SUSTAINABLE
PLACES 2025

THEMATIC SESSION

Data Centers, Digital Twin & AI for Sustainability

Day 2 Thurs. 09 Oct. 2.00 - 5.30 PM CEST

THEMATIC TRACK

SUSTAINABLE PLACES 2025

8-10 October 2025

Milano

Comune di Milano

R2M RESEARCH TO MARKET SOLUTION

Data Centers, Digital Twins & AI for Sustainability

Organized by Italian PropTech Network · R2M RESEARCH TO MARKET SOLUTION

Contributors RICS · TEHA

HYCOOL-IT HYBRID COOLING & MANAGEMENT FOR IT INFRASTRUCTURES · DYMAN · IES · IZQUATTRO THE TWO-PHASE COOLING COMPANY · ICOPOWER BEYOND ENERGY SAVING TECHNOLOGIES

OPENING REMARKS

CHIARA TAGLIARO

Assistant Professor, Department of Architecture, Built Environment and Construction Engineering | Italian Proptech Network (IPN)

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How Datacenter impact territories

MARCO LEONE, MRICS

Senior Advisor Nomisma & Revalo

Intro: How Datacenter impact territories

Data Centers are **highly strategic** assets for **local communities**, but their **value is complex** and can be difficult to communicate, especially to non-experts.

Data Centers have significant economic and social impacts, which must be assessed with tailor-made solutions for each case, applying scientific and accurate models.

Only with adequate preliminary assessment and a **robust measurement method** can the project's **benefits be valued and communicated**.

Intro: how Datacenter impact territories

A sustainable and shared **approach** is needed **on multiple fronts**:

- a **technical aspect** during the design phase;
- **fundraising and financing** implementation;
- management of **operations**;
- **periodic assessments** to verify and report to investors and public and private stakeholders on the achievement of established objectives
- **stakeholder engagement** and the various phases of listening emerge as fundamental aspects in the development and monitoring of activities.

Intro: Datacenter impact territories

High Investment volumes

The technologies and operation of DCs require very significant investments, especially given a saturated market on the supply side, with costs that have increased dramatically in recent years.

Need for areas, energy, connectivity

Data center sites require large areas to house server infrastructure, high availability of electricity, and stable connectivity on ultra-broadband fiber optic networks.

Changes in the urban environment

The infrastructure requirements and investments of DCs are tailored to local contexts, potentially altering some urban structures. However, these structures can benefit local businesses by facilitating access to new technologies.

Impact on direct & indirect employment

New, high-tech infrastructures attract human capital, especially highly specialized ones. Alongside this, other productive activities and related service providers are indirectly activated.

Impact on real estate, social and environment

The construction or conversion of infrastructure for DC generates benefits in various areas, from real estate to the environment. The social benefits, in addition to employment, include training programs and improved community services.

Datacenter & Public Interest

Marco Leone, MRICS
Senior Advisor Nomisma & Revalo

SHARE SOME VIEWS WITH

On. Giulia Pastorella
Deputata, Vicepresidente di AZIONE
Prima firmataria progetto legge
sullo sviluppo dei DC in Italia

https://www.sustainableplaces.eu/
Milano, 9 ottobre 2025

DC Development & Public Interest

The reason why of the new Bill

The public governance – State level vs Regional and local level

Key target: the Digital Sovereignity

How Public & Private Partnership need to be structured

Background and perspectives for innovation

Luca Dozio (Datacenter Observatory, PoliMI) - Major market trends

Gianluca Metti (MRICS, Starching SPA – Maestrale SRL) - Why data centers are not an evolution of logistics and the role of tenants in driving data center development

Mattia Mariani (IDA, Deerns) - New Key Performance Indicators for different stakeholders, who are interested in what (operators VS users)

MAJOR MARKET TRENDS

LUCA DOZIO

Datacenter Observatory, PoliMI

POLIMI SCHOOL OF MANAGEMENT

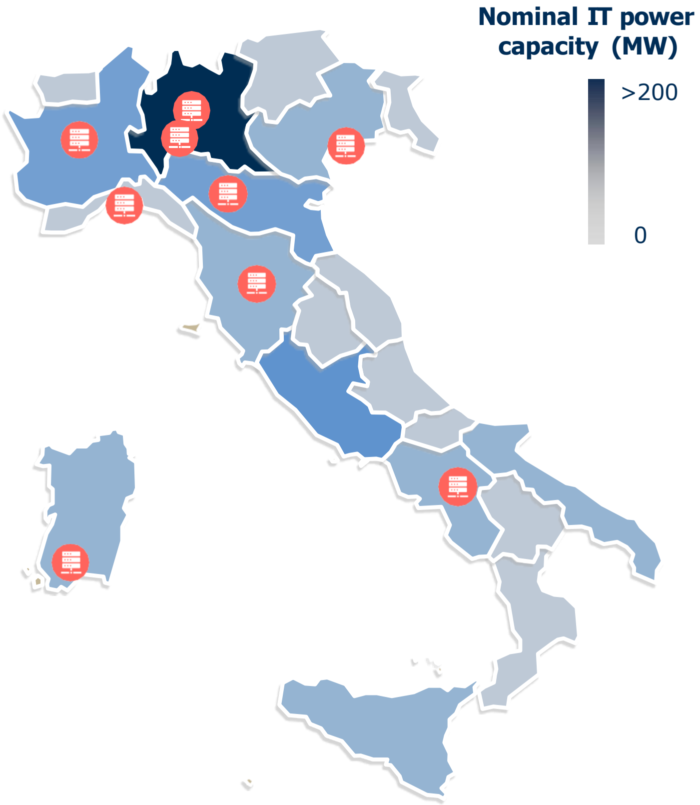
osservatori.net digital innovation

09.10.2025

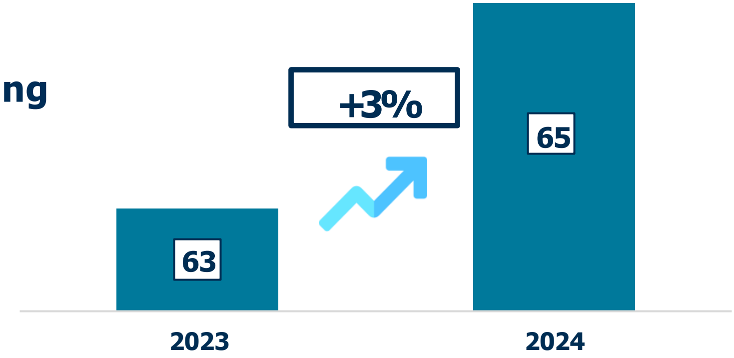
Data Center Observatory

Data Center Observatory for Sustainable Places

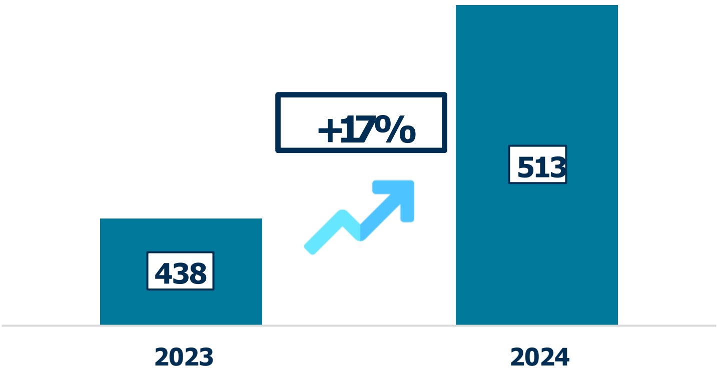
The current snapshot of Data Center infrastructures in Italy



Players with active enabling physical infrastructures



Nominal IT power capacity (MW)

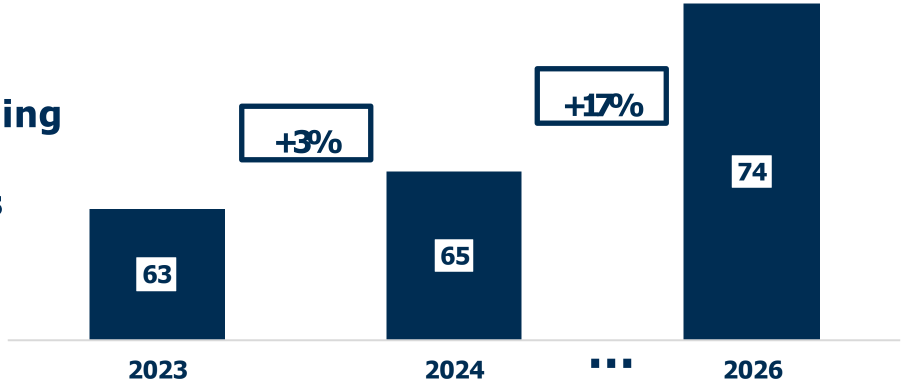


Reference sample: 186 Enabling physical infrastructures

Geographical location of new openings 2025 and 2026 (excluding small Data Centers, less than 0.5 MW)

The current snapshot of Data Center infrastructures in Italy

Players with active enabling physical infrastructures



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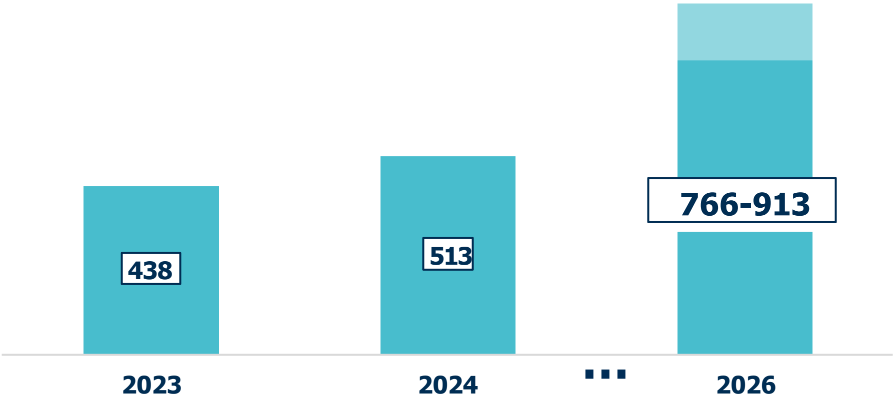


Concentration of nominal IT Power Capacity in Lombardy, specifically in the Metropolitan City of Milan

A snapshot of investments in Medium and High Power Data Centers in Italy

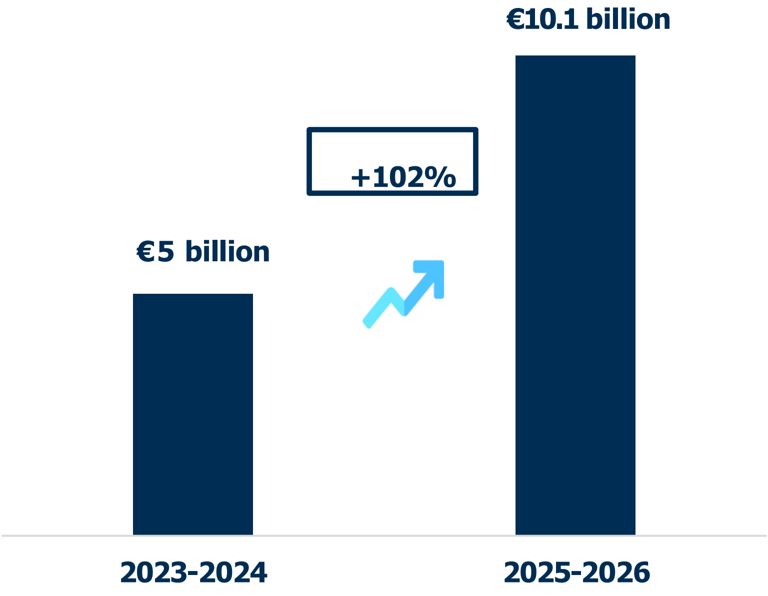
Expansion of national operators and repercussions for the sector

Development plans of international Cloud Providers with positive spillovers on the supply chain

AI market growth and **impacts on Data Center infrastructure technologies**

Strengthening the country's connectivity and creating new hubs

Growing **attention of institutions**



Land purchase

DC Preparation

Building

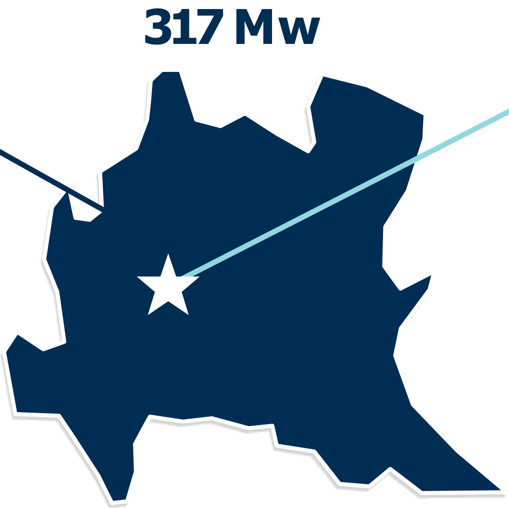
Servers and IT infrastructures

The role of Lombardy and the Milanese hub

Lombardy

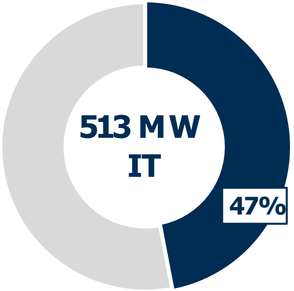
25 Players with Operational Data Centers in 2024

8 - 12 billion euros of investments in the Lombardy region planned between 2023 and 2026

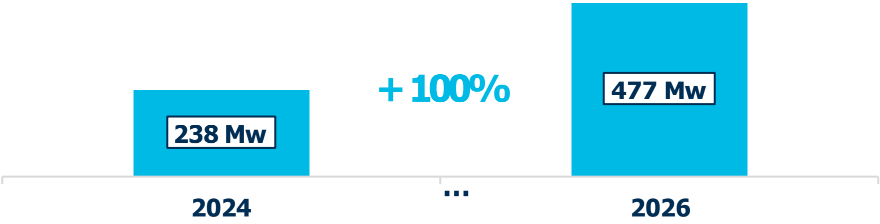


Metropolitan City of Milan

22 Players with Operational Data Centers in 2024



Risk of future saturation for the Metropolitan City of Milan?*



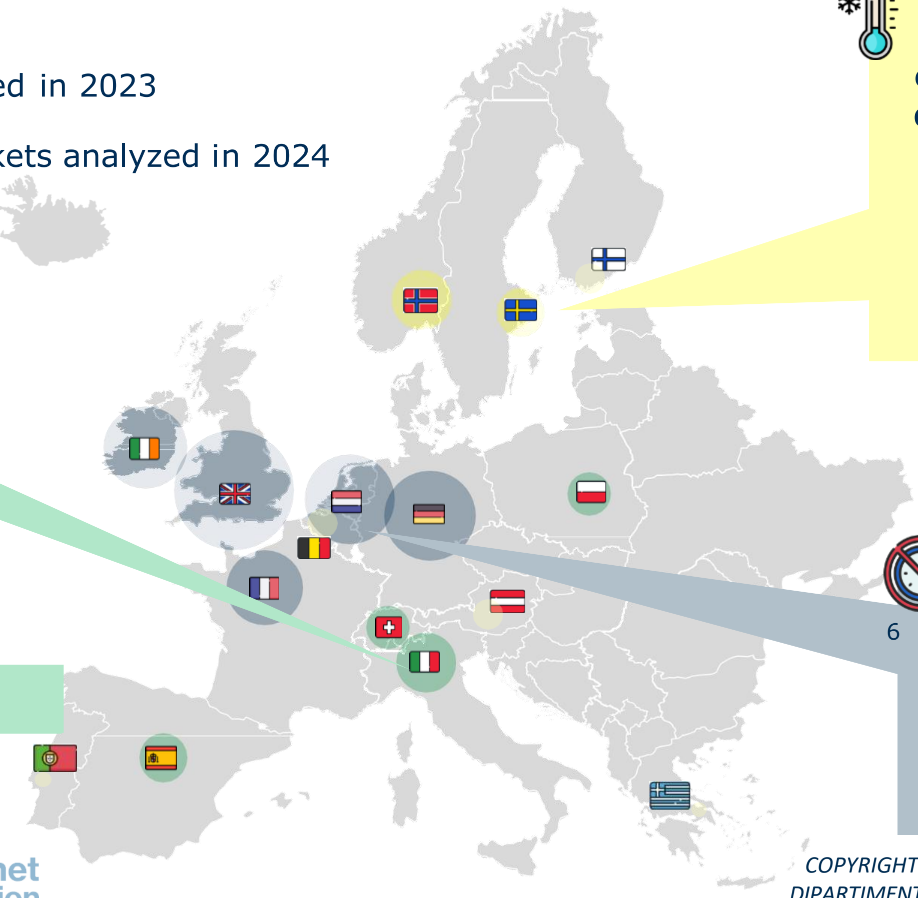
*Forecast of the evolution of the nominal IT power installed in the Metropolitan City of Milan according to the "best scenario"

Milan in the European panorama

FLAPD Markets

Emerging markets identified in 2023

Other new emerging markets analyzed in 2024



Italy's central role among the emerging countries in the Mediterranean and Balkan belt

The city of Madrid has **excellent growth dynamics**, also supported by a **more favorable trend in the price of energy**

The Nordics market is emerging, **driven by the deployment of AI-ready infrastructures** due to favorable climatic conditions and high connectivity with other European regions

In the main FLAPD markets, the first **cases of "non-openings" due to energy saturation problems** are beginning to be seen

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WHY DATA CENTERS ARE NOT AN EVOLUTION OF LOGISTICS AND THE ROLE OF TENANTS IN DRIVING DATA CENTER DEVELOPMENT

GIANLUCA METTI MRICS

Senior Project Manager, Starching SPA – Maestrale SRL

Agenda

What is a DC

People

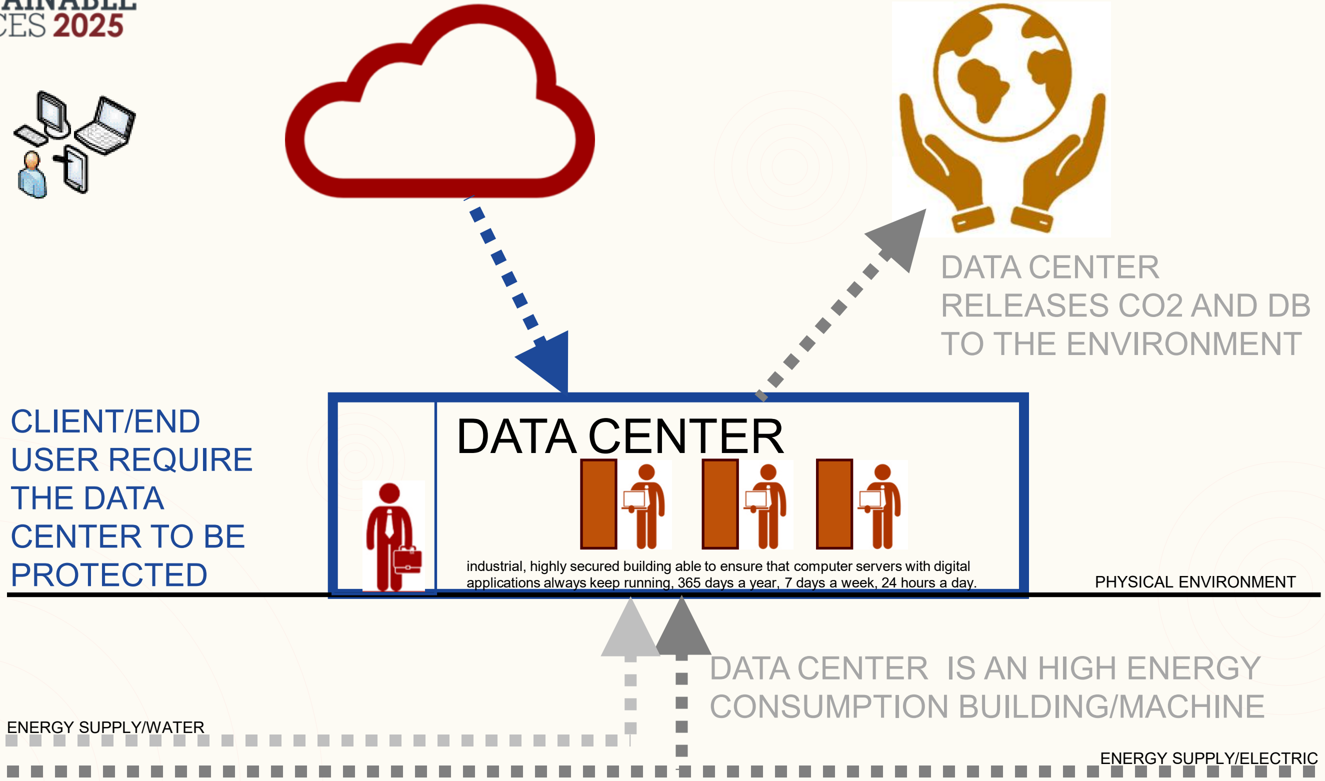
Critical Points

Design Process & Learning Curve

Design Review and QA/QC

What is a DC

WHAT A DATA CENTER IS?



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NOVOGRID

THE FUTURE OF DATA CENTERS

THE ROLE OF DATA CENTERS HAS UNDERGONE A SIGNIFICANT TRANSFORMATION. WITH THE RISE OF REMOTE WORK AND INCREASED MOBILITY, ORGANIZATIONS ARE NOW ACCESSING AND USING DATA IN NEW WAYS, PRESENTING STRUCTURAL CHALLENGES FOR TRADITIONAL DATA CENTERS. AS REMOTE AND HYBRID WORK MODELS BECOME THE NORM, THE DEMAND FOR SECURE AND RELIABLE DATA ACCESS HAS INCREASED. AS A RESULT, ORGANIZATIONS MUST ENSURE THAT THEIR DATA CENTERS CONSISTENTLY PROVIDE SECURE REMOTE ACCESS FOR EMPLOYEES/USERS. THIS REQUIRES A ROBUST AND ADAPTABLE INFRASTRUCTURE THAT CAN ADDRESS THE CHALLENGES OF REMOTE WORK, INCLUDING BANDWIDTH LIMITATIONS, CONNECTIVITY ISSUES, AND CYBERSECURITY THREATS.

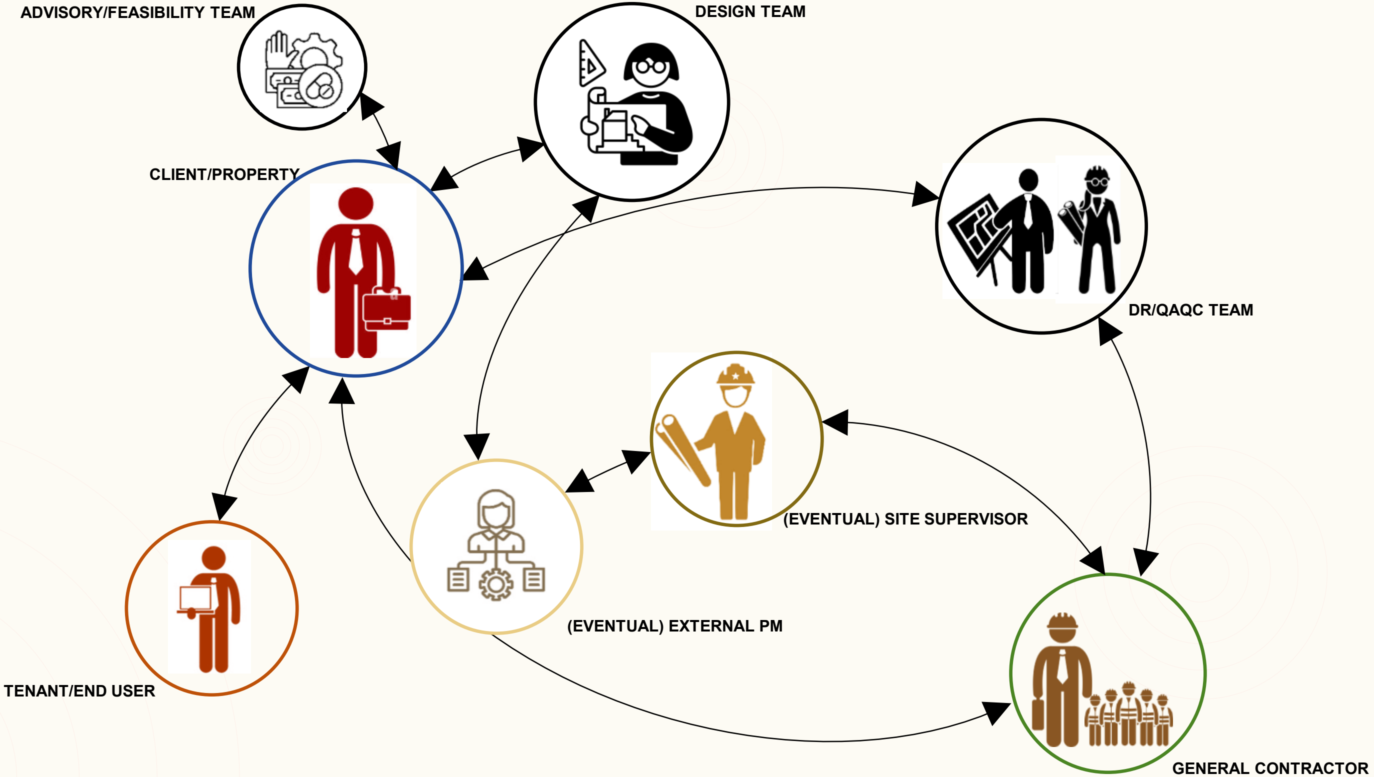
RAPID TECHNOLOGICAL ADVANCES, INCLUDING ARTIFICIAL INTELLIGENCE, "INTERNET OF THINGS" DEVICES, AND 5G, ARE PUSHING MODERN DATA CENTERS TO CONSUME UNPRECEDENTED AMOUNTS OF ENERGY. MCKINSEY PREDICTS THAT DEMAND FOR DATA CENTERS WILL RISE TO 35 GIGAWATTS BY 2030, A SIGNIFICANT INCREASE FROM 17 GIGAWATTS IN 2022. UNFORTUNATELY, TODAY'S ENERGY GRID IS NOT EQUIPPED TO MEET THE FUTURE NEEDS OF THESE DATA CENTERS, PARTICULARLY IN RURAL AREAS AND MANY INTERNATIONAL LOCATIONS. AS A RESULT, WE CAN EXPECT TO SEE A CONCERTED EFFORT TOWARD NETWORK MODERNIZATION IN 2025 TO ADDRESS THIS GROWING DEMAND.

THIS MODERNIZATION WILL REQUIRE THE CONSTRUCTION OF ADDITIONAL TRANSMISSION LINES, NEW SUBSTATIONS, AND BETTER COORDINATION OF DIFFERENT ENERGY SOURCES. FOR EXAMPLE, COMBINING RENEWABLE ENERGY SOURCES SUCH AS SOLAR WITH RELIABLE FOSSIL FUELS CAN IMPROVE ENERGY EFFICIENCY AND 24-HOUR RELIABILITY. IN FACT, MANY DATA CENTER DEVELOPERS ARE PARTNERING WITH RENEWABLE ENERGY COMPANIES TO TAKE ADVANTAGE OF THE NEED FOR LARGE AMOUNTS OF ENERGY FOR DATA CENTER OPERATIONS.

MAESTRALE

People

WHO ARE THE KEY PLAYERS



DC PROCESS DESIGN – FROM ADVISORY TO HAND OVER TO OPERATION

CONFIDENCE THROUGH STANDARD APPLICATION

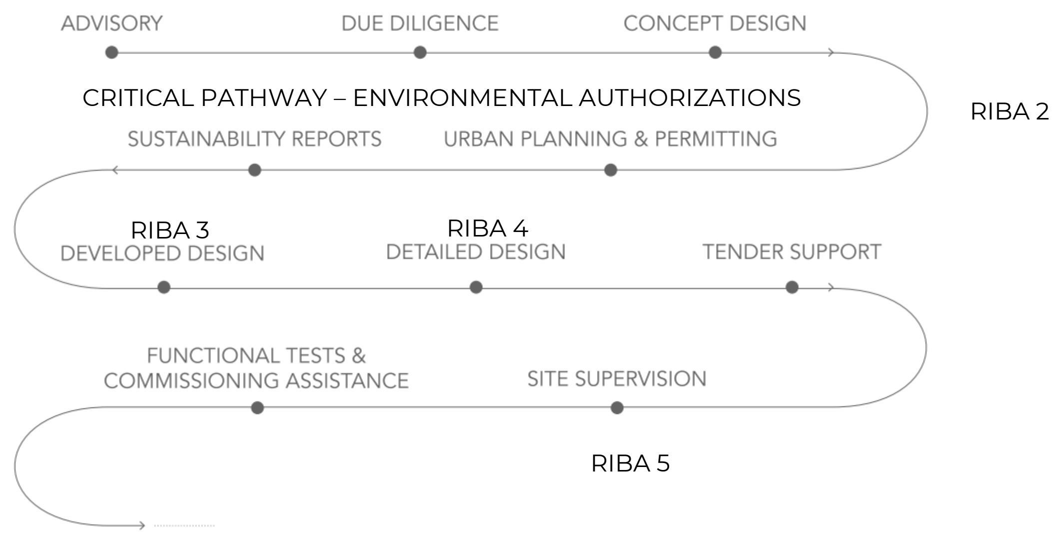
APPROACH TO THE CLIENT

TRUST: emphaty is the base to build up proficient relationship to a continuous improvement. For the Engineering supplier means: be involved day by day in the knowledge of the Company

INTEGRITY: separate in clearly way the role in the Project (Responsibility Matrix is one of the most important Project Management tools)

POTENTIAL CONFLICT OF INTEREST: don't accept any mission which could be in conflict with others Client or phase of the project (is you are Designer you can't accept Design Review at the same time)

STANDARD APPLICATION
OPR: Operation technical requirement by the Client
SOQ: technical specification submitted by the Tenant
The Game is respect all of them (Phase RIBA 2)



MAESTRALE

Critical Points

KPI TO EVALUATE ENERGY EFFICIENCY

Overall, a **lower PUE** signifies **higher energy efficiency**, showing that a greater portion of the consumed energy is being used directly for computing tasks, rather than going towards cooling systems, electrical losses, lighting, and other support infrastructure. Conversely, a **higher PUE** indicates **lower energy efficiency**, with more energy expended on non-computing functions.

PUE = (÷ Total Facility Power÷ IT Equipment Power) x 100%

DCiE = 1 ÷ PUE

PUE (Power Usage Effectiveness) and DCiE (Data Center Infrastructure Efficiency) are both metrics used to evaluate the energy efficiency of data centers. DCiE is the **inverse** of PUE and is expressed as a **percentage**. It quantifies the proportion of energy that is directly used by IT equipment out of the total energy consumed by a data center.

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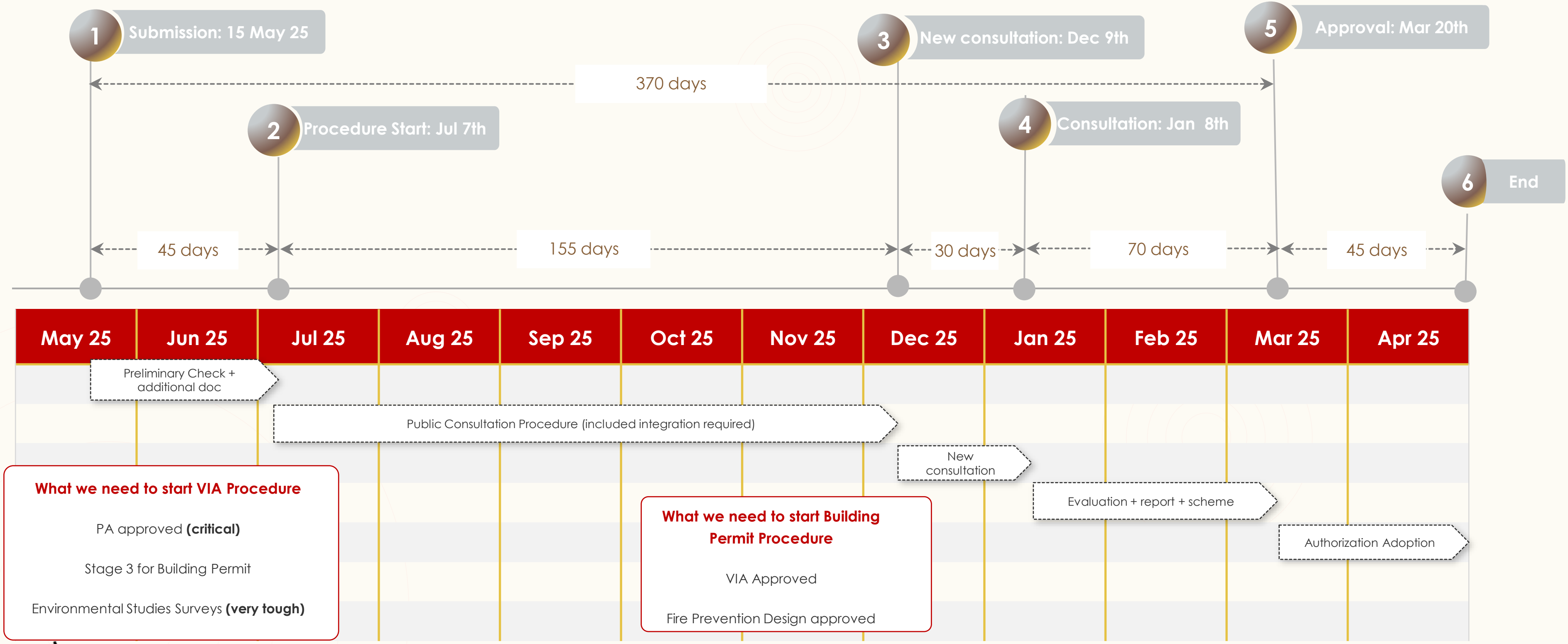
VIA PROCEDURE – EXAMPLE
WHAT IT SHOULD BE….BUT

VIA PROCEDURE – IN REAL WORLD 18 MONTHS….



MAESTRALE

Design Process & Learning Curve

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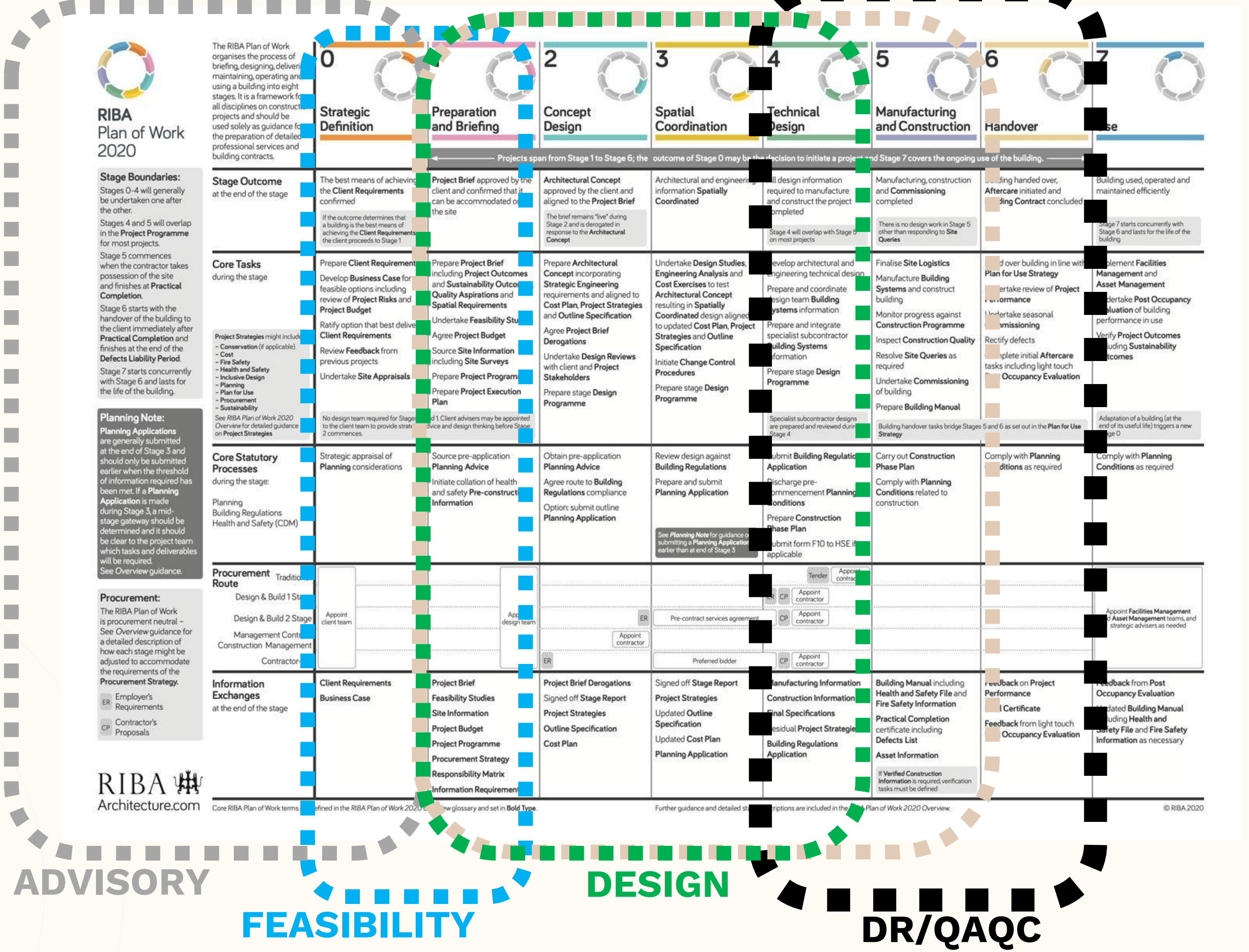
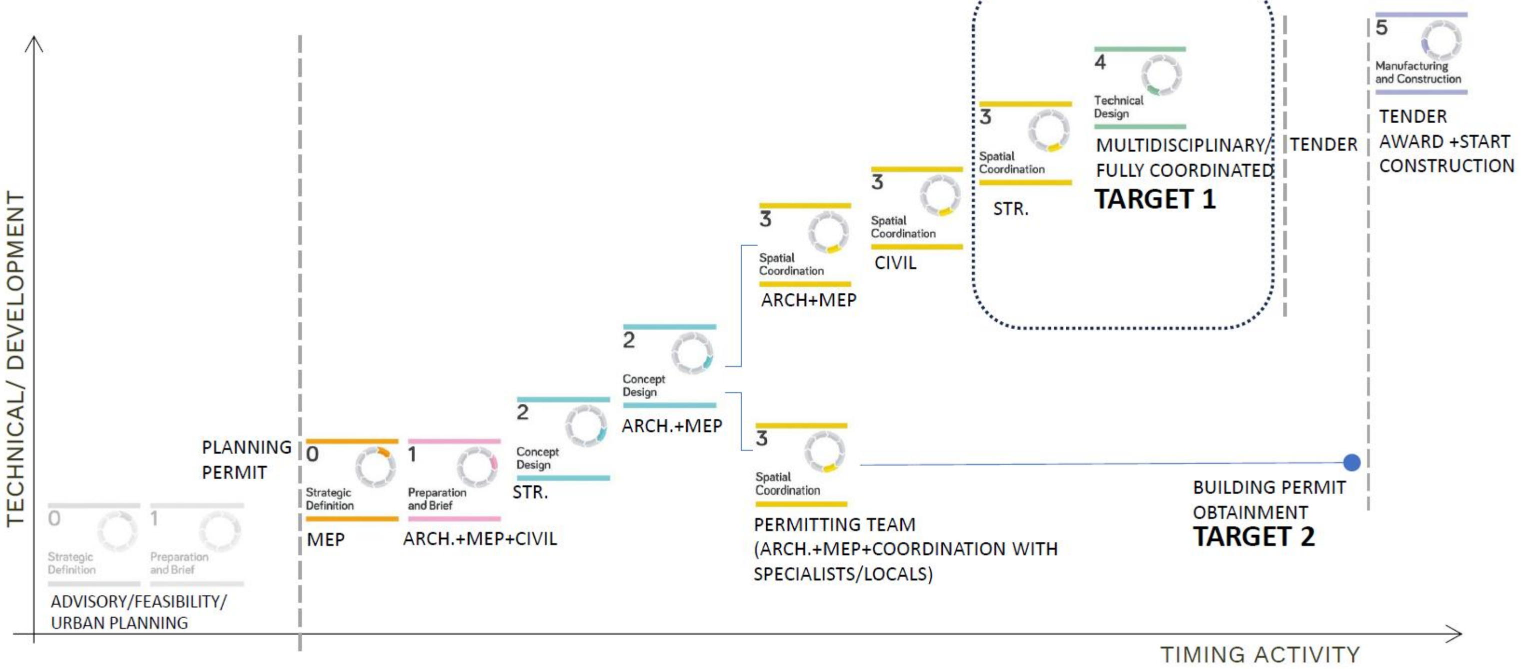
NB ACTIVITIES DURING THE DIFFERENT STAGES MAY OVERLAP DEPENDING IN DIFFERENT SOW, MARKETS, LEVEL OF COMPLEXITY DOCUMENT USED IN THE UK (AND EMEA) TO DESCRIBE THE STAGES IN DESIGN/CONSTRUCTION PROJECTS.



MAESTRALE

RIBA STAGES 0-4 WITHIN DATA CENTER ENVIRONMENT HAVE DIFFERENT IMPLEMENTATIONS/SPEED WITH REGARD TO THE SEVERAL DISCIPLINES



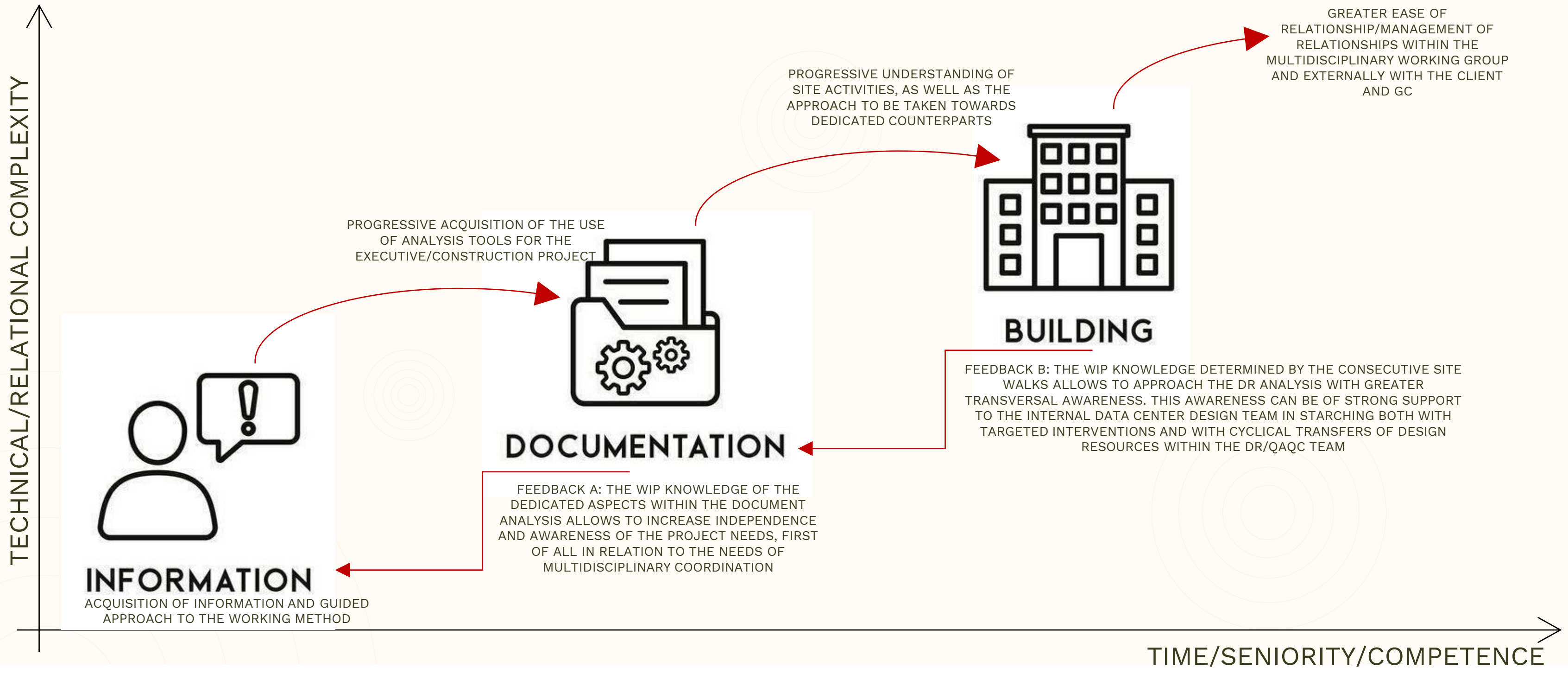
Design Review and QA/QC

DR/QAQC DEFINITION

DR (DESIGN REVIEW) is the process through which a dedicated consultant analyzes the construction design documentation (RIBA STAGE 5, or STAGE 4 depending on the tender package information being provided to the GC) delivered by the general contractor to the customer and verifies its compatibility in relation to the guidelines provided by the customer and the possibility of being used properly on site in order to correctly construct the building and guarantee its functionality within the times (RIBA STAGE 6/7) described in the procurement contract.

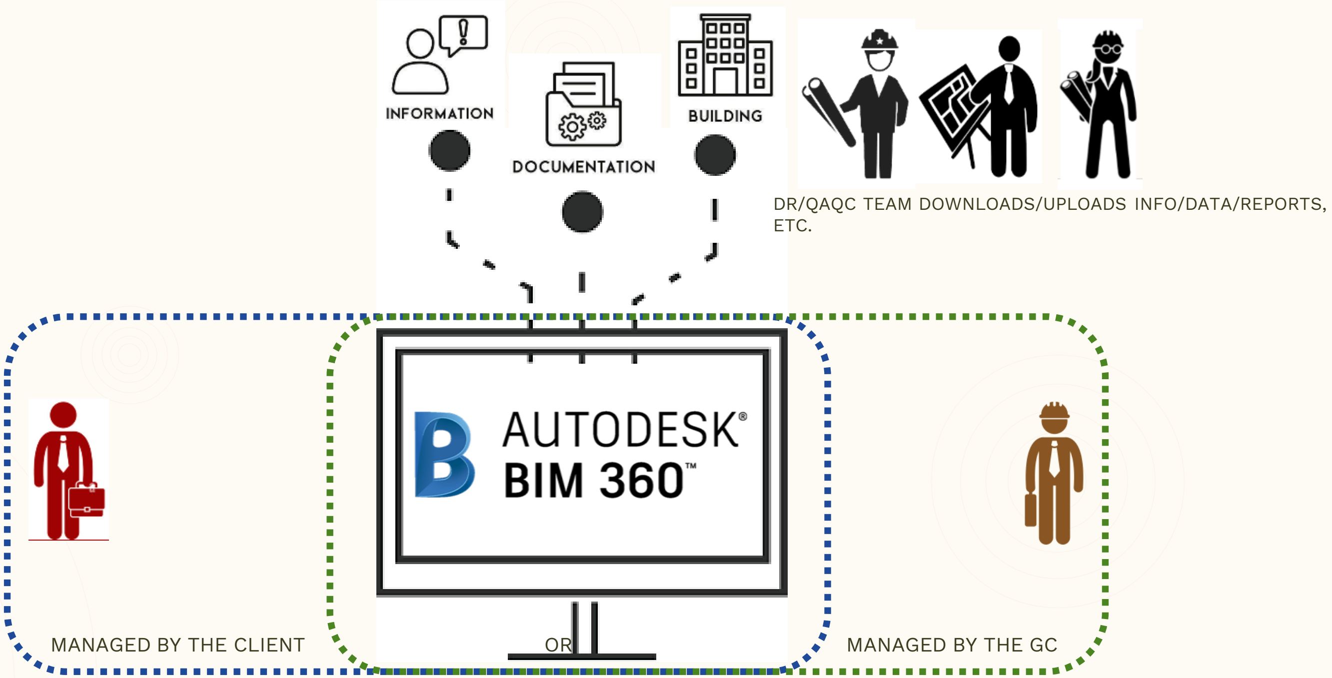
QA/QC is the combination of **quality assurance**, the process or set of processes used to measure and assure the quality of a product (the Data Center as building), and **quality control**, the process of ensuring products and services meet consumer expectations (as from provided guidelines).
"Quality assurance" is a process oriented and focuses on defect prevention (through design&docuentation check), while "quality control" is product oriented and focuses on defect identification (following site walks).

LEARNING CURVE WITHIN TEAM



THE DR/QAQC TEAMS USES A SHARED PLATFORM TO EXCHANGE INFORMATIONS

BIM 360 IS THE PLATFORM MOSTLY USED (THERE ARE OTHER ONES AS WELL, EQUIVALENT TO IT)



NEW KEY PERFORMANCE INDICATORS FOR DIFFERENT STAKEHOLDERS

MATTIA MARIANI

Vice-president Sustainability Group ITALIAN DATA CENTER ASSOCIATION
Unit Director Building Performance Group Deerns Italia

Background

European Green Deal

The European Green Deal is an ambitious strategy by the European Commission to make the EU the first climate-neutral continent by 2050.

Main objectives include:

- **Climate neutrality by 2050:** Reduce net greenhouse gas emissions to zero.
- **55% emission reduction by 2030**, compared to 1990 levels.
- **Circular economy:** Promote the reuse and recycling of materials.
- **Clean energy:** Transition to renewable and efficient energy sources.
- **Biodiversity:** Protect and restore natural ecosystems.

Ensuring the **SOCIAL** and **ECONOMIC SUSTAINABILITY** of the transition.

Background

EEED: Standard for Data Center Efficiency

Power Usage Effectiveness (PUE)

Calculation of PUE and verification vs limits

Heat recovery

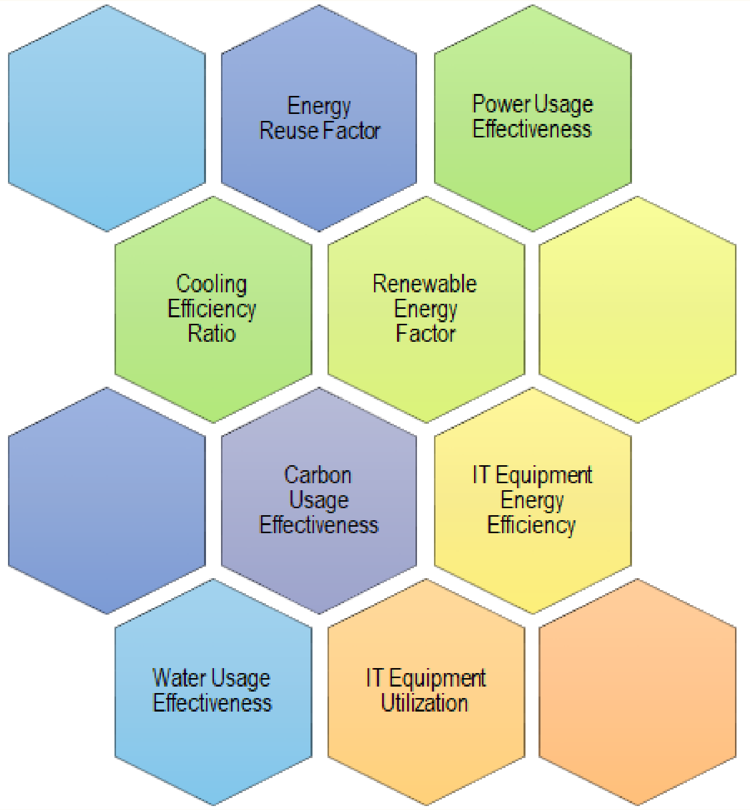
Support in feasibility study to avoid wasted energy

Energy Audit on regular basis

To monitor improvement options

Reporting

Mandatory annual reporting on energy performance



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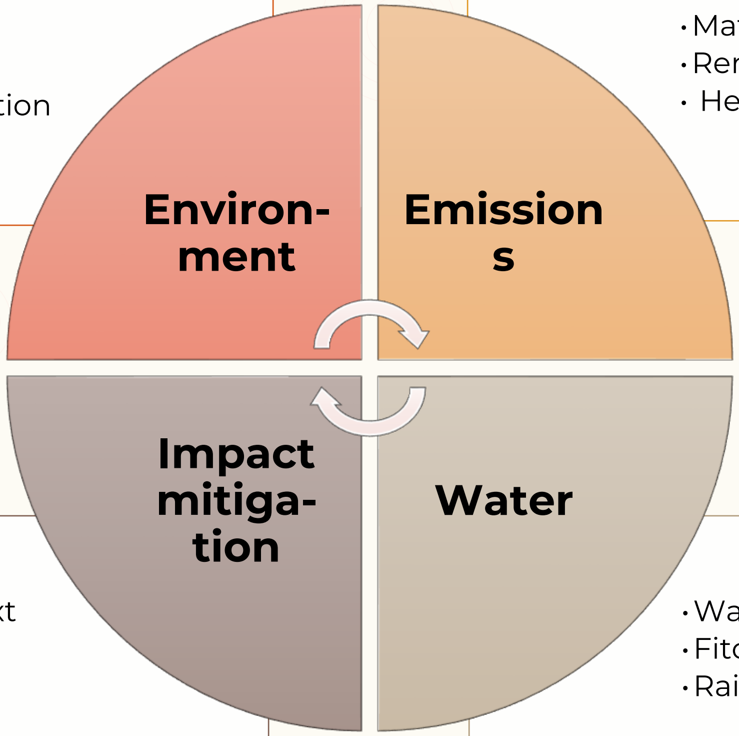
Requests from Public Authorities

Sustainability topics

- Green roof / green wall
- Local fauna protection
- Brownfield
- Heat island effect reduction
- Vegetation on site

- Circular Economy
- Material reuse
- Renewables on sites
- Heat recovery

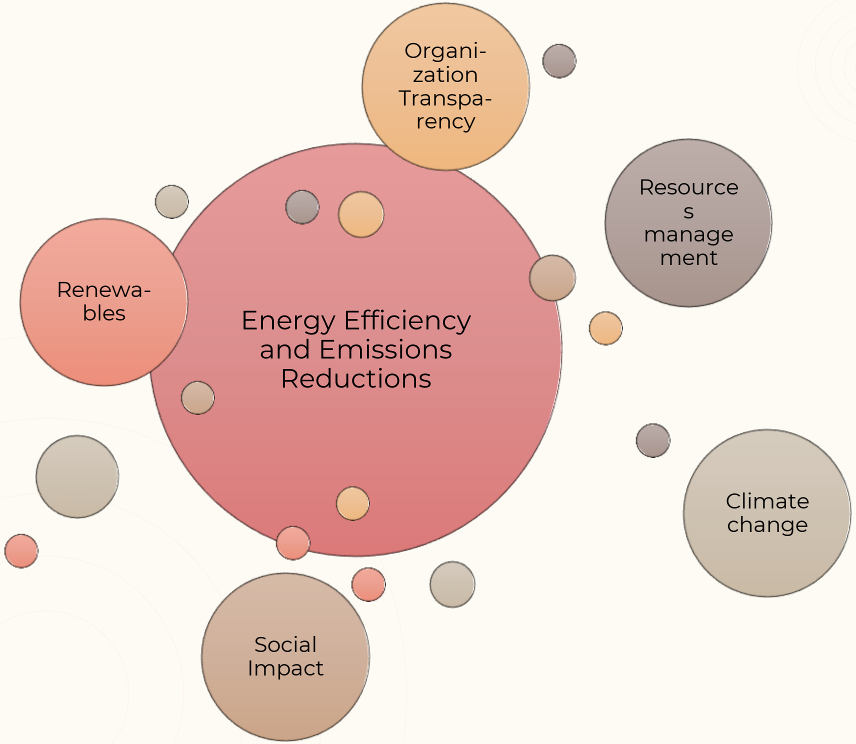


- Integration in the context (e.g aesthetic)
- Vegetation in the neighbourhood
- Noise and pollution

- Water reuse
- Fito-depuration of water
- Rainwater management

ESG

From IDA Working group Sustainability



ESG

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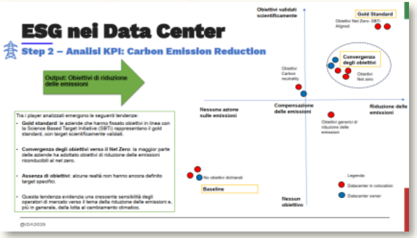
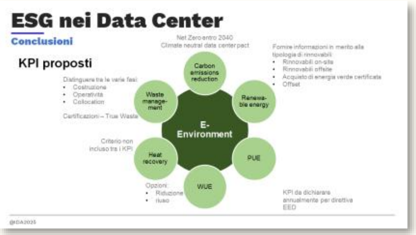
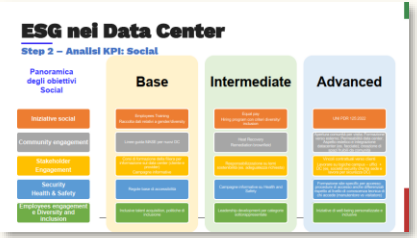
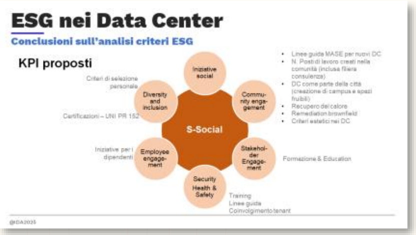
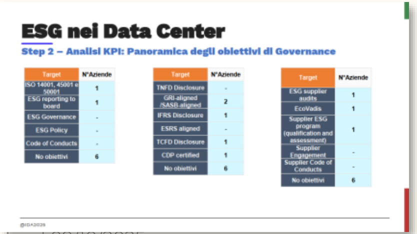
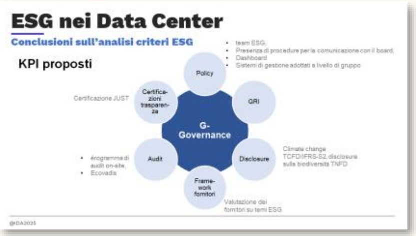






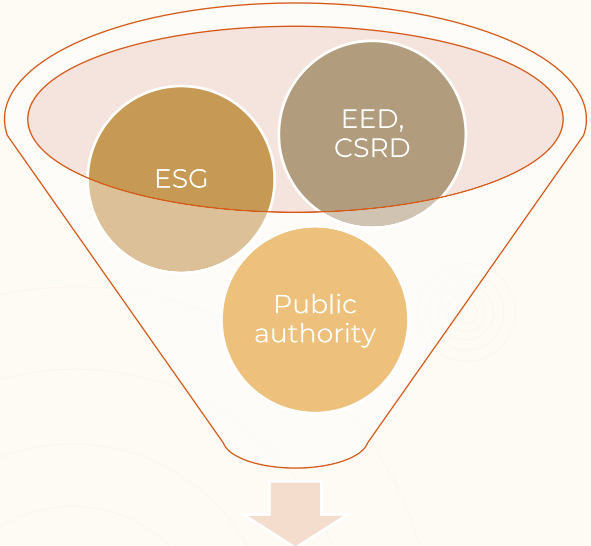




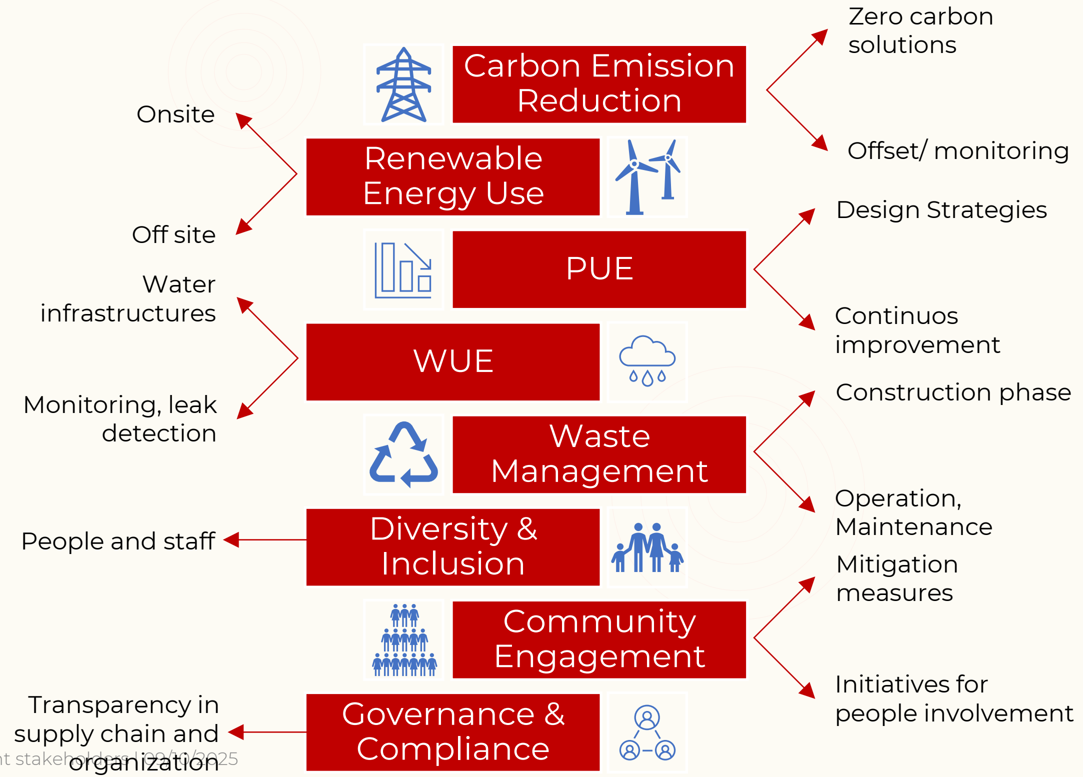


Outcomes

Key inputs for Design and Operation of a Data center



Design input: high efficiency, low emission, integration with community



Technology Block

Giuseppe Zummo (InQuattro) – Two-phase cooling solutions to increase efficiency and reduce consumption.

Alessandro Piccinini (IES/R2M Solution) – Applications of digital twins to support decarbonization processes.

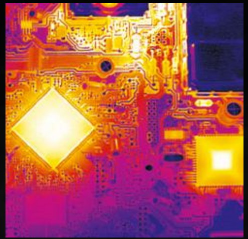
Luigi Filippo Borea (ICOPOWER) - Voltage Regulation, microinterruptions and Power Quality - Optimizing your Energy Flows"

Two-phase cooling solutions to increase efficiency and reduce consumption.

GIUSEPPE ZUMMO

CEO, INQUATTRO

Challenges in Data Centers



🔥 Power Density Crisis

AI processors are reaching 1000W+ per chip with extreme miniaturization, generating heat densities that traditional cooling systems simply cannot handle—we're hitting the physical limits of air and conventional liquid cooling.

⚡ Efficiency Gap

Standard cooling technologies force data centers to choose between performance, energy efficiency (PUE 1.5-2.5), and sustainability (high water usage)making advanced new cooling not just an option, but a necessity for next-generation AI infrastructure.

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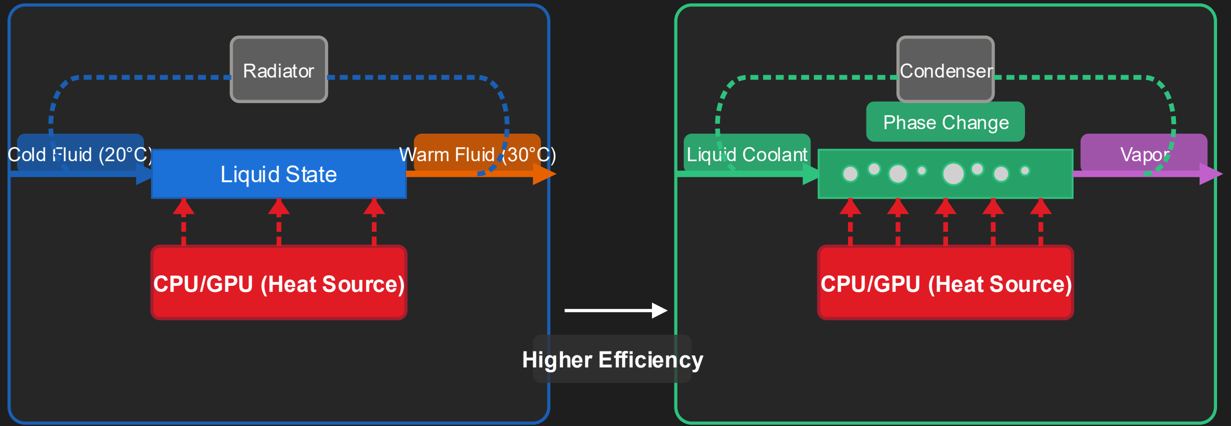
The Two-Phase Cooling Com

Solution

Single-Phase vs Two-Phase Cooling

Single-Phase Liquid Cooling

Two-Phase Cooling



Sensible Heat Transfer

- Coolant absorbs heat and increases in temperature
- Heat capacity limited by specific heat of fluid
- Requires higher flow rates for efficiency
- Typically supports up to 15-30 W/cm²

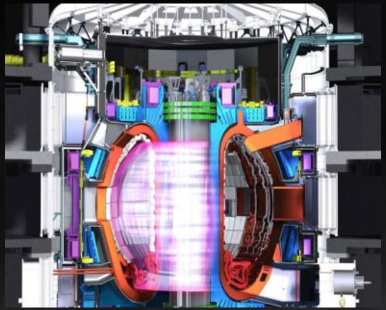
Latent Heat Transfer (Phase Change)

- Coolant absorbs heat and evaporates
- Phase change absorbs 5-10x more heat
- Lower flow rates with higher efficiency
- Supports up to 100 W/cm² heat flux

IN QUATTRO
The Two-Phase Cooling Company

Solution: Two-Phase Cooling System

High Efficiency Heat Transfer: Evaporative and Condensation



Advantages

- Thermal Power Density: +100 W/cm^2
- Dielectric Fluid (No Water)
- Eliminates the external cooling infrastructure: Chillers & Evaporative Cooling Towers
- AI processors ready
- Safety

Cooling Technology of Nuclear Reactors

High Power Electronics

IN QUATTRO
The Two-Phase Cooling Company

Efficiency of Two-Phase Cooling System

PUE- Power Usage Effectiveness

1.05 - 1.2
Two-Phase Cooling

VS

1.5 - 2.5
Traditional Cooling

Two-Phase Cooling Technology: Optimized for Efficiency

Two-Phase Cooling system uses 30-50% less electricity than traditional cooling, delivering major cost savings and environmental benefits.

Efficiency of Two-Phase Cooling System

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The Two-Phase Cooling Company

WUE- Water Usage Effectiveness

Two-Phase Cooling: Operates in Hot Climates

Two-Phase Cooling technology operates efficiently even in demanding environments, utilizing dry coolers in ambient temperatures as high as 45°C

IN QUATTRO
The Two-Phase Cooling Company

Two-Phase Cooling Solution

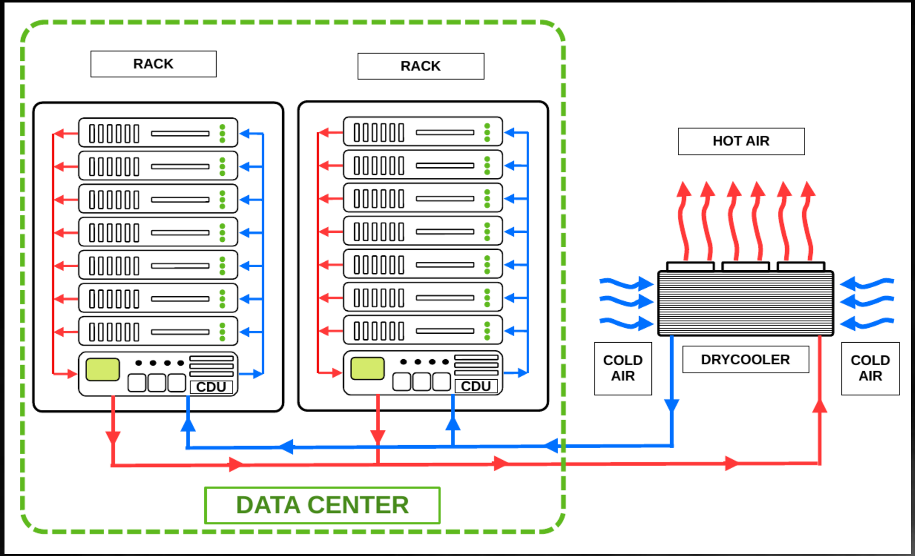
Data Center Infrastructure Simplification

ELIMINATED

~~Chillers~~

~~Cooling Towers~~

~~CRAC Units~~



Simplified Design: Fewer mechanical components reduce maintenance overhead

Lower Installation Costs: Reduced facility infrastructure requirements

Improved Reliability: Fewer points of failure in the cooling system

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The Two-Phase Cooling Company

Two-Phase Cooling Solution

COLD PLATES

CPU: +1000 Watt

GPU: +1000 Watt

Material: Aluminum

Patented Technology

Trade Mark: EvaCooling

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The Two-Phase Cooling Company

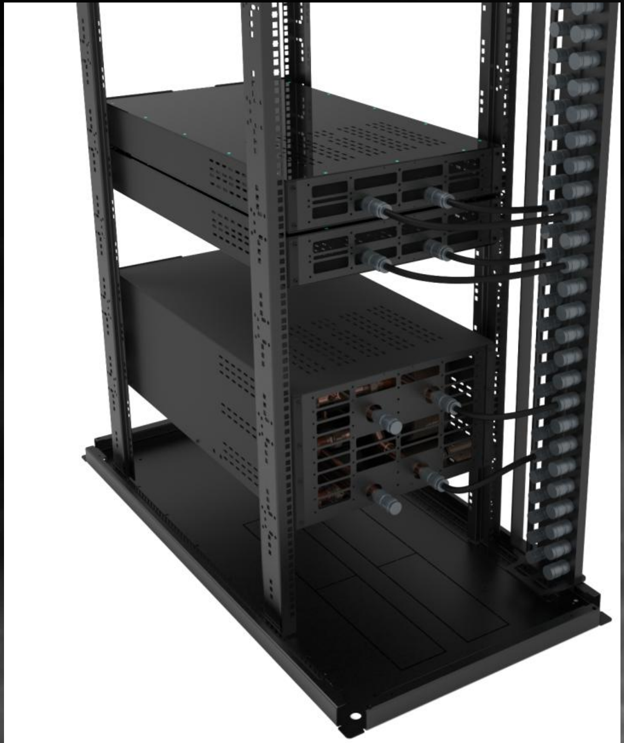
Two-Phase Cooling Solution

CDU: 15 KW, 30 KW, 50 KW, 100 KW

Facility Water: 45°C max

Cold Plate: Intel Xeon, Nvidia H100, GB200, etc.

Delivery: January 2026



IN QUATTRO
The Two-Phase Cooling Company

About Us

- 4 co-founders, researchers
- Patents in EU, Taiwan and US
- Cumulative +30 years of experience in two-phase flow systems: space, electronics, nuclear.
- Enea spin-off
- Legal Headquarter in Rome, Italy
- Operational Headquarter in Formello (Rome)
- ESA – Lazio Innova BIC Rome

IN QUATTRO
The Two-Phase Cooling Company

Team

G.Zummo, PhD Mec. Eng,
CEO, CTO and Co-founder

R. Perna, PhD Areonautics
Chief Operational Officer

F.Baldo, MBA, Ms Mech Eng,
Chief Commercial Officer

L. Saraceno, Thermal Engineer
Chief Product & co-founder ,

A. Di Giacomo, Phd
Student, Aerospace Engineer

A. Scotini,
Co-founder & Technician

F. Marozzi. Msc. Finance,
Chief Financial Officer

A. Tibuzzi, Phd
Elec. Eng,Investment Advisor
OBLOO VC

F. Riccardi, Phd student,
Thermal Engineer

F.Romanello
Electronic Engineer, & Co-
founder

C. Dumesnil,
Technician

L.De Felici, Phd
Student, Aerospace Engineer

THANK YOU!

Contact Giuseppe Zummo: g.zummo@in-quattro.com

THE TWO-PHASE COOLING COMPANY

www.in-quattro.com

www.eva-cooling.com

Applications of digital twins to support decarbonization processes.

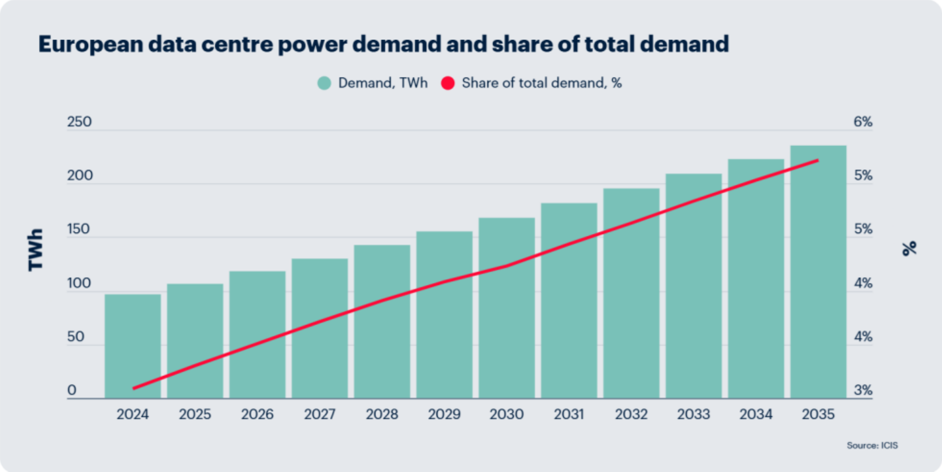
ALESSANDRO PICCININI

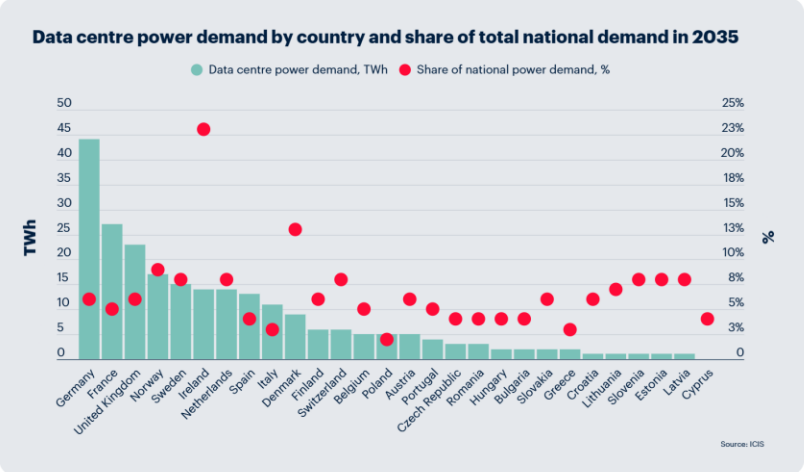
Energy Division Technical Manager - R2M Solution

Data Centers - Energy Impact

Current Consumption in EU	Projected 2035 Consumption in EU	**Net Increase in EU**
96 TWh/a (3.1% of total EU energy use)	**236 TWh/a** (5.7% of total EU energy use)	**+140 TWh** additional energy demand by 2035

Source: I.C.I.S. , Data centres: Hungry for power 2024





SUSTAINABLE PLACES 2025

R2M RESEARCH TO MARKET SOLUTION

Data Centers vs EPBD IV Targets: Energy Impact Comparison

Current Consumption in EU	Projected 2035 Consumption in EU	**Net Increase in EU**
96 TWh/a (3.1% of total EU energy use)	**236 TWh/a** (5.7% of total EU energy use)	**+140 TWh** additional energy demand by 2035

Source: I.C.I.S. , Data centres: Hungry for power 2024

Comparison with EPBD IV Challenge - Not Residential

Buildings in the EU currently consume ~4,200 TWh, with not-residential buildings using ~1,400 TWh.

Source: BPIE, EU Buildings Climate Tracker 3rd edition

2030 Target

Non-residential: 16% of worst-performing buildings renovated

Expected reduction if ZEB

~224 TWh

2035 Target

Non-residential: 20/22% of worst-performing buildings renovated

Expected reduction if ZEB

~280 TWh

Data Center net consumption increase: **50%** if worst building becomes ZEB — EPC G → A4

100% if upgraded EPC G → C

The R2M Digital Twin Approach

Urban/Portfolio Energy Modelling	Detailed Building Energy Modelling	Continuous Commissioning /Performance Monitoring

Urban/Portfolio Energy Modelling

- Use ICD & IVN to assess simulation potential
- Identify buildings needing most attention
- Estimate efficiency potential (for funding & planning)

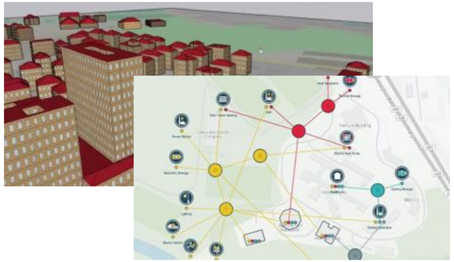
Detailed Building Energy Modelling

- Use VE for creating the Digital Twin
- Analyze in-depth scenarios with low uncertainty
- Explore innovative efficiency improvements

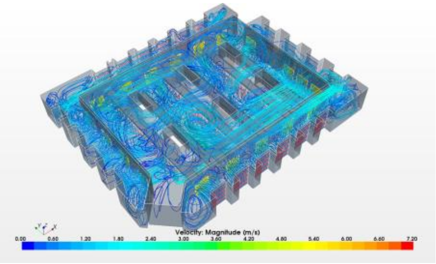
Continuous Commissioning /Performance Monitoring

- Monitor building/data center performance
- Detect anomalies
- Optimize operational efficiency continuously

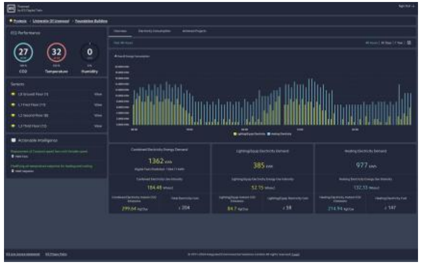
iVN
iCD
iCM



VE



iSC
LIVE

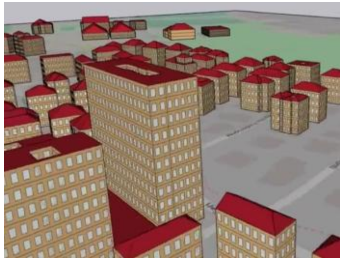


The R2M Digital Twin Approach

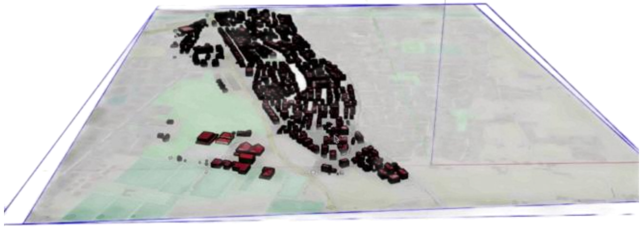
Urban/Portfolio Energy Modelling

iCD iCM

+DHC4Padova



Detailed **heating** and **cooling hourly demand** simulation with IES ICD



MAIN OBJECTIVES

GIS Mapping

GIS mapping identifies heat demand and sources.

Energy Model Assessment

Detailed assessment of heating and cooling needs (IES ICD)

Techno-Economic Evaluation

Techno-economic evaluation for energy solutions using District HC.

Climate Goals

Supports Padua's 2030 climate neutrality goals.

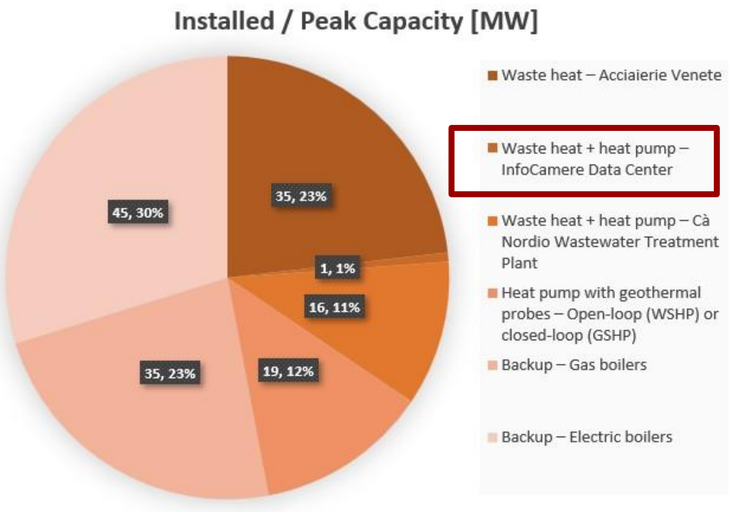
SUSTAINABLE PLACES 2025

The R2M Digital Twin Approach

Urban/Portfolio Energy Modelling

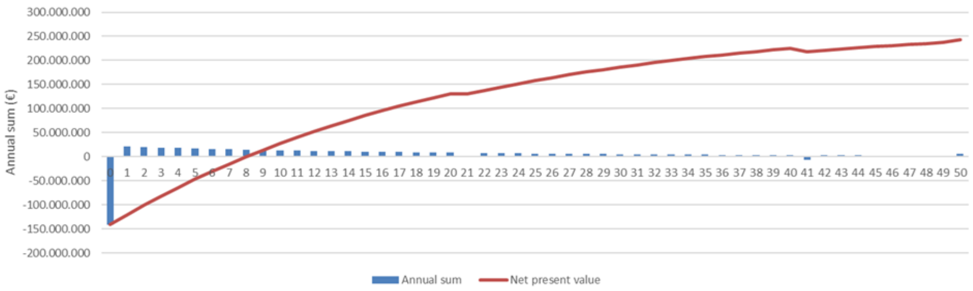
iCD iCM

+DHC4Padova



2-ZIP SUD -3GDH-2025 - WH - WSHP

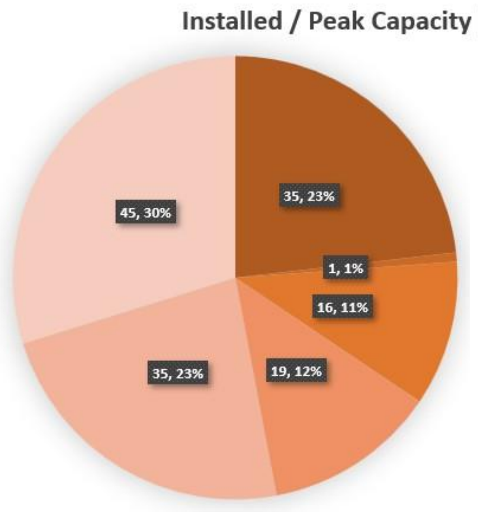
- **58,000 tCO_2/year** (–88% compared to gas boilers)
- **Average payback** 10–12 years
- **1.3 million m² of buildings** served across the 4 pilot districts



The R2M Digital Twin Approach

Urban/Portfolio Energy Modelling

+DHC4Padova



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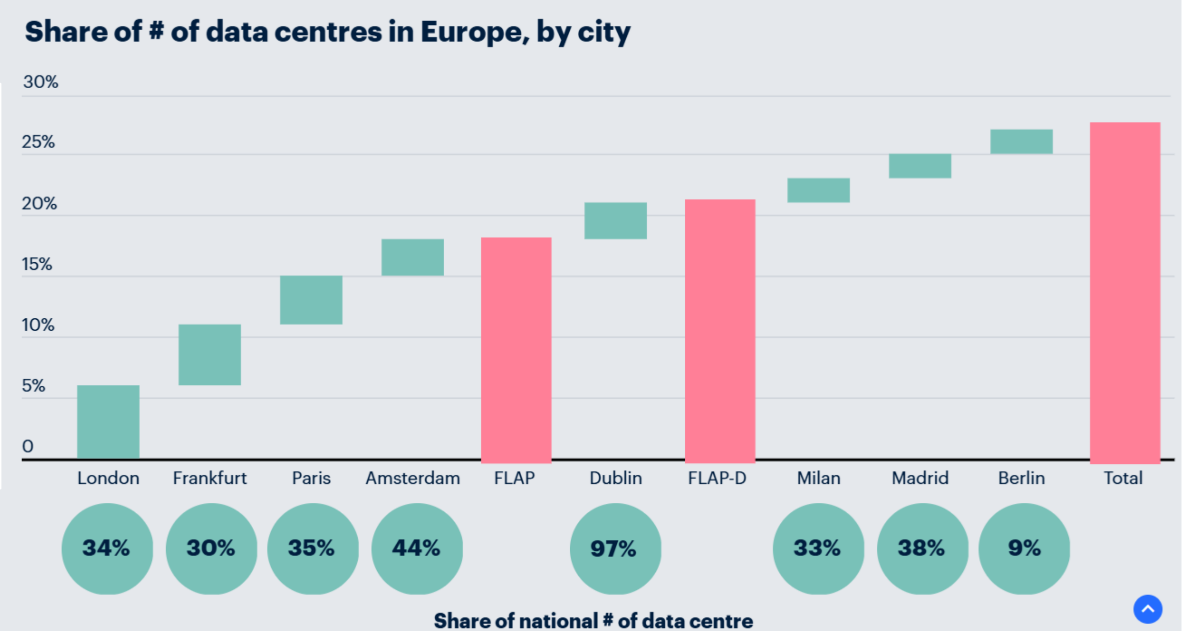


The R2M Digital Twin Approach

Urban/Portfolio Energy Modelling

EPBD Ready - Compilance Report

EPBD Ready Reports

Produce an **"EPBD Ready" report** from dynamic simulations and high-fidelity building models to assess compliance and pinpoint regulatory risks.

Energy Scenarios & Costs

Energy scenarios and costs define the path to EPBD compliance and estimate the energy class, the savings and associated financial KPIs.

Quarterly updates ensure ongoing alignment with evolving regulations.

RIF.	ITEM	RISK	NOTE	AZIONI CONSIGLIATE
Art. 5	Involucro	basso	Adozione requisiti minimi per sostituzione o rinnovamento	check su scenari di efficientamento
Art. 9	Soglia minimia	alto	Baseline dati 2020 Soglia 16% al 2030 Soglia 26% al 2033	Monitoraggio normativa nazionale per calcolo base dati (classi a rischio dalla D/E alla G)
Art. 10	Obbligo FV	medio	non residenziali+sup>500 mq.+ristrutturazione	Pianificare installazione FV entro 31/12/2027
Art. 14	Punti di ricarica	medio	In caso di ristrutturazione importante+5 posti auto	Punti di ricarica, pre-cablaggio, posti bici
		alto		

The R2M Digital Twin Approach

Detailed Building Energy Modelling

ESA Madrid

LEED Dynamic Energy Model

R2M has successfully completed the LEED Gold certification for the building housing ESA Madrid's Data Center.

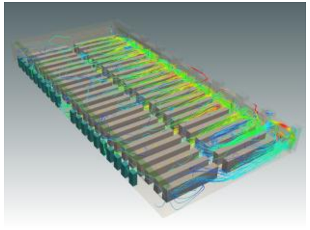
Energy Type	Units	Proposed Design		Baseline Design		Percent Savings	
		Energy Use	Cost (€)	Energy Use	Cost (€)	Energy Use	Cost
Electricity	kWh	2,150,344.95	144,073.12	2,382,480.93	159,626.24	9.74	9.74
Gas	kWh	4,397.08	379.91	123,715.41	10,689.02	96.45	96.45
Subtotal (Model Outputs):		2,154,742.03	144,453.03	2,506,196.34	170,315.26	14.02	15.18

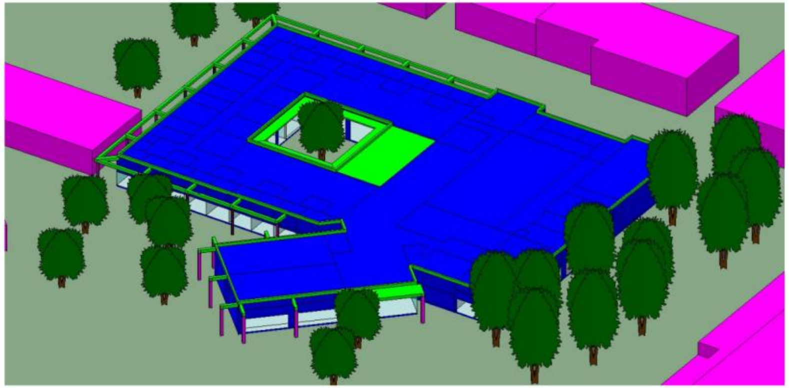
On site Renewable Energy	Energy Generated (kWh)	Renewable Energy Cost (€)	Narrative
Photovoltaic Panels	430,291.32	-28,829.53	Generated from source
Wind Power	0.00	0.00	Generated from source
Solar Water Heating	0.00	0.00	Generated from source
Combined Heat and Power (electricity)	0.00	0.00	Generated from source

Exceptional Calculations	Energy Savings	Cost Savings	Narrative

Summary	Units	Proposed Design		Baseline Design		Percent Savings	
		Energy use	Cost (€)	Energy use	Cost (€)	Energy use	Cost
Total	kWh	1,724,450.71	115,623.50	2,506,196.34	170,315.26	31.19	32.11

Percent Savings	
Energy use	Cost
31.19	32.11





KEY FACTS

32%

Cost Savings

31%

Energy Savings

13

Point

2600

sqm

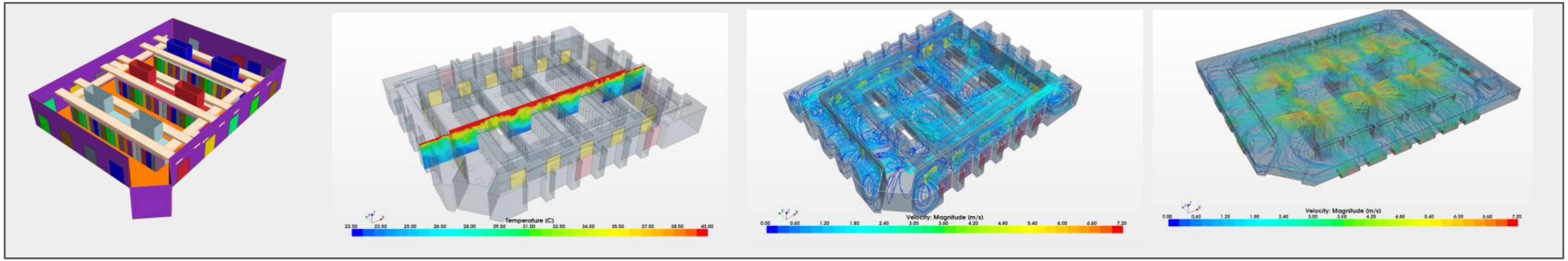
The R2M Digital Twin Approach

Detailed Building Energy Modelling

VE

Central Bank of Oman Data Center

CFD Analysis



IES Consulting used CFD to investigate the ventilation system performance inside the data centre at the Central Bank of Oman.

Airflow impact analysis

Building type: Data Centre

The R2M Digital Twin Approach

Continuous Commissioning /Performance Monitoring

Integrating **real-time data** with IES simulations via **IPMVP Option D** allows direct comparison of **actual and simulated consumption**, enhancing **anomaly detection** and enabling **continuous energy optimisation**.

The R2M Digital Twin Approach

Continuous Commissioning /Performance Monitoring

iSC LIVE

Real-Time Data

Operational consumption captured from building systems and metering infrastructure

IES Simulation

Physics-based energy modelling calibrated to building characteristics

IPMVP Option D

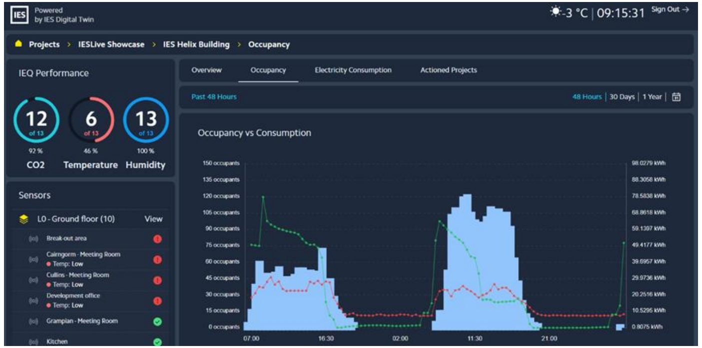
Comparison of Real Time Data With IES Simulation

Optimisation

Enhanced anomaly detection and continuous performance improvement

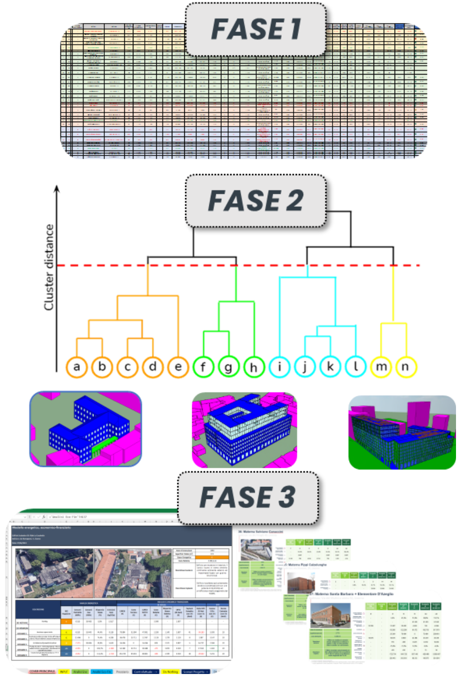
Key Benefits

- Automated variance detection between predicted and actual performance
- Rapid identification of operational inefficiencies
- Quantifiable energy savings verification
- Compliance with international M&V protocols



The R2M Modelling Experience – Available to Everyone

- Database of building **archetypes** and **climate zones**
- **Advanced clustering** to identify representative buildings
- Dynamic **modelling and calibration** using **IES-VE**
- **Quick Simulation results**



Analyzed Archetypes

- E1 Residential
- E2 Offices
- E3 Hospitals
- E4 Recreational
- E5 Commercial
- E6 Sports
- E7 Schools
- E8 Industrial
- E9 Datacenter

The R2M Modelling Experience – Available to Everyone

Web Interface

Users input required building parameters. Three precision tires are available

API Connection

Secure connection will be established to proprietary server

AI Data Cleaning AI

Algorithms verify and complete data

Auto Cluster Assignment

Building is algorithmically assigned to the most appropriate cluster Dynamic model

Results Delivery

Data-driven dynamic energy simulation outputs with energy and economic-financial KPIs for informed decision-making.

SUSTAINABLE PLACES 2025

IES

R2M RESEARCH TO MARKET SOLUTION

The R2M Modelling Experience – Available to Everyone - CASE STUDY

MAIN OBJECTIVES

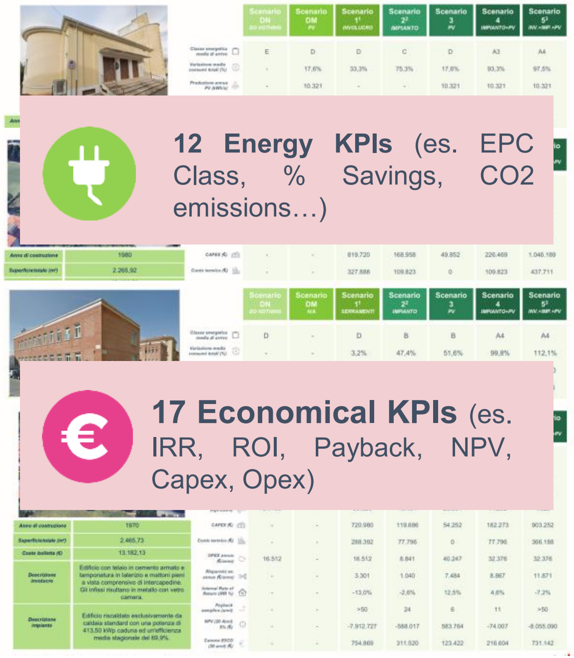
Support an italian Region:

- **Identify energy efficiency measures** to implement in order to adapt buildings to regulatory requirements
- **Develop economic-financial evaluation** that supports the Administration in strategic evaluations.[1]

#1000 Schools

Area: 2.000.000 m² total

Total Energy Consumption: 100 GWh/anno [2]



12 Energy KPIs (es. EPC Class, % Savings, CO2 emissions…)

17 Economical KPIs (es. IRR, ROI, Payback, NPV, Capex, Opex)

Analysis result for each building

Average error <10%

Compared to Standard simplified Energy audit

For each category or archetype, the overall result

Join Our Stepwise Decarbonisation Planning Workshop

When

10 October 11:00 - 13:00

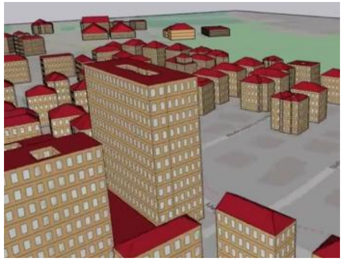
Where

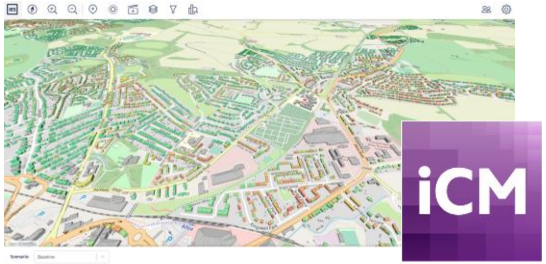
Room 5

What is Step-WISE?

Step-WISE is a European programme aimed at promoting **free training sessions** for local authorities and energy consulting companies in the development of **decarbonisation plans** using the **Step-WISE Toolkit**

Learn to develop comprehensive decarbonisation plans using **the IES-ICL Tool**





Join the project

Fill out the form!

Voltage Regulation, Microinterrumptions and Power Quality - Optimizing your Energy Flows

Luigi Filippo Borea

CEO Icopower S.r.l.

Energy efficiency:

Energy efficiency means using less energy to perform the same task or produce the same result

Power quality:

Power quality refers to how well electrical power supports the proper operation of equipment.
It involves maintaining stable voltage, frequency, and waveform without distortions or interruptions

Voltage Regulation and Microinterrumptions (AKA micro outages)

POWER QUALITY PROBLEMS

COSTS INCREASE

Spain power outage struck (28 April 2025)

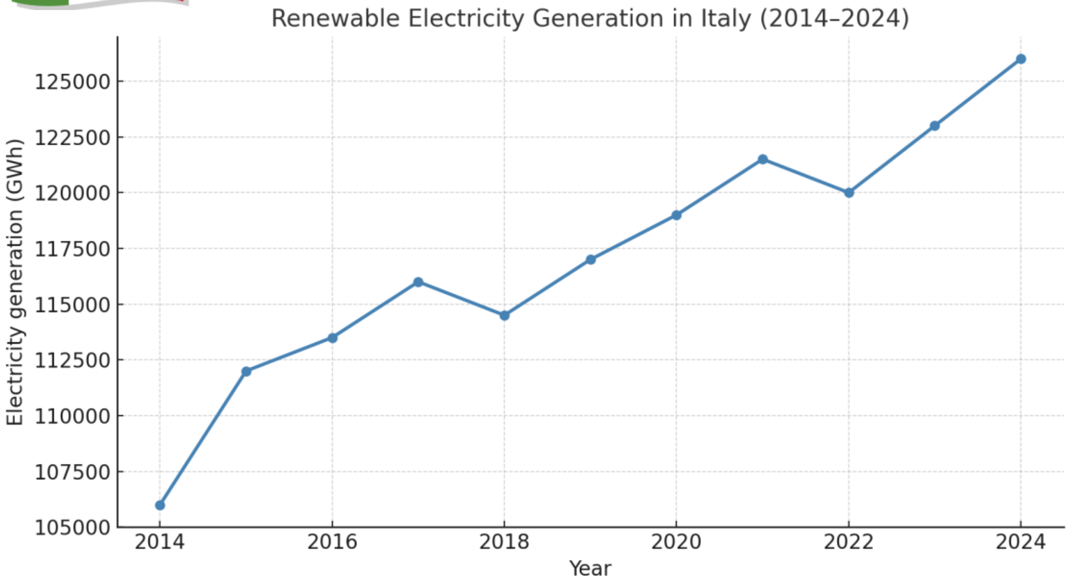
On **28 April 2025 at 12:33 CEST**, a massive power outage struck the Iberian Peninsula, affecting mainland Spain, Portugal, Andorra, and parts of southwestern France.

The blackout resulted from a sudden loss of approximately **15 gigawatts** of generation within about **5 seconds** — roughly 60 % of the grid's load.

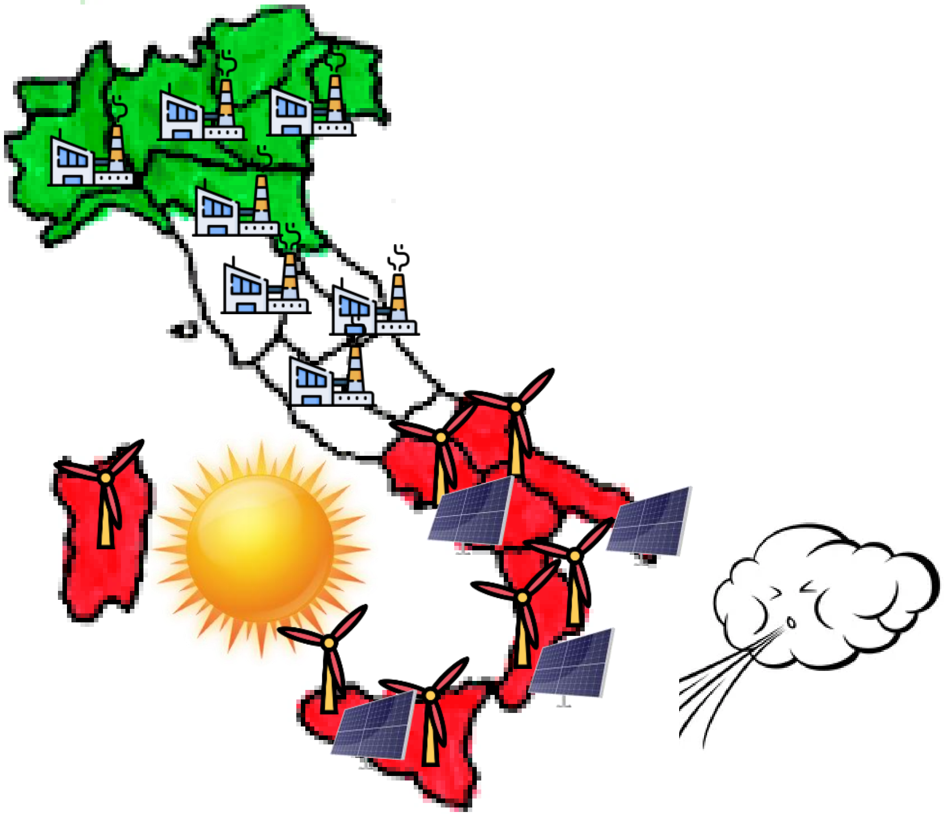
Many sources report that the blackout lasted **about 10 hours.**

The Spanish business lobby (CEOE) estimated that the blackout would have reduced Spain's GDP by **1.6 billion euros**

One of the reasons: grid instability



What happens in Italy



1) Energy transportation problems
2) Supply instability

SUSTAINABLE PLACES 2025

ICOPOWER® BEYOND ENERGY SAVING TECHNOLOGIES

What is Terna (Italy’s power grid operator), doing

Terna’s **2025-2034 Development Plan** envisages **over €23 billion** in investments over the next 10 years to upgrade the national transmission grid.

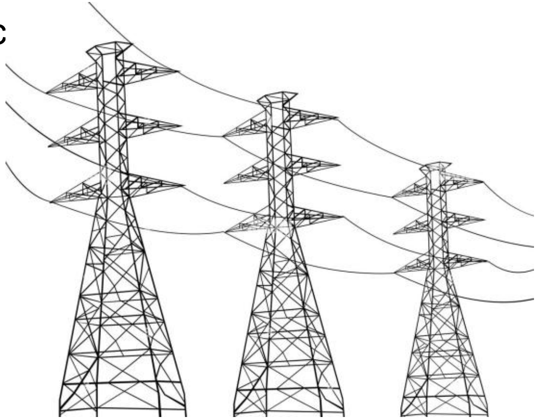
These investments will target several major areas:

•Construction of high-voltage direct current (HVDC) lines and submarine c

•Increasing capacity for energy exchange between different market zones

•Resolving grid congestion.

•Integrating more renewable energy sources into the grid.



Consequences

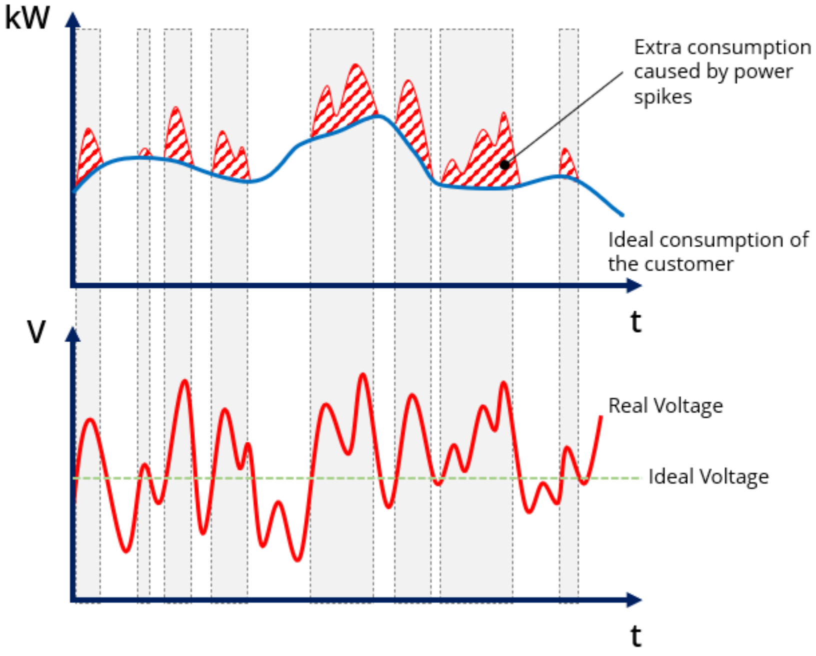
The increase in electrical energy supplied by renewable sources, combined with the need to transport this energy, will make the power grid much more unstable and cause voltage levels to rise.

This will mean an increase in electric waste (and therefore costs) and a rise in power quality issues (further costs).

Opportunity: Voltage Optimization

The electricity power grid generally fluctuates according to the user’s consumption and it is normally higher than what is required.

Power spikes can cost to companies in the form of damage and waste of electricity (the so-called “power loss").



How can you solve it? Voltage Optimizers

Optimizing the power consumption to only allow the necessary energy for the equipment to work, so eliminating waste, could mean a **reduction of consumption around 4% - 6%**

Another problem: Power micro-outages (AKA «*short power interruptions*» or «*micro interruptions*»)

Momentary (or short) power interruptions are brief losses of electrical power supply often caused by faults, switching operations, or disturbances in the power grid.

Duration: usually less than one second

Causes: temporary faults, protection system operations, lightning, or switching in the electrical network.

Effects: may cause electronic devices to restart or disturb sensitive equipment.

SUSTAINABLE PLACES 2025

An idea of what it means
A case study

ICOPOWER
BEYOND ENERGY SAVING TECHNOLOGIES

- Company specialized in tomato processing
- More than 5 micro outages per day
- Continous production downtime. Each time all the products must be thrown because of sterilization issue
- Damages for thousand euros eache time

The solution: micro outages compensator

How does it work?

- It continuously monitors the input voltage, remaining ready to intervene if a voltage drop occurs below the tolerance limits.

- In the event of a micro-interruption, it reacts in less than 5 ms

- When the mains voltage returns, the static switch closes again, restoring power supply from the grid and recharging the supercapacitor battery.

Final considerations

Many problems (that will increase)

… but there are also solutions!

Luigi Filippo Borea

FILIPPO.BOREA@ICOPOWER.COM

02 - 36631400

COFFEE BREAK

R&D Block – Key Results from EU Projects

Marcello Aprile (PoliMI, HYCOOL-IT) – High-efficiency cooling technologies to reduce energy consumption and emissions.

Yannick Krabben (MODERATOR Project) – Integration of immersion cooling, advanced thermal storage, and innovative insulation to maximize waste heat recovery.

Attila Moró t z - (HeatWise) – Heat Marriage: Thermal Connection of Data Centers and Building

Robert Birke (Dyman | Università degli Studi di Torino**) -** Dynamic maged self-cooling HPC Data Centers

Efficient thermal management of IT server rooms in tertiary buildings

MARCELLO APRILE

Politecnico di Milano

Hycool-it overview

HYCOOL-IT aim is to develop a set of processes supported by both **digital** and **technical equipment** innovative solutions for an efficient and reliable development of **IT Server Rooms for advanced tertiary buildings**, with a special focus on its replicability through **standardisation**

Small data centers (100 kW) in tertiary buildings (e.g., Hospitals, Universities):

a) Quite common in EU (25 racks on average)
b) Energy intensive (peak power & operational time)
c) Conventional CRAC system is not the most efficient solution (PUE 1.5 ÷ 1.8)
d) Available waste heat normally not recovered / exploited

Key objectives of Hycool-it

- **Building Digital Twin (BDT) PasS** solution to optimize design, operation and maintenance of advanced server rooms, including waste heat recovery, following a standardized approach for energy modelling (**SimBOTs**)

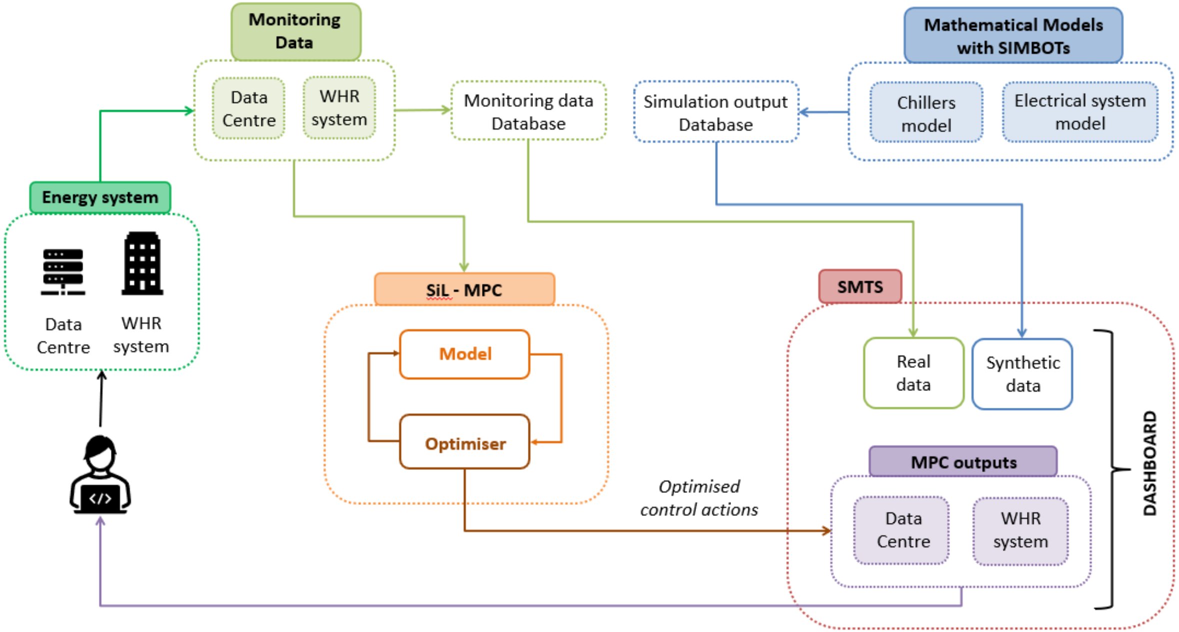
- Innovative **Rack-Integrated Adsorption Chiller** to cool liquid-cooled servers and provide free air-conditioning to the server room and waste heat for later use (DH)

- Validation in laboratory and real operating conditions (Polimi Bovisa Campus)

- Engineering guidelines, standards, business models for market replicability

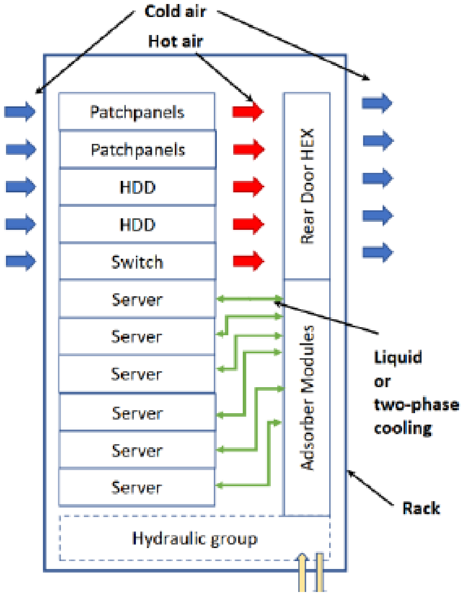
Key results: Building Digital Twin PaaS

- BDT is key to generate baselines and forecasting to support designers in the design phase, choosing the best design option and for maintenance engineers to enable performance contracting to realise the KPI's

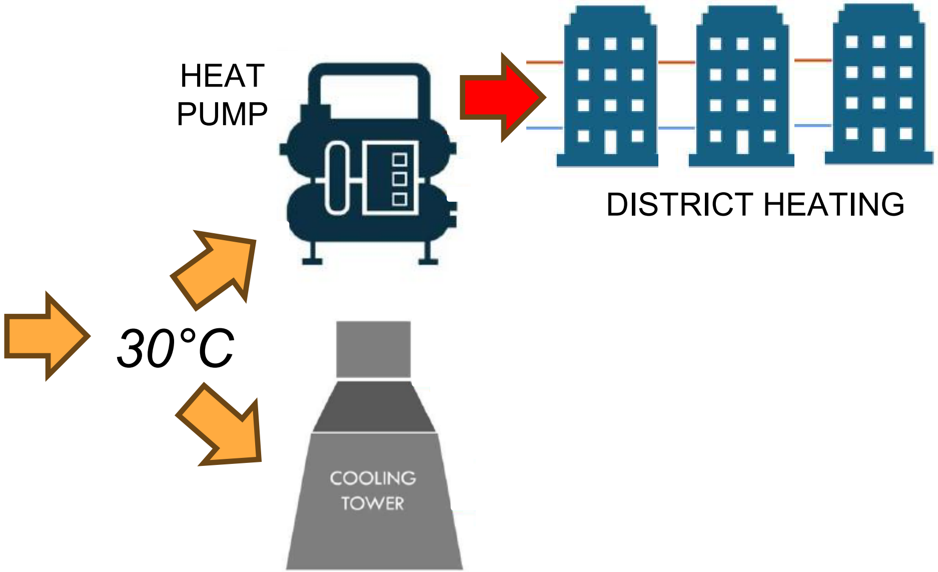


Key results: Rack-integrated Adsorption Chiller

- Rack-integrated adsorption chiller for waste-heat powered server cooling is developed and optimized to carry out efficient liquid cooling of IT servers and, simultaneously, provide cooling to the server room itself in a compact, self-contained, and cost-effective way



$PUE \cong 1.1$



Key results: pilot building @Polimi

- Renovation of server room and its cooling system (in-row coolers, chillers, BDT for commissioning and operational optimization) including waste heat recovery for building space heating

Server room
32 racks (100+ kWe)
12 in-row coolers

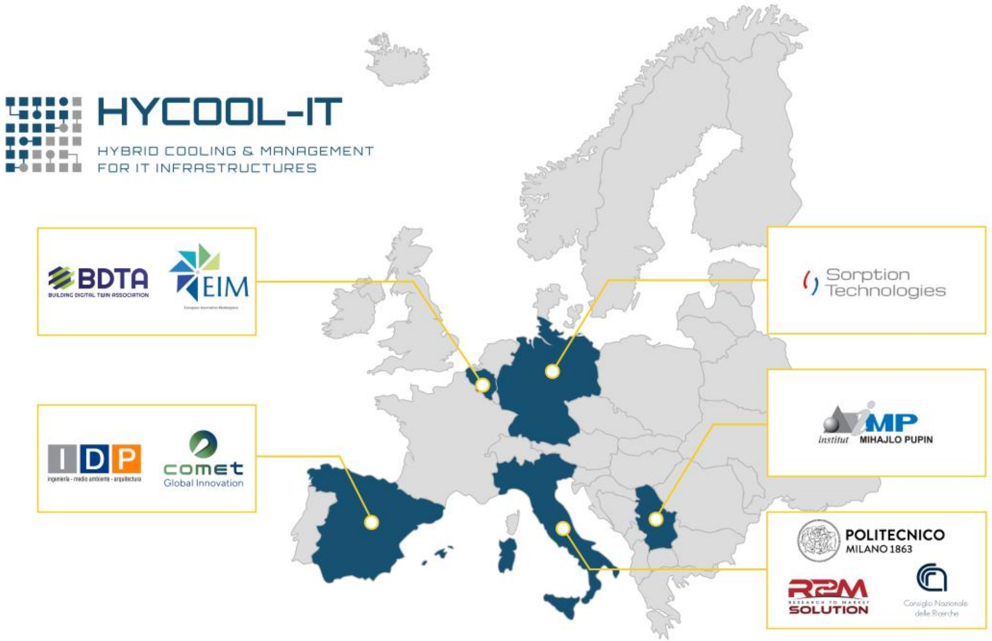
Cooling plant
2 large chillers with free cooling
1 emergency generator

University building
2 large boilers for SH
1 heat pump (140 kWth), using the cooling plant chilled water as heat source

SUSTAINABLE PLACES 2025

Hycool-it consortium

Hycool-IT is a 3-year research and innovation project involving 9 partners from 6 European countries



[What is HyCool IT?](https://hycoolit-project.eu)
Visit https://hycoolit-project.eu

Thank you

Contact details
www.hycoolit-project.eu
marcello.aprile@polimi.it

SUSTAINABLE PLACES 2025

R2M RESEARCH TO MARKET SOLUTION

Comune di Milano

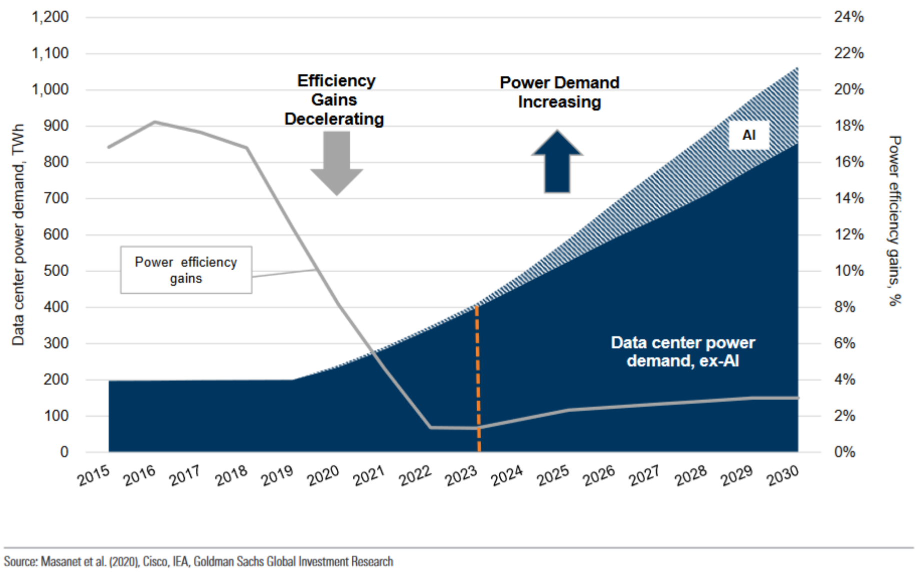
Turning Waste into Value: MODERATOR’s approach to Heat Recovery in Data Centres

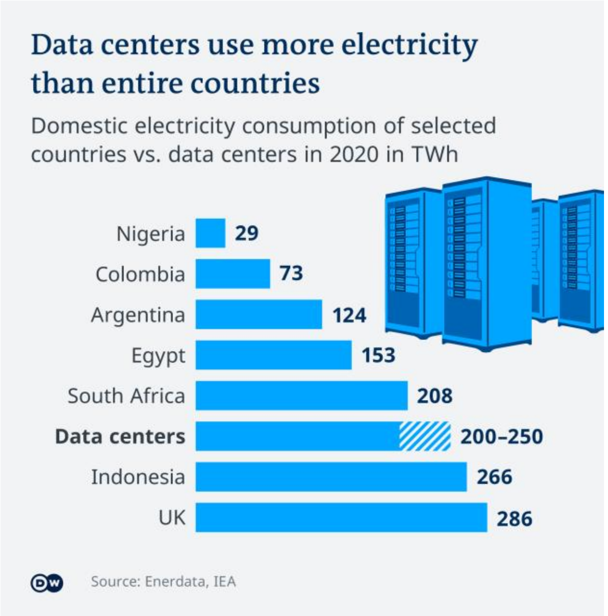
YANNICK KRABBEN

Competence Centre for Thermal Energy Storage
Lucerne University of Applied Sciences and Arts

Background

Data centers dynamics and heat recovery potential



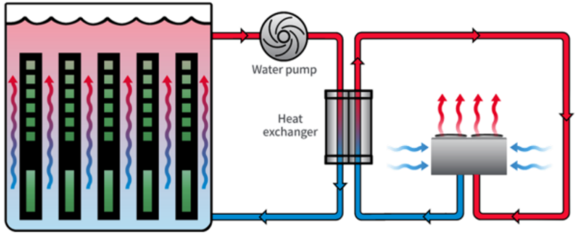


Even with low PUE (very efficient cooling systems) almost **all of the installed IT power consumption is converted into heat!**

Background

Immersion cooling as a game changer

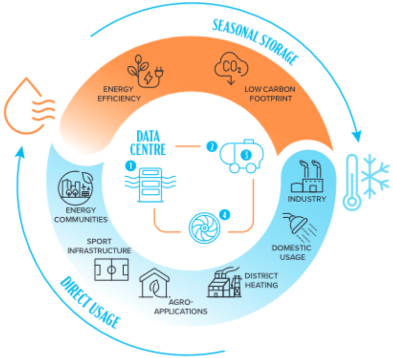
- Removal of the heat generated by the IT components using a single-phase dielectric liquid, i.e. a fluid that conducts heat and acts as an electrical insulator, which absorbs the heat from the tank by convection and releases it to the environment through a conventional heat exchanging system
- Common dielectric fluids have a heat capacity by volume about 1,300 times higher than air, improving significantly the cooling efficiency
- PUE achieved = 1.1 (ideal PUE close to 1)
- The dissipated heat can be released from the "hot" fluid in another fluid for **direct exploitation** or in a heat storage system capable of storing heat **for prolonged periods (seasonal storage)**

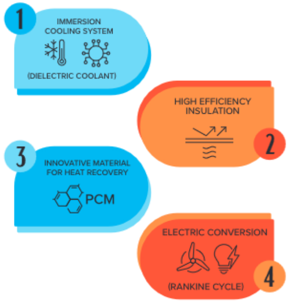


With the MODERATOR approach both main obstacles that hinder the reuse and further exploitation of waste heat from data centers can be efficiently tackled

Overall Goal

- Development and demonstration of an integrated prototype demonstrator based on an immersion cooling system combined with novel and highly efficient long-term storage materials and systems
- On-site demonstration of different exploitation options (space heating, hot water production, electricity generation) of the recovered heat



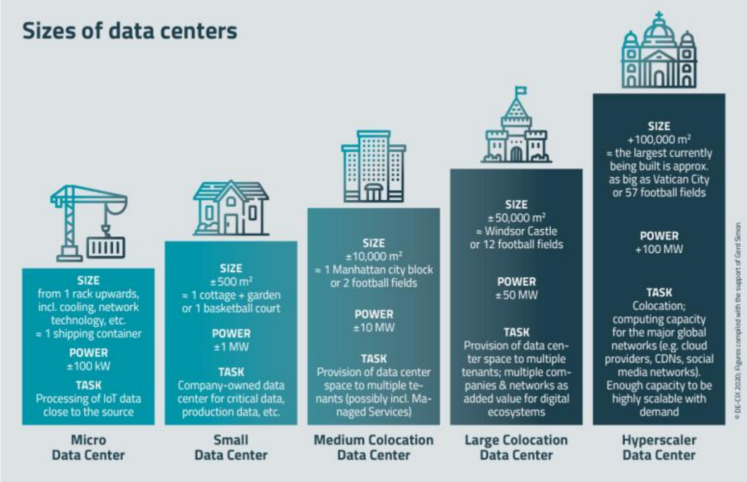


Three **key elements** ensuring the heat recovery and its storage over extended periods of time:

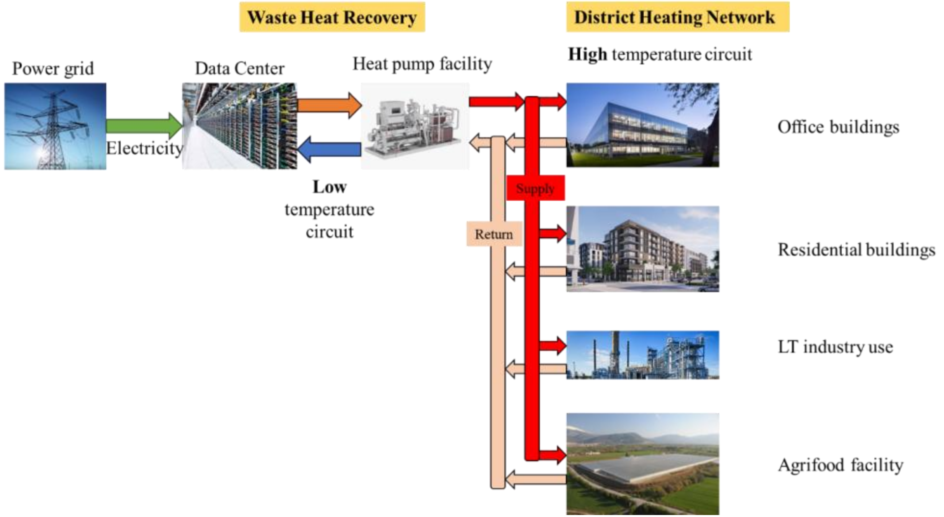
1. immersion cooling system
2. innovative phase-change material (PCM) for heat storage
3. highly efficient multilayered insulation coupled with an electricity conversion system (Rankine cycle-based)

- ✓ MODULARITY: The modular design approach allows easy and straightforward scale-up. It can find applications in small (few kW) to large (several MW) data centers, on a site-by-site basis.
- ✓ SIMPLICITY: Direct installation in any location (indoors or outdoors) without heavy facilities requirements.
- ✓ SUSTAINABILITY: Safe and clean for human health and the environment, exploiting recycled materials and being a by definition zero-effluent concept.

Indicative applications and potential end users mapping

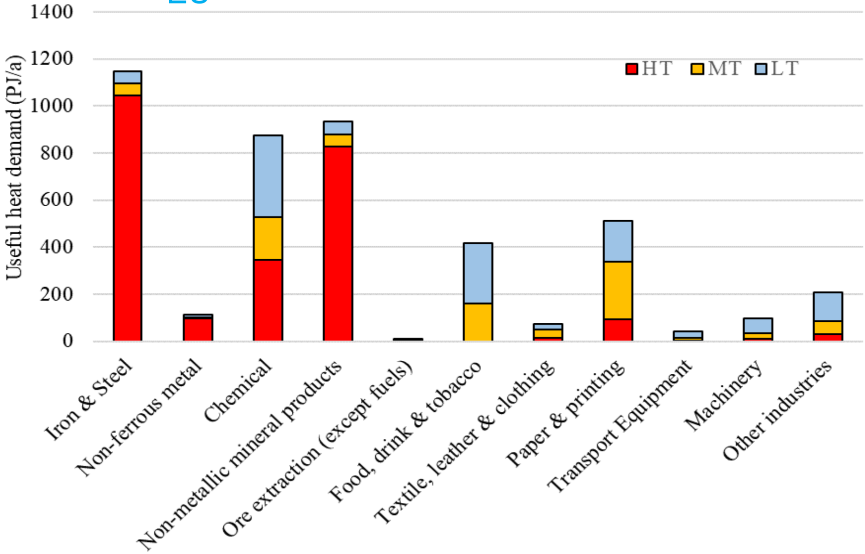


Technologies for waste heat upgrade – Heat upgrading by coupling a heat pump with a Data Center in a District Heat Networking

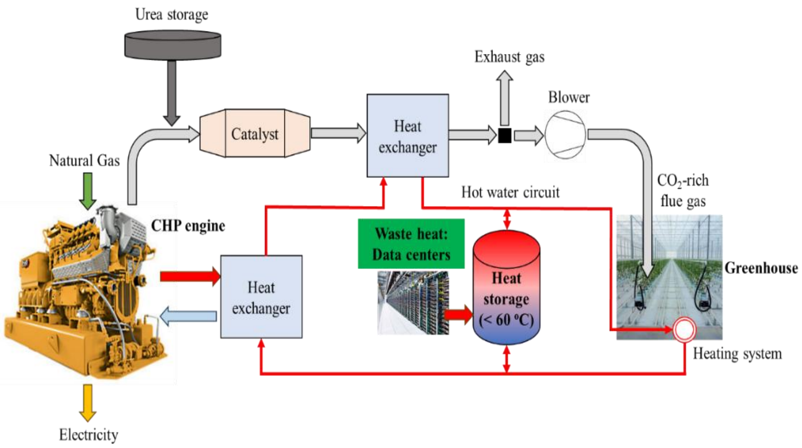


Indicative applications and potential end users mapping

Heat demand for the industry in the EU



Integration of a Data Center derived waste heat to the heating system of a greenhouse

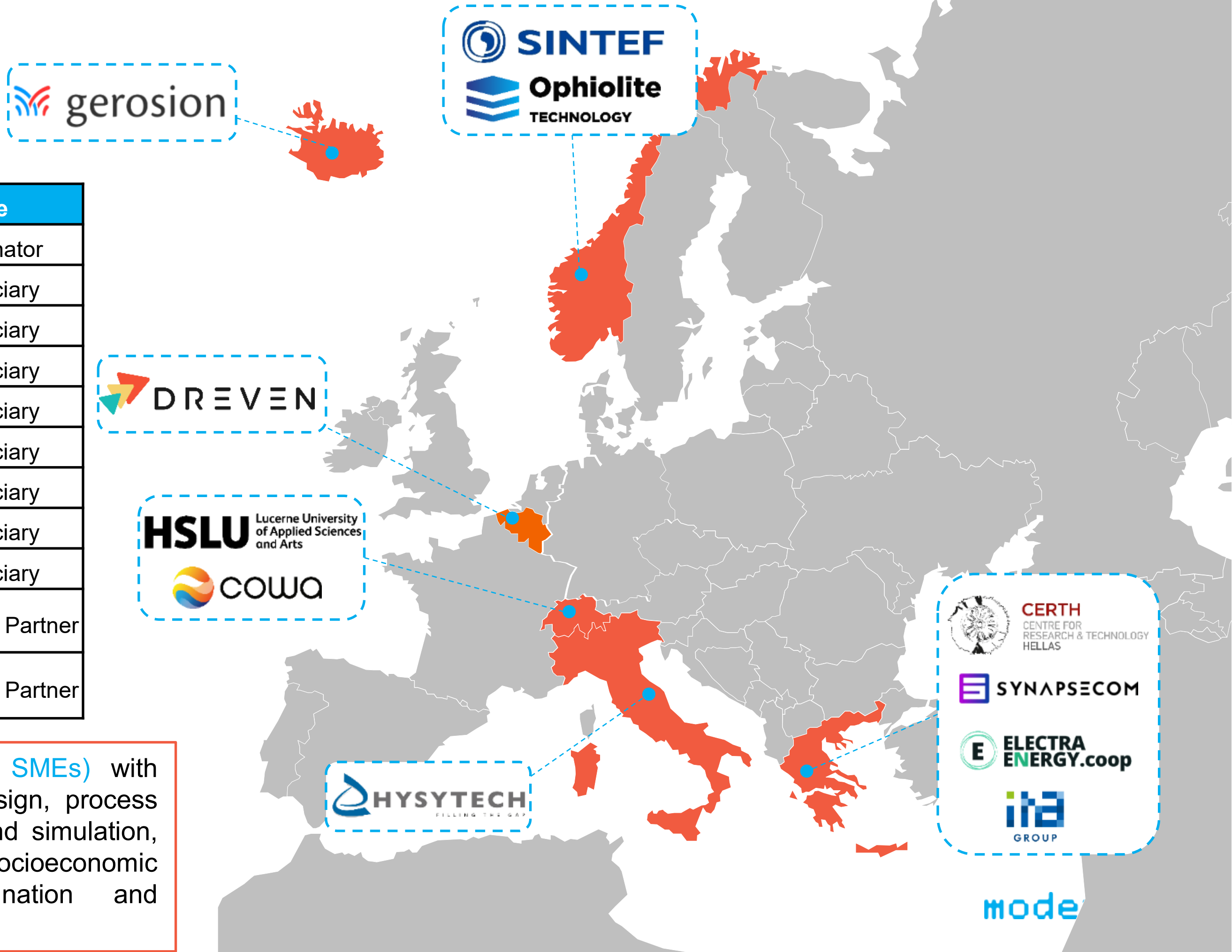


Pardo et al., 2012. European Commission, Joint Research Centre, Institute for Energy and Transport.

Consortium

	Partner	Country	Role
1	CERTH	Greece	Coordinator
2	SYNAPSECOM	Greece	Beneficiary
3	HYSYTECH	Italy	Beneficiary
4	SINTEF	Norway	Beneficiary
5	DREVEN	Belgium	Beneficiary
6	OPHIOLITE	Norway	Beneficiary
7	ITA	Greece	Beneficiary
8	GEROSION	Iceland	Beneficiary
9	ELECTRA	Greece	Beneficiary
10	HSLU	Switzerland	Associated Partner
11	COWA	Switzerland	Associated Partner

11 partners (3 research organizations, 8 SMEs) with experience on material science, system design, process engineering, systems operation, modeling and simulation, technoeconomic, environmental and socioeconomic assessment, roadmap design, dissemination and communication, etc.



moderator

Immersion Cooling and Advanced Materials for Heat Recovery from Data Centers

Thank you!

http://moderatorproject.e
../

info@moderatorproject.eu

@moderatorproeu

@moderatorproeu

Contact:
yannick.krabben@hslu.ch

2COOL2WASTE INITIATIVE

Co-funded by the European Union

Heat Marriage: Thermal Connection of Data Centers and Building

Attila Mórotz

Project coordinator, HEATWISE project

H1 Systems Ltd.

Thermal integration and optimisation of buildings and data centres

PUE <1.05
ERF >95%
PES 20%

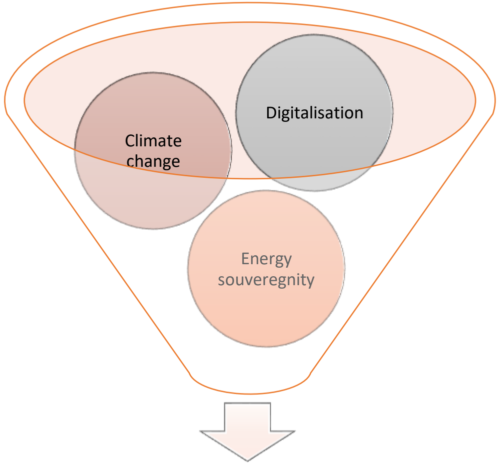
World-class DC cooling efficiency

All heat captured and used

Massive decarbonisation

HEATWISE

The challenges



What kind of relationship shall it be?

Critical infrastructure (24/7)

Latency

Energy density

IT power growth

EDGE

Energy, asset, white space cost

Shelter & Comfort (24/7)

Prosumer

EV charging

Energy label

Costs & Asset value

RES targets

Energy efficiency targets

CO2 targets

Minimum performance

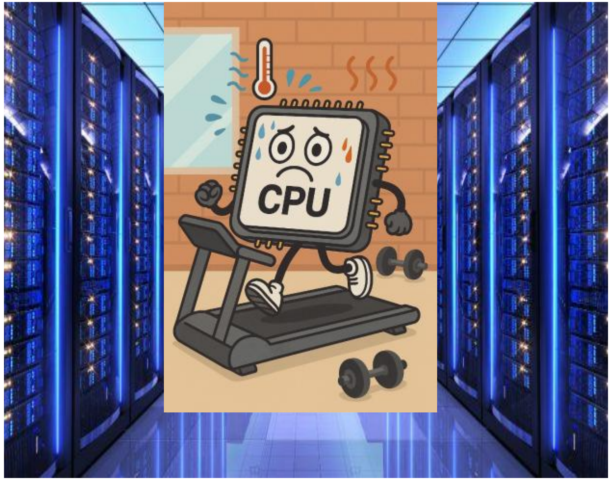
Standards

HEATWISE

The problem of the mainstream DC cooling

Air cooling
- CRAC
- CRAH
- Free cooling
- …

18-32 °C



25-35 °C

Cooling machinery inefficiencies
1. Air has low heat capacity
2. Summer heat challenges
3. Large machinery, wall throuputs and airducts
4. Noise

Cooling strategy deficiencies
- Limited data: inlet temp, humidity, dew point, airflow
- Limited optimisation, delayed cooling
- Standard or human driven cooling

System deficiencies
1. Thermal throttling causing
    - Latency (SLA)
    - Lower IT utilisation (longer ROI)
2. Low energy efficiency PUE 1.6
3. Waste heat is really wasted

HEATWISE solution for DC cooling

Hybrid cooling

Adjustable and component specific temperature levels

DATA
1. Temp
2. Humidity
3. Airflow
4. …
5. …
6. …

DATA
1. CPU temp
2. CPU utilisation
3. Memory temp
4. Fan rpm
5. Power
6. ….

DATA
1. Main power
2. Heating power
3. Waste heat reused
4. …
5. …
6. …

Value proposition

Performance

- Higher IT utilization rate
- High quality heat

- 95% IT utilisation, **no thermal throttling**
- 45-65°C **stable heat flux** to building
- **High temp** DC cooling 40-55°C

Business

- Lower OPEX
- Supply & revenue diversification

- Up to 100 kW/rack → less white space
- Zero water → no risk for IT
- Waste heat gets value

Compliance

- EU directives: RED, EED, EPBD
- National targets: D, F, E

- Data & Reporting tools
- PUE, ERF, PUE, WUE

Decarbonisation

- Energy saving
- Green energy

- 20% primery energy saving
- CO_2 emission decrease
- Total waste heat reuse

HEATWISE

HEATWISE project in numbers

2024-2026

4.5 MEUR total budget

- 3.2 MEUR
- 1.3 MER

11 partners

8 countries

6 use cases

5 climatic zones

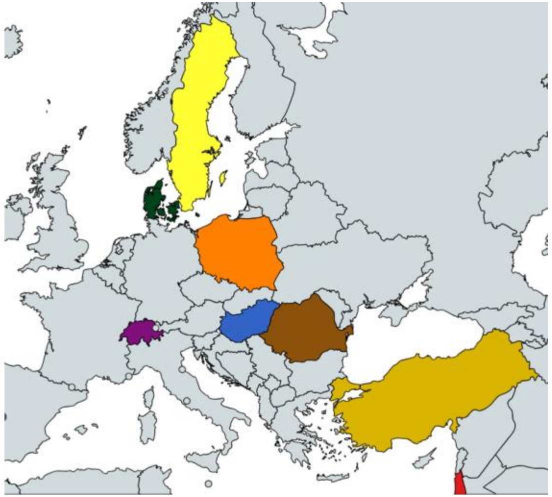
5 pilots

3 benchmark pilots

2 hybrid cooled pilots

35 deliverables

HU	H1 SYSTEMS
SE	RISE, HÖGSKOLAN I GÄVLE, MGSustainable
DK	
PL	PSNC
CH	Empa
RO	asro
TR	TOFAŞ, KoçSistem
IL	ZUTACORE



AAU (DK)
university campus

PSNC (PL)
supercomputing centre

TOFAS (TR)
smart facotry

EMPA (CH)
mixed use building

RISE (SE)
industrial warehouse

HEATWISE

The research road to HEATWISE

BodenType DC (Horizon2020)
- 2017-2020
- PUE 1.028
- Birth of holistic cooling control

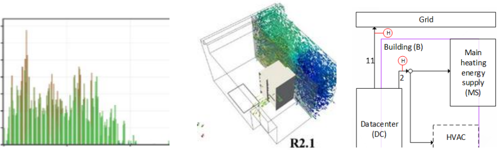
EcoQube (Horizon2020)
- 2020-2024
- AI-augmented cooling
- Zonal heat management

HEATWISE (Horizon Europe)
- 2024-2026
- Waste heat reuse in buildings
- Heat optimization, maximization

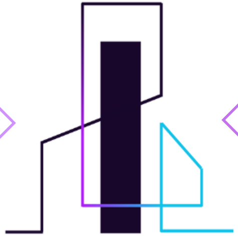
Novel methods, tools, strategies

Building control
BEMS

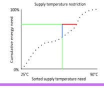
Analitics & Planning



Hybrid air and liquid cooling



Marriage strategies



Business case & policy recommendations

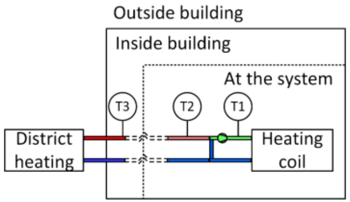
TCO, NPV, IRR
EED, EPBD, EN

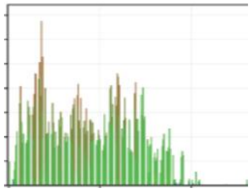
DC
Holistic cooling control

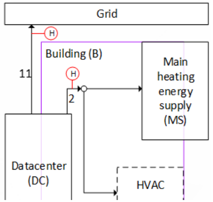
Analytics
Evaluation and metering of buildings' waste heat reuse

Novelties
- New methodology, process is described for waste heat potential ealuation of buildings
- Simulations of using building as thermal storage
- Metering strategy and KPIs

Key findings
- Mains often too hot
- Provide heat straight to the system e.g. HVAC
- 7 KPIs to describe buildings' performance in relation to waste heat







Results
- Evaluation methodology
- Website: D3.2, D3.3
- Datasets (Oct. 2025)

Dissemination
- Lecture in November 2025 by AAU
- Publications are coming
- Training and workshop in Apr/May 2026 by AAU

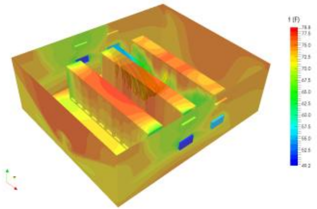
HEATWISE

Planning

Cooling efficiency increased via CFD simulation

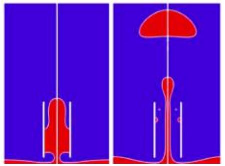
Why CFD?

- Full volumetric data
- Complete airflow awareness
- Upfront redesign assessment



Novelties

- Rack, server & cold-plate level modeling
- IPMI data validated models
- Micro-baffle optimisation for film boiling

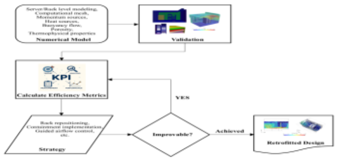


Key findings

- 10-75% cooling efficiency increase potential
- New KPI: Recirculation Index (RI)

Results

- dataCentreDST© software with OpenFOAM backend
- KPI-informed design evaluation method



Dissemination

- Website: D4.1
- 2 publications
- 2 are in the pipeline
- Training and workshop in Apr 2026 at RISE in Lulea

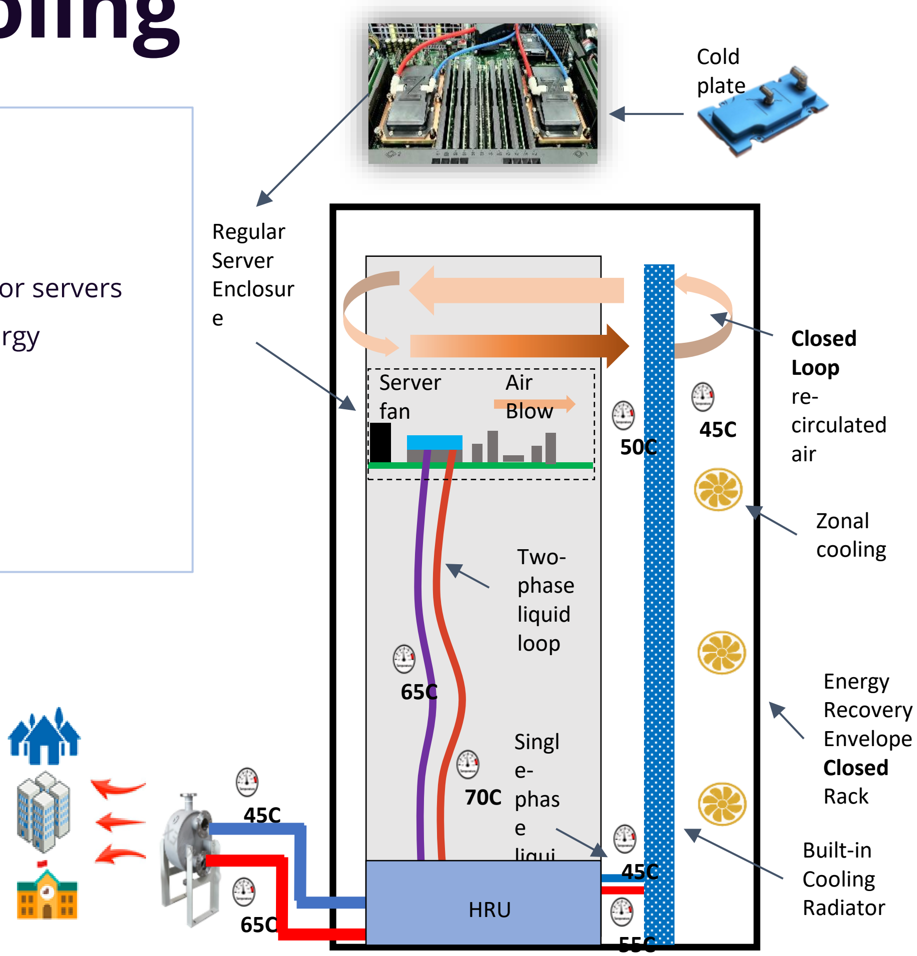
HEATWISE

Hybrid cooling

Two-phase direct-to-chip cooling

- Cools the CPU/GPU
- Retrofitted cold-plates
- Closed loop dielectric liquid safe for servers
- Phase change captures latent energy
- Uniform cooling across chiplets

Collects 70% of heat



Closed cabinet air cooling

- Cools auxiliary components
- In-rack closed loop air-liquid heat exchanger
- Zonal cooling

Collects 30% of heat

HEATWISE

Control & Optimisation Tools

Data Centre's holistic cooling control

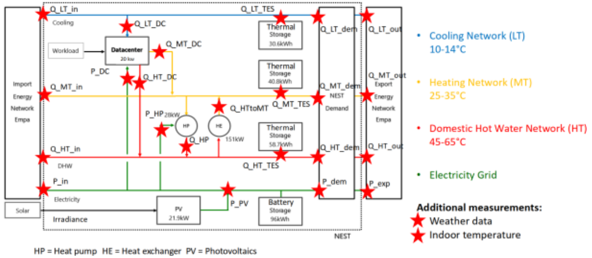
- Digital Twin for prediction
- Self-assessment tool for KPI calculation
- Workload orchestrator for heat distribution
- Self-optimisation tool for air cooling control

Building's EMS

- Heat demand forecast
- Heat gain from humans and equipment
- Multi vector interactions

Novelties

- MOTA algorithm for DC waste heat maximisation



Results

- HEATWISE data model
- DC control scenarios
- BEMS heat flow scenarios
- Design guidelines

Dissemination

- Publication on MOTA
- Publication on windtunnel tests (end of 2025)

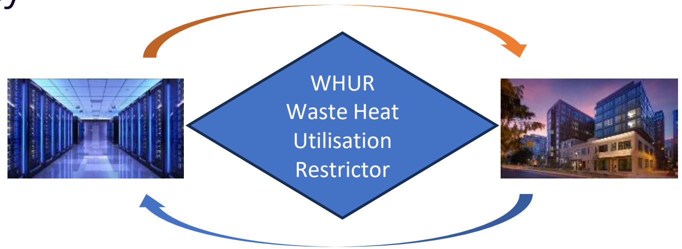
HEATWISE

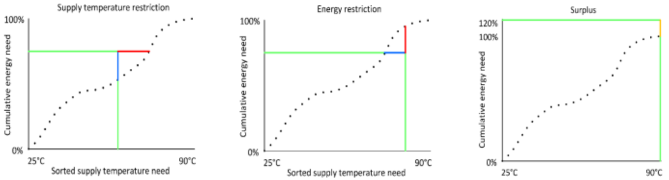
DC and Building marriage strategies

Relation
- Balancing demand and supply
- Hierarchy or Partnership
- Freedom and Obligations

Objectives
- Cost minimization
- EE maximisation

Novelties
- WHUR and calc. algorithm
  - Supply temperature restriction
  - Energy restriction
  - Surplus of heating energy
- KPIs for BEMS





Results
- WHUR
- KPIs for
  - energy flow,
  - operational efficiency,
  - costs and CO_2
- 7 building KPI
- 4 DC KPI
- 13 BEMS KPI

Dissemination
- Website: D3.3, D7.1
- LinkedIn
- Final conference 2026 Nov

HEATWISE

Business cases

All to come in 2026

Use cases

- University campus
- Supercomputing centre
- Smart factory
- Mixed use building
- Industrial warehouse
- Hotel
- Hospital

Technical and financial feasbility

Policy evaluation

AAU (DK)
university campus

PSNC (PL)
supercomputing centre

TOFAS (TR)
smart facotry

EMPA (CH)
mixed use building

RISE (SE)
industrial warehouse

HEATWISE

CONTACT

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HEATWISE

www.heatwise.eu

THANK YOU

DYNAMICALLY MANAGED SELF-COOLING HPC DATA CENTERS.

Robert Birke

DYMAN | UNIVERSITÀ DEGLI STUDI DI TORINO

Project Overview

- DYMAN: DYnamically MANaged self-cooling HPC Data Centers
- Topic HORIZON-EIC-2023-PATHFINDERCHALLENGES-01-01:

Clean and efficient cooling

DYMAN
10 partners / 4 countries
36 months (1st July 2024 - 30th June 2027)
3,999,000 €

Successful HOP ON proposal

DYMAN
11 partners / 5 countries
36 months (1st July 2024 - 30th June 2027)
4,390,875 €

Goals

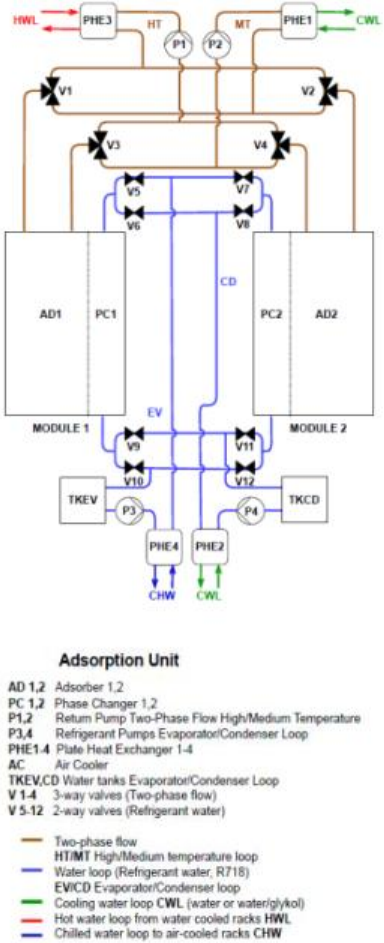
- **Overall Goal:**

Development of alternative solutions to address the growing **cooling demands in data centres:**

- **Goal 1**: Development of **2 cooling prototypes** (adsorption chillers) combining **3D-printed adsorber HEX** and **two-phase flow cooling** for 2 applications (rack-integrated and central data centre cooling).
- **Goal 2**: Coupling hardware with a **management system** to efficiently control cooling in data centres.
- **Goal 3**: Validation at **2 test beds**: BSC and UNITO's HPC.

Core Concepts

- **Core concept 1**. Design new **adsorption chillers** based on:
  - **low-temperature adsorbents** achieving high capacities at very low driving temperatures (<50 °C).
  - **adsorption heat exchangers** made of 3D printed structures.
  - **Aim**: integrate the adsorption material into a porous structure, which reduces the internal thermal resistances and improves heat transfer by two-phase flow, enhancing the heat transfer rate and reducing the internal electricity consumption of the unit.



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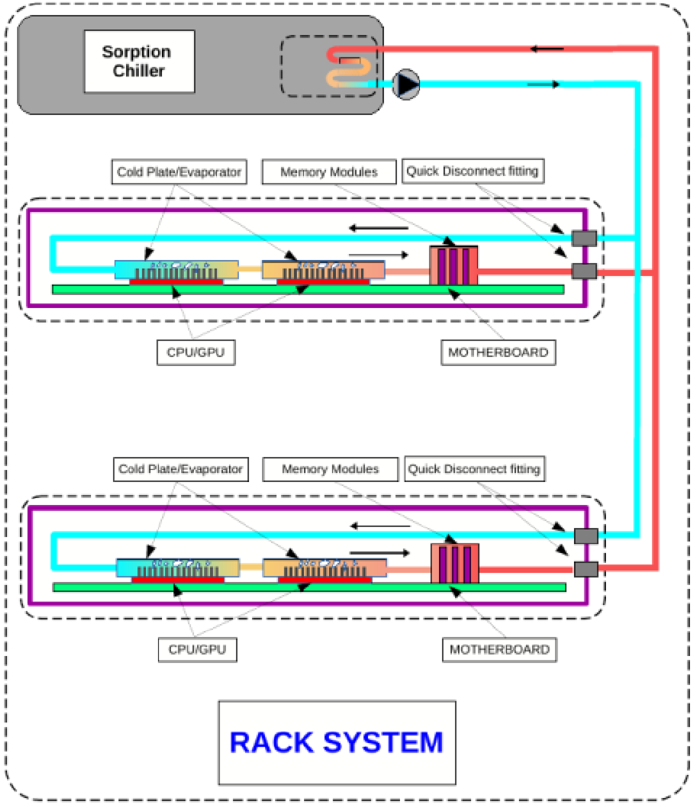
DYNAMICALLY MANAGED SELF-COOLING HPC DATA CENTERS

Core Concepts

- **Core concept 2.** Further develop a **two-phase cooling system** for high-performance computing servers to handle thermal loads more efficiently from next-generation processors.
    - **Aim:** **Combining two-phase cooling directly with heat-powered cooling** could significantly improve efficiency over conventional air or water-based cooling methods alone.



Testbeds

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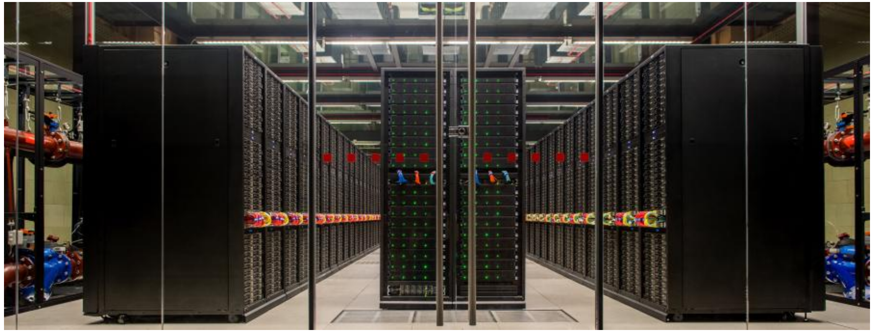
Partner: HPC4AI @ UNITO



Partner: MN @ BSC

EIC Challenge Objectives

- **Reduce** investment/operational **costs**,
- **Increase efficiency**, operational reliability and interoperability,
- **Avoid** the use of critical raw materials (**CRM**) or harmful refrigerants,
- Pursue **circularity by design** approaches, low environmental impact, and low carbon footprint.

DYMAN’s Pillars

- **Pillar 1** - Technical development of DYMAN's **cooling systems**.
- **Pillar 2** – Technical development of **control and management systems**.
- **Pillar 3** – **Validation** of DYMAN complete solutions.
- **Pillar 4** – **EIC portfolio activities**: Exploitation, dissemination, communication, and business and value chain creation.

Main Results so far - Key Exploitable Results (KERs)

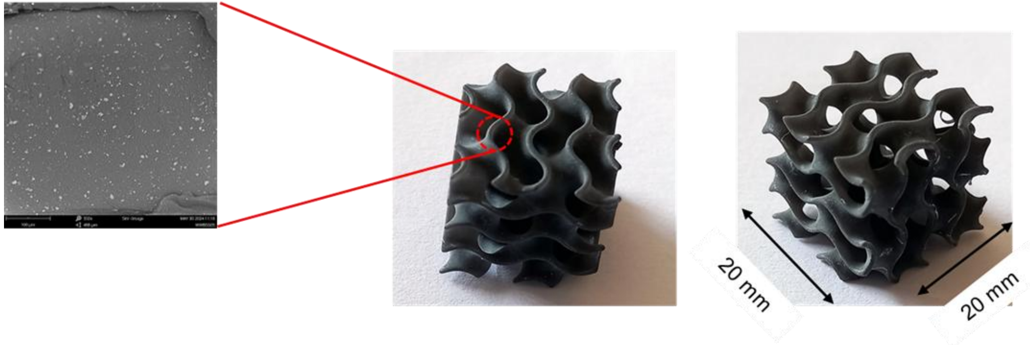
DYMAN
DYNAMICALLY MANAGED SELF-COOLING HPC DATA CENTERS

Novel 3D-printed adsorber heat exchanger (KER1)

Partner: CNR

TRL_i 2 – TRL_f 3

Novelty: integration of *low-temperature hydrophobic adsorption materials* into a *porous structure,* maximizing heat transfer.



Nearly finished.

Main Results so far - Key Exploitable Results (KERs)

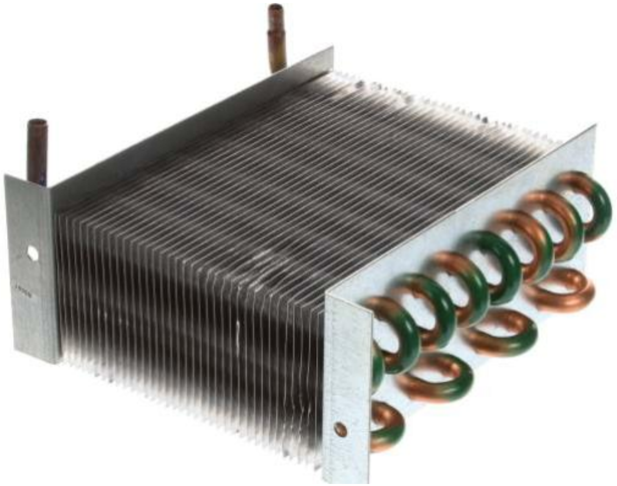
DYMAN
DYNAMICALLY MANAGED SELF-COOLING HPC DATA CENTERS

New enhanced condenser (KER2)

Partner: SOR

$\mathrm{TRL_i}$ 4 – $\mathrm{TRL_f}$ 6

Novelty: *inner enhanced surface* that *improves heat transfer* in condensation & *external surface* will integrate the *adsorption material of the heat pump*.



Possible picture of new condenser.

Nearly finished.

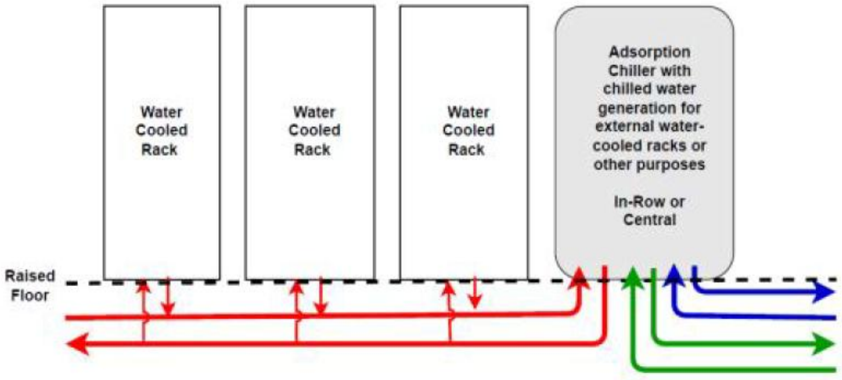
Main Results so far - Key Exploitable Results (KERs)

Design for novel adsorption chiller for data center cooling (KER2)

Partner: SOR

TRL$_i$ 3 – TRL$_f$ 5

Novelty: *low-temperature materials*, *3D-printed adsorbers* and *two-phase flow* for internal heat transfer for central, in-row and in-rack IT cooling.



Nearly finished.

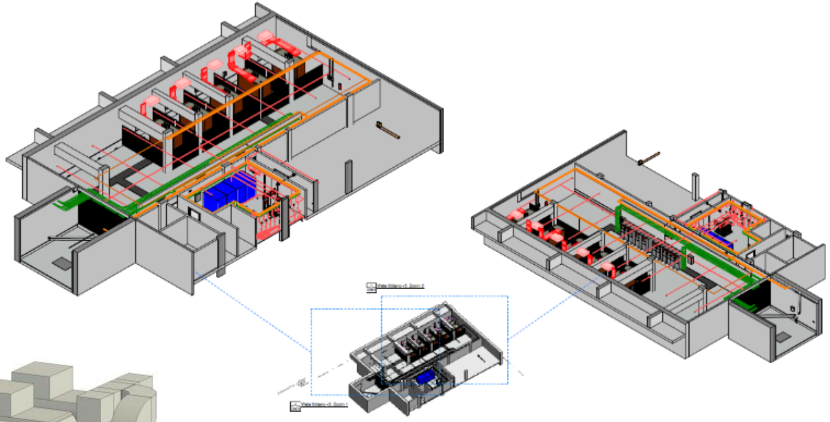
Main Results so far -
Key Exploitable Results (KERs)

ICT Common Data Environment for DC operation optimisation (KER5+9)

Partner: UNITO/IDP

TRL_i 3-5 – TRL_f 6-7

Novelty: Virtual testbed for optimisation of facilities' performance by integrating monitoring and simulation processes before physical implementation.



Ongoing.

Main Results so far - Key Exploitable Results (KERs)

EAR extension for dynamic management of the cooling system, servers, and storage for energy-efficient data centres (KER8)

Partner: EAS

TRL$_i$ 3 – TRL$_f$ 6-7

Novelty: *high-level algorithms* to *dynamically optimise* the *cooling system* and the *computational elements* into one solution, helping reduce the carbon footprint.

Ongoing.

Main Results so far -
Key Exploitable Results (KERs)

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SIMBOT of adsorption equipment (KER6)

Partner: BDTA

TRL_i 2 – TRL_f 6

Novelty: *mathematical model for simulation of adsorption equipment* to introduce it in the market through *virtual test and simulation,* promoting the equipment and making it available to the general public.

Initial definition of SIMBOTs, generic SIMBOTs and basic library component established. Real-time models are in execution and testing.

Ongoing.

Conclusion and Next Steps

DYMAN
DYNAMICALLY MANAGED SELF-COOLING HPC DATA CENTERS

- **Physical components** (adsorption chiller) will be finished in December 2025.

- **Virtual testing** (digital twin test beds) will be done prior to the physical installation of the adsorption chillers at BSC and UNITO.

- **Collaboration** with other Clean and Efficient Cooling projects from the **EIC portfolio**.

DYMAN

DYNAMICALLY MANAGED
SELF-COOLING HPC DATA CENTERS

Thank you for your attention :)

DYMAN - This project has received funding from the European Commission Horizon Europe Programme under Grant Agreement No. 101161930

Data Center Italia
the engine of the country's digital future

Alessandro Viviani

Associate Partner, TEHA Group

COMMUNITY DATA CENTER ITALIA

Data Center Italia Community: the engine of the country's digital future — a cross-sector platform aimed at bringing together the main stakeholders of the extended data value chain.

A think tank designed to develop scenarios, strategies, and policies that can **support the growth of the sector and help position Italy as a European and global benchmark.**

Partner

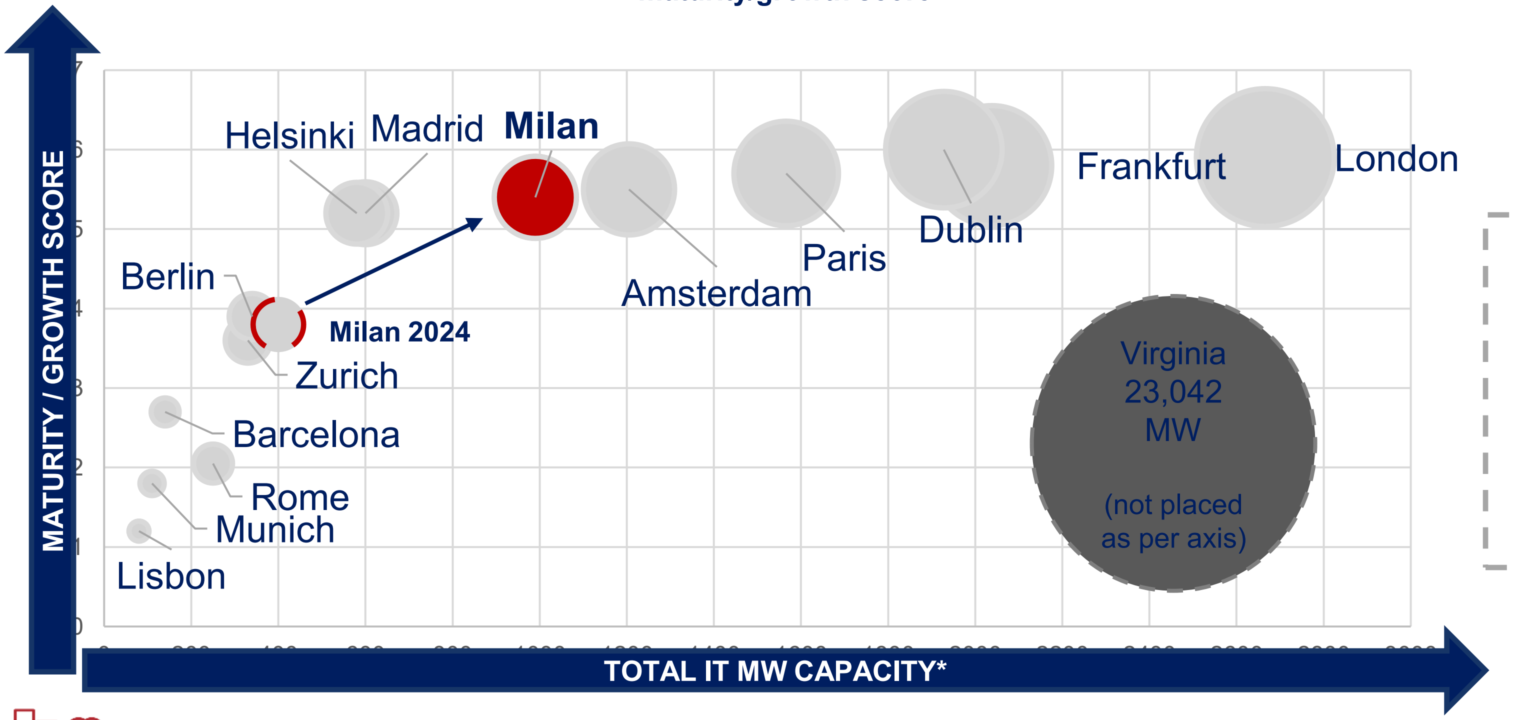
Junior Partner

Knowledge Partner

WHAT IS GOING ON?

Milan is currently undergoing a phase of development that will position it as one of the **leading regions for data centers in Europe**

Comparison of key data center markets by IT MW capacity (installed and pipeline) and maturity/growth score



(2023)

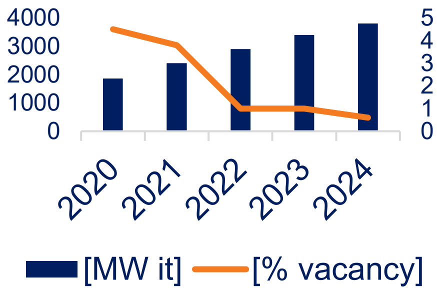
GDP Lombardy:
530 billion $

GDP Virginia:
720 billion $

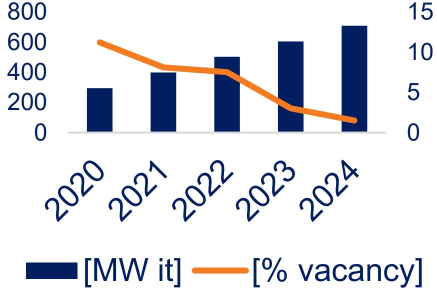
(*) Installed + pipeline capacity
Source: TEHA Group elaboration on Cushman & Wakefield, Istat and BEA data, 2025

Increasing IT capacity is being matched by a steady decrease in vacancy rates

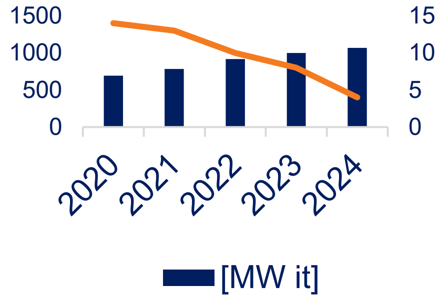
North Virginia



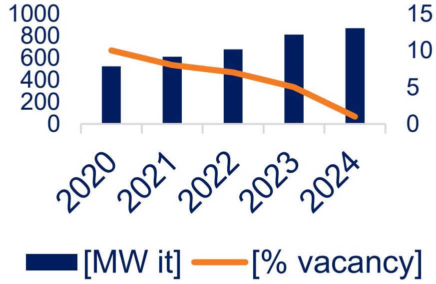
Phoenix



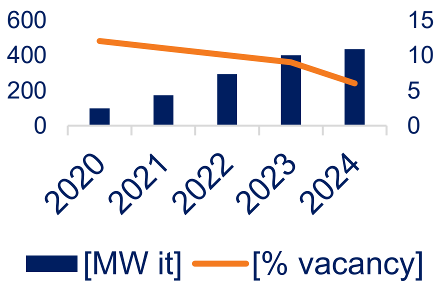
London



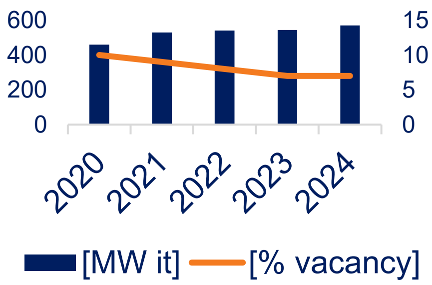
Frankfurt



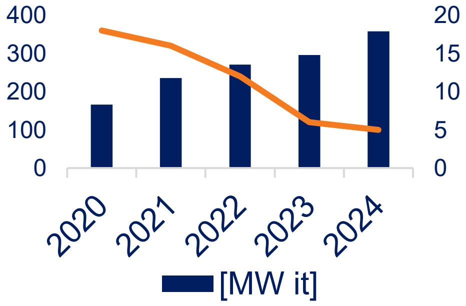
Paris



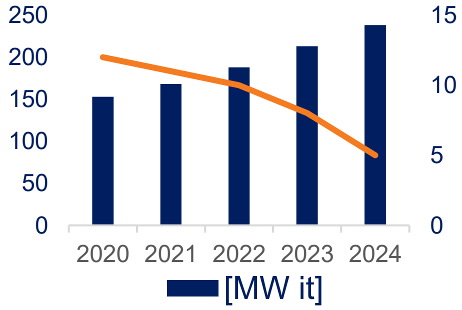
Amsterdam



Dublin



Milan

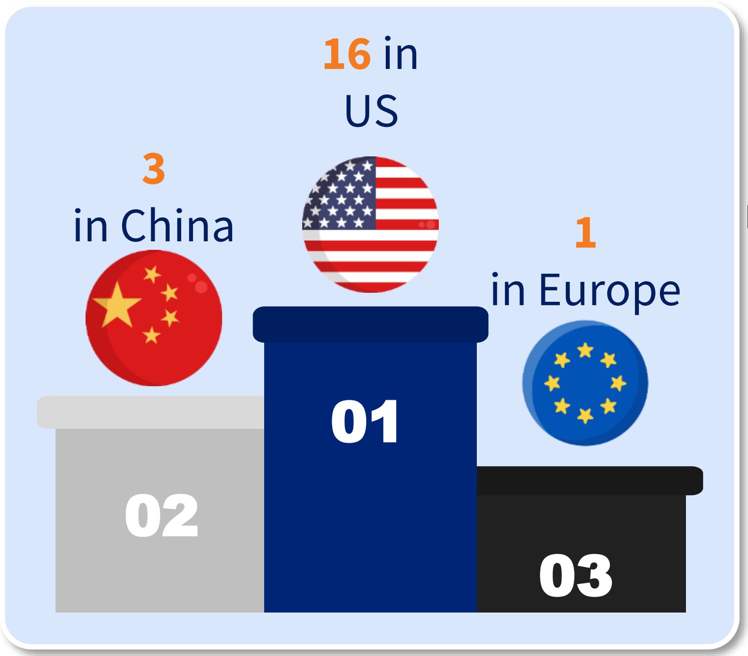


Source: TEHA Group elaboration on various sources, 2025

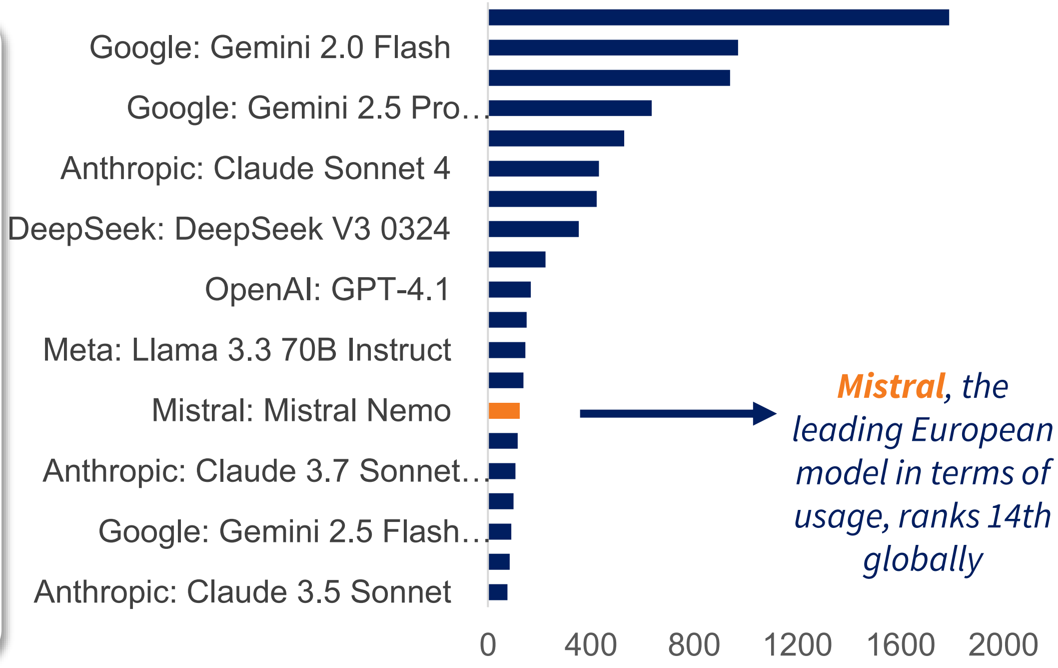
SUSTAINABLE PLACES 2025

Shall we take the US as a benchmark?

The top 20 LLMs by usage have been developed:



Use of Large Language Models (LLMs)(billions of tokens*), May 2025



* A token is a portion of text (word or part of a word) processed by the AI model

Source: TEHA Group elaboration on Openrouter AI data, 2025

SUSTAINABLE PLACES 2025

Will we see development beyond the Regions?

Lazio region is gaining importance in the data center landscape, with Rome's IT capacity growing at a 45% CAGR.

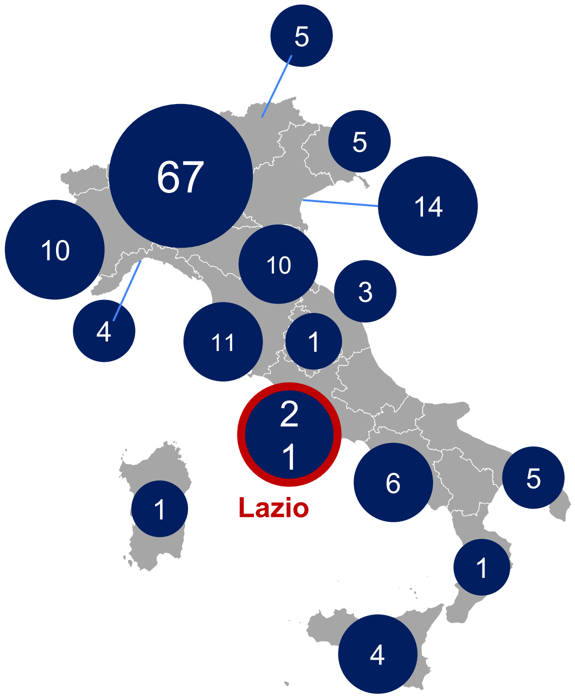
Southern Italy could offer key opportunities driven by international data routes and its **geo-political link to Africa**.

Still to be demonstrated

50% - 60% of data infrastructure is managed on-premise.
A significant share will need to be aligned with security standards (**NIS2**), enabling new **hybrid data infrastructure** development

Potential upside

Number of data centers by Italian region

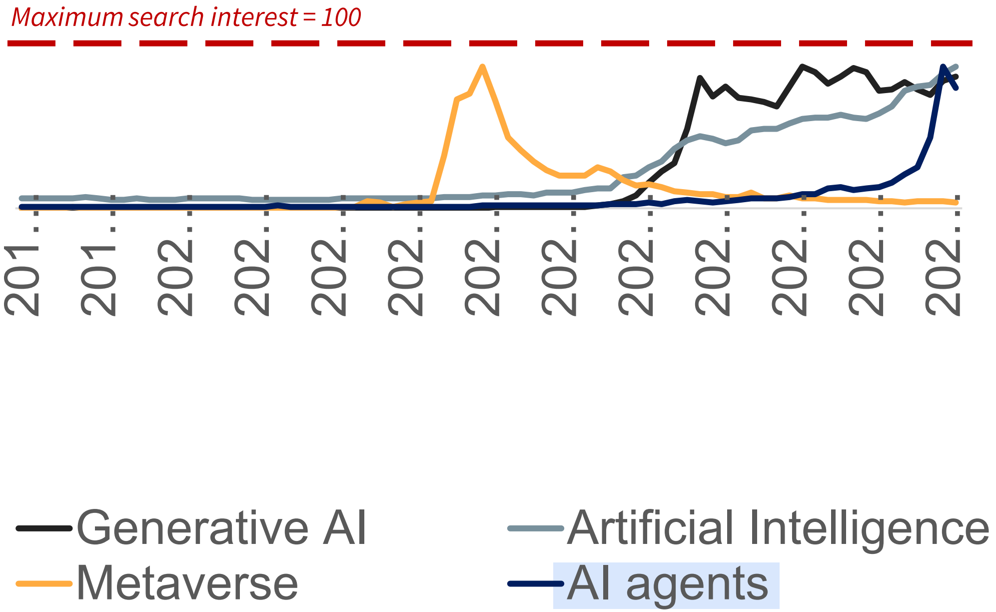


Source: TEHA Group elaboration on Data Center Map data and various sources, 2025

AI Agent is about to enter a new phase of development in the coming months, one that will be more distributed and will require advanced platform capabilities that businesses will need to have access to

AI agents' saw a **+331% rise** in mentions during **corporate earnings calls** compared to last year

Google searches for selected technology trends
(Index Number), 2019-2025



Need for new capacity

Gartner predicts 40% of existing AI data centres will be operationally constrained by 2027

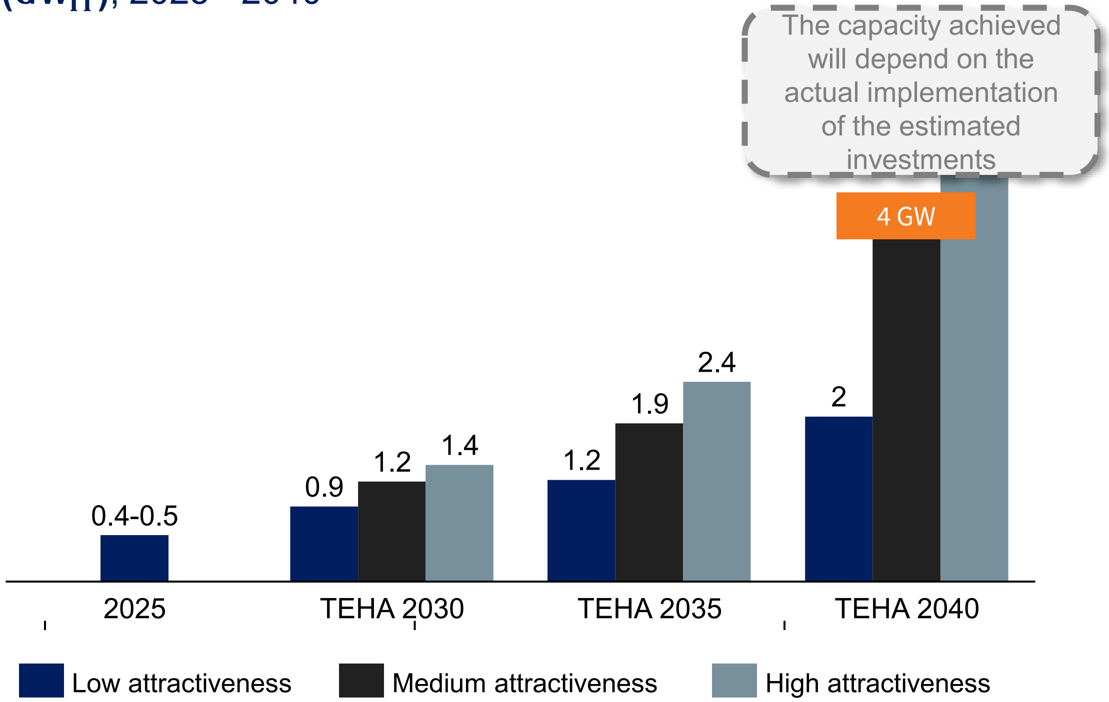
Need for increased performance

Slow response times, high computational costs, and scalability bottlenecks can make real-world applications difficult

Note: the default Y-axis shows normalized (0-100) volume rather than the real number of searches, 100 represents the maximum search interest for the keyword in the selected time frame
Source: TEHA Group elaboration on Google Data, 2025

How to define a scenario for Italy? Our proposal

Forecasts for the growth of data centers in Italy under different scenarios
(GW_{IT}), 2025 - 2040



Source: TEHA Group elaboration on Politecnico di Milano data and various sources, 2025

SUSTAINABLE PLACES 2025

HOW CAN WE CREATE SUSTAINABLE AND SCALABLE MODEL?

The adoption of best practices in three domains is crucial for infrastructure development:

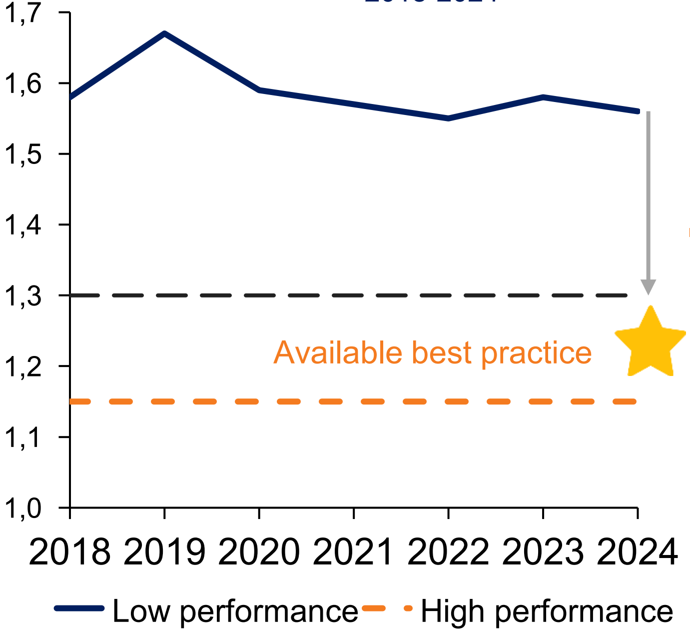
1.
Energy

2.
Resources

3.
Territorial Integration

High performance data centers save energy, reduce emissions and limit the need for new infrastructures

Average datacenter PUE at global level, 2018-2024



- 1.2 GW

(44% of Energy Release)

Impact of adopting best PUE practices

11 GW_p
Equivalent installed PV capacity

≈ 16 thousands football pitches

39 GWh
Storage batteries

≈ 4 MACSE auction
≈ 30% of 2040 new BESS capacity (Terna scenario)

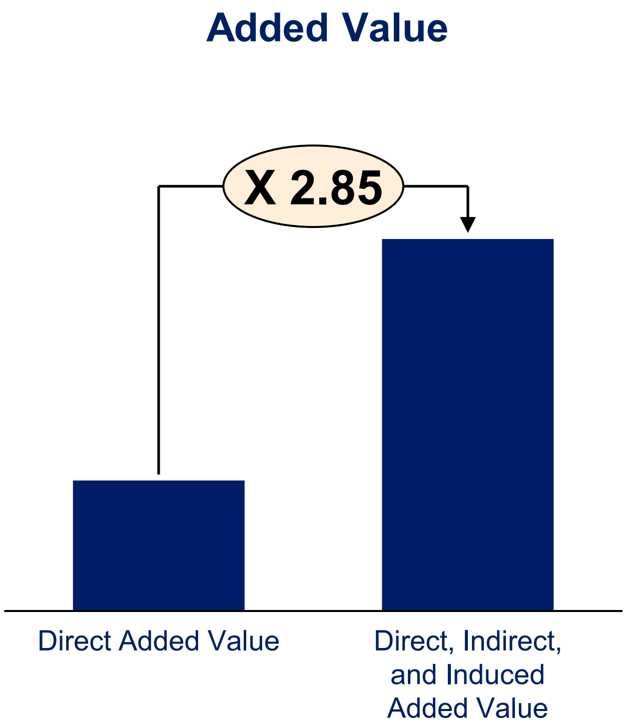
- 2 MtonCO_2
Emissions avoided

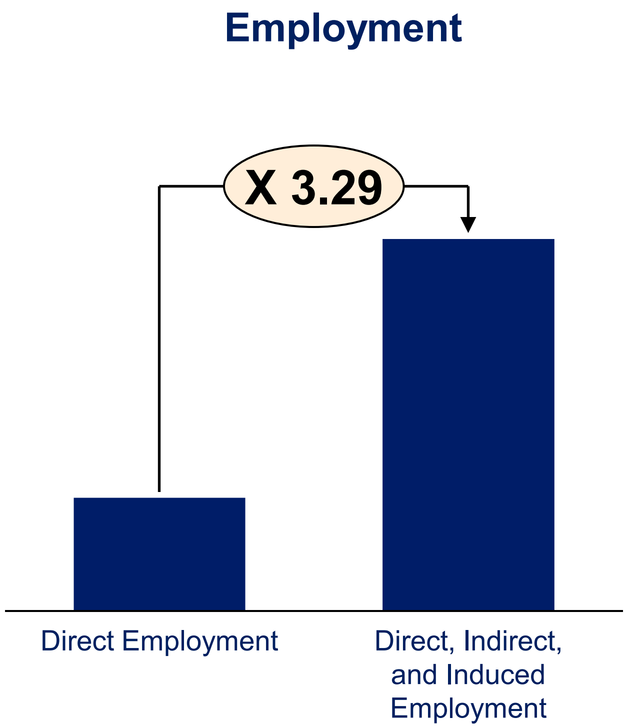
= 1.5 million less cars per year

SUSTAINABLE PLACES 2025

Source: TEHA Group elaboration on IEA, Politecnico di Milano, ICIS and various sources, 2025

Today there is still a lack of full awareness of the benefits generated by data center investments, which drive economic growth, employment, and innovation





SUSTAINABLE PLACES 2025

Source: TEHA Group, 2025

Best practices should be prioritized by policies as they provide significant systemic benefits

Italy has taken important steps with initial legislative proposals aimed at defining the scope of data center activity and facilitating investment.

However, a stronger national framework **is needed to ensure that all projects consistently adopt international best practices.**

If an infrastructure project:

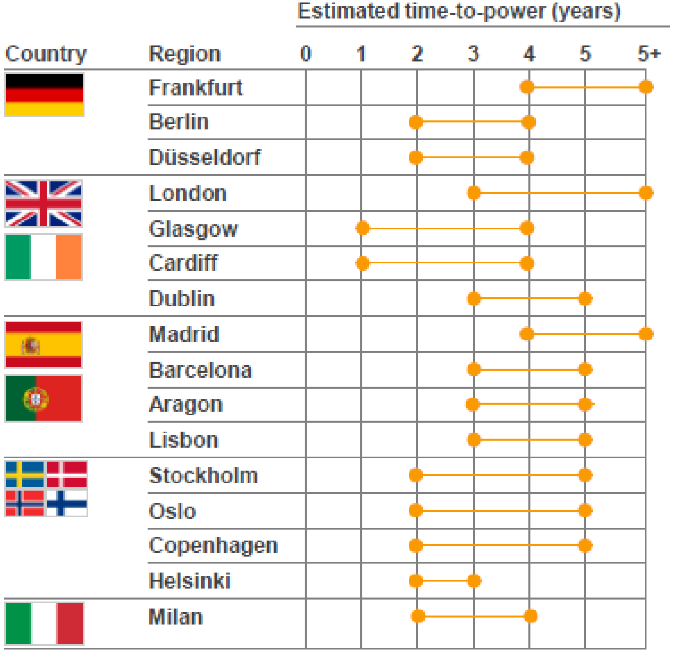
- maximizes efficiency
- minimizes land use and infrastructure-related development
- delivers tangible benefits to local communities
- is carbon neutral and environmentally sustainable thanks to circularity principles

... then it should be granted access to a streamlined and incentivizing permitting process

HOW TO TACKLE THE ENERGY ISSUE?

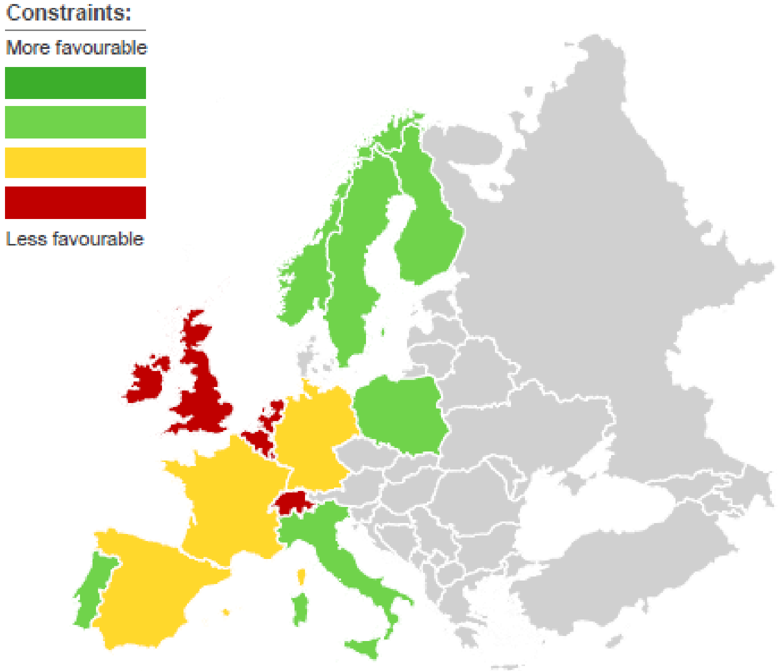
Time-to-power and grid constraints are shaping the European data center buildout landscape

City level time-to-power considerations[1]



[1] Based on greenfield interconnections

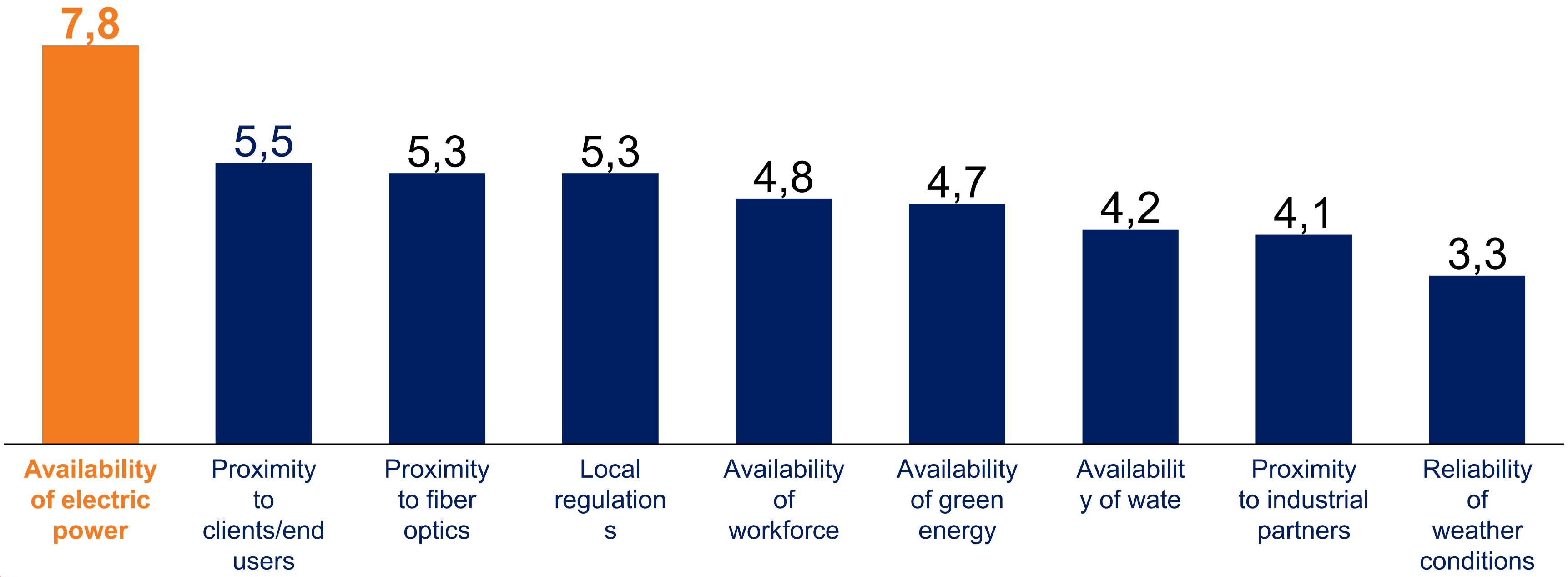
Country level grid constraint considerations



Source: Bloom Energy, 2025

Access to power is the primary factor in selecting a data center site for operators

Average evaluation of key considerations in site selection, from most important (10) to least important (1)



SUSTAINABLE PLACES 2025

Source: TEHA Group elaboration on Bloom Energy data, 2025

Power assets are the main enabling factor for data center investments. However, the model expected by developers is currently the most complex to implement

Critical factors:

- + 99.99% reliability
- Sustainability
- Rapid deployment

Preferred energy model by developers:

- 100% network electric power supply
- Continuous availability from renewable sources (24/7 RES)
- Diesel backup systems

TIME TO POWER IN EUROPE: 2–5 YEARS

INCREASING NETWORK INSTABILITY (see SPANISH BLACKOUT)

RESTRICTIONS ON THE CONSTRUCTION OF NEW DATA CENTERS DUE TO ENERGY NETWORK CONSTRAINTS

ACCESS TO RENEWABLE ENERGY COMPETITION WITH OTHER INDUSTRIAL SECTORS

RESTRICTIONS ON DIESEL USE IN BACKUP SYSTEMS AND HEATING

THIS MODEL IS CURRENTLY THE MOST DIFFICULT TO PURSUE

A flexible and technology-neutral energy strategy is needed to prevent infrastructure constraints from becoming a barrier to data center investment

Source: TEHA Group elaboration, 2025

The objective for attracting investments in Italy

FROM OBSTACLE…	…TO GRID ASSET
• Consumption only	• Lower impact on infrastructure
• Grid congestion	• Flexibility resources
• Slow grid upgrade	• Higher reliability

Data & Energy Hub

Data & Energy Hubs must emerge as game changers, transforming data centers from a source of pressure on the power grid into a resource for the system, helping to reduce energy costs and environmental impact.

This is not merely a technological evolution, but a new paradigm of integration between digital infrastructures and the energy transition.

Objective

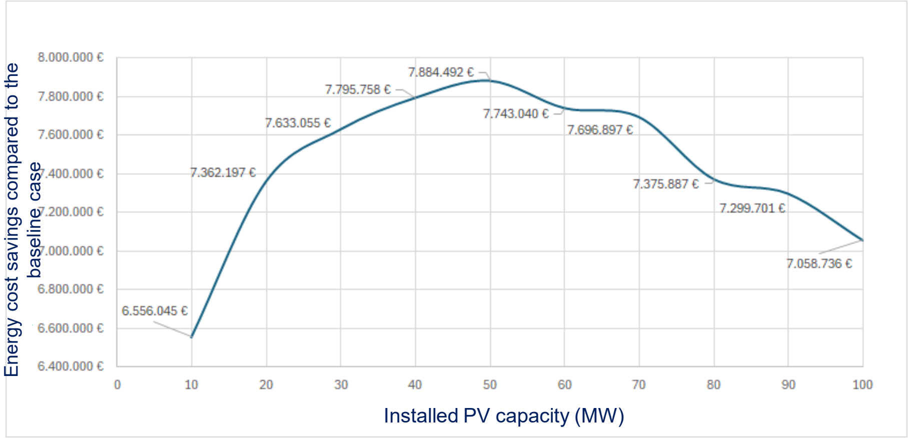
Immediate action is needed to make energy quickly accessible to data centers at a competitive cost.

What benefits?

BENEFIT 1: ENERGY COST REDUCTION

100 MW/6h BESS with variation in installed PV capacity enables significant reduction in energy costs:
-7.5% energy costs resulting in + 7,9 M€ EBIT

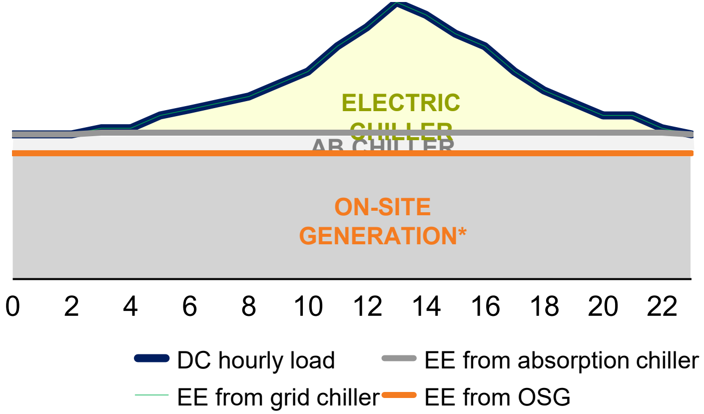
100 MW/6h BESS with variation in installed PV capacity



BENEFIT 2: REDUCTION IN THE NEED FOR GRID CONNECTION

On-site cogeneration offers a flexible solution to reduce grid load — **reducing the need for external grid connection by up to 82%**

Hourly DC profile vs. energy supplied by the cogeneration plant on a typical summer day (MW)



Socurce: TEHA Group and W2A elaborations, 2025

SUSTAINABLE PLACES 2025

DO WE HAVE A MATURE VALUE CHAIN?

The data center value chain involves multiple areas of activity

Capital Provider
- Equity investor
- Private Debt
- Banks

Developer
- Site scouting
- Technical/financial due diligence
- Design
- Permitting and authorizations
- EPC (Engineering, Procurement & Construction)

Real Estate Funds and Asset Managers
- Capital raising from the market
- Portfolio acquisition and management
- Asset enhancement and optimization

Data Center Operator
- Facility management (energy, cooling, physical security)
- Digital infrastructure operation (networks, interconnections, SLAs)

Data Center Users
- Enterprise
- Colocation non-hyperscale
- Hyperscaler
- Edge

SUSTAINABLE PLACES 2025

Source: TEHA Group, 2025

The data center value chain involves multiple areas of activity

Capital Provider

- Equity investor
- Private Debt
- Banks

Real Estate Funds and Asset Managers

- Capital raising from the market
- Portfolio acquisition and management
- Asset enhancement and optimization

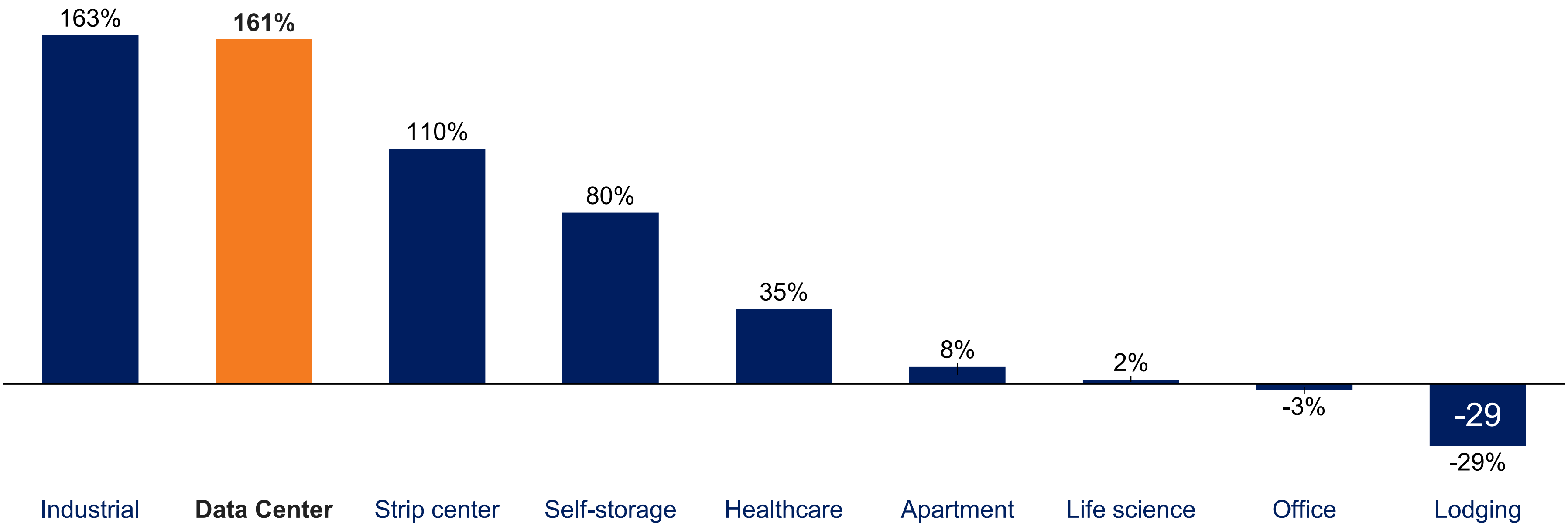
CRITICAL ISSUES:

- **Lack of dedicated financing**
- **Lack of proactive interest from Real Estate**

Source: TEHA Group, 2025

In North America, the data center sector recorded a +161% increase in market capitalization between 2019 and 2025, positioning itself among the most dynamic and attractive real estate asset classes

Growth in real estate market capitalization in North America (%), 2019–2025

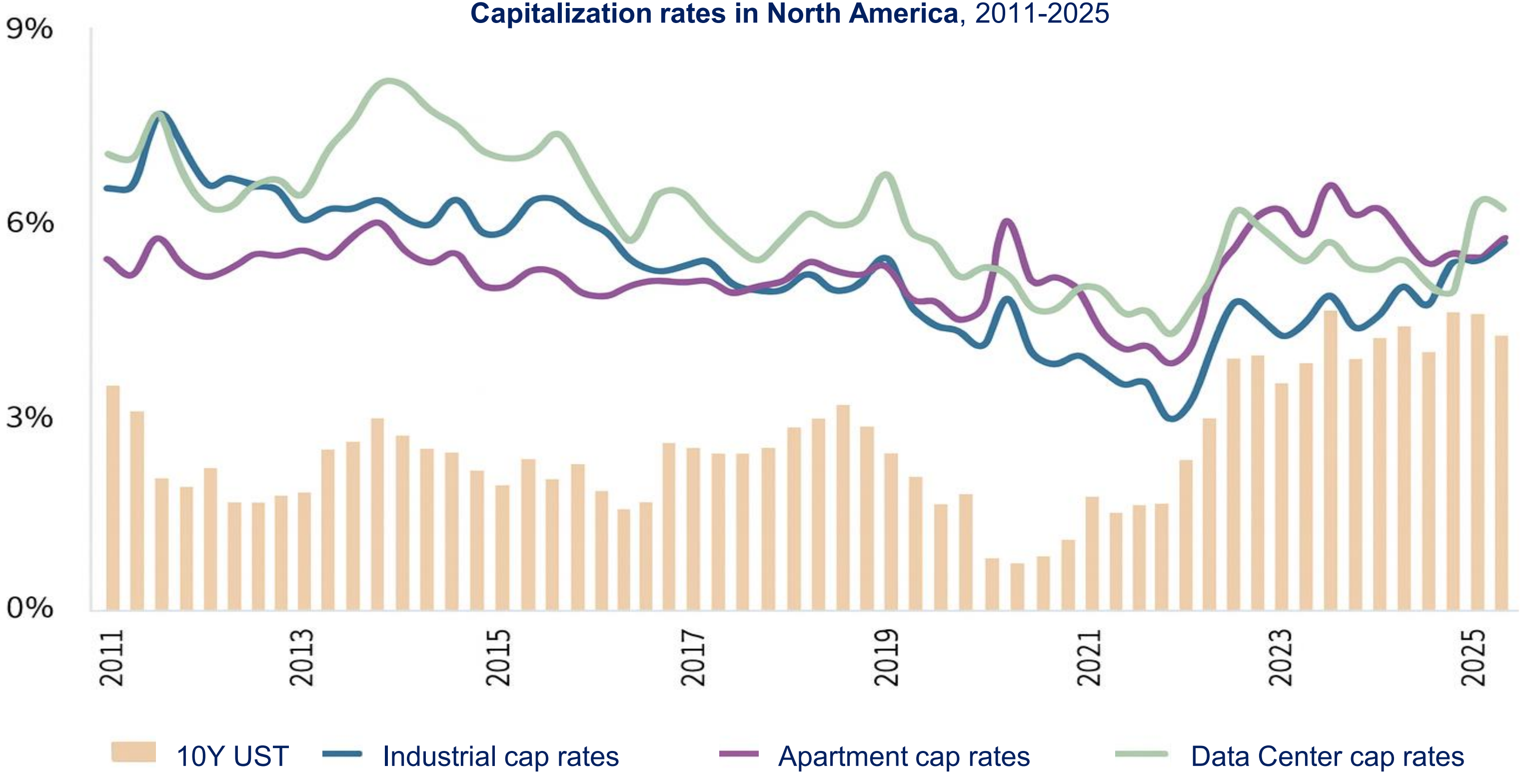


SUSTAINABLE PLACES 2025

Source: TEHA Group on JLL, 2025.

The trend in data center capitalization rates in North America shows a premium compared to real estate investments with a similar risk profile

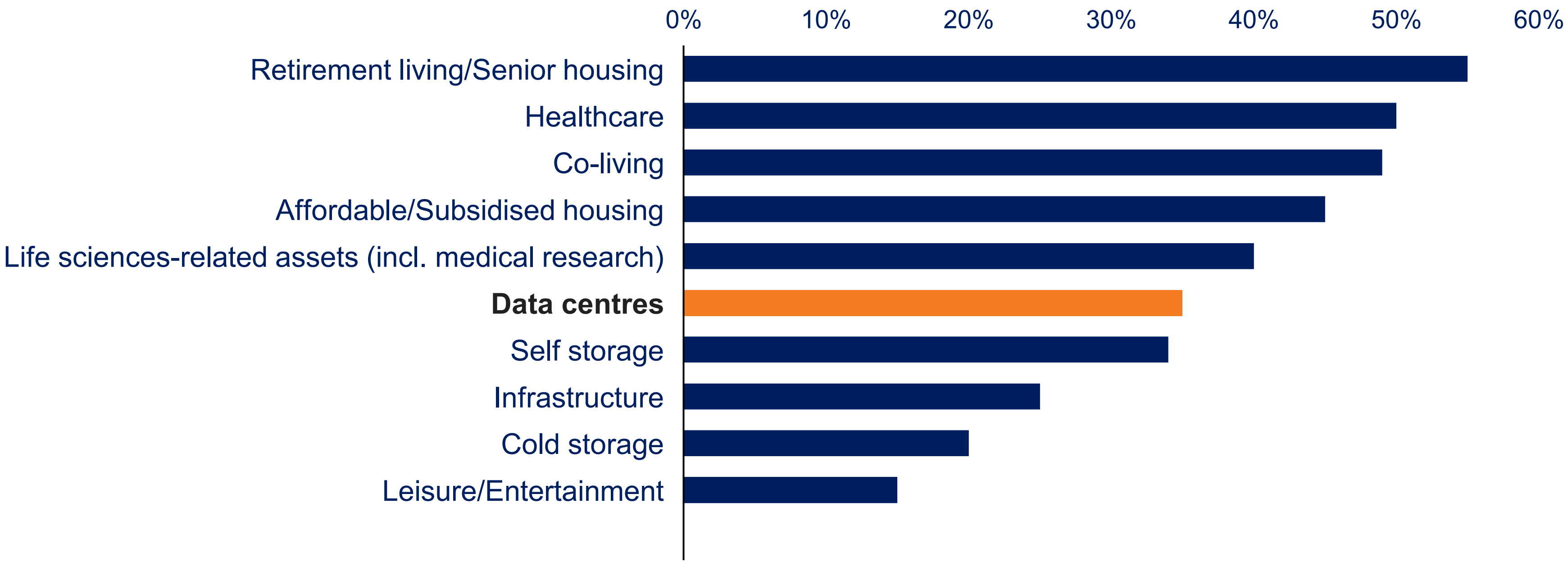
Capitalization rates in North America, 2011-2025



Source: TEHA Group on JLL, 2025.

In Europe, data centers are still far from being an alternative sector of particular interest to investors

Alternative sectors targeted for investment in Europe (%), 2024



Survey Question: “Are you pursuing investments in any of the following alternative sectors?” (multiple answers possible)

SUSTAINABLE PLACES 2025

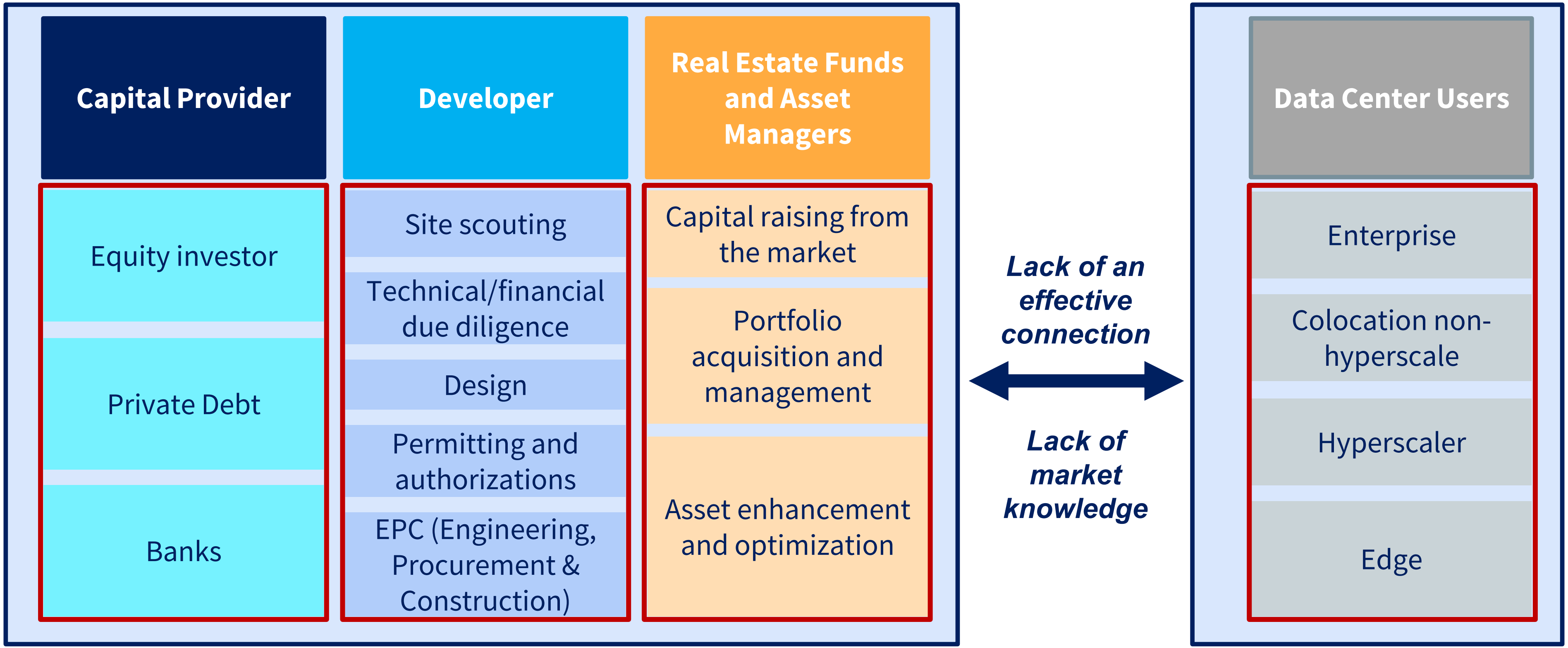
Source: TEHA Group on «European Lender Intentions Survey 2024» CBRE, 2025.

While investments in data centers are growing in the United States, the European market still needs to overcome several critical challenges

FACTOR	United States	EU
Regulation	Relatively uniform regulatory and fiscal framework	Differentiated regulatory, fiscal, urban planning, and permitting rules
Demand	More predictable demand, driven by hyperscalers	Less predictable demand evolution
Liquidity / Transparency	Homogeneous, large-scale market. High liquidity and market transparency, with easier valuation and exit strategies	Fragmented market. Lower liquidity, fewer listed operators, assets harder to value and trade
Energy and ESG	Relatively limited constraints regarding energy and sustainability	Greater energy and grid constraints, stricter ESG criteria making projects more complex and costly
Finance	Presence of REITs specialized in data centers	Lack of dedicated financial instruments for data centers
Local context	Local opposition exists but with limited impact on overall development	Frequent and more influential local opposition affecting permitting processes

Source: TEHA Group on various sources 2025.

The data center sector in Italy suffers from the absence of an integrated ecosystem connecting capital providers, developers, and funds/asset managers on one side, and end users on the other



Source: TEHA Group, 2025

The data center value chain involves multiple areas of activity

Developer

- Site scouting
- Technical/financial due diligence
- Design
- Permitting and authorizations
- EPC (Engineering, Procurement & Construction)

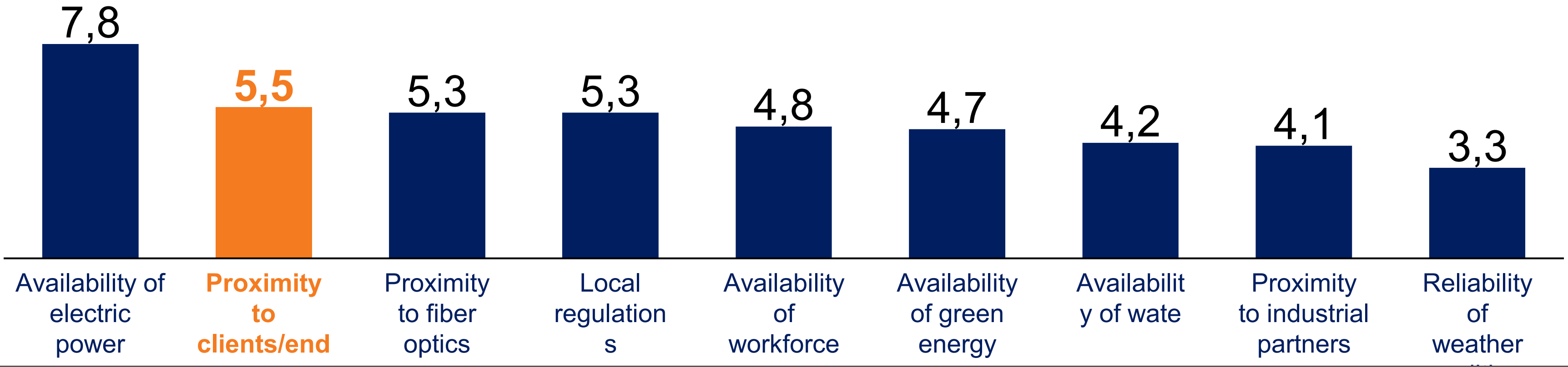
CRITICAL ISSUES:

- **Unstructured value chain and systemic criticalities (regulatory, energy)**

Source: TEHA Group, 2025

There are different types of data centers, each with specific technical and logistical requirements. Their location must consider not only the availability of energy and enabling infrastructure but also the “digital proximity” to major urban and industrial demand centers, where end users of ICT services are concentrated.

Average evaluation of key considerations in site selection, from most important (10) to least important (1)*



The development of data centers is currently heavily concentrated in Northern Italy, supported by demand, the business model requirements of hyperscalers, and the availability of enabling infrastructure.

In Central and Southern Italy, it will be strategic to activate measures that can foster the creation of diversified initiatives, such as investments in edge data centers, leveraging competitive advantages like lower energy costs.

SUSTAINABLE PLACES 2025

(*) Survey conducted by Bloom Energy

Source: TEHA Group on various sources, 2025

Critical Issues – Site Scouting

Risk of site incompatibility with demand and with energy/TLC requirements

	Issue	Critical points
1	**Location vs. demand**	• **The location must follow demand** • **Site selection must consider the different data center archetypes**
2	**Infrastructure constraints**	• **The model expected by developers** (100% grid power supply, RES 24/7, diesel backup systems) **is currently the most complex to pursue**, and few players are proposing alternative models • **Slow adoption by developers of alternative models**

Risk related to urban planning and permitting

	Issue	Critical points
3	**Environmental and urban planning impact management inherited from renewables**	• **Urban planning and permitting processes are more complex** than for renewables development and **overlap between site identification and the subsequent EPC phase**

If, in renewable energy projects, permitting mainly focuses on environmental and landscape assessments and on grid connection, for data centers the authorization process has a different nature — primarily linked to urban planning constraints, resource consumption, and potential local opposition.

	Issue	Critical points
4	**NIMBY (Not In My Back Yard) effect**	• **Local opposition (NIMBY) currently receives limited attention**

Source: TEHA Group, 2025

The data center value chain involves multiple areas of activity

CRITICAL ISSUES:

- **Talent gap**

Data Center Operator

Facility management (energy, cooling, physical security)

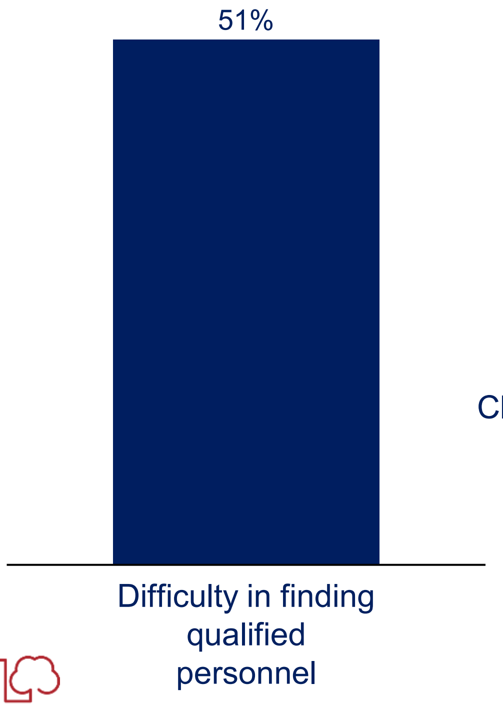
Digital infrastructure operation (networks, interconnections, SLAs)

SUSTAINABLE PLACES 2025

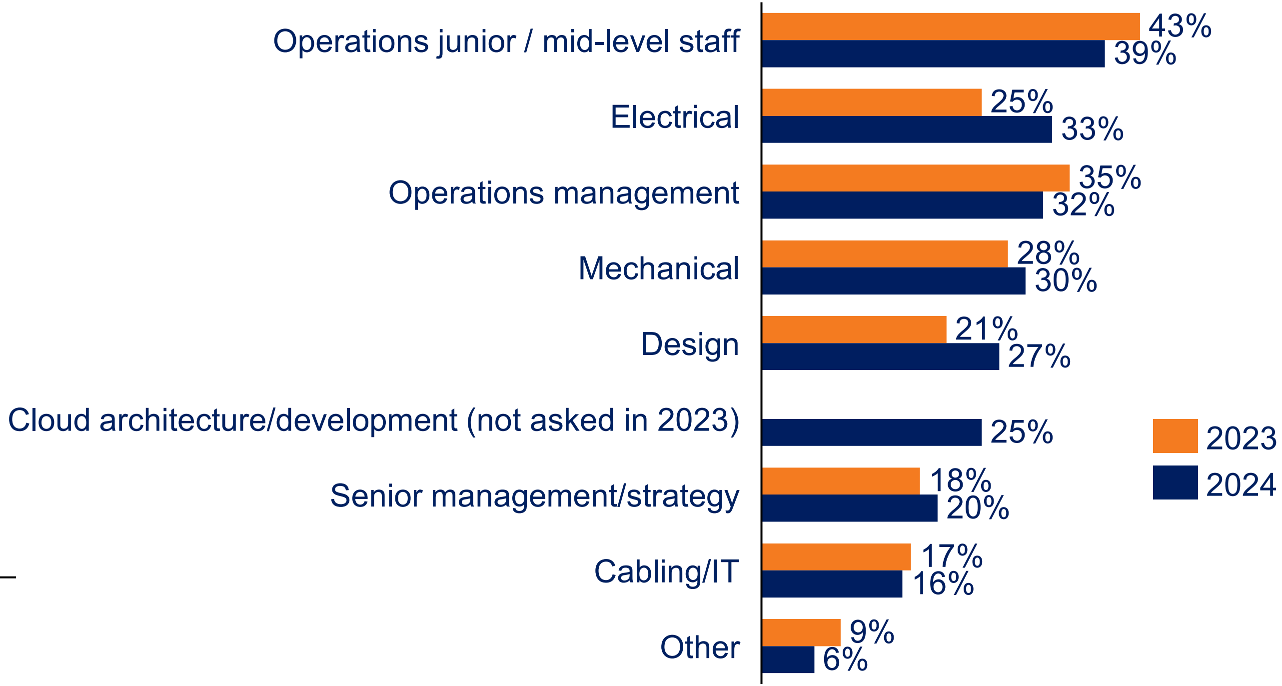
Source: TEHA Group, 2025

According to a recent Uptime Institute survey, half of data center operators struggle to find qualified talent. The most significant skill gaps include junior and mid-level operations roles (39%), electrical roles (33%) and mechanical roles (30%), as well as operational management (32%)

Difficulty in finding qualified personnel (%), 2024



Main areas where personnel skills gaps are reported (%), 2024



Source: TEHA Group elaboration on Uptime Institute Global Data Center Survey 2024, 2025.

Community Data Center Italia

COMMUNITY DATA CENTER ITALIA

Data Center Italia Community: the engine of the country's digital future — a cross-sector platform aimed at bringing together the main stakeholders of the extended data value chain.

A think tank designed to develop scenarios, strategies, and policies that can **support the growth of the sector and help position Italy as a European and global benchmark.**

Partner

Junior Partner

Knowledge Partner

THANK YOU

Alessandro Viviani

Associate Partner, TEHA Group
alessandro.viviani@ambrosetti.eu

Q&A

SUSTAINABLE PLACES 2025

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