Energy Management at DESY/XFEL

Jens-Peter Jensen
Magurele, 24.Nov 2017
DESY 10 kV Mains

LINAC, DESY, buildings

PETRA, FLASH, Photo Science

load distributor

Cryogenic, XFEL, AMTF, HERA

Diagram showing DESY 10 kV Mains with various labels and symbols.
DESY operates for European-XFEL

- Accelerator and their subsystems
- Cryogenic, Modules, RF system
- High power supply
- Cooling and ventilation
- IT and computing
- Smoke detection and emergency service
# Energy Consumption of DESY and XFEL

## Electric Consumption

<table>
<thead>
<tr>
<th>Facility</th>
<th>Electric Consumption</th>
<th>Peak Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESY</td>
<td>150 GWh</td>
<td>23 MW&lt;sub&gt;peak&lt;/sub&gt;</td>
</tr>
<tr>
<td>XFEL</td>
<td>60 GWh</td>
<td>10 MW&lt;sub&gt;peak&lt;/sub&gt;</td>
</tr>
<tr>
<td>DESY + XFEL</td>
<td>210 GWh</td>
<td></td>
</tr>
</tbody>
</table>

## Heating

<table>
<thead>
<tr>
<th>Source</th>
<th>Consumption</th>
<th>Peak Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>City heat Hamburg</td>
<td>17 GWh</td>
<td>10 MW&lt;sub&gt;peak&lt;/sub&gt;</td>
</tr>
<tr>
<td>Heat recuperation</td>
<td>7 GWh</td>
<td></td>
</tr>
</tbody>
</table>

## Chilled water

<table>
<thead>
<tr>
<th>Consumption</th>
<th>Peak Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 GWh</td>
<td>6 MW&lt;sub&gt;peak&lt;/sub&gt;</td>
</tr>
</tbody>
</table>
Electrical Energy Costs

Price components (rounded)

- Electrical Energy, EEX: 3 Ct/kWh
- EEG, renewable Energy: 7 Ct/kWh
- Current tax: 2 Ct/kWh
- Grid usage 110 kV: 2 Ct/kWh
- Total (before VAT): 14 Ct/kWh

- 5 Ct/kWh = 35 % cost for energy and grid usage
- No exemption from EEG and current charge for research facilities like DESY
- Therefore DESY needs no energy monitoring according to ISO 5001
- Energy Audit every 3 years, done in 2016
Energy Management is a Comprehensive Approach

- Energy Monitoring
  - Internal Costing
  - Account Third Party
  - Optimize Operation
  - Analyze Energy Efficiency
  - Estimate Consumption
  - Evaluate Load Pattern
  - Financial Controls
  - Budgeting
  - Plausibility Check
How to Organize an Energy Monitoring System

- Energy Monitoring is a general task for operation and administration
- Overview of all energy and supply grids
- Combined with the commercial requirements
- Central contact point for Energy Monitoring
- Central instrument for Energy Management
- According to DIN EN ISO 50001 located at the „top management“
- The use of an Energy Management system is always profitable
The energy management team ensures the improvement of energy related performance.

The size of the teams is related to the complexity of the facility

- As DESY has that complexity we formed a team across the divisions
- Each member has an energy godfather for his system
  - Cryogenic
  - Accelerator
  - RF system or RF test stand
  - Test beams
  - etc
Counters are a Tool for an Overall Concept

- Counters are an important tool for data acquisition and for storage in a data base
- Central administration of the data and cost allocation to the users
- Virtual counters are needed because of the complex structure of mains
- Integrate all counters in an energy monitoring software for automatic reading
- Energy means electricity, heat, cooling, cold water, compressed air, oil, fuel etc.
Examples of the benefits from Energy Counting

Cryogenic compressor oil recuperation for heat utilization

- Start of project: 2015
- Start of construction: 2016
- Commissioning: March 2017
- Calculated savings: 7,000 MWh
- Costs savings: 200,000 €/year
- Invest costs: 800,000 €
Cryogenic heat recuperation

- Pumping unit
- Breox oil and water exchanger
Unusual drinking water consumption in a building

Drinking water was used for rack cooling !!
Grid usage charge reduction

- Charge of grid usage depends on
  - The voltage level and
  - The full load hours in a year (§19 NEV)

- The full load hours must be more > 7000 h/year for a severe reduction

- Example: 150 GWh/7000 h => 21.4 MW_{peak}
- < 7000 h/y 150 GWh x 2 Ct/kWh = 3 MioEuro
- > 7000 h/y 150 GWh X 0.8 Ct/KWh = 1.2 MioEuro
- Saving 1.8 MioEuro
Grid use charge reduction

- Grid power is the average power over 15 minutes
- The highest 15 minutes power in a year is charged

Calculation:

- 2016: 23 MW charged peak power
- 2017: 150 GWh consumption estimated
  - 21.3 MW peak power for 7000 h/year
  - 21 MW peak power was chosen (>147 GWh)

- How to reach the goal by lowering the peak power?
Lowering the peak power in 2017

- Monday to Friday we have a power peak of 2 MW between 9am to 3pm
  - Shift the test stands operation time into the afternoon, night and morning hours
  - The control room must be informed in advance by a load > 100 kW
  - Result: 1 MW less between 10am to 2pm

- This works fine from October to May and during shut down

- During the summer season the refrigerator for the air conditioning need more compressor power of about 1 MW

- Therefore a diesel generator was rented to cut the power peaks

- This works fine and we were able to keep the peak power below 21 MW
**Load Management DESY**

![Graph showing power generation and usage]

- **Leistungmaximum**: 21,0 MW
- **Gesamt DESY**: 20,20 MW
- **15 Min-Wert SOLL**: 56,67 %
- **15 Min-Wert IST**: 54,91 %

**PETRA**
- **Geb 47c (Nl):** 207 kW
- **Geb 47c (W):** 311 kW
- **Geb 47c (Mv):** 97 kW
- **Geb 47c (Mv):** 134 kW
- **PETRA-Berliner Str.** 1.001 kW
- **PETRA-Südost.** 1.176 kW

**Kryogenikanlage**
- **Kryogenik FLASH 1 (1.0):** 2.249 kW
- **Kryogenik XPEL 1 (1.0):** 2.732 kW
- **Kryogenik XPEL 2 (0.5):** 1 kW

*DESY ohne XFEL Beleuchtung: Kryogenikanlage XPEL ist jedoch nicht enthalten.*

**Informationsleistungen**

- **Deutsch**
- **Englisch**
- **Rusisch**
- **Türkisch**
- **Deutsch**

**Start diesel generator**
District cooling ring at DESY

- Modern refrigerators are more efficient
- Reduction of CO2
- Free cooling in winter season possible
- Lower energy cost
- Less maintenance labor
- Less spare units
- Cooling ring is more reliable
- Noise emission and ground vibration are separated from the experimental halls and buildings
Conclusion

Energy monitoring means:

➢ Energy controlling and reporting, monthly newsletter
➢ Operation management of accelerators, experimental areas, facilities and their subsystems
➢ Energy purchase according to the power pattern
➢ Investigate energetic footprint of buildings
➢ Design and control of energy saving measures
➢ Make aware that energy has a value
➢ No „free lunch“ policy anymore for collaborators or guests institutes