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OCP SUMMIT

DATA CENTER
FACILITIES

From PUE via EUE to Synergy

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San José (CA)
March 15th 2019

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Background

Asperitas Immersed Computing

Principal Commercial Officer, per Sept 2018

Deerns Engineering

Business Unit Manager Data Centers, per April 2009

Tata Steel Europe

Various Technical & b2b Commercial roles, per October 1989

PUE was great for guidance

- PUE was the focus, leading to improvements, leading to impressive achievements in industry
- Technology is available to perform well below 2 approaching PUE 1.1 or less
- Successful technology implementation now depends on client's business case and geography
- Business case more and more influenced by politics and pressure of society

$$PUE = \frac{IT + (Cooling + Power + Lighting)}{IT}$$

Impressive achievements on PUE for data centers

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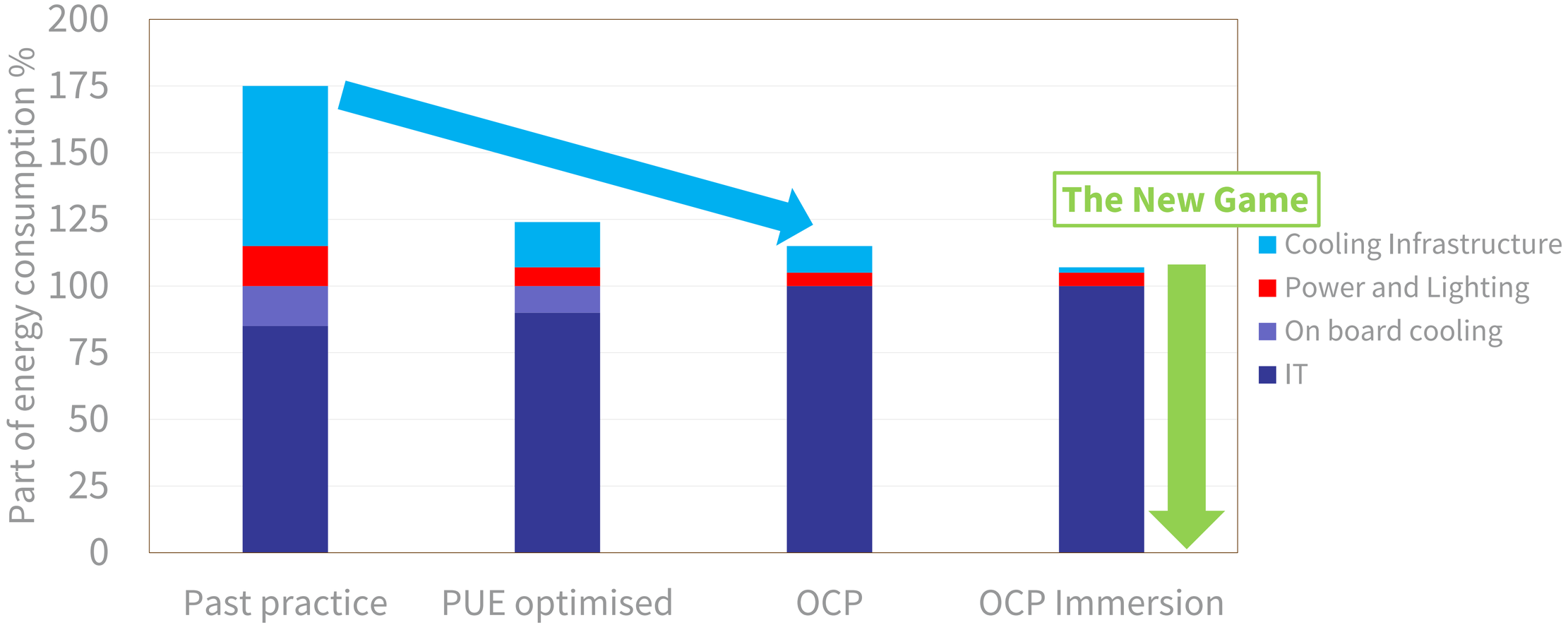

So what is happening ?

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- CAGR data center industry steady above 10%
- Global power consumption growth
- Major part still fossile fuel powered
- Associated global CO_2 emission growth

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UNITED NATIONS CLIMATE CHANGE CONFERENCE

- A fundamental DC change is needed, a New Game has started

Energy Reuse Effectiveness

ERE, or Energy Reuse Effectiveness, is a metric for measuring the benefit of reusing energy from a data center.

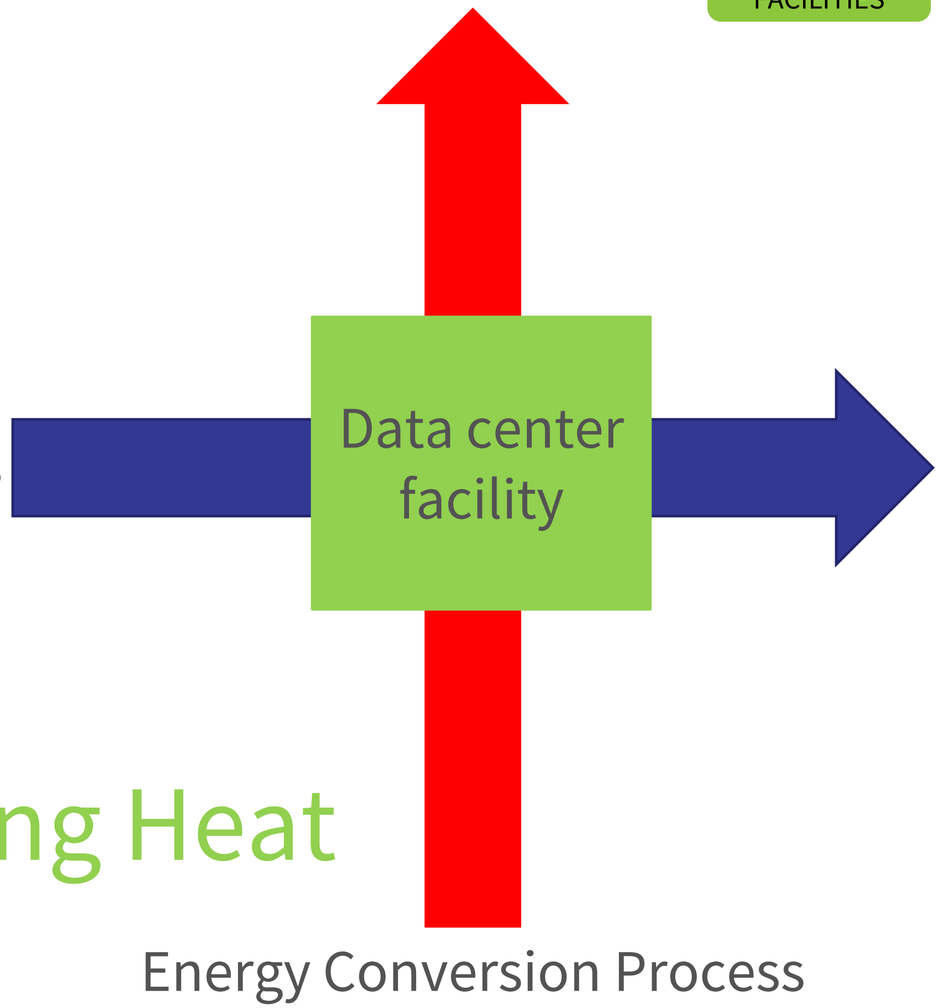
ERE = 0 means all energy reused

ERE = PUE means no energy reused

$$ERE = \frac{IT + (Cooling + Power + Lighting) - \boldsymbol{Reuse\ Power}}{IT}$$

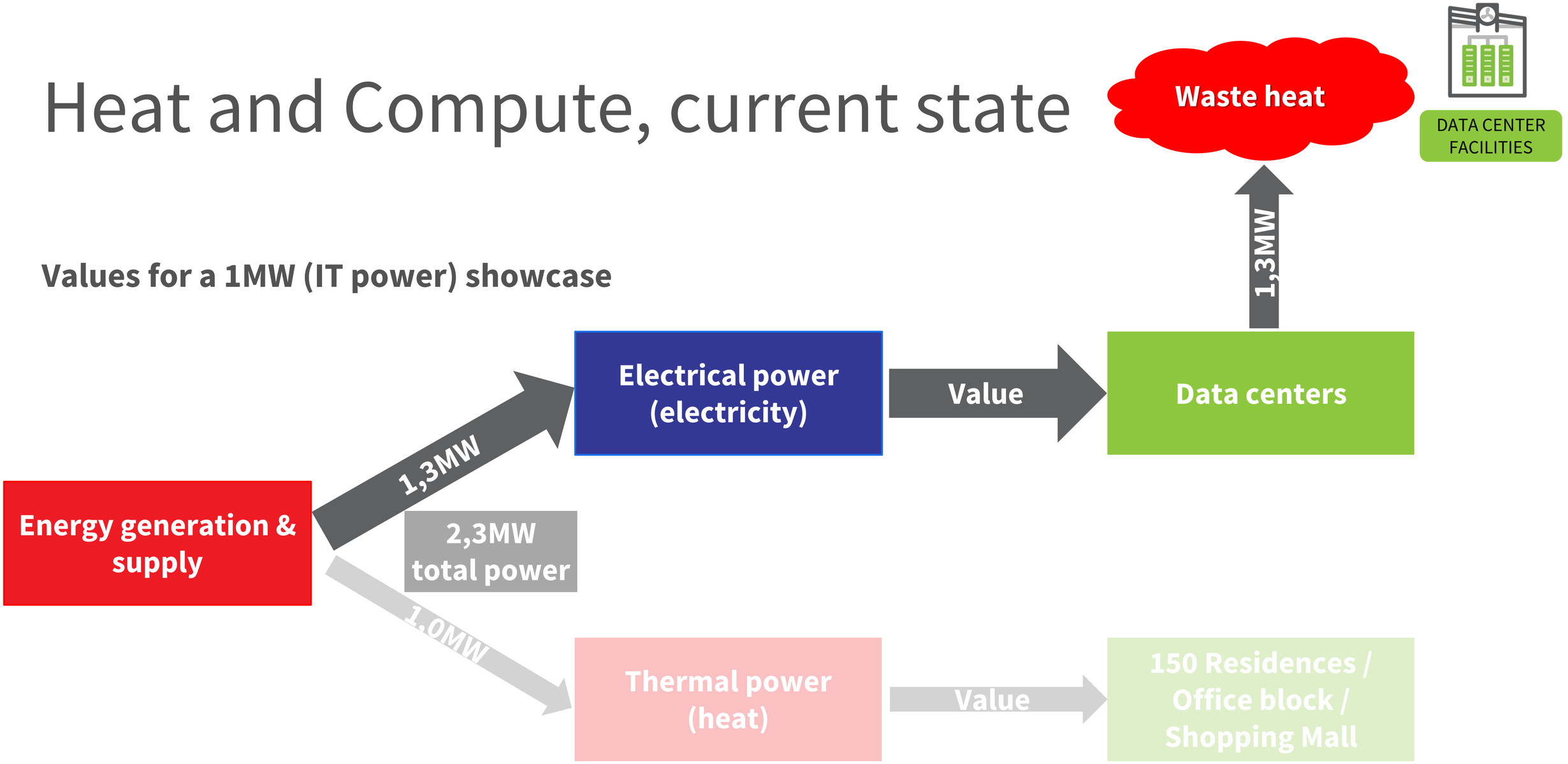
The New Game, consequences for future data centers on:

- IT/Data center process
- Excess heat (former waste heat)
- Electricity
- CO_2
- Energy storage

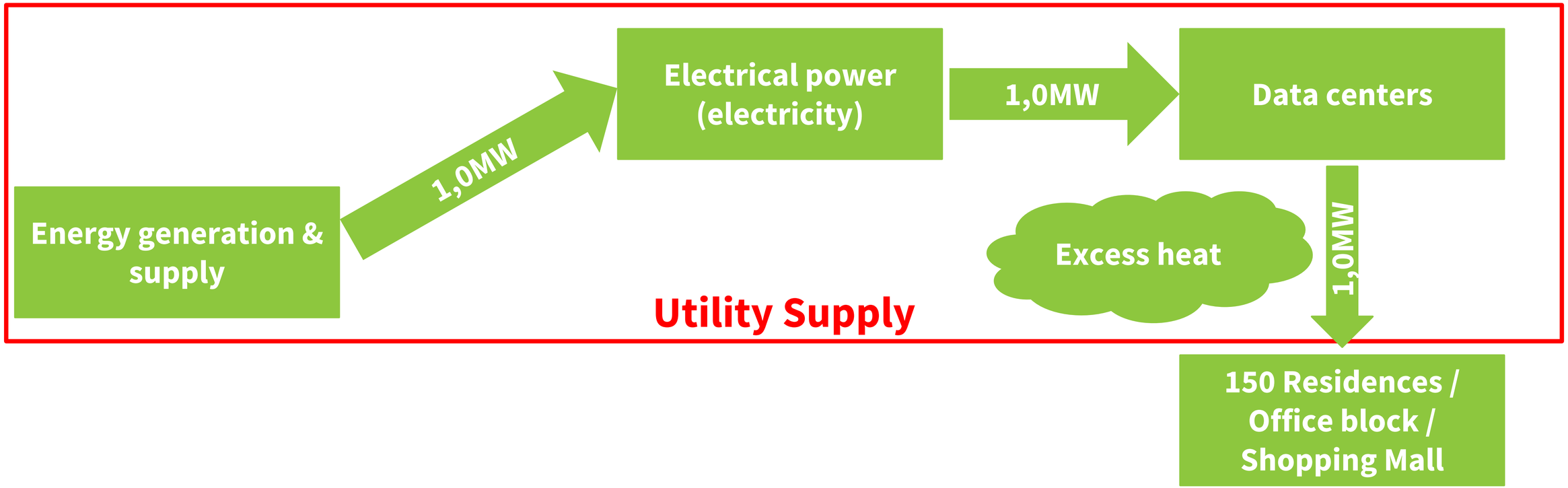


The New Game is about combining Heat and Compute in space and time

Heat and Compute, current state



Energy reuse, future state data centers, combination in space



Daily and seasonal dynamics future for data centers, combination space and time

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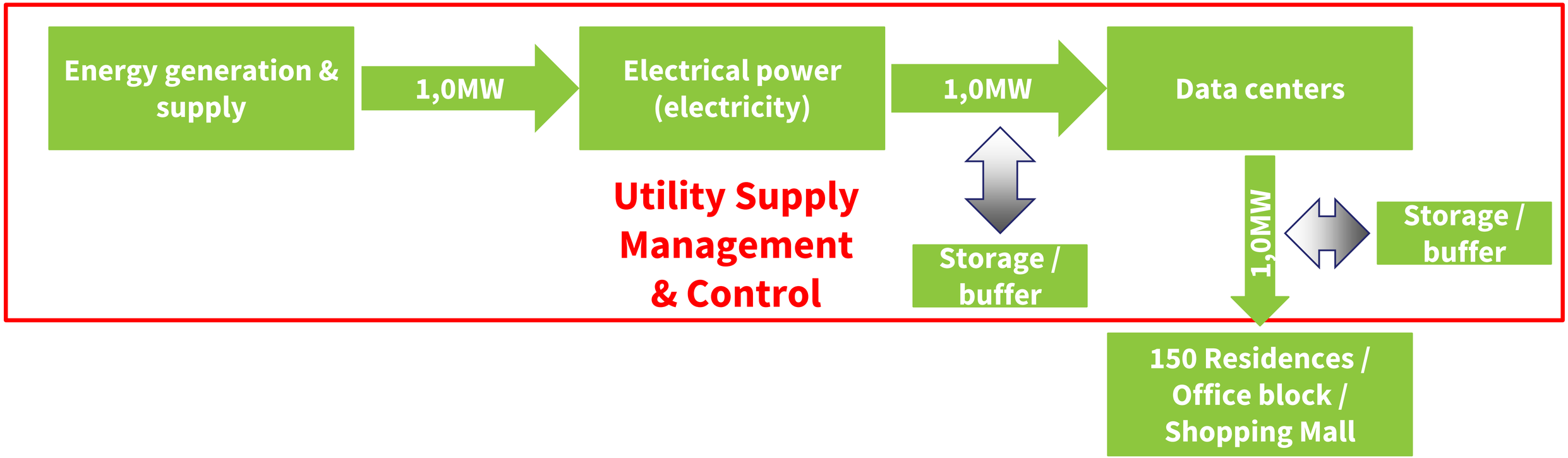

Current European scene (selection)

- Excess heat reuse adopted in Scandinavia and scaling up (Denmark Esbjerg, Sweden Stockholm, Finland Mäntsälä)
- Transition to non-natural gas heating ongoing in The Netherlands
- Thermal Storage (ATES) mature and common practice
- Large scale electrical buffering (a.o. The Green Bay) planned
- Small scale Combined Heat and Compute by Qarnot France
- Volkswagen Financial Services data center supplying excess heat to adjacent private users (approx. 800MWh/year)

Players in The New Game for future data centers (alphabetical order)

- Consumers of CO_2 (agricultural)
- Consumers of heat (many)
- Data center operators and/or owners
- Data center designers and users
- Government
- Urban planners and developers
- Utility grid operators
- Utility providers

Energy traction

- Electrification of heat
- Smart energy
- Thermal grids

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Hyperscalers are setting the liquid scene

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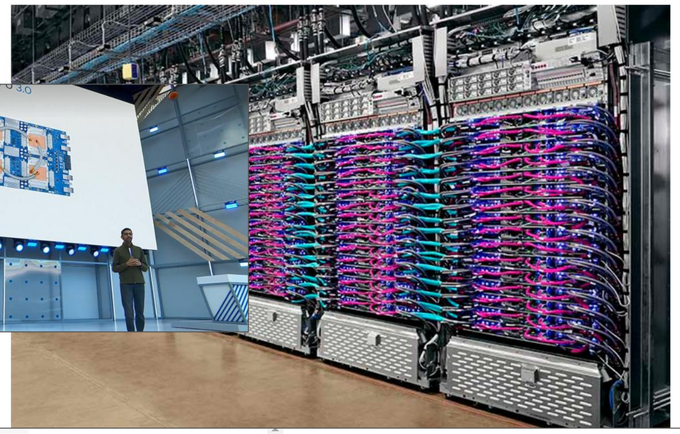
Google Shifts to Liquid Cooling for AI Data Crunching

BY RICH MILLER - MAY 8, 2018 — LEAVE A COMMENT



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By Alvin Soon - on 12 Jun 2018, 12:12pm

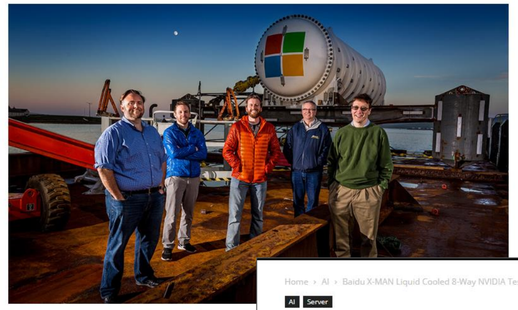

Image sour

consider as new network

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Plans to contribute technology to Open Compute Project

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AI Server

Baidu X-MAN Liquid Cooled 8-Way NVIDIA Tesla V100 Shelf

By Patrick Kennedy - April 4, 2018

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Baidu X MAN SXM2 Watercooling

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Back to the data center: Infrastructure requirements for liquid technology

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- Liquid infrastructure in the whitespace
  - Air: Water based CRACs
  - Air: In-row water based coolers
  - Air/Liquid : Rear door water based coolers
  - Liquid: Direct Liquid to Chip
  - Total Liquid Cooling: Enclosed immersion
  - Total Liquid Cooling : Open bath immersion

  Liquid Penetration
- Adiabatic/dry-cool combination
- Phasing out of chiller/DX technology

- Liquid (thermal) infrastructure for transport and buffering in urban areas
  - Project driven, or
  - Policy driven
  - Bottom line always financials driven
- Sustainability add-ons:
  - Heat pumps
  - Generation 4 heat grids (see next)
  - Temperature chaining (see next)

Generation 4 heat grids

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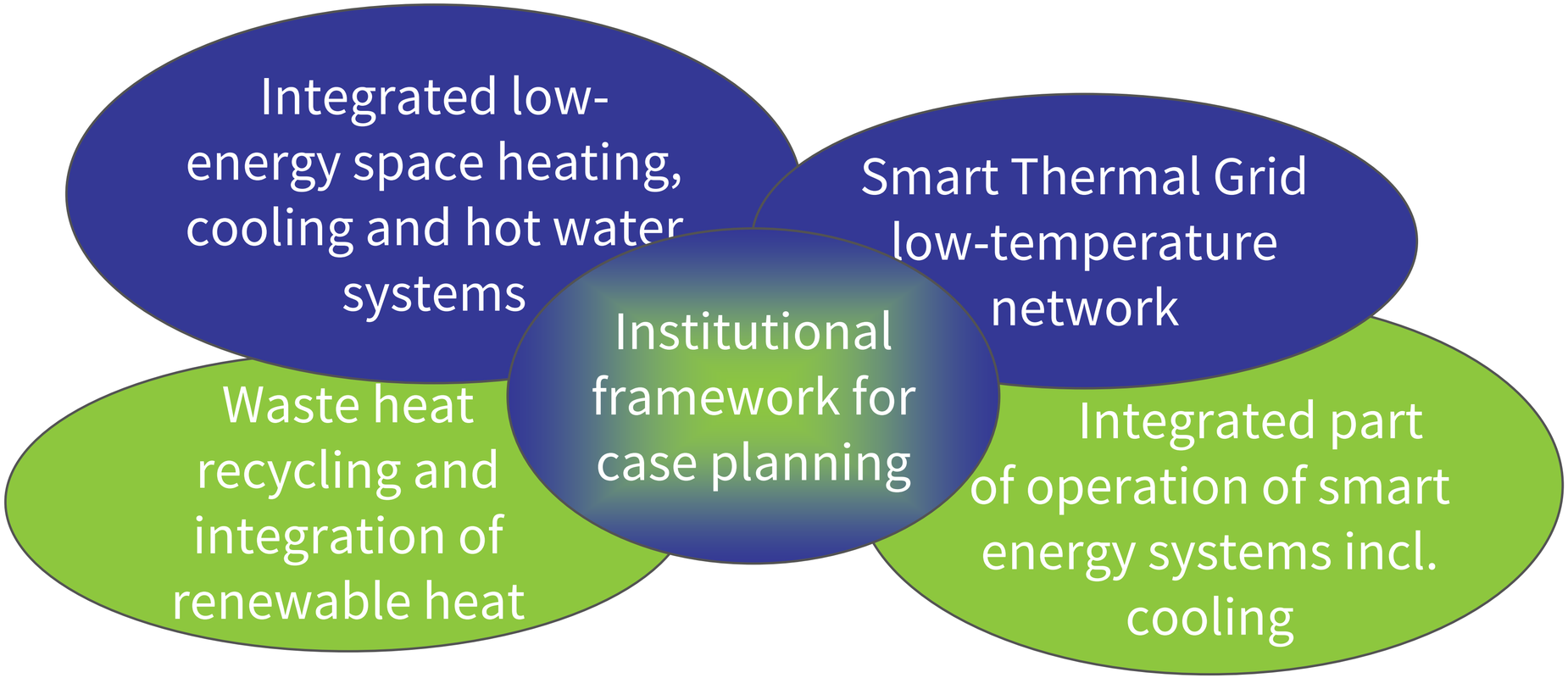

Optimising liquid infrastructures

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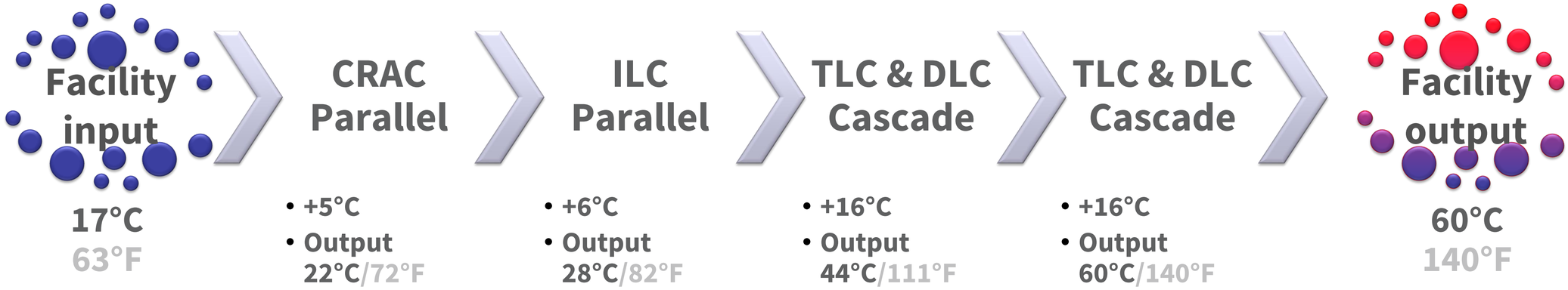
TECHNOLOGY	TYPICAL	
	INLET	OUTLET
CRAC (generic)	6-18°C	12-25°C
ILC (e.g. USystems)	18-23°C	23-28°C
DLC (e.g. Asetek)	18-45°C	24-55°C
TLC (e.g. Asperitas)	18-40°C	22-48°C

TECHNOLOGY	EXTREME	
	INLET	OUTLET
CRAC (generic)	21°C	30°C
ILC (e.g. USystems)	28°C	32°C
DLC (e.g. Asetek)	45°C	**65°C**
TLC (e.g. Asperitas)	55°C	**65°C**

Increasing ΔT with temperature and technology cascading



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Create High ΔT

- 3-stage cooling for optimal water volume utilisation
- Below 28°C/82°F, chiller (coolant evaporization)
- Between 28-35°C/82-95°F, adiabatic (water evaporization)
- 35°C/95°F and above, free cooling with closed water based system

Valuable heat

Temperature cascading, example

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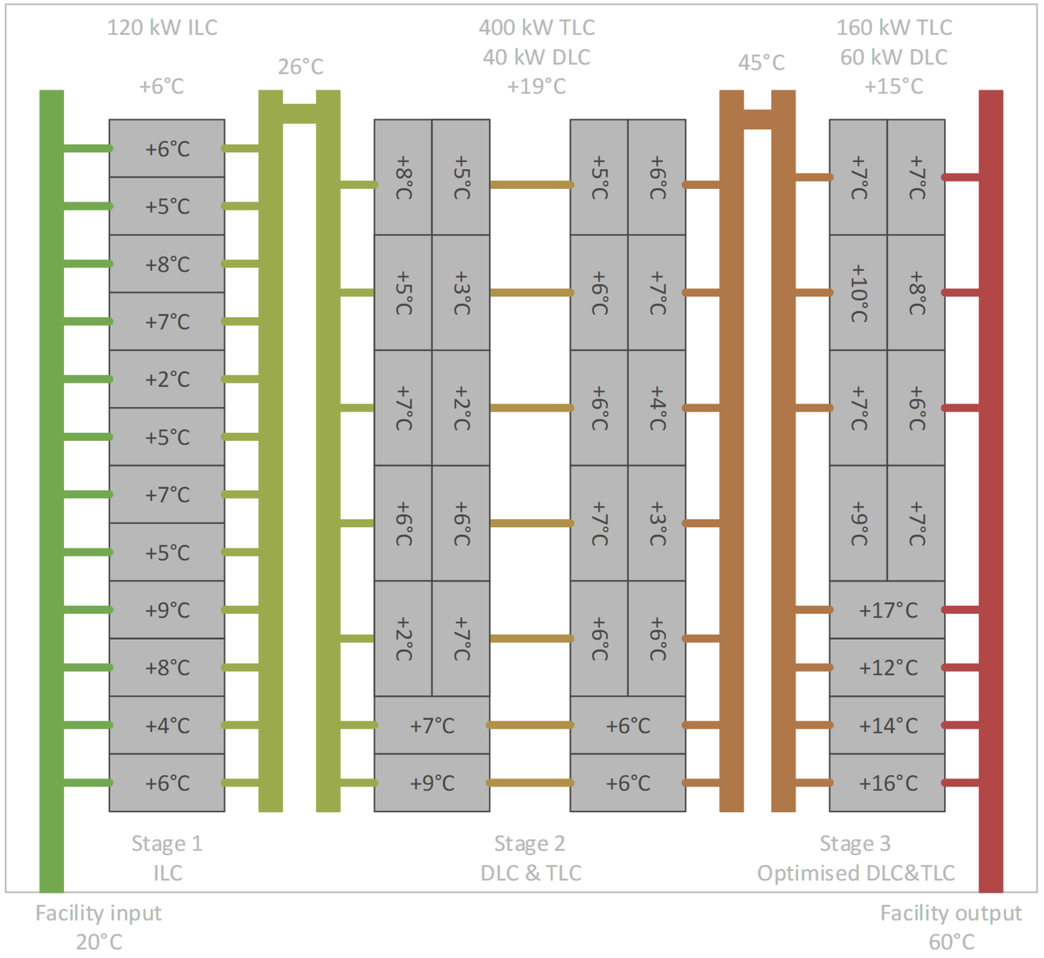
- Closed room 3-stage configuration
- ILC setup maintains air temperature WS
- Water volume decreased by 85%
  - ΔT 6°C : 30 l/s, at ΔT 40°C : 4.5 l/s only !
- Cooling options
  - Closed cooling circuit with pumps and coolers
  - Closed cooling circuit with pumps and reuse behind Heat Exchanger



What needs to be done?

- Focus on external heat consumption
  - Preferably free cooling guarantee
- Government involvement
  - Incentives (tax, permit, other)
  - Intermediate for (industrial) heat reuse
  - Information footprint as part of district planning
- More (low temperature) heating networks to be developed
- Focus on TCO, not just CAPEX
- PUE – need for a new “easy” metric
  - PUE systematics may easily be misinterpreted
  - PUE discourages IT efficiency
  - New metric needs to give insight in actual efficiency

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Industry wide engagement needed for future generation Data Centers

- Time is running out
- Industry standardization has started a.o. via OCP
- Leaders set the standards, technology, temperatures etc. just like we have set the ASHRAE (air) envelope in the past
- Together we have the required skills and knowledge
- The Future Data Center is not only about what is **in** it, but certainly what is **around** it

Join the New Game !


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