“Go now or wait and see?” – Optimal Investment Planning for CCS

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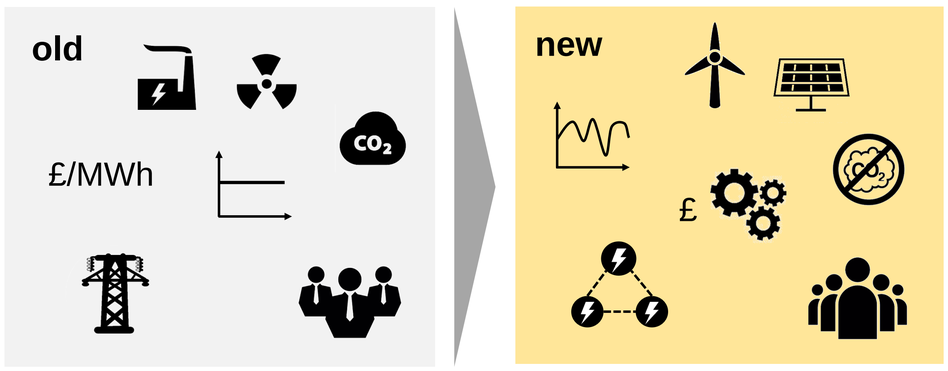
Motivation

- CCS in power generation is widely recognised as being vital to least cost decarbonisation
- Today however, it is generally referred to as being too costly
- Consequently, relatively small sums are spend on research & development, in the hope that a future “super technology” will bring prices down



- Additionally, power systems are in a transition w.r.t. supply, demand, markets, transmission & distribution, environmental constraints
- Power technologies cannot be compared in isolation but require assessment within the systemic context

The Electricity System Optimisation Framework

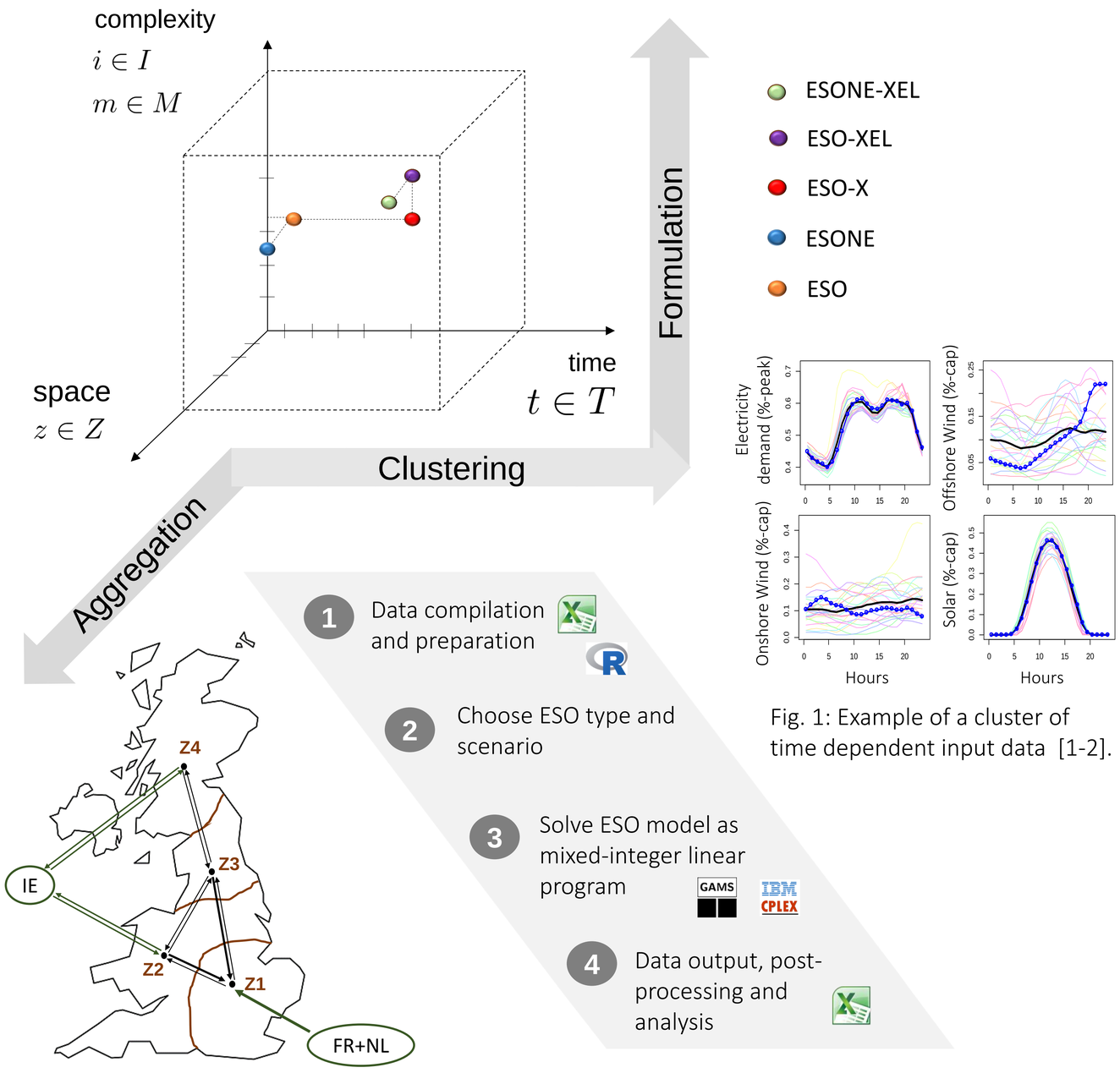


Fig. 1: Example of a cluster of time dependent input data [1-2].

Results from the ESO-XEL model

Should we wait with investment in CCS **today** if a “super technology” becomes available in the **future**?

— No, CCS remains a vital part of the least cost solution. Total system cost by 2050 without CCS deployment could be 44 % greater.

Carbon Price –no ST | Zero-CO_2Target –no ST | Carbon Price –ST

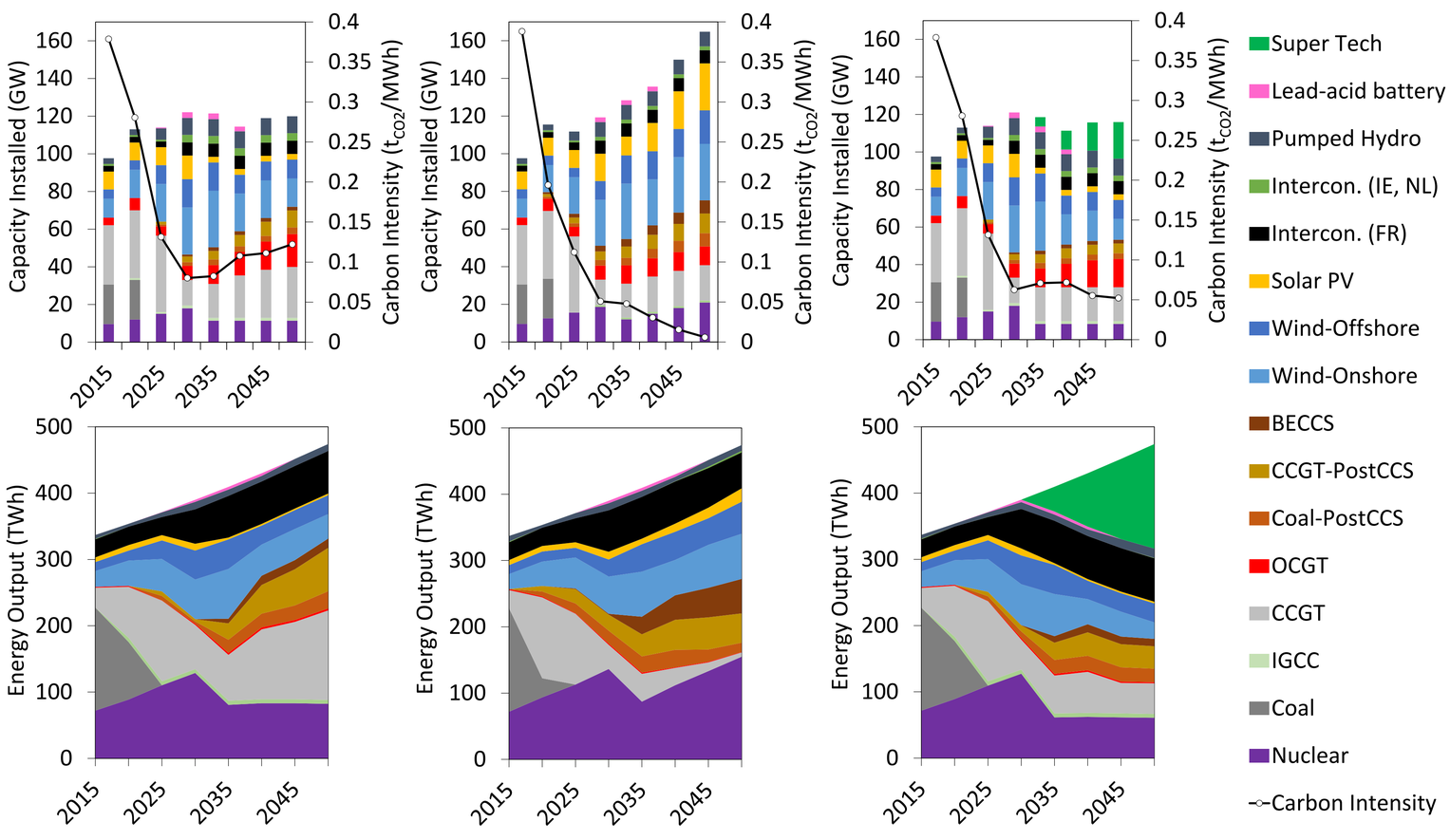
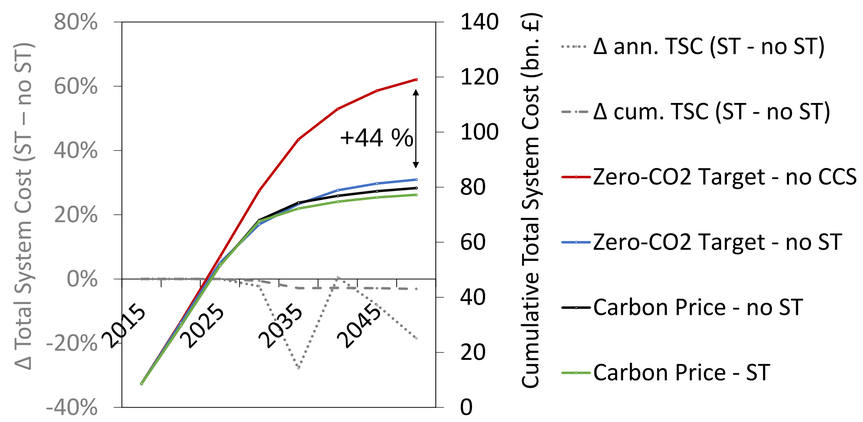


Fig. 2: Study of decarbonisation via carbon price, and an enforced zero CO_2 emission target by 2050 without the availability of a “super technology” (ST), and with a ST available from 2035 onwards.



Conclusions

- Optimal investment timing for CCS remains unaffected by a future disruptive technology.
- However, optimal CCS capacity deployment by 2050 reduces by 30 %, energy output by 36 %.
- It is unlikely that a carbon price alone will lead to a complete decarbonisation of the power sector.

A potential “super technology” — Chemical Looping Combustion (CLC)

Tab. 1: Parameterisation of a 500 MW unit NGCC-CLC as “super technology” in the ESO-XEL model.

Characteristic	**Unit**	**CCGT-CCS**	**NGCC-CLC** [3]
Efficiency	$\%_{HHV}$	45.5	46.8
CAPEX	$£_{2016}$/kW	2,368	1,066
OPEX (fixed)	$£_{2016}$/MWh	2.8	2.46
OPEX (fuel, CO_2 tax, CO_2 T&S)	$£_{2016}$/MWh	42.1	37.8
Carbon Intensity (emit./cap.)	t_{CO2}/MWh	0.041 / 0.369	0 / 0.386
Economic Lifetime	Years	30	30
Minimum Stable Generation	%	70	40

References

[1] S. Pfenninger and I. Staffell, 2016. Energy, 114, pp. 1251–1265
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[3] S. Consonni, G. Lozza, G. Pelliccia, et al., 2006. J. Eng. Gas Turbines Power 128 (3), pp. 525-534.

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