

Gefördert durch:



Bundesministerium  
für Wirtschaft  
und Energie

aufgrund eines Beschlusses  
des Deutschen Bundestages



# Research results of the AC4DC project

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## Project summary

Project title: AC4DC - Adaptive Computing for Green Data Centers

BMWi code: 01 ME11046A

Term: 01/05/2011 to 30/10/2014

Consortium: Rittal GmbH & Co. KG

BTC IT Services GmbH

Zweckverband Kommunale Datenverarbeitung Oldenburg

OFFIS e.V.

Borderstep Institut für Innovation und Nachhaltigkeit  
gemeinnützige GmbH

University of Paderborn

Project director: Bernd Hanstein, Rittal GmbH & Co. KG

Website: [www.AC4DC.com/](http://www.AC4DC.com/)

## Research topics

### Temporal and spatial shifting of workloads

- Development of a new container data centre
- Load management internal to the data centre – measurements and integration are still ongoing. Partial solutions can already be integrated.
- Multi-site load management – testing of sub-elements such as the energy storage system, adaptive UPS and CHP are ongoing with test data centres.
- Decentralised data backup
- Application scenarios and demand-oriented business models, assessment of energy and material saving potential complete, scenarios and roadmapping

## Development of a new type of container data centre

In the project, a new type of container data centre with combined heat and power unit (CHP) was designed and built as a prototype.

Specifications of the container data centre:

- 20 kW uninterruptible power supply (UPS)
- 20 kW water cooling (“Liquid Cooling Package” – LCP)
- RiZone control software

Specifications of the combined heat and power unit

- 2 redundant motors
  - 2 x 8 kW electrical energy
  - 2 x 17 kW thermal energy
  - 9 kW absorption cooling capacity
- (Invensor LTC 09)

## System-spanning control of air conditioning

One objective of this project was to develop practical approaches and implement them as prototypes with respect to adjustment of the optimal operating point of a data centre in compliance with all active components of the air conditioning:

- Fine-grained measurement of the electricity needs of individual infrastructure elements in the participating data centres
- Analysis of existing energy monitoring and control technology in the area of air conditioning
- Investigation of the free cooling mode option in Germany, with the result that a 60% reduction in CO<sub>2</sub> emissions is possible (Germany 96.1% of days)

### Conclusion:

- The system-spanning air conditioning control reduces the PUE from 1.3 to 1.1. Achievable energy savings in current DC: approx. 17%.
- Based on the research results from AC4DC, Rittal developed and made public the RiMatrix S product.

## Comprehensive energy optimization in data centres

For the energetic optimisation of a data centre (DC), the following aspects of the project were studied across the entire value chain:

- Load-adaptive uninterruptible power supply in the DC
- Load-adaptive ventilation and cooling systems in the DC
- Load-related energy models for servers (for example, modern servers require approx. 20% of their maximum power when idle, and older ones more than 50%)
- Dynamic load and power management (LPM), including virtualisation
- Framework conditions: Weather influence (free cooling), use of existing energy storage, variable electricity rates

### Conclusion:

- Through load-adaptive operation of IT and DC infrastructure, around 25% of energy can now be saved in traditional data centres

## Consolidation of IT resources

In the project an energy efficient data centre operation with two separate server pools and systematic virtualisation as well as dynamic load and power management was tested:

- The shared server pool is operated continuously and at maximum capacity through dynamic virtualisation (objective)
- The batch server pool is only activated when the shared server pool cannot meet the required service level agreements (SLA)
- For the LPM, work is being carried out on an interface for the overarching management systems openStack and openNebula to promote use in production environments.

### Conclusion:

- With the current virtualisation rate in data centres, energy savings of 6% to 11% in IT technology is generally realistic
- Based on the entire data centre, energy savings of up to 40% are expected in the future through more virtualisation

## Decentralised backup

In the project, a software solution for secure decentralised backup of files to existing and mostly unused storage areas of terminals was developed and analysed for holistic energy-saving potential:

- A functional software solution that requires no change in the hardware configuration for terminals was developed
- Testing of the software solution demonstrates the feasibility of decentralised cloud backup services, taking advantage of unused storage areas of existing terminals

### Conclusion:

- Increase utilisation and hence the value added by terminals
- Demand for storage systems in the data centre decreases (low power consumption)
- Decentralised data backup saves small companies about €100/year and mid-size enterprises about €5000/year compared to alternative backup systems
- Decentralised data backup is suitable for the market



## Live migration of services between data centres

Development of multi-site load management in a network of several data centres with the aim of holistic energy reduction:

- Analysis of energy-relevant location parameters, including local price of electricity, energy mix, outside temperatures for lower-cost open-air cooling, and performance indicators such as PUE, infrastructure, and resources of the data centre
- Assessment and weighted combination of location advantages for systemic coordination of multi-site load management
- Development of a tool for planning a virtual data centre (network), including relevant customer requirements (growth forecasts), location, and environmental parameters

Conclusion:

- Through the load and power management of a data centre network, a further 20% of operating costs can be saved.

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## Patents and publications

- Rittal has registered five protective rights in regard to content from AC4DC
- 8 publications