



**Barcelona  
Supercomputing  
Center**  
*Centro Nacional de Supercomputación*





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# MareNostrum 5

Sergi Girona

European Workshops on HPC Infrastructures

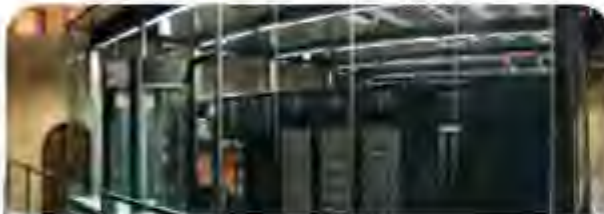
EuroHPC pre-exascale

([https://www.euhpcinfrastructureworkshop.org/?page\\_id=656](https://www.euhpcinfrastructureworkshop.org/?page_id=656))

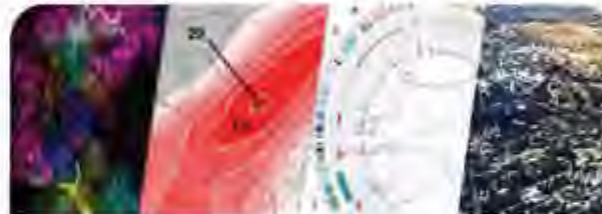
14/10/2020

# Barcelona Supercomputing Center Centro Nacional de Supercomputación

## BSC-CNS objectives



Supercomputing services  
to Spanish and EU researchers



R&D in Computer, Life, Earth and  
Engineering Sciences



PhD programme, technology  
transfer, public engagement

BSC-CNS is  
a consortium  
that includes

Spanish Government

60%



Catalan Government

30%



Univ. Politècnica de Catalunya (UPC)

10%



# MareNostrum 4

Total peak performance: **13.9 Pflops**

General Purpose Cluster:	11.15 Pflops	(1-07-2017)
CTE1-P9+Volta:	1.57 Pflops	(1-03-2018)
CTE2-Arm V8:	0.65 Pflops	(12-2019)
CTE3-AMD:	0.52 Pflops	(12-2019)

## MareNostrum 1

2004 – 42.3 Tflops  
1<sup>st</sup> Europe / 4<sup>th</sup> World  
New technologies

## MareNostrum 2

2006 – 94.2 Tflops  
1<sup>st</sup> Europe / 5<sup>th</sup> World  
New technologies

## MareNostrum 3

2012 – 1.1 Pflops  
12<sup>th</sup> Europe / 36<sup>th</sup> World

## MareNostrum 4

2017 – 11.1 Pflops  
2<sup>nd</sup> Europe / 13<sup>th</sup> World  
New technologies

# MareNostrum – Chapel infrastructure

System	Year	Total power	Power consumption (KW)	Total Cooling Capacity (KW)	Cooling
MN1	2004	3x1 MVA (2+1)	650	Outdoors: 940 Indoor: 755	Air cooled Chillers: 4 x 235 : STULZ MODELO CSO 2352 Crahs: 10 x 75,5 : STULZ ASD-740
MN2	2006		750	Outdoors: 1175 Indoor: 896,4	Air cooled Chillers: 5 x 235 : STULZ MODELO CSO 2352 Crahs: 8 x 75,5 + 2 x 146,2: STULZ ASD-(740-1500)
MN3	2012	2x2 MVA+1 MVA (partial redundancy)	1080	Outdoors: 2202,6 Indoor: 1400	Air cooled, RDHX Chillers: <ul style="list-style-type: none"> <li>• 5 x 235 : STULZ MODELO CSO 2352</li> <li>• 2 x 513,8: CLIMAVENETA NECS/CA 2015</li> </ul> HxB: 2 x 1400 Crahs: 6 x 75,5 + 2 x 146,2: STULZ ASD-(740-1500)
MN4	2017		1300		Air cooled, RDHX

## The new headquarters, ready in 2S 2020



# Location



# MareNostrum 5. A European pre-exascale supercomputer

- **200 Petaflops** peak performance ( $200 \times 10^{15}$ )
- **Experimental platform** to create supercomputing technologies “made in Europe”
- **217 M€** of investment



## Hosting Consortium:

Spain Portugal Turkey Croatia

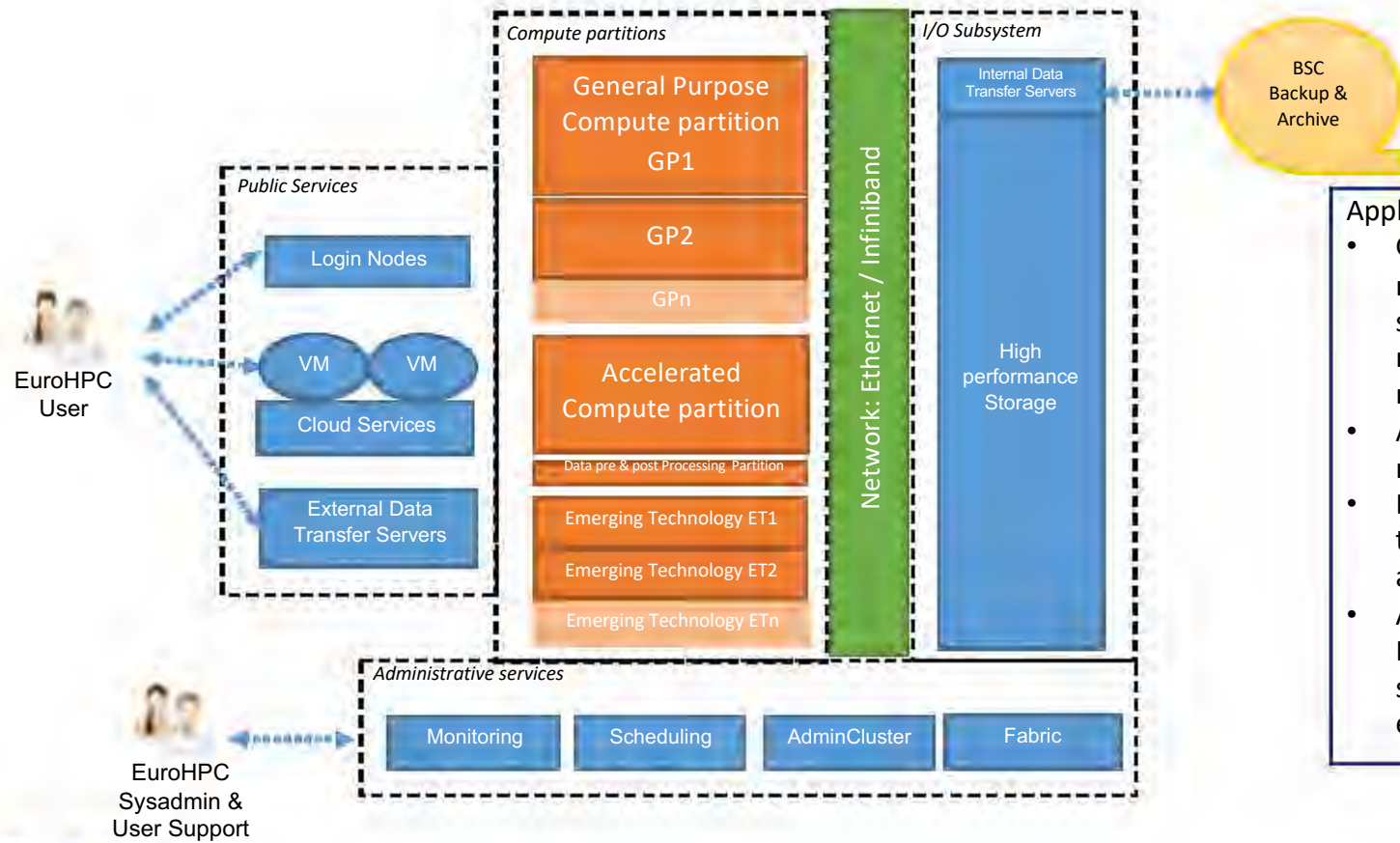


*The acquisition and operation of the EuroHPC supercomputer is funded jointly by the EuroHPC Joint Undertaking, through the European Union's Connecting Europe Facility and the Horizon 2020 research and innovation programme, as well as the Participating States Spain, Portugal, Croatia, and Turkey*





# MareNostrum5 concept



- Applications:**
- General purpose partitions, open to all researchers with MPI, OpenMP codes, standard HPC codes. Scalable machine to run codes with high scalability, thousands of nodes.
  - Accelerated partition: Any GPU application ready to scale to thousands of GPUs
  - Emerging technologies: prepare workloads to exascale era, exascale technology assessment
  - Any domain with workflows mixing General Purpose and GPU, e.g. Earth science, Life science, Engineering, AI and AI driven executions.



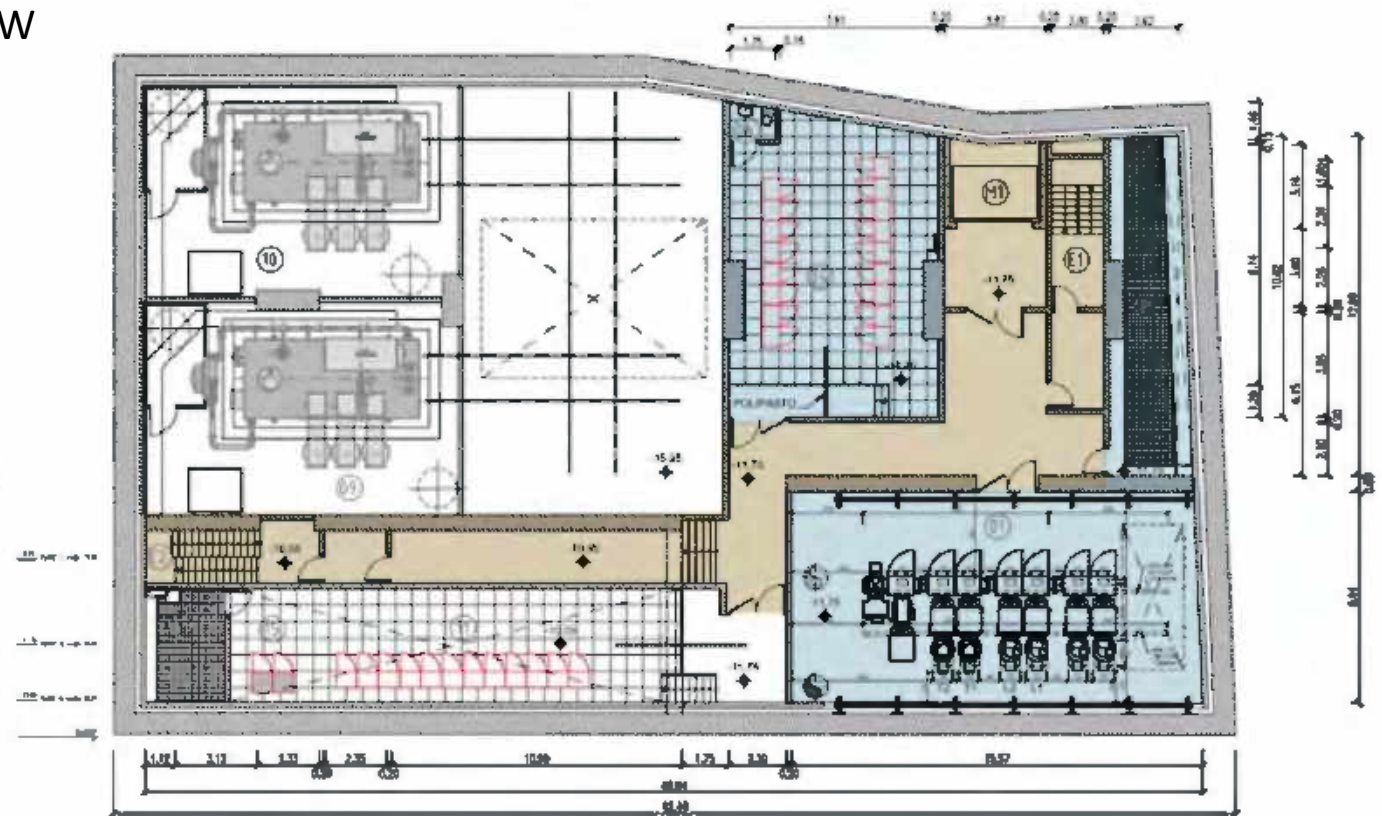
# Power supply feeder and substation

- Total capacity: 110 kV 2x25MVA, expandable to 2x40MVA
- Initial power consumption: 20MW
- Line
  - Total length (m): 1145
  - Underground
  - 2 circuits



# Power supply feeder and substation

- Total capacity: 110 kV 2x25MVA, expandable to 2x40MVA
- Initial power consumption: 20MW
- Substation
  - Constructed area: 4288 m<sup>2</sup>
  - Area: 42 x 26 meters
  - Depth: 18 meters
  - 110 kV to 25 kV



# Power supply feeder and substation

- Total capacity: 110 kV 2x25MVA, expandable to 2x40MVA
- Initial power consumption: 20MW
- 25 kV loop
- Emergency line, 5 MVA
- All green energy, by contract



# MN5 Tender some requirements Infrastructure


- Not exceed: 12 MW (under HPL) and PUE of 1,08
- Per rack requirements
  - Power, weight, recommended dimensions, dissipation, ...
  - Remove doors
  - Cabling, colours, visibility ...
- Each rack must dissipate minimum of 95% of heat generated
- Cold-water 18°C up to 1MW
- Warm-water 35°C up to 12 MW
- MN5 site as Exhibition center (L2-I10 very high)

# MN5 Site preparation

- Public tender: CONOBR02019010OP
  - Awarded on 01/08/2019
  - Awarded Prize: 12.557.990 € (excluding VAT)
    - Including: project, construction and maintenance
  - Awardee: Climava SL
  - Formalisation on 26/11/2019

- Climava SL 

- Gisela Valderrama, Jaume Villa
- <https://www.climava.com>

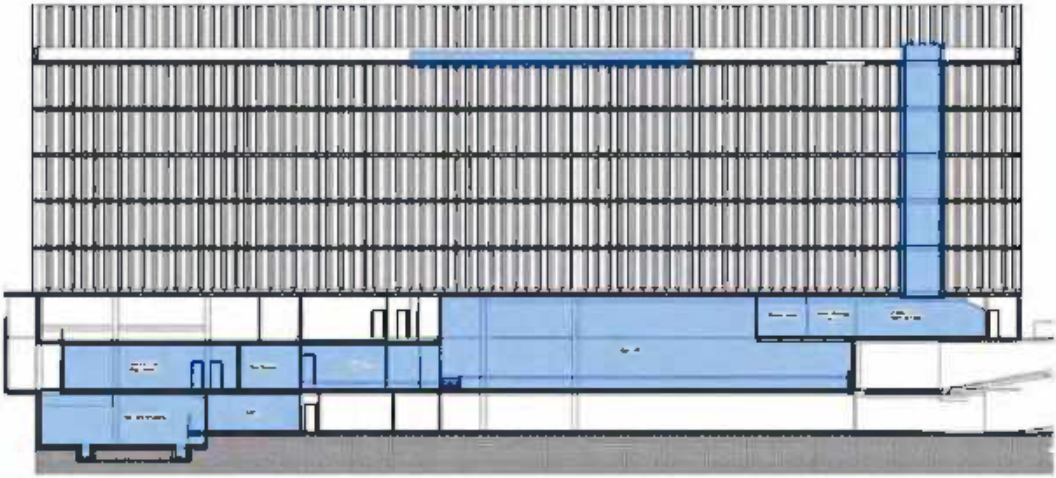
- Global Technia Consulting 
  - Lluís Gironella
  - <https://www.b-global.tech>



Expected date before covid19:	September 2020
Expected date:	April 2021

# Space available for MN5

Floor		m <sup>2</sup>	Total
P-3	Transformers	426	470
	Fire extinction	49	
P-2	Compute Room	847	1374
	Access to compute room	46	
	Batteries room	73	
	Low voltage room	408	
P-1	Chillers & Pumps room	466	711
	Riser / "PATIO"	9	
	Visitors area	236	
Roof		320	320
Total		rounded	2875



# Electrical loads

ELECTRICAL LOADS		
AREA	LOAD TYPE	kW
MNS	IT Load	13.840
	Critical IT Load	1.160
	<b>TOTAL IT</b>	<b>15.000</b>
	Chillers	663
	Cooling Towers	182
	Pumps	185
	M&E rooms ACV	51
	Auxiliary UPS	30
	<b>TOTAL M&amp;E</b>	<b>1.111</b>
	<b>TOTAL MNS</b>	<b>16.111</b>
MN4	IT Load	1.300
	Critical IT Load	200
	<b>TOTAL IT</b>	<b>1.500</b>
	M&E Load	100
	<b>TOTAL M&amp;E</b>	<b>100</b>
	<b>TOTAL MN4</b>	<b>1.600</b>
TORRE GIRONA	IT Load	480
	Critical IT Load	120
	<b>TOTAL IT</b>	<b>600</b>
	M&E Load	200
	<b>TOTAL M&amp;E</b>	<b>200</b>
	<b>TOTAL TORRE GIRONA</b>	<b>800</b>
<b>TOTAL</b>		<b>18.511</b>
PUE*	MNS + MN4	1,07

\* Overall PUE for MNS + MN4 is been taken into consideration as both are sharing the Cooling Tower and Chiller plant.

\*\* PUE has been estimated assuming rated equipment capacity, underestimating partial or season loads



# Thermal loads

PHASE	
SERVICIO	
MNS	DLC (<80kW/rack)
	RDHs (<80kW/rack)
	Air (<80kW/rack)
	RDHs (<30kW/rack)
	Air (<30kW/rack)
	Ambient CFD (Env.)
	Ambient Expo (Env. + Expo)
	M&E rooms
	LV switchboard room
	Chiller room
	Fire room
	Battery room
	DLC (<80kW/rack)
	RDHs
	Air
M&E rooms + Expo	
<b>TOTAL</b>	
Capella	DLC (<80kW/rack)
	RDHs (<80kW/rack)
	Air (<80kW/rack)
	RDHs (<30kW/rack)
	Air (<30kW/rack)
	Ambient (Env.)
	M&E rooms
	DLC (<80kW/rack)
	RDHs
	Air
	M&E rooms
<b>TOTAL</b>	
<b>TOTAL</b>	

PHASE 1				
%	HT (kW)	MT (kW)	LT (kW)	TOTAL (kW)
60%	12,600	0	0	12,600
7%	0	950	0	950
3%	0	0	450	450
95%	0	950	0	950
5%	0	0	50	50
10%	0	0	48	48
10%	0	0	48	48
40%	0	0	193	193
20%	0	0	98	98
16%	0	0	75	75
1%	0	0	5	5
3%	0	0	15	15,5
82%	12,600	0	0	12,600
12%	0	1,900	0	1,900
4%	0	0	549	549
2%	0	0	242	242
<b>0%</b>	<b>12,600</b>	<b>1,900</b>	<b>791</b>	<b>15,291</b>
62%	1,000	0	0	1,000
24%	0	392	0	392
14%	0	0	228	228
60%	0	108	0	108
10%	0	0	12	12
50%	0	0	30	30
50%	0	0	30	30
56%	1,000	0	0	1,000
28%	0	500	0	500
15%	0	0	270	270
2%	0	0	30	30
<b>100%</b>	<b>1,000</b>	<b>500</b>	<b>300</b>	<b>1,800</b>
<b>0%</b>	<b>13,600</b>	<b>2,400</b>	<b>1,091</b>	<b>17,091</b>

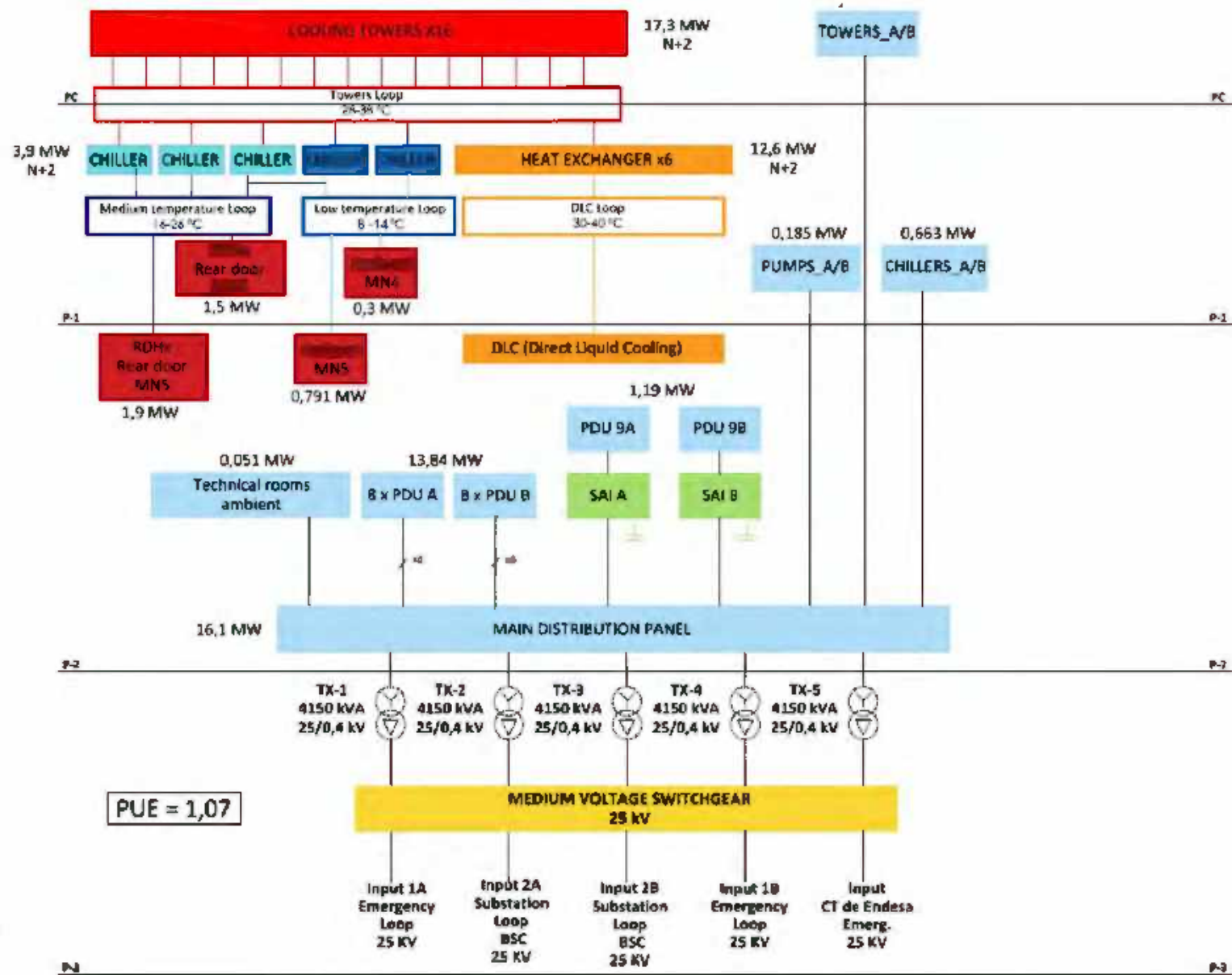
PHASE 2				
%	HT (kW)	MT (kW)	LT (kW)	TOTAL (kW)
60%	12,600	0	0	12,600
7%	0	950	0	950
3%	0	0	450	450
95%	0	950	0	950
5%	0	0	50	50
10%	0	0	48	48
10%	0	0	48	48
40%	0	0	193	193
20%	0	0	98	98
16%	0	0	75	75
1%	0	0	5	5
3%	0	0	15	15,5
82%	12,600	0	0	12,600
12%	0	1,900	0	1,900
4%	0	0	549	549
2%	0	0	242	242
<b>0%</b>	<b>12,600</b>	<b>1,900</b>	<b>791</b>	<b>15,291</b>
62%	1,000	0	0	1,000
24%	0	392	0	392
14%	0	0	228	228
60%	0	108	0	108
10%	0	0	12	12
50%	0	0	30	30
50%	0	0	30	30
56%	1,000	0	0	1,000
28%	0	500	0	500
15%	0	0	270	270
2%	0	0	30	30
<b>100%</b>	<b>1,000</b>	<b>500</b>	<b>300</b>	<b>1,800</b>
<b>0%</b>	<b>13,600</b>	<b>2,400</b>	<b>1,091</b>	<b>17,091</b>

GENERATION
CAPACITY (N)
REDUNDANCY

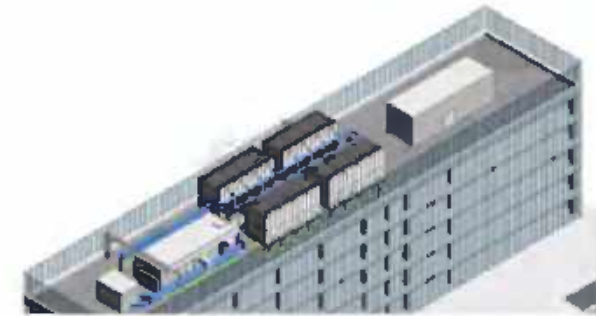
HT (kW)	MT (kW)	LT (kW)	CT (kW)
12,600	2,871	1,150	17,297
N+2	N+2	N+2	N+2

HT (kW)	MT (kW)	LT (kW)	CT (kW)
13,600 (*)	2,871	1,150	17,297
N+2	N+2	N+2	N+2

(\*) Heat exchanger upgrade is required for N+2 redundancy

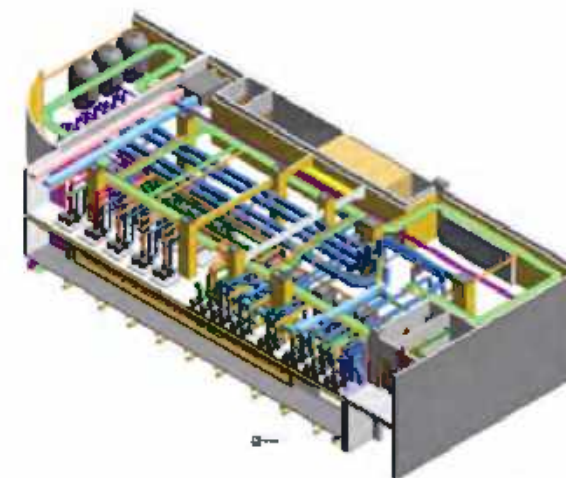


# Cooling towers



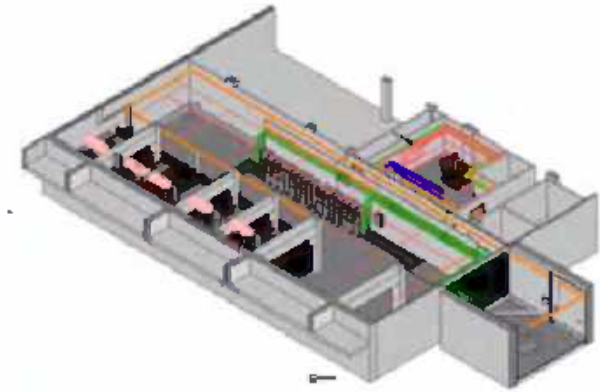
- 14+2 Torraval CTFP-2436(SB)
- Water flow: 1500 m<sup>3</sup>/h
- Outlet: 28,1°C
- Inlet: 38,1°C
- Wet bulb temperature: 25°C
- Total dissipation power: 17300 kW

# Heat exchanger, chiller and pumps room



- 6 (4+2) Heat exchanger T25-PFM
  - Water flow: 1170 m<sup>3</sup>/h (tower) – 1170 m<sup>3</sup>/h (racks)
  - Temperatures
    - To tower: outlet: 28,1°C , Inlet: 38,1°C
    - To rack: outlet: 30°C , Inlet: 40°C
  - Total dissipation power: 13500 kW
- 5 (2 MT + 1 LT+ 2) Chillers
  - Water flow: 302 m<sup>3</sup>/h + 151 m<sup>3</sup>/h
  - Temperatures, separate loops
    - 16°C – 26°C
    - 8°C – 14°C
    - To rack: outlet: 30°C , Inlet: 40°C
- Redundancy: N+2 in chillers and heat exchangers

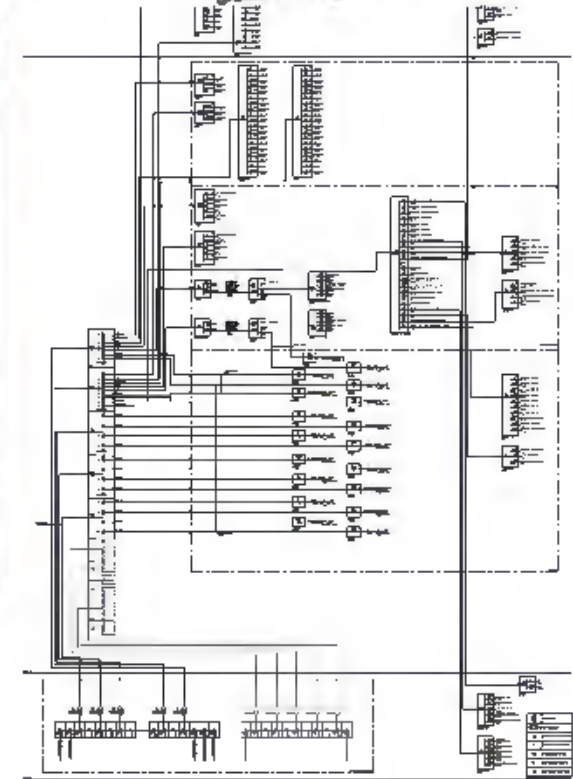
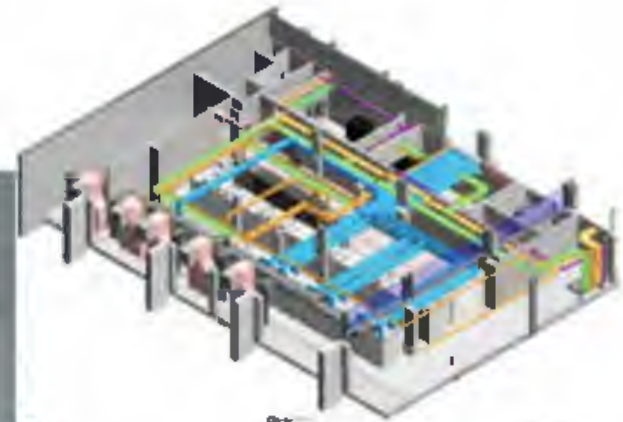
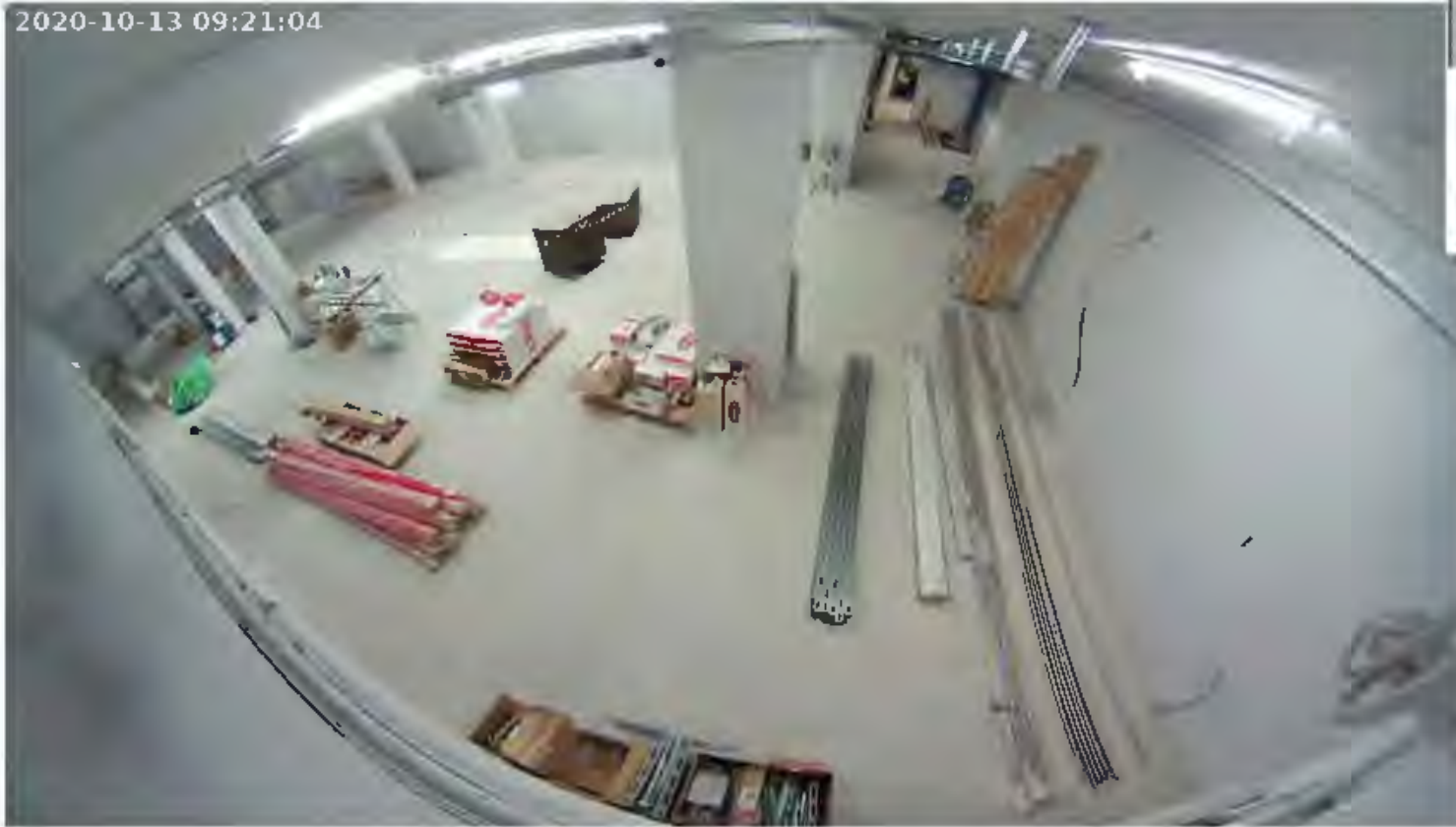
# Transformers



- 5 x TRANSFORMADOR 4150KVA  
VACUUM CAST FILLED DRY
- 4150 kVA
- Primary: 25 kV, Secondary: 420 V
- Frequency: 50Hz
- 3 phases

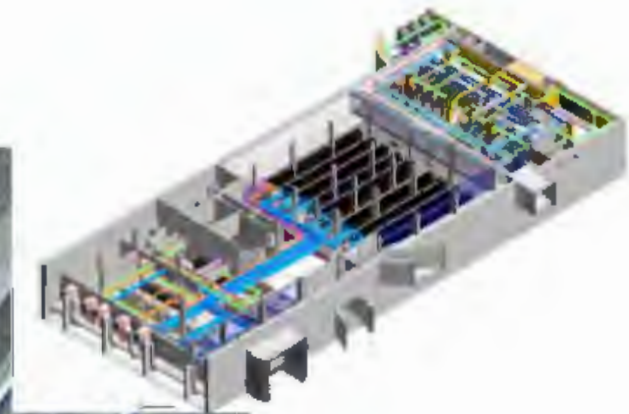
# Low Voltage/Switchboard Room

2020-10-13 09:21:04



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# Compute room



# Virtual compute room, Cooling





# Virtual compute room, Power



# Virtual compute room





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**EXCELENCIA  
SEVERO  
OCHOA**

# Thank you

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