Integrating Green Urban Data Centers into Smart Electricity Grids & Smart Sustainable Cities

Massimo Bertoncini, Project Coordinator
Engineering Ingegneria Informatica

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Engineering: a global ICT player supporting utilities business

✓ Foreign Customers account for a 7% share of the global revenue
✓ More than 7000 full time employees
✓ More than 400 employees working in the Utilities General Direction
MARKETS AND COMMERCIAL OFFER: MAIN CUSTOMERS

- FINANCE
  - Intesa Sanpaolo Group
  - Monte Paschi Siena Group

- OIL & SERVICES
  - ENI Group
  - Autostrade per l'Italia
  - Costa Crociere
  - Poste Italiane

- INDUSTRY
  - Fiat Group
  - Whirlpool
  - Piaggio
  - Ferrero
  - Lavazza
  - Benetton

- CENTRAL GOVERNMENT
  - Ministries
  - Public Bodies and Agencies
  - Defence and Homeland security authorities and agencies
  - EU bodies and agencies

- LOCAL AUTHORITIES
  - All the Italian Regions
  - Italian main Municipalities
  - Provinces
  - Consortiums

- HEALTHCARE
  - 51% of hospitals
  - 64% health operators
  - Regions
  - Universities
  - Consortia

- ENERGY & UTILITIES
  - Hera
  - Acea
  - Enel
  - THÜGA Group
  - Iride Group
General Overview

• The project consortium

• Background and Vision

• Objectives & Major innovation

• GEYSER Marketplaces for Data Center Flexibility
Project Identity Card

- **Acronym**: GEYSER

- **Full Title**: *Green nEtworked data centres as energY proSumers in smaRt city encironments*

- **Starting Date**: 1 November 2013

- **Duration**: 36 months

- **EU Maximum financial grant**: 2.979.000,00 €

- **Partners**: 9

- **Country coverage**: Italy, Greece, Ireland, Romania, Germany, Switzerland, The Netherlands
The Consortium

*SARA withdrew from the project
GEYSER Consortium

Building upon the legacy of the GAMES European R&D project

End users
ASM Terni (Power DSO)
GITA (Green IT/Smart City)
ENG (DC Owner/Operator & Cloud Service Provider)

Academy/R&D
TUC, RWTH, ZHAW

Industrial Players
ICT Players (ENG, SiLO)
Smart Grids/Data Centres
Technology/Solution Providers (ABB)
Smart Energy Intelligent SaaS Providers (Wattics)
Data center energy efficiency is clearly becoming more and more an urgent issue to address for DC Operation and Strategic Managers.

- Need to focus on intelligent solutions addressing DC performance AND energy management and optimization.

One solution to mitigate energy costs has recently been data/application migration trend towards free-cooled data centers located in Norway, Iceland or in the middle of some cold nowhere ("follow-the-least-energy cost" strategy).

- Major drawbacks:
  - Customers security concerns
  - Data networking costs are not negligible and affect the overall performance cost
  - Only a financial-driven exercise
  - No impact on the overall environmental sustainability and resource efficiency

On the other hand, a significant share of data centers are situated within urban contexts (Bank. Hospitals, public/private offices).
Our positioning is for managing and solving locally (at district/city levels) those challenges which have been occurring close to the point-of-failure, reducing in this way value chain length and costs (es. Sustainable agriculture, zero waste, local energy supply systems reducing transmission losses).

The long-term goal is to move forward towards sustainable locally optimized urban contexts
- Enabled by Local Smart Energy Systems
Local Sustainable Energy Supply Systems

• **Rising shares** of fluctuating **Renewable Energy Sources** (PV farms, Wind farms, biomass) are distributed along **Low or Medium Voltage** branches of the **electricity networks**

• The **integration of the power generated by distributed RESs** has posing serious **stability and security problems** to the power network operators (DSOs), which so far (according to the current regulations) **require TSO global operators intervention** to solve the operational challenges.

• **Smart Grid** has emerged in the last years as an **effective organizational and technological paradigm** to allow **power distributors** to **proactively manage** their actual power network, and accordingly **defer significant investments** for grid expansion.

• A major benefit from Smart Grids implementation is the capability to **provide power network** with some levels of **flexibility to deal with stochastic RESs**.
Data Centers vs Smart City & Smart Grids

- Emphasis on individual performance and sometimes on **trade off between performance and energy efficiency**

- **No active links among Data Centers and Smart Cities** (no energy or info exchange)

- **Urban Data Centers** are operated in **uncoordinated way** and their **Energy efficiency** has been so far addressed in an **isolated way**
Data Centers have can contribute to System-level Energy Efficiency

- **Urban Data Centers** have a large yet mostly unexploited flexibility potential to contribute to smart city local energy consumption optimization and smart grid optimized operation, at the extent to shift IT workload.

- Energy efficiency should be addressed in a holistic synergistic way, by considering the interaction of Data Centres with the relevant stakeholders within urban contexts (electricity distributors, district heating operators, energy suppliers, smart city/district energy managers).

- Data Centers are expected to turn on into flexible energy players at the crossroads of Smart City and Smart Energy Grids.

- Data Centers may gain substantial (financial) benefits from the integration and collaboration with City Utilities and Energy Stakeholders (Energy Traders,...)
  - Smart City fair incentive sharing can reward Data Centers at the extent to outperform penalties due to lowering of energy efficiency or operational performance.
Think Global
Act Local
(GLOCAL)
Data Centers & Smart grids: Flexible Management of Energy Resources – RES Usage Maximization

Follow-the-sun strategies

Green – Predicted renewable energy production
Red – Predicted DC energy consumption
Smart grids: Flexible Management of Active Energy Resources - Demand Response

**Peak Shaving**

- Optimized consumption
- Power back to grid

**Load Levelling**

- Optimized consumption
- Power back to grid
Main objectives

• develop a technological and business framework for effectively operating **renewable energy-powered networked Data Centres** acting as a flexible **energy player** within a **Smart City /Smart Energy Grid context**, which:

  – Will be able to monitor, control, reuse and optimize overall Data Centre’s energy consumption and production, from renewable energy sources in particular, within the framework of a **unified representation of energy** (either electrical, thermal, geothermal, solar, hydraulic) (**Data Center Local Optimization**)  

  – Will actively involve DCs as **energy prosumers** within a smart city **energy flexibility marketplace**, which will be contributing to integrate DCs into **Smart Grid/Smart City –Global Level Optimization**
GEYSER approach: integrating Data Center in Smart grids and Smart City

• Data Centers as adjustable adaptive power consumers

• “Follow-the-sun” strategies
  – Use intermittent renewable energy sources when and where they are available

• Innovative Value Proposition and Novel service offering to
  – Energy Network Operators (going beyond electricity)
    • System services (Ancillary Services) offering tailored to local balancing markets (Voltage regulation, reactive power, congestion management, load leveling, peak shaving)
  – Energy (power, heat) retailers/suppliers/traders and Smart District/City Energy Manager
    • Energy consumption flexibility to optimize the global district/city energy consumption

• While...
  – Optimizing IT load management matching utilities needs for services aimed at more efficient power network stability and security of supply
GEYSER Major Innovations

- Considering Data Centers as a stakeholder exchanging ENERGY, including electricity AND heating/cooling (Smart City ENERGY networks)

- Data Center-level optimized management of energy, including Renewable Energy Source powered or with green energy contracted at the meter

- Comprehensive set of Local Balancing Services offered to DSO/electricity operator (e.g. Ancillary services like voltage regulation, demand response/consumption flexibility), going beyond Demand Response

- DC participating to the Optimized ENERGY management of a Smart District/Smart City by Local Energy Marketplace (Smart City Integration)

- Cooperative business models (and enabling IT platform) for nurturing DC cooperation among all the DC ecosystem stakeholders (DCs, energy providers, DSOs, DC End users) by fair incentive sharing
Energy Consumption Flexibility through effective Combination of Optimized Demand and Supply Management policies

- demand (IT load) flexibility (spatial/temporal migration)
- local generation flexibility especially ancillary regulation services for grid stabilization
- storage flexibility (heat, electricity in UPS)
DCs as Flexible Energy Players: The GEYSER Marketplace

• **Scheduling marketplaces**, aimed at setting up a request for energy mix procurement for smart city (day ahead versus one hour ahead). Tailored to energy sellers/retailers/aggregators

• Near real time **Local Balancing** Marketplace for Distribution Systems Operators
DC supporting Smart City Energy Optimized Management

• Data centers will be **supporting smart city ENERGY requirements**

• Main stakeholder is **the smart city /district energy manager** who will be in charge for procuring energy (in all the necessary forms and with an economically optimized portfolio of energy carriers/mix (power, heat, gas,...)

• Smart city energy manager actor will do a **bid** on the **scheduling marketplace** (es. One day/hour ahead) for the energy requirement

• **Different stakeholders** are willing to participate in this energy marketplace, like energy suppliers, large building energy prosumers, and (urban) data centers or urban data center technical aggregators
GEYSER Scheduling Marketplace

- Urban Data Center
- Power
- Heat
- Networked Data Center IT Workload adaptation
- Energy (Power, Heat) Trader
- Power request
- Heat request
- DSO
- Smart City Energy Mix Demand
- Network Technical constraints mgmt

Bid Placement
GEYSER Local Balancing Marketplace

**Urban Data Center**
- Load
- Flexibility
- Aggregation

**Networked Data Center**
- IT Workload
- Adaptation

**Smart district Node**

**Local Balancing Market**
- Building prosumer

**Scenario “01”: DC for DSO**

**DSO**

**GEYSER**

European Utility Week 2014
Data Center supporting DSO operations

• Data centers are willing to collaborate with DSOs with the aim of providing local system services to alleviate their specific operational problems

• For example data centers could provide flexibility services to DSO:
  – to manage peak shaving in the DSO network
  – to provide a firm load diagram (load leveling)
  – to provide local balancing service systems like voltage regulation or reactive power regulation
  – To contribute to reduce congestion or RES curtailment
GEYSER Architecture
A common place to share insights, experiences, both bad and good, and best practices on how data centres can become flexible energy players within smart grids and smart cities

Call for collaboration among the whole spectrum of stakeholders: from the data centre industry to energy service providers, smart grid operators, academia and knowledge institutes, and city policy makers

Join our community’s Linkedin Group at

http://www.linkedin.com/groups/Networked-Data-Centres-Smart-Grids-7485057

...and let the games start!
Thanks for your attention

http://www.geyser-project.eu
massimo.bertoncini@eng.it

Questions?