



Integrated Energy Portfolio

Optimizing Campus Use and Procurement

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Challenges of Energy Master Plans

- Energy Master Plans are an extension of the Capital Plan and Campus Master Plan processes
 - 5-year horizon
 - Itemized initiatives and projects
 - Dominant focus on payback through savings
- Campus modernization, resiliency and sustainability goals exist through 2050 and beyond
- Energy project and procurement commitments last up to 30 years
 - Renewable Energy
 - CHP
 - Micro Grid
 - Conservation Projects

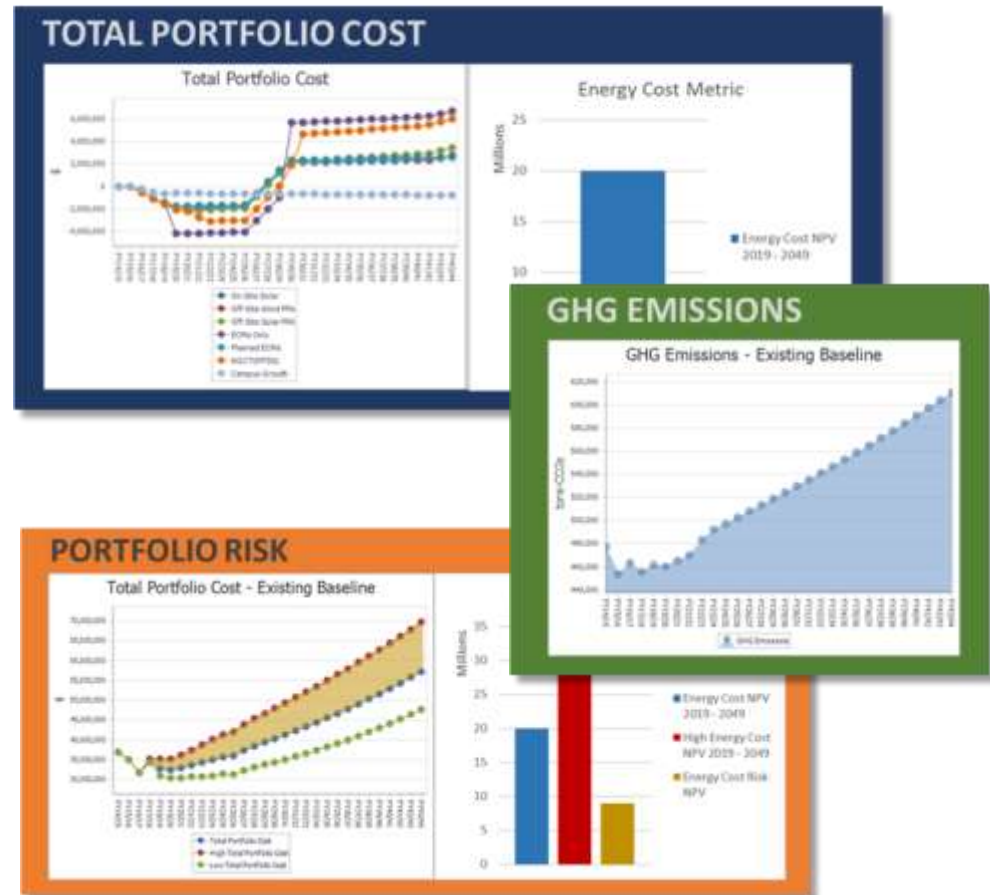
Unresolved Questions from the Energy Master Planning process:

- How do all of our energy commitments and investments fit together?
- What is the total cost of our energy portfolio?
- What is the inherent risk within our total energy portfolio?
- Are we on track to meet long-range cost and sustainability goals?
- How can we measure our goal gaps and resolve them?
- How does one path forward compare to another?

- The IEP combines all energy related costs into a single 30-yr portfolio ledger
 - Supply contracts
 - Transmission and Distribution
 - Conservation projects
 - On-campus generation
 - Renewable energy
 - Storage
- Baseline metrics show current portfolio status:
 - Cost and Risk NPV
 - GHG Emissions
 - Investment Paybacks
 - Financing and Operating Costs



Integrated Energy Portfolio



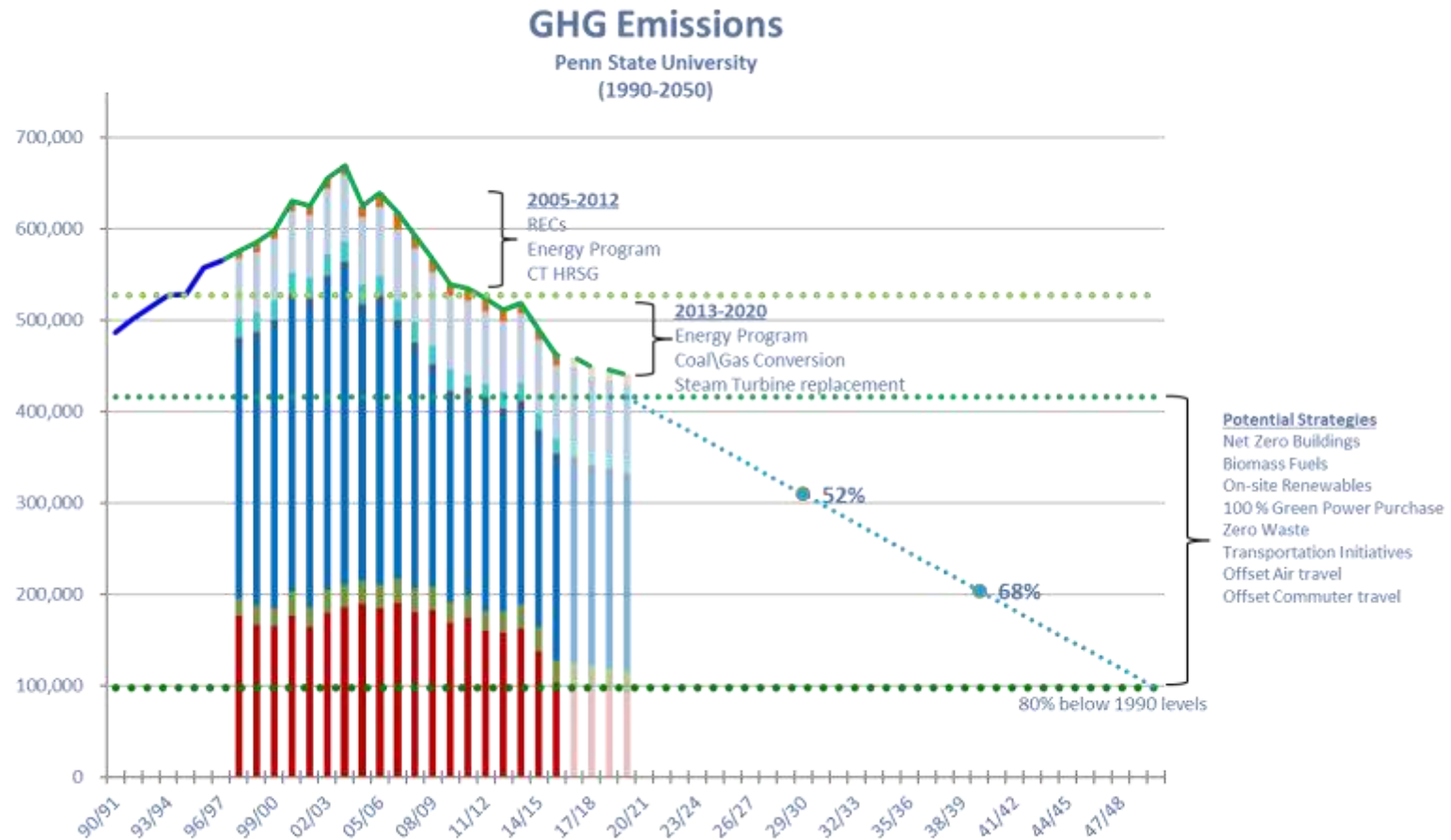


- Scenarios defining future path decisions are valued by comparison to baseline metrics
- Scenarios are combinations of:
 - Project Investments
 - Procurement contracts
 - Campus growth/attrition
 - Campus design and reinvention
- Scenario valuation performed on multiple levels:
 - Seasonal
 - Monthly
 - On/Off Peak
 - Hourly intervals
 - Annual cost rollout

IEP Transaction Register

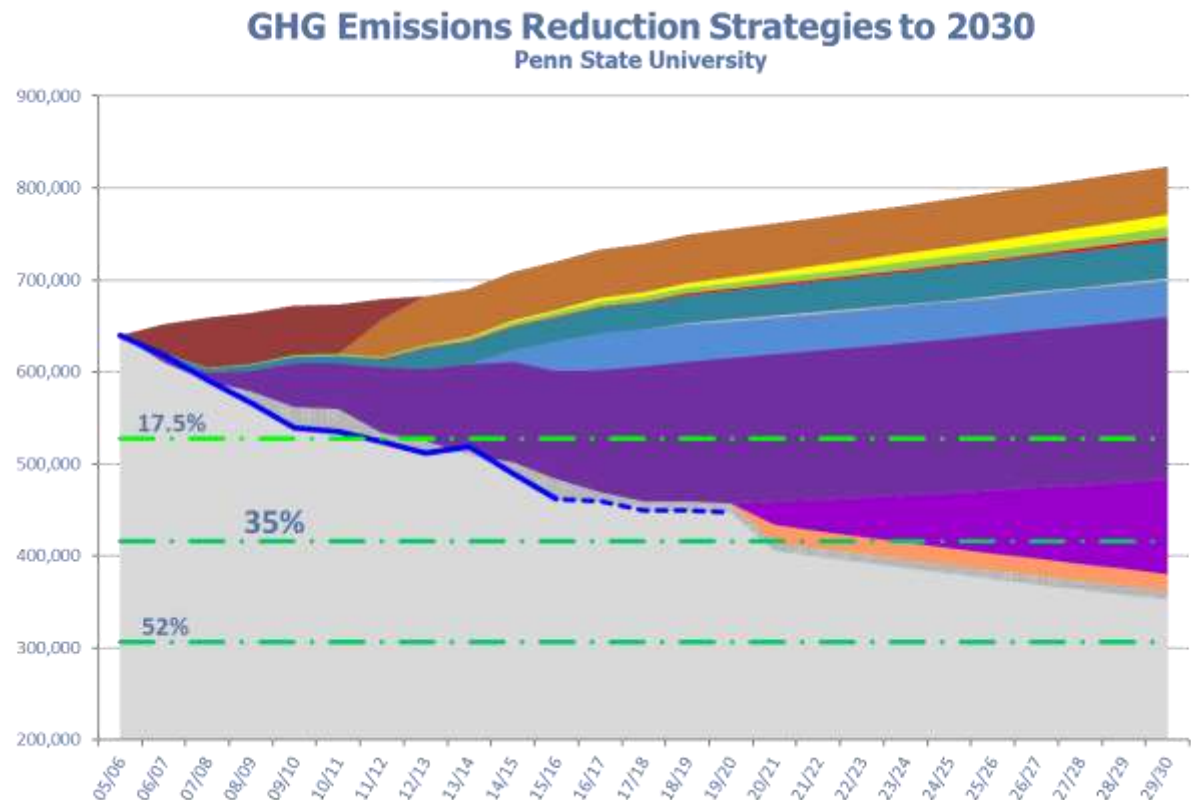
Transaction ID	Transaction Name	Allocation	Value	UOM	Jan FY17/18	Feb FY17/18	Mar FY17/18	Apr FY17/18	May FY17/18	Jun FY17/18
TRAN03	PJM Charges		ATC Volume	kWh	26,640,320	34,466,334	27,089,953	27,280,198	29,394,157	29,178,031
TRAN03	PJM Charges		On-Site DER Offset	kWh	(130,823)	(130,823)	(130,823)	(130,823)	(130,823)	(130,823)
TRAN03	PJM Charges		Off-Site DER Offset	kWh	0	0	0	0	0	0
TRAN03	PJM Charges		Transmission Cost	\$	74,000.00	74,000.00	74,000.00	74,000.00	74,000.00	74,000.00
TRAN03	PJM Charges		Ancillary Costs	\$	33,000.00	33,000.00	33,000.00	33,000.00	33,000.00	33,000.00
TRAN03	PJM Charges		UCAP	kW	60,348	60,348	60,348	60,348	60,348	60,348
TRAN03	PJM Charges		RPM	\$/kW	3.8321	3.8321	3.8321	3.8321	3.8321	5.0186
TRAN03	PJM Charges		Demand Discount Rate	\$/kW	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
TRAN03	PJM Charges		Demand Cost	\$	213,010.69	213,010.69	213,010.69	213,010.69	213,010.69	284,615.29
TRAN03	PJM Charges		ARR	\$	(5,000.00)	(5,000.00)	(5,000.00)	(5,000.00)	(5,000.00)	(5,000.00)
TRAN03	PJM Charges		APN	\$	13,500.00	13,500.00	13,500.00	13,500.00	13,500.00	13,500.00
TRAN03	PJM Charges		Capacity MCHC	\$	29,200.00	29,200.00	29,200.00	29,200.00	29,200.00	29,200.00
TRAN03	PJM Charges		GRT	\$	56,543.51	60,077.12	59,130.63	64,348.28	78,051.84	72,194.74
TRAN03	PJM Charges		On-Site DER Offset Cost	\$	(1,824.59)	(1,423.71)	(1,806.80)	(1,819.22)	(1,749.38)	(2,057.12)
TRAN03	PJM Charges		Off-Site DER Offset Cost	\$	0.00	0.00	0.00	0.00	0.00	0.00

- Penn State is committed to reducing its impact on the environment and climate



Penn State GHG Emissions include stationary sources, purchased electricity, OPP & Fleet vehicles and estimated commuter miles, air travel, waste, refrigerants and animal management.

- GHG reduction goals exist as a key measure of our success:
 - 17.5% by 2012 (completed)
 - 35% by 2020
 - 52% by 2030
 - 80% by 2050
- Our baseline IEP illustrated a gap between our 2020 35% reduction goal and current operations including the anticipated impacts of our 5-year master plans.





GHG Emissions
Below 2005

2005 GHG Emissions were 639,824 MTCO₂e.
35% reduction results in a 2020 target of 415,886 MTCO₂e



Total Portfolio
Cost (TPC) Increase

TPC reflects all energy and related costs including finance, operations and delivery. TPC is calculated as a Present Value of future costs.



Reduce Total Energy Cost
(TEC)

TEC reflects energy and delivery costs only and represents the true underlying cost of energy without finance and operating costs. TEC is also a NPV metric.



Reduce Risk Exposure

Risk Exposure is quantified as the difference between the expected TEC (above) using a current forward price curve and a high market case adjusting forward prices for volatility (risk). Risk Exposure is also a NPV metric.

- Decisions regarding renewable energy needed to include other projects commitments not yet implemented:
 - Campus growth
 - Planned energy projects (ECMs)
 - On-campus solar project
- An adjusted Planned Baseline better reflected the GHG gap.



Metric	Existing Baseline	Delta to Existing Baseline (Scenario – Baseline)			Planned Baseline
		Campus Growth	Planned ECMs	On-Site Solar	
TPC NPV	\$518,560,169	\$8,827,290	(\$10,864,507)	\$1,801,469	\$518,758,648
TEC NPV	\$518,560,169	\$8,827,290	(\$37,617,623)	\$19,824	\$490,223,888
TEC Risk NPV	\$81,724,430	\$1,435,581	(\$4,570,672)	(\$562,842)	\$78,549,343
GHG Emissions	465,391	472,674	443,510	463,936	449,337
GHG Reduction	27.3%	26.1%	30.7%	27.5%	29.8%

- To close the GHG gap, we created several scenarios with relative economics and break evens.
- Reducing consumption was most attractive, but challenged by limited capital and available projects.
- Breakeven wind and solar PPA rates were tested in the market with an RFI.
- Natural gas CT project optimized the outcomes.



Metric	Planned Baseline	Delta to Planned Baseline (Scenario – Baseline)				
		ECMs Only	Off-Site Wind PPA	Off-Site Solar PPA	NGCT	NGCT + Off-Site Solar PPA
TPC NPV	\$518,758,648	(\$2,665,613)	\$0	\$0	(\$5,716,997)	(\$5,716,280)
TEC NPV	\$490,223,888	(\$40,183,527)	\$0	\$0	(\$23,820,515)	(\$23,819,798)
TEC Risk NPV	\$78,549,343	(\$6,294,480)	(\$5,083,055)	(\$6,384,219)	(\$3,173,729)	(\$9,378,988)
GHG Emissions	449,337	415,688	415,707	415,800	431,136	397,597
GHG Reduction	29.8%	35.0%	35.0%	35.0%	32.7%	37.9%

- The IEP quickly assesses the benefit/cost of new or possible cost saving opportunities
- The IEP standardizes opportunity assessments vs. one-off spreadsheets with varying inputs/assumptions

OTHER CASE STUDIES

- On-site CHP cost savings analysis
- On-Site solar cost analysis and pricing strategy
- Hydro proposal assessment
- Long-term hedging policy structure and value proposition

FUTURE USE CASES

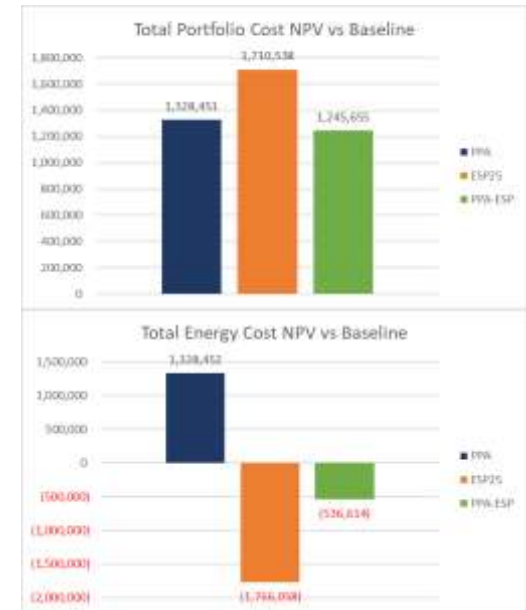
- Budget planning and monitoring
- Capital strategies and allocation planning
- Renewable strategy and blending of multiple projects
- Storage analysis and valuation (gas and electric)

Case Study 2: Proposal Assessment



2MW On-Campus Solar Proposal

- PPA rate proposal increased portfolio costs
- Scenarios created for self funding and a buyout at year 6 to reduce cost impacts
- Self-Financing showed marginal improvement

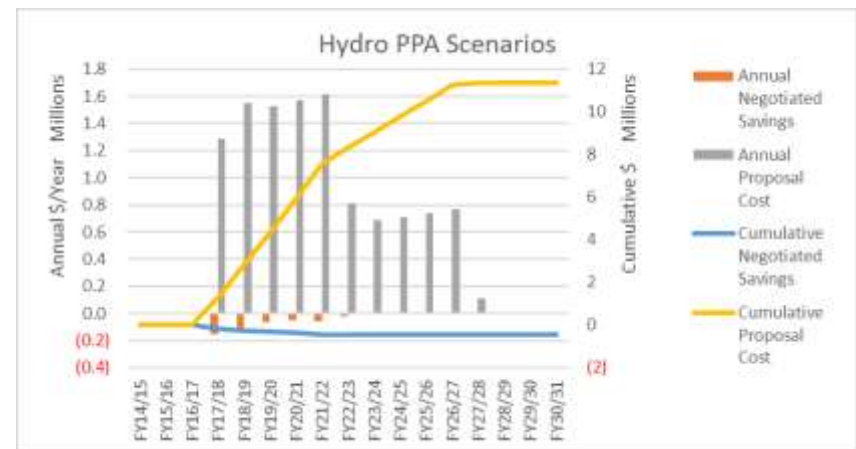


Solar



20MW Hydro PPA Proposal

- Proposed PPA rate increased portfolio cost by over \$11 million
- Negotiated rate targeted portfolio break even or better
- Negotiated outcome resulted in nearly \$200,000 savings

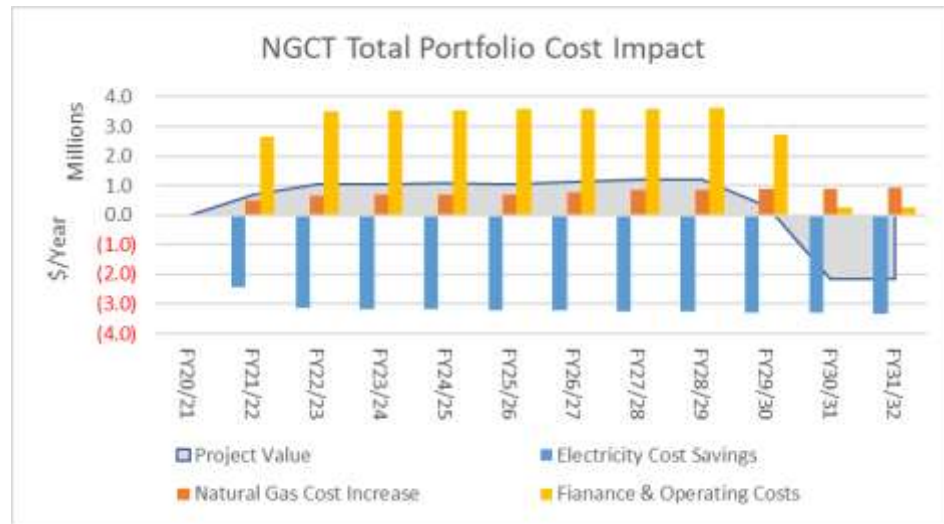


Hydro



NGCT

TPC NPV1	(\$5,716,997)
TEC NPV	(\$23,820,515)
TPC Risk NPV	(\$2,988,720)
GHG Emissions2	449,337
GHG Reduction	2.7%



7MW on-campus CHP project

- Project was initiated in response growing campus and thermal requirements
- Engineering consultant's valuation used variables not relevant to PSU's portfolio
- PSU portfolio analyzed the true value of on-site generation including:
 - Utility and PJM offsets
 - on/off peak pricing conversion to natural gas
 - PA REC offsets
- Project value was more relevant to PSU and exceeded Engineering assessment