**Objectives and Measures**
**BASE SCENARIO**

| OBJECTIVE / ATTRIBUTE | UNIT | IRP-2 Evaluation Report with Utility CHP | Plan 1 Least Cost Plan | Plan 2 Meets the State RPS Law -- Oahu Only | Plan 3 Maximize Renewable Energy Plan | Plan 4 Meets the State RPS Law | Plan 5 Maximize Fuel Diversity Plan | Plan 6 Combination Plan |
|---|---|---|---|---|---|---|---|---|
| **1. Protect the Environment** | | | | | | | | |
| a. Potential for impact to potable water sources | | | -Potable water will not be used as a cooling source<br>-Higher use of fossil fuels contribute to higher risk of pollution of potable water by fuel oil spill<br>-Higher use of fossil fuels contribute to global warming, cause rise in ocean levels & reduce potable supply | -Potable water will not be used as a cooling source<br>-Increased potable water use for biomass crop<br>-Lower use of fossil fuels contribute to lower risk of pollution of potable water by fuel oil<br>-Biomass crop increases potable water supply by seeding clouds, putting water into ground, and reducing runoff | -Potable water will not be used as a cooling source<br>-Increased potable water use for biomass crop<br>-Lower use of fossil fuels contribute to lower risk of pollution of potable water by fuel oil<br>-Biomass crop increases potable water supply by seeding clouds, putting water into ground, and reducing runoff | -Potable water will not be used as a cooling source<br>-Higher use of fossil fuels contribute to higher risk of pollution of potable water by fuel oil<br>-Higher use of fossil fuels contribute to global warming, cause rise in ocean levels & reduce potable supply | -Potable water will not be used as a cooling source<br>-Higher use of fossil fuels contribute to higher risk of pollution of potable water by fuel oil and coal<br>-Higher use of fossil fuels contribute to global warming, cause rise in ocean levels & reduce potable supply | -Potable water will not be used as a cooling source<br>-Higher use of fossil fuels contribute to higher risk of pollution of potable water by fuel oil and coal<br>-Higher use of fossil fuels contribute to global warming, cause rise in ocean levels & reduce potable supply |
| b. Potential for impact to marine environment | | | -Higher level of importation of petroleum products increases risk of a fuel spill<br>-Higher use of fossil fuels contribute to global warming, cause rise in ocean levels | -Lower risk of a fuel spill due to lower importation of petroleum products<br>-Lower contribution to global warming<br>-Reduce sediment build up on reefs, since agriculture reduces erosion | -Lower risk of a fuel spill due to lower importation of petroleum products<br>-Lower contribution to global warming<br>-Reduce sediment build up on reefs, since agriculture reduces erosion | -Higher level of importation of petroleum products increases risk of a fuel spill<br>-Higher use of fossil fuels contribute to global warming, cause rise in ocean levels | -Higher level of importation of petroleum products increases risk of a fuel spill<br>-Higher use of fossil fuels contribute to global warming, cause rise in ocean levels | -Higher level of importation of petroleum products increases risk of a fuel spill<br>-Higher use of fossil fuels contribute to global warming, cause rise in ocean levels |
| c. Potential for impact to terrestrial environment | | | -Small amount of land used for fossil fuel resources<br>-Higher use of fossil fuels contribute to an increase in risk of fuel spills<br>-Higher use of fossil fuels contribute to global warming, cause rise in ocean levels & reduce land mass | -Extensive use of land for wind, PV, biomass, MSW resources<br>-Large plot of green space from biomass crop<br>-Higher risk of impact on threatened and endangered species<br>-Large amount of wind would keep land locked into non-urban use<br>-MSW to reduce landfill buildup<br>-Lower risk of fuel spills | -Extensive use of land for wind, PV, biomass, MSW resources<br>-Large plot of green space from biomass crop<br>-Higher risk of impact on threatened and endangered species<br>-Large amount of wind would keep land locked into non-urban use<br>-MSW to reduce landfill buildup<br>-Lower risk of fuel spills | -Moderate use of land for wind, resource<br>-Moderate risk of impact on threatened and endangered species<br>-Increased risk of fuel spills<br>-Higher use of fossil fuels contribute to global warming, cause rise in ocean levels & reduce land mass | -Moderate use of land for wind, resource<br>-Moderate risk of impact on threatened and endangered species<br>-Increased risk of fuel spills<br>-Higher use of fossil fuels contribute to global warming, cause rise in ocean levels & reduce land mass | -Moderate use of land for wind, resource<br>-Moderate risk of impact on threatened and endangered species<br>-Increased risk of fuel spills<br>-Higher use of fossil fuels contribute to global warming, cause rise in ocean levels & reduce land mass |
| d. Carbon dioxide ($CO_2$) emissions | Tons | 167,707,854 | **159,290,611** | **156,438,071** | **153,147,339** | **158,969,856** | **165,013,902** | **158,364,351** |
| e. Volatile organic compounds (VOC) emissions | Tons | 13,344 | **9,042** | **9,246** | **9,359** | **9,031** | **9,010** | **9,380** |
| f. Carbon monoxide (CO) emissions | Tons | 58,063 | **48,737** | **52,866** | **56,104** | **48,653** | **51,075** | **51,056** |
| g. Particulate matter under 10 microns ($PM_{10}$) emissions | Tons | 35,917 | **35,756** | **34,964** | **34,419** | **35,685** | **34,425** | **34,649** |
| h. Nitrogen oxides ($NO_X$) emissions | Tons | 319,897 | **331,704** | **325,597** | **320,389** | **331,021** | **283,823** | **320,380** |
| i. Sulfur oxides ($SO_X$) emissions | Tons | 334,826 | **320,330** | **308,642** | **301,212** | **319,479** | **294,621** | **304,650** |
| **2. Economical Electricity** | | | | | | | | |
| a. Utility Accumulated present worth of revenue requirements (including transmission line capital projects) | Dollars PW Year 2003 $(000) | 6,915,289 | **6,734,325** | **7,219,442** | **7,720,972** | **6,744,260** | **7,068,748** | **6,825,055** |
| b. "Average rate" impact over 20-year planning period (residential, commercial, industrial) | ¢/kWh Nominal | 17.77<br>15.39<br>12.74 | **17.63**<br>**15.27**<br>**12.64** | **18.95**<br>**16.44**<br>**13.61** | **19.98**<br>**17.35**<br>**14.37** | **17.67**<br>**15.30**<br>**12.66** | **17.74**<br>**15.37**<br>**12.73** | **17.87**<br>**15.47**<br>**12.81** |
| c. Total Resource Cost (TRC) | Dollars PW Year 2003 $(000) | 7,214,315 | **7,176,157** | **7,661,275** | **8,162,805** | **7,186,093** | **7,262,926** | **7,266,887** |
| End Effects | Dollars PW Year 2003 $(000) | 3,479,309 | **3,283,743** | **3,550,872** | **3,746,588** | **3,289,325** | **3,325,054** | **3,271,602** |
| Study Period Total Resource Cost | Dollars PW Year 2003 $(000) | 10,693,623 | **10,459,900** | **11,212,147** | **11,909,393** | **10,475,418** | **10,587,979** | **10,538,489** |
| Societal Cost | Dollars PW Year 2003 $(000) | 7,352,386 | **7,296,826** | **7,779,785** | **8,279,438** | **7,306,591** | **7,378,666** | **7,384,575** |
| d. Typical residential monthly bill impact | Dollars Nominal | 106.63 | **105.81** | **113.71** | **119.88** | **106.00** | **106.42** | **107.20** |
| e. Impact to the State economy | | | Minimal | Minimal | Minimal | Minimal | Minimal | Minimal |
| "Average" Real Gross State Product | Dollars PW Year 2003 $(million) | N/A | **61,926** | **61,999** | **61,924** | **61,909** | **61,935** | **61,937** |
| "Average" Real Household Expenditures | Dollars PW Year 2003 $(million) | N/A | **32,436** | **32,420** | **32,384** | **32,429** | **32,424** | **32,418** |
| Employment Created | Person-Years | N/A | **1,874** | **1,884** | **1,892** | **1,874** | **1,882** | **1,878** |
| **3. Power Quality and Reliability** | | | | | | | | |
| a. Generating system reliability | Years per Day | 13.9 | **21.3** | **20.8** | **26.2** | **21.3** | **24.0** | **25.6** |
| b. Appropriate mix of baseload, cycling and peaking generating capacity | | | -Two new peaking units are preferred additions to existing generation | - Peaking capacity preferred. Plan includes one additional peaking unit<br>-Biomass and MSW resources are fixed dispatch type units, which | - Peaking capacity preferred. Plan includes one additional peaking unit<br>-Biomass and MSW resources are fixed dispatch type units, which | -Two new peaking units are preferred additions to existing generation | - Peaking capacity preferred. Plan includes one additional peaking unit | - Peaking capacity preferred. Plan includes one additional peaking unit |
| c. System power quality | | | No new intermittent or fixed dispatch resources | -High levels of intermittent (as-available) wind and PV resources will have an impact on operational system power quality | -High levels of intermittent (as-available) wind and PV resources will have an impact on operational system power quality | -Moderate levels of intermittent (as-available) wind resources will have a moderate impact on operational system power quality | -Moderate levels of intermittent (as-available) wind resources will have a moderate impact on operational system power quality | -Moderate levels of intermittent (as-available) wind resources will have a moderate impact on operational system power quality |
| **4. Energy Security & Sustainable Future** | | | | | | | | |
| a. Ability to utilize different types of fuel | | | -Greatest use of oil for new resources<br>-Does not include any alternate fuel types | -Low use of oil for new resources. New resources use oil, biomass, MSW, wind and solar | -Low use of oil for new resources. New resources use oil, biomass, MSW, wind and solar | -Moderate use of oil for new resources. New resources use oil and wind | -Low use of oil for new resources. New resources use oil, coal, and wind | -Low use of oil for new resources. New resources use oil, coal, wind, and solar |
| b. 1. CHP penetration (Demand) | MW | 41.0 | **65.2** | **65.2** | **65.2** | **65.2** | **25.2** | **65.2** |
| 2. CHP penetration (Energy) | GWh | 5,080 | **8,724** | **8,724** | **8,724** | **8,724** | **2,726** | **8,724** |
| c. System fossil fuel efficiency | BTU/kWh | 9,199 | **8,955** | **8,653** | **8,458** | **8,935** | **9,230** | **8,878** |
| d. 1. DSM penetration (Demand) | MW | 98.9 | **168.7** | **168.7** | **168.7** | **168.7** | **168.7** | **168.7** |
| 2. DSM penetration (Energy) | GWh | 5,092 | **10,418** | **10,418** | **10,418** | **10,418** | **10,418** | **10,418** |
| e. Energy produced by commercially available indigenous and renewable resources (wind, PV, biomass, MSW) | GWh | 6,781 | **6,781** | **12,154** | **15,724** | **7,119** | **8,697** | **8,706** |
| f. Renewable Portfolio Percentage (Oahu only) | 2010 % | 9.2% | **11.6%** | **11.6%** | **13.3%** | **11.6%** | **12.2%** | **12.9%** |
| (end of year) | 2015 % | 8.3% | **12.2%** | **15.3%** | **19.6%** | **12.2%** | **12.8%** | **13.6%** |
| | 2020 % | 8.0% | **13.1%** | **20.3%** | **21.1%** | **13.8%** | **13.6%** | **14.4%** |
| g. Fuel oil consumption | MBTU | 1,448,980,854 | **1,397,962,683** | **1,341,696,982** | **1,305,286,443** | **1,394,418,232** | **1,255,880,395** | **1,323,871,915** |
| Fuel coal consumption | MBTU | 324,530,742 | **310,632,921** | **310,632,921** | **310,632,921** | **310,632,921** | **449,770,199** | **366,231,049** |
| **5. Minimize Potential Negative Societal and Cultural Impacts** | | | | | | | | |
| a. Potential negative impacts on social practices within various cultures | | | -Minimal impact due to small footprint of new generating units | -Potential for siting of wind farms on culturally sensitive sites | -Potential for siting of wind farms on culturally sensitive sites | -Potential for siting of wind farms on culturally sensitive sites | -Potential for siting of wind farms on culturally sensitive sites | -Potential for siting of wind farms on culturally sensitive sites |
| b. Compatibility with community lifestyles and planning processes | | | -Minimal impact due to small footprint of new generating units | -Extensive use of land for wind, PV, biomass, MSW resources<br>-Higher maintenance of green space for biomass plantation<br>-Benefits from multi-purpose use of land for wind & some PV<br>-Significant benefit of lower density development for land extensive RE resources such as wind & biomass<br>-Requires siting of new transmission infrastructure outside | -Extensive use of land for wind, PV, biomass, MSW resources<br>-Higher maintenance of green space for biomass plantation<br>-Benefits from multi-purpose use of land for wind & some PV<br>-Significant benefit of lower density development for land extensive RE resources such as wind & biomass<br>-Requires siting of new transmission infrastructure outside | -Moderate use of land for wind resource<br>-Moderate benefit from multi-purpose use of land for wind<br>-Moderate benefit of lower density development for land extensive RE resources such as wind<br>-Requires siting of new transmission infrastructure outside areas already under similar use | -Moderate use of land for wind resource<br>-Moderate benefit from multi-purpose use of land for wind<br>-Moderate benefit of lower density development for land extensive RE resources such as wind<br>-Requires siting of new transmission infrastructure outside areas already under similar use | -Moderate use of land for wind resource<br>-Moderate benefit from multi-purpose use of land for wind<br>-Moderate benefit of lower density development for land extensive RE resources such as wind<br>-Requires siting of new transmission infrastructure outside areas already under similar use |
| c. Land use | Acres | 24 | **8** | **1,876** | **2,180** | **308** | **919** | **920** |
| Multi-Purpose Land Use | Acres | 0 | **0** | **1,721** | **1,963** | **285** | **855** | **855** |
| Dedicated Land Use | Acres | 24 | **8** | **155** | **217** | **23** | **64** | **65** |
| d. Employment | # Jobs Created | 74 | **36** | **107** | **107** | **38** | **61** | **74** |
| **6. Increase Plan Flexibility** | | | | | | | | |
| a. Resilience under sensitivity analysis | | | Less resilient under high fuel price scenarios | -Renewables add cost stability with higher fossil fuel costs | -Renewables add cost stability with higher fossil fuel costs | | -The coal unit adds cost stability with higher fuel price scenarios | -The coal unit adds cost stability with higher fuel price scenarios |
| b. Flexibility of plan resources | | | -Large CHP market increases flexibility | -Large CHP market increases flexibility<br>-Large amount of small PV resources provide for a greater amount of flexibility | -Large CHP market increases flexibility<br>-Large amount of small PV resources provide for a greater amount of flexibility | -Large CHP market increases flexibility | -Small CHP market provides less flexibility | -Large CHP market increases flexibility |
| **7. Utility Financial Integrity & Competitiveness** | | | | | | | | |
| a. Total Capital | Dollars PW Year 2003 $(000) | 744,340 | **206,860** | **1,116,040** | **1,880,890** | **255,500** | **683,650** | **691,561** |
| Generation Capital | Dollars PW Year 2003 $(000) | | **139,040** | **1,035,630** | **1,799,600** | **185,320** | **611,150** | **619,061** |
| Transmission Capital | Dollars PW Year 2003 $(000) | | **67,820** | **80,410** | **81,290** | **70,180** | **72,500** | **72,500** |
| b. Annual revenue requirements in the first 10 years of the plan | Dollars PW Year 2003 $(000) | 4,195,177 | **4,160,071** | **4,215,297** | **4,480,326** | **4,160,071** | **4,280,078** | **4,197,584** |
| c. Rate impact over the first 10 years of the plan | ¢/kWh Nominal | 13.39 | **13.38** | **13.55** | **14.26** | **13.38** | **13.28** | **13.48** |