Small Modular Reactors - Tesla or Theranos?

The National Academies of Sciences, Engineering, and Medicine

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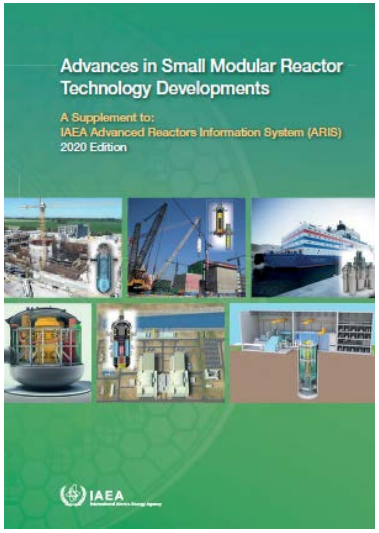
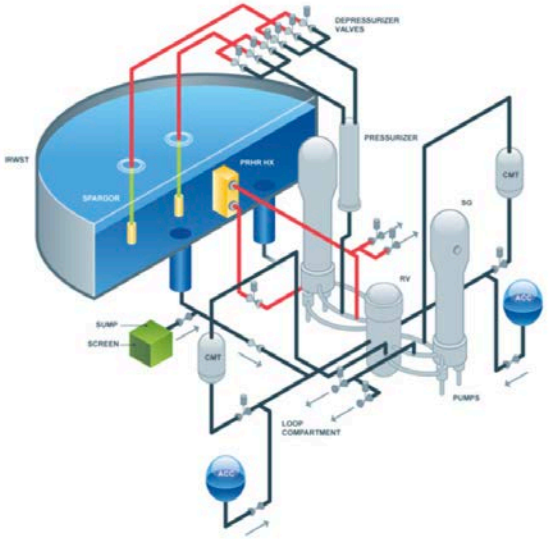
Claim & Underpinning Arguments

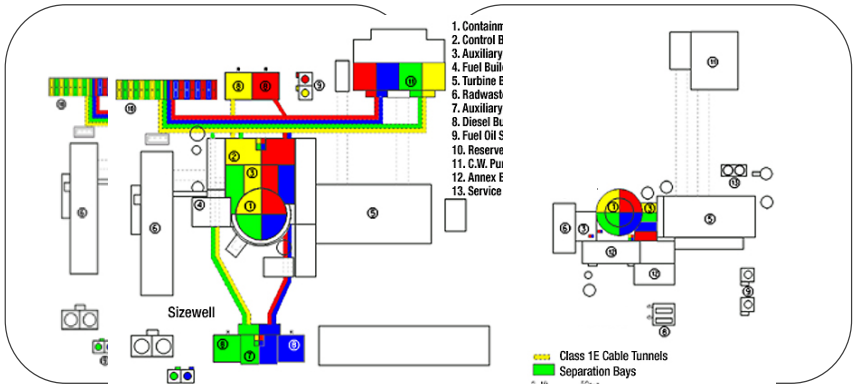


A fleet of SMRs will safely deliver a competitive electricity generation cost by a combination of:

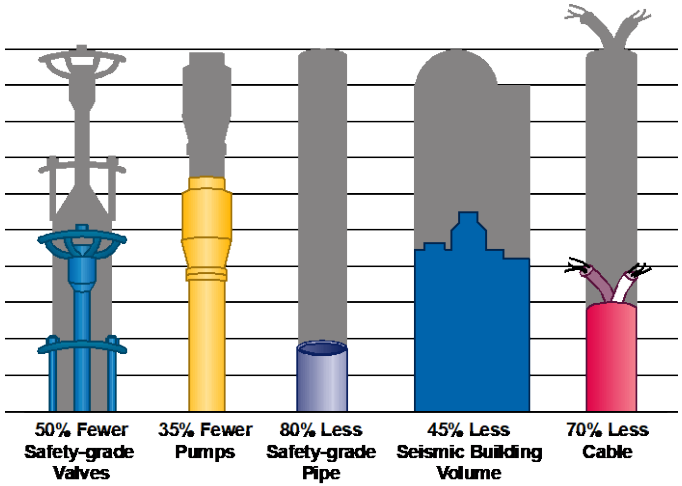
- Passive Safety
- Modularisation
- Modularity
- Smaller Plant

Passive Safety Systems: reduce CDF/LRF, reduce plant systems and footprint, and hence reduce cost and schedule



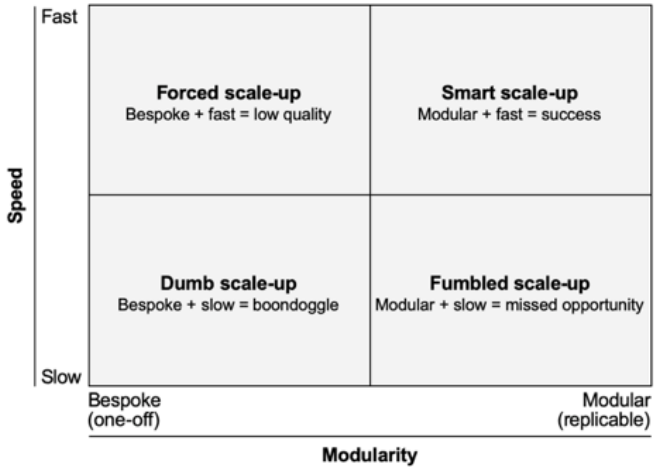


Sizewell B AP1000



Reactor	Active Commissioning Months	Cumulative Load Factor	1st Outage Duration Days
Sanmen 1	5.2	90.8%	46.66
Sanmen 2	4.1	20.0%	28.14
Haiyang 1	4.7	92.5%	
Haiyang 2	5.4	96.9%	

Modularisation: Factory fabrication of modules for shipment and installation in the field will improve quality and reduce cost and schedule



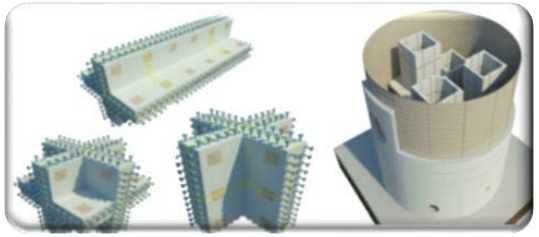
Flyberg: Four Ways to Scale Up

Pros:

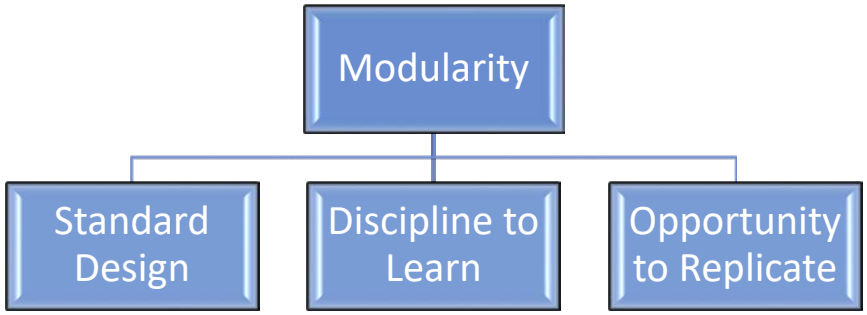
- Working in a better controlled environment
- Quality improvement
- Reducing construction schedule
- Reducing maintenance costs
- Cost-saving in labour and construction

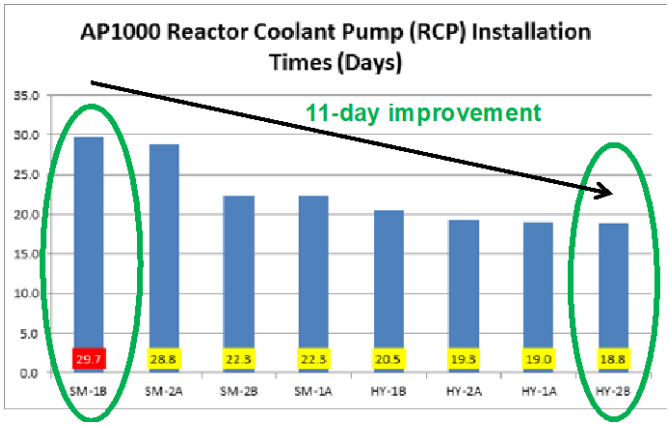
Cons

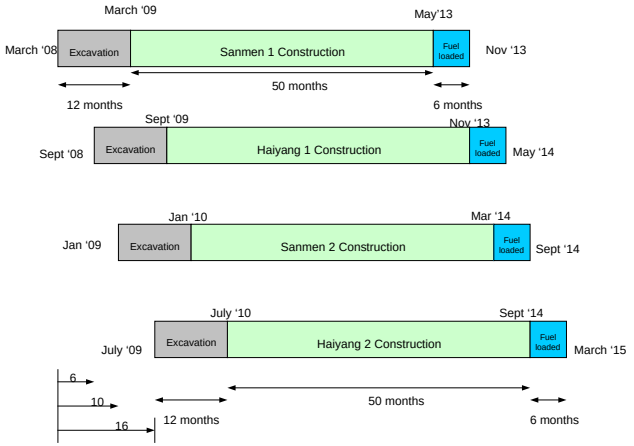
- Licensing and regulation
- Higher transportation cost
- More complex logistics
- Supplier management
- High supply chain start-up costs



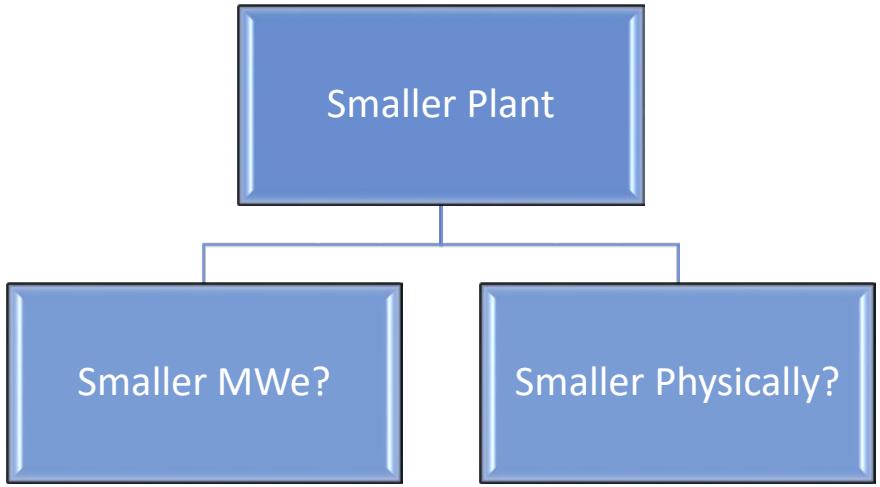
Modularity: The building of a number of identical plants on the same site will create a learning curve benefit



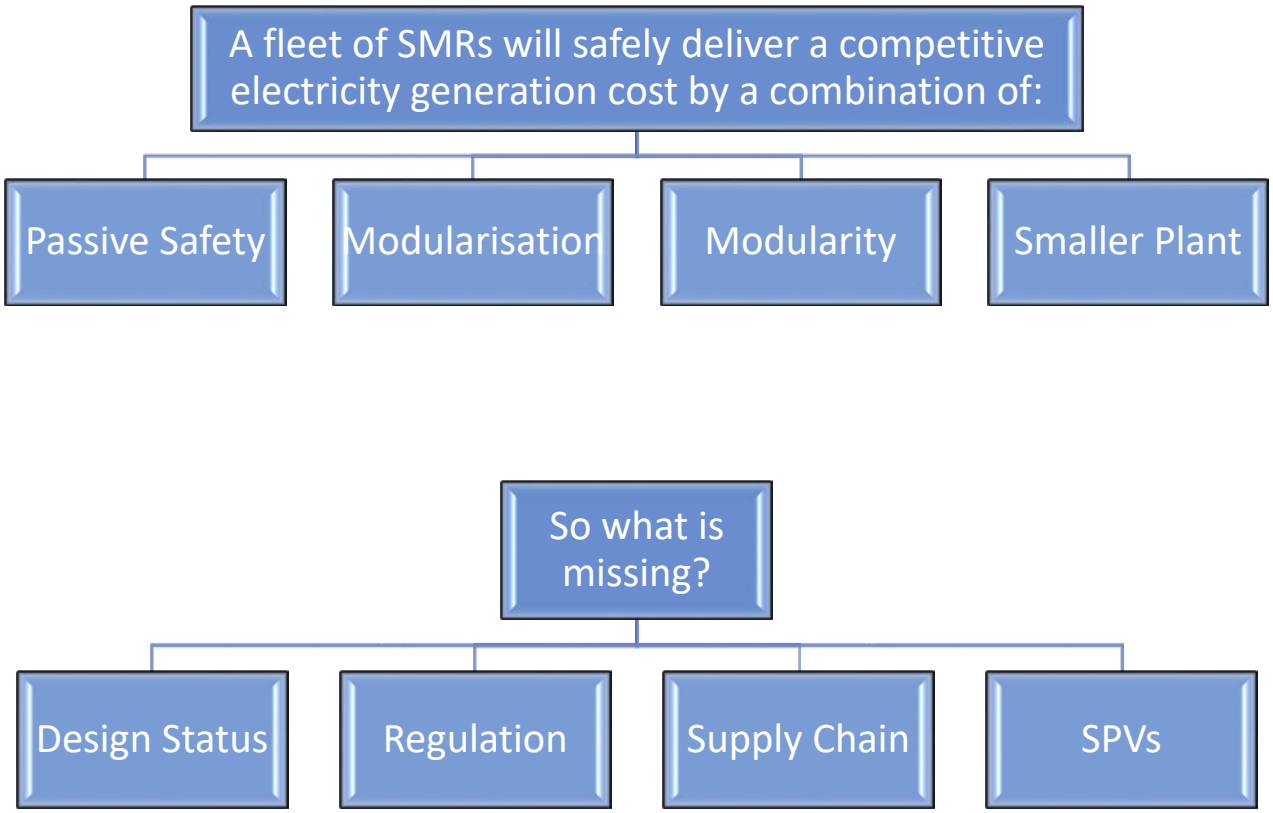




Smaller Plant: faster to construct, opens a wider supply chain, and hence reduces cost and schedule



Implicit Hypothesis: Executing these arguments will result in the economies of multiples beating the economy of scale



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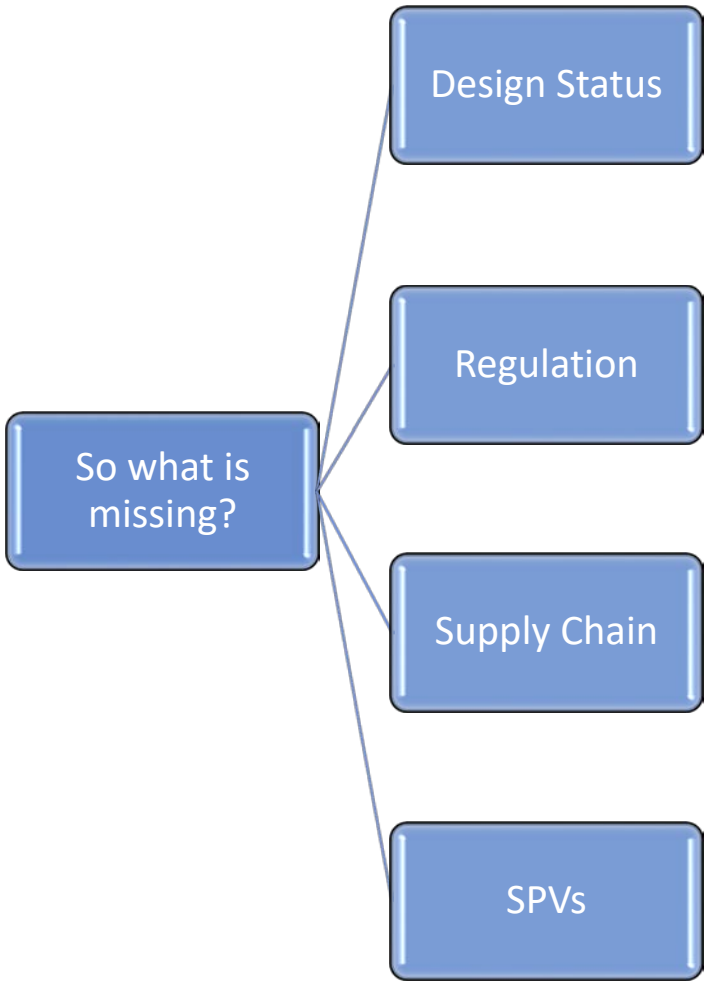

- Design for Construction
- Design Completion

- FOAK vs NOAK
  - Design
  - Regulation
- National vs International

- *"Vendors have lost much knowledge and skills when experienced experts have retired and new types of competence are needed for new technologies. Thus good reputations earned in the past are no guarantee for success and the experience and competence of persons assigned to the project are more important"* *Laaksonen, STUK*

- Client
- Contractor

Conclusions

There is a proliferation of SMRs in the design phase

- They generally claim to be simple, safe and cheap to build
- There are only 2 under construction

Recent experience indicates passive safety, modularisation, and modularity are necessary but not sufficient to safely deliver a commercial electricity price

- Design status, regulation, supply chain and SPVs require particular attention

The move to smaller plants appears to be reversing?

- As design progresses, SMR sizes are increasing both physically and in MWe
- Is the economy of multiples not compensating for the loss of economy of scale?

In the West, we appear to have “forgotten” how to build nuclear power stations

- For SMRs to succeed, we need fleet commitments to both relearn and to release the economy of multiples

Questions

1. How are the number of civil sub-module designs minimised?
2. Is there a need for a sub module-module assembly building on site? Is space allocated?
3. Who will manufacture the civil sub modules – what nuclear pedigree and experience do they have?
4. What consideration if any has been given to stick building the first unit and moving to modularisation on later units?
5. What technology, if any, is shared between between modules and what regulatory assessment has been made of this sharing?
6. What cost benefit accrues from this sharing?
7. How are designs changes arising from the FOAK managed
8. How is the time period between modules and between sites optimised?
9. What learning is predicted for the various disciplines across the build programme, what assumptions underpin this, and how is this benchmarked?
10. How is the discipline to learn being set up and reinforced?
11. Has the design been stress tested against a Fukushima type station black out?
12. Is there sufficient space provided for maintenance, outage and refueling?
13. Have vendors been identified for the key components and are such vendors qualified for nuclear applications?
14. What specific, relevant, current nuclear skills do the partners have in named individuals, not just in historic company experience?
15. Does the overall fleet schedule consider resource availability recognizing FOAK units absorb an inordinate amount of resource that can impact other units in process at the same time

Useful References

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Thank You