INTERNATIONAL KYOTO COOLING®

the Cooling problem solved

Mees Lodder

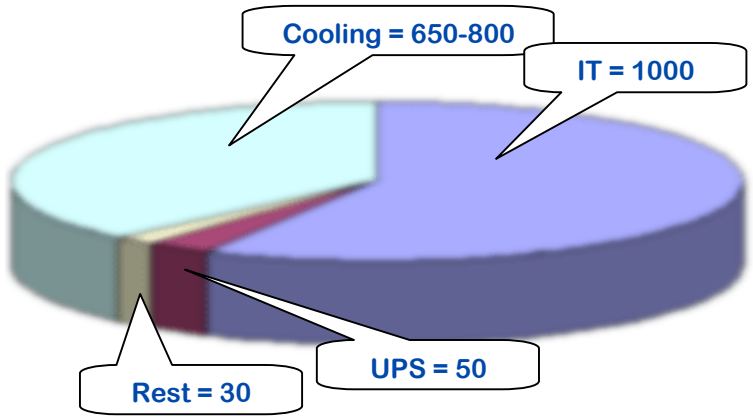
KyotoCooling®

- Perfect and unlimited cooling of ICT hardware
- > 80% decrease in cooling costs
- Sustainable ⇨ **GREEN**
- Handles dynamic loading of ICT equipment
- Scalable datacenter
- Meets Tier IV qualification
- Up to 40% lower national grid demand
- Stable E-power consumption i.e. “flat liner”
- No cooling water needed in datacenter

Energy consumption existing design

- About 60% for the primary process (IT)
- About 35% for cooling of the primary process
- 5% UPS conversion loss
- 3% rest (lighting etc.)
- Factor of Cooling power:

  $Power_{(IT+Cooling)} / Power_{IT} = 1.65 - 1.80$

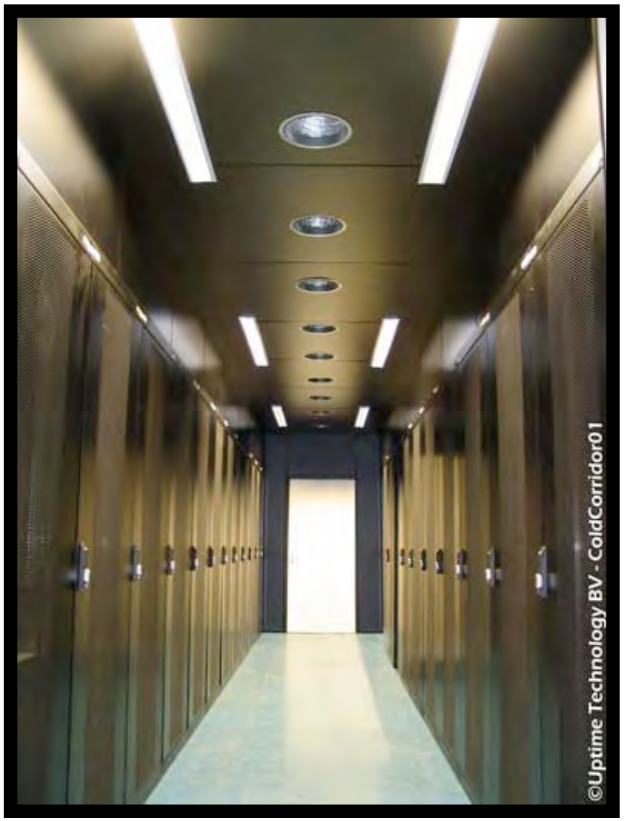


- Primary use (IT equipment) not adjustable
- UPS conversion loss limited adjustable
- Potentially best savings possible in cooling

New Cooling Design

2 steps

Step 1: Physical separation Cold / Hot air



- Separation of make up and return air
- Make up air only through IT hardware
- Bypass airflow en recirculation banned!
- Maximize delta T to cool unit

How to separate?

- Closed Cold aisles
- Closed Warm aisles
- Chimney Cabinets

Swimmingpool example

- Water is available everywhere
- Same temperature everywhere
- Obstacles no problem
- No venturi-effect
- No distribution problems inside the swimmingpool

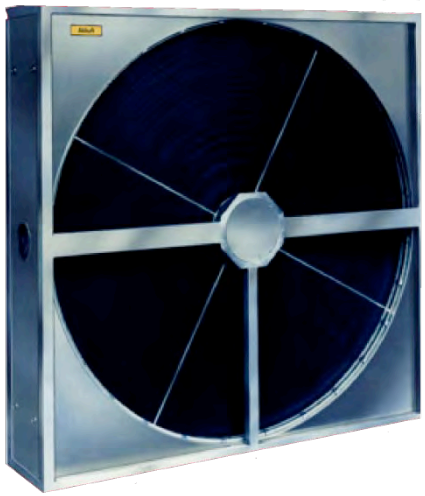
- One condition : add as much water of the same temperature anywhere in the swimmingpool.

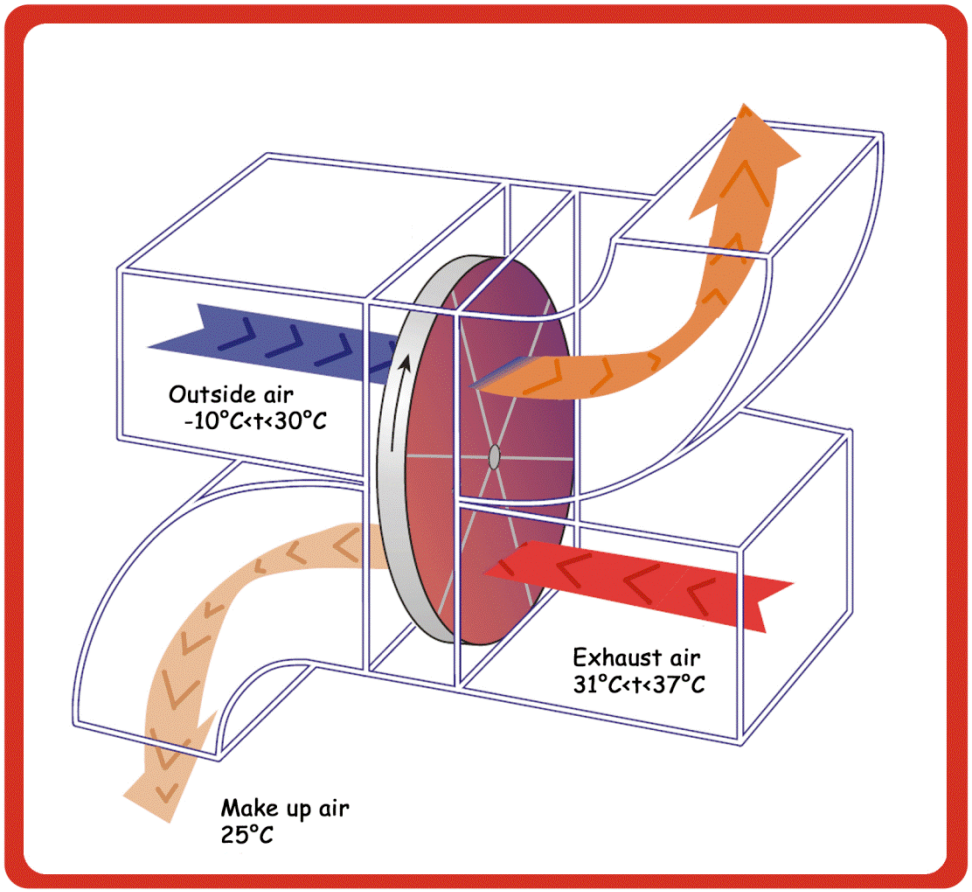
- CFD simulations

Step 2:
Cooling recirculation air by air/air cooler

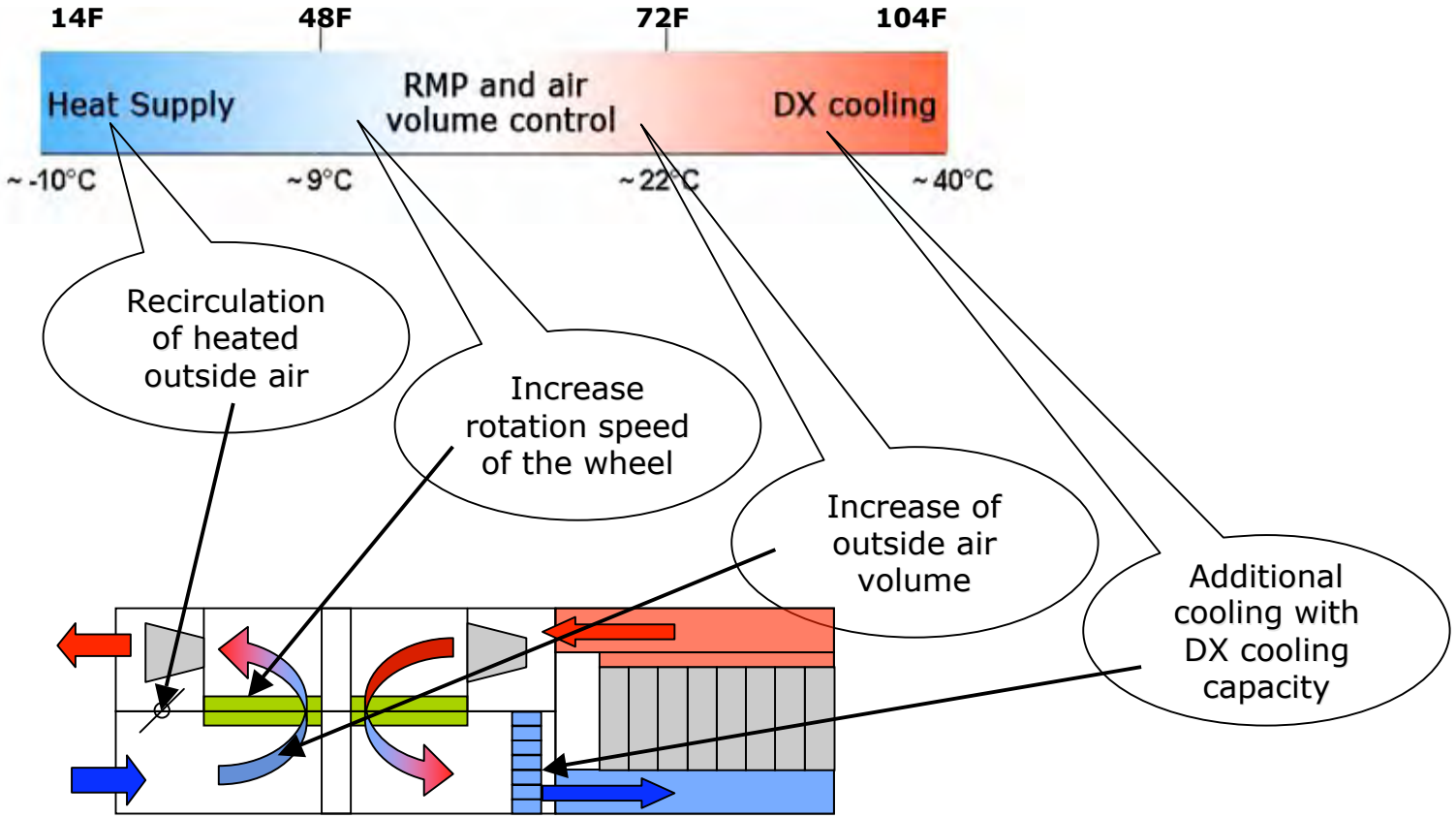
- Total of recirculation air to centralized (outside) air handlers.
  - Recirculation air cooled by outside air by air/air cooler
  - 100 % cooling by <22°C/72°F outside air temperature
  - Return air temperature 28-37°C / 82-98°F
  - Make up air temperature 20-25°C / 68-77°F

Recirculation cooling by air/air cooler



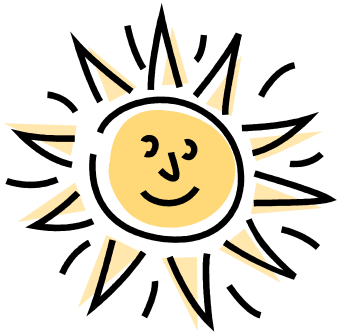


Control mechanism KyotoCooling®

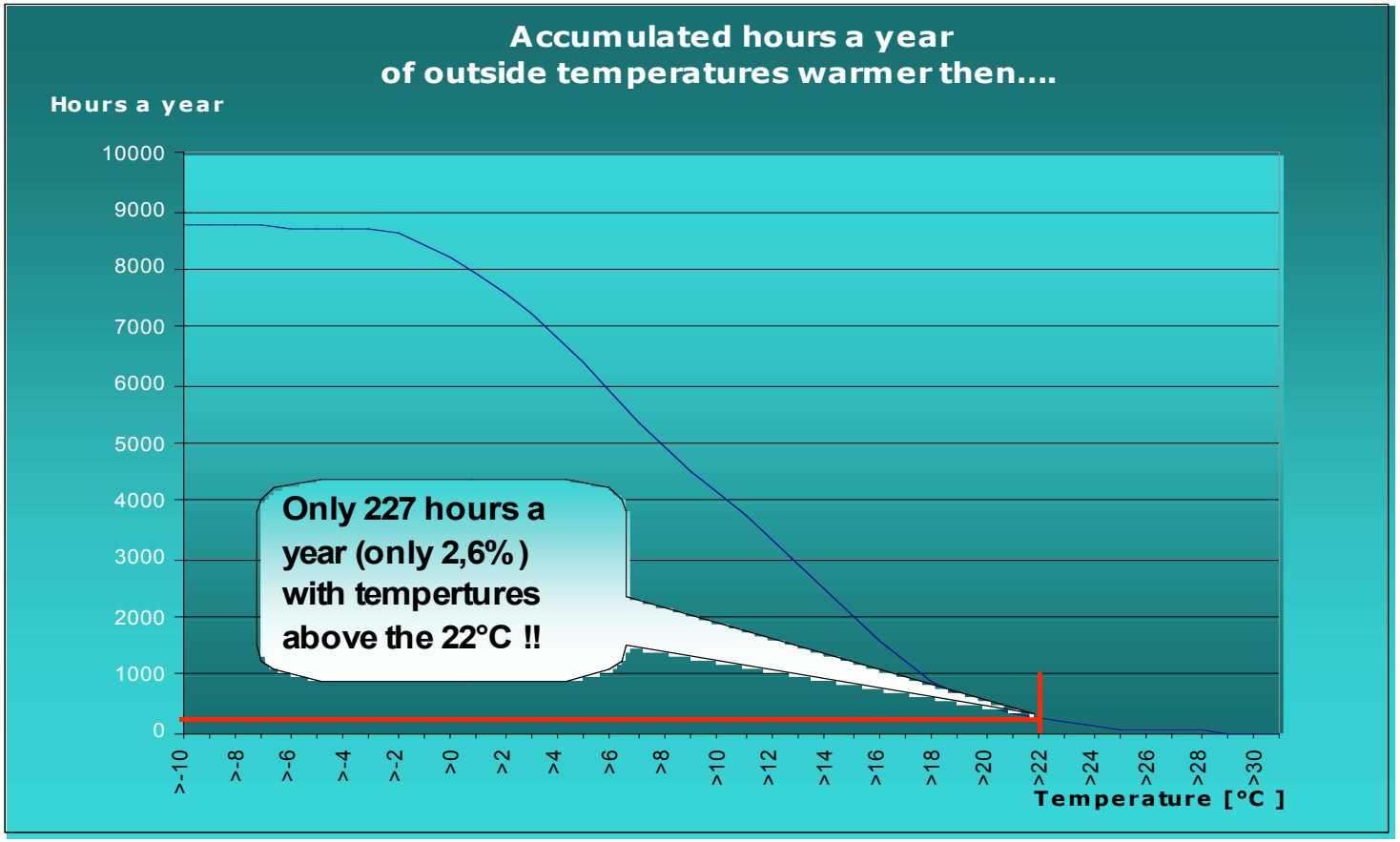


Capacity of a rotary heat exchanger

- Maximum wheel size available : 6000mm/ 20ft
- Make up air temperature : 25°C / 77°F
- Specific Δt over IT equipment : 12°C / 20°F
- Inside recirculation per hour : 150.000 m^3 / 5.000.000 ft^3
- Maximum wheel rotations per min. : 6
- Cooling capacity : 600 kWatt



In perspective with the Dutch climate



Source : KNMI

Usage of new cooling concept

- < 22°C/ 72°F ⇨ only air/air cooling ⇨ 97 %
- 22-30°C ⇨ air/air and add. cooling ⇨ < 3 %
- > 30°C/86°F ⇨ only add. cooling ⇨ < 1 %

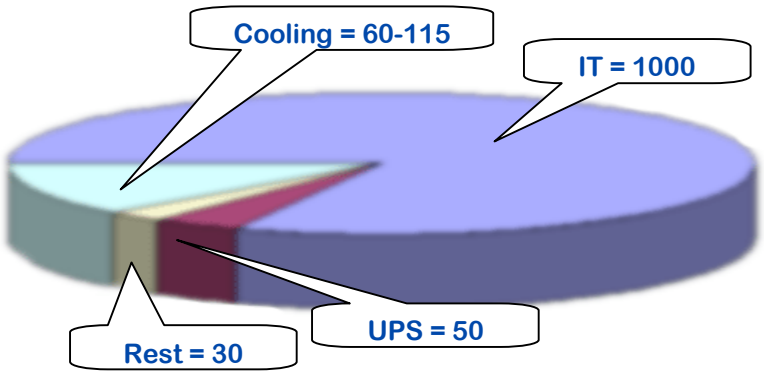
- Innovative cool design based on “proven” technology ⇨ required reliability of total system is guaranteed

Note: figures based on “Dutch” climate

Energy consumption with KyotoCooling®

- About 85% for the primary process (IT)
- About 8% for cooling of the primary process
- 4% UPS conversion loss
- 2% rest (lighting etc.)
- Factor of Cooling power:

  $Power_{(IT+Cooling)}/Power_{IT} = 1,1$



Dynamic loading

- Control of cooling through flow control (not temperature)

  When power consumption IT equipment is related to workload the cooling capacity should adjust to the workload.

So…. What's in it for you?

- Perfect and unlimited cooling of IT hardware
- 80% decrease in cooling costs
- Sustainable ⇨ **GREEN**
- Handles dynamic loading of ICT equipment

And there is more…

Building a (commercial) datacenter

- Which customers will come ?
- When will they come ?
- How much power will they consume ?
- How many cabinets i.e. m^2 will they use ?
- How will their power demand evolve ?

We won't find the answers
and if we do, it will be too late!!
Even the customers themselves don't know.

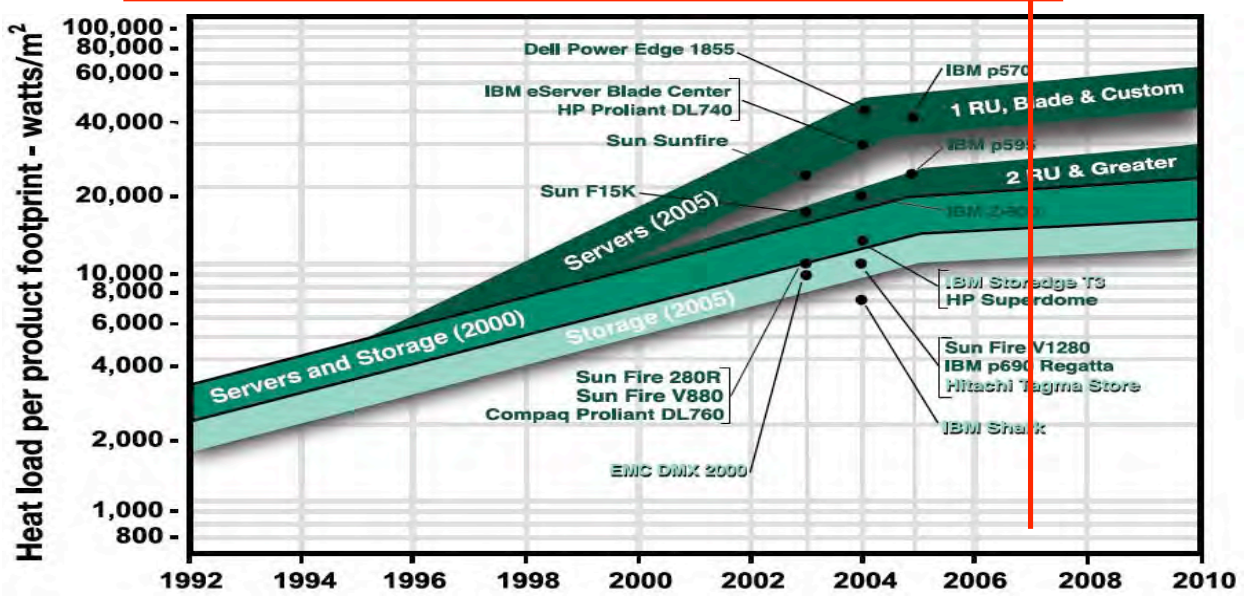
Design parameters…power per cabinet

How much power per cabinet do we use on average?
What is the power consumption right now?

1000 W/m^2 ⇨ 2,5 kWatt per cabinet
1500 W/m^2 ⇨ 3,8 kWatt per cabinet
2500 W/m^2 ⇨ 6,3 kWatt per cabinet
3000 W/m^2 ⇨ 7,5 kWatt per cabinet
5000 W/m^2 ⇨ 12,5 kWatt per cabinet

Now on sale…

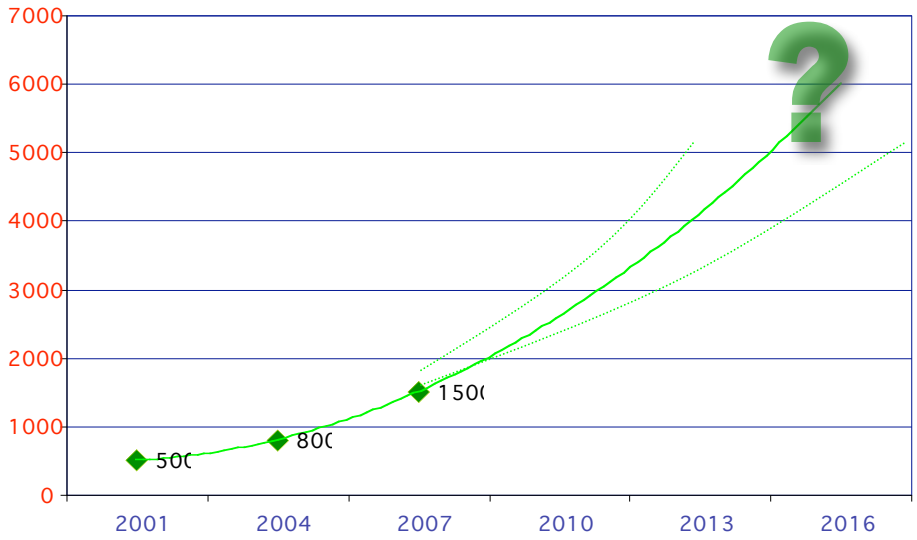
- 27kWatts (and more) in a cabinet!



Source: The Uptime Institute and ASHRAE

What about capacity per m2 ?

- Energy consumption in the future? 2010 -2015
  - Further miniaturization of IT components leads to higher density in IT equipment and will increase the energy consumption in a cabinet.
- The trend is steep !
  - 500 W/m^2 in the year 2000; 1500 W/m^2 today.
- Will 5000 W/m2 be the norm for the future?



Analysis of a datacenter investment

- **Total investment:** 100%
  - The building incl. the site 20%
  - Electrical 40%
  - Mechanical 30%
  - Other infrastructure 10%

80% of the costs is related to the number and the extend of the customers!!

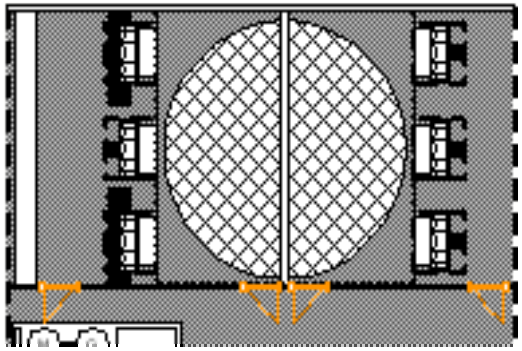
But we don't know to much about them….do we?

Solution

- Building capacity “Just in Time”
- Modular and based on the actual demand of the customer:
  - Build a Casco (multi floor) datacenter
  - Install m^2 on data floor based on demand
  - Adjust energy and cooling to the actual demand

Now, at start, we have to invest less than 40% of the total investment of 100 %

The Kyoto 'CoolCell'

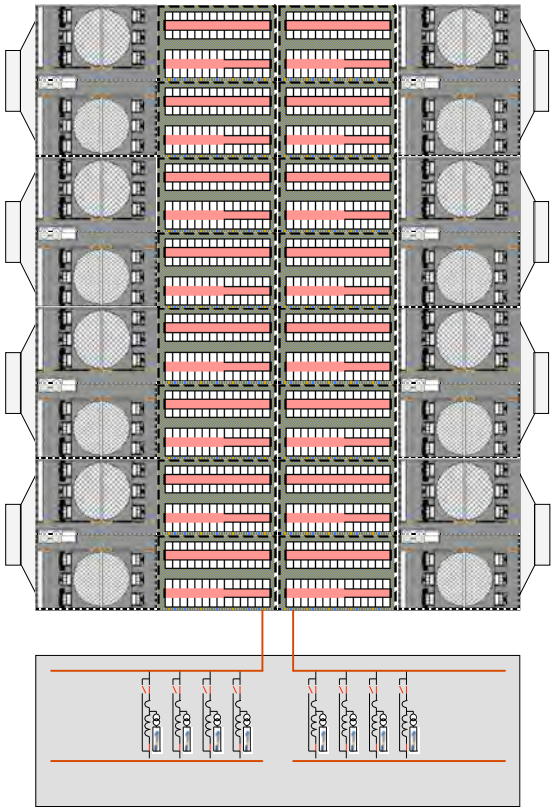


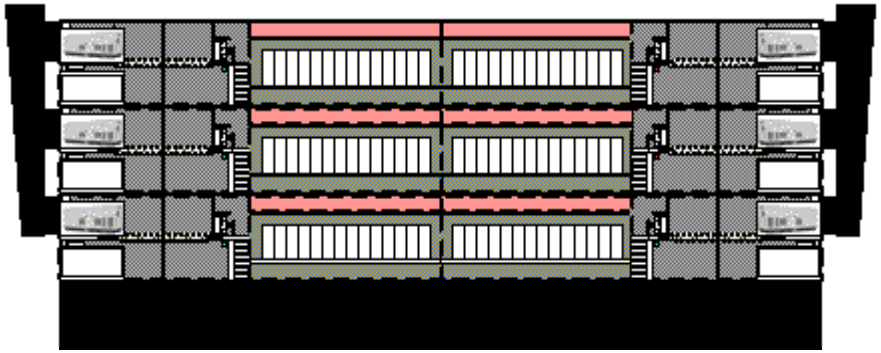
KyotoCooling per cell:

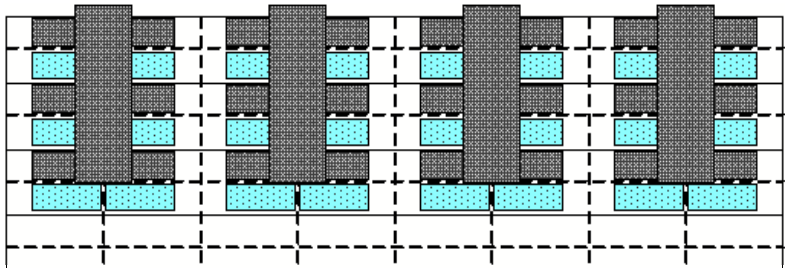
- ❖ Additional cooling machines

- Cooling with DX (Freon) ⇨ no water or central piping
- No peak in power demand with "cooling" ⇨ "flat liner"
- Up to 40% lower demand of the national grid

Building a scalable datacenter







concurrent maintainable *and* fault tolerant

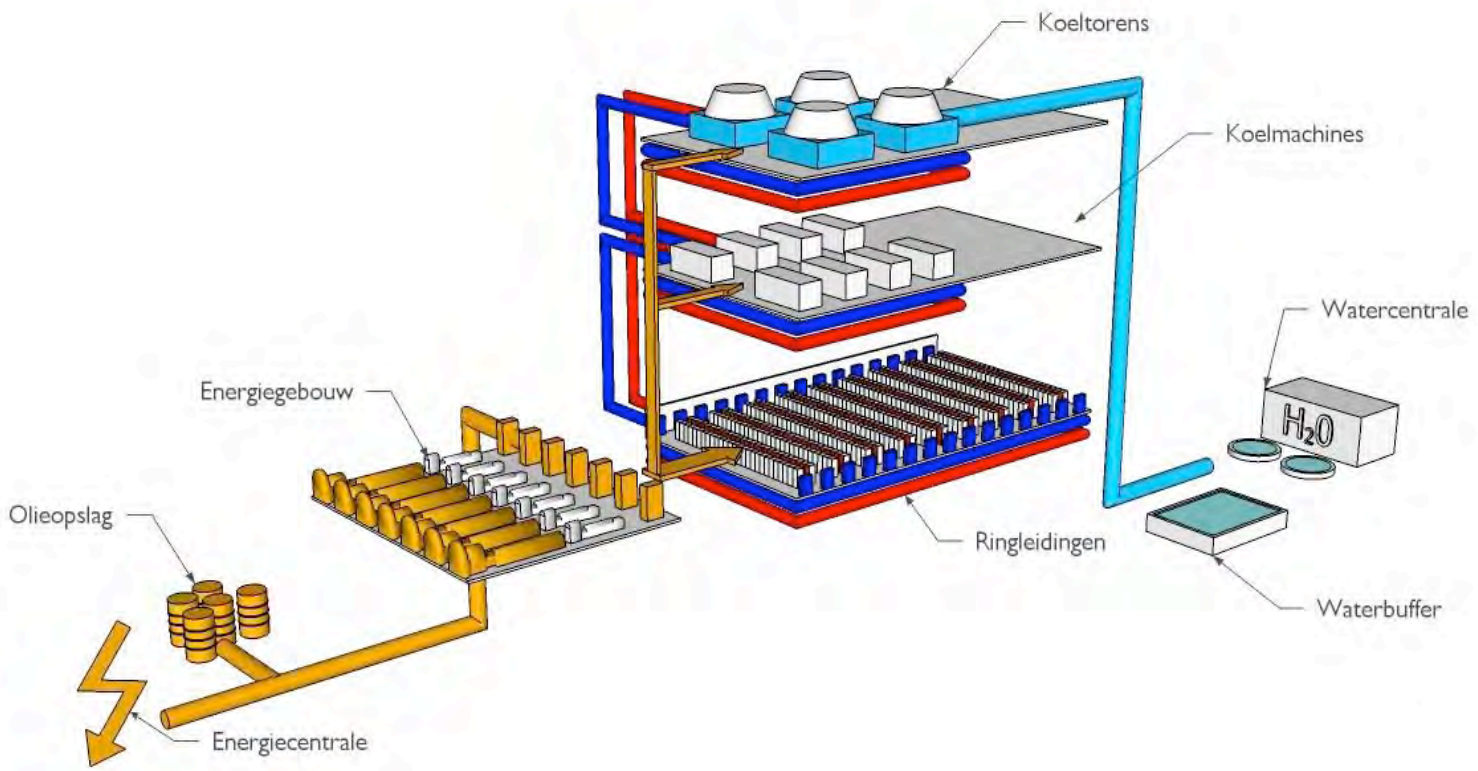
- KyotoCooling cell is totally independent
- (N+1) x S : each S has built in redundancy

- Electrical infrastructure
- Always A and B feed from different Dynamic UPSses (isolated redundant systems) N x S + 2

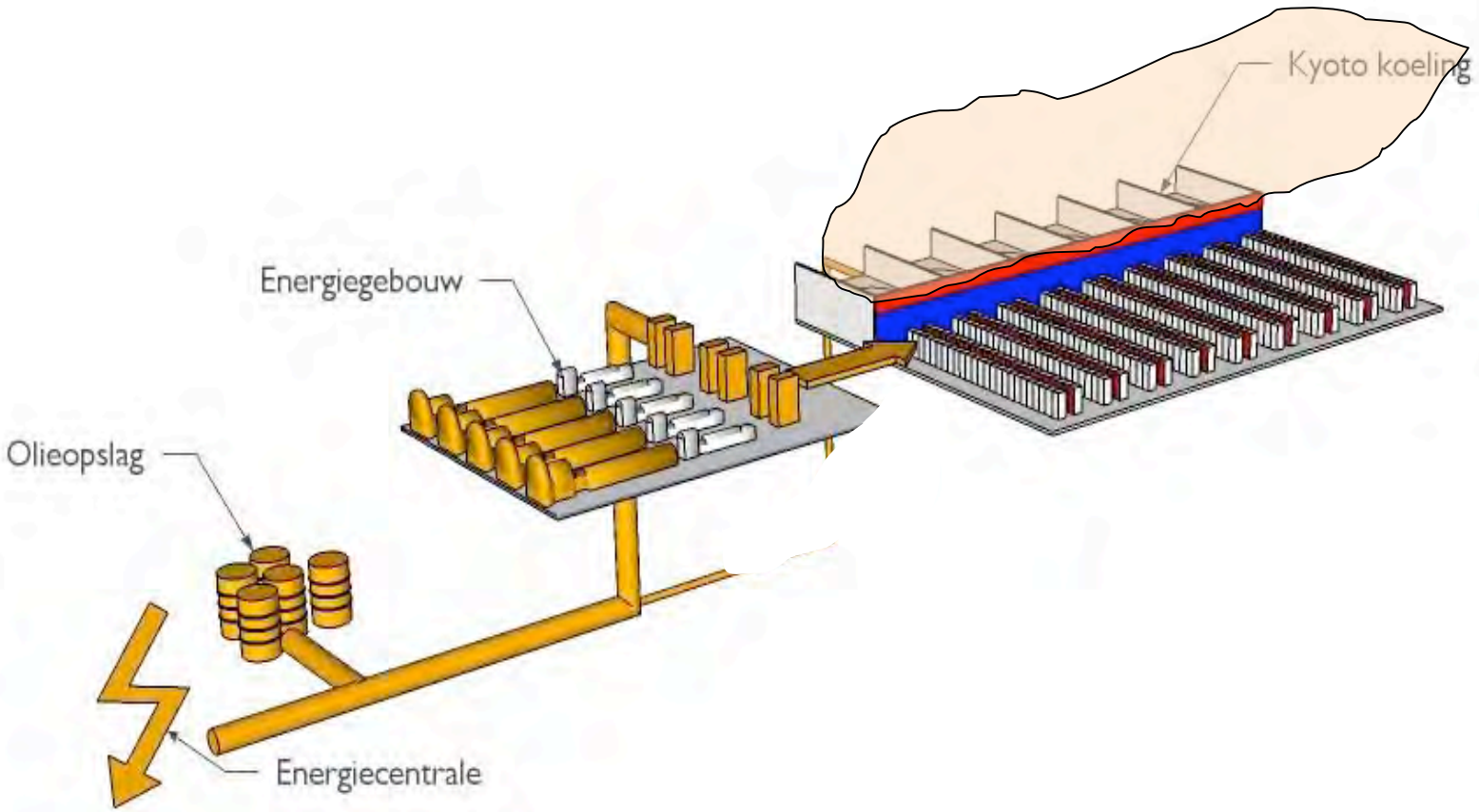
Safety net :

- NEVER destroy IT equipment by cooling system breakdown !

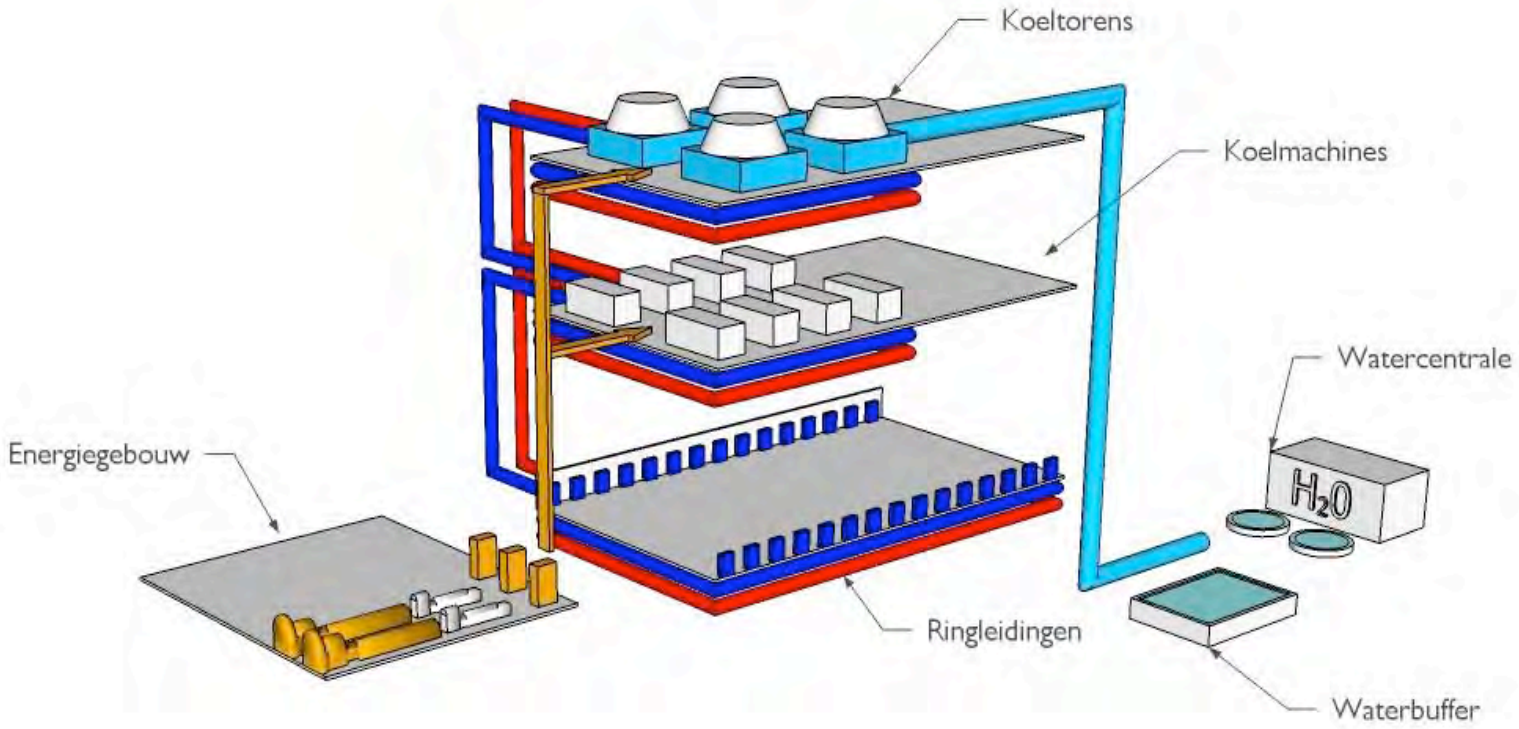
Conventional technical infrastructure



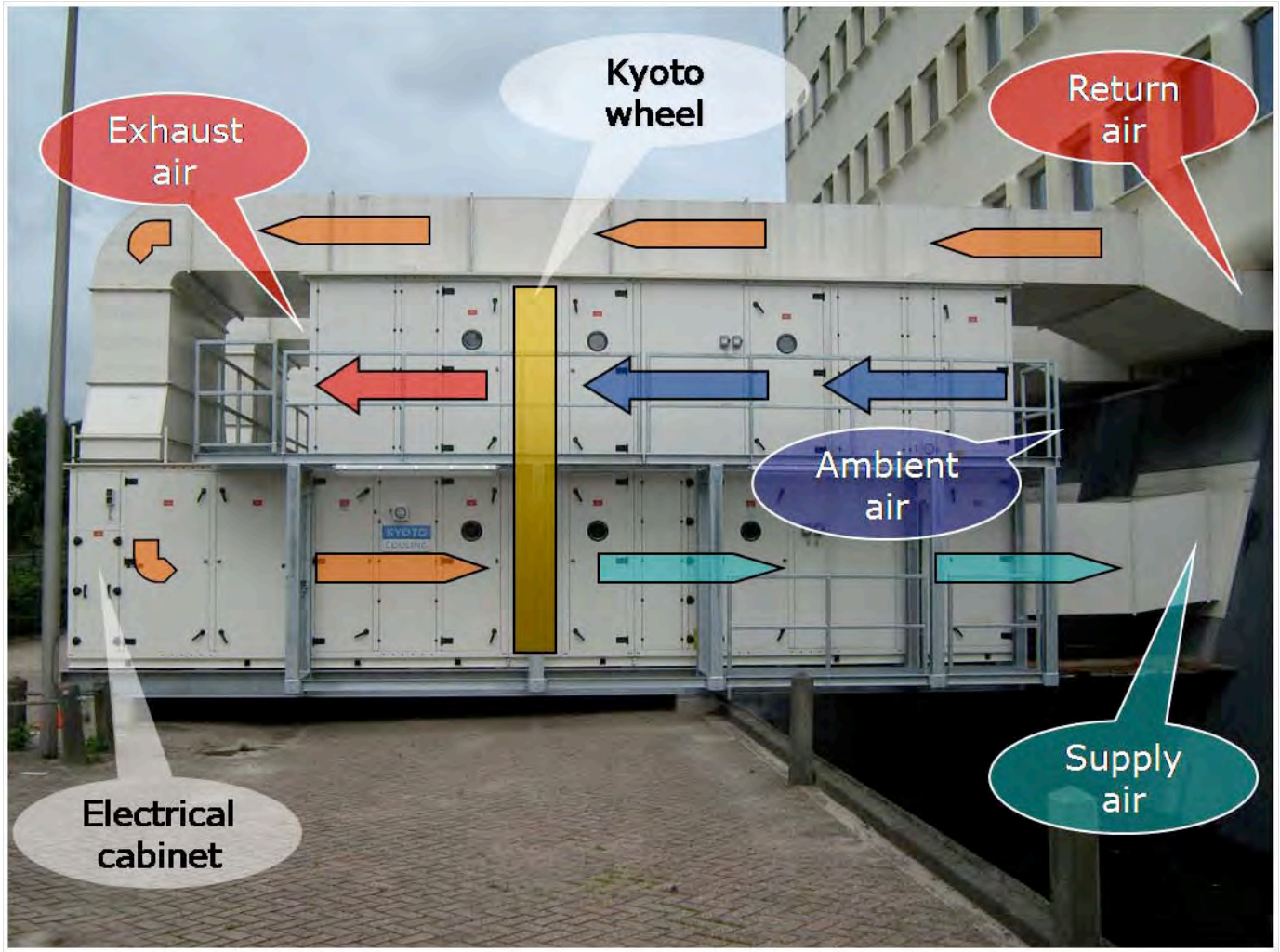
Kyoto infrastructure



Obsolete Infrastructure



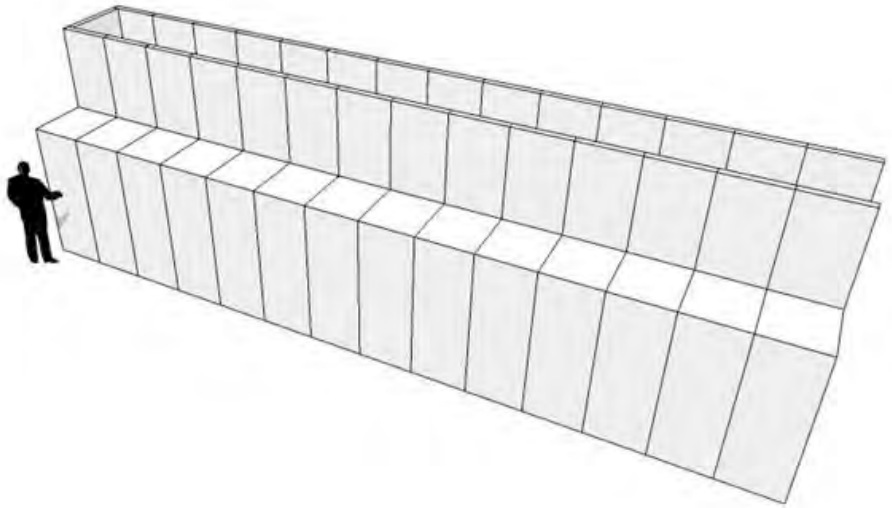
KyotoCooling @ Work



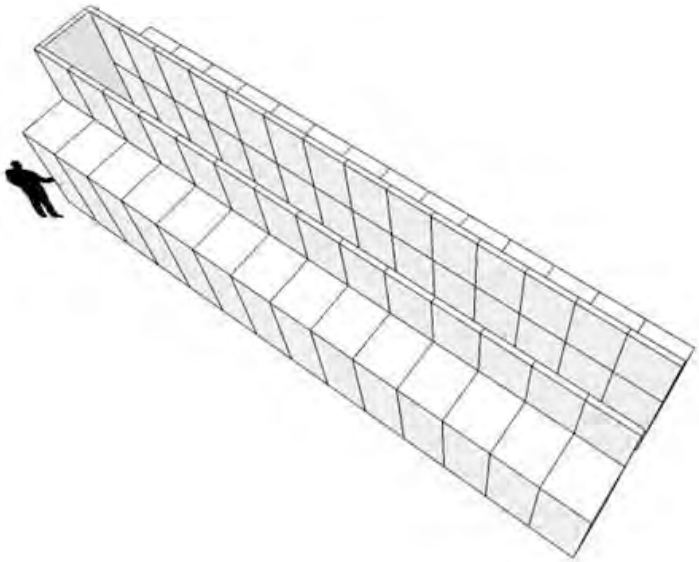
CABINET

CABINET

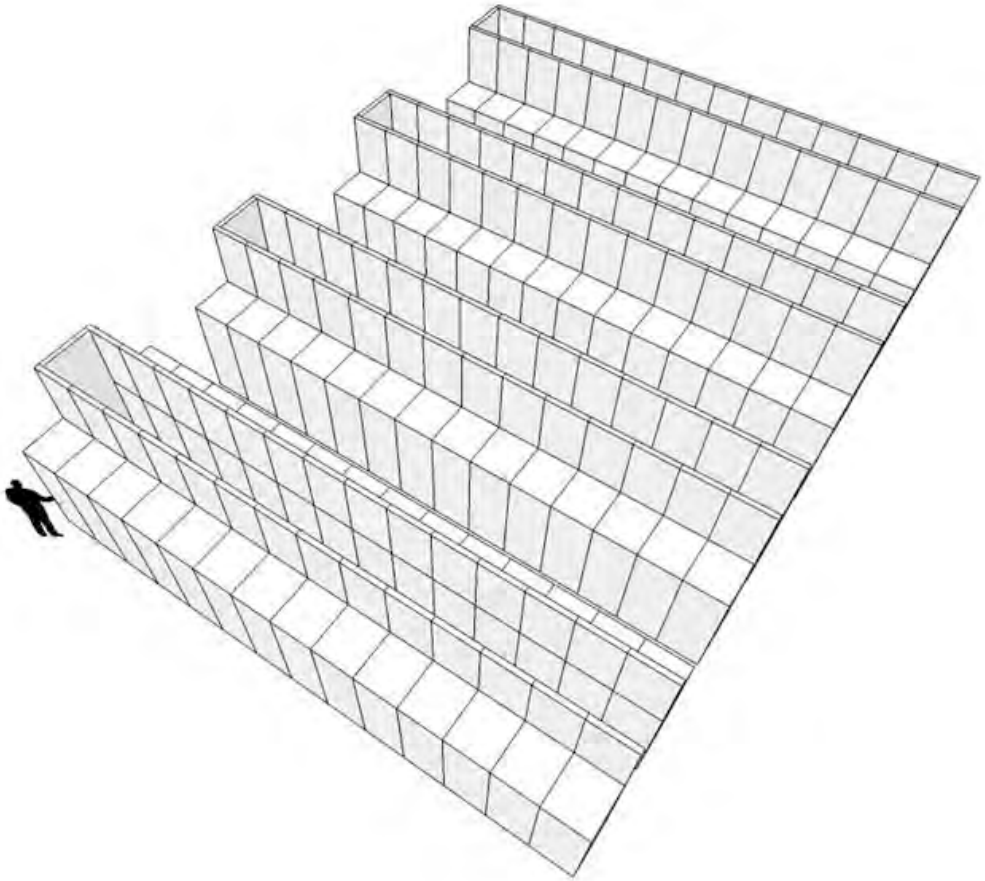
ROW of CABINETS



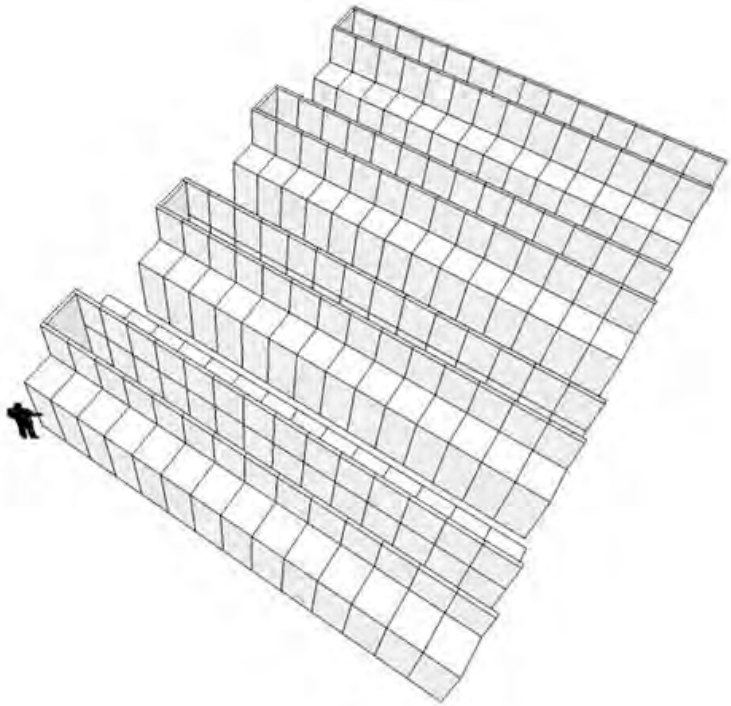
ROW of CABINETS



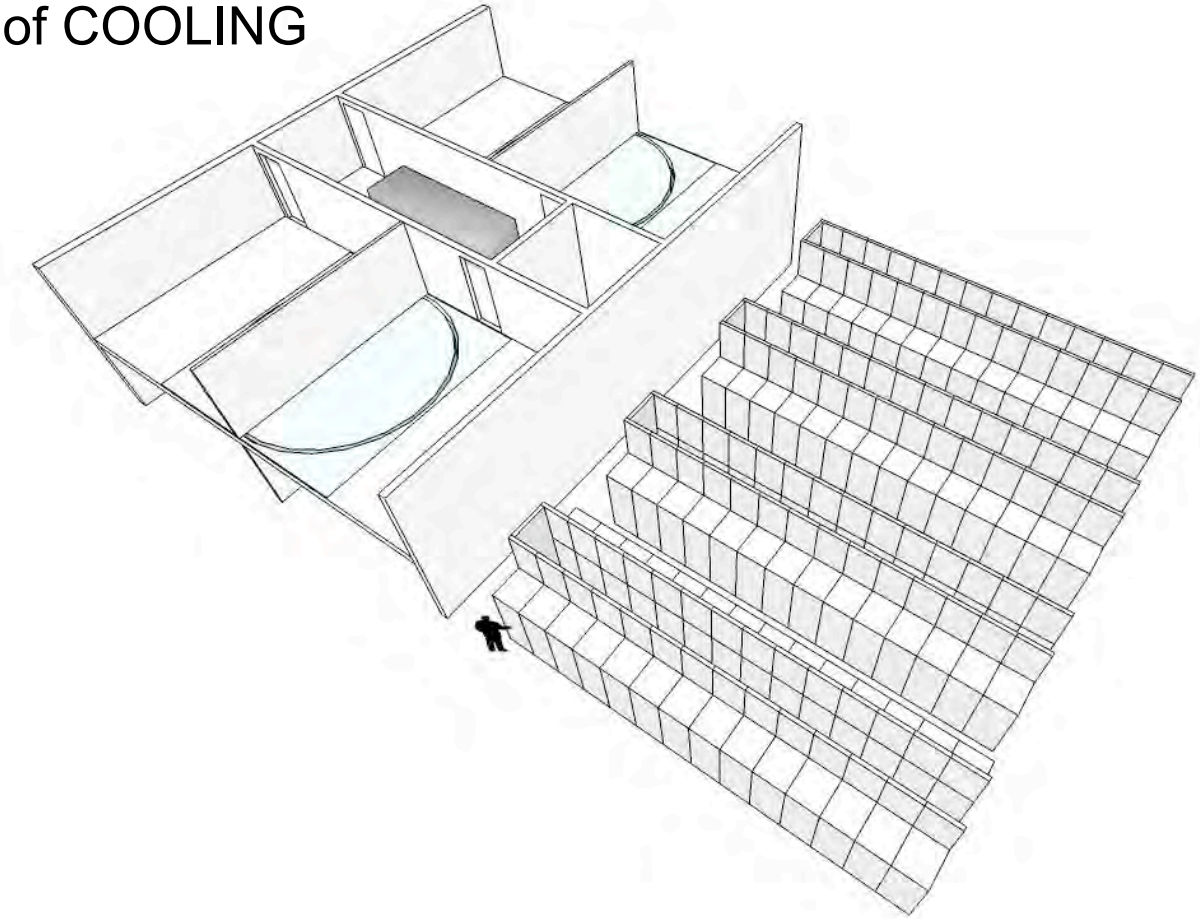
FIELD of CABINETS



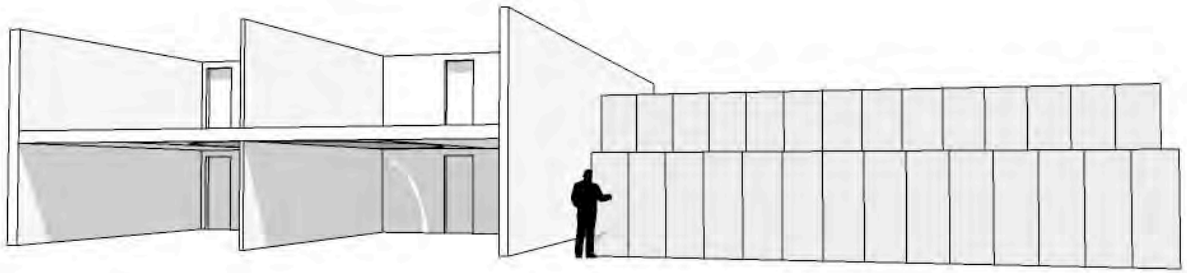
CONCEPT of COOLING



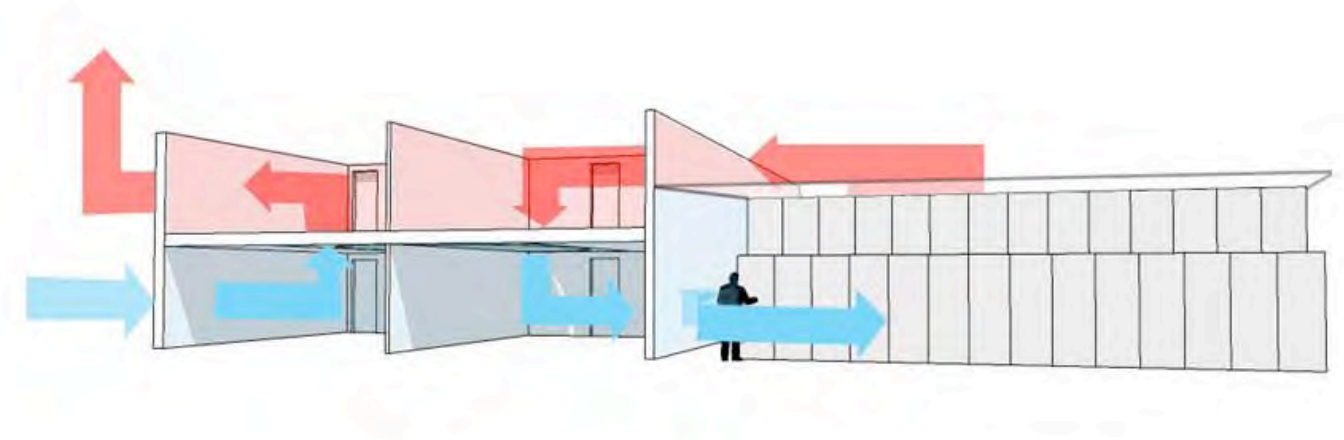
CONCEPT of COOLING



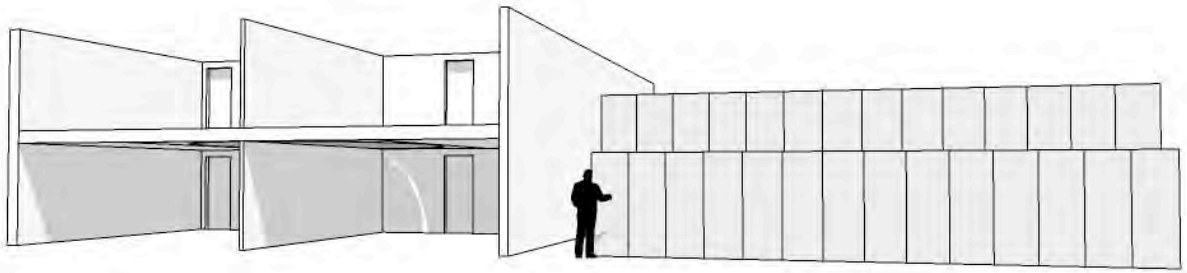
CONCEPT of COOLING



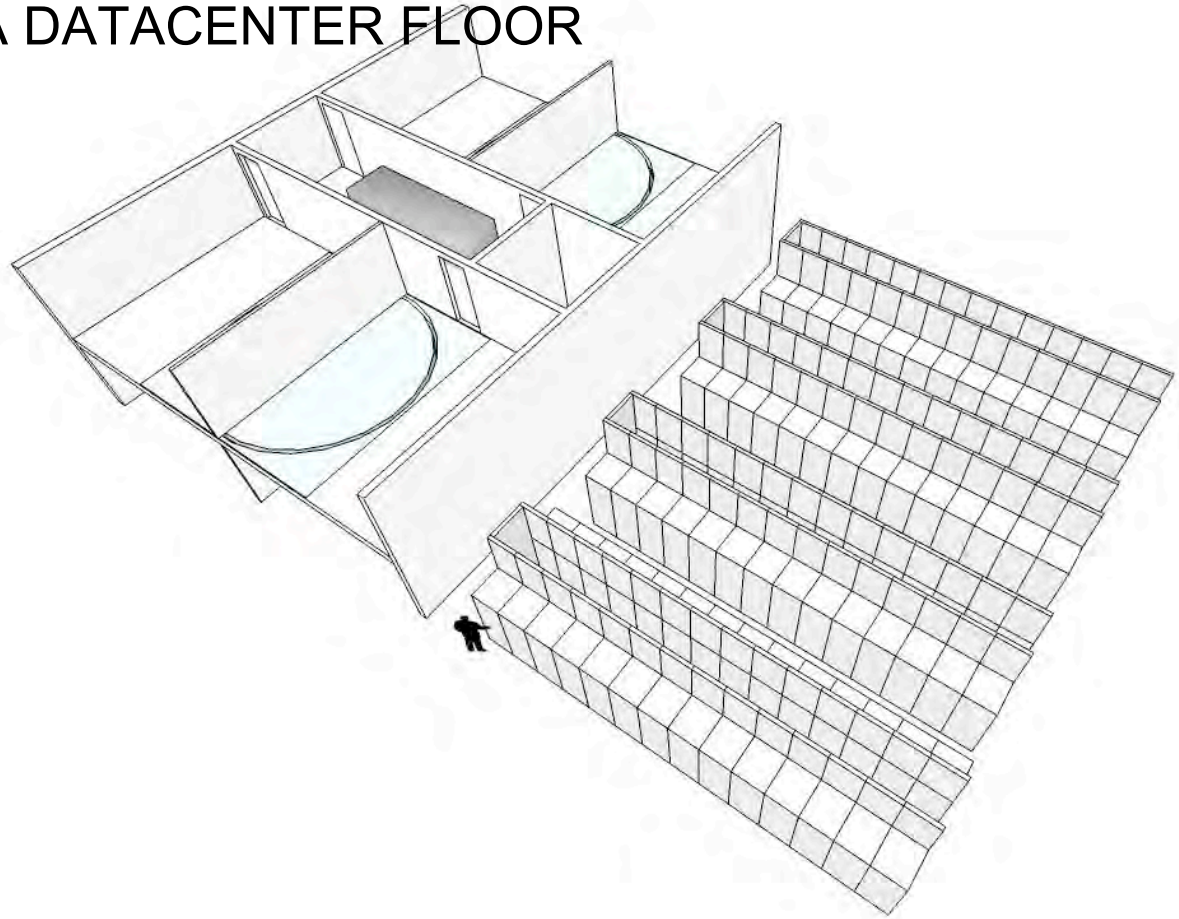
CONCEPT of COOLING



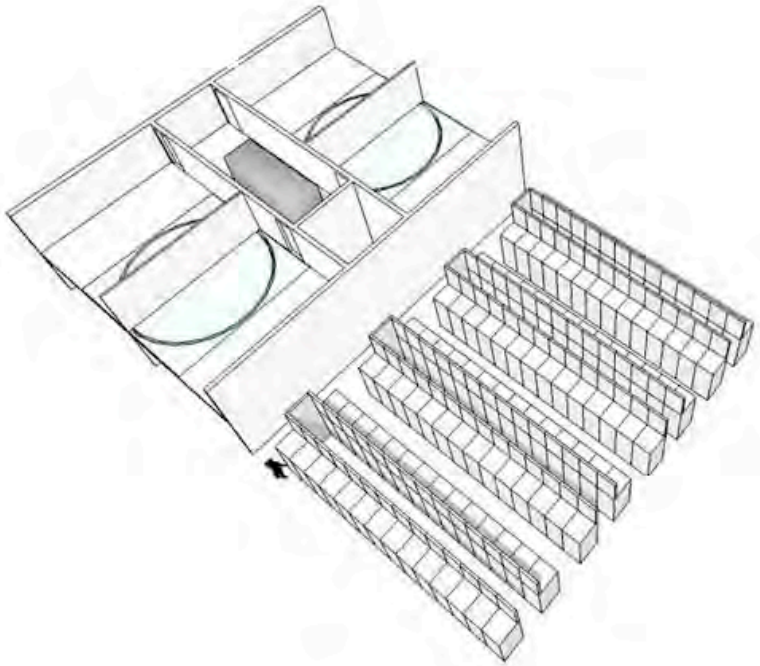
CONCEPT of COOLING



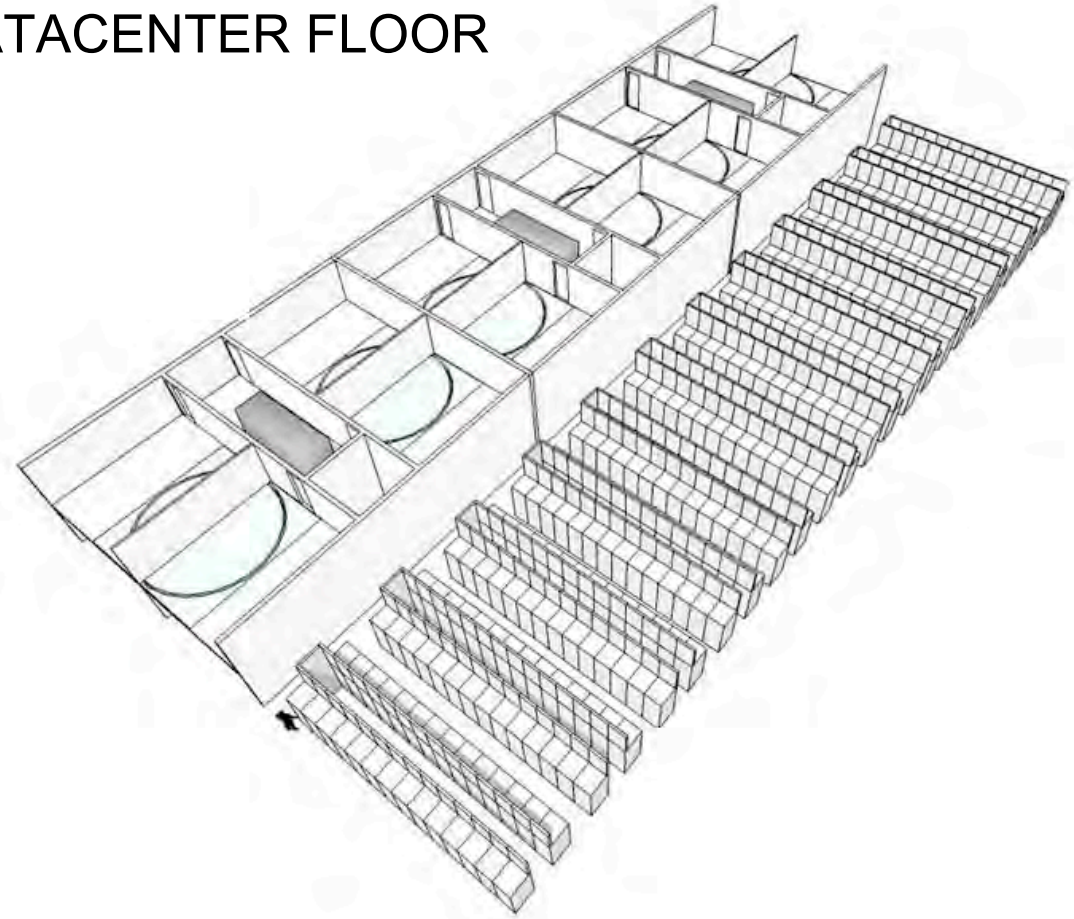
BUILDING A DATACENTER FLOOR



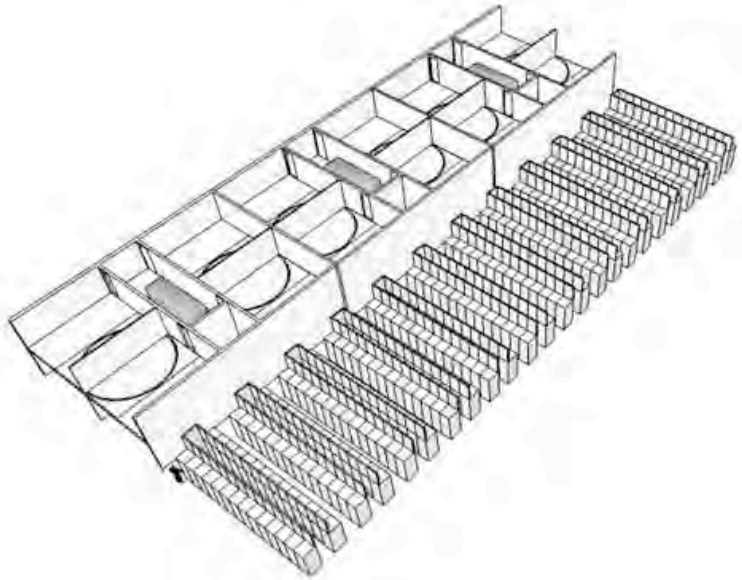
BUILDING A DATACENTER FLOOR



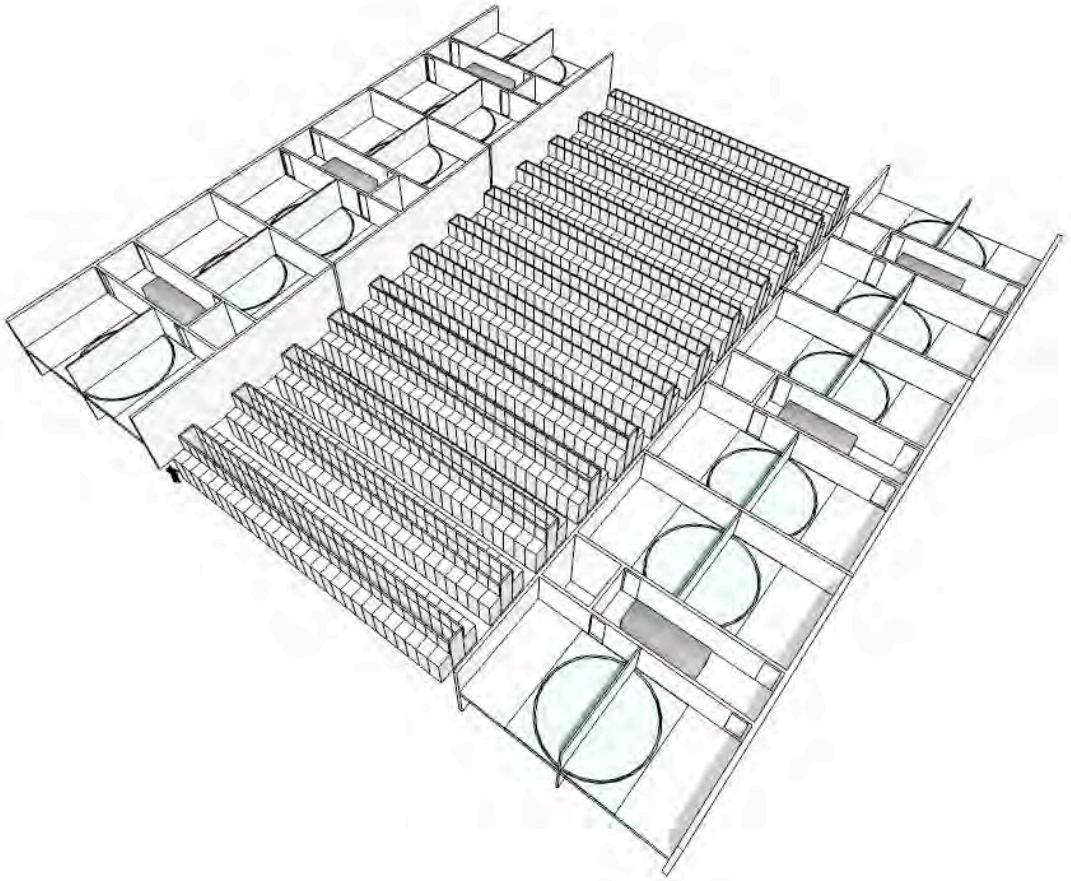
BUILDING A DATACENTER FLOOR



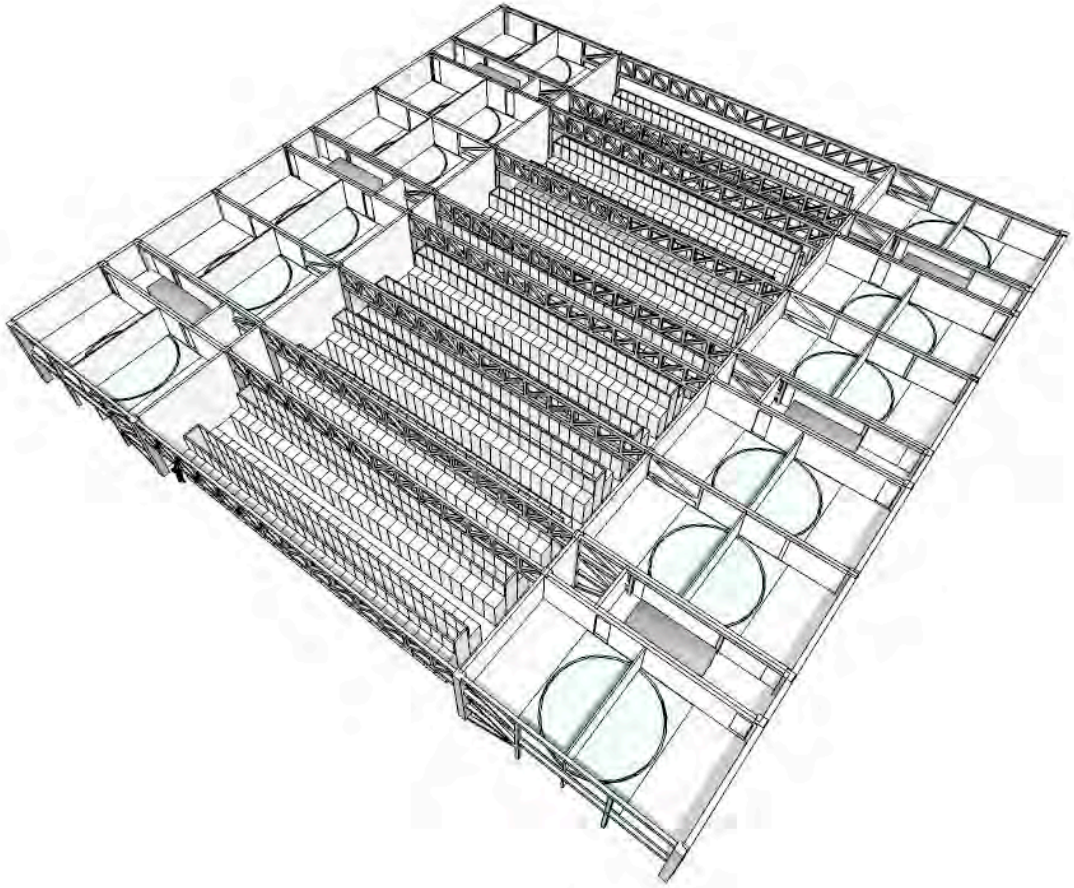
BUILDING A DATACENTER FLOOR



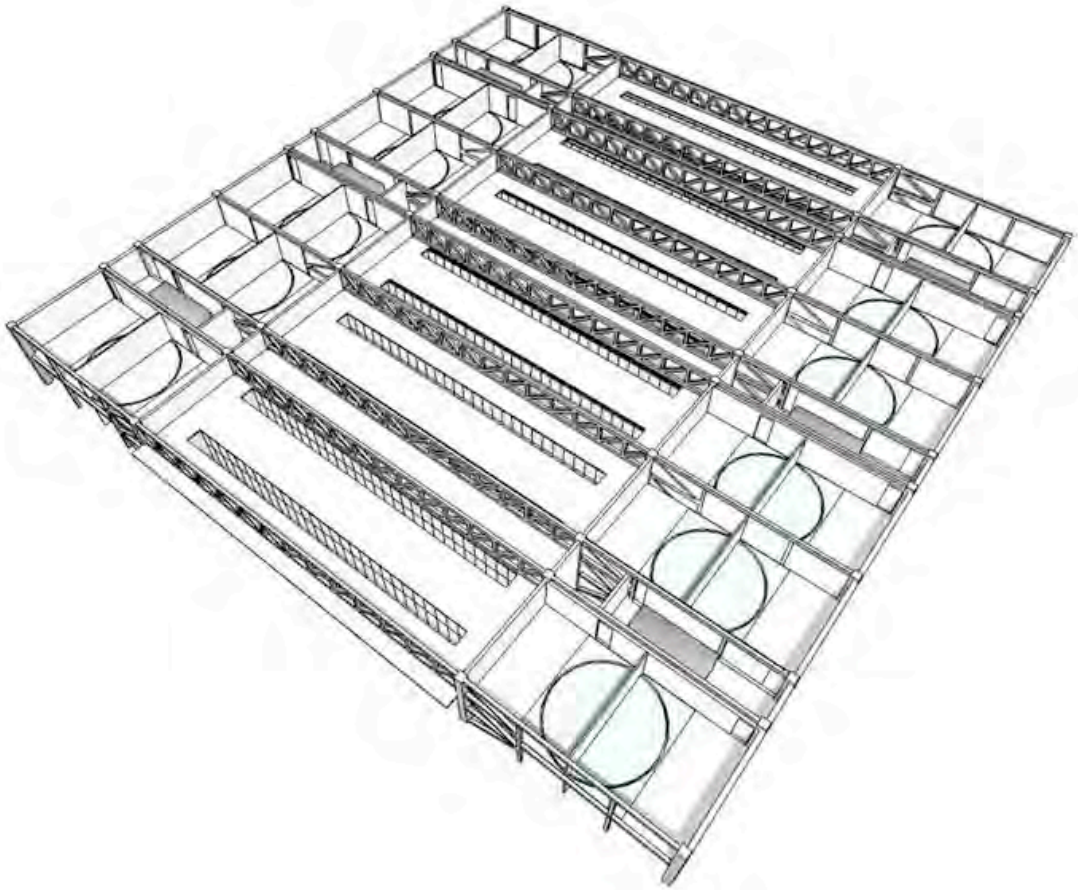
BUILDING A DATACENTER FLOOR



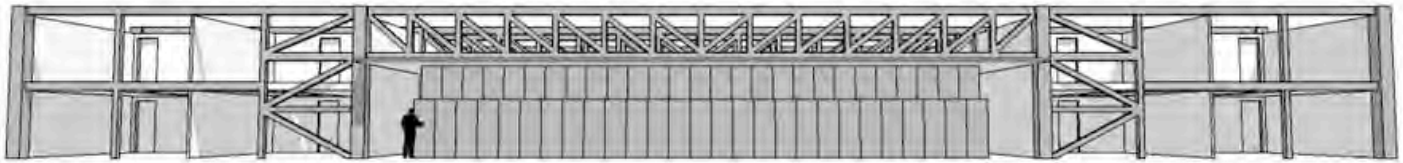
CONSTRUCTION



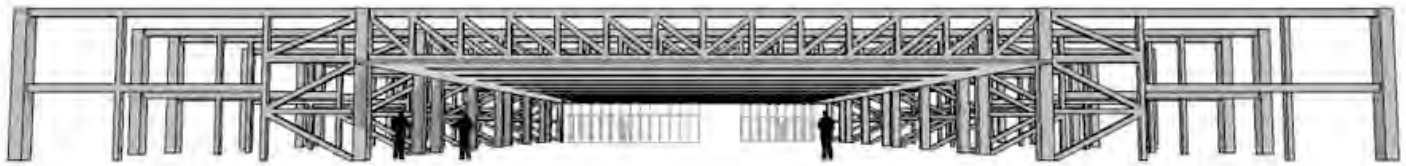
CONSTRUCTION



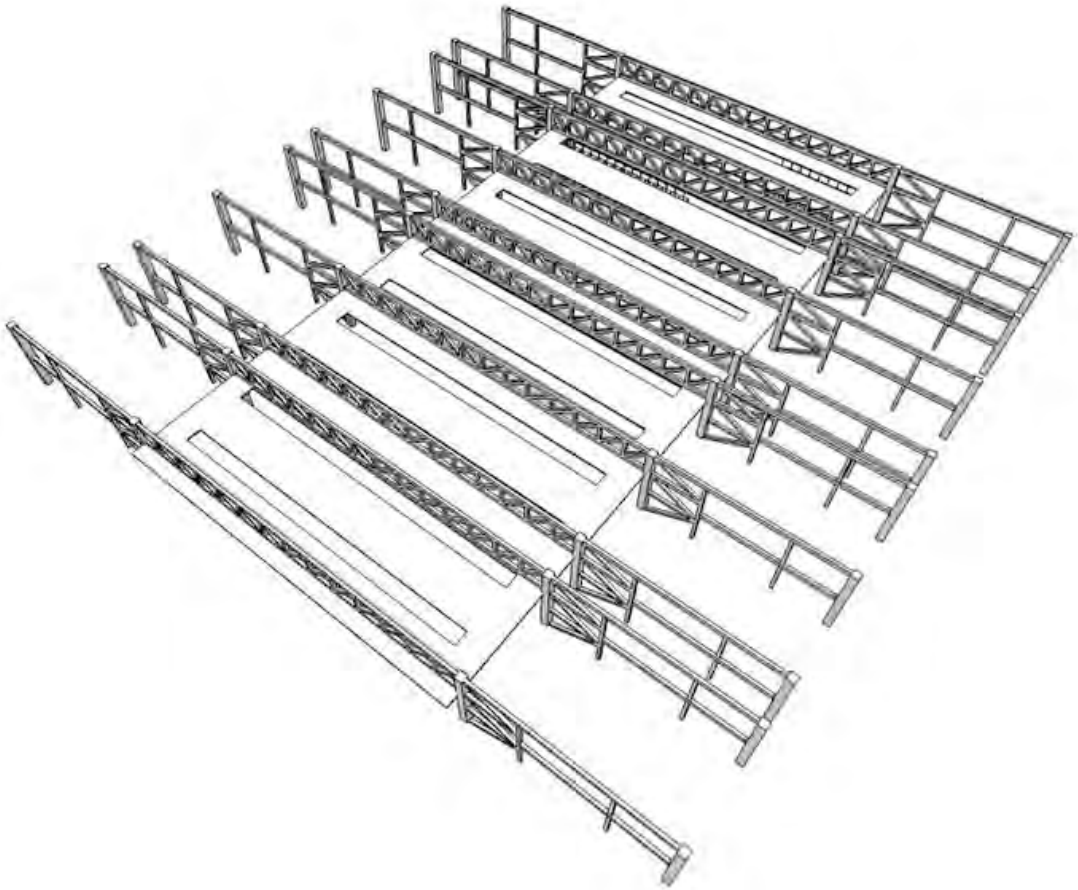
CONSTRUCTION



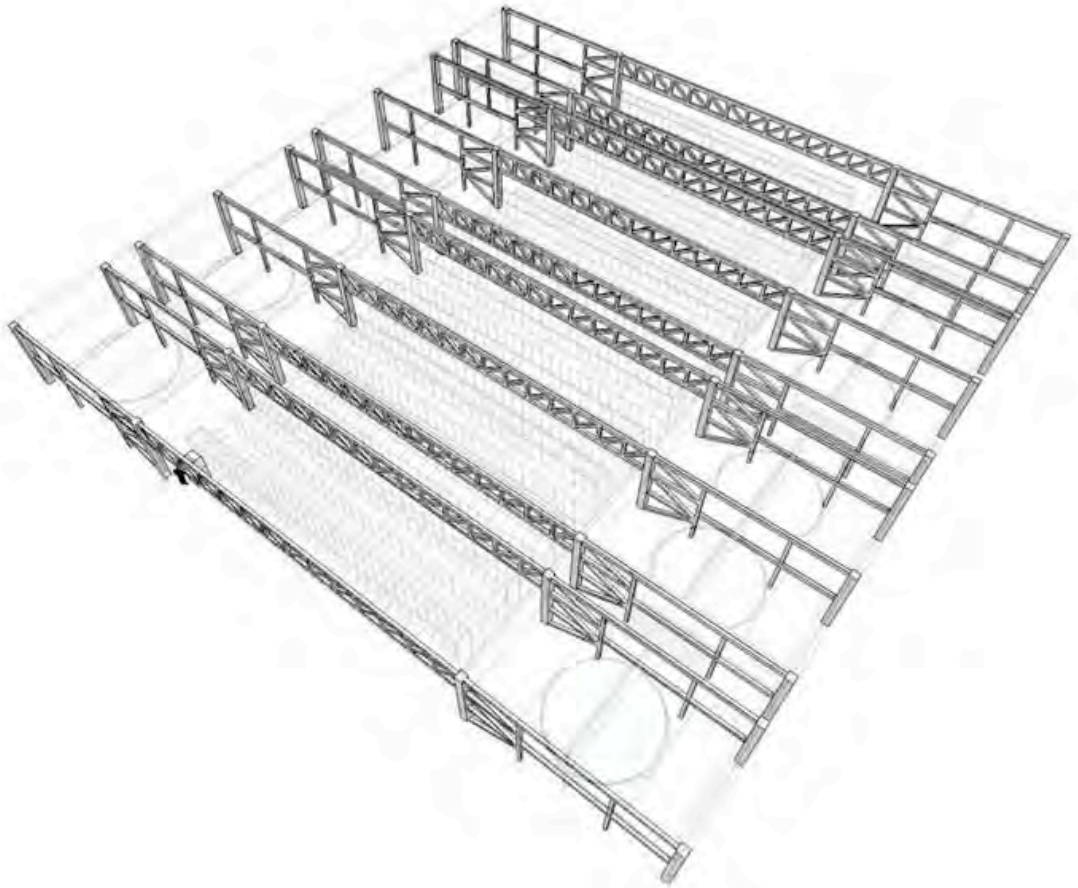
CONSTRUCTION



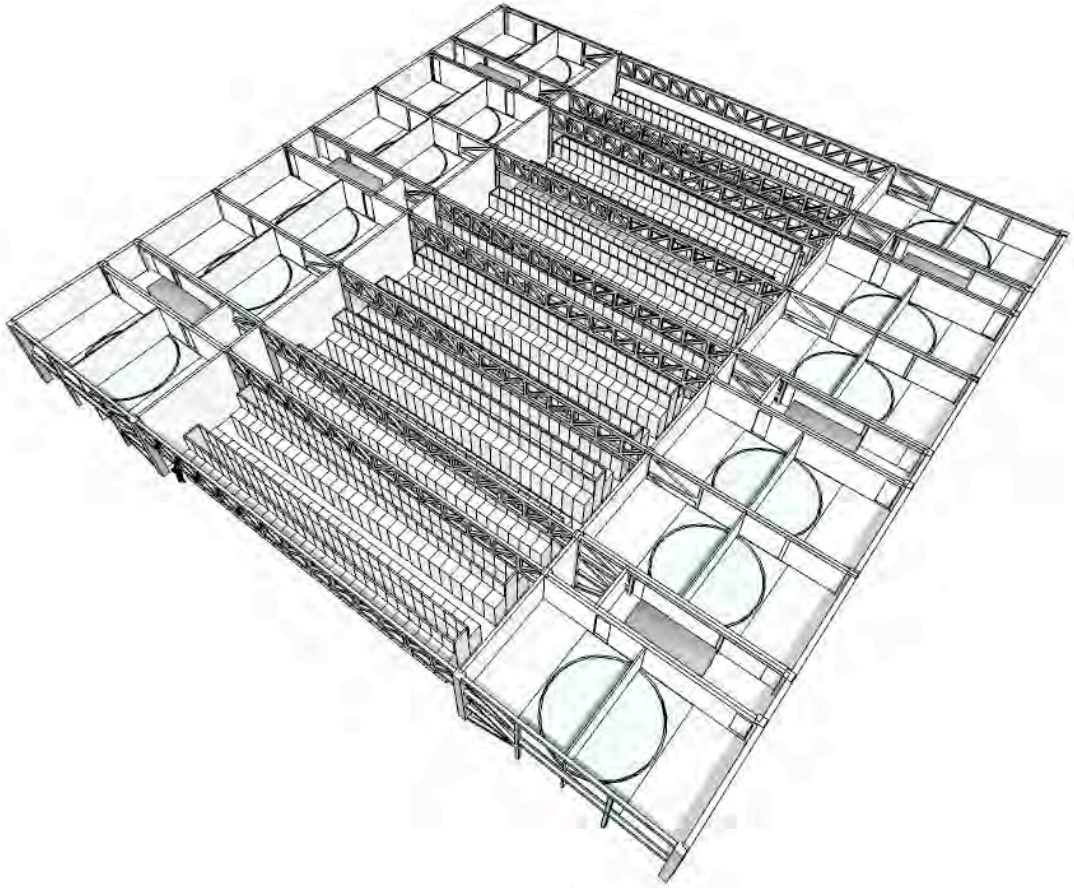
CONSTRUCTION



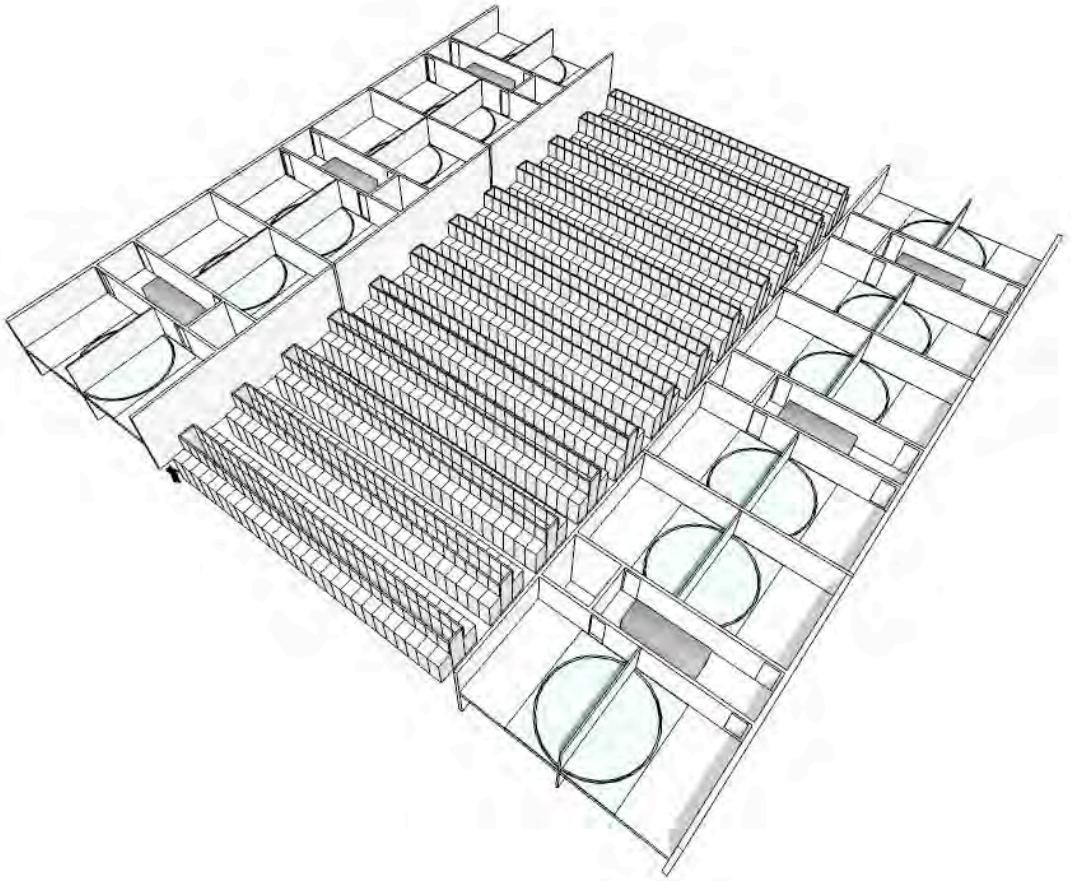
CONSTRUCTION



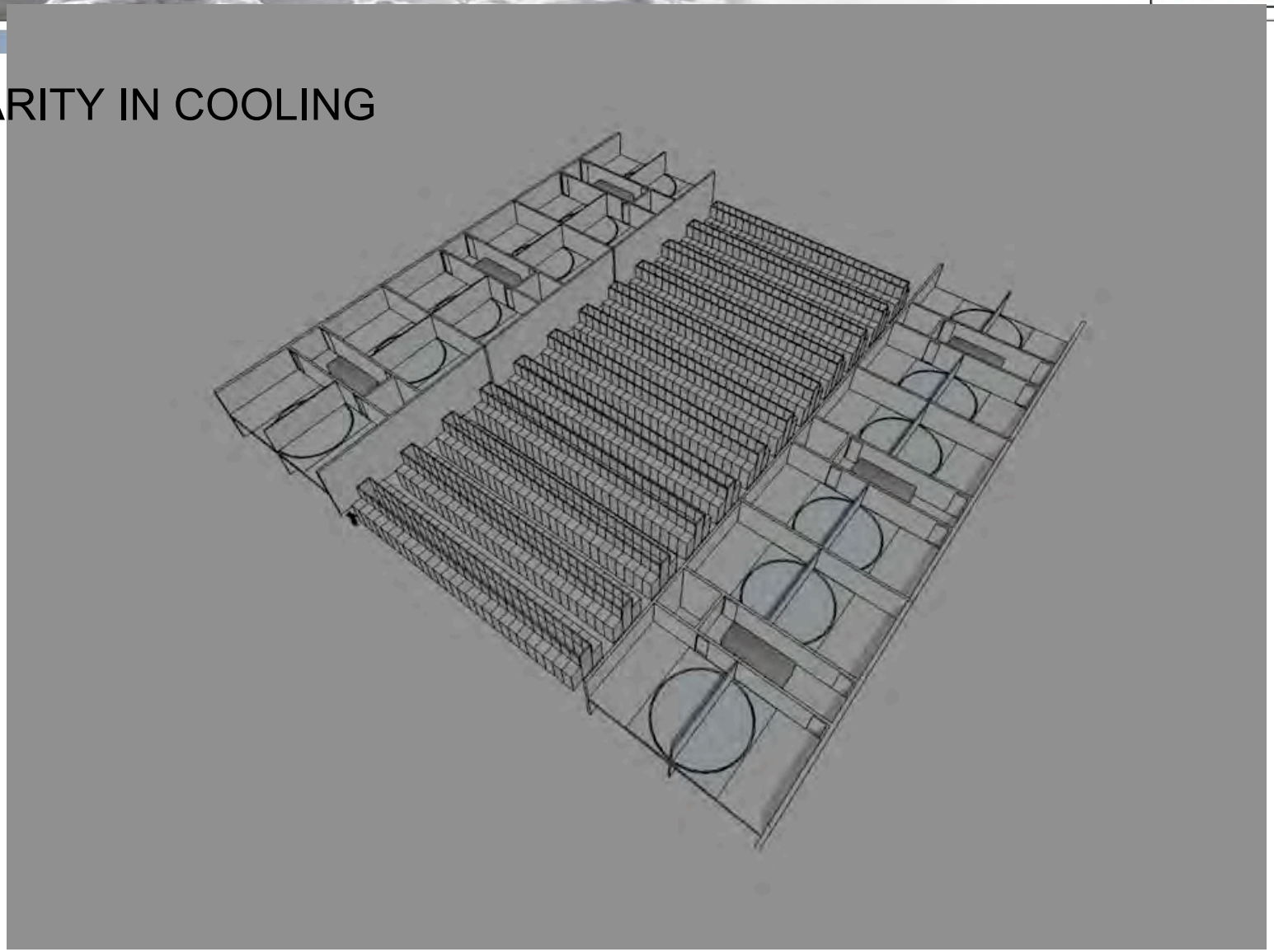
CONSTRUCTION



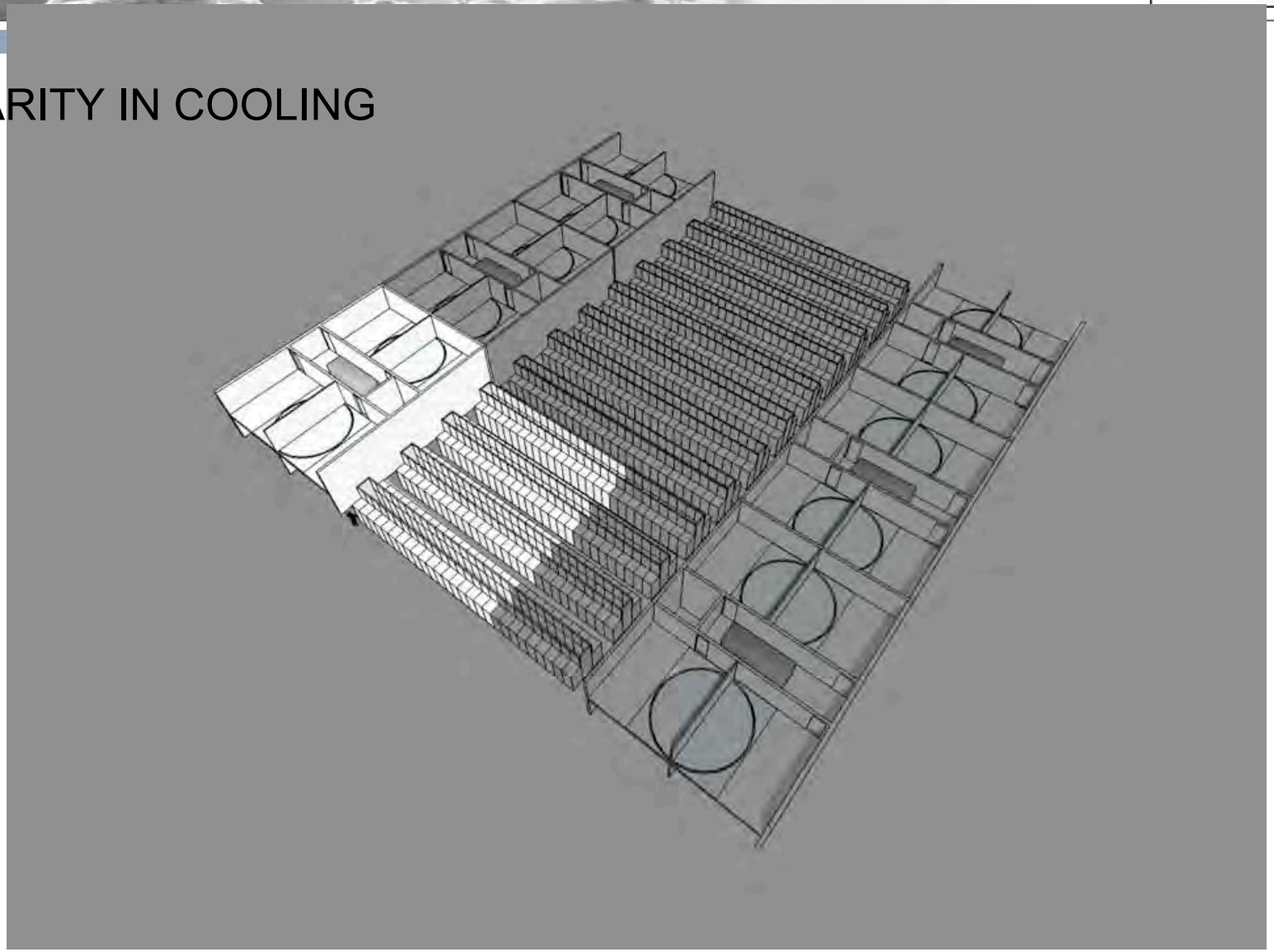
MODULARITY



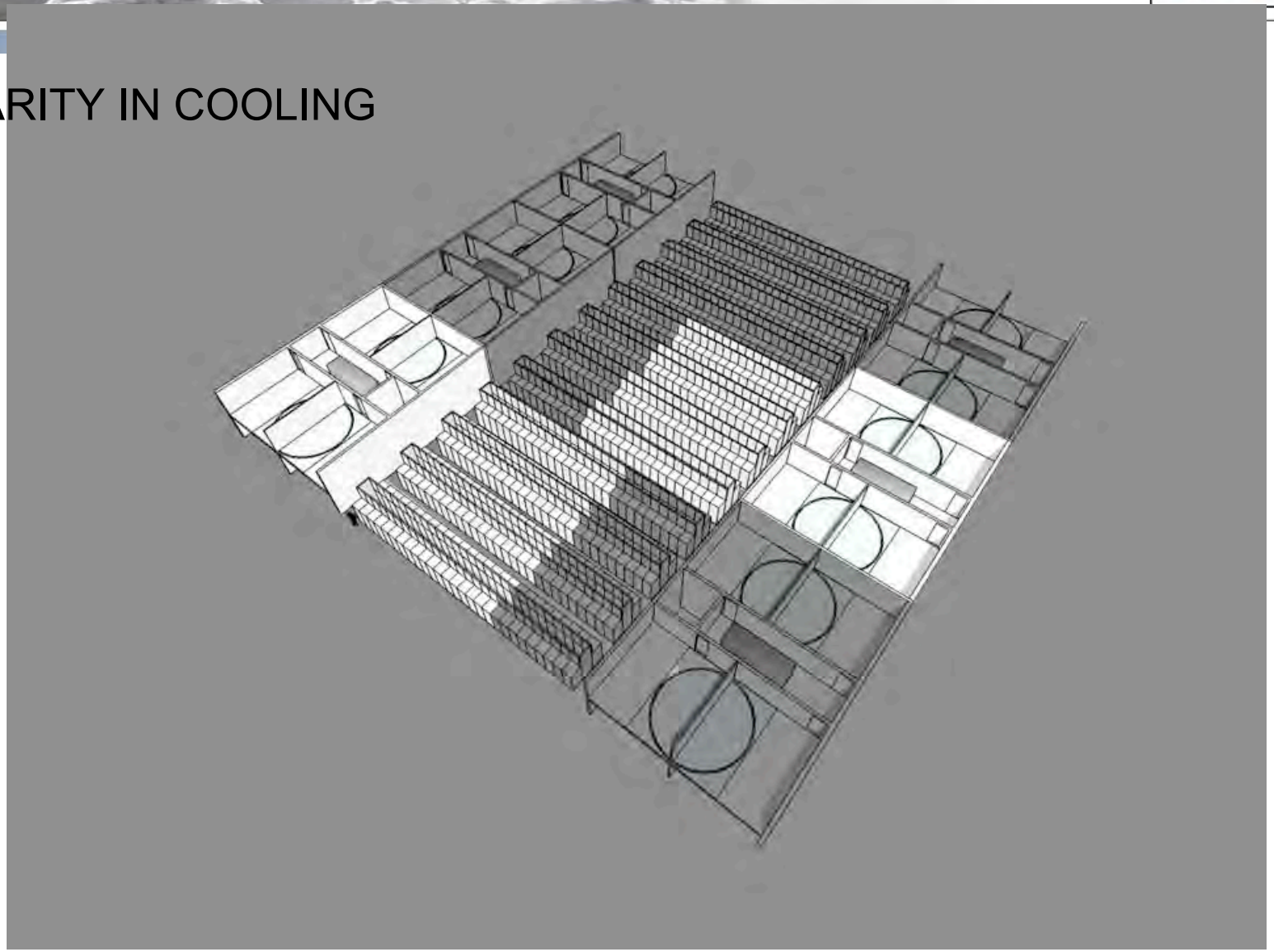
MODULARITY IN COOLING



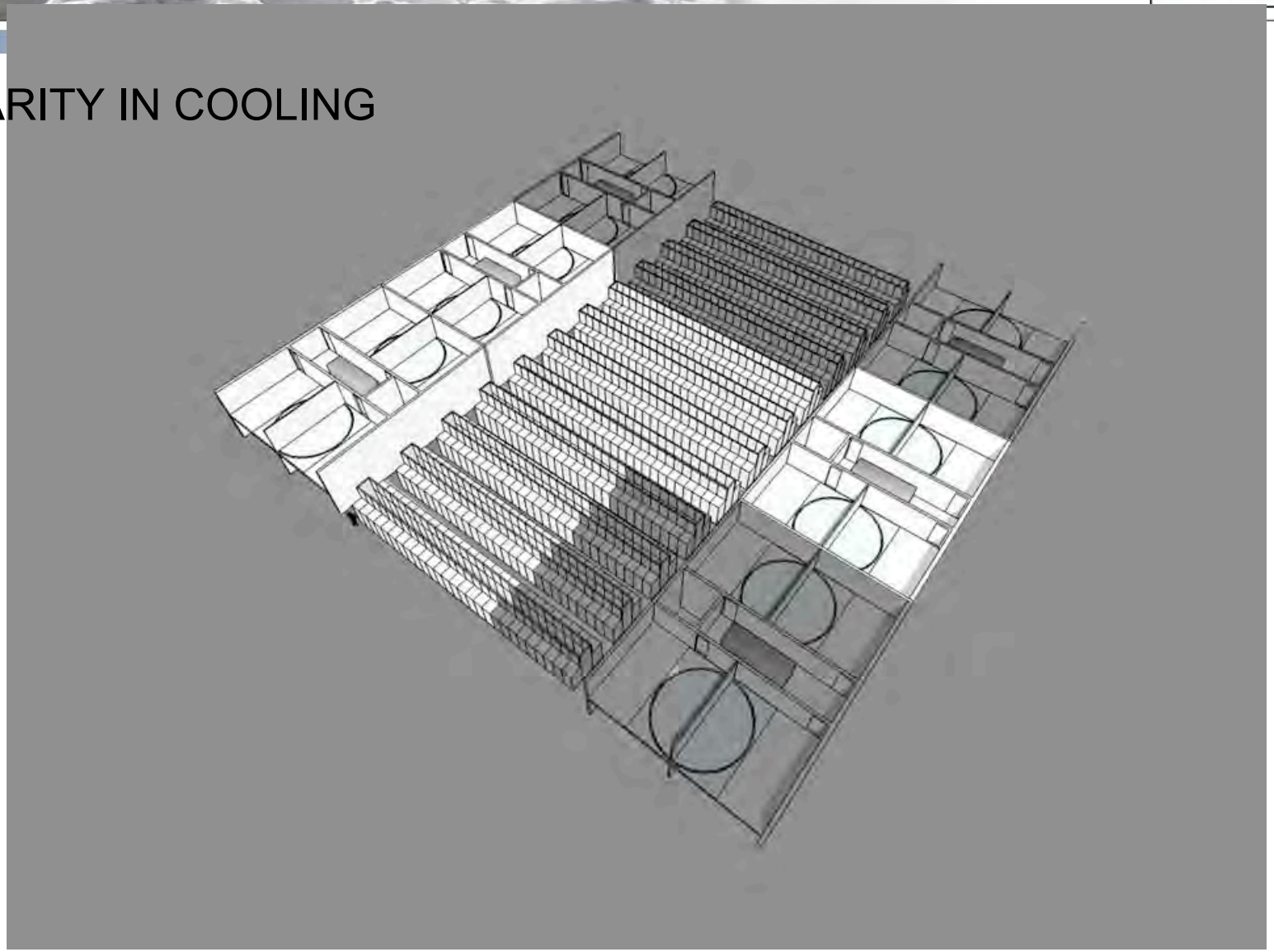
MODULARITY IN COOLING



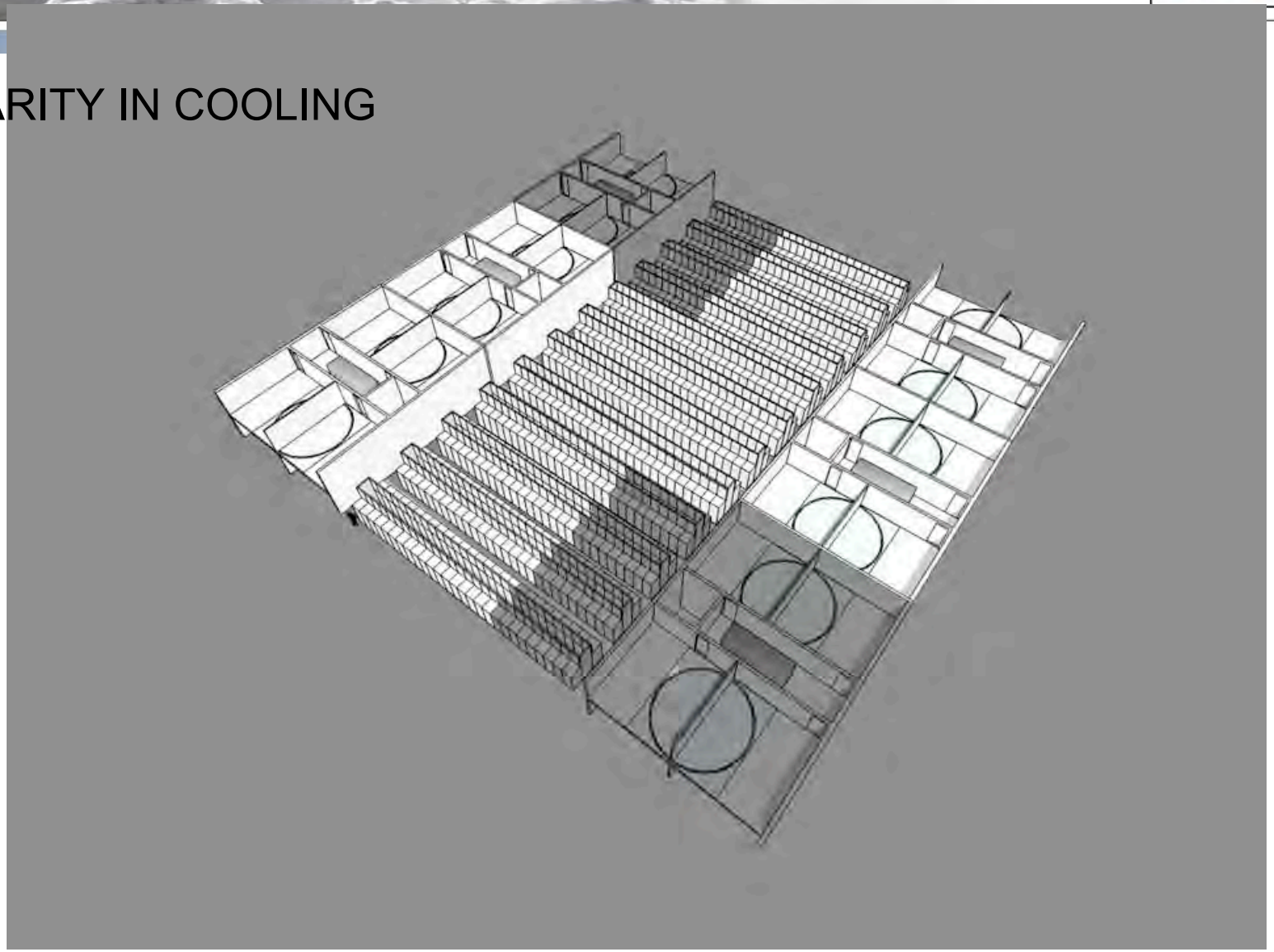
MODULARITY IN COOLING



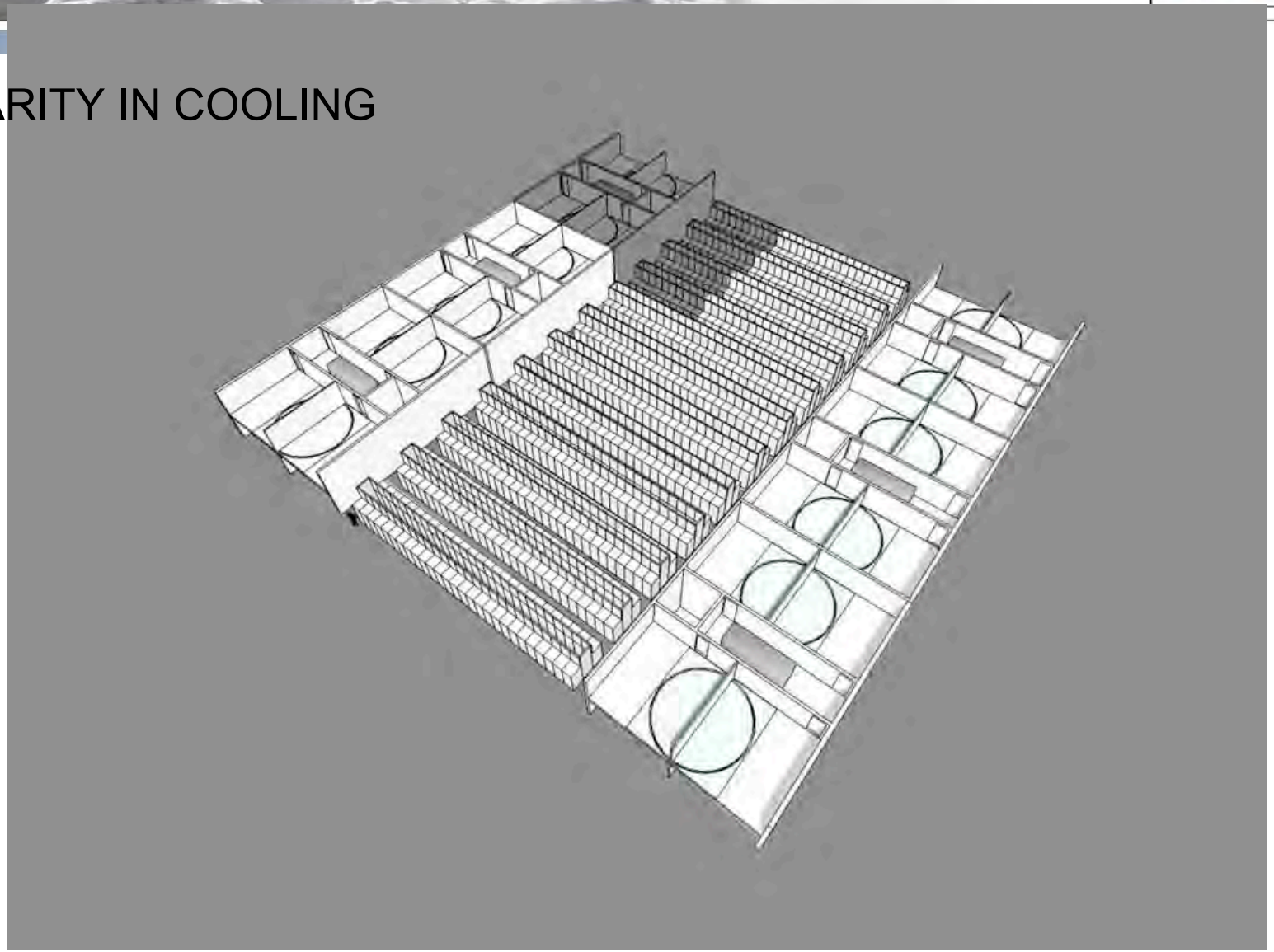
MODULARITY IN COOLING



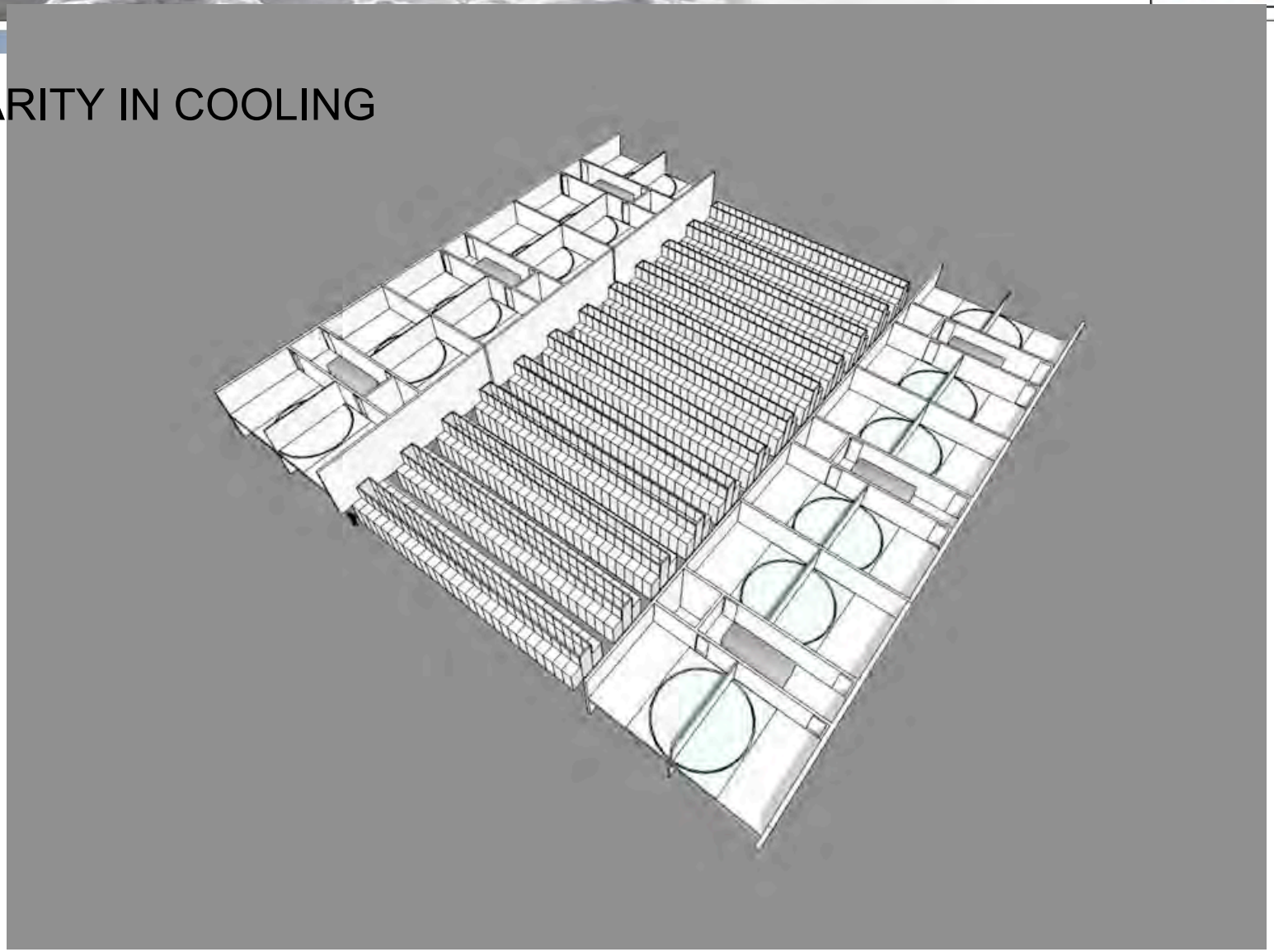
MODULARITY IN COOLING



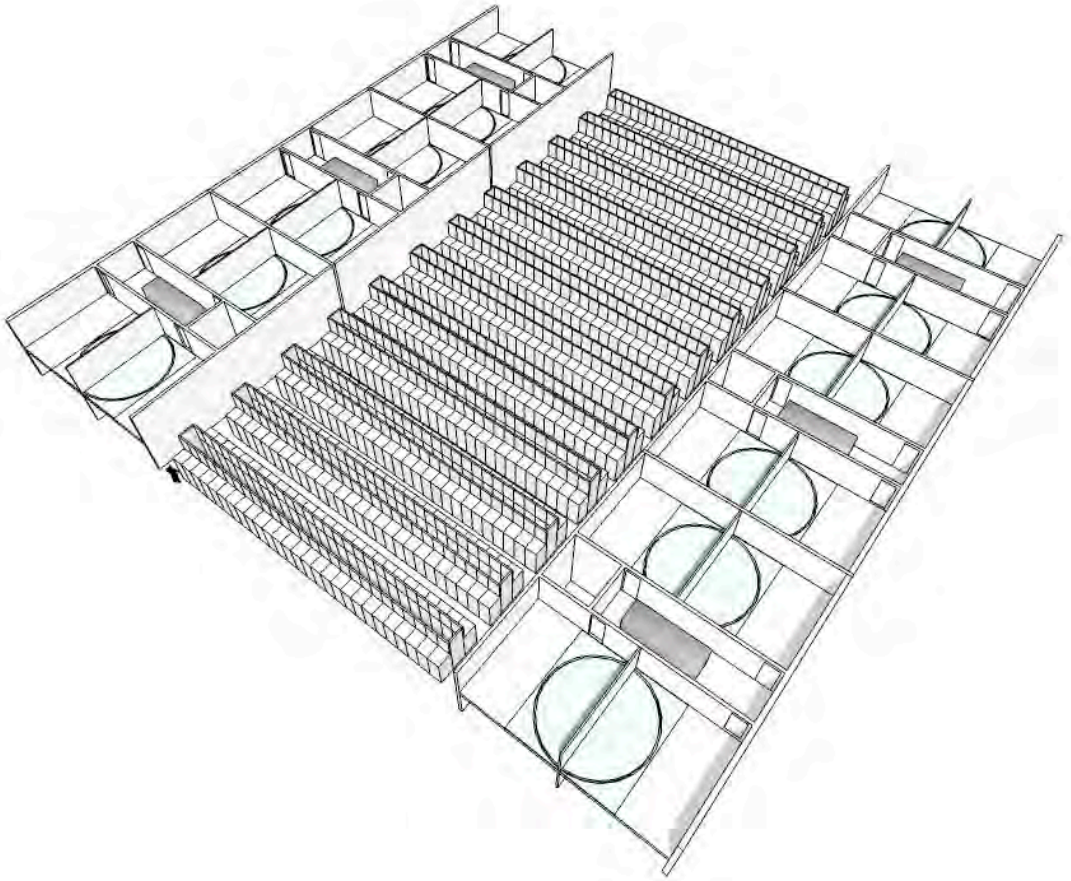
MODULARITY IN COOLING



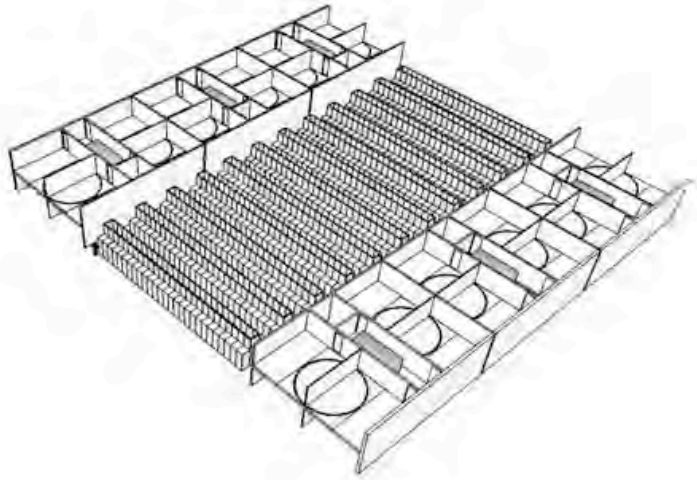
MODULARITY IN COOLING



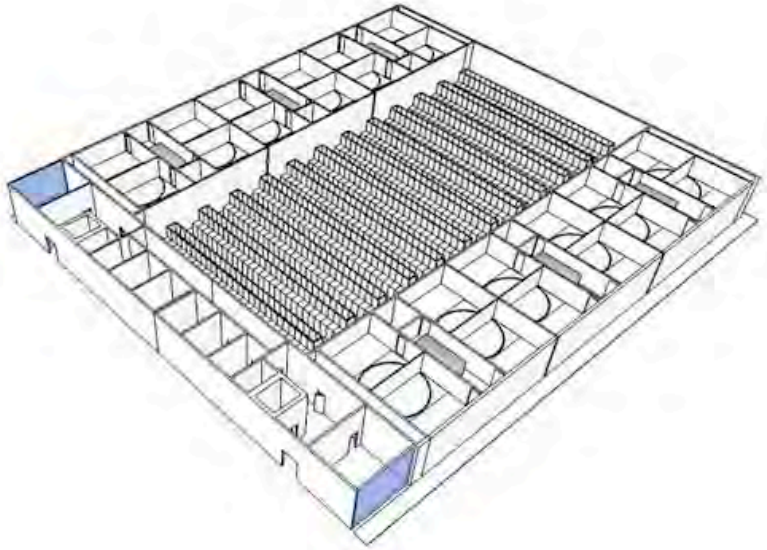
MODULARITY IN COOLING



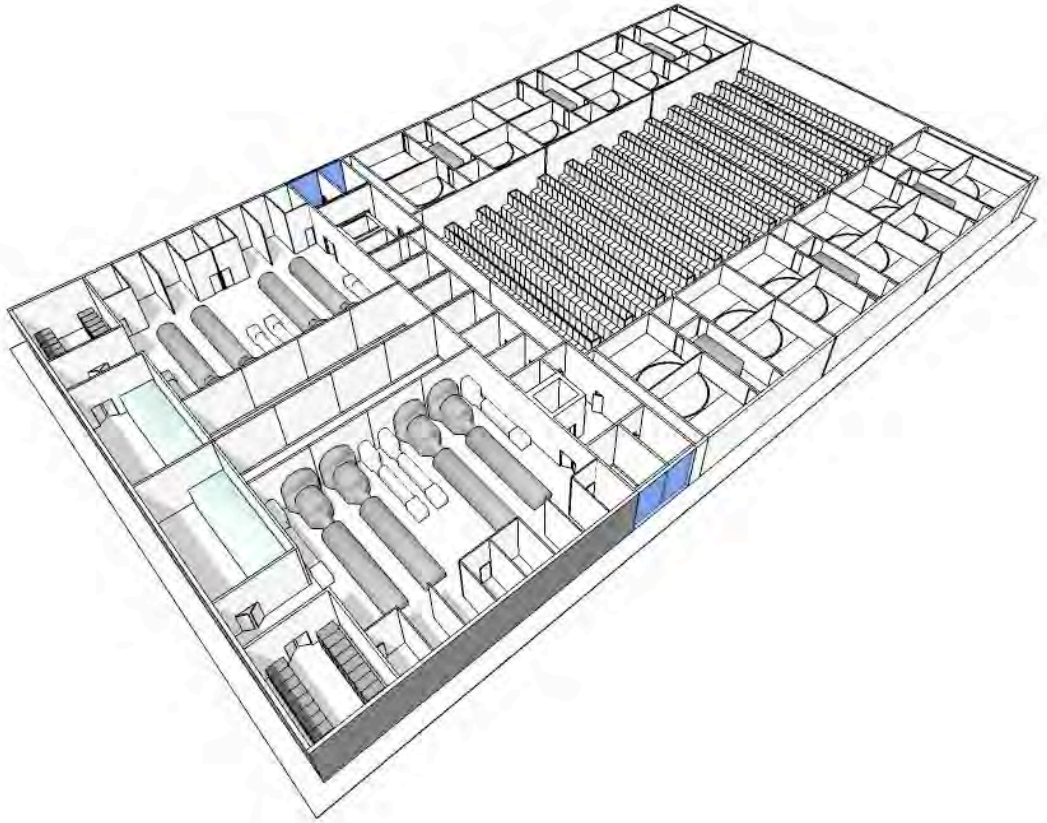
DATACENTER FLOOR & COOLING



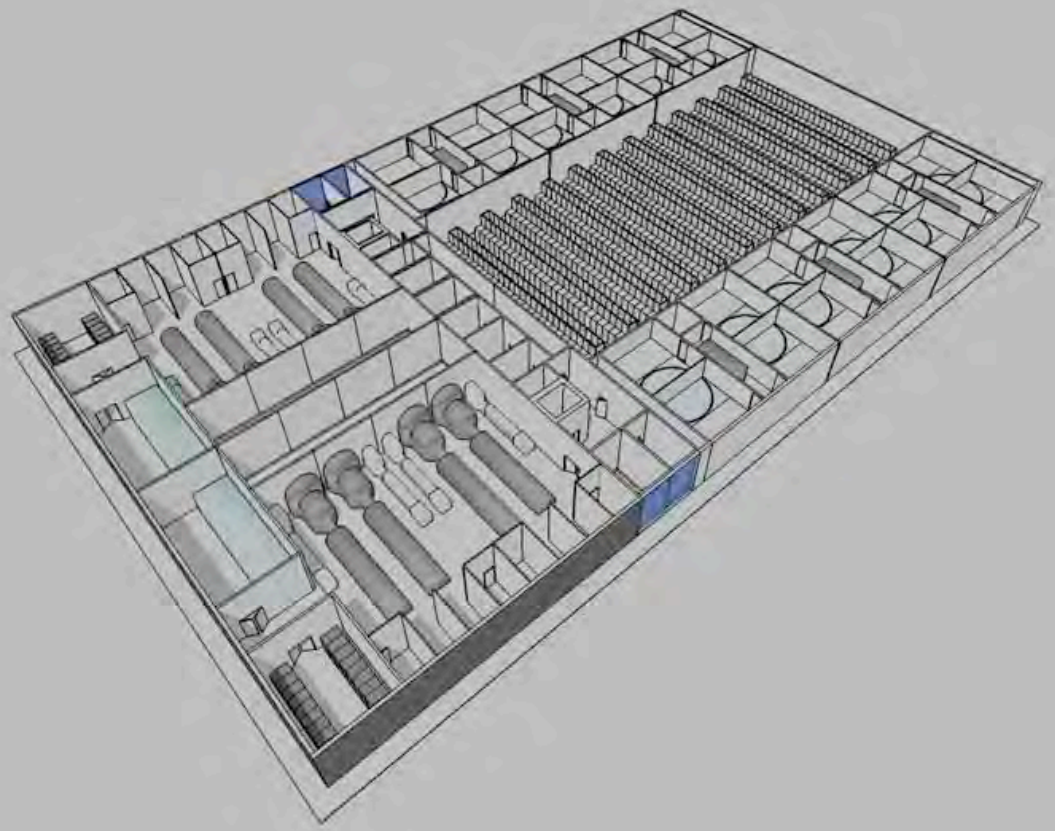
DATACENTER FLOOR - ENTRANCE



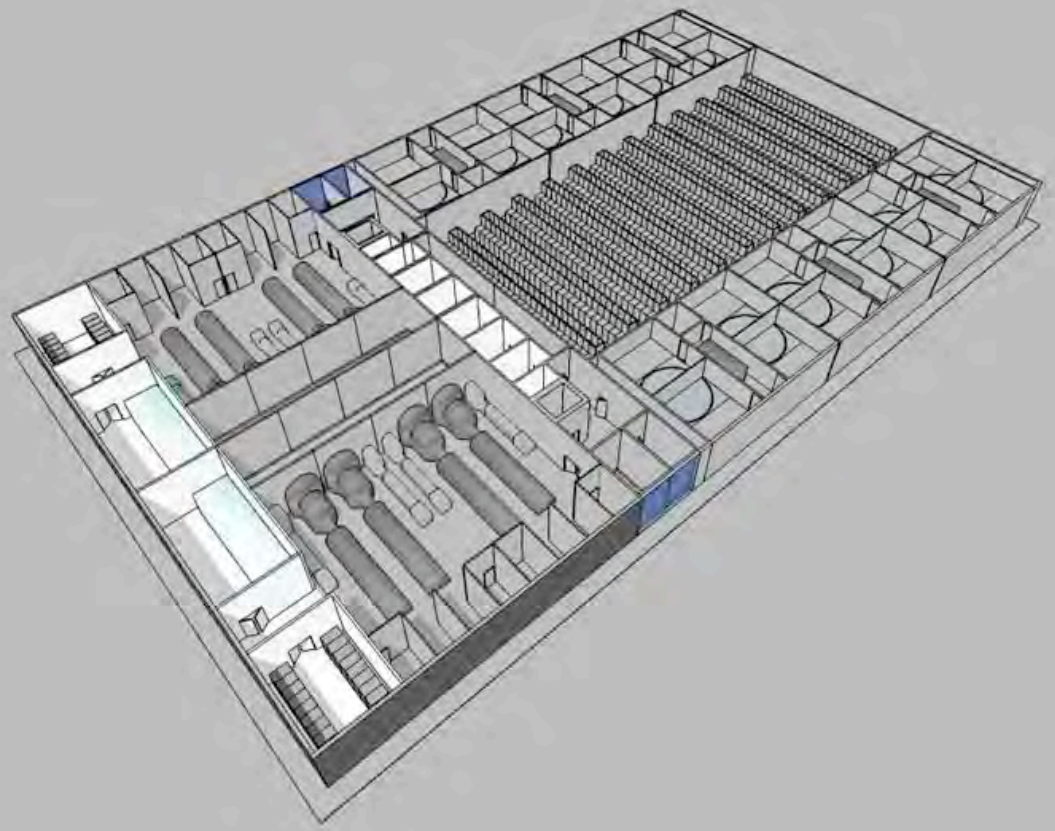
DATACENTER FLOOR - POWER PLANT



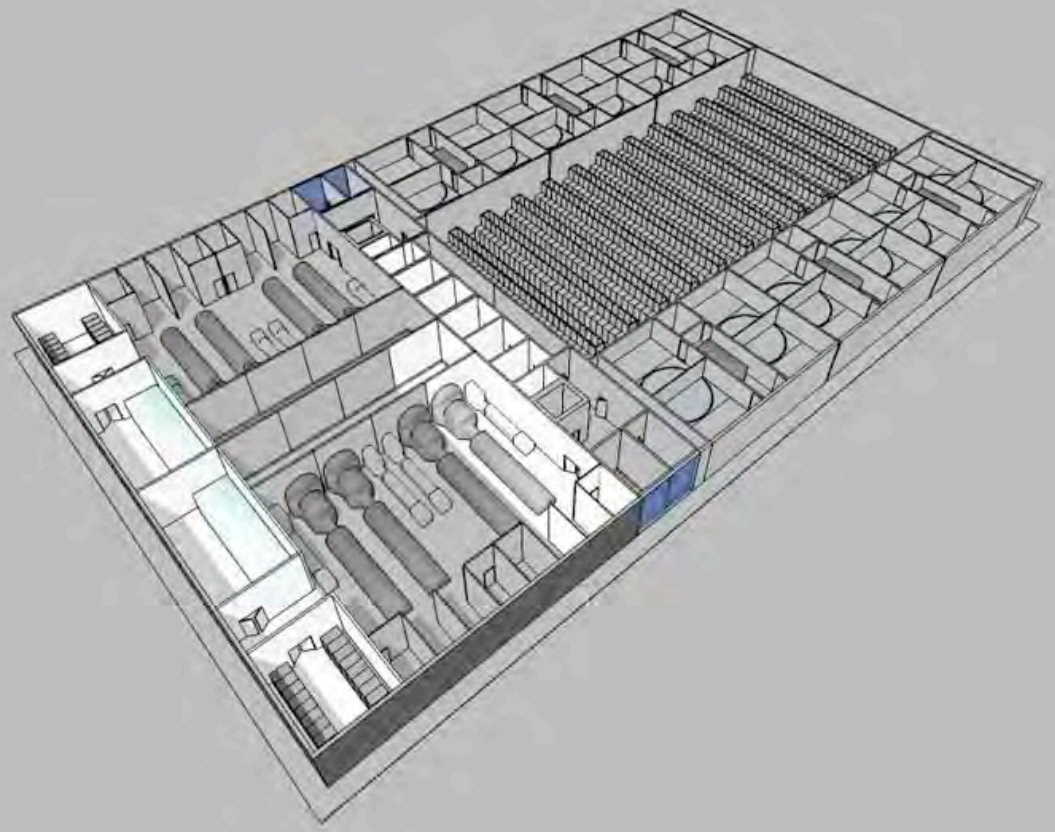
MODULARITY IN POWER



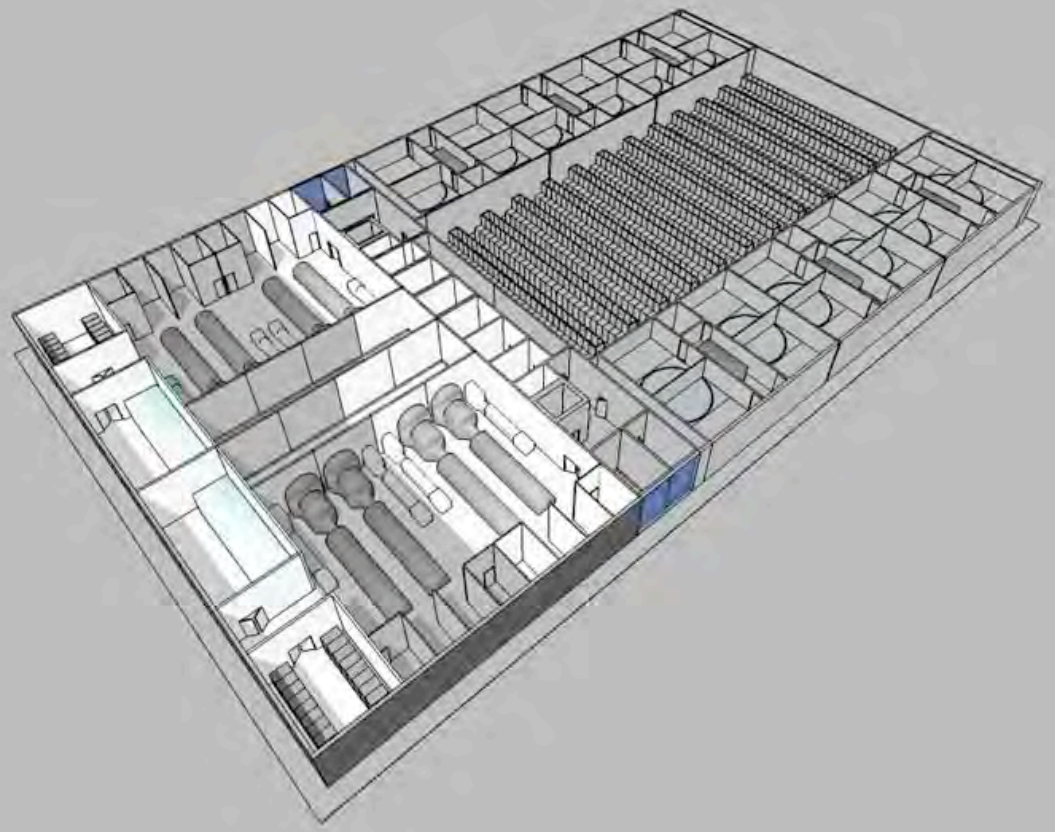
MODULARITY IN POWER



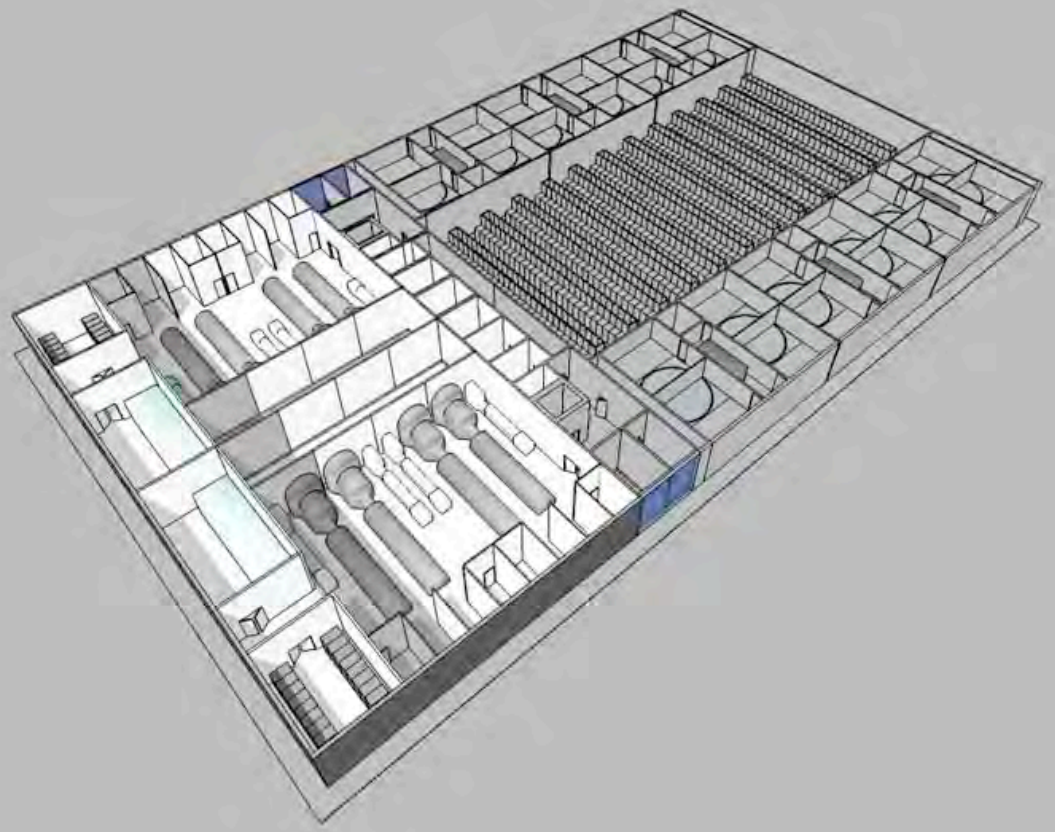
MODULARITY IN POWER



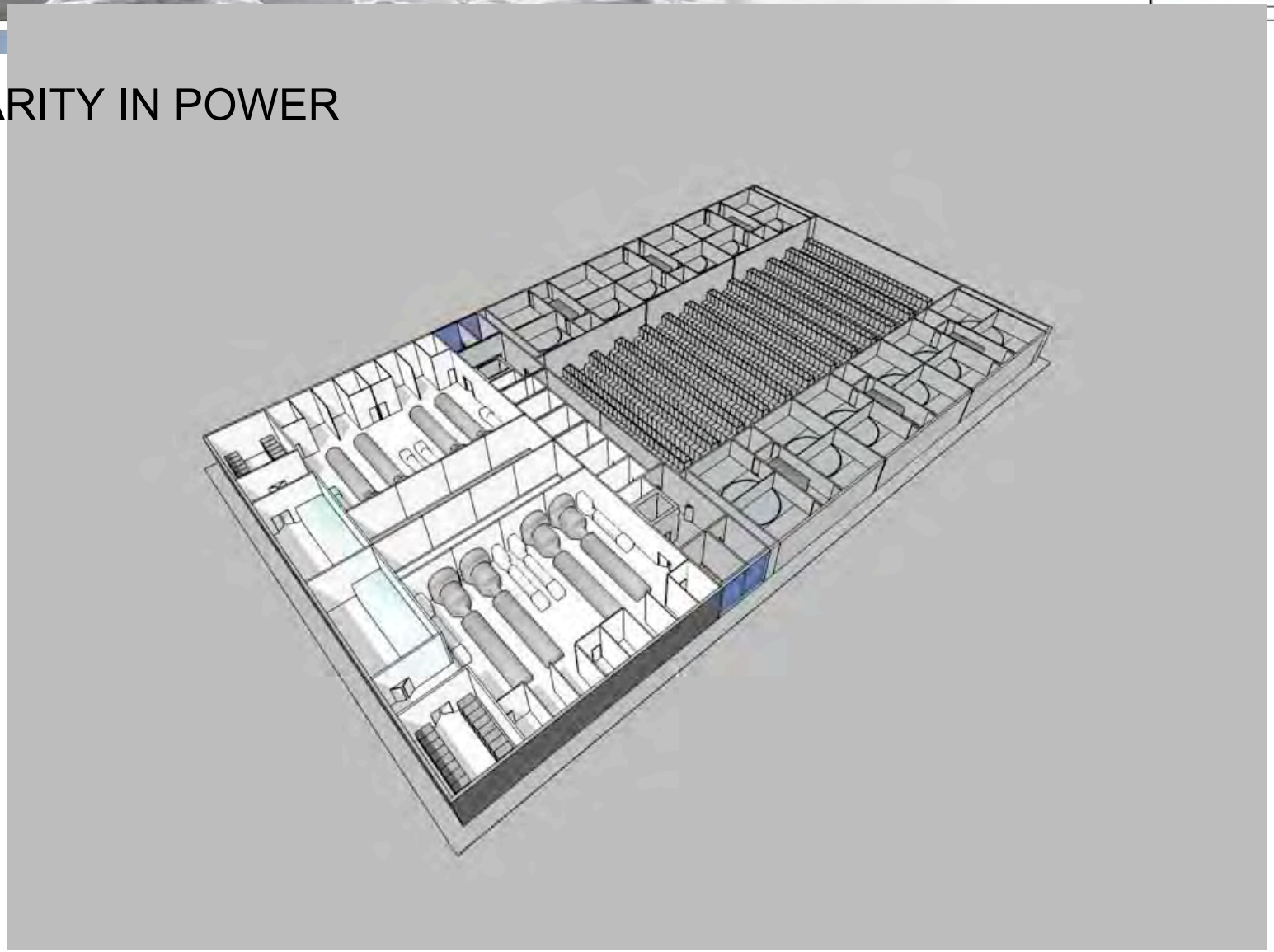
MODULARITY IN POWER



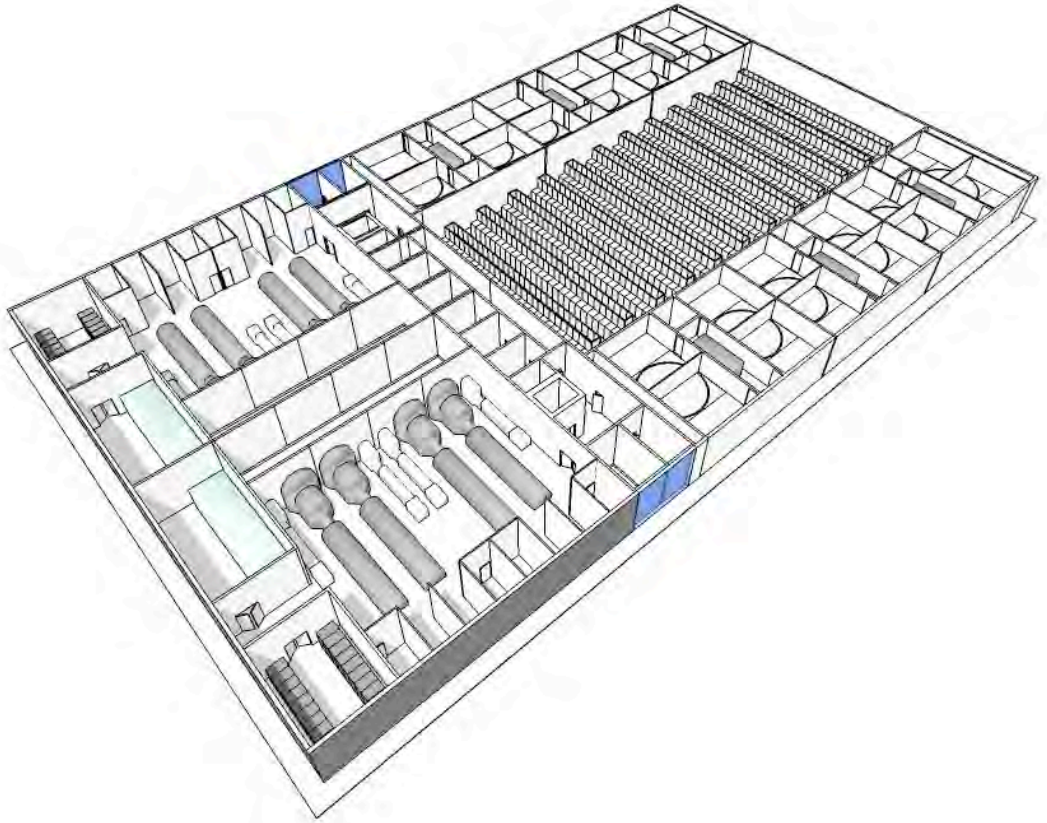
MODULARITY IN POWER



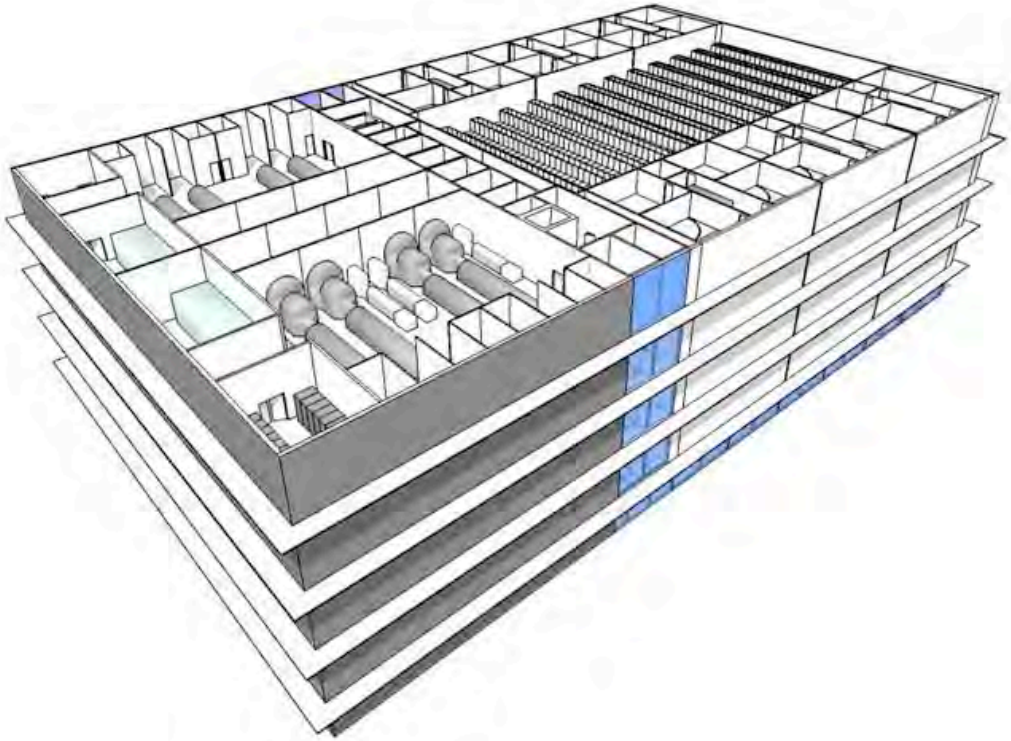
MODULARITY IN POWER



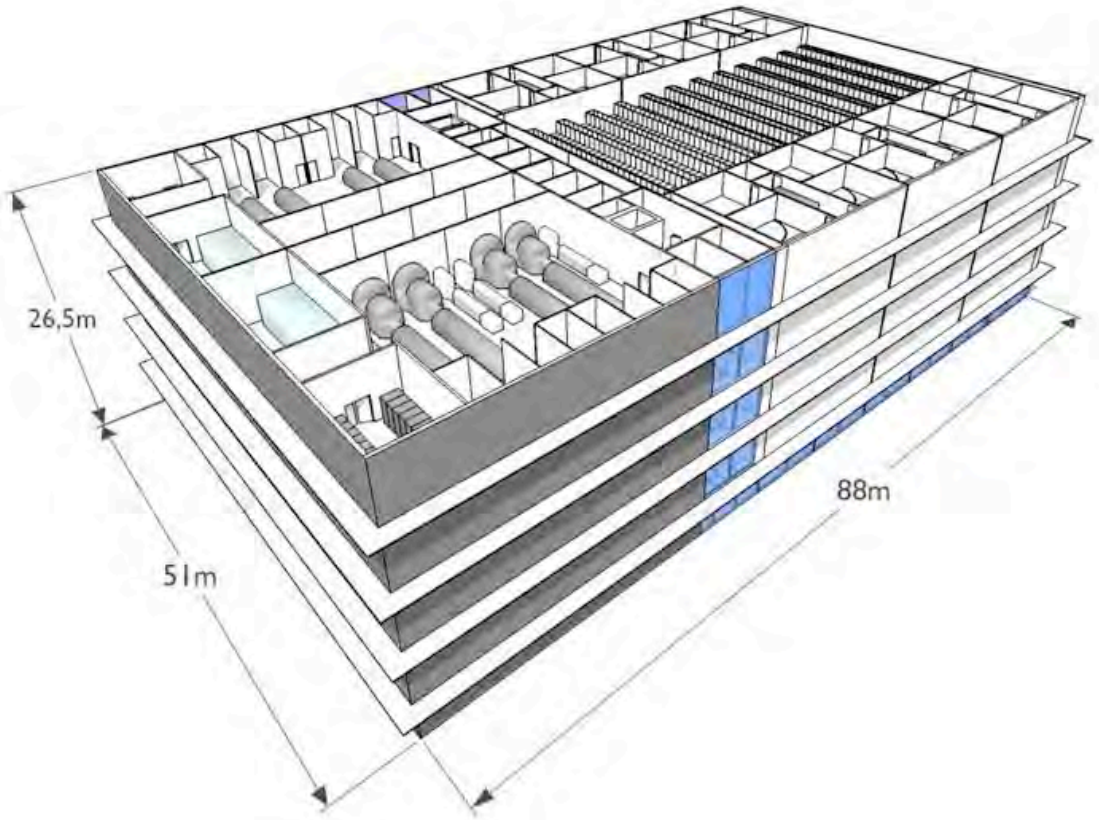
DATACENTER FLOOR



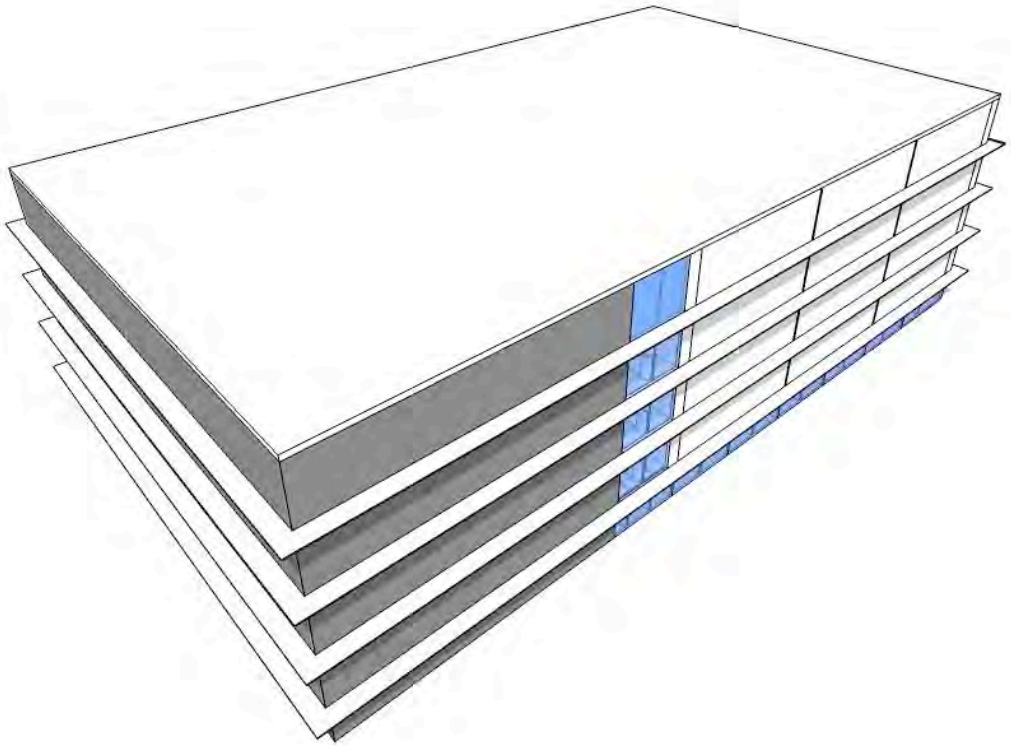
DATACENTER BUILDING



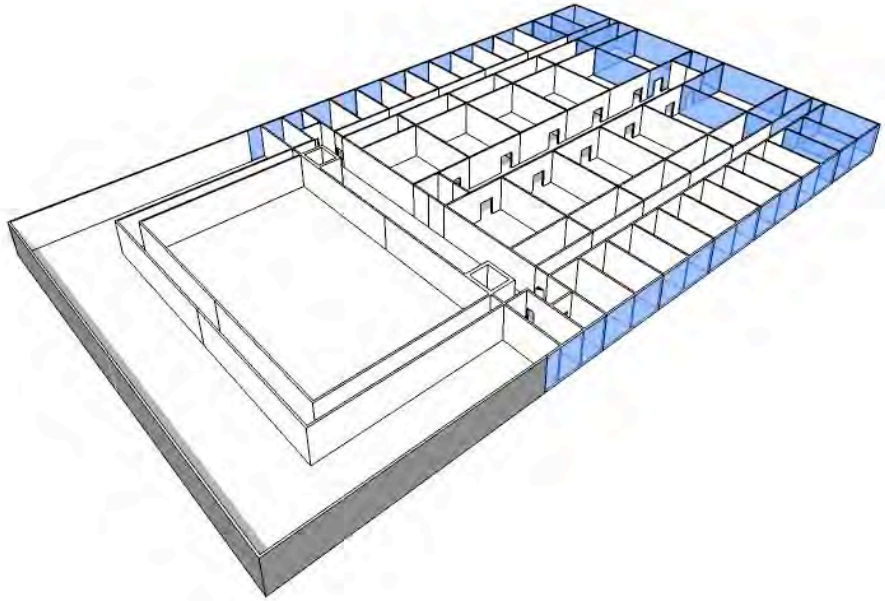
DATACENTER BUILDING



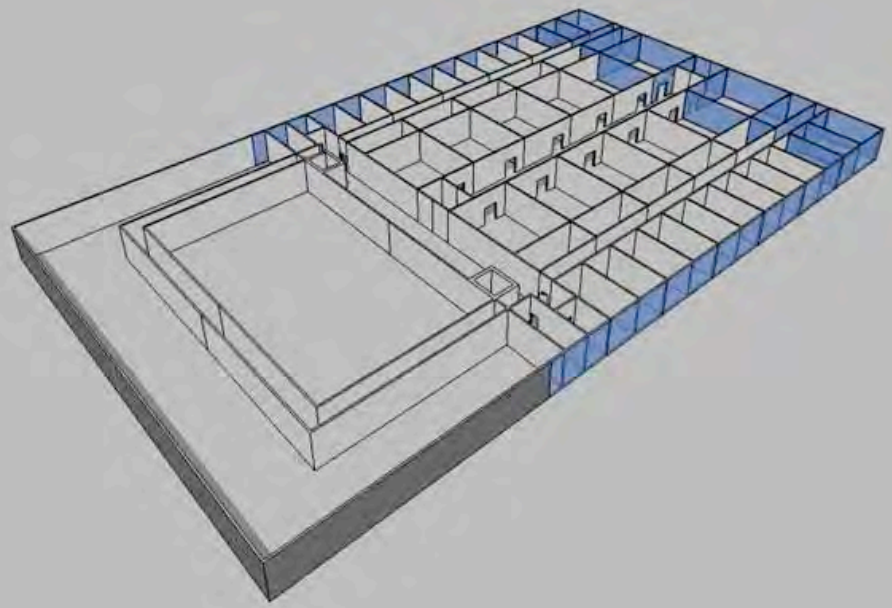
DATACENTER BUILDING



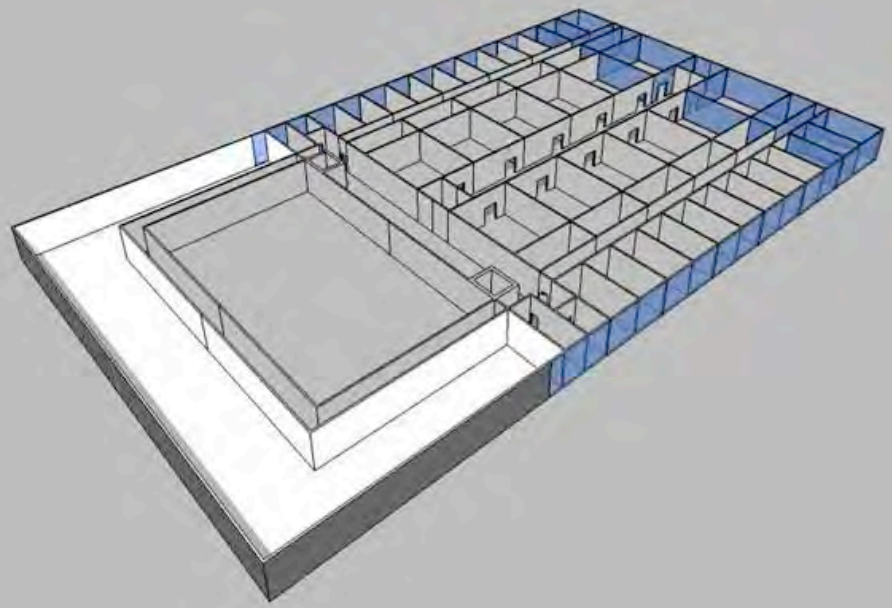
DATACENTER GROUND FLOOR



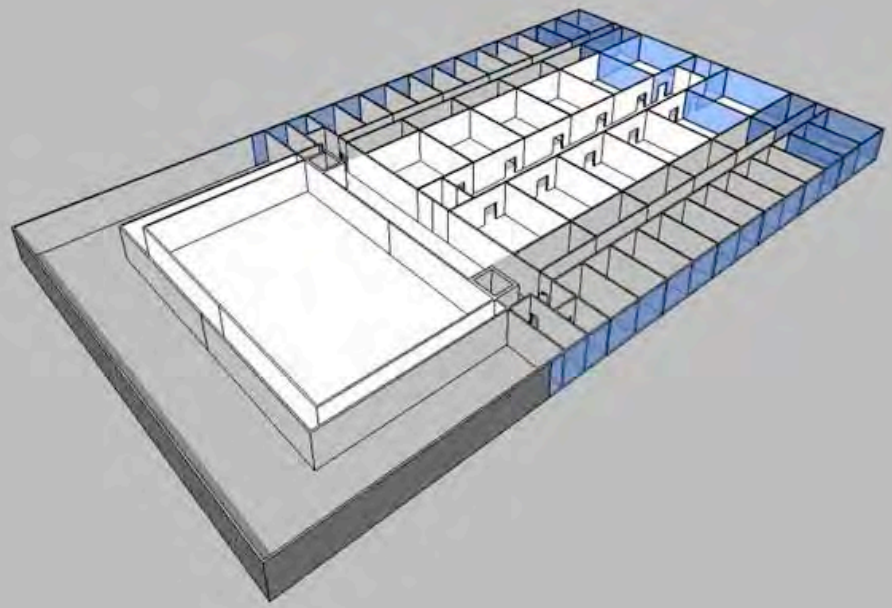
DATACENTER GROUND FLOOR



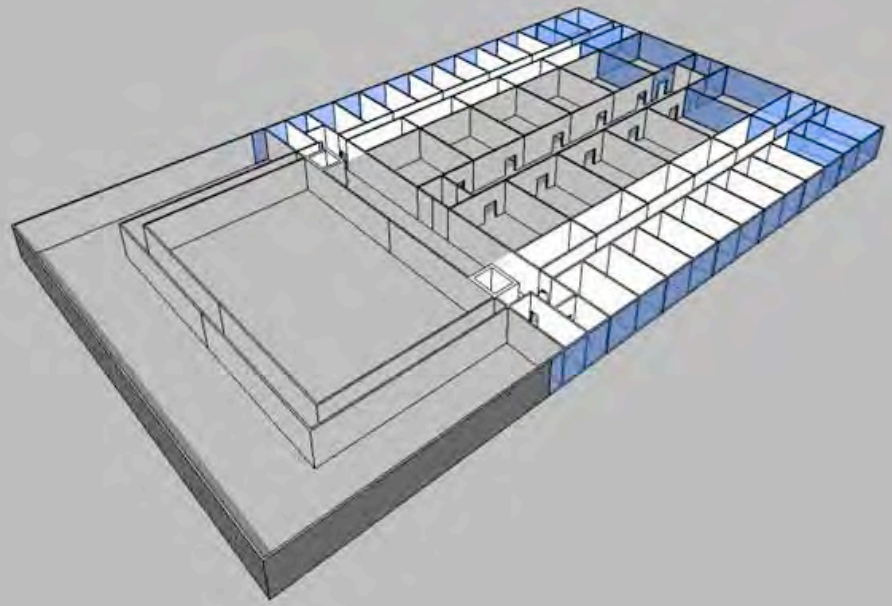
DATACENTER GROUND FLOOR - SUPPORT



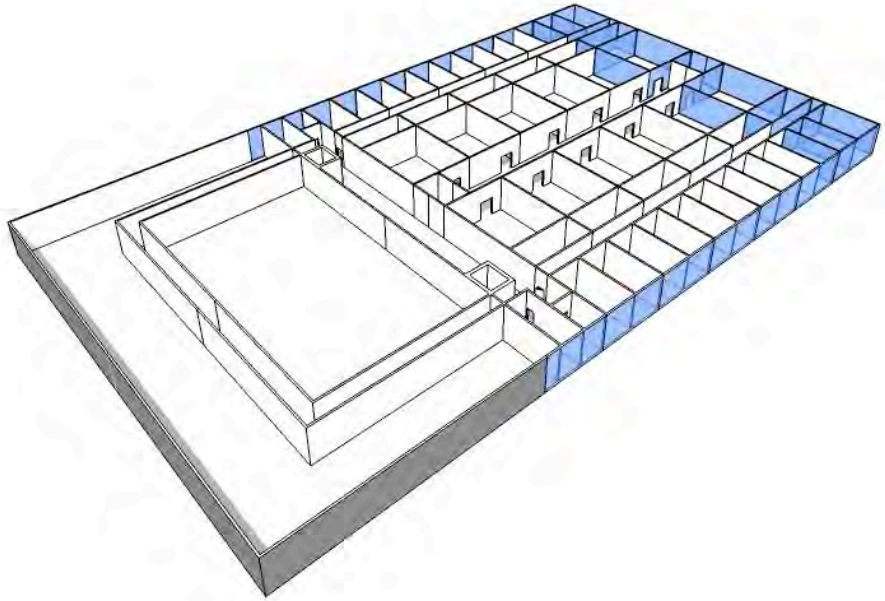
DATACENTER GROUND FLOOR - STORAGE



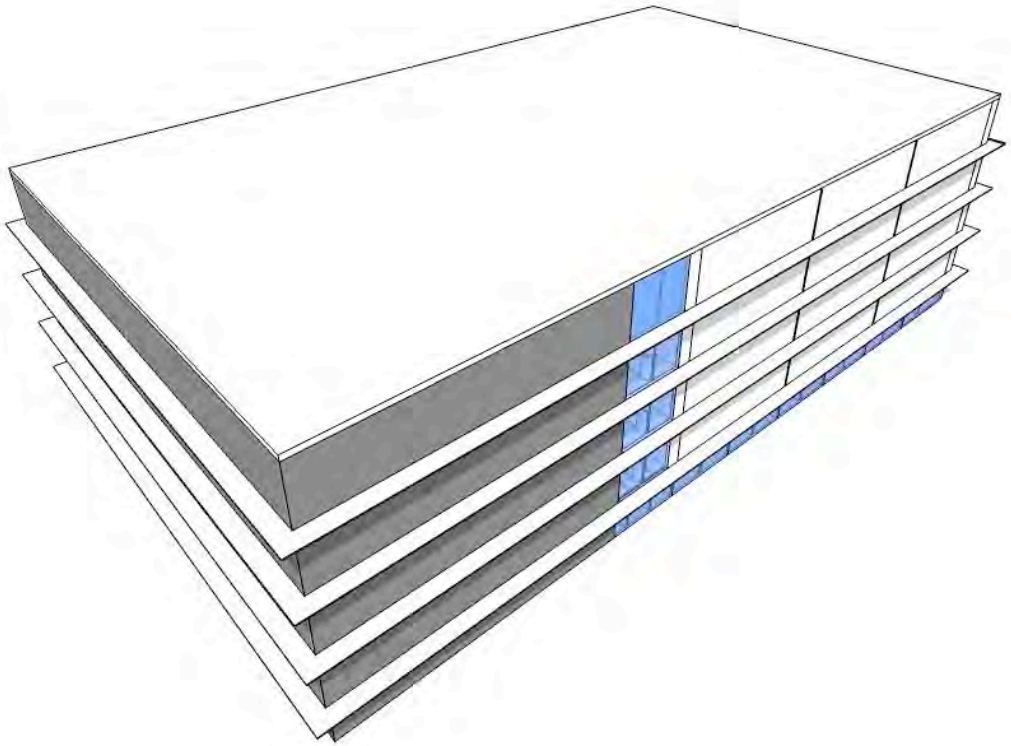
DATACENTER GROUND FLOOR - OFFICES



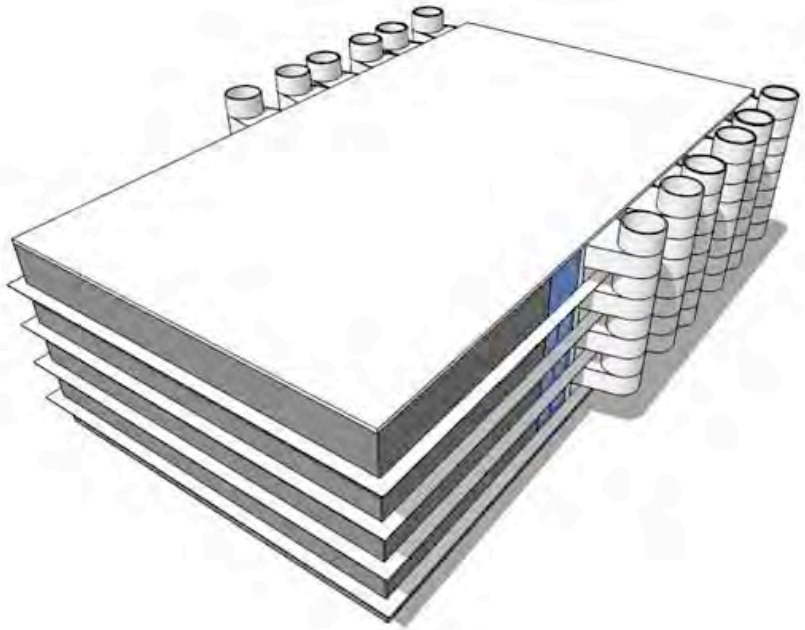
DATACENTER GROUND FLOOR



DATACENTER BUILDING



DATACENTER BUILDING - AIR DUCTS



DATACENTER BUILDING

Financial implications of KyotoCooling

- **Investment costs conventional - Kyoto**
  - Investment – 5/10 %
- **Modular CapEx**
- **OpEx savings**
  - 400 kEuro per MWatt IT-load
- **CO2 emission reduction**
  - Kg Co2 reduction annually / MWatt It Load

Where can and should this be applied?

Everywhere

Always

It is hard to explain to your CEO that you want to spent more money to build a more complicated , less continuous, environment unfriendly datacenter , with higher OpEx every year !!

Seminar "Seeing is believing"

Summer 2009

Amersfoort, the Netherlands

Info @ www.kyotocooling.com

Patent Pending

Resume KyotoCooling®

- **OPEX :**
  - Saving money and be green at the same time
  - In the Netherlands a datacenter of 5000 m^2 and 2500 W/m^2 saves approx. € 2.500.000 / $ 3.500.000 each year

- **CAPEX**
  - Scalable investment
  - Upgradable power and cooling in a live datacenter
  - Lower investments versus the classic concept

Overview Scalable Datacenter with KyotoCooling®

- **OPEX :**
  - Saving money and be green at the same time
  - In the Netherlands a data center of 5000 m^2 and 2500 W/m^2 saves approx. € 5.000.000 each year
- **CAPEX**
  - JIT investments
  - Upgradeable power and cooling in a live data center
  - Lower investments versus the classic concept
- **Operational**
  - No water in the data center
  - Less continuity incidents / higher availability
  - No complicated infrastructure for cooling
  - Safety net in case of mechanical cooling breakdown