FP7 ICT 2013.6.2

Green Data Net – datacenters in Europa op basis van zonne- en windenergie

ICTroom, ir. Norbert Engbers

(ir. Eric Taen)

6 nov 2014 - IT Room Infra

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Deze lezing wordt u aangeboden door:

Datacenter works

ICT room

SIEMENS

Strukton Worksphere

TE connectivity ENTERPRISE NETWORKS

Remtech

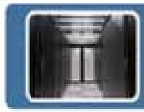
ICTroom®

The Data Centre Facility Infrastructure specialist

Constructional
- Building, Interior, Brownfield, Greenfield

Mechanical
- Cooling, Fire Control, Pumps

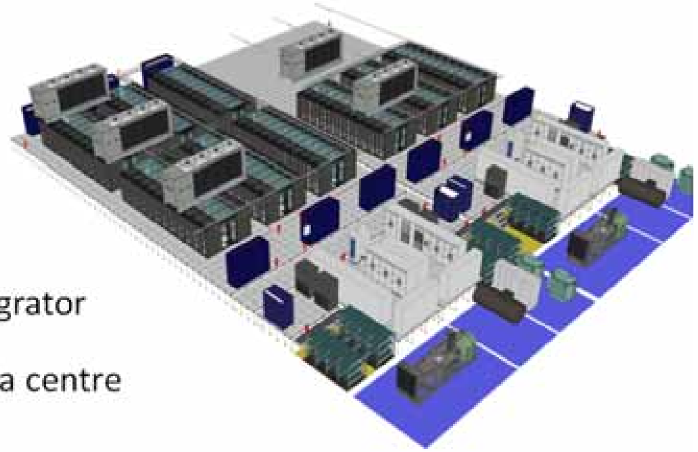
Electrical
- Commercial power, No Break, Short Break. Main Boards, Sub Boards, Rack power



Room Infra
- Racks, Data cabling, PDU, Security

Management
- Maintenance, 24/7 security staffing, Customer Implementation, Uptime DFI

Expertise
- Consultancy, Design, Quick scans, Audits



- <u>Independent</u> Smart Integrator
- Leading Specialist in Data centre Facility Infrastructure
- Since 2001 - from products to full built-out Turn-key Data Centers to Modular Data Centers
- SME Employing > 50 data centre professionals with a yearly turnover of 24 Mio €

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IMD ICTroom Modular Datacenter

FP7 ICT-2013.6.2

Data Centers in an Energy-Efficient and Environmentally Friendly Internet

<u>Call for projects</u>

“Development of system level technologies and associated services v
the energy and environmental performance of data centers”

Expected results

GreenDataNet will address data centre challenges by developing:

- An **integrated energy management system** that can monitor and automatically optimise power, cooling, IT and storage in individual data centres.
- An **extension of this system towards networks of data centres** to achieve higher share of renewable energy and facilitate smart grid integration.
- The necessary hardware, software and prediction models to efficiently **integrate local PV** resources into data centres.
- The overall cost of the project is €4.3m. The European Commission has made a grant of €2.9m to fund the project.

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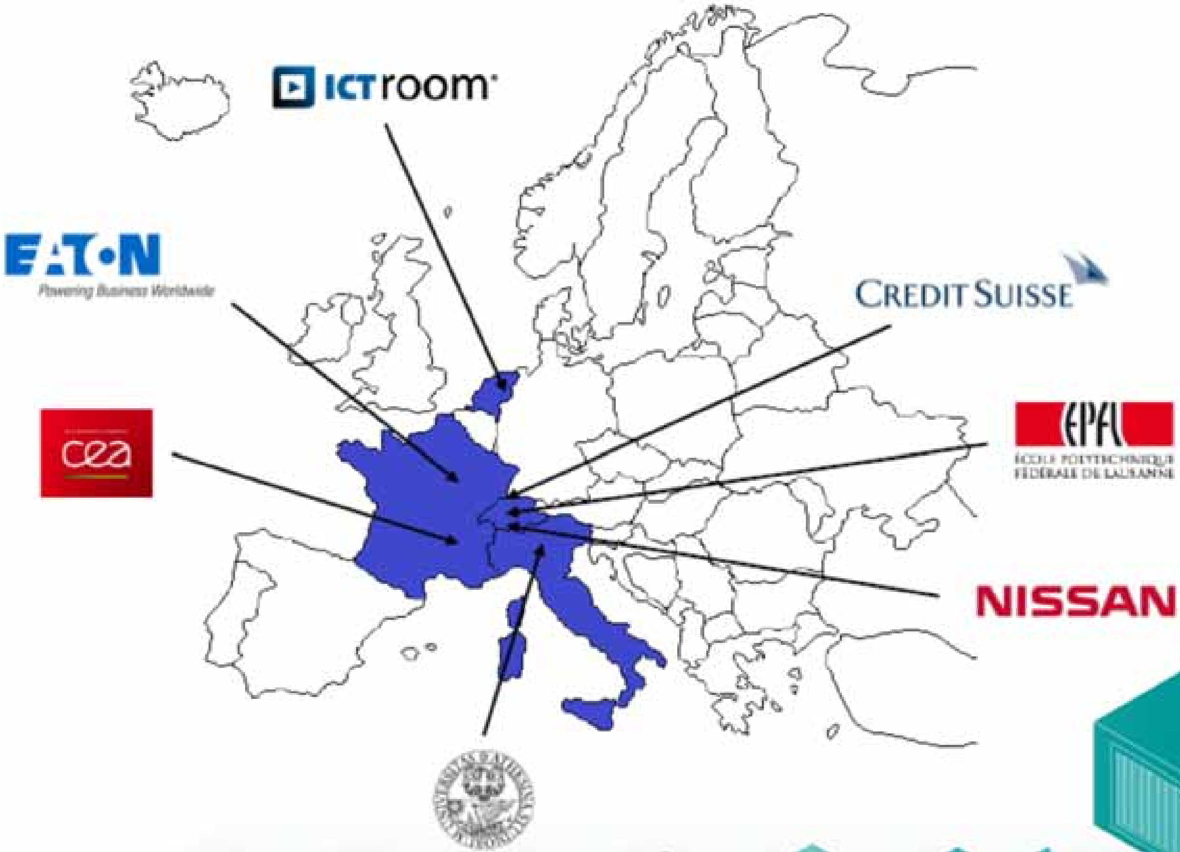
Data Centers in an Energy-Efficient and Environmentally Friendly Internet

European Commission

SEVENTH FRAMEWORK PROGRAMME

Green Data Net



Consortium GreenDataNet

Project Partners

Eaton Power Quality France	Large Enterprise (Industrial)	Project coordination; power architectures; virtualisation technologies; demonstration and pilots; dissemination
CEA Solar Energy Institute France	Research institute (Industrial)	Energy management and prediction; renewable integration; smart grid schemes
ICTroom Netherlands	S/M Enterprise (Integrator)	Data centre requirements; energy monitoring tools; Demonstration and pilots
Swiss Federal Institute of Technology Lausanne Switzerland	University (Research)	IT/cooling optimisation; control algorithms; energy monitoring
Nissan International Switzerland	Large Enterprise (Industrial)	Storage using second life EV batteries
Credit Suisse Switzerland	End user	End user experience and one of the Pilots
University of Trento Italy	University (Research)	Smart grid optimisation algorithms

Expectations from the European Commission

- Technology exploration, not product development
  – but should facilitate and accelerate future product development
- Holistic approach – innovation at system integration level,
  not individual component (IT, cooling, power) level
- Need to consider data centers in urban environments
  (“no Facebook data center on the North Pole”)
  - Integration within surrounding environment (e.g. office buildings, municipal facilities) through heat reuse
  - Integration within existing / future smart grid schemes through two-way connection to utilities / load sharing
- Target of 80% renewable power, not at single data center level
  but at network of data centers, building or neighborhood levels

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Data Centre Challenges

Data centres have become major contributors to the global rise in energy consumption and emissions

- About 2% of overall electricity consumption
- Rising faster than any other industry – annual growth of 10-15%
- The EU has committed to reduce both energy consumption and emissions by 20% by 2020 – data centres need to take their share of cuts
- IT equipment accounts for only about a third to a half of the total consumed power

Urban Data Centre Challenges (1)

Addressing these challenges faces additional hurdles …

1. Improving data centre **energy efficiency** is still based on a "silo approach"
   - Most efforts have focused on individual components (servers, cooling …)
   - Further improvement could be obtained through integration of the 3 silos (IT, cooling, power)

2. Effective **energy management** through DCIM experiences significant adoption barriers
   - Cost, complexity and installation effort are important obstacles, especially for small and medium size data centres
   - Unclear pricing and return on investment

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Urban Data Centre Challenges (2)

3. Making further use of **renewables** and **heat reuse** have met mixed results
   - Need to cope with variable and intermittent nature of most viable sources of alternative power
   - Technical feasibility of data centre heat reuse

4. Connecting to **smart grid** schemes faces several obstacles
   - No appropriate integration of local energy sources (e.g. wind, solar)
   - Unavailability of large scale storage capabilities

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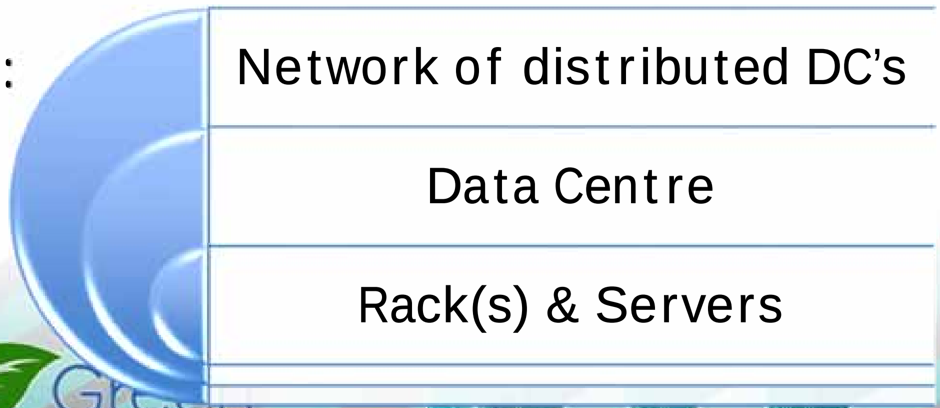
- Aims at addressing these challenges with a system level optimisation solution, allowing a network of urban data centres to collectively improve their energy and environmental performance

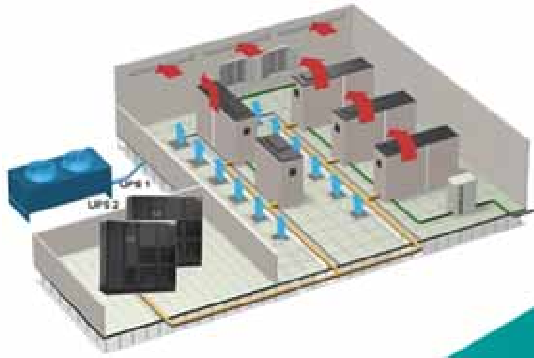
- Development of integrated smart energy management and optimisation techniques…
- ..at incrementing levels:



Urban DC’s

Strengths and Weaknesses

•In general less focus on energy efficiency
•Monitoring and optimal operation usually less implemented
•Due to scale few possibilities for large efficient installations



•Close to heat users
•Less complex, better predictable
•Easier use of renewable energy sources
•Better feasible pilots for optimised energy management

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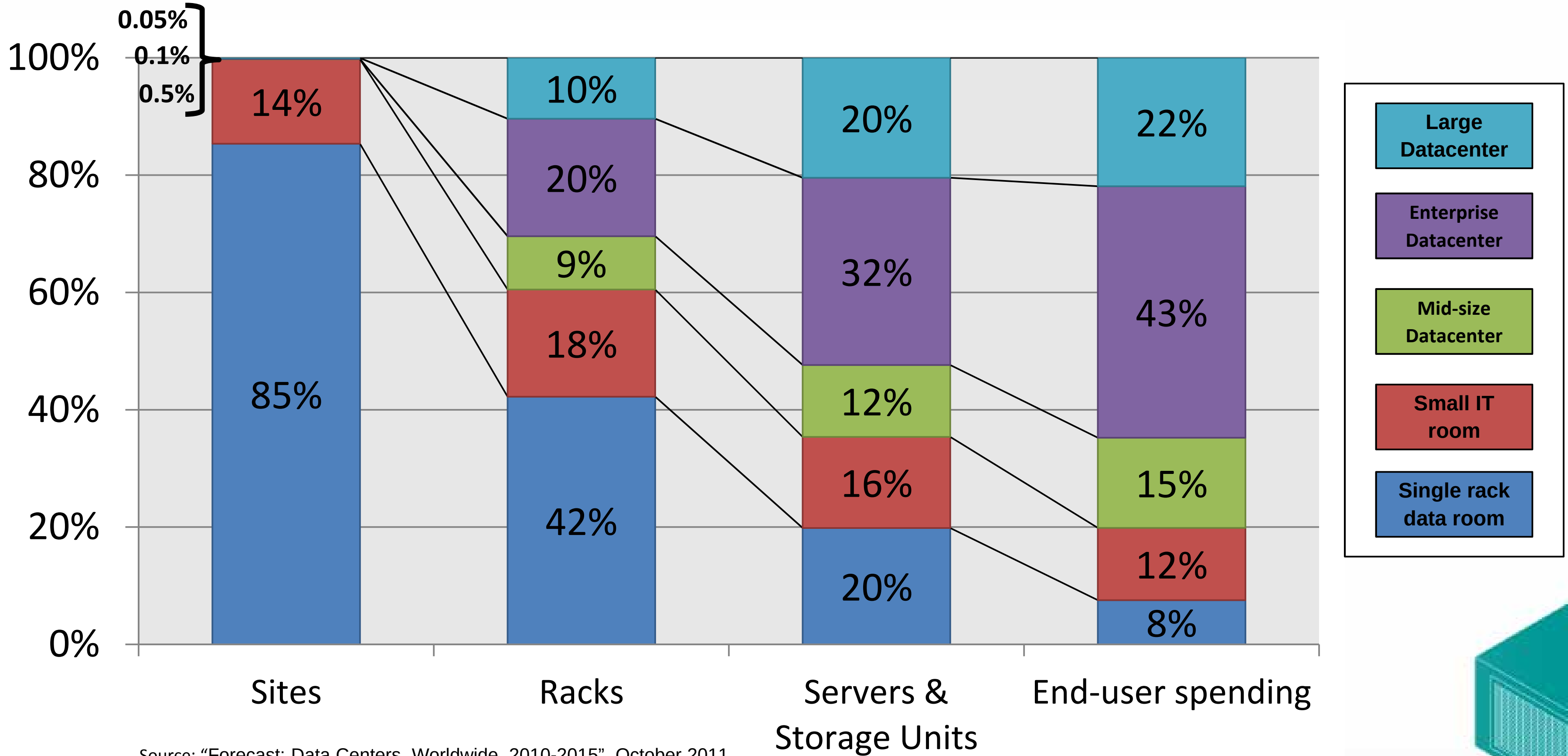
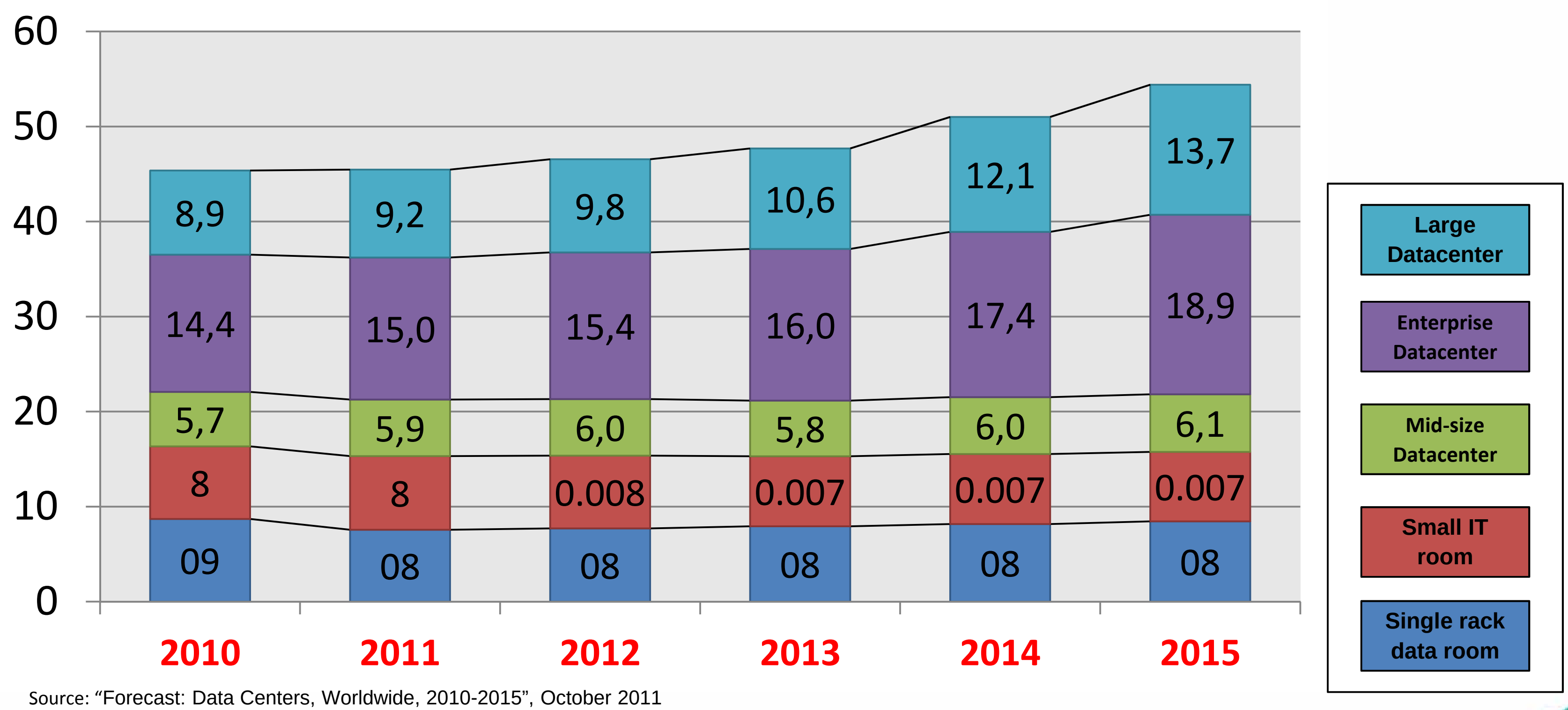
Data Centre Market - Rack to Grid Strategy



Source: "Forecast: Data Centers, Worldwide, 2010-2015", October 2011

Server & Storage - Installed Base Forecast



Source: "Forecast: Data Centers, Worldwide, 2010-2015", October 2011

Despite higher growth in the large DC space, Small-to-Midsize data centers will continue to represent 40% of the installed base

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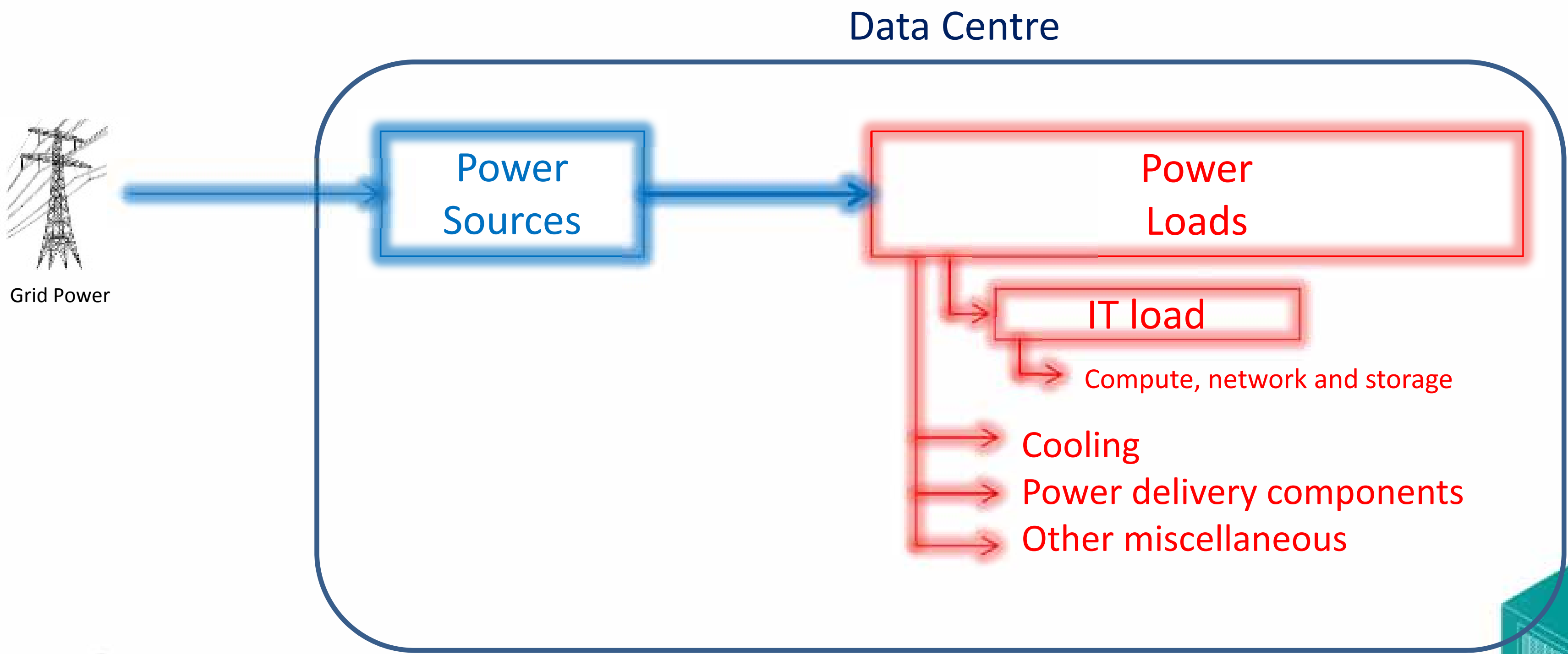
Data Centre Today



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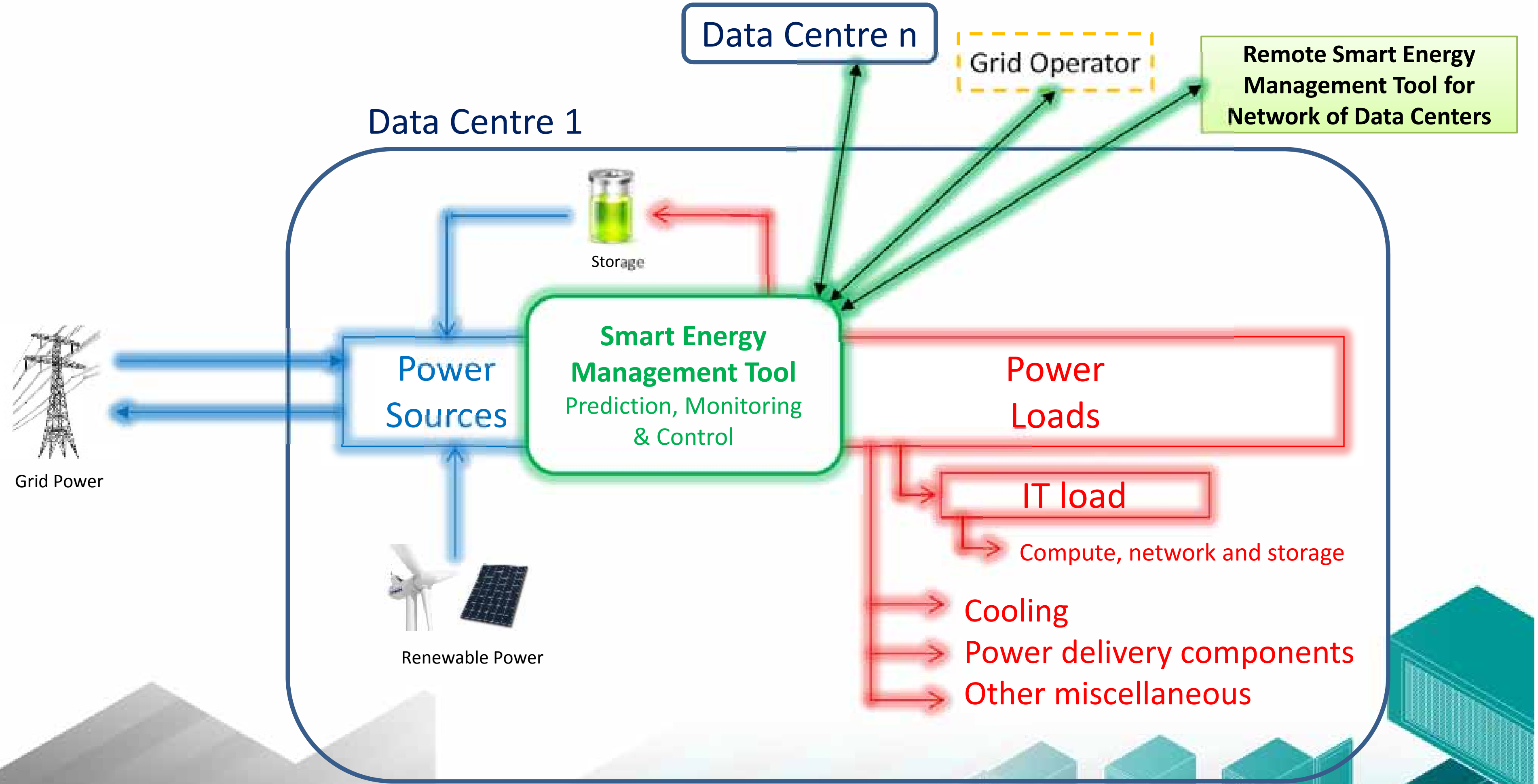
Energy Management at Data Centre Level



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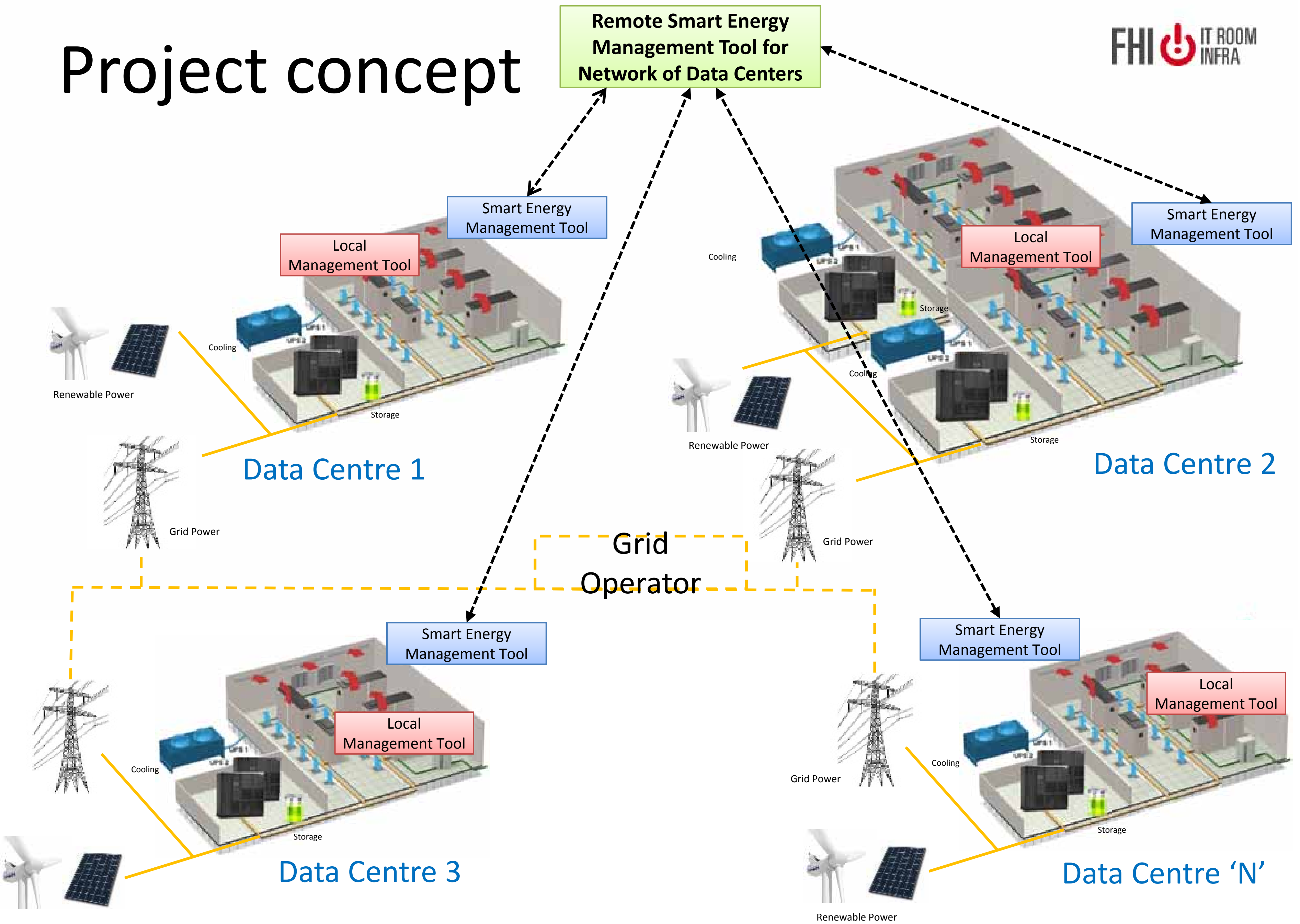
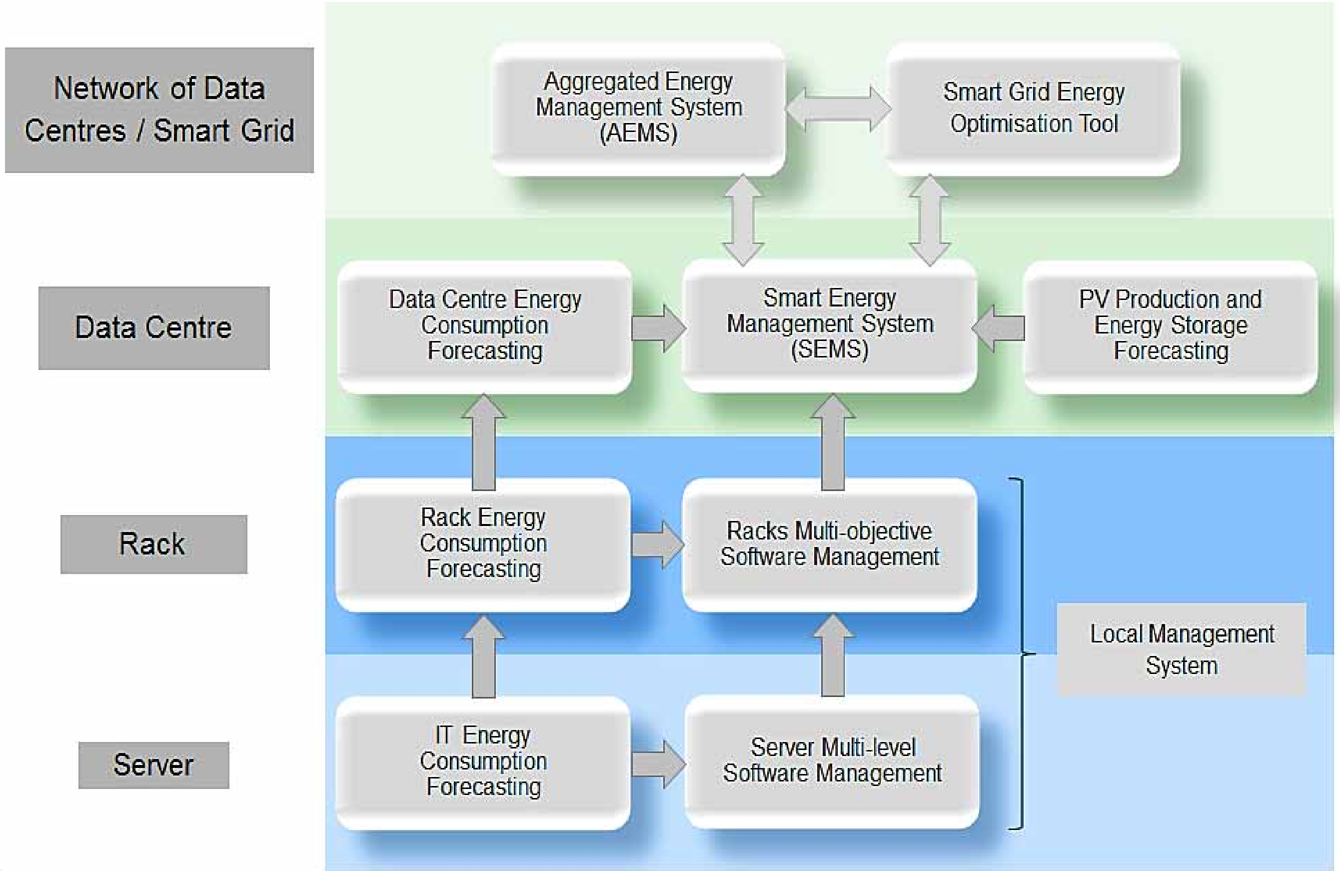
Project concept



Monitoring and optimization from Rack to Grid



Type casting data centres

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Item	Variation
Quantity of racks	Few - Thousands
IT-Area	Small – Medium - Large
Power	Small – Medium - Large
Business	Hosting – Colocation - Enterprise
User	Single tenant - Multi tenant
Life cycle phase	Green field - Brown field - Refurbishment
Operation	Lights out - 365/24 personnel
Equipment	Telecom equipment - Server equipment
Levels Availability	Low . . . High
Levels Security	Low . . . High
Levels Efficiency	Low . . . High
Location	Rural – Industrial – Urban
…	…

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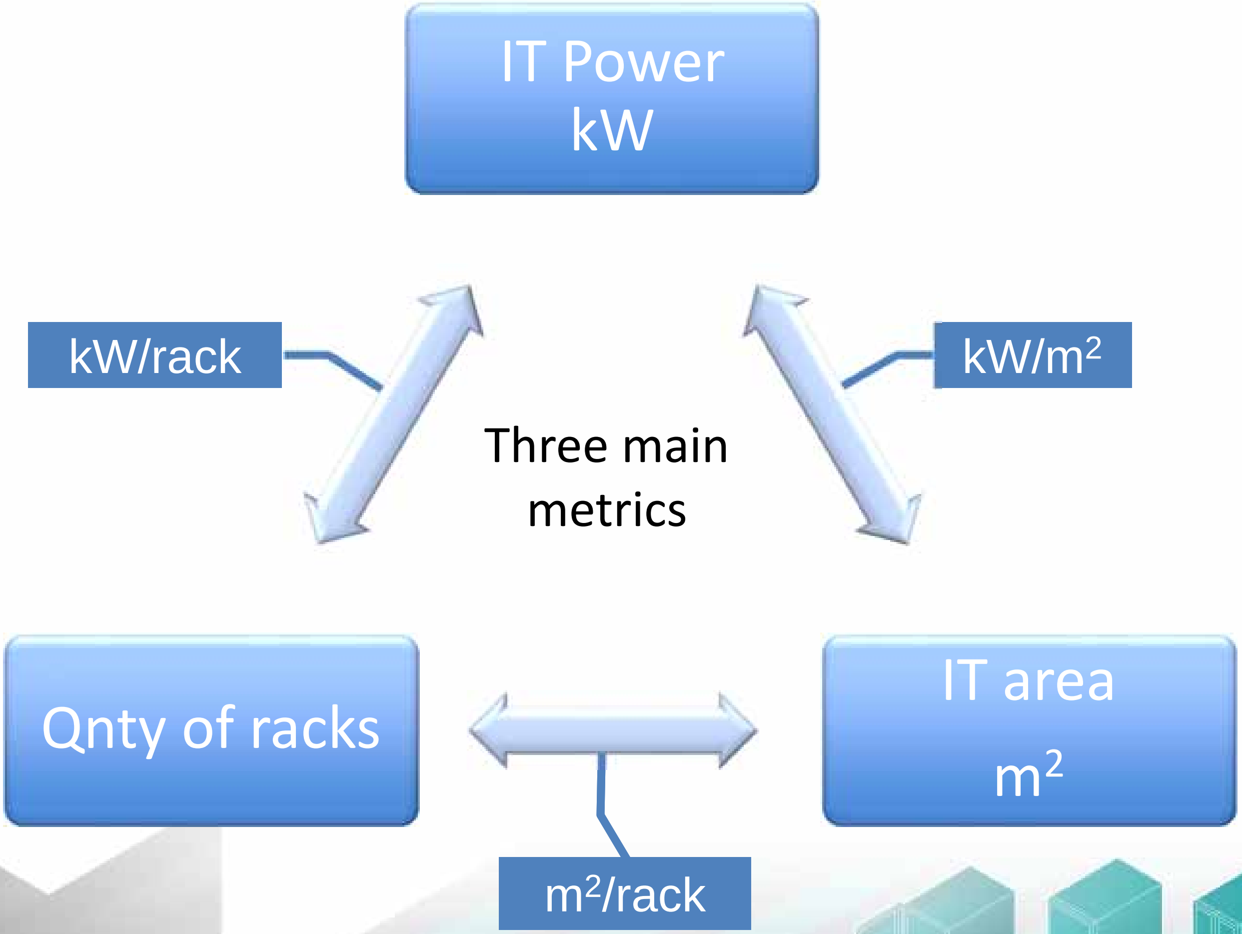
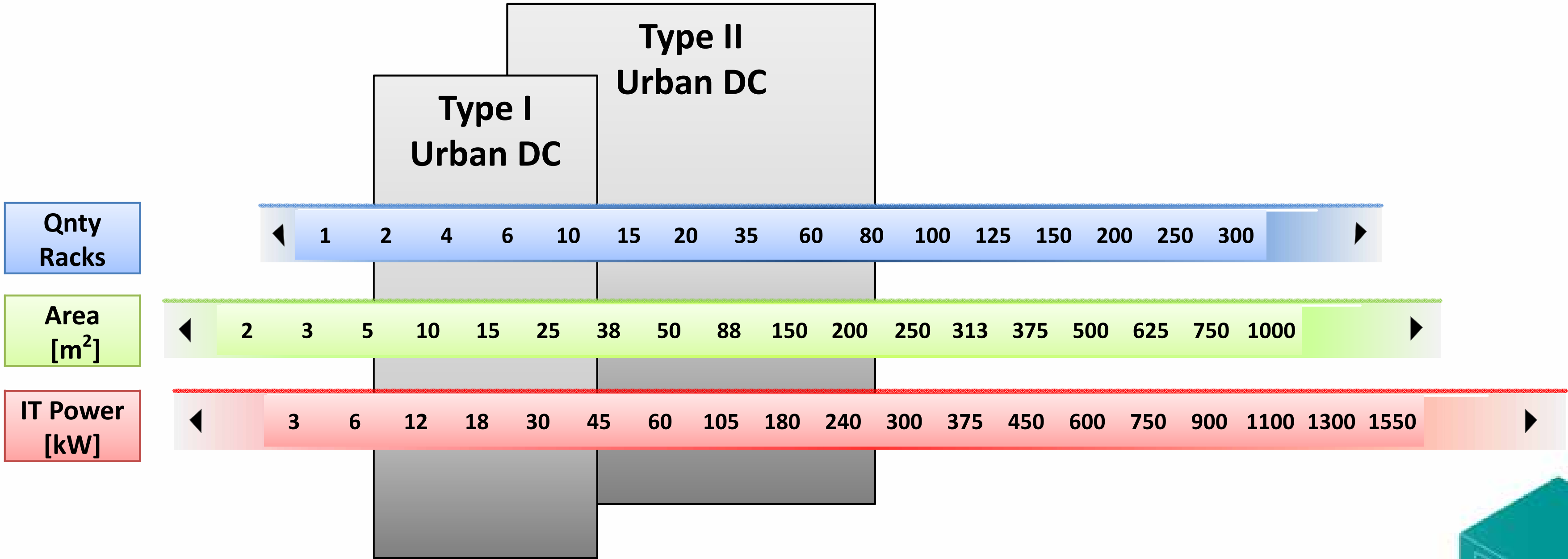
DC Specification



Urban DC Types



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Urban DC type specification

Urban DC type I

Total Power 40 kW
@ PUE= 1.3

30 kW

8 racks

20 m²

Urban DC type II

Total Power 130 kW
@ PUE= 1.3

100 kW

25 racks

70 m²

Typical values

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Urban DC type specification

Urban DC type I

- Availability Tier ranges (I – II)
- N or N+1 topologies
- Mainly DX cooling
- Local UPS or even UPS per rack
- Applied in SME
- Single user
- Location within or nearby a city
- Non-data centre specific building
- Limited monitoring and security systems

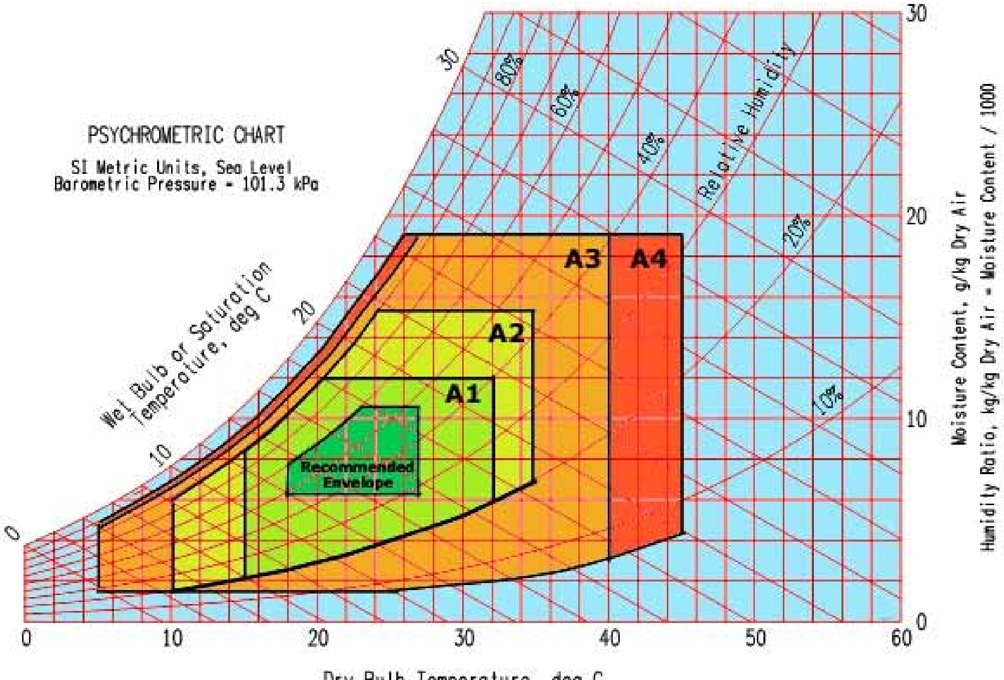
Urban DC type II

- Availability Tier ranges (II – III)
- N+1 topologies, even some 2N
- DX systems or dedicated systems using chilled water cooling
- Typically centralised UPS
- Applied in SME, Governmental, NPOs, Corporates
- Location within or nearby a city
- Better monitoring and security systems

Urban DC Specification

Urban DC type I and II

- Environmental conditions accord ASHRAE → A2
  - 10 – 35 °C at server inlet
  - 20 – 80 % R.H.
- PUE ~ < 1,3
- Local Energy sources
- Focus on PV power and re-use of EV batteries



ASHRAE Environmental Classes for Data Centers

Urban DC Specification

- A clear trend is visible of new data centres that are based on <u>modular</u> architectures made of multiple type II data centres.
- Therefore Urban Data Centre type I and II do also allow the project to cover a broad range of data centres, from IT room with few kW of IT load to few MW data centres.

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KPI's

- GreenDataNet cooperates with projects DOLFIN, GENIC, RenewIT, DC4Cities, GEYSER, All4Green and CoolEmAll
- Investigation of KPI's by this Smart City cluster
- Too many…

No	KPI	No	KPI
1	Power Usage Effectiveness (PUE)	41	Green Energy Coefficient (GEC)
2	Corporate Average Data Center Efficiency (CADE)	42	Energy Reuse Factor (ERF)
3	Data Center Infrastructure Efficiency (DCIE)	43	Energy Reuse Effectiveness (ERE)
4	Compute Power Efficiency (CPE)	44	Carbon Emission Factor (CEF)
5	Data Center Energy Productivity (DCeP)	45	Carbon Intensity per Unit of Data (CIUD)
6	Data Centre Utilisation (DCU)	46	Green Power Usage Effectiveness (GPUE)
7	Server Compute Efficiency (ScE)	47	Return of Green Investment (RoGI)
8	Data Center Compute Efficiency (DCcE)	48	Total Cost of Ownership (TCO)
9	Coefficient of Performance of the Ensemble (COP)	49	Carbon Credit
10	Energy Efficient Ratio (EER)	50	PAR4 *
11	Seasonal Energy Efficient Ratio (SEER)	51	Building Heat Loss
12	Imbalance of Racks Temperature	52	Weighted energy Balance in Data Centres
13	Data Center Power Density (DCPD)	53	Global KPI of Energy Efficiency
14	Data Centre Density (DCD)	54	Data Centre Performance per Energy (DPPE)
15	Space, Watts, and Performance *	55	Load match and Grid Interaction indicators
16	Useful work *	56	IT- power usage effectiveness (ITUE)
17	Data Centre Productivity	57	Total power usage effectiveness (TUE)
18	Transactions per second per Watt (TPS/Watt)	58	Data Centre Fixed to Variable Energy Ratio (DC FVE
19	Deployed Hardware Utilization Ratio (DH-UR)	59	Partial Power Usage Effectiveness (pPUE)
20	Deployed Hardware Utilization Efficiency (DH-UE)	60	IT Equipment Energy Utilization (ITEU)
21	Site Infrastructure Power Overhead Multiplier (SI-POM)	61	IT Equipment Energy Efficiency (ITEE)
22	IT Hardware Power Overhead Multiplier (H-POM)	62	Green Energy Coefficient (GEC)
23	Server Utilization / Hardware Utilization / Network Utilization	63	Energy Consumption KPI (KPIEC)
24	Relative Humidity Difference (RHD)	64	Task Efficiency KPI (KPITE)
25	HVAC Effectiveness	65	Energy Reuse KPI (KPIREUSE)
26	Rack Cooling Index (RCI)	66	Renewable Energy KPI (KPIREN)
27	Data Center Cooling System Efficiency (CSE)	67	Global Synthetic KPI (KPIGP)
28	Air Economizer Utilization (AEU)	68	Data Center Maturity Model (DCMM)
29	Water Economizer Utilization (WEU)	69	Code of Conduct *
30	Airflow Efficiency (AE)	70	Return Temperature Index (RTI)
31	Air management flow indicators	71	Physical Server Reduction Ratio (PSRR)
32	Cooling System Sizing (CSS)	72	Data Centre Measurement, Calculation and Evaluation Methodology (DOLFIN Project) *
33	Total harmonic distortion (THD)*		
34	UPS Load Factor		
35	UPS System Efficiency		
36	UPS Usage		
37	Lighting Density*		
38	Carbon Usage Effectiveness (CUE)		
39	Carbon Emissions Balance		
40	Water Usage Effectiveness (WUE)		

Reduced KPI's

Cluster activity,

in conjunction with

ISO/IEC JTC1 SC39-WG1

No	KPI description	KPI
1	Power Usage Effectiveness	PUE
2	Partial Power Usage Effectiveness	pPUE
3	Energy Reuse Effectiveness	ERE
4	Renewable Energy Factor	REF

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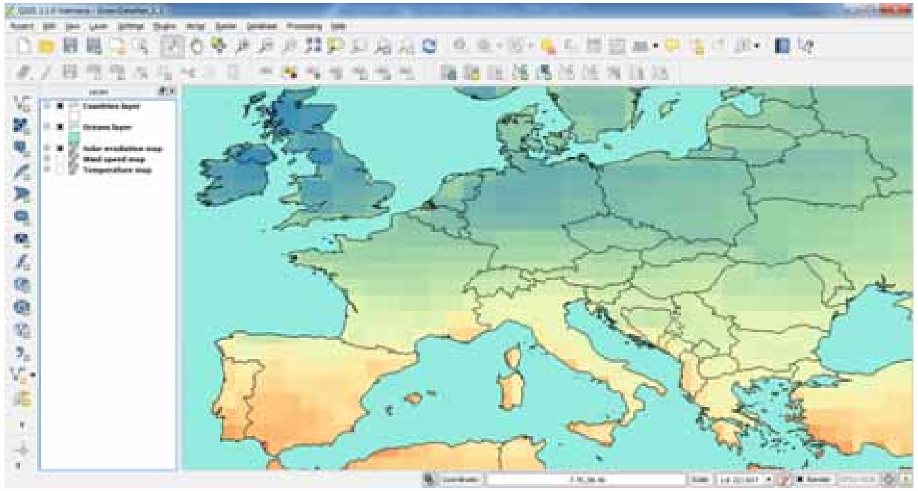
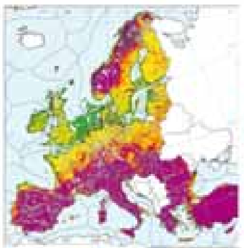
Data centre location 'selector'

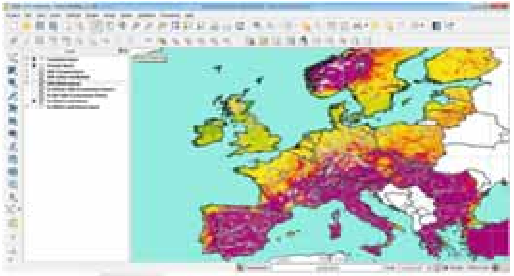
QGIS tool and GreenDataNet

- Open Source tool
- Integration of several maps format
- Ability to compile several maps
- Easiness of use

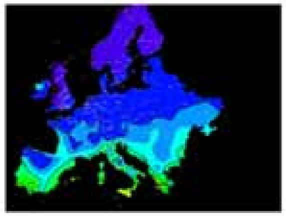




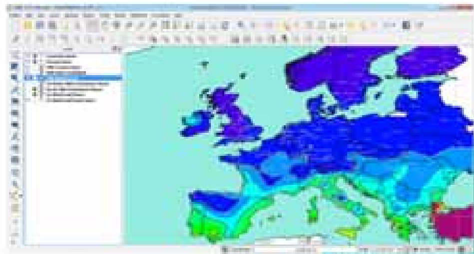
European Wind Load Hours
(Source European Environment Agency)



European Wind Load Hours integrated

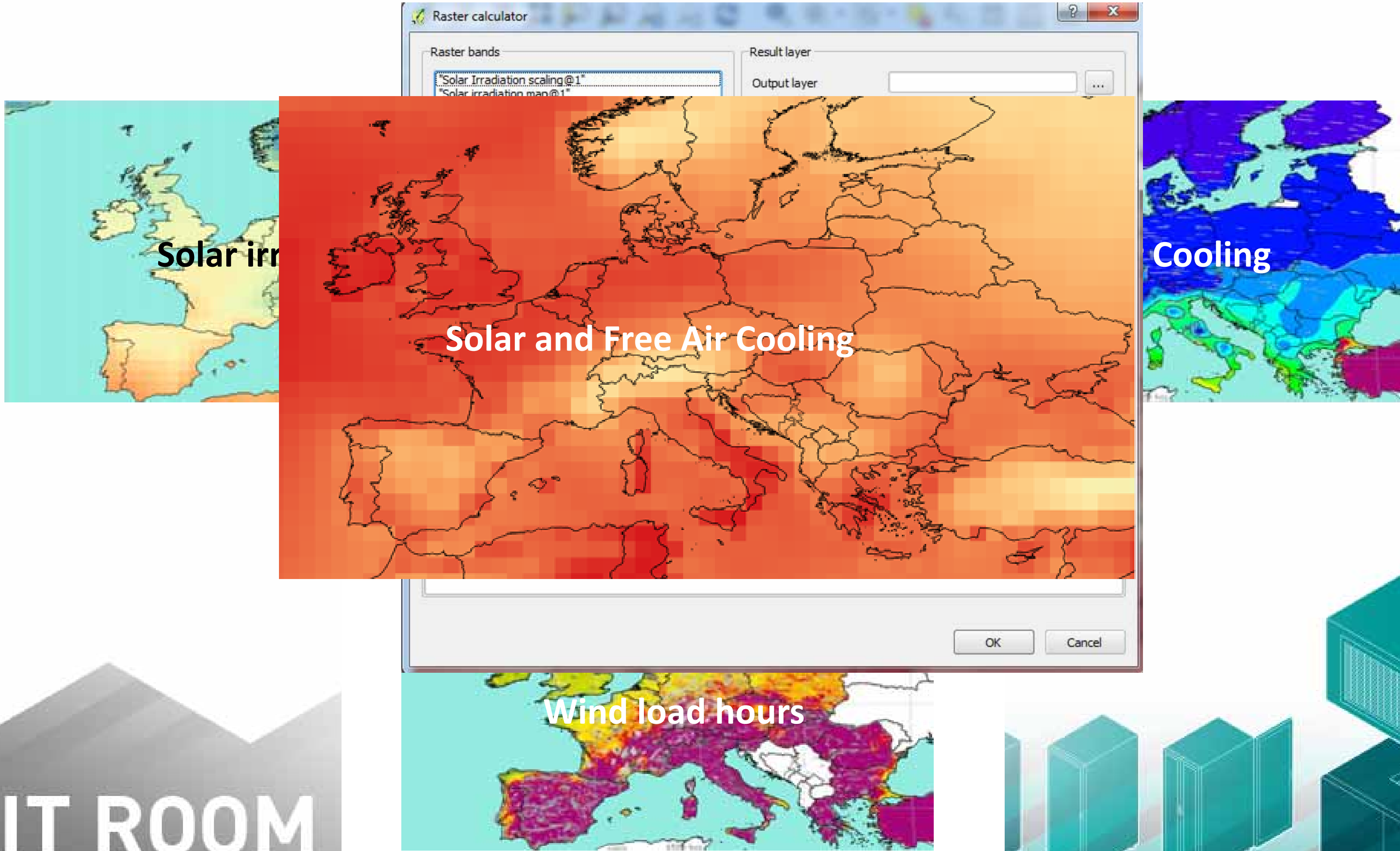


Free Air Cooling hours map
(source ASHRAE)



ASHRAE Free Air Cooling hours map integrated

Customized criteria



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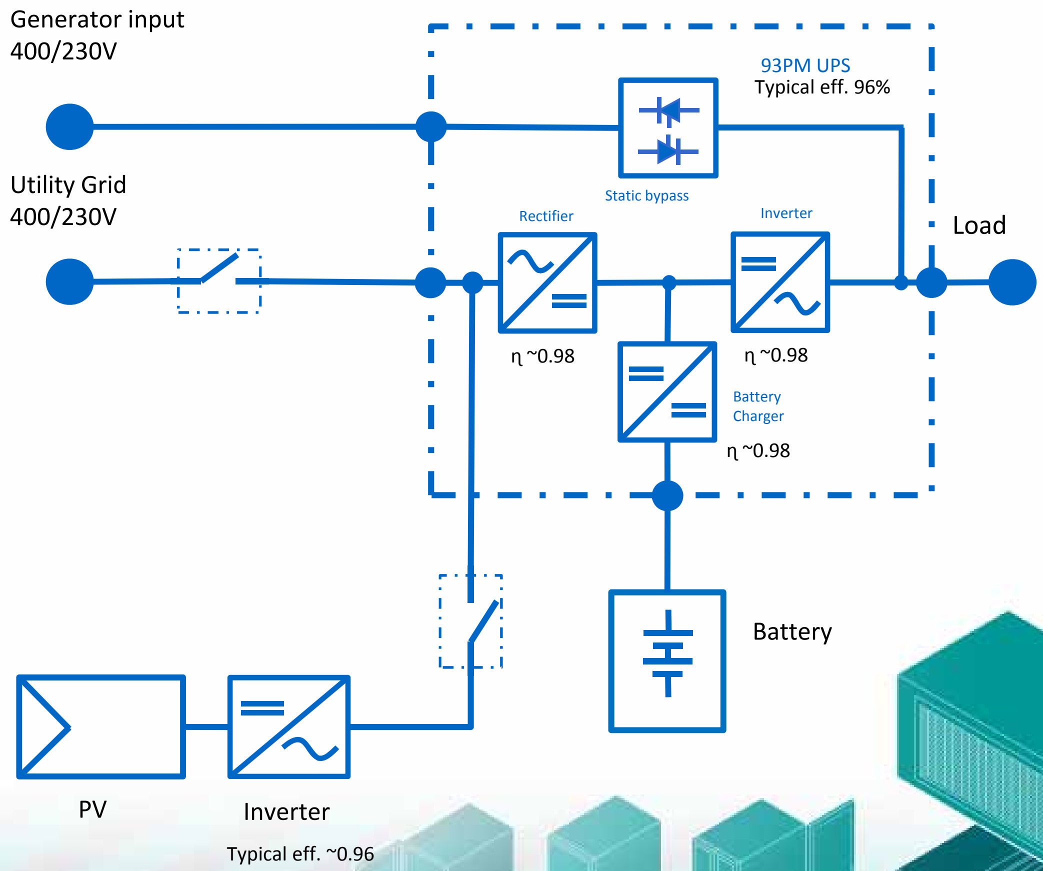
Energy Storage and PV Architecture Design

Grid connected PV inverter

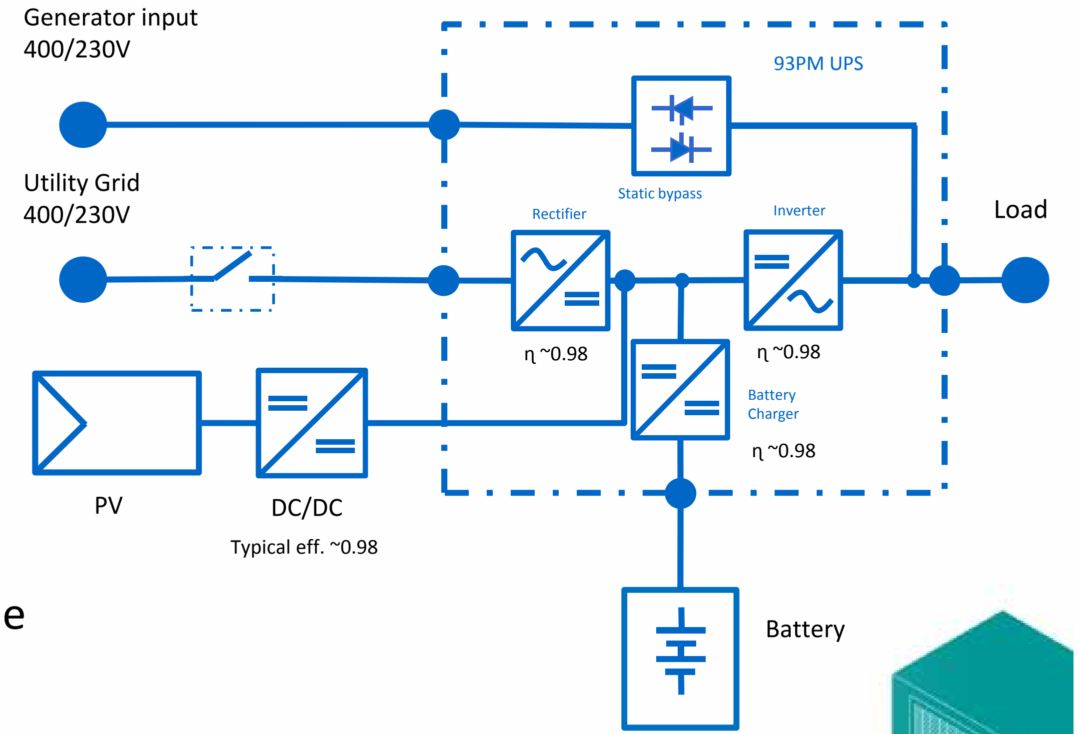
- Grid-connected solar inverter:
  - Typical weighted efficiency: ~96%
  - Disconnection device(s) needed for islanding/anti-islanding
- Power conversions efficiency: 91%
- Power backfeed to utility grid is possible



Energy Storage and PV Architecture Design

DC/DC connected PV inverter

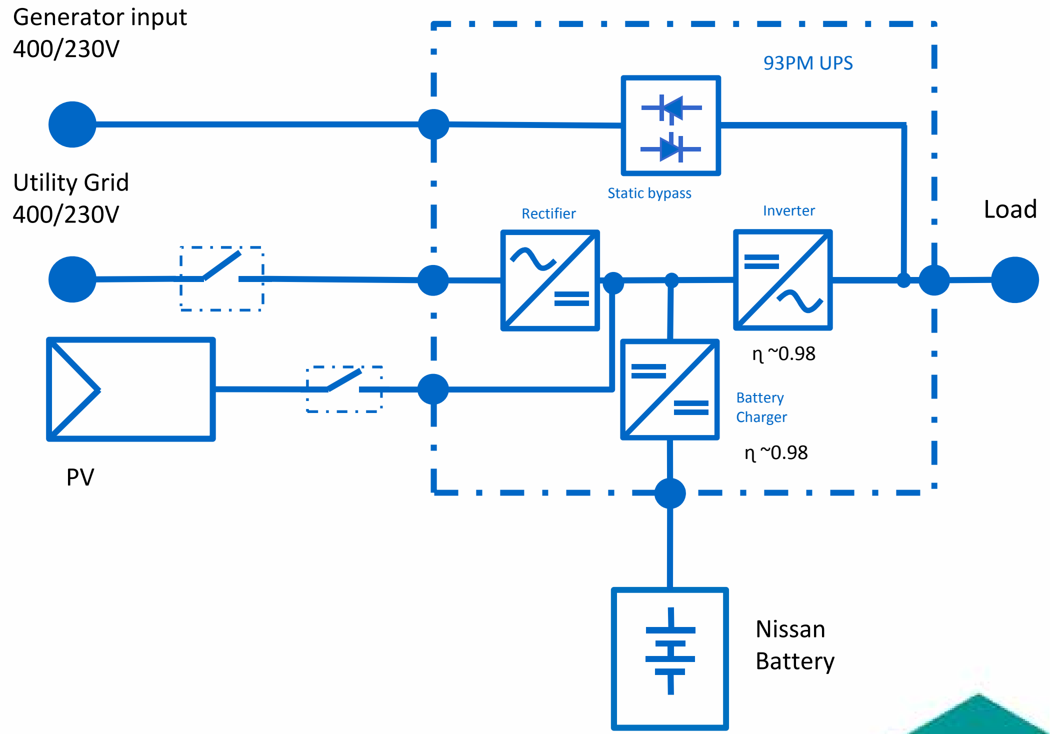
- DC/DC-converter for PV connection:
  - Output voltage of the DC/DC-converter shall be matched with UPS DC-link voltage
  - MPPT control implemented to DC/DC-converter
- Power conversions efficiency 95%
- Power backfeed to utility grid is possible (depends on the rectifier topology)
- PV array voltage can be lower



Energy Storage and PV Architecture Design

DC bus connected PV inverter

- Highest power conversion efficiency reachable: 96%
- PV array voltage range shall be carefully matched with UPS DC-link voltage range
- High voltage PV array in needed
- MPPT algorithm required in rectifier, inverter and battery converter control
- Power backfeed to utility grid is possible (depends on the rectifier topology)
- The most integrated system solution



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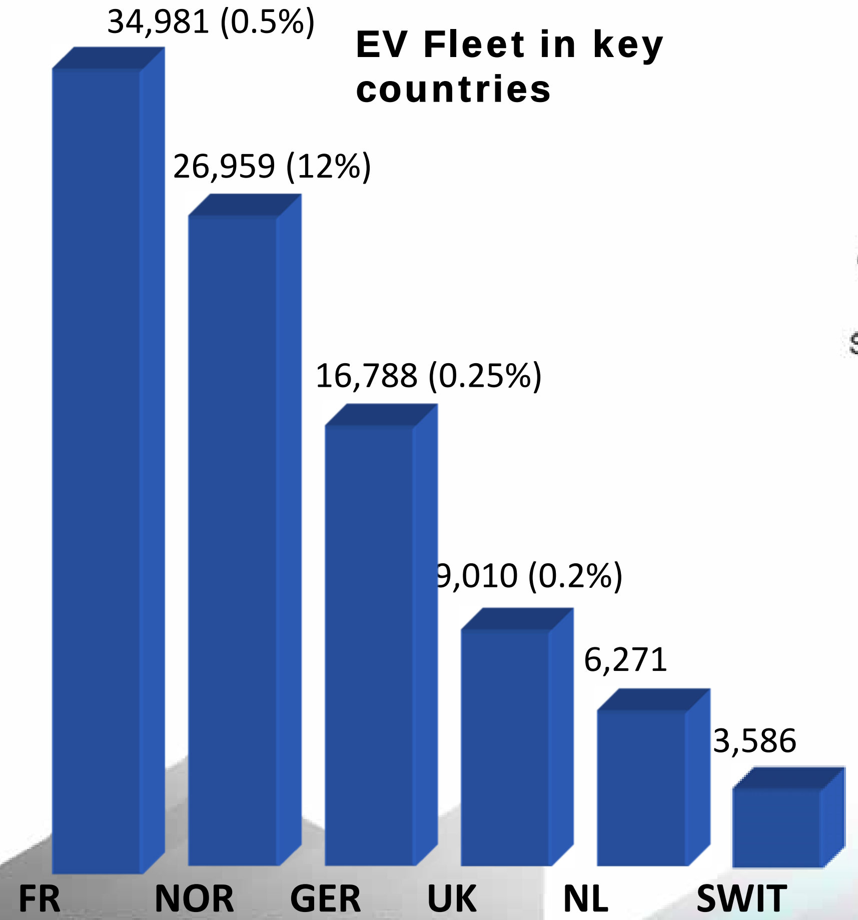
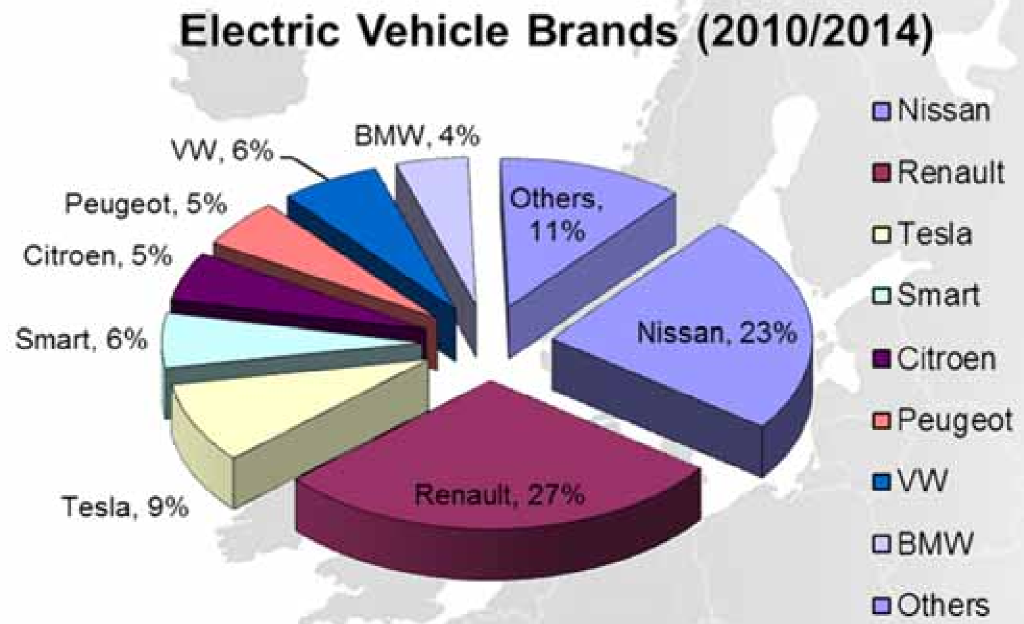
Electric vehicles in Europe





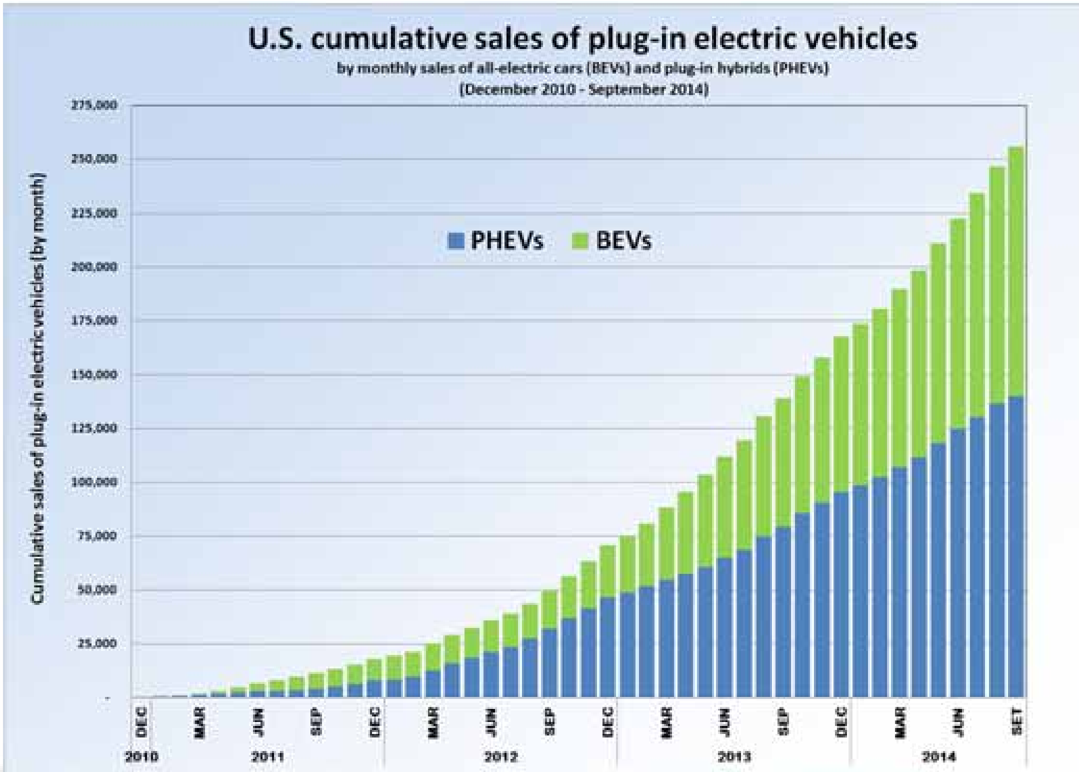
Renault-Nissan 50% of the park and 54% market share in 2013

EV sales up by 91% in H1 2014

Electric vehicles in Europe

http://en.wikipedia.org/wiki/History_of_the_electric_vehicle

First generation Prius



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Renault-Nissan Battery 2nd life strategy

Energy Storage and PV Architecture Design

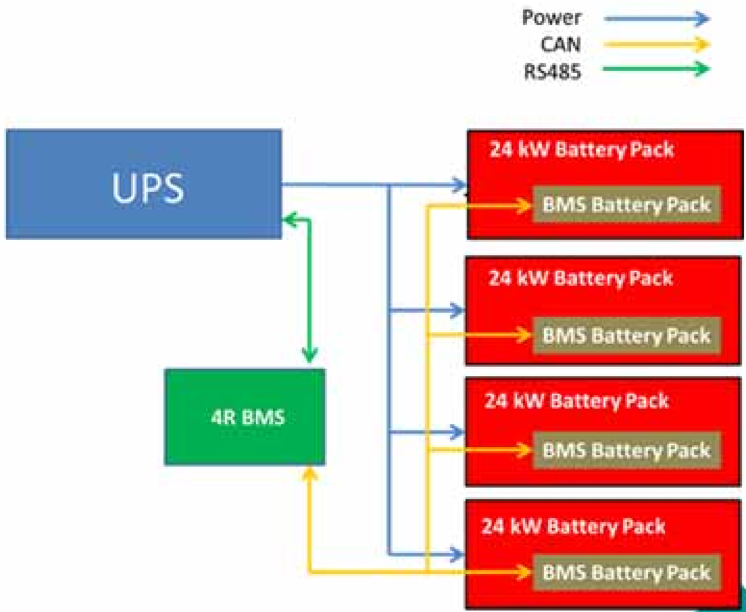
- Nissan batteries were already used in applications for the residential and grid market

- Evaluation of the Battery specification data centre applications
  - Different voltage range between

    Nissan battery (240V-403V) and
    UPS battery charger (330-500V):

    - HW modification on charger required

    - Modification of the control of the BMS needed
  - Available capacity in discharging: ~70 – 90% (depending on the C-rate)
  - Capacity of the UPS battery charger is limited



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Dank voor uw aandacht!

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http://www.greendatanet-project.eu

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