



Power balance challenge for a prototype fusion plant

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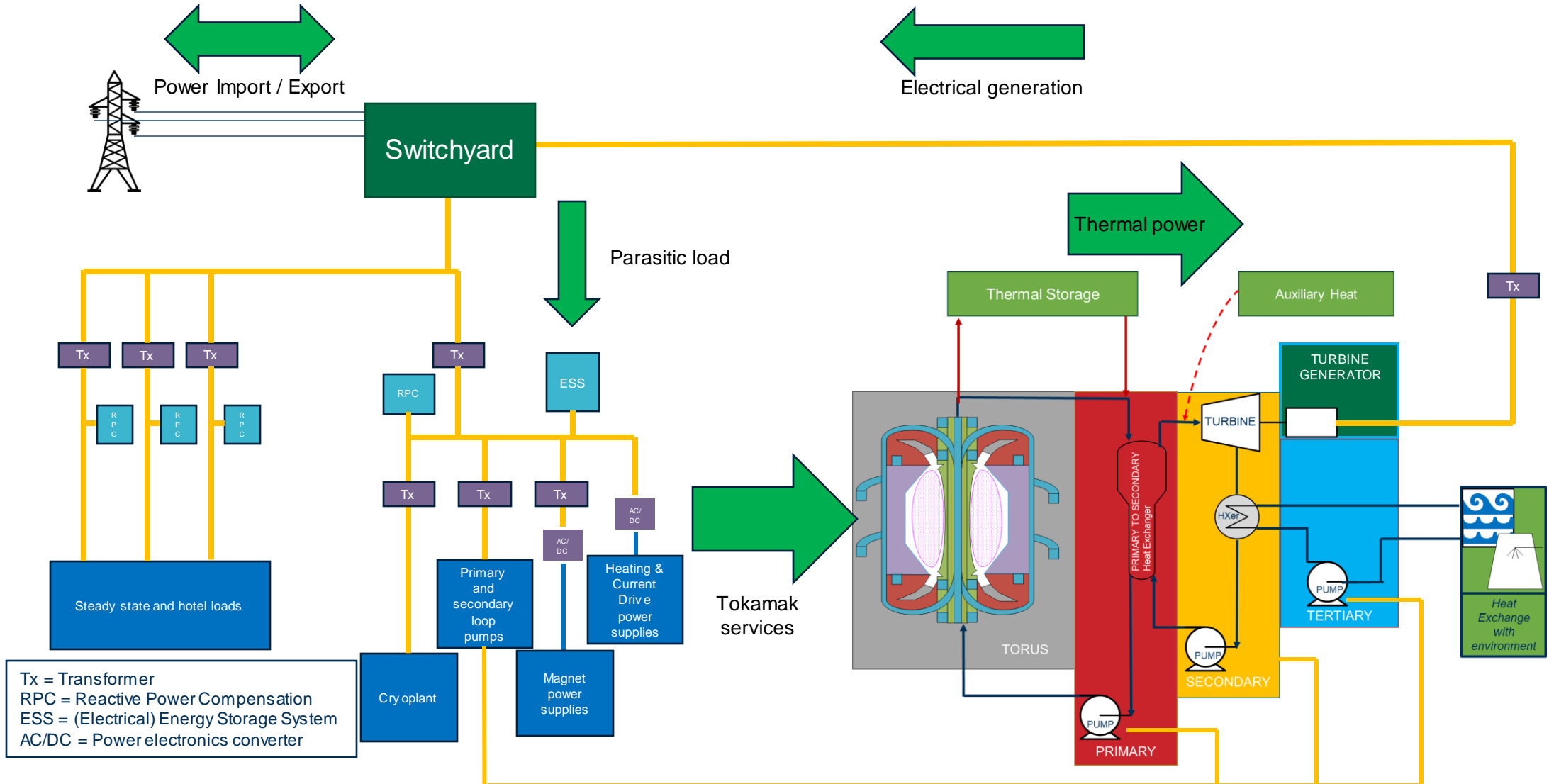
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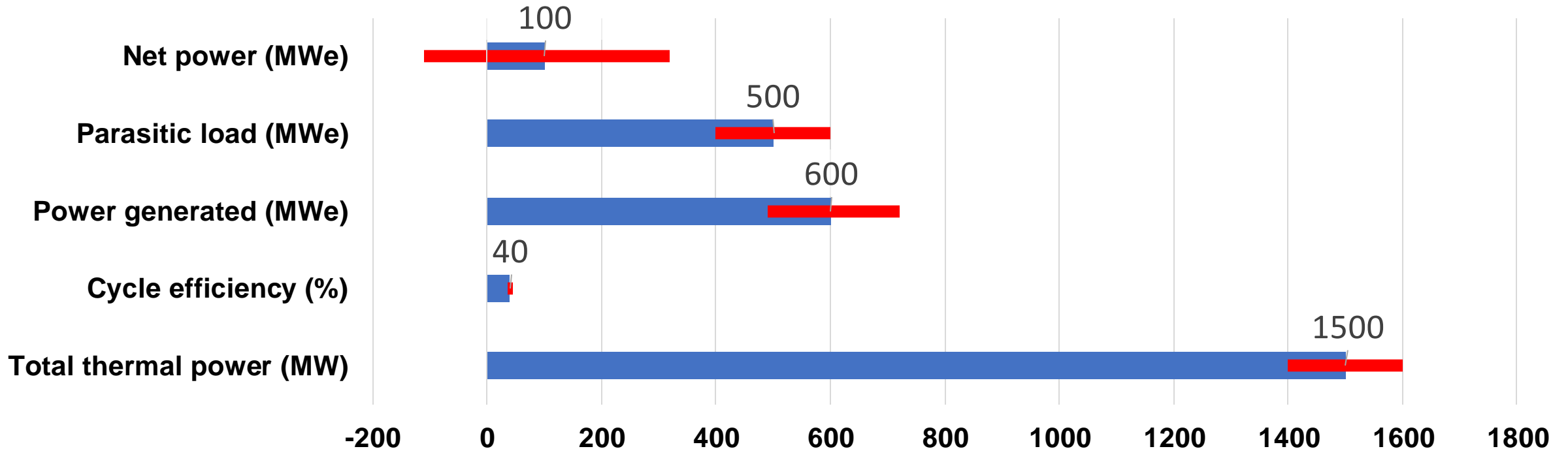
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Power Balance Block Diagram



Net power uncertainty for steady-state operation

Tokamak prototype powerplant indicative power balance with uncertainties

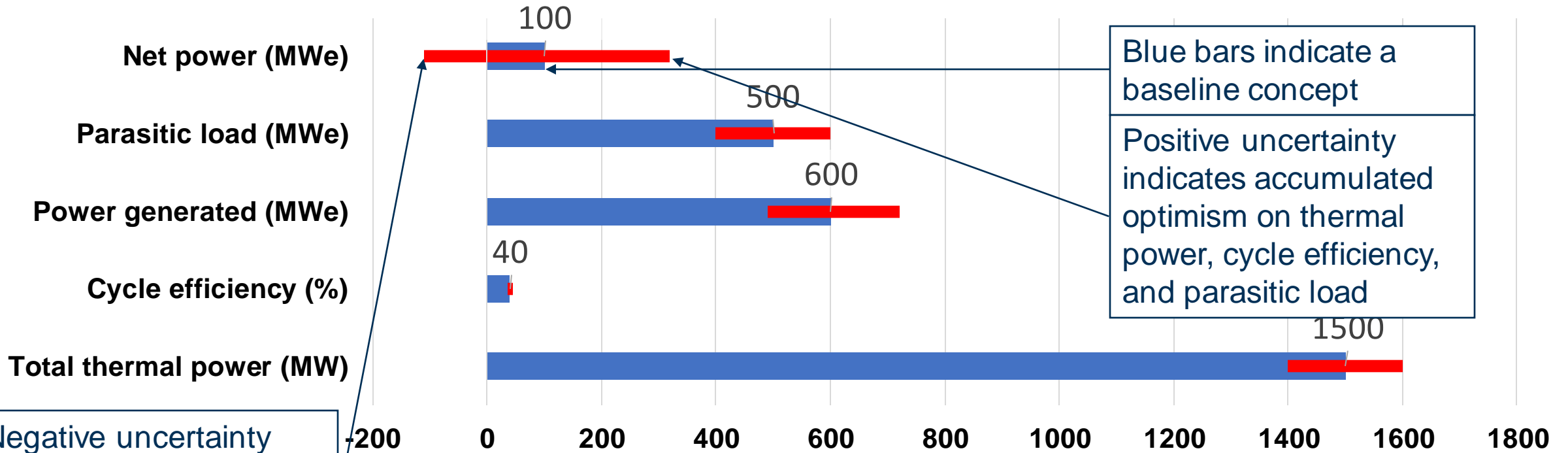


$$\text{Power generated} = \text{Total thermal power} \times \text{Cycle efficiency}$$

$$\text{Net power} = \text{Power generated} - \text{Parasitic load}$$

Net power uncertainty for steady-state operation

Tokamak prototype powerplant indicative power balance with uncertainties



Blue bars indicate a baseline concept

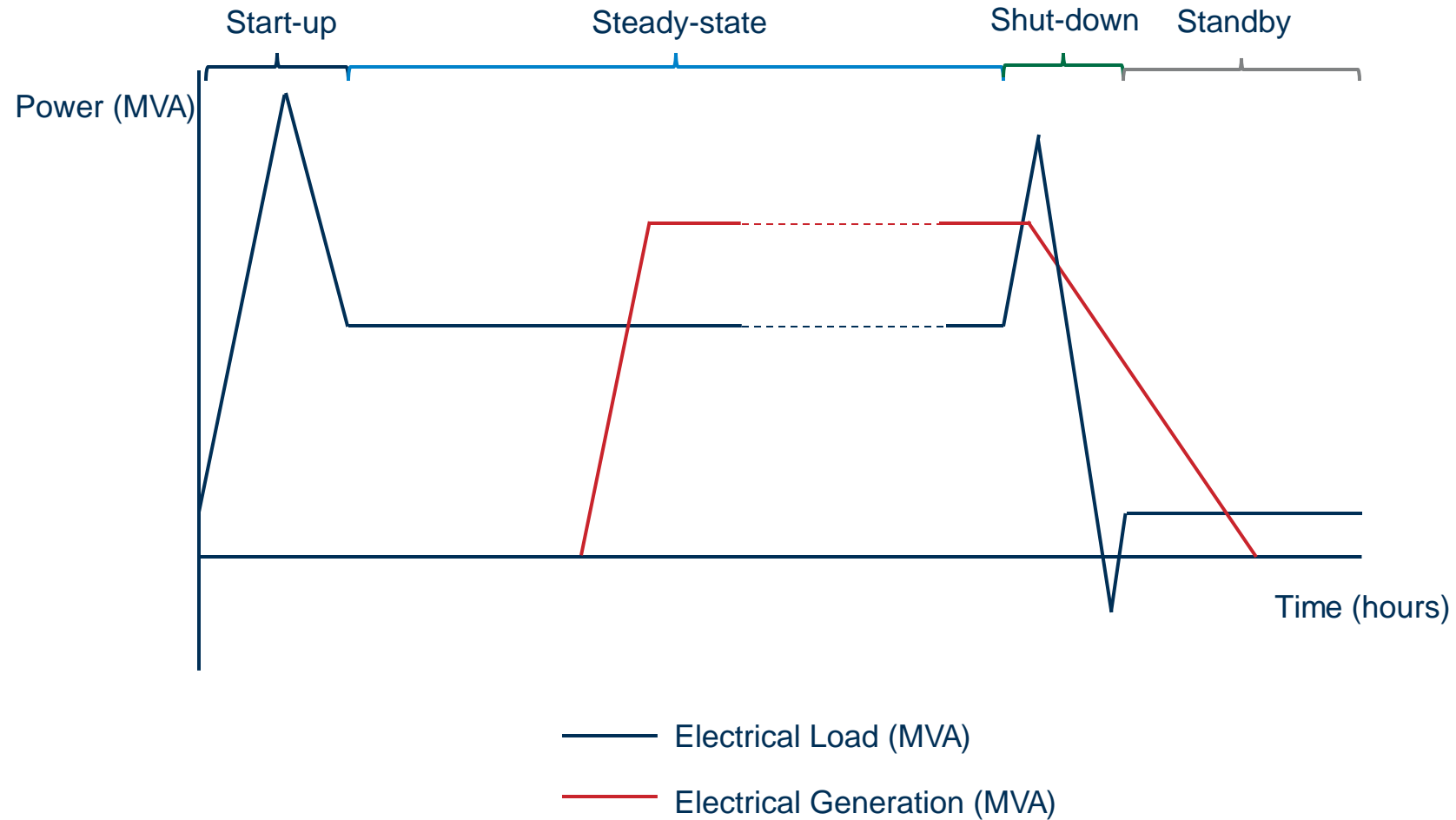
Positive uncertainty indicates accumulated optimism on thermal power, cycle efficiency, and parasitic load

Negative uncertainty indicates accumulated pessimism on thermal power, cycle efficiency and parasitic load

$$Power\ generated = Total\ thermal\ power \times Cycle\ efficiency$$

$$Net\ power = Power\ generated - Parasitic\ load$$

Load Profile and Generation Profile



Conclusion - Power balance challenge for a prototype fusion plant

The accumulated power balance uncertainties for a prototype fusion power plant are significant. Mechanisms for managing this are:

- Consistent and integrated management of steady-state parasitic loads in the design phase. I.e. a “Power Budget”
- Balance of efficiency and flexibility in the design of the power generation system.

The start-up and shut-down regimes will also be important, and could drive maximum ratings across the plant. There is a closely coupled design trade space with external electrical grid constraints, electrical energy storage, thermal energy storage and auxiliary heating.