UPS Topologies - Project Performance Comparisons

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Overview

Let’s explore UPS solutions:
- Plant cost
- Quantity of redundant plant
- Building cost
- TCO – energy, water, maintenance

Which UPS topology best suits your project?

Why?
Typical UPS topologies:

N+1 parallel UPS
Typical UPS topologies:

1+1 or N+N UPS
Typical UPS topologies:

Group-redundant system
- “n” out of “n+1”
- Static Switch selection from non-parallel UPS
Typical UPS topologies:

Block Redundant system
- one redundant unit
- backs up “n” non-parallel others
Dependability:

= Availability + Reliability ..... 

+ Maintainability + Safety

What does this mean to your UPS topology choices?
Availability & Reliability:

Technology selection – lifetime performance

- Failure time - history & theory (MTBF)
- Repair time - history & theory (MTTR)

Reduce / eliminate single points of failure

Reduce common failure modes (esp. controls)
Availability & Reliability:

Coverage – what needs to be supported by UPS?
Maintainability & Safety:

What are the risks and complexity in:

Day to day operations?
Upgrade of plant for load growth?
Maintainability & Safety:

What are the risks and complexity in:
Failure mode operations?
Replacement of plant?
  - Planned
  - After major failure
About Parallel vs. Non-parallel UPS:

Non-parallel preferred:

For systems that are to be “upgraded” later
- Not locked in to any model or manufacturer
- Original kit can remain to its end of useful life

Reduce common-mode failure points = higher dependability
Lifecycle costs:

What makes up the CAPEX cost of the UPS system?

UPS plant, energy storage, switchgear

Downstream
distribution to load
Lifecycle costs:

What **ELSE** makes up the CAPEX cost of the UPS system?

The building
- indoor and outdoor
- fire services
- lighting
- security
- etc
Lifecycle costs:

What **ELSE** makes up the CAPEX cost of the UPS system?

Upstream power and switchgear

- normal and standby
- HV, LV
- transformers
- generators
Lifecycle costs:

What **ELSE** makes up the CAPEX cost of the UPS system?

Cooling plant
- Chillers
- pumps
- piping
- fans
- controls
Lifecycle costs:

What makes up the OPEX cost of the UPS system?
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Some Available UPS Technologies:

- Static Double Conversion
- Rotary (Hybrid) UPS
- Static Delta Conversion
- Dynamic Diesel UPS
- Offline UPS

CAPEX differs

OPEX differs
Energy Storage solutions:

VRLA or Lead Acid (wet) Batteries
Minutes or hours of backup time – selected based on standby power scheme
Limited life in service – high refresh cost
Energy Storage solutions:

Flywheel
- Seconds of backup time
- Requires standby power quick-start
- Extended life in service

Not well suited to parallel generators
Energy Storage solutions:

What about cooling?

- Ride through on cooling a requirement with high density loads
- Seconds available to restart and cool if conditions are to be maintained
Project Comparison

Sample project requirements:

1000kW IT Load per “module”

Critical cooling to operate during mains failure

New Build
N+1 Static UPS
N+1 Static UPS - Space
N+N Static UPS - Space
N+1 Rotary UPS
N+1 Rotary UPS - Space
N+1 DRUPS – All Load

Schematic:
N+1 DRUPS – All Load

External BYPASS
(Emergency / Maintenance)

Normal Power Path:
Coupling Choke Isolation

Long-Term Backup Power Source:
Coupled Standby Generator

Short-Term Backup Power Source: M/G + min. 10 sec Flywheel

Base Diagram courtesy of Piller
N+1 DRUPS – All Load

Schematic – IT Load Power:

- IT Load in two halves
- Capacity to each half is 550kW (800A Static Switch)
N+1 DRUPS – All Load
N+1 DRUPS – All Load - Space
## Summary Comparison

<table>
<thead>
<tr>
<th>Option</th>
<th>Capex</th>
<th>Opex (pa)</th>
<th>NPV (1)</th>
<th>MTBF</th>
</tr>
</thead>
<tbody>
<tr>
<td>N+1 Static UPS</td>
<td>$5.4M</td>
<td>$550k</td>
<td>$33M</td>
<td>1.3M hrs</td>
</tr>
<tr>
<td>N+N Static UPS</td>
<td>$6.3M</td>
<td>$690k</td>
<td>$29M</td>
<td>1.4M hrs</td>
</tr>
<tr>
<td>N+N Delta UPS</td>
<td>$5.9M</td>
<td>$550k</td>
<td>$29M</td>
<td>1.4M hrs</td>
</tr>
<tr>
<td>N+1 Rotary UPS</td>
<td>$5.9M</td>
<td>$460k</td>
<td>$30M</td>
<td>6.7M hrs</td>
</tr>
<tr>
<td>N+1 DRUPS All Load</td>
<td>$7M</td>
<td>$410k</td>
<td>$30M</td>
<td>23M hrs</td>
</tr>
</tbody>
</table>

Note 1: NPV against an assumed revenue stream for the IT space supported
Conclusions

What counts is the BIG picture
UPS technology is a PART of the picture
TCO includes all the parts

Which UPS topology best suits your project?

Why?
Discussion

For more information and a slide pack incl. reference UPS schematics:

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