Demand Driven Deployment Capabilities in Cyclus

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Outline

1) Background
2) Motivation
3) D3ploy
4) Demonstrations
5) Conclusions

CYCLUS

- Agent-based framework [1]
- Compatible with plug-in libraries
- Gives users ability to customize agents
- Agent types: facilities, institutions and regions
- Discrete time steps

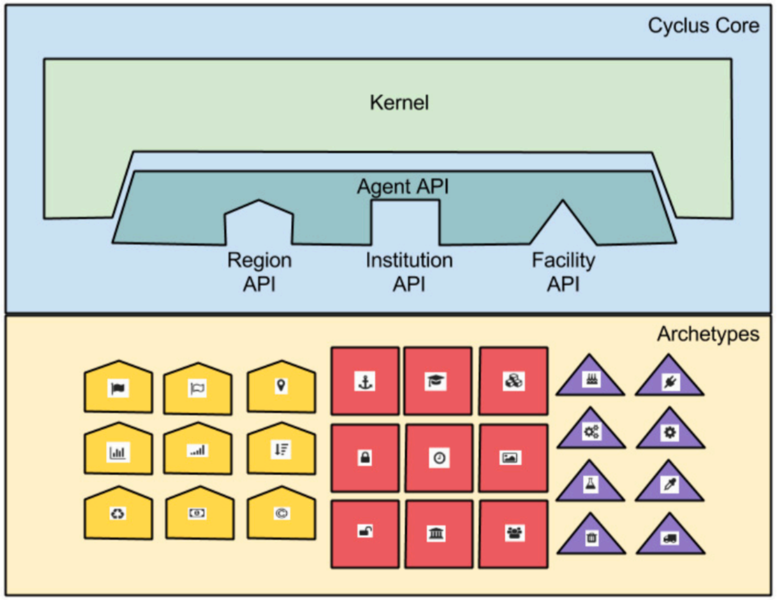

Figure 1: Cyclus has a modular architecture [1]

Current fuel cycle simulators

Gap in capability: User must define when facilities are deployed

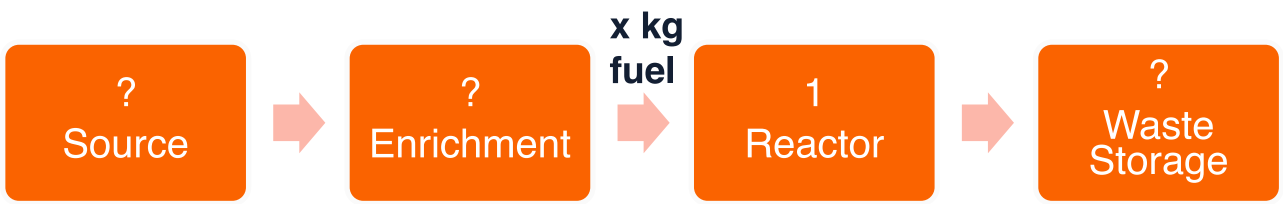

Figure 2: User defined Deployment Scheme

Bridging the gap: Developed demand-driven deployment capability in Cyclus, d3ploy.

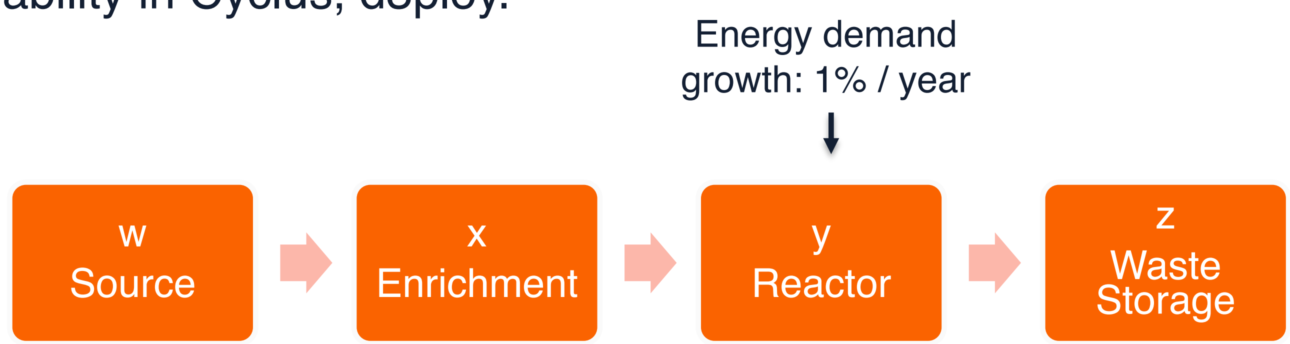

Figure 3: Demand Driven Deployment Scheme

D3ploy -- Input Options

	Input Parameter
Required Inputs	Demand driving commodity
	Demand equation
	Facilities it controls
	Capacities of the facilities
	Prediction method
	Deployment driven by installed capacity
Optional Inputs	Buffer type
	Buffer size
	Facility preferences
	Facility constraint

Table 1: D3ploy Input Parameters

D3ploy – Logic Flow

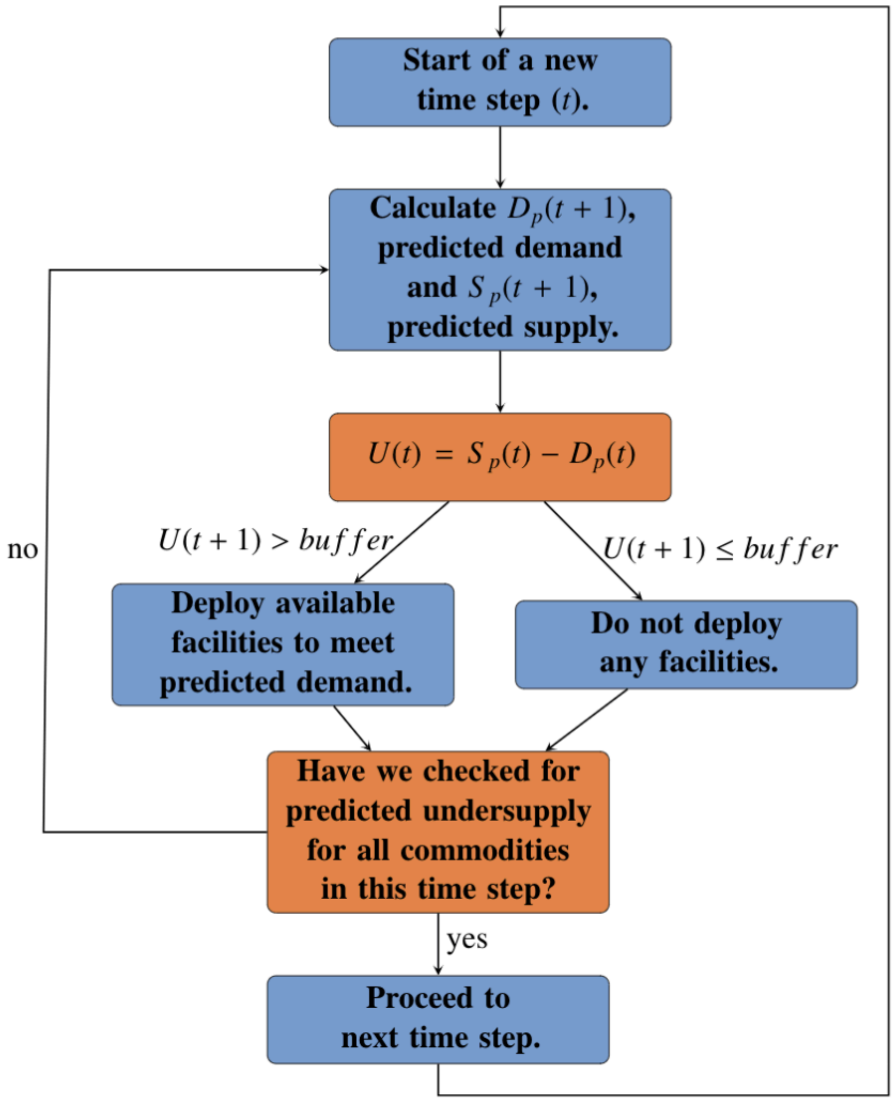

Fig. 1: D3ploy logic flow at each time step in CYCLUS.

Figure 3: D3ploy logic flow

Prediction Methods

- Non-Optimizing Methods
  - Demand Response
  - Moving Average
  - Autoregressive Moving Average
  - Autoregressive Heteroskedasticity
- Deterministic Methods
  - Fast Fourier Transform
  - Polynomial Fit
  - Exponential Smoothing and Holt-Winters
- Matrix Solution
  - Uses supply and demand to create a system of equations in matrix form.
  - Solving the matrix returns the number of facilities required at a given time-step.

D3ploy -- Input Options

	Input Parameter	Example
Required Inputs	Demand driving commodity	Power
	Demand equation	10000 MW
	Facilities it controls	Source, reactor, sink
	Capacities of the facilities	3000 kg, 1000 MW, 50000 kg
	Prediction method	Power: fast fourier transform Fuel: moving average Spent fuel: moving average
	Deployment driven by installed capacity	True
Optional Inputs	Buffer type	Absolute
	Buffer size	Power: 3000 MW Fuel: 0 kg Spent fuel: 0 kg
	Facility preferences	-
	Facility constraint	-

Table 2: D3ploy Input Parameters with example

Constant Power Demand

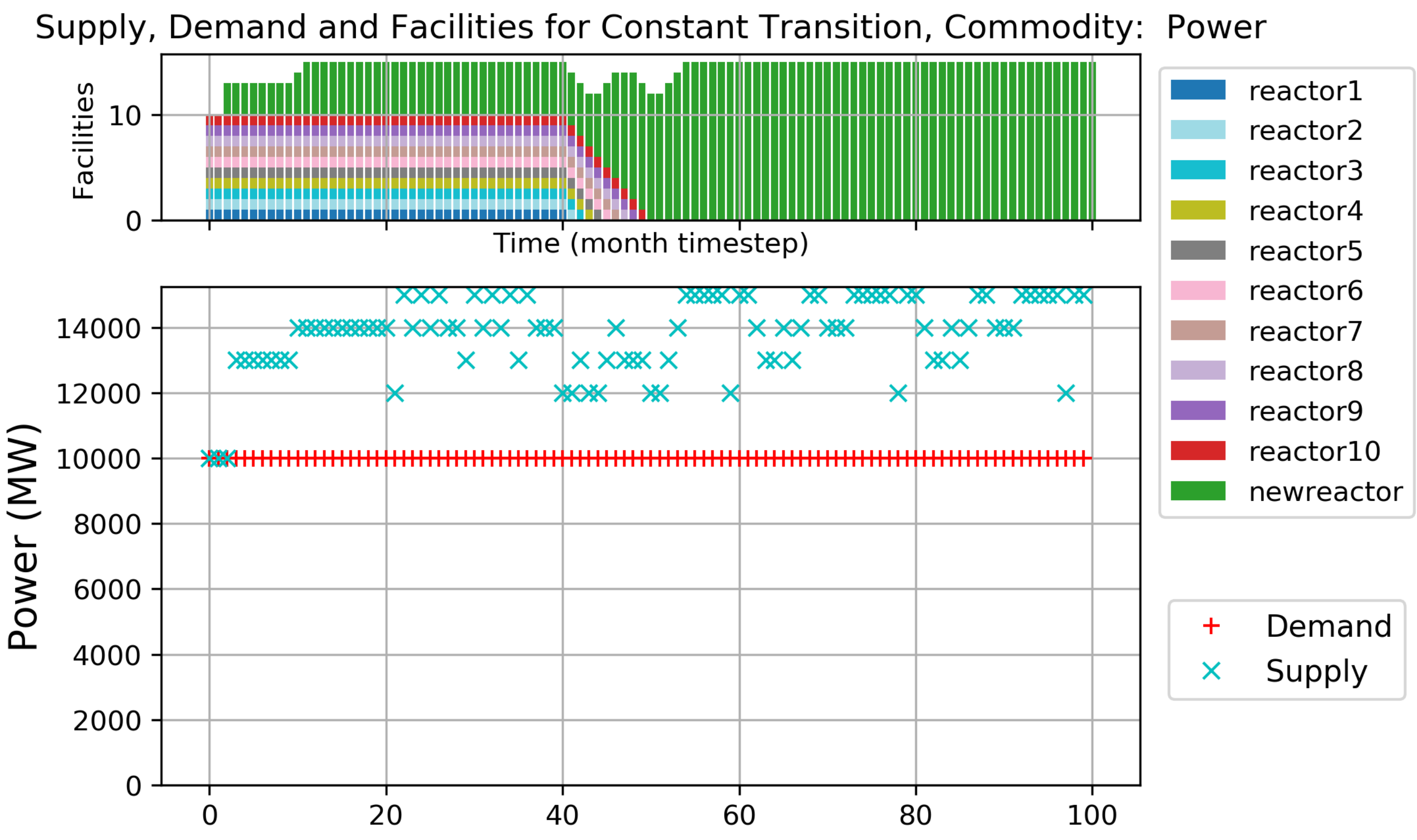

Figure 4: Power commodity supply and demand for transition scenario of constant 10000MW power demand

Demonstrations

Constant Power Demand

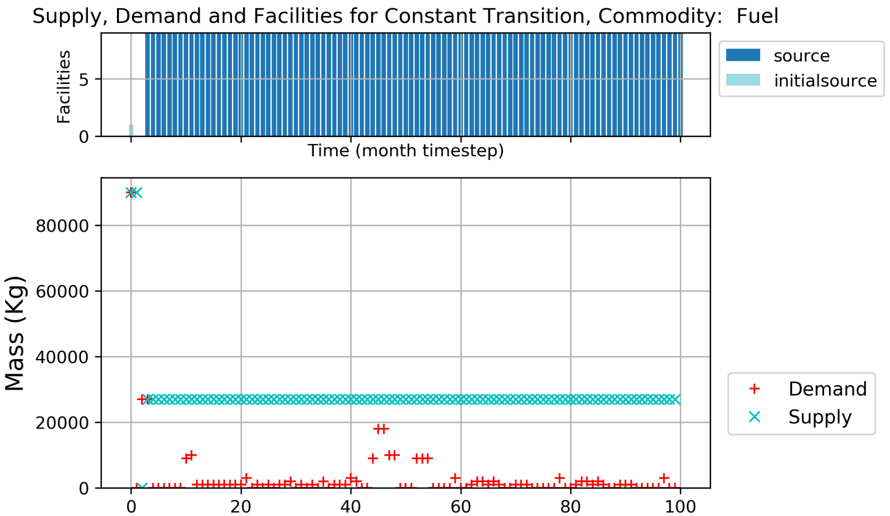

Figure 5: Fuel commodity supply and demand for transition scenario of constant 10000MW power demand

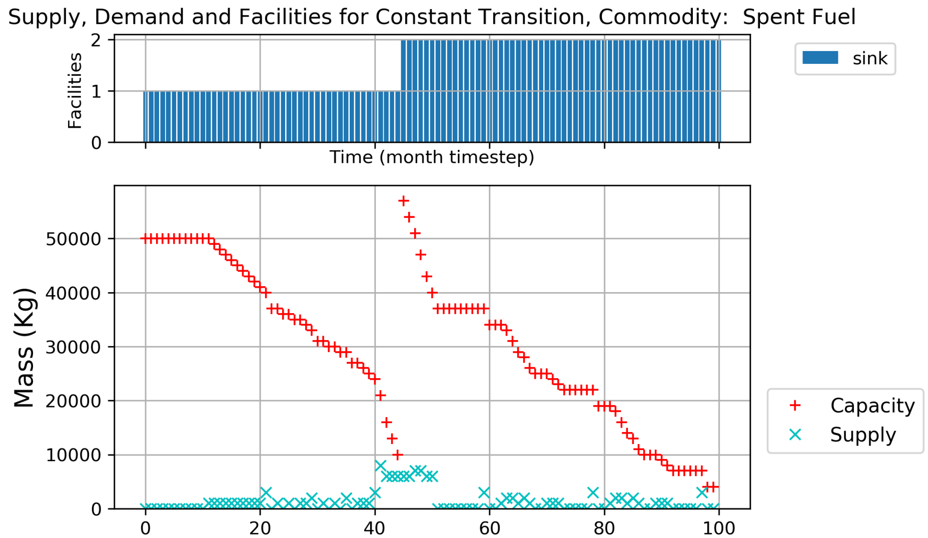

Figure 6: Fuel commodity supply and demand for transition scenario of constant 10000MW power demand

Linear Power Demand

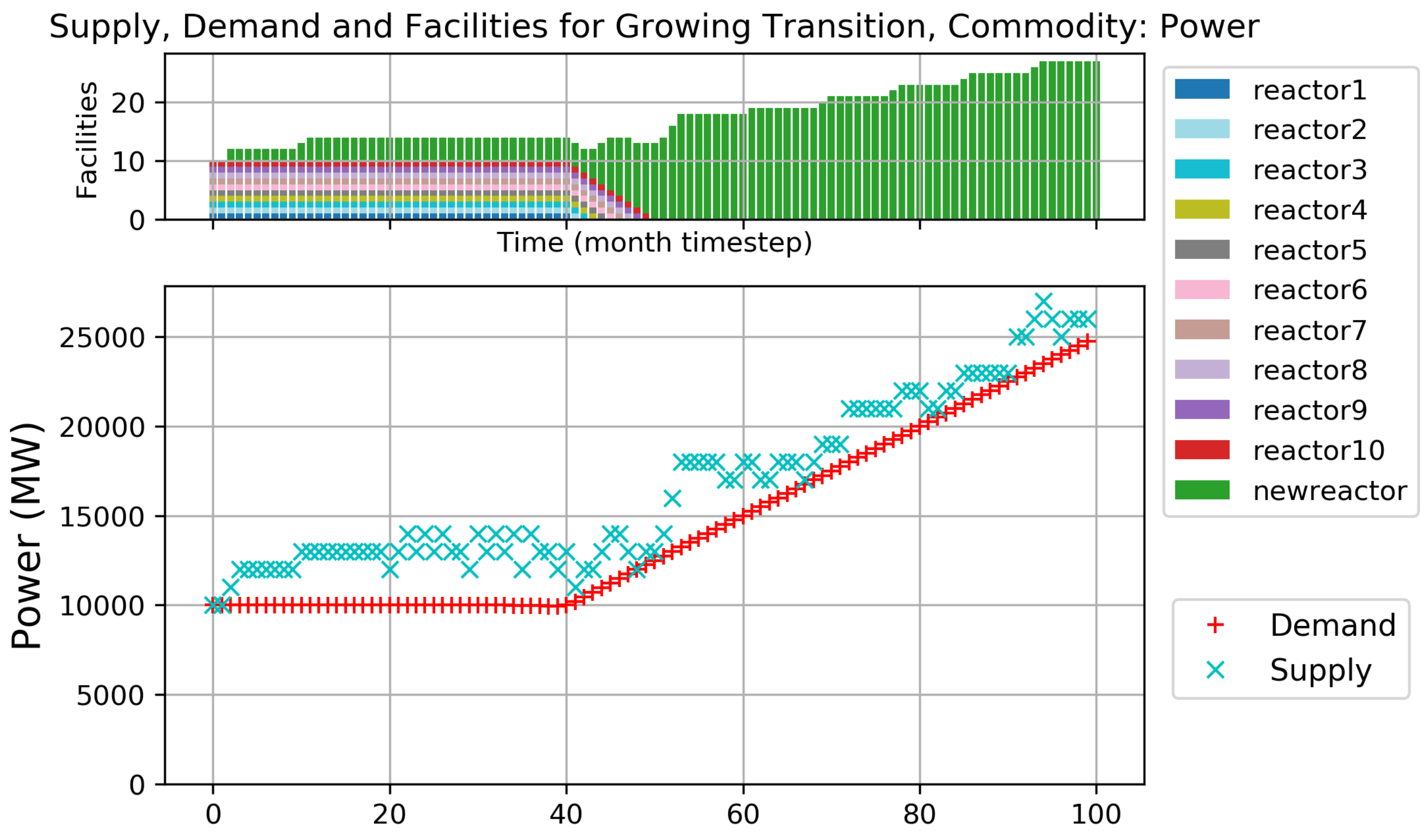

Figure 7: Power commodity supply and demand for transition scenario of linearly increasing power demand

Sinusoidal Power Demand

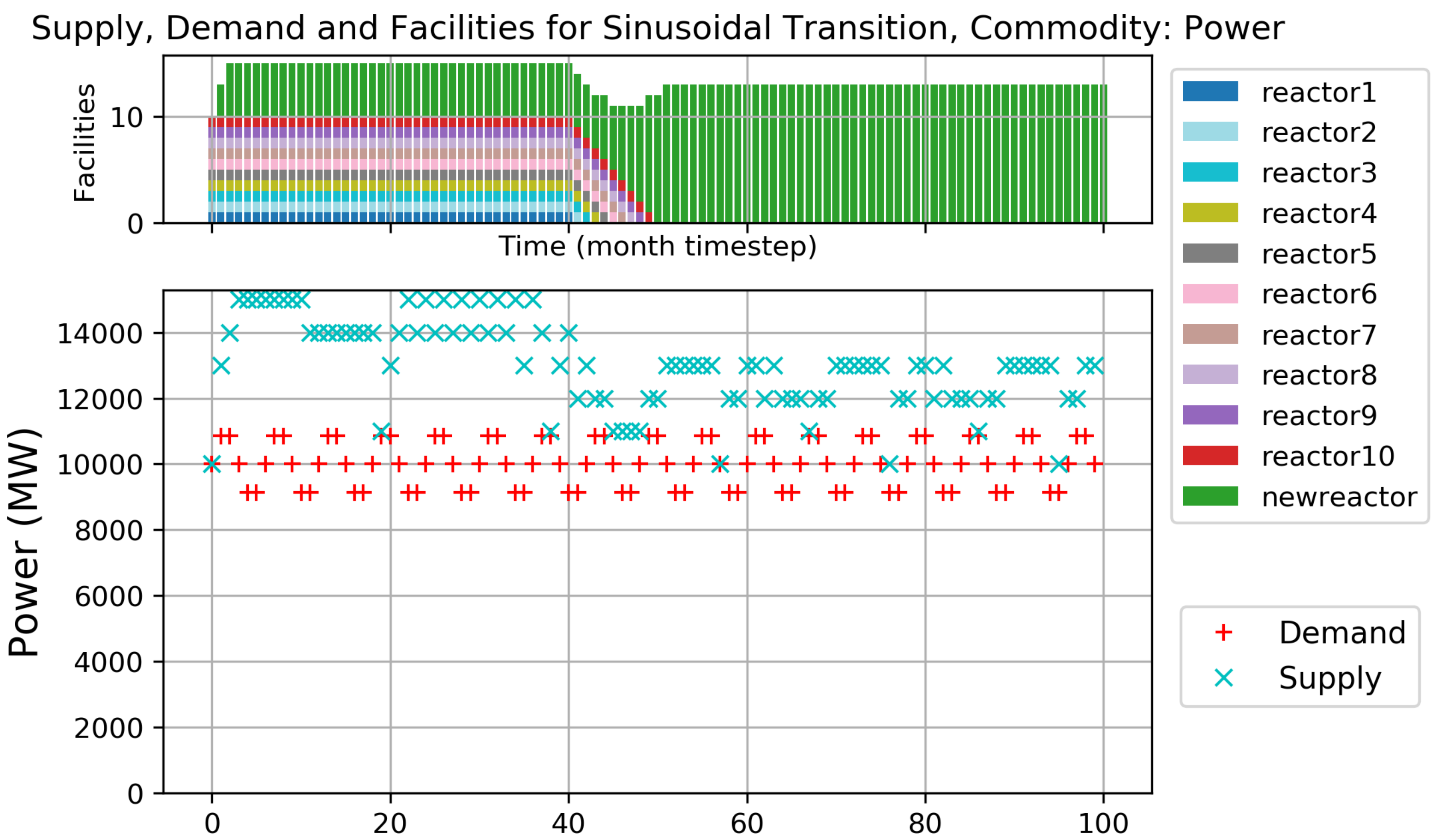

Figure 8: Power commodity supply and demand for transition scenario of sinusoidal power demand

Conclusions

❖**Demand driven deployment capabilities in Cyclus** are important to automate setting up of transition scenarios.

❖**Future Work:** Similar power demand transition scenarios extended to include more nuclear fuel cycle facilities such as reprocessing facilities etc.

References

[1]: K. D. HUFF, M. J. GIDDEN, R. W. CARLSEN, R. R. FLANAGAN, M. B. MCGARRY, A. C. OPOTOWSKY, E. A. SCHNEIDER, A. M. SCOPATZ, and P. P. H. WILSON, “Fundamental concepts in the Cyclus nuclear fuel cycle simulation framework,” Advances in Engineering Software, 94, 46–59 (Apr. 2016).

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Thank You

Any Questions?

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