Potential Stranded Capital Analysis on EPA Light-Duty Technology Cost Analysis

United States
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Potential Stranded Capital Analysis on EPA Light-Duty Technology Cost Analysis

Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

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Executive Summary

The United States Environmental Protection Agency (EPA) contracted with FEV, Inc. to determine incremental direct manufacturing costs (IDMC) for a set of advanced light-duty vehicle technologies. The technologies selected are on the leading edge for reducing emissions of greenhouse gases in the future, primarily in the form of tailpipe carbon dioxide (CO2). Examples of technologies evaluated include: downsized turbocharged gasoline direct-injection (GDI) engines, advanced transmissions (e.g., 8-speed automatic, 6-speed dual clutch), and hybrid electric vehicles.

To develop incremental direct manufacturing costs, advance vehicle technology configurations were evaluated against baseline vehicle technology configurations, representative of the current state of design, and having similar overall driving performance. For each case study, both the new and baseline configurations utilized a common set of boundary conditions for the analysis (e.g., technology maturity, production year, production volumes, manufacturing location, equipment life). Using the same boundary conditions for both analyses, a consistent framework for all costing work was established. A detailed description of the costing methodology used to develop the incremental direct manufacturing costs can be found in EPA report “Light-Duty Technology Cost Analysis Pilot Study (EPA-420-R-09-020).”

In selected cases where the boundary conditions and parameters assumed in the primary analysis differ, an adjustment can be made to the incremental direct manufacturing cost accounting for these differences. Examples of case study specific parameter adjustments are volume differences, technology maturity differences, timeframe differences, and production duration differences.

Using conservative assumptions, this report investigates the potential saddling of cost onto a new technology configuration as a result of the production equipment and/or tooling for the baseline configuration being abandoned before the planned fully depreciated life. An applicable scenario is when a new technology configuration is launched into production forcing a baseline technology out of production prematurely. In this case any production equipment and/or tooling, which can only be used to produce the baseline technology, and which cannot be redispositioned to another plant continuing to make the baseline technology, would be removed from service and sold for scrap. It is assumed the financial loss associated with abandoning capital investment and tooling from the baseline technology configuration would indirectly be recovered by the new replacing technology over some number of years of its production.

Within the context of this report, the term stranded capital and stranded tooling will be used to define capital investment and tooling which has been decommissioned prior to the end of its fully depreciated life. In the FEV analysis, the fully depreciated life and useful life are assumed to be the same as a means of simplifying the analysis.

The foundation for the stranded capital and tooling analysis are the previously completed EPA Light-Duty Vehicle Technology Cost Analysis case studies. For each case study, the FEV manufacturing team assembled a cost estimate for the total capital investment and tooling, which could **only** be used to manufacture the baseline technology. Any baseline technology capital investment or tooling, or portion of capital investment or tooling, which could be used to manufacture other products, was not included in the cost estimate. Using a straight-line depreciation method, the estimated stranded capital and tooling impact was calculated for three, five, and eight years. The average useful life used in the calculation was ten years with an assumption of zero residual value. The sum of the stranded capital and tooling for each of the evaluated periods (i.e., 3, 5, and 8 years) was then divided by 2,250,000 new technology vehicle units; 2,250,000 vehicle units representing the sale of 450,000 units/year over five years (450,000 x 5).

Table ES-1 the results for six case studies are presented, showing the potential stranded capital impact at three, five and eights years of product life, based on the methodology and set of conservative assumptions described in the report. The table includes the results for two dual clutch transmission (DCT) studies, an 8-speed automatic transmission (AT) study, two downsized (DS), turbocharged (T), gasoline direct injection (GDI) studies, and a powersplit hybrid electrical vehicle (HEV) study.

Table ES- 1: Potential Stranded Capital Analysis Results
($/New Vehicle Technology Configuration)

Replaced Technology	New technology	Potential Stranded capital cost per vehicle with new technology, with product life ended after:		
		3 years	5 years	8 years
Conventional V6	DSTGDI I4	$56	$40	$16
Conventional V8	DSTGDI V6	$60	$43	$17
6-speed AT	6-speed DCT	$55	$39	$16
6-speed AT	8-speed AT	$48	$34	$14
6-speed DCT	8-speed DCT	$28	$20	$8
Conventional V6	Power-split HEV	$111	$79	$32

1 Introduction

1.1 Objectives

The objective of this work assignment is to determine the potential magnitude of stranded capital investment and tooling costs, associated with the launch of a new advanced vehicle technology configurations, prematurely replacing existing/baseline technology configurations. The case studies investigated in this analysis are based on advanced technologies considered leading edge for reducing emissions of greenhouse gases in the future. Further, the case studies selected for this analysis are the same for which FEV has previously developed incremental direct manufacturing costs as part of prior work assignments completed for EPA.

In the original incremental direct manufacturing case studies, the same boundary conditions and parameters were employed for both the baseline and new technology configurations evaluated. This methodology provides a common framework for costing, allowing a good means of comparison. As part of these established boundary conditions, it was assumed both the baseline and new technology configurations would run their planned full production life cycle. Additional details on the incremental cost analyses can be found in the following published reports and in reports being prepared for subsequent case studies.

- Light-Duty Vehicle Technology Cost Analysis – Pilot Study (EPA-420-R-09-020)
- Light-Duty Vehicle Technology Cost Analysis – Report on Additional Case Studies (EPA-420-R-10-010)
- Light-Duty Technology Cost Analysis, Power-Split and P2 HEV Case Studies (EPA-420-R-11-015)

To understand the tooling and capital investment financial impact of the baseline technology **not** running a full production life cycle, the potential result of a new advance replacement technology being regulated into production too quickly, EPA contracted with FEV to conduct a potential stranded capital investment and tooling analysis. It is recognized that an accurate analysis would need to know just how quickly the new technologies (government standards) were phasing in, and would also be very specific to individual companies, factories, and manufacturing processes, particularly in regard to finding alternative uses for equipment and facilities. Such a thorough analysis would be a prohibitively large undertaking. Nevertheless, in order to account for the possibility of stranded capital costs, FEV has performed a bounding analysis, using conservative assumptions, of the potential stranded capital costs associated with rapid phase-in of technologies due to new standards, using data from FEV's primary teardown-based cost analyses.

A planned production life of 10 years was assumed for all equipment and tooling. The cost impact of canceling production of the baseline technology after three, five and eight years was evaluated. For each production run scenario (i.e., 3, 5, and 8 years) total potential stranded capital investment and tooling values were developed. For this analysis, the assumption is the early introduction of the new advance technology is responsible for prematurely ending the production life of the baseline technology. Therefore, the new technology should be accountable for recovering the stranded capital investment and tooling from the baseline technology configuration. Amortizing the combined total stranded capital investment and tooling by 2,250,000 new advance vehicle units (450,000 units per year x 5 years), an added cost per vehicle was established for each production run scenario.

A simple, three-year baseline product cancellation example to illustrate the above:

- $100,000,000 of dedicated baseline technology production equipment is identified to produce part "ABC."
- Assuming a straight line depreciation, and 10-year useful life, depreciated value per year is equal to $10,000,000.
- Following three years of manufacturing, the baseline technology is replaced by a new technology configuration "XYZ."
- Part "ABC" is used in no other product made at this factory or another factory, and the equipment used to make part "ABC" is not reconfigurable to make some other part.
- Remaining value of baseline equipment at point of cancellation $70,000,000 (7 years x $10,000,000 depreciation expense/year).
- Amortization volume based on estimated new vehicle technology configuration sales over five years equals 2,250,000 vehicle units (450,000 units/year x 5 years).
- Estimated additional cost per new vehicle technology unit, accounting for baseline stranded capital and tooling equals $31.11/vehicle ($70,000,000 stranded capital and tooling /2,250,000 vehicle units).

1.2 Capital Investment and Tooling Definitions

Capital investment is defined as the facilities, machines, and other equipment used in the manufacturing process that are not directly in contact with the part produced. Simple examples of capital investment include stamping presses, injection mold machines, welding equipment, and diecast machines. Tooling, on the other hand, is generally the part-contacting components of the manufacturing process. In relationship to the example listed for capital investment, a stamping die, injection mold, weld tips, and diecast molds would all be examples of tooling. There are grey areas as to what constitutes tooling versus capital equipment, especially for component assembly processes. Generally, the OEM (original equipment manufacturer) will have detailed definitions for the less clear-cut manufacturing operations. For this analysis, a deeper understanding of what is considered capital investment versus tooling is not required.

All capital investment and tooling has a useful life expectancy, typically based on anticipated service hours or units produced. For example, assume a progressive stamping die has a purchased financed value of $250,000. The life expectancy of the stamping die is eight years, producing 450,000 engine brackets per year with a zero dollar residual value at end of the die's life. The company that owns the die is using a straight-line depreciation method to expense the die. If, after four years, the part produced by the die is considered obsolete, approximately half the value of the die ($125,000) is unrecoverable (i.e., stranded tooling). Because the majority of tooling is generally considered dedicated, stranded tooling is generally more prevalent in comparison to stranded capital investment. This is especially true when automotive part and vehicle manufactures purchase production equipment with higher flexibility; a trend which has been growing over the last several decades. For the incremental direct manufacturing case studies, FEV assumed a flexible manufacturing environment when developing the cost models. FEV also assumed multiple manufacturing facilities and/or production lines existed, producing similar products, facilitating the ramping down of baseline production components and the ramping up of new technology components.

In the previous engine bracket example, the progressive stamping die would be run on a 400-ton stamping press (capital investment). Since the stamping press can run several different parts, simply by switching out the production dies, the stamping press would not become stranded upon deletion of the engine bracket. The terminology used within this analysis to identify capital investment, which can be utilized to produce several different parts, is referred to as flexible capital investment.

In comparison, dedicated capital investment is production equipment constructed to only manufacture one part. If the part becomes obsolete, independent the reason, the capital becomes stranded. In some cases where a portion of the capital equipment can be reused, the equipment is considered semi-dedicated. Therefore, only a defined portion becomes stranded.

More discussion on the designation of dedicated, semi-dedicated, and flexible capital investment and tooling will be covered in the methodology section (Section 2.1).

1.3 Case Studies Evaluated

The specific cases evaluated within this report include those previously studied for developing incremental direct manufacturing costs for a set of advance light-duty technologies: technologies aimed toward reducing greenhouse gas emissions. This work was completed by FEV for EPA.

The six advance technology configurations analyzed were:

- A 2.0L, I4, 4-valve, dual overhead cam (DOHC), dual variable valve timing (d-VVT), turbocharged, gasoline direct injection (GDI) engine, compared to an equivalent conventional 3.0L, V6, 4-valve, DOHC, d-VVT, naturally aspirated (NA), port fuel injected (PFI) engine.
- A 3.5L, V6, 4-valve, dual overhead cam (DOHC), d-VVT, turbocharged, GDI engine, compared to an equivalent conventional 5.4L, V8, 3-valve, single overhead cam (SOHC), VVT, NA, PFI engine.
- A 6-speed wet dual clutch transmission (DCT), compared to an equivalent 6-speed automatic transmission.
- An 8-speed automatic transmission, compared to an equivalent 6-speed automatic transmission.
- An 8-speed wet DCT, compared to an equivalent 6-speed wet DCT.
- An 2.5L NA PFI engine, electronically control continuously variable transmission (eCVT) power-split hybrid electric vehicle (HEV), compared to a conventional 3.0L NA PFI engine, 6-Speed AT baseline vehicle.

2 Methodology for Developing Stranded Capital Investment and Tooling Values

FEV assembled a cross function team (CFT) of manufacturing experts (employees and those otherwise under contract) to perform the analysis. The CFT, with an average relevant experience level of 24 years, employed technology expertise from several areas, including: design and development, vehicle integration, production development, manufacturing engineering (supplier and OEM), cost estimating, and product benchmarking.

The core members of the CFT first developed the methodology and tools required to conduct the analysis as discussed in detail in Section 2.1. Following the analysis set-up, the first case study was selected for the evaluation. The study steps are presented in Section 2.2 along with the aid of Figure 2-2. The same process steps were repeated for all technologies evaluated.

2.1 Analysis Set-up:

1) Determine and define the conditions for establishing "Stranded Capital & Tooling." Determination based on input from EPA and other sources reviewing prior "Light-Duty Vehicle Technology Cost Analysis" studies. Examples of established analysis boundary conditions include:

- Average investment and tooling fully depreciated life of 10 years
- Production life duration for baseline equipment: 3, 5, and 8 years
- Total new vehicle technology configuration amortization volume (5 years x 450,000 vehicle units/year)

2) Determine case studies to best represent the impact of Stranded Capital losses in total effort to implement emission reduction technologies.

3) Develop stranded capital and tooling analysis (SCTA) worksheet (Figure 2-1 & Figure 2-2). Key worksheet data fields include:

A. Component/Assembly Name

B. Investment & Tooling description

C. Investment & Tooling Categorization

D. Investment & Tooling Value as New (i.e., estimated purchase cost)

E. Estimated Stranded Capital Investment and Tooling Loss (3, 5, and 8 years)

4) Developed categorization of investment and tooling.

A. Investment Categorization Definitions:

- **i)** Flexible <FLX>: Can be used to manufacture parts in either the baseline or new technology configuration (0% stranded)
- **ii)** Re-Useable <RU>: Equipment can be used in alternative industries, equipment sold off at defined percent (50% stranded) of remaining value
- **iii)** Semi-Dedicated <SD>: Approx 50% of equipment is flexible (50% stranded)
- **iv)** Dedicated <DD>: Custom manufacturing equipment (100% stranded)

B. Tooling Categorization Definitions

- **i)** Flexible <FLX>: Can be used to manufacture parts in either the baseline or new technology configuration (0% stranded)
- **ii)** Perishable <PER>: Frequent replacement of tooling (0% stranded)
- **iii)** Semi-Dedicated Tooling <SDT>: Approx. 50% of tooling is dedicated (50% stranded)
- **iv)** Dedicated <DD>: Commodity-specific (100% stranded)

Indented Bill of Materials (0 1 2 3 4 5 6 7 8 9 10 11 12)		Investment Description	Investment Categorization: Flexible <FLX>: Re-Useable <RU>: Semi-Dedicated <SD>: Dedicated <DD>: (Definitions in Comment Box)	Investment Value "New"		Estimated Stranded Investment Loss: Resale Loss	Estimated Stranded Investment Loss: 3 Years Remaining Investment Value	Estimated Stranded Investment Loss: 5 Years Remaining Investment Value	Estimated Stranded Investment Loss: 8 Years Remaining Investment Value
						50%	70%	50%	20%
Ford 3.5L Engine (Surrogate)									
							$ -	$ -	$ -
	OEM Engine Assembly						$ -	$ -	$ -
1	Engine Assembly	Assembly Equipment	DD	$ 19,500,000			$ 13,650,000	$ 9,750,000	$ 3,900,000
2	Piston & Rod Assembly	Assembly Equipment	DD	$ 3,000,000			$ 2,100,000	$ 1,500,000	$ 600,000
2	Cylinder Head and Camshaft Assembly	Non-sync pallet transfer (assemble valve train complete and test)	DD	$ 4,500,000			$ 3,150,000	$ 2,250,000	$ 900,000
							$ -	$ -	$ -
	F Block with Plugs			$ -			$ -	$ -	$ -
							$ -	$ -	$ -
2	Block machine	CNC machines, semi-flex assembly machines & washers, robot load, part pallets (rgh. Machine, assemble brg. caps, finish machine, wash, assemble plugs, air test & inspect (V to I configuration)	DD	$ 13,125,000			$ 9,187,500	$ 6,562,500	$ 2,625,000
							$ -	$ -	$ -
2	F Block cubed machine	Included above	FLX	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
3	F Block-Trimmed	Trim Press	FLX	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
4	F Block-Cast	Die Cast Machine	FLX	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
5	F Block-Raw Material	NA	NA	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
3	F - Liners Cylinder Block	Commodity Pricing	NA	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
2	F Dowel, Heads	Commodity Pricing	NA	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
2	F Dowel, Heads	Commodity Pricing	NA	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
2	F Dowel, A/C Compressor	Commodity Pricing	NA	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
2	F Dowel, Alternator	Commodity Pricing	NA	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
2	F Dowel, Bell Housing	Commodity Pricing	NA	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
2	F Plug, Coolant, Block, Large	Commodity Pricing	NA	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
2	F Plug, Coolant, Block, Medium	Commodity Pricing	NA	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
2	F Plug, Coolant, Block, Small	Commodity Pricing	NA	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
2	F Coolant Diverters	Stamping press	FLX	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
2	F Plastic Protector	Mold press	FLX	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
1	F Main Bearing, Crank, Top	Bearing manufacturing equip.	FLX	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
1	F Thrust Bearing, Crank, Upper	Bearing manufacturing equip.	FLX	$ -			$ -	$ -	$ -
							$ -	$ -	$ -
	F Crank			$ -			$ -	$ -	$ -

Figure 2-1: Sample Stranded Capital Section of SCTA Worksheet

Indented Bill of Materials		Tooling Description	Tooling Categorization	Tooling Value "New"	Estimated Stranded Tooling Loss		
0 1 2 3 4 5 6 7 8 9 10 11 12			Flexible <FLX> Perishable <PER> Semi-Dedicated Tooling <SDT> Dedicated <DD> (Definitions in Comment Box)		3 Years Remaining Tooling Value 70%	5 Years Remaining Tooling Value 50%	8 Years Remaining Tooling Value 20%
Ford 3.5L Engine (Surrogate)							
					$ -	$ -	$ -
OEM Engine Assembly					$ -	$ -	$ -
1	Engine Assembly	Fixtures/Pallets/Misc	DD	$ 20,800,000	$ 14,560,000	$ 10,400,000	$ 4,160,000
2	Piston & Rod Assembly	Fixtures/Pallets/Misc	DD	$ 3,200,000	$ 2,240,000	$ 1,600,000	$ 640,000
2	Cylinder Head and Camshaft Assembly	Assembly part pallets, spindles, multi-spindle heads, special spindle columns, part feeders, air test seals and mounting plates, gauges	DD	$ 4,800,000	$ 3,360,000	$ 2,400,000	$ 960,000
					$ -	$ -	$ -
	F Block with Plugs			**$ -**	$ -	$ -	$ -
					$ -	$ -	$ -
2	Block machine	Machining - part pallets, tooling, machining part programs, inspection program, special gauges Assembly - part pallets, spindles, multi-spindle heads, special spindle columns, part feeders, gauges Washers - part programs Part Handling - dunnage, robot programs	DD	$ 14,000,000	$ 9,800,000	$ 7,000,000	$ 2,800,000
					$ -	$ -	$ -
2	F Block cubed machine			**$ -**	$ -	$ -	$ -
					$ -	$ -	$ -
3	F Block-Trimmed	Dies	DD	**$ 225,000**	$ 157,500	$ 112,500	$ 45,000
					$ -	$ -	$ -
4	F Block-Cast	Molds	DD	**$ 14,062,500**	$ 9,843,750	$ 7,031,250	$ 2,812,500
					$ -	$ -	$ -
5	F Block-Raw Material			**$ -**	$ -	$ -	$ -
					$ -	$ -	$ -
3	F - Liners Cylinder Block	Cast tube	DD	**$ 20,000**	$ 14,000	$ 10,000	$ 4,000
					$ -	$ -	$ -
2	F Dowel, Heads			**$ -**	$ -	$ -	$ -
					$ -	$ -	$ -
2	F Dowel, Heads			**$ -**	$ -	$ -	$ -
					$ -	$ -	$ -
2	F Dowel, A/C Compressor			**$ -**	$ -	$ -	$ -
					$ -	$ -	$ -
2	F Dowel, Alternator			**$ -**	$ -	$ -	$ -
					$ -	$ -	$ -
2	F Dowel, Bell Housing			**$ -**	$ -	$ -	$ -
					$ -	$ -	$ -
2	F Plug, Coolant, Block, Large			**$ -**	$ -	$ -	$ -
					$ -	$ -	$ -
2	F Plug, Coolant, Block, Medium			**$ -**	$ -	$ -	$ -

Figure 2-2: Sample Stranded Tooling Section of SCTA Worksheet

2.2 Stranded Capital & Tooling Case Study Steps

1) Select case study for stranded capital and tooling evaluation.

2) Transfer component and assembly part names/descriptions from baseline Comparison Bills of Materials (CBOM) developed in the prior tear-down studies into the SCTA worksheet.

3) CFT team review of stranded capital and tooling SCTA worksheet. Team members are assigned subsystem and system responsibilities based on industry experience.

4) Using the baseline and new technology CBOMs (developed in primary teardown analyses), identify potential capital investment and tooling in the baseline technology configuration, which is not likely to be transferable to the new technology configuration.

5) Based on Step 4 above, define manufacturing processes in detail, identifying equipment and tooling requirements. Summarize details in SCTA worksheet.

6) From the categorization menu in the SCTA worksheet, establish categorization codes (e.g., flexible, dedicated, semi-dedicated) for investment and tooling items captured in Step 5 above.

7) Enter in investment value ($) for components/assemblies with capital investment identified as re-useable, semi-dedicated, or dedicated. For tooling identified as dedicated or semi-dedicated, enter in tooling value ($).

8) The SCTA worksheet automatically calculates the stranded capital and tooling values for the three-, five-, and eight-year truncated production periods.

9) At the bottom of the SCTA worksheet, a combined total stranded capital and tooling value is calculated for each of the truncated production periods.

10) An estimated cost per new advance technology vehicle is calculated for each truncated production period, using the values derived in Step 9 along with the total estimated new advance vehicle sales during a five-year period (i.e., 450,000 units/year x 5 years = 2,250,000 vehicles)

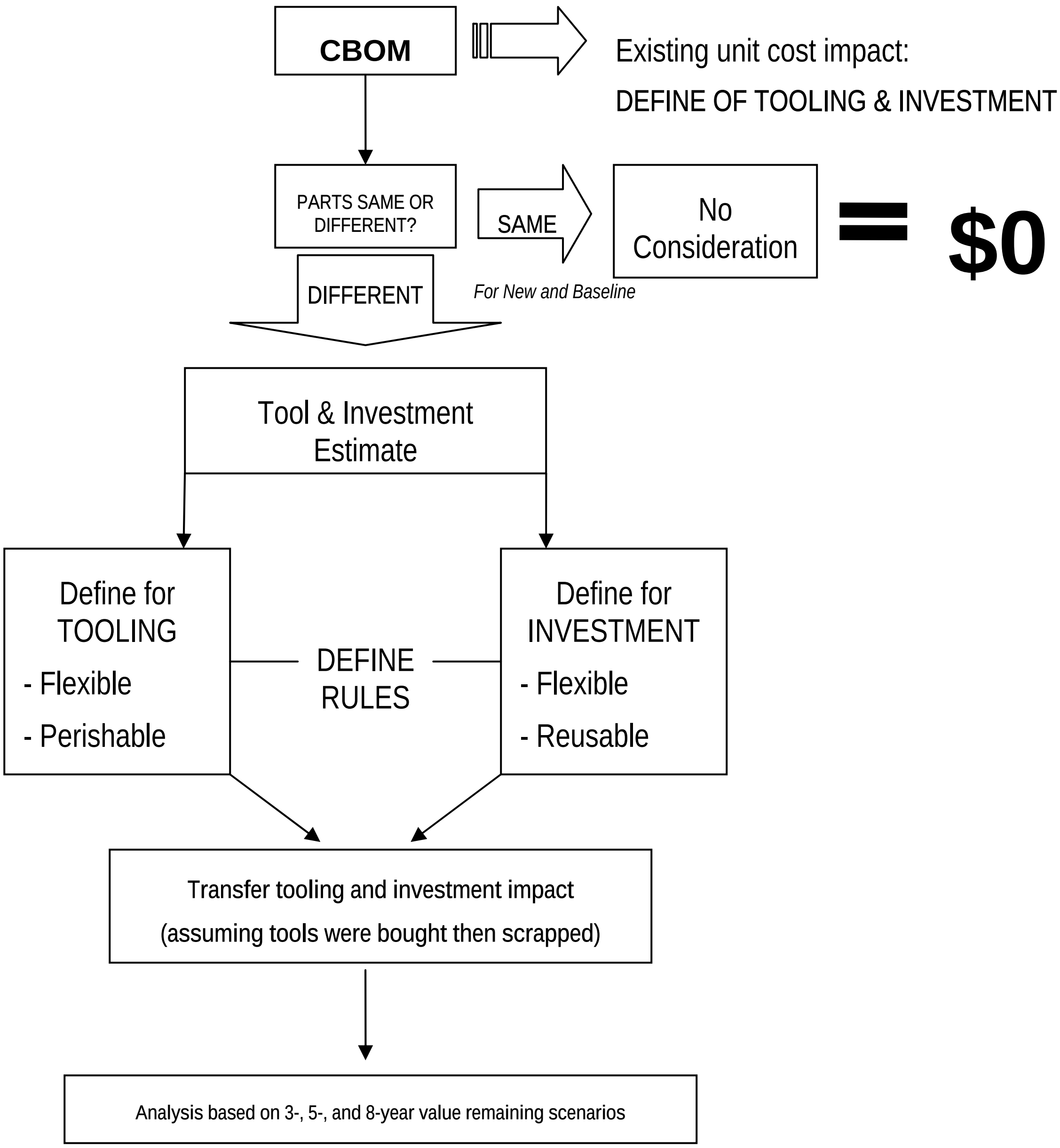

Figure 2-3: Stranded Capital and Tooling Case Study Steps

3 Key Assumptions in the Stranded Capital and Tooling Analysis

Listed below are the key assumptions made as part of the stranded capital and tooling analysis.

- All manufacturing equipment was bought brand new when the baseline technology started production (i.e., no carryover of equipment used to make the previous components that the baseline technology itself replaced).
- Manufacturing equipment and tooling used to make the baseline technology components is straight-line depreciated over a 10-year life.
- Factory managers do not optimize capital equipment phase-outs (i.e., they are assumed to routinely repair and replace equipment without regard to whether or not it will soon be scrapped due to adoption of new vehicle technology).
- Estimated stranded capital is amortized over five years of annual production at 450,000 units (of the new technology components). This is the same annual production volumes used in the incremental direct manufacturing cost studies.

4 Case Study Results

The results for the stranded capital and tooling analyses for the six evaluated case studies are captured below in Table 4-1. In the table, the total stranded capital and tooling values are present for each technology at each production truncation period. The "New" column in the table represents the estimated purchase price of the baseline vehicle technology capital and tooling prior to any depreciation. This value only represents the portion of equipment and tooling which cannot be used to manufacture any other component or assembly without extensive rework and financial burden.

A unit cost, in addition to the total lump sum values, is also present in the table. These values represent the total stranded capital and tooling lump sum values amortized over five years at 450,000 units/year of the new vehicle technology configurations.

Because many of the detailed spreadsheet documents generated within this analysis are too large to be shown in their entirety, electronic copies can be accessed through EPA's website **http://www.epa.gov/otaq/climate/publications.htm**

Table 4-1: Summary of Potential Stranded Capital and Tooling Estimates

Summary of Potential Stranded Capital & Tooling Estimates					
Component	Costs	New	@ 3 Yrs.	@ 5 Yrs.	@ 8 Yrs.
Engines					
3.0L V6 NA PFI to 2.0L I4 Turbo GDI	Inv. & Tlg. $	$181,781,500	$126,827,050	$90,590,750	$36,236,300
	$/Unit	$80.79	$56.37	$40.26	$16.11
5.4L V8 NA PFI to 3.5L V6 Turbo GDI	Inv. & Tlg. $	$194,417,889	$135,672,522	$96,908,944	$38,763,578
	$/Unit	$86.41	$60.30	$43.07	$17.23
Transmissions					
6-Speed AT to 6-Speed DCT	Inv. & Tlg. $	$205,756,250	$123,039,875	$87,885,625	$35,154,250
	$/Unit	$91.45	$54.68	$39.06	$15.62
6-Speed AT to 8-Speed AT	Inv. & Tlg. $	$163,786,250	$107,503,375	$76,788,125	$30,715,250
	$/Unit	$72.79	$47.78	$34.13	$13.65
6-Speed DCT to 8-Speed DCT	Inv. & Tlg. $	$89,553,000	$62,687,100	$44,776,500	$17,910,600
	$/Unit	$39.8	$27.86	$19.90	$7.96
Fusion Eng. & Trans.					
Conventional V6 to Power-split HEV	Inv. & Tlg. $	$387,537,750	$249,866,925	$178,476,375	$71,390,550
	$/Unit	$172.24	$111.05	$79.32	$31.73

5 Glossary of Terms

Dedicated: Custom manufacturing equipment (100% Stranded). Equipment design is specific to a component design such that there is minimal opportunity to retool and little value other than scrap metal. Dedicated hardware within the manufacturing process, while often generic in its component design, is in many cases configured in such that it is less likely to be reused.

Flexible: Can be used to manufacture baseline or new technology parts (0% Stranded). Equipment is generic and oftentimes an off-the-shelf design that can be easily redeployed for other component manufacturing within some constraints (turning, milling, work envelop size, etc.)

Capital Investment: The facilities, machines and other equipment within the manufacturing process that are not directly in contact with the part produced. Among auto manufacturers, investment is also referred to as the facilities and equipment part of process (versus part-contacting tooling, cutting tools, fixtures, gauges, etc.).

Perishable: Frequent replacement of tooling (0% Stranded). Perishable is often referring to the wearable part of the cutting tool or part-contacting components of the process that are prone to wear or have a given life.

Re-Usable: Equipment can be used in alternative industries, equipment sold-off at defined percent of remaining value. Equipment can be components of either dedicated or flexible equipment.

Semi-Dedicated: Approximately 50% of equipment is flexible and 50% dedicated or stranded

Stranded Capital: The abandoned equipment costs, either as new, or at reduced value when replaced after a prematurely truncated period of time in production.

Stranded Tooling: The abandoned tooling costs, either as new, or at reduced value when replaced after a prematurely truncated period of time in production.

Tooling: Generally the part-contacting components of the manufacturing process, such as part-contacting cutting tools, fixtures, gauges, etc.