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Seminario Online
25 Giugno 2024 ore 10:30

Introduzione al Digital Twin: Obiettivi e soluzioni

Status e avanzamenti futuri Digital Twin nel settore della Digitalizzazione

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Lab. Aperto: Ambiente di test multi-task e multi-location per la Formazione ed il Trasferimento Tecnologico (TT) (Spoke 6 & Spoke 2)



Obiettivo – (ENEA) Sviluppo di 3 Gemelli Digitali (**Digital Twins**), 3 casi d'uso – ambienti di test per studenti, aziende,... - azioni di TT) nelle 3 aree di specializzazione:

Transizione Digitale
(FP6,FP8)

Transizione Energetica
(FP1,FP2)

Biofarma&Salute
(FP4,FP7)



*A **Digital Twin** can be defined as a virtual representation of a physical asset enabled through data and simulators for real-time prediction, optimization, monitoring, controlling, and improved decision making throughout the life cycle of the asset and beyond.*

Fonte: Internet

Fonte: Rasheed, O. San and T- Kvamsdal, Digital Twin: Values, Challenges and Enablers from a Modeling Perspective, IEEE. Access, 8:21980-22012, 2020.

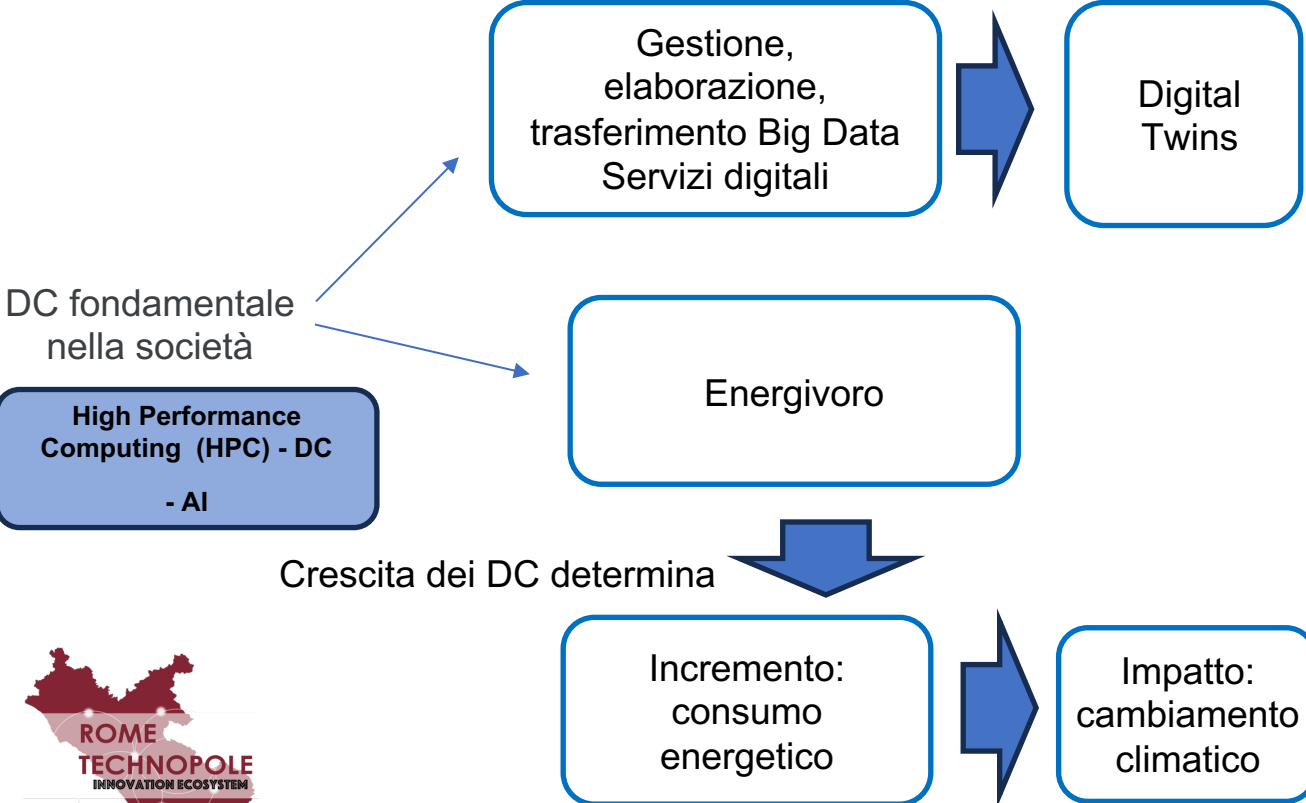




Data Center (DC)

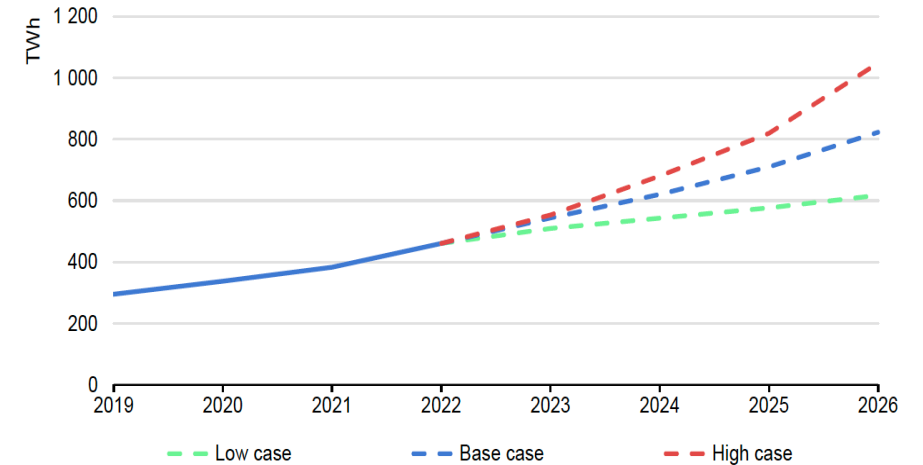
Transizione Digitale

Sistema complesso (interdipendenze: aspetti computazionali ed energetici).



Perchè un Data Center (DC) Digital Twin (DT)?

L' Agenzia Internazionale per l'Energia (AIE) stima che il consumo globale di elettricità nei DC nel 2022 sia stato di **460 TWh**, quasi il **2%** della domanda globale di elettricità che corrisponde a circa un **1%** delle relative emissioni del gas serra.



Source: IEA, *Electricity 2024, Analysis and forecast to 2026*, Report 2024

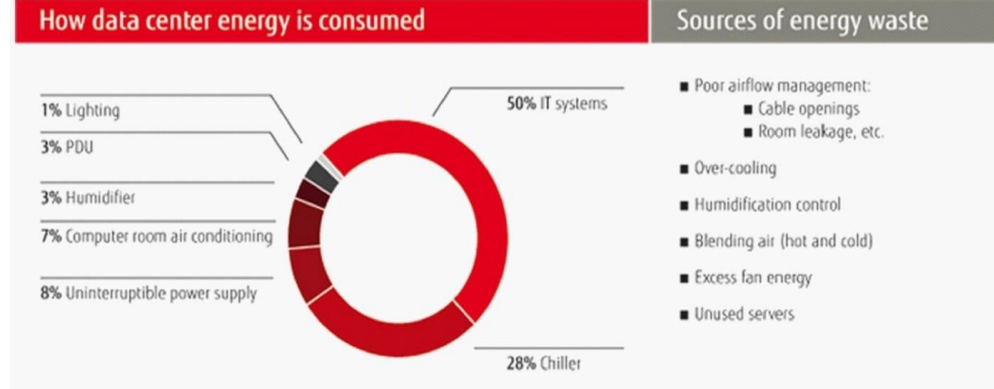




Inefficienze DC...

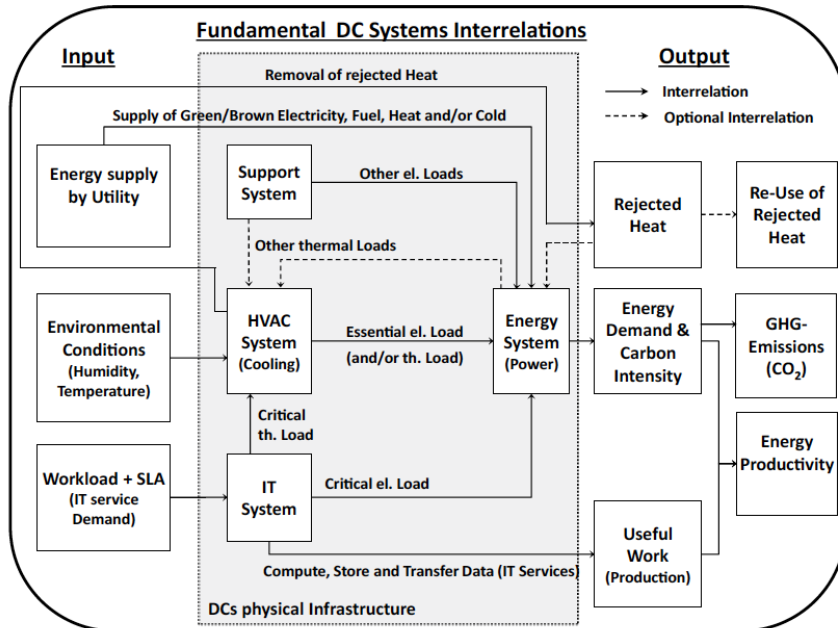
• Componenti/Consumi DC:

- Sistema IT: 50%
- Sistema di cooling: 25-50%

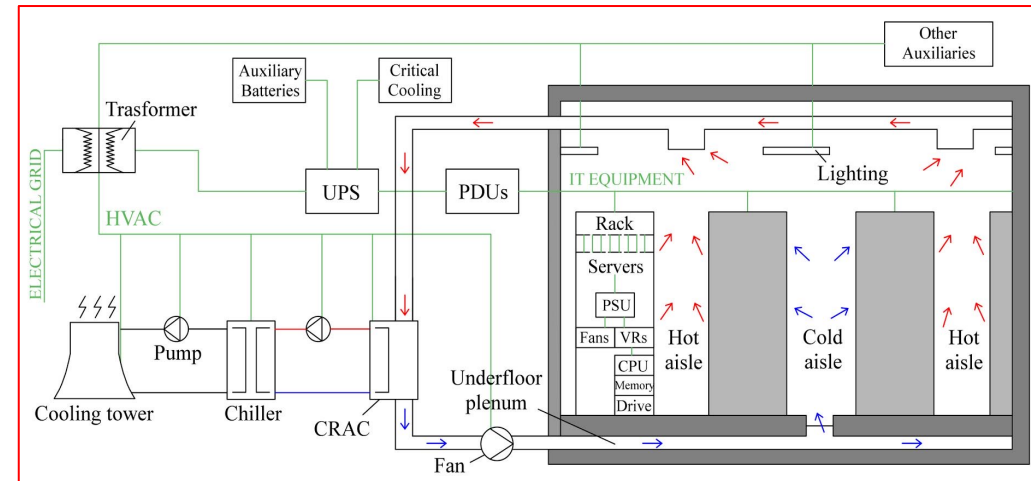


Fonte: EC, P.O. Svetoslav Mihaylov, Info Day 19 SepT. 2016

• Correlazione fra le componenti/sistemi DC



• Layout DC



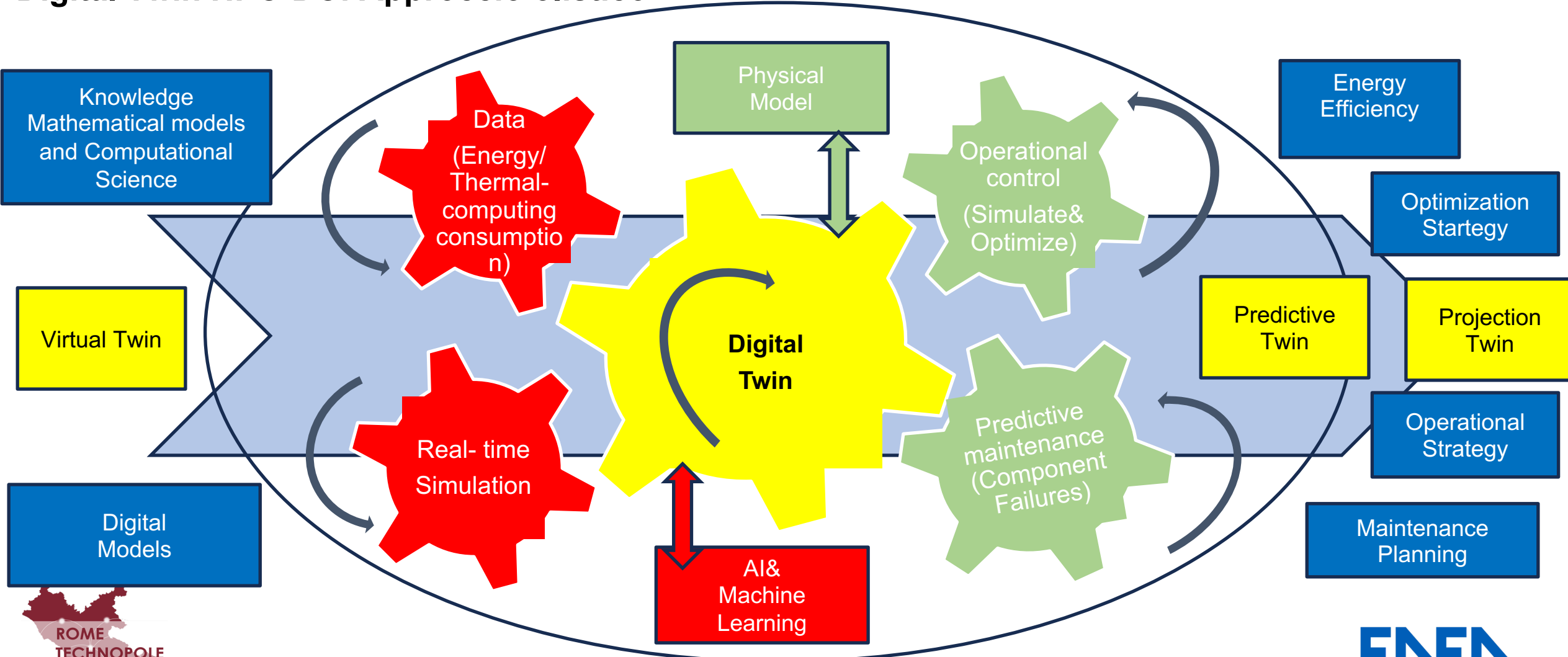
Fonte: M.Chinnici, et al., Pervasive Computing, 2016

Fonte: Schödwell et al 2013/ (Useful Work) M.Chinnici, et al., IEEE CGC Conference, 2013





Digital Twin HPC-DC: Approccio olistico





Lab. Aperto: Ambiente di test multi-task e multi-location per la Formazione ed il Trasferimento Tecnologico (TT) (Spoke 6 & Spoke 2)

Transizione Digitale
(FP6,FP8)



Partner	Task: Digital Twin HPC-DC
ENEA (Coordinatore)	To support the creation and management of Digital Twin (DT) and to implement an exhaustive High Performance Computing (HPC)-Data Center (DC) Digital Twin. - The operative analytical dashboard to provide a detailed analysis of the whole DC' management processes both in terms of performance and energy efficiency included the user requests to load distribution. - dashboard system will be integrated with the (energy, thermal computing)data collection. - Immersive environment.
EXT: Trakti s.r.l.	- Blockchain analytic dashboard, policies and immersive environment.





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Introduction to Digital Twins on HPC Datacenter

- Virtual replica of physical objects or systems
- Real-time data collection via sensors and IoT

Enea Portici CRESCO6

-434 calculation nodes

-192GB for each node

-Intel Xeon Platinum
8160

-48cores for each node

-Intel Omnipath 100gb/s





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The Digital Transition

- Accelerated by technological developments
- Significant challenges in energy consumption
- Data centers consume 1% of the world's electrical energy*



* International Energy Agency (IEA) e il report di Uptime Institute



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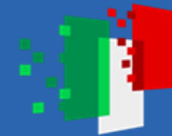
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Role of Digital Twins in Data Centers

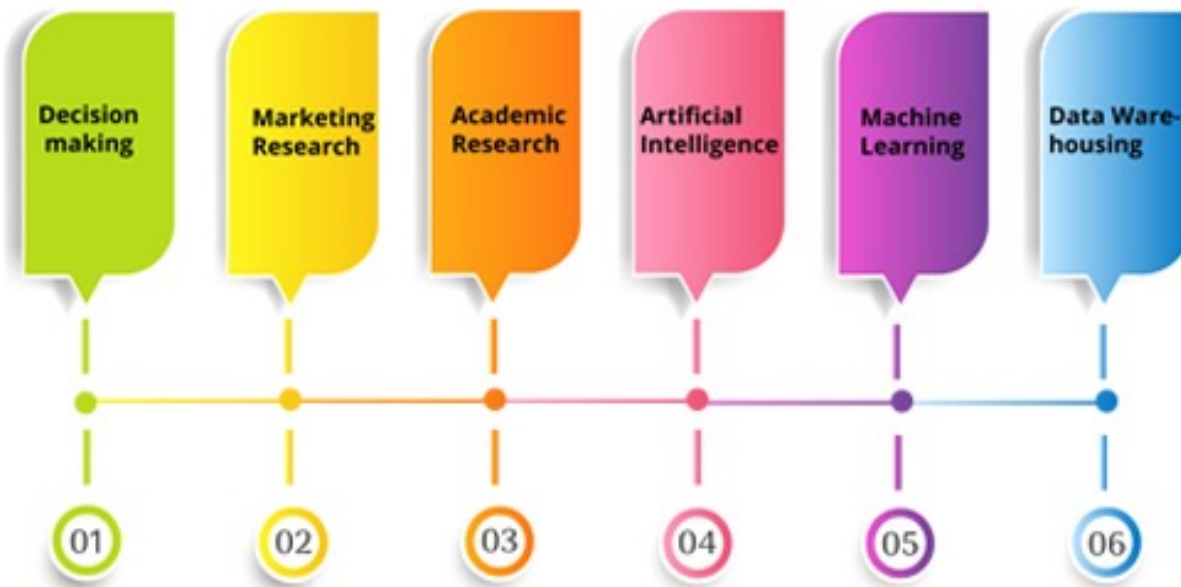
- Simulate and optimize operations
- Test cooling configurations
- Analyze airflow efficiency
- Predict component failures





Importance of Data Collection

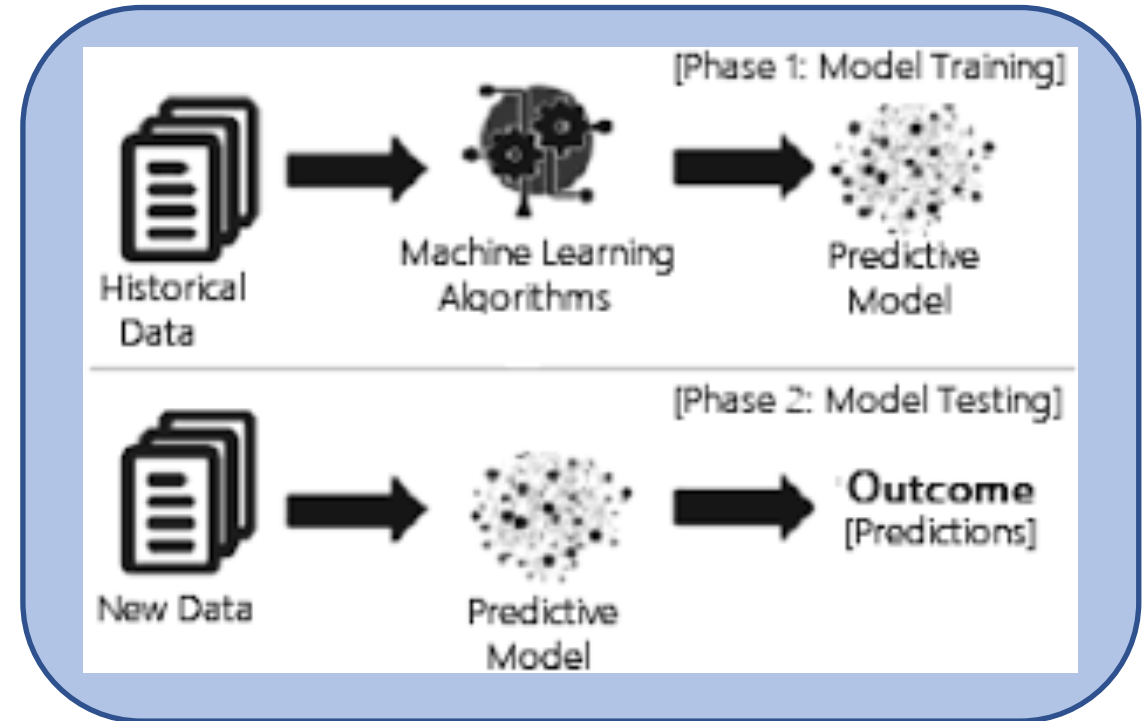
- Continuous flow of updated data
- Essential for refining predictive models





Artificial Intelligence and Predictive Models

- Analyze vast volumes of data
- Identify hidden patterns
- Predict future energy consumption
- Optimize user workloads



Digital twin



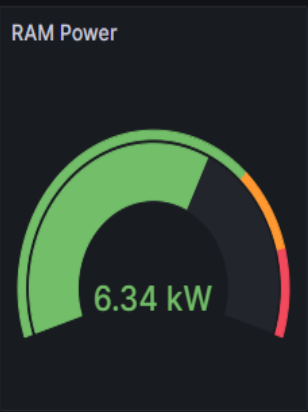
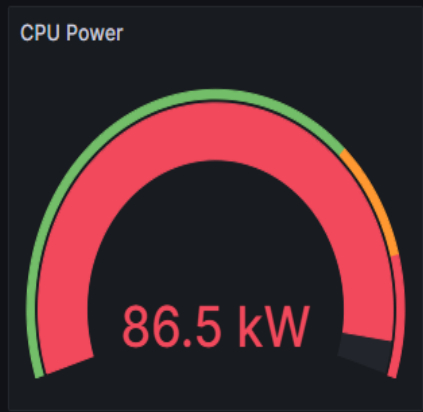
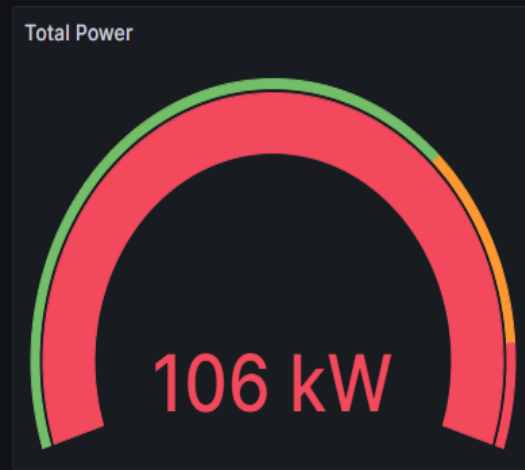


Data Visualization with Dashboards

- Clear and immediate view of performance
- Monitor energy consumption and workloads
- Inform timely decisions

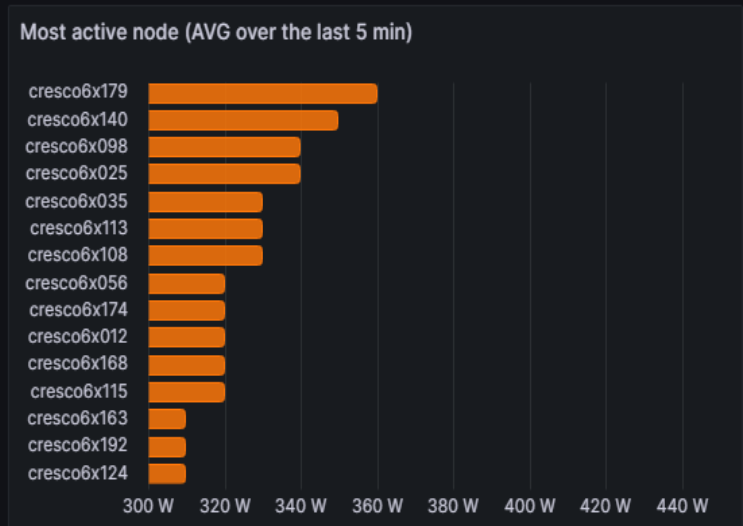


Consumption Data and Temperatures



Alert Panel

- High temperature inlet [View alert rule](#)
 - Normal
 - > 1 instance
- High working nodes tempe... [View alert rule](#)
 - Normal
 - > 1 instance



MIN power node

nodename	sys_power	cpu_power	mem_power	cpu1_temp	cpu2_temp	amb_temp	exh_temp
cresco6x129	120	90	9	37	33	19	28
cresco6x007	120	90	11	36	31	18	29



MAX power node

nodename	sys_power	cpu_power	mem_power	cpu1_temp	cpu2_temp	amb_temp	exh_temp
cresco6x179	360	290	23	82	76	20	46



Ambiente temp - Most stressed node

nodename	ambient_temp
cresco6x195	21°C
cresco6x194	21°C

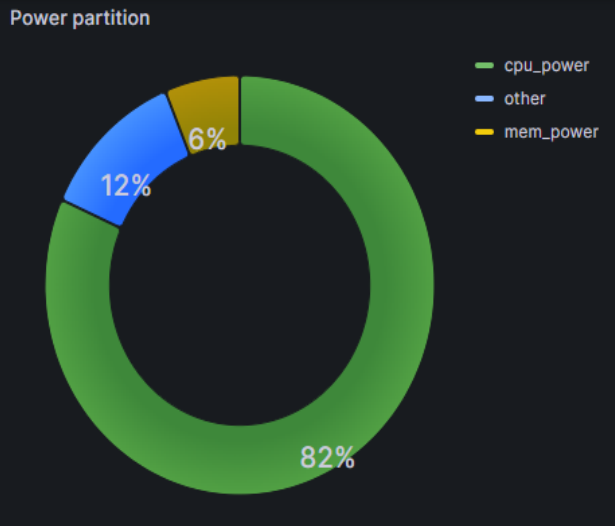
Most thermally stressed node

nodename	delta
cresco6x126	43°C
cresco6x029	43°C

CPU - most stressed node

nodename	cpu1_temp	cpu2_temp
cresco6x179	82°C	76°C

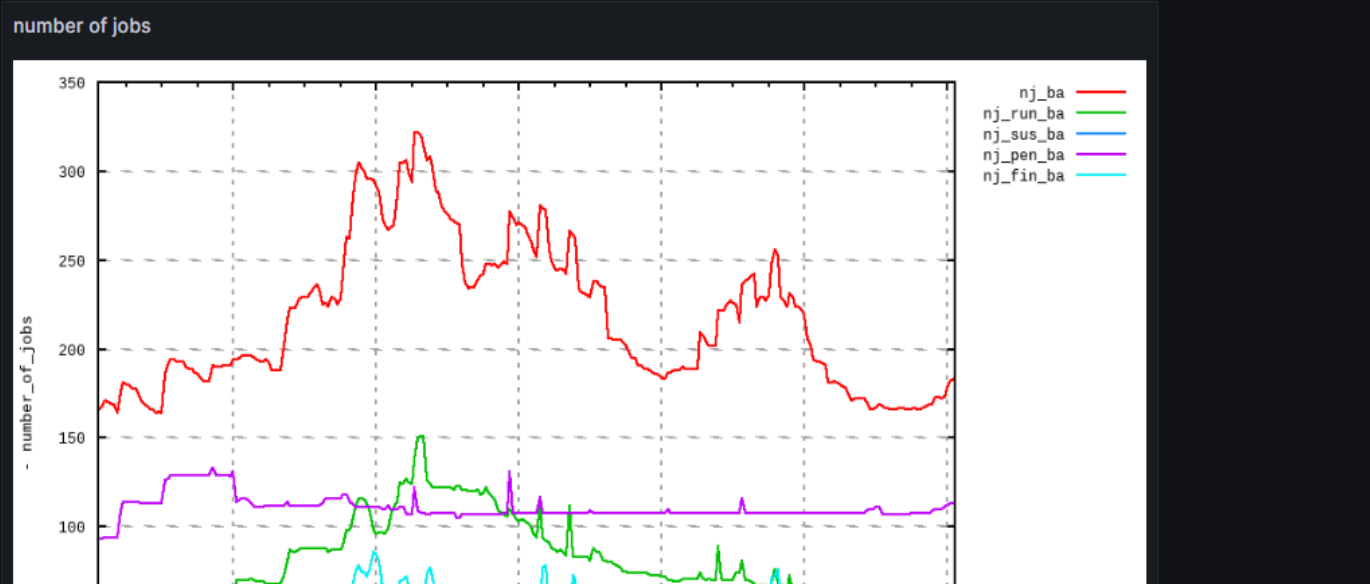
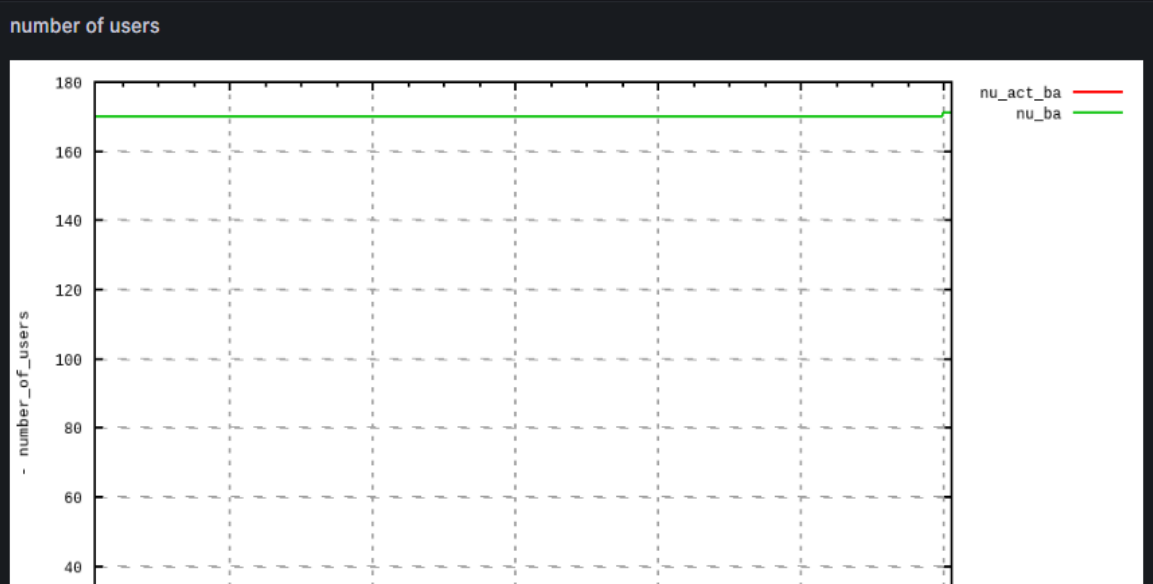




Pending Jobs

Userid	Username	Cores	Queue	Sub_script
5537	[Redacted]	32400	cresco6_48h24	eugenio
28031	[Redacted]	24024	cresco6_48h24	cimini
28111	[Redacted]	20160	cresco6_48h24	jcalda
28066	[Redacted]	10368	cresco6_48h48	sh
27184	[Redacted]	7632	cresco6_48h24	sh
26591	[Redacted]	6120	cresco6_48h24	bsub_cresco6
28007	[Redacted]	4848	cresco6_48h24	bsub_cresco6
Total		144373		

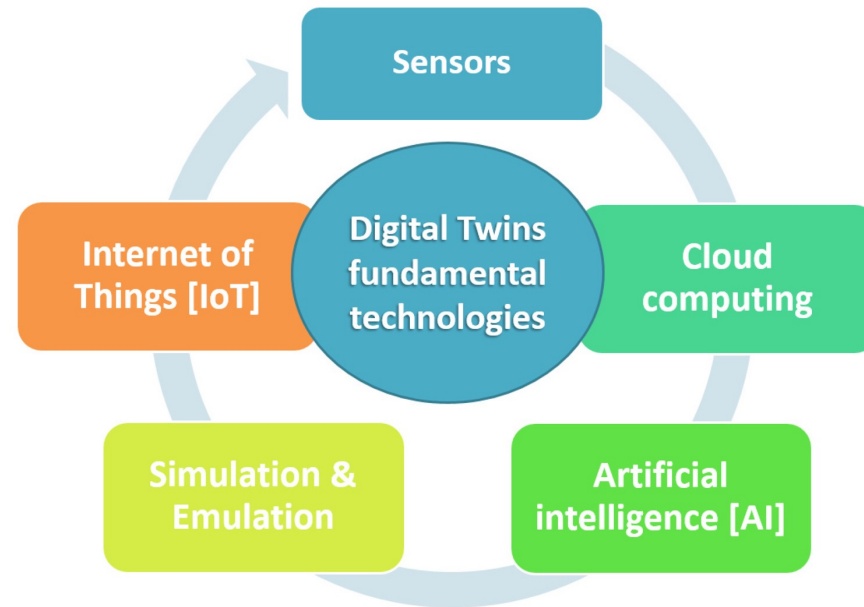
Performance graphs





Benefits of Digital Twins and AI in Data Centers

- Improve operational efficiency
- Reduce energy consumption
- Identify and eliminate bottlenecks
- Optimize resource allocation





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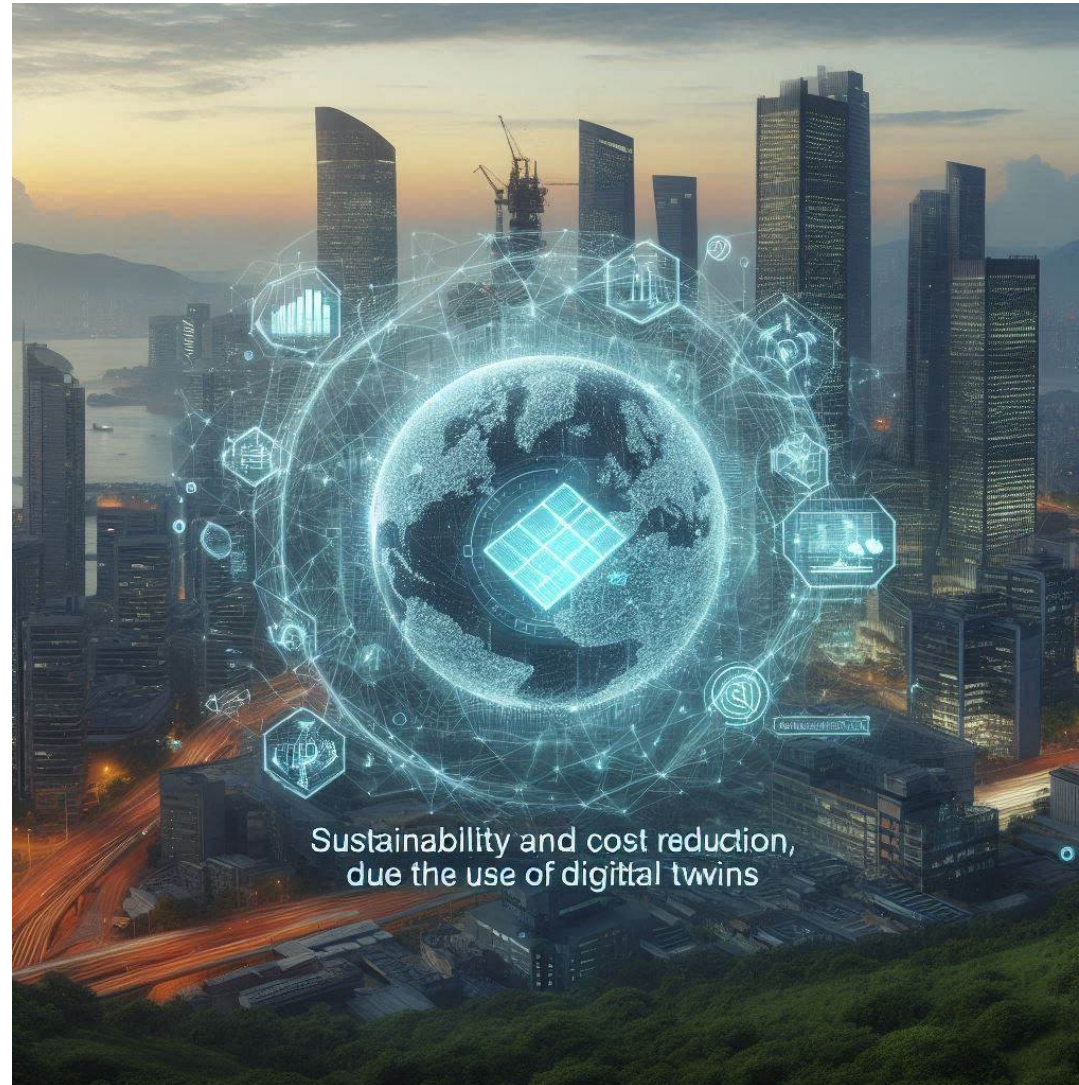


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Sustainability and Cost Reduction

- Reduce carbon footprint
- Lower operational costs





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Conclusion

- Digital transition: Essential journey
- Digital twins: Tackle energy and data challenges
- Contribute to a greener, smarter future
- Immersive environments and control dashboards
- Provide critical usage information per user

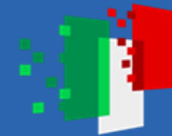




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Thanks

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<https://ict.enea.it/hpc-infrastruttura-per-il-calcolo-scientifico/>



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