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CDUK

UK Centre for Carbon Dioxide Utilisation

CO2Chem

An EPSRC Grand Challenge Network

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Foreseeing a future using CO_2

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Engineering and Physical Sciences Research Council

How Can CCU Provide a Net Benefit?

Professor Peter Styring

Director, UK Centre for Carbon Dioxide Utilisation

The University of Sheffield

UKCCSRC

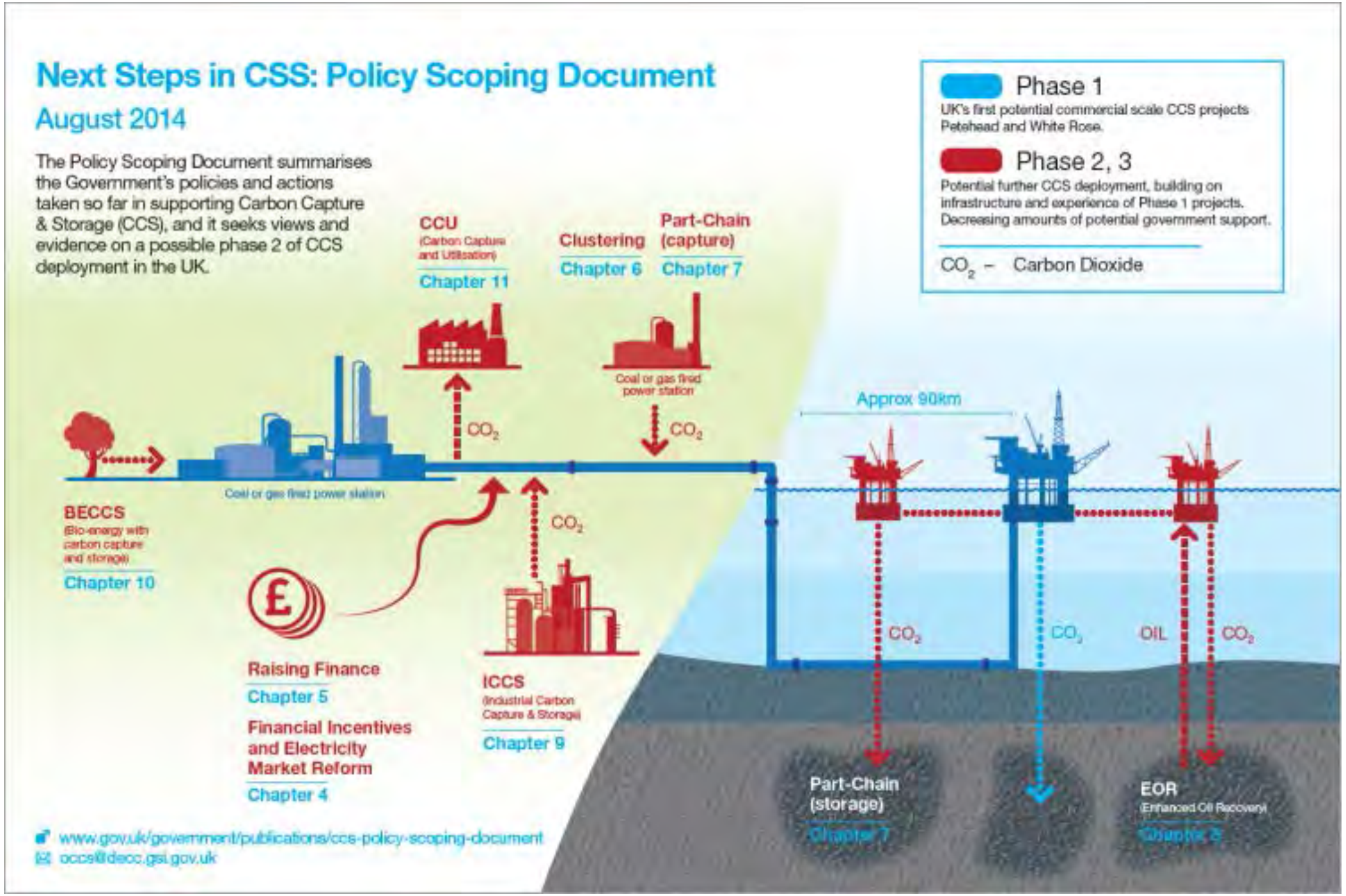
Biannual Conference

Cardiff. 10 September 2014

Next Steps in CSS: Policy Scoping Document

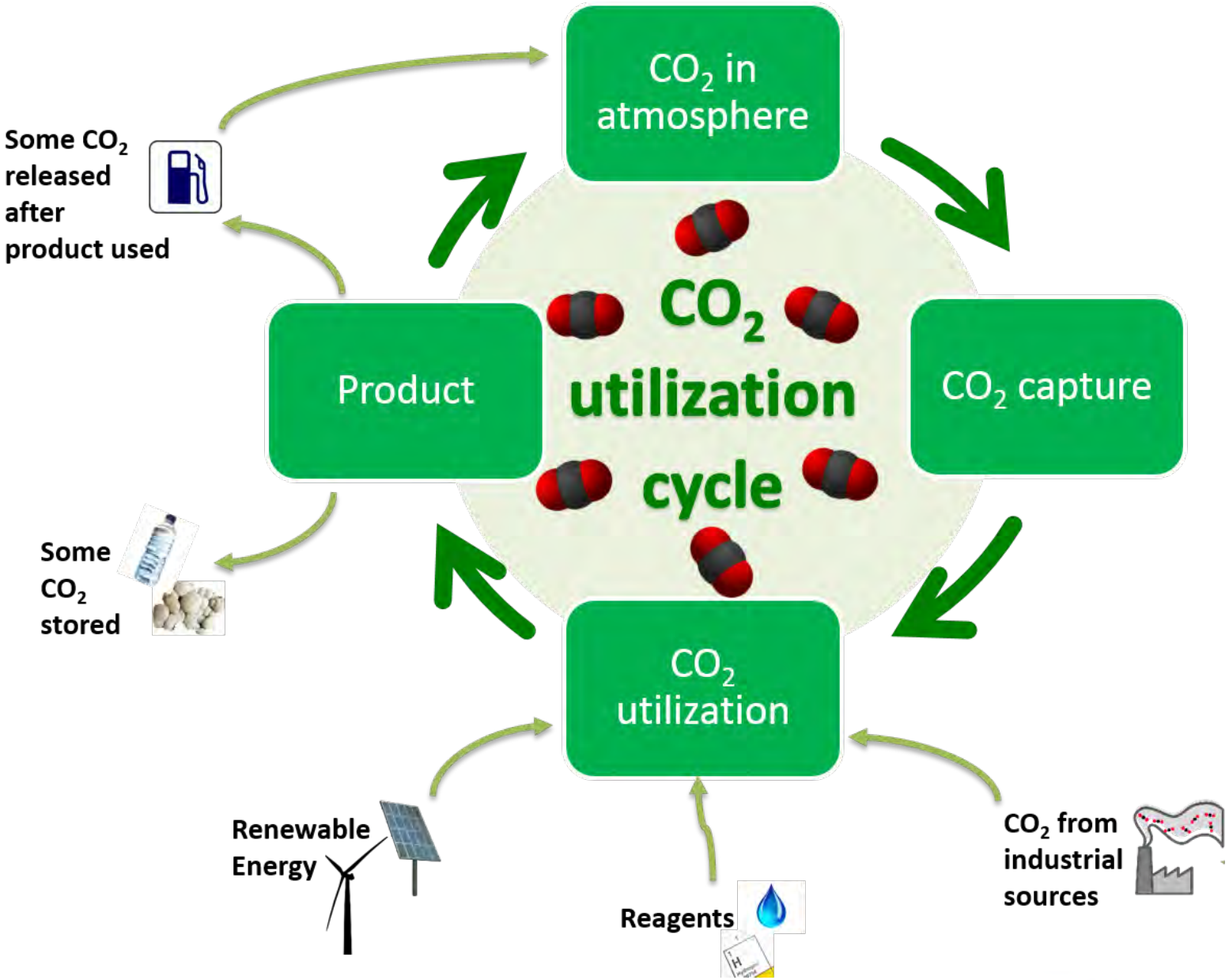
August 2014

The Policy Scoping Document summarises the Government's policies and actions taken so far in supporting Carbon Capture & Storage (CCS), and it seeks views and evidence on a possible phase 2 of CCS deployment in the UK.

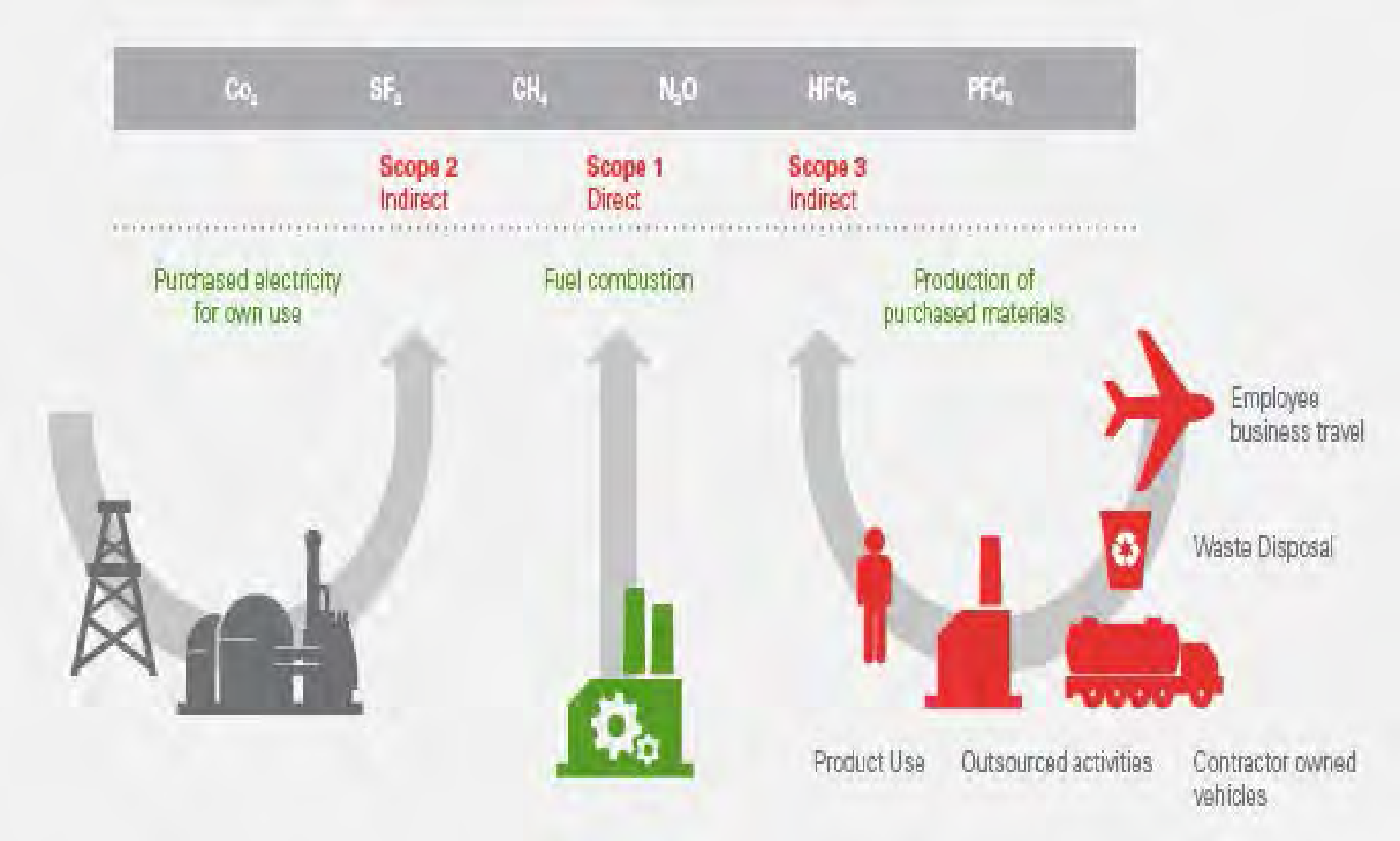


www.gov.uk/government/publications/ccs-policy-scoping-document
ccs@decc.gsi.gov.uk

Department of Energy & Climate Change


CO_2 in atmosphere
Some CO_2 released after product used
CO_2 utilization cycle
Product
CO_2 capture
Some CO_2 stored
CO_2 utilization
Renewable Energy
Reagents
CO_2 from industrial sources

Towards a Hybrid LCA Analysis of Carbon Dioxide Utilisation (CDU) Processes

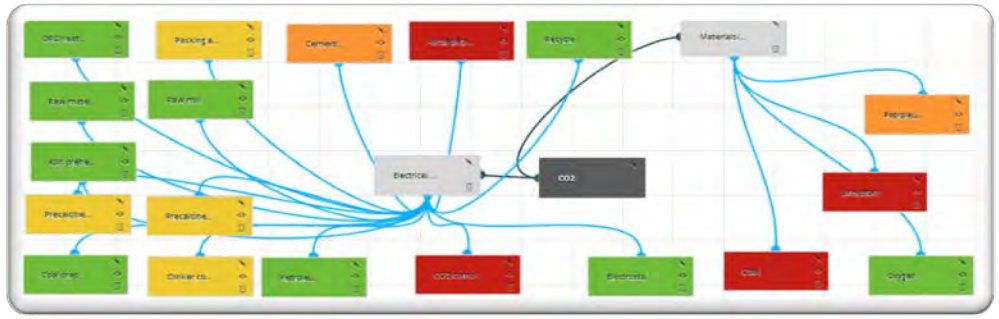


Modelling CDU Processes- CH_3OH and Carbon mineralisation

Process are modelled using Supply Chain Environmental Analysis Tool SCEnAT which is a cloud based Decision Support System (DSS) application, which incorporates Life Cycle Assessment (LCA) and a hybrid Input-Output (I-O) methodology.

Scope 1 emissions are shown in supply chain map, colour coded from highest to lowest emitter.
Scope 2 and 3 emissions results are obtained as %

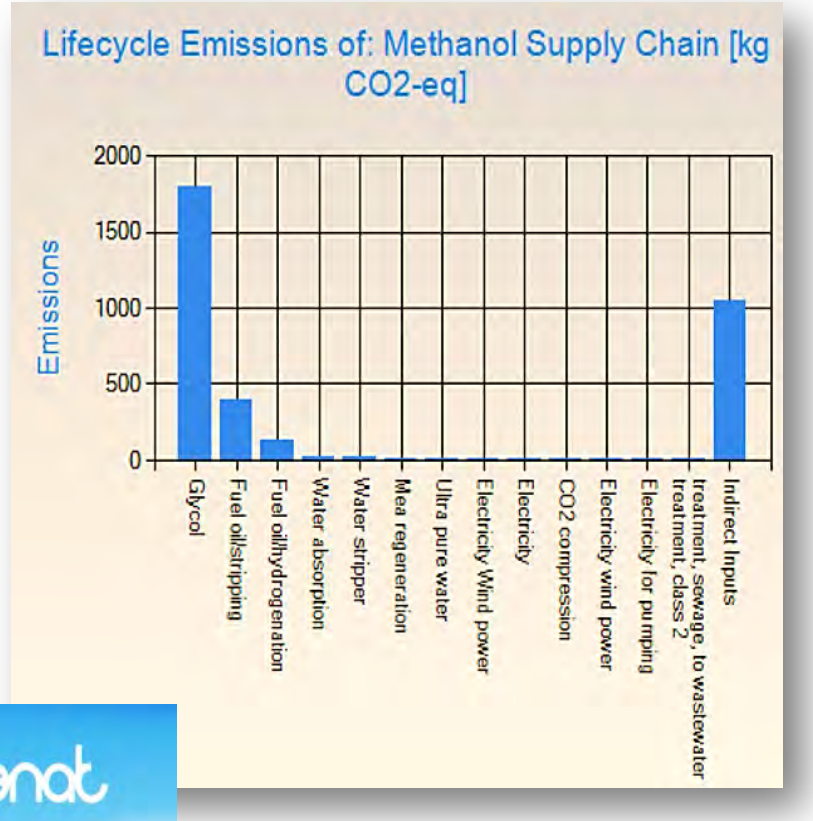
Perso...	Busin...	Trans... and	Trade	Const...	Utilities	Equip...	Metals	Miner...	Chem...	Fuels	Wood and	Textiles	Food	Mining	Fishing	Fores...	Agric...
0.0%	0.2%	1.1%	0.1%	0.0%	21.3%	0.1%	0.5%	0.4%	1.3%	0.4%	0.1%	0.0%	0.0%	4.5%	0.0%	0.0%	0.3%



Perso...	Busin...	Trans... and	Trade	Const...	Utilities	Equip...	Metals	Miner...	Chem...	Fuels	Wood and	Textiles	Food	Mining	Fishing	Fores...	Agric...
0.0%	0.0%	0.1%	0.0%	0.0%	2.7%	0.0%	0.1%	0.1%	0.5%	0.1%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.1%

Outputs from SCENAT

SCENAT can help interpretation stage of LCA, an example of these findings are:



- For 1 tonne of methanol produced, 3,411.73 kg CO_2-eq are emitted, 69.43% direct emissions.
- Top carbon emitter processes: Dehydration 52.7%, Fuel consumption in stripper.
- 1,270.51 litres of glycol are required to reduce water content by 99.4 %.
- 1 tonne of CO_2 emitted per 1 tonne of methanol produced after considering CO_2 capturing stage.
- Input –output analysis identified utilities (21.3%), mining (4.5%) and chemicals (1.3%) as the three highest scope 3 emitters.

Carbon Dioxide Utilisation- Importance of full LCA study

‘There is a necessity to perform an extensive LCA with additional impact categories and statistical analysis due to the lack of available data at industrial scale for relatively new CDU processes’

‘Adapting existing impact assessment tools to analyse specific chemical process models will contribute to predict potential environmental impacts, present alternative supply chains to lessen these impacts and support or oppose CDU at large scale as a sustainable technology’

Smart CO_2 Transformation

‘Highlighted is the need for further studies around how low carbon electricity can be guaranteed for CDU processes’

‘Performing complete LCA studies on CDU processes at this stage presents an opportunity to prevent rather than react to environmental issues unlike most chemical processes currently available in the market’

European Commission

SEVENTH FRAMEWORK PROGRAMME

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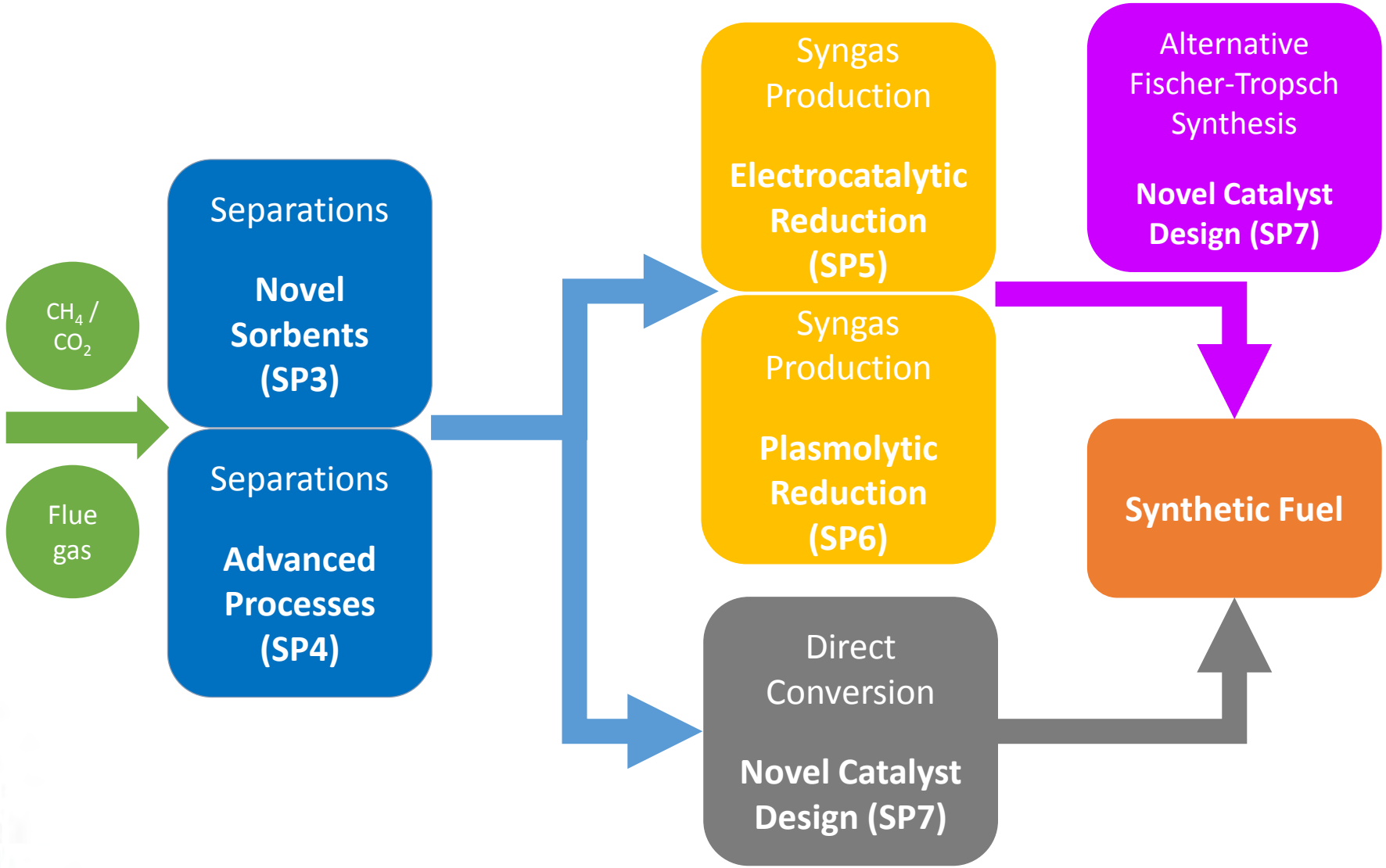
Coordinated, Comprehensive Approach to Carbon Capture & Utilization



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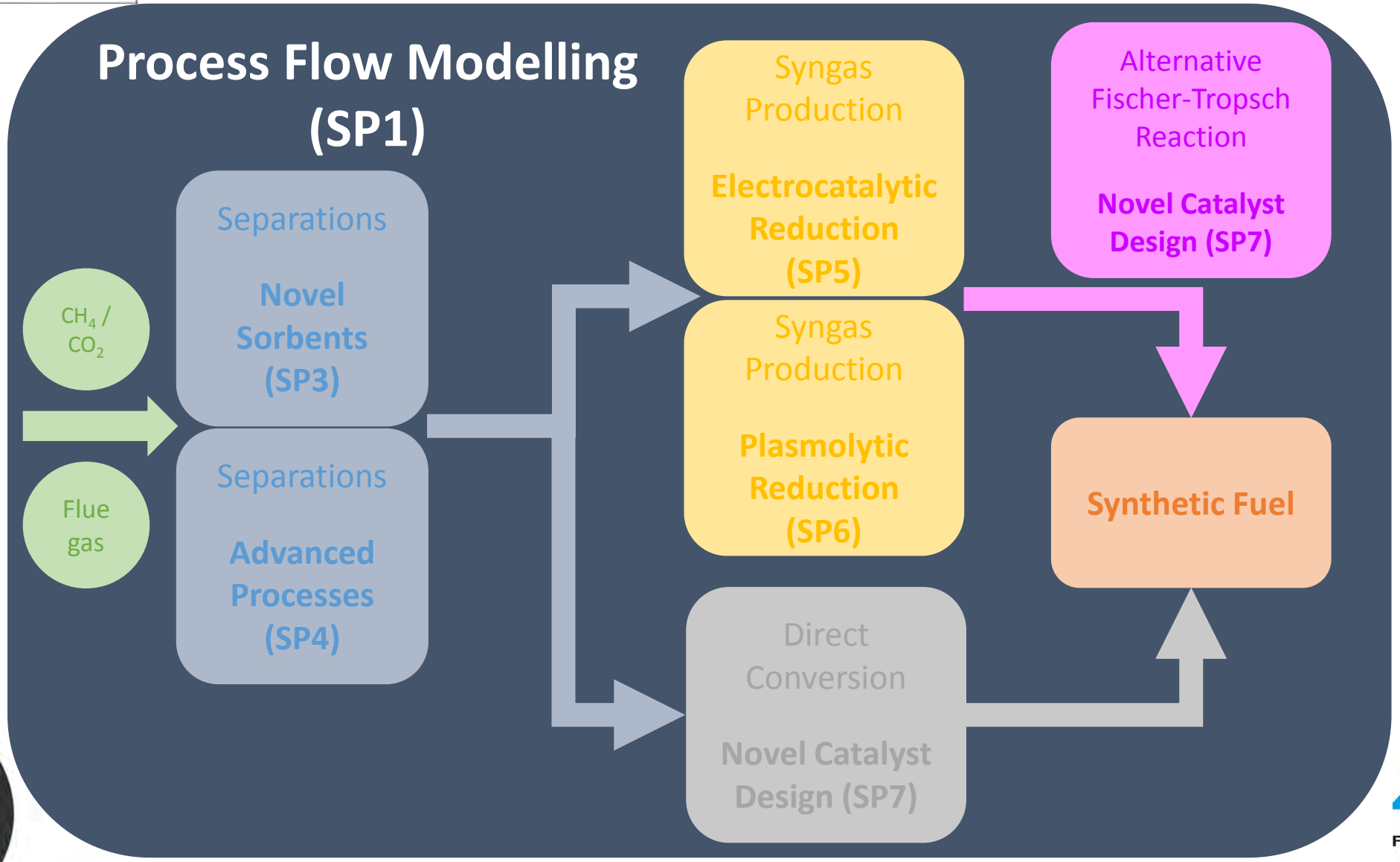
Methodology



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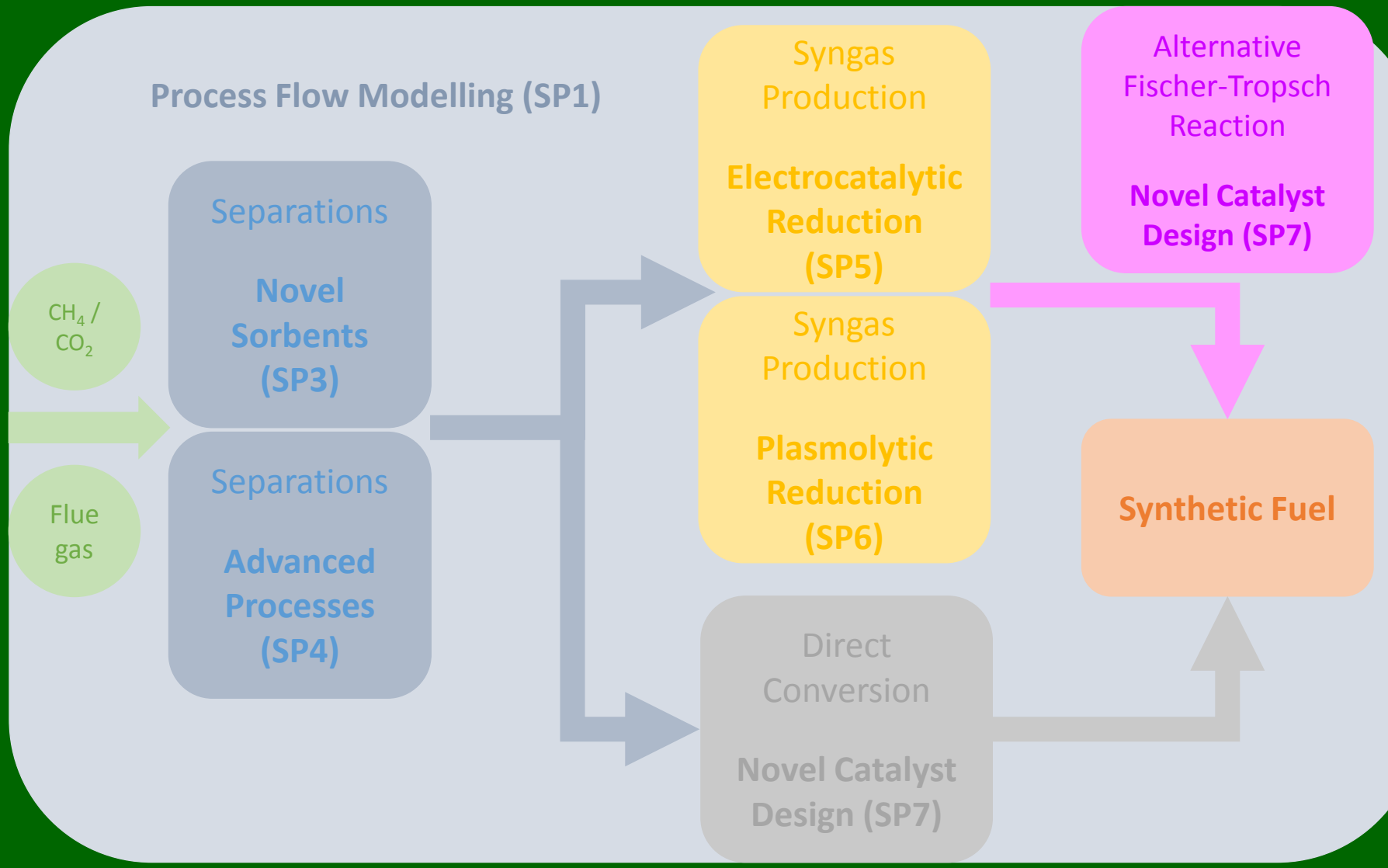
Sustainability modelling(SP2)



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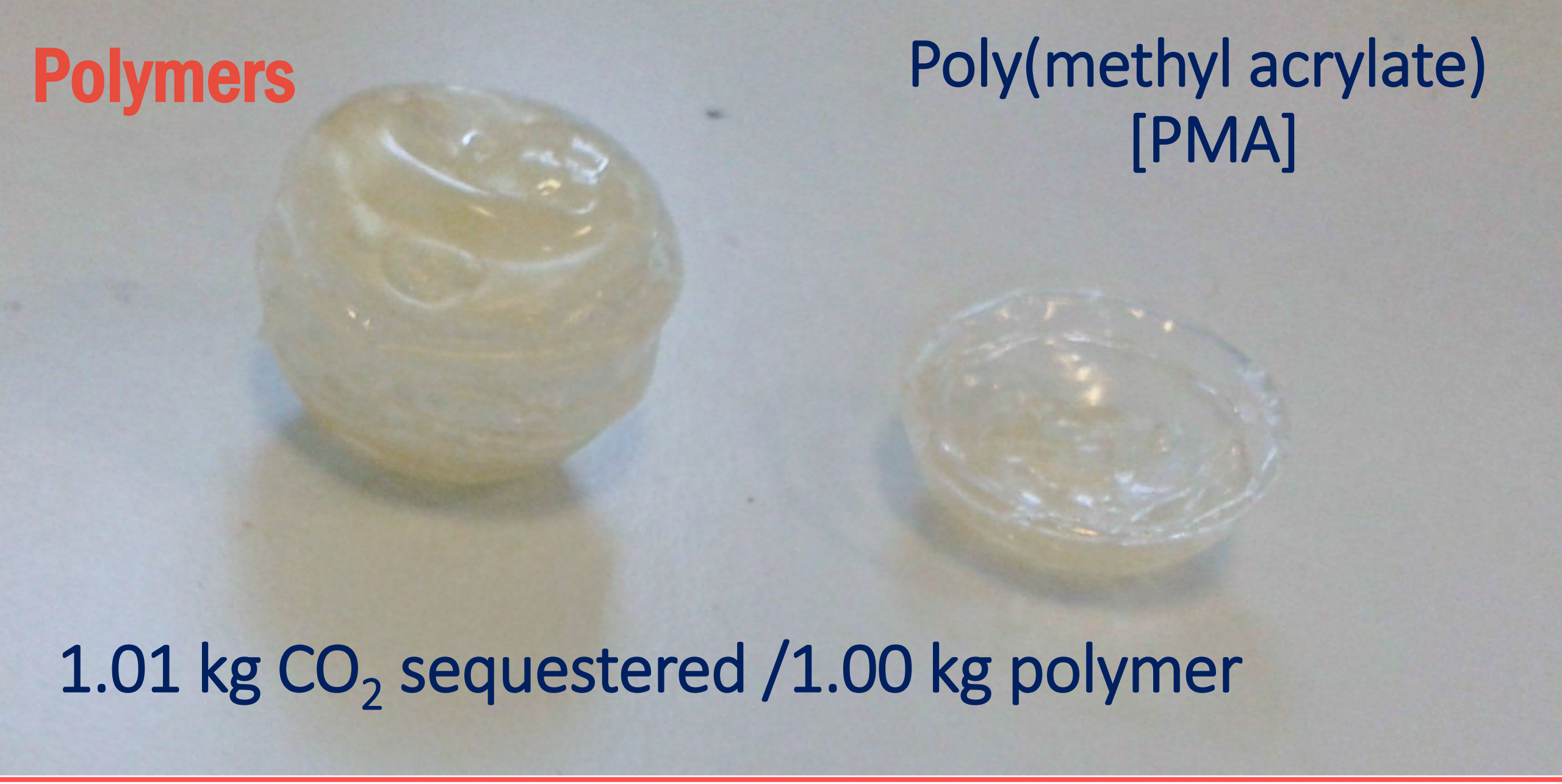
FCU
Foreseeing a future using CO_2

Polymers

Poly(methyl acrylate) [PMA]



1.01 kg CO_2 sequestered /1.00 kg polymer

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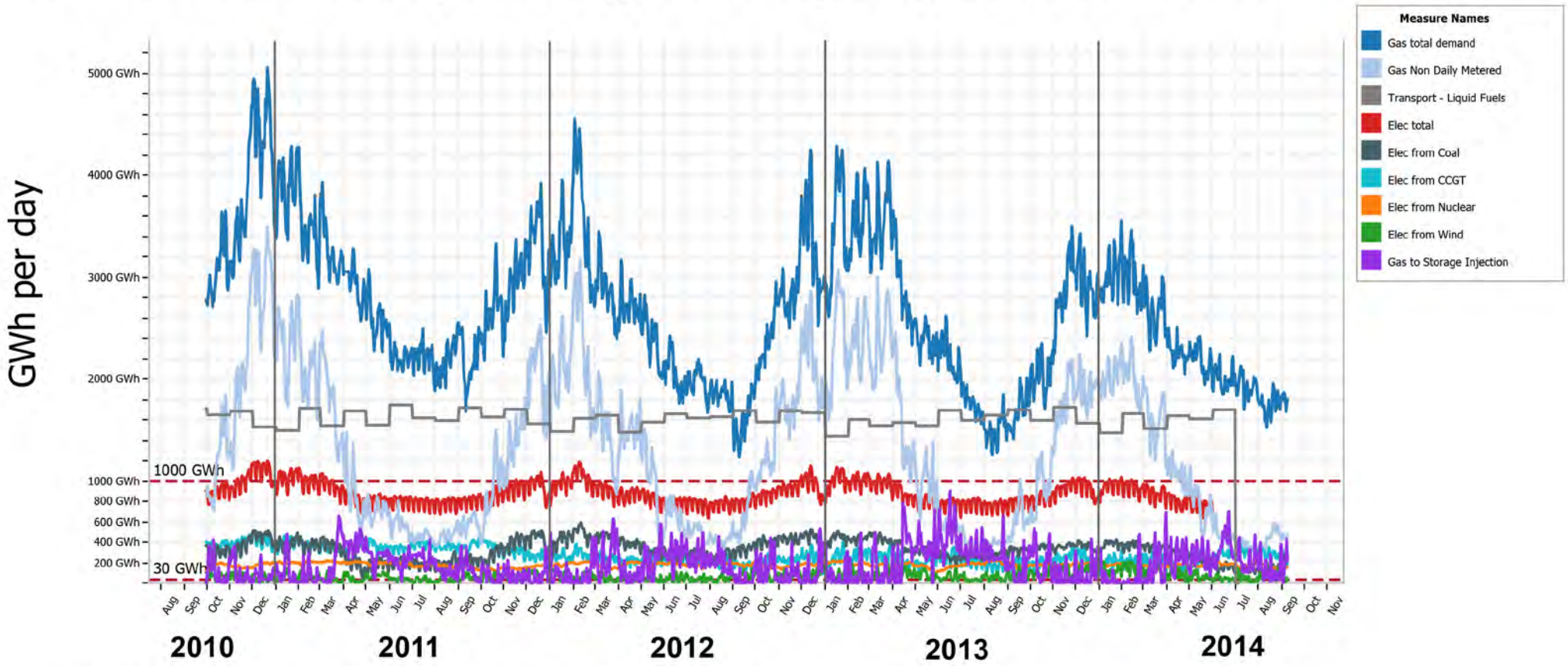
SEVENTH FRAMEWORK PROGRAMME
BIS Department for Business Innovation & Skills
DEPARTMENT OF ENERGY & CLIMATE CHANGE

Energy Storage and Vectoring

This data covers four winters of data from Oct 2010

- National Transmission System Gas data
- Transmission Level Electrical Data
- Liquid Fuels for internal delivery
- Wind includes distributed generation

Transmission level daily GB Energy - in GWh per day from October 2010



Gas and electrical data derived from National Grid plc website.

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Transport fuels derived from Table 3.13 Deliveries of petroleum products for inland consumption from DECC website

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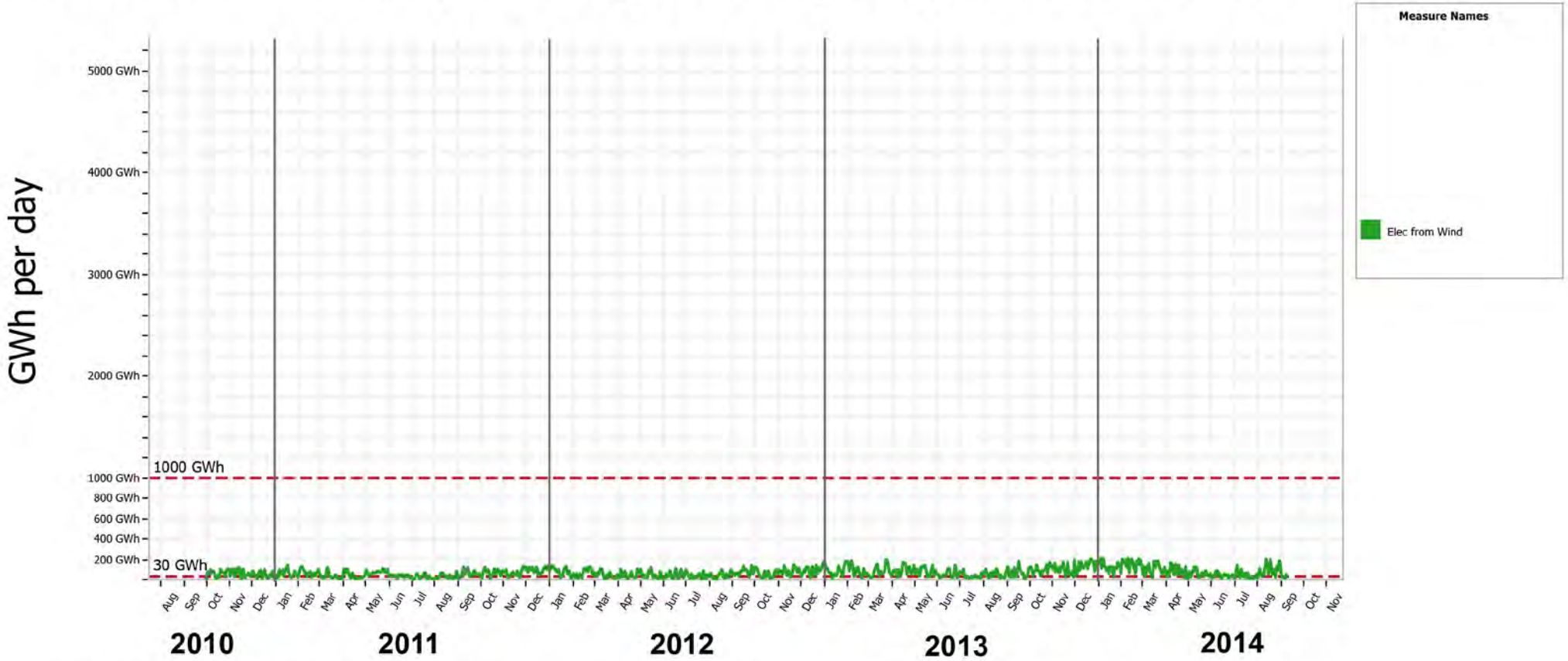
Transmission level daily GB Energy - in GWh per day from October 2010



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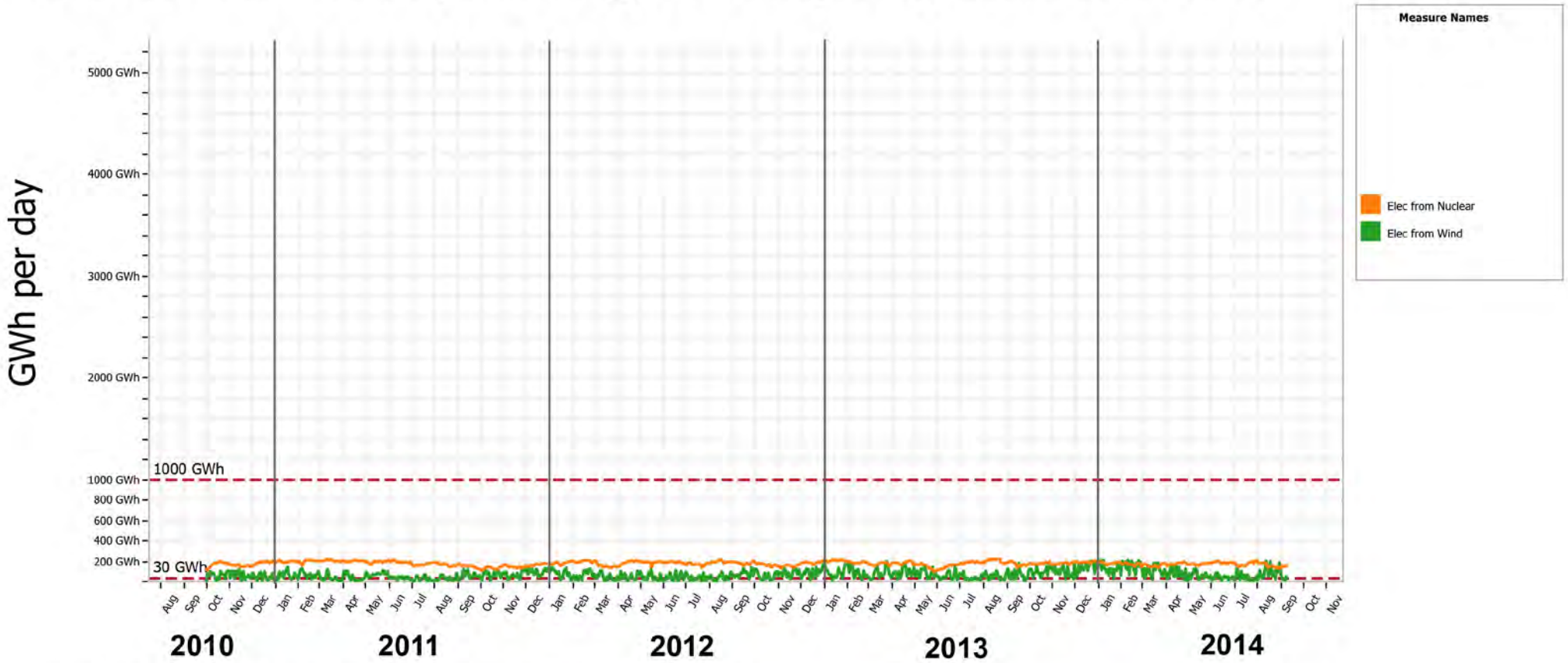

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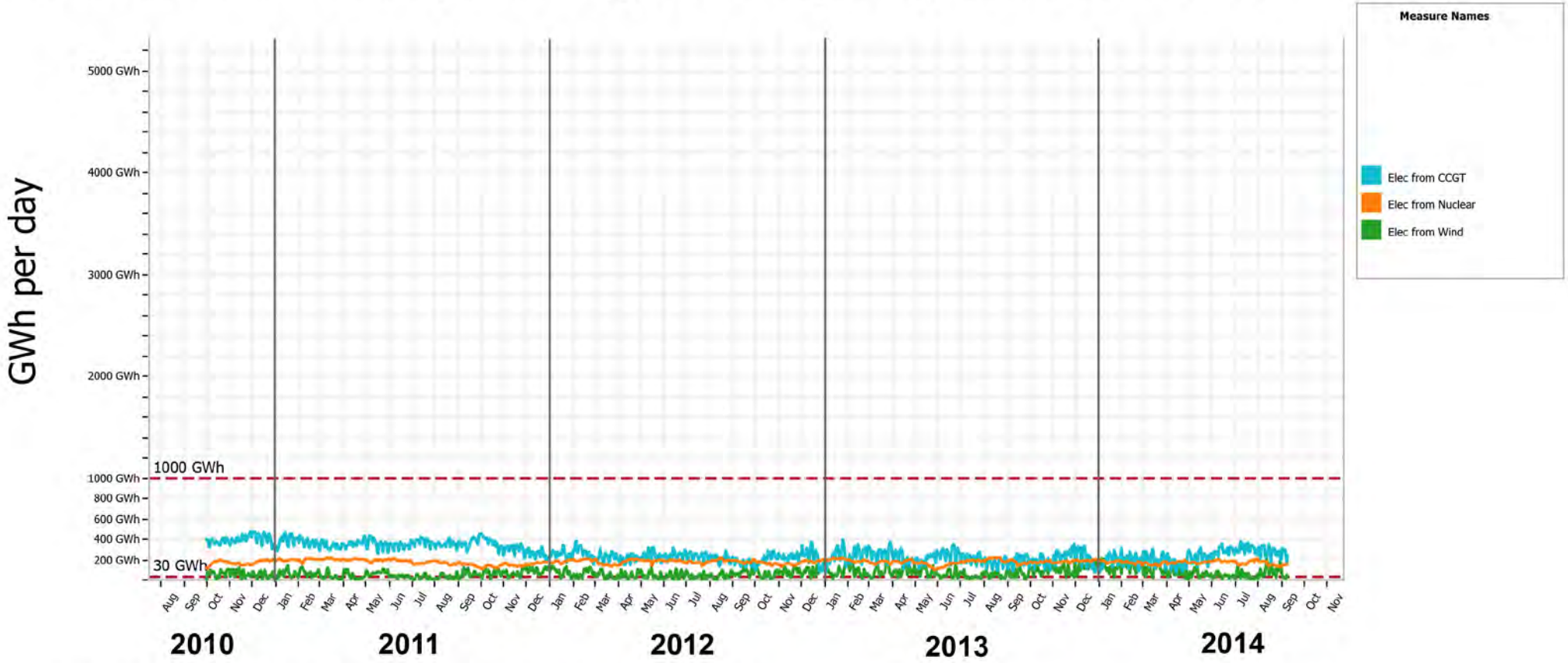

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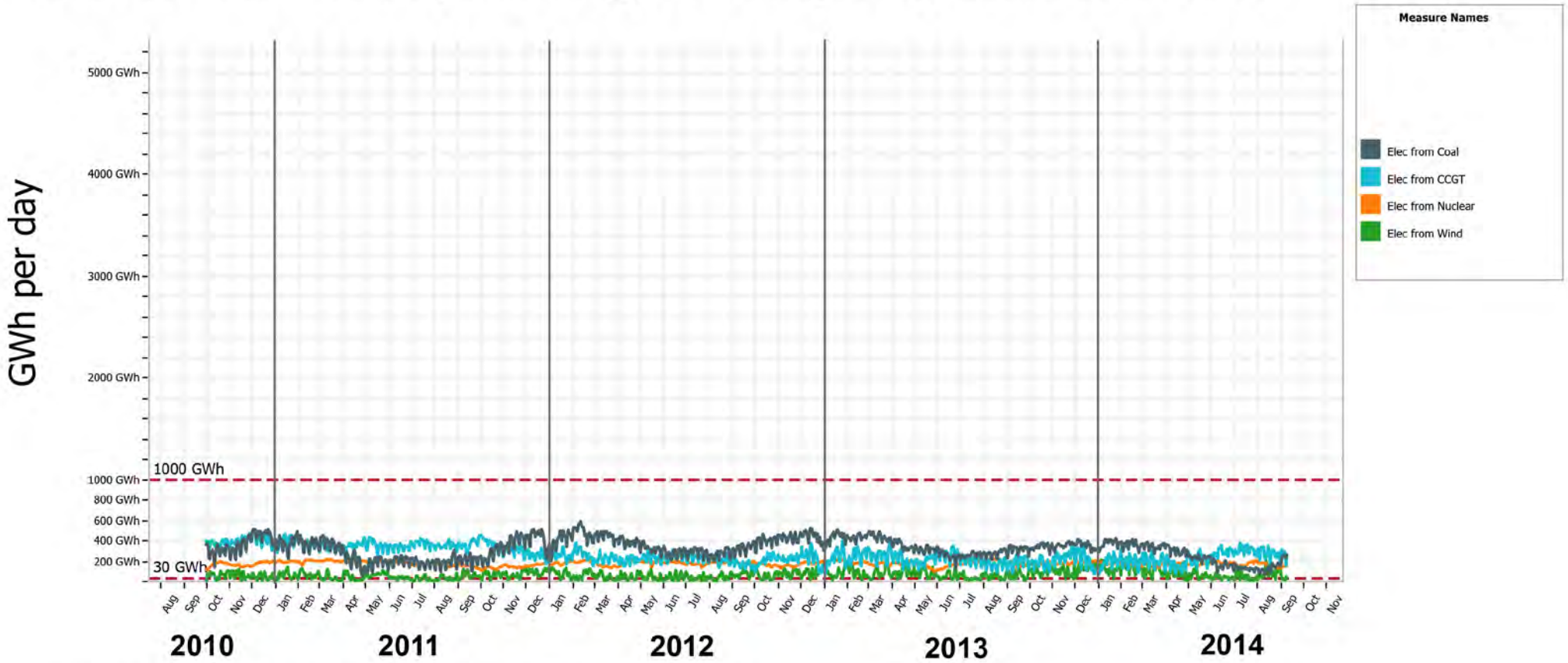

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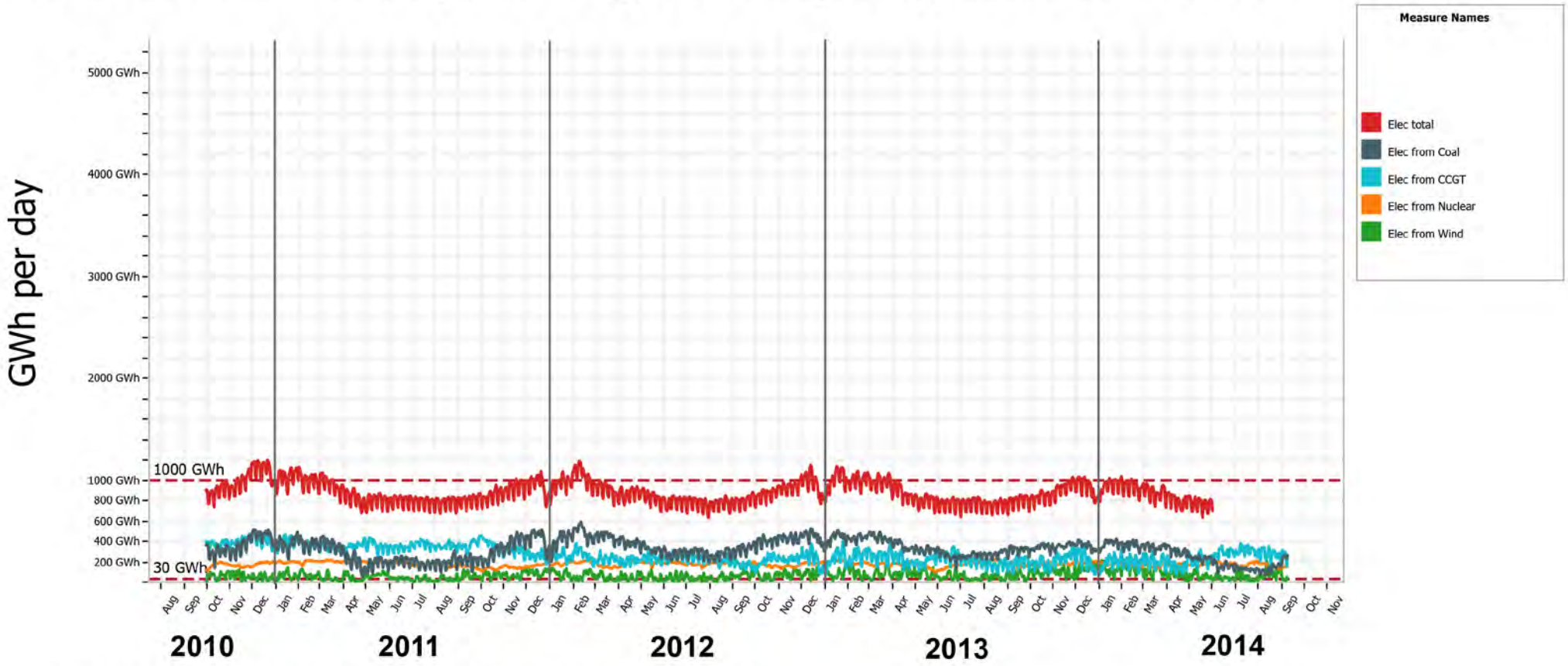

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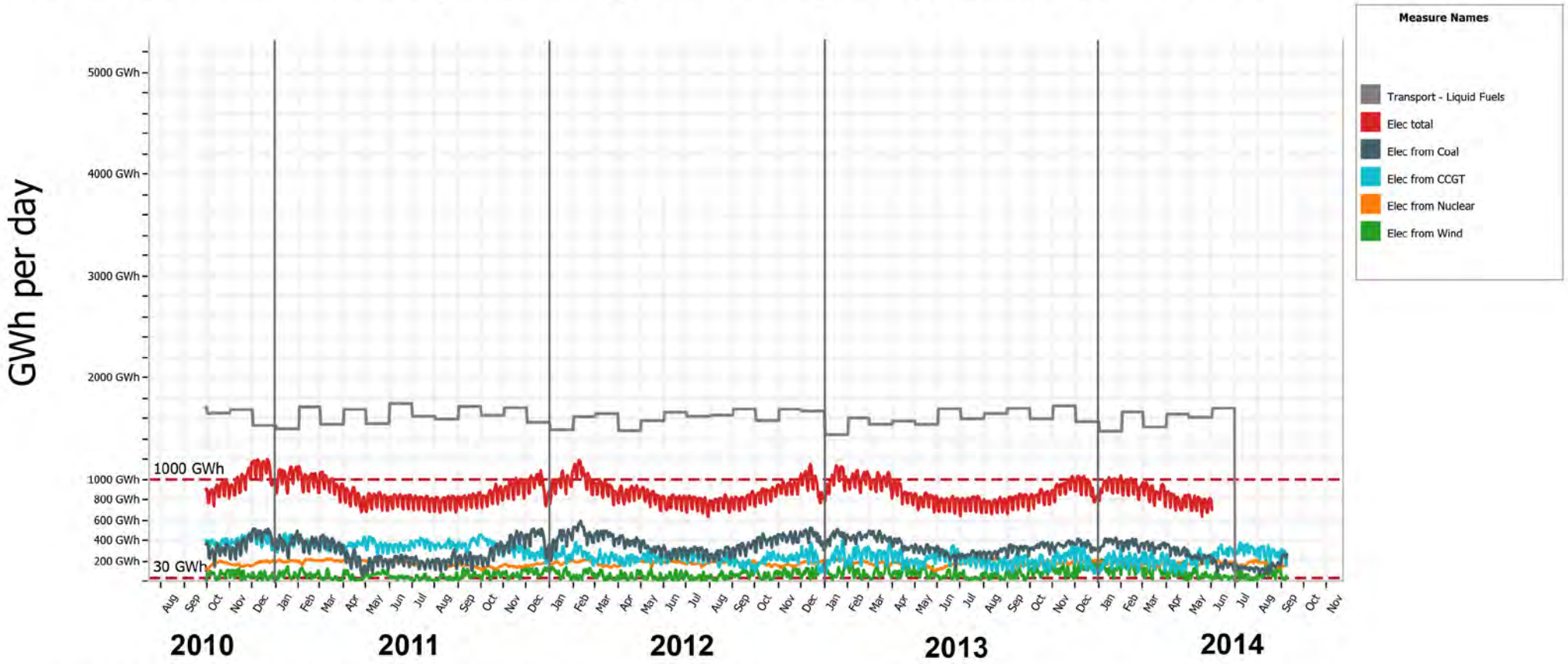

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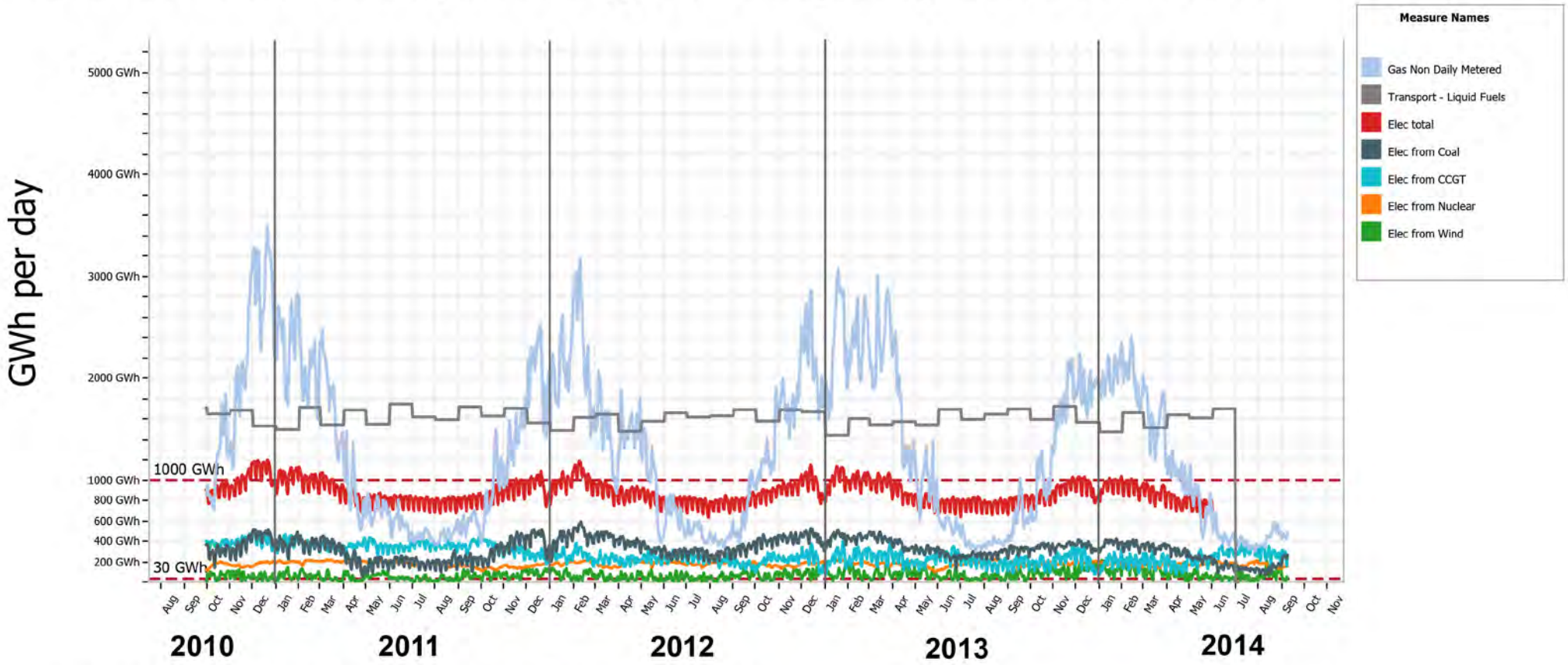

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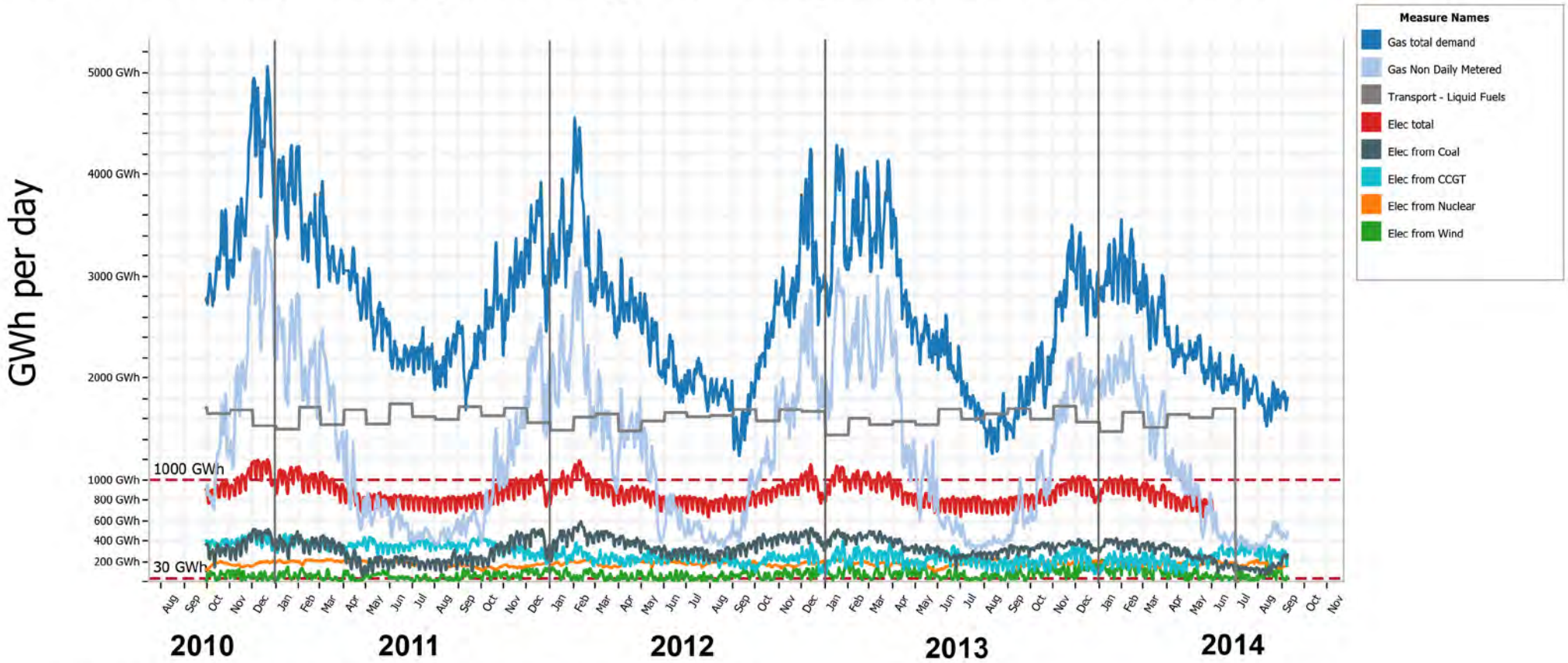

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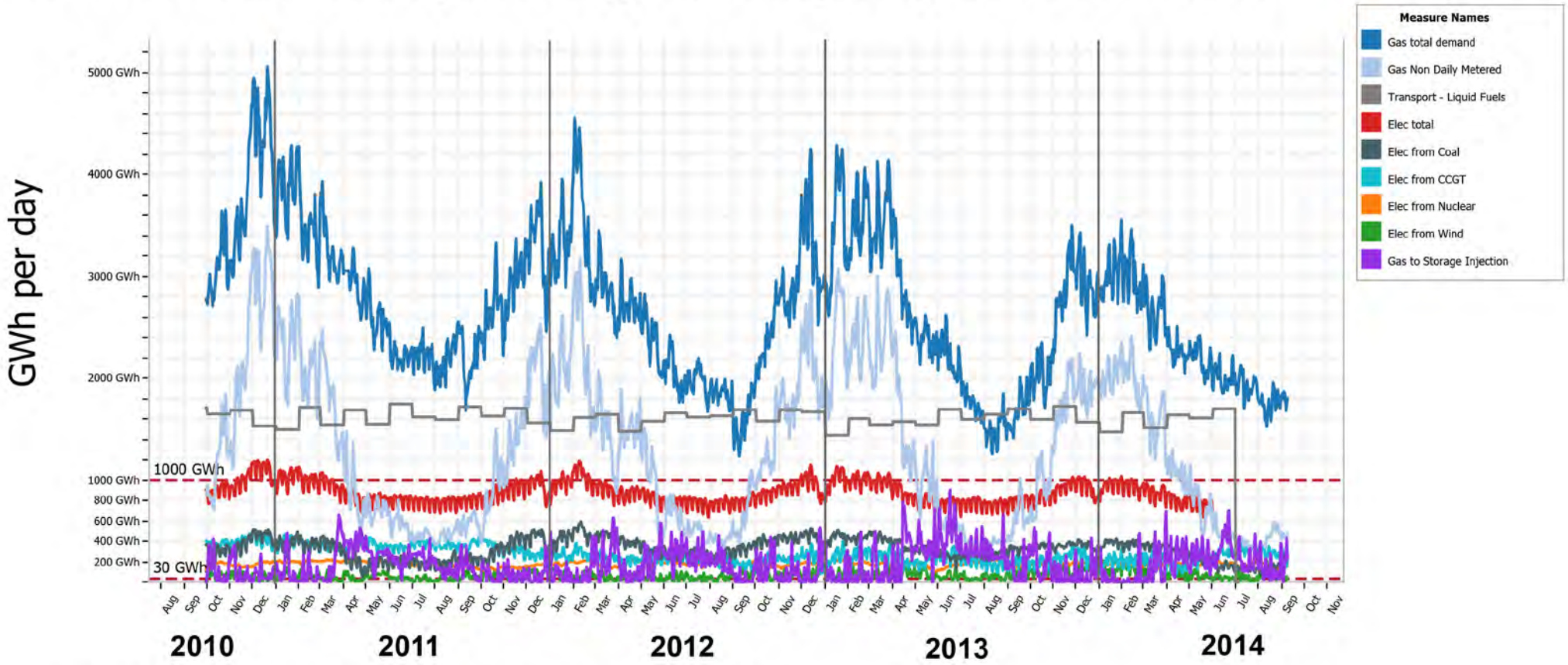

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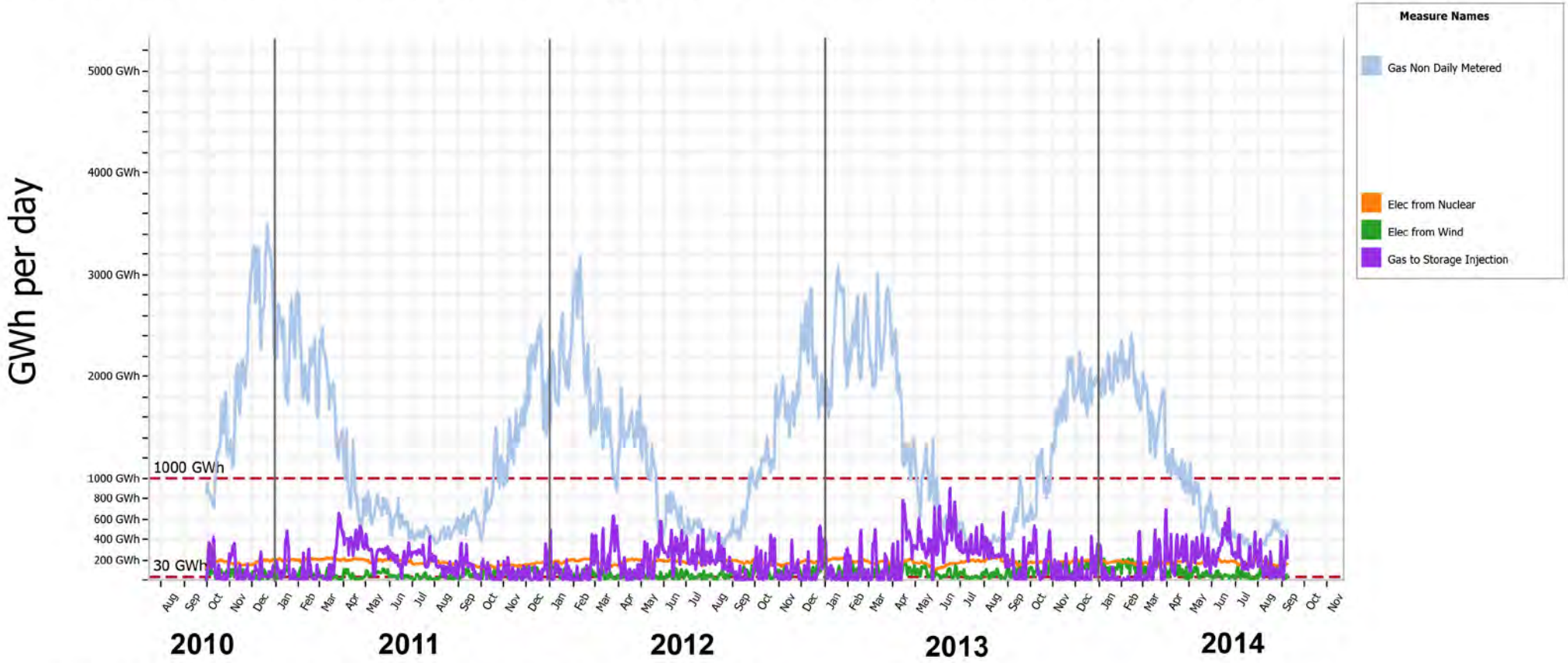

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Q-MAX

- LPG
- 266,000 m^3
- 80% GB daily electricity demand

Conclusions

- CCU/CDU is a complementary, not replacement technology for CCS
- Polymers, Minerals and Synthetic Fuels represent the most promising ways forward
- Full and comparative life cycle analysis (LCA) is require up to Scope 3 with a ‘Cradle to Grave’ or ‘Cradle to Cradle’ approach
- Carbon sequestrated is not necessarily the key indicator: we should also be looking at carbon avoided
- Scope 3 LCA allows us to identify ‘Hot Spots’ in the supply chain so that efforts can be made to reduce their environmental and economic impact
- Energy (and feedstock) supply chain security at minimum cost will become an important feature of any CCUS activity

Acknowledgements

- Professor Peter Hall
- Professor Lenny Koh
- Dr Grant Wilson
- Dr George Dowson
- Dr Anthony Rennie
- Katy Armstrong
- Ana Villa Zaragoza
- Liam Goucher

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