Rice University's Net-Zero Carbon Path

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Like many college and university campuses, Rice University in Houston, Texas is striving to balance multiple (and sometimes conflicting) needs and goals:

- Serve a growing campus (25 percent increase in conditioned space planned)
- Provide reliable utility services
- Reduce operating costs
- Address deferred maintenance
- Achieve sustainable, net-zero carbon campus

Through an integrated master planning process, Rice found that it could address all of these needs and goals. Starting in 2012, Rice partnered with Sebesta, Inc. to develop the 30-year Rice Integrated Climate and Energy Master Plan, or RICEMaP. Other institutions can learn from Rice's experiences as they strive to take control of energy, financial, maintenance, and infrastructure factors on campus.

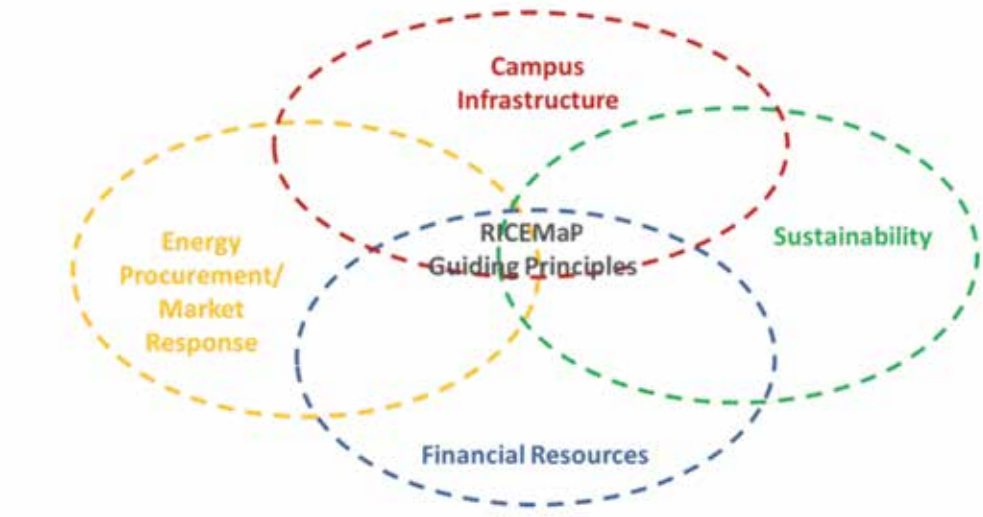
THE PROCESS

The master plan included an integrated analysis of the way energy is produced, distributed, and used on Rice's campus.

The process started with establishing a baseline of the age, condition, and capacity of the campus utility production and distribution systems. The campus already had chiller plants, boiler plants, and cogeneration capabilities, but it was anticipated that upgrades and the addition of new equipment over the 30-year master plan horizon would be essential to meeting campus energy needs.

In parallel with the analysis of campus utility production and distribution systems, the RiceMaP team investigated energy usage profiles of campus academic, administrative, residential, and research buildings. Based on detailed energy audits of representative campus facilities, the team developed an achievable target of 30 percent energy reduction, with a simple payback of 2.5 years.

Employing techniques similar to those used in its analyses of the campus buildings, the RICEMaP team discovered ways to improve plant operations. An example is the installation of steam piping to interconnect the campus's North and South plants, which provides more flexibility and efficiency in plant steam production operations, as well as increased reliability.



MASTER PLAN

Combining the findings of the utility infrastructure and building efficiency investigations, the team developed an integrated analyses of future energy requirements and associated investments for the campus over the 30-year RICEMaP horizon. They compared four scenarios in terms of capital cost, operating expense, and associated environmental performance:

- Scenario 1: Business as usual. This is the baseline scenario if Rice continues with current facility operations while expanding its facilities to meet future campus growth.

Figure 1: RICEMaP 30-Year Present Value Comparison of Four Scenarios

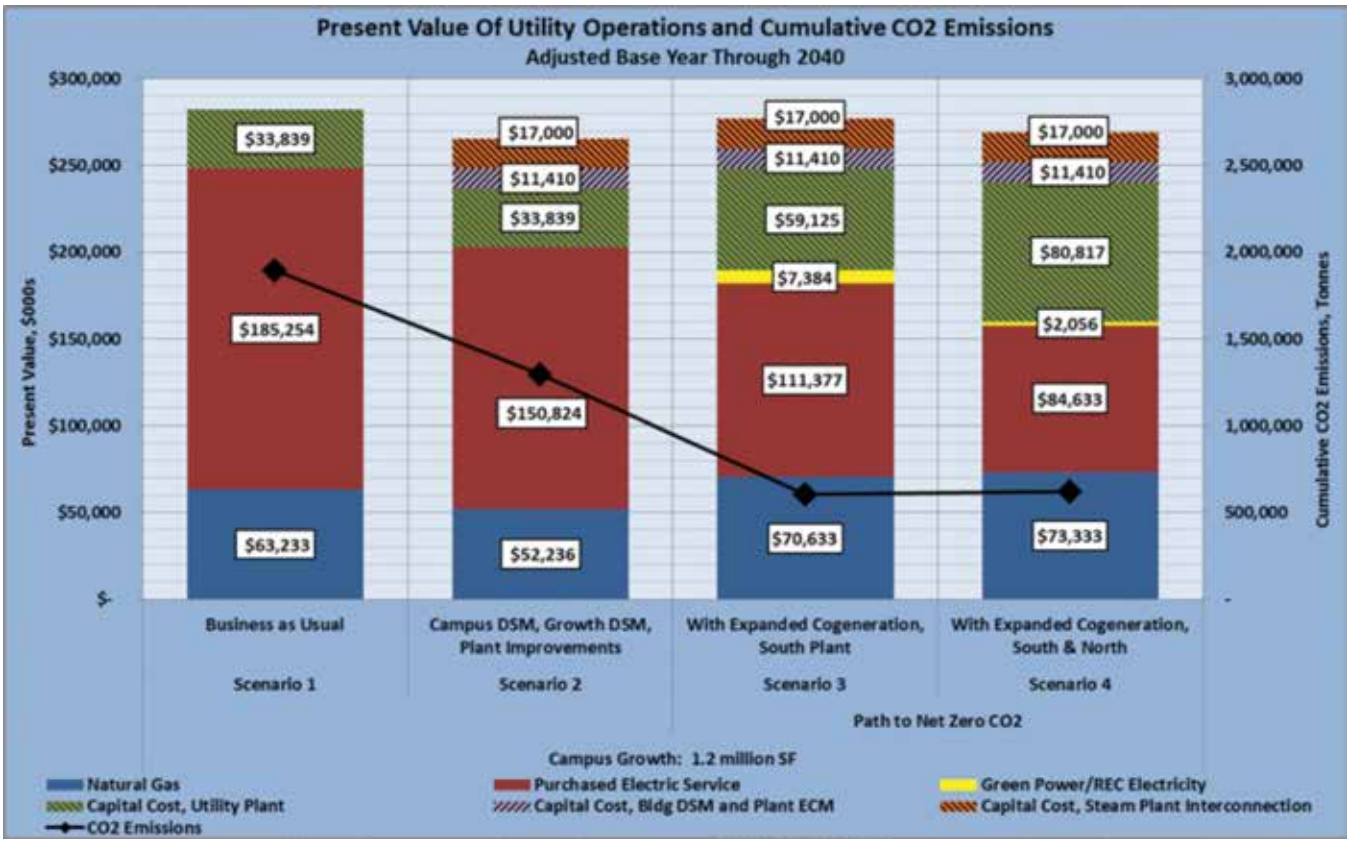
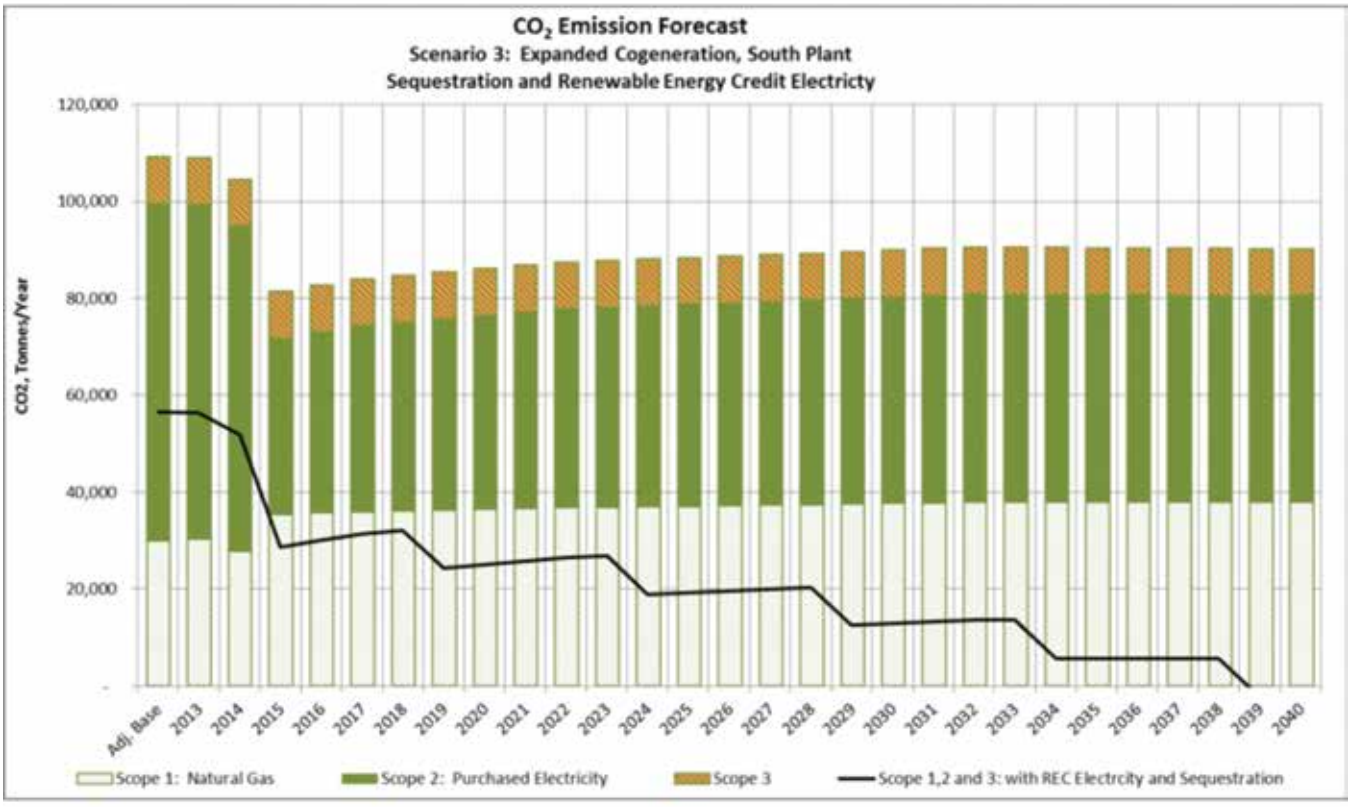


Figure 2: RICEMaP Scenario 3 Net-Zero Carbon Strategy.



- Scenario 2: This scenario examined the impact that investing in campus energy-efficiency and plant operational improvements would have on freeing up utility capacity to meet future growth.
- Scenario 3: Building on Scenario 2, this scenario included installing 6.2 megawatts of cogeneration capacity at the campus's South Plant.
- Scenario 4: Building on scenario 3, this scenario included expanded cogeneration capacity at the campus's North Plant when the current cogeneration system needs to be replaced (estimated for 2024).

Figure 1 compares the 30-year present value of capital cost and operating expense for each scenario and the cumulative greenhouse gas (GHG) emissions (black line).

Scenario 1, the business-as-usual scenario, has the highest overall cost, with a $282 million net present value over the 30-year study period.

For Scenario 2, it was determined that by investing $28.4 million in energy-efficiency improvements in campus buildings and infrastructure, Rice could offset the need to add more utility production capacity to support campus growth, and also reduce total campus energy and capital costs, achieving a net present cost reduction of more than $17 million. This scenario would also reduce cumulative campus GHG emissions over the 30-year period by about 30 percent (see black line in Figure 1).

For Scenario 3, investing an additional $25 million in cogeneration infrastructure (beyond Scenario 2) at the South Plant, plus purchasing $7.4 million in green power, reduces cumulative campus GHG emissions by 68 percent compared to Scenario 1. Scenario 3 has a total net present cost savings of $5 million versus Scenario 1.

Scenario 4 has a $13 million savings compared to Scenario 1, while reducing campus GHG emissions by about 70 percent.

Through deploying a combination of renewable energy generation and carbon sequestration strategies (see Figure 2), it was projected that Rice could reasonably achieve its net-zero carbon goal by 2038.

RICEMAP IMPLEMENTATION

Completed in 2013, RICEMaP provided the campus administration with a clear roadmap and financial justification for investing in building and utility system infrastructure. Campus administration selected Scenario 3 for implementation. Rice has begun to implement the recommended campus building energy-efficiency and utility infrastructure improvements, and has also begun to generate onsite renewable electric energy and to procure it off-site as well.

LESSONS LEARNED

There are valuable lessons to be learned from Rice's journey. An integrated approach to facility and utility plant efficiency can free up plant capacity to support future growth, eliminating the need for costly central plant expansion projects. And through long-term planning, future operating cost savings can more than offset investments in campus infrastructure, while improving campus reliability and sustainability.

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