## 10-31-2013-energy-cost-calculator-generic-power-only

Input are highlighted in green

### Capital Cost

CapitalCost=70000000

### Electrical and Fuel--base year

NetPlantCapacity=25000

CapacityFactor=85

AnnualHours=CapacityFactor/100\*8760

NetStationEfficiency=20

FuelHeatingValue=18608

FuelConsumptionRate=NetPlantCapacity/(NetStationEfficiency/100)\*3600/FuelHeatingValue/1000

FuelAshConcentration=5

AnnualGeneration=NetPlantCapacity\*8760\*CapacityFactor/100

CapitalCostNEC=CapitalCost/NetPlantCapacity

AnnualFuelConsumption=FuelConsumptionRate\*AnnualHours

AnnualAshDisposal=AnnualFuelConsumption\*FuelAshConcentration/100

#### Electric and Fuel—base year from Gasification Power Generation

### Expenses--base year

FuelCost=22.05

LaborCost=2000000

MaintenanceCost=1500000

InsurancePropertyTax=1400000

Utilities=200000

AshDisposal=100000

Management=200000

OtherOperatingExpenses=400000

TotalNonFuelExpenses=LaborCost+MaintenanceCost+InsurancePropertyTax+Utilities+AshDisposal+Management+OtherOperatingExpenses

TotalExpensesIncludingFuel=FuelCost\*AnnualFuelConsumption+TotalNonFuelExpenses

FuelCostKwh=AnnualFuelConsumption\*FuelCost/AnnualGeneration

LaborCostKwh=LaborCost/AnnualGeneration

MaintenanceCostKwh=MaintenanceCost/AnnualGeneration

InsurancePropertyTaxKwh=InsurancePropertyTax/AnnualGeneration

UtilitiesKwh=Utilities/AnnualGeneration

AshDisposalKwh=AshDisposal/AnnualGeneration

ManagementKwh=Management/AnnualGeneration

OtherOperatingExpensesKwh=OtherOperatingExpenses/AnnualGeneration

TotalNonFuelExpensesKwh=LaborCostKwh+MaintenanceCostKwh+InsurancePropertyTaxKwh+UtilitiesKwh+AshDisposalKwh+ManagementKwh+OtherOperatingExpensesKwh

TotalExpensesIncludingFuelKwh=FuelCostKwh+TotalNonFuelExpensesKwh

### Taxes

FederalTaxRate=34

StateTaxRate=9.6

ProductionTaxCredit=0.009

CombinedTaxRate=StateTaxRate+FederalTaxRate\*(1-StateTaxRate/100)

### Financing

DebtRatio=75

EquityRatio =100-DebtRatio

InterestRateOnDebt=5

EconomicLife=20

CostOfEquity=15

CostOfMoney =DebtRatio/100\*InterestRateOnDebt+EquityRatio/100\*CostOfEquity

TotalCostOfPlant =CapitalCost

TotalEquityCost =TotalCostOfPlant\*EquityRatio/100

TotalDebtCost =TotalCostOfPlant\*DebtRatio/100

CapitalRecoveryFactorEquity =CostOfEquity/100\*(1+CostOfEquity/100)^EconomicLife/((1+CostOfEquity/100)^EconomicLife-1)

CapitalRecoveryFactorDebt=InterestRateOnDebt/100\*(1+InterestRateOnDebt/100)^EconomicLife/((1+InterestRateOnDebt/100)^EconomicLife-1)

AnnualEquityRecovery =CapitalRecoveryFactorEquity\*TotalEquityCost

AnnualDebtPayment =TotalDebtCost\* CapitalRecoveryFactorDebt

DebtReserve =AnnualDebtPayment

### Income other than energy

CapacityPayment=166

InterestRateonDebtReserve=5

AnnualCapacityPayment=CapacityPayment\*NetPlantCapacity

AnnualDebtReserveInterest=DebtReserve\*InterestRateonDebtReserve/100

### Escalation/Inflation

GeneralInflation=2.1

EscalationFuel=2.1

EscalationForProductionTaxCredit=2.1

EscalationOther=2.1

### Depreciation Schedule

DepreciationFraction =1/EconomicLife

### Tax Credit Schedule

"TaxCreditFrac": [1,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]

### Annual Cash Flows

Common vars in each year are highlighted in yellow

#### Year1

EquityRecovery =AnnualEquityRecovery

EquityInterest1 =CostOfEquity/100\*TotalEquityCost

EquityPrincipalPaid1 =EquityRecovery-EquityInterest1

EquityPrincipalRemaining1 =TotalEquityCost-EquityPrincipalPaid1

DebtRecovery =AnnualDebtPayment

DebtInterest1 =InterestRateOnDebt/100\*TotalDebtCost

DebtPrincipalPaid1 =DebtRecovery-DebtInterest1

DebtPrincipalRemaining1 =TotalDebtCost-DebtPrincipalPaid1

FuelCost1 =AnnualFuelConsumption\*FuelCost

NonFuelExpenses1 =TotalNonFuelExpenses

DebtReserve1 =DebtReserve

Depreciation =TotalCostOfPlant\*DepreciationFraction

CapacityIncome =AnnualCapacityPayment

InterestOnDebtReserve =AnnualDebtReserveInterest

TaxesWoCredit1 =((CombinedTaxRate/100)/(1-CombinedTaxRate/100))\*(EquityPrincipalPaid1+DebtPrincipalPaid1+EquityInterest1-Depreciation+DebtReserve1)

TaxCredit1 =AnnualGeneration\*ProductionTaxCredit\*TaxCreditFrac1

Taxes1 =((CombinedTaxRate/100)/(1-CombinedTaxRate/100))\*(EquityPrincipalPaid1+DebtPrincipalPaid1+EquityInterest1-Depreciation+DebtReserve1-TaxCredit1)

EnergyRevenueRequired1 =EquityRecovery+DebtRecovery+FuelCost1+NonFuelExpenses1+Taxes1+DebtReserve1-CapacityIncome-InterestOnDebtReserve

#### Year2

EquityInterest2 =CostOfEquity/100\*EquityPrincipalRemaining1

EquityPrincipalPaid2 =EquityRecovery-EquityInterest2

EquityPrincipalRemaining2 =EquityPrincipalRemaining1-EquityPrincipalPaid2

DebtInterest2 =InterestRateOnDebt/100\*DebtPrincipalRemaining1

DebtPrincipalPaid2 =DebtRecovery-DebtInterest2

DebtPrincipalRemaining2 =DebtPrincipalRemaining1-DebtPrincipalPaid2

FuelCost2 =FuelCost1\*(1+EscalationFuel/100)^(Year-1)

NonFuelExpenses2 =NonFuelExpenses1\*(1+EscalationOther/100)^(Year-1)

DebtReserve2=0

TaxesWoCredit2 =((CombinedTaxRate/100)/(1-CombinedTaxRate/100))\*(EquityPrincipalPaid2+DebtPrincipalPaid2+EquityInterest2-Depreciation+DebtReserve2)

TaxCredit2 =AnnualGeneration\*ProductionTaxCredit\*((1+EscalationForProductionTaxCredit/100)^(Year-1))\*TaxCreditFrac2

Taxes2 =((CombinedTaxRate/100)/(1-CombinedTaxRate/100))\*(EquityPrincipalPaid2+DebtPrincipalPaid2+EquityInterest2-Depreciation+DebtReserve2-TaxCredit2)

EnergyRevenueRequired2 =EquityRecovery+DebtRecovery+FuelCost2+NonFuelExpenses2+Taxes2+DebtReserve2-CapacityIncome-InterestOnDebtReserve

The others follow the same pattern as Year2

#### Year20

DebtReserve = - DebtReserve1

### Current $ Level Annual Cost (LAC)

PresentWorth1=EnergyRevenueRequired1\*(1+CostOfEquity/100)^-B130

TotalPresentWorth=SUM(PresentWorth1: PresentWorth20)

CapitalRecoveryFactorCurrent= CapitalRecoveryFactorEquity

CurrentLevelAnnualRevenueRequirements =TotalPresentWorth\*CapitalRecoveryFactorCurrent

CurrentLACofEnergy =CurrentLevelAnnualRevenueRequirements/AnnualGeneration

RealCostOfMoney =(1+CostOfEquity/100)/(1+GeneralInflation/100)-1

CapitalRecoveryFactorConstant=CapitalRecoveryFactor(RealCostOfMoney\*100, EconomicLife)

ConstantLevelAnnualRevenueRequirements =TotalPresentWorth\*CapitalRecoveryFactorConstant

ConstantLACofEnergy =ConstantLevelAnnualRevenueRequirements/AnnualGeneration

function CapitalRecoveryFactor(i: number, N: number) {

const A = i / 100 \* Math.pow((1 + i / 100), N) / (Math.pow((1 + i / 100), N) - 1);

return A;

}

## 10-31-2013-energy-cost-calculator-gasification-power-generation-model

Input are highlighted in green

### Unit Conversions

BtuPerCubicFoot = 150

BtuPerPound = 8000

MetricTonsPerHour = 24

DollarPerMetricTons = 20

CubicFootPerPonds = 5.6

DollarPerMillionBtu = 5

KjPerCubicMeter = BtuPerCubicFoot\*1.055056\*35.31

KjPerKg = BtuPerPound\*1.055056/0.4535924

USTonsPerHour = MetricTonsPerHour/0.907

DollarPerUSTons = DollarPerMetricTons/0.907

CubicMeterPerKg = CubicFootPerPonds/35.31\*2.205

DollarPerMillionBtu = DollarPerMillionBtu/1055\*3.6

### Fuel Properties

GasolineDensity = 750

GasolineHigherHeatingValueMjPerKg=47.3

GasolineLowerHeatingValueMjPerKg=44

LightDieselDensity=810

LightDieselHigherHeatingValueMjPerKg=46.1

LightDieselLowerHeatingValueMjPerKg=43.2

HeavyDieselDensity=850

HeavyDieselHigherHeatingValueMjPerKg=45.5

HeavyDieselLowerHeatingValueMjPerKg=42.8

NaturalGasDensity=0.724

NaturalGasHigherHeatingValueMjPerKg=50

NaturalGasLowerHeatingValueMjPerKg=45

COHigherHeatingValueMjPerKg = 10.1

COLowerHeatingValueMjPerKg=10.1

H2HigherHeatingValueMjPerKg=142

H2LowerHeatingValueMjPerKg=120

CH4HigherHeatingValueMjPerKg=55.5

CH4LowerHeatingValueMjPerKg=50

CODensity=101325\*28/8314/298

H2Density =101325\*2/8314/298

CH4Density =101325\*16/8314/298

GasolineHigherHeatingValueKjPerL =GasolineHigherHeatingValueMjPerKg\*GasolineDensity

GasolineLowerHeatingValueKjPerL =GasolineLowerHeatingValueMjPerKg\*GasolineDensity

LightDieselHigherHeatingValueKjPerL =LightDieselHigherHeatingValueMjPerKg\*LightDieselDensity

LightDieselLowerHeatingValueKjPerL =LightDieselLowerHeatingValueMjPerKg\*LightDieselDensity

HeavyDieselHigherHeatingValueKjPerL =HeavyDieselHigherHeatingValueMjPerKg\*HeavyDieselDensity

HeavyDieselLowerHeatingValueKjPerL =HeavyDieselLowerHeatingValueMjPerKg\*HeavyDieselDensity

NaturalGasHigherHeatingValueKjPerL=NaturalGasHigherHeatingValueMjPerKg\*NaturalGasDensity\*1000

NaturalGasLowerHeatingValueKjPerL =NaturalGasLowerHeatingValueMjPerKg\*NaturalGasDensity\*1000

COHigherHeatingValueKjPerM =COHigherHeatingValueMjPerKg\*CODensity\*1000

COLowerHeatingValueKjPerM =COLowerHeatingValueMjPerKg\*CODensity\*1000

H2HigherHeatingValueKjPerM =H2HigherHeatingValueMjPerKg\*H2Density\*1000

H2LowerHeatingValueKjPerM =H2LowerHeatingValueMjPerKg\*H2Density\*1000

CH4HigherHeatingValueKjPerM =CH4HigherHeatingValueMjPerKg\*CH4Density\*1000

CH4LowerHeatingValueKjPerM =CH4LowerHeatingValueMjPerKg\*CH4Density\*1000

### Capital Cost

GasifierSystemCapitalCost = 300000

GasCleaningSystemCapitalCost = 50000

PowerGenerationCapitalCost = 450000

EmissionControlSystemCapitalCost = 25000

HeatRecoverySystemCapitalCost = 50000

GasifierSystemCapitalCostPerKwe = GasifierSystemCapitalCost/NetElectricalCapacity

GasCleaningSystemCapitalCostPerKwe = GasCleaningSystemCapitalCost/NetElectricalCapacity

PowerGenerationCapitalCostPerKwe = PowerGenerationCapitalCost/NetElectricalCapacity

EmissionControlSystemCapitalCostPerKwe = EmissionControlSystemCapitalCost/NetElectricalCapacity

HeatRecoverySystemCapitalCostPerKwe = HeatRecoverySystemCapitalCost/NetElectricalCapacity

TotalFacilityCapitalCost = GasifierSystemCapitalCost + GasCleaningSystemCapitalCost + PowerGenerationCapitalCost + EmissionControlSystemCapitalCost + HeatRecoverySystemCapitalCost

TotalFacilityCapitalCostPerKwe = TotalFacilityCapitalCost/NetElectricalCapacity

### Electrical and Fuel--base year

GrossElectricalCapacity = 650

NetElectricalCapacity = 500

CapacityFactor = 85

HHVEfficiencyOfGasificationSystem = 65

NetHHVEfficiencyofPowerGeneration = 23

FractionOfInputEnergy = 20

CleanGasComposition = ?

CO = 20

HydrogenGas = 12

Hydrocarbons = 5

CarbonDioxide = 12

Oxygen = 0

HigherHeatingValue = 18608

MoistureContent = 15

AshContent = 5

CarbonConcentration = 30

ParasiticLoad =GrossElectricalCapacity-NetElectricalCapacity

AnnualHours =CapacityFactor/100\*8760

AnnualNetElectricityGeneration =NetElectricalCapacity\*AnnualHours

OverallNetSystemEfficiency=HHVEfficiencyOfGasificationSystem\*NetHHVEfficiencyofPowerGeneration/100

NitrogenGas =100-(CO+HydrogenGas+Hydrocarbons+CarbonDioxide+Oxygen)

CleanGasMolecularMass=(CO\*28+HydrogenGas\*2+Hydrocarbons\*16+CarbonDioxide\*44+Oxygen\*32+NitrogenGas\*28)/100

CleanGasDensity =101325\*CleanGasMolecularMass/8314/298

CleanGasHigherHeatingValue=(CO\*COHigherHeatingValueKjPerM+HydrogenGas\*H2HigherHeatingValueKjPerM+Hydrocarbons\*CH4HigherHeatingValueKjPerM)/100

CleanGasLowerHeatingValue =(CO\*COLowerHeatingValueKjPerM+HydrogenGas\*H2LowerHeatingValueKjPerM+Hydrocarbons\*CH4LowerHeatingValueKjPerM)/100

TotalFuelPowerInput =NetElectricalCapacity/(NetHHVEfficiencyofPowerGeneration/100)

CleanGasPowerInput =TotalFuelPowerInput\*(1-FractionOfInputEnergy/100)

DualFuelPowerInput =TotalFuelPowerInput\*FractionOfInputEnergy/100

CleanGasFlowRateVolume =CleanGasPowerInput/CleanGasHigherHeatingValue\*3600

CleanGasFlowRateMass =CleanGasFlowRateVolume\*CleanGasDensity

AnnualCleanGasConsumption =CleanGasFlowRateMass\*AnnualHours/1000

DualFuelFlowRate =DualFuelPowerInput/HeavyDieselHigherHeatingValueKjPerL\*3600

AnnualDualFuelConsumption =DualFuelFlowRate\*AnnualHours

BiomassFeedRate=CleanGasPowerInput/(HHVEfficiencyOfGasificationSystem/100)/HigherHeatingValue\*3600

AnnualBiomassConsumptionDryMass =BiomassFeedRate\*AnnualHours/1000

AnnualBiomassConsumptionWetMass =AnnualBiomassConsumptionDryMass/(1-MoistureContent/100)

CharProductionRate =AshContent/100\*BiomassFeedRate/(1-CarbonConcentration/100)

AnnualCharProduction =CharProductionRate\*AnnualHours/1000

### Heat--base year

### Expenses--base year

### Taxes

### Income other than energy

### Escalation/Inflation

### Financing

### Depreciation Schedule

DepreciationFraction =1/EconomicLife

### Tax Credit Schedule

"TaxCreditFrac": [1,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]

### Annual Cash Flows

### Current $ Level Annual Cost (LAC)