



INFOBATT – Montreal September 2011

Providing a Full Uptime Battery Warranty
Case Studies of the Supply of Sustainable
Energy

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Motive Power
Systems



Reserve Power
Systems



Special Power
Systems

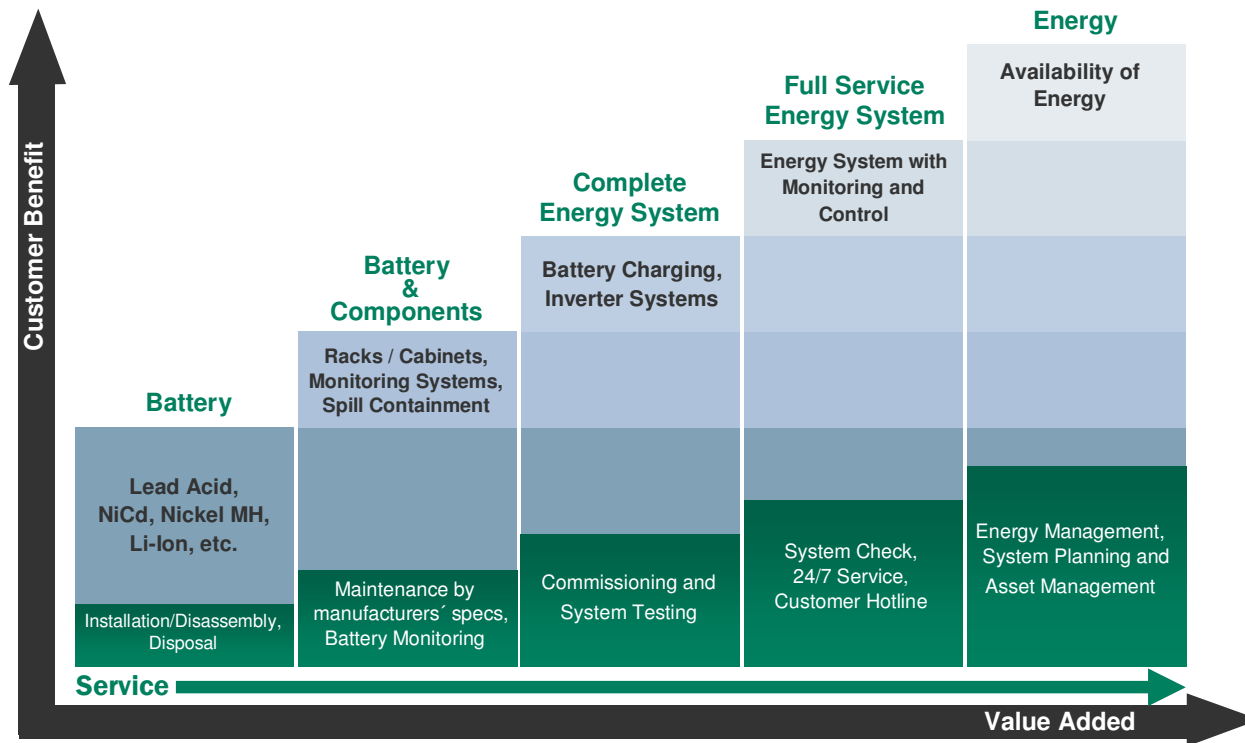


Service

Product warranty vs guaranteed supply of energy



Sustainable Energy Solutions



Component warranty ← **↔** → Guaranteed supply of energy



AGV at charging station –
opportunity charge



AGV moving material in a
manufacturing setting

AGV System (Automatic Guided Vehicle)

- 3 shift operation 24/7
- Opportunity charging
- Customer “full uptime warranty requirement:
 - **The AGV system must operate 100% of the time continuously, 24/7 for a period of 5 years from date of start up of the equipment**

System Design Parameters:

- Number of Vehicles: 20
- Average run time per task: 47 min
- Time between charging: 40 min
- Operating time: 24hr/day (3 shifts), 7 days/week
- Discharged capacity per operational cycle (task): 22Ah
- Discharged capacity in 24 hours: 636Ah
- Battery size selected (Capacity): 180Ah
- DC system voltage: 48VDC
- Number of daily capacity turns of the battery: 3.5
- Battery type selected: High rate nickel cadmium
- Number of battery chargers: 8
- Battery charger output current: 240A
- The battery would be “opportunity” charged for short durations after every set of defined job cycles.

Based on the design parameters, the expected lifetime of the battery system was calculated from the following data:

- 3,000 discharge cycles over the life of the battery
- Battery capacity 180Ah
- 636Ah discharged per day

$3000 \text{ cycles} \times 180\text{Ah} / 636\text{Ah/day} = 850 \text{ days}$

Based on 360 day operation: $850 \text{ days} / 360\text{days/yr} = 2.36 \text{ years}$ expected battery lifetime

Case Study #1

Rotation of Spare Batteries throughout the AGV System

1st Qtr			2nd Qtr			3rd Qtr			4th Qtr		
vehicle no.	battery no.	spare battery no.	vehicle no.	battery no.	spare battery no.	vehicle no.	battery no.	spare battery no.	vehicle no.	battery no.	spare battery no.
1	1	21	1	21	16	1	16	11	1	11	6
2	2	22	2	22	17	2	17	12	2	12	7
3	3	23	3	23	18	3	18	13	3	13	8
4	4	24	4	24	19	4	19	14	4	14	9
5	5	25	5	25	20	5	20	15	5	15	10
6	6		6	1		6	21		6	16	
7	7		7	2		7	22		7	17	
8	8		8	3		8	23		8	18	
9	9		9	4		9	24		9	19	
10	10		10	5		10	25		10	20	
11	11		11	6		11	1		11	21	
12	12		12	7		12	2		12	22	
13	13		13	8		13	3		13	23	
14	14		14	9		14	4		14	24	
15	15		15	10		15	5		15	25	
16	16		16	11		16	6		16	1	
17	17		17	12		17	7		17	2	
18	18		18	13		18	8		18	3	
19	19		19	14		19	9		19	4	
20	20		20	15		20	10		20	5	

5th Qtr			6th Qtr			7th Qtr			8th Qtr		
vehicle no.	battery no.	spare battery no.	vehicle no.	battery no.	spare battery no.	vehicle no.	battery no.	spare battery no.	vehicle no.	battery no.	spare battery no.
1	6	1	1	1	21	1	21	16	1	16	11
2	7	2	2	2	22	2	22	17	2	17	12
3	8	3	3	3	23	3	23	18	3	18	13
4	9	4	4	4	24	4	24	19	4	19	14
5	10	5	5	5	25	5	25	20	5	20	15
6	11		6	6		6	1		6	21	
7	12		7	7		7	2		7	22	
8	13		8	8		8	3		8	23	
9	14		9	9		9	4		9	24	
10	15		10	10		10	5		10	25	
11	16		11	11		11	6		11	1	
12	17		12	12		12	7		12	2	
13	18		13	13		13	8		13	3	
14	19		14	14		14	9		14	4	
15	20		15	15		15	10		15	5	
16	21		16	16		16	11		16	6	
17	22		17	17		17	12		17	7	
18	23		18	18		18	13		18	8	
19	24		19	19		19	14		19	9	
20	25		20	20		20	15		20	10	

In order to achieve the 5 year warranty with one change out of the system it was necessary to increase the available capacity of batteries. To do this we added five additional battery sets which were rotated into the system:

Additional advantages to the added capacity:

- It provided a pool of five spare battery sets, which were available for troubleshooting the system if required.
- The spare sets provided time to perform routine maintenance on the batteries, therefore all batteries had one week or more available for maintenance over a 12 month period.
- Provided margin for the customer to modify his production thru put rate.

Requirements for Full Uptime Warranty;

- A properly sized and reliable battery system:
- A reliable battery charging system:
 - design MTBF. Spare components for repair as well as a spare charger
- Remote monitoring of energy usage:
 - A remote monitoring system was connected to each battery and located in each of the vehicles. Included a wireless interface with the customer's AGV control computer system. Customer able to modify the routing and work schedule of each vehicle . In addition, it provided valuable historical data of the operation .
- A 24/7 full service system contract:
 - A "local" service company was trained and certified by the battery manufacturer and contracted to provide maintenance and support for the complete DC system.
- Asset management:
 - In this particular case, the DC system was purchased as a fixed capital investment and retain the service portion of the contract as a monthly maintenance cost.
 - The total cost to the customer for the 5 years including capital investment and maintenance costs can be summarized as follows:
 - Total cost of \$25.00 per day per vehicle
 - \$0.04 per Amp-hour for the total system over the 5 years operation
 - Or a total of \$1.63 per kW-hr of energy supplied over the 5 years



Location: Nürnberg Germany:

53 employees

3-shift production

28,000 sq ft data center

1.6 petabyte monthly data traffic

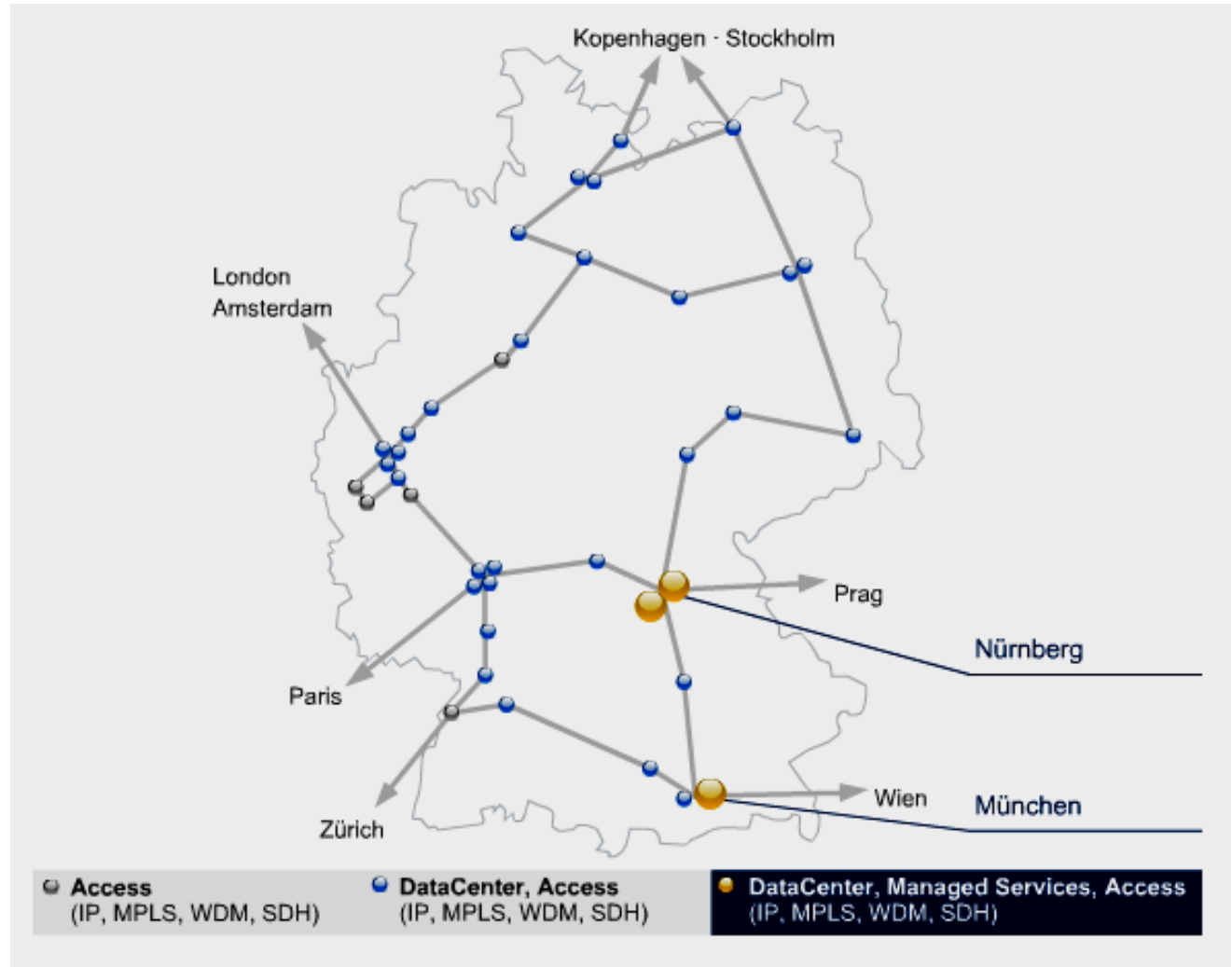
(1,600,000 gigabyte)

5 UPS Systems totaling 1 MW power



IP Exchange's main products

- ✔ data transport & data center operating
- ✔ around the clock service
- ✔ housing & hosting
- ✔ business connections
- ✔ data security, backups, storage
- ✔ outsourcing



The Customer's Requirement:

An installed energy solution providing 800KW of back up power including batteries, accessories, 2 UPS Systems as well as a monitoring systems with remote access via the internet. The back up power is rented to the Customer on a monthly basis for a total guaranteed contract period of 10 years.

The total solution includes:

- 2 UPS Systems
- Flooded lead acid battery back up banks with Aquagen recombinant vent system
- Remote monitoring system 24/7 accessible
- Contract of a service and maintenance company for the system with 24/7 response
- Immediate availability of spare battery cells, charger and UPS key components for repair
- 10 year guarantee of energy availability

System design parameters:

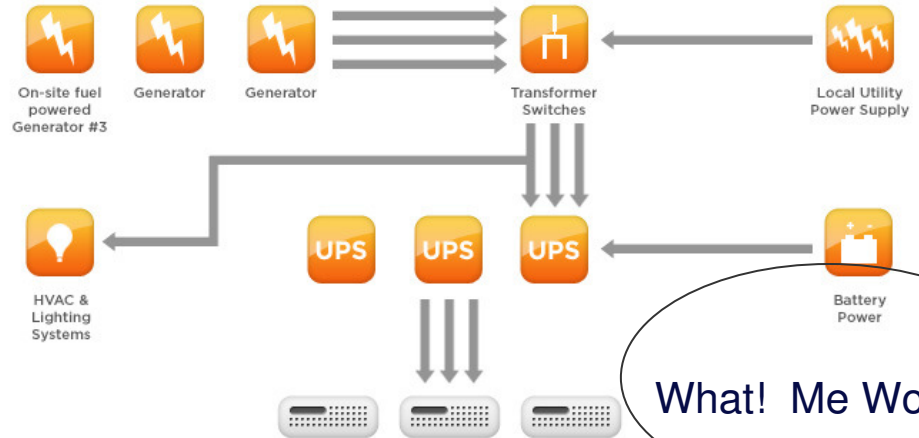
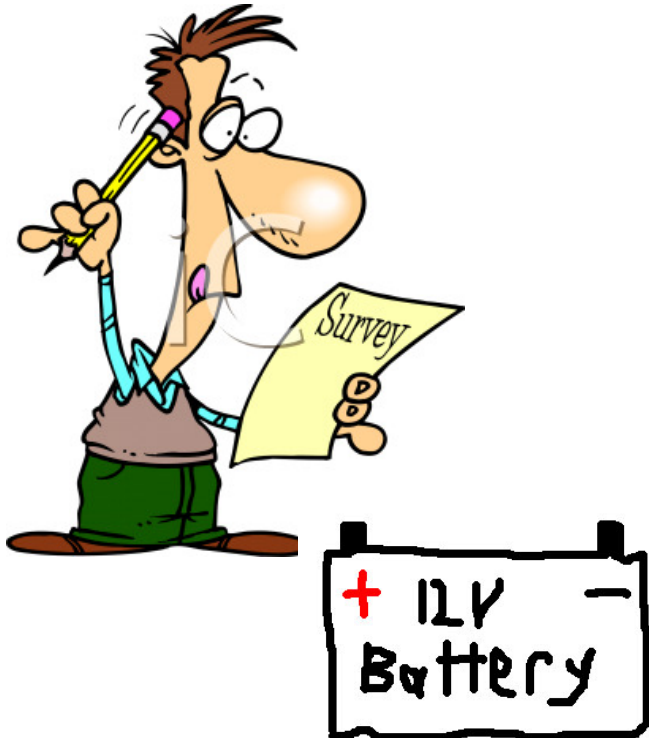
- Customer has a **critical application** and requires guaranteed energy to protect their investment.
- The criteria for energy availability are customer defined.
 - 10 years guaranteed available back up power
- The operational criteria are defined.(e.g.)
 - Expected number of cycles or outages
 - DC loads
 - Environmental conditions
 - Expected lifetime.
- The cost structure is defined
 - Customer wants to reduce or eliminate capital costs (off balance sheet financing)
 - Rental of energy
 - Maintenance is a monthly planned expense

Requirements for 100% guarantee of energy:

- Battery type and Ah size:
 - determined based on load requirements, other operational parameters, environment and expected lifetime.
- Battery charger:
 - required MTBF and fastest recharge time
- Calculated number of replacements of the battery over the warranted period:
 - none required
- Proper service and maintenance of the battery including 24/7 service support
- A remote monitoring system that provides sufficient information to determine the “operational condition” of the battery at any given time. And provides for dispatch of on-site service personnel as required.
- Staged spare parts and components for immediate deployment by the service company.
- Manufacturer management and support for battery and charger systems (asset management)

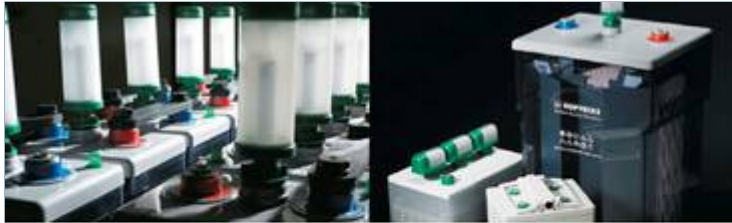
Summary

BATTERIES?
 WARRANTIES?



VS





Thank you for
your attention!

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