Shell Gas to Liquids

Synthetic Fuels for Large Cities

Half the world's population lives in cities, accounting for an estimated 75% of the world's energy demand. With air quality concerns, cities are seeking cleaner alternative fuels to combat rising air pollution.

City governments can have significant influence and lead by example, making their policies a model for energy sustainability. Moreover, city governments have considerable purchasing power, which could enable them to influence the vehicle and technology markets. Given their density of infrastructure and concentration of activity, large cities have the potential to be very efficient and fast in making things happen.

Synthetic Gas to Liquids (GTL) Fuel is currently considered to be the most cost effective alternative fuel for addressing local emissions. GTL Fuel is part of a family of synthetic fuels that can be made using the Fischer Tropsch process from a range of feedstocks: natural gas (GTL), biomass (BTL) and coal (CTL). Importantly, synthetic fuels can be used in existing diesel engines and existing infrastructure with no modification.

GTL Fuel can contribute cost-effectively to addressing cities' key concerns of energy security and diversification, a cleaner environment and economic development. It has the added advantage of being relatively easy to implement. The limited but growing supplies of GTL Fuel available will have optimum impact if focused first on densely populated and congested large cities with wide public transport networks. GTL Fuel could be used with all diesel vehicles, achieving immediate emissions reductions in every vehicle of the fleet.

By targeting fleets of buses, taxis, vans and trucks that operate within polluted urban environments, this provides the opportunity to refuel centrally or along a pre-determined highway. It also enables the development of dedicated vehicles based on 100% synthetic fuels, thus gaining maximum emissions impact and other performance benefits.

Shell has conducted trials in major cities around the world, collaborating with automotive manufacturers (including Volkswagen/Audi, Toyota and Daimler Chrysler) and governments in London, Berlin and California. These successful bus, truck and car trials show significantly lower local emissions and up to 5% lower CO_2 tailpipe emissions.
In Shanghai for example, we are supporting a Clean Energy Centre to promote energy efficiency and demonstrate GTL Fuel in taxis and buses – delivering lower emissions in traffic congested areas.

As an example, using GTL Fuel with the current London bus fleet could immediately cut approximately 560 tons per year of NOx (16%) without any vehicle modifications.
Moreover, GTL Fuel could greatly contribute to London's Taxi Emissions Strategy reducing around 40% of the PM produced by London taxis.

	Conventional Diesel		GTL Projection▲		GTL Projection as percentage benefits	
Vehicle	**PM** (t/yr)	**NOx*** (t/yr)	**PM** (t/yr)	**NOx** (t/yr)	**PM**	**NOx**
Taxis	**94**	**799.6**	**56**	**759.6**	**40%**	**5%**
Buses + Coaches	**56**	**3498.3**	**45**	**2938.6**	**20%**	**16%**

*Source: London Atmospheric Emissions Inventory 2002 Report and Appendix Figures for "central + inner + outer" and user of PM 10 values

▲Derived by applying generic GTL emissions factors to LAEI data

Order of magnitude calculations on air quality effects on London were performed using generic GTL emissions factors, using Shell emissions data published in the open literature. Shell is currently working with an academic institution to improve on these estimates, using a recognised Air Quality modelling technique.

Currently, CO_2 emissions from a GTL system are comparable to those from a modern, complex refinery system on a lifecycle analysis (LCA) basis. Considerable R&D efforts are currently underway to increase GTL process efficiency and to reduce greenhouse gas (GHG) emissions for future generation GTL plants. GTL Fuel will prepare the market for the development and implementation of biomass based synthetic fuels, Biomass to Liquids (BTL) Fuel (2nd generation bio-fuel, non-food crop derived). BTL can reduce GHG emissions by more than 85% compared with refinery diesel and has the potential to be near zero CO_2 on an LCA basis. GTL Fuel can provide a bridge towards sustainable mobility based on renewable transportation fuels.

Synthetic Fuel Benefits

- GTL Fuel is currently the most cost-effective alternative fuel to reduce local emissions.
- Available in increasing volumes.
- Can be used in existing engines and refuelling infrastructure.
- Flexibility of use: blended with diesel, biodiesel, or used 100%.
- Diversification of energy supply: natural gas biomass and coal-derived.
- Maximum emission impact from GTL Fuel (100%) in large cities where air quality is under strain.
- Local emission reductions (particulates, NOx, HC, CO).
- Reductions of up to 5% CO_2 in tailpipe emissions.
- GHG emissions from a GTL system are comparable to a crude oil refinery system.
- GTL provides a platform for the development of renewable BTL, which can reduce GHG emissions by as much as 90% compared with refinery diesel.
- Synthetic fuels can also be used in other applications, such as marine, aviation, ports and trains.

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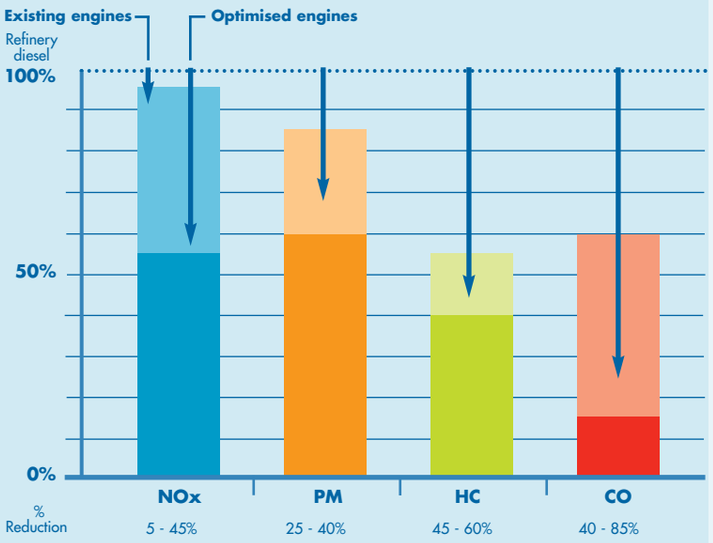
Significant local emissions benefits of GTL Fuel

Emissions reductions for light duty diesel engines



- Introduction of GTL Fuel will reduce criteria pollutants from new AND existing vehicles
- Engines optimized to run on GTL Fuel can deliver further emissions reductions particularly for NOx

Synthetic fuel is colourless (on the right) compared to standard diesel (on the left)

Synthetic fuel's combustion (on the right) is immensely cleaner than standard diesel's combustion (shown on the left)