MIT/CFS: Conceptual Fusion Reactors vs. a Working Fission Reactor

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Parameter	Proposed SPARC Fusion Reactor		Proposed ARC Fusion Reactor	GINNA Fission Plant
	Optimistic	Conservative		
OUTPUT POWER RATE				
Fusion Thermal Power Output (MW)	140	55	525	
Neutron percentage	n/a	n/a	0.80	
Neutron thermal output (MW)	n/a	n/a	420	
Blanket power amplification rate	n/a	n/a	0.44	
Blanket amplification (MW)	n/a	n/a	183	
Total Thermal Power Output (MW)	140	55	708	
Thermal-to-Electric Efficiency	n/a	n/a	0.40	
Total Electric Power Output (MW)	n/a	n/a	283	
FUSION Q				
Injected Heating Power	12.8	25.2	39.0	
Fusion Q	**10.9**	**2.2**	**13.5**	
INPUT POWER RATE				
Electric Input Power for Heating (MW)	n/a	n/a	90	
Electric Input Power for BOP (MW)	n/a	n/a	10	
Total Electric Power Input (MW)	n/a	n/a	100	48
Total Electric Power Output (MW)	n/a	n/a	283	608
NET POWER RATE				
Net Electric Power Output (MW)	n/a	n/a	183	560
Overall Reactor Power Gain	n/a	n/a	**3**	**12.67**

Known Value	
Estimated Value	
Hypothetical Value	

Things to Keep in Mind:

1. No experimental fusion reactor has ever produced a single Watt of thermal power from fusion in excess of the electrical power required to operate the reactor. In plain English, this means (despite the abundance of enthusiastic publicity in the past decade) that there is no confirmed physicial evidence that fusion can be a useful source of energy.

2. The proposed ARC plant would consume twice the power of the GINNA fission plant. The ARC plant would produce half the power rate of the GINNA plant.

3. Half of the required fuel mixture needed for ARC *does not exist* as a natural resource. Fusion scientists hypothesize that ARC could breed its own tritium.

REFERENCES
SPARC: Creely, A., Greenwald, M., Ballinger, S., Brunner, D., Canik, J., Doody, J., . . . Zhu, J. (2020).
Overview of the SPARC tokamak. Journal of Plasma Physics, 86(5), 865860502.

ARC: A compact, high-field, fusion nuclear science facility and demonstration power plant with demountable magnets, B.N. Sorbom,et al. https://arxiv.org/abs/1409.3540

Design Parameter	Value
Major Radius	3.3 m
Minor Radius	1.13 m
Toroidal Field (on axis)	9.2 T
Fusion Power	525 MW
Total Thermal Power	708 MW (accounts for blanket reactions)
Net Electric Power	190 MWe (assumed 40% efficiency)
Plasma Volume	141 m^3
Plasma Current	7.8 MA
Tritium Breeding Ratio	1.1
LHCD Coupled Power	25 MW (~70 MWe wall-plug)
ICRF Fast Wave Coupled Power	13.6 MW (~20 MWe wall-plug)