

Generator Cost Datasets for Use with Power Flow Cases



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Outline



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Motivation



- Simulator Optimal Power Flow (OPF) is a powerful tool for economic analysis
- Requires cost curve input
- PowerWorld Corporation is developing datasets to use with Simulator OPF
- Interim approach between absence of price information and large scale formulation (such as Henwood EnerPrise Market Analytics Module)

Determining Generator Costs



- Fuel
 - Type
 - Cost
 - Heat content per unit volume
- Heat Rate: Input/Output Efficiency

Cubic Cost Model



- Total generator operating cost is modeled using cubic function of power output

$$C_i(P_{gi}) = \underbrace{(A_i + B_i P_{gi} + C_i (P_{gi})^2 + D_i (P_{gi})^3)} * fc + V_{OM} P_{gi}$$

Units are
in \$ / hour

Parameter	Value
A	373.5
B	8.00
C	0.0000
D	0.0000
Unit Fuel Cost (\$/MBtu)	1.000
Variable O&M (\$/MWh)	0.000

Variable O&M (V_{OM})

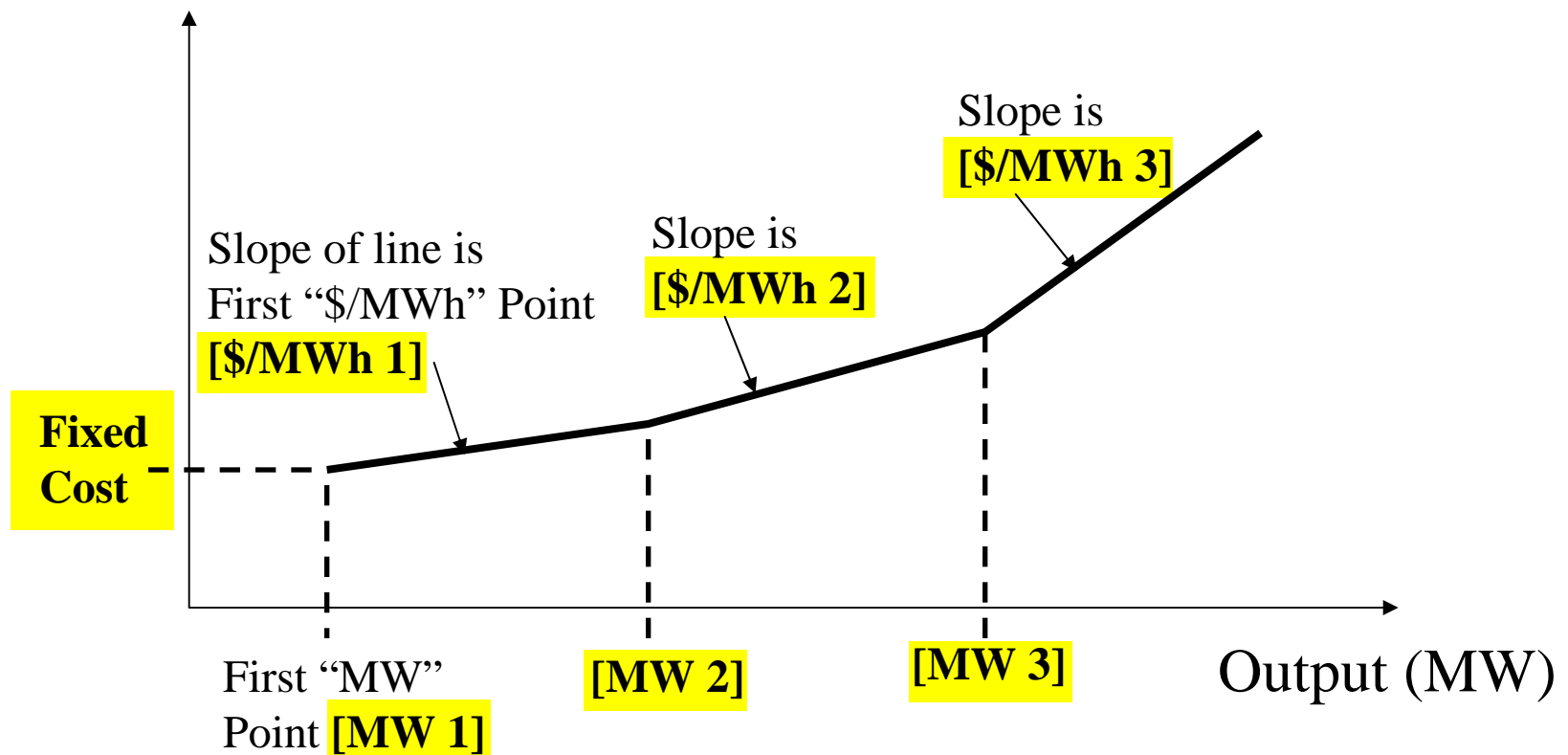
Fuel cost (fc)

Generator Cost Datasets

Piecewise Linear Cost Model



Piecewise Linear Cost Curve (units = \$/h)

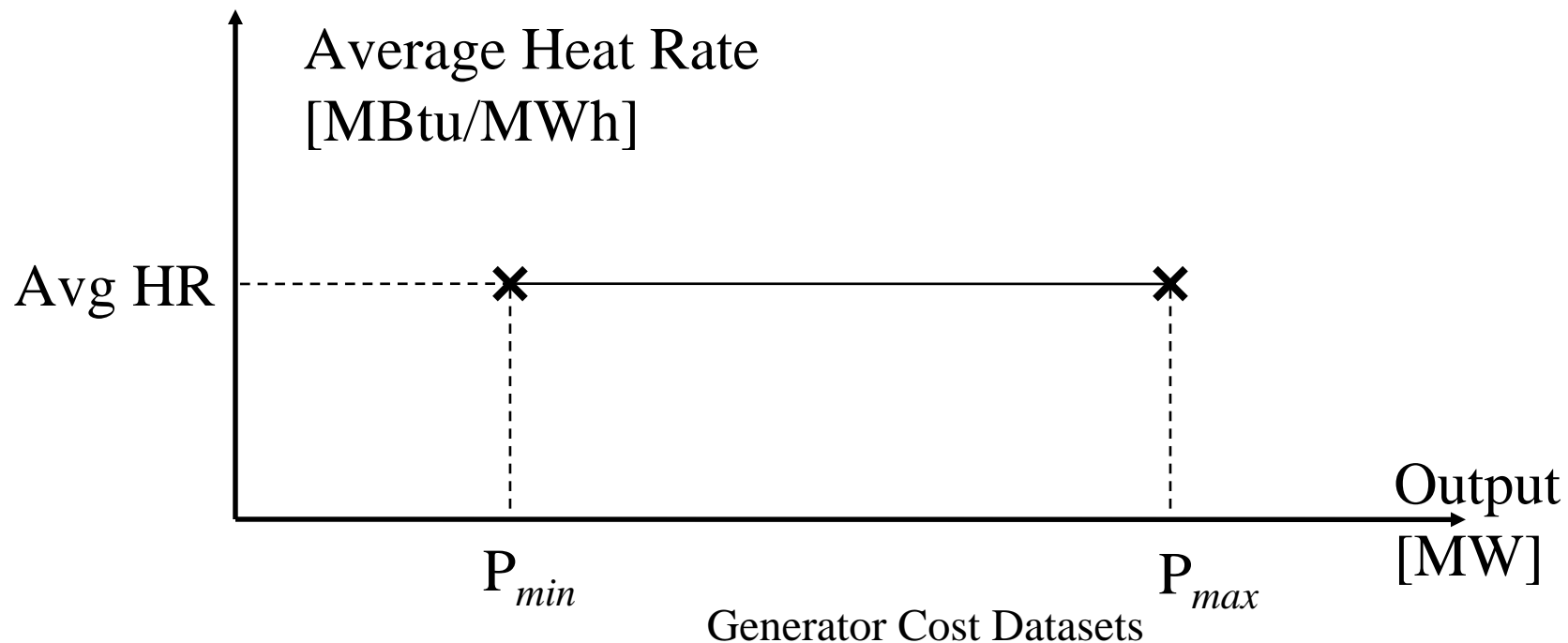


Input variables are highlighted and bold

Heat Rate Assumptions



- Simplified model assumes uniform heat rate across operating range of output
 - MBtu = amount of energy or fuel put in
 - MWh = amount of energy coming out of plant



Simplified Cost Model



- All parameters go to zero, except linear coefficient (B_i) and fuel cost:

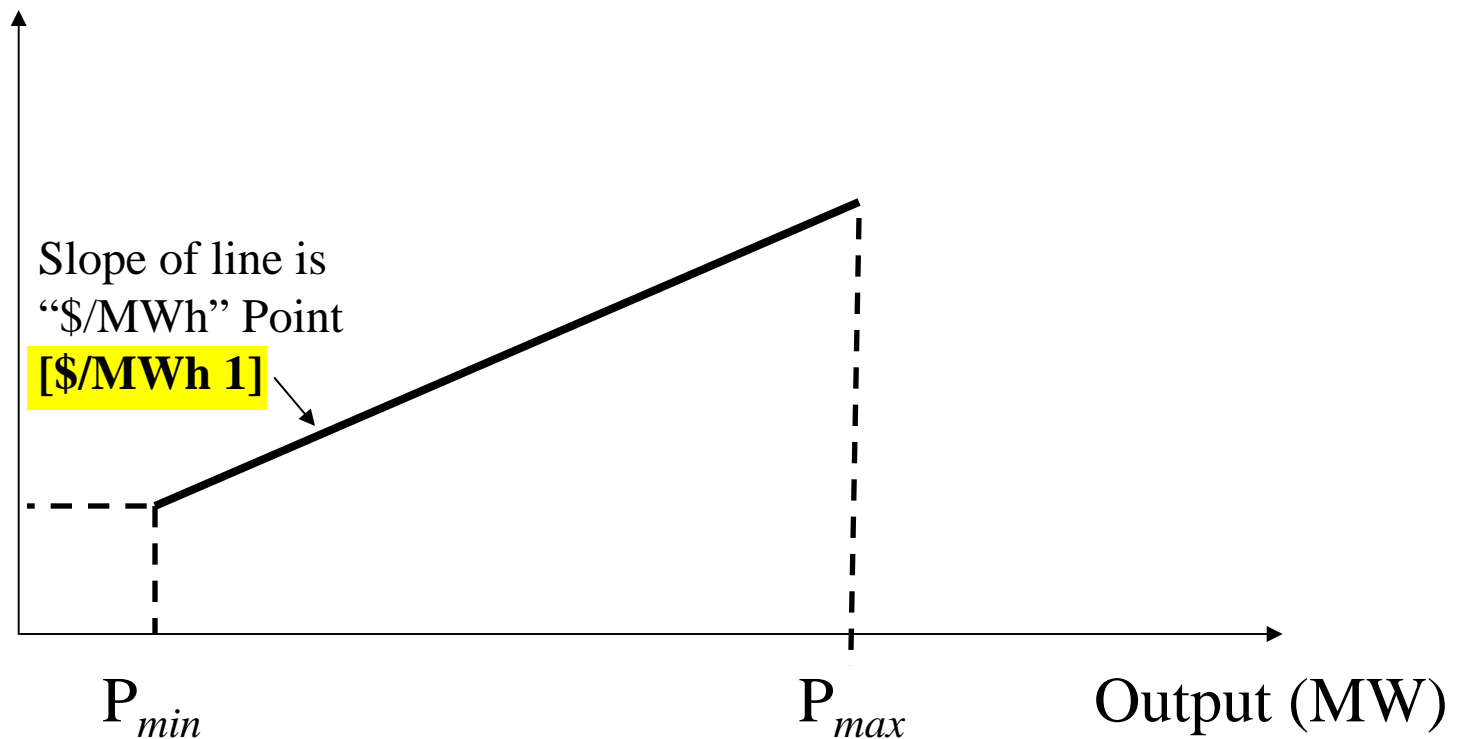
$$C_i(P_{gi}) = B_i P_{gi} * fc$$

- B_i : Average heat rate, units are MBtu/MWh
- fc : units are \$/MBtu

Simplified Piecewise Linear Cost Model



Piecewise Linear Cost Curve (units = \$/h)



Information Sources



- PowerWorld cost datasets are compiled using publicly available sources
 - FERC forms 423, 860, and 906 for utility plants
 - EIA forms 423, 860, and 906 for non-utility plants
 - Trade magazine and websites
- Updated annually with the best available information

Auxiliary File Format



- Single offer price (cost) per MWh for all generator output
- Corresponding fuel cost (\$/MBtu)

```
// Piecewise Linear Cost curves for LMP analysis - eastern PJM Areas 25-35
// 2004 PowerWorld Corporation, Simulator Training version 10.0

DATA (GEN, [BusNum, BusName, GenID, GenFuelCost, GenFuelType, GenUnitType])
{
  30 "CONE G1 " "H " 1.11 "Coal" "ST (Steam Turbine)"
  <SUBDATA BidCurve>
    //MW Price[$/MWhr]
      0.00 8.37
  </SUBDATA>
  30 "CONE G1 " "L " 1.11 "Coal" "ST (Steam Turbine)"
  <SUBDATA BidCurve>
    //MW Price[$/MWhr]
      0.00 8.37
  </SUBDATA>
}
```

Spreadsheet Format



- Sort and adjust parameters to develop different scenarios

The screenshot shows a Microsoft Excel spreadsheet titled "Microsoft Excel - Book1". The spreadsheet contains a table of generator records. The columns are labeled A through I, and the rows are numbered 1 through 11. The data is as follows:

1	Gen Records								
2	BusNum	GenID	BusName_NomVolt	GenCostModel	GenBidMW	GenBidMWH	GenFuelCost	GenFuelType	GenUnitType
3	30	H	CONE G1_ 22.00	Piecewise Linear	0	8.3694	1.11	Coal	ST (Steam Turbine)
4	30	L	CONE G1_ 22.00	Piecewise Linear	0	8.3694	1.11	Coal	ST (Steam Turbine)
5	31	H	CONE G2_ 22.00	Piecewise Linear	0	8.3694	1.11	Coal	ST (Steam Turbine)
6	31	L	CONE G2_ 22.00	Piecewise Linear	0	8.3694	1.11	Coal	ST (Steam Turbine)
7	32	H	KEYS G1_ 22.00	Piecewise Linear	0	8.7357	1.11	Coal	ST (Steam Turbine)
8	32	L	KEYS G1_ 22.00	Piecewise Linear	0	8.7357	1.11	Coal	ST (Steam Turbine)
9	33	H	KEYS G2_ 22.00	Piecewise Linear	0	8.7357	1.11	Coal	ST (Steam Turbine)
10	33	L	KEYS G2_ 22.00	Piecewise Linear	0	8.7357	1.11	Coal	ST (Steam Turbine)
11									

View From Simulator



- Sort or filter data according to unit type or other parameters to develop unit commitment patterns by season or hour of day

PowerWorld Simulator 10.0 SCOPF, ATC, PQVQ. Status: Initialized Case: N035-26.pwb

File Edit Insert Format Case Information Options/Tools Window Help

Abort Edit Mode Run Mode Script Mode Log Single Solution - Full Newton

Options USE AREA ZONE SORT ISM RECD

Generators using Linear Cost Models

	Number	Name	ID	Status	AGC	Gen MW	Min MW	Max MW	Fuel Cost	Fuel Type	Unit Type	MW Break1	MWh Price1	M
1	30	CONE G1	H	Closed	YES	445.40	262.00	445.40	1.110	Coal	ST (Steam Turbine)	0.00	8.37	
2	30	CONE G1	L	Closed	YES	404.60	238.00	404.60	1.110	Coal	ST (Steam Turbine)	0.00	8.37	
3	31	CONE G2	H	Closed	YES	445.40	262.00	445.40	1.110	Coal	ST (Steam Turbine)	0.00	8.37	
4	31	CONE G2	L	Closed	YES	404.60	238.00	404.60	1.110	Coal	ST (Steam Turbine)	0.00	8.37	
5	32	KEYS G1	H	Closed	YES	432.65	254.50	432.60	1.110	Coal	ST (Steam Turbine)	0.00	8.74	
6	32	KEYS G1	L	Closed	YES	417.35	245.50	417.40	1.110	Coal	ST (Steam Turbine)	0.00	8.74	
7	33	KEYS G2	H	Open	YES	0.00	254.50	432.60	1.110	Coal	ST (Steam Turbine)	0.00	8.74	
8	33	KEYS G2	L	Open	YES	0.00	245.50	417.40	1.110	Coal	ST (Steam Turbine)	0.00	8.74	

Edit Mode X-Y Location

Benefits and Limitations



- Quickly identify LMP tendencies of a given market
 - General dispatch patterns
 - Load pockets
 - Areas of congestion and constrained paths
- Easy to develop scenarios by adjusting variables
 - Fuel price
 - Wide-area ISO market vs. individual control areas
- Not a direct substitute for large scale unit commitment and forecasting formulation

Target Availability



- Eastern Interconnect: July 2004
- ERCOT and Western Interconnect: August 2004
- To be offered for an annual subscription
- Seeking beta testers to help improve the quality of information

Discussion



- Is this a product of interest?
- Would this enhance the value of Simulator OPF “out of the box?”
- What features should be added?
- What types of generator cost information are you using to perform economic/LMP studies?
 - Source of information
 - Level of detail
 - Source of pricing model
 - Simulator OPF, GE MAPS, etc. as a standalone model
 - In conjunction with external Unit Commitment modules