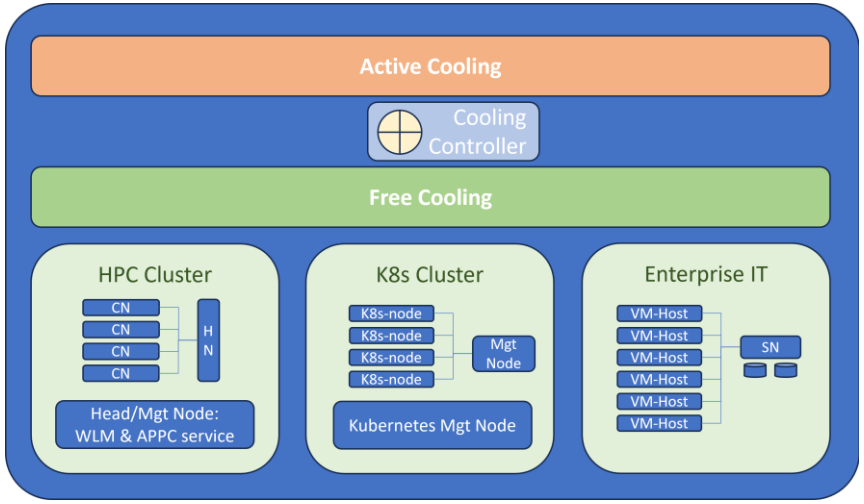
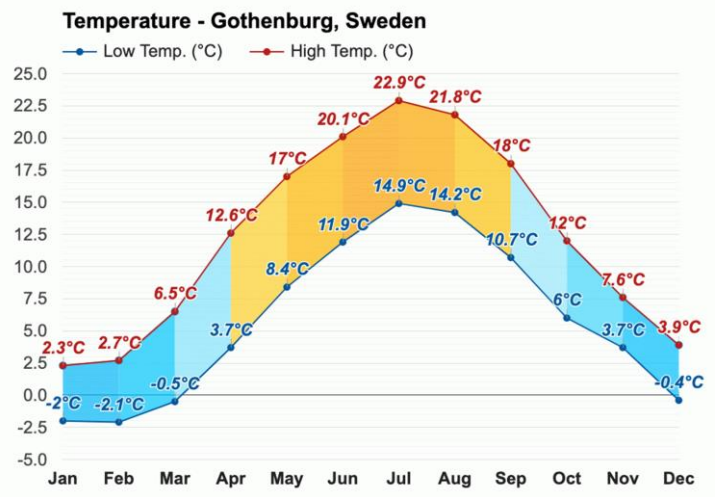
APPC Active Power Profile Control

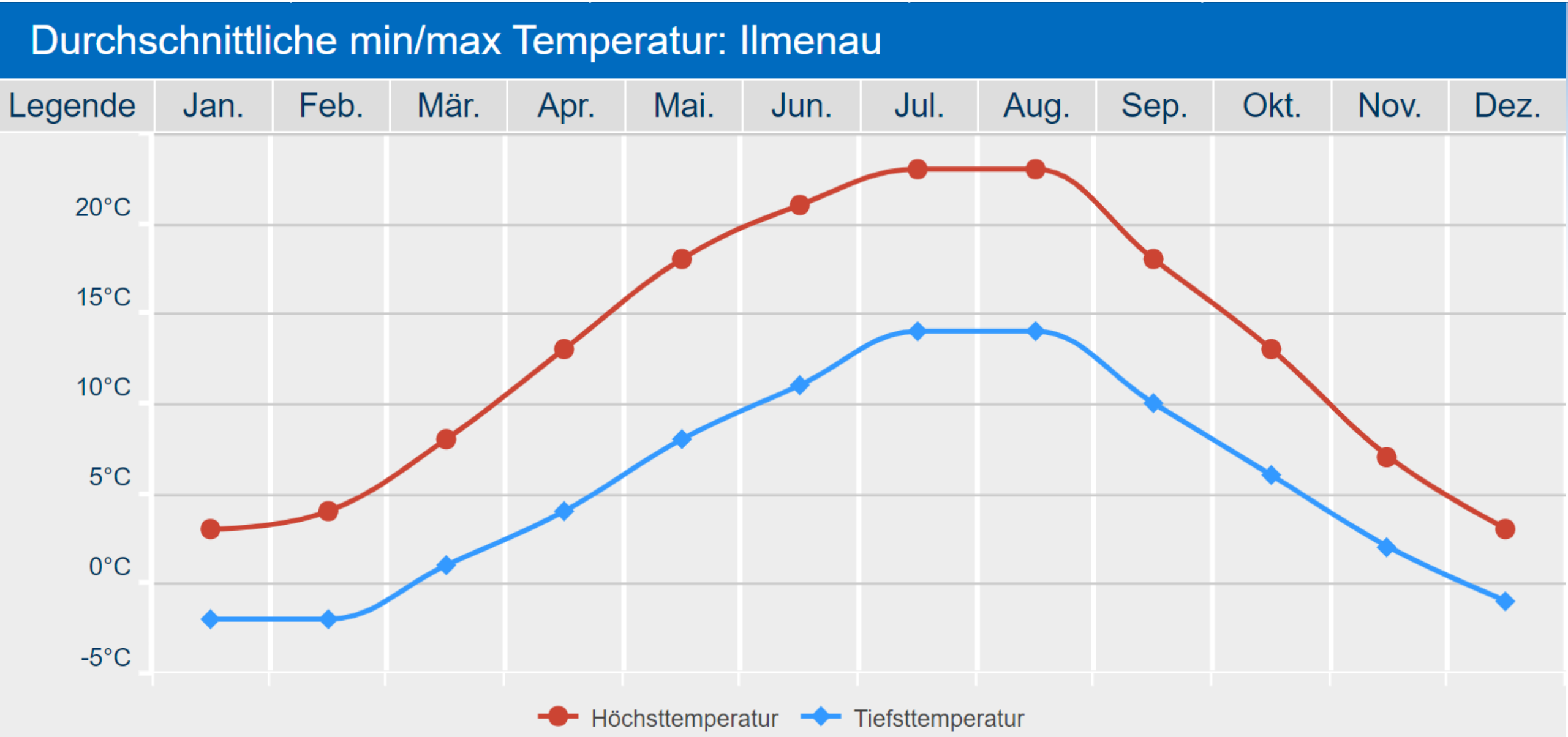
Sustainability that pays off by reduced energy costs.

Solution: managing the power envelope

Steer/reduce/avoid switching to active cooling by APPC





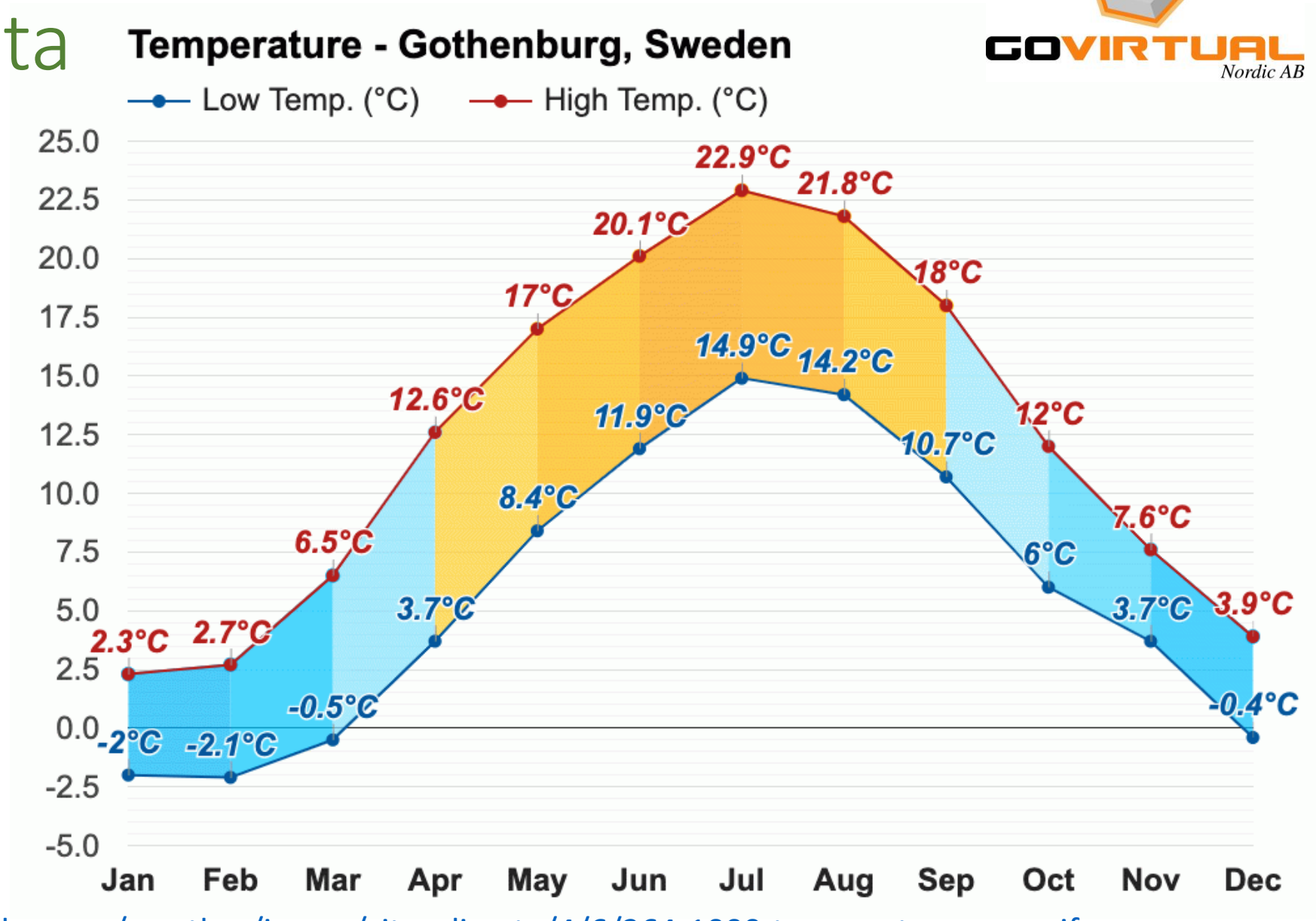


https://www.wetter24.de/vorhersage/klima/deutschland/ilmenau/18235372/

Weather Data

Weather data from different sources.

This example reflects multi-year average.



https://www.weather-atlas.com/weather/image/city_climate/4/6/264-1000-temperature-c-en.gif

Weather Data

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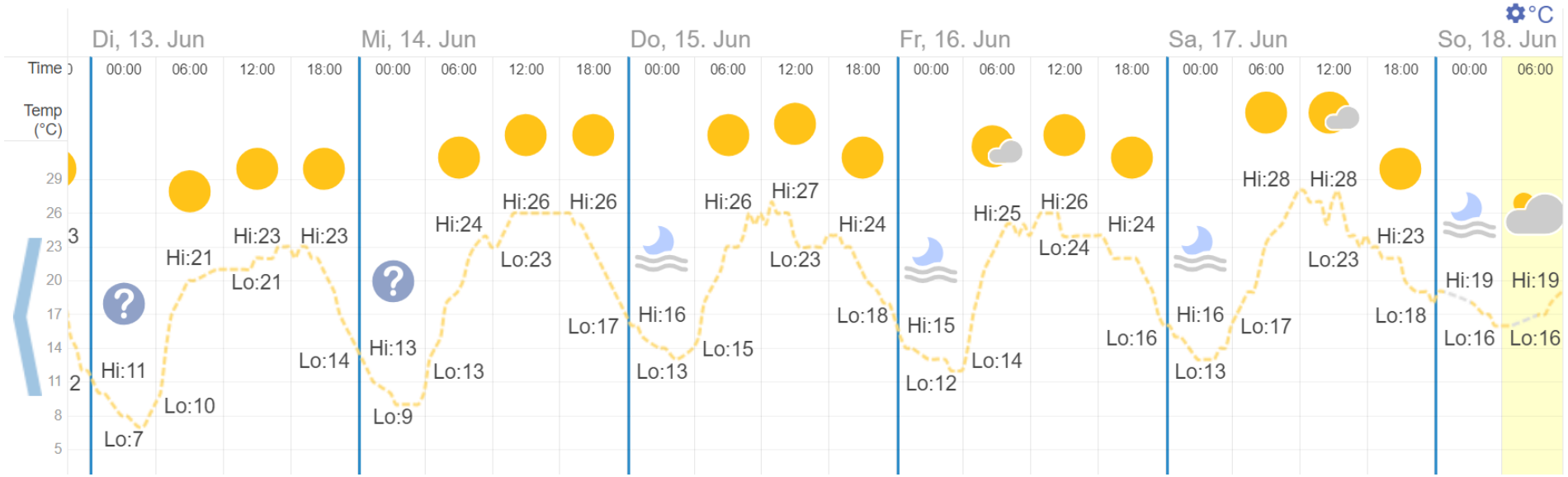
Juni 2023 Weather in Gothenburg — Graph



June 2023 Gothenburg Weather

Day	High (°C)	Low (°C)
June 1	18,90	9,70
June 2	17,00	7,40
June 3	19,30	6,80
June 4	21,20	8,90
June 5	21,30	9,50
June 6	20,70	12,50
June 7	23,20	10,30
June 8	21,40	12,10
June 9	25,10	13,10
June 10	25,50	11,70
June 11	24,00	12,50
June 12	25,20	12,50
June 13	24,30	12,40
June 14	28,50	13,10
June 15	27,50	17,50
June 16	27,90	15,40
June 17	29,60	15,90
June 18	22,90	16,80
June 19	23,30	14,10
June 20	23,90	17,90
June 21	22,30	17,40
June 22	22,20	16,60
June 23	21,80	16,70
June 24	21,20	14,60
June 25	23,80	14,40
June 26	28,90	15,10
June 27	21,50	15,40
June 28	24,30	14,40
June 29	22,60	16,40
June 30	20,70	15,20

Weather data from different sources.

Graph https://www.timeanddate.com/weather/sweden/goteborg/historic?month=6&year=2023

Table https://www.extremeweatherwatch.com/cities/gothenburg/year-2023#:~:text=June%202023%20Gothenburg%20Weather

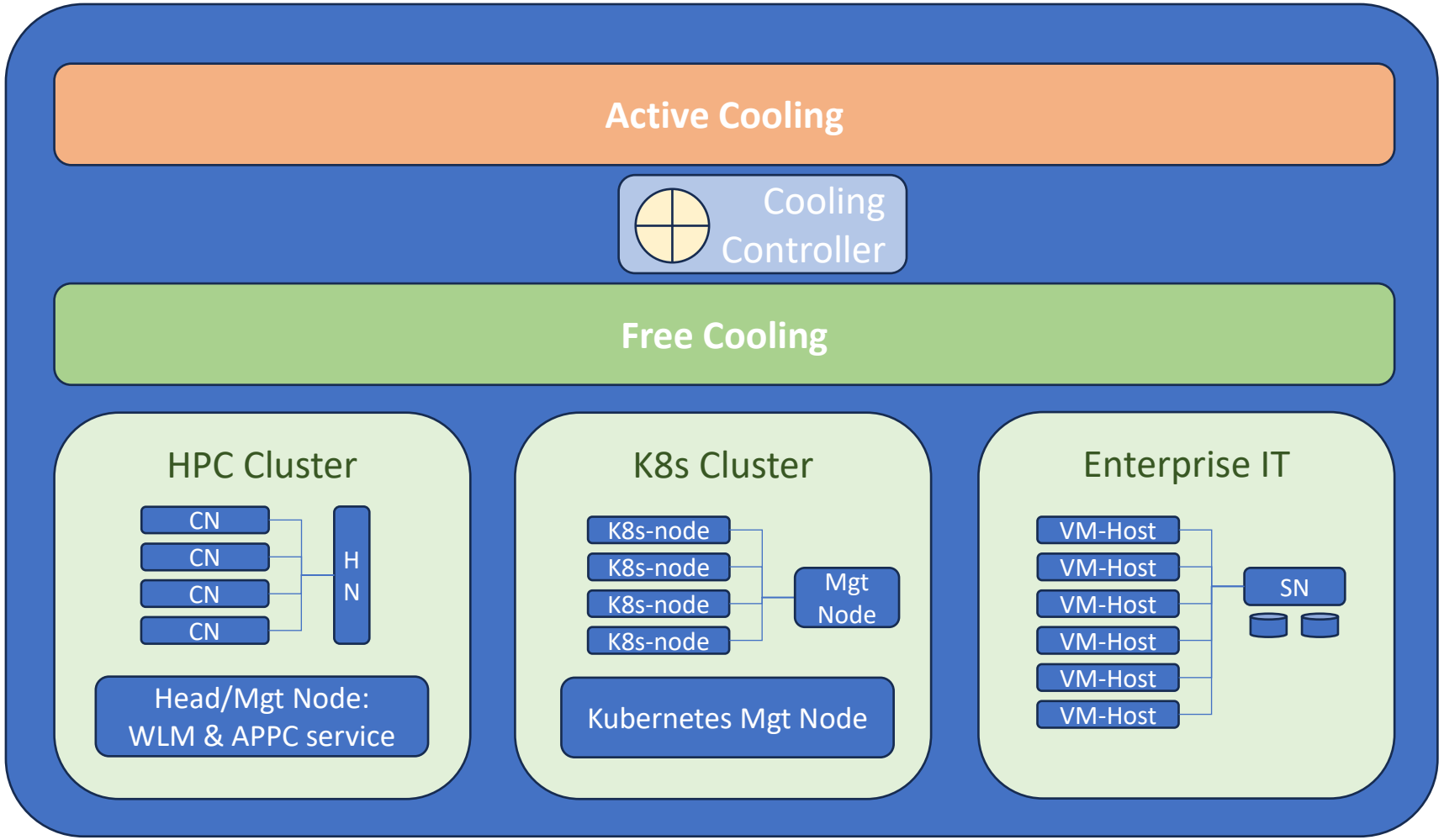
Compare:

June 14th low: 13,1°C or 9°C

June 14th high: 28,5°C or 26°C

This is actually not a question of precision, but rather ***where*** the sensors are located and the impact of averaging between multiple sensor locations.

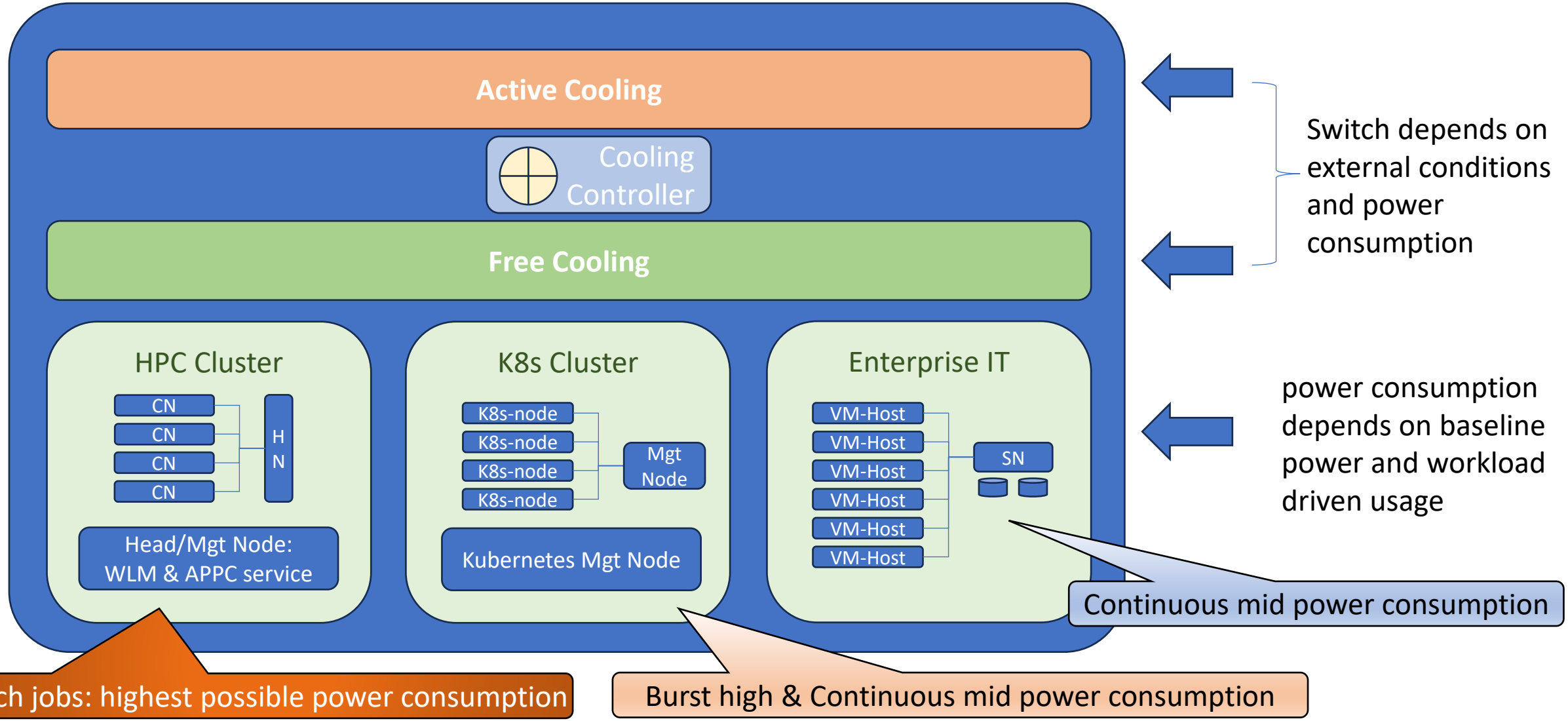
Example Data Center



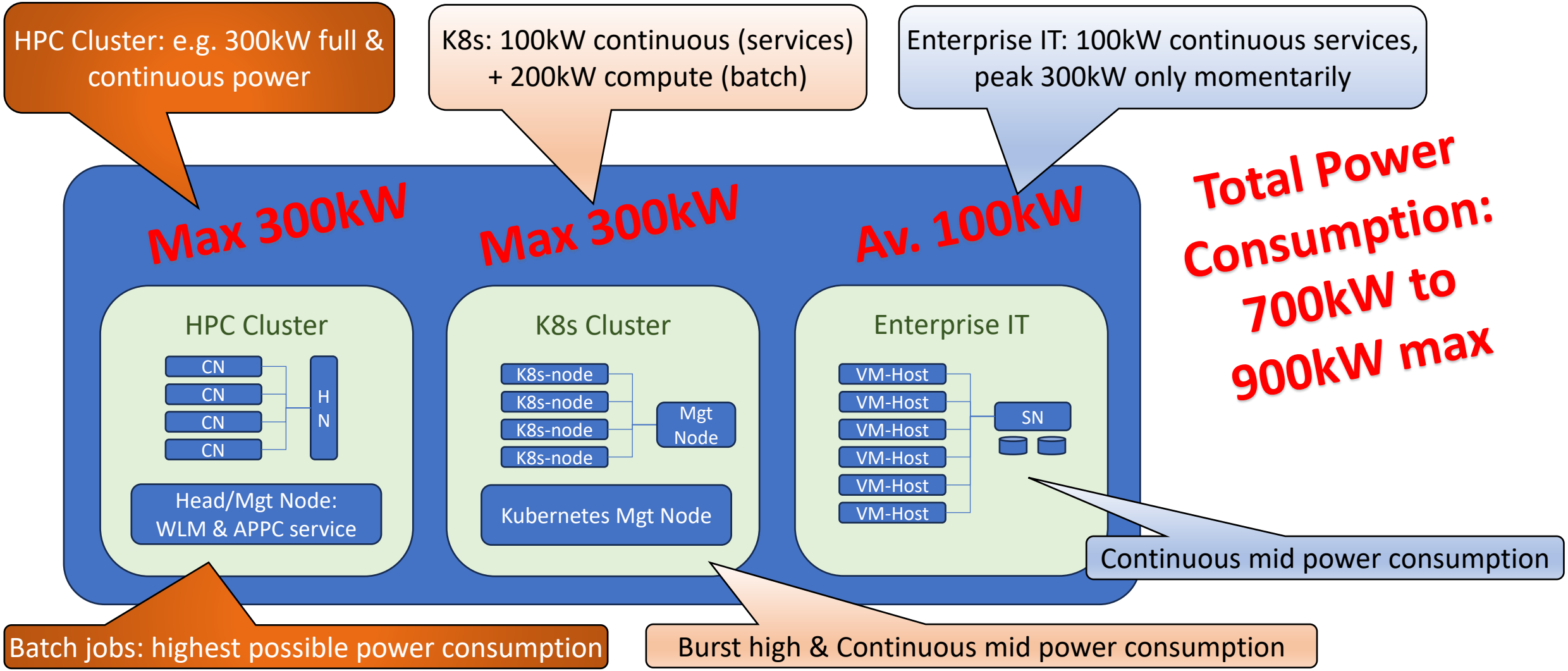
Switch depends on external conditions and power consumption

power consumption depends on baseline power and workload driven usage

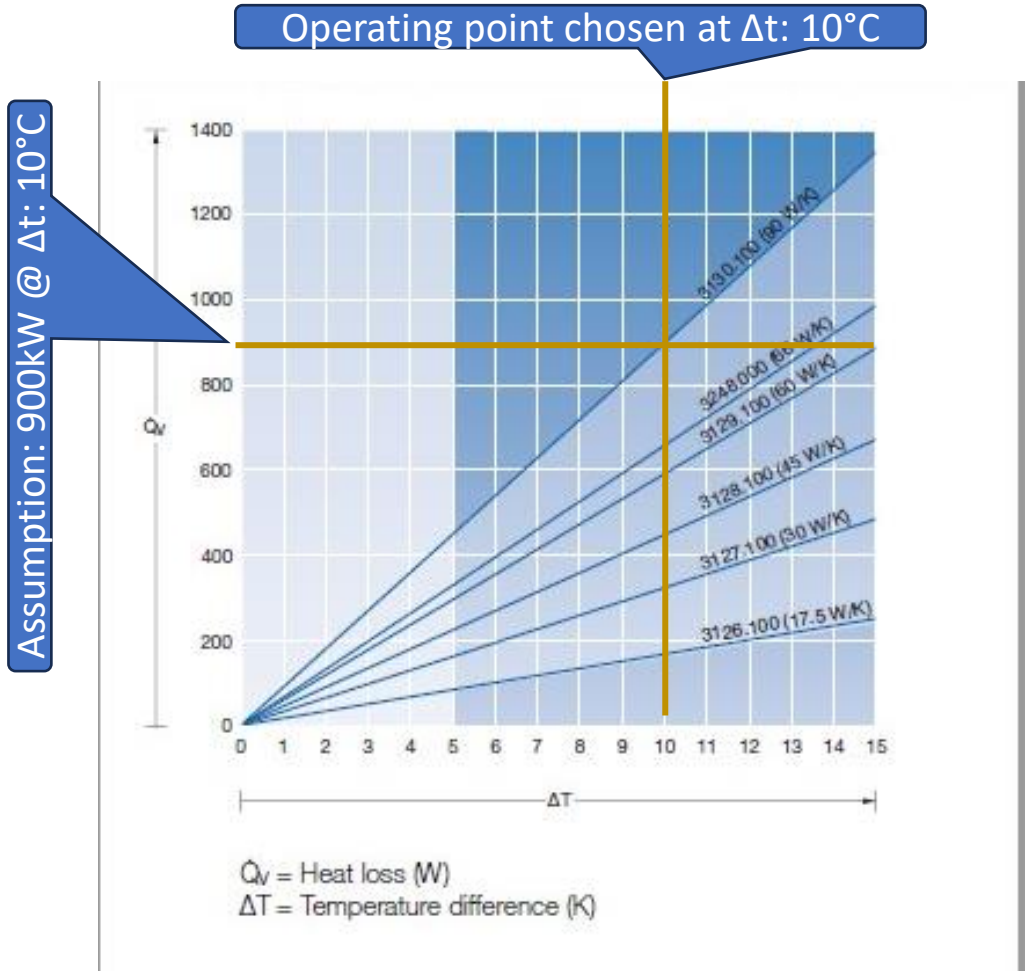
Example Data Center

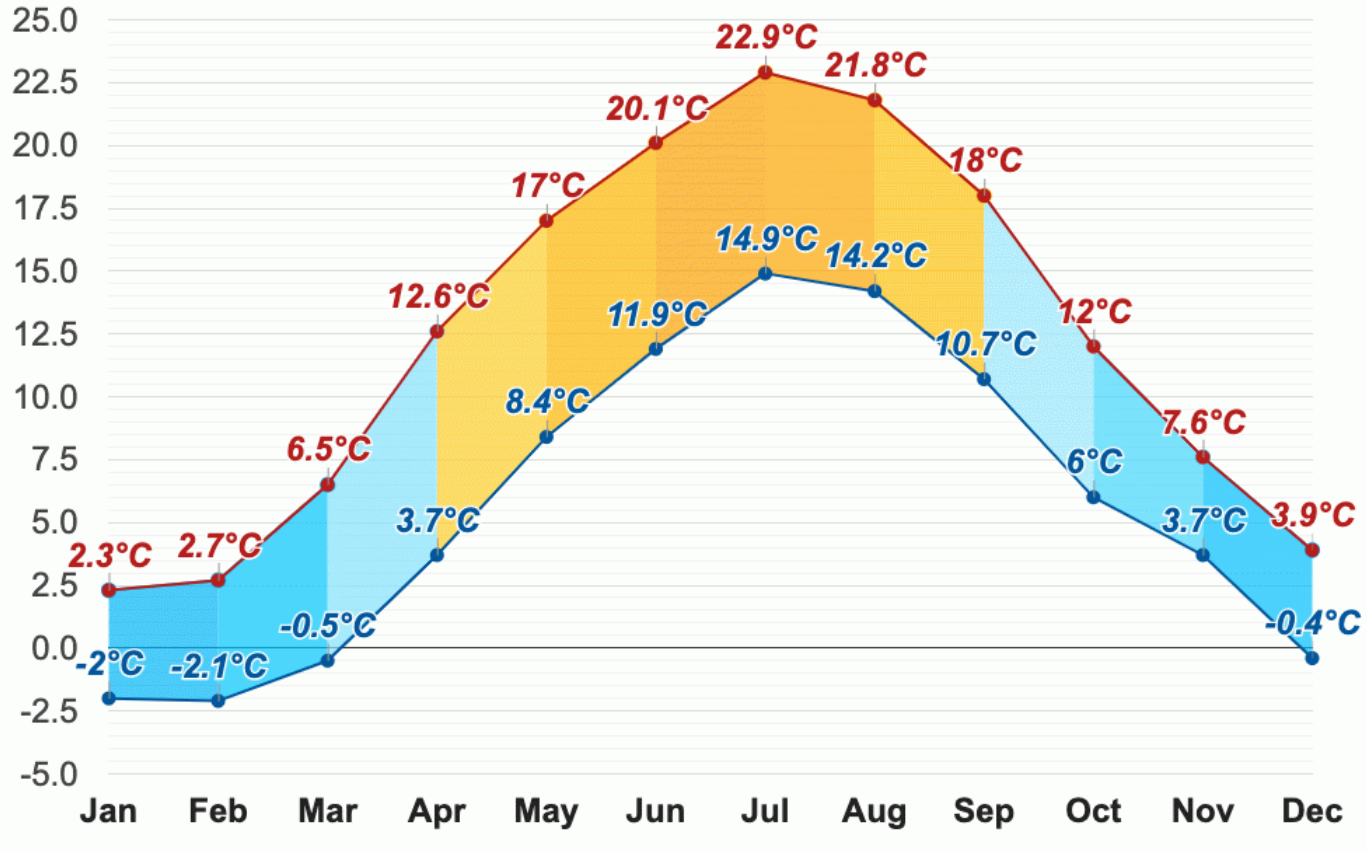


Example Data Center



Free Cooling: Air to Air Heat Exchanger

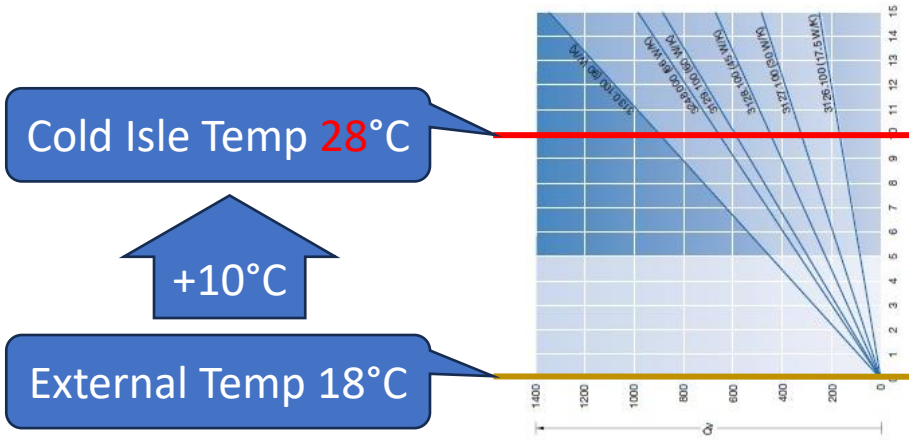




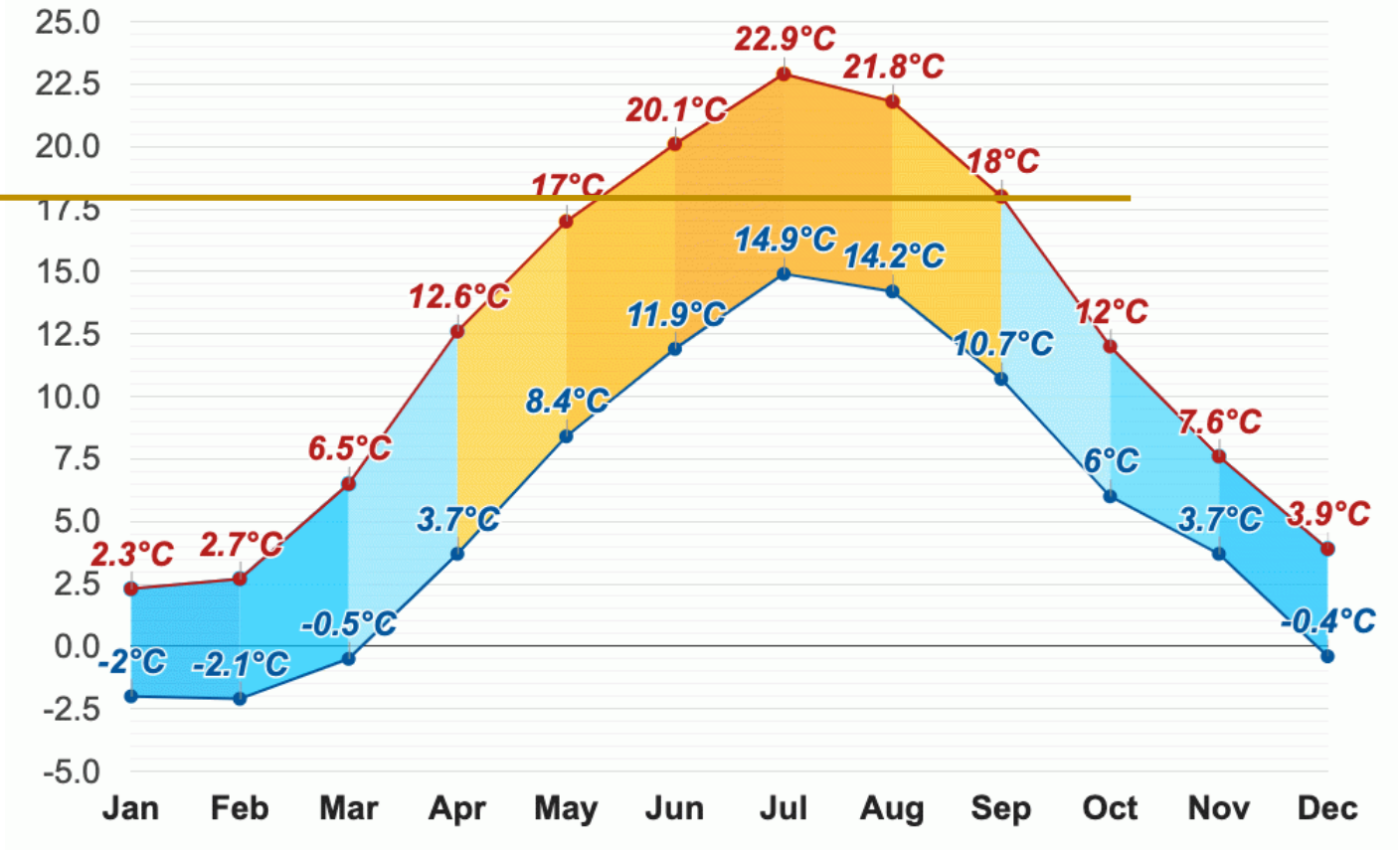
https://www.rittal.com/CharLine/gb/3126100_3127100_3128100_3129100_3130100_3248000_50-60Hz_400breit.jpg

Note: the diagram covers up to 1,x kilo Watts Qv. We re-use the graph for 1,x Mega-Watts.

Free Cooling Limit: switch to Active



Δt 10°C at nominal power / chosen operating point.
Nominal power chosen as 900kW



Free Cooling Limit: switch to Active

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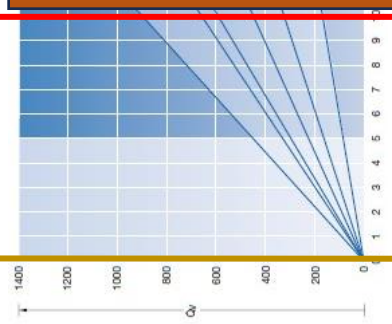
Power intense (= costly) cooling

Cold Isle Temp 28°C

+10°C

External Temp 18°C



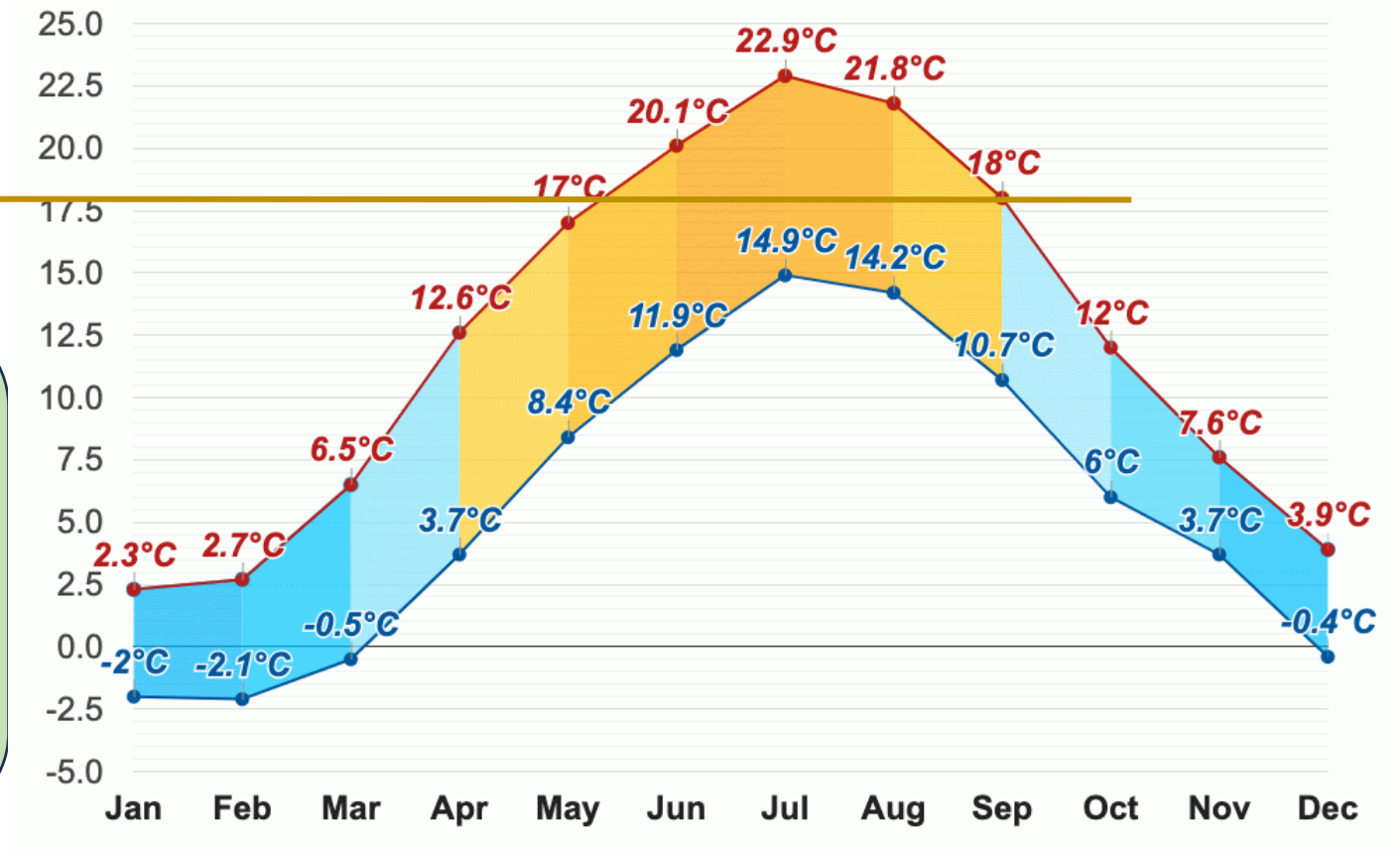
300 nodes =>
~300kW max

HPC Cluster

CN
CN
CN
CN

HN

Head/Mgt Node:
WLM & APPC service



Free Cooling Limit: switch to Active

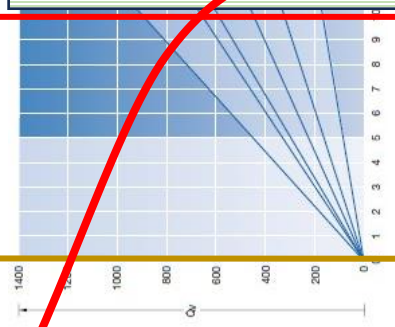
GOVIRTUAL Nordic AB

Less power intense cooling – less costs

Cold Isle Temp 28°C

+10°C

External Temp 18°C



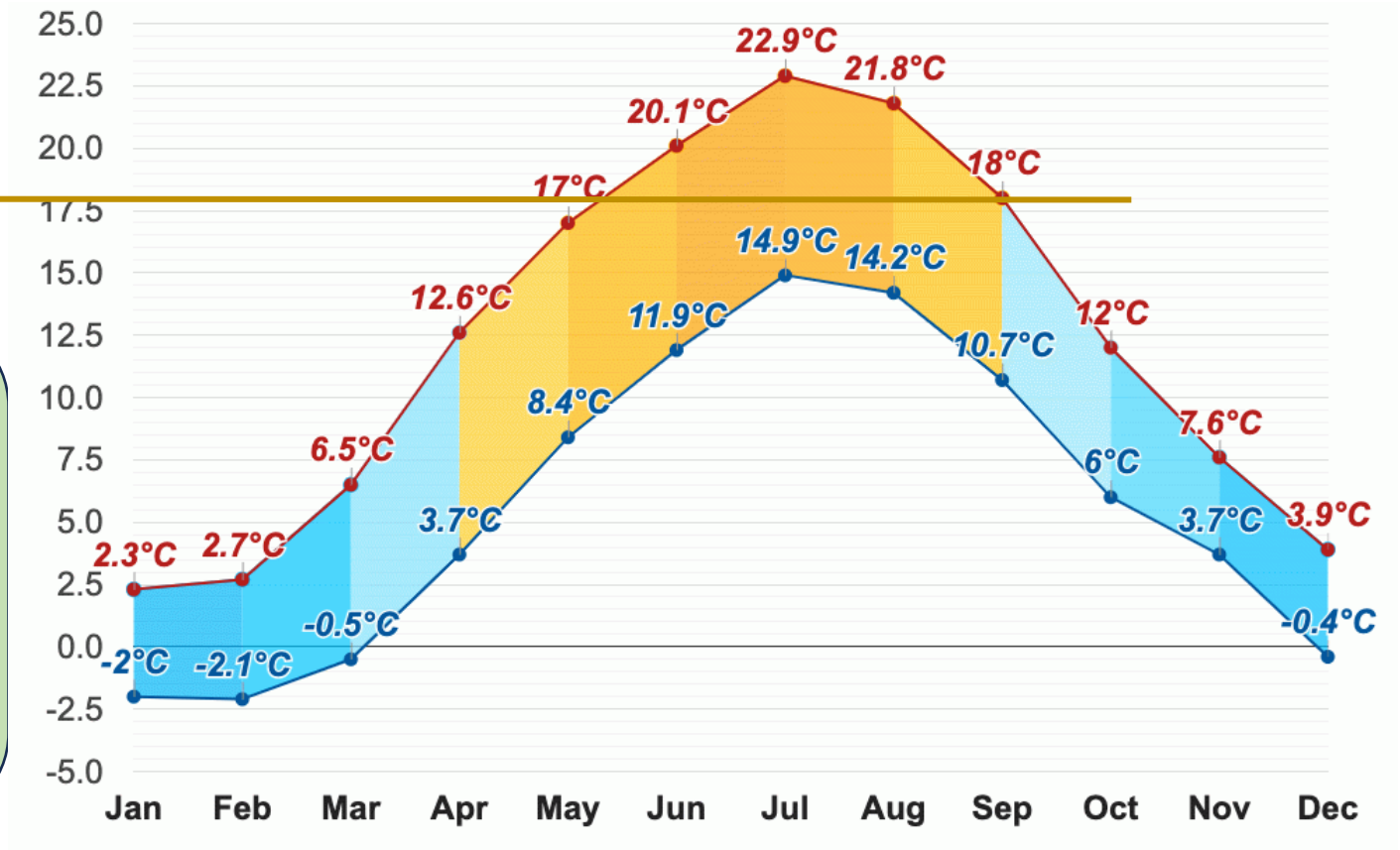
300 nodes =>
~300kW max
APPC reduces by
150kW during
mid-day time

HPC Cluster

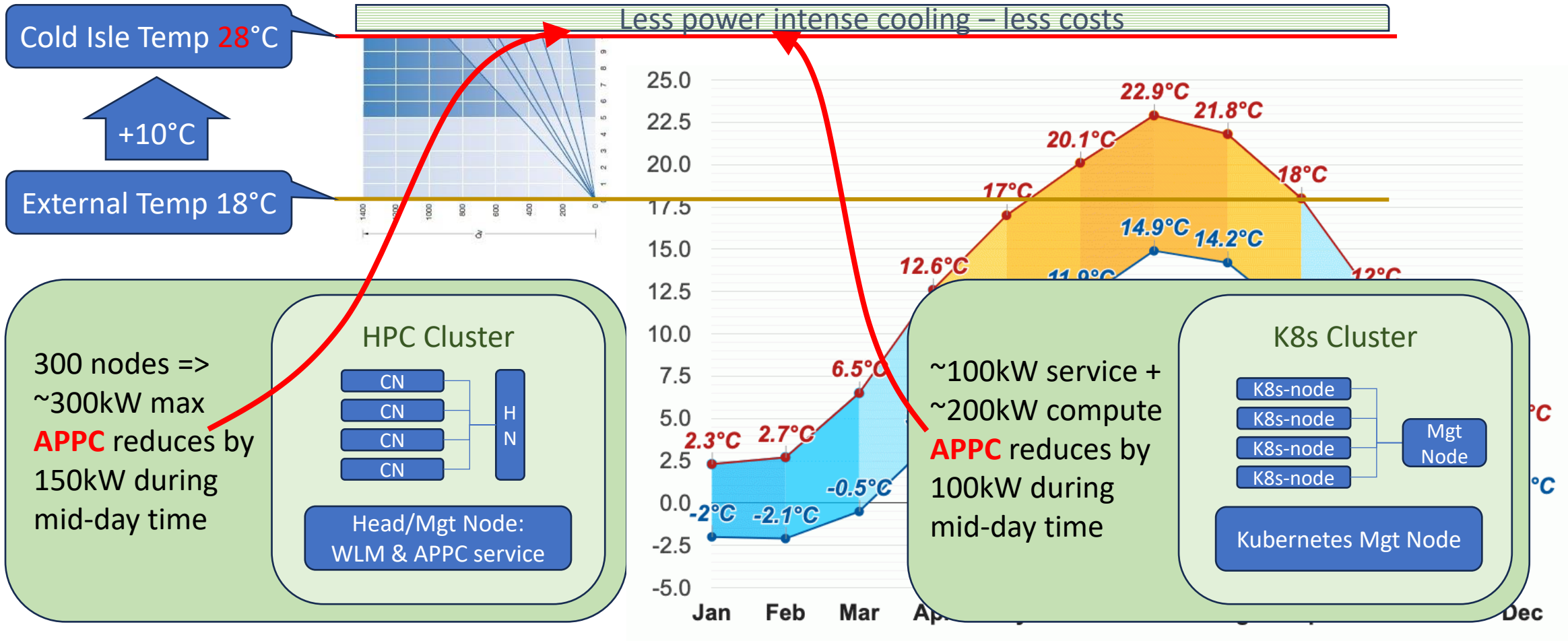
CN
CN
CN
CN

H
N

Head/Mgt Node:
WLM & APPC service



Free Cooling Limit: switch to Active



Free Cooling Limit: switch to Active

GOVIRTUAL Nordic AB

Operating point 900kW @ Δt: 10°C

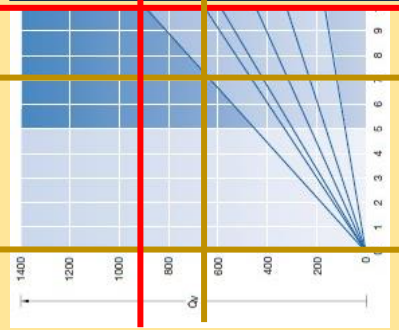
Operating point 650kW @ Δt: 7°C

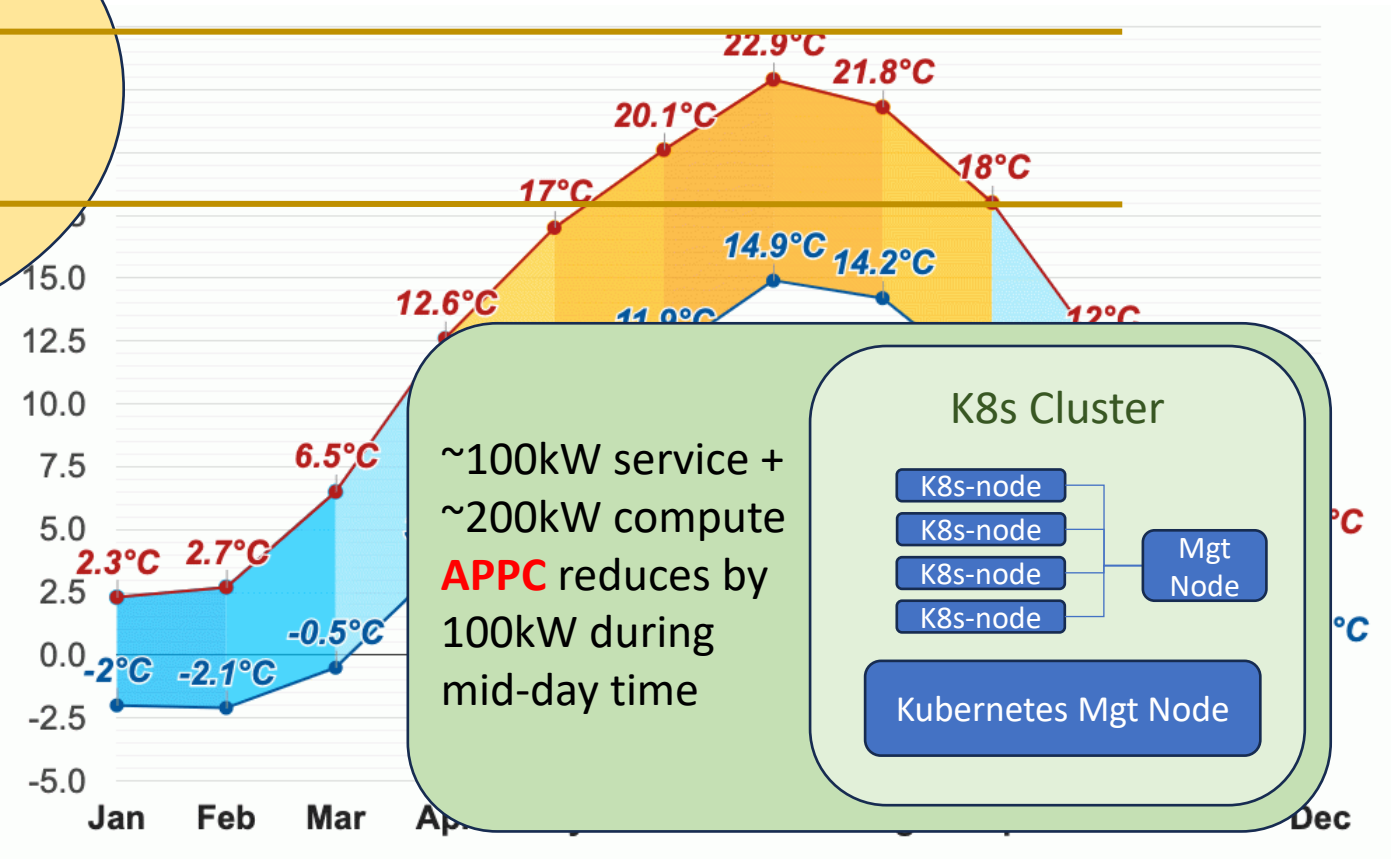
Cold Isle Temp 28°C

+10°C

External Temp 18°C

Less power intense cooling – less costs





300 nodes =>
~300kW max
APPC reduces by
150kW during
mid-day time

HPC Cluster

CN
CN
CN
CN

H
N

Head/Mgt Node:
WLM & APPC service

~100kW service +
~200kW compute
APPC reduces by
100kW during
mid-day time

K8s Cluster

K8s-node
K8s-node
K8s-node
K8s-node

Mgt
Node

Kubernetes Mgt Node

Free Cooling Limit: stay free!!

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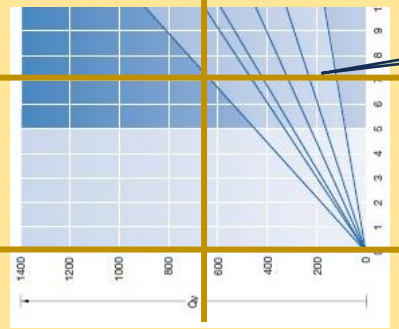
Operating point 650kW @ Δt: 7°C

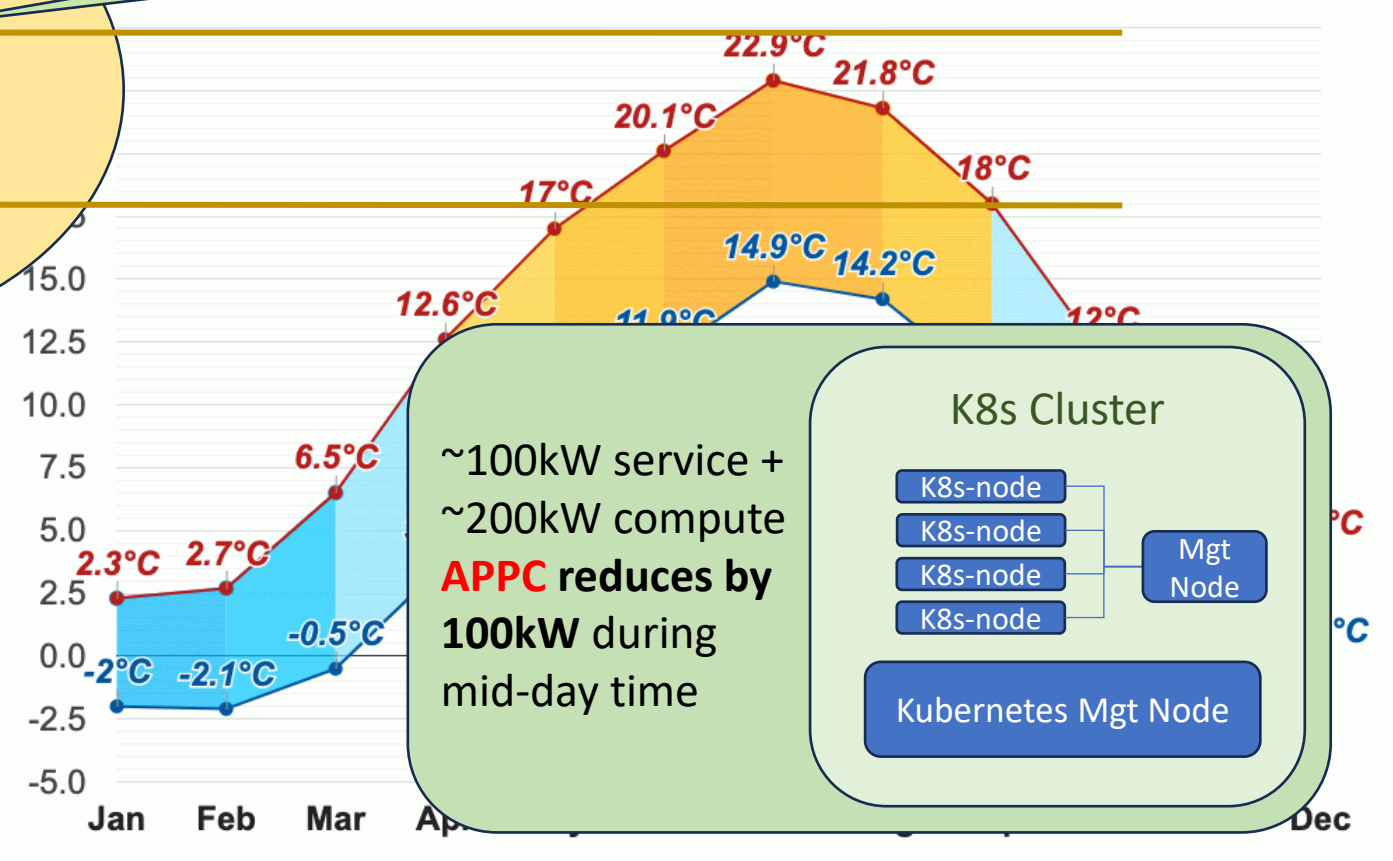
Free cooling maintained

Cold Isle Temp 25°C

+7°C

External Temp 18°C





300 nodes =>
~300kW max
APPC reduces by 150kW during mid-day time

HPC Cluster

CN
CN
CN
CN

H N

Head/Mgt Node:
WLM & APPC service

~100kW service +
~200kW compute
APPC reduces by 100kW during mid-day time

K8s Cluster

K8s-node
K8s-node
K8s-node
K8s-node

Mgt Node

Kubernetes Mgt Node

APPC Active Power Profile Control

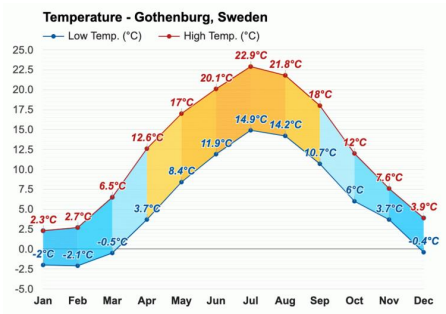
Calculate Power Savings

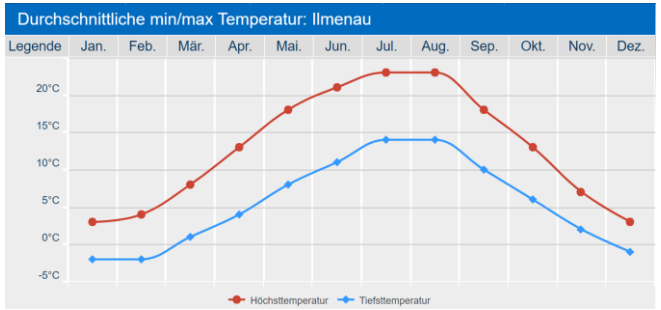
APPC active control: <**low impact**>

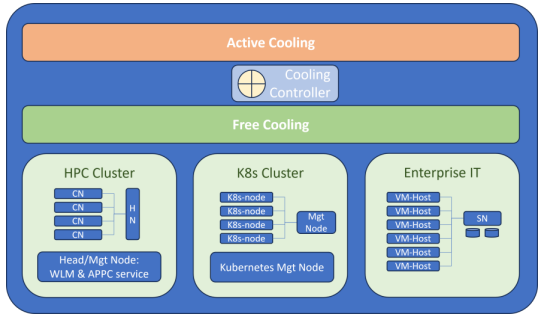
- Summer: **250kW**, 6 hours/day, 5 months
- Spring: **250kW**, 4 hours/day| 2 months
- Autumn: **250kW**, 4 hours/day| 1,5 months
- Limit K8s to 200kW, HPC to 150kW
- Assumption: Active Cooling power consumption equal to computer power consumption (actual value depends on technology used)

	per day							
	h	kW	kWh	months	days	kWh	€/kWh	€
Summer	7	250	1.750	5	153	267.750	0,34 €	91.035 €
Spring	4	250	1.000	2	61	61.000	0,34 €	20.740 €
Autumn	4	250	1.000	1,5	45	45.000	0,34 €	15.300 €
							Total	**127.075 €**

Note: **Total** lists avoided energy costs for active cooling. Postponed energy for computation is expected to be moved into "no-sun" times.







APPC Active Power Profile Control

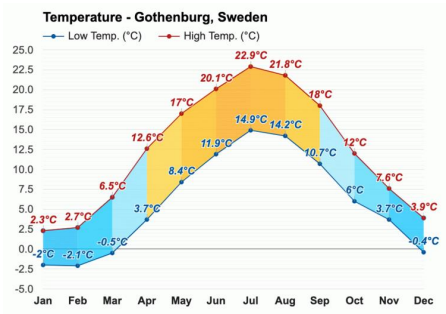
Calculate Power Savings

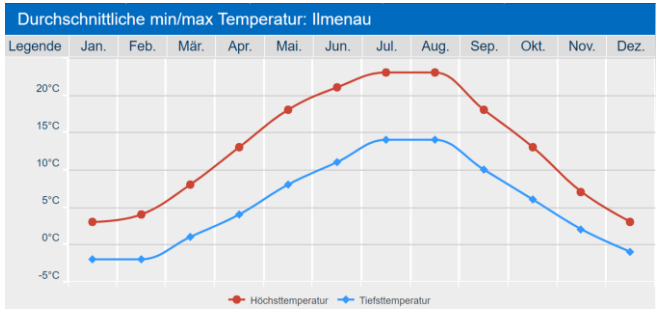
APPC active control: <**moderate**>

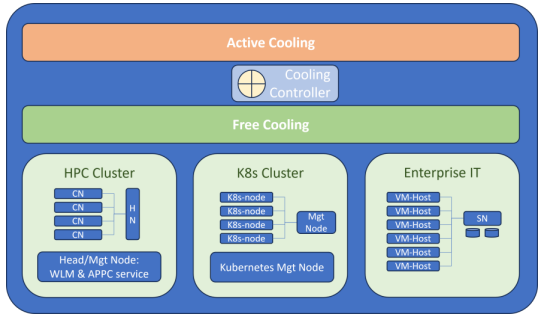
- Summer: **400kW**, 6 hours/day, 5 months
- Spring: **400kW**, 4 hours/day| 2 months
- Autumn: **400kW**, 4 hours/day| 1,5 months
- Limit K8s to 100kW, HPC to 100kW
- Assumption: Active Cooling power consumption equal to computer power consumption (actual value depends on technology used)

	per day							
	h	kW	kWh	months	days	kWh	€/kWh	€
Summer	7	400	2.800	5	153	428.400	0,34 €	145.656 €
Spring	4	400	1.600	2	61	97.600	0,34 €	33.184 €
Autumn	4	400	1.600	1,5	45	72.000	0,34 €	24.480 €
							Total	**203.320 €**

Note: **Total** lists avoided energy costs for active cooling. Postponed energy for computation is expected to be moved into "no-sun" times.







APPC Active Power Profile Control

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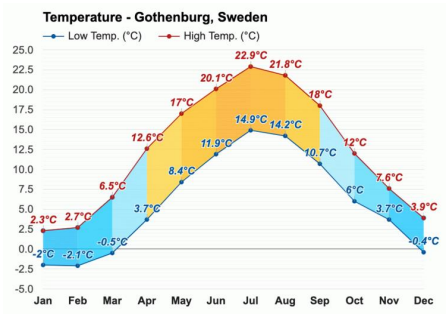
Calculate Power Savings

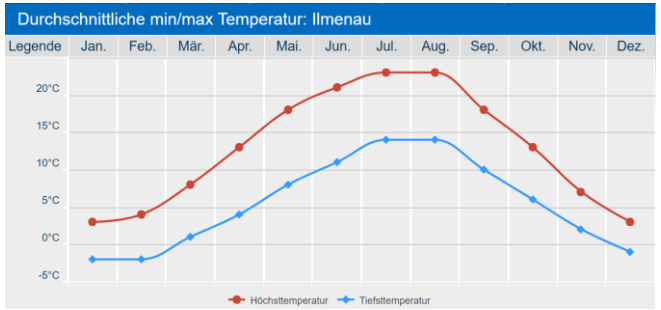
APPC active control: <**agressive**>

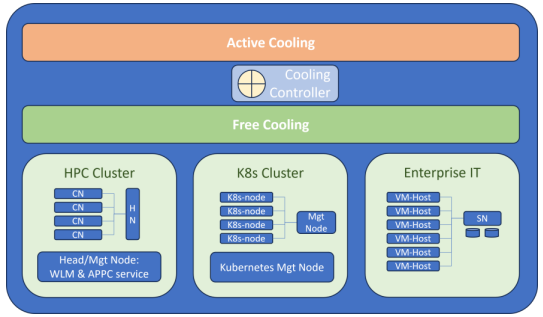
- Summer: **700kW**, 6 hours/day, 5 months
- Spring: **700kW**, 4 hours/day| 2 months
- Autumn: **700kW**, 4 hours/day| 1,5 months
- Limit Enterprise-IT to 100kW, K8s to 100kW, HPC to zero
- Assumption: Active Cooling power consumption equal to computer power consumption (actual value depends on technology used)

	per day							
	h	kW	kWh	months	days	kWh	€/kWh	€
Summer	7	700	4.900	5	153	749.700	0,34 €	254.898 €
Spring	4	700	2.800	2	61	170.800	0,34 €	58.072 €
Autumn	4	700	2.800	1,5	45	126.000	0,34 €	42.840 €
							Total	**355.810 €**

Note: **Total** lists avoided energy costs for active cooling. Postponed energy for computation is expected to be moved into "no-sun" times.







APPC Active Power Profile Control

How to use the savings?

	per day							
	h	kW	kWh	months	days	kWh	€/kWh	€
Summer	7	700	4.900	5	153	749.700	0,34 €	254.898 €
								58.072 €
								42.840 €
								355.810 €

oned energy

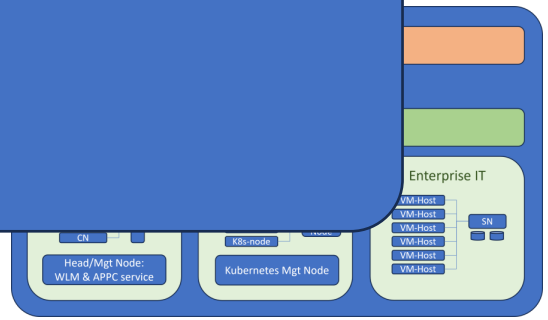
+300 TFLOPs

or

+180kW Power

or

Additional (wo)menpower



APPC Active Power Profile Control

Advantages beyond direct costs savings

APPC active controlling the power envelope

- Adjust power consumption to availability of power:
  - During hot or very cold weather (Water power)
  - Due to draught (Water power)
  - Due to calms (Wind power)
  - Due to clouds or nights (Solar power)
- Achieving sustainability targets / certificates

APPC Active Power Profile Control

Cost Effective Sustainability

Contacts:
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