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Newcastle University

Energy to sustainable fuels and transport

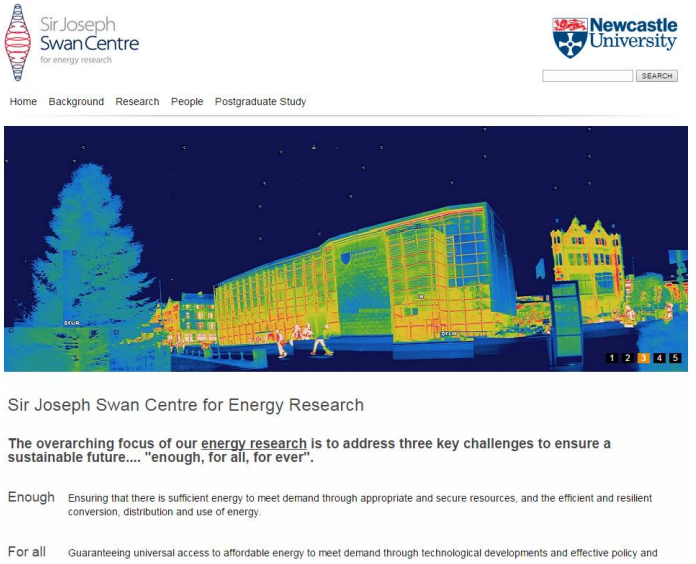
EERA JP Energy System Integration Workshop
Lyngby, DK, 2-4 November 2016

Andrew Smallbone, Senior Research Associate

2nd November 2016

Sir Joseph **Swan Centre**
for Energy Research

- Approx. 120 affiliated academic research staff
- Staff from at least 13 Academic Units from SAgE, HASS and FMS
- Over £50m research funding in last 3 years
- Expertise in all aspects of energy research
- Swan Centre core 50 staff & full-time research students based in Mechanical Engineering School



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Energy themes where Newcastle University has key research strength:

Resilient Infrastructure and systems	Intelligent networks and energy storage	Electrochemistry and hydrogen
Bio-resource production, recovery and use	Renewable energy systems	Environmental impact assessment and mitigation
Building, industrial and transport demand reduction	Justice and governance	Logistics and planning
Clean use of fossil fuel	Mechanical and electric power systems	Thermal systems and combustion

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EPSRC Centre for Energy Systems Integration

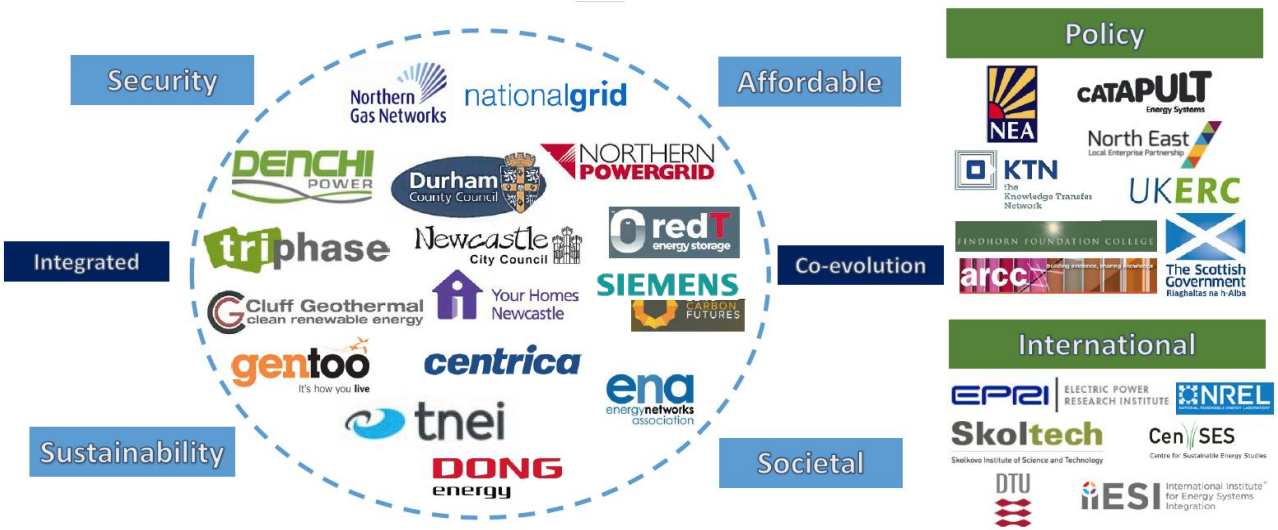
- €30m National Centre funded by EPSRC and Industry
- Supply & demand of energy out to 2050
- NU is the lead – 5 year project

Durham University

University of Sussex

The University of Edinburgh

Heriot-Watt University



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Energy to sustainable fuels and transport

The challenge

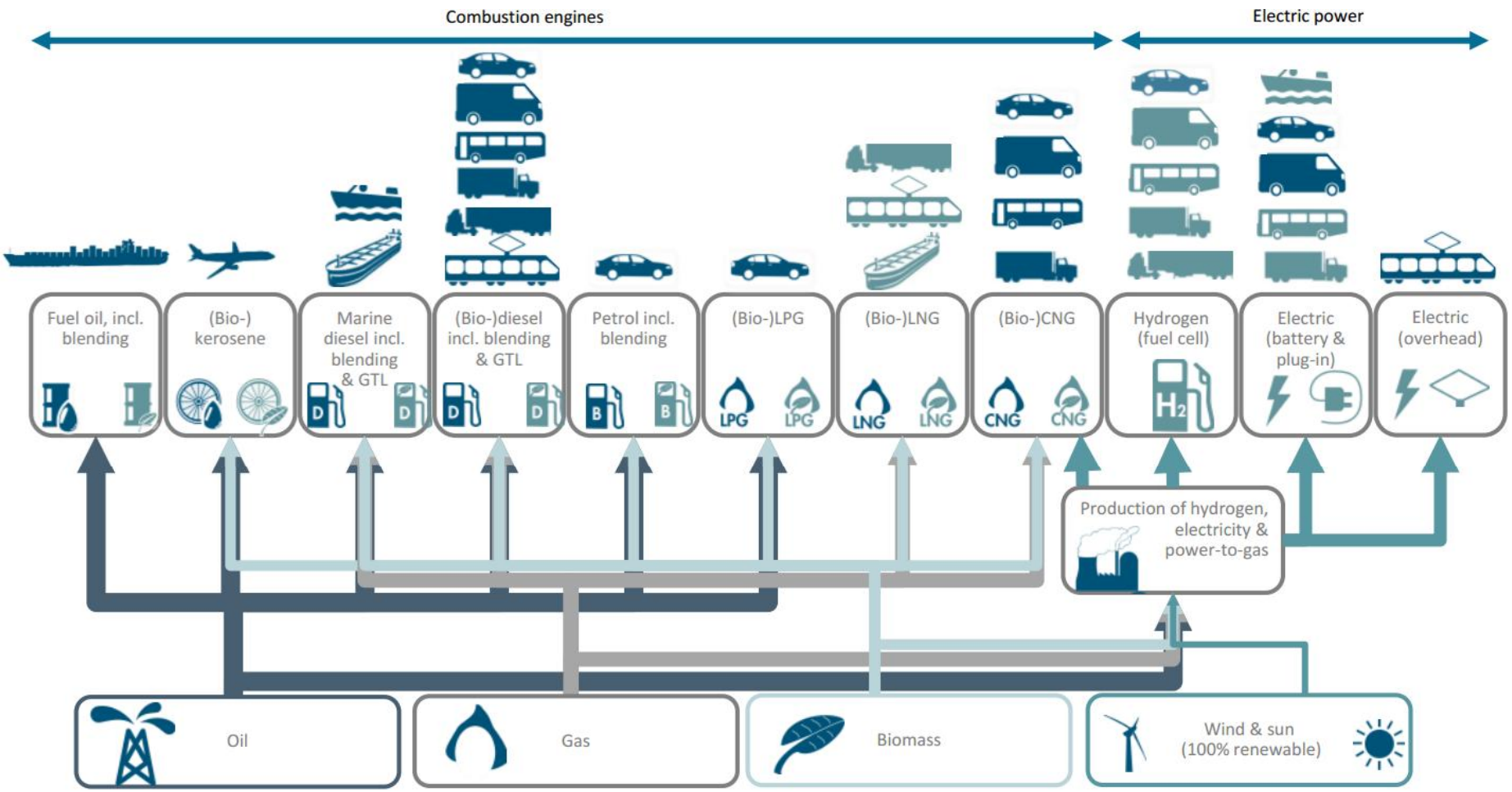

Figure 1: Interrelationships between raw materials, energy carriers (light green = low-carbon variant) and market sectors (light green = not yet developed)

Source: A Vision on sustainable fuels for transport: Key findings of SER vison programme

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Some of the challenges

- Currently we have a very good and simple system…with known issues.

Tank-to-wheel

- Different transportation modes have specific challenges
- Market is very competitive with large R&D budgets

Energy carriers

- Multiple-energy carriers…this will increase.
- Infrastructure takes time to grow

Well-to-tank

- Evolving and uncertain
- Large capital investment required

Sector-based analysis is very common and mature research…holistic analysis is not.

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Some of the challenges

Market interference has unintended consequences

- EC 1998 ACA agreement – reduce CO2 by 25% in 10 years

So… "Buy more diesels!"

Millions of vehicle registrations by fuel type, UK
Petrol | Diesel | Alternative

Source: FuelsEurope Statistical Report 2015

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Tools and methods

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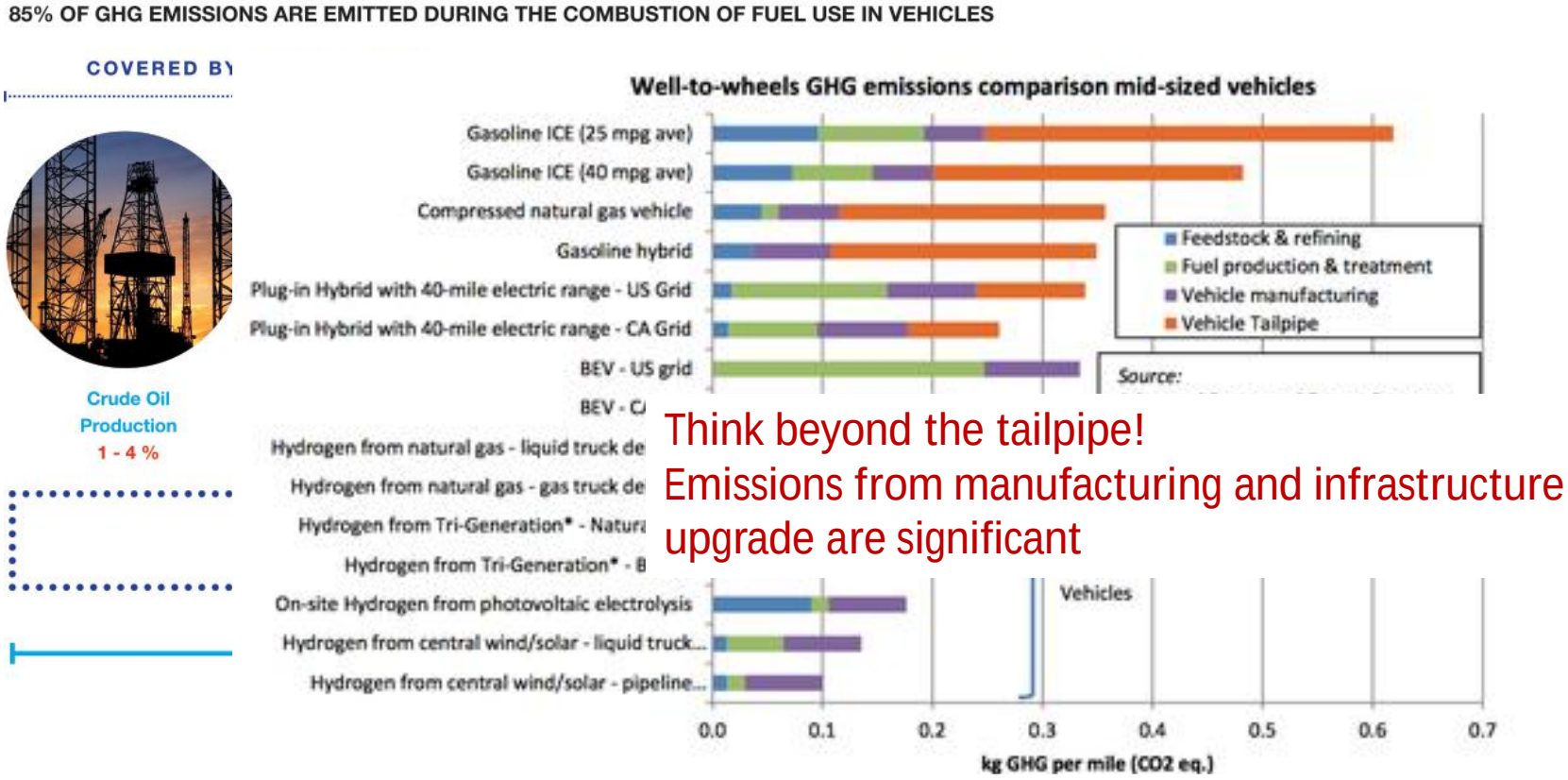
Tools and methods

System level analysis

- Life-cycle analysis and assessment
- Well-to-Tank, Tank-to-Wheel and Well-to-Tank analysis



Think beyond the tailpipe!
Emissions from manufacturing and infrastructure upgrade are significant

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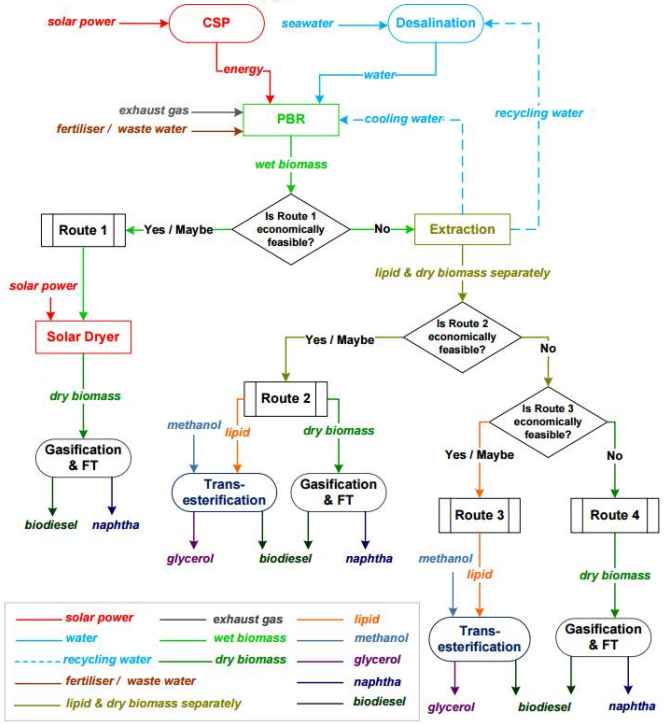
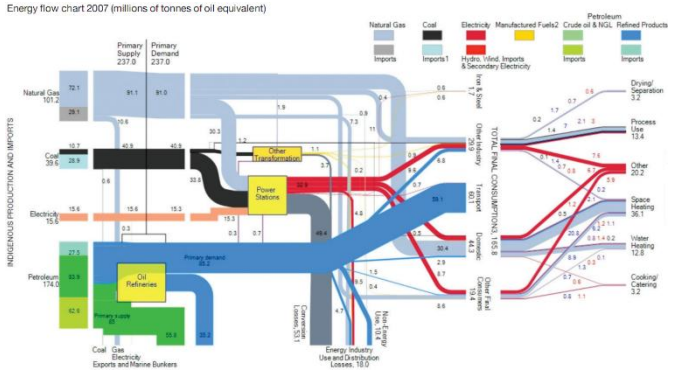
Tools and methods

Well-to-Tank Analysis

- Primary energy source to energy carrier
  - Well established chemical engineering methods
  - Chemical process industry
- Distribution of energy
  - Managing the national and local distribution networks
  - Network and infrastructure simulation
  - Multi-agent modelling
- Filling up at the fuel/charging station
  - Impact on the national electricity grid





Digest of UK Energy Statistics 2007, MARKAL modelling

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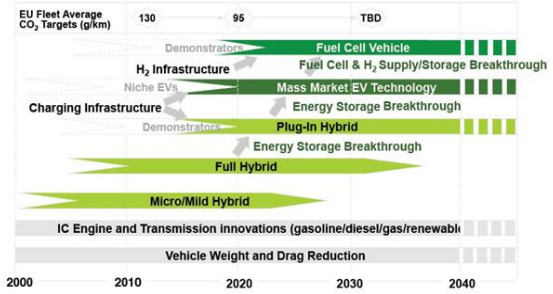
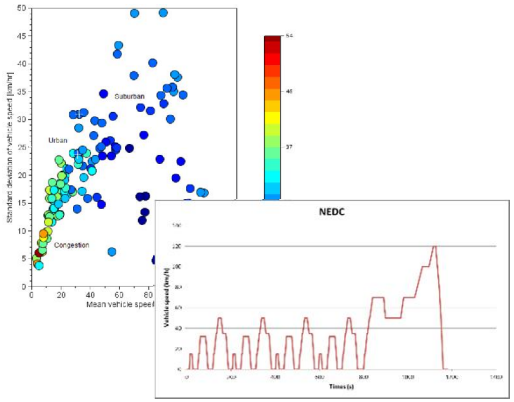
Tools and methods

Tank-to-Wheel analysis

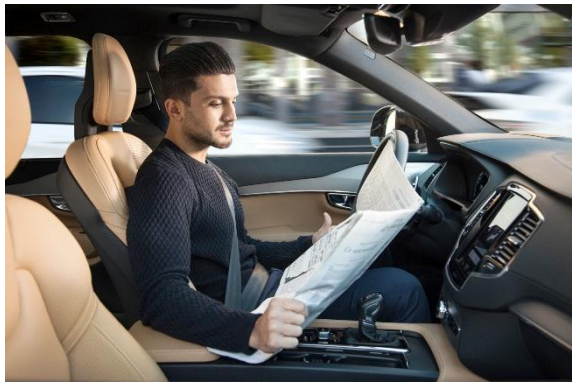
- Vehicle technology
  - Powertrain simulators (GT-Power etc.)
  - Impact of the changing the fuel, opportunities for future powertrain
  - Multi-fuel vehicles





- Use of the vehicle
  - Drive-cycle analysis (standard & real world) using vehicle (ProtoDrive, AVL Cruise)
  - Account for all emissions

- Impact on consumers, natural environment and resources
  - Almost all fuel economy savings have been offset by heavier vehicles, more journeys and additional air-conditioning
  - Autonomous vehicles
  - Market assessment and consultation with consumers



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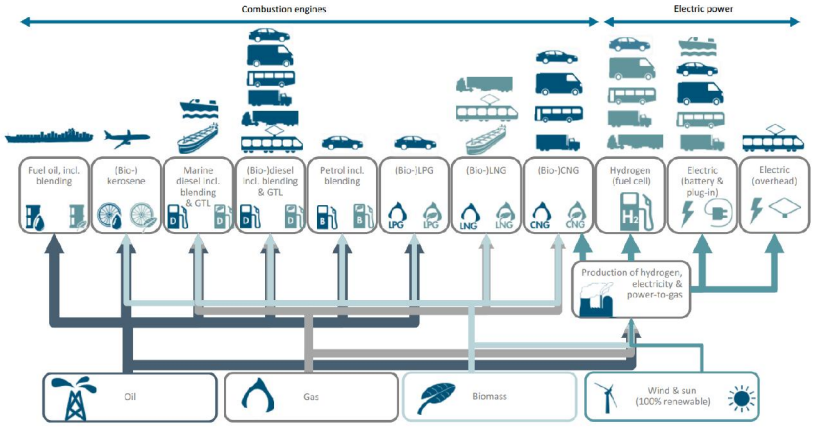
Tools and methods

Model informed decision-makers

- Multi-objective optimisation
- Medium term thinking
- Lots of uncertainty…have to identify the winners early on.
- Interrelationships have not been considered, only parallel systems
- Displacement and offsetting problems

- Knowledge and access to data
  - High quality
  - Age
  - Relevance
  - future technology modelling?

- Geography & temporal issues



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Summary

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Summary

- Uncertainty – there are very few “knowns” – scenario based analysis
- We’ve already made mistakes by not addressing this problem as a system

- Models and methods are reasonably well established in almost all areas

- Generally, solutions are considered upstream and downstream
- Very little integration and joined-up thinking

- Our analysis should reflect more interconnection of the new energy carriers