BENEFITS OF HOLISTIC PLANNING

Using the example of datacenter cooling and communal heating supply.

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eurammon Symposium, June 30, 2023

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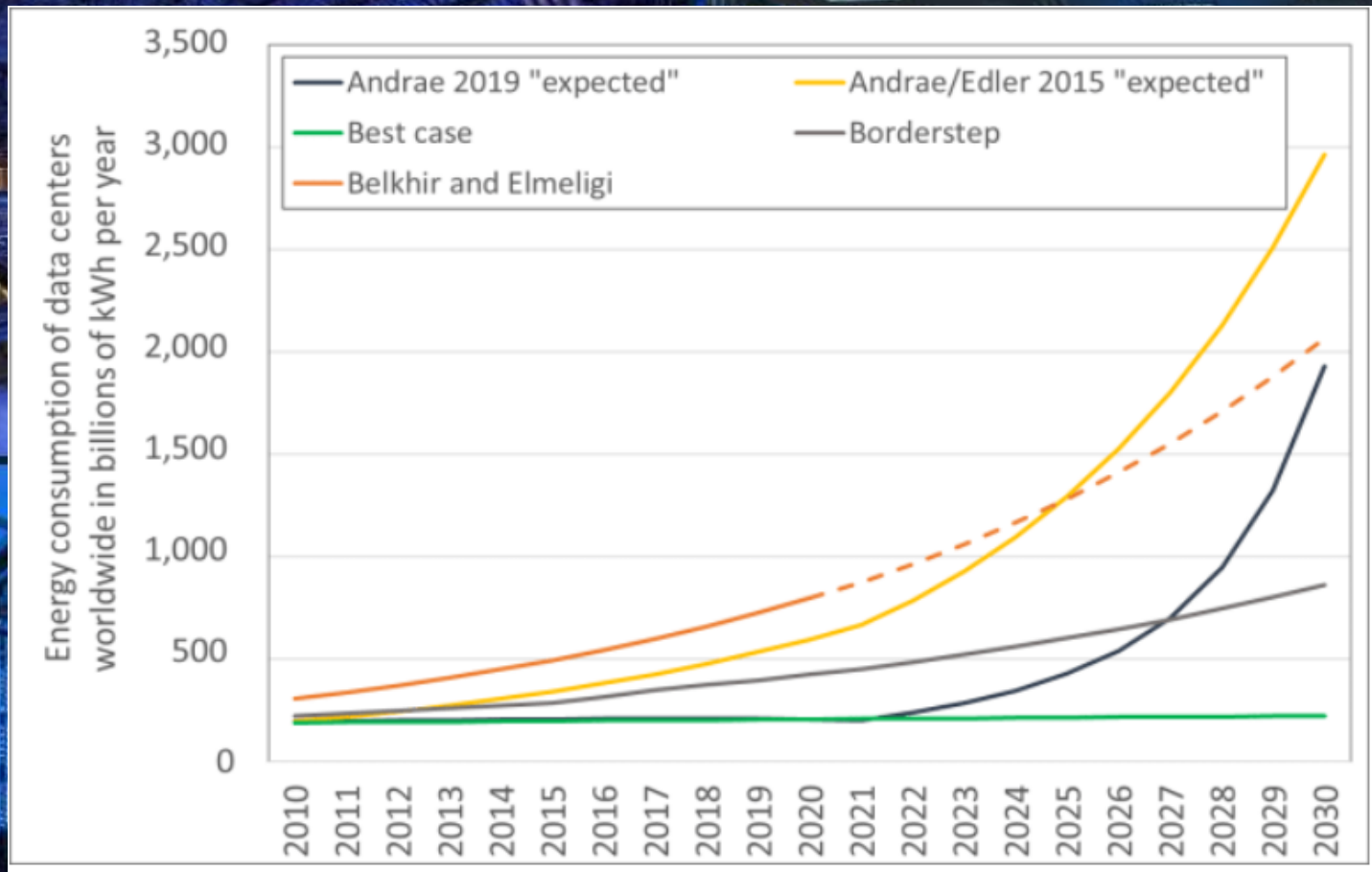
refrigerants delivered by mother nature

Introduction: What is a data center?

A data center is a building or a group with a dedicated space to hold computer systems and associated components.

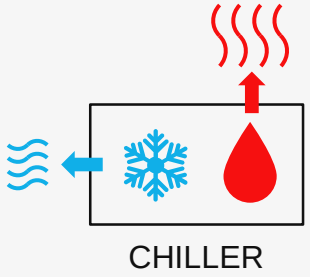
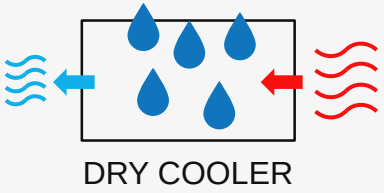
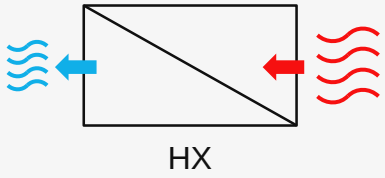
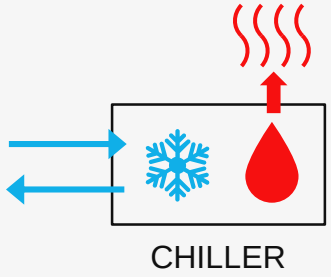
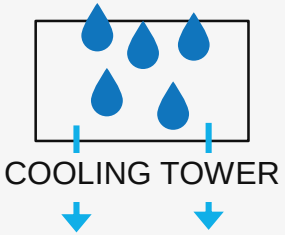
Each installation needs cooling, and a large data center uses as much electricity as a small town.

Not surprisingly, most studies expect a more or less strong increase of data center energy consumption.



Source: researchgate

Data center cooling: Several methods.

Air-cooled active	Air-cooled passive #01	Air-cooled passive #02	Water-cooled active	Water-cooled passive
				
Uses a chiller that cools the air.	**Passive cooling using dry-coolers.**	**Passive cooling using other devices e.g. cross-flow heat exchanger supply/ exhaust air.**	**Cooling via secondary refrigerant cycle from a chiller.**	**Direct water-cooling (without chiller) e.g. of the water from dry-coolers.**

Data center cooling best option? What if … we have further energy demands?

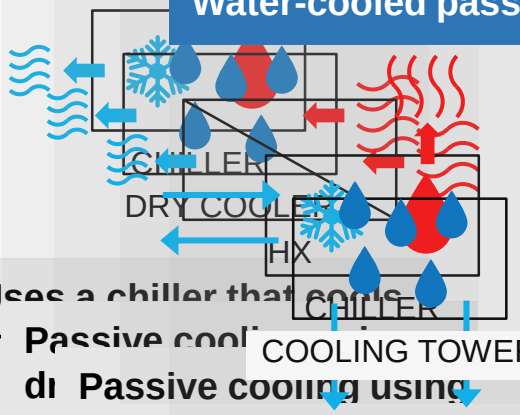
Air-cooled active

Air-cooled passive #01

Air-cooled passive #02

Water-cooled active

Water-cooled passive



Uses a chiller that cools th

Passive cooli

Passive cooling using dr

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su

Cooling via secondary re

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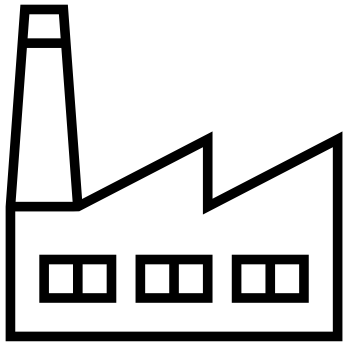
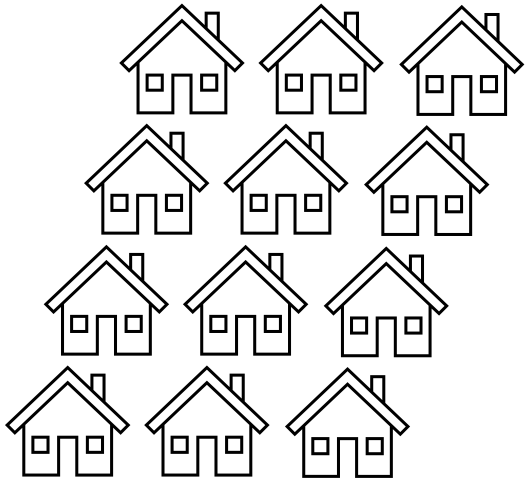
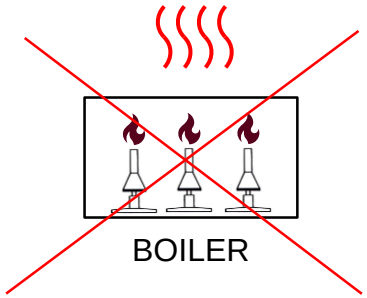
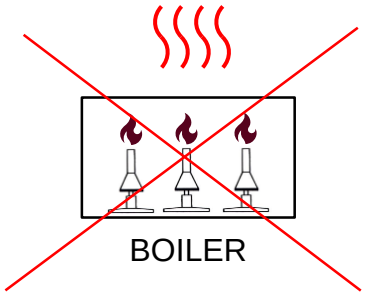
Direct water-cooling (without chiller) e.g. of the water from dry-coolers.

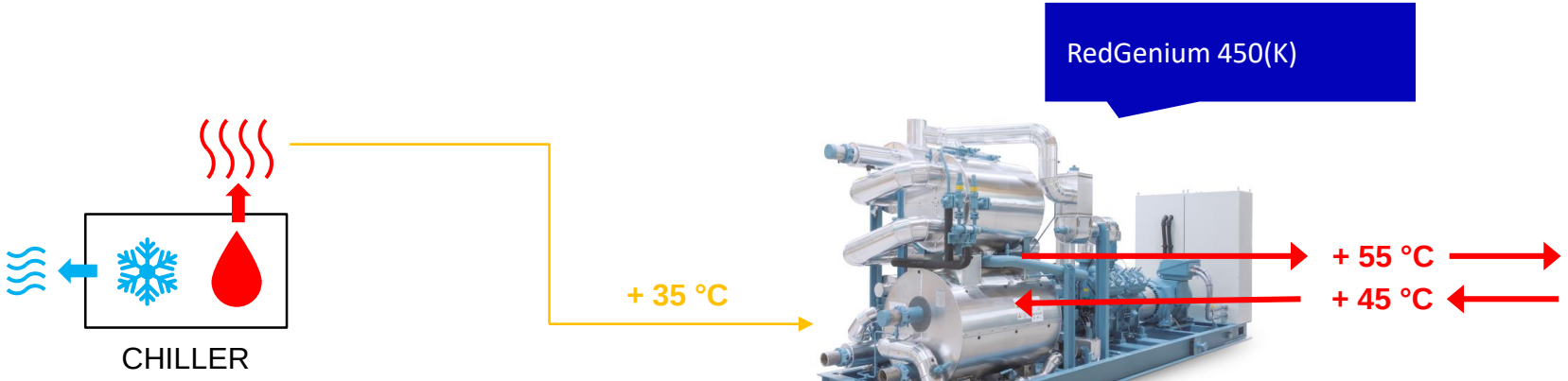








Data center active air-cooled and low temperature heating demand.



Total energy consumption

1,123 MWh

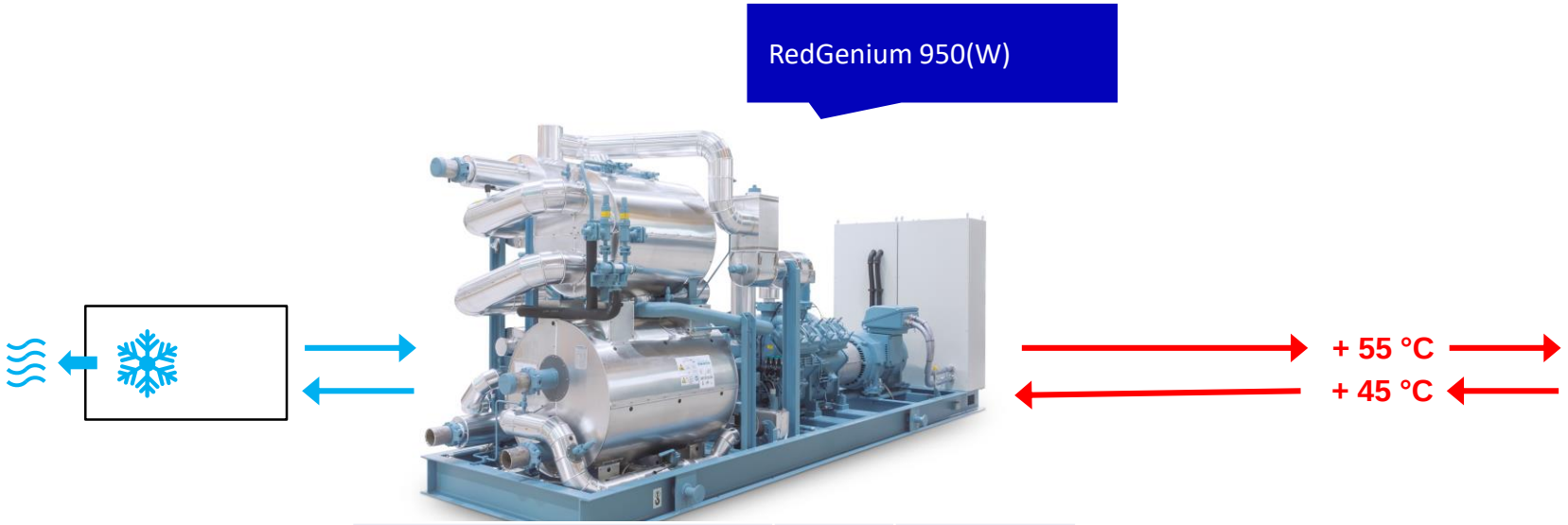
Combined COP
(cooling plus heating)

8.1

Cooling capacity	800	kW
Required cooling temp. DC	+15	°C
Chiller suction temp. ca.	+5	°C
Chiller condensing temp.	+35	°C
Driving power (full load, at net)	126	kW
EER	6.35	
Annual operating time	6000	hrs.
Average load	80	%
Annual energy consumption	605	MWh
CAPEX	100	%

Heating demand	1.0	MW
Heat source	+35	°C
Heat pump suction temp. ca.	+31	°C
Heat sink supply temp.	+55	°C
Driving power (full load, at net)	108	kW
COP	9.26	
Annual operating time	6000	hrs.
Average load	80	%
Annual energy consumption	518	MWh
CAPEX	100	%

Data center active air-cooled and low temperature heating demand with 1x unit.



Heating demand	1	MW
Cooling capacity *	800	kW
Required cooling temp. DC	+15	°C
Suction temp. ca.	+5	°C
Heat sink supply temp.	+55	°C
Driving power (full load, at net)	225	kW
COP	4.44	
EER	3.56	
Annual operating time	6000	hrs.
Average load	80	%
Annual energy consumption	1080	MWh
CAPEX	95	

Total energy consumption

1,080 MWh

Combined COP
(cooling plus heating)

8.0

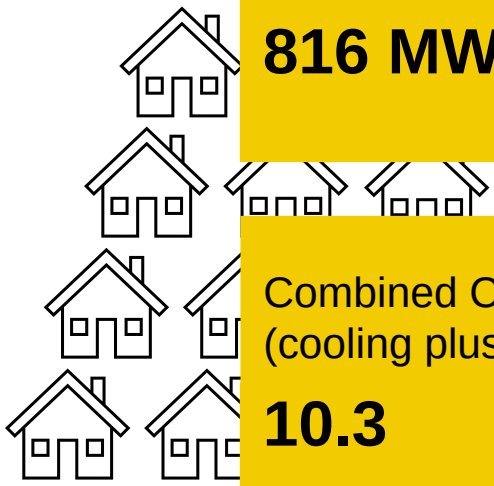
* Surplus heating capacity to be dissipated via secondary condenser e.g. air-cooled.

Data center active water-cooled and low temperature heating demand, 1x unit.

RedGenium 750(W)

+ 20 °C
+ 15 °C

+ 55 °C
+ 45 °C



Heating load provided	955	kW
Cooling capacity	800	kW
Required cooling temp. DC	+15	°C
Suction temp.	+13	°C
Heat sink supply temp.	+55	°C
Driving power (full load, at net)	170	kW
COP	5.62	
EER	4.71	
Annual operating time	6000	hrs.
Average load	80	%
Annual energy consumption	816	MWh
CAPEX	85	

Total energy consumption

816 MWh *

Combined COP
(cooling plus heating)

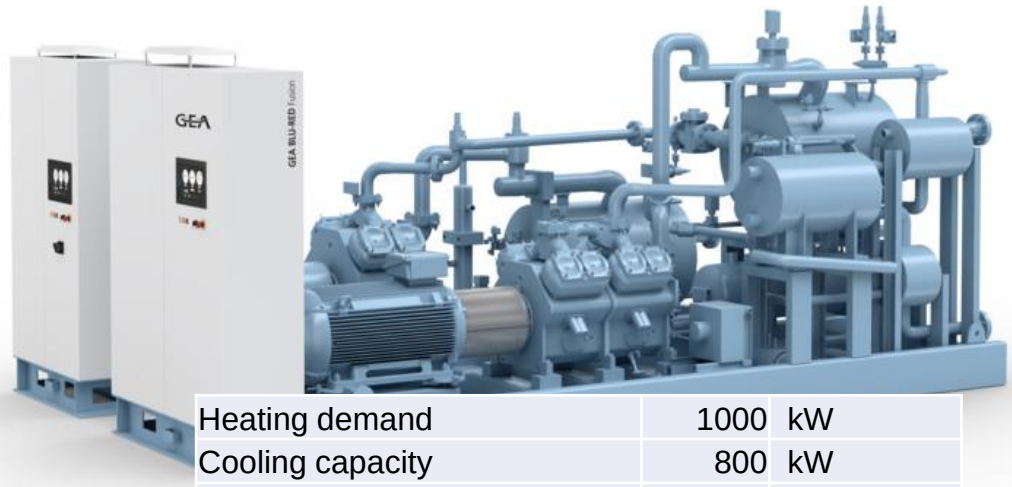
10.3

* compared to the first set-up:

-27 % less energy

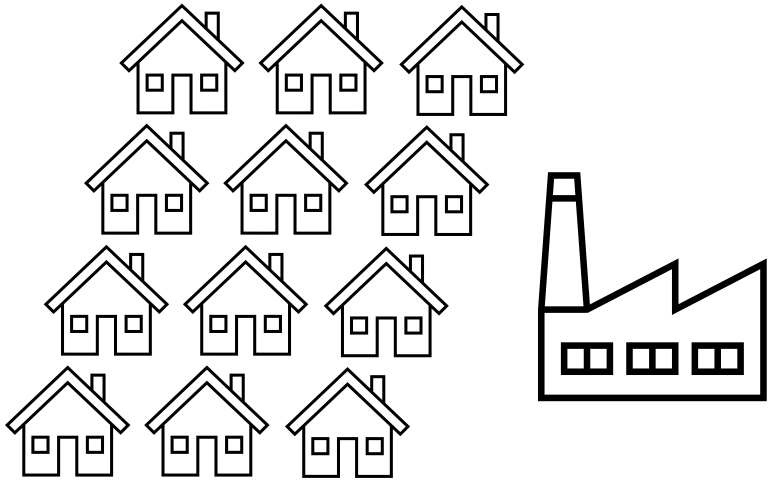
Data center active water-cooled and HIGH temperature heating demand.

Blu-red fusion



+ 20 °C
+ 15 °C

+ 90 °C
+ 70 °C



Heating demand	1000	kW
Cooling capacity	800	kW
Required cooling temp. DC	+15	°C
Suction temp.	+14	°C
Heat sink supply temp.	+90	°C
Driving power (full load, at net)	295	kW
COP	3.39	
EER	2.71	
COP combined	6.10	
Annual operating time	6000	hrs.
Average load	80	%
Annual energy consumption	1416	MWh

Two-stage solution for higher capacity demands.

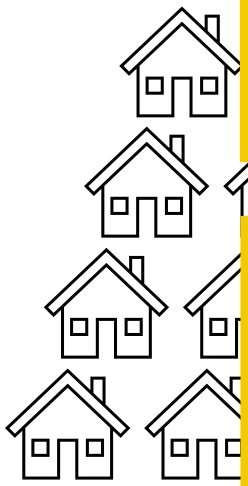
Gea blux
(compax inside)

+ 20 °C
+ 15 °C

Image shows design in progress

RedGenium 950(K)

+ 90 °C
+ 70 °C



Total energy consumption

4.16 GWh

Combined COP
(cooling plus heating)

5.7

Cooling capacity	2260	kW
Required cooling temp. DC	+15	°C
Chiller suction temp. ca.	+11	°C
Chiller condensing temp.	+48	°C
Driving power (full load, at net)	418	kW
EER	2.61	
Annual operating time	6000	hrs.
Average load	80	%
Annual energy consumption	2.01	GWh

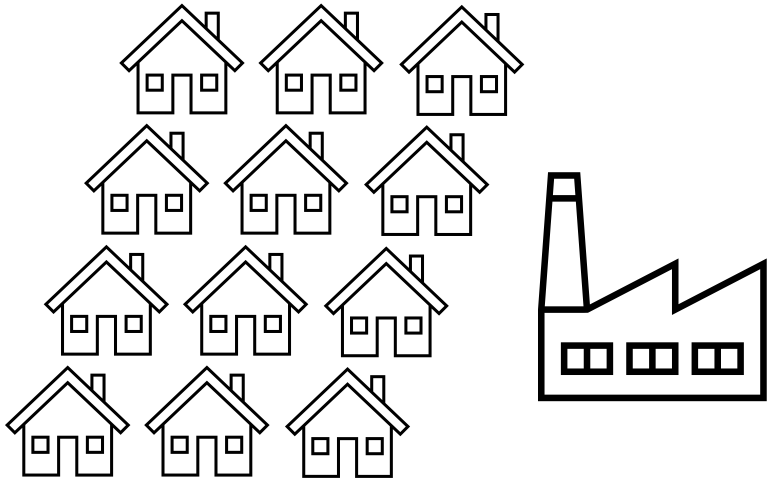
Heating capacity max	2675	kW
Heat source	+48	°C
Heat pump suction temp. ca.	+44	°C
Heat sink supply temp.	+90	°C
Driving power (full load, at net)	447	kW
COP	3.09	
Annual operating time	6000	hrs.
Average load	80	%
Annual energy consumption	2.15	GWh

Single-stage custom solution for very high capacity demands.

+ 20 °C
+ 15 °C

First new **L XHP** compressor based heat pump unit installation

+ 90 °C
+ 70 °C



Heating capacity max	5215	kW
Cooling capacity	3055	kW
Required cooling temp. DC	+15	°C
Suction temp.	+13	°C
Heat sink supply temp.	+90	°C
Driving power (full load, at net)	2057	kW
COP	2.54	
EER	1.49	
COP combined	4.02	
Annual operating time	6000	hrs.
Average load	80	%
Annual energy consumption	10.49	GWh

Summary

- Holistic planning, i.e. cooling and heating demand considered together, provides significant saving potentials.
- Direct water-cooling in gernal is the more efficient (and effective) cooling method.
- Minimum paramter to be considered for best suited equipment:

  → Heating demands and location(s).

  → Heat sink temperature level of the heating demand.

  → Required cooling temperature for the IT.

  → Capacity demands.

  → (Part-) load regulation needs.

eurammon e. V. is always available as a sparring partner for questions on refrigeration with natural refrigerants.

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