Assessing Microgrid Feasibility: Getting to Yes (or No)

Boston, June 29, 2016

Laxmi Rao, International District Energy Association
ABOUT IDEA

Non-profit industry association formed in 1909

2000 + members – 26 nations

Major urban utilities, public and private universities & colleges, healthcare, pharma, airports, industry

Education, Outreach & Industry support
District Energy – Community Scale Heating and Cooling

- Underground pipe network enable “combining” heating and cooling requirements of multiple buildings

- Creates a “market” for valuable thermal energy

- Aggregated thermal loads creates scale to apply fuels, technologies not feasible on single-building basis

- **Fuel flexibility** improves energy security, local economy
Infrastructure for Local Clean Energy Economy

- Connects thermal energy sources with users
- **Enables CHP and Resiliency**
- Urban infrastructure – hidden community asset
- Energy dollars re-circulate in local economy,
- Improves livability
Districts, Municipalities, Towns, Cities
Future-Prooﬁng an Energy Efﬁcient Infrastructure
Planning Community Energy

The Built Environment
- Climate Zone
- Building types and sizes
- Land area
- Plausible piping routes

Buildout Phasing Rate

The Energy Environment
- cost of gas
- cost of electric energy & power
- utility obligations
- net metering
- electric standby

The Financial Environment
- expectation of return
- Life Cycle Term
- Equipment Costs
- Construction Costs
- Escalation
- Labor Costs

EFFICIENCY

RELIABILITY

GHG REDUCTION

DISASTER RESILIENCY
Questions

• Urban Planners
• Developers
• Architect/Engineers
• Facility Managers
• DE enterprises
• Financiers

• What Type?
• How Big?
• How Soon?
• How Much?
• Environmental Impact
• Economic Return
• Resiliency
Planning Guide for Community Energy

- **Project champions:** Mayors, community energy, economic development and sustainability staff, elected officials, planners
- Consider energy in comprehensive planning, brownfield/revitalization projects, Climate Action Plans
- Variety of project developers: opportunities for collaboration and public/private partnerships
  - Local governments
  - Communities
  - Other public sector developers
  - Institutions
  - Corporations and industrial parks
  - Private property developers
  - Landowners and building operators
COMMUNITY ENERGY: PLANNING, DEVELOPMENT AND DELIVERY

Stages of Development

1: Objectives Setting
2: Data gathering
3: Project definition
4: Options appraisal
5: Feasibility study
6: Financial modeling
7: Business modeling
8: Marketing and business development;
9: Project procurement
10: Delivery
Objectives Setting

Economic

• Strengthen local economy, retain energy dollars, stable high-quality jobs
• Develop infrastructure to exploit locally sustainable energy supplies
• Keep energy rates down

Energy security

• Reduce reliance on imported energy and lessen impact of volatile market
• Enable fuel flexibility
• Enhance reliability and resilience

Emission reductions

• Energy Efficiency
• Lower carbon solutions
Data Gathering

- Development building mix
- Build-out and phasing
- Anchor loads
- Heating/cooling loads
- Physical barriers

- Other existing infrastructure: gas and heat networks and electricity sub-stations; waste-to-energy plants, industrial processes that dump heat; transport infrastructure for bulky fuels such as biomass

- Financial Factors: escalation rate, hurdle rate, energy prices.....
Project Definition

<table>
<thead>
<tr>
<th>Occupancy Type</th>
<th>input values here</th>
<th>input values here</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Office</td>
<td>1,000,000</td>
<td>3</td>
</tr>
<tr>
<td>Medium Office</td>
<td>1,500,000</td>
<td>10</td>
</tr>
<tr>
<td>Small Office</td>
<td>300,000</td>
<td>20</td>
</tr>
<tr>
<td>Warehouse</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stand Alone Retail</td>
<td>500,000</td>
<td>4</td>
</tr>
<tr>
<td>Strip Mall</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Primary School</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Secondary School</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Supermarket</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Quick Service Restaurant</td>
<td>30,000</td>
<td>4</td>
</tr>
<tr>
<td>Full Service Restaurant</td>
<td>30,000</td>
<td>4</td>
</tr>
<tr>
<td>Hospital</td>
<td>1,200,000</td>
<td>1</td>
</tr>
<tr>
<td>Outpatient Health Clinic</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Small Hotel</td>
<td>250,000</td>
<td>2</td>
</tr>
<tr>
<td>Large Hotel</td>
<td>500,000</td>
<td>1</td>
</tr>
<tr>
<td>Midrise Apt</td>
<td>1,000,000</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6,310,000</strong></td>
<td><strong>59</strong></td>
</tr>
</tbody>
</table>
IDEA First Order District Energy/CHP Screening Tool

High level understanding of opportunity

• **Data** – Regional Load Profiles, Energy Prices, Labor Rates, Financial Rates, Pipe Cost,
• **Project Definition** - District Composition, Phasing
• **Options appraisal** – Comparing with Baseline
• **Feasibility** - Net Present Value

What should we do next?
Life Cycle Cost = CAPEX + OPEX

- CAPEX: Initial Investment
- OPEX for 25 years
Screening Tool Alternatives

• Stand Alone Building Plant – BAU

• Build a District Energy System

• Build a District Energy System with Combined Heat and Power

• Connect to Existing District Steam System
Screening Tool Options

BAU – Stand alone building system

vs

District Energy system with CHP
Capital Expense

• Unit Cost estimates by system type
  – Boilers
  – Chillers
  – Electrical CHP equipment
  – Distribution Piping
  – Building SF Costs (n Roof, mechanical room)

• Debt Service
Operating Expense

• Energy Costs
• Labor Costs
• Maintenance Costs (LTSA)
• Consumables
Building Energy Demand Sources

• DOE 8760 hours reference building data
  OR

• Existing hourly meter data
  – Electric power, natural gas, cooling
Load Profiles – Residential, Office
District Energy Composite Demand Profile

annual (24 x 365) district electric load

Power (MWh)

Time of Year

INTERNATIONAL DISTRICT ENERGY ASSOCIATION
Energy Load Profiles
Location Dependent
Economic Considerations

• Discount Rate/ Hurdle Rate

• Escalation Rates
  – Electricity
  – Natural Gas
  – General Inflation

• Loan Terms
Phasing & Site Master Plan

PRELIMINARY DEVELOPMENT PROGRAM

<table>
<thead>
<tr>
<th>USE</th>
<th>QUANTITY</th>
<th>DEVELOPMENT AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>1,191 units</td>
<td>1,538,250 SF</td>
</tr>
<tr>
<td>Commercial</td>
<td>208,750 SF</td>
<td>208,750 SF</td>
</tr>
<tr>
<td>Office</td>
<td>608,000 SF</td>
<td>608,000 SF</td>
</tr>
<tr>
<td>Hotel</td>
<td>150 rooms</td>
<td>150,000 SF</td>
</tr>
<tr>
<td>Structured Parking</td>
<td>2,215 spaces</td>
<td>750,750 SF</td>
</tr>
<tr>
<td>Open Space</td>
<td>5.8 acres</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>GRAND TOTAL</strong></td>
<td><strong>3,251,750 SF</strong></td>
<td></td>
</tr>
</tbody>
</table>

Illustrative Plan Key
- MEDIUM DENSITY RESIDENTIAL
- HIGH DENSITY RESIDENTIAL
- RETAIL AND MIXED-USE
- MEDIUM OFFICE BUILDINGS
- HOTEL
- COMMUNITY CENTER
- STRUCTURED PARKING
- SURFACE PARKING
* MIXED-USE MAY CONTAIN COMMERCIAL, OFFICE, AND OR RESIDENTIAL USES.
IDEA District Energy Screening Tool Processing Summary

• Excel Spreadsheet

• Inputs

• Derive Composite Energy Load Profiles

• Calculate annual operating costs of alternatives

• Develop cash flow projections, compute NPV of alternatives – COST ONLY
District Energy Screening Tool

• Provides a way to:
  – Explore Concepts with Team
  – Organize Data
  – Evaluate Sensitivity
  – Educate Team

• Quantifies high level estimates to get to: