An accurate calculation of energy efficiency indicators, such as the Power Usage Effectiveness (PUE), is a fundamental step in order to analyse the overall energy efficiency of a data center. In the INFN CNAF Tier-1 a new monitoring infrastructure, also known as Building Management System (BMS), has been recently implemented using the Schneider StruXureWare Building Operation software (SBO) software. During the design phase of this new BMS, a great attention was given to the possibility of collecting several detailed information about the electrical absorption of specific devices and parts of the facility. Considering the annual trends of these parameters and the demands for reducing the operating costs it became clear that some improvements were certainly needed in the very short time.

The INFN Tier-1 facility supervision system is based over 2 principal software: - Schneider StruXureWare® Building Operation software (SBO) architecture, the principal BMS and alarm system with long-term trends - Schneider APC StruXureWare® Data Center Expert (DCE), for fine monitoring, tuning and notification over InRow RP and Metered Power Distribution Units (PDUs).

The analysis of PUE and its subdivision in pPUE for Cooling and Power. Continuity shows that these 2 elements are crucial for a PUE improvement. The reduction of our average annual PUE was also mandatory due to the increasing cost of the electrical energy. For this reason, a hardware upgrade of the cooling system and chilled water distribution system has been seriously considered.

The INFN CNAF Tier-1 Facility resources

- 1 Dedicated electrical line from energy distribution networks: 15,000 V Voltage = 4.0 kW Power
- 2 EuroDiesel Rotary dieSEL UPS = 1700kW each (3340 kW real Power with a 0.8 comp) = 3.5 days autonomy
- 1 Standard diesel generator(no UPS) = 1360kW can be used for emergency power or non-rf equipment (e.g. chillers)
- 3 Transformers (2 in production, 1 reserved) 3.5 MVA each 15,000 V => 400 V
- 2 separated 4000 A electrical distribution lines (RED & GREEN)

The INFN Tier-1 Building Management System (BMS)

The new cooling system project

Our Tier-1 use Computer Room Air Handler (CRAH), therefore cooling is accomplished by blowing air across an air-water heat exchanger (the APC Inflow RP). The cold water is provided by chillers that consume most of the energy required by the whole cooling process. SO WE FOCUS ON CHILLERS UPGRADE.

We started the design of a new project based on Custom chiller with an innovative cooling technology: The Danfoss Turbocor® oil-free centrifugal compressor with magnetic bearing (magnetic levitation of the rotor):
- No friction between moving parts
- Low Noise
- High duration of mechanical parts
- Low electricity consumption

Chillers based on this compressor are the most efficient on the market.

Actual chillers: we use data from the BMS system for cooling requirement and the related electrical energy consumption. Custom chillers: we estimated the energy consumption using the interpolated vendor data sheet tables with the 2013-2015 real trend of temperature in our city and a fix Cooling Energy requirement of 700 kW.

The EER parameter is very helpful for comparing chillers efficiency

<table>
<thead>
<tr>
<th>EER</th>
<th>Custom chiller</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5</td>
<td>Turbocor 500 kW</td>
</tr>
<tr>
<td>5.0</td>
<td>Turbocor 300 kW</td>
</tr>
<tr>
<td>5.0</td>
<td>Screw Chiller 500 kW</td>
</tr>
</tbody>
</table>

With the collaboration of an external specialist engineering firm we have defined an executive project to be realized in the future years in anticipation of a consistent increase of the IT resources: Project definition (with max. External Temperature => 40 °C):
- Total cooling power (Eurovent conditions): 1400 kW
- Single chiller nominal cooling power (Eurovent conditions): 700 kW
- Total Number of chillers: 3 (in a 2 + 1 redundant configuration)

Modular design and realization, the installation must be split into 3 Independent phases with the last 2 that could be optional.

Annual Saving Phase 1 => ~120-130 K€
PBP (Payback Period) Phase 1 => ~4-5 Years

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