SWISS HARMONY

In Tune with Nature

EMISSIONS ANALYTICS

Swiss Harmony

Real-world fuel economy test of CarTuner on passenger car

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Executive summary

- Increase in fuel economy of 3.9% on the combined cycle – statistically significant
- Strongest effect seen in urban operation, up 4.6% on average – statistically significant
- The extra-urban results showed smaller uplifts with lower significance, but still a positive result
- Consequently, there is a 3.7% reduction in carbon dioxide – statistically significant
- Carbon monoxide down 38% – statistically significant

- Positive result on this vehicle, which is a high selling model
- Further testing would be required to make general claims across the vehicle fleet

OBJECTIVE

Objective

- To assess the fuel economy benefits of Swiss Harmony's CarTuner product on a single EU type approved passenger car
- To determine the effect on CO_2 greenhouse gas emissions
- To determine the effect on CO pollutant emissions

METHOD

Test plan

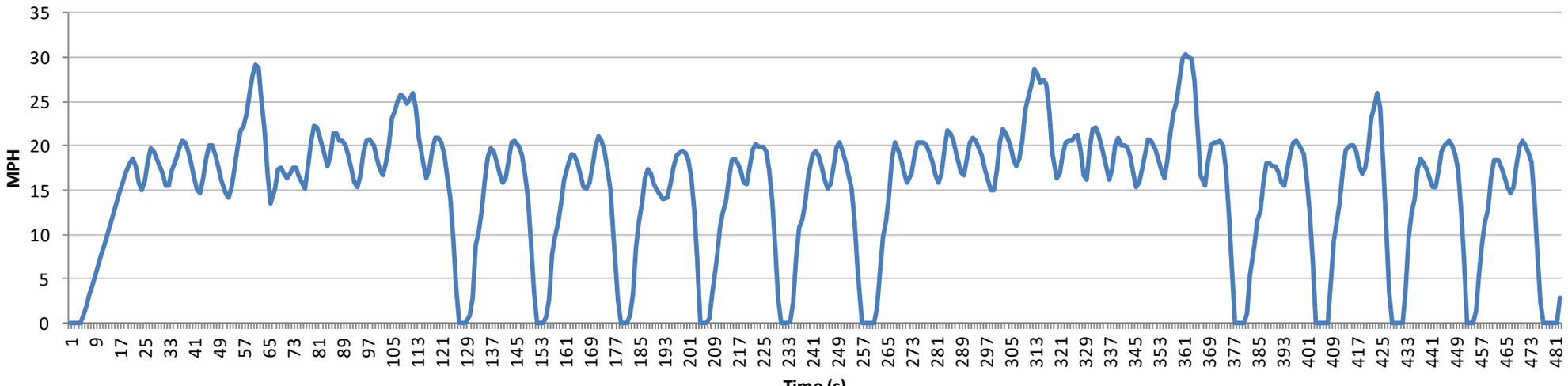
- Location: Bruntingthorpe Proving Ground, Leicestershire, UK
- Dates: 23 to 24 November 2015

- Receive and inspect vehicle
- Create tailpipe connection
- First test
- CarTuner installation
- Second test
- Restore tailpipe and return

Test protocol

- Warm up cycle
- Test cycle:
  - 3.5 km urban cycle at average speed of 22 kph
  - 6.1 km rural cycle at average speed of 78 kph
  - 6.1 km motorway cycle at average speed of 104 kph
- Repeat complete cycle multiple times during each test
- Match climatic conditions for first and second tests as closely as possible

Test cycle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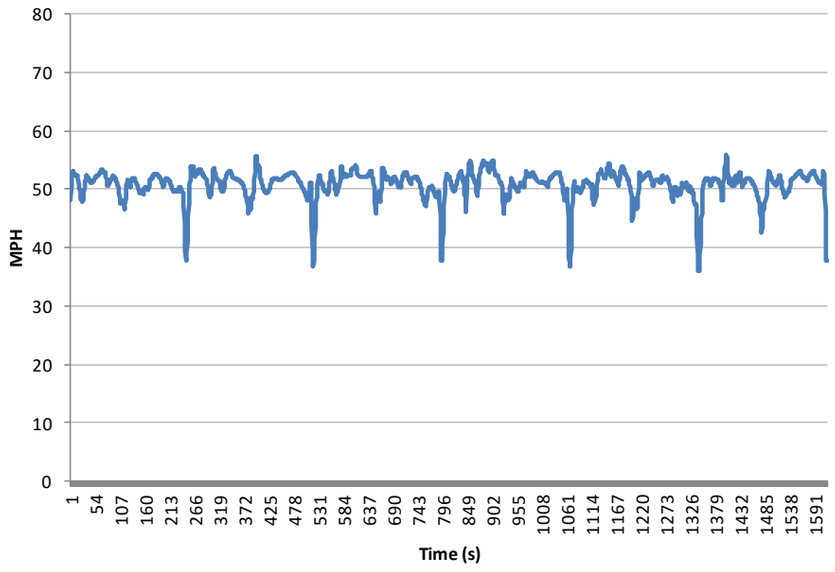
Time (s)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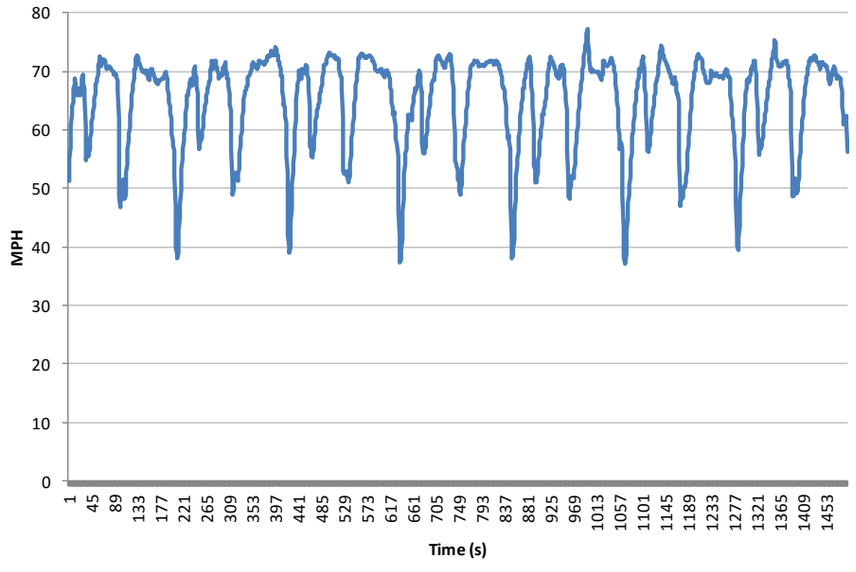
Time (s)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1 45 89 133 177 221 265 309 353 397 441 485 529 573 617 661 705 749 793 837 881 925 969 1013 1057 1101 1145 1189 1233 1277 1321 1365 1409 1453
Time (s)

Data capture

- CO_2 and CO from gas analyser (NDIR)
- NO and NO_x from gas analyser (NDUV)
- Hydrocarbons from gas analyser (FID)
- MPG derived using carbon balance method
- Speed and altitude from GPS
- Temperature, humidity and pressure from independent weather station
- Engine data via CANBUS
- Time aligned

Analysis

- Each test phase broken down into multiple sub-samples
  - To prove repeatability
  - Mean and standard deviation of sub-samples calculated
  - Outliers eliminated
- Any weather-affected repeats removed
  - Initial rural and motorway repeats after installation discarded
- Fuel economy results normalised to reference cycle
- “Comparison of means” method used to assess whether statistically significant change after installation
  - 1-tailed test as only testing for improvement
- Combined cycle made up of weighted average of urban (50%), rural (25%) and motorway (25%)

VEHICLE

Vehicle: FE14 ZTF

- Vauxhall Insignia
- CDTi Elite Nav
- Hatchback
- Diesel
- Year of manufacture: 2014
- Engine size: 1956cc
- Official CO_2 emissions: 140 g/km
- 2 wheel drive
- 6-speed automatic
- Miles on odometer: 34547 at start

EQUIPMENT

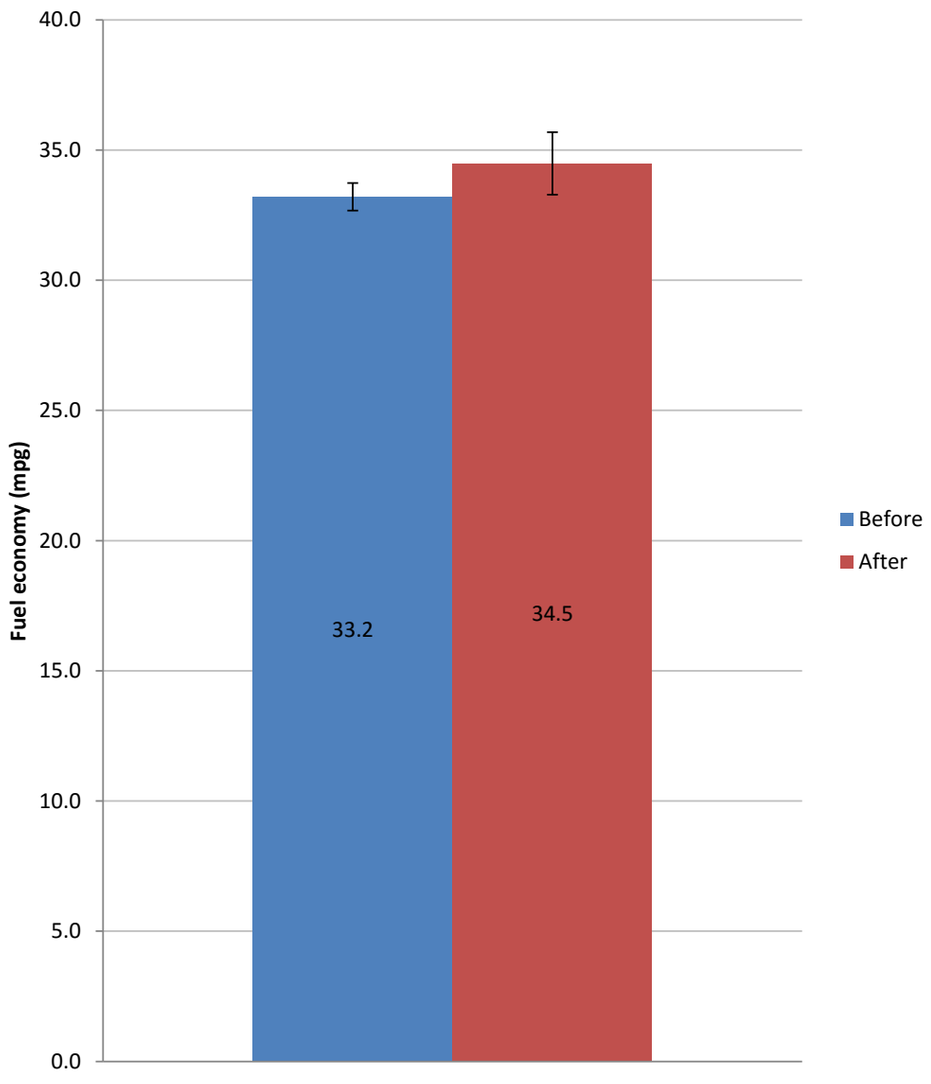
Equipment

- Laboratory-grade equipment
  - Precision of 2-3%
- Portable Emissions Measurement System connects to tailpipe
  - Captures emissions for CO_2, CO, NO, NO_2, total hydrocarbons
  - At 1 Hertz
- Air temperature, pressure, humidity
- GPS for speed and altitude
- Engine data via CANBUS
- Weights approximately 95kg if running with auxiliary batteries

RESULTS

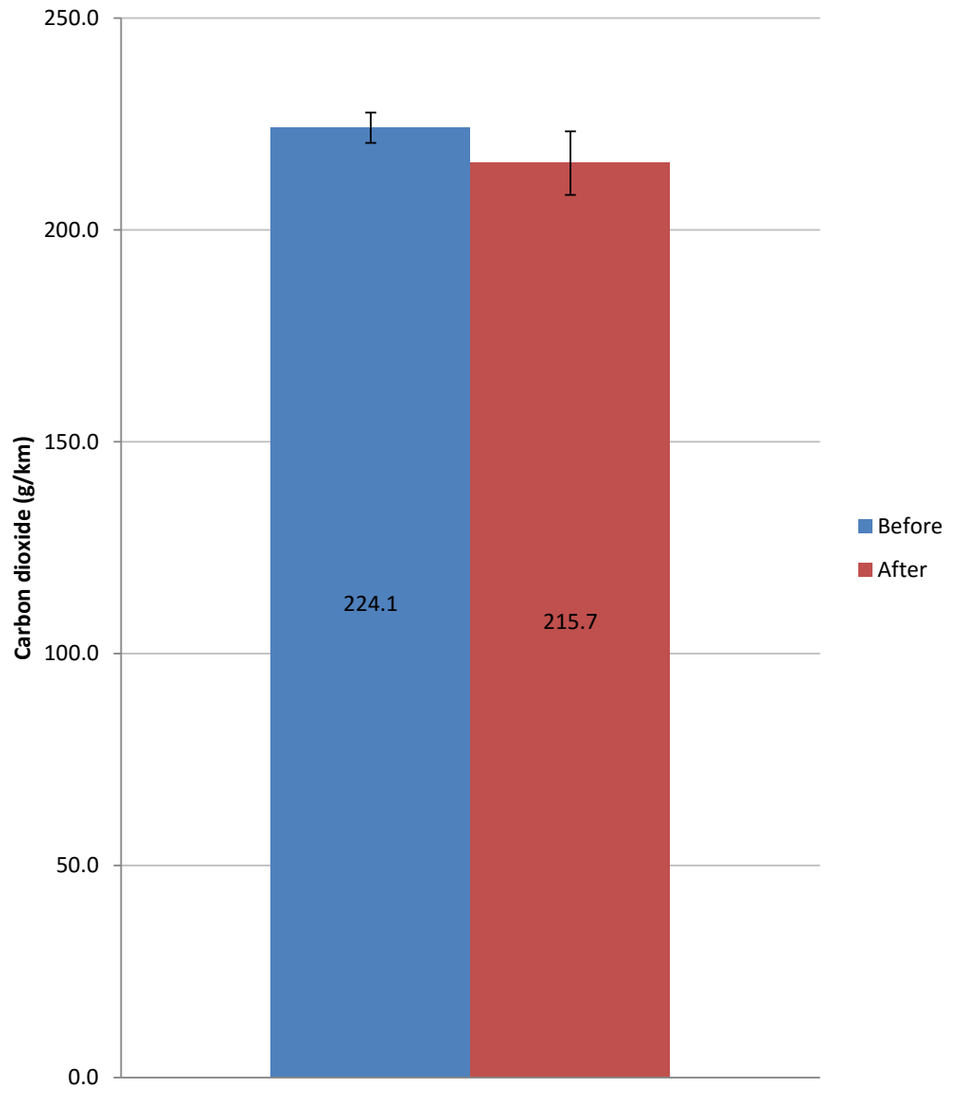
Fuel economy results

- 3.9% improvement in fuel economy over combined cycle (chart)
  - Significant @95%
- 4.6% up in urban
  - Significant @95%
- 3.5% up in rural
  - Significant @90%
- 2.2% up in motorway
  - Not significant



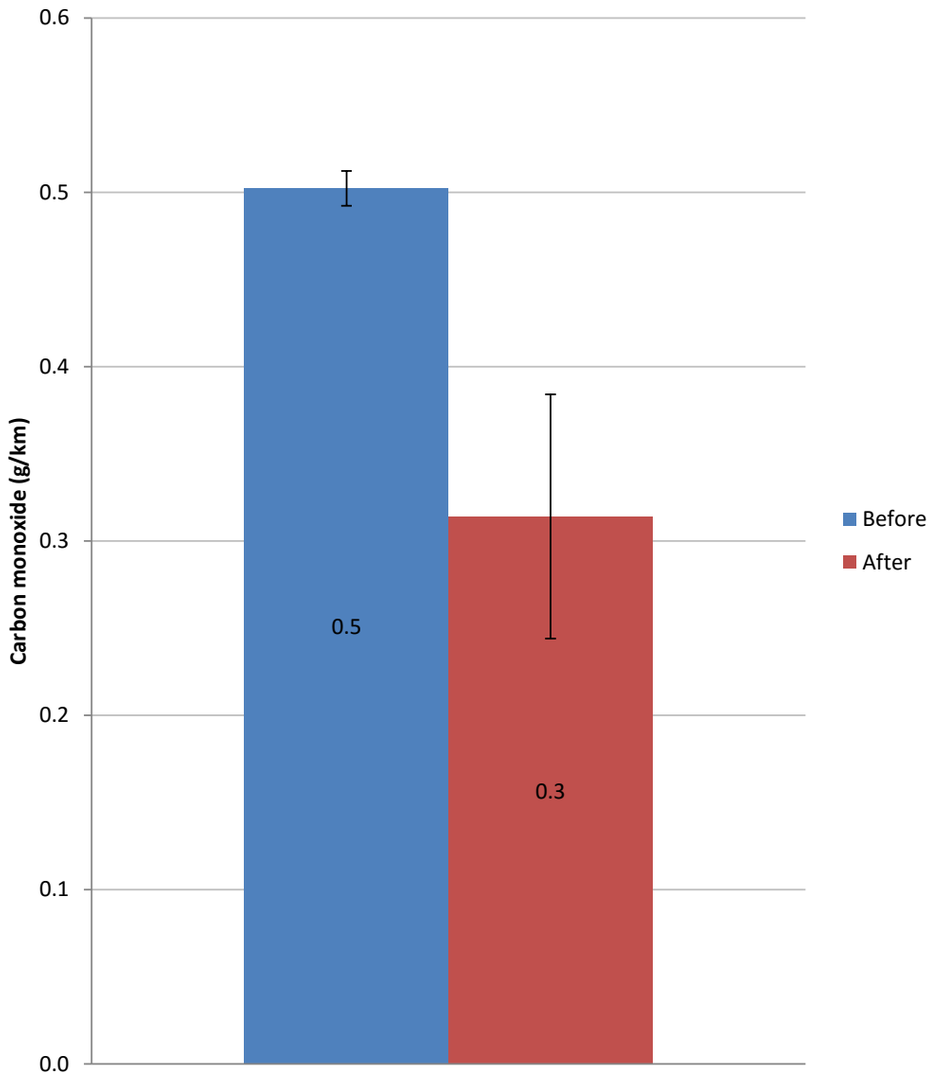
Carbon dioxide results

- 3.7% reduction in CO_2 over combined cycle (chart)
  - Significant @95%
- 4.4% down in urban
  - Significant @95%
- 3.4% down in rural
  - Significant @90%
- 2.2% down in motorway
  - Not significant



Carbon monoxide results

- 38% reduction in CO over combined cycle (chart)
  - Significant @95%
- 38% down in urban
  - Significant @95%
- 40% down in rural
  - Significant @99%
- 33% down in motorway
  - Significant @90%



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