Level 2 CHP Feasibility Studies
Overview and Checklist

The tool provides an introduction to the elements of a Level 2 CHP feasibility study. It also includes a checklist that energy users who are considering implementing CHP at their facilities can use to:

- Review the results of a completed Level 2 CHP feasibility study for completeness
- Help develop the scope for the procurement of a Level 2 study

The checklist is a comprehensive listing of the items and issues that are considered in Level 2 studies. Please note, however, that each item in the checklist may not apply to every project.

What Is a Level 2 Feasibility Study?

A Level 2 CHP feasibility study is a detailed analysis of the economic and technical viability of installing a CHP system. Usually, a Level 2 study will consider the return on investment for multiple CHP system sizes, prime movers, and heat applications. The Level 2 study normally follows a Level 1 CHP feasibility analysis and is based on more detailed engineering and operational data from the site.

The **purposes** of a Level 2 study are to:

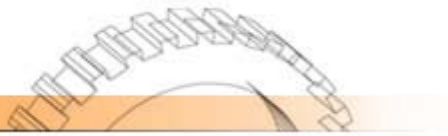
- Replace the assumptions used in the Level 1 feasibility analysis with verified data to identify optimal CHP system configuration and sizing, appropriate thermal applications, and economic operating strategies.
- Estimate final CHP system pricing.
- Calculate return on investment.

The **outcomes** of a Level 2 study are:

- Pricing estimates for construction and operation and maintenance of the CHP system.
- Existing and projected utility rate analysis.
- Final project economics, including simple payback and life-cycle cost analysis of the investment.

The **goals** of a Level 2 study are to:

- Ensure that the recommended CHP system meets the operational and economic goals of the investor.
- Provide all the information needed to make a final investment decision.



Who Can Conduct a Level 2 Feasibility Study?

Different types of companies, including engineering firms, independent consultants, project developers, and equipment suppliers, can conduct Level 2 studies. *Project developers* and *equipment suppliers* may do so for reduced costs if the end user agrees to move forward with them on the project if the results of the feasibility study meet some mutually agreed upon threshold. Alternatively, *engineering firms or consultants* can provide an independent third-party analysis of the CHP opportunity at an end-user's site.

Regardless of the type of organization selected for the Level 2 study, end users should look for the following critical qualities and capabilities when selecting the company that will conduct the analysis:

- Previous experience with CHP and with the type of application under study.
- Sufficient in-house resources covering a full range of expertise, including engineering, finance, operation, and environmental permitting.
- A proven track record of successfully completed Level 2 studies.

A number of CHP Partners provide both the experience and resources required for a successful Level 2 study. To review a list of CHP Partners, visit www.epa.gov/chp/chp_partners.htm.

Suggestions for Ensuring the Success of a Level 2 Feasibility Study

A number of best practices have emerged for conducting successful Level 2 CHP feasibility studies. End users can use the best practices that follow as models as they undertake their own studies.

- Before the Level 2 study begins, it is recommended that the end user work together with the engineer, consultant, project developer, or other entity selected to perform the analysis to develop a mutual understanding of all operational goals for the project, including needs for control, monitoring and maintenance, and whether the system will be designed to run in the event of a utility outage. The potential for future load growth, due either to planned site expansion or new construction, should also be considered.
- Successful Level 2 feasibility studies generally involve multiple site visits and thorough review of existing electrical, mechanical, and structural drawings.
- Accurate system pricing generally involves making upfront determinations about system size and location, prime mover, thermal applications, and preliminary design drawings, including flow diagrams, equipment specifications, monitoring and control specification, piping and wiring, and tie-in to existing building systems.
- Level 2 studies may need to include a detailed thermal and electrical load profile to determine final system sizing and operation. To the extent possible, hard data should be used to develop these profiles, pulled from electric utility interval data, existing controls systems and/or the installation of data-loggers at the site.

CHECKLIST FOR LEVEL 2 FEASIBILITY STUDIES

1 EXECUTIVE SUMMARY

- 1.1 Clear delineation of the objective of the feasibility study.
- 1.2 Brief description of site, energy needs, and recommended CHP equipment selection.
- 1.3 Overview of project concept and economics. Simple payback, net present value, and/or discounted cash flow for various financial arrangements.
- 1.4 Recommendations and rationale.

2 DESCRIPTION OF EXISTING SITE PLAN AND EQUIPMENT

- 2.1 Description of existing site and major energy consuming equipment; identify systems/equipment that could be replaced or impacted by the proposed CHP system.
- 2.2 Plot plan of site and proposed location of CHP system.
- 2.3 Description and location of existing electric feeds, transformers, and meters including critical parameters such as voltage.
- 2.4 Description and location of existing gas lines, meters, fuel storage, etc., including critical parameters such as pressure and capacity.
- 2.5 Identification of any site/location constraints or restrictions (site access, adjacent properties, noise/zoning limitations).
- 2.6 Site expansion plans, if applicable.
- 2.7 Emergency/back-up power requirements and existing generating equipment.
- 2.8 Review of any possible power and thermal energy sales arrangements.

3 SITE ENERGY REQUIREMENTS

- 3.1 Review of recent gas and electric bills.
- 3.2 Review of current and projected gas (or other fuel) and electric rates.
- 3.3 Development of average hourly use patterns for each type of energy (on a seasonal basis if appropriate) with thermal energy uses segregated by type/quality (e.g., temperature, pressure, form [steam, hot water, hot air]).
- 3.4 Tables and/or graphs showing daily and annual use profiles for each form of energy (e.g., electric/steam/hot water/chilled water).
- 3.5 Breakdown of energy usage, by type of energy, for equipment that is to be displaced by CHP.
- 3.6 Review of CHP analysis methodology.
  - 3.6.1 Description of computer modeling methods used.
  - 3.6.2 Displaced thermal loads estimates and methodology

3.6.3 Displaced electrical requirement estimates and methodology.

4 CHP EQUIPMENT SELECTION

4.1 Rationale for equipment selection.

4.1.1 Thermal output
4.1.2 Capacity
4.1.3 Emissions
4.1.4 Site constraints
4.1.5 Other

4.2 Discussion of alternative CHP system configurations

4.3 A quantitative and qualitative comparison of prime movers evaluated, including model, kW capacity, fuel consumption comparison, seasonal performance, electric and thermal energy displaced, sound levels, emissions, maintenance requirements, availability/reliability, net revenue, capital cost, simple pay back, or other "profitability index" used by the client.

5 DESCRIPTION OF PREFERRED CHP SYSTEM

5.1 System description – prime mover, generator, heat recovery

5.2 Electric and total CHP efficiency, amount of site energy displaced

5.3 Schematic of system – detailed layout

5.4 Single line diagram of thermal system

5.5 Single line diagram of electrical system.

5.6 System tie-ins

5.7 Controls and monitoring

5.8 Necessary site modifications

6 SYSTEM OPERATION

6.1 Operating hours per year.

6.2 Recommended operating profile (e.g., thermally base loaded, electric load following, peaking).

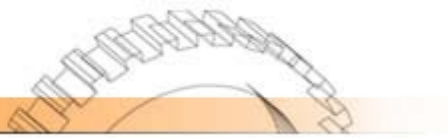
6.3 Stand-alone (islanding) and black start capability needed?

6.3.1 Is load shedding required? If so, how is it implemented? How is crossover accomplished?

7 REGULATORY AND PERMITTING REQUIREMENTS OVERVIEW

7.1 Review and description of emissions requirements for permitting, including source(s) of information.

7.2 Review and description of local siting and zoning requirements.



8 TOTAL CHP SYSTEM COSTS

8.1 Total costs – Summary of all inclusive or turnkey costs.

8.1.1 Capital costs - equipment
8.1.2 Installations costs – engineering, construction, commissioning

8.2 Capital costs - line item breakdown of major equipment/component costs.

8.2.1 Prime mover
8.2.2 Fuel compressor (if needed)
8.2.3 Black start capability (if needed)
8.2.4 Generator
8.2.5 Heat recovery
8.2.6 Cooling tower or other heat dump
8.2.7 Site electric tie-in and grid interconnection (islanding requirements included if needed)
8.2.8 Controls
8.2.9 Site thermal tie-in
8.2.10 Additional thermal utilization equipment (e.g., absorption chillers)
8.2.11 Other equipment/modifications

8.2.11.1 Sound attenuation
8.2.11.2 Stack
8.2.11.3 Inlet air handling
8.2.11.4 Vibration

8.2.12 Emission controls

8.3 Installation costs – line-item breakdown of engineering, permitting, construction, and contingency costs

8.3.1 Site preparation
8.3.2 Buildings (if needed)
8.3.3 Materials
8.3.4 Engineering
8.3.5 Construction
8.3.6 Permitting fees
8.3.7 Contingency

9 Non-fuel O&M costs (fixed and variable) – details on maintenance costs for major system components and site interfaces; information on costs of turnkey versus self-maintenance, and major maintenance/overhaul items and schedule

9.1 Prime mover

9.2 Heat recovery equipment

9.3 Thermal utilization equipment

9.4 Emissions control

10 PROJECT SCHEDULING-BREAKDOWN OF EACH PHASE (should include major subcategories or elements)

10.1 Purchase of equipment.

10.2 Construction

10.3 Permitting

10.4 Commissioning

11 ASSUMPTIONS FOR CASH FLOW ANALYSIS

11.1 Financing options and assumptions

- 11.1.1 Debt/equity ratio
- 11.1.2 Discount rate
- 11.1.3 Interest rate/Cost of debt
- 11.1.4 Tax rate

11.2 Total installed costs

- 11.2.1 CHP equipment and installation from Section 8 above
- 11.2.2 Any capital credit for displaced equipment purchases

11.3 Operation and maintenance

- 11.3.1 Self maintained
- 11.3.2 Supplier/vendor maintenance contract

11.4 Fuel and electric rates

- 11.4.1 Based on detailed tariffs/rates
  - 11.4.1.1 Electric – customer charge, demand charge, commodity charge; peak, off-peak, shoulder
  - 11.4.1.2 Gas – commodity, delivery
- 11.4.2 Provide fuel/electric escalation rates assumed for outyears.
- 11.4.3 Review any changes to tariffs due to CHP
  - 11.4.3.1 Supplemental electric tariffs
  - 11.4.3.2 Standby rates/exit fees
  - 11.4.3.3 Gas incentive rates

11.5 Any additional costs or credits

- 11.5.1 Incentives
- 11.5.2 Value of reliability
  - 11.5.2.1 Cost of facility outages and value of increased power reliability
- 11.5.3 Other benefits that can be monetized or assigned value
  - 11.5.3.1 Emission credits
  - 11.5.3.2 Other

11.6 Sensitivity analysis – impact of varying:

- 11.6.1 Fuel costs
- 11.6.2 Electric rates
- 11.6.3 Incentives