



# **IS THE FUTURE ELECTRIC?**

## **Pathways to a Low Carbon Economy – The Role of Natural Gas and Biofuels**

British Institute of Energy Economics  
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# The New Energy Future By 2050

**RISING ENERGY  
DEMAND**

**SUPPLY  
PRESSURE**

**CLIMATE  
CHANGE**

**9 billion people ; 75% living in cities**

2.5 billion more than today

**2 billion vehicles**

800 million at the moment

**4-5 times richer**

as population in developing countries shifts from poverty to middle class

**Double the energy**

supplying twice as much energy as now whilst reducing emissions from CO<sub>2</sub> and GHG

**Twice as efficient**

using half the energy as now to produce each dollar of wealth

**6-10 times more**

energy from renewable sources

# Shell's Response To The CO<sub>2</sub> Challenge



Supplying More Natural Gas



Supplying More Biofuels



Progressing CCS



Energy Efficiency In Our Operations

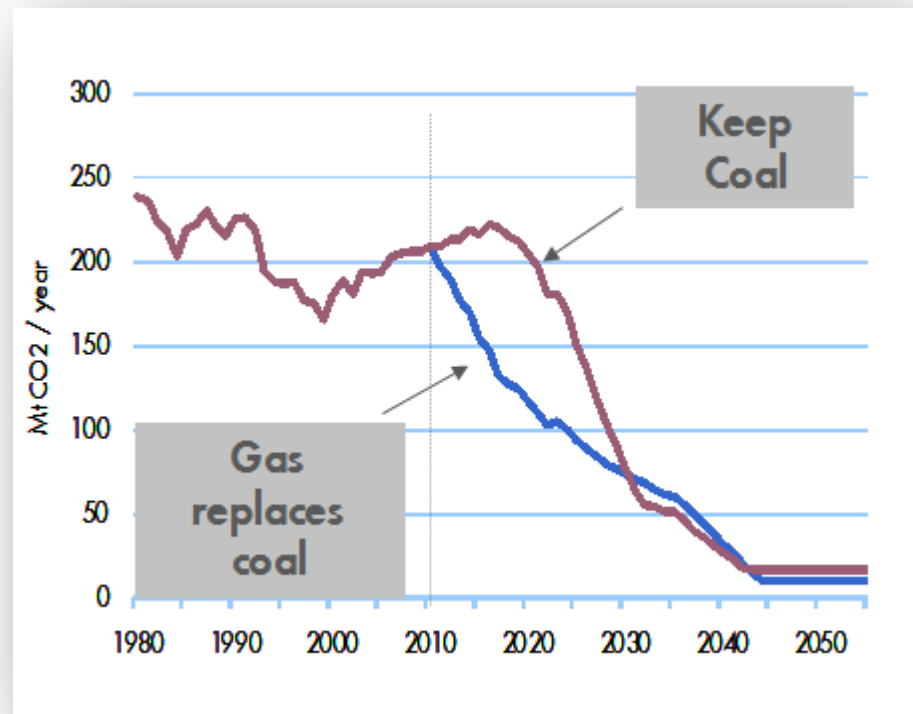
# The Case For Gas in Power Generation

## Immediate advantages from coal to gas switching ...

- Gas plants are more energy efficient than coal plants: 55-60% vs. 34-42%
- Modern gas plants emit 70% less CO<sub>2</sub> than old coal plant and 50% less than modern coal plant
- They also produce relatively little nitrogen oxide, sulphur dioxide or particulates
- Modern gas plants are based on clean, proven technology with much better public acceptance than coal or nuclear

### Potential UK Power CO<sub>2</sub> Emissions

*Gas replacing coal offers a potential 20% cumulative reduction in UK CO<sub>2</sub> emissions by 2050 at same net present cost*





# The Case For Gas in Power Generation

Longer-term we can capture the carbon ...



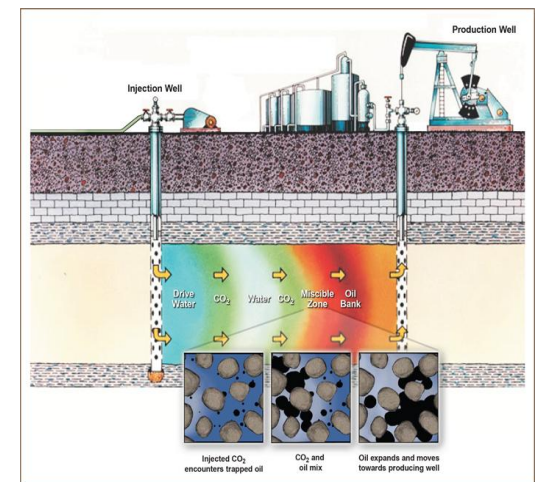
CAPTURE

- ~17 CO<sub>2</sub> capture and production facilities in operation in 2009 including capture from natural gas based processes
- A number of flue gas capture pilot plants have > 1000 run hours at representative CCGT flue gas conditions



TRANSPORT

- Existing US, Canadian & Turkish CO<sub>2</sub> pipelines estimated to be ~2,600 kms in length
- Oldest pipelines have been in operation for ~40 years.
- CO<sub>2</sub> ships are also in operation for smaller volumes.

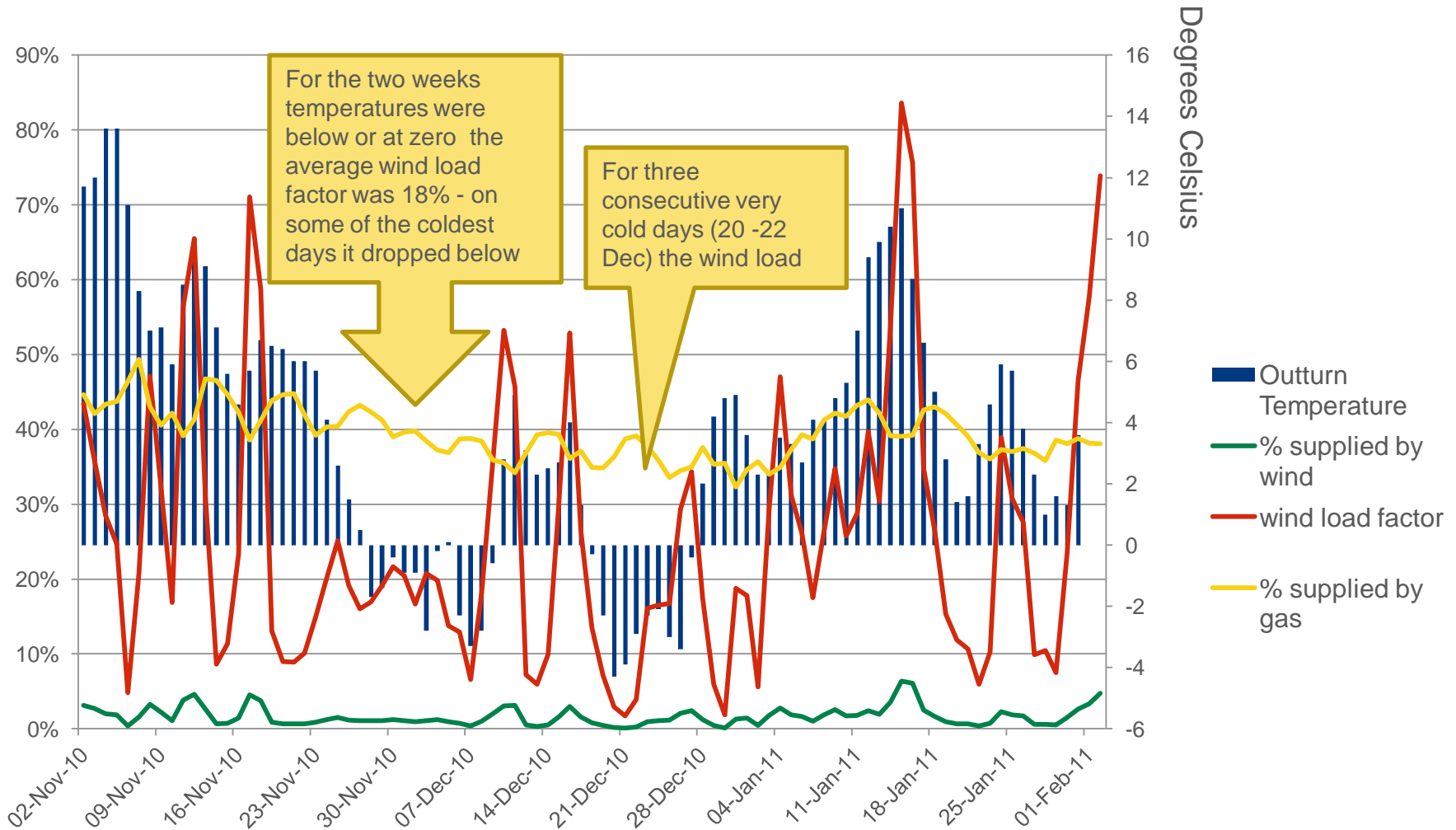


STORAGE

- ~40 years of history injecting CO<sub>2</sub> into oil fields to recover residual trapped oil.
- CO<sub>2</sub> also occurs naturally in subsurface reservoirs and has remained safely there for millions of years.
- Global reservoir capacity could hold ~85 years of the world's CO<sub>2</sub> emissions (I

# The Case For Gas in Power Generation

## An essential complement to wind generation ...



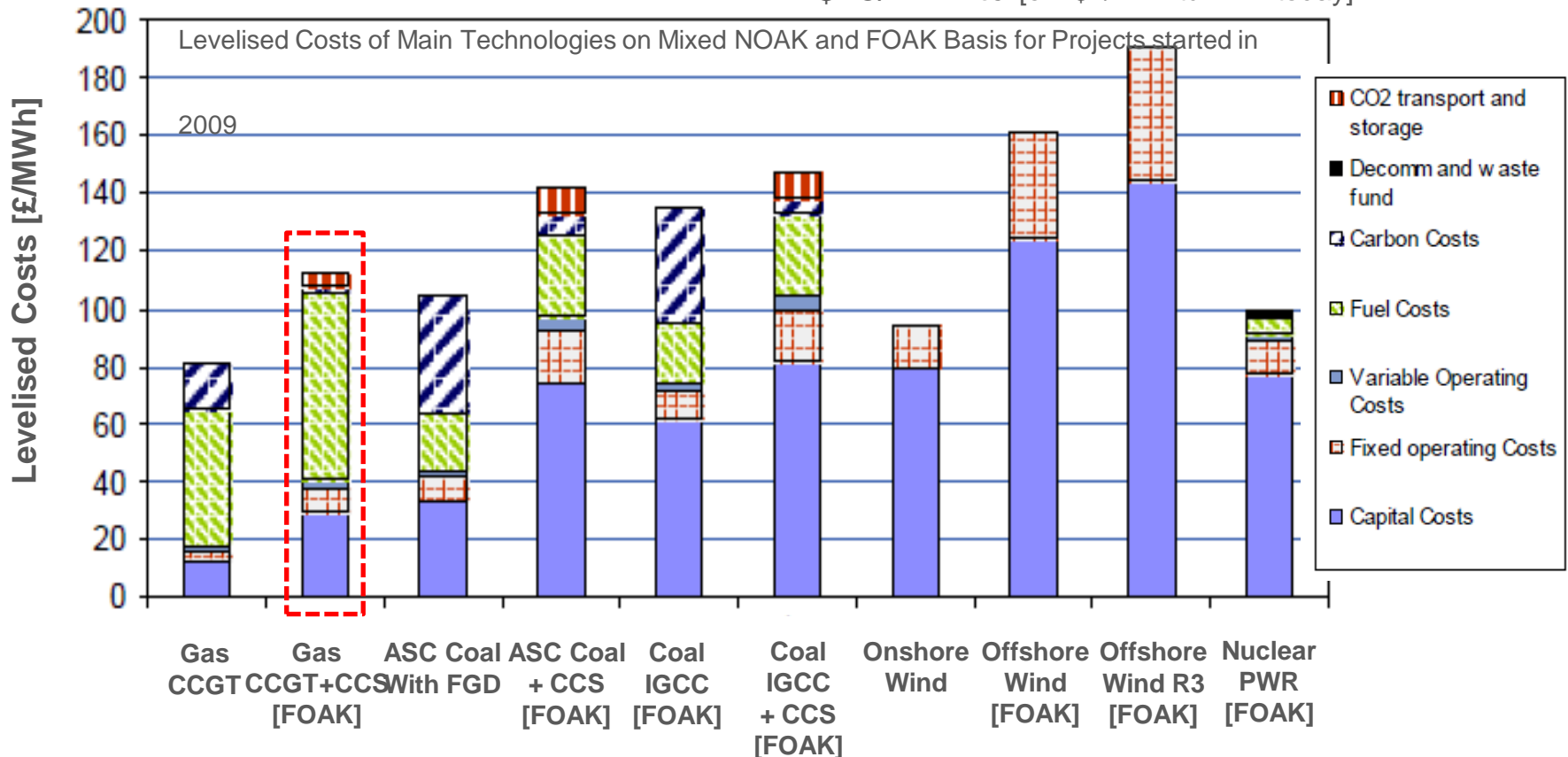
Note: The wind statistics include only metered wind generation – about 50% of total installed wind capacity

Source: BM reports, Shell analysis

# The Case For Gas in Power Generation

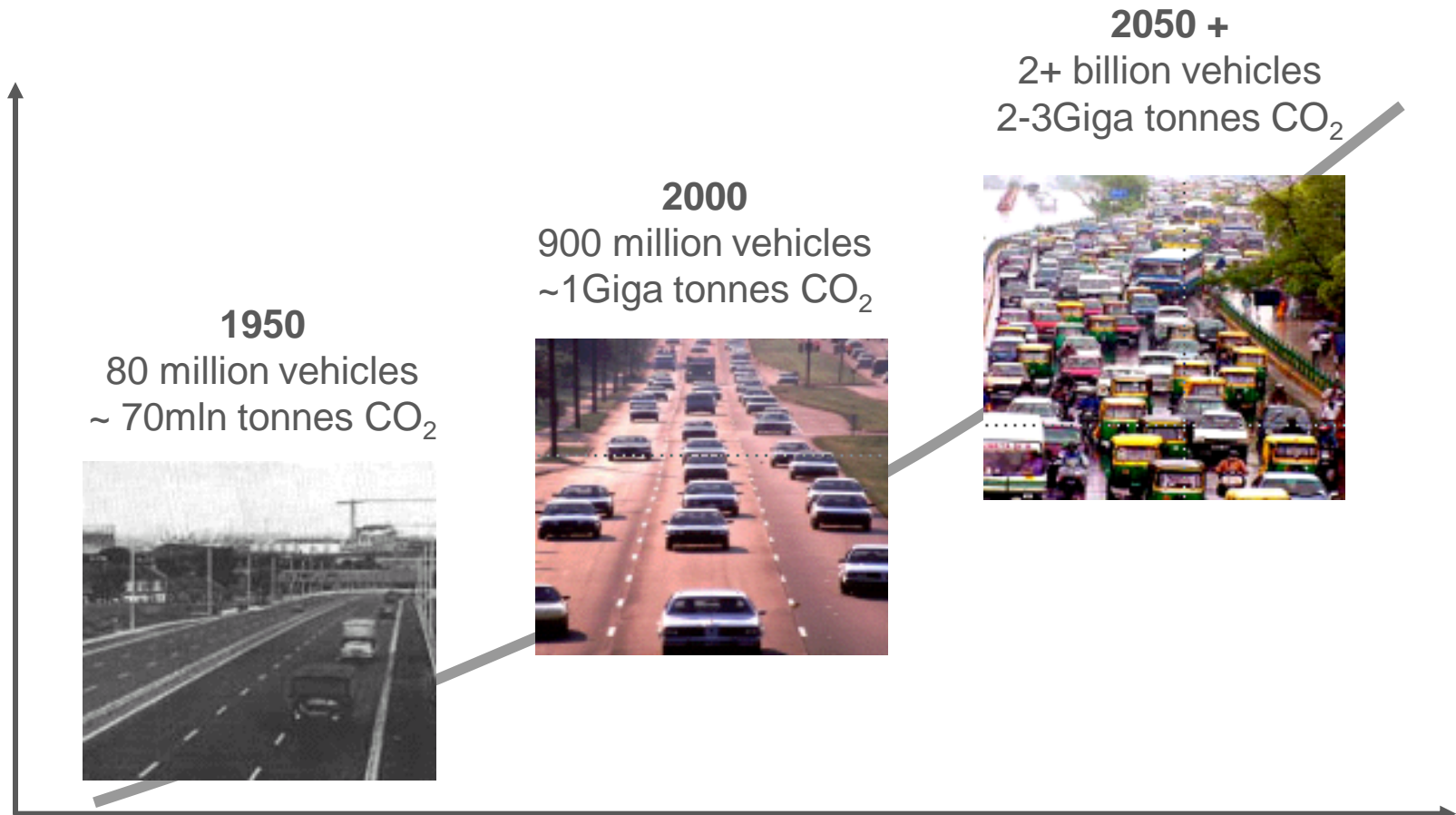
## Least cost for the consumer ...

- Gas CCS vs. R3 offshore wind:
  - 60% of the unit cost
  - Capital cost about one sixth
  - Breakeven gas price of ~ \$19/MMBtu [c.f. \$7/MMBtu NBP today]



# How To Meet The Growing Demand for Mobility

## In An Environmentally and Socially Responsible Way ...



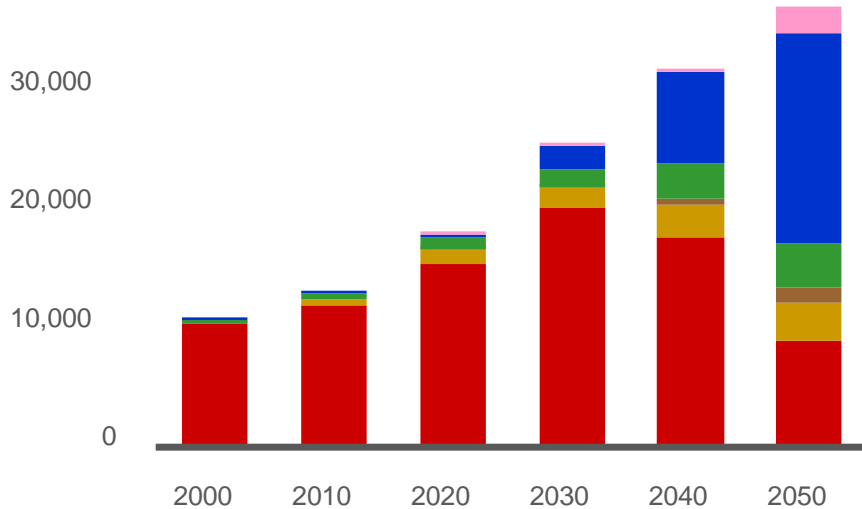
Source: WBCSD Energy & Climate Change Facts and Trends to 2050



# A Revolution in Transport

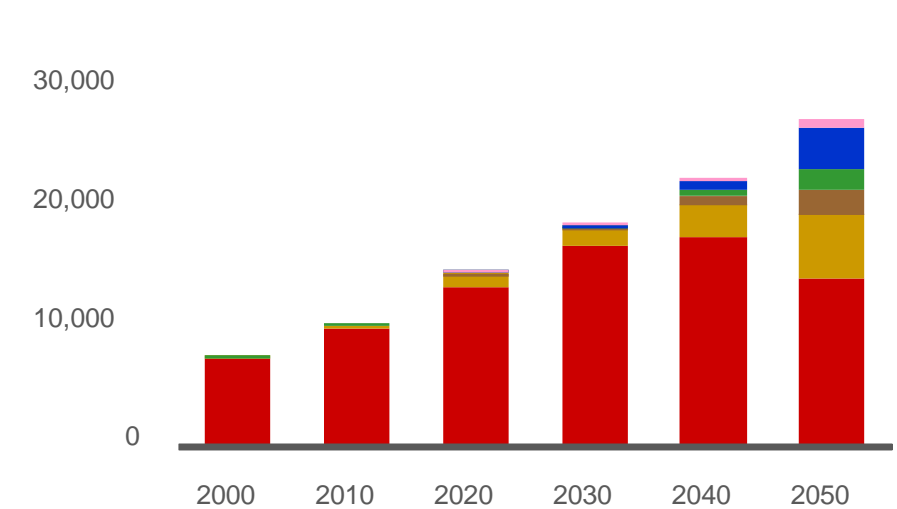
## WORLD PASSENGER TRANSPORT ROAD

billion vehicle km per year  
40,000



## WORLD FREIGHT TRANSPORT ROAD

billion vehicle km per year



- Liquid Hydrocarbon Fuels
- Biofuels 1<sup>st</sup> gen
- Biofuels 2<sup>nd</sup> gen
- Gaseous Hydrocarbon Fuel
- Electricity Commercial
- Hydrogen



Porsche Electric 1900

Oil remains dominant next two decades  
 Strong growth in biofuels  
 Strong efficiency improvements required  
 Electrification making inroads next decade

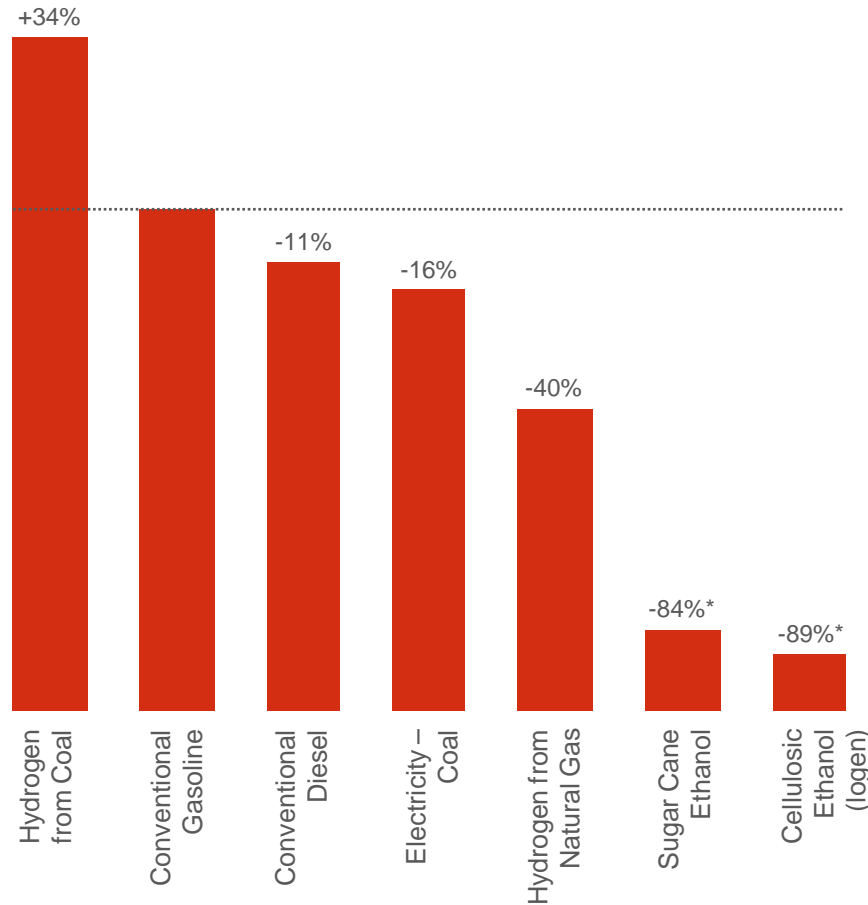
SOURCE: IEA, SHELL

SOURCE: IEA/SHELL

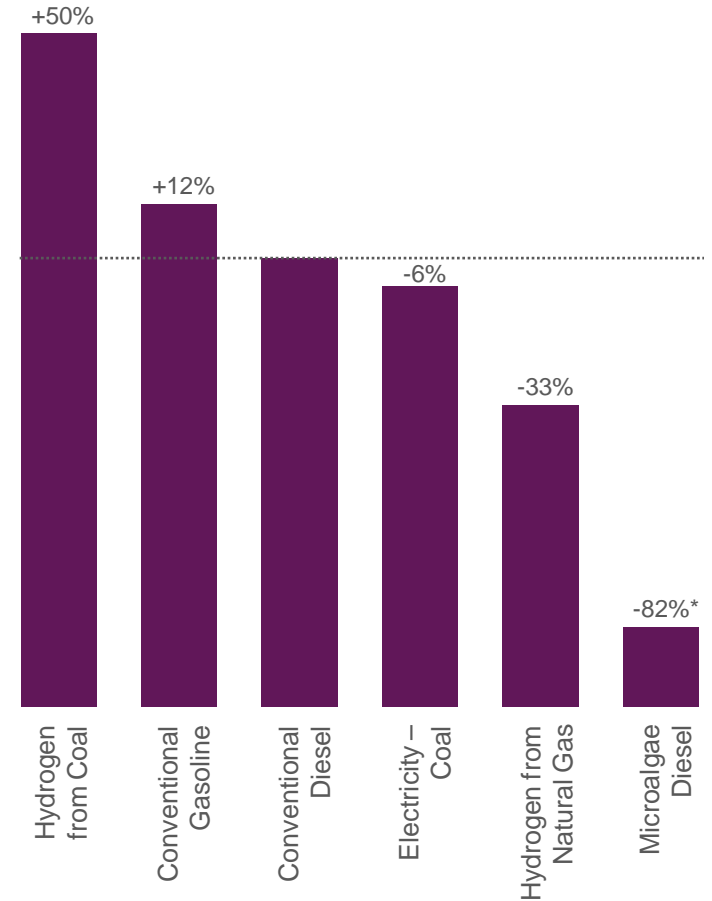
# Gasoline Compared to Alternative Fuels

## Well to Wheel CO<sub>2</sub> Intensities

### Conventional Gasoline Baseline



### Conventional Diesel Baseline

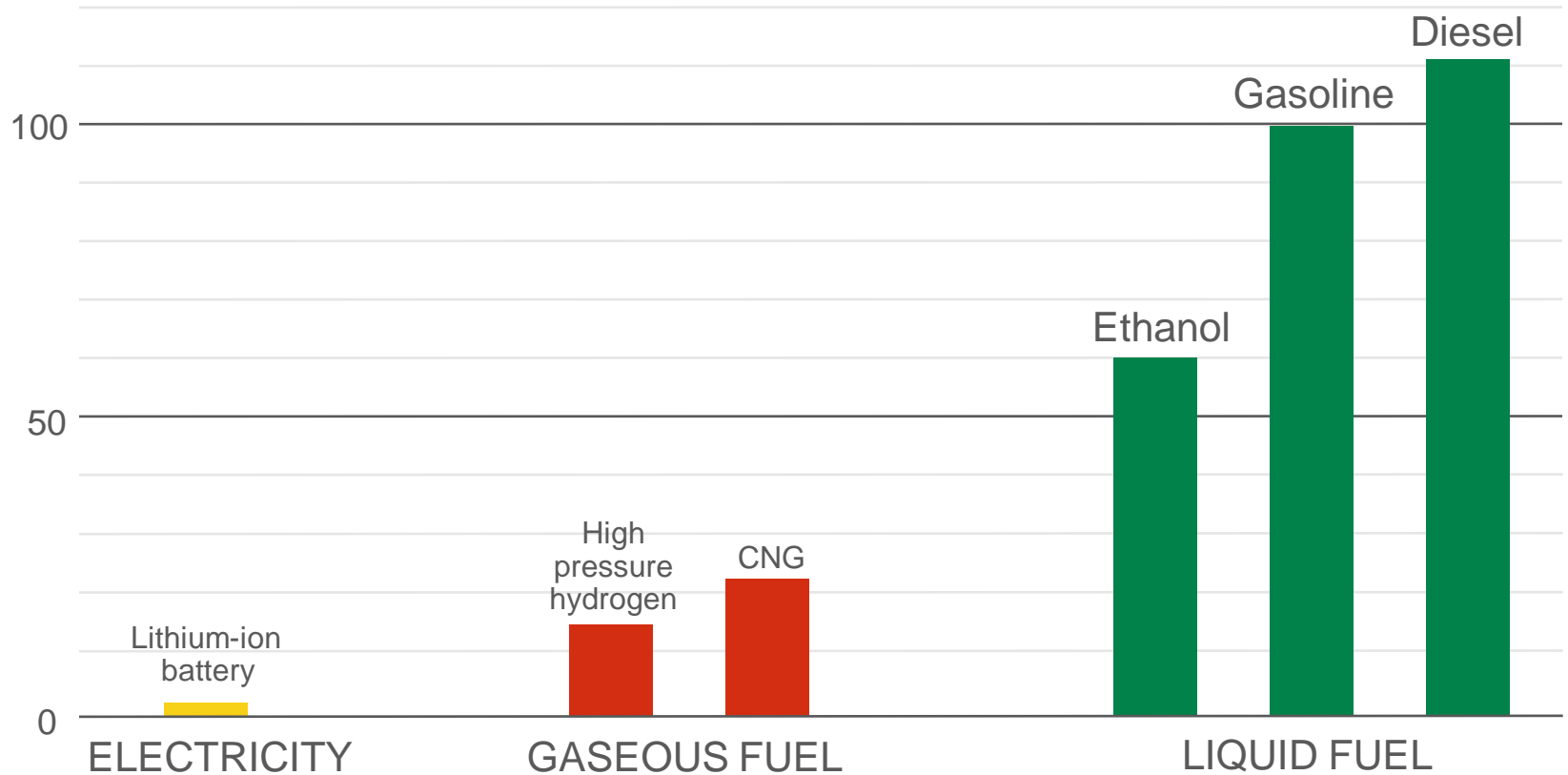


Source: CONCAWE/JRC/EUCAR WtW report (version 3)

\* Biofuels numbers do not include land use change effects

# Volumetric Energy Density Of Various Fuels

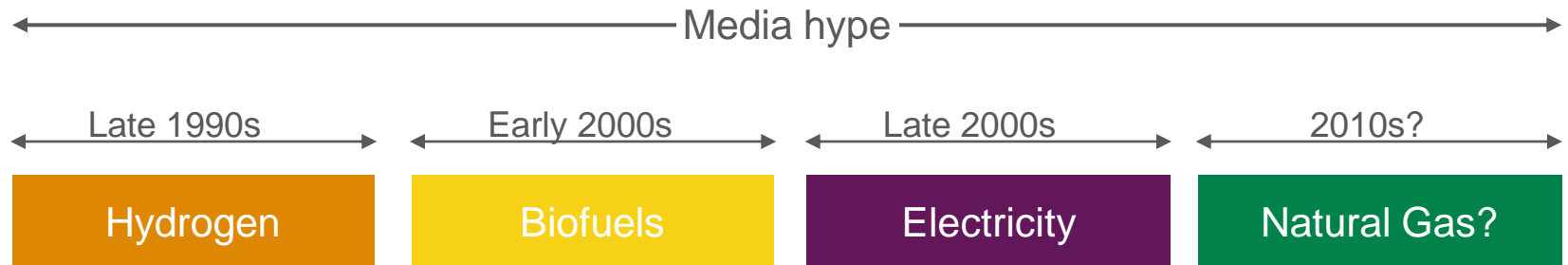
Volumetric Energy Density (Gasoline=100)



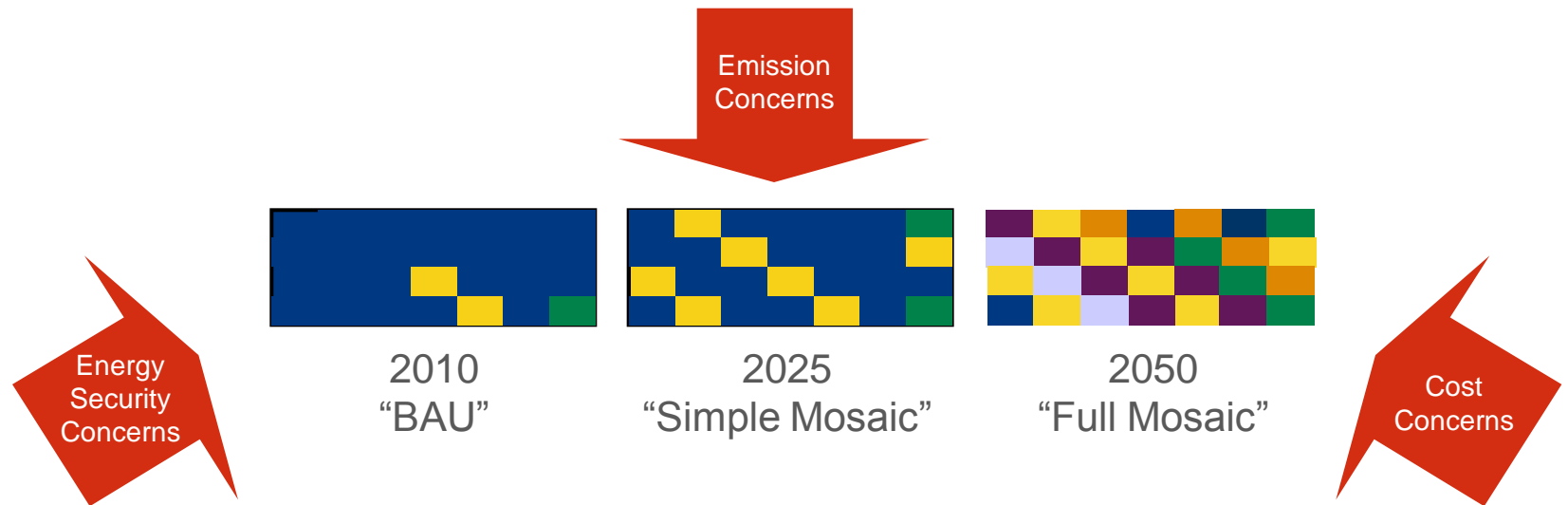
Toyota estimate

**GASEOUS FUELS HAVE LOWER VOLUMETRIC ENERGY DENSITY THAN LIQUID FUELS – AND LI-ION BATTERIES ARE EVEN LOWER.**

# The Continuing Search For The Replacement Of Liquid Hydrocarbons In Road Transport Yields No Silver Bullet



The "real" answer?



# Conclusions

- Gas and biofuels are essential components of pathways to a low carbon economy
- Gas is well positioned for both the short and long-term energy mix
  - Coal to gas switching is the quickest and cheapest way to meet near term CO<sub>2</sub> emission reduction targets
  - Gas is the cheapest, most flexible complementary supply to intermittent renewables
  - With CCS, gas will be part of the long term solution – a "Destination Fuel"
- The most effective solutions for achieving a low CO<sub>2</sub> energy future are vehicle efficiency and lower CO<sub>2</sub> liquid fuels – especially biofuels.

**Is The Future Electric? Conditional Upon The Decarbonisation of Power .... And Not As Soon As Some Think**



