UNIVERSITÄT PASSAU
Fakultät für Informatik und Mathematik

Analysis of Incentive-based Demand Response Mechanism

ENERDAY – 8th April 2016

Robert Basmadjian, Florian Niedermeier, and Hermann de Meer

Computer Networks & Communications
Prof. Hermann de Meer

Motivation (1)

UNIVERSITÄT PASSAU
Fakultät für Informatik und Mathematik

- In 2007 the energy consumed by data centres (DC) in Western Europe was 56 TWh and is projected to increase to over 100 TWh per year by 2020
- ICT resources of DCs are over-provisioned to cope with workload fluctuations and to guarantee QoS
  - Almost 70% of servers in DCs are in idle state
- Servers contribute 40% to overall DC energy consumption
  - The other 60% is due to storage, networking devices and cooling equipment

Motivation (2)

- Demand Response (DR) is used in electricity grids to manage costumers' energy consumption during power shortage
- Demand Response Research Center in LBNL analyzed DR for the case of DCs and showed that:
  - DCs are very good candidates to participate in DR due to:
    - **Significant** energy demand
    - Highly automated IT infrastructure providing **flexibilities**
- Major drawback of today's market condition is the **inflexibility** of electricity tariffs
  - Making DR in practical for DCs

Roadmap

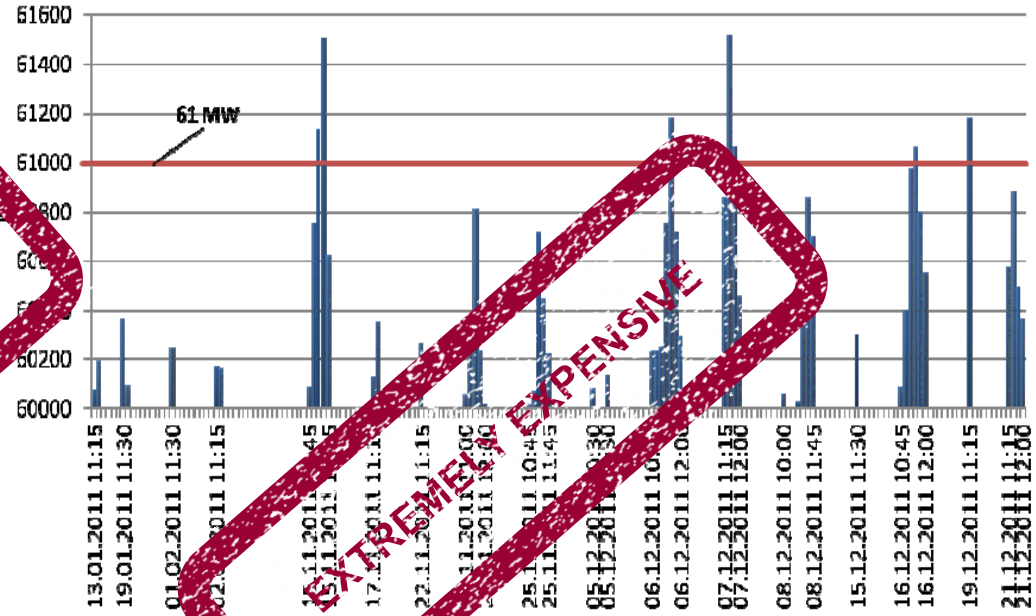
UNIVERSITÄT PASSAU
Fakultät für Informatik und Mathematik

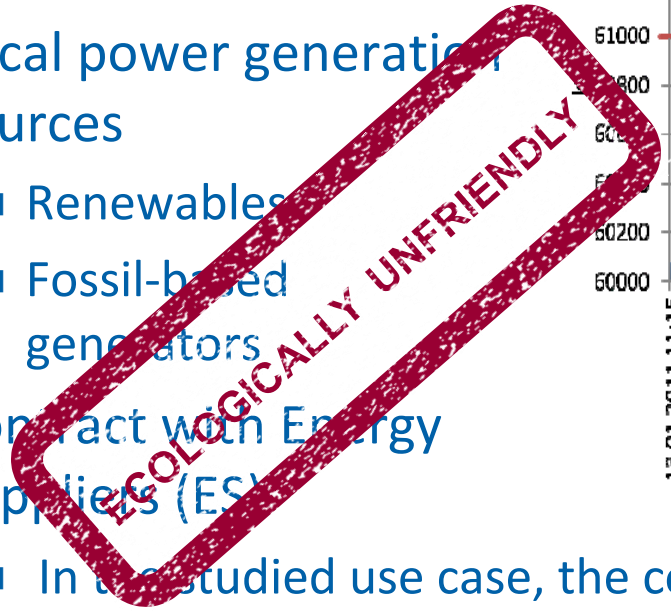
- Problem Description
- Our Approach
  - Current Situation
  - Energy Management
  - Green Agreements
- Cost-benefit Analysis
  - Methodology
  - Obtained Results
- Conclusion

Problem Description

UNIVERSITÄT PASSAU
Fakultät für Informatik und Mathematik

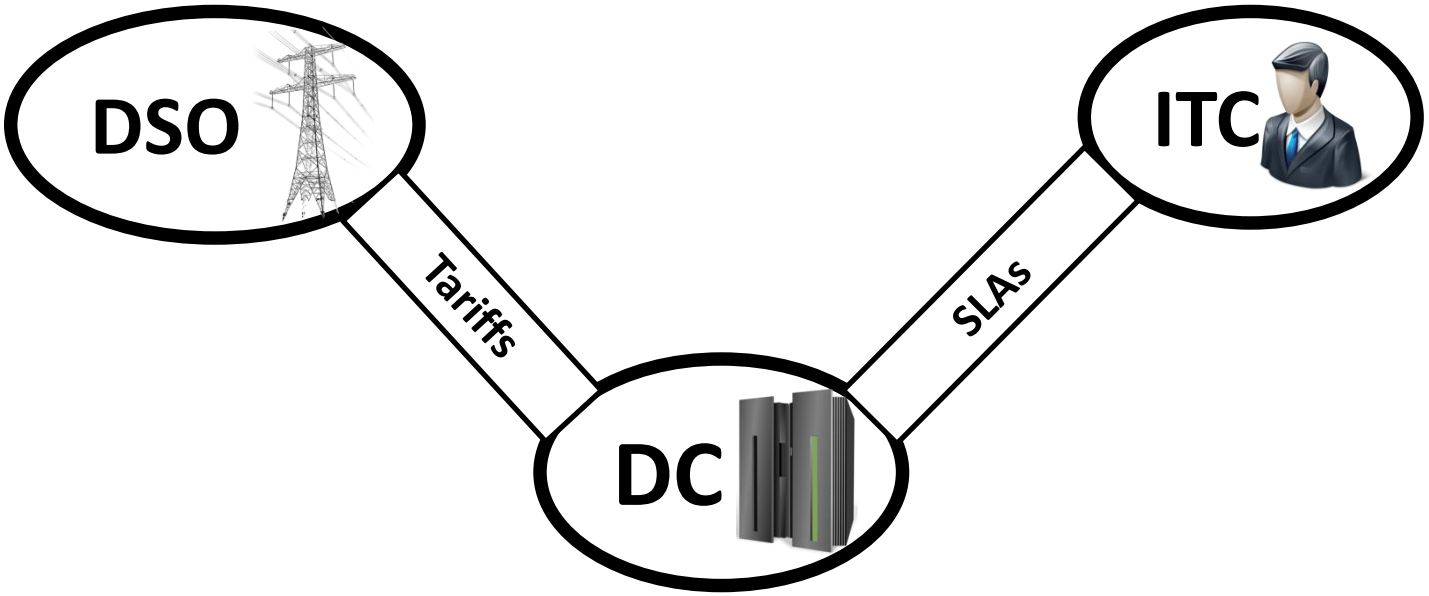
- Distribution System Operators (DSO) have:
  - Local power generation sources
    - Renewables
    - Fossil-based generators
  - Contract with Energy Suppliers (ES)
    - In the studied use case, the contract states:
      - Maximum power demand is 61 MW
      - Additional 1 KW of demand (even for 1 sec) is assumed to cost 54 € (2011)





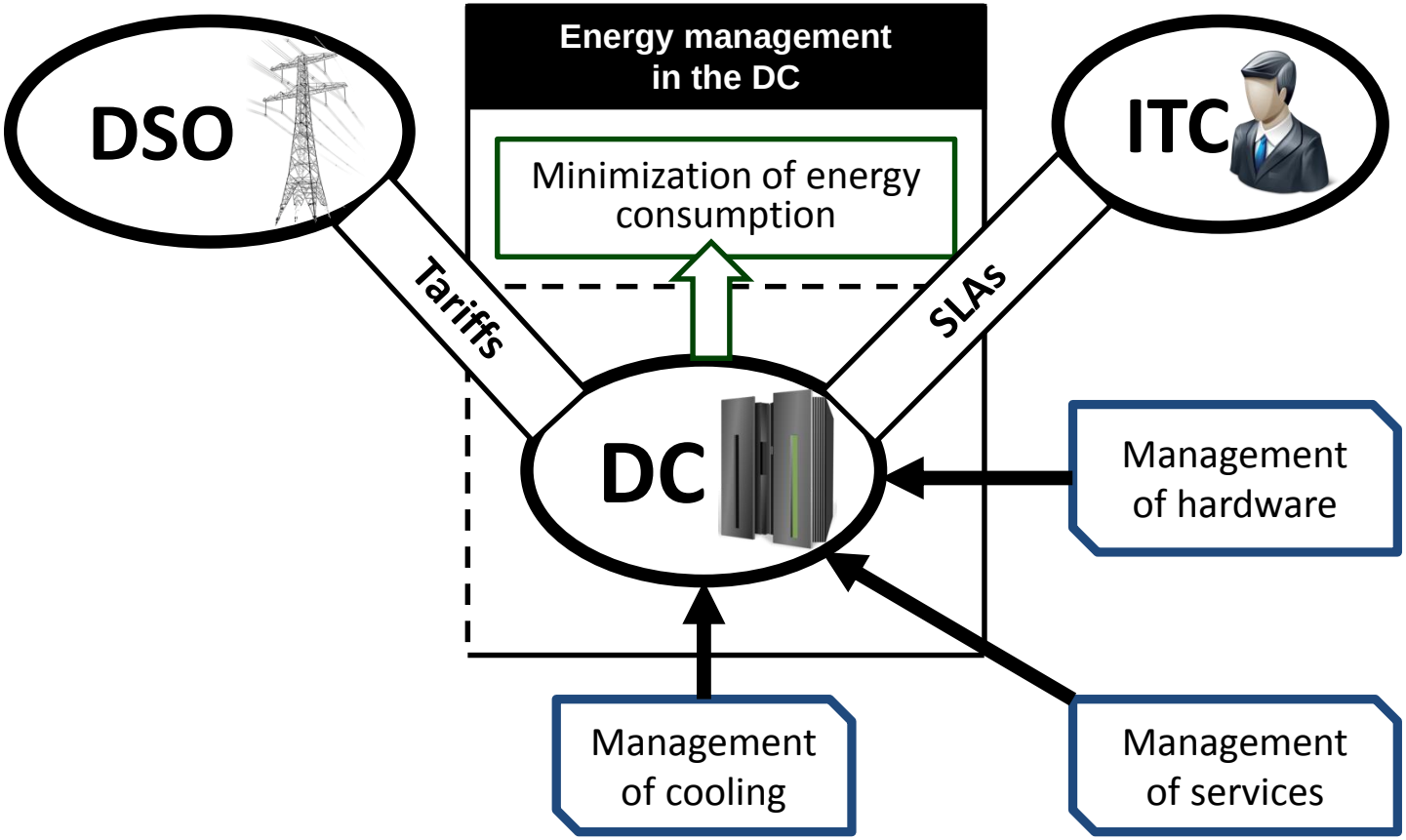
Our Approach

Current Situation



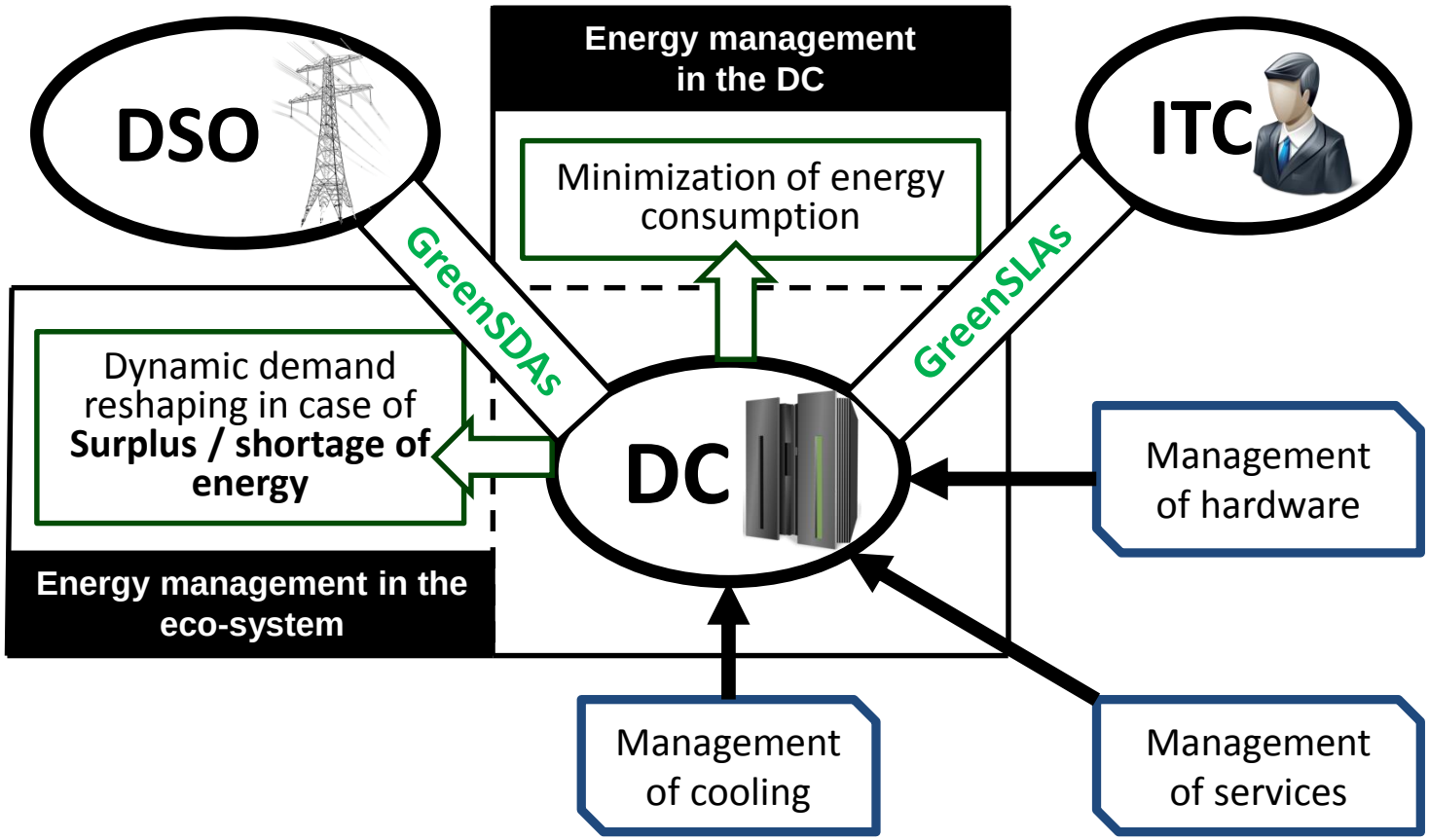
Our Approach

Energy Management



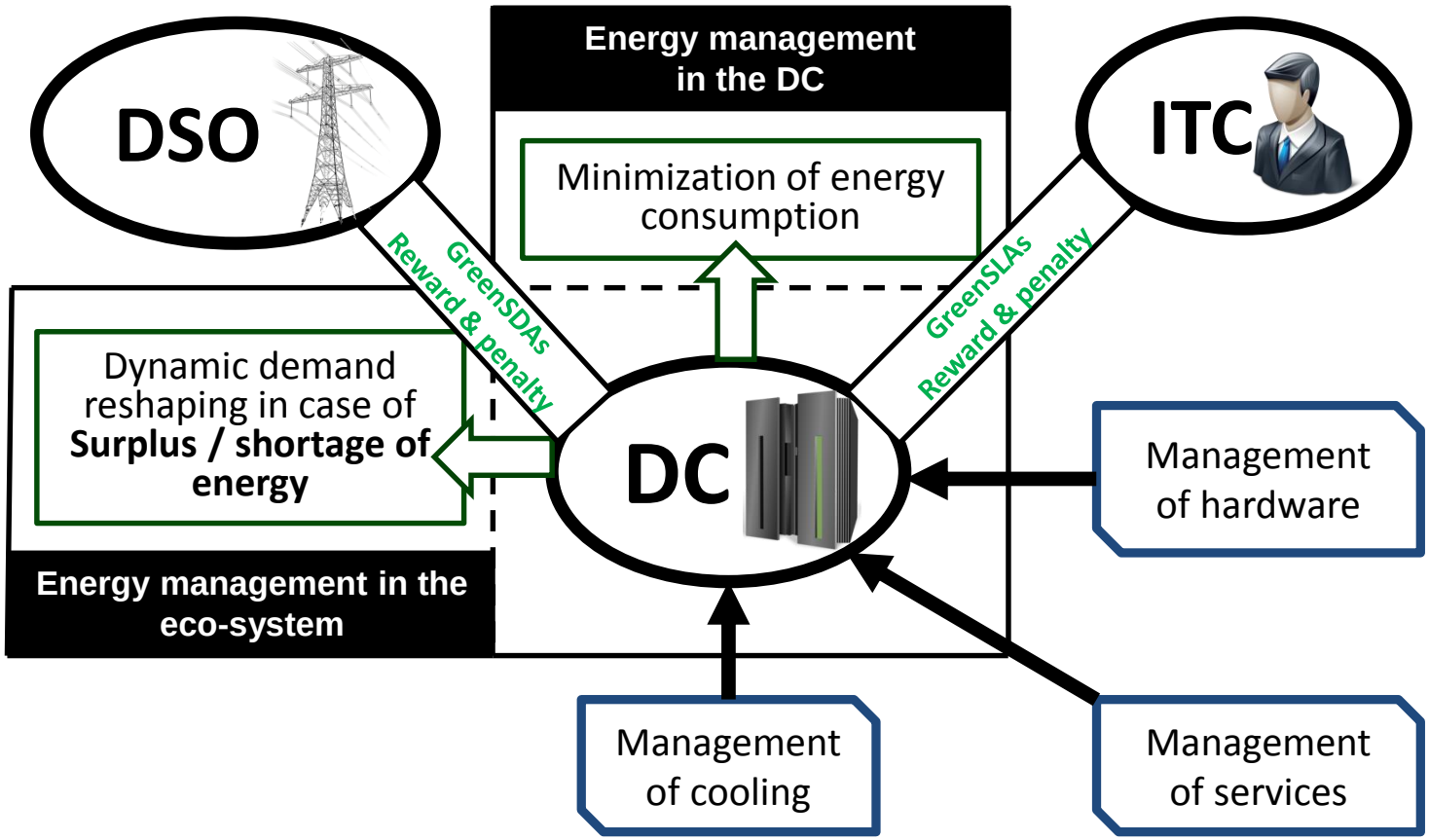
Our Approach

Green Agreements



Our Approach

Green Agreements

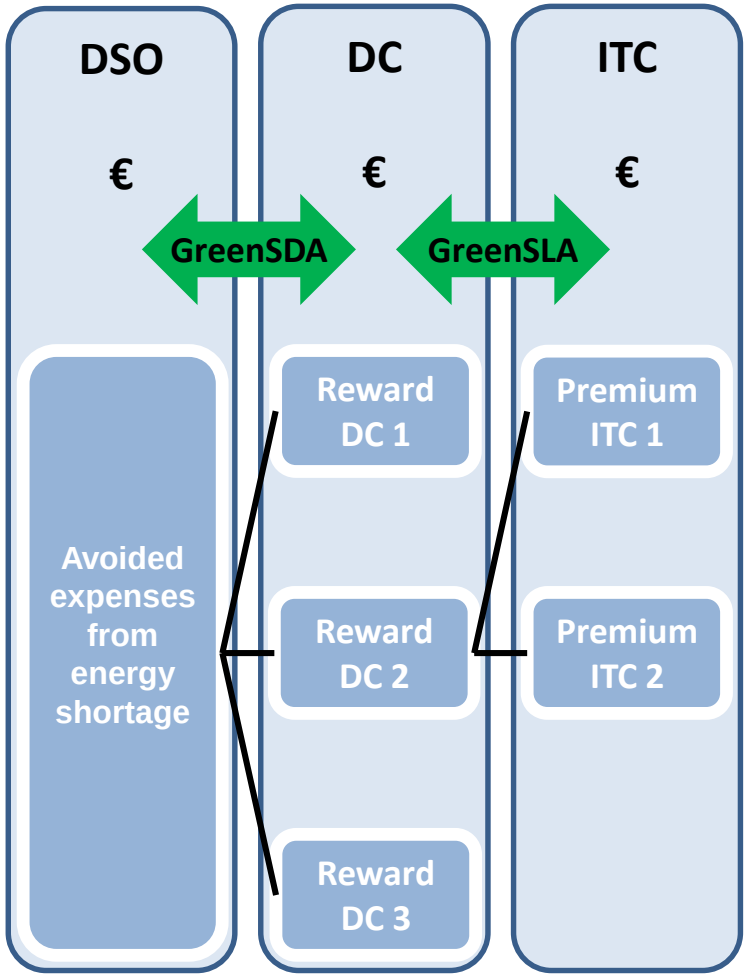


Cost-benefit Analysis

Methodology

UNIVERSITÄT PASSAU
Fakultät für Informatik und Mathematik

- Analysis was performed on 3 steps
  - No energy management
  - With GreenSDA
  - Both with GreenSDA and GreenSLA
- DSO
  - Costs of 27918 € to cover a power shortage of 517 kW (exceeding 61 MW in 2011)
- DC
  - We studied the dependent and independent flexibilities of Innowerk-IT
  - 55 kW of power reduction
- Assumption
  - Maximum static reward of 2500 €



Cost-benefit Analysis

Obtained Results

UNIVERSITÄT PASSAU
Fakultät für Informatik und Mathematik

Type of Benefit	Euro
Static reward for one DC of type Innowerk-IT	250,00 €
Dynamic reward	2216,52 €
Saved Energy Per Flexibility Internal	0 €
Saved Energy Per Flexibility External	0,48 €
Total	2467,00 €

Type of Cost	Euro
DC Penalty	0 €
Flexibility Recovery Cost	4,03 €
Static ITC Reward	125,00 €
Dynamic ITC Reward	42,54 €
Total	171,57 €

- Innowerk IT's profit would be $\mathbf{2467 - 171,57 = 2295,43}$
- All the detailed results can be found at
  - http://www.all4green-project.eu/sites/default/files/documents/
    - D4.3 Section III1.4

Conclusion

- DR schemes for the case of DCs are attractive through incentive-based mechanisms
  - GreenSDAs and Green SLAs
  - Reward and penalty schemes
- Reward and penalty schemes contribute to incentivize parties in DR participation
  - The collaboration scheme
    - Is beneficial for three parties (DSO, DC, ITC)
    - Induces a WIN/WIN/WIN situation