

The Martec Group is a partnership of technical market research professionals.

Mission
To support client planning initiatives through technical and scientific product, market and industry analysis

Martec Snapshot

- Founded in 1984
- Principal practice areas:
 - > Transportation
 - > Healthcare
 - > Chemicals
 - > Electronics
- Offices in Detroit, Chicago, Frankfurt, Tokyo and Beijing
- The firm serves global automotive suppliers across all light and heavy-duty vehicle systems

1

Martec evaluated incremental hardware costs at the vehicle manufacturer level.

In order to assure good connectivity with the modeling exercise for each technology, Martec was given:

- Written functional description from which a bill-of-materials was developed
- Reference technical specification from the industry
- Reference to an existing vehicle or architecture in production
- A particular supplier's implementation of the technology

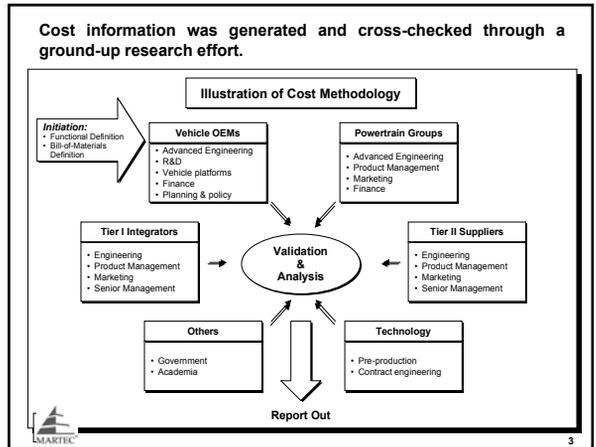
The defined hardware content was costed in 2003 US dollars for the years 2009 and beyond assuming:

- A highly competitive, high volume purchasing environment
- At least 3 automakers employing the hardware at = 500,000 units annually
- At least 3 competent suppliers available to each automaker

Martec did not assume or attempt to calculate:

- Retail price equivalent
- Currently unknown advances in design and or manufacturing

2



Martec's results are reported in a matrix for calculation of net hardware costs vs. baseline.

A bill-of-materials description representing the functional application of each discrete technology is provided in the matrix.

- Costs to the automaker for the defined hardware are shown on a net basis
- Credits also are shown where a new technology would reduce baseline hardware content and cost

All study vehicles were required to meet Federal Tier 2 Bin 5 criteria emissions standards.

- Baseline as well as proposed future technology packages
- Lean-burn aftertreatment costs are expressed on a net basis vs. forecast 2009 stoichiometric Bin 5 baseline

Manufacturer-level costs not captured by Martec include:

- R&D, application engineering, calibration and controls development
- Warranty and possible recall costs associated with new technologies
- Capital and labor costs associated with vehicle level integration and assembly
- Cross-system impacts to vehicle level costs

4

Questions and Answers on
Technology
Cost Assessment

5

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle						
Technology	Technology Description - Hardware and Functionality	2.2L DOHC 4V A4 FWD	3.0L DOHC 4V A4 FWD	3.4L DOHC 4V A4 RWD	3.3L OHV 2V A4 RWD	5.3L OHV 2V A4 AWD
Technology	Technology Description - Hardware and Functionality	Cavalier (SC)	Taurus (LC)	Tacoma (ST)	Town & C (NV)	Sierra (LT)
DOHC from OHV	Substitution of DOHC 4V gas engine for OHV 2V gas engine of equal cylinder count. Content increase for Vee engine intakes; New cam drive, +3 camshafts, +2 valves per cylinder, cam bearing surfaces, extra valve seats and valve guides, roller cam followers. Assumes All heads and Fe block for OHV and All heads and All block DOHC.	-	-	-	\$ 500	\$ 600
External EGR Credit	External EGR can be deleted if not needed or another means of exhaust dilution is available.	\$ (25)	\$ (25)	\$ (25)	\$ (25)	\$ (25)
Variable Cam Phaser	Line DOHC engines - 1 phaser on intake Vee DOHC engines - 2 phasers (11 on each intake bank) Line or Vee OHV - 1 phaser provides coupled functionality	\$ 35	\$ 70	\$ 70	\$ 35	\$ 35
	Line DOHC engines - 2 phasers Vee DOHC engines - 4 phasers Dual: Practical solution for OHV engines undefined.	\$ 70	\$ 140	\$ 140	\$ 140	\$ 140
	Line DOHC engines - 1 phaser linked to both camshafts Vee DOHC engines - 2 phasers (1 linked to both camshafts on each bank) Line or Vee OHV - 1 phaser provides coupled functionality	\$ 50	\$ 115	\$ 115	\$ 35	\$ 35



6

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle						
Technology	Technology Description - Hardware and Functionality	2.2L DOHC 4V A4 FWD	3.0L DOHC 4V A4 FWD	3.4L DOHC 4V A4 RWD	3.3L OHV 2V A4 RWD	5.3L OHV 2V A4 AWD
Technology	Technology Description - Hardware and Functionality	Cavalier (SC)	Taurus (LC)	Tacoma (ST)	Town & C (NV)	Sierra (LT)
Variable Valve Lift (VVL)	Intake phasing credits must be added to all VVL and CVVL concepts. 4 lost motion devices each operating 1 intake valve pair per cylinder. 4 actuators, drivers, harness. Intake valves only. Baseline DOHC valvetrain is separate cam lobe and roller finger follower w/ HLA for each valve of 4V per cylinder. Cylinder head redesign required for low cost valve pairing concept.					
	Discrete 2-step VVL (DVVL) - Electromagnetic (EM)		\$ 120			
	DVVL - EM			\$ 180	\$ 180	
	DVVL - Electrohydraulic (EH)			\$ 75		



7

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle						
Technology	Technology Description - Hardware and Functionality	2.2L DOHC 4V A4 FWD	3.0L DOHC 4V A4 FWD	3.4L DOHC 4V A4 RWD	3.3L OHV 2V A4 RWD	5.3L OHV 2V A4 AWD
Technology	Technology Description - Hardware and Functionality	Cavalier (SC)	Taurus (LC)	Tacoma (ST)	Town & C (NV)	Sierra (LT)
Variable Valve Lift (VVL)	Intake phasing credits must be added to all VVL and CVVL concepts. 6 lost motion devices each operating 1 intake valve pair per cylinder. 3 solenoids, drivers, harness. Intake valves only. Baseline DOHC valvetrain is separate cam lobe and roller finger follower w/ HLA for each valve of 4V per cylinder. Cylinder head redesign required for low cost valve pairing concept.					
	DVVL - EM		\$ 115	\$ 115		
	DVVL - EH			\$ 115		
	DVVL - EH				\$ 150	
Continuously Variable Valve Lift (CVVL)	Ratio linkage including roller element for each pair of intake valves. 1 control shaft positioned by 1 electrohydraulic actuator per bank. Roller finger follower operates 1 pair of intake valves per cylinder. Hydraulic lash adjusters remain. Control of intake valves only. DOHC engines only. Baseline DOHC valvetrain is separate cam lobe and roller finger follower w/ HLA for each valve of 4V per cylinder. Cylinder head redesign required for low cost valve pairing concept.	\$ 150	\$ 275	\$ 275	\$275+DOHC	\$300+DOHC



8

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle						
Technology	Technology Description - Hardware and Functionality	2.2L DOHC 4V A4 FWD	3.0L DOHC 4V A4 FWD	3.4L DOHC 4V A4 RWD	3.3L OHV 2V A4 RWD	5.3L OHV 2V A4 AWD
Technology	Technology Description - Hardware and Functionality	Cavalier (SC)	Taurus (LC)	Tacoma (ST)	Town & C (NV)	Sierra (LT)
Cylinder Deactivation - Electrohydraulic	6 lost motion devices each operating 1 valve pair 3 solenoids, drivers, harness. Deactivating all I, E valves in each cylinder for 1/2 of the engine cylinders. Excludes any necessary NVH improvements. Baseline DOHC valvetrain is separate cam lobe and roller finger follower w/ HLA for each valve of 4V per cylinder. Cylinder head redesign required for low cost valve pairing concept.			\$ 115	\$ 115	
Cylinder Deactivation - EH	6 lost motion devices each operating 1 valve 3 solenoids, drivers, harness. Deactivating all I, E valves in each cylinder for 1/2 of the engine cylinders. Excludes any necessary NVH improvements. Baseline cost is 2V per cylinder OHV using RHVL lifters.				\$ 115	
Cylinder Deactivation - EH	8 lost motion devices each operating 1 valve, 4 solenoids, drivers, harness. Deactivating all I, E valves in each cylinder for 1/2 of the engine cylinders. Excludes any necessary NVH improvements. Baseline cost is 2V per cylinder OHV using RHVL lifters.					\$ 150



9

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle						
Technology	Technology Description - Hardware and Functionality	2.2L DOHC 4V A4 FWD	3.0L DOHC 4V A4 FWD	3.4L DOHC 4V A4 RWD	3.3L OHV 2V A4 RWD	5.3L OHV 2V A4 AWD
Technology	Technology Description - Hardware and Functionality	Cavalier (SC)	Taurus (LC)	Tacoma (ST)	Town & C (NV)	Sierra (LT)
DVVL/Deact Combinations	Intake phasing credits must be added to all VVL combinations. Add 2-step (closed) to intake valves on 1/2 the cylinders for deact. - requires higher cost solenoids - 1 per deactivated cylinder. Add 2-step on exhaust valves for deact on 1/2 the cylinders. Add 2-step solenoids to get to 1 per non-deact cylinder - no cylinder pairing possible. Can operate DVVL and For Cylinder Deact independently at any time - a deactivated cylinder does not use DVVL while deactivated.	\$ 200	\$ 200	\$ 200	\$ 200	\$ 260
DVVL/EH with Cylinder Deactivation - EH Camless Valve Actuation (CVA)	Electromagnetic camless valve actuation. Assume 4 valves per cylinder. Includes control electronics. Expressed as net cost per engine 1 actuator per valve pair. Controller. Credit existing valvetrain. 4V is a requirement. These costs are excluded.	\$ 690	\$ 780	\$ 780	\$ 1,100	\$ 1,300
	Electrohydraulic camless valve actuation. Assume 4 valves per cylinder. 1 actuator per valve pair. Includes hydraulics and control electronics. Expressed as net cost per engine.	\$ 575	\$ 650	\$ 650	\$ 900	\$ 1,100



10

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle						
Technology	Technology Description - Hardware and Functionality	2.2L DOHC 4V A4 FWD	3.0L DOHC 4V A4 FWD	3.4L DOHC 4V A4 RWD	3.3L OHV 2V A4 RWD	5.3L OHV 2V A4 AWD
Technology	Technology Description - Hardware and Functionality	Cavalier (SC)	Taurus (LC)	Tacoma (ST)	Town & C (NV)	Sierra (LT)
Variable Geometry Turbocharging	VGT gasoline turbo, charge air cooler, piston upgrade, piston cooling, steel crankshaft, cooling system splice, plumbing, rmp, pressure sensor & bearing upgrade. Excludes any needed increase in transmission torque capacity or modifications to aftertreatment system.	\$ 400	\$ 400	\$ 400	\$ 400	\$ 400
Electric Assist Turbocharging	Waste-gate gasoline turbo with 12V EAT functionality at 1800-1500W consumption. Includes charge air cooler, piston and ring upgrade, piston cooling, steel crankshaft, cooling system splice, plumbing, head gasket upgrade, pressure sensor & bearing upgrade. Excludes any needed increase in transmission torque capacity or modifications to aftertreatment system.	\$ 475	\$ 475	\$ 475	\$ 475	\$ 475
Gasoline Engine Downsizing Credits	These credits apply only when the baseline vehicle gasoline engine is replaced by another gasoline engine of the type described for each credit. For the study A1L and NE SCAF modelled/idealized turbo gas engines at 65%, aggressive hybrids at 63% and moderate hybrids at 74% so these credits can be applied to those vehicle packages. L4 DOHC 4V remains L4 DOHC 4V Downsizing credit V8 DOHC 4V moves to L4 DOHC 4V Downsizing credit V6 DOHC 4V moves to L4 DOHC 4V Downsizing credit V6 DOHC 4V moves to L5 DOHC 4V Downsizing credit V8 OHV 2V moves to L4 DOHC 4V Downsizing credit V8 OHV 2V moves to L5 DOHC 4V Downsizing credit V8 OHV 2V moves to L6 DOHC 4V	na	\$ (700)	\$ (550)	\$ (700)	\$ (550)
			\$ (700)	\$ (550)	\$ (200)	\$ (50)
						\$ (300)



11

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle							
Technology	Technology Description - Hardware and Functionality	L4		V6		V8	
		2.2L DOHC 4V AA FWD Cavalier (SC)	3.0L DOHC 4V AA FWD Tauros (LC)	3.4L DOHC 4V AA RWD Tacoma (ST)	3.3L OHV 2V AA RWD Town & C (MV)	5.3L OHV 2V AA AWD Sierra (LT)	5.3L OHV 2V AA AWD Sierra (LT)
Supercharging	Advanced supercharger including charge air cooler, inlet and ring upgrade, piston cooling, steel crankshaft, bypass and plumbing, head gasket upgrade, pressure sensor & bearing upgrade. Excludes any needed increase in transmission torque capacity.	\$ 435	\$ 435	\$ 435	\$ 435	\$ 435	\$ 435
Variable Charge Motion	Active valve port timing (alloying hydraulically actuated "bump" in each port).	\$ 30	\$ 50	\$ 50	\$ 50	\$ 50	\$ 60
Direct Injection (DIG) I	Wall-gate DIG 90-100 bar pressures. Excludes all modifications to base engine.	\$ 135	\$ 185	\$ 185	\$ 185	\$ 185	\$ 210
Direct Injection (DIG) - Lean Burn Stratified Charge	Wall-gate DIG 90-100 bar pressures. Excludes all modifications to base engine.	\$ 135	\$ 185	\$ 185	\$ 185	\$ 185	\$ 210
Lean Burn DIG Aftertreatment Cost Delta	AVL designed 3.0L V6 with 3.73 gms engine-out NOx. System includes inactive exhaust cooler. Scaled using baseline engine displacements. AVL CDS System Wall-gate DIG 90-100 bar, on sense or virtual cylinder pressure sensing, intake phaser, DVI, DVI, supplemental OH exhaust valve operation for dilution management w/ high pressure oil pump and plumbing. Stoichiometric aftertreatment.	\$ 365	\$ 500	\$ 570	\$ 560	\$ 560	\$ 900
Gasoline HCCI (AVL CBI System)	Hydraulic pump, actuators, fit design, can move CR from 7.10.	\$ 400	\$ 600	\$ 600	na	na	na
Variable Compression Ratio	Hydraulic pump, actuators, fit design, can move CR from 7.10.	\$ 320	\$ 380	\$ 380	\$ 380	\$ 440	\$ 440



12

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle							
Technology	Technology Description - Hardware and Functionality	L4		V6		V8	
		2.2L DOHC 4V AA FWD Cavalier (SC)	3.0L DOHC 4V AA FWD Tauros (LC)	3.4L DOHC 4V AA RWD Tacoma (ST)	3.3L OHV 2V AA RWD Town & C (MV)	5.3L OHV 2V AA AWD Sierra (LT)	5.3L OHV 2V AA AWD Sierra (LT)
Baseline High-speed Diesel Engine Displacement	Downsized 4-cyl 2.2L diesel engine modeled by AVL to provide equivalent performance to each baseline gas engine.	1.78L L4	2.40L L4	2.28L L4	2.31L L4	3.85L L6	
Baseline High-speed Diesel Aftertreatment Cost Delta over diesel	DOHC 4V turbo diesel. Common rail, -1,800 bar, Piezo-actuated injectors, VNT, cooled EGR. Includes downsize credit. Excludes any needed increase in transmission torque capacity.	\$ 1,000	\$ 300	\$ 300	\$ 800	\$ 950	
Diesel Advanced Multi-Mod	AVL designed 2-leg system revised to single leg per MECA. Scaled from 2.8L V6 with 0.32 gms engine-out NOx.	\$ 500	\$ 575	\$ 600	\$ 600	\$ 1,000	
Diesel Advanced Multi-Mod Aftertreatment Cost Delta	DOHC 4V turbo diesel. Common rail, -1,800 bar, Piezo-actuated injectors, VNT, cooled EGR. Includes downsize credit. Excludes any needed increase in transmission torque capacity. FEVAREL, ARF-DEC light duty advanced aftertreatment system (DEER 8-2003). Scaled from 1.8L engine containing 1 pre-cat (DOC + LNT functionality), 1 underfloor LNT and CDPF. MECA supplied PGM loadings expressed as a range.	\$ 1,000	\$ 300	\$ 300	\$ 800	\$ 950	
Diesel Engine and Aftertreatment downsizing substitution for Aggressive Hybrid	Pw NESCOP design scaling of hybrid vehicles, use L4 DOHC 4V turbo diesel AMM for this large truck vehicle class but only with the aggressive hybrid drivetrain. Aftertreatment cost is included in this cost.	\$250-350	\$300-450	\$280-400	\$285-400	\$500-725	
						\$ 900	



13

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle							
Technology	Technology Description - Hardware and Functionality	L4		V6		V8	
		2.2L DOHC 4V AA FWD Cavalier (SC)	3.0L DOHC 4V AA FWD Tauros (LC)	3.4L DOHC 4V AA RWD Tacoma (ST)	3.3L OHV 2V AA RWD Town & C (MV)	5.3L OHV 2V AA AWD Sierra (LT)	5.3L OHV 2V AA AWD Sierra (LT)
Drivetrain Technologies							
Transmission	Conventional step gear	\$ 100	\$ 100	\$ 100	\$ 100	\$ 100	\$ 100
Transmission	Leveller gear set design	\$ 50	\$ 75	\$ 75	\$ 75	\$ 75	\$ 90
Continuously Variable Transmission (CVT)	Best CVT. NESCOP assumptions. Assumes competitive market for belt technology free of losses and IP protection. Assumes global volume and capital infrastructure on par with step-gear transmissions.	\$ 150	\$ 175	\$ 175	\$ 175	na	na
Automated Manual Transmission 6 speed	6-speed, dual wet clutch, fully automated. Price paid only in US. Manual transmission capacity does not exist in Europe.	neutral	neutral	neutral	neutral	neutral	neutral



14

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle							
Technology	Technology Description - Hardware and Functionality	L4		V6		V8	
		2.2L DOHC 4V AA FWD Cavalier (SC)	3.0L DOHC 4V AA FWD Tauros (LC)	3.4L DOHC 4V AA RWD Tacoma (ST)	3.3L OHV 2V AA RWD Town & C (MV)	5.3L OHV 2V AA AWD Sierra (LT)	5.3L OHV 2V AA AWD Sierra (LT)
14V belt starter alternator (side off)	14V inverter. Includes inverter/rectifier, diode upgrade, belt tensioner upgrade. Credit alternator. Starter motor required for cold start. Maximum cylinder displacement = 495, for each in start includes 14V Pb acid battery upgrade. 60W machine. Includes belt upgrade, power electronics, DC-DC converter for split system.	\$ 200	na	na	na	na	na
42 Volt BAS - Belt Drive w/ side off	Liquid cooled electronics. Credit alternator and starter. Maximize starter motor for 5.3L cost crank. Excludes battery upgrade.	\$ 450	\$ 450	\$ 450	\$ 450	\$ 600	\$ 600
42 Volt ISG w/ Launch, Regen, Side Off	150W motor. Inverter integration, power electronics, DC-DC converter split system, liquid cooled, credit starter and alternator. Excludes battery upgrade.	\$ 600	\$ 600	\$ 600	\$ 600	\$ 800	\$ 800
42V system lead acid battery for BAS	36V 20Ah advanced adsorbent glass mat (AGM) lead acid battery - 72 kw-hr. Targeted primarily for the BAS system above.	\$ 120	\$ 120	\$ 120	\$ 120	\$ 120	\$ 120
42V system lead acid battery set for ISG	36V 50Ah advanced adsorbent glass mat (AGM) lead acid battery set - 1.98 kw-hr. Targeted primarily for the ISG system above.	\$ 330	\$ 330	\$ 330	\$ 330	\$ 330	\$ 330
42V system NiMH battery upgrade	Full battery pack including 36 cells, 43.2V, 44Ah, 605 kWh capacity, 2117 kJ energy (net SAFT 30V NiO2 air cooled (AC) 30V NiMH/SAFT) for BAS or ISG.	\$ 400	\$ 400	\$ 400	\$ 400	\$ 400	\$ 400
42V system NiMH battery upgrade	Full battery pack including 36 cells, 43.2V, 45.8 A-h, 1.98 kw-hr capacity for ISG.	\$ 1,090	\$ 1,090	\$ 1,090	\$ 1,090	\$ 1,090	\$ 1,090



15

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle							
Technology	Technology Description - Hardware and Functionality	L4		V6		V8	
		2.2L DOHC 4V AA FWD Cavalier (SC)	3.0L DOHC 4V AA FWD Tauros (LC)	3.4L DOHC 4V AA RWD Tacoma (ST)	3.3L OHV 2V AA RWD Town & C (MV)	5.3L OHV 2V AA AWD Sierra (LT)	5.3L OHV 2V AA AWD Sierra (LT)
Original Moderate / Motor Assist Hybrid Mechanizations	Based upon the Honda Insight architecture with design changes. Small car uses 30kW PM motor, 144V 50kWh NiMH battery pack. All other vehicles use 50kW PM motor, 208V 1.8 kWh NiMH battery pack. All vehicles include costs for CVT transmission, power electronics w/ 1 inverter and controls. Excludes cost of replacement battery pack.	\$ 2,650	\$ 2,750	\$ 2,750	\$ 2,750	\$ 2,750	\$ 2,750
Original Aggressive / Fully Integrated Hybrid Mechanizations	Based upon the Toyota Prius architecture with design changes. All vehicles use 30 kW PM generator / starter, 50 kW PM motor and 288V 1.8 kWh NiMH battery pack. Cost includes hybrid continuously variable auto transmission, power electronics w/ 2 inverters and 1 dc-dc voltage converter for 500V output and controls. Credit given for baseline vehicle starter and generator. Excludes cost of any replacement battery pack.	\$ 3,000	\$ 3,000	\$ 3,000	\$ 3,000	\$ 3,000	\$ 3,000



16

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle							
Technology	Technology Description - Hardware and Functionality	L4		V6		V8	
		2.2L DOHC 4V AA FWD Cavalier (SC)	3.0L DOHC 4V AA FWD Tauros (LC)	3.4L DOHC 4V AA RWD Tacoma (ST)	3.3L OHV 2V AA RWD Town & C (MV)	5.3L OHV 2V AA AWD Sierra (LT)	5.3L OHV 2V AA AWD Sierra (LT)
Revised Moderate / Motor Assist Hybrid Mechs	04 Honda Civic Hybrid architecture scaled by NESCOP to fit each vehicle class. Net cost includes a conventional transmission, NiMH battery pack at 144V, control and power electronics including 1 inverter for 144V system, 1 permanent magnet motor/generator. Credit given for baseline vehicle generator. Excludes cost of replacement battery pack.	\$ 1,650					
	Battery pack 9.0 Ah, moqen 15kW, CVT transmission.		\$ 2,100		\$ 2,100		
	Battery pack 12.0 Ah, moqen 20 Kw, CVT transmission. This vehicle may not meet the load carrying and towing continuous gradeability performance of the baseline vehicle for this class.			\$ 2,100			
	Battery pack 15.0 Ah, moqen 25 Kw, 5 speed automatic transmission. This vehicle may not meet the load carrying and towing continuous gradeability performance of the baseline vehicle for this class.					\$ 2,450	



17

Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle						
Technology	Technology Description - Hardware and Functionality	Variable Hardware Cost Delta Per Vehicle				
		L4	V6	V8	V8	V8
		2.2L DOHC 4V A4 FWD Cavalier (SC)	3.0L DOHC 4V A4 FWD Taurus (LC)	3.4L DOHC 4V A4 RWD Taurus (ST)	3.3L OHV 2V M RWD Town & C (RV)	6.3L OHV 2V M AWD Sierra (LT)
Revised Aggressive / Fully Integrated Hybrid Mechs	04 Toyota Prius hybrid architecture design scaled by HESCCAP to fit each vehicle class. Fuel cost includes continuously variable hybrid transmission, NiMH battery pack at 201 EV, control and power electronics including 2 inverters w/ 1 dc/dc converter for 500V system voltage, 1 permanent magnet generator/engine starter, 1 permanent magnet drive motor. Credit given for baseline vehicle generator and starter motor. Excludes cost of any replacement battery pack.					
	Battery pack 5 SAH, drive motor 40kw, generator 25kw	\$ 2,500				
	Battery pack 7 SAH, drive motor 60kw, generator 30kw		\$ 3,100		\$ 3,100	
	Battery pack 7 SAH, drive motor 60kw, generator 30kw. This vehicle may not meet the load carrying and towing continuous gradeability performance of the baseline vehicle for this class.			\$ 3,100		
	Battery pack 10 4AA, drive motor 80kw, generator 40kw. This vehicle may not meet the load carrying and towing continuous gradeability performance of the baseline vehicle for this class.					\$ 4,000



Vehicle Manufacturer Discrete Hardware Cost Delta 2009+ High Volume Variable Hardware Cost Delta Per Vehicle						
Technology	Technology Description - Hardware and Functionality	Variable Hardware Cost Delta Per Vehicle				
		L4	V6	V8	V8	V8
		2.2L DOHC 4V A4 FWD Cavalier (SC)	3.0L DOHC 4V A4 FWD Taurus (LC)	3.4L DOHC 4V A4 RWD Taurus (ST)	3.3L OHV 2V M RWD Town & C (RV)	6.3L OHV 2V M AWD Sierra (LT)
Technologies						
Other Leaf Reducing						
Advanced Power Steering	Electrohydraulic power steering 14V electrical system, EPS required for large (EPPS) truck class 14V2V EPS - 42V is requirement for large truck.					\$ 60
	Electric power steering (EPS) case EPS	\$ 20	\$ 40	\$ 40	\$ 40	\$ 40
Electric 42V Demand Water Pump	42V requirement for demand water pump	\$ 50	\$ 50	\$ 50	\$ 50	\$ 50
High Efficiency Generator	30% high efficiency Lundell machine	\$ 40	\$ 40	\$ 40	\$ 40	\$ 40
Weight Reduction	Aluminum extensive vehicle - body. Cost per pound saved	\$ 250	\$ 250	\$ 250	\$ 250	\$ 250
Important Notes on Technology Cost Matrix						
Vehicle manufacturer costs represent variable hardware cost delta over baseline technologies. R&D, capital investment and other costs associated with implementing new technologies are excluded. Costs are forecast 2009+ at assumed high volume levels. See Methodology Section for full description.						

