TECHNOLOGY CHARACERTIZATIONS
FOR ELECTRICAL GENERATION TECHNOLOGIES

DRAFT for Comment ***June 13, 2006***

The following Table presents a strawman proposal for the various important characteristics of technologies for consideration by the 21st Century Energy Plan. Comments and further suggestions and refinements are requested. Once the technology characterization matrix has been completed, then each work team will be asked to provide as much of the relevant data as it can, for each technology type being considered. Sources for the variables/criteria indicated in the matrix at this point include: (1) discussions by various participants in the Alternative Generation Workgroup; (2) categories used for the Michigan Electricity Options Study in the mid-1980s; and (3) economic and employment impact studies of the Michigan economy completed for the Michigan Public Service Commission in the mid-1980s.

Table 1: Strawman Proposal for Technology Comparisons, Version 1.0

Technology		**Technology Type 1**	**Technology Type 2**	**Technology Type 3**	**Technology Type 4**
Basic Description					
Fuel Type(s)[1]					
Unit Electrical Capacity (kW, or range of sizes in kW)					
CURRENT	**Installed Cost ($/kW)**[2]				
	Electrical Efficiency (in %, HHV/LHV)				
	Heat Rate (BTU/kWh)				
	Net Efficiency (in %, Electrical + Thermal)				

[1] Depending on operating characteristics, it may be necessary to complete separate Technology Type characterizations for at least some of the indicated categories, for the same basic technology using different types of fuel.
[2] Installed Cost assumes no financing cost. This is sometimes termed “overnight cost”.

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Technology		Technology Type 1	Technology Type 2	Technology Type 3	Technology Type 4
CURRENT	Waste Heat Temperature (degrees Centigrade)				
	Reactive Power[3] (Y/N)				
	Availability (%)				
	Forced Outage Rate (%)				
	Capacity Factor (annual average %)[4]				
	Load Following Capability (%)[5]				
	Fuel Cost ($/kWh)				
	Fixed O&M Cost ($/kWh)				
	Variable O&M Cost ($/kWh)				
	Levelized Cost ($/kWh)				
	Lead Time – order to install (Months)				
	Longevity/Durability (Months)				
	Footprint (sq. ft./kW)				
	Criteria Emissions after installation & operation of all planned pollution control devices[6]				

[3] The thrust of this category, "Reactive Power" is the extent to which each type of facility might produce (and/or require) ancillary services. I think we are going to need a general category for "Ancillary Services" and then some way to indicate by type of service which, if any, can be usefully supplied by the technology being considered, and which, if any, the technology requires some other facility to provide for its operation. Reviewers are asked to suggest a framework for consideration of all relevant ancillary services.

[4] Capacity Factor may be required only for variable-output generators, such as wind or solar.

[5] How much can these units follow load increases/decreases? How much can they be turned down? Can they run for short periods of time to produce greater than their nameplate rating of output?

[6] Proposed for consideration of air emissions are the following (in lbs./MWh except for Radionuclides, in rem/year): CO, CO2, Hg, HAPs, NOx, Sox, Radionuclides, TSP, Sub 2.5 Micron Particulates, VOCs.

Technology		Technology Type 1	Technology Type 2	Technology Type 3	Technology Type 4
CURRENT	Solid Wastes[7]				
	Water Quality[8]				
	Employment Effects[9]				
	Economic Multiplier Effects[10]				
	Accidents/Vulnerabilies[11]				
	Rate Impact Tests[12]				

[7] Proposed for consideration of solid wastes are the following (measured in tons/year, or other relevant units specified): (a) scrubber sludge disposal; (b) fly ash disposal; (c) bottom ash disposal; (d) hazardous waste disposal; (e) radioactive waste disposal; (f) other important waste disposal (specify type(s) and quantity(ies)).

[8] Proposed for consideration regarding water quality issues are the following variables: (a) Water intake (quantity of make-up water; in gal./hour, or similar unit); (b) Water intake velocity (in feet/second, or other similar unit); (c) Water consumption (gallons per time period); (d) Water discharge (quantity in gal./hour); (e) Water discharge (thermal; how many Btu's are released in the discharge, per what time period); (f) Water discharge to surface water? If yes, then what is quantity in cubic feet per time period?; (g) Water discharge suspended solids. If yes, what quantities (e.g., in mg/liter); (h) Water discharge dissolved oxygen? If yes, what are they and what quantities (e.g., in mg/liter); (i) Water discharge contaminants? If yes, what are they and what quantities (e.g., in ppm or ppb)?

[9] Employment effects are being estimated for a research project currently underway by Michigan DEQ and NextEnergy. When that project is completed, it is anticipated that the following data can be compiled for all major system types and fuel types: (a) direct Michigan employment (direct job-years per million dollars of expenditures); (b) indirect employment (job-years at Michigan suppliers per million dollars of expenditures); (c) induced employment (which is a measure of the effects of consumer spending in the Michigan economy, as a result of combined payroll received by both direct and indirect employees, plus respending effects of dollars saved on energy bills); (d) substitute employment effects (jobs lost from the traditional utility sector, if any, due to shifts to new technology, measured in Michigan job-years).

[10] Economic multiplier information is expected to be available from the analysis being completed by MDEQ/Next Energy. It is expected that the following data might be available (all units expressed in dollars per million dollars of investment in each major technology type): (a) labor costs; (b) capital costs (including financing costs); (c) fuel costs (note percentage of fuel from in-state versus out-of-state sources, depending on fuel type); (d) raw material costs; (e) Michigan-specific production; (e) imports (from outside of Michigan but within U.S.); (f) imports (from outside U.S.).

[11] The purpose of this proposed variable is to capture additional qualitative information about potential accidents or hazards due to natural disaster, human error, terrorist action, etc. Two qualitative scales (e.g. 1-5, with 1 being least vulnerable) are proposed, to capture both the potential likelihood and magnitude of such problems.

[12] A series of standardized benefit/cost tests was developed in the mid-1980s, particularly for use in evaluating demand-side management measures and programs. It was published under the title, *California Standard Practices Manual*. These benefit-cost tests are used to evaluate cost effectiveness from various perspectives, including: (a) utility cost test; (b) participant cost test; (c) ratepayer impact measure test (include consideration of differential rate effects on different customer classes, if options address only specific classes of customers); (d) total resource cost test; and (e) societal cost test. A matrix indicating which

Technology		**Technology Type 1**	**Technology Type 2**	**Technology Type 3**	**Technology Type 4**
PROJECTED – 2010	**Installed Cost ($/kW)**				
	Electrical Efficiency (LHV)				
	Availability (%)				
	Levelized Cost ($/kWh)				
PROJECTED – 2024	**Installed Cost ($/kW)**				
	Electrical Efficiency (LHV)				
	Availability (%)				
	Levelized Cost ($/kWh)				
Applications					
Technology and Market Challenges					
Commercial Status / # Units in the Field					
Leading Manufacturers					

costs and benefits are included in each of these tests can be provided at a future Team meeting. The purpose of such benefit cost testing is to insure consistent comparisons are made amongst the various technologies being considered.

Technology	**Technology Type 1**	**Technology Type 2**	**Technology Type 3**	**Technology Type 4**
Manufacturing Locations				
Comments				