More from Less by Smart Data Centers
～ from molecule to bits over watt ～

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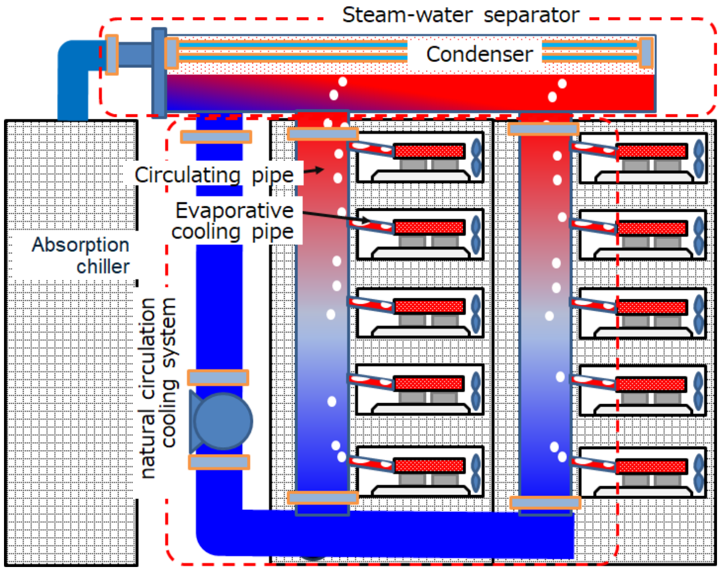
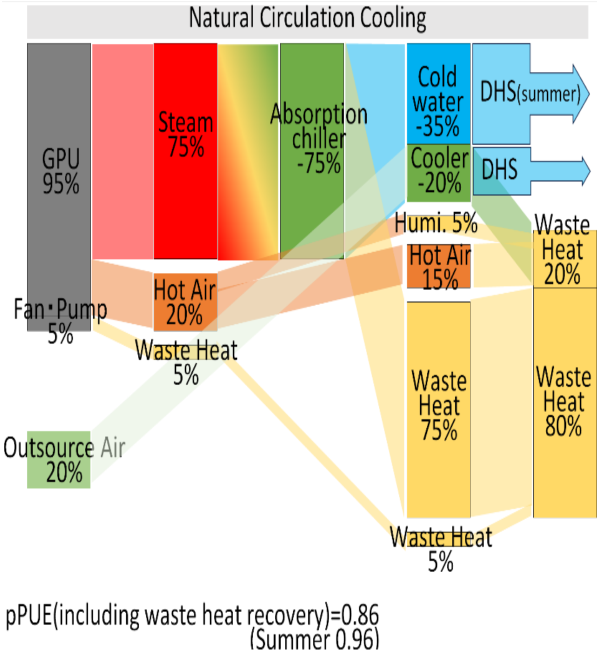
Missing pieces & story in the draft roadmap

1. Water usage is going to change by **"dry"** cooling
2. Collocate Data Center with local infrastructures for **PUE < 1.0**, i.e., not isolated facility and reuse of heat & **"Shell".**
3. **Embodied** carbon (**=BS**); most of discussion is **operational** carbon (**=PL**)
4. Contribution of Data Center for reduction of carbon footprint to "all" industries, i.e., **"More from Less by Bits over Watts".**
    a. **AS IS**; improve (i.e., renovation) of energy efficiency by optimization
    b. **TO BE**; transit (i.e., innovation) to digital native system structure, i.e., **"from molecule to {digital} bits(i.e., photon) over watt"**
5. Changing in Data Center industry
    a. Cost structure of infrastructure components
    b. Stakeholder, i.e., new players who has larger investment money
    c. Geo-politics from **physical to digital (politics), e.g., data governance/sovereignty**, but **digital fully depends on electrical power**

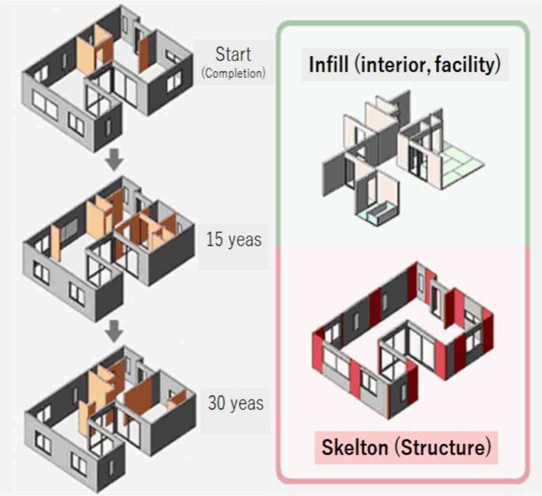
- It consists of server racks, a natural circulation cooling system, and a waste heat recovery absorption chiller.
- Achieving a **PUE ＜1.0** by utilizing waste heat from GPU





Skeleton&Infill : smat ”Shell”

- Why East Germany able to achieve rapid economic development after the Cold War?
  - ➢ Skelton&Infill buildings (Easier & Cheaper Renovation)
- Nippon Life Insurance's investment property

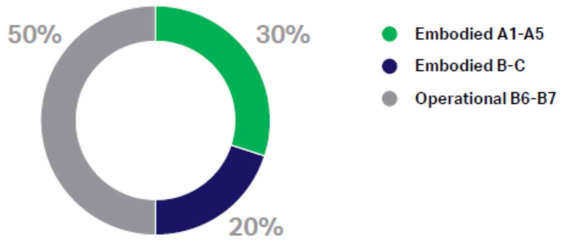


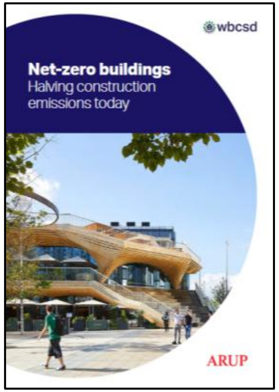
- Importance of Scope 3 Embodied Carbon
  1. Compliance (i.e., IR)
  2. Finance (i.e., BS)

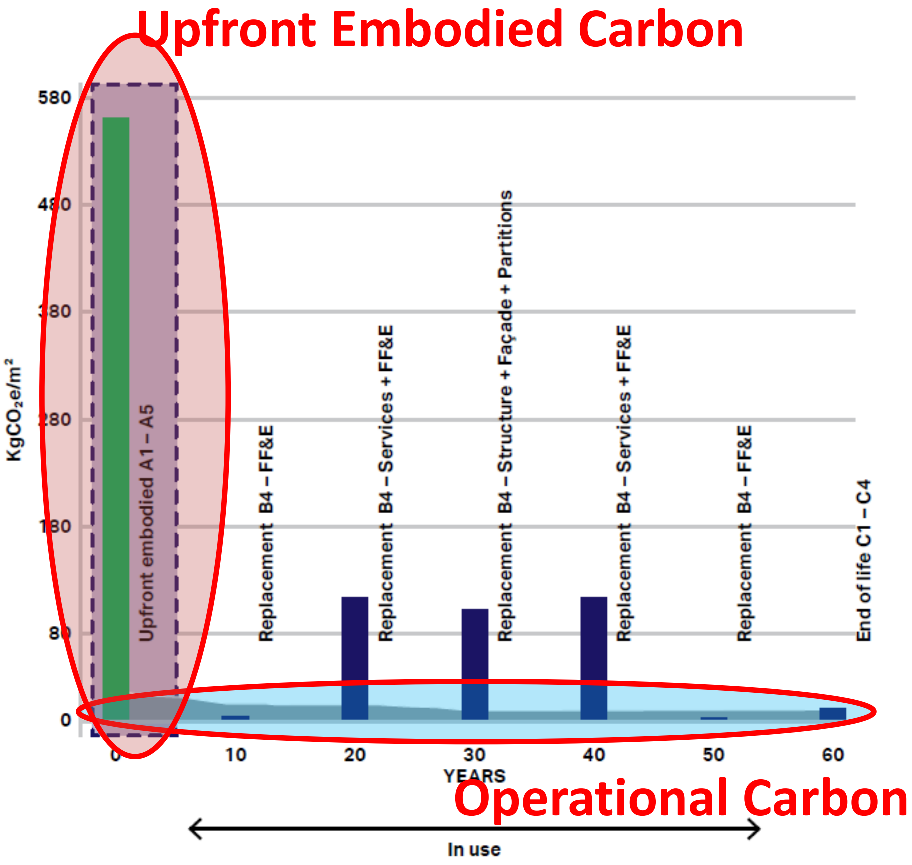
  【ex.】LCD factory in Osaka,
  Paper factory in Finland

Watt, Bits & “Shell”

GHG emissions in the life cycle of a building

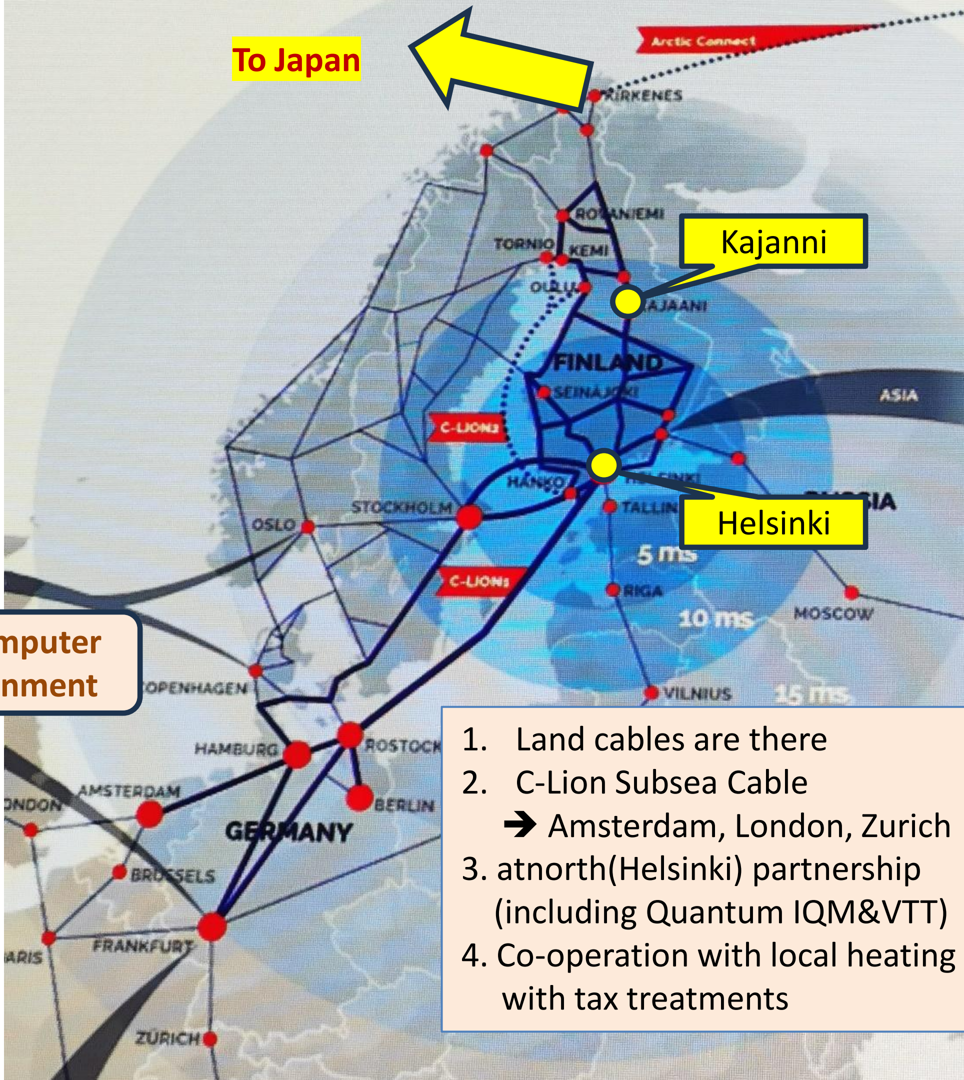






出典 : Net-zero buildings – Halving construction emissions today (WBCSD, January, 2023)

1. 100% DLC, i.e., liquid cooling
2. No Co-generator
   (with data back-up system)
3. Extra land and power capacity
   for future expanding



1. Land cables are there
2. C-Lion Subsea Cable
   ➔ Amsterdam, London, Zurich
3. atnorth(Helsinki) partnership
   (including Quantum IQM&VTT)
4. Co-operation with local heating
   with tax treatments

Simple equation

Watt・Bit and Shell(Molecule)

Energy to build, operate and to maintain

物流 》 電流 》 情流

Material (Molecule) 》 **Electricity** (Power/Watt) 》 **Digital bits** (Digital Function)

x0000 : x00 : 1

Energy to build, operate and to maintain

Embodied Carbon

Operational Carbon

物流	》	電流	》	情流
Material		Electricity		Digital bits
(Molecule)		(Power/Watt)		(Digital Function)
x0000	:	x00	:	1

Toward Digital/Cyber Complete

Legacy; Physical/Molecule

Energy Efficiency

- ❖ Physical Complete; Run only by molecule
  - ✓ Run; Electricity replaces Gas engine
- ❖ Physical First; Optimize molecule by Bits
- ❖ Cyber First; Design molecule by bits
  Replace molecule by bits
- ❖ Cyber Complete; Run only by bits

To-Be; Cyber/Bits

(*) molecule= "thing"
bits ="function/code"

Toward Digital/Cyber Complete

Legacy; Physical/Molecule

Energy Efficiency

- Physical Complete; Run only by molecule
- Physical First; Optimize molecule by Bits

AS IS for **Operational** carbon

- Cyber First; Design molecule by bits
- Cyber Complete; Run only by bits

TO BE for **Embodied** carbon

To-Be; Cyber/Bits

(*) molecule= "thing"
bits ="function/code"

Carbon Neutral infrastructure by EP-x00 (Energy Productivity) for DC

	Of Digital	By Digital
AS IS	● Virtual Machine ● Huge Memory & Processor ● Program(i.e.,code)	Digital Twin (CPS; Cyber Physical System) with LoD* & LLM
TO BE	Electron → Photon → Quantum	Cyber First

(*) LoD; Linked Open Data

Carbon Neutral infrastructure by EP-x00 (Energy Productivity) for DC

	Of Digital	By Digital
AS IS	• Virtual • Huge M Pro • Dat	Twin System) LLM
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Operational Carbon, i.e., PL

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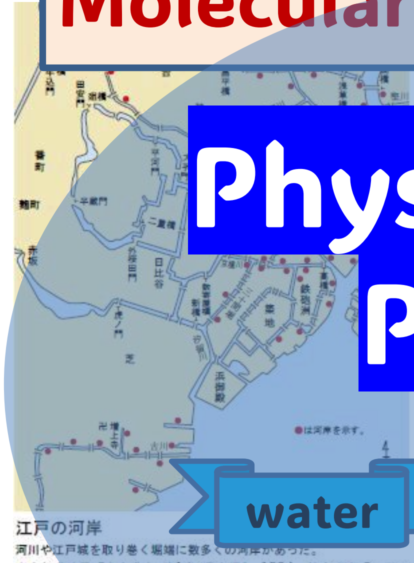
Main infrastructure,,,

Molecular



**Molecular
+
Energy(electricity)**

Physical Geo-Politics

water

Transport/Logistics
Energy/Power

【Extended land】
Logistics, water & sewage, defense
～Sharing Economy～

Bits

Information
Digital

Digital Geo-Politics

Non-fossil fuel energy,
including Renewal energy,
for energy and economic security,
especially for the digital and
computation infrastructure

👇

Economical Security for Digital Economy and it's infrastructure

Carbon Neutral infrastructure by EP-x00 (Energy Productivity) for DC

	Of Digital	By Digital
AS IS	● Virtual Machine ● Huge Memory & Processor ● Data Cent	Digital Twin (CPS; Cyber Physical System) with LoD*
TO BE	Electron → P →	First

Embodied Carbon, i.e., BS

Life-time/Supply-Chain

(*) LoD; Linked Open Data

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Thanks

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