The economics of electricity storage

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Why consider storage?

At generation level:

- Spinning reserve.
- Generation capacity deferral.
- Renewables.
- Load leveling.

These applications require 10's to 100's of MWe power output for periods of half to several hours, duty cycles from once per month to daily.

Why consider storage?

In the transmission and high-voltage distribution systems:

- Transmission line stability.
- Voltage regulation.
- Transmission facility deferral.
- Distribution facility deferral.

The first two applications require storage capacity measured in seconds, the second two, for up to a few hours.

Why consider storage?

To meet customer needs:

- Customer demand reduction
- Transit system peak demand reduction
- Reliability and power quality, high power
- Reliability and power quality, high energy
- UPS systems

The first two applications require storage measured in hours, the second, seamless supply for minutes.

Storage alternatives—a list

The alternatives relevant for the electricity supply industries are:

- Superconducting magnet energy storage (SMES)
- Batteries (lead-acid and other rechargeable)
- Hydrogen-based storage
- Flow batteries (VRB, ZBB)
- Pumped storage
- Compressed-air energy storage (CAES)
- Flywheels
- Supercapacitors

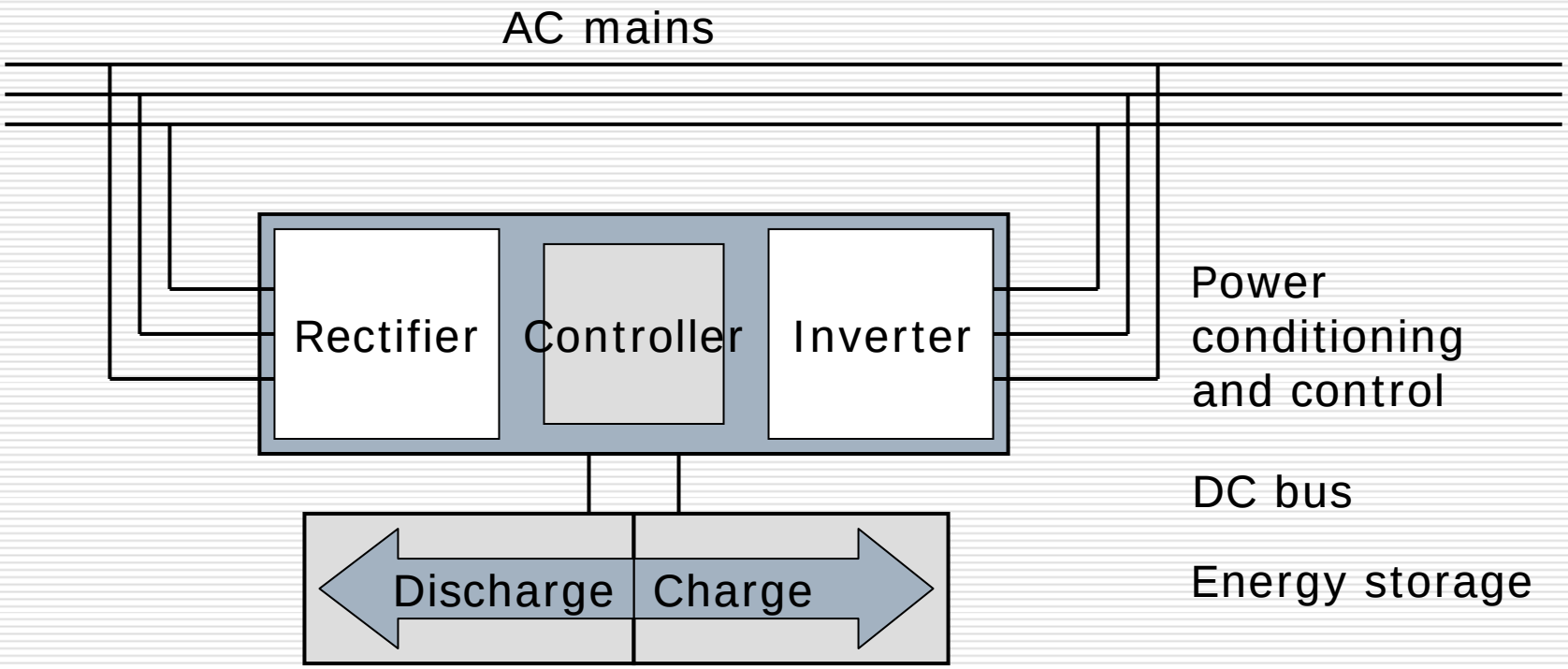
These all compete with gas turbines and diesel gensets in many applications.

A critical distinction

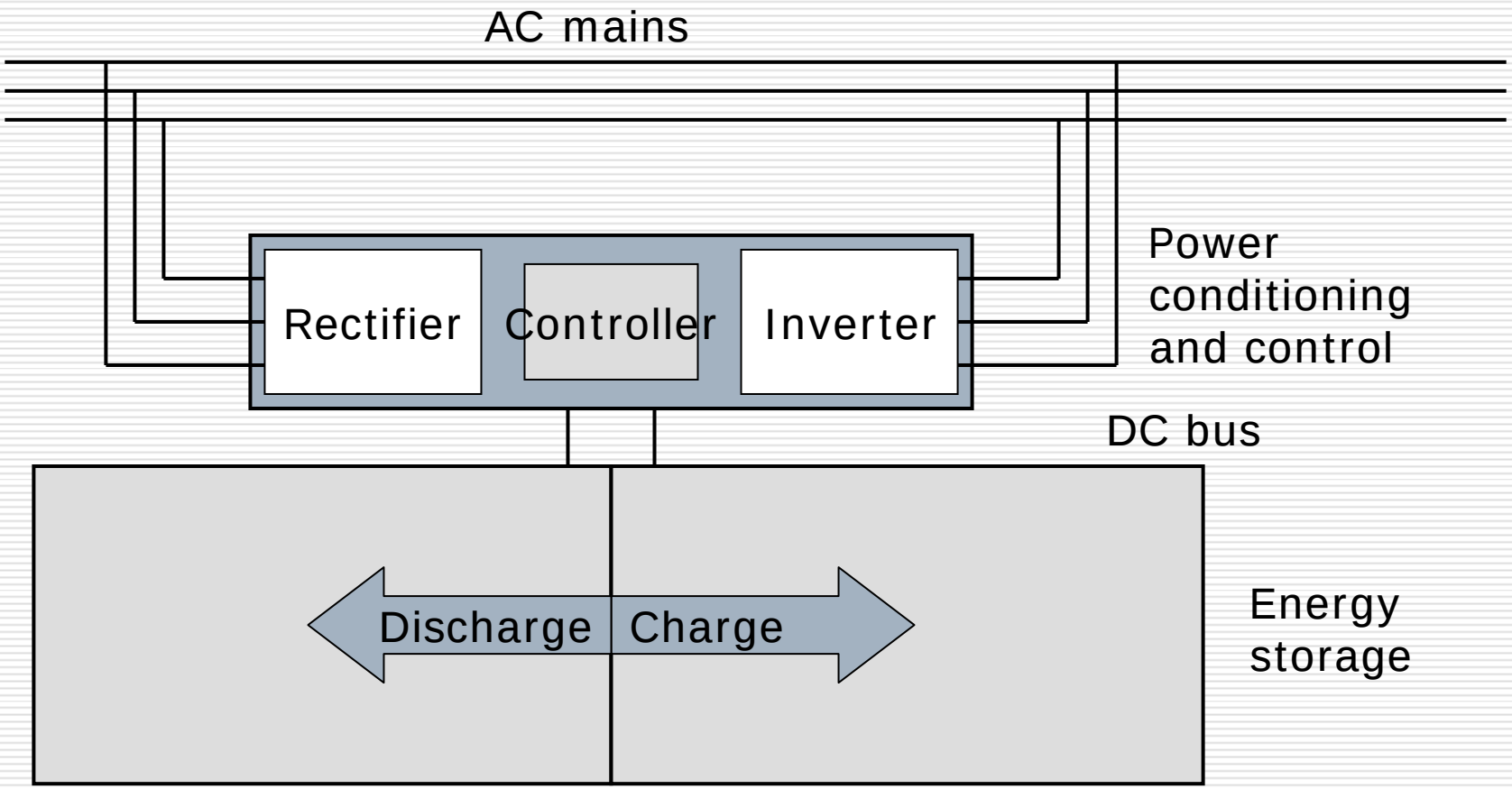
- Batteries, flywheels, supercapacitors and SMES systems can provide seamless (UPS) supply.
- Pumped storage systems, CAES systems—and gas turbines and diesel gensets, cannot, because they rely upon rotating machinery.

Hence, the first group can add value in ways not available to the second.

Generic energy storage system: Case 1: high power/stored energy ratio.

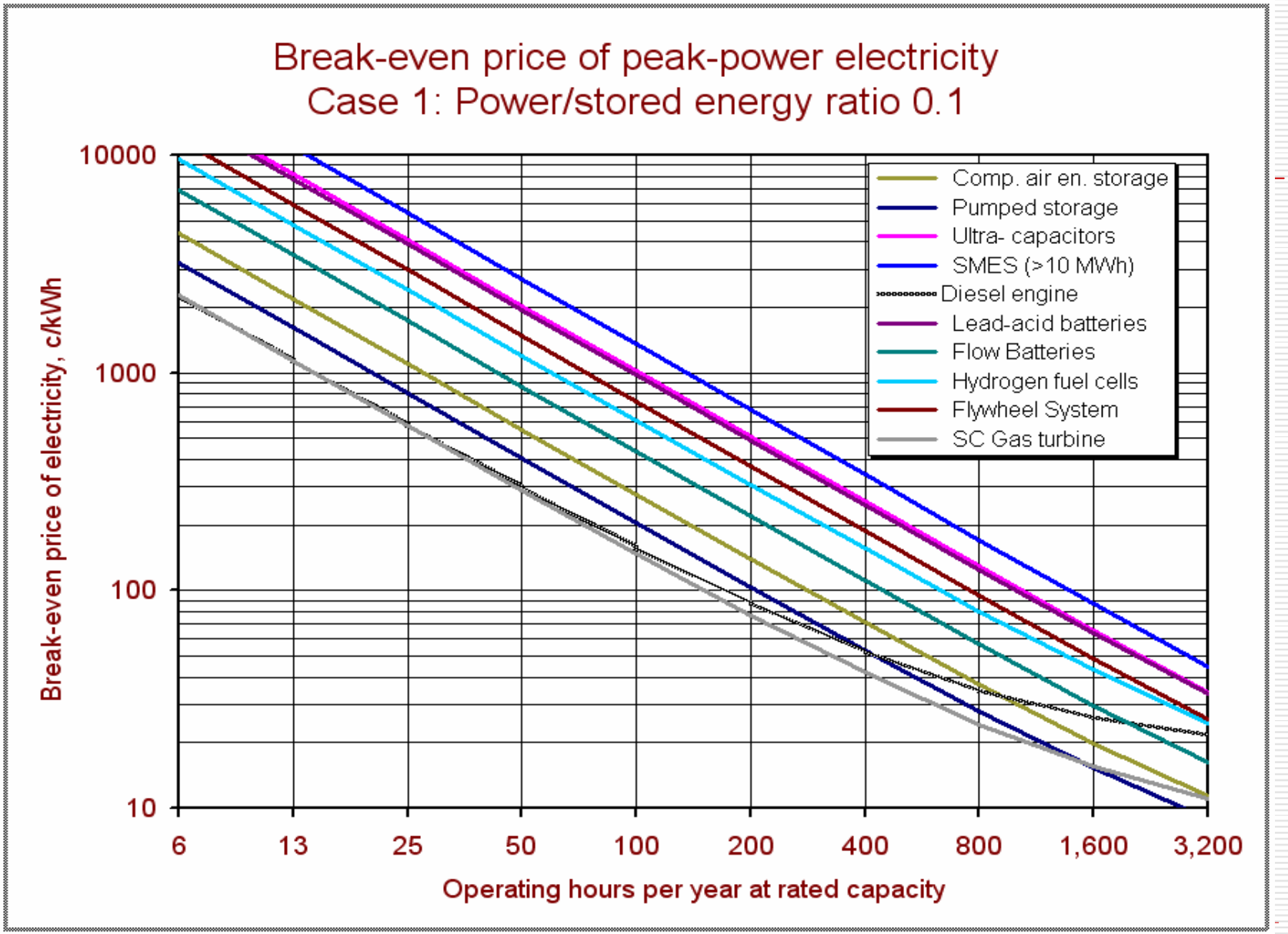


Generic energy storage system: Case 2: low power/stored energy ratio.



The model's assumptions

- Power/stored energy ratio for three cases: 0.1, 0.4, 1.6 kW/kWh.
- Power condtioning systems cost $1,200/kW power input for all devices using semiconductor power control systems.
- Cost of power output = ($1,200/efficiency).
- Cost of energy rating depends on device.
- Total system cost calculated for all three P/E cases.
- Electricity purchased at off-peak rates of 2c/kWh. Gas costs $5.50/GJ, diesel, $20/GJ.



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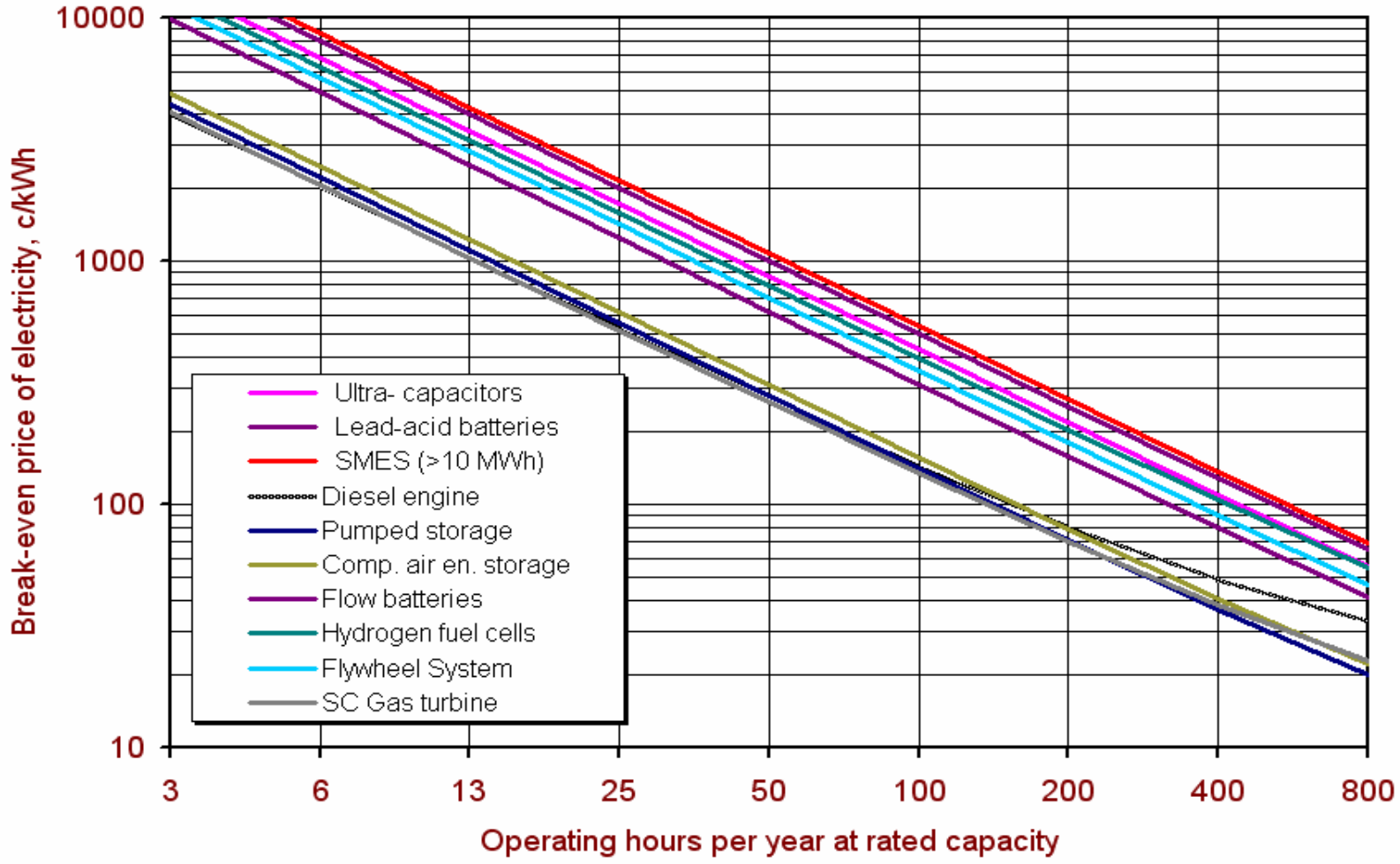
Break-even price of peak-power electricity
Case 2: Power/stored energy ratio 0.4



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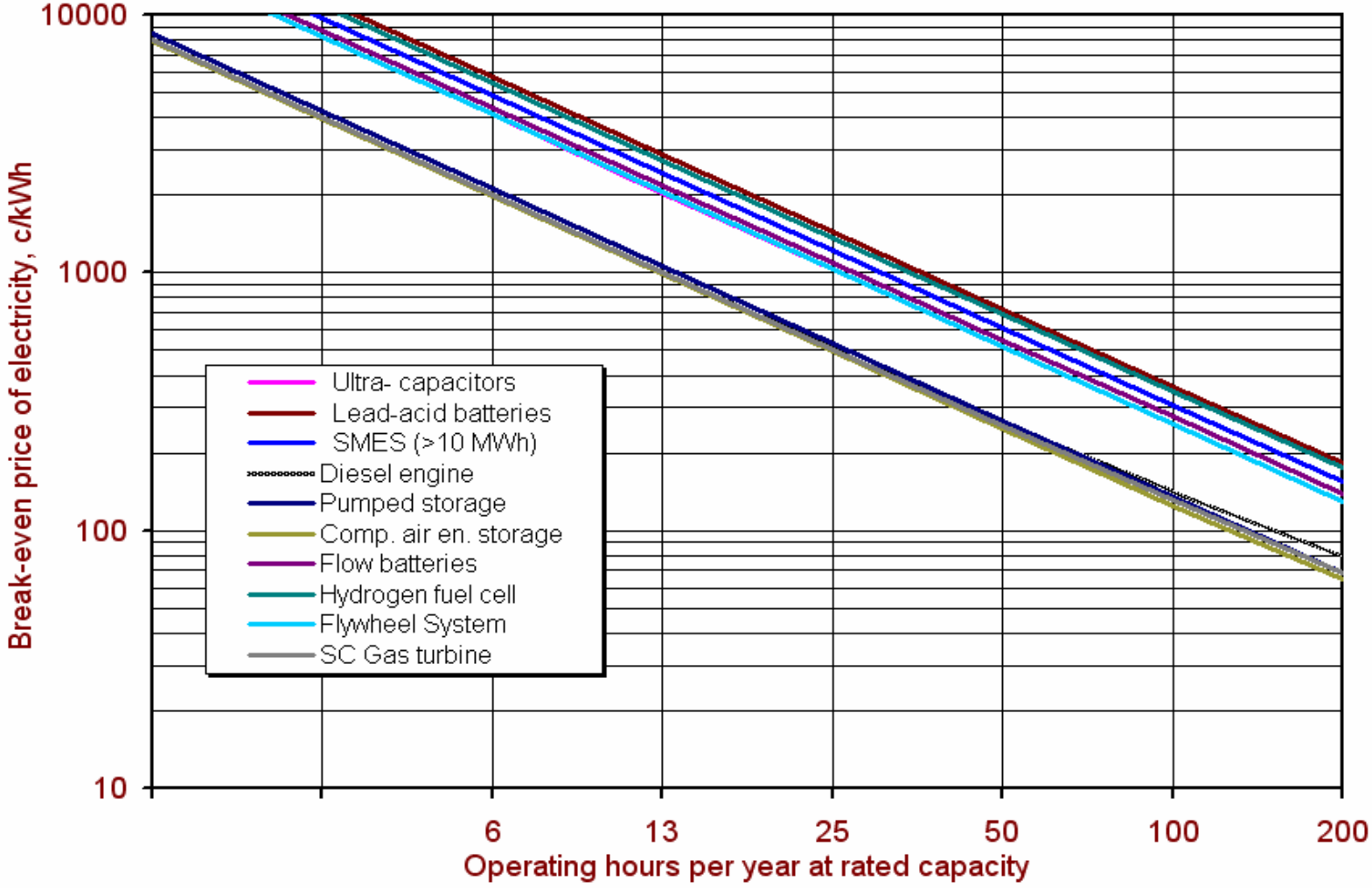
Break-even price of peak-power electricity
Case 3: Power/stored energy ratio 1.6



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The application technology fit

- For peak lopping or load leveling, no storage system can compete with gas turbines or diesel gensets. Pumped storage and CAES are next most competitive.
- But all of these require rotating machinery, so none can provide an uninterruptible power supply.
- The power conditioning systems essential to the new technologies add cost, but add value.
- Their niche is to supply power seamlessly, for seconds to a few minutes, until power from the mains can be restored, or backup supplies (turbines, gensets) can be brought on line.
- It matters little what sort of storage technology is used, as for such short time periods costs are totally dominated by those of the power conditioning system.

Early applications of storage

Currently, storage systems are best suited to:

Generation-based applications:

- Substituting for spinning reserve.

Transmission and distribution:

- Transmission line stability and voltage regulation.

Customer-based applications:

- UPS systems.
- Handling cyclic loads e.g. cranes, draglines, construction plant.

But this is just the beginning!

Storage as a disruptive technology

The high cost of power conditioning currently holds back the deployment of storage. But these costs are falling, thanks to the car companies.

When they do, the electricity industry will be changed forever:

- Electricity will become like other commodities that can be stored.
- There will be a massive shift in bargaining power to the customer as a consequence.
- In power industry terms, this will all come about very soon.

You have been warned!