Can direct cooling still be considered the Best Available Technology for large estuarine and coastal applications in the U.K.?

Adam Waugh
Natural England

Overview

- Why do we need nuclear?
- Direct cooling advantages and mitigation methods
- What are the risks to hearing fishes?
- Viable compensation strategies
- Are there any alternatives?

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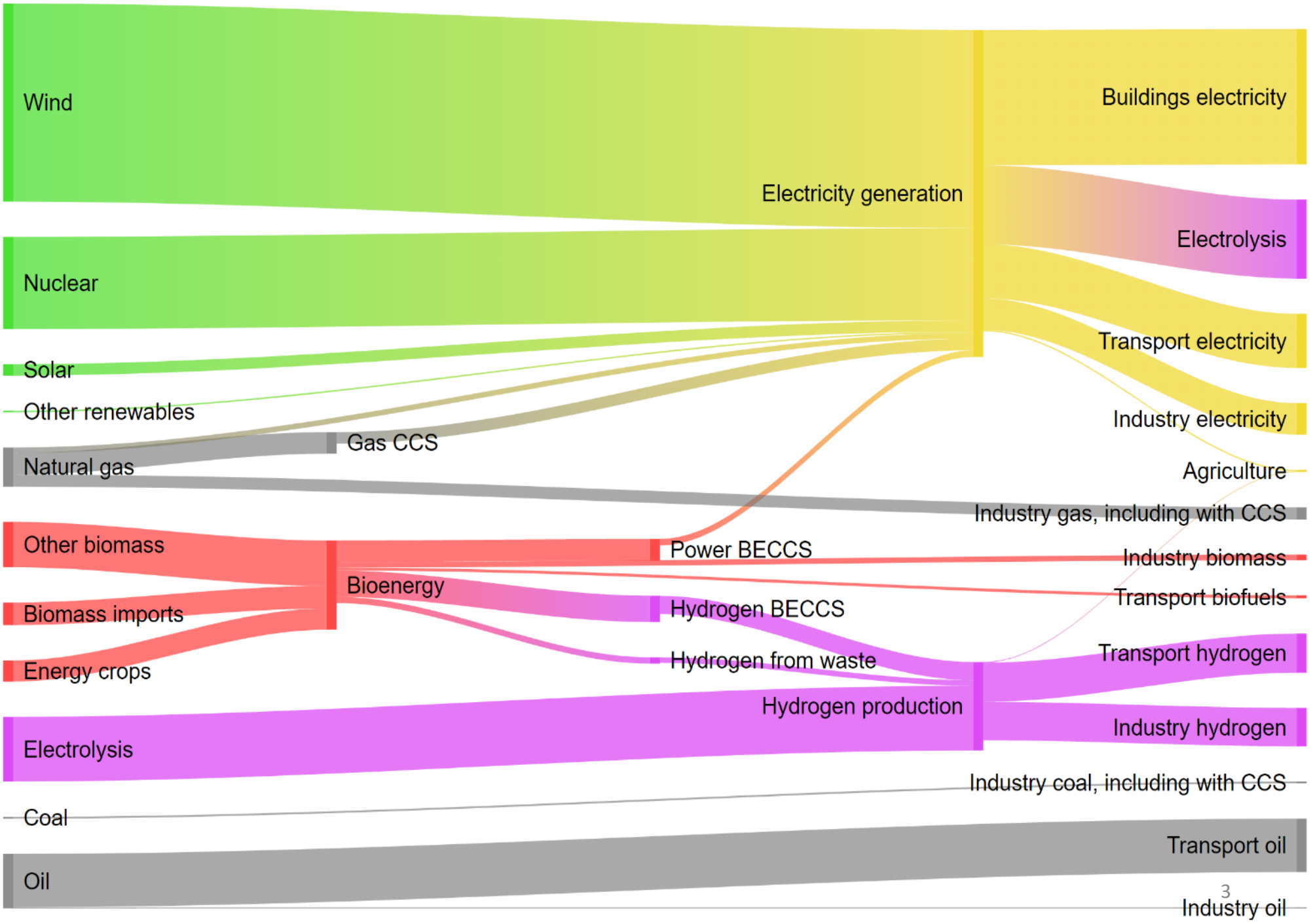
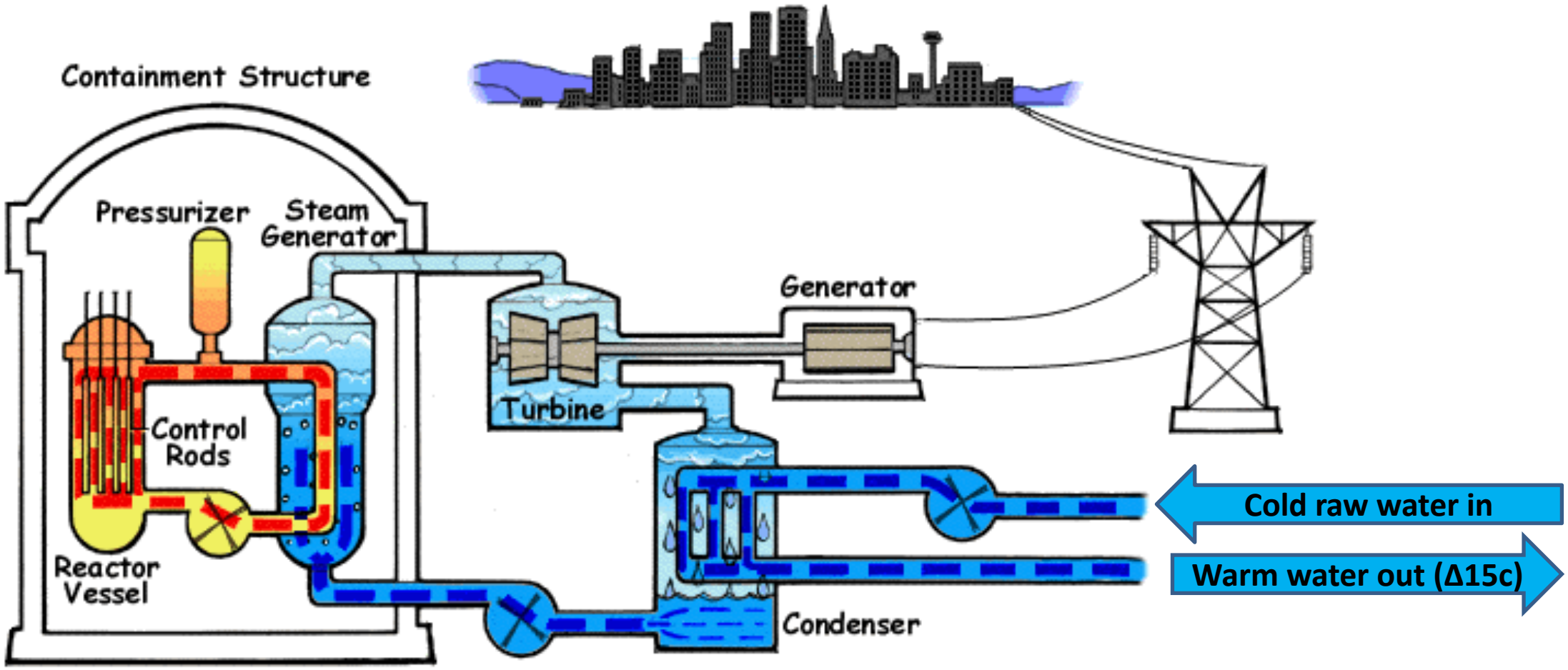
Nuclear in 2019 contributes 56 TWh[1]

Nuclear in 2050 aim – 252 TWh (450% increase)[1]



1 BEIS 2021 Net Zero Strategy Charts and Tables v1.1 05-04-2022

Nuclear power generation thermal efficiency



NRC. (June 25 2017). Pressurised Water Reactor [Online], Available: http://www. https://www.nrc.gov/reading-rm/basic-ref/students/animated-pwr.html

Benefits of direct cooling on thermal efficiency

	Direct cooling	Cooling towers		
		Natural draught (wet)	Mechanical draught (wet)	Natural draught (dry)*
Generation efficiency	Higher efficiency	Typically 0.5 - 1.5% less efficient than direct cooling	Typically ~2% less efficient than direct cooling	Lowest efficiency 2 - 3% less efficient than direct cooling
Water abstraction	High	Moderate/low	Moderate/low	None
Visual impact	Occasional foam or 'slick' at outfall	High	Moderate	High

Adapted from table 7.2 Environment Agency, 2010. SC070015 Cooling report
Authors: Turnpenny, A.W.H., Coughlan, J., Ng, B., Crews, P., Bamber, R.N., Rowles, P.. Cooling Water Options for the New Generation of Nuclear Power Stations in the UK

Current ‘guidance’

Environment Agency, 2010. SC070015 Cooling report Authors: Turnpenny, A.W.H., Coughlan, J., Ng, B., Crews, P., Bamber, R.N., Rowles, P.. Cooling Water Options for the New Generation of Nuclear Power Stations in the UK

“… *direct cooling can be BAT* [Best Available Technology] *for estuarine and coastal sites, provided that best practice in planning, design, mitigation and compensation are followed*.”

Popular mitigation methods

Low velocity intakes – size required for adequate cooling

Acoustic fish deterrent – installation and maintenance

Fish return & recovery systems

EA HPC predicted annual impact without AFD - Migratory Assemblage Species

	A	B	C	D	E	F	G	H				
Species	No. of fish lost due to HPC Impingement	No. of fish lost due to HPC Entrainment	No. of equivalent adults lost due to HPC Impingement	No. of equivalent adults lost due to HPC Entrainment	Total No. of equivalent adults lost due to HPC Entrapment	Total Tonnes of equivalent adults lost due to HPC Entrapment	Relevant Population SSB (t)/ *Fishery (t)*/ number of fish	Annual proportional loss from the relevant population due to HPC Entrapment				
								Predicted value results	Uncertainty range results			
									1st %ile	5th %ile	95th %ile	99th %ile
Twaite shad	763 (fish)	-	117	-	117	-	86,696	0.1%	0.04%	0.06%	0.65%	1.1%
Allis shad	23 (fish)	-	9	-	9	-	1,083	0.9%	0.27%	0.37%	4.7%	8.1%
Sea lamprey	50 (fish)	-	50	-	50	-	15,269	0.3%	0.09%	0.12%	0.54%	0.73%
River lamprey	20 (fish)	-	20	-	20	-	116,109	0.02%	0.01%	0.015%	0.03%	0.04%
Atlantic salmon	76 (fish)	-	17	-	17	-	17,616	0.1%	0.0004%	0.01%	0.45%	1.6%
Sea trout	8 (fish)	-	8	-	8	-	8,750	0.1%	0.02%	0.03%	0.26%	0.4%

Table 3 CD 8.20 TB020 - Summary Technical Brief_ Summary of Quantitative Impact Assessment Results. Draft-06.pdf

EA HPC predicted annual impact without AFD - Marine Assemblage Species

	A	B	C	D	E	F	G	H				
Species	No. of fish lost due to HPC Impingement	No. of fish lost due to HPC Entrainment	No. of equivalent adults lost due to HPC Impingement	No. of equivalent adults lost due to HPC Entrainment	Total No. of equivalent adults lost due to HPC Entrapment	Total Tonnes of equivalent adults lost due to HPC Entrapment	Relevant Population SSB (t)/ *Fishery (t)*/ number of fish	Annual proportional loss from the relevant population due to HPC Entrapment				
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European sprat	1,322,637 (fish) 3,557,152 (larvae)	3,557,152 (larvae)	3,482,256	124,500	3,606,756	55.90	7,704	0.7%	0.47%	0.52%	0.98%	1.1%
Whiting	1,708,720 (fish)	-	662,984	-	662,984	197.57	2,179	9%	3.9%	5.4%	23%	31%
Dover sole	157,565 (fish) 324,176 (larvae)	1,106,693 (larvae) 991,212 (eggs)	170,362	0.02	170,362	60.14	809	7%	1.2%	1.8%	11%	15%
Atlantic cod	302,034 (fish)	-	51,648	-	51,648	245.12	1,118	22%	3.6%	5.4%	36%	52%
Atlantic herring	37,549 (fish) 221,128 (larvae)	193,487 (larvae)	114,464	267	114,731	7.46	*157*	5%	2.9%	3.2%	6.1%	7%
European seabass	23,626 (fish) 13,129,264(larvae)	6,108,346 (larvae) 9,456,586 (eggs)	14,401	0.0001	14,401	16.17	565	3%	1.3%	1.6%	4.7%	5.4%
European plaice	1,446 (fish) 550,129 (larvae)	1,300,201 (larvae)	16,630	15	16,646	5.33	1,332	0.4%	0.02%	0.04%	0.3%	0.4%
Thornback ray	2,358 (fish)	-	1,457	-	1,457	4.78	*122*	4%	1.8%	2.1%	4.7%	5.5%
Blue whiting	7,375 (fish)	-	2,862	-	2,862	0.39	514,008	0.0001%	0.00002%	0.00003%	0.00015%	0.0002%

Table 2 CD 8.20 TB020 - Summary Technical Brief_ Summary of Quantitative Impact Assessment Results. Draft-06.pdf

Collection

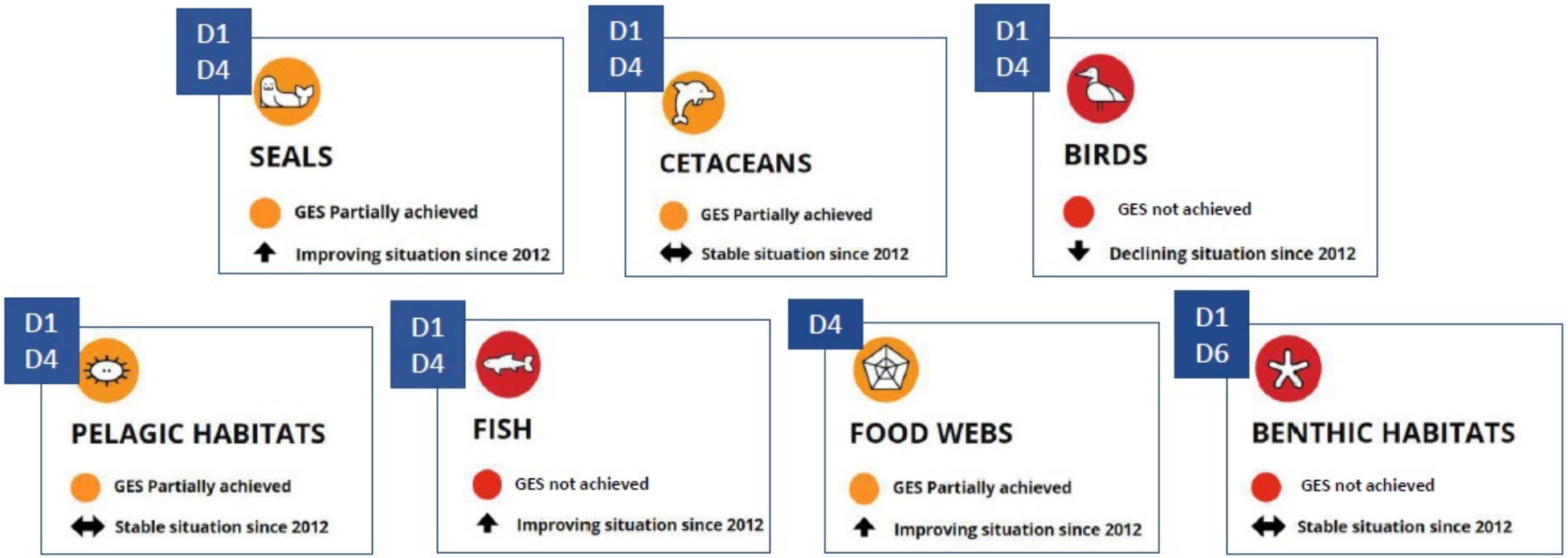
Biodiversity net gain

- Biodiversity net gain (BNG) is a strategy to develop land and contribute to the recovery of nature. It is a way of making sure the habitat for wildlife is in a better state than it was before development.
- Broadly speaking, marine net gain aims to put the marine environment into recovery.
- Principle 6: Marine net gain will be a mandatory requirement. It will apply to all marine development, subject to any minimal thresholds and other exemptions

Consultation on the Principles of Marine Net Gain.pdf
https://consult.defra.gov.uk/defra-net-gain-consultation-team/consultation-on-the-principles-of-marine-net-gain/supporting_documents

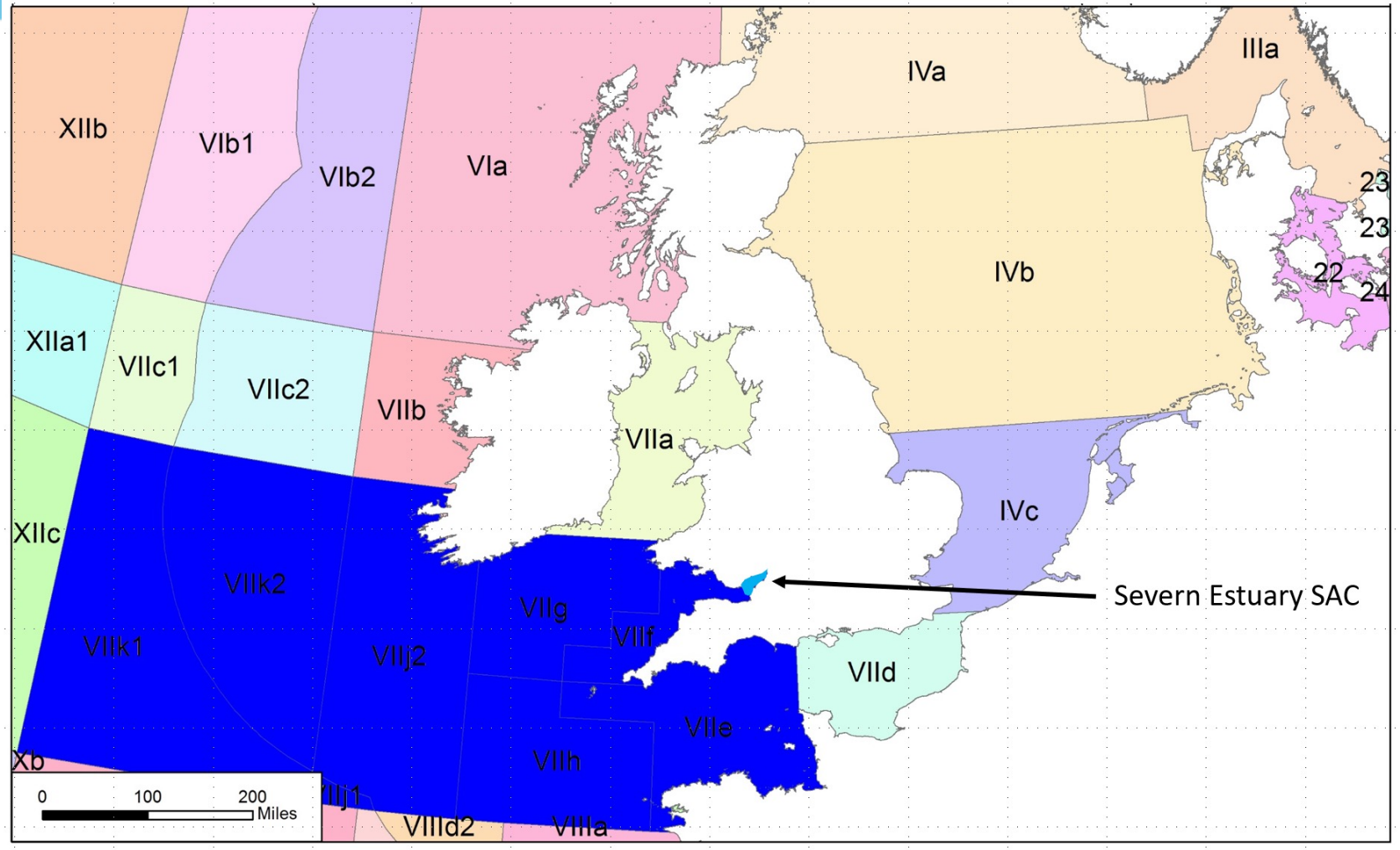
Good Environmental Status Assessment

2018 Good Environmental Status Assessment



Defra (2019) Marine Strategy Part One: UK updated assessment and Good Environmental Status

Scale of assessing losses for marine fishes - cod



Hinkley Point C – Environmental Permit variation – EPR/HP3228XT/V004 – APP/EPR/573

Adapted from Waugh (2020) TB011 - Scale of assessment areas for marine fishes and assessment method comparing Sprat losses with Spawning Stock Biomass

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Life

The Atlantic cod may be five separate species rather than one

A genetic analysis of thousands of Atlantic cod has revealed they all belong to one of five distinctive groups, suggesting they aren't interbreeding and belong to different species

By Michael Le Page

3 July 2023

Atlantic cod are officially just one species, Gadus morhua
Pix Box/Shutterstock

Atlantic cod are actually five separate species of fish, not one, researchers have claimed after conducting a genetic analysis – though not everyone agrees with their findings.

"What we thought was a single species is actually more species," says Einar Arnason at the University of Iceland. "It's important in terms of biodiversity."

Secretary of State view on scale of assessing point source impacts

"Contrary to the appellant's findings, I have found that the Agency's approach to considering smaller population sizes more reflective of existing and emerging research identifying complexities in population structures and the presence of distinct genetic populations, linked to site fidelity, closely related spawning and feeding areas or natal homing responses.

I do not doubt that the ICES figures, based on long term, accepted approaches to calculating SSBs, can be considered robust when assessing necessary management responses to wider scale impacts, such as fishing, on the broader populations defined.

However, for the purposes of assessing a point source impact, and one that will be effectively continuous with no immediate adaptation responses, this reinforces my concerns that finer scale populations estimates are more reflective of actual effects."

Report to the Secretary of State for Environment, Food and Rural Affairs Hinkley Point C – Environmental Permit variation – EPR/HP3228XT/V004 – APP/EPR/573 2021 Paragraph 11.171

Secretary of State HRA conclusion

"Consequently, having reviewed the submissions, assessed levels of uncertainty and areas of scientific disagreement, I have concluded that, in absence of an AFD, it cannot be concluded that there would not be adverse effects on the integrity of the Severn Estuary/ Môr Hafren SAC and Ramsar site, the River Usk / Afon Wysg SAC and the River Wye / Afon Gwy SAC.."

Report to the Secretary of State for Environment, Food and Rural Affairs Hinkley Point C – Environmental Permit variation – EPR/HP3228XT/V004 – APP/EPR/573 2021 Paragraph 12.4

Viable compensation strategies

Migratory fishes – barrier removal

Marine and estuarine fishes – direct compensation

Marine and estuarine fishes – indirect compensation through habitat creation

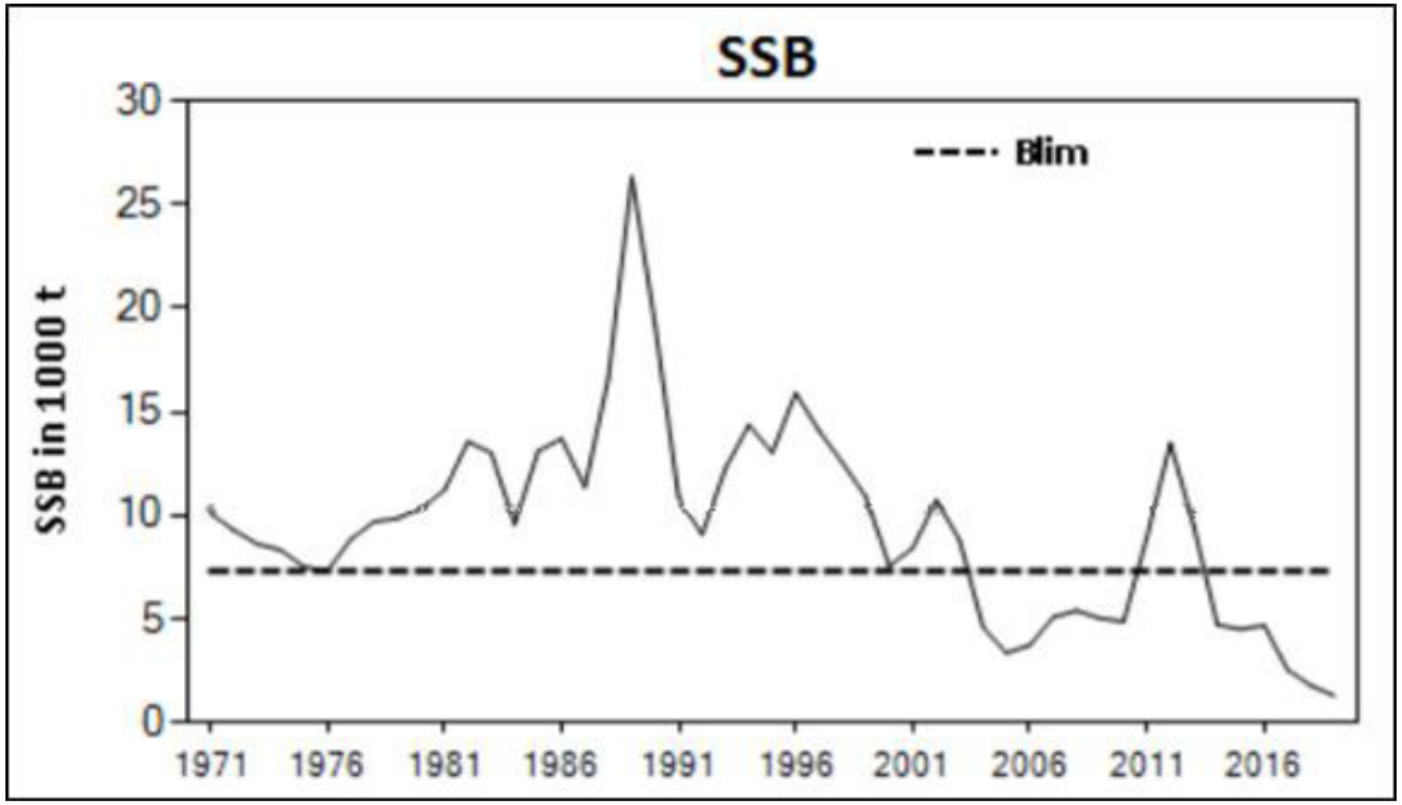
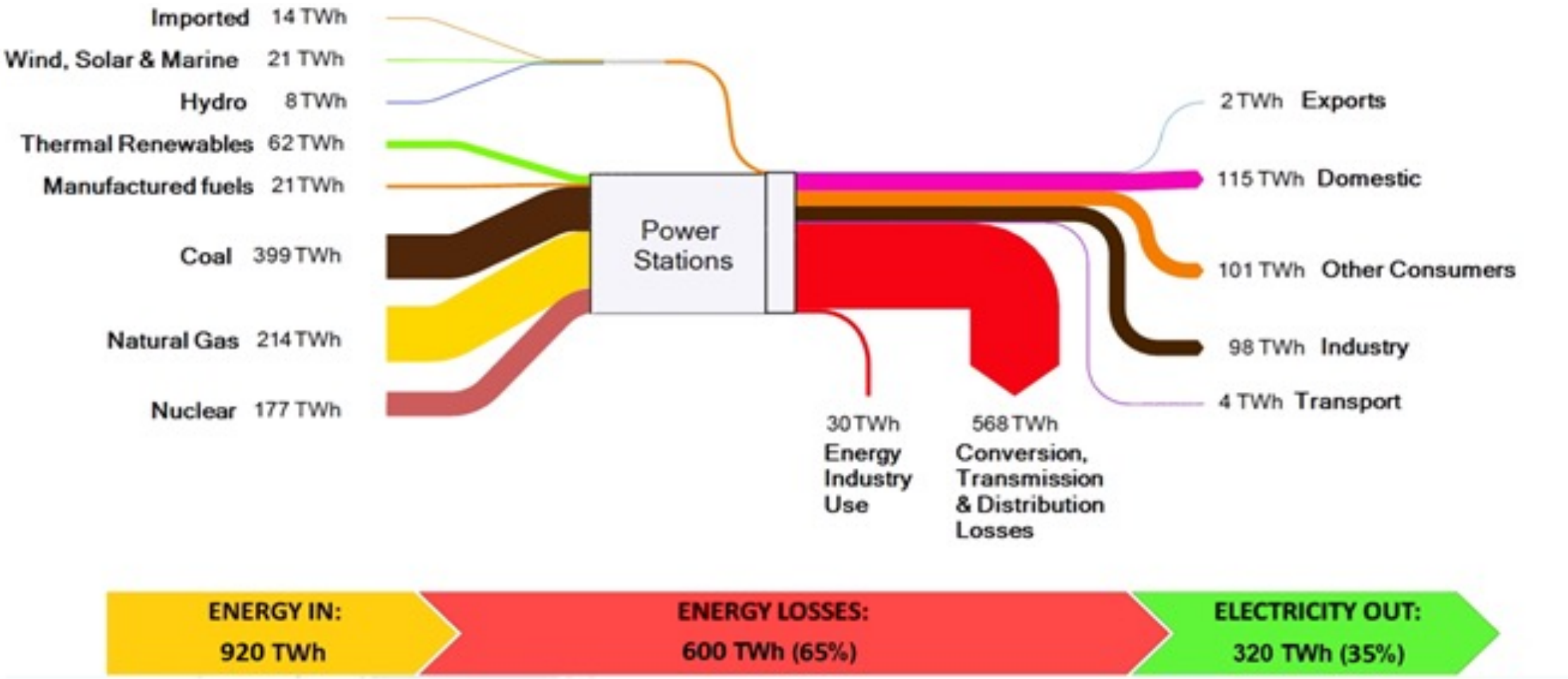


Figure 2 SSB of Atlantic cod in areas VIIe-k, 1970-2019 (adapted from ICES, 2019 CD Ref: 9.60)

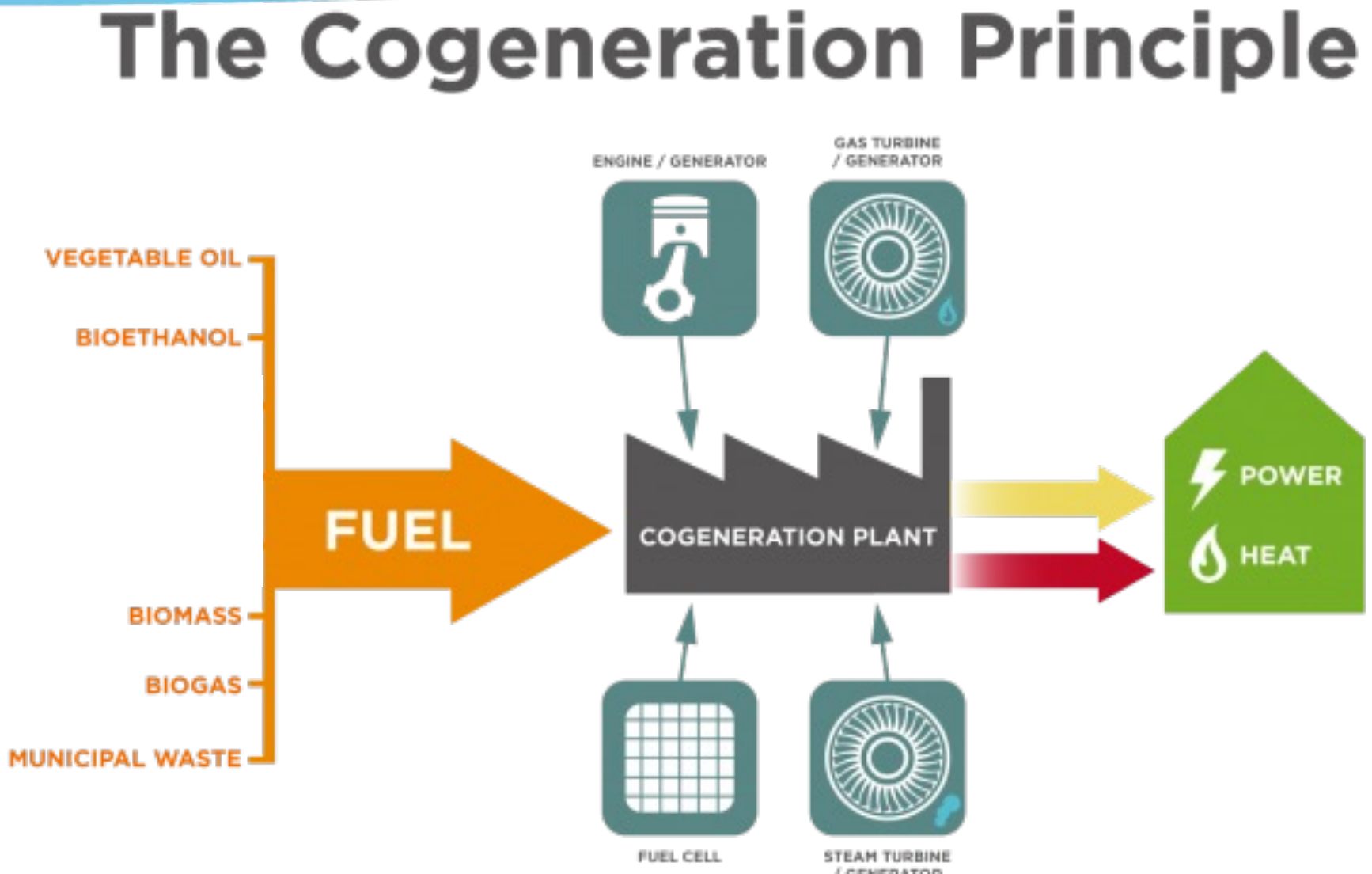
Adapted from Waugh (2020) TB011 - Scale of assessment areas for marine fishes and assessment method comparing Sprat losses with Spawning Stock Biomass

Impact of transmission losses



UK energy flows 2012 shown at http://www.green-peninsula.com/2013/09/electricity-generation-efficiency-uk-2012/

NNB alternatives - cogeneration



Domestic solar

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Heat pumps

SMRs/ AMRs

Alternative cooling methods

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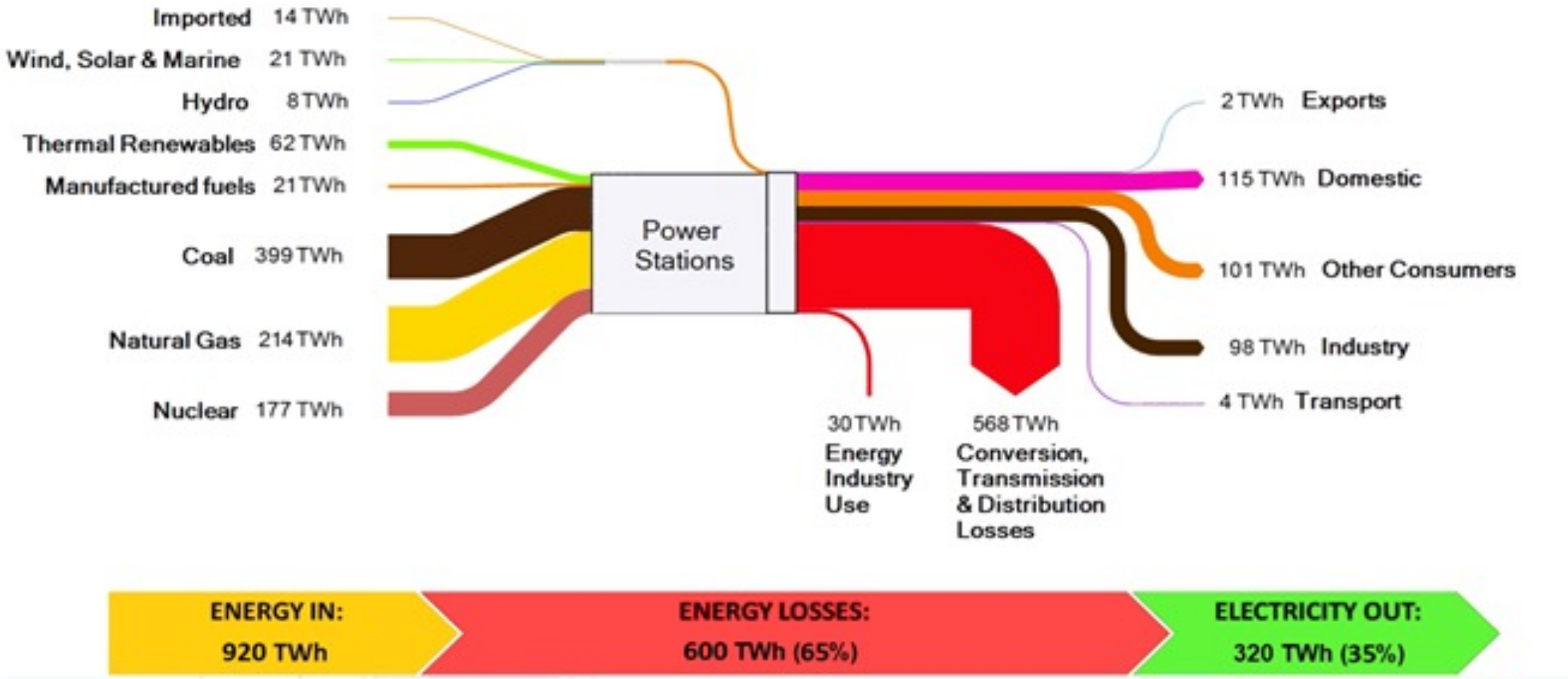

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Summary

- Net zero by 2050
- "… *direct cooling can be BAT* [Best Available Technology] *for estuarine and coastal sites, provided that best practice in planning, design, mitigation and compensation are followed*."
- Net gain/finer scale populations now being recognised
- Alternatives

Thank you!

adam.waugh@naturalengland.org.uk