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# TRANSPORTATION RESEARCH

# CIRCULAR

Transportation Research Board, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20418

## ENERGY CONSIDERATION IN TRANSPORTATION DESIGN, CONSTRUCTION AND OPERATION

mode  
1 highway transportation

subject areas  
11 administration  
17 energy and environment

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Table 1. Summary of TRB Questionnaire - Energy Considerations in Transportation Design,

State	Energy Position in DOT				Value Engineering			Quality Assurance/Performance		
	Yes/ No	Division Location	Written Policy On Energy	Used In		Energy Considered	Examples Where Energy Considered	Contract Changed If Only Energy Saved	Used Yes/ No	Type of Construction
				Design	Construction					
Alabama										
Alaska	Yes	Research	No	Yes	Yes	Seld.		Possibly	Yes	Buildings
Arizona	Yes	Planning Design	Yes	Yes	Yes	No		Possibly	Yes	
Arkansas	No		Yes	No	No			Case-by- Case	No	
California	Yes	Planning Design Laboratory	Yes	Yes	Yes	Yes	Barriers, Soundwalls Landscape Irrigation	Yes	No	Thickness of PCG
Colorado										
Connecticut										
Delaware	Yes	Design Construction Maintenance Materials	No	Yes	Yes	No		Doubtful	No	
Florida	Yes	Executive	Yes	Yes	Yes	No		No	Yes	Asphalt Concrete P.C. Concrete
Georgia	Yes	Other	Yes	No	No		Informal Use		Yes	Aggregates Asphalt Concrete
Hawaii	No		Yes	No	Yes	No		Yes	Yes	P.C. Concrete Strength
Idaho	No		No	Yes	No			Yes	Yes	
Illinois	No		No	Yes	Yes			Yes	Yes	Asphalt Concrete
Indiana	No		No	Yes	No	No		Yes	No	
Iowa	No		No	Yes	Yes	No		No	Yes	Highway Construction
Kansas	No		No	No	Yes	No		Case-by- Case	Yes	All Construction
Kentucky	No		No	Yes	Yes	Yes	Scrubber Sludge	Maybe	Yes	Epoxy Coated Re-Bars P.C. Concrete
Louisiana										
Maine										
Maryland	No		No	Yes	Yes	Yes	Fly Ash	Yes	Yes	Asphalt Concrete P.C. Concrete
Massachusetts	No		No	No	No			Yes	Yes	Bridge Rehabilitation
Michigan	No		Yes	Yes	Yes	Yes	Rest Area Design	Yes	Yes	P.C. Concrete Pavements
Minnesota	No		No	Yes	Yes		Lighting, Buildings, Heaters for Traffic Control Cabinets	No	Yes	Aggregate Base and Density Asphalt Concrete Density
Mississippi										
Missouri	No		Yes	Yes	Yes	Yes		No	No	
Montana										
Nebraska	No		No	Yes	No	Yes	Haul Distance		Yes	Asphalt Concrete
Nevada	No		No	Yes	No	No		Yes	Yes	
New Hampshire	No		No	No	No	Yes		No	Yes	
New Jersey	Yes	Construction Maintenance Physical Plants	Yes	Yes	Yes	Yes	Steam Plants Solar Heating "U" Turn Facilities	No	Yes	Asphalt Concrete Pavements P.C. Concrete
New Mexico	Yes	Design	No	Yes	No	Yes		No	Yes	
New York	Yes	Technical Services	No	No	Yes	Yes		No	Yes	Asphalt Concrete P.C. Concrete
North Carolina	No		No	Yes	No	Yes	Signal Timing Design	No	Yes	Asphalt Concrete P.C. Concrete Pavt. Marking, Signals
North Dakota										
Ohio										
Oklahoma	No		No	No	No			Maybe	Yes	
Oregon	No		Yes					Yes	Yes	Asphalt Concrete Pavements P.C. Concrete Pavements
Pennsylvania	Yes	Design	No	Yes	Yes	Yes		No	Yes	Asphalt Concrete
Rhode Island	No		No	No	No				No	
South Carolina	No		No	Yes	Yes	Yes		Maybe	Yes	
South Dakota	Yes	Construction Maintenance	Yes	Yes	No	Yes	Asphalt Recycling	No	No	
Tennessee	No		No	No	No			No	No	
Texas	No		No	No	No				No	
Utah										
Vermont	Yes	Design	No	Yes	Yes	Yes		Yes	Yes	Aggregate Base, Asphalt Concrete, P.C. Concrete
Virginia										
Washington	Yes	Maintenance	No	Yes	Yes	Yes		No	No	
West Virginia	No		No	Yes	Yes	No		No	Yes	All Types
Wisconsin	No		Yes	Yes	Yes	No			No	
Wyoming										
District of Columbia	No		No	No	No			Yes	No	

Construction and Operations

State	Spec.		Recycling				Operations To Conserve Energy											References
	Energy Saved	Used Yes/No	Permitted or Required by Contract	Performed by DOT	Removed Matl. Property of	Energy Saver	Reduced Lighting	Other Fuels For Trucks	Reduce Snoeploerig	Bus or Car Pool Lanes	Park and Ride Lots	Vans for Employees	Coordinate For Free Flow	Traffic Signals Computer Control (Entire City)	Other			
Alabama																		
Alaska	Yes	Yes	Perm.			Yes	Yes					Yes	Yes	Yes				
Arizona	?	Yes	Perm/Req.		Cont/DOT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Co-Sign For Employee Vans		9-14	
Arkansas		Yes	Perm/Req.		Cont.	No	Yes				Yes	Yes	Yes	Yes			15	
California	No	Yes	Perm/Req.	Yes	Cont/DOT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Tree Thinning-Reduce Ice Convert Lighting		16,17	
Colorado																		
Connecticut																		
Delaware		Yes	Req.	Yes	Cont/DOT	Yes	Yes	Yes			Yes	Yes	Yes	Yes	Smaller Cars Building Weatherization Convert Lighting			
Florida	Yes	Yes	Perm/Req.		Cont.	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes				
Georgia	Yes	Yes	Perm/Req.		DOT	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Extensive List		18-20	
Hawaii	Yes	Yes	Perm.		Cont.	Yes	Yes		Yes									
Idaho		Yes	Req.		DOT	Yes	Yes		Yes				Yes	Yes	Solar Heating for Asphalt Building Alterations			
Illinois	Yes	Yes	Perm/Req.		Cont.	Yes	Yes		Yes				Yes		Reserve Parking for Car Pool Vehicles			
Indiana		Yes	Perm/Req.		Cont.	Yes	Yes				Yes	Yes			Reserve Parking for Car Pool Vehicles			
Iowa	No	Yes	Perm/Req.		Cont/DOT	Yes	Yes		Yes		Yes							
Kansas	?	Yes	Perm/Req.		Cont/DOT	Yes	Yes	Yes	Yes		Yes	Yes						
Kentucky	No	Yes	Perm.	Yes	Cont/DOT	Yes	Yes		Yes		Yes	Yes	Yes					
Louisiana																		
Maine																		
Maryland	Yes	Yes	Perm.		Cont.	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes				
Massachusetts	No	Yes	Perm.			Yes				Yes	Yes	Yes						
Michigan	?	Yes	Perm/Req.	Yes	Cont/DOT	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Maintenance Garages		21	
Minnesota	Yes	Yes	Perm.		Cont.	Yes	Yes	Yes		Yes	Yes		Yes	Yes	Alternative Fuel Gasohol & Wood			
Mississippi																		
Missouri		Yes	Perm.		Cont/DOT	Yes	Yes		Yes		Yes		Yes		Extensive List			
Montana																		
Nebraska	Yes	Yes	Perm/Req.	Yes	Cont/DOT	Yes	Yes						Yes	Yes				
Nevada	?	Yes	Perm/Req.	Yes	Cont/DOT	Yes	Yes		Yes				Yes	Yes				
New Hampshire		Yes	Req.		Dot	Yes	Yes		Yes									
New Jersey	Yes	Yes	Perm/Req.	Yes	Cont/DOT	Yes	Yes	Yes		Yes	Yes	Yes	Yes		Building Alterations and Boilers		22	
New Mexico	Yes	Yes	Perm/Req.	Yes	Cont/DOT	Yes		Yes	Yes	Yes	Yes	Yes	Yes					
New York	Yes	Yes	Perm.		Cont.	Yes		Yes		Yes		Yes	Yes					
North Carolina	Yes	Yes	Perm/Req.	Yes	Cont/DOT	Yes	Yes	Yes			Yes		Yes	Yes				
North Dakota																		
Ohio																		
Oklahoma	?	Yes	Perm.			Yes												
Oregon	?	Yes	Perm/Req.	Yes	Cont/DOT	Yes	Yes		Yes	Yes		Yes	Yes		Variable Work Shifts			
Pennsylvania	No	Yes	Perm/Req.	Yes	Cont/DOT	Yes	Yes		Yes	Yes	Yes	Yes						
Rhode Island		Yes	Req.		Cont.	Yes					Yes	Yes	Yes	Yes				
South Carolina	?	Yes	Req.		Cont.	Yes	Yes				Yes	Yes			Replace Cutbacks with Emulsions Asphalts At Low Temperatures			
South Dakota		Yes	Perm/Req.	Yes	Cont/DOT	Yes	Yes	Yes	Yes									
Tennessee		Yes	Perm/Req.		Cont.	Yes				Yes	Yes	Yes	Yes					
Texas		Yes	Perm/Req.	Yes	Cont/DOT	Yes	Yes	Yes	Yes	Yes	Yes				Solar Heating for Asphalt Wind Electricity Generation			
Utah																		
Vermont	?	Yes	Req.		DOT	Yes	Yes			Yes	Yes	Yes	Yes		Reduce Building Temperature			
Virginia																		
Washington		Yes	Perm/Req.		Cont/DOT	Yes	Yes	Yes		Yes	Yes	Yes						
West Virginia		Yes	Perm.		Cont.	No		Yes		Yes	Yes	Yes	Yes		Extensive List		23-29	
Wisconsin		Yes	Req.		Cont.	Yes	Yes		Yes	Yes	Yes	Yes			Ramp Metering, Signals Reduce Building Temperature		30,31	
Wyoming																		
District of Columbia		Yes	Perm/Req.	Yes	Cont/DOT	No	Yes		Yes		Yes	Yes						

Table 2. Energy Conservation Activities - Georgia, Missouri, West Virginia

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GEORGIA

- Solar panels on liquid asphalt cement storage tanks at state plant
- Solar panels for hot water and heating at rest area
- Mandatory reduced mileages on all DOT vehicles
- Reduced speed limit to 50 mph for DOT vehicles
- Provide car pooling information and computer assistance to companies
- Closed some maintenance "barns" and consolidation operations
- Heating plant major changes in 3 DOT larger buildings
- Timers installed on some DOT heating/a/c plants
- Energy audits performed on all larger buildings
- Utility useages monitored
- Additional insulation used in new roof replacement
- Storm windows added to most field buildings
- One electric meter used to replace two, where possible
- Small vestibules with second door added to front and back of field offices
- Closed in an open ceiling in a field office
- Manually reduce a/c at night
- Turn lights out during lunch at field offices
- Cleaning/recycling road sign blanks
- Timers on a/c at rest areas, considered

## MISSOURI

- Switch from use of cutback asphalt to emulsions
- Partition and insulate maintenance buildings
- Reduce striping program
- Reduce mowing program
- Reduce vehicle fleet
- Downsize cars and pickups
- Recycle guard rail by straightening
- Recycle signs in sign reclamation shop

## WEST VIRGINIA

- Placed day/night switch on outside lighting at field offices
- Auditors check for energy conservation on every field contact

Example: (a) Garage doors open with heat on  
(b) Lights on in day where not converted as in no. 1 above

- Placed initial insulation at certain locations and have added insulation at others
- Reduced the number of vehicles on the road (see no. 7)
- State cars can no longer be taken home by everyone
- Reduced the number of substations

Example: Reduced 5 in Kanawha County  
Reduced 1 in Marion County

- Eliminated Courtesy Patrols
  - Purchased smaller cars for the fleet
- 

## ENERGY PUBLICATIONS

State agencies were asked to rate the effectiveness of eight energy-related publications in the questionnaire. These publications (see references 1-8) include widely publicized and distributed reports by the TRB and the FHWA. Results tabulated in Table 3 indicated a disturbing finding that many of the individuals preparing the questionnaire, presumably among the most knowledgeable persons within the agencies on energy matters, are unaware of the existence of these publications. The committee is at a loss to explain this finding, and hopes that continued technology transfer efforts within TRB and FHWA will improve this situation.

The states of Arizona, Arkansas, California, Georgia, Michigan, New Jersey, West Virginia, and Wisconsin supplied lists of additional energy

related references (see references 9-31).

## CLOSURE

Although thirty-one percent of the reporting states have energy policies, sixty-nine do not, which strongly indicates that energy considerations within the transportation community are not currently of major concern, even though energy prices are high and the prospects of an energy shortage in the near future are still very high. On the plus side, 70 percent of the reporting agencies have some form of value engineering and performance specifications in the design and construction of transportation facilities. About

Table 3. Effectiveness of Publications

Title	References	Agency and Report No.	Date	No. of Responses (%)			
				Very Valuable	Satisfactory	Do Not Use	Unaware of Publication
Energy Conservation and Federal Aid Program		FWHA Bulletin	1/21/81	1 (2)	13 (33)	10 (25)	16 (40)
State Transportation Finances within the Context of Energy Constraints		NCHRP 231		2 (5)	10 (24)	17 (41)	12 (30)
Considerations in Transportation Energy Contingency Planning		TRB Special Report 191		1 (2)	17 (42)	13 (33)	9 (23)
Waste Materials as Potential Replacements for Highway Aggregates		NCHRP 166		3 (8)	13 (34)	12 (32)	10 (26)
Ways to Use Waste Products in Highway Construction		AASHTO AGC, ARTBA Task Force 16 Report		1 (2)	7 (18)	14 (35)	18 (45)
Optimizing the Use of Materials and Energy in Transportation Construction		TRB Special Report 166		3 (7)	13 (33)	13 (33)	10 (27)
Energy Involved in Construction Materials and Procedures		NCHRP Synthesis 85		3 (7)	11 (28)	17 (43)	9 (22)
Energy Requirements for Roadway Pavements		Asphalt Institute IS 173	1/79	3 (7)	9 (23)	14 (35)	14 (35)

one half of these agencies believe that energy is conserved as a direct result of these programs. By far the most generally employed "energy conservation" measure is recycling, as 100 percent of the agencies utilize recycling to some extent. Although the energy savings may not be known, they all believe recycling is cost effective. Finally, most agencies employ traditional energy conservation measures in their direct cost operations. These include reduced lighting, the use of solar heating where practicable, and the like.

In closing, the Committee is both encouraged and concerned about the results of this questionnaire. There are several states that have vigorous energy policies. Other agencies are making some attempts at energy management. But the majority of the agencies reporting, plus presumably most of the agencies not reporting, have little or no energy management programs in the design and construction of their transportation facilities.

## REFERENCES

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3. Considerations in Transportation Energy Contingency Planning. TRB Special Report 191.
4. Waste Materials as Potential Replacements for Highway Aggregates. NCHRP Report 166.
5. Ways to Use Waste Products in Highway Construction. Task Force 16 Report. Report of Joint Cooperative Committee of AASHTO, AGC and ARTBA.
6. Optimizing the Use of Materials and Energy in Transportation Construction. TRB Special Report 166.
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16. "Resource Conservation," Policy and Procedure P78-17, California Department of Transportation, Revised May 16, 1983.
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  31. "Energy Consumption - Energy and Materials," Subject 40, Facilities Development Manual, Wisconsin Department of Transportation.