Fuel Cost Allocation in Cogeneration Production of Power and Water

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Subject of Presentation

Methods which may be used to allocate fuel consumption to power or water produced.

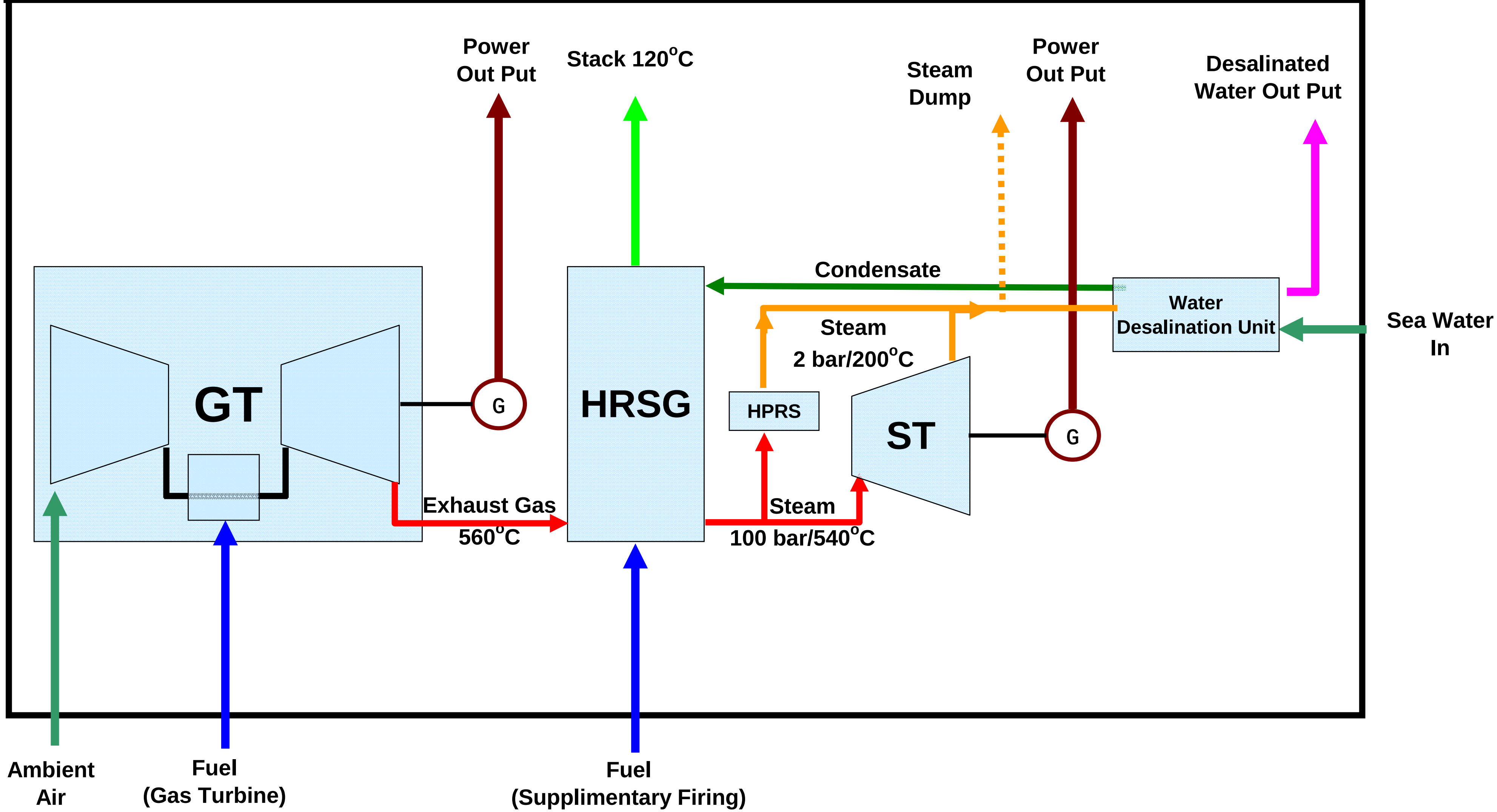
1, Simple Cycle GT-Power Station (open cycle)

The allocation is straight forward as only power will be produced. Hence 100% fuel consumption to be allocated to power

2, Combined Cycle Power Plants (CCGT) – Cogeneration

the solution is not so simple as both power and water will be produced in the plant simultaneously and that at different outputs over the year.

COMBINED CYCLE WATER AND POWER PLANT



General Assumptions:

Total_Fuel_Cogen = Saving_Factor * (Fuel_E + Fuel_W)

The formula shows that there is a savings component if power and water is produced simultaneously instead of in separate processes.

100% Load:

		Efficiency	Output
Single Cycle	GT only	**36%**	MW
CCGT	GT/HRSG + ST	**55%**	MW
Cogen	GT/HRSG + ST + Distiller	**94%**	MW + Water

Task - How to determine :

Total_Fuel_Cogen = Allocated_Fuel_E + Allocated_Fuel_W

Definition: Main Allocation Techniques for Cogen

A, Asymmetric Methods (e.g. Reference Cycle)

- **Allocated_Fuel_E = Fuel_E**
- **Allocated_Fuel_W = Total_Fuel_Cogen - Fuel_E**

B, Symmetric Method

- **Allocated_Fuel_E = Fuel_E * factor_E**
- **Allocated_Fuel_W = Fuel_W * factor_W**

Symmetric allocation requires the ***formula definition***:

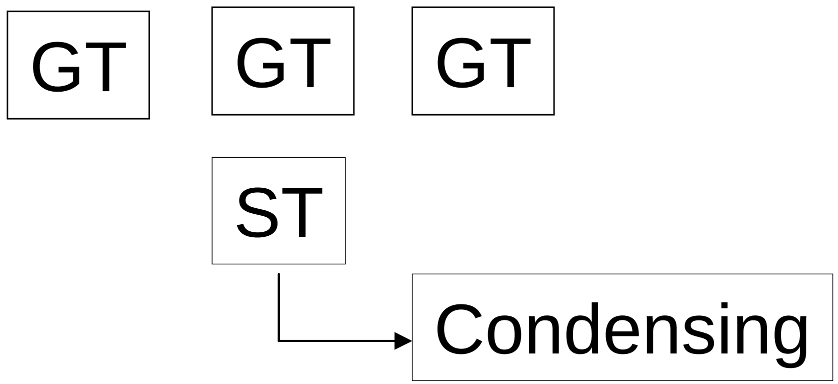
- **factor_E = factor_W**

Shortcomings in Reference Cycle Methods:

- **The fuel consumption in combined water and power plants depends significantly on the point of operation.**
- **The Allocation varies at the different load points which may not be captured by the Reference Cycle.**
- **How the comparative data is initially prepared.**

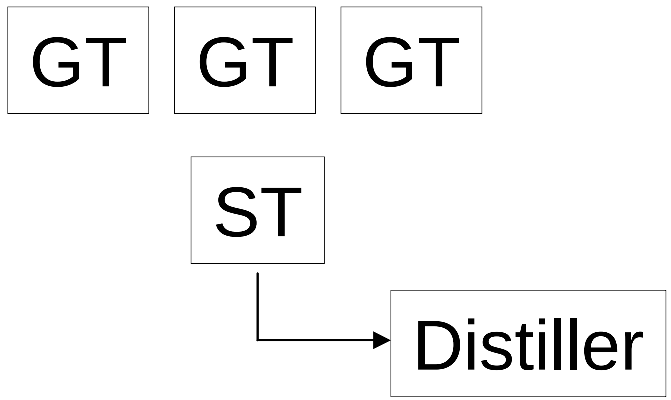
Typical heat rates in Reference Cycle method at 100% load

Step 1



RC heat rate: 6960 kJ/kWh

Step 2



Plant heat rate 9100 kJ/kWh

Alternative Solution: Marginal Cost Method:

- **Instead of using the allocation of fuel consumption of a Reference Cycle Power Plant one may use the marginal fuel consumption of the Combined Power and Water Plant at all different points of operation!**

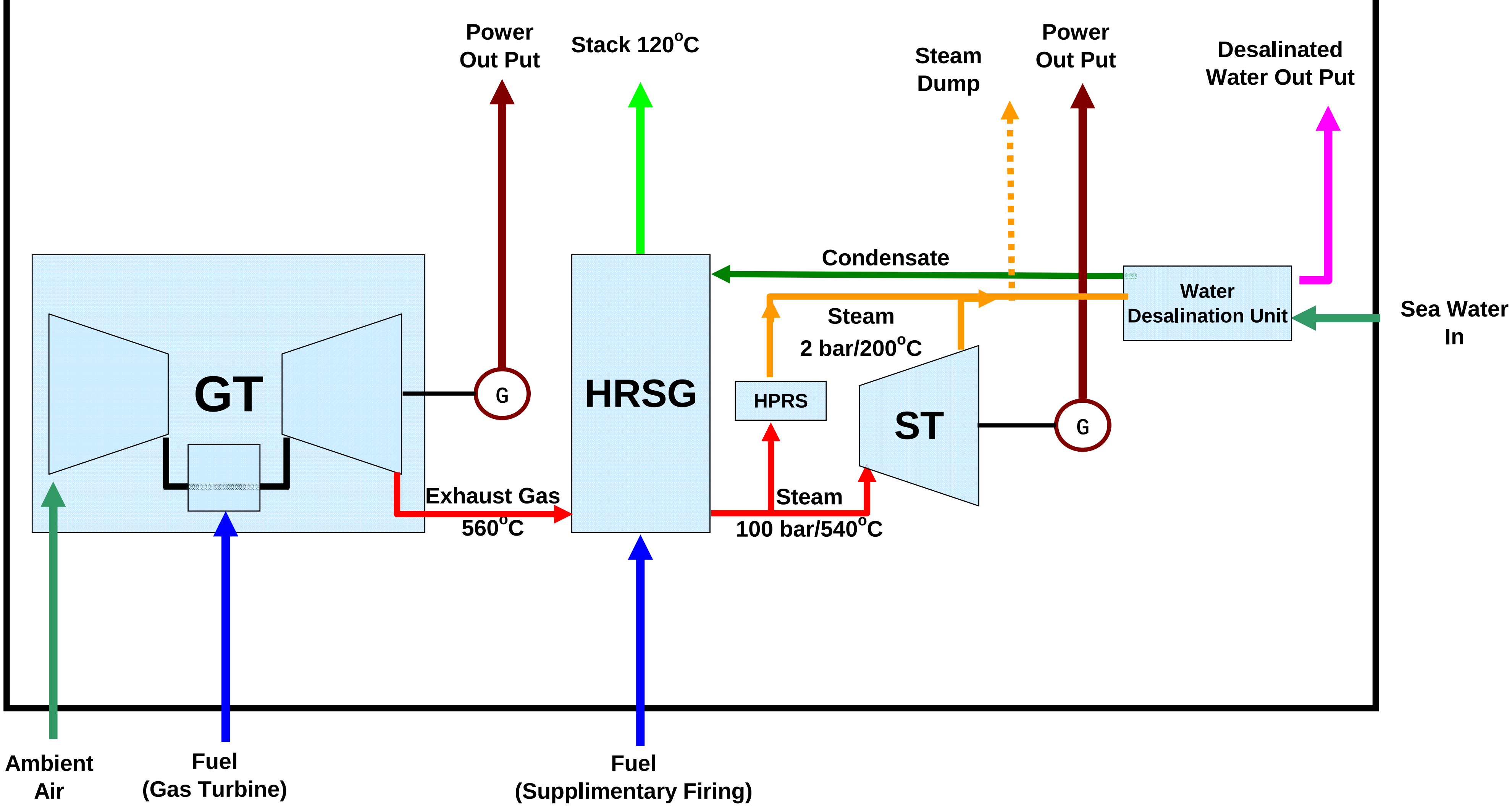
- **Which means cost of last unit (MW or MIGD) produced**

- **Derived from 2 independent calculations**

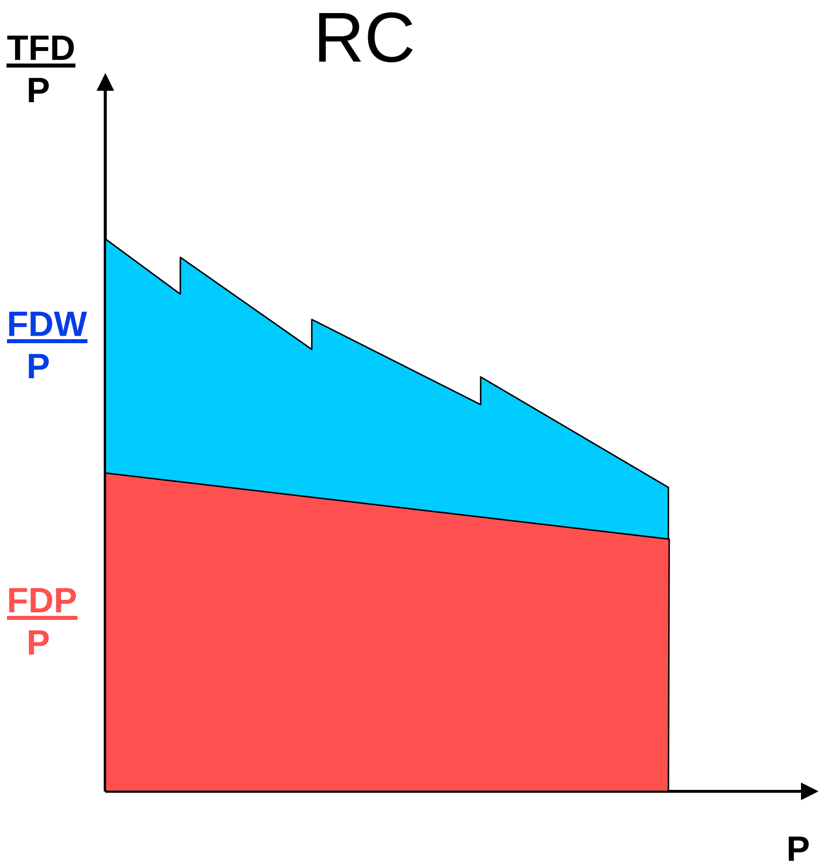
Example – Seasonal Variations in Fuel Allocation

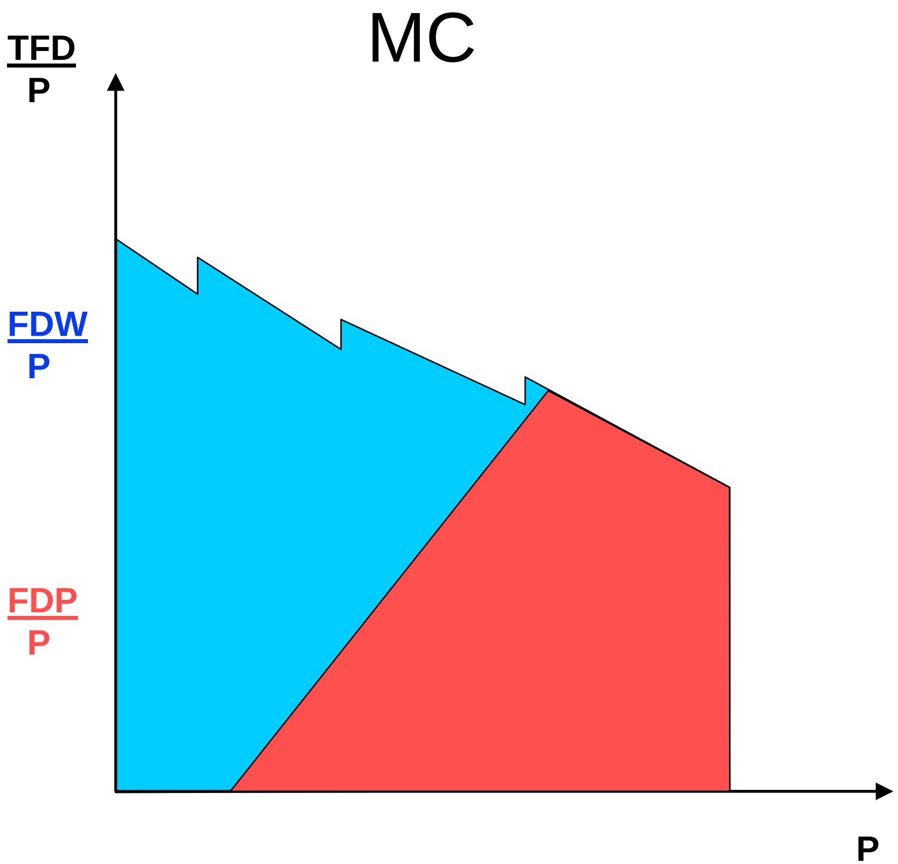
		'Summer' Case	most efficient point	'Winter' Case
	MW	1,350	1200	430
	MIGD	85	85	85
Power to Water Ratio	**MW/MIGD**	16	14	5
Reference Cycle Method	***Allocation to power***	70%	69%	45%
	Allocation to water	30%	31%	55%
Marginal Cost Method	***Allocation to power***	79%	69%	15%
	Allocation to water	21%	31%	85%

COMBINED CYCLE WATER AND POWER PLANT



Reference Cycle vs Marginal Cost Allocation



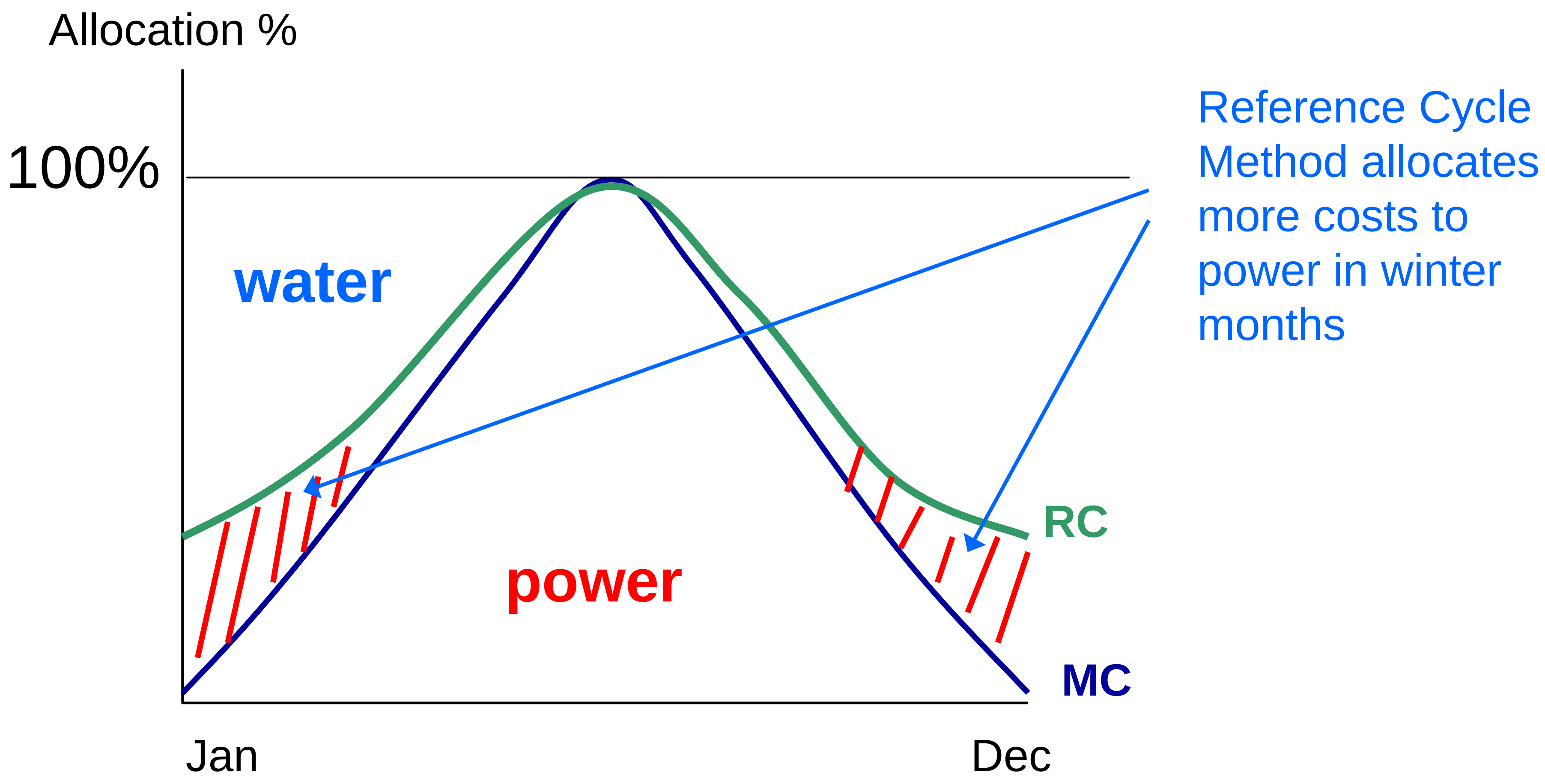


$\frac{FDP}{P}$ = Fuel demand Power/Power = Unit Cost Power

Source: Dr. Gerhard Lakits

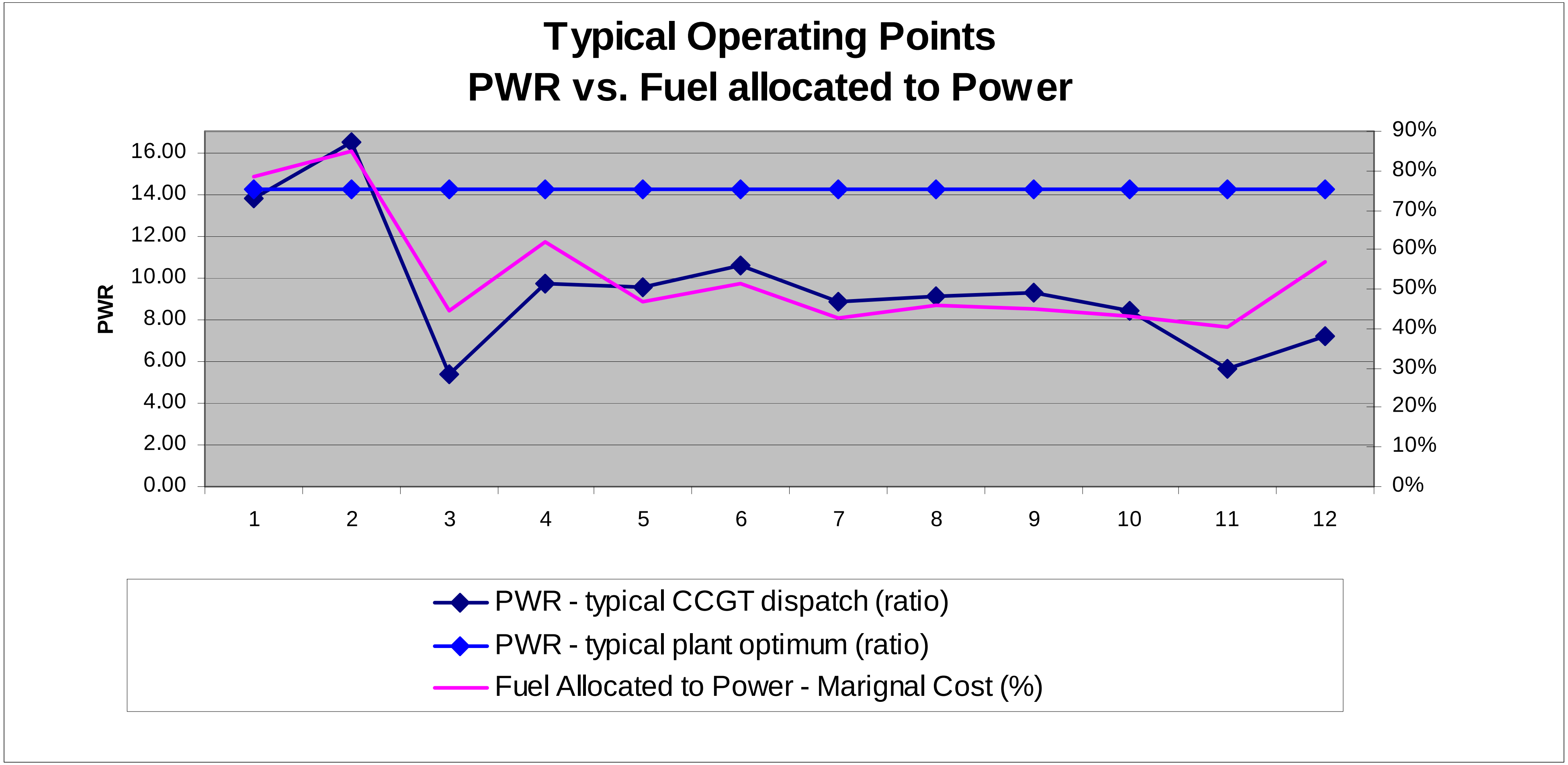
Results

A. Comparison Symmetric to Asymmetric Allocation

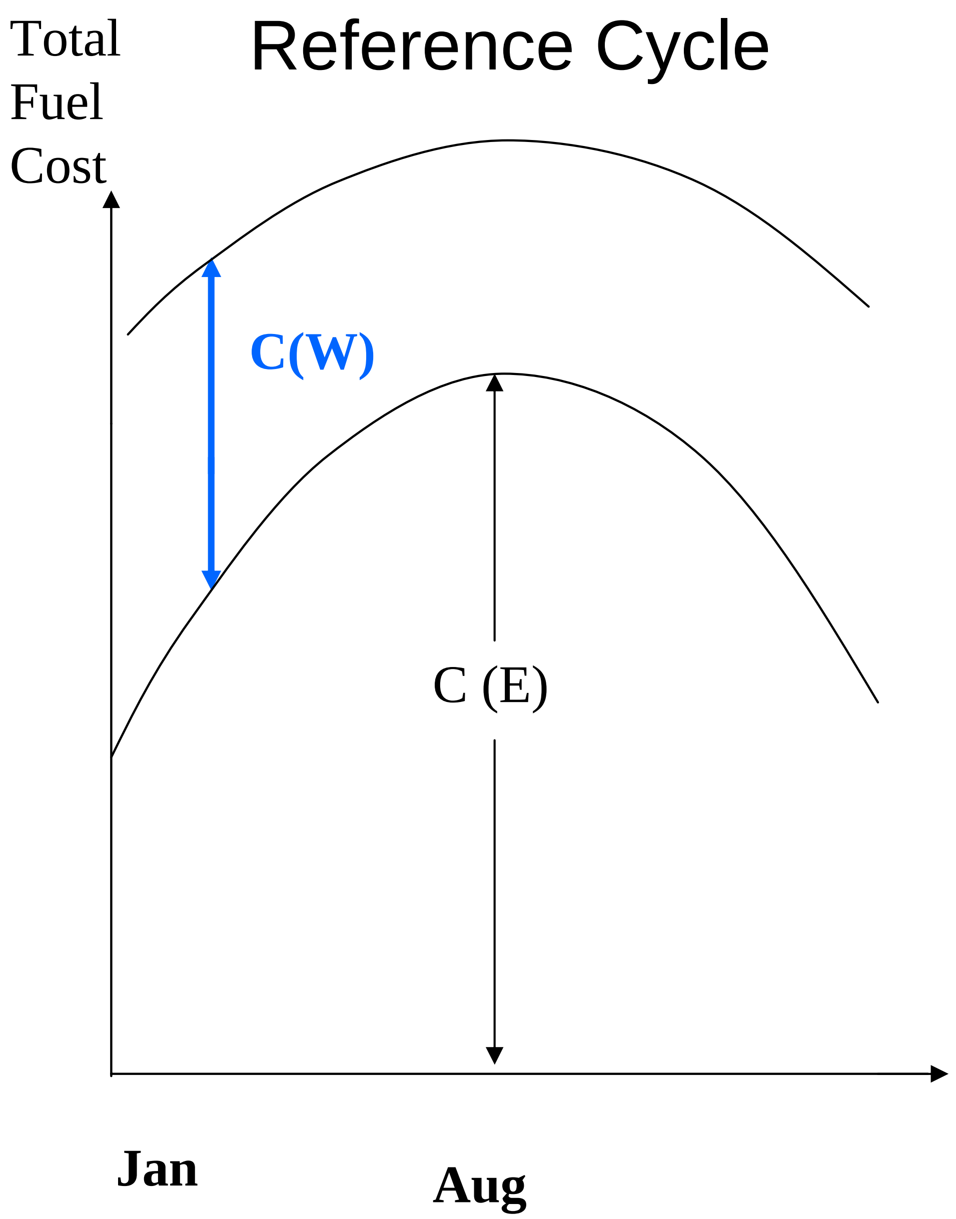


B. Symmetric to Asymmetric Allocation

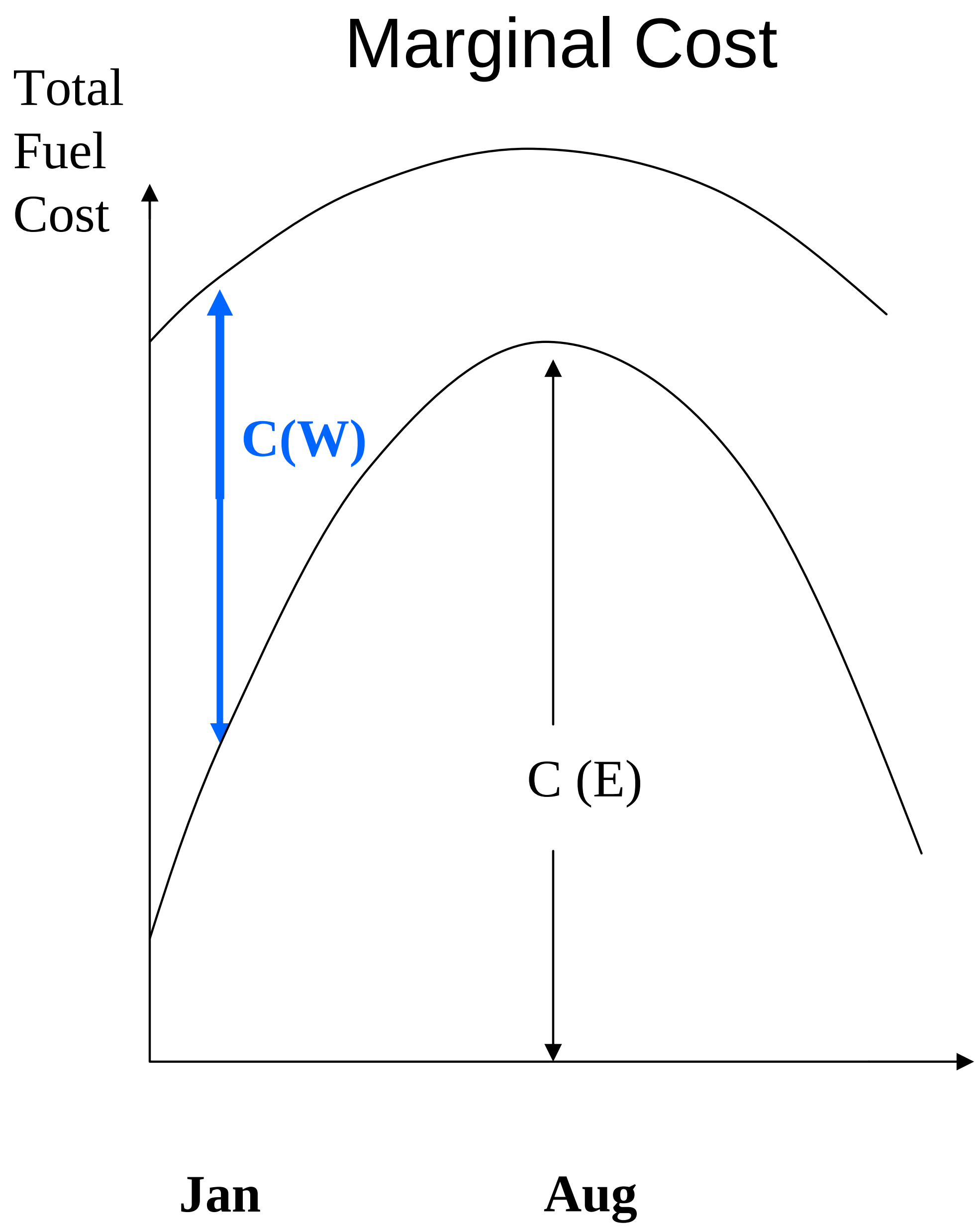
Volatility of Results



Conclusion



Total
Fuel
Cost
Reference Cycle
C(W)
C (E)
Jan
Aug



Marginal Cost
Total
Fuel
Cost
C(W)
C (E)
Jan
Aug

THANK YOU