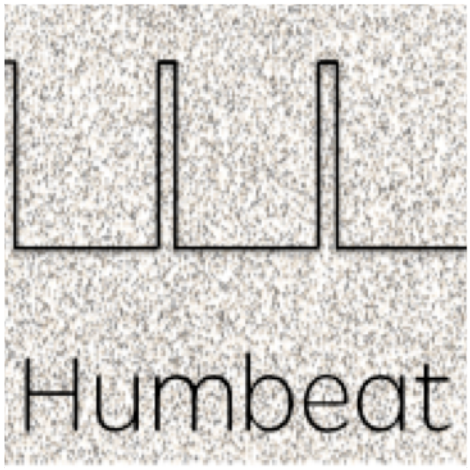
Nuclear baseload? Or nuclear backbone?

Humbeat explains why backbone could replace baseload nuclear power operation, and discusses how and why nuclear can remain a successful technology in future energy systems.



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Innovation and disruption go hand-in-hand in today's electricity markets

In the past, national power systems received reliable levels of power from sturdy *baseload* assets, particularly nuclear and coal. This was supplemented by a small number of *dispatchable* assets (gas or hydro) to meet the peaks and troughs of power's demand profile. Decarbonising electricity has introduced a large number of smaller, *non-dispatchable* generating assets into consumer-centric power systems. As a consequence:

- Assets have complex commercial drivers for generation planning – including both rebates and costs avoided
- Power system coordinators ("TSOs") have less visibility of these asset capabilities and generation plans, making their essential task much more complicated
- Commercial and operational influences of small, non-dispatchable assets have transferred through power markets to traditional large plants, altering their fundamental economics … somewhat negatively
- A wave of innovative and disruptive activity is breaking, attempting to "solve the problem" of integrating lots of small and/or renewable assets into country-wide power systems

The *integration* of renewable power sources is a hot topic. Demand Side Response, power storage and interconnectors are considered essential to make large power systems work with a high share of renewable generation. Incentives have been introduced to encourage efficient markets during integration. Technology solutions are looking into the "big data" challenge of coordinating large numbers of small independent assets.

More consumer-centric assets mean that future power demand peaks may be higher, and troughs may be deeper, depending on how hard (and where) the wind blows or the sun shines … or, how power is valued at a point in time. Power demands will be more volatile; power flows will become important.

Humbeat therefore believes that "baseload" is out-dated. The right nuclear response to this prediction, if it is correct, may secure beneficial and economic nuclear power operation as a part of national power systems for decades to come.

Saving the planet or making money?

Today's power markets closely knit an asset's commercial value to its technical capabilities and performance. Asset value is optimised by buying or selling technical capability for the best price. Making choices close to delivery can reward the asset owner, but creates challenge for the TSO.

Commercially operated electricity storage assets, for instance, will either pause, discharge or charge depending on price signals at that point in time. The impact on national power balance of a change in commercial/operational decision may therefore be up to twice the capacity of the asset (e.g. if a 50 MW charge becomes a 50 MW discharge, power balance changes by 100 MW). Multiple storage assets changing plans at the same time, and near to the point of delivery, may result in a very difficult change in national power balance.

Renewable assets are radically shifting the once-mature, now alarmingly vulnerable, power sector. Recent investment in renewables doesn't yet look to slow, as asset manufacturing costs fall. Generation assets, renewables included, will remain being operated commercially. The shift to a global low carbon power supply will continue; power market changes are here to stay! So as independent asset owners operate to optimise their own returns, volatility of power balance, and price, close to the point of delivery, will likely increase. TSOs will require tools to help manage the system effects of commercial asset operation. "Virtual Power Plants" may be one such tool, but when operated independently and commercially, they could just as easily hinder as help.

As consumer-centric generation increasingly offsets demand, it leaves less room for traditional large baseload asset operation. The inflexible baseload market is therefore not a growth market. So, although baseload power generation has served nuclear well over the past years, and will likely continue to do so, being restricted to *inflexible* baseload operation will not be a good thing in the future.

Many nuclear operating assets are not set up to respond to TSO or market demands, making them commercially vulnerable. Unable to generate more on demand, and able to turn down only in emergency or pre-planned situations, excludes these assets from short term commercial gains, and exposes them to potentially significant losses. The task of weighing the safety, operational and commercial pros and cons of a reactive change to a generation plan, will be too onerous to allow a timely response to the fast-moving electricity market.

A new concept: backbone power

It is difficult to imagine a 100% renewable power system with independent, commercial, market participants, without serious complexity in system operation. Humbeat proposes that a 'renewables +' system is more readily achievable. Nuclear can be part of the '+', and we believe it should reposition itself to be a flexi-load capable, dispatchable, large *and* low-carbon generation capability which provides a **backbone** for future power systems. Building responsive flexibility into plant designs, safety justifications and operating rules ahead of time, will pay dividends in many currencies, but requires nuclear to leave behind its "inflexible" branding.

Further, TSOs require controllable assets to provide "insurance" against emergent shorts or oversupplies of power. They require "ancillary services" to help flow power at near-constant volts and frequency across their systems. Currently provided largely by thermal plant, alternate sources of "ancillary services" must be found for the future. It is in the interest of nuclear power to be connected to a stable power system. Nuclear could help to provide more ancillary services, just maybe not always at full power output. Another good reason for flexi-load capability.

It is difficult to predict precisely when the need for backbone will replace the need for baseload, but there are three signs that this transition has already started … and will continue:

- September's storm-induced blackout in South Australia exposed a power system vulnerability, which would have had less severe an impact on consumers had a suitable backbone capability been in place
- French and German nuclear power responses during periods of extreme weather, hints at a policy-induced backbone being already present in these countries
- Nuclear operation during minimum demand periods has been described by the UK's TSO as requiring regular deloads from 2021 onwards

How do we establish a backbone nuclear fleet?

As new nuclear power opportunities are investigated, we have a chance to consider "backbone" capabilities in critical technical, operational and commercial decisions.

Incorporating new capabilities within the early stages of design is proven to be less costly than retrofitting at a later date. Designing and building flexible nuclear can draw on a wealth of global experience, from within and out-with the nuclear industry. Our goal should be to design *safe, secure* and *useful* nuclear plants, which integrate into energy markets and are future-proofed against market innovations.

Building and commissioning flexible plants is but one part. Plant operating rules and its operations culture must also be developed. Operators must be supported to hold steadfast to their safety and security obligations, as well incorporate a wide spectrum of risks into efficient and timely decision making across maintenance, engineering, fuel route and operations tasks.

Lastly, we must consider re-examining revenue frameworks for nuclear plants, which work for all stakeholders. Asset owners require revenue certainty to pursue investments. TSOs require the ability to procure services through markets which are efficient. Customers require cost-efficient generation without excessive market risk. And we all need low-carbon electricity.

Finding the right design, culture and commercials will unlock nuclear's future as the backbone of low-carbon electricity and energy systems.