Sigma (\text{Gbyte}') + \gamma \cdot \Sigma (\text{Gbps})}{\text{Total specification energy (kWh) of all the IT Equipment}}$$

$\alpha$ ,  $\beta$  and  $\gamma$  are determined so that ITEE should become 1, if all the IT equipments have standard energy saving performance based on 2005 standard. If all the IT equipments have the performance that doubles the standard performance based on 2005 standard as of 2009, the ITEE becomes 2.



# 7. Establishing New Index for Data Centers

Current index  
and issues

$$\text{PUE} = \frac{\text{Overall consumption by data centers}}{\text{Consumption by IT equipment}}$$

(Power Usage Effectiveness)

PUE is used by many companies

⇒ However, PUE is related to the **facility efficiency** of data centers

A new total index for data centers  
is required!



Study sample: DPPE ( Datacenter Performance Per Energy )

$$\text{DPPE} = \text{function} \left( \begin{array}{l} \text{IT Equipment Utilization} \\ \text{IT equipment Efficiency} \\ \text{Total energy consumption} \\ \quad - \quad \text{Natural electric energy} \\ \text{Power Usage Effectiveness} \end{array} \right)$$