



Sviluppo di **SISTEMI BIM** per il **CONTENIMENTO** dei **CONSUMI ENERGETICI** degli **EDIFICI OSPEDALIERI**

La ricerca **STREAMER** e il **CASO STUDIO** della
AZIENDA OSPEDALIERO-UNIVERSITARIA CAREGGI a Firenze

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Streamer

European research on energy-efficient healthcare districts

**Semantic-driven Design through Geo and Building Information Modeling for
Energy-Efficient Buildings Integrated in Mixed-use Healthcare Districts**

Progetto finanziato nel 7° Programma Quadro

1 settembre 2013 – 31 agosto 2017

Area Tematica EeB

«Optimised design methodologies for energy-efficient buildings integrated in the neighbourhood energy systems»



IL CONTESTO DELL'ESPERIENZA



OBIETTIVO ▶ EFFICIENZA ENERGETICA DEGLI EDIFICI



**EFFICACIA DEI
RISULTATI** ▶ INTERVENTI ALLA SCALA URBANA



STRATEGIA ▶ AZIONI IN FASE DI PROGETTAZIONE

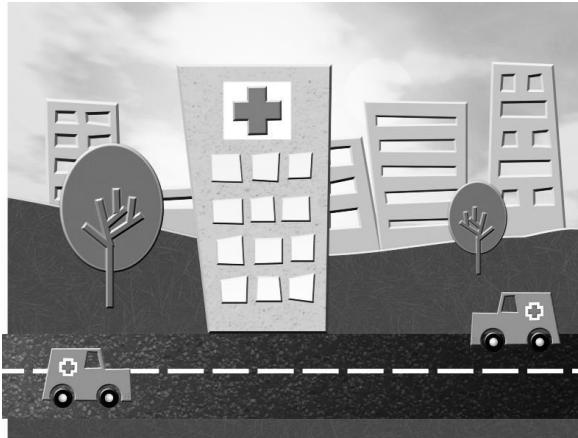


FOCUS ▶ DISTRETTI OSPEDALIERI





OSPEDALI IN EUROPA



- Gli ospedali e tutti gli edifici inseriti all'interno di un distretto sanitario sono strutture tra le più «energivore» e più «inquinanti»
- Un ospedale consuma in media 2,5 volte più di un edificio destinato a uffici



- In Europa sono presenti circa 15.000 ospedali che sono responsabili di almeno il 5% dell'emissione annuale europea di anidride carbonica (pari a 250 milioni di tonnellate)
- La sanità genera circa il 10% del PIL ed un sistema sanitario può arrivare a pesare fino al 60% sulla spesa di un Paese



EFFICIENZA ENERGETICA NEI DISTRETTI SANITARI

L'interoperabilità degli strumenti di gestione e controllo del processo di progettazione è una delle tematiche sulle quali si concentrano la ricerca e le innovazioni nel campo dei sistemi di modellazione BIM (Building Information Modelling).



Su tale principio si basa la capacità di gestire, su piattaforme di scambio e condivisione di dati complessi e conoscenze pluridisciplinari, le attività e i ruoli dei diversi operatori che intervengono nel processo di programmazione, progettazione e gestione degli interventi.

Nell'ambito di interventi di nuova costruzione o di retrofitting all'interno dei grandi distretti ospedalieri, la possibilità di sviluppare modelli progettuali capaci di simulare condizioni alternative e di misurarne gli effetti garantendo un feedback condiviso è una condizione essenziale per ottimizzare l'attività di gestione durante l'intero ciclo di vita degli edifici.



FINE E STRUMENTI DI STREAMER

OBIETTIVO STRATEGICO

RIDUZIONE DEL 50% DEL CONSUMO ENERGETICO E DELLE EMISSIONI DI ANIDRIDE CARBONICA NEI NUOVI PROGETTI O NEL RETROFITTING DI EDIFICI NEI GRANDI DISTRETTI SANITARI

MEZZI

STRUMENTI PROGETTUALI AVANZATI COME IL BIM E IL GIS.

Tali strumenti sono in grado di indirizzare le scelte di coloro che si occupano del progetto e della gestione dei grandi complessi ospedalieri verso l'efficienza energetica.

In tal modo è possibile indagare e ottimizzare

- l'involucro,
- l'organizzazione (tipologica, spaziale e funzionale) degli edifici,
- il sistema degli impianti e delle apparecchiature medicali e
- il sistema di infrastrutture a rete dell'intero distretto sanitario e del suo intorno.



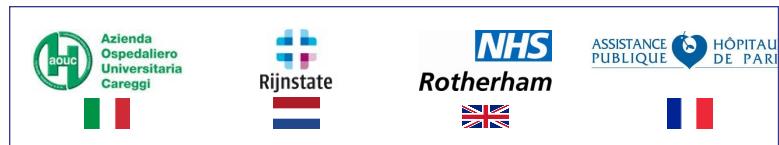
IL CONSORZIO

19 PARTNERS afferenti a 9 PAESI UE

8 piccole/medie imprese



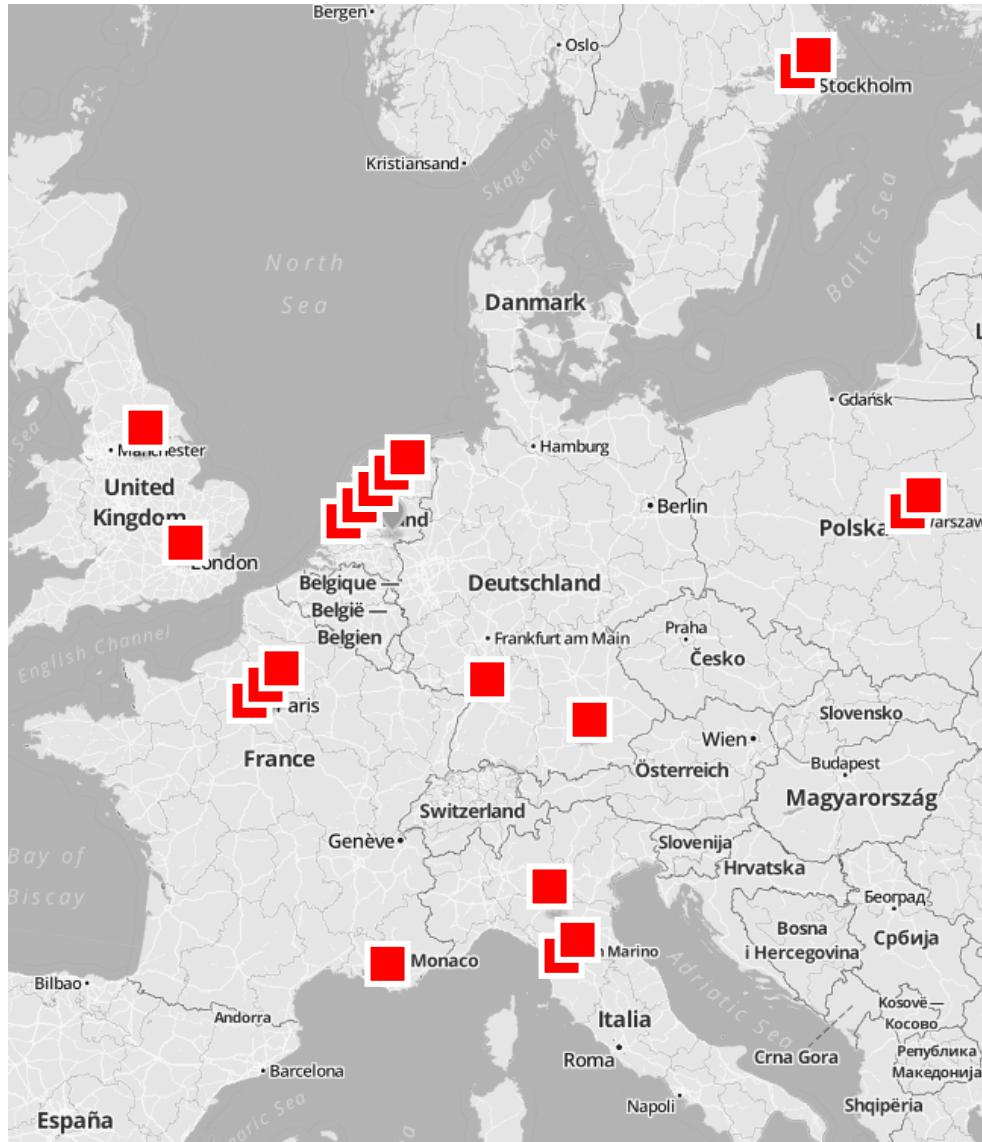
4 ospedali



3 imprese di costruzioni



4 enti di ricerca





GLI OSPEDALI IN STREAMER

I quattro distretti ospedalieri sono coinvolti quali casi studio per la verifica dei risultati attesi

NHS di Rotherham (Gran Bretagna)



Rotherham

Rijnstate Ziekenhuis di Arnhem (Olanda)



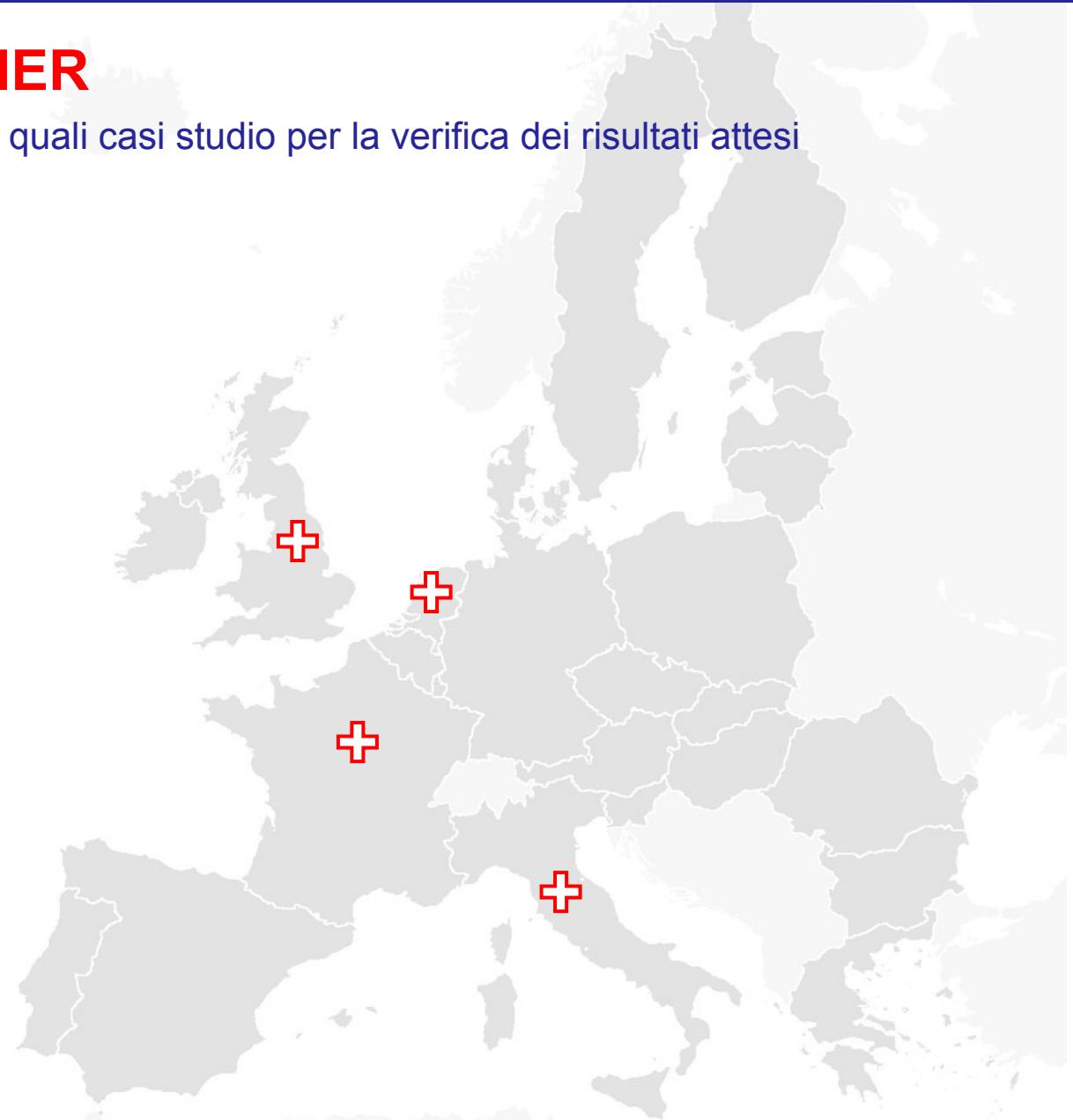
AP-HP di Parigi (Francia)



AOU di Careggi (Italia)



Azienda
Ospedaliero
Universitària
Careggi





DOMANDA ENERGIA TERMICA OSPEDALE CAREGGI

PATTERN CARATTERISTICO GRANDI STRUTTURE OSPEDALIERE:

PICCHI DOMANDA INVERNALI

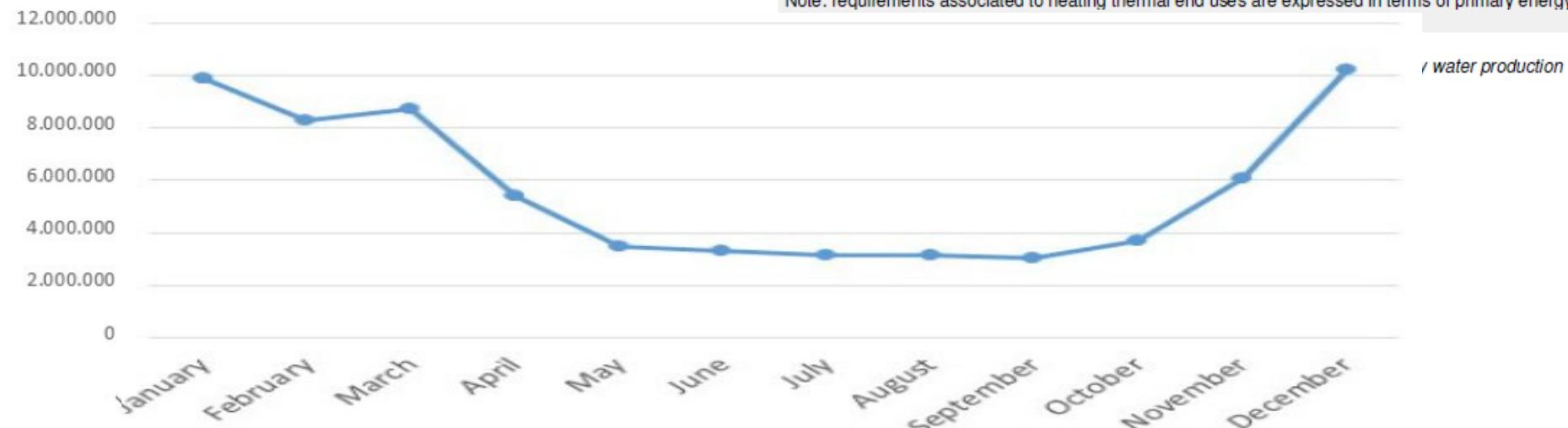
BASE LOAD ESTIVO PER ACS E BATTERIE UTA

RETROFIT IDEALE:

*COGENERAZIONE/TRIGENERAZIONE
OTTIMIZZATA SU DOMANDA REPARTI (BIM)*

	2008	2009	2010	2011	2012	2013	2014	Average Year
Period	kWhp	kWht						
January	11.069.189	9.395.704	10.386.547	9.930.650	9.298.742	9.133.493	9.791.000	9.869.054
February	7.566.165	8.931.804	7.585.814	6.553.469	10.116.312	9.068.161	8.215.600	8.303.621
March	11.002.819	7.340.649	9.739.848	9.342.850	5.833.866	9.085.476	7.948.710	8.724.251
April	6.965.714	4.397.044	5.250.631	4.857.398	5.093.040	6.000.028	8.189.130	5.427.309
May	3.846.261	3.473.056	3.696.870	3.266.297	2.617.656	3.977.728	4.860.850	3.479.645
June	3.566.145	2.610.143	4.166.667	3.525.527	2.652.098	3.474.331	4.802.550	3.332.485
July	4.020.617	3.006.317	3.168.532	2.263.578	2.915.687	3.595.870	5.264.200	3.161.767
August	3.668.003	2.355.831	3.601.114	2.932.057	3.116.254	3.198.580	5.408.540	3.145.307
September	3.934.136	2.209.965	3.344.768	1.809.613	3.350.608	3.531.420		3.030.085
October	3.437.293	4.335.433	3.851.665	3.738.116	2.995.563	3.690.840		3.674.818
November	4.218.320	6.106.649	8.071.301	5.166.916	6.148.734	6.817.020		6.088.157
December	13.359.677	12.671.518	9.124.117	6.232.408	10.532.280	9.487.010		10.234.502
Year	76.654.338	66.834.112	71.987.875	59.618.880	64.670.839	71.059.957	54.480.580	68.471.000

Note: requirements associated to heating thermal end uses are expressed in terms of primary energy - fuels: natural





DOMANDA ENERGIA FRIGORIFERA OSPEDALE CAREGGI

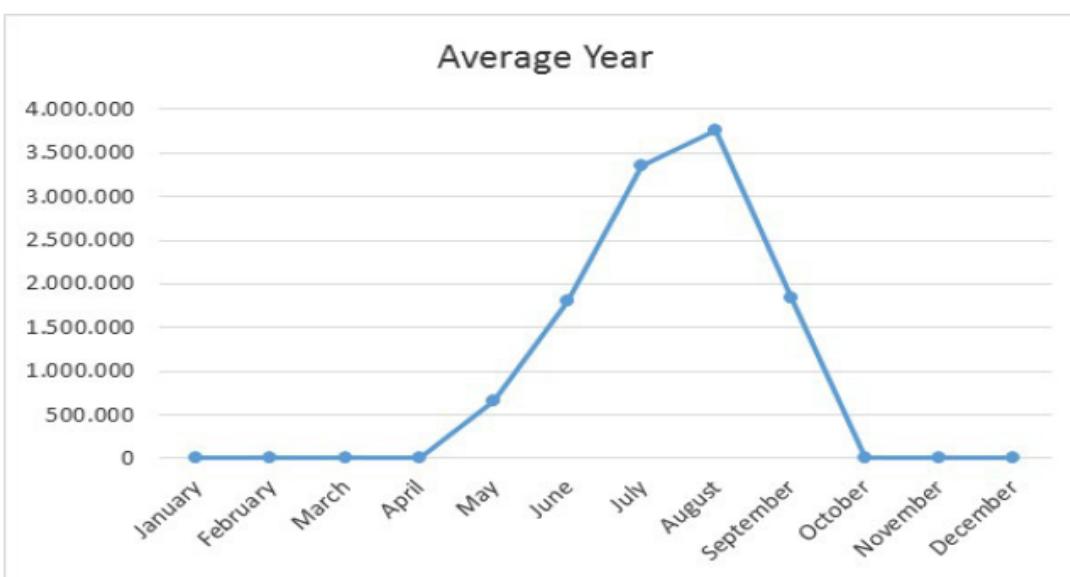
PATTERN CARATTERISTICO GRANDI STRUTTURE OSPEDALIERE IN CLIMI TEMPERATI:

PICCHI DOMANDA CONCENTRATI IN ESTATE PER RAFFRESCAMENTO

REPARTI CLIMATIZZATI

RETROFIT IDEALE:

TRIGENERAZIONE UTILIZZO ABSORPTION CHILLERS
OTTIMIZZATA SU DOMANDA REPARTI (BIM)



Period	Average Year	2009	Average Year
	kWhp	kWhp	kWht
January	3.259.597		
February	3.031.612		
March	3.170.937		
April	3.224.004		
May	3.442.715	218.711	656.133
June	3.824.657	600.653	1.801.958
July	4.341.036	1.117.032	3.351.097
August	4.476.205	1.252.201	3.756.603
September	3.839.833	615.829	1.847.488
October	3.572.768		
November	3.325.207		
December	3.439.186		
Year	42.947.757	3.804.426	11.413.277



DOMANDA ENERGIA ELETTRICA OSPEDALE CAREGGI

PATTERN CARATTERISTICO GRANDI COMPLESSI SANITARI:

*PRESENTE PICCO ESTIVO DOVUTO ALL'ALIMENTAZIONE
ELETTRICA DEI SISTEMI DI RAFFRESCAMENTO*

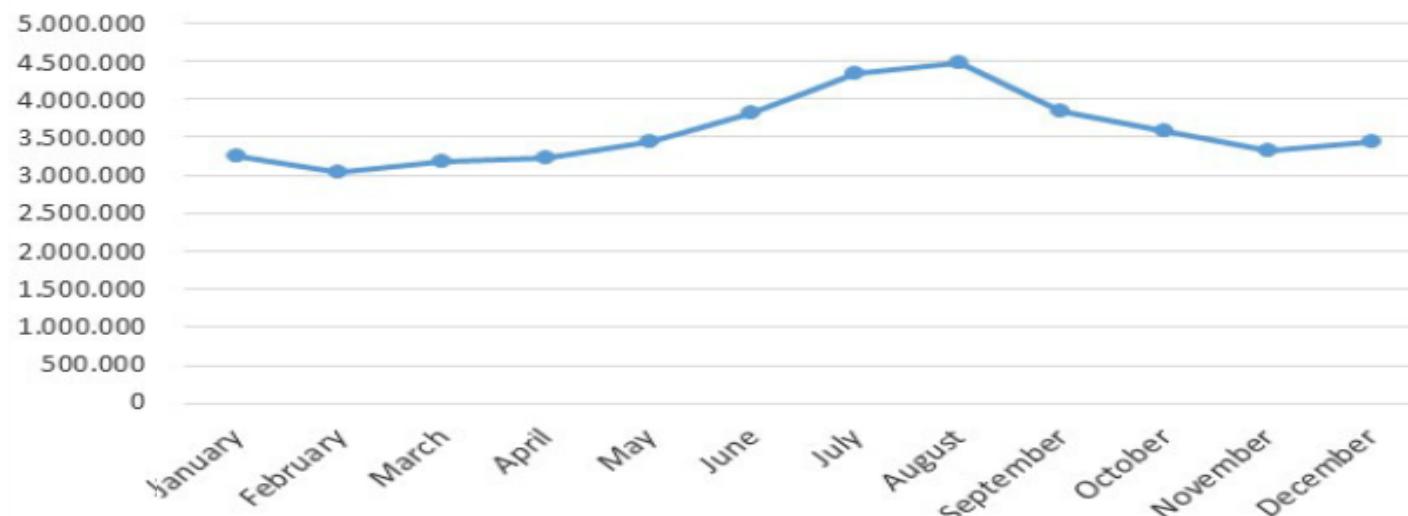
*PICCO RIDOTTO RISPETTO A GRANDI OSPEDALI PER
PRESENZA DI UN ABBONDANTE BASE LOAD TUTTO L'ANNO*

RETROFIT IDEALE:

TRIGENERAZIONE OTTIMIZZATA SU DOMANDA REPARTI (BIM)

	2008	2009	2010	2011	2012	2013	2014	Average Year
Period	kWhe							
January	2.951.955	3.040.250	3.105.891	3.194.713	3.316.818	3.947.957	3.917.917	3.259.597
February	2.852.238	2.706.694	2.916.768	2.890.506	3.267.810	3.555.658	3.454.760	3.031.612
March	3.012.124	2.926.049	2.844.068	3.199.379	3.233.590	3.810.409	3.962.730	3.170.937
April	2.948.133	2.990.375	3.250.397	3.141.229	3.270.857	3.743.033	3.832.920	3.224.004
May	3.228.576	3.396.697	3.202.701	3.387.232	3.419.507	4.021.576	3.976.770	3.442.715
June	3.536.258	3.522.558	3.740.135	3.826.515	4.154.243	4.168.230	4.251.970	3.824.657
July	4.083.685	4.188.630	3.229.272	4.216.089	5.206.054	5.122.488	4.769.250	4.341.036
August	4.029.727	4.312.974	3.229.272	4.224.866	4.990.265	6.070.125	4.598.850	4.476.205
September	3.498.256	3.677.080	3.125.103	4.059.551	4.282.886	4.396.123		3.839.833
October	3.335.720	3.236.785	3.229.272	3.498.940	4.095.971	4.039.920		3.572.768
November	3.041.968	3.000.158	3.125.103	3.143.522	3.803.330	3.837.158		3.325.207
December	3.006.124	3.128.378	3.250.005	3.324.941	3.951.082	3.974.588		3.439.186
Year	39.524.764	40.126.628	38.247.987	42.107.483	46.992.413	50.687.265	32.765.167	42.947.757

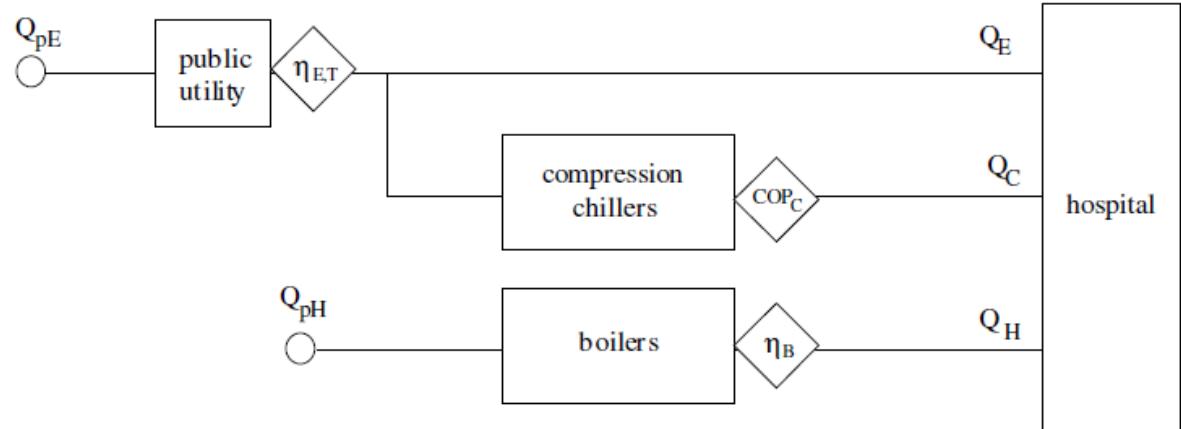
Table 03 Historical Careggi electric energy requirements (kWhe)





ENERGY RETROFIT TRIGENERAZIONE

STATO DI FATTO



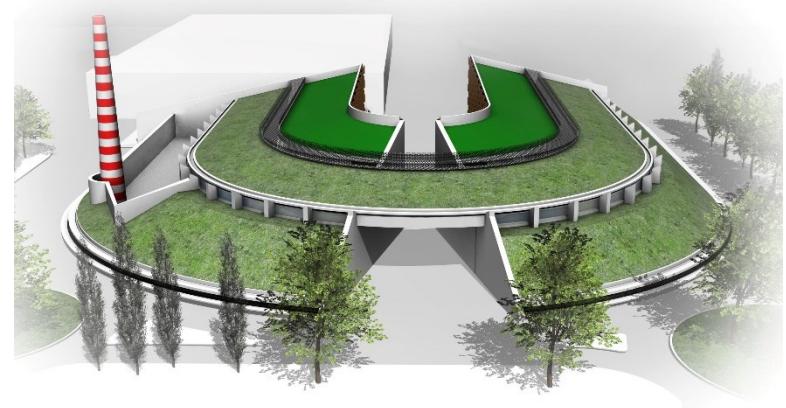
ENERGY RETROFIT: TRIGENERAZIONE A GAS NATURALE

Electric Nominal Power 10,5 MW_e

Recovered Heat (heating) 17,3 MW_t

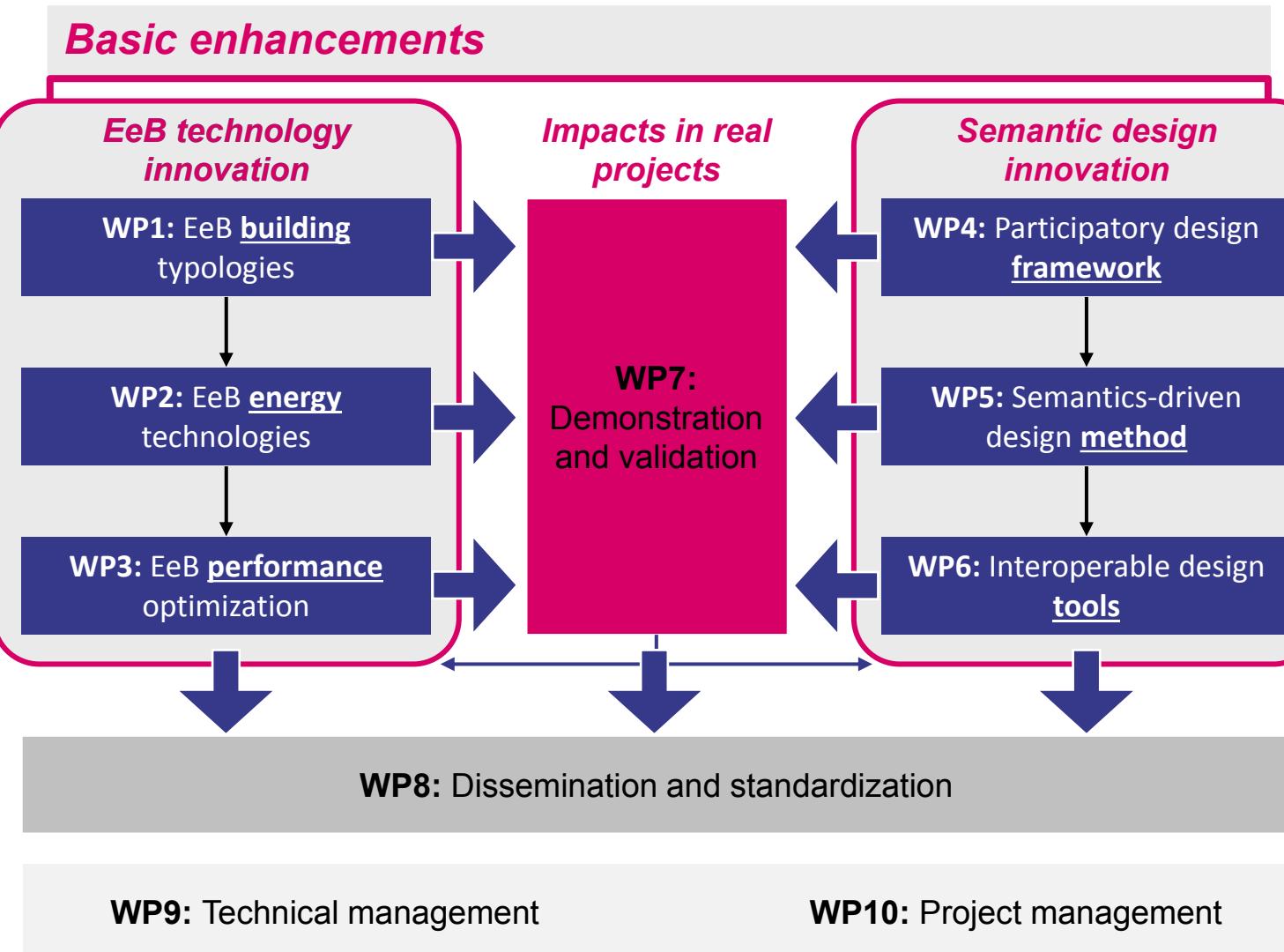
3 back up gas-fired boilers 11 MW_t

Absorption chillers cooling power 6,3 MWf





PROGRAMMA DI RICERCA





RISULTATI DEL PROGRAMMA DI RICERCA

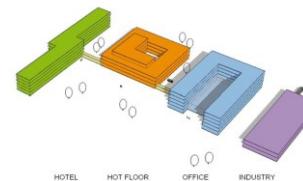
INNOVAZIONE DI PROCESSO

MODELLO SEMANTICO

INDICATORI QUALITÀ

NUOVI STRUMENTI

Labelling System

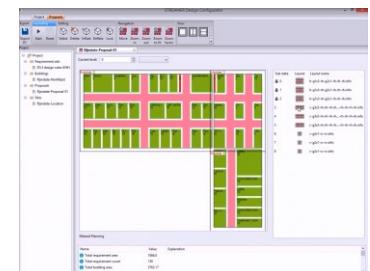


KPIs (Key Performance Indicators)

PoR (Programme of Requirements)

DR (Design Rules)

EDC (Early Design Configurator)



CEN (Early energy Simulation)

DDST (Dashboard)





IL RUOLO DELL'AOU CAREGGI NEL PROGETTO

L'AOU Careggi ha strategicamente deciso di avvalersi dell'Università di Firenze come terza parte, utilizzando, ai fini della ricerca, il sistema informatizzato e geo-referenziato "**SACS®** - Sistema per l'Analisi delle Consistenze Strutturali".

Data base in uso ed in continuo aggiornamento

Attualmente risultano mappati più di 16.000 ambienti in 52 edifici.

L'obiettivo dell'Azienda è di:

IMPLEMENTARE QUESTO SISTEMA CON I RISULTATI DELLA RICERCA "STREAMER" PER UTILIZZARLO QUALE SUPPORTO IN TUTTE LE FASI DECISIONALI RIGUARDANTI IL PROPRIO PATRIMONIO IMMOBILIARE IN UN'OTTICA DI CONTENIMENTO ENERGETICO ED EFFICIENZA FUNZIONALE.



Azienda Ospedaliero Universitaria Careggi SACS sacs@aou-careggi.toscana.it

Sistema di Analisi delle Consistenze Strutturali dell'Azienda Ospedaliero-Universitaria Careggi

Eureka! Powered by SACS Per la corretta visualizzazione è necessario installare Autodesk Design Review

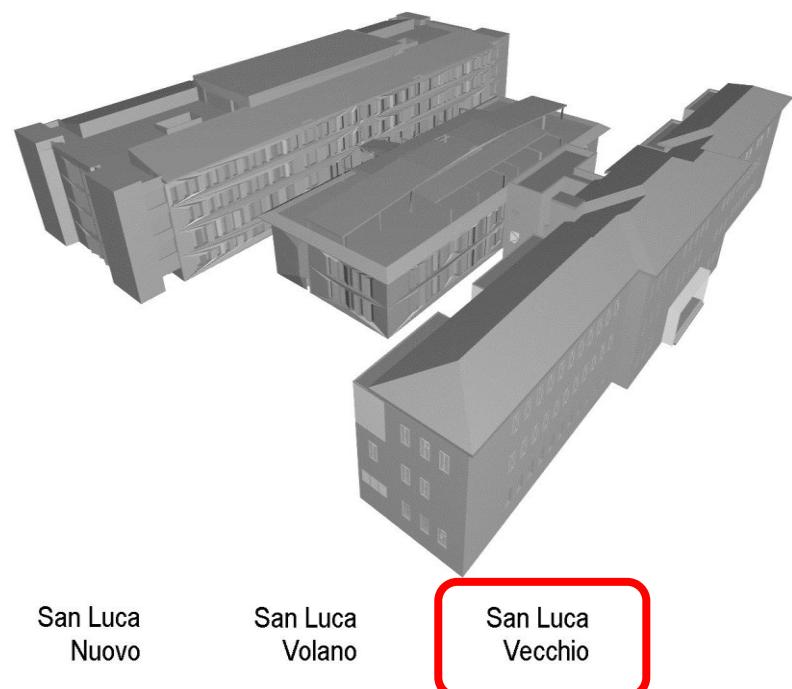
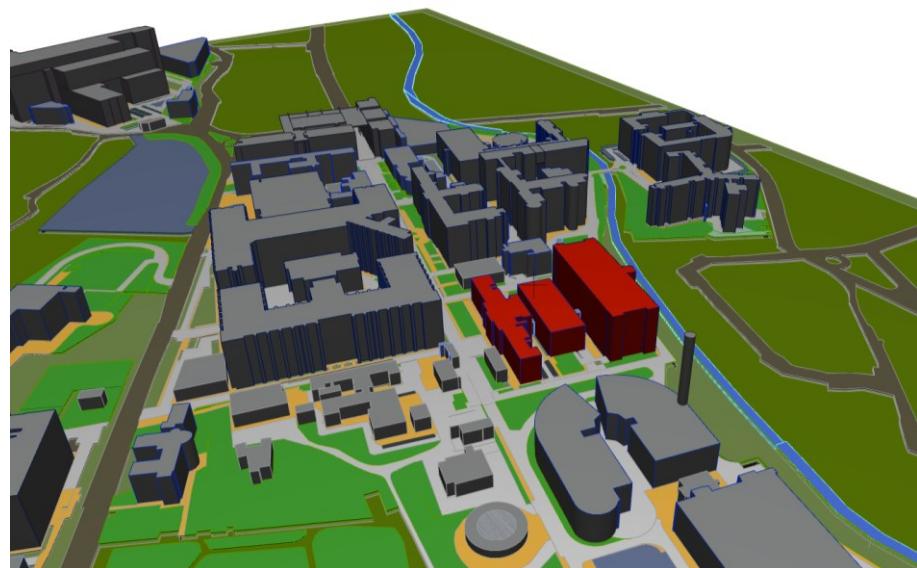
Elenco DAL Elenco SOG Elenco AAD Elenco Destinazioni d'Uso
S.A.C.S. – REPORT COMPLETO AOUC



IL CASO STUDIO

Considerando la programmazione dei futuri interventi sul patrimonio strutturale, l'AOU di Careggi ha scelto di utilizzare il polo oncologico "San Luca", in particolare l'edificio più vetusto, quale oggetto della validazione dei risultati della ricerca.

Il polo si articola in un complesso di tre edifici posto nel cuore del distretto, in adiacenza alla nuova centrale di trigenerazione.



San Luca
Nuovo

San Luca
Volano

San Luca
Vecchio



IL CASO STUDIO

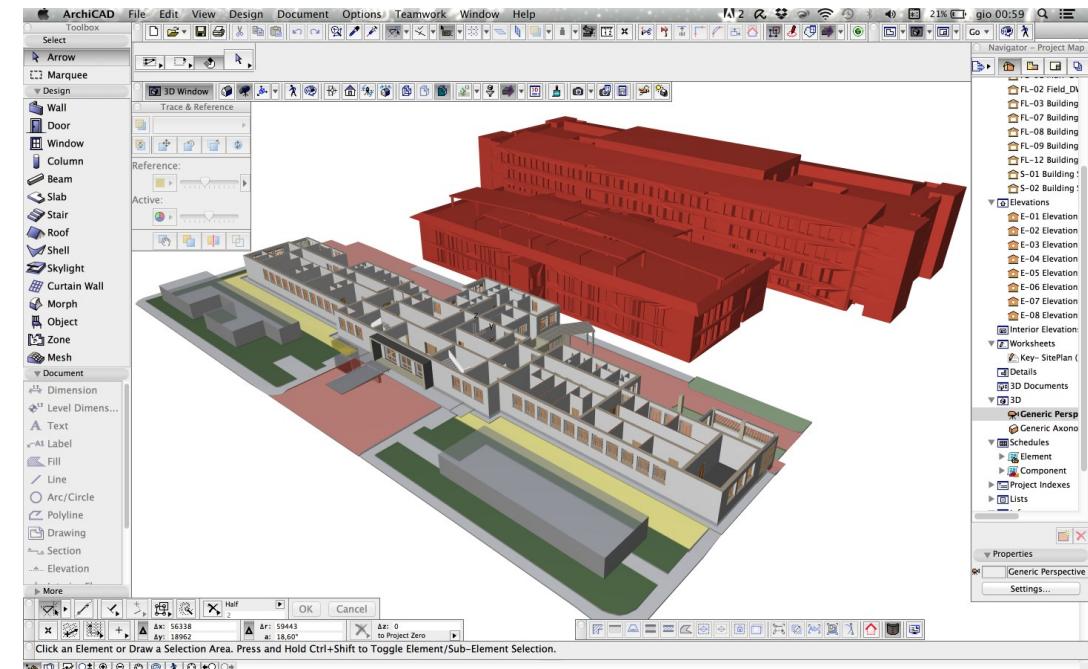
La Direzione dell'Azienda, considerata la vetustà e l'inefficienza – funzionale e prestazionale - del primo edificio (San Luca Vecchio), si è posta il problema del tipo di intervento da intraprendere, cioè se effettuare una demolizione e ricostruzione oppure una ristrutturazione profonda.

"STREAMER" DIVENTA QUINDI LO STRUMENTO STRATEGICO PER EFFETTUARE QUESTA SCELTA SECONDO CRITERI DI EFFICIENZA ENERGETICA.





MODELLAZIONE BIM-GIS DEL DISTRETTO E DEL CASO STUDIO





PROGRAMMA FUNZIONALE ED ETICHETTATURA

STREAMER: 89 unità spaziali

ROOM	
Access hall	Traffic support equipment space with at least two doors that can be crossed without more than one door to be opened simultaneously.
Ambulance hall	Space for loading and unloading of patients to / from the ambulance.
Analysis room	Space designated for basic analysis of blood and urine samples
Ante-rooms	Traffic support equipment space with at least two doors that can be passed with several doors open at once. Located in the wards.
Archives	Space designated for storage of documents
Baby-changing room	Space designated for changing of diapers
Basement	Technical space underneath the hospital
Bedroom	Space where food is served
Canteen	Space where food is served
Central hall	Entrance hall to the hospital
Changing room (personnel)	Space with an area for examination of patients and area for conversation
Conference room	Room for groups (for teaching , conversation , etc.)
Conservation room	Room in which the deceased are kept in a conditioned space
Consultation + examination room	Room with an area for examination of patients and area for conversation
Day room	Room set up for relaxing and socializing between patients and visitors within the wards
Delivery room	Room for giving birth
Disinfection room	Room designated for cleaning and disinfection of medical equipment
Disposal	Treatment space for waste patients
Examination room CT	Room for examination with CT
Examination room MRI	Room for examination with MRI
Examination room Endoscopy	Room designated for endoscopic examination and treatment of patients
Examination room MRI	Room for examination with MRI
Examination room Ultrasound	Room for the visual assessment of the patient's health in the emergency department related to the correct level of care
Examination room X-ray	Room for examination with X-ray
Emergency room (ambulatory)	Space with medical equipment, or examining post
Emergency room (acute)	Emergency room for the treatment of acute patients, etc. I
Holding	Rooms for patients waiting on operation, nearby the operation theatre
Isolated escape routes	Vertical connection
Kitchen	Space for the preparation of food
Kitchen cleaning room	Rooms designated for cleaning the meat, cutlery, etc.
Laboratory	Room where tests are carried out in order to have information about patient's health
Laundry room	Space designated for washing of textiles
Storage	Space designated for storage and inspection of medicines
Nursing room	Rooms designated for cleaning and washing reusable instruments for surgical centres
Operating theatre	Central post for personnel on the patient departments
Operative room	Rooms that are set up to handle the patient, while within the emergency department
Office	Overnight room for on-call staff
Oral radiology	Overnight room for oral radiology
Patient room	Overnight room for patients
Recovery room	Large operating theater in connection with robot arm or other mobile equipment
Patient room	Rooms for one or more patients
Patient room (with hospital)	Luxury family-oriented patient room in which the mother also gives birth
Patient room (intensive care)	Rooms for intensive care
Patient room (maternity)	Patient room on the intensive care department
Promotional room	Rooms designed for staff training and educating (excluding kitchen)
Reception	Rooms for reception
Photocopying room	Space with printers, copying equipment, etc.
Printer room	Space for printing
Preparation room	Room adjacent to operating room, designated for preparation of sterile instruments for surgery
Preparation room	Rooms adjacent to operating room, designated for preparation of staff/nurses surgery
Preparation room	Rooms adjacent to operating room, designated for preparation of staff/nurses surgery
Recreation room	Space for private relaxation and leisure of patients
Recovery room	Rooms that are set up to monitor patients recovering from anaesthesia
Receiving room	Rooms for the collection and sorting of waste
Rehabilitation room	Rooms for rehabilitation that require to be stored in a heating area
Rehabilitation room	Using area for relatives with children and possible overnight accommodation
Rehabilitation room Patient	Patient space for occasional individual resting
Rehabilitation room	Rooms for rehabilitation
Resuscitation/Childrens ER	Room for resuscitation of children after delivery
Resuscitation room (not only for children)	Rooms for resuscitation
Rooms for decontaminating medicines	Rooms for decontaminating medicines for example
Sanitation room	Rooms designated for rehabilitation of actives of radioactive, biological or chemical substances
Shop	
Storage	
Storage for disabled people	Space for the rehabilitation of patients
Storage stock, infection control	Space for storing sterile goods
Storage	Storage
Gymnastic room	Space for the rehabilitation of patients
Technical room	Rooms for technical equipment (building services).
Space for disabled people	
Fracture room	Rooms for immediate care of severely injured patients (emergency department)
Emergency room/Emergency room ER	Space for the emergency care of patients
Emergency room	Space for the emergency care of patients
Operating room	Space designated for operating of incoming goods
Operating room	Operating machine for bedridden
Operating room	Rooms for cleaning waste before their incineration
Operating room	

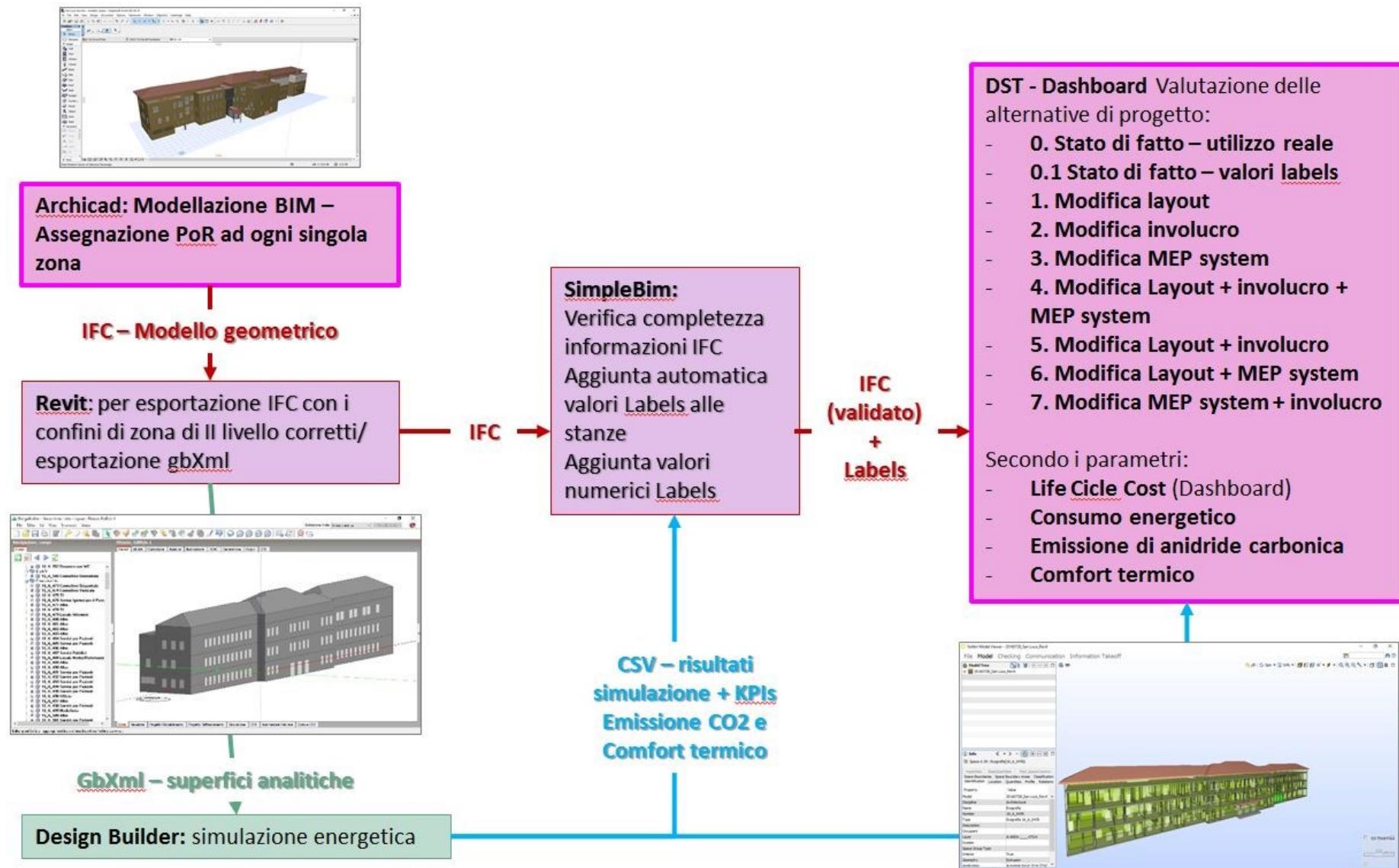
ROOM								
Air lock	Traffic support equipment space with at least two doors that can be crossed without more than one door to be opened simultaneously.							
Ambulance hall	Space for loading and unloading of patients to / from the ambulance							
Analysis room	Space designated for basic analysis of blood and urine samples							
Ante-Room	Traffic support equipment space with at least two doors that can be passed with several doors open at once. Located in the wards.							
Archives	Space designated for storage of documents							
Baby-Changing room	/							
Basement	Technical space underneath the hospital							
Breast feeding room	/							
Canteen	Space where food is served							
Central hall	Entrance hall to the hospital							
Changing room (personnel)	/							
Conference room	Room for groups (for teaching , conversation , etc.)							
Conservation room	Room in which the deceased are kept in a conditioned space							

A	B	C	D	E	F	G	H
STREAMER Spatial Units Identifier	Description	Bouwcollege layer class	Hygiene class	AccessSecurity class	UserProfile class	Equipment class	Construction class
AirLock	Traffic support equipment space with at least two doors that can be crossed without more than one door to be opened simultaneously.	I	H5	A5	U4	EQ1	C1
AmbulanceHall	Space for loading and unloading of patients to / from the ambulance	I	H1	A3	U4	EQ1	C4
AnalysisRoom	Space designated for basic analysis of blood and urine samples	I	H5	A5	U3	EQ4	C1
AnteRoom	Traffic support equipment space with at least two doors that can be passed with several doors open at once. Located in the wards.	H	H1	A2	U4	EQ1	C1
Archives	Space designated for storage of documents	O	H1	A5	U1	EQ1	C2
BabyChangingRoom	/	O	H1	A2	U4	EQ1	C1
Basement	Technical space underneath the hospital	I	H1	A4	U4	EQ1	C2
BreastFeedingRoom	/	O	H1	A2	U4	EQ1	C1
Canteen	Space where food is served	H	H1	A2	U2	EQ1	C3
CentralHall	Entrance hall to the hospital	O	H1	A1	U4	EQ1	C4
ChangingRoomPersonnel	/	I	H1	A5	U4	EQ1	C1
ConferenceRoom	Room for groups (for teaching , conversation , etc.)	O	H2	A2	U1	EQ2	C1
ConservationRoom	Room in which the deceased are kept in a conditioned space	I	H2	A5	U1	EQ3	C1
ConsultationExaminationRoom	Room with an area for examination of patients and area for conversation	O	H3	A2	U1	EQ2	C1
Darkroom	/	O	H2	A5	U1	EQ2	C1
DayRoom	Room set up for relaxing and socializing between patients and visitors within the wards	H	H2	A2	U4	EQ1	C1
DeliveryRoom	Room for giving birth	HF	H3	A3	U4	EQ4	C1
DisinfectionRoom	Room designated for cleaning and disinfection of medical equipment	I	H4	A5	U4	EQ6	C1

7 Label per ogni unità spaziale

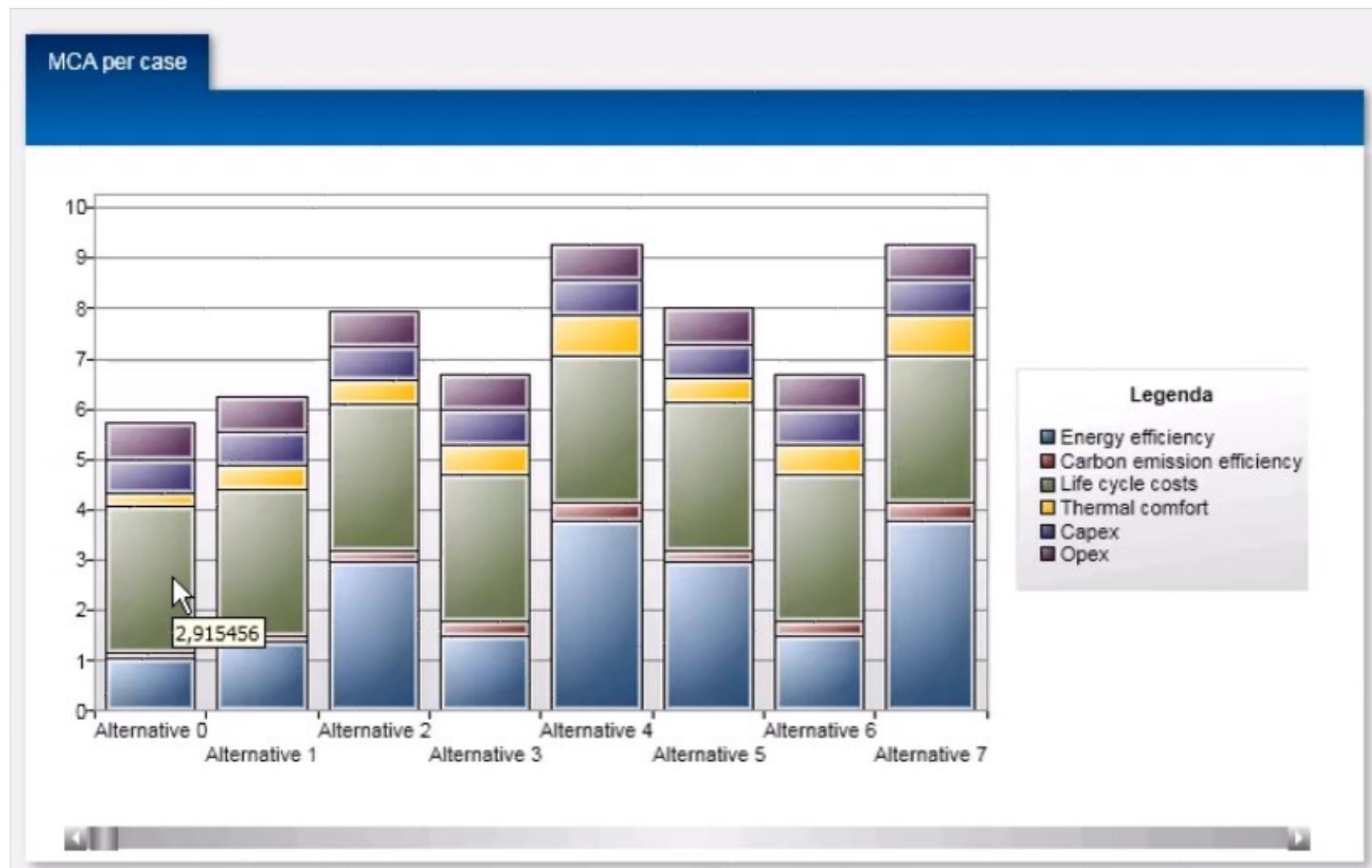


SIMULAZIONE ENERGETICA DEL CASO STUDIO





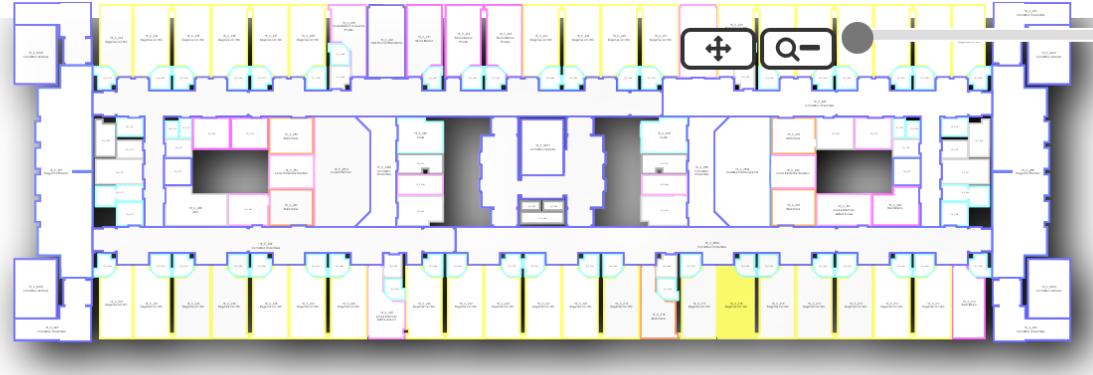
USO DELLA DASHBOARD





IL SISTEMA SACS POTENZIATO CON STREAMER

- Multiselezione
- Panning
- Legenda
- Azzerza selezione



Generali	Organizzazione	Personale	Risorse	Tecnologie	STREAMER
<p>Space Unit: PatientRoom (Room for one or more inpatients)</p> <p>Classe Energia: 3 - Deg./Bassa Diagn./Altro Blocco Op.</p> <p>Bouwcollege Layer Class TEORICO: H</p> <p>Bouwcollege Layer Class REALE: H</p> <p>Hygienic Class TEORICO: H2</p> <p>Hygienic Class REALE: H2</p> <p>Access Security Class TEORICO: A2</p> <p>Access Security Class REALE: A2</p> <p>User Profile Class TEORICO: U4</p> <p>User Profile Class REALE: U4</p>					