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Options For Natural Gas Vehicles In the UK Transport Roadmap

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Outline

- Context for the United Kingdom
- Current situation
- Possible future developments

UK Context

- 80% GHG reduction by 2050
- UK Government estimates requirement for 1.7M electric vehicles by 2020 to kick-start strategy for electric future
- EV estimated to give 25% reduction in CO_2 over "fossil fuel alternatives"
  - 55% reduction using 2020 generation mix if 40% renewable or low carbon generation

UK sees electrification of energy system as route to carbon reduction target

UK Energy System

Energy consumption	MGGe*	Bcm Gas	TWh
Total UK	58000	250	2800
Electricity Transmission	7000	31	350
Gas Transmission	22800	100	1100
Road Transport	17000	70	770
HGV	4000	18	200
Cars	10500	42	475

UK Energy System

- So road transport is about 30% of primary energy consumption
- Electricity transmission capacity less than half this
- Gas Transmission and Distribution move over 40% of UK energy
- Huge upgrading of electricity system required just for provision of electric vehicles even with improved efficiency.

But UK also proposes moving heating load to electric

Future Scenario – 2030 results

~40% increase in demand from 2010

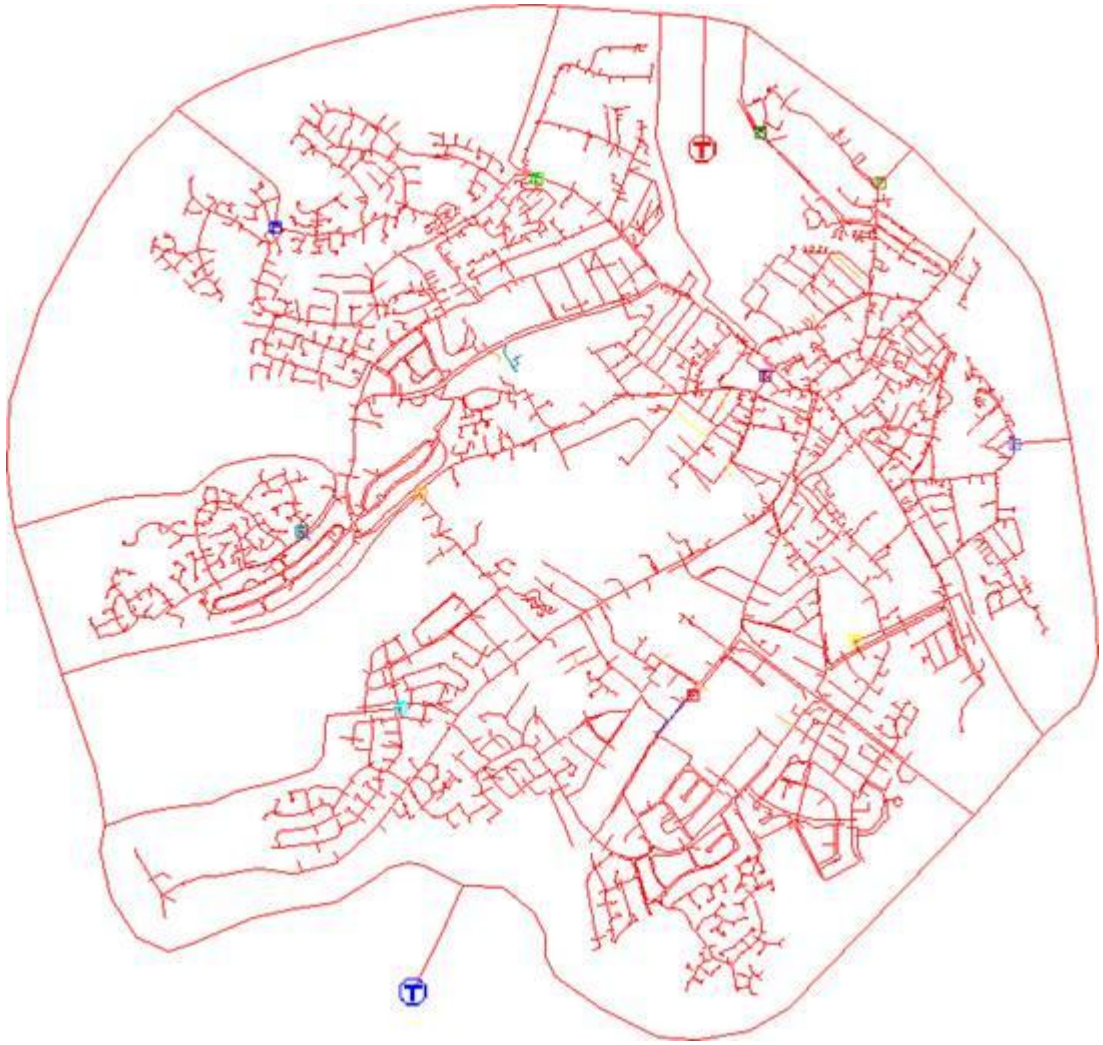
Scenario includes:

Uptake of electric vehicles at 75% by 2040

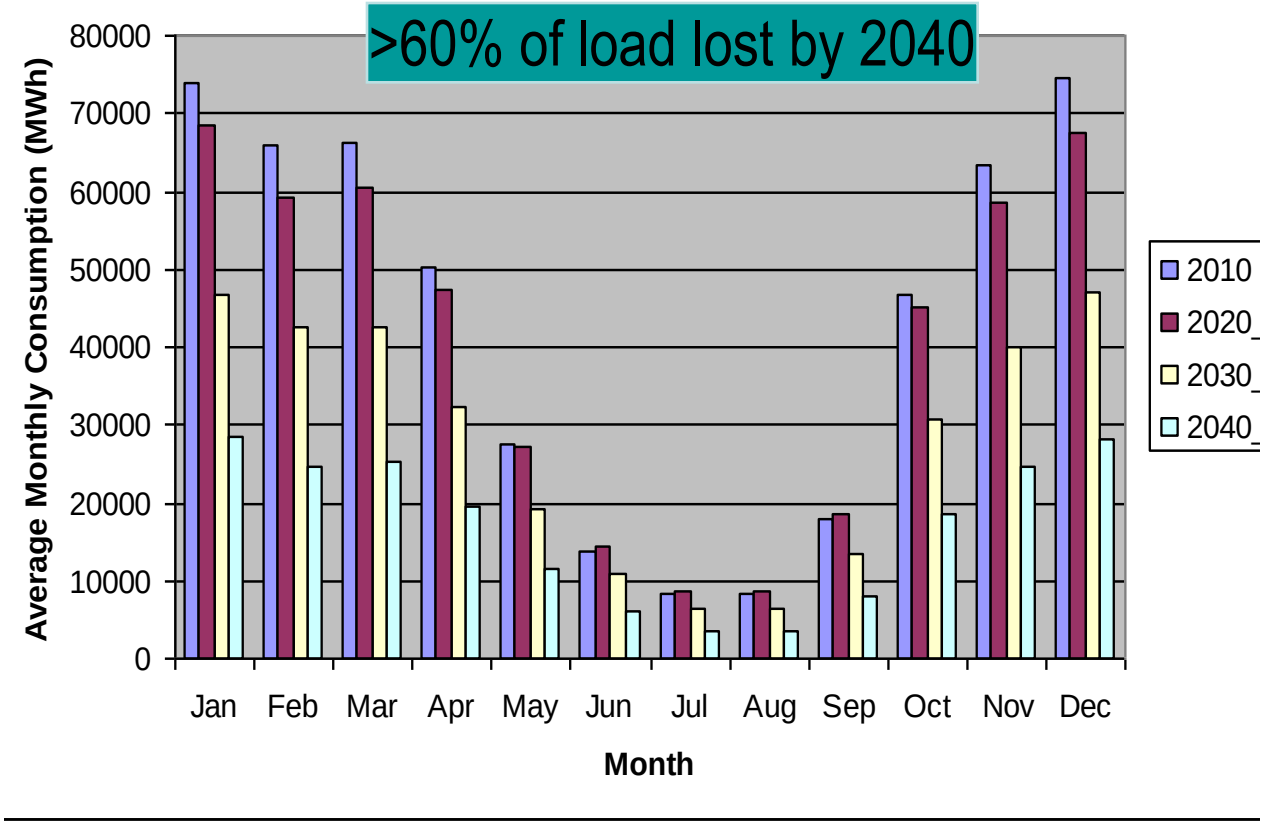
Steady growth in uptake of new technologies including solar PV, fuel cells, heat pumps etc

Future Scenario – 2040 results

200-350% increase in demand from 2010



Monthly Gas Consumption by Decade



Future Electricity Scenario

- Key sensitivity to growth of electric vehicles
  - Electric vehicle uptake depends on advances in technology & cost
  - Full electric or hybrid?
  - Driver routines will shape charging profiles. These could cause demand peaks that will begin to dominate the electric network by 2030
  - Demand side management will be required to contain growth in peak loads and optimise generation/transmission/distribution
  - Fast charge points likely to be fed by separate 11kV system
  - Charging points at grid extremities therefore whole network impacted
- Current network requires some significant upgrades by 2030 and a rebuild between 2030 and 2040

2010 Redpoint /ENA study estimates extra cost of £700 billion to upgrade electricity network in their “electric revolution” scenario as opposed to those that retain gas.

So where are NGVs?

- World market growing by 30% per annum
- Technology improvements are bringing down costs and improving efficiencies
- A carbon reduction of over 20% per vehicle is achievable over existing vehicle fleets using CNG. This can increase to 80% with biomethane.
- Other GHG also reduced compared to diesel and petrol
- Natural gas infrastructure in UK is scaled to meet the demand
- Biomethane acceptance means that the natural gas network is likely to become increasingly decarbonised.
- Electricity generation will be largely fossil fuel derived for many years, with low transmission and distribution efficiencies
- Future potential for reforming to hydrogen means that natural gas grid has important strategic role.

Where is the potential for NGVs?

- Uptake of electric propulsion for larger vehicles, particularly heavy goods vehicles (HGVs) is likely to remain low
  - Payload constraints
  - Need for large numbers of batteries
  - Charging times impact logistics
  - Approximately 1/3 of all transport fuel is used for HGVs and commercial and fleet vehicles,
  - all are directly amenable to Natural Gas use
  - Dual fuel technology means that HGVs are currently experience fastest growth in CNG sector worldwide

UK – new momentum

- Largely driven by biomethane agenda
  - Sheffield City Council small fleet (Chesterfield biogas)
  - Gasrec opened first liquefied biomethane plant in Albury (Hardstaff), fuelling up to 150HGVs
  - Coca Cola trialling HGVs fuelled on biomethane at Olympic Games
- LNG and LCNG fuelling HGVs operated by Hardstaff around UK
- Dual fuel technology developed by Hardstaff and Loughborough University giving flexibility for diesel powered HGVs
  - technology expanding internationally with a number of leading developers
- New flagship projects being developed focused on small fleets.

Emissions

Table shows output from Argonne Labs GREET model using current power generation mix relative to a baseline gasoline ICE.
No allowance has been made for biomethane in this table.

	Total energy	CO_2	NOx, total	NOx, urban	PM2.5
Dedicated CNG Vehicle, Normal NG	2.1	-20.3	-18.7	-23.4	-16
LNGV Dedicated Normal NG	5.8	-18.4	1.3	-21.3	-37.2
LPGV Dedicated	-3.5	-14.7	-8.5	-15	-24
Fuel Cell Vehicle NG H2	-36	-49.3	-58.6	-70	44
Fuel Cell Vehicle CNG	-34.5	-48.8	-65	-82	-52
Grid Independent Hybrid CNG*	-31	-45	-38	-37	-29
Electric Vehicle	-30.7	-29.1	-8	-54	261

Infrastructure

- Fleets can be highly competitive
- Estimated cost 5p/km after fixed costs have been paid, compared to 15p/km for diesel (CNG Services, UK)
- LNG is becoming an increasing option for both LNG and LCNG fuelling
- Very limited CNG-grid connection at present

CO_2 savings

Vehicle Type	Miles pa / vehicle	Efficiency Mpg	Annual consumption gallons	CO_2 saved tonne/ vehicle	CO_2 saved per mile, kg
Heavy duty dual Fuel	75000	7.5	10000	30.0	0.4000
Commercial Vehicle large	30000	20	1500	4.5	0.1500
Commercial Vehicle (small)	20000	28	714	2.1	0.1071
Car (diesel)	12000	40	300	0.9	0.0750
Car (petrol)	12000	35	343	1.0	0.0857
Electric car (SMART)	10000			0.5	.05

High level infrastructure cost

Vehicle Type	NGV uptake percent	CO_2 saving tonnes pa	station investment	cost £ per tonne of CO_2 saved	Gas Demand Bcm gas
Heavy duty dual Fuel	50.00%	6,000,000	400,000,000	13.33	9
Commercial Vehicle large	50.00%	2,250,000	400,000,000	35.56	3.4
Commercial Vehicle (small)	30.00%	642,857	120,000,000	37.33	.9
Car (diesel)	5.00%	225,000	50,000,000	44.44	.3
Car (petrol)	5.00%	1,337,143	260,000,000	38.89	1.8
Electric		0.5	5000-15000	400-1200	

The future?

- Fully electric scenario could remove the need for gas distribution in the UK over the next 20 -30 years
  - This would also remove the potential for development of biomethane infrastructure
  - Could also damage the potential for future carbon-free hydrogen economy
- But CO_2 reduction from CNG vehicles can be better than from EVs, biomethane further improves this situation
- There has been a significant move to natural gas for HGVs in the USA, with increasing LNG availability.
  - A significant opportunity also exists in the UK, but LNG road supply is an issue
- Large and fleet vehicles provide a significant early option for decarbonisation of the transport system through natural gas and biomethane.
- Renewable transport fuel obligation (RTFO) provides investment incentive

The future –technology options

Wider take up of dual fuel vehicles
Biomethane projects alongside grid based filling stations, biomethane to grid

Use of cold/ expansion energy at pressure reduction stations - liquefaction for fleet based LNG.

PRS could potentially support 1000 vehicle/day plant

Low pressure fuelling – adsorbed natural gas at 35 bar

Home fill

Distributed reformer networks to provide hydrogen for fuel cell vehicles

Natural gas provides a sustainable bridge to 2050

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Conclusions

- Opportunities exist for NGVs to make impact in UK
- Momentum is being established by a number of pioneers
- Potential for biomethane and a hydrogen economy appear to conflict with plans for a totally electric future
- Decarbonisation using NGVs and biomethane appears a lower cost option than electric vehicles
- HGVs and large vehicles provide ideal early opportunity to increase the uptake of NGVs
- The gas distribution infrastructure is ideally sized to develop these options
- There are a number of technology options to allow gas distribution networks to play a role in the transport future

Thank you for your attention

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