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Impacts of Data Centers Physical Protection
Survivability Vs. Sustainability

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MISSION CRITICAL ENGINEERING

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Impacts of Data Centers Physical Protection Survivability Vs. Sustainability

- Many newly critical facilities combine a physically protected shell with a high tier objective.
- Cooling systems as well as generators require massive airflow. This is incompatible with with the requirements regarding endurance to blast impact that might affect equipment.
- Tier IV sites require compartmentalization and multiple active components.
- Is a physical hit equivalent to a single failure?
- The presentation will discuss topologies of protected fata centers, impact on tier levels, PUE, Capex & Opex as well as cost distribution between facility, electromechanical systems and protection elements.

Transition Slide

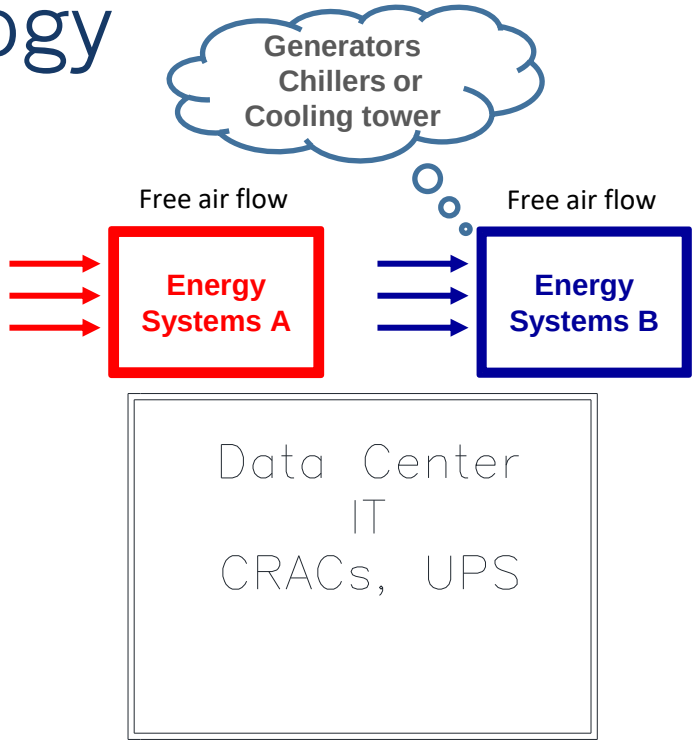
Agenda

- Characteristics of data centers
- Protected sites - characteristics and risks
- Tier III sites
- Tier IV sites
- Impact on PUE
- Cost impacts

- Out of this discussion:
  - Specific threats and protection level
  - IT Systems architecture – best system availability is probably achieved by spreading the risks between multiple sites
  - Lower tier level (I or II) sites

Unprotected Site Topology

- Soft shell
- Free air flow
- Infrastructure Availability
  2N or almost 2N energy systems.
- Option for free cooling
  (depends on environment climate)

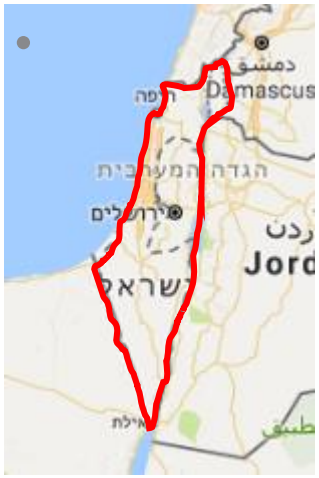


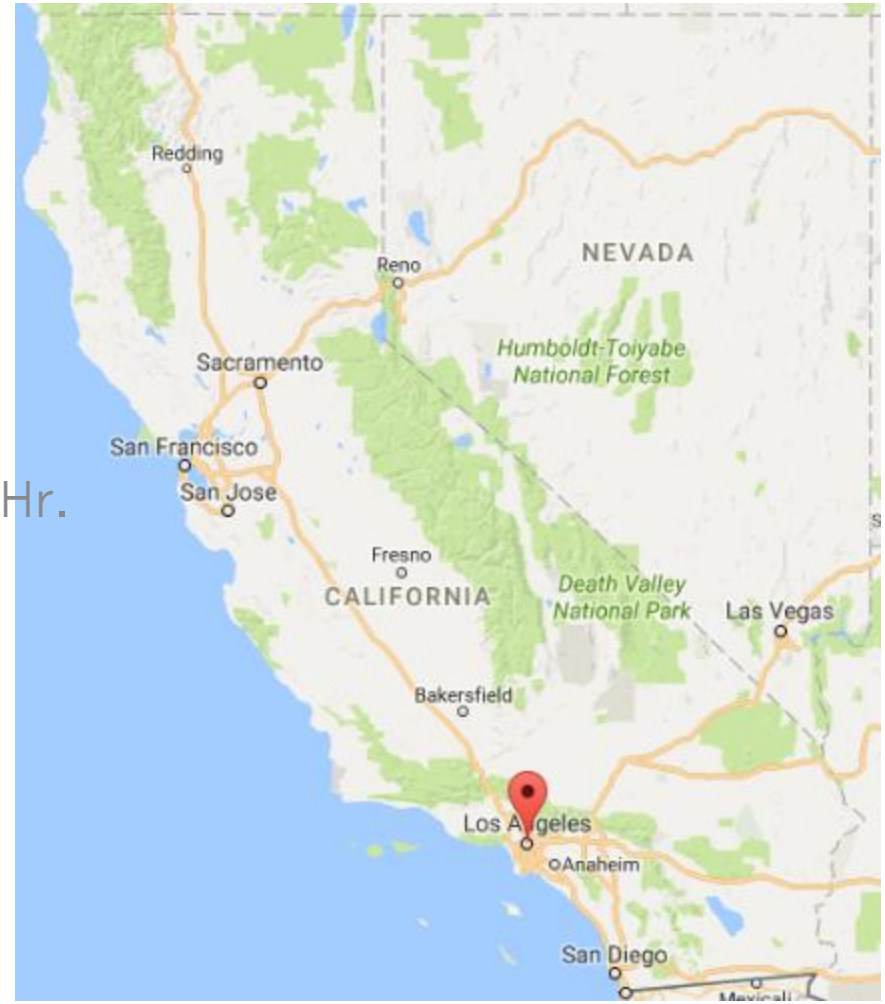
My Neighborhood - Israel

- The entire country is under the threat of missiles hitting
- Every house has a shelter
- Every new apartment has a shelter protecting against 1500 Lb. bomb@15 M
- Every new apartment has BC filtration system
- Many protected critical facilities

My Neighborhood

- California area = 20 X Israel
- Less options for redundancy
- Single electrical grid
- Cost of electricity – 0.1 $/KW*Hr.
- Cost of water –2.00 $/$M^3$





Protected site risks

- Physical hit:
  - Direct hit or nearby hit (blast, shrapnel)
  - Target aiming or statistical hit
  - Type of weapon: missile, bomb…
- BC (or ABC) protection
- EMP
- Terror attack

- Air heat exchangers (radiators) are very sensitive to blast and so are electrical boards and control equipment.

Protected site characteristics

- Heavy shell – cost of shell and protection.
- Blast impact – airflow (independent of shell).
- Underground – cost, air movement, underground water level.
- BC filtration – operation and movement limitations.
- Operation – shift from routine to emergency.

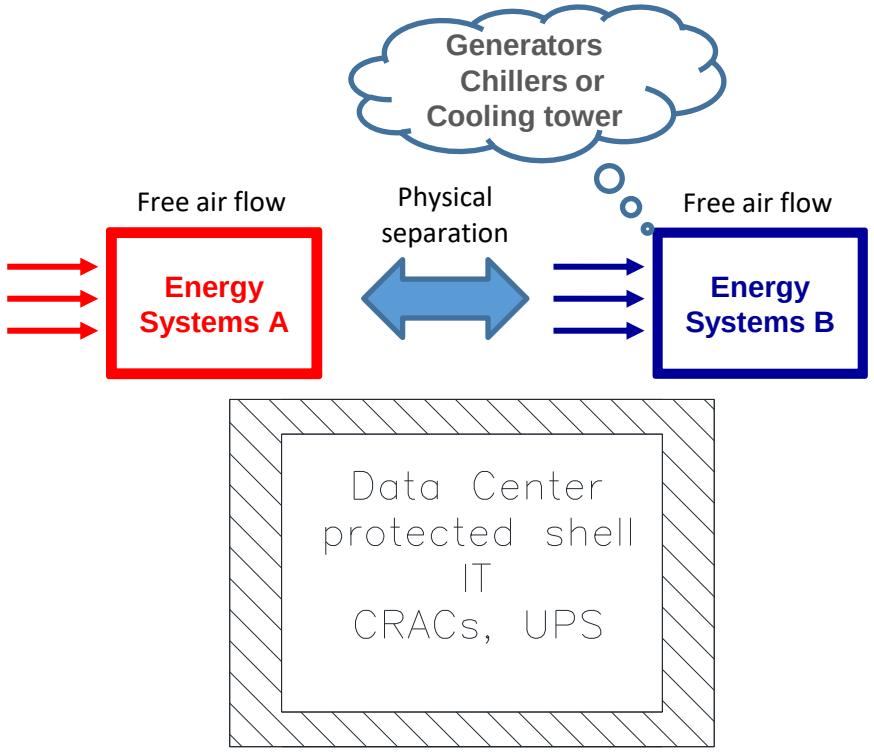
- Generator size – impact by additional power demand for air movement (blowers).
- Tier IV - demand for compartmentalization – dual air paths.
- Autonomous operation for 3-7 days: fuel and water reservoirs.

Protection Philosophy

- Physical survivability.
- Enhanced Infrastructure Availability.
- Pre-Alarm (time to shift to protected mode) or constant protection.
- Can we define an equivalent protection tier level?
- Residual Tier level after physical hit.
- Protect your data and IT equipment or keep business continuity.

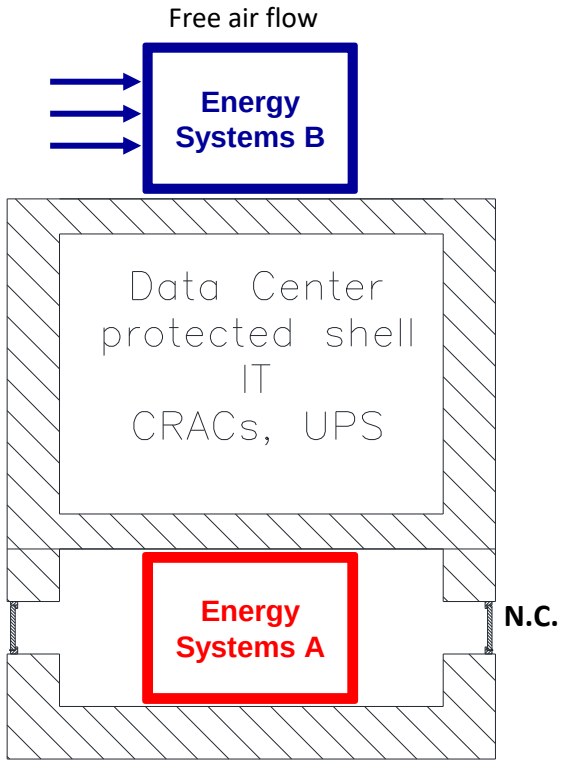
Protected DC

- Non-protected energy systems.
- Statistical survivability from single hit by separation.
- After a hit – option to install mobile generators and chillers.
- Tier III or tier IV
- No influence of protection on efficiency.

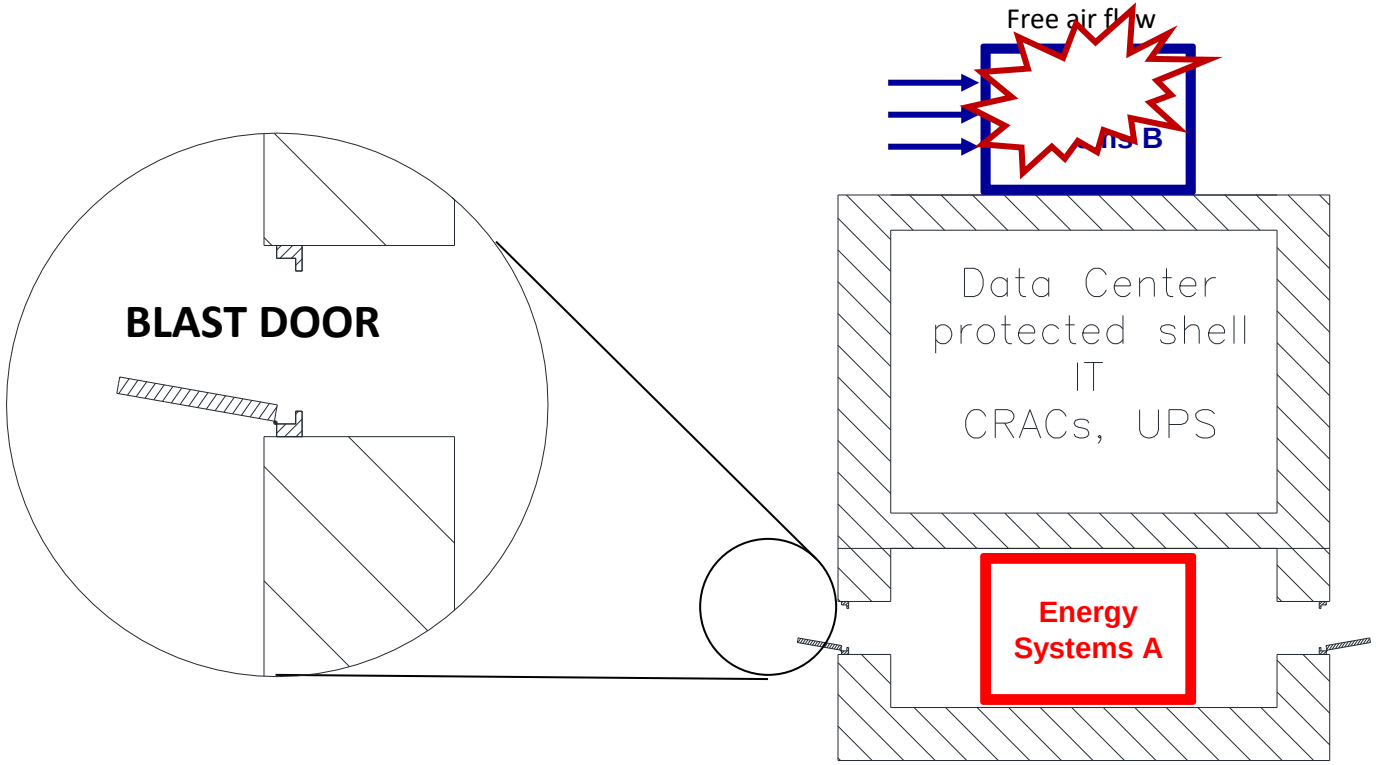


Protected DC – Tier III

- Differentiation between Tier rating and risk of hit.
- Normally one system is running.
- The other is encapsulated behind blast doors.
- Doors open in case of system failure or physical hit
- Scheduled testing of redundant protected system
- The physical protection is affected after a failure
- Irrelevant for Tier IV - Demand for concurrent operation of two energy systems
- Possibility of low PUE



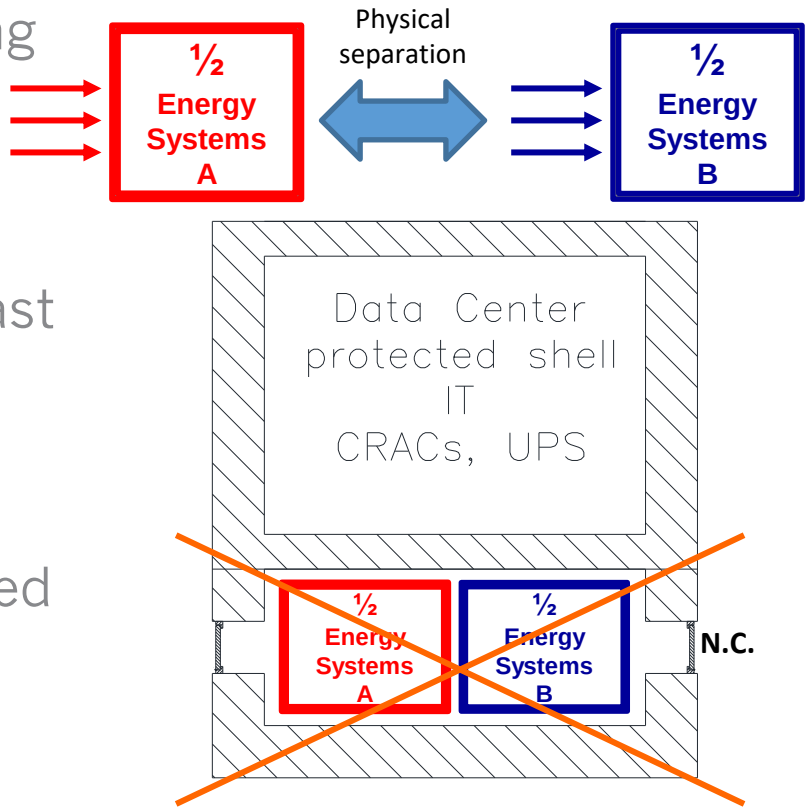
Protected DC – Tier III



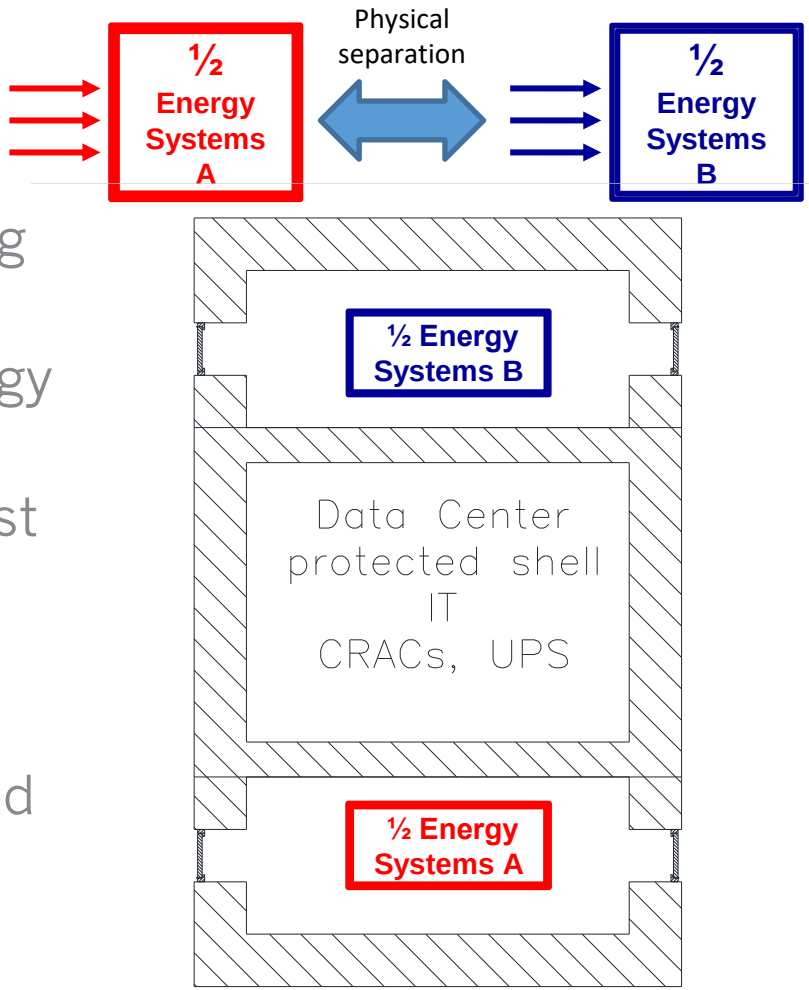
Blast door

Protected DC – Tier IV

- Differentiation between tier rating and risk of hit
- Concurrent operation of two energy systems 50% each
- The rest is protected behind blast doors
- Doors open in case of system failure or Physical hit
- The physical protection is affected after a failure
- ~~Compartmentalization~~ ?



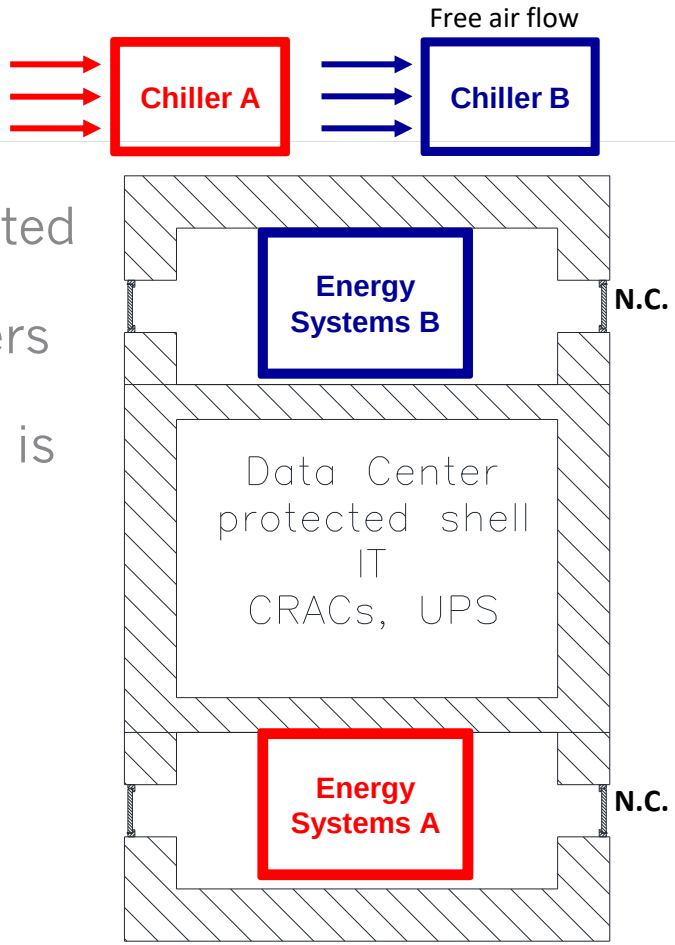
Protected DC – Tier IV



- differentiation between Tier rating and risk of hit
- concurrent operation of two energy systems 50% each
- The rest is protected behind blast doors
- Doors open in case of system failure or Physical hit
- The physical protection is affected after a failure
- Compartmentalization

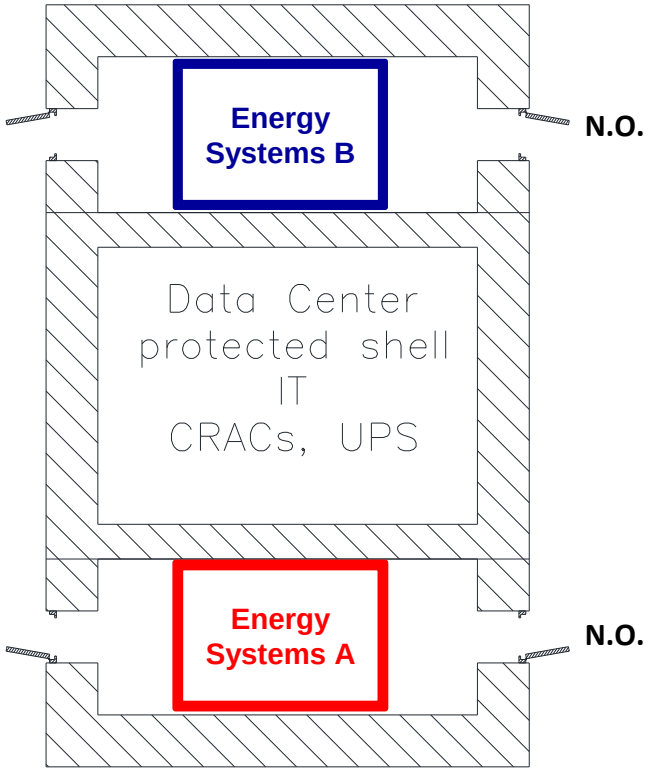
Protected DC – Tier IV

- Separation between outside chillers operating with free airflow and protected chillers
- Option for installing only cooling towers outside
- Generators can be protected. If utility is available no effect on PUE
- Protected energy systems operate in case of failure or hit
- Physical protection affected after failure
- Lower PUE
- High Capex



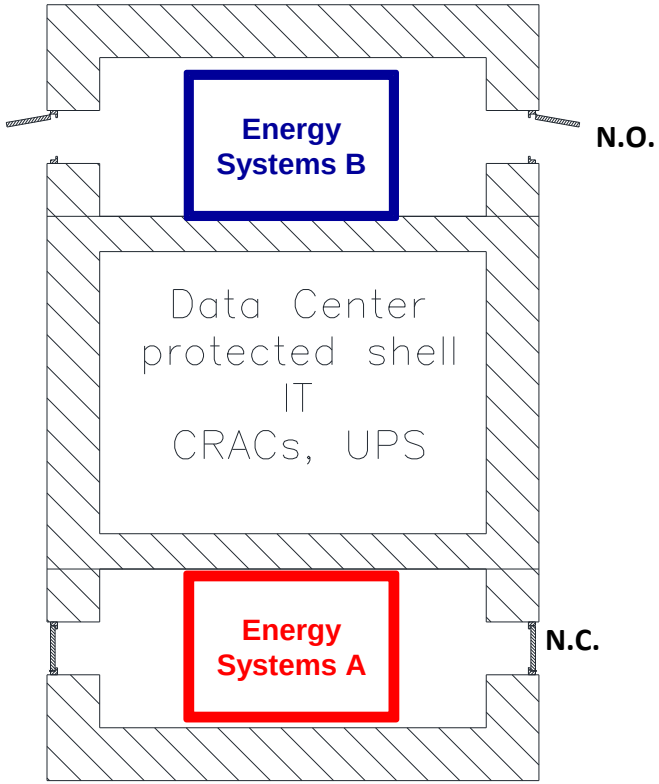
Protected DC – Tier IV

- Differentiation between routine and emergency
- **Routine** – Tier IV
- Normally (doors open) both systems are running – Tier IV configuration
- Medium-high PUE



Protected DC – Tier III

- Differentiation between routine and emergency
- Routine – Tier IV
- Shift to emergency mode
- **Emergency** – Tier III
- Emergency (one set of doors is closed) one system is running – Tier III configuration
- Loss of redundancy and protection after first hit
- Medium-high PUE



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- Routine – Tier IV
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- **Emergency** – Tier III
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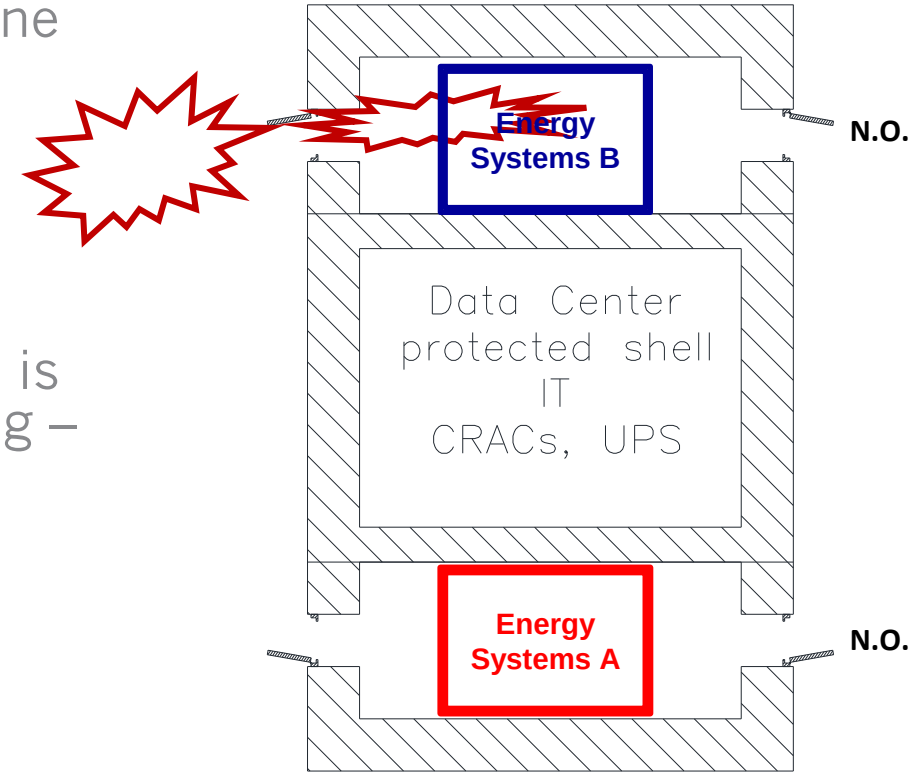
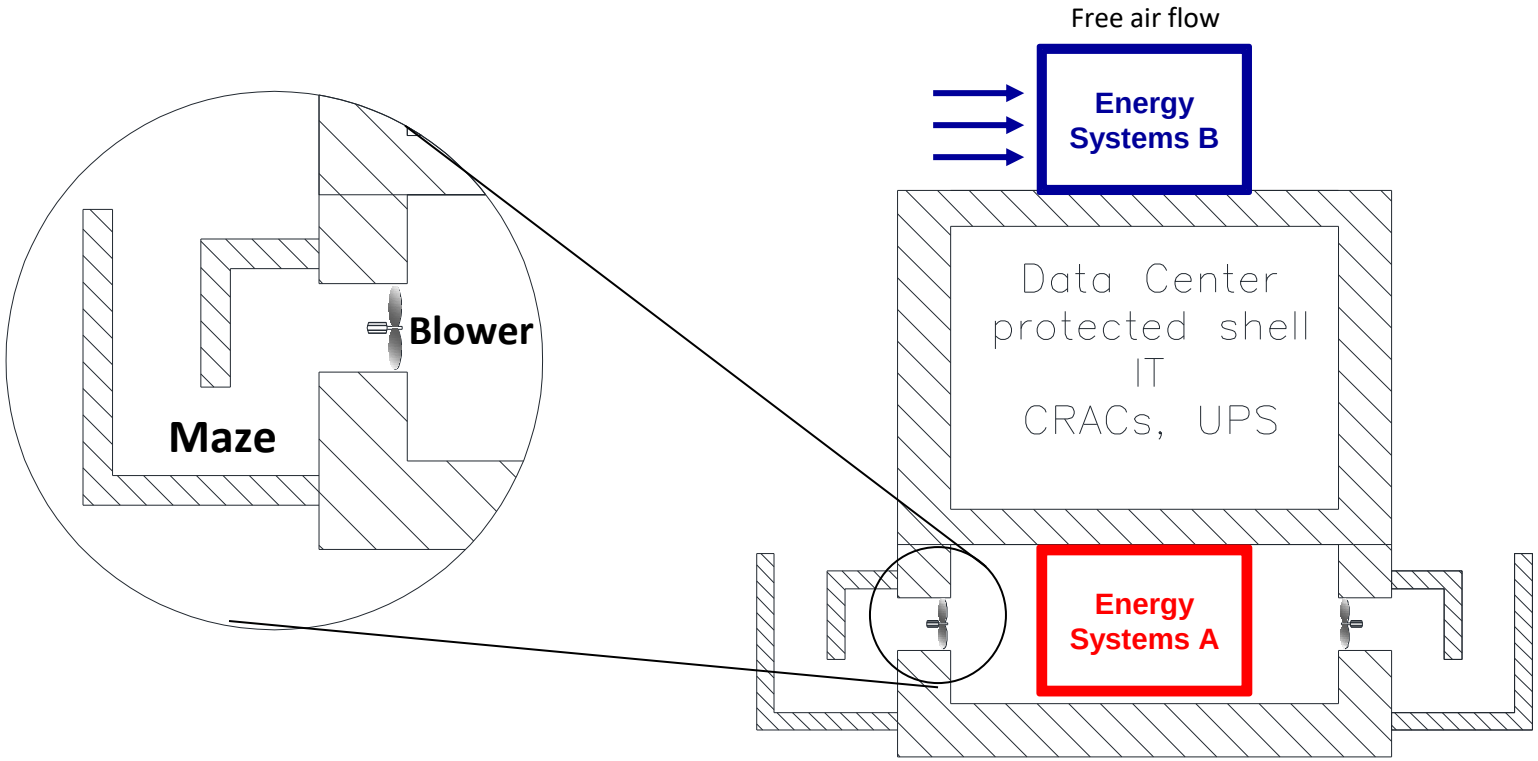


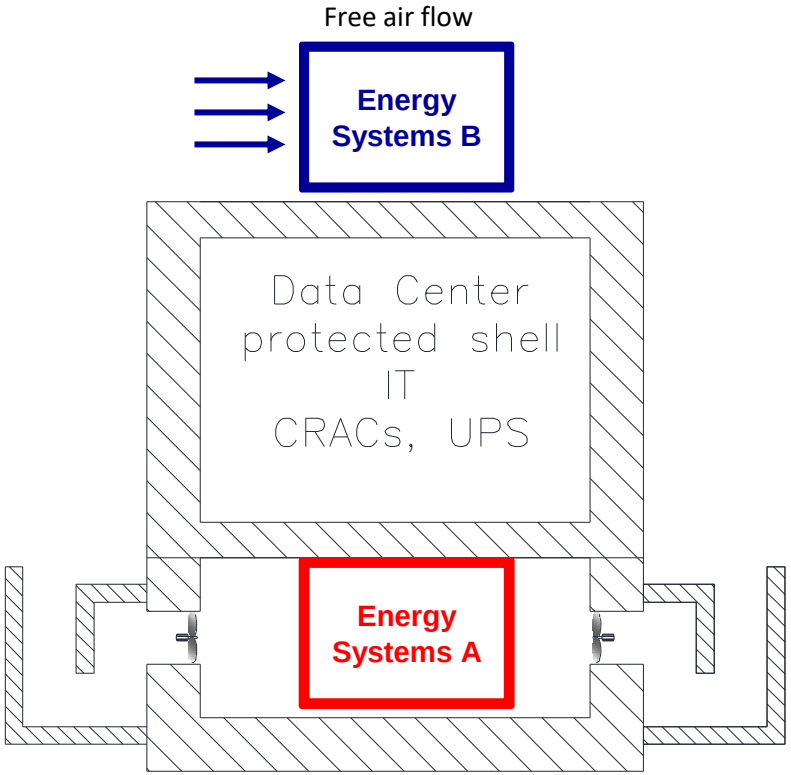
Protected DC



Blowers

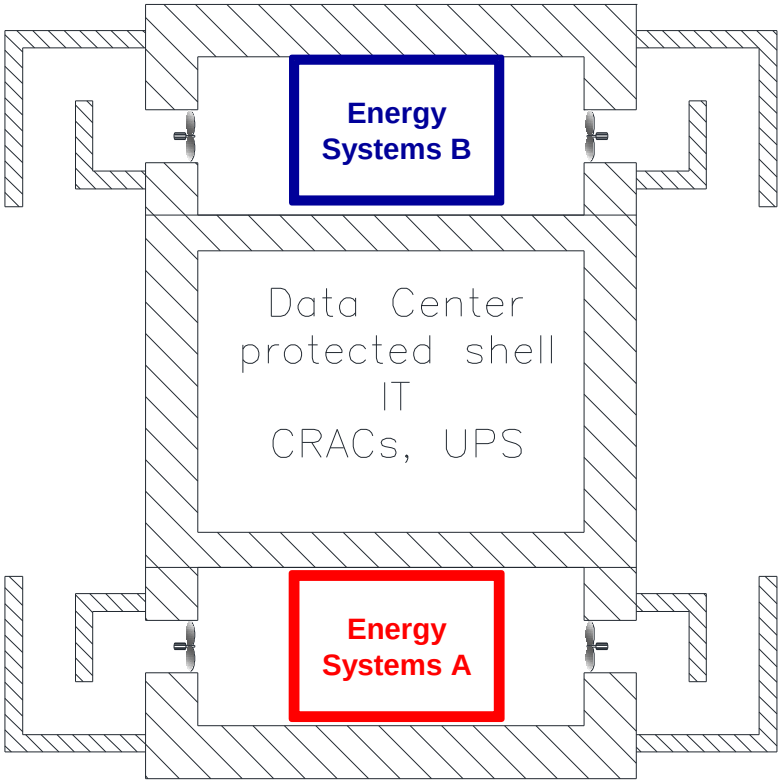
Protected DC – Tier IV

- Differentiation between Tier rating and risk of hit
- Concurrent operation of both energy systems
- Medium-high PUE
- Protection is kept after physical hit



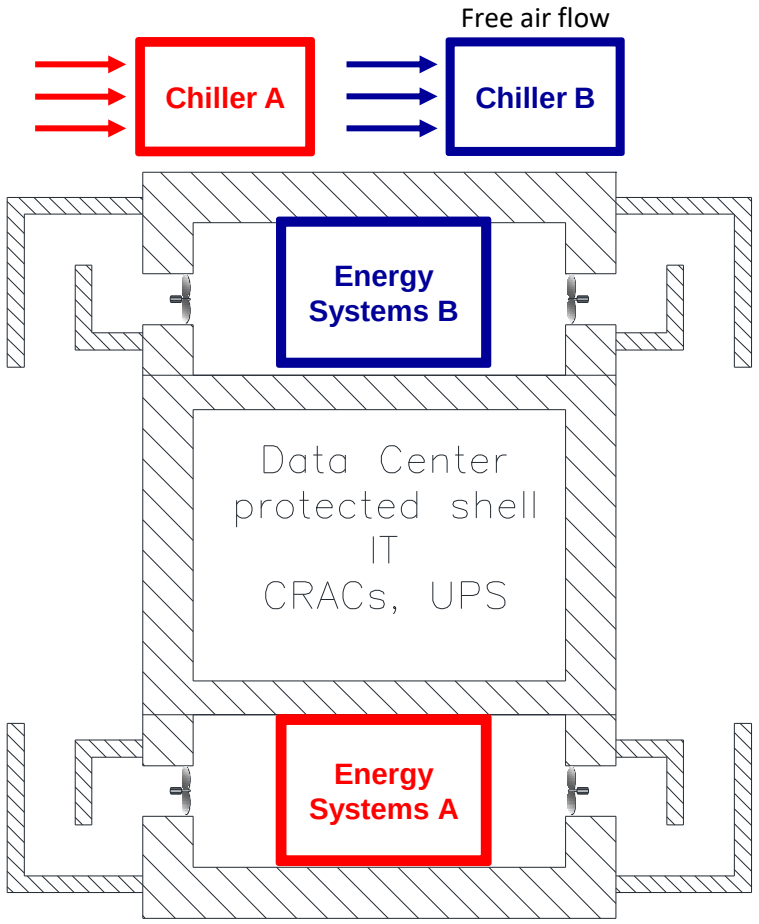
Protected DC – Tier IV

- Symmetry between Tier rating (availability) and survivability
- Concurrent operation of two energy systems
- Very high PUE



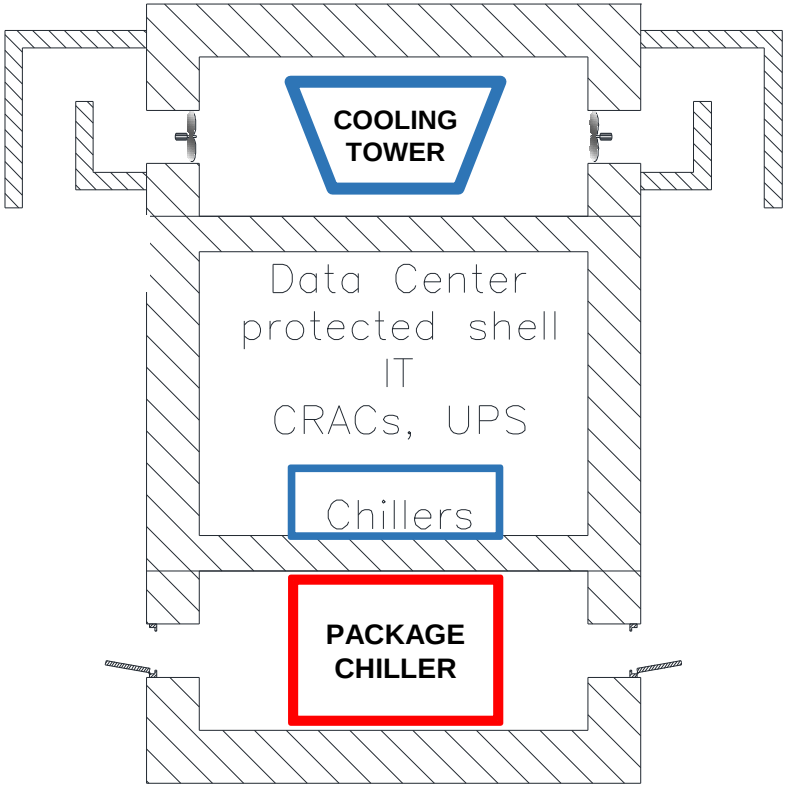
Protected DC – Tier IV

- Separation between outside chillers operating with free airflow and protected chillers
- Option for 50% chillers in each plant
- Option for installing only cooling towers outside
- Generators have no effect on PUE
- Protected energy systems operate in case of failure or hit
- The physical protection is kept after failure
- Low PUE
- High Capex



Cooling: package chillers Vs. cooling towers

- Cooling tower:
  - Better PUE / COP.
  - Need for water reservoir equivalent to generators fuel backup time.
  - Moisture challenge.
- Package Chiller:
  - Reduced PUE.
  - Closed system.

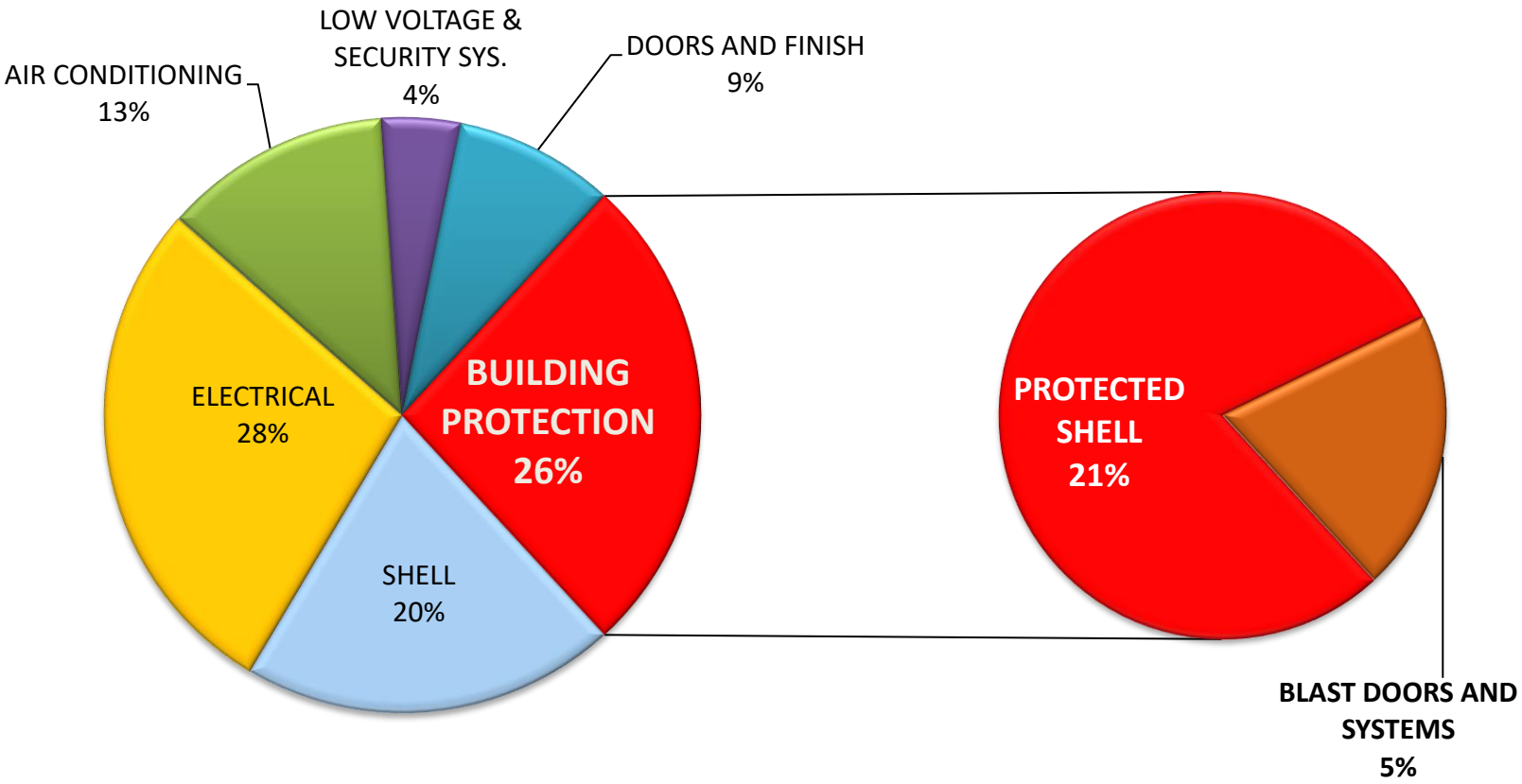


Power and PUE (Tier IV example)

- Chillers (package)
  - 1.17 KW/TR
  - COP = 3.07
- Forced air power consumption
  - 0.73 KW/TR
- Total power consumption
  - 1.88 KW/TR
  - COP = 1.85 (64% worse)

- PUE = 2.22
- PUE (without blowers) = 1.91
- Blowers influence = 16%

COST - Based on protected Tier III DC



3 Key Things You Have Learned During this Session

1. Differentiation between Tier rating and protection level.
2. Shifting from routine to emergency.
3. Efficiency and cost impacts.

Thank you

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