Technology Cost and Effectiveness Estimates

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Advancing transportation innovation for the public good

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Direct Manufacturing Costs (DMC)

- Sources:
  - FEV, ANL BatPac model, Agency estimates of mass reduction and 2012-2016 final rule and TAR (OEM and supplier interviews, product plan submissions and Ricardo)
- Defined by:
  - Source $ year (*e.g.*, 2010$)
    - Adjusted using GDP deflator
  - Model Year (MY) of applicability (*e.g.*, 2017)
    - Defined the year in which learning starts (learning can go forward or backward)
  - Learning rate (FRIA Table V-28)
    - No learning – applied to technologies driven mostly by commodity prices
      - 0% indefinitely
    - "Flat" curve – applied to mature technologies
      - 3% reduction for first 5 yrs., 2% reduction for 2nd 5 yrs., followed by 1% indefinitely
    - "Steep" curve – applied to emerging technologies
      - 20% reduction every 2 years for 2 cycles
    - Once 2 cycles of "steep" learning was applied, technologies transitioned to "flat" learning

Direct Manufacturing Costs (DMC) - continued

- Defined by:
  - Engine architecture (*e.g.*, I-4, V-6, V-8)
  - Mass reduction impact on hybrid/electric vehicles battery and component sizing

Indirect Costs (IC)

- Defined by:
  - Indirect Cost Multiplier (ICM) applied to DMC
    - 4 complexity levels
      - Low, Medium, High1 and High2
    - 2 timeframes
      - Near term
      - Long term (applied after full implementation of technology is assumed - *e.g.,* MY2018 or MY2024)

Complexity	Near Term	Long Term
Low	1.24	1.19
Medium	1.39	1.29
High1	1.56	1.35
High2	1.77	1.5

Application of Stranded Capital

- FEV assumed a 10 year production life for capital depreciation
  - If a technology evaluated by FEV was replaced before the 10th year, there was the potential for stranded capital
  - FEV derived stranded capital costs for situations when technology was replaced after 3, 5 and 8 years of production
  - FEV assumed that if capital was stranded it would be recouped over a 5 year period
- NHTSA extrapolated the FEV values and created a look up table that defined stranded capital for years 1-10 (FRIA Table V-31)
  - If the CAFE model replaced a technology evaluated by FEV before the 10th year it applied the corresponding stranded capital cost from Tabled V-31 for 5 years
- The other option would have been to assume a 5 year product life (*i.e.*, capital costs amortized over 5 years)

Engine Downsizing Costs

EPA Class	NHTSA Class	18-bar		24-bar			27-bar		
		Technology List	Abs. Cost	Technology List	Abs. Cost	Inc. Cost to 18 bar	Technology List	Abs. Cost	Inc. Cost to 24 bar
Subcompact	Subcompact, Compact	I4 to I3 wT	-$193	I4 to I3 wT	-$193	$0	I4 to I3 wT	-$193	$0
small car	Midsize PC	I4 DOHC to I4 DOHC wT	-$85	I4 DOHC to I4 DOHC wT	-$85	$0	I4 DOHC to I4 DOHC wT	-$85	$0
large car	Large PC	V6 DOHC to I4 wT	-$547	V6 DOHC to I4 wT	-$547	$0	V6 DOHC to I4 wT	-$547	$0
		V8 DOHC to V6 DOHC wT	-$274	V8 DOHC to V6 DOHC wT	-$274	$0	V8 DOHC to I4 DOHC wT	-$821	-$547
		V8 OHV to V6 DOHC wT	$315	V8 OHV to V6 DOHC wT	$315	$0	V8 OHV to I4 DOHC wT	-$232	-$547
minivan	Minivan LT, Midsize LT	I4 DOHC to I4 DOHC wT	-$85	I4 DOHC to I4 DOHC wT	-$85	$0	I4 DOHC to I4 DOHC wT	-$85	$0
		V6 DOHC to I4 wT	-$547	V6 DOHC to I4 wT	-$547	$0	V6 DOHC to I4 wT	-$547	$0
		V6 SOHC to I4 wT	-$382	V6 SOHC to I4 wT	-$382	$0	V6 SOHC to I4 wT	-$382	$0
		V8 DOHC to V6 DOHC wT	-$274	V8 DOHC to V6 DOHC wT	-$274	$0	V8 DOHC to I4 DOHC wT	-$821	-$547
		V8 SOHC to V6 DOHC wT	-$84	V8 SOHC to V6 DOHC wT	-$84	$0	V8 SOHC to I4 DOHC wT	-$631	-$547
small truck	Small LT	V6 SOHC to I4 wT	-$382	V6 SOHC to I4 wT	-$382	$0	V6 SOHC to I4 wT	-$382	$0
large truck	Large LT	V6 DOHC to I4 wT	-$547	V6 DOHC to I4 wT	-$547	$0	V6 DOHC to I4 wT	-$547	$0
		V6 OHV to I4 DOHC wT	$270	V6 OHV to I4 DOHC wT	$270	$0	V6 OHV to I4 DOHC wT	$270	$0
		V6 SOHC to I4 wT	-$382	V6 SOHC to I4 wT	-$382	$0	V6 SOHC to I4 wT	-$382	$0
		V8 DOHC to V6 DOHC wT	-$274	V8 DOHC to V6 DOHC wT	-$274	$0	V8 DOHC to I4 DOHC wT	-$821	-$547
		V8 OHV to V6 DOHC wT	$315	V8 OHV to V6 DOHC wT	$315	$0	V8 OHV to I4 DOHC wT	-$232	-$547
		V8 SOHC 3V to V6 DOHC wT	-$155	V8 SOHC 3V to V6 DOHC wT	-$155	$0	V8 SOHC 3V to I4 DOHC wT	-$703	-$547

* 2007$ and applicable in MY2012

Turbocharging Costs

Configuration	Baseline	Source	Applicable MY	Cost (2007$)	Notes
TURB18-I	increment to base engine	FEV	2012	$404	
TURB18-V	increment to base engine	FEV	2012	$681	
TURB24-I	increment to base engine	FEV	2012	$606	Single-stage turbo, 1.5x 18 bar
TURB24-V	increment to base engine	FEV	2012	$1,022	Single-stage turbo, 1.5x 18 bar
TURB27-I	increment to base engine	2017+ NPRM	2012	$1,010	2-stage turbo, 2.5x 18 bar
TURB27-V	increment to base engine	2017+ NPRM	2012	$1,703	2-stage turbo, 2.5x 18 bar

* 2007$ and applicable in MY2012

Effectiveness Derivation

- Mapped DOT vehicle classes to EPA classes (FRIA Table V-15)
- Derived absolute effectiveness estimates for each step in decision trees using EPA's Lumped Parameter Model (LPM) - (FRIA Tables V-17 thru V-27)
- Calculated incremental effectiveness estimates for each technology using absolute effectiveness for each step
  - "In-path" synergies (those within a decision tree - *e.g.*, engine path) were taken into account because absolute effectiveness estimates accounted for preceding/existing technologies
- Derived "between-path" synergies (*e.g.*, engine technology to transmission technology)
  - Systematically "walked" through applications of individual technologies to define synergies between pairs of technologies
  - Iteratively evaluated hundreds of technology combinations to ensure these combinations closely aligned with overall fuel consumption reductions predicted by the LPM
    - Focused on combinations that the CAFE model most often forms dynamically