Renewable Energy in Coconino County

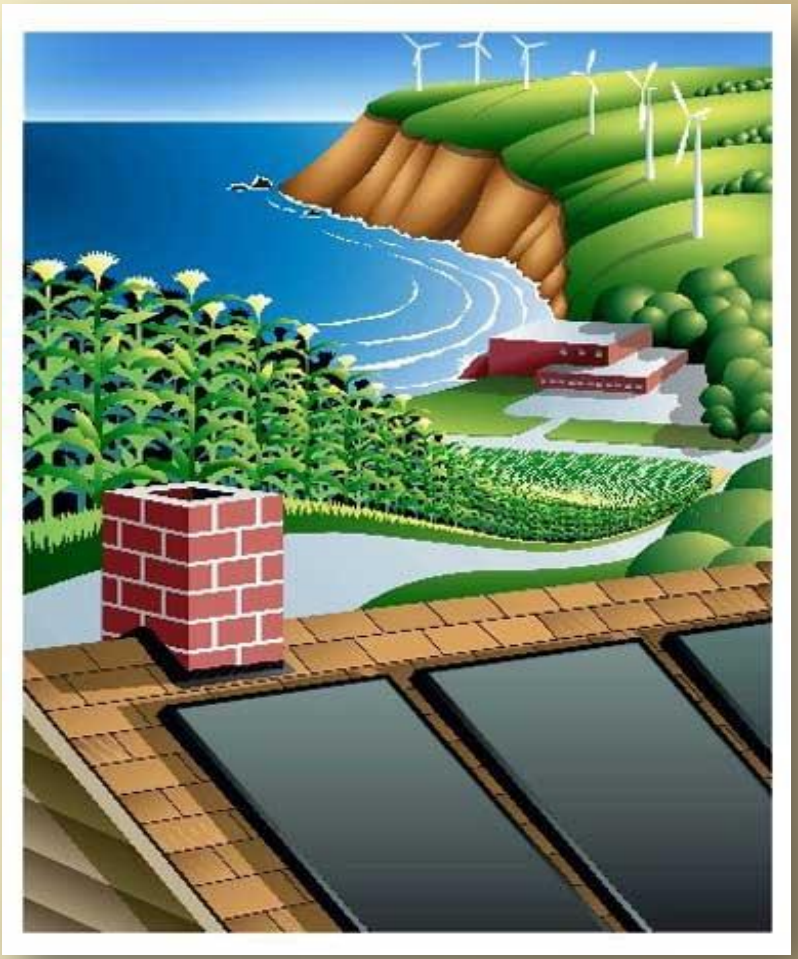
Cost Benefit Analysis

Terms and Acronyms

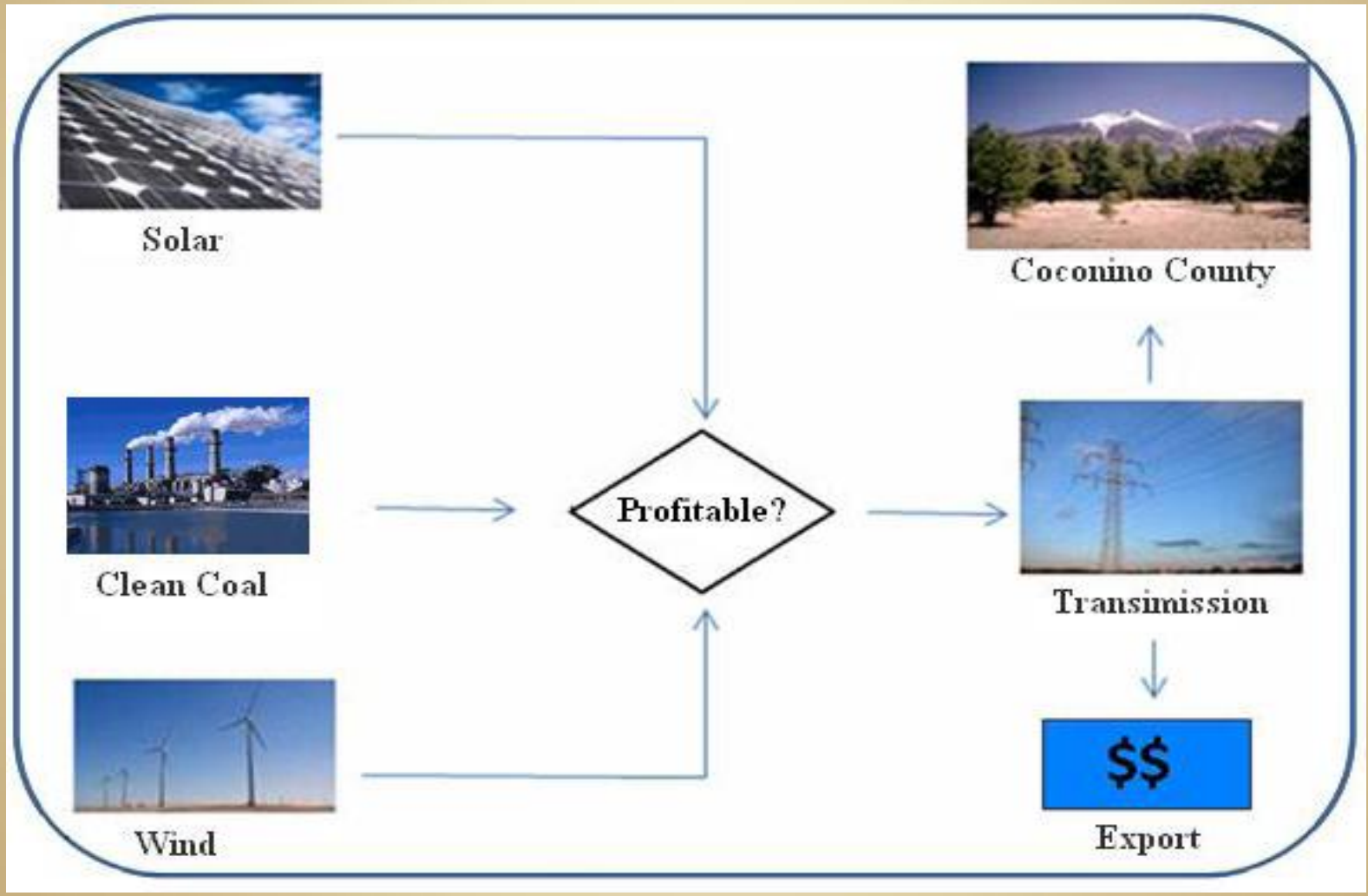
- APS- Arizona Public Service
- CCSEDI- Coconino County Sustainable Economic Development Initiative
- SES- Sustainable Energy Solutions
- NREL- National Renewable Energy Laboratory
- JEDI- Jobs and Economic Development Impact Model
- GE- General Electric
- O&M- Operation and Maintenance
- RE- Renewable Energy
- Man-Week- 40 hour work week

Team and Sponsors

- Team
  - Mindy Dyar
  - Andrews Boateng
  - Nick Everson
- Main Sponsor
  - APS
    - Steve Catanach
- Co-Sponsor
  - CCSEDI
    - Amy LeGere
    - Ron Hubert



Project Description



Approach

- Feasibility in Coconino County?
- Profitable in Coconino County?
  - YES
    - Studied qualified resources
  - NO
    - Dismissed resource from project
- Design Challenges
  - Limited information on Coconino County
  - Lack of software models for every resource
- Trade-offs made
  - Narrow the scope of project in order to complete it

Process

- Cost Benefit Analysis
  - Tangible Benefits
    - Costs of plant construction and maintenance
    - Costs of fuel
  - Intangible Benefits
    - Environmental opportunity costs
      - Water
      - Air Quality
    - Economic Incentives
      - Jobs created
      - Tax incentives
  - Cost per kWH comparison (kWH = kilowatt-Hour = 1000 Watts consumed in an hour)

Requirements

- Mechanical
  - Wind and Solar Technologies
    - Size and efficiency of units
- Economic Impacts
  - Jobs, Taxes, Revenues
- Environmental
  - Emissions, Water Use
- Social
  - Improved Health
  - Ranchland and Farmland Preservation

Actual Results

- Social
  - Wind
    - Improved Health due to zero emissions and pollutants
    - Preserves Ranchland and Farmland
  - Solar
    - Improved Health
    - Ranchland and Farmland Preservation
- Environmental
  - Wind
    - Zero emissions and uses no water
  - Solar
    - Emissions

Actual Results

- Economic Impacts
  - Wind and Solar
  - 169 jobs (wind) , 2373 (solar) during construction and 20 jobs (wind), 57 (solar) during O&M annually for a 60MW plant
  - 1.4% - 1.8% increase in property value of the land for both wind and solar
  - Increased revenues for the Coconino County for both wind and solar

Actual Results

- Mechanical
  - Wind (1.5MW GE Wind Turbine)

- Solar (Parabolic Trough)

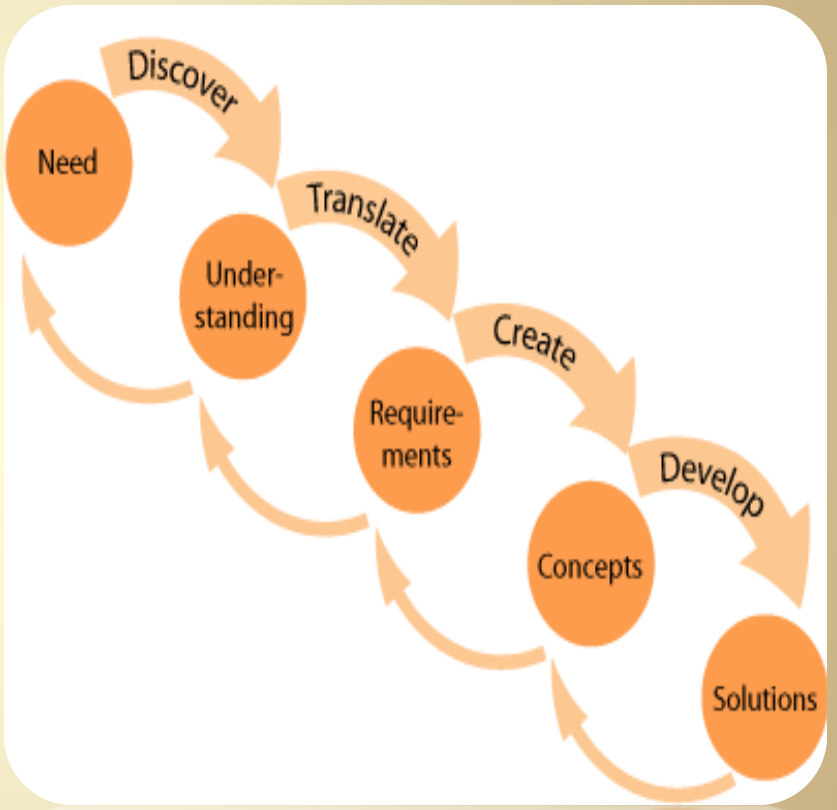
Actual Results

Clean Coal/Wind/Solar Cost Analysis														
Clean Coal Reducing Ash and Particulates and Capturing CO_2	Generation MW	Generation Cost $/MWYr	Cost for Generation with Dirty Coal $/Yr	Fuel Usage Tons/Yr	Water Usage Gal/Yr	Coal Cleaning $/Ton	Pressurized Fluidized Bed Combustion Cost $/Yr	CO2 Emissions Tons/Yr	Carbon Capture and Storage $/Yr	Jobs Created Construction and O&M	Jobs Value to County $/yr	Net Adjusted Generation Costs $/Yr	Initial Assumed Cost Cents/kWh	Adjusted Assumed Cost Cents/kWh
	500	332,880	166,440,000	1,051,200	6,014,178,000	21,497,916	300,000,000	4,432,560	265,953,600	669	$2,792,830	751,098,686	3.8	17.1
		Based on $38/MWh[1]		Based on 120 Tons/Hr[5]	Based on 690 Gal/MWh[6]	Based on $4.85/Ton[3]	Based On $600/kW[4]	Based on 920Kg CO2/MWh[2]	Based on $60/Ton Combusted Coal[7]					
Wind	Generation MW	Generation Cost $/MWYr	Total Production Cost $/Yr	Fuel Savings $/Yr	Water Savings $/Yr	Ash and Particulate Reduction Tons/Yr	Avoided Sox Emissions Tons/Yr	Avoided NOx Emissions Tons/Yr	Avoided CO2 Emissions Tons/Yr	Jobs Created Construction and O&M	Jobs Value to County $/yr	Net Adjusted Generation Costs $/Yr	Initial Assumed Cost Cents/kWh	Adjusted Assumed Cost Cents/kWh
	500	946,080	473,040,000	36,014,112	60,141,780	125,000	34,605	57,294	4,432,560	1,569	6,550,000	370,334,108	10.8	8.5
		Based on $108/MWh[8]		Based on $34.26/Ton Coal[9]	Based on $1/100Gal[10]					Based on JEDI[11]	Based on JEDI[11]			
Solar Thermal	Generation MW	Generation Cost $/MWYr	Total Production Cost $/Yr	Fuel Savings $/Yr	Water Savings $/Yr	Ash Reduction Tons/Yr	Avoided Sox Emissions Tons/Yr	Avoided NOx Emissions Tons/Yr	Avoided CO2 Emissions Tons/Yr	Jobs Created Construction and O&M	Jobs Value to County $/yr	Net Adjusted Production Costs $/Yr	Initial Assumed Cost Cents/kWh	Adjusted Assumed Cost Cents/kWh
	500	1,471,680	735,840,000	36,014,112	$0	125,000	34,605	57,294	4,432,560	20,145	84,097,992	615,727,896	16.8	14.1
		Based on $168/MWh[8]								Based on SAM[12]	Based on SAM[12]			

1. Cholla Power Plant Average Total Cost of Generation; 2. Controlling Power Plant CO2 Emissions: netl.doe.gov; 3. Energy Citations: osti.gov; 4. PFBC: worldbank.org; 5. Responsibility Report: Pinnacle Corporation; 6. Renewing Arizona's Economy: PIRG Education Fund; 7. CCS: fossil.energy.gov; 8. AZ Renewable Energy Assessment: Black and Veatch; 9. World Price Index, 2007; 10. Residential Water Bill: April, 2008; 11. Jobs and Economic Impact Model: National Renewable Energy Laboratory; 12. Solar Advisor Model: National Renewable Energy Laboratory. Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California: Black & Veatach

Project Cycle

- Research
- Approach
- Analyze
- Summarize



Research Phase

- Accomplishments
  - Researched different types of proven RE technologies in the county.
  - Learned various economics concepts.
- Budget
  - No money spent in this phase.
- Time Spent
  - 3.75 Man-Weeks Spent

Approach Phase

- Accomplishments
  - Phased certain RE technologies out of project due to a lessened potential of being implemented.
  - Chose specific technologies for the renewable resources.
  - Refined requirements and specifications to focus the scope of project.
- Budget
  - No money spent in this phase.
- Time Spent
  - 5 man-weeks

Analysis Phase

- Accomplishments
  - For Wind Technologies
    - The JEDI model was used to quantify intangible benefits for wind in the county
    - Case studies and reports were used to quantify both economic and external benefits
  - For Solar Technologies
    - We used reports and case studies to determine profitability and economic impacts, both tangible and intangible.
- Budget
  - No money spent in this phase.
- Time Spent
  - 5 Man-weeks

Summarization Phase

- Accomplishments
  - Weighed the benefits of wind and solar generation to clean coal in the categories of:
    - Water Usage
    - Emissions Reduction
    - Jobs Created
    - Taxes and Revenues
    - Preservation of Ranchland
- Budget
  - No money spent in this phase.
- Time Spent
  - 7 Man-weeks

Client Deliverables

- Summary of feasibility and profitability of solar and wind generation within Coconino County
- Quantified tangible and intangible benefits
- Decision Table
- Final Project Report
- Final Presentation

Benefits to Client

- Client will have more information when proposing renewable energy generation within the county in terms of:
  - Water use
  - Emissions reduction
  - Economic Impacts
  - Health Benefits
  - Sale of Excess Power

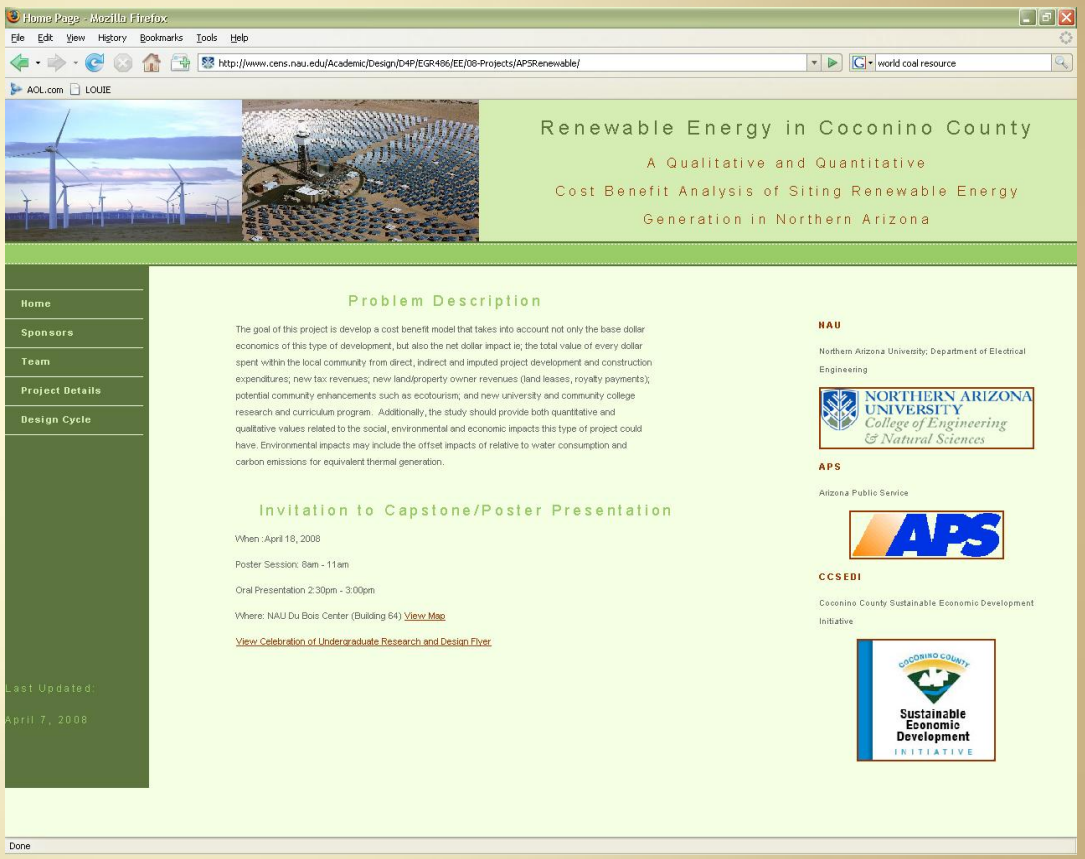
Further Recommendation

- Biomass should be researched further because of its abundance in Northern Arizona

- Further research into the cost of emissions to the environment
- Local social impacts:
  - Environmental tourism
  - Increased revenues due to added curriculum at NAU

Website

- Please visit our website
  - Go to cens.nau.edu
  - Departments
  - EE
  - EE projects
  - APS Renewable



http://www.cens.nau.edu/Academic/Design/D4P/EGR486/EE/08-Projects/APSRenewable

Thank You!

Any Questions?