SEA - MILAN AIRPORTS

DREAM PROJECT

Matteo Giampaolo

Infrastructure Department
Project Manager

ETIP SNET South-Eastern Regional Workshop

Nicosia (Cyprus), November, 23th 2017

DREAM Project and WP8 overview

- Give access to markets for **local flexibilities** (DR)
- Take **network reconfiguration** and DER control into account (cell concept)
- Investigate **local**, **peer to peer** and **dynamical hierarchical control**
- Develop **active network** with **distributed intelligence** for aggregators and DSOs

DREAM

- Test and demonstrate the practical validity of DREAM framework in order to trade ancillary service (distributed balancing market).
- Flexibility bids calculation describing the ability of each prosumers to adjust their consumption depending of price signals.

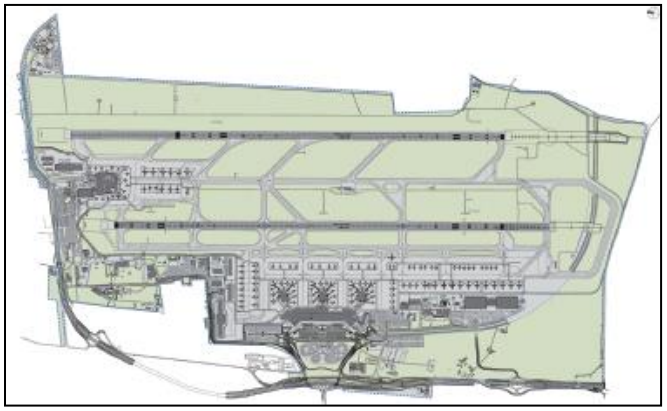
WP8

SEA Group – Malpensa airport

SEA (Società Esercizi Aeroportuali) and the Group's companies manage and develop the Milan airport system (Linate and Malpensa).

Milan Malpensa airport is the intercontinental airport of Milan and is the main hub of northern Italy. It includes **two passenger terminals and one cargo terminal**:

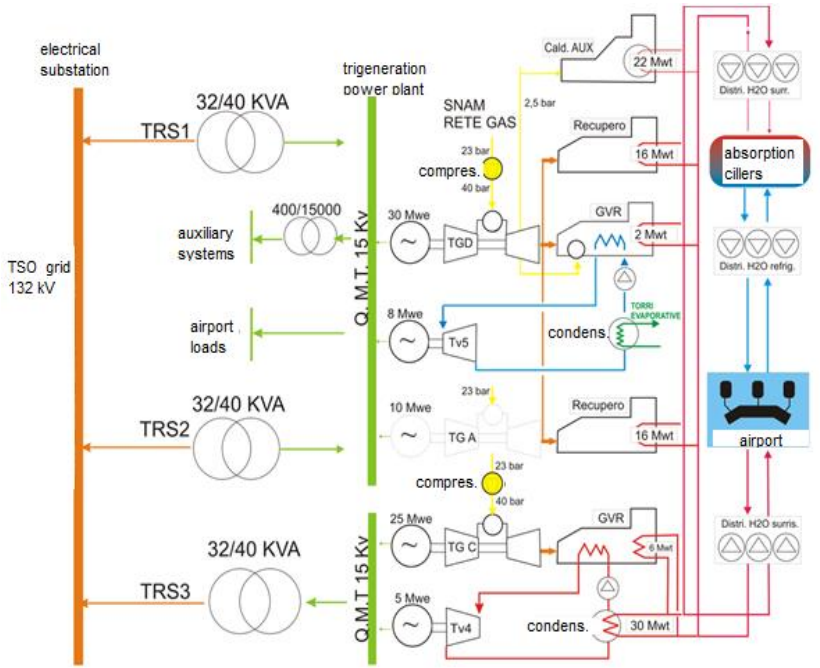
- 22 mln passenger/year
- more than 500,000 tonnes of cargo/year



SEA Malpensa airport trial site – SEA Energia plant

- The trial sites at Milan Malpensa Airport, is characterized by the presence of a trigeneration plant managed by "**SEA ENERGIA**".
- Part of the **electricity** is sold to third parties through the national grid, while **heat and cooled water** are used inside the airport only.

- The current working cycle is composed by a Gas Turbine (TGC) and a Steam Turbine (TV4)
- The average electric power produced is about 30 MW
- Availability of 6 tanks with storage capabilities of 60 MWh
- 1 electrical chiller cooling power: 7 MW, COP avg: 7

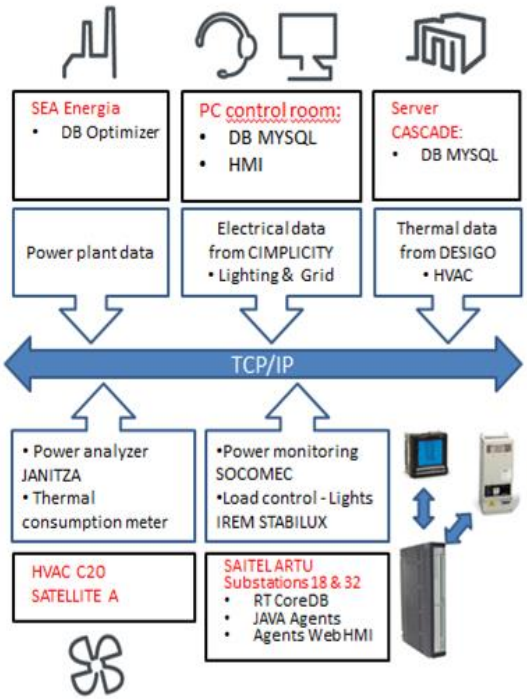


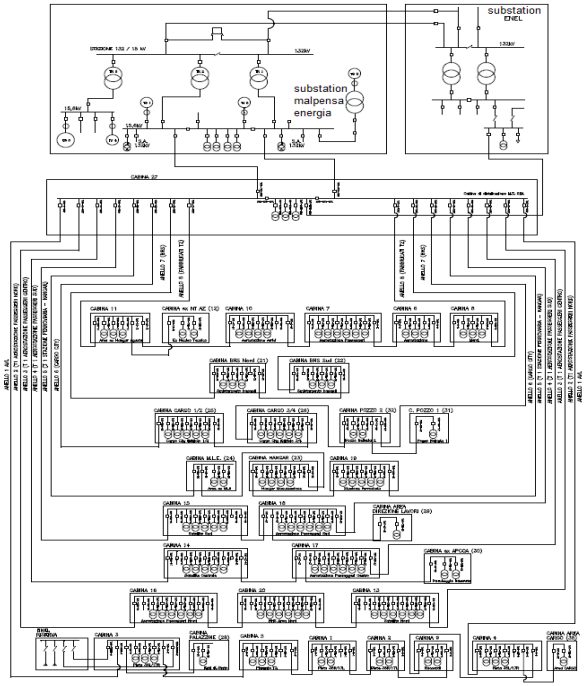
→ Pth heat = 40 MW

→ Pth cool = 40 MW

SEA Malpensa airport trial site

The medium voltage network at Malpensa consists of an eight closed distribution rings operating at 15 kV voltage, from which thirty substations for the secondary distribution are derived.





Elect Tot Power (avg): 15MW

Trial infrastructure

- Airport MV grid : 8 rings operated in closed loop (only 2 rings involved in the test);
- 3 secondary substations under test;
- 1 secondary substation with an Advanced RTU (executing JAVA);
- flexible devices (7 HVAC systems, 6 sets of apron lighting towers);
- SEA control room;
- SEA Energia control room.

Campaigns of tests

Trial site main objective

- **Create a coordinated VPP** of entire airport energy system in order to participate at all market phases (day-ahead, ancillary service and balancing markets).

Trial site tests

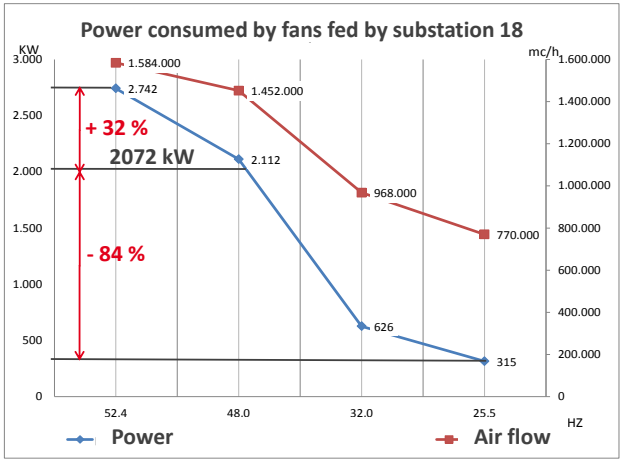
- The device agents, which represent the prosumers involved in the tests, are identified and enabled to exchange information with the DREAM components connected at the same communication infrastructure.
- Some algorithms to compute flexibility bids has been developed.
- Some **test campaign** has been done to test the algorithms related to **«Provision of MV/LV flexibilities in a short term time scale»** under different conditions:
  - weather;
  - electrical grid load;
  - external grid behaviour;
  - electricity price.

Campaigns of tests - flexibility

Flexible loads - Lighting

- ✓ Regulated by means IREM STABILUX
- ✓ Voltage of the regulator decreases from 220V to 175 V
- ✓ Active power consumption decreases from 9.1 kW to 5.2 kW (43%) (power factor 0.93)
- ✓ Illuminance level decreases of 16 %
- ✓ Time of activation :15 min (3V/min)

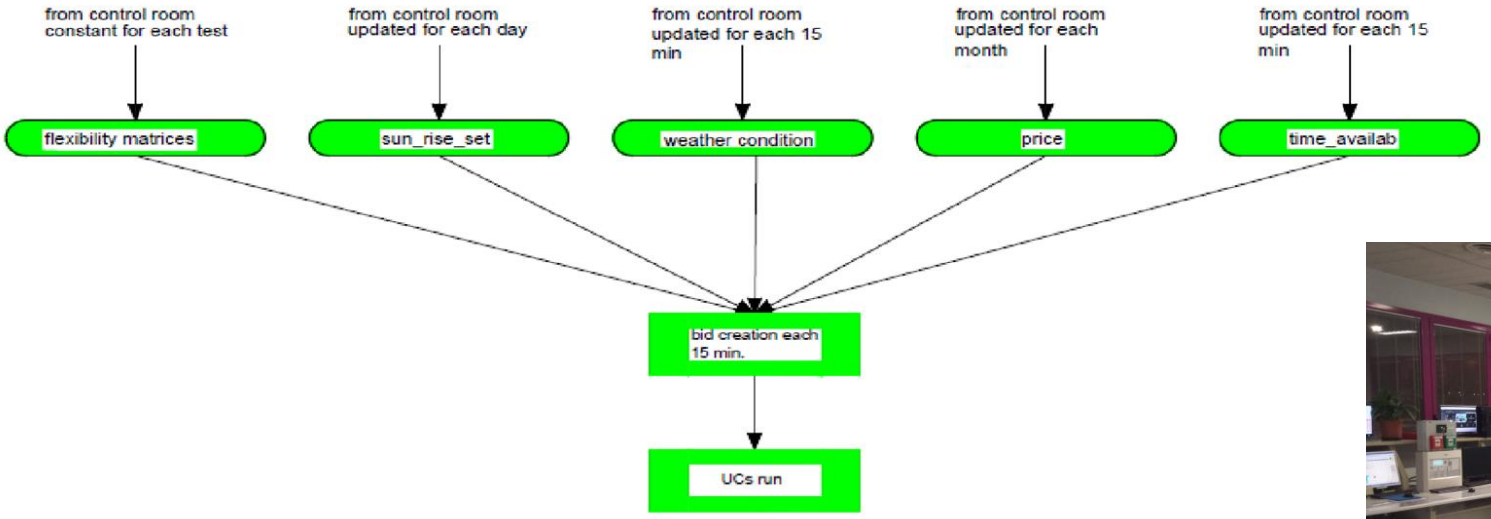
Flexible loads - HVAC

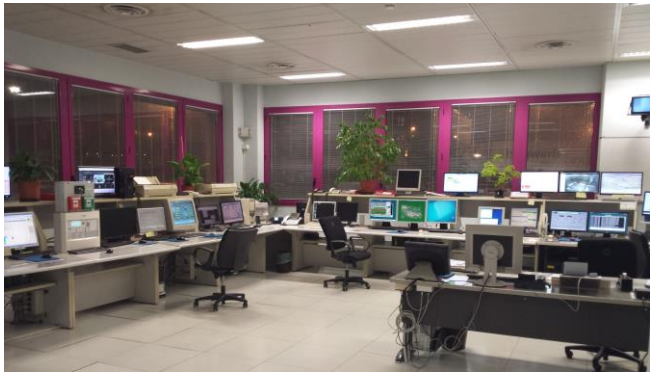


- ✓ The frequency levels of inverters ranges between 25.5–52.4 Hz
- ✓ The rated frequency level is about 48 Hz
- ✓ Decreasing the frequency from 48 to 25 Hz, the power decreases of about 84 %

Campaigns of tests - flexibility bids

Optimization for market-based approach → selection of loads flexibility each 15 min to restore reserve margin used in case of trigeneration temporary breakdown and/or voltage deviation occurring.





- UCs have been implemented in PC present in control room;
- the tests have been done with different weather condition;
- the tests have been run with different ancillary service market price behavior;
- it is possible also change some parameter of the test:
  - the maximum ramp-up/rump-down gradient of the trigeneration power plant
  - the price paid by SEA loads.

Campaigns of tests - output

Example of measurements (thermal and electrical) in the airport grid

Query 1 | cimpvalue | sea_flexbids | cimpvalue | cimpvalue

Limit to 50000 rows

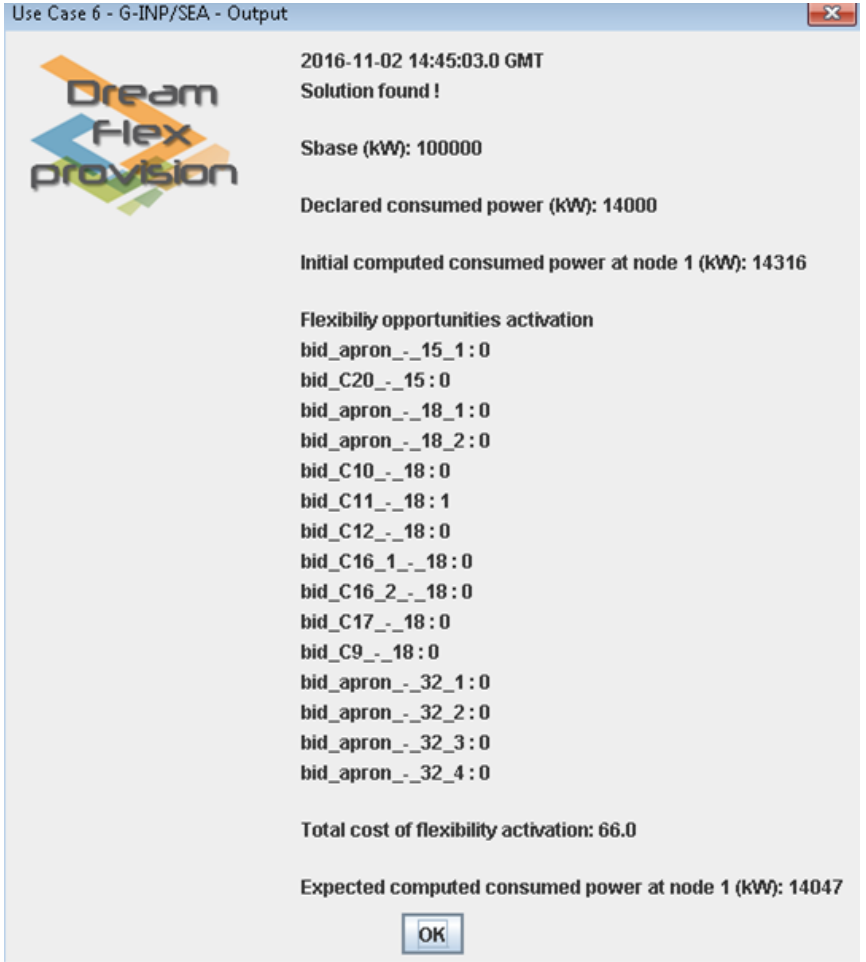
```
1  .ECT * FROM cimplicity.cimpvalue
2  ere timestamp > '2016-10-20'
3  der by description,timestamp;
```

Result Grid | Filter Rows: | Export: | Wrap Cell Content:

Tagname	Description	Value	TimeStamp
\EL_MXPE_C032_MT005.M_P.VALUE	32-26-152 - Potenza attiva	-170.553462162871	2016-10-20 10:45:03
\EL_MXPE_C032_MT005.M_Q.VALUE	32-26-152 - Potenza reattiva	-133.754300023992	2016-10-20 10:45:03
\EL_MXPE_C032_MT005.M_VRS.VALUE	32-26-152 - Tensione concatenata R-S	15529.0049484997	2016-10-20 10:45:03
\EL_MXPE_C032_MT005.M_VST.VALUE	32-26-152 - Tensione concatenata S-T	15520.2965338783	2016-10-20 10:45:03
\EL_MXPE_C032_MT005.M_VTR.VALUE	32-26-152 - Tensione concatenata T-R	15506.1819886382	2016-10-20 10:45:03
\EL_MXPE_C032_MT001.M_P.VALUE	32-SSC-152 - Potenza attiva	428.992319262978	2016-10-20 10:45:03
\EL_MXPE_C032_MT001.M_Q.VALUE	32-SSC-152 - Potenza reattiva	88.0604880654238	2016-10-20 10:45:03
\EL_MXPE_C032_MT001.M_VRS.VALUE	32-SSC-152 - Tensione concatenata R-S	15515.6999142169	2016-10-20 10:45:03
\EL_MXPE_C032_MT001.M_VST.VALUE	32-SSC-152 - Tensione concatenata S-T	15521.2614655345	2016-10-20 10:45:03
\EL_MXPE_C032_MT001.M_VTR.VALUE	32-SSC-152 - Tensione concatenata T-R	15510.096783963	2016-10-20 10:45:03
\EL_MXPE_C018_BT066.IS	CAB.18 - QGBT - Int.Q66 Trend	0	2016-10-20 10:45:03

Results of the optimization: every 15 minutes

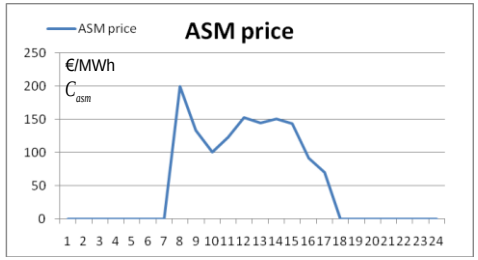
Example of flexibility bids calculation



Campaigns of tests - algorithm

This Use Case implemented and tested: **"Flexibility activation optimization for risk management while balancing market participation"**

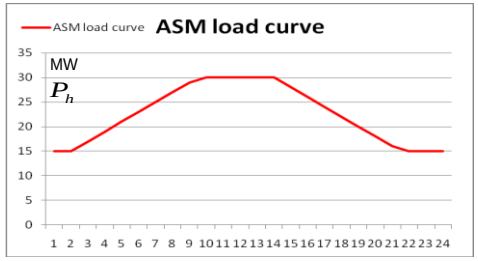
Determination of the needed reserve margins to avoid the risk of not respecting the ADLC

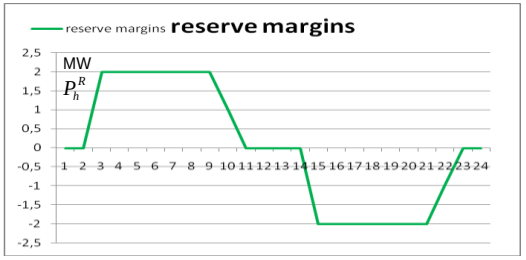


$$\max \sum_{h=1}^{24} \left(C_{asm} - C_{marg}\right) P_h$$

$$P_{h-1} - P_h \le \Delta_{down} \quad P_h - P_{h-1} \le \Delta_{up}$$

$$\forall h \in N \quad P_{airport,h} \le P_h \le P_{max} \quad \boxed{P_h^R = P_h - P_{h-1}}$$





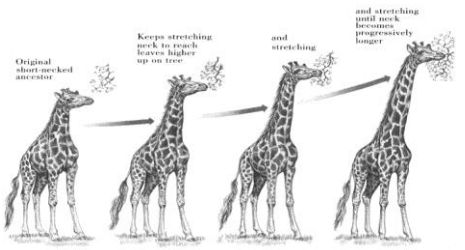
Optimization problem formulation

$$\min \sum_i \sum_l c_{il} \times x_{il}$$

$$\forall i \in N, \quad |V_i| \le V_{MV\max,i} \quad \forall i \in N, \quad V_{MV\min,i} \le |V_i|$$

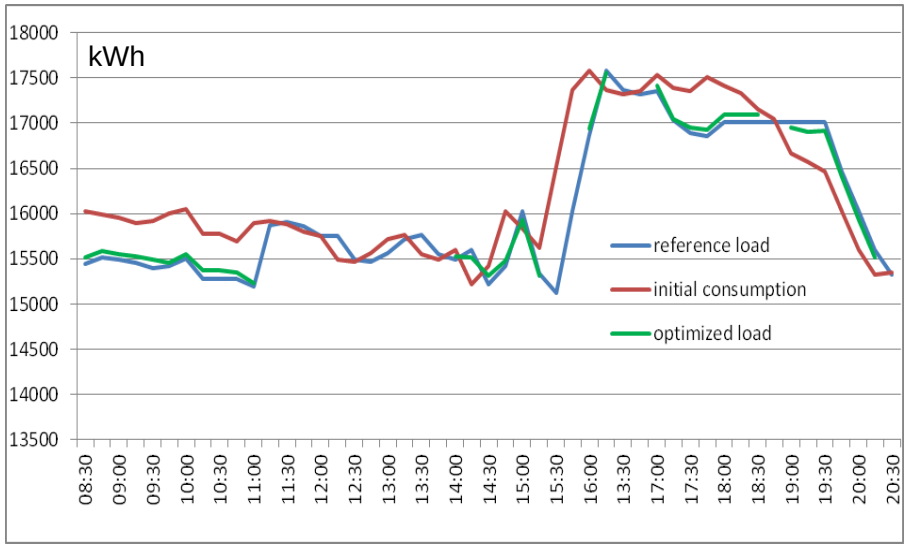
$$\forall j \in L, \quad |I_j| \le I_{j\max} \qquad |P_{ADLC,qt} - P_{tot,qt-1}| \le T$$

solved with a "genetic" algorithm

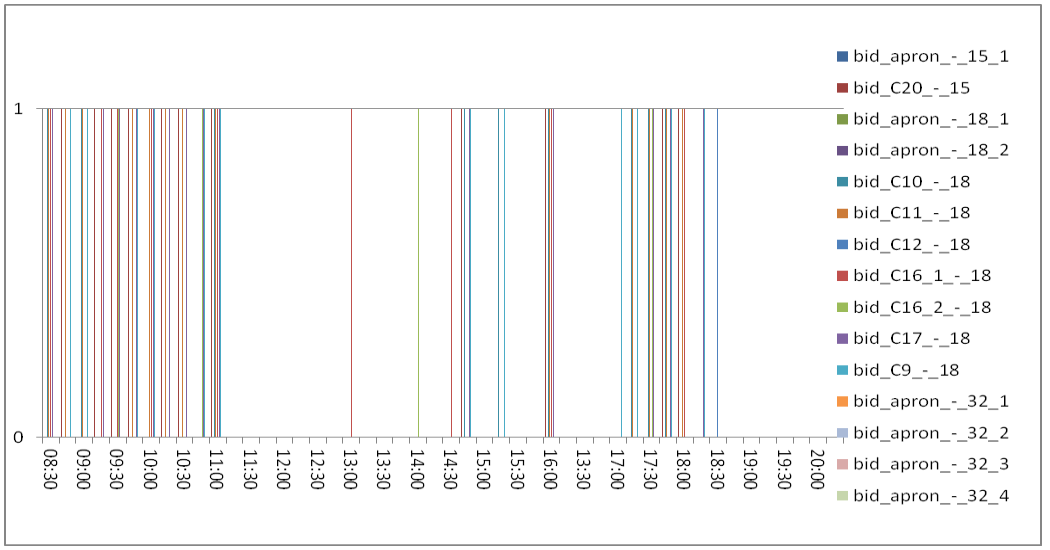


Campaigns of tests - output

Airport load curve profiles



Flexible loads



SEA trial site - Major results summary

Use case implemented and tested : "Flexibility activation optimization for risk management while balancing market participation"

At present, SEA energy producers are mainly operating in the Day-Ahead Market, and DREAM concept is offering the capability of to compete within the other energy exchange markets, which might offer better profit opportunities.

Trial site main results

- **Create a coordinated Virtual Power Plant (VPP)** of entire airport that enables it to participate at all market phases (day-ahead, ancillary service and balancing markets).
- **Reduce the risk of not respecting dispatching orders** in ancillary services market by using flexibility resources of the airport.
- **Reduce grid reinforcements** during airport load growth.

SEA trial site - main exploitable results

- ✓ **Validation and provision of end users flexibility opportunities and technical validation of end users flexibility offers**
  - ➢ One of the main goals achieved in the Malpensa trial site was the evaluation and the measurement of the flexibility degree of the different devices involved in the test (HVAC and Lighting systems). Further devices will be examine in the future.

- ✓ **Optimization of MV constraints management based on LV flexibility opportunities**
  - ➢ In Malpensa trial site the voltage deviations are reduced by means OLTC (On Load Tap Changer) placed in main substation. If this device doesn't control the Tap, the electrical network would be subject to voltage deviations. To increase the life-cycles time of the OLTC is possible to prevent the voltage deviation by means a properly selection of flexibility resources.

- ✓ **Classification and pre-emption of flexibility offers**
  - ➢ To achieve the previous results by means algorithms developed, it has been built a mechanism to classify validated flexibility offers by cost and efficiency to solve grid contingencies.
    In the future this mechanism will be enhanced and applied to other devices.

SEA Group - revenue, profitability and resources

The actual size of benefits and revenues is to be assessed by a detailed analysis of the possible extension of DREAM applications, based on adequate considerations of safety and security constraints, as well as of comfort requirements.

The actual evaluation of tangible benefits from the pilot application of DREAM framework already provides a **high degree of confidence in the achievement of profitability from the deployment of an advanced integrated energy system**.

SEA Group needs the following key resources:

- enhanced control & integration system able to collect data from different SCADAs;
- use of Advanced RTUs;
- energy exchange market interface;
- multi-agent system able to manage decentralized control system in heterarchical way;
- efficient management of local constraints;
- integrated system design exploiting the DREAM framework.

THANKS FOR YOUR ATTENTION !!!

Engr. Matteo GIAMPAOLO
Infrastructure Department
Project Manager

Phone: +39 02 74865104
matteo.giampaolo@seamilano.eu