Economic Load Dispatch with Transmission Line Losses - Revised

This script performs economic load dispatch (ELD) calculation with transmission line losses using a modified approach.

Contents

Initialize data and parameters

```
clc;
clear;
close all;

% Extract generator data
PG_data = [
 0.00142, 7.20, 510, 200, 450, 150, 0.00010;
 0.00194, 7.85, 310, 150, 350, 100, 0.00015;
 0.00284, 8.12, 335, 100, 225, 50, 0.00020
];

% Extract data
N = length(PG_data(:,1));
a = PG_data(:,1);
b = PG_data(:,2);
c = PG_data(:,3);
pg_min = PG_data(:,4);
pg_max = PG_data(:,5);
ploss_coeff = PG_data(:,7);

% Set parameters
pd = 975;  % Demand
tolerance = 0.00001;  % Convergence tolerance
max_iterations = 100;

% Initialize generators at minimum values to start
pg = pg_min;

% Initial calculation of losses
ploss = zeros(N, 1);
for i = 1:N
    ploss(i) = ploss_coeff(i) * (pg(i)^2);
end
```

Iterative Lambda Search Method

Start with a reasonable lambda range

```
lambda_min = 8;
lambda_max = 12;
lambda = (lambda_min + lambda_max) / 2;

fprintf('Initial conditions:\n');
fprintf('Demand (Pd) = %.2f MW\n', pd);
fprintf('Initial generation: %.2f MW\n', sum(pg));
```

```
fprintf('Initial losses: %.2f MW\n', sum(ploss));

% Main optimization loop
iteration = 1;
converged = false;

while ~converged && iteration <= max_iterations
    fprintf('\n--- Iteration %d ---\n', iteration);

    % Calculate penalty factors
    pf = 1 ./ (1 - 2 * pg .* ploss_coeff);

    % Update generation based on lambda and penalty factors
    for i = 1:N
        % Economic dispatch equation with penalty factor
        pg_unconstrained = (lambda/pf(i) - b(i)) / (2 * a(i));

        % Apply generator limits
        pg(i) = max(pg_min(i), min(pg_max(i), pg_unconstrained));
    end

    % Calculate losses with updated generation
    total_loss = 0;
    for i = 1:N
        ploss(i) = ploss_coeff(i) * (pg(i)^2);
        total_loss = total_loss + ploss(i);
    end

    % Check power balance
    power_balance = sum(pg) - total_loss - pd;

    fprintf('Lambda = %.6f\n', lambda);
    fprintf('Total generation: %.4f MW\n', sum(pg));
    fprintf('Total losses: %.4f MW\n', total_loss);
    fprintf('Power balance: %.4f MW\n', power_balance);

    % Check convergence
    if abs(power_balance) < tolerance
        converged = true;
        fprintf('Converged! Power balance within tolerance.\n');
    else
        % Binary search to adjust lambda
        if power_balance > 0
            % Generation exceeds demand + losses, increase lambda to reduce generation
            lambda_min = lambda;
        else
            % Generation less than demand + losses, decrease lambda to increase generation
            lambda_max = lambda;
        end

        lambda = (lambda_min + lambda_max) / 2;
    end

    iteration = iteration + 1;
end
```

```
Initial conditions:
Demand (Pd) = 975.00 MW
Initial generation: 450.00 MW
Initial losses: 9.38 MW

--- Iteration 1 ---
Lambda = 10.000000
```

```
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 2 ---
Lambda = 11.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 3 ---
Lambda = 11.500000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 4 ---
Lambda = 11.750000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 5 ---
Lambda = 11.875000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 6 ---
Lambda = 11.937500
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 7 ---
Lambda = 11.968750
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 8 ---
Lambda = 11.984375
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 9 ---
Lambda = 11.992188
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 10 ---
Lambda = 11.996094
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 11 ---
Lambda = 11.998047
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW
```

```
--- Iteration 12 ---
Lambda = 11.999023
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 13 ---
Lambda = 11.999512
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 14 ---
Lambda = 11.999756
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 15 ---
Lambda = 11.999878
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 16 ---
Lambda = 11.999939
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 17 ---
Lambda = 11.999969
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 18 ---
Lambda = 11.999985
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 19 ---
Lambda = 11.999992
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 20 ---
Lambda = 11.999996
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 21 ---
Lambda = 11.999998
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 22 ---
Lambda = 11.999999
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
```

```
Power balance: 1.2500 MW

--- Iteration 23 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 24 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 25 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 26 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 27 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 28 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 29 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 30 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 31 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 32 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 33 ---
Lambda = 12.000000
```

```
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 34 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 35 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 36 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 37 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 38 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 39 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 40 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 41 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 42 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 43 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW
```

```
--- Iteration 44 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 45 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 46 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 47 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 48 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 49 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 50 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 51 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 52 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 53 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 54 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
```

```
Power balance: 1.2500 MW

--- Iteration 55 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 56 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 57 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 58 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 59 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 60 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 61 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 62 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 63 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 64 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 65 ---
Lambda = 12.000000
```

```
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 66 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 67 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 68 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 69 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 70 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 71 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 72 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 73 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 74 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 75 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW
```

```
--- Iteration 76 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 77 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 78 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 79 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 80 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 81 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 82 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 83 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 84 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 85 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 86 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
```

```
Power balance: 1.2500 MW

--- Iteration 87 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 88 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 89 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 90 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 91 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 92 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 93 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 94 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 95 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 96 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 97 ---
Lambda = 12.000000
```

```
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 98 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 99 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW

--- Iteration 100 ---
Lambda = 12.000000
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Power balance: 1.2500 MW
```

Display final results

```
fprintf('\n=== FINAL RESULTS ===\n');
fprintf('Optimal lambda = %.6f\n', lambda);

for i = 1:N
    incremental_cost = 2 * a(i) * pg(i) + b(i);
    fprintf('Generator %d: Pg = %.4f MW, Incremental Cost = %.4f $/MWh\n', ...
            i, pg(i), incremental_cost);
end

fprintf('Total generation: %.4f MW\n', sum(pg));
fprintf('Total losses: %.4f MW\n', sum(ploss));
fprintf('Generation - Losses = %.4f MW\n', sum(pg) - sum(ploss));
fprintf('Demand = %.4f MW\n', pd);
fprintf('Power balance check: %.6f MW\n', sum(pg) - sum(ploss) - pd);
```

```
=== FINAL RESULTS ===
Optimal lambda = 12.000000
Generator 1: Pg = 450.0000 MW, Incremental Cost = 8.4780 $/MWh
Generator 2: Pg = 350.0000 MW, Incremental Cost = 9.2080 $/MWh
Generator 3: Pg = 225.0000 MW, Incremental Cost = 9.3980 $/MWh
Total generation: 1025.0000 MW
Total losses: 48.7500 MW
Generation - Losses = 976.2500 MW
Demand = 975.0000 MW
Power balance check: 1.250000 MW
```

Calculate total generation cost

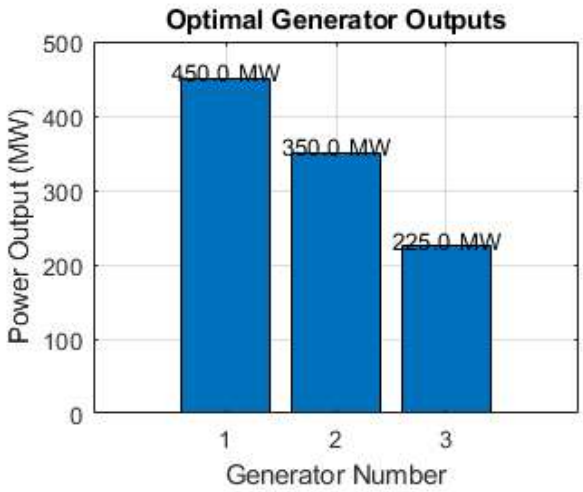
```
total_cost = 0;
for i = 1:N
    % Cost function: a*P^2 + b*P + c
    gen_cost = a(i)*(pg(i)^2) + b(i)*pg(i) + c(i);
    total_cost = total_cost + gen_cost;
end
fprintf('Total generation cost: %.2f $/h\n', total_cost);
```

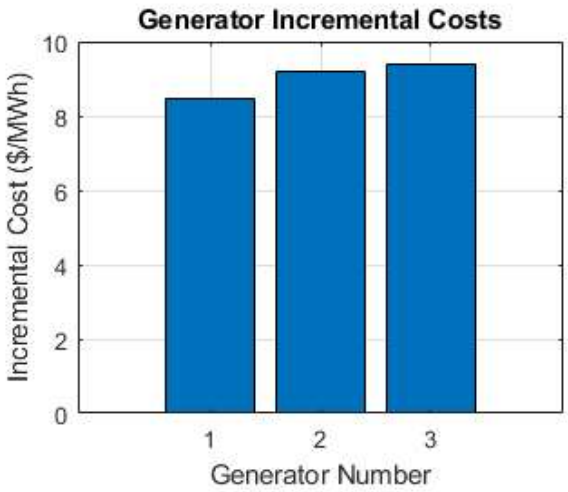
```
Total generation cost: 9638.48 $/h
```

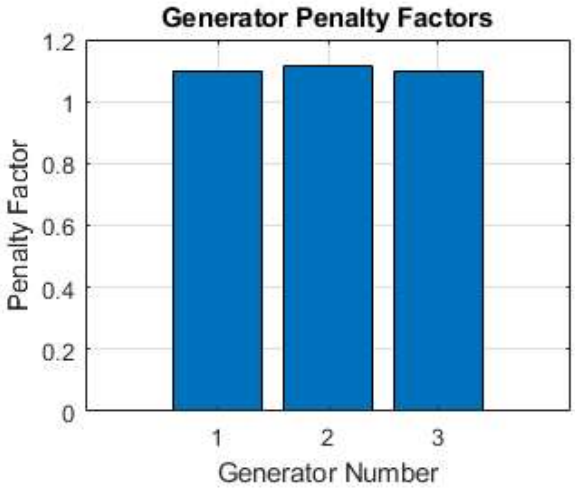
Plot results

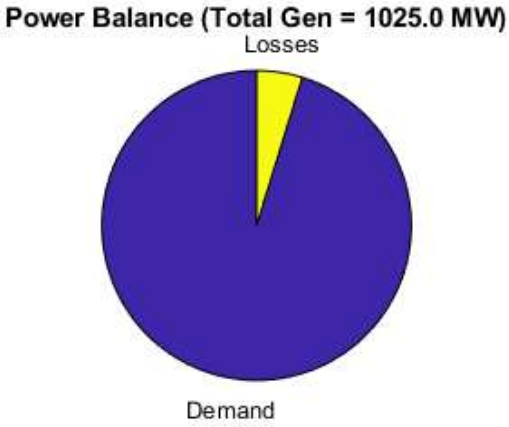
```
figure('Name', 'Economic Load Dispatch Results', 'Position', [100, 100, 800, 600]);

% Generator outputs
subplot(2, 2, 1);
bar(pg);
grid on;
xlabel('Generator Number');
ylabel('Power Output (MW)');
title('Optimal Generator Outputs');
xticks(1:N);
for i = 1:N
    text(i, pg(i)+10, sprintf('%.1f MW', pg(i)), 'HorizontalAlignment', 'center');
end

% Incremental costs
subplot(2, 2, 2);
inc_costs = zeros(N, 1);
for i = 1:N
    inc_costs(i) = 2 * a(i) * pg(i) + b(i);
end
bar(inc_costs);
grid on;
xlabel('Generator Number');
ylabel('Incremental Cost ($/MWh)');
title('Generator Incremental Costs');
xticks(1:N);

% Penalty factors
subplot(2, 2, 3);
pf = 1 ./ (1 - 2 * pg .* ploss_coeff);
bar(pf);
grid on;
xlabel('Generator Number');
ylabel('Penalty Factor');
title('Generator Penalty Factors');
xticks(1:N);

% Power balance
subplot(2, 2, 4);
pie([pd, sum(ploss)], {'Demand', 'Losses'});
title(sprintf('Power Balance (Total Gen = %.1f MW)', sum(pg)));

fprintf('\nOptimization complete.\n');
```

```
Optimization complete.
```









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