IDC 機房高壓直流供電(Higher Voltage direct current)

與節能效率

台灣總代理:奕富達科技

Allan Lin 林宏泉

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Agenda

- Netpower 介紹
- hvDC 系統優勢與解決方案
- hvDC 測試機房與安規及標準
- hvDC 各國節能實例

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Infra Tech

Netpower Labs 2000年成立於瑞典
全球第一家專營380V DC解決方案

Founded in 2000
Based in Stockholm, (Nacka)
Sweden

- Researching period: 2000 – 2004
- Developing period: 2005 –
- Lobbying/Marketing: 2006 –
- ISO 9001/14001

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Mission and Ambition 使命、野心

- 380V DC UPS solution 全球領導廠商
- DC Power先驅，驗證IDC 機房10%~30% 效能提升
- 倡導“直流供直流 DC for the DC”
- 一年內投資回收(Pay Back Time)
- 大幅提升資訊機房可靠度與可用性

DC Power systems with very high:

- System reliability - Safe operation
- Power quality - No disturbances
- Energy efficiency - Significantly reducing energy costs

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ICT本為直流基礎設備

Technically - solely advantages! 技術上獨有的優勢

- Simple solutions, Easy to — **解決方案簡單**
  - Handle & understand — 易於了解與掌控
  - Maintain — 易於維護
  - Expand — 易於擴充
- Easy to connect in parallel — **容易並聯**
  - System DC — 系統 直流
  - Batteries DC — 電池 直流
  - Solar cells DC — 太陽能板 直流
  - Fuel Cells DC — 燃料電池 直流
- IT components are all DC-based **IT設備全為直流**
- Used in Telecom, Utility, Alarms, Control systems etc.
  (12, 24, 48, - 110, 220, 380 VDC)
  - 電信、市電、警報與**控制系統亦全都使用直流**

DC -- For all critical applications !!!

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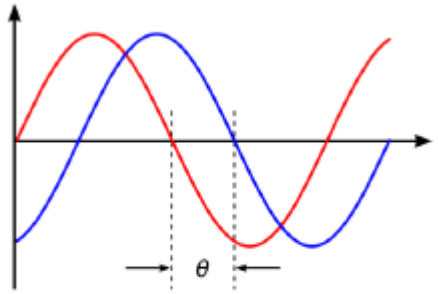
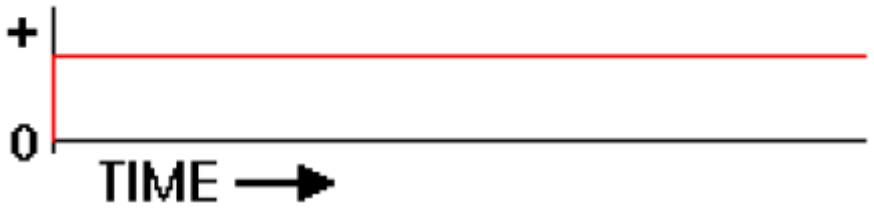
AC System reliability and Efficiency??

交流系統可靠度與效率??



AC PHASE SHIFT



DC VOLTAGE WAVE FORM
WILL "PHASE OUT" AC

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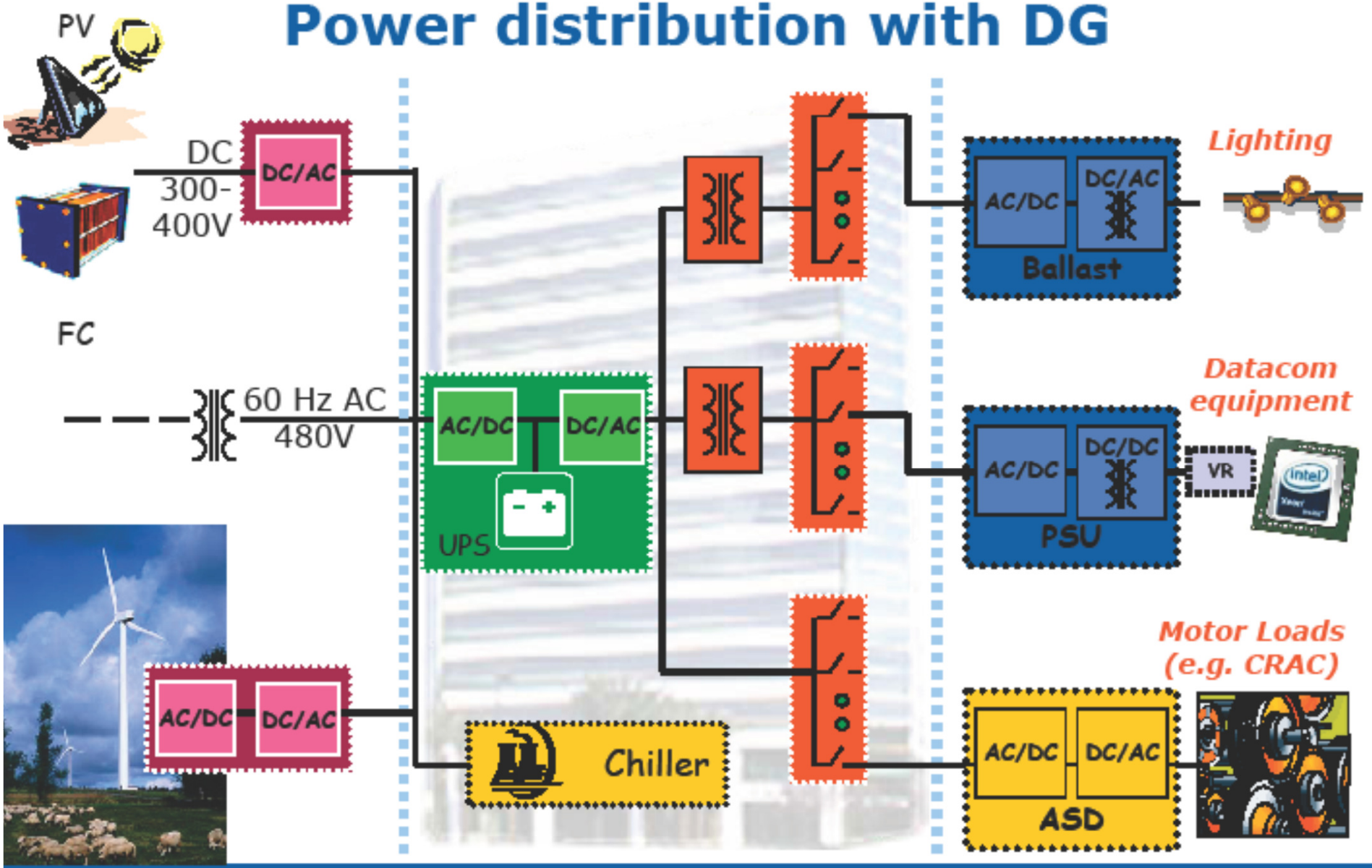
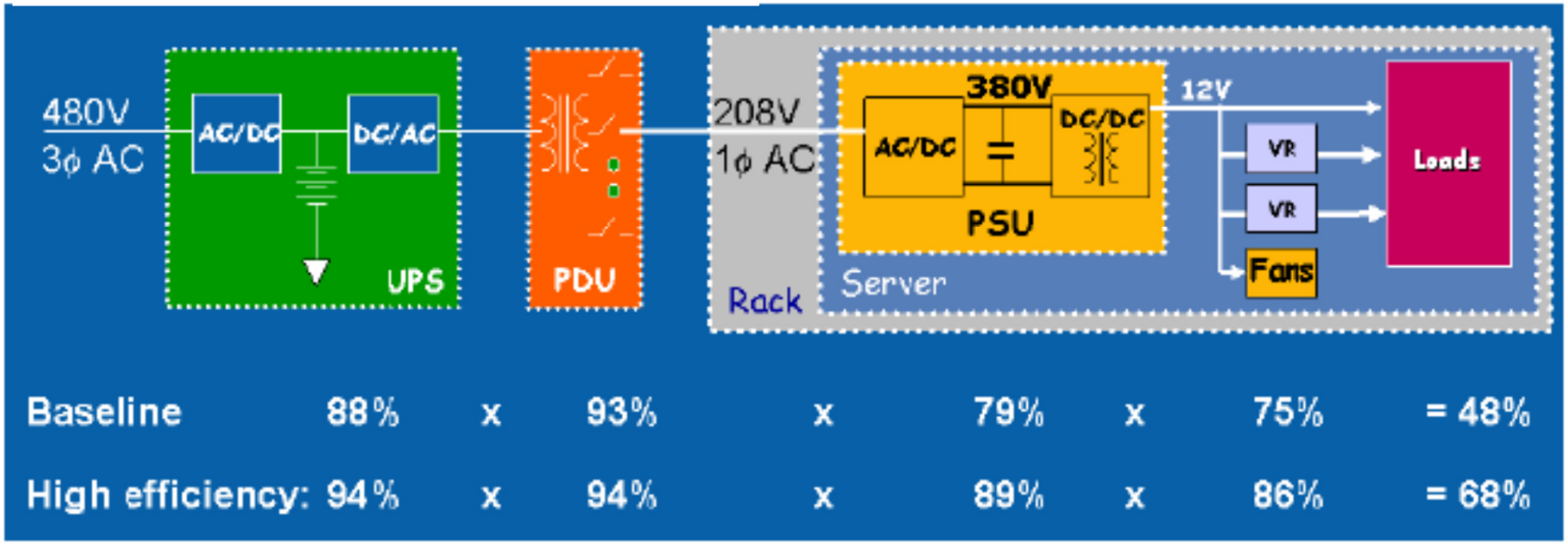
Power distribution with DG

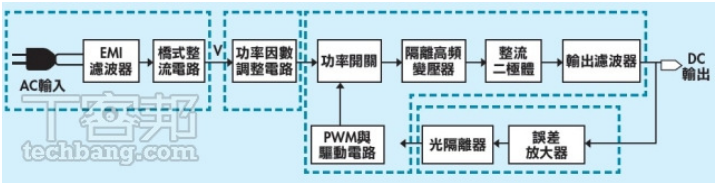


PV : Photo Voltaic
FC : Fuel Cell

INTEL'S VISION



- AC 系統效率低落，普遍AC供電系統效率低於50%
- AC 並聯UPS系統，單機負載率低於50%，導致整個系統效率更差
- AC 並聯UPS系統擴容的同步要求、降低可靠度與可用性
- AC 系統複雜度高，設備原廠維修制度致使維護不易
- AC 系統存在單一故障點，Tier 4架構代價高昂
- THDi/THDv考量，導致建置的直接與間接成本攀高 …



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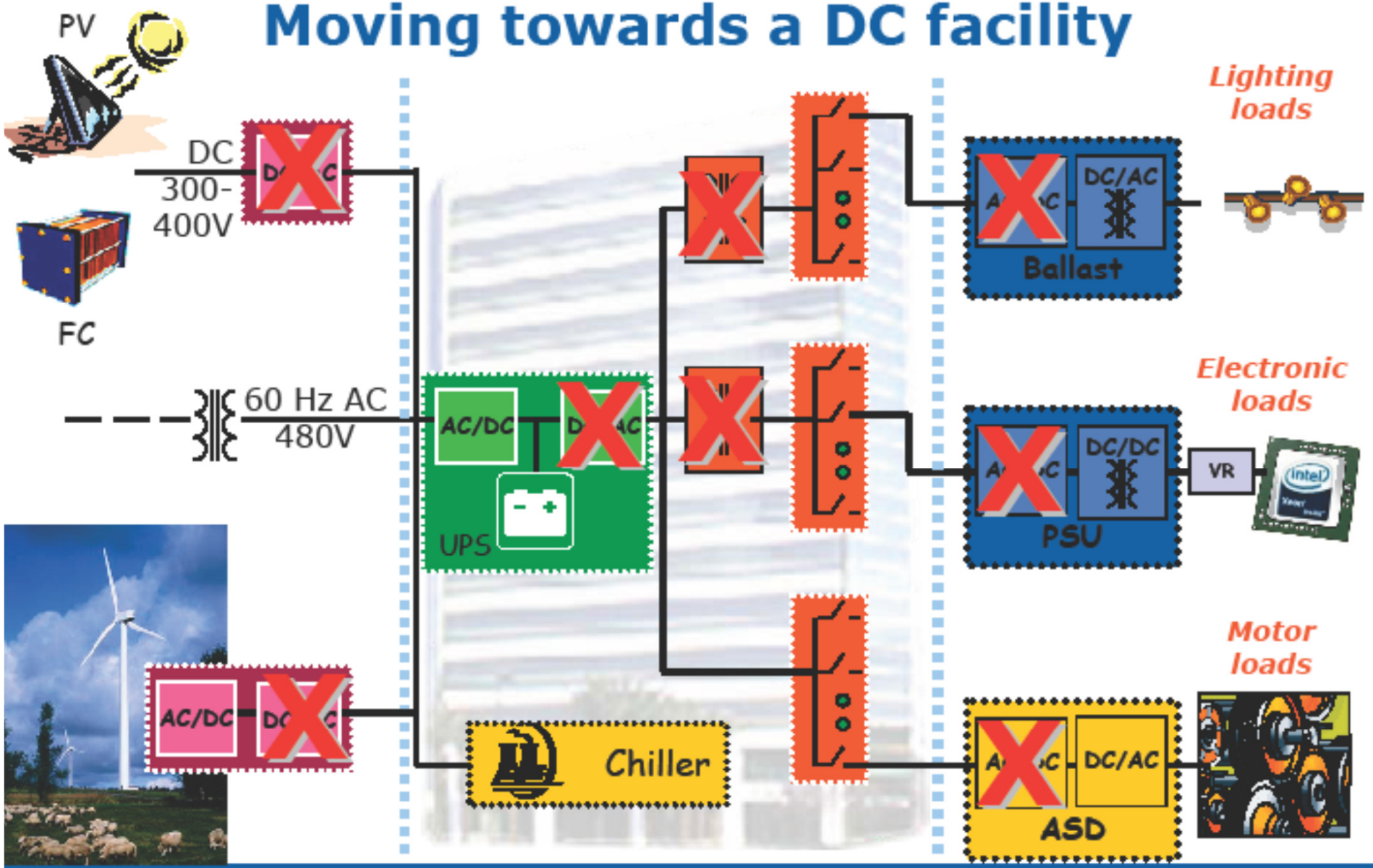
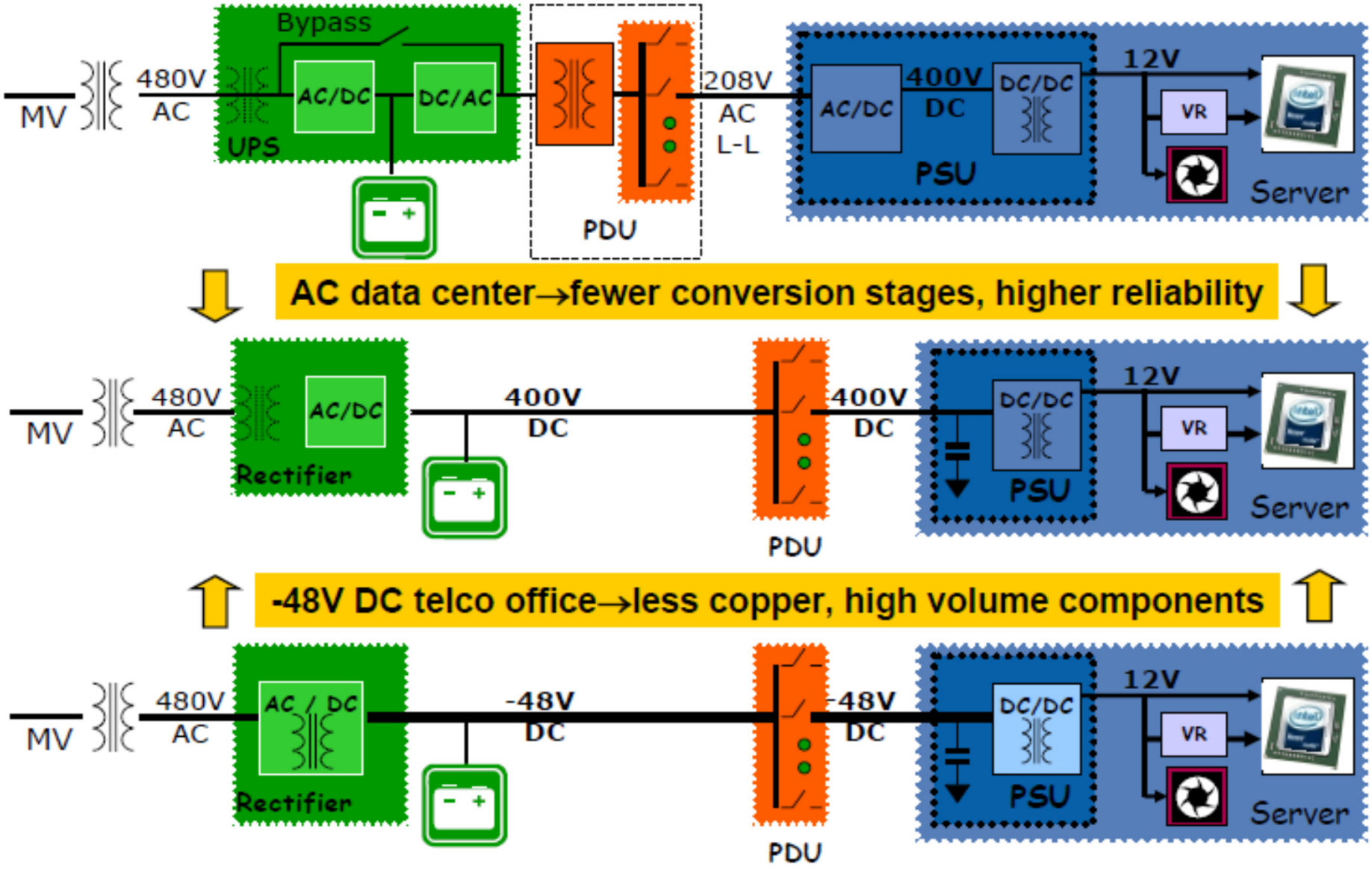
Moving towards a DC facility



Moving towards 400Vdc



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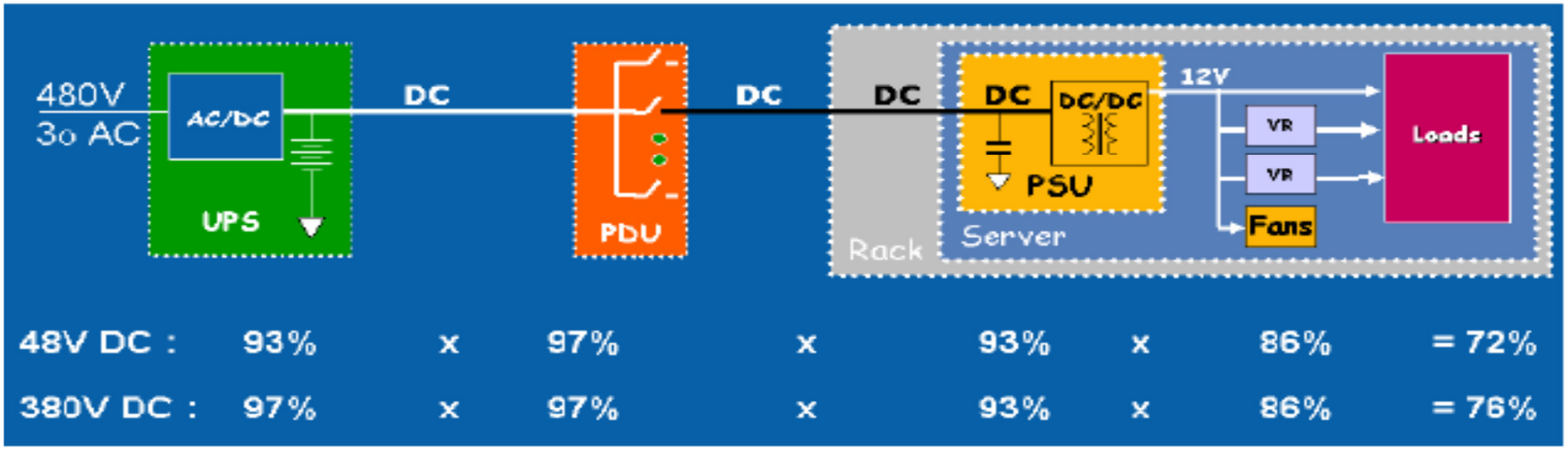
INTEL'S VISION



- hvDC供電系統效率，從AC系統48%大幅提升到**76%**
- DC 系統並聯與擴容無同步要求，大幅提升系統可靠度**200%**

資料來源:
Berkerly_DCDemo_FinalReport

DC 機房效率提升
28.2%

Option	Availability	Unavailability	Probability of failure in 5 years
AC Tier IV configuration	0.999996	3.9 e -06	13.63%
DC configuration**	0.999998	2.4 e -06	6.72%
DC Improvement		62.5%	200%

Table 3. Reliability analysis results from Relex* software calculations by EYP Mission Critical Facilities.

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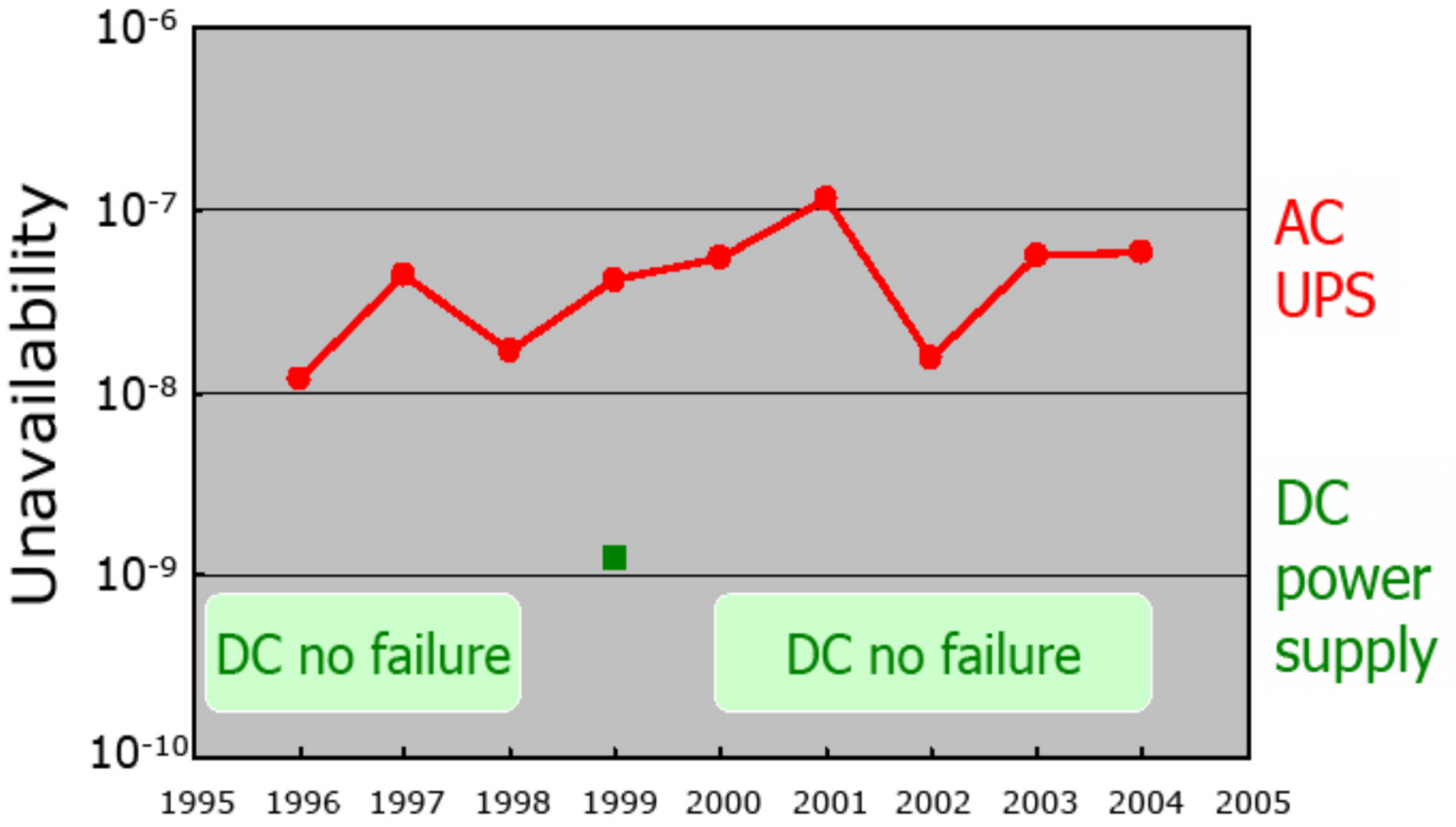
Reliability Field Data of Power Systems

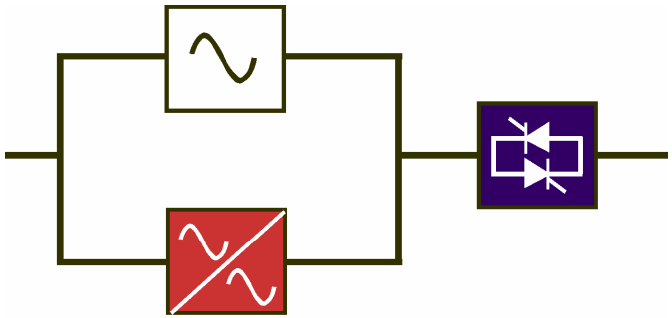
NTTFACILITIES



(Field data for 10,000 UPSs and 23,000 DC systems)

AC and DC UPS - 系統可靠度比較

AC UPS

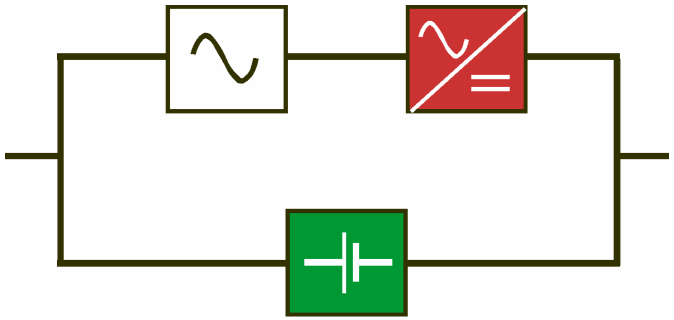


$U_{AC} = 7.4 \cdot 10^{-6}$ (3h)
t_{down} = 3 min 50 s

Availability=99.99926%

DC UPS

案例比較: NTT Facilities



$U_{DC} = 9 \cdot 10^{-10}$ (8h)
t_{down} = 0.03 s

Availability=99.99999991%

VS. Uptime TIA942 Tier IV

- Site Availability: 99.995%
- Annual IT downtime due to site: 0.4 Hrs

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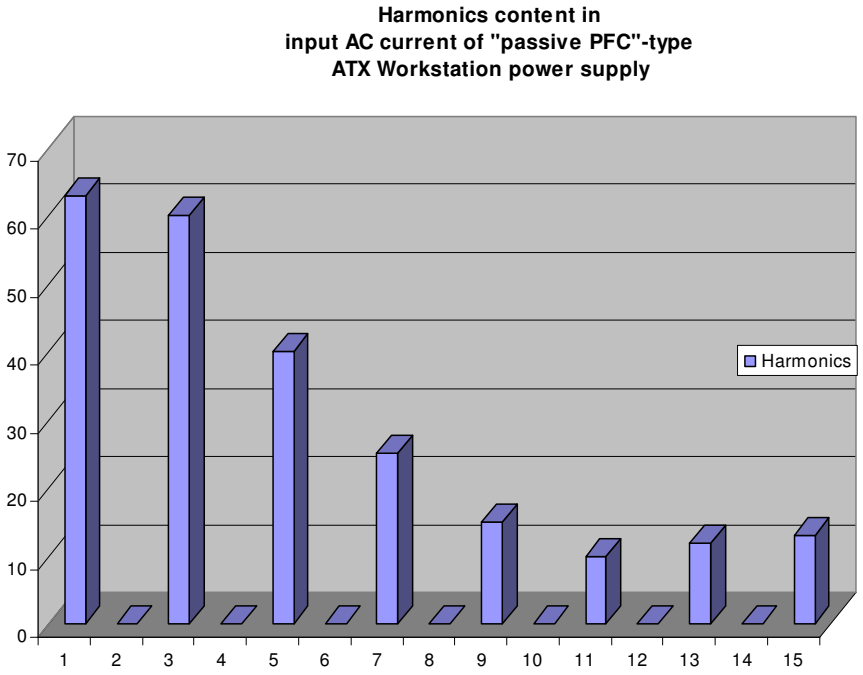
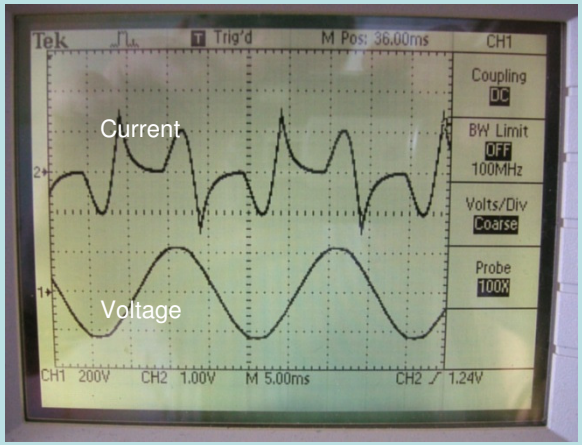
PSU 的 PFC 功因校正電路諧波

Considerable amount of harmonics cause bad effects in the AC mains:

- •Causing disturbances to other equipment
- •Causing active power energy losses in the AC grid
- •Causing currents in the zero return lead

... also ”Active PFC” shows a large amount of harmonics





1.72 A rms
5.05 A peak
77.3 % THD

系統效率低落主因

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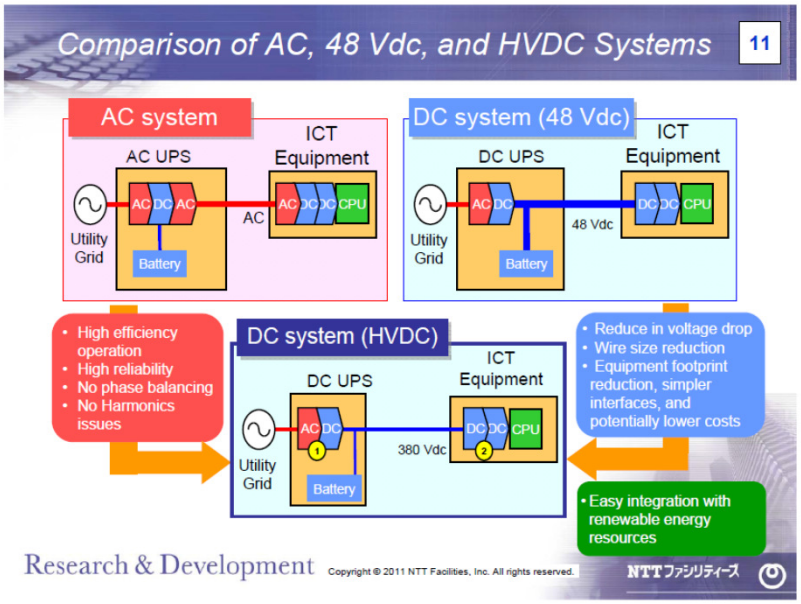
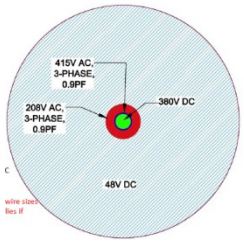
HVdc 高壓直流供電其他優勢

- HVdc供電不存在交流三相平衡問題，此舉可降低交流電力配電、電源排插與結線複雜度
- 沒有電壓/電流諧波問題，可降低前級發電機容量，與減除ICT 設備PSU中的功率因數校正回路，提升DC/DC PSU效率
- 因減少交/直流的轉換次數，斷路器(breaker)的使用數量可大幅降低，INTEL研究案例中，減少50%斷路器數量

•降低纜線銅截面積(Copper area; Pf = R x I^2)與線徑

- •相較於48V DC系統，可降低36倍纜線銅截面積，也可改善因傳送距離而產生的壓降問題
- •相較於 AC UPS，線徑可降低40%





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hvDC 解決方案

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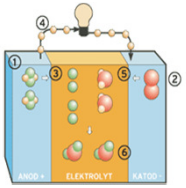
DC UPS 380V

AC/DC DC/AC

Solar cells

Fuel cells



AC

Reserve power

AC/DC

Battery

Uninterruptible Power Supply

IT Equipment

DC/DC

12 V, 5V

Electronics

380 V DC

Power Supply Unit

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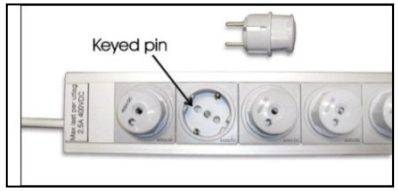
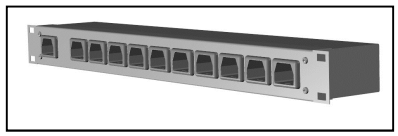
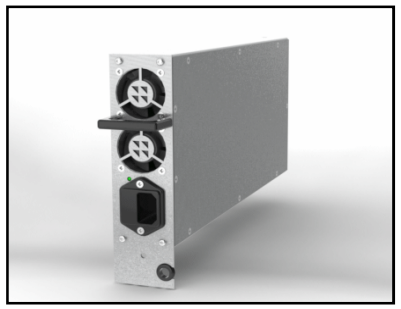
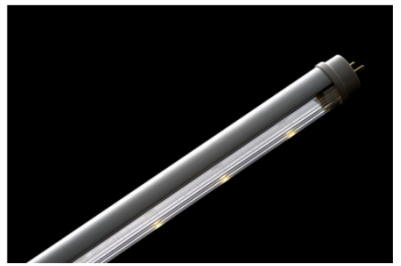
Product portfolio 產品範圍

- **Systems**
  - Flexible 10 kW –> MW
  - Already 3rd generation
  - Unique solar (PV) integration
- **Components**
  - Connectors, distribution modules, LED lighting, kWh meters, control & monitoring devices
- **Know-How**
  - Technical lead position
  - Active in standardisations
  - Longest field experience (over 7 years)









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DC UPS 380V – System Solution - 2,5 kW to 135 kW

112/135 kW => MW

Power Cabinet includes:

- Distribution & battery fuses
- AC fuses
- Power control unit (-remote management)
- Hot swappable rectifier modules "pay as you grow"
- Battery 380V
- Modular architecture enables systematic growth up to 0.1MW (in steps of 2,5 kW)

Netformer (not shown)

Modular architecture – system growth in steps of 22.5 kW to 135 kW

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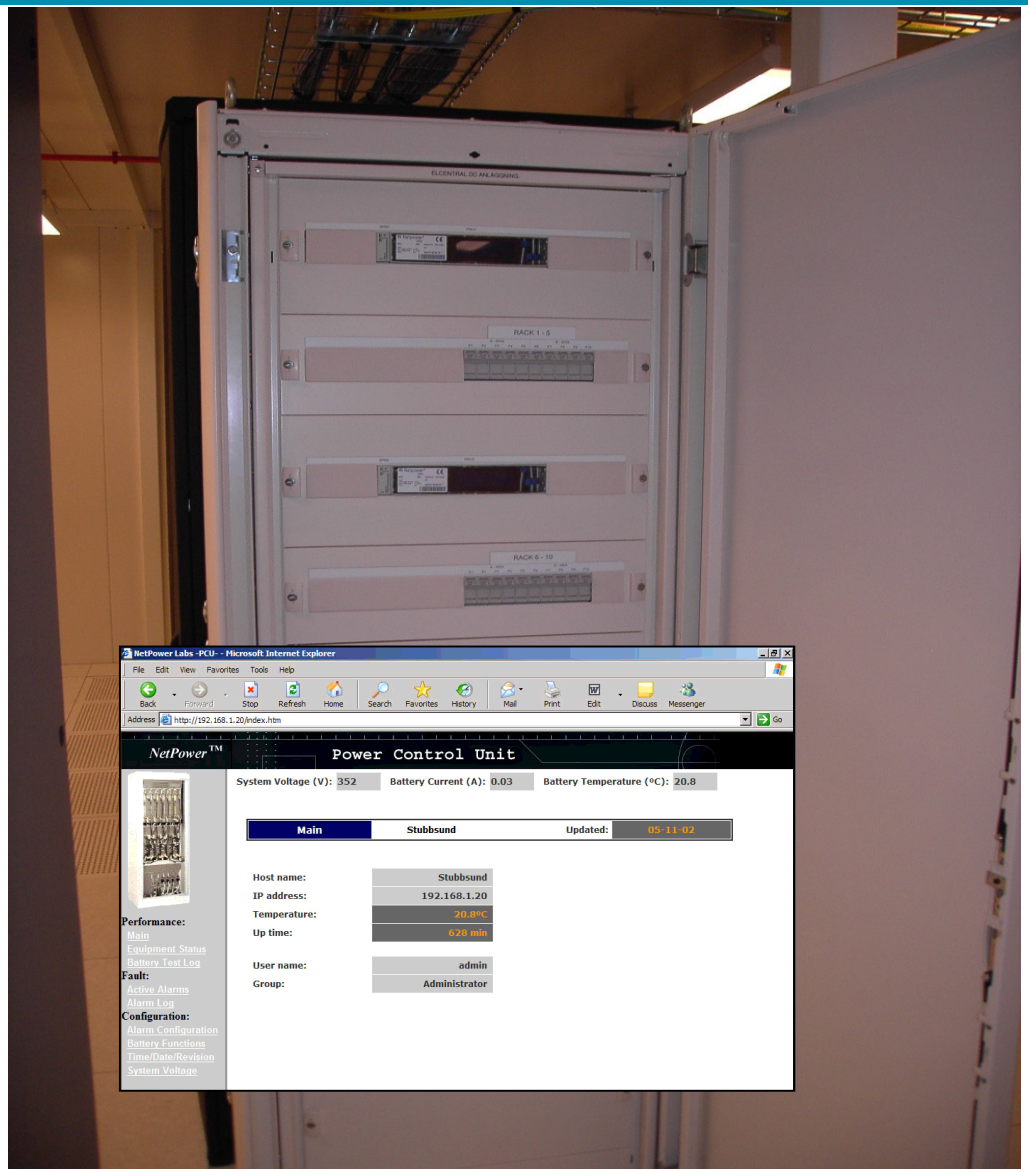
PDU - Intelligent Distribution Module (kWh)

Features:

- 10 x 20A
- Remote monitoring
- Embedded Web server
- TCP/IP FTP etc.
- Integrated data logging
- (kWh/temperature/voltage)

- Based on standard interfaces
- Built-in alarm functions
- No specific client software



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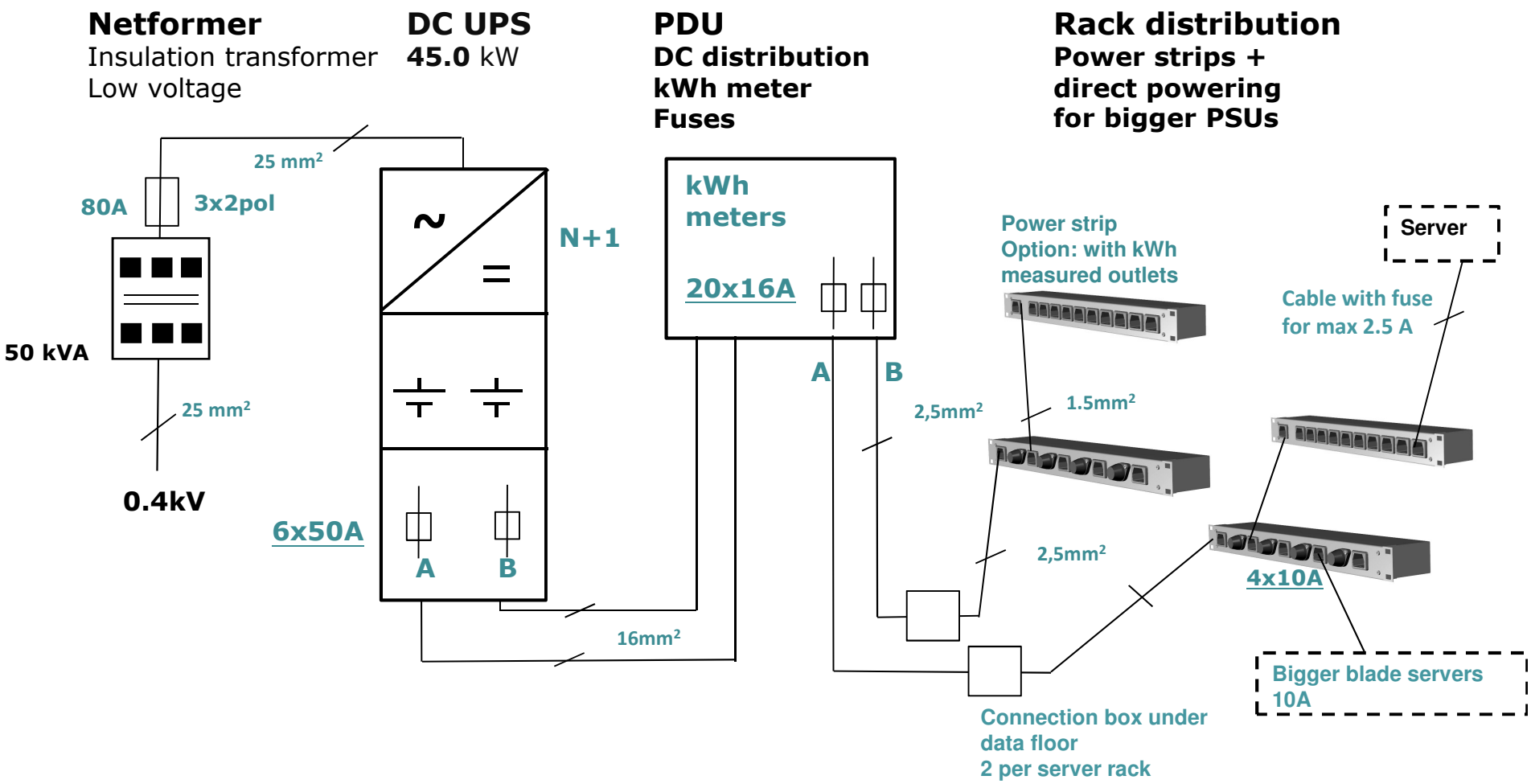
DC UPS Installation / Distribution



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DC UPS – Distribution - In Server room

Distribution Unit
- 4x10A Fuses

Alt.
- Connection box under data floor

Multiway outlet / 400V DC plug
- 10 Outlets / 10A
- 10 m cable

Option
- kWh meter on each outlet

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600/400 VDC Outlet

Features
- Touch Safe
- Passes UL & IEC finger probe
- Arcing Protection
- Hot Plug Rated
- First Mate, Last Break Ground Contact
- Integrated Latch

Ratings
- 400 VDC (IEC)
- 600 VDC (UL)
- 20A

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hvDC demo site
& Future Trend

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Internet 新趨勢與研究

1. Internet uses 2% of the worlds energy resources*

*November 2011 Barath Raghavan and Justin Ma ICSI and UC Berkeley

2. MPEG – DASH 新標準崛起,推升IDC需求

多媒體影音串流需求日增，2011年MPEG已提出可在HTTP上進行動態與適應性媒體串流的新標準--MPEG-DASH，以解決不同品牌終端裝置與後端伺服器間互通相容問題，並已獲得廣泛業者支持。

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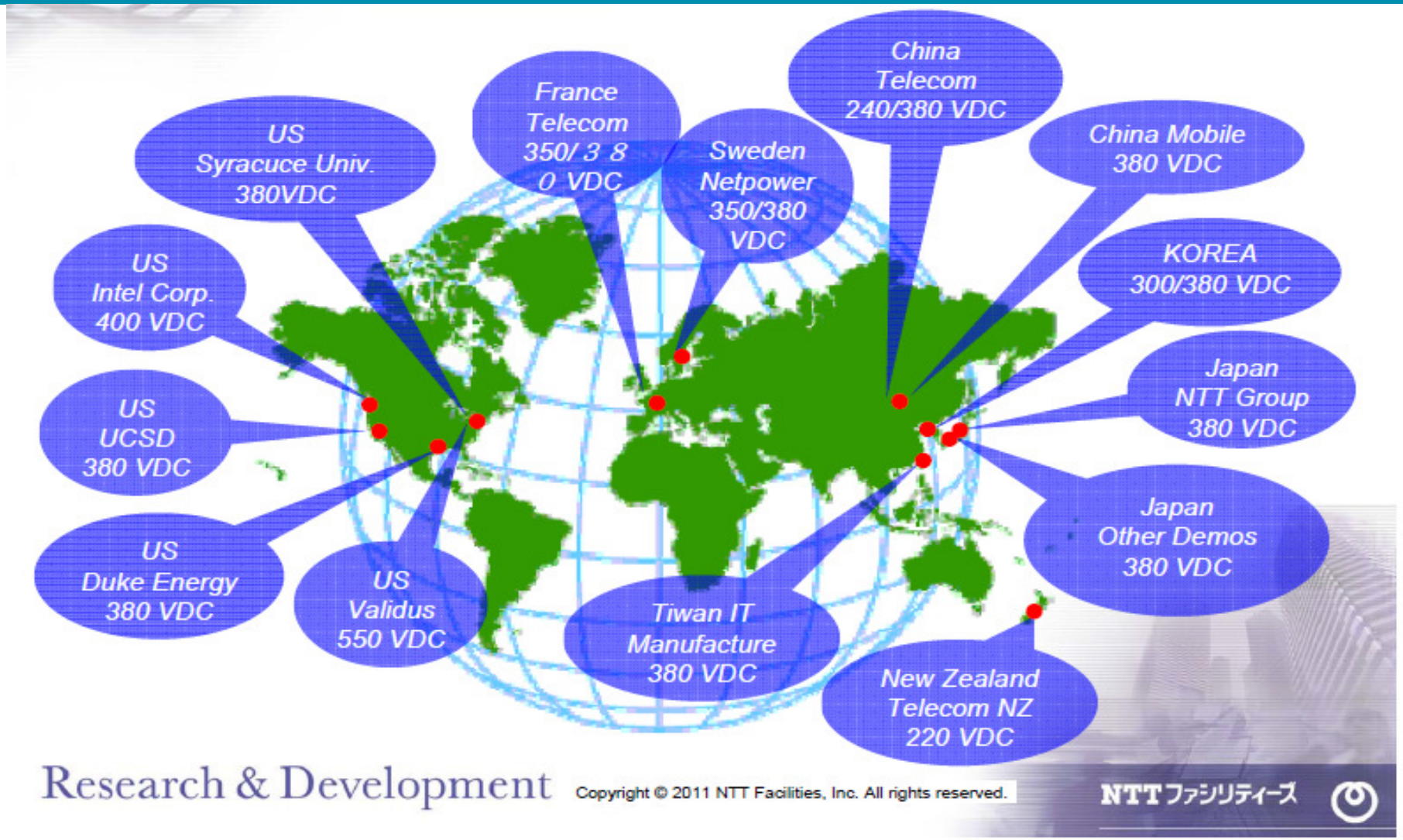
全球 hvDC 供電試運點與運作機房



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全球 hvDC 供電試運點與運作機房

Site	Location	Op Date	Max kW
Gnesta Municipality	Gnesta	Mar-06	9kW
Elicom	Toreboda	Mar-06	4.5kW
NTT NEDO Project	Sendai	Feb-07	20kW
NTT Univ. Microgrid	Aichi	May-07	50 kW
France Telecom	Lannion France	Nov-07	31.5kW
Ericsson	Stockholm	Mar-08	4.5kW
Soderhamm Teknikpark	Soderhamm	Jun-08	6kW
NTT Data Corp	Mitaka City,Tokyo	Jan-09	100 kW
NTT Lab.	Mitaka City, Tokyo	Jan-09	100 kW
NTT Facilities	Toshima-ku, Tokyo	Jan-09	100 kW
Compare Test Lab	Hammaro Karlstad	Jun-09	4.5kW
Korea Telecom	Seoul, Korea	Jun-09	N/A
Univ of Calif/San Diego	San Diego, CA	Nov-09	20 kW
Syracuse Univ	Syracuse, NY	Dec-09	150 kW
Swedish Energy Agency	Eskilstuna	Jan-10	18 kW
Compare Test Lab	Hammaro Karlstad	Oct-10	500 kW
Duke Energy	Choriotte, NC	Aug-10	30 kW
NTT EAST	Tokyo	Dec-10	100 kW
NTT	Atsugi City, Kanagawa	Feb-11	100 kW

Research & Development

NTTファシリティーズ

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Other use of 380 VDC plug & socket-outlet

Chung Cheng University in Taiwan
September 2010

2011 Case Study IBM XiV

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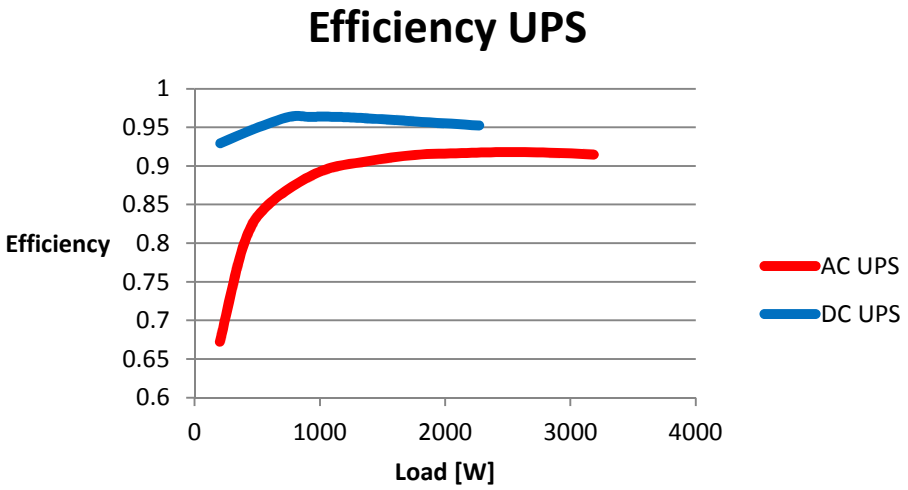
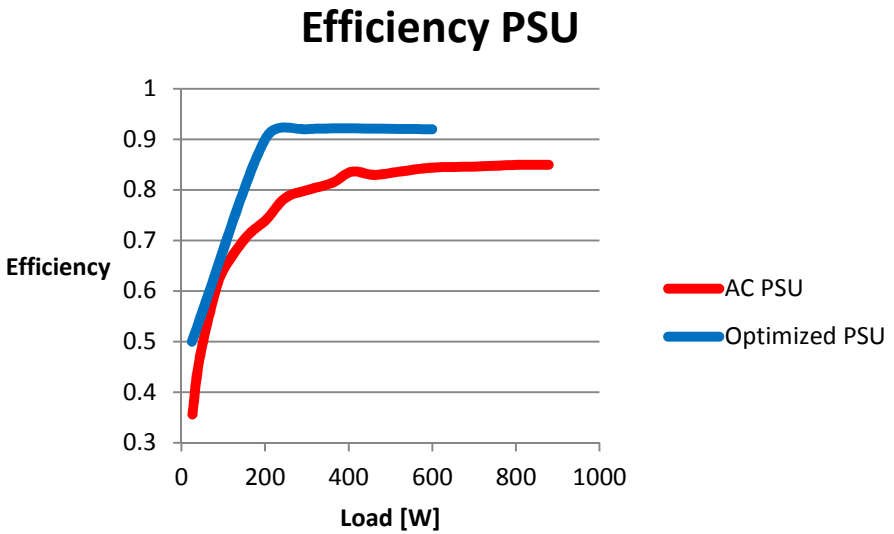
DC UPS vs AC UPS - Efficiency – XiV





Load: **220W/PSU** (in normal operation)

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