Traffic Related Impact of Fracking Operations

Dr. Neil Thorpe, Dr. Paul Goodman

11th October 2016

www.refine.org.uk
@ReFINEresearch

The ReFINE Project

RESEARCHING FRACKING

- **Re**searching **F**racking **IN E**urope
- International consortium led jointly by Newcastle and Durham Universities (also Cambridge, Stanford, Strathclyde, Keele and Hull)
- Working with academics in 7 countries
- ***Independent*** research into all aspects of fracking
- ***Impartial:*** Neither pro- nor anti- fracking
- Funded by NERC and Industry
- Research topics prioritised by Independent Science Board
- Launched 2013 – Lead by Prof. Richard Davies @ Newcastle
- See: www.refine.org.uk

Traffic-related Impacts

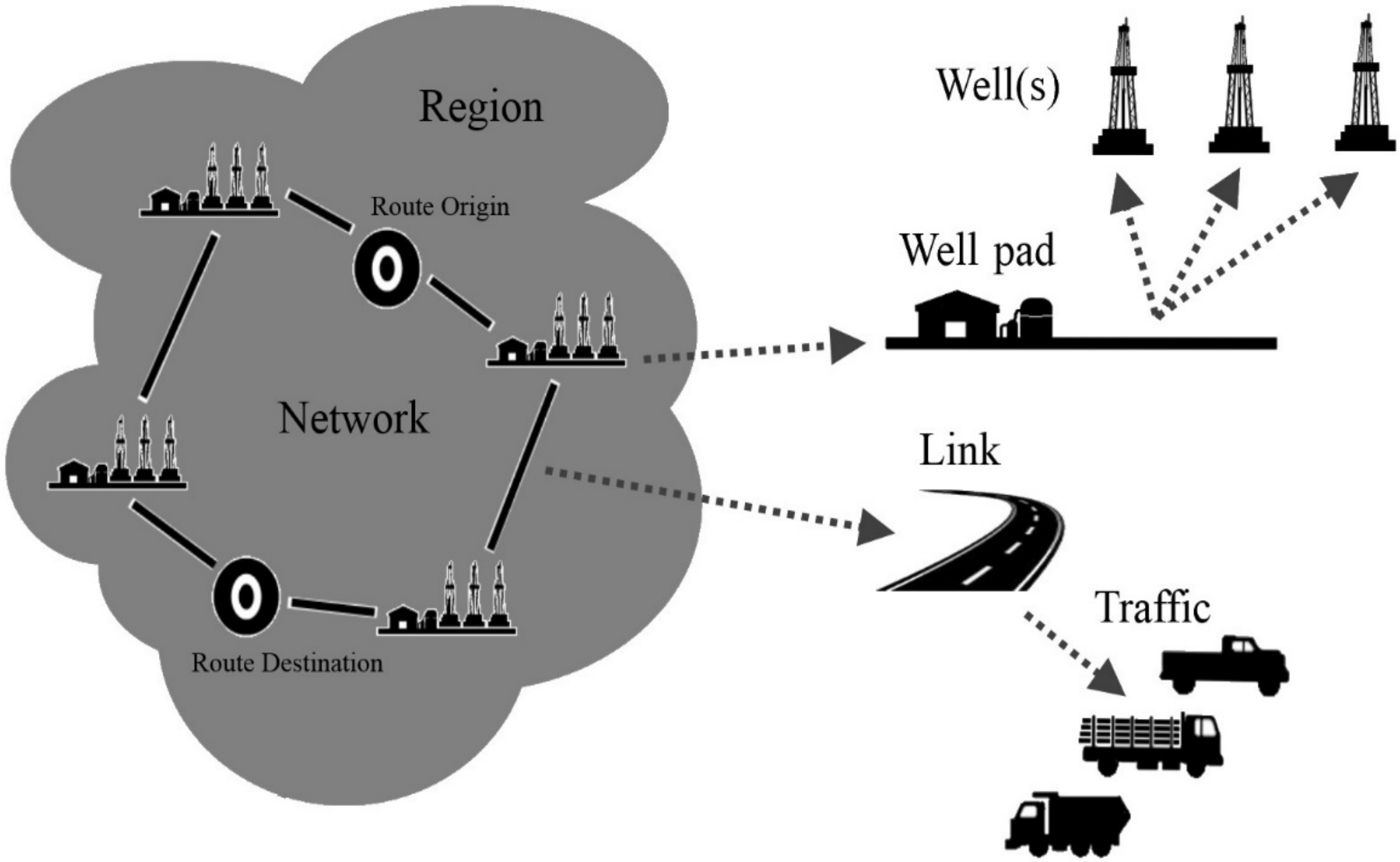
RESEARCHING FRACKING

- Examine impacts relating to:

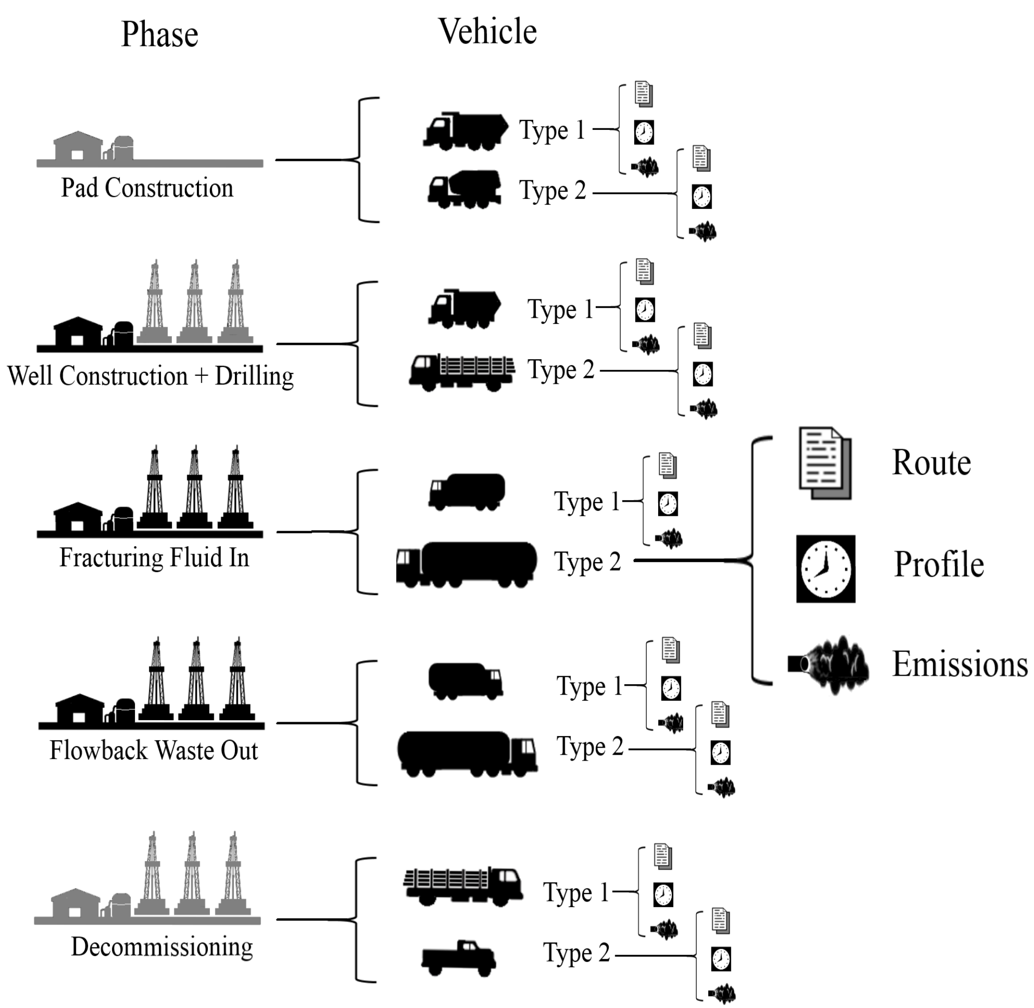
  Primarily the use of tankers for water transport

  - Additional congestion and disruption to journeys
  - Greenhouse gas emissions (CO_2)
  - Local air-quality impacts, primarily:
    - Oxides of nitrogen (esp. nitrogen dioxide, NO_2)
    - Particulate matter (PM_{10} and $PM_{2.5}$) including suspended dust
    - Volatile organic compounds and hydrocarbons
  - Noise
  - Axle loading on road structure

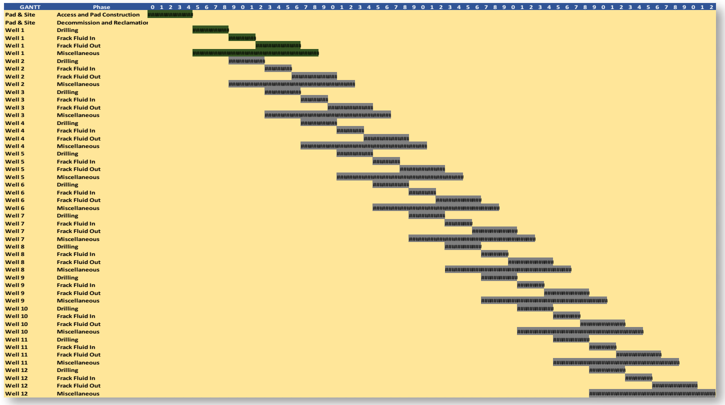
Spatial Representation



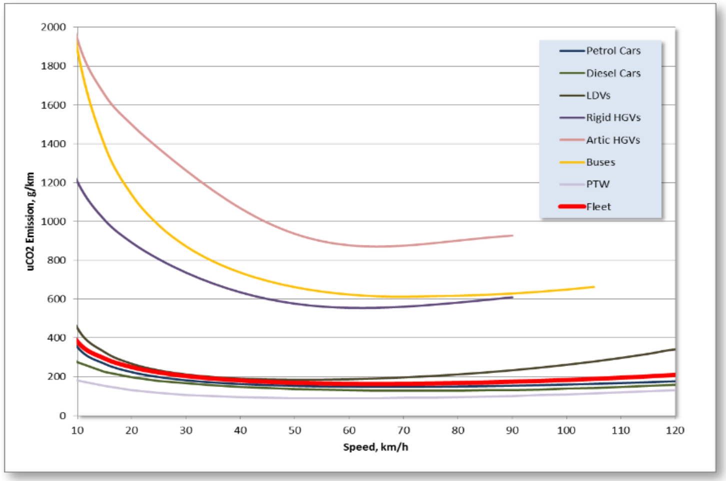
Well Pad Site Activities



User-defined Gantt Chart



Speed-based emissions factors



Site Considerations

RESEARCHING FRACKING

- Number and spatial distribution of well pads
- Number of wells per pad (6-10? More? Sources: NY DEC, Tyndall Centre)
- Number of vertical (2k m^3) vs. horizontal wells on pad
- Amount of fracking water per well (4.5k-35k m^3 Source: AEA)
- Availability of water from local sources
- Amount of flow-back water (e.g. 30% - 75% Source: AMEC)
- Storage of flow-back water and chemicals on site?
- Connections to pipeline infrastructure for water and gas
- Economies of scale in all of the above
- Number of times the well is 're-fracked' (0-4? Sources: AMEC and AEA)
- 'Early' vs. 'Peak' well development – Technology Improvements
- Capacities and loading of vehicles
- Ancillary site traffic

Traffic Generation

RESEARCHING FRACKING

- Two types of traffic generated:
  - Light Duty Vehicle traffic through the movements of site workers
  - Heavy Duty Vehicle traffic associated with construction and operation
- The latter is of greater import than the former
- Heavy Duty Vehicle movements associated with:
  - Initial pad and well construction (≈15%)
  - Delivery of water, sand and chemicals to the site (≈60%)
  - Removal of wastewater from the site (≈20%)
  - De-commissioning and site restoration (≈5%)
  - Total HDV movements: 7000 – 10000 over the lifetime a single 10 well pad (Source: NY DEC, 2009/2011)

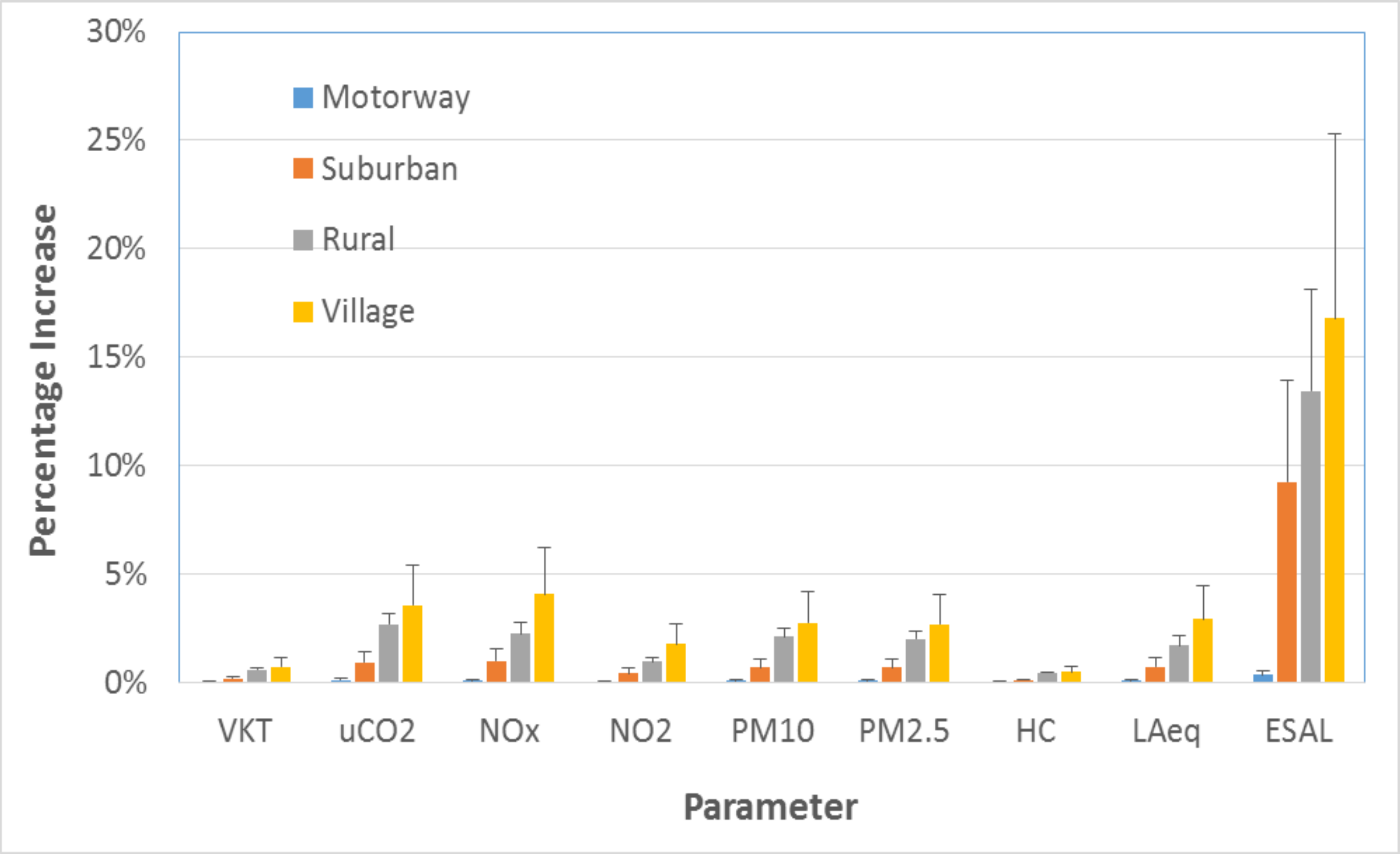
Further Traffic Considerations

- Proportion of journeys on highway, trunk, local and rural networks
- Vehicle sizes and loadings:
  - 17t-25t rigid body lorries (10m^3 Capacity) used for construction?
  - 40t+ tankers carrying 37,000 litres of water?
- HDV fleet turnover and technologies (assume Euro V or VI?)
- HDV fuels (assume diesel, little alternate fuel take-up)
- Local transport plans (e.g. rerouting to avoid AQMAs)
  - Longer journey = more CO_2, but less impact on local concentrations
- Timing of movements to de-conflict with other traffic
  - Lower concentrations, but potential noise issue

- **Compounding Effects:**
  - **Operation of one well -> Negligible impact**
  - **Operation of multiple wells -> Non-linear effect on congestion** (Source: AEA)

Sample Results: 1 Pad, 6 Wells

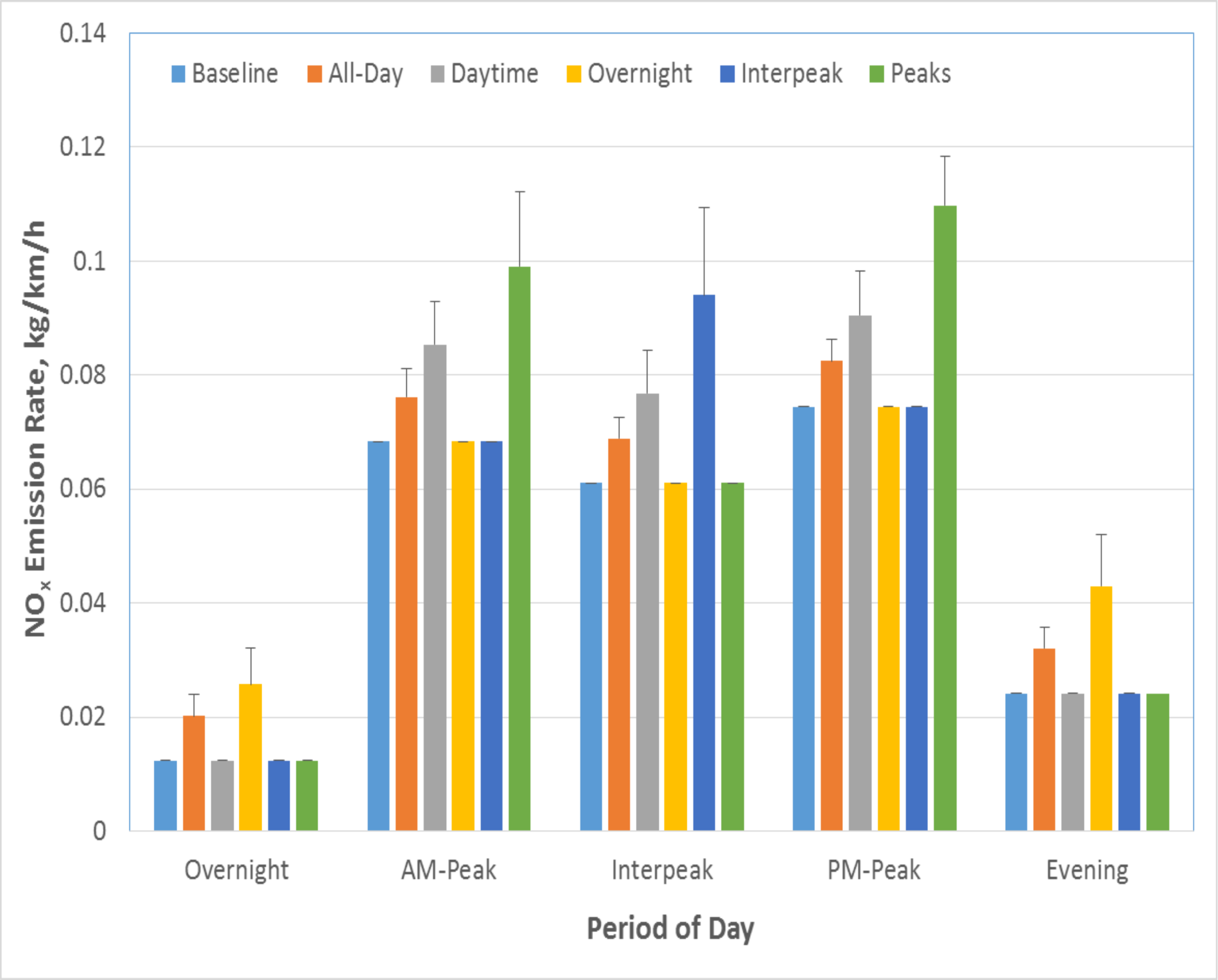
ReFINE RESEARCHING FRACKING



%-age increase over baseline traffic, 85-week operation, all water by tanker

Sample results: NO_x emissions

RESEARCHING FRACKING



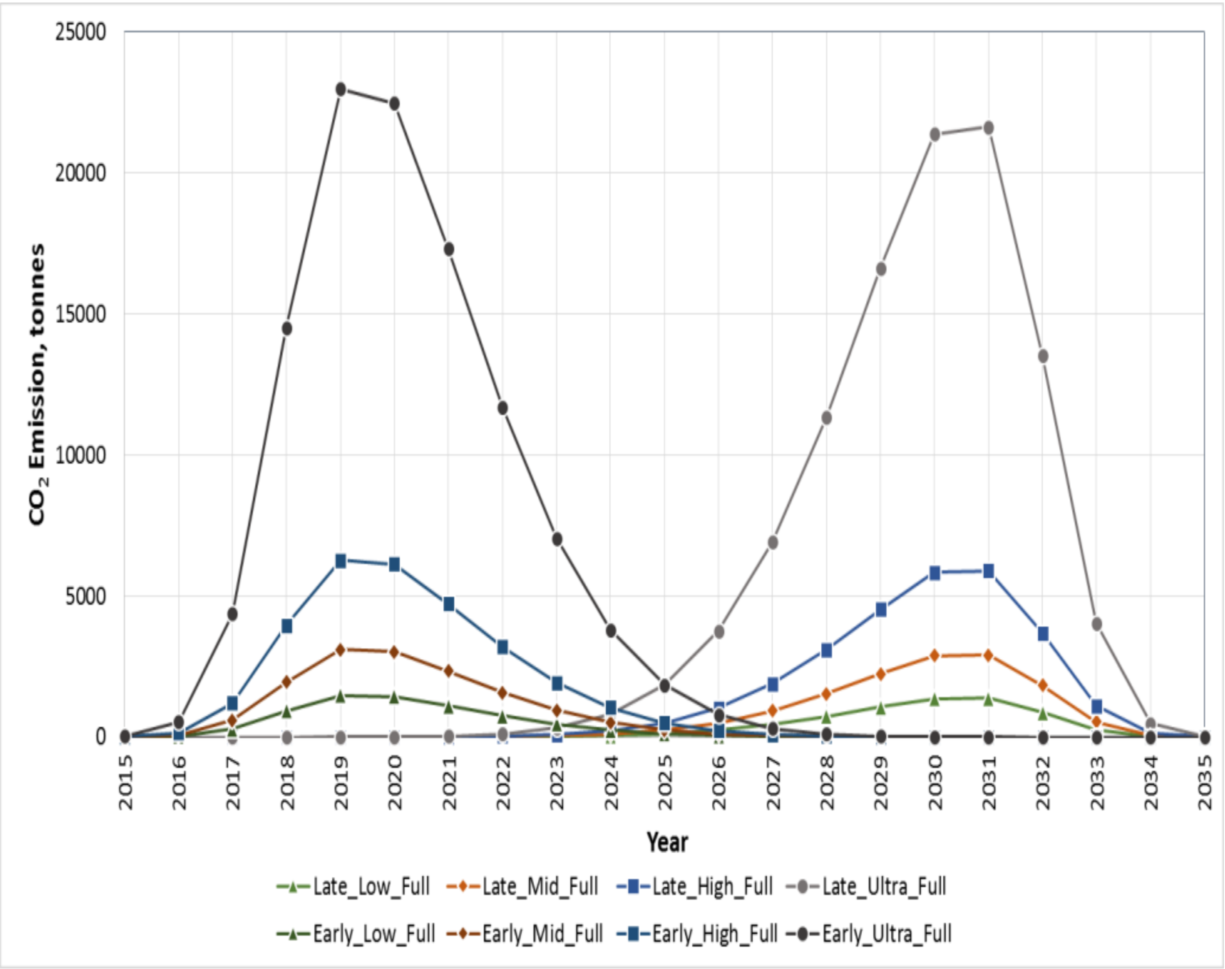
Variation in NOx emission rates at point of highest traffic demand in pad operation, based on arrival and departure patterns

'Village roads' scenario

Estimate of 71 to 109 vehicle movements during the day

Development Scenarios: CO_2

RESEARCHING FRACKING



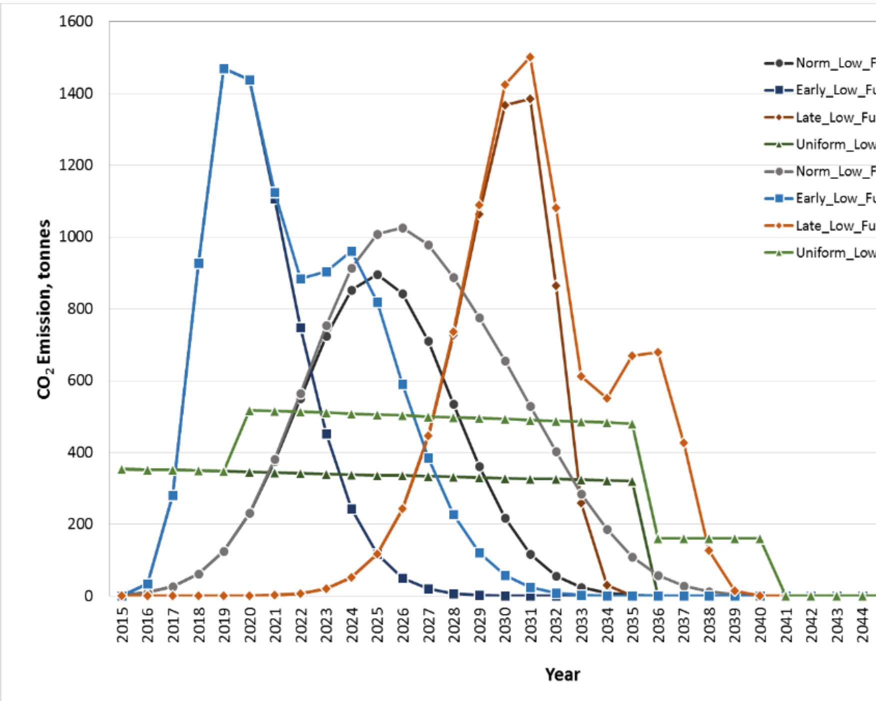
Low: 190 wells
Mid: 400 wells
High: 810 wells
Ultra: 2970 wells

Different development policies: ‘early’ vs. ‘late’

Technology and fuel consumption changes over 2015 to 2050

Extreme results ranges:
6.6kT CO_2 ‘late low’
108kT CO_2 ‘early ultra’

Development Scenarios: CO_2, NO_x

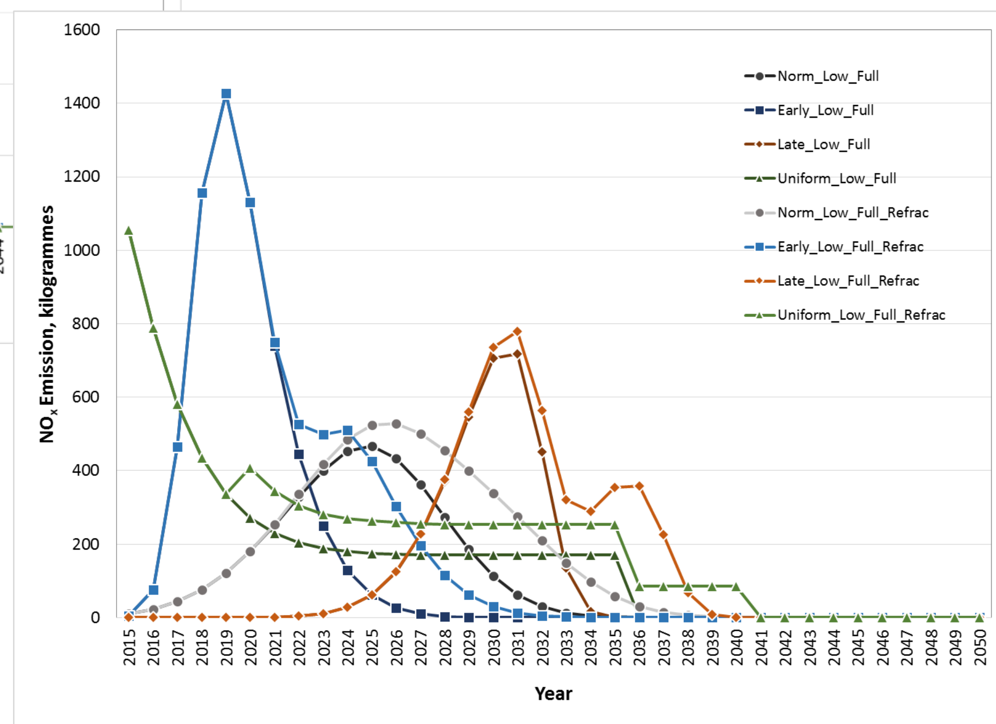


NO_x profiles more dependent on vehicle technology than CO_2

Latest trucks = EURO VI -> SCR catalyst and EGR engine technology

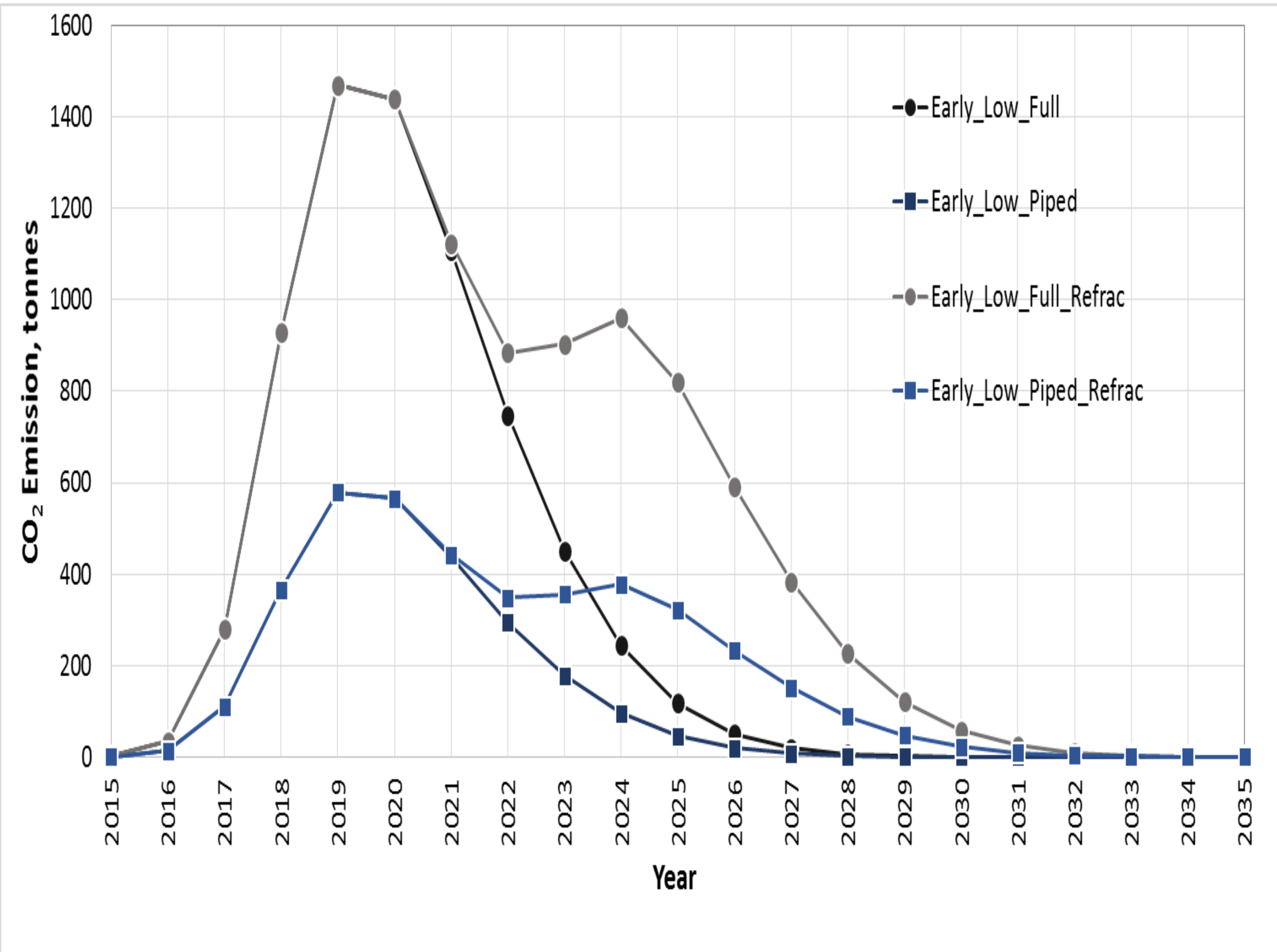
These profiles are from the 'Low' development scenario

Show effects of technology and refracking – but all water still delivered and removed by road.



Tanker vs. Pipeline?

RESEARCHING FRACKING



Effect on profile for low scenario, based on either:

- Full road transport

Versus:

- 90% of inbound demand by pipeline
- No flowback processing at sites

- Approximate 60% reduction in overall VKT values

Conclusions

RESEARCHING FRACKING

Results for a single site are highly variable, depending primarily on:

- Number of wells on the pad
- Water demand and flowback produced
- Infrastructure assumptions
- Time periods/intensity of operations

%age increases over baseline could be negligible, but localised issues may occur (e.g. air quality standard exceedences)

Results for a region/development scenarios are also highly variable: need more information on the potential scale and spatial distribution of operations

Future Work

RESEARCHING FRACKING

- Continuing development of model on the ReFINE projects:
    - Better definition of site operations
    - Better spatial modelling
    - More detail in traffic models
    - Application to specific case studies
    - Optimisation of code
- Extension to European operations:
    - M4ShaleGas project: http://www.m4shalegas.eu/project.html
- Health and exposure impacts

Summary

RESEARCHING FRACKING

- A novel simulation model has been developed to estimate the traffic-related impacts from fracking operations
    - greenhouse gas, local air quality, noise and axle loading impacts on roads

- Based on a series of ***hypothetical*** scenarios for illustrative purposes only, results are:
    - Single well pad can create substantial increases in local air quality pollutants during peak activity
    - Short-duration/large-magnitude events may adversely affect local ambient air quality and noise
    - Daily NOx emissions may increase by over 30% and hourly noise levels can increase significantly (+3.4 dBA), although this is highly sensitive to the baseline traffic level

doi:10.1016/j.envint.2016.02.002

Acknowledgements and Publications

RESEARCHING FRACKING

This research was carried out as part of the ReFINE (Researching Fracking in Europe) consortium led by Newcastle and Durham Universities and funded from 2013 to 2015 by the Natural Environment Research Council (UK), Shell and Chevron, and now by Ineos and Centrica. We are grateful to the Faculty of Science and Faculty of Science, Agriculture and Engineering ethics committees at Durham and Newcastle Universities respectively

Publication: Paul S. Goodman, Fabio Galatioto, Neil Thorpe, Anil K. Namdeo, Richard J. Davies, Roger N. Bird. **Investigating the Traffic–related Environmental Impacts of Hydraulic-fracturing (Fracking) Operations.** ***Environment International. 89-90, April-May 2016, 248-260.***

Available online:

http://www.journals.elsevier.com/environment-international/
http://www.sciencedirect.com/science/article/pii/S0160412016300277

For further information contact:

Dr Neil Thorpe

Lecturer in Transport Studies

- Email: neil.thorpe@ncl.ac.uk
- Telephone: +44 (0) 191 208 7803
- Fax: +44 (0) 191 208 6502
- Address: School of Civil Engineering and Geosciences
  Room 2.23
  Cassie Building
  Newcastle University
  Newcastle upon Tyne
  NE1 7RU
  UK

www.refine.org.uk
@ReFINEresearch

ReFINE
RESEARCHING FRACKING

Newcastle University
Durham University