Programme Area: Nuclear

Project: System Requirements for Alternative Nuclear Technologies

Title: Using small modular reactors to supply district heat networks

Context:

The purpose of the System Requirements for Alternative Nuclear Technologies project was to capture the high level technical performance characteristics and business-case parameters of small thermal plants, which will be of value to the potential future of the UK's energy system. The project included small nuclear reactors, enabling comparison with other small-scale plants, such as those powered by bio-mass. The project outputs will help enable the subsequent contrast of a range of specific technologies.

USING SMALL MODULAR REACTORS TO SUPPLY DISTRICT HEAT NETWORKS

ALTERNATIVE NUCLEAR TECHNOLOGIES PROJECT: PHASE 3

MARCH 2016

energy technologies institute

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AGENDA

ANT phases 1 & 2 - Role & requirements of SMRs

ANT phase 3 - Objectives

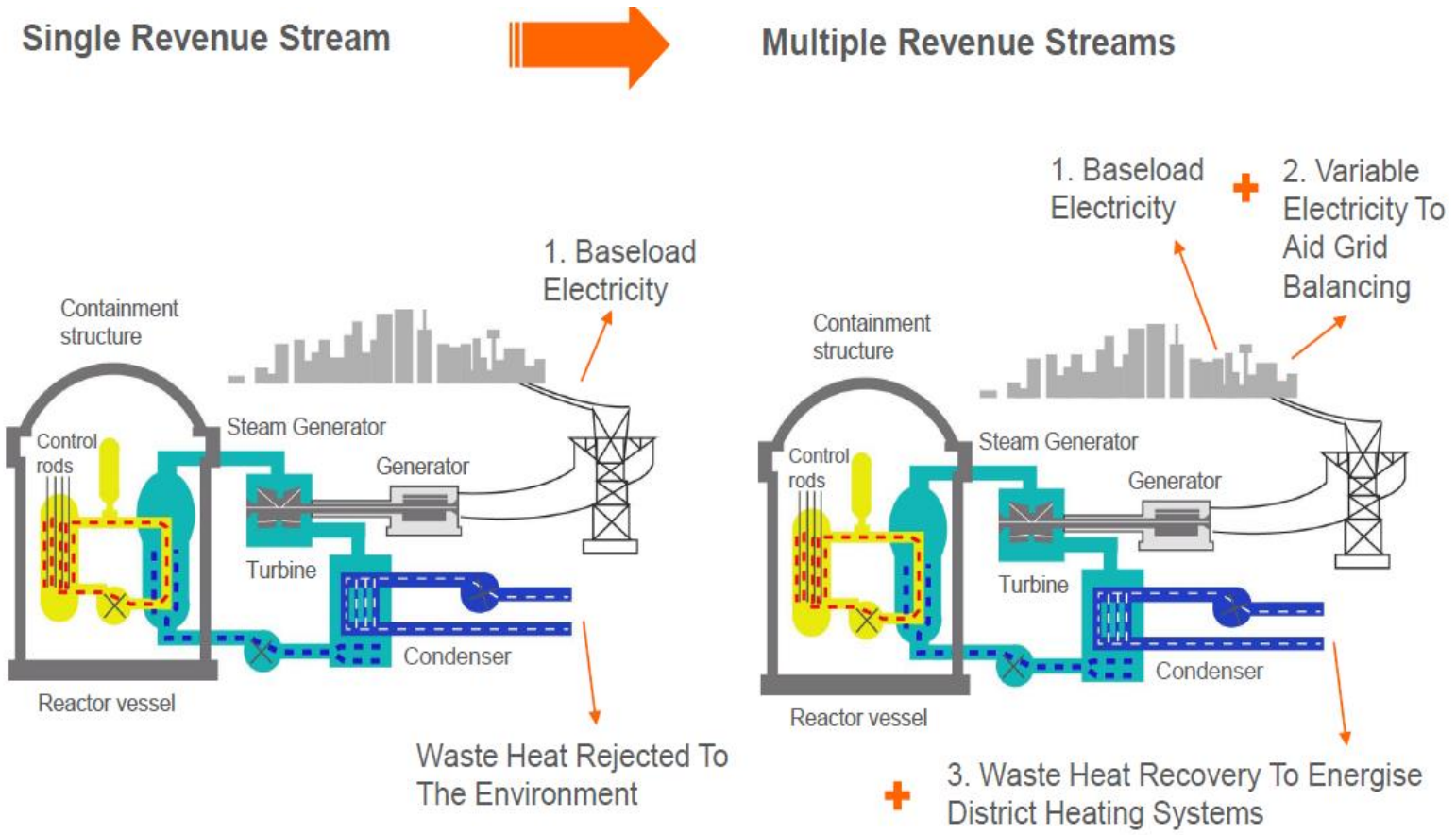
Approach

Draft findings

Wider implications

Questions / discussion

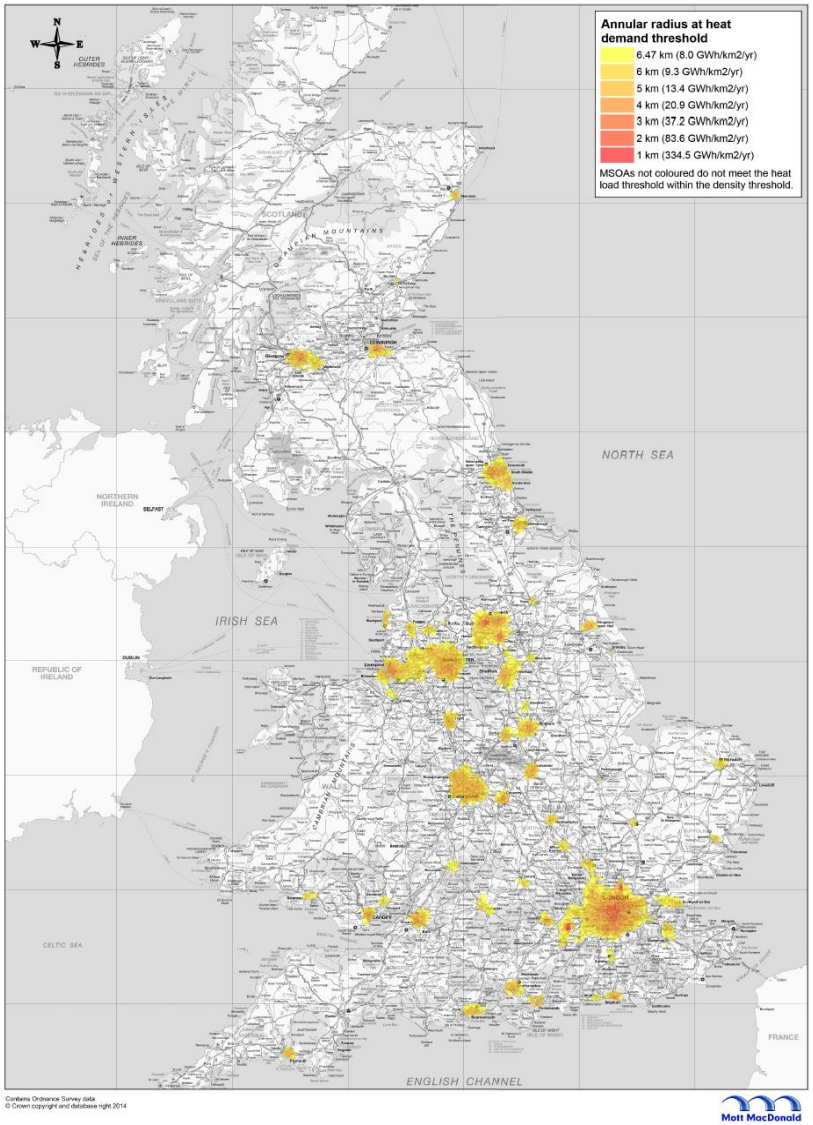
ANT phases 1 & 2

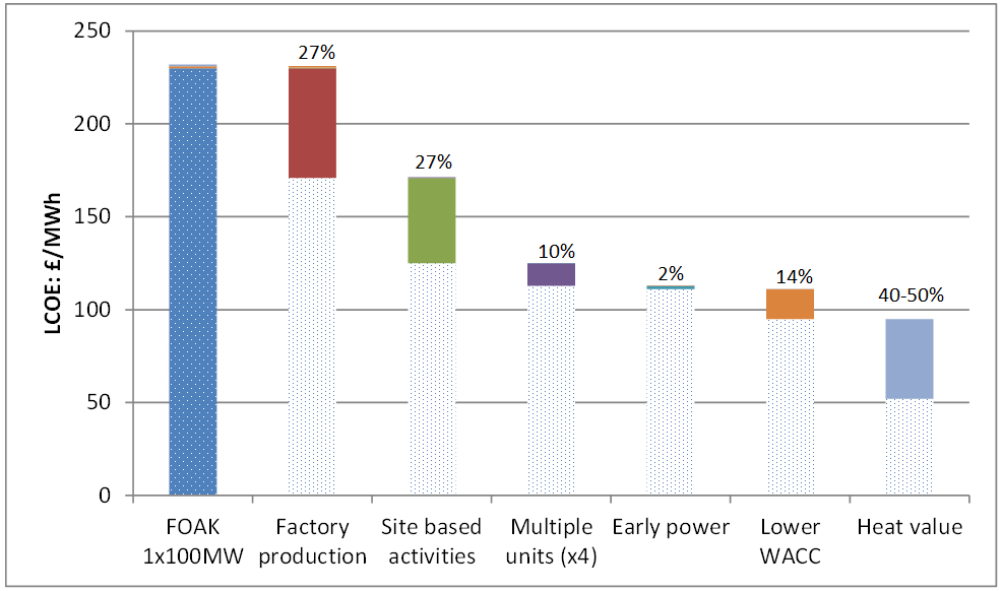


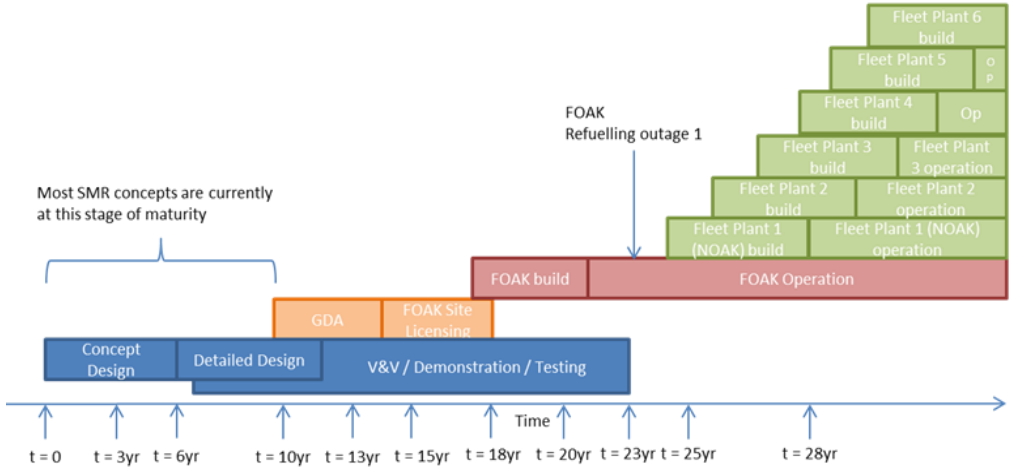
Source: Energy Technologies Institute

Focus on Light Water Reactor Technologies

ANT phases 1 & 2







Summary report at: www.eti.co.uk/wp-content/uploads/2015/10/ANT-Summary-Report-with-Peer-Review.pdf

ANT phase 3 Objectives - 1

Can SMRs reliably provide heat to District Heat networks?

Investigate technical and economic viability of extracting heat from SMRs for supplying DH networks

- Validate earlier findings via engineering analysis
- Test different types of SMRs (size and efficiency)
- Implications for regulatory assessment via GDA

ANT phase 3 Objectives - 2

Is the concept of inland siting robust?

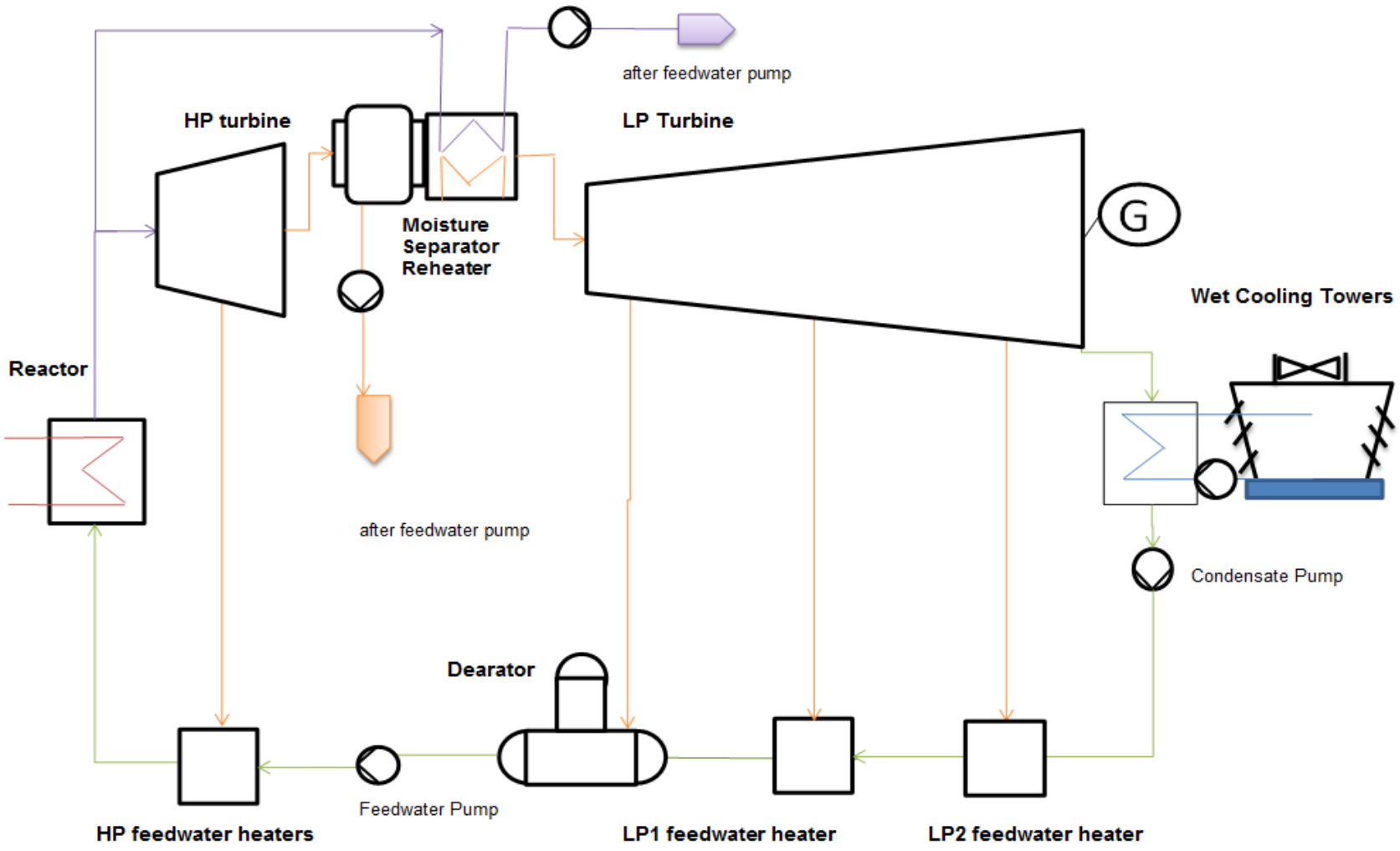
Consider resilience of SMR plants to changing climatic and regulatory conditions

- Future restrictions on water abstraction
- Alternative plant cooling technologies
- Assume water always is available for safe reactor shutdown
- Impact on cost & performance

Approach - scope

Task 1	‘Electricity-only’ steam cycles	NuScale & mPower approximations Thermoflex software

Task 1 – Electricity only steam cycle

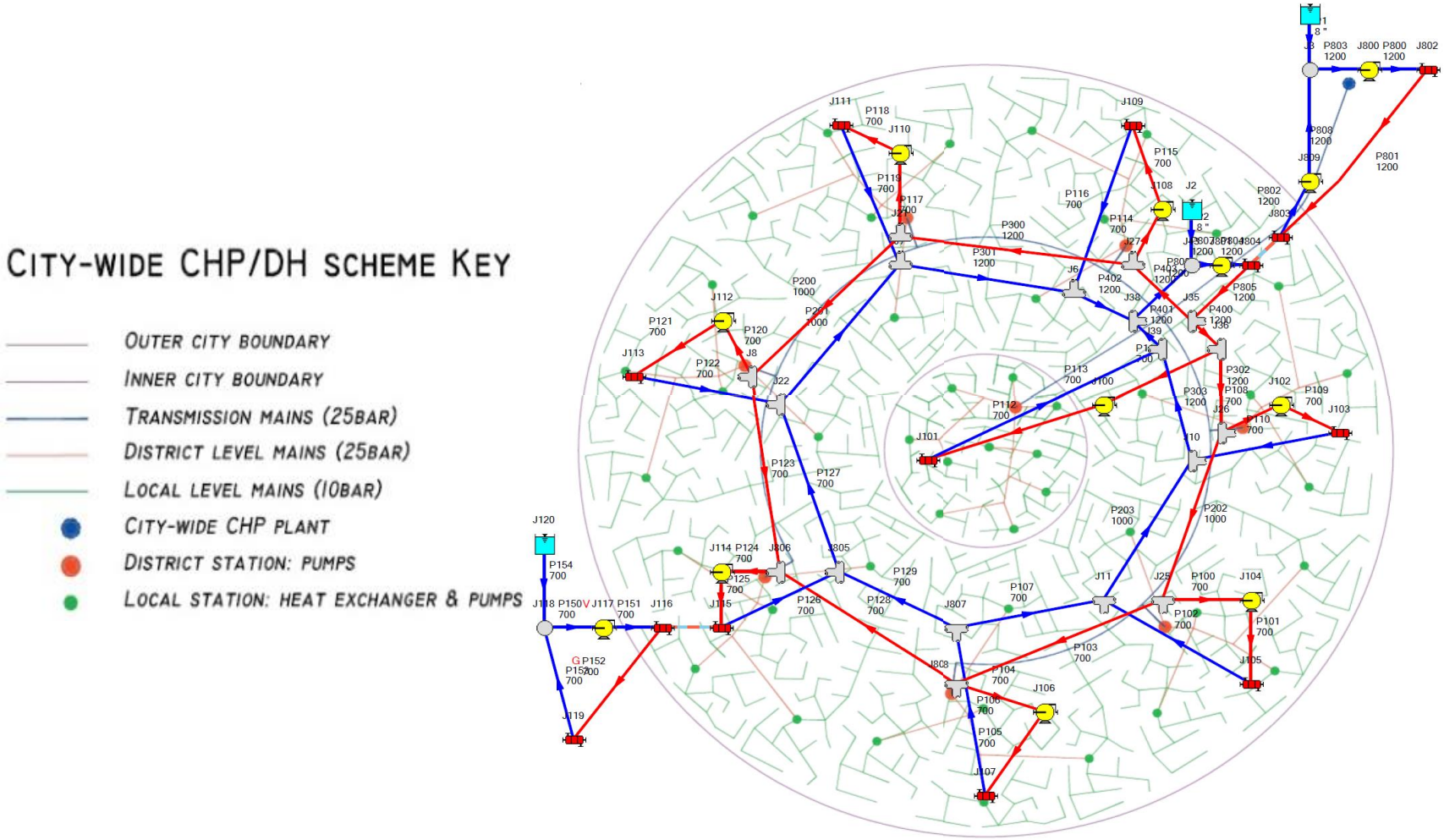


Indicative 'electricity-only' steam cycle for Plant B (mPower approximation) (Thermoflex software)

Approach - scope

Task 1	‘Electricity-only’ steam cycles	NuScale & mPower approximations Thermoflex software
Task 2	DH network modelling	End-user requirements Steam extraction/supply temperature

Task 2 – DH network modelling

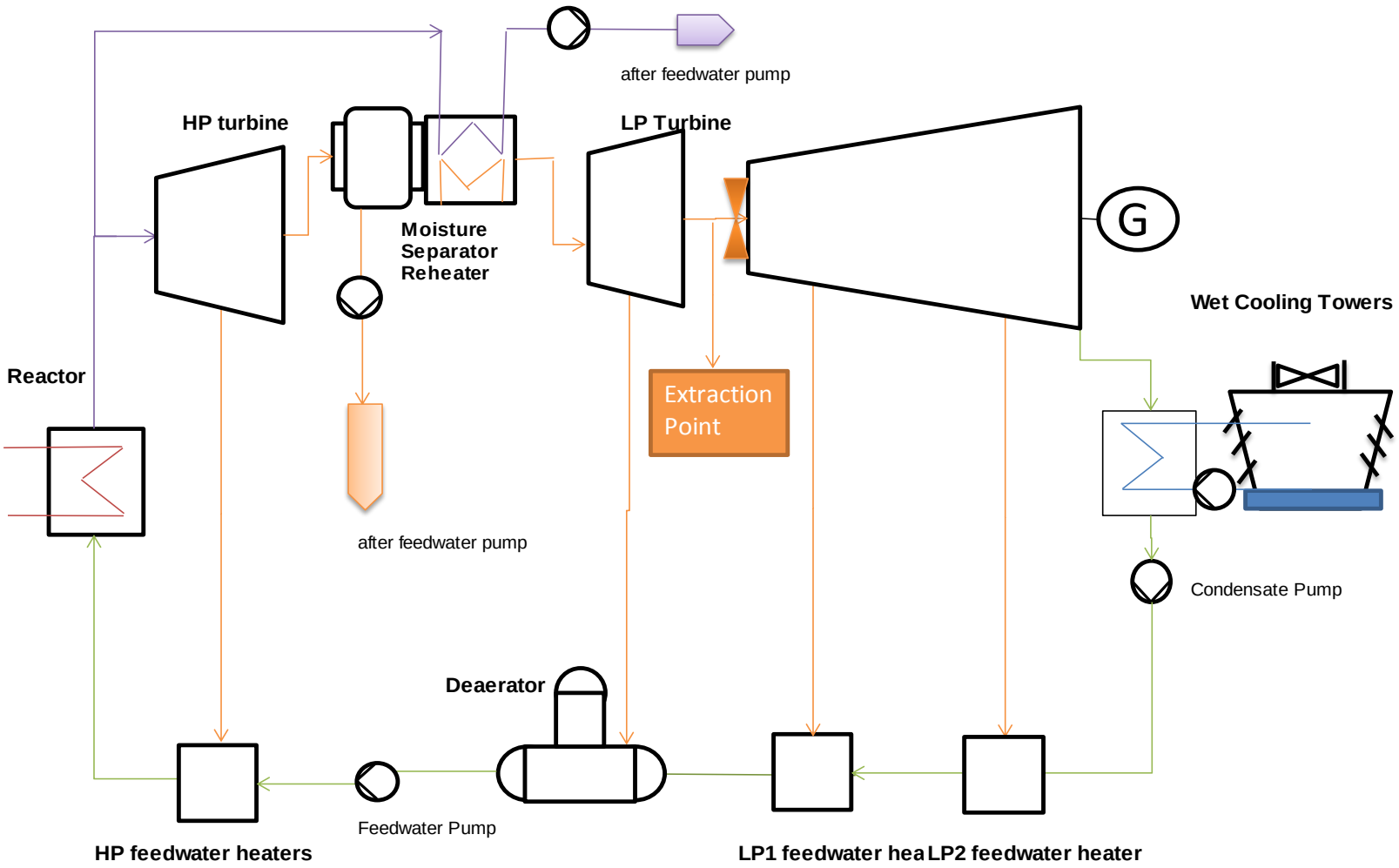


Process pressure drop and heat loss model for indicative city scale DH network (AFT Fathom model)

Approach - scope

Task 1	‘Electricity-only’ steam cycles	NuScale & mPower approximations Thermoflex software
Task 2	DH network modelling	End-user requirements Steam extraction/supply temperature
Task 3	CHP steam cycles	Heat extraction for flexible operation Performance modelling

Task 3 – CHP steam cycle



Indicative steam cycle with heat extraction for Plant B (mPower approximation) (Thermoflex software)

Approach - scope

Task 1	‘Electricity-only’ steam cycles	NuScale & mPower approximations Thermoflex software
Task 2	DH network modelling	End-user requirements Steam extraction/supply temperature
Task 3	CHP steam cycles	Heat extraction for flexible operation Performance modelling
Task 4	Cooling system options	Air Cooled Condensers Plant configuration & performance
Task 5	Cost assessment	CAPEX & OPEX increments (£/kWe) PEACE software
Task 6	Economic assessment	SMR economic model (ANT Phase 1) LCOE & IRR of CHP plants
Task 7	International review	Literature & interviews Nuclear CHP & large-scale DH

Draft findings

1. Conclusions of ANT Phases 1 & 2 validated
2. SMR heat supply (CHP) is technically feasible and easy to implement
3. CHP solutions can provide flexible heat and power independently
4. CHP improves SMR economics – costs are modest; revenues large
5. Different SMR design philosophies (module size & efficiency) make little difference to CHP cost or performance
6. Many international examples of heat supply to DH networks from large power plants, including nuclear
7. Plant cooling technologies that use very little water are technically feasible and could be retrofitted

Wider implications

8. Design capable of heat supply should be selected for regulatory assessment via GDA
9. SMR plants should be designed and built ‘CHP ready’
10. ‘CHP ready’ compatible with submission of single design into GDA process, facilitating economies of multiples
11. Hybrid cooling techniques unlock more sites in a changing climate
12. Consideration given to ‘ACC ready’?
13. Magnitude of DH network infrastructure could be a major political and social issue
14. Implications of ANT Phases 1 & 2 reinforced

Questions / discussion

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