Best Practices from Energy Master Planning at three North American Universities

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Laxmi Rao, International District Energy Association

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Agenda

About District Energy

Benefits of Energy Master Plans (EMP)

Landscape for Community EMP

Incorporating Objectives and Constraints

Developing Energy Master Plans

Energy Master Plans of Three North American Campuses – Best Practices and Learnings

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

ABOUT IDEA

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Formed in 1909: 111th year

501 (c) 6 non-profit industry association; near Boston, MA USA

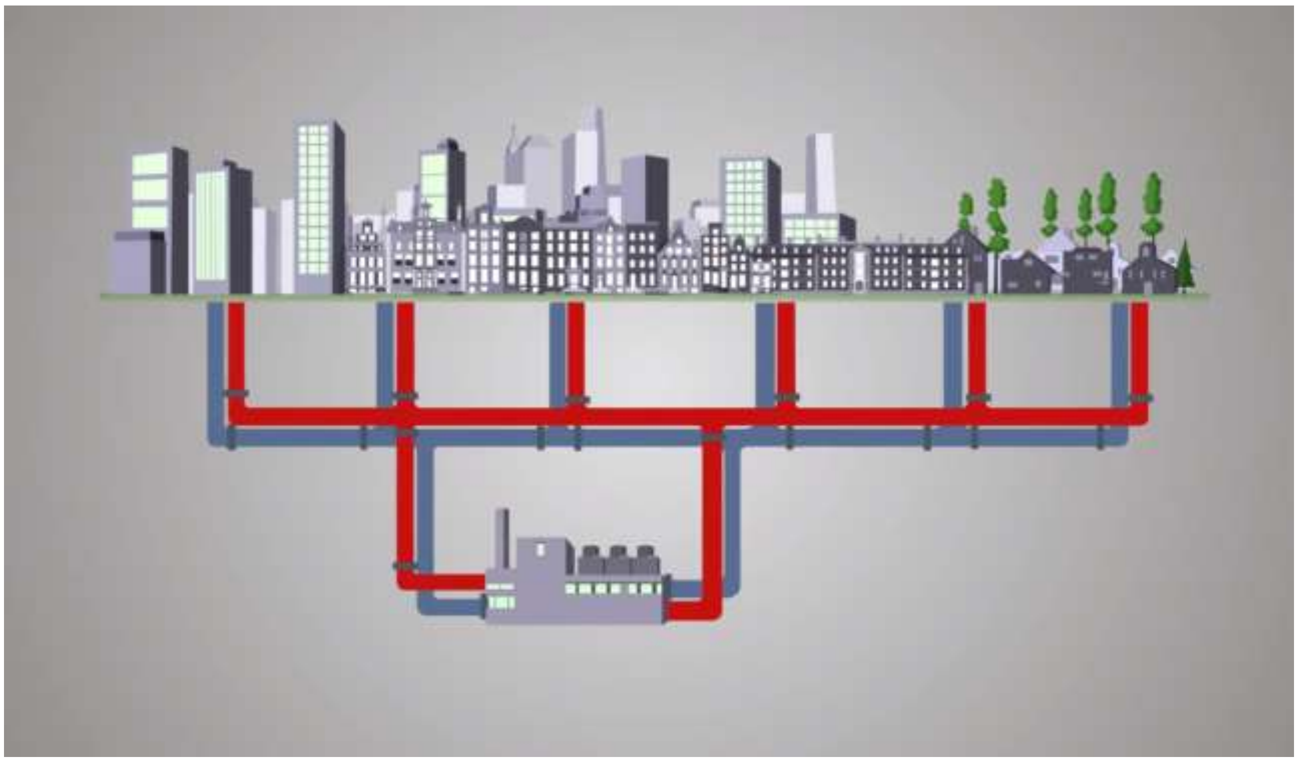
2500+ members – 27 nations

56% end-user systems, majority in North America

Major urban utilities, public/private universities & colleges, healthcare, pharma, airports, industry, etc.

District Energy
Community Scale Heating & Cooling

- Underground network provides urban infrastructure and enables "**combining** " heating & cooling loads of multiple buildings
- Aggregated thermal loads creates **scale** to apply fuels, technologies not feasible on single-building basis



- **Enables CHP & fuel flexibility**
- **Connects** thermal energy sources with users
- Re-circulate energy dollars in **local economy**

Benefits of Energy Master Plans

- **Leading activity that helps plan the energy systems for managing growth or changed functions**

- **Provides pathways for risk mitigation**

- **Helps evaluate stakeholder objectives overlaid on technical alternatives**

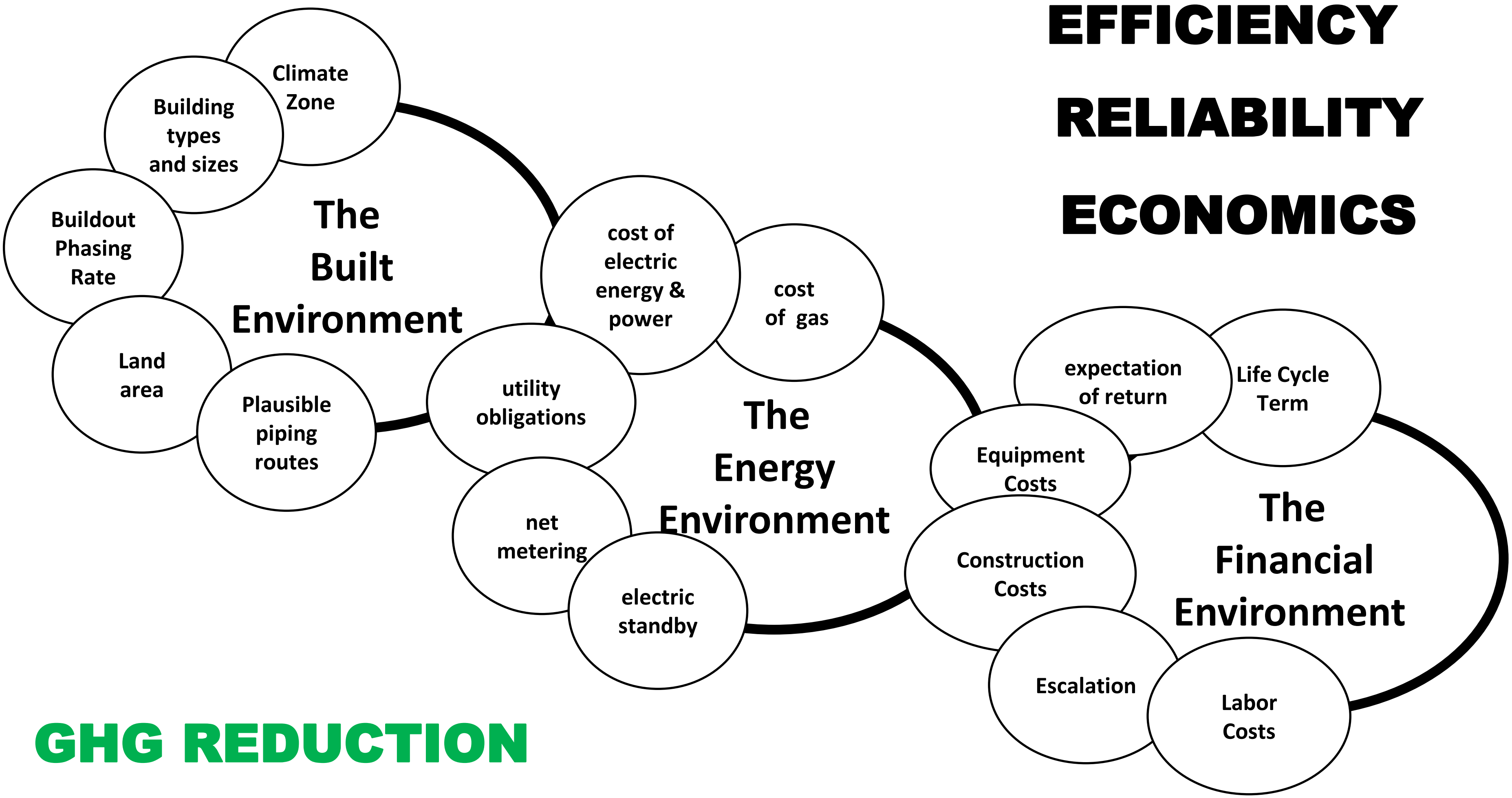
- **Enables looking beyond a buildings energy conservation project and study alternatives that are feasible across clusters of building**

Landscape for Community Energy Master Planning

EFFICIENCY

RELIABILITY

ECONOMICS



GHG REDUCTION

DISASTER RESILIENCY

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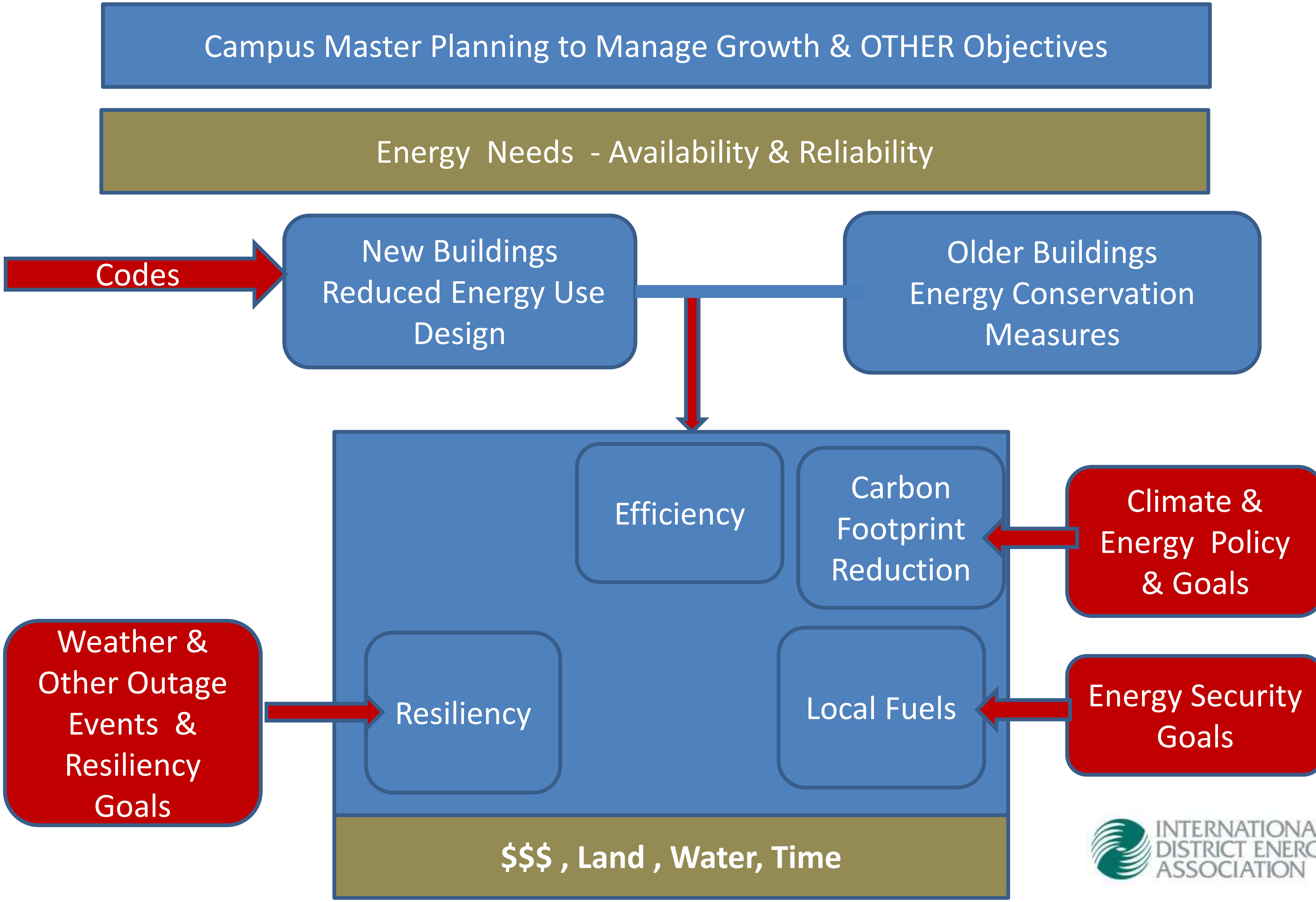
Incorporating Objectives and Constraints



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Developing Energy Master Plans

Stakeholders

- Project Initiators
- City, State and Federal Agencies
- Architect/Engineers/Planners
- Facility Managers
- Developers
- DE enterprises
- Financiers
- Students

Questions

- What Technologies?
- How Big?
- How Soon?
- Economic Return?
- **Environmental Impact?**
- **Resiliency?**
- **Energy Security?**

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3 North American EMP sites

UC Davis - California National Primate Research Centre (CPNRC)

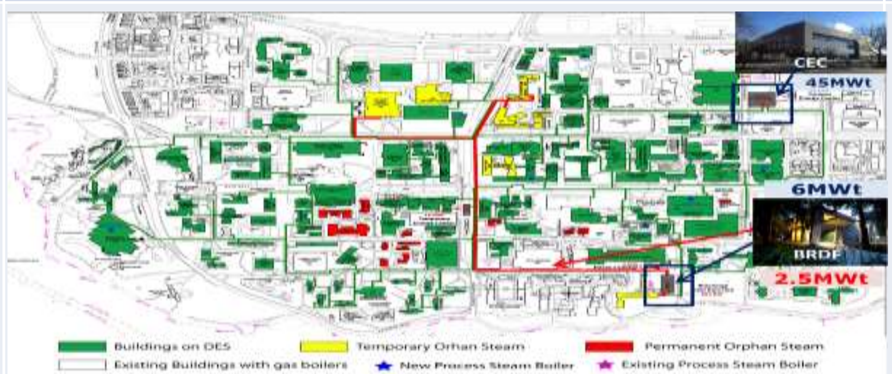
UC Davis California National Primate Research Center

Modernizing district heating and leveraging renewable solar thermal

UT Austin - New Medical District

Supporting fast track mission-critical campus healthcare expansion

University of British Columbia (UBC) - Bioenergy Research and Demonstration Facility (BRDF)



Resource for The Evolution of Low Carbon District Energy and Innovative Solutions

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3 North American EMP's

Campus	Systems	Location	Climate Zone (ASHRAE-IECC)
UC Davis	Power, Heating and Cooling	Davis, California, USA	Mediterranean
UT Austin	Power, Heating and Cooling	Austin, Texas, USA	Humid-subtropical
UBC	Power, Heating	Vancouver, BC, Canada	Oceanic

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Drivers and Objectives

UC Davis	UT Austin	UBC
• **Aging** district heating and cooling systems • UC Davis and U. of California's Policy on Sustainable Practices **GHG targets** • Improved **Reliability & Efficiency**	• New **fast-track** Medical Campus • UT Austin **GHG targets** • **Minimize system needs** to meet new growth • Improved **Reliability & Efficiency** • **Demand Side** Efficiency	• **Aging** steam system • UBC Climate Action Plan **GHG targets** • Vancouver **seismic risk** • Improved **Reliability & Efficiency**

Resiliency

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<tr><th>UC Davis</th><th>UT Austin</th><th>UBC</th></tr>
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Diverse heating supply
solar thermal panels/ hot water boilers
Dual Fuel sources:

biogas from landfill/biodigester
Natural gas

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100% on-site generation N+1 redundancy for prime movers
Redundant electric interconnection to the Austin Energy grid
Thermal energy storage tank for planned and unplanned chilled water outages
Triple redundancy hot water loop
1. Heat pump chiller.
2.Hot water boilers when the heat pump chiller cannot operate due to low loads
3.Steam-to-hot-water plant served by the main campus CHP system.

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Replaced old powerhouse with new facility designed for seismic risk.
Fully redundant second electric transmission line from grid.

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Outcomes

UC Davis	UT Austin	UBC
• Solar Thermal - 17% of the CNPRC heating load option to expand • • Supplemental gas-fired hot water boilers with a new heating hot water (HHW) distribution system to supply 83% of the heating load. • Hot Water Thermal Energy Storage for 2000 gallons • Additional electric chillers to provide cooling	• Medical District power from existing UT Austin 134 MW CHP plant. • Hot water system with a heat pump chiller and watertube boilers to provide 53,000 MBH • A new15,000t on Chiller Station • 5.5-million-gallon chilled water thermal energy storage tank to provide 5 MW peak load shifting capacity.	• Converting steam to hot water • Bioenergy Research and Demonstration Facility (BRDF) BRDF to provide renewable heat and power. • Facility close to 1 million dry tons of waste

Best Practices & Learnings from Energy Master Planning at 3 North American Universities

COOPERATION & PEOPLE

- Identify, involve, engage and manage stakeholders and drivers **from the start and even through commissioning and first year of operation.**

- **Stakeholders - the list can be long!**

  University Staff from various units: Utility, Facility, Sustainability, Energy and Water Services, Project Services, Building Operations, Risk Management Services, Infrastructure Development, Campus Planning, Finance, Treasury, Legal Services, and Human Resources End User staff, Engineering Firm, Major Equipment Vendors

- Develop a well-rounded project team with major **stakeholders included in decision making process**

- **Establish good, frequent communication**
    - UBC BRDF located next to residential community
    - multiple public engagement events before construction
    - community emissions committee during the first year of operations

- Community engagement **takes time and effort**

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DATA & ANALYSIS

- Using **real data** vs estimates or factors
- Determine what are the **critical functions for resiliency**
- Using **Life Cycle Cost Analysis** to evaluate the economics of proposed alternatives
- **Aligning** NPV with GHG reduction, reliability and redundancy objectives
- Design-build project delivery method to **fast track** and get budget flexibility through an open-book approach
- **Proving** the central plant concept **rates f**or chilled water and hot water were less expensive than stand alone equipment in the respective buildings

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ALIGNMENT & INTEGRATION

- EMP should **align with Campus Master plans** for growth and function
- **Integrate Building** Energy Conservation Measures into EMP
- Engage in **long-term thinking** and integrate **local energy resources**
- For expansions and modular campuses look for **integration with existing energy systems**
- The EMP process is an **iterative planning process that involves people, technology and $**

Thank You

Laxmi Rao, International District Energy Association,

Collaborators

Juan Ontiveros, UT Austin

Joseph Yonkoski , UC Davis

Joshua Wauthy, & Paul Holt, University of British Columbia

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