DARPA / ONR / DOE

THERMOELECTRIC WORKSHOP

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Introduction to Amerigon

Amerigon Thermoelectric Usage

Future Markets

- CCS
- Car Platforms

Performance Requirements

Summary and Conclusions

Amerigon

World's largest supplier of TE systems for automobiles

Currently supplying TE-based climate control systems to Ford and Toyota

Usage will expand to most major automobile companies over the next three years (U.S., Europe, Japan, Korea)

Projected to become world's largest commercial user of TEs within one year

Owns or controls 19 issued U.S. patents on TE systems for automobiles

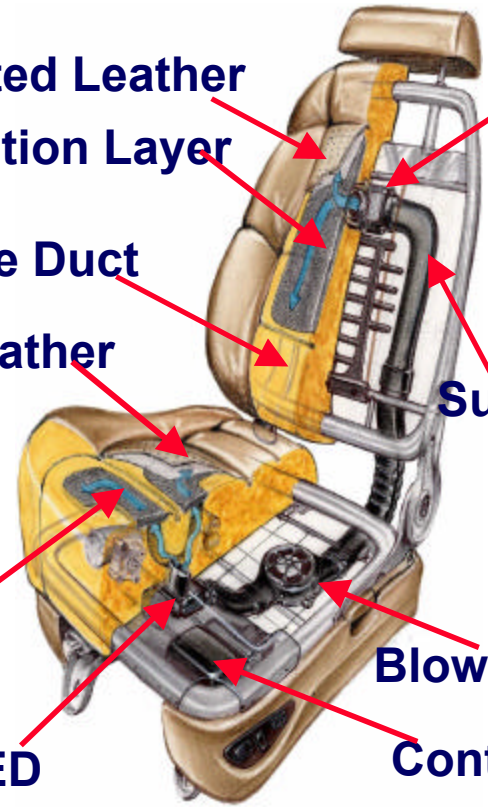
Production in California, Mexico and China (in 2002)

CCS System
(Climate Control Seat System)

AUTOMOTIVE CCS

CCS™ Vehicle Seat Application

Production CCS™ Assembly



2001 Lexus LS 430

Front seat option in the all new Lexus flagship model

Available since October 2000

Sold in North America, Europe

75% to 80% take rate

2003 Ford Expedition

High production volume vehicle

4 TEs per vehicle

Available Summer 2002

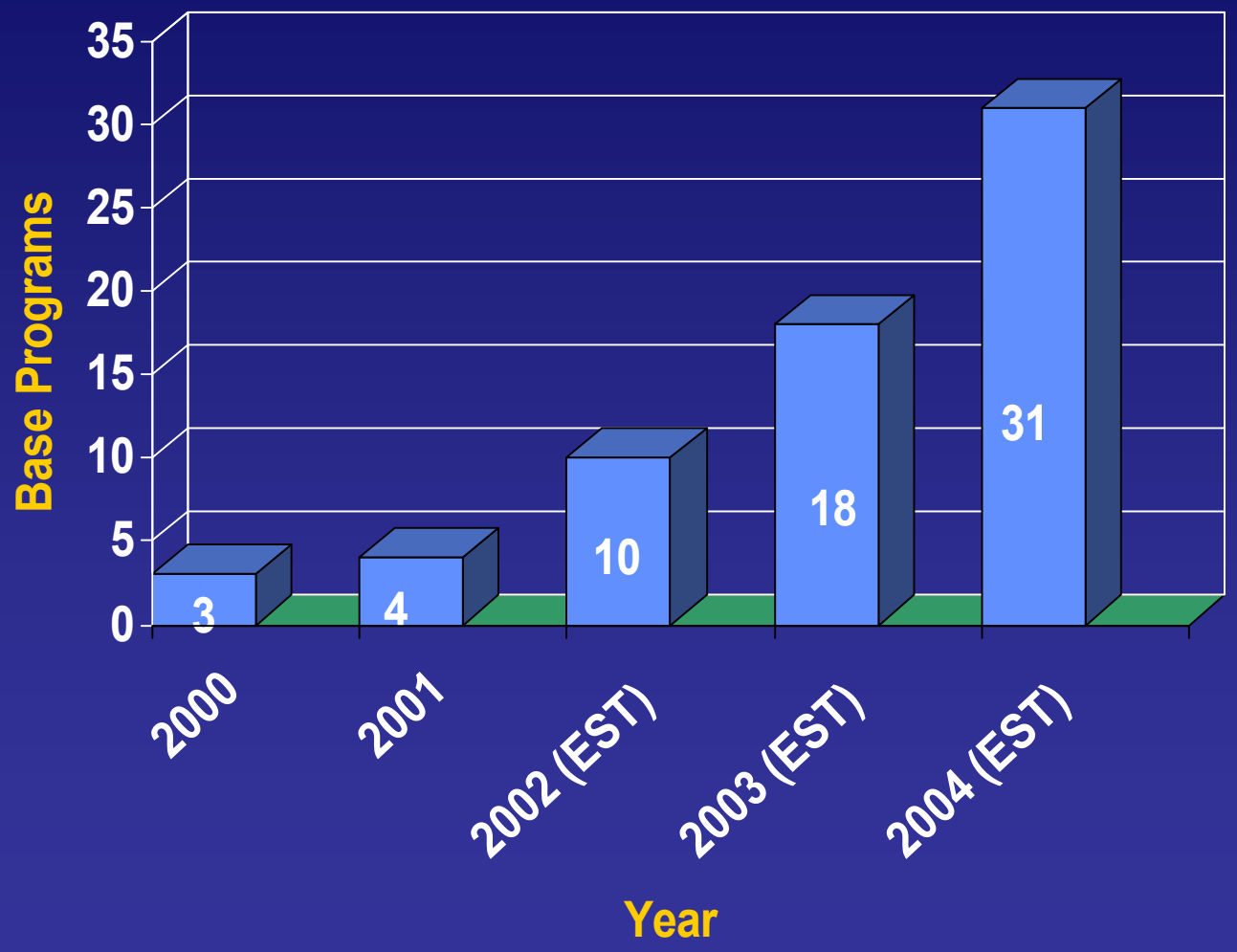
Infiniti CCS for 2003

Q45 and M45

Front row seat option

Available summer 2002

Growth for CCS Programs



Potential Automotive Markets for Thermoelectrics

Auto Industry Opportunities for Advanced TEs

Cooling/Heating/Ventilation:

- Present HVAC system replacement
- Auxiliary HVAC (including CCS)
- HVAC for EVs, hybrids, etc.
- Quiet systems for trailers, vans, campers
- Defrost/demist
- Localized temperature control (instruments, on-board refrigerator, etc.)

Power Generation:

- Exhaust waste heat recovery
- Engine coolant waste heat recovery
- Co-cycle generation
- Alternator replacement

Potential Automotive Markets

High Efficiency Enables:

- 4 CCS units versus 2 per car
- Usage as remote conditioners in headliner, backs of seats, console
- Small car mini HVAC

System Integration (Plus Higher Efficiency):

- Reduced HVAC load, size, weight and cost
- Waste power recovery
- Less total vehicle power consumption
- Complete HVAC systems

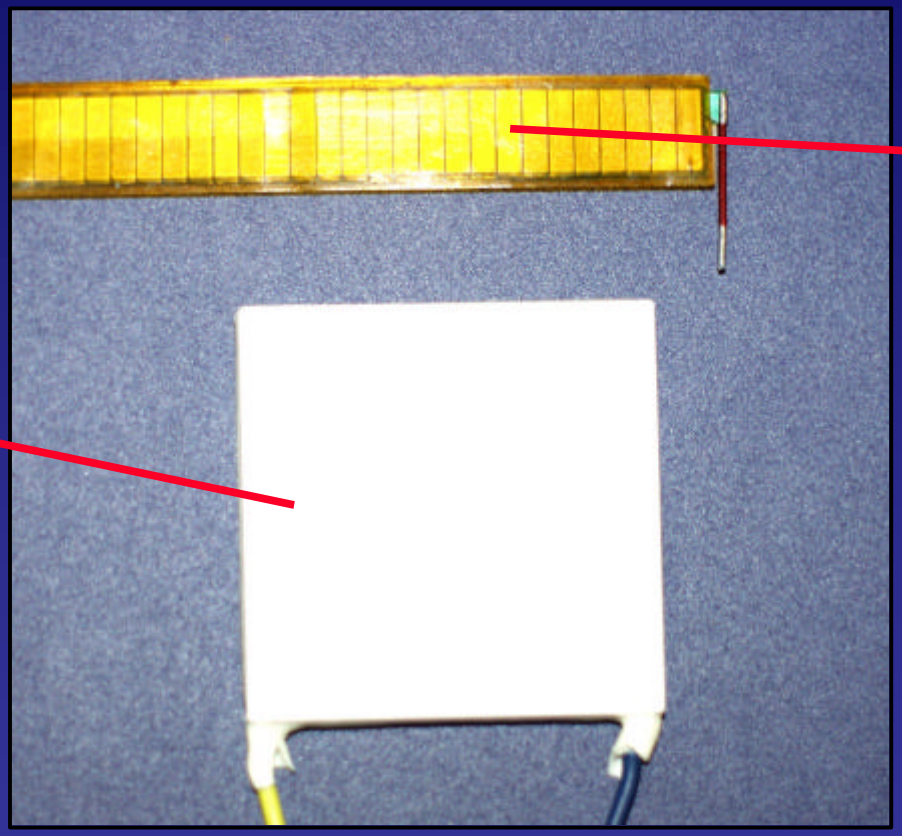
But Any New System Must:

- Be reliable, durable, light weight
- Be cost effective at the system level
- Help meet long-term environmental goals

Automotive TE Material Requirements
(My View)

	COOLING (HEATING)		POWER GENERATION	
Characteristic	Present	Needed	Present	Needed
Thermal Power Density (W/CM^2))	4 - 8 (15 - 25)	10 - 80 (30 - 200)	6 - 12	50 - 200
Thickness (MM)	1.0 - 2.0	0.050 - 0.200	4 -10	0.100 - 0.500
Power Output (W)	15 - 30 (60 - 100)	20 - 3,000 (50 - 10,000)	14 - 25	500 - 4,000
Cost/Watt Output ($/W)	0.20 - 0.25 (0.06 - 0.10)	0.04 - 0.24 (0.01 - 0.06)	?	0.08 - 0.40
Efficiency (% Carnot)	8 -12	24 - 50	3 - 4	16 - 25

TED Technology Comparison



Current TED Technology

- Flat TED
- Ceramic Material
- 40x40x4 mm
- 254 Elements

New TED Technology

- Flat Strip TED
- Flexible Circuit
- Circular Design
- 10x140x2 mm
- 228 Elements

Summary

Considerable opportunity with two times today's ZT

But, the HOLY GRAIL is . . . .

Four times today's performance