Hydrogen in the Energy System

Interim update

January 2016

www.erpuk.org

Conclusions & Recommendations from earlier work

- Strategic approach to hydrogen
- Systems analysis – cross sectors and markets
- Roadmap for delivery of hydrogen infrastructure
- Support UK's leading hydrogen & fuel cell companies
- Understand production of hydrogen

Opportunities

Specific markets	- **Intelligent Energy** £1.2 billion deal - Indian Telecom Towers - Back-up & portable power supplies - CHP units in buildings - Forklifts
Transport	- UK H2Mobility - Local projects – Aberdeen, London - International – California, Norway
Grid management	- **ITM Power-to-Gas** – 2 units operating in Germany - **ETI Coal gasification/salt-cavern storage** - surplus to other markets: industry, transport
Heat	- **Leeds H21 feasibility study**: 100% H_2 in city gas network
Industry	- decarbonise process heat

Benefits of hydrogen

- Transport
  - Better range than battery electric
  - Quick refuelling compared to batteries

- Decarbonise domestic heat
  - Utilise gas network – less digging up of roads
  - Easier to install? – less disruption than heat pump
  - Less space required
  - Safety issues – cooking with hydrogen?

Key conclusion

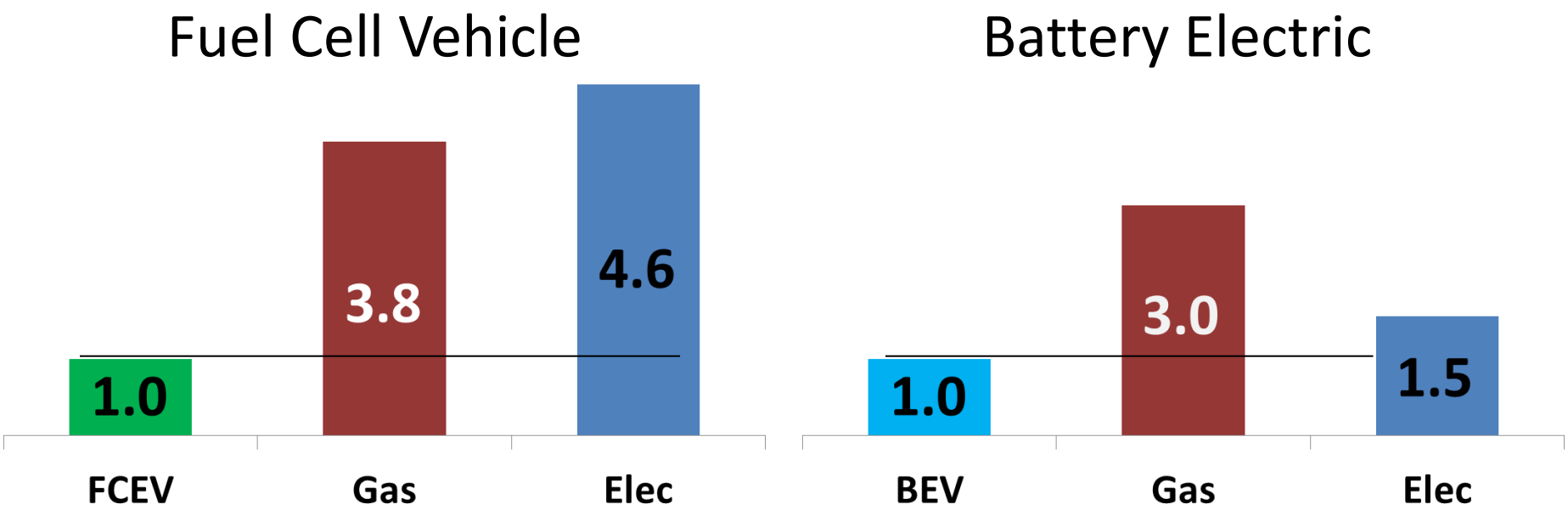
Hydrogen could play a role in decarbonising the energy system.

However, extensive use has implications for primary energy demand.

- a consideration missing in most analysis

Challenges for H2 - Efficiency

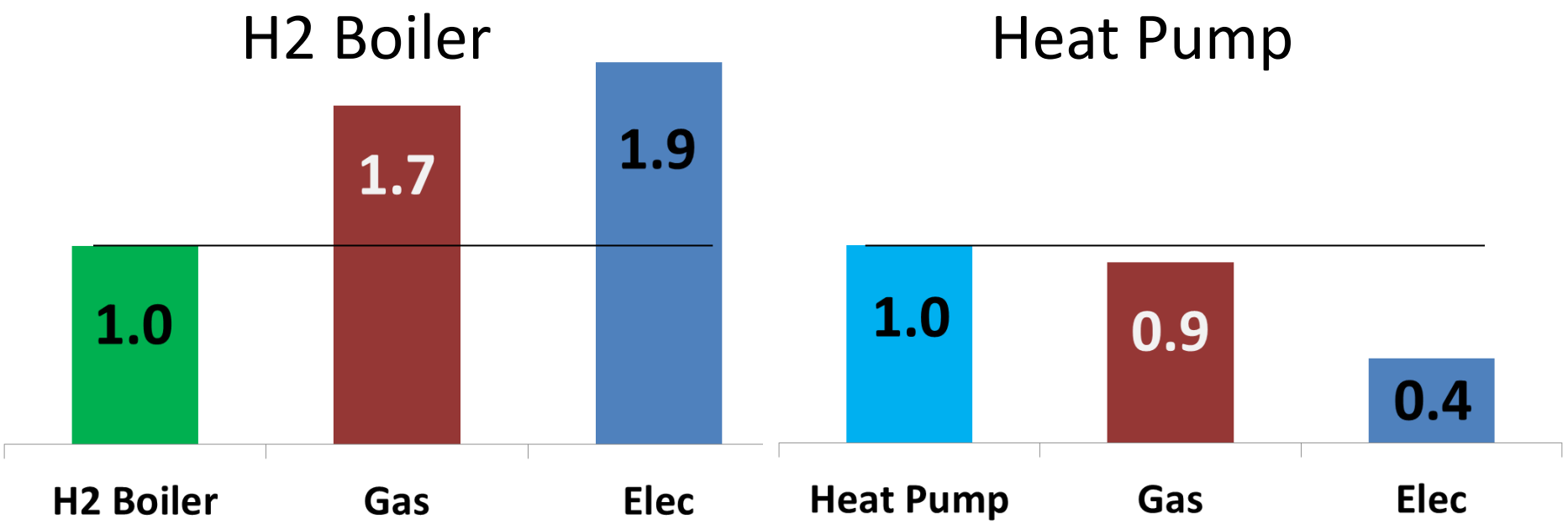
Transport



Comparative energy use: conversion losses mean that to deliver 1 unit of energy service (FCEV or BEV) requires additional primary energy.

Challenges for H2 - Efficiency

Heat



Comparative energy use: End use efficiency means that delivering 1 unit of energy service (heat) from H2 Boiler requires more primary energy than from a Heat Pump.

System analysis of hydrogen

E4Tech report for CCC

Critical Path 2050:

~ 50 % of all transport
8 TWh industrial power
< 5 % power generation

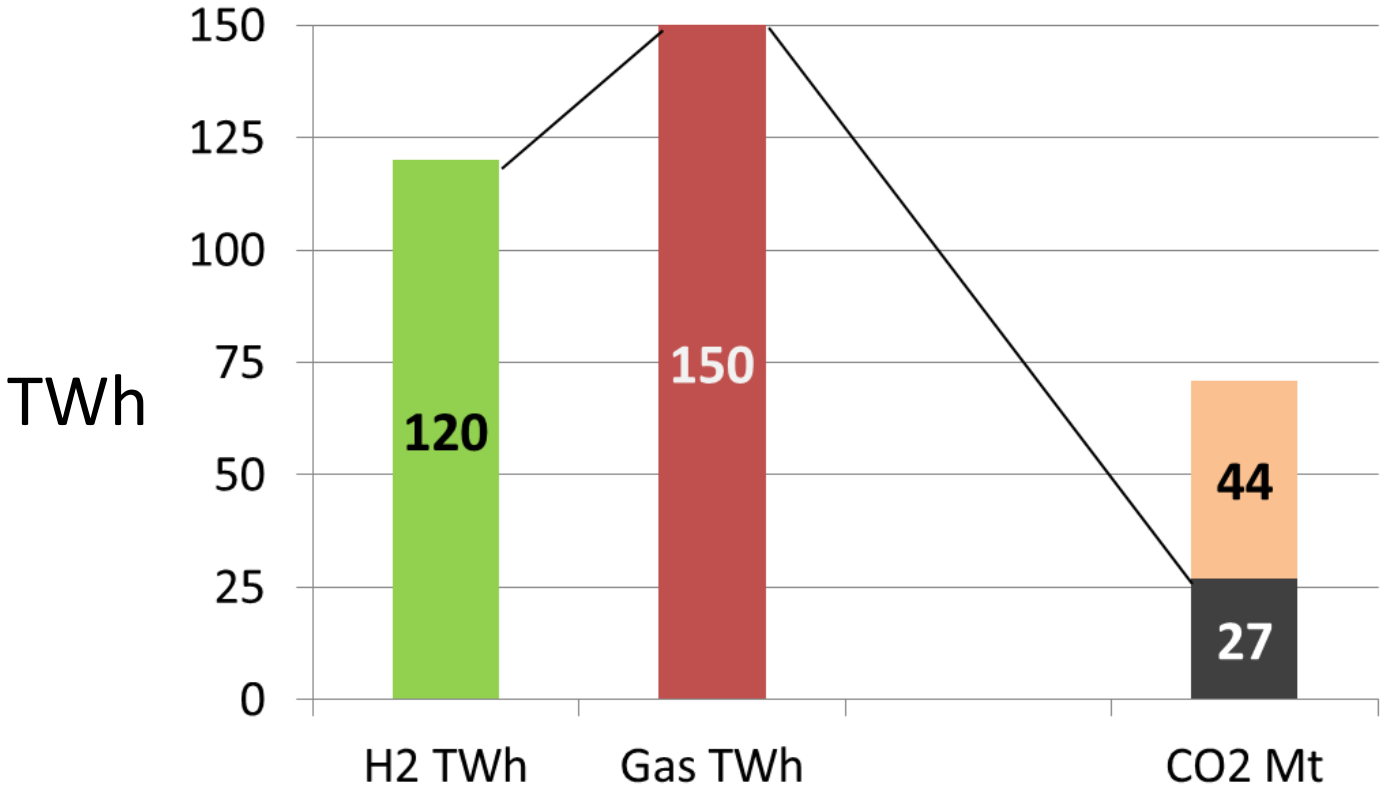
= 143 TWh of H_2
(3.6 million tonnes of H_2)

Full Contribution 2050:

> 90 % of all transport
~ 70 % of building heat
50 % industrial fuel use
~ 10 % power generation

= 860 TWh of H_2
(21.8 million tonnes H_2)

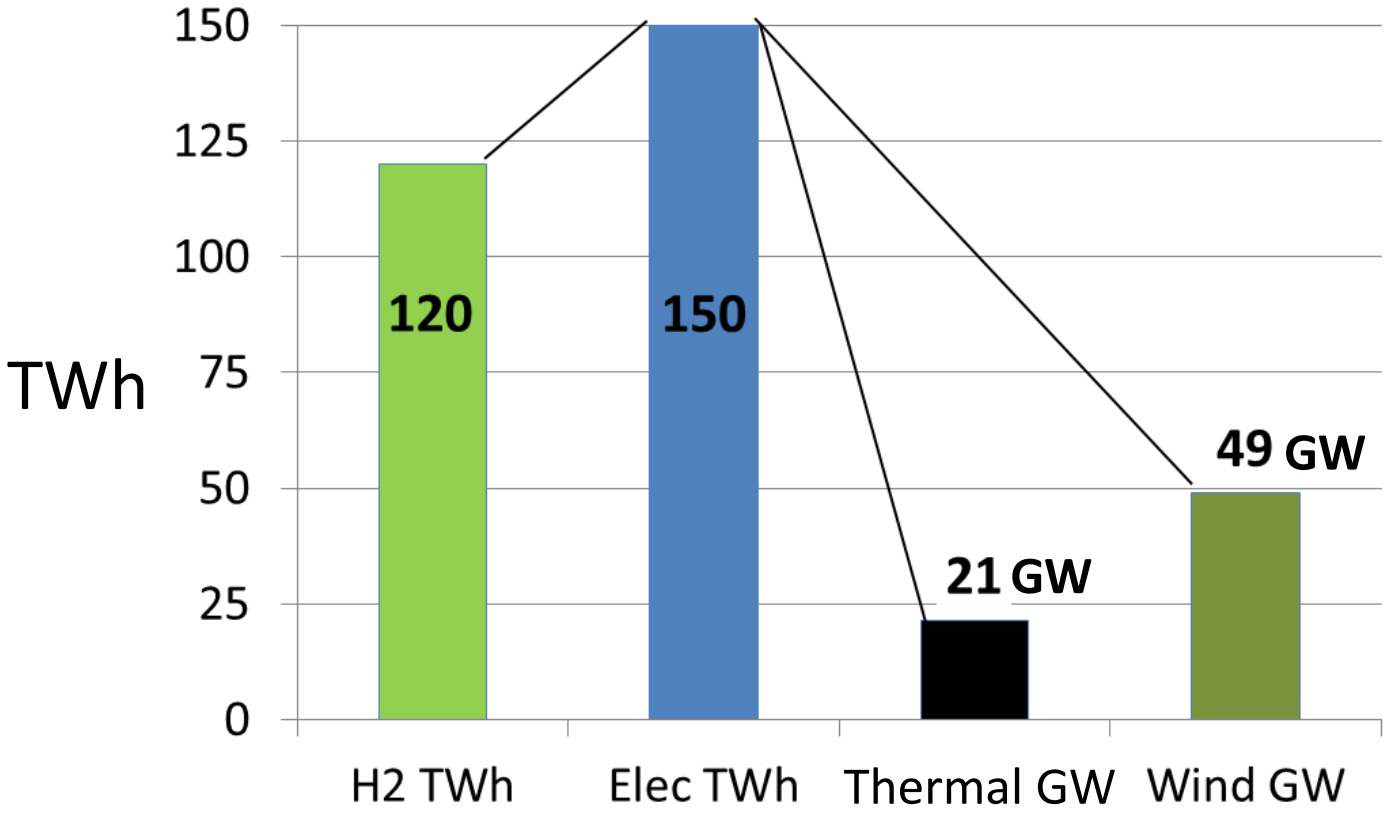
Critical Path - hydrogen



Delivering 120TWh of hydrogen requires 150 TWh of gas, producing 27 $MtCO_2$. Rest of energy system produces >44 $MtCO_2$ for CCS.

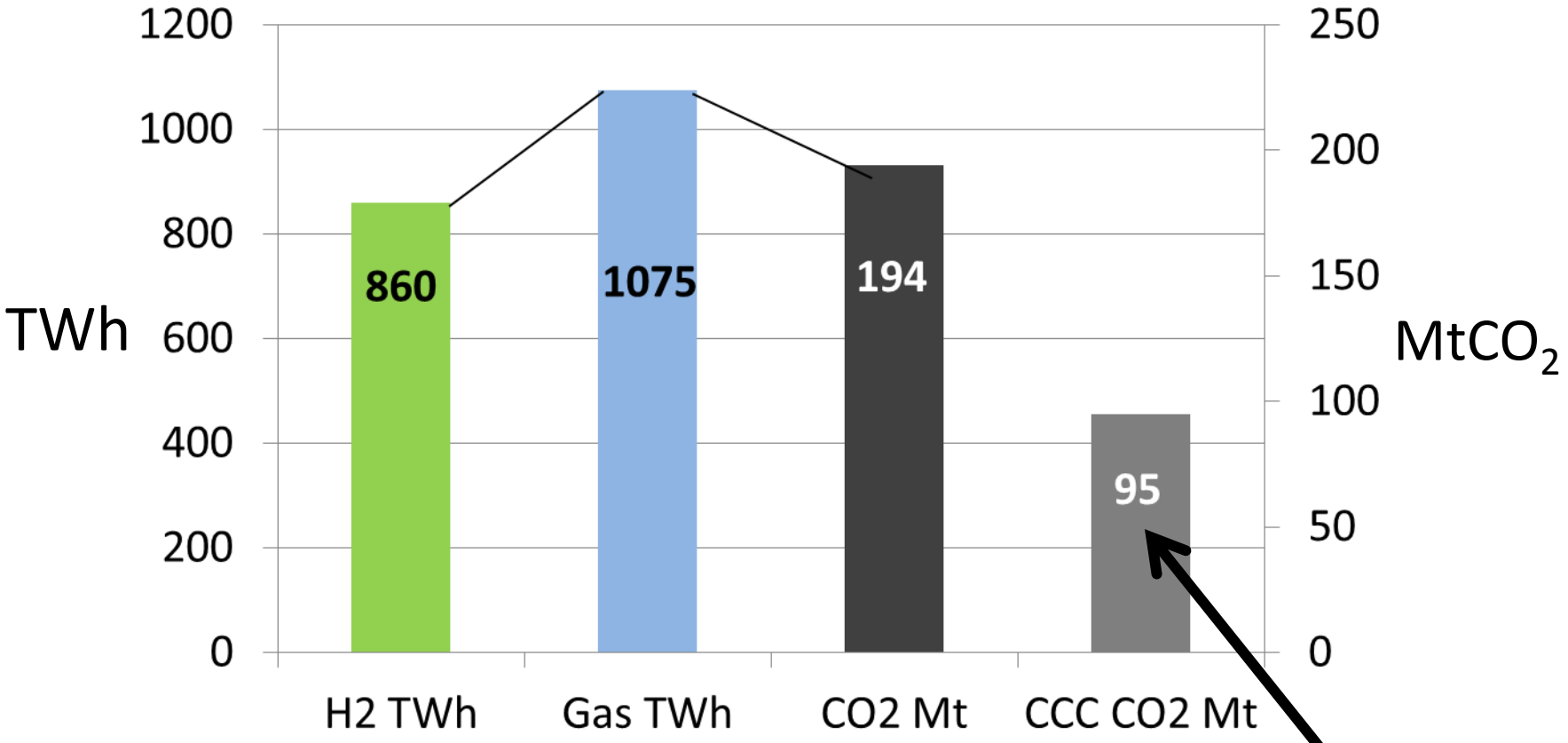
Note: ~23TWh of hydrogen came from electrolysis.

Critical Path - hydrogen



Delivering 120TWh of hydrogen requires 21GW of dedicated thermal plant or 49GW of wind (at 35% load factor).

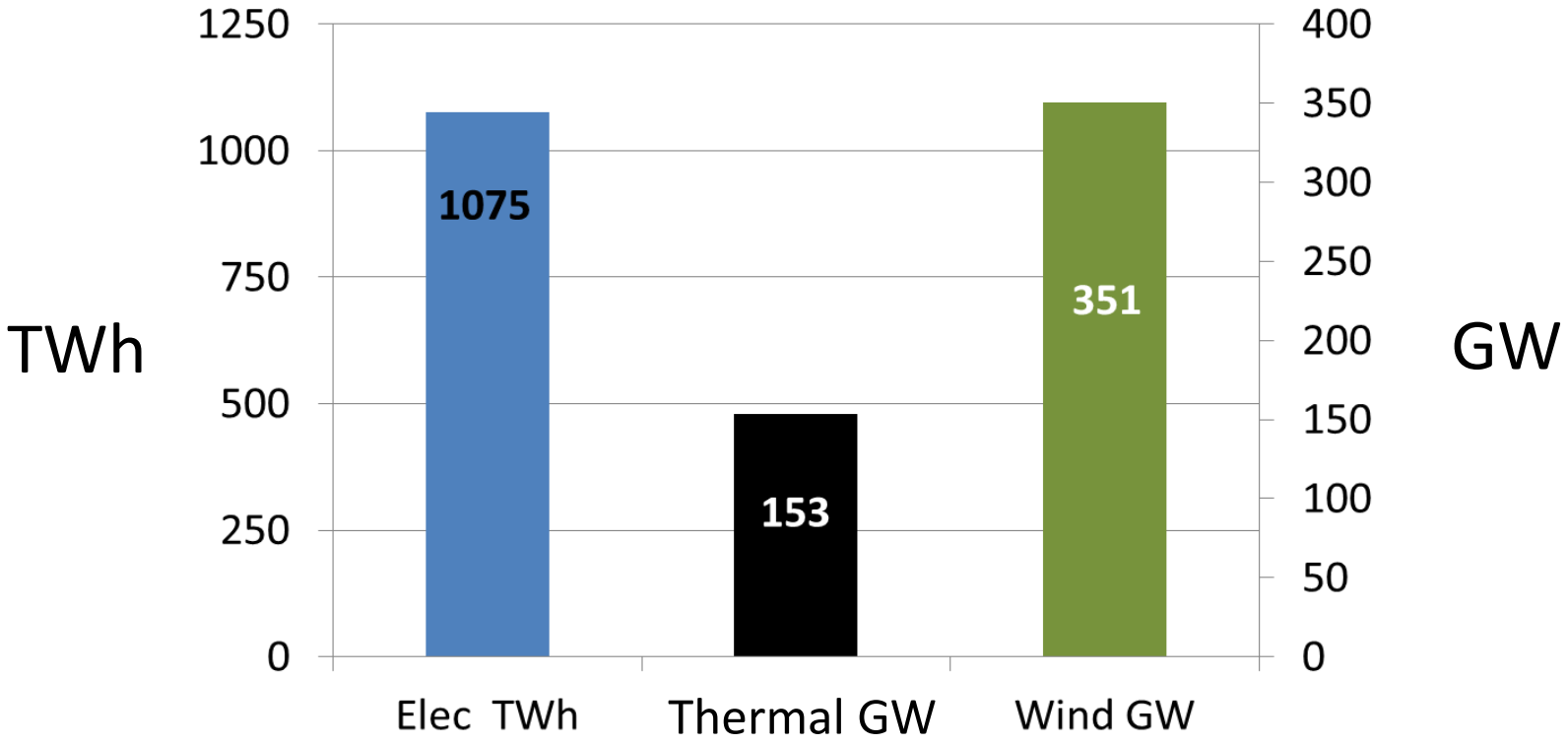
Full Contribution Scenario



Delivering 860 TWh of hydrogen requires 1075TWh of gas, producing 194 $MtCO_2$ for CCS. Compared to 95 $MtCO_2$ from CCC Central 2050 Scenario.

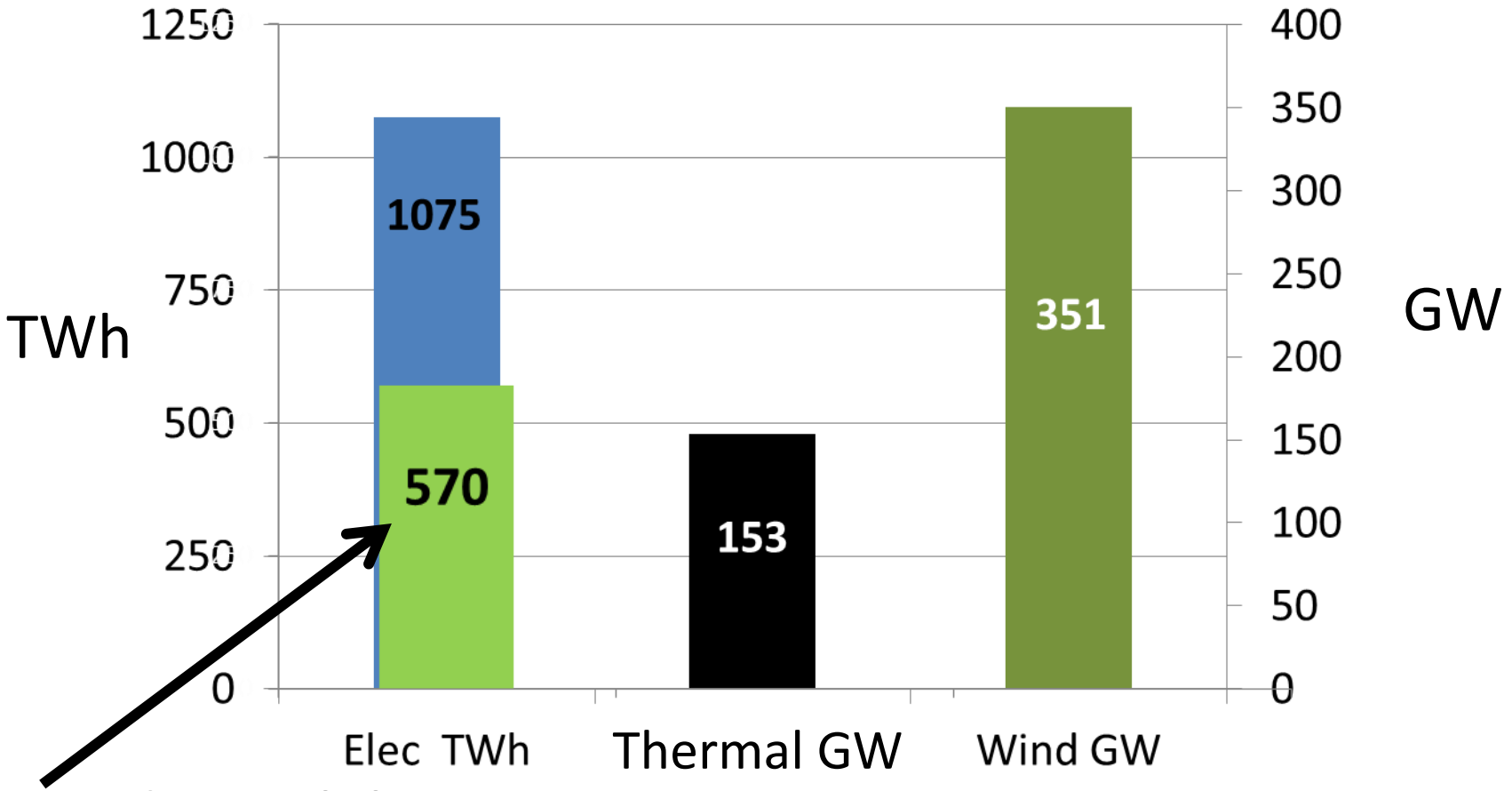
Total CO_2 for CCS in CCC Central 2050 Scenario

Full Contribution



Delivering 860TWh of hydrogen requires 153GW of dedicated thermal plant or 351GW of wind (at 35% load factor).

Full Contribution



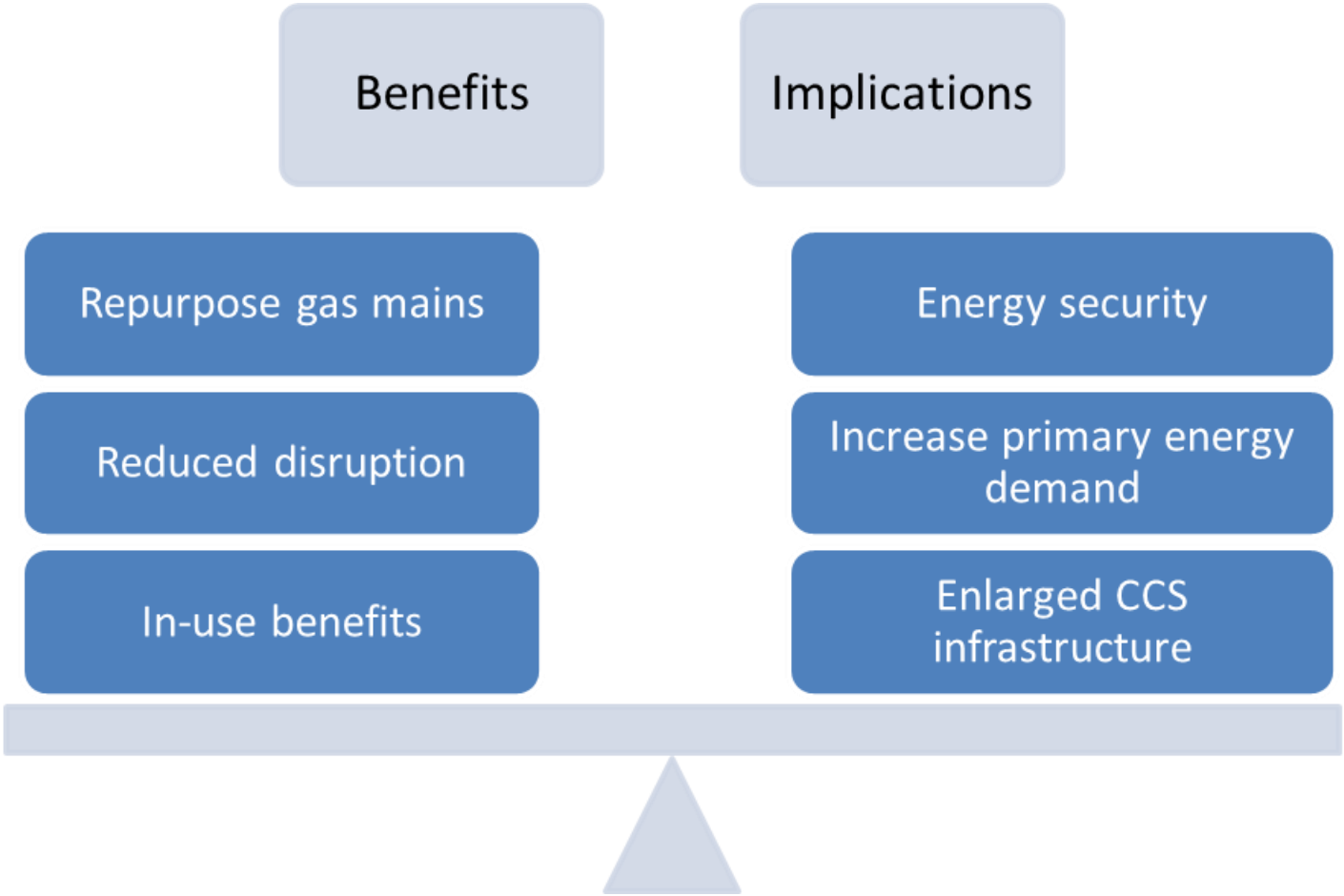
Compared to Total Electricity demand in CCC Central 2050 Scenario

Context

ETI screening identified economic CO_2 storage = 12.5 Gt
(possibly rising to 75 Gt)

@ 200 $MtCO_2/yr$ -> mostly filled by 2100

Trade offs


Benefits
Implications
Repurpose gas mains
Reduced disruption
In-use benefits
Energy security
Increase primary energy demand
Enlarged CCS infrastructure

Additional Conclusions

Decarbonising heat: major energy-system challenge

Hydrogen could have a role in grid management and as part of a portfolio for transport and heat.

Enablers and research needs

- CCS
- System modelling
  - Comparative energy distribution infrastructure costs
  - Practical, Social & Technical comparison of options for heat
  - Cross vector assessments
  - Assess primary energy supply costs and impacts
- Hydrogen storage - particularly for transport
- Alternative sources – e.g. waste
- Hydrogen safety aspects