Tees Renewable Energy Plant

and the long term need for grid scale biomass

September 2016

Introduction

The 299MW Tees Renewable Energy Plant (Tees REP) will be one of the UK's largest producers of renewable energy

Capacity	299MW
Location	Teesport, UK
Technology	Circulating fluidised bed
Fuel	Wood pellets / wood chips

- World's largest dedicated biomass CHP plant
- Fuelled with wood pellets and wood chips
  - mainly imported from US and Europe
  - doors are open to local suppliers
- Enough to power to supply about 600,000 homes, as well as heat for new businesses
- Construction cost £650m

Tees REP Overview

Advanced stage of development: Project has been developed since 2008

Investment

- Total £900m capital raise
- Equity 50:50 Macquarie / PKA
- 14 lenders UK and Non-UK

Construction/ contractors

- Built under single lump-sum contract: Tecnicas Reunidas and Samsung
- NTP Issued August 2016, COD due early 2020
- Boiler supplied by Amec Foster Wheeler

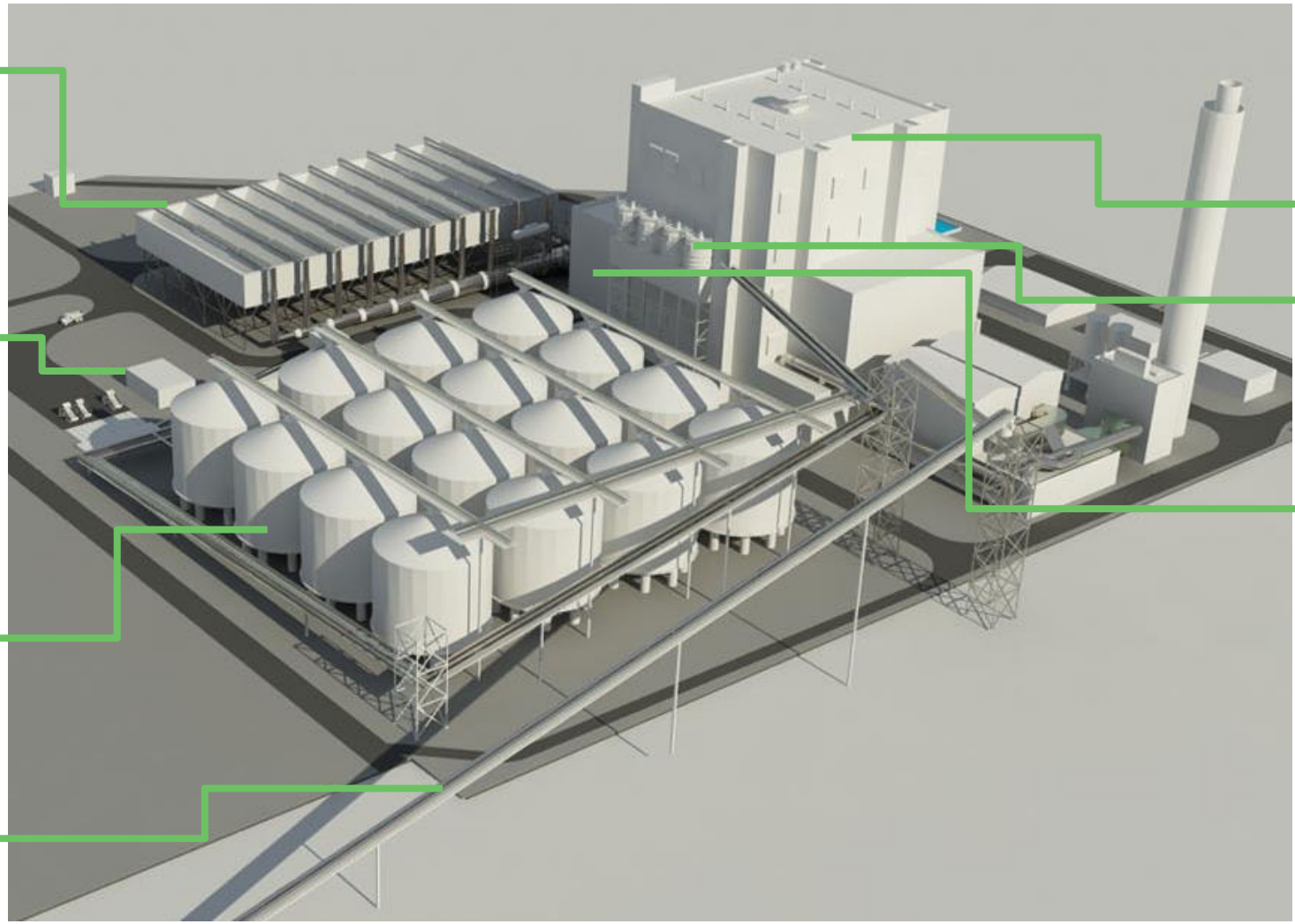
Operations

- Main O&M Contractor is Fortum UK
- Port services: PD Ports
- Long term fuel supply contract with Enviva

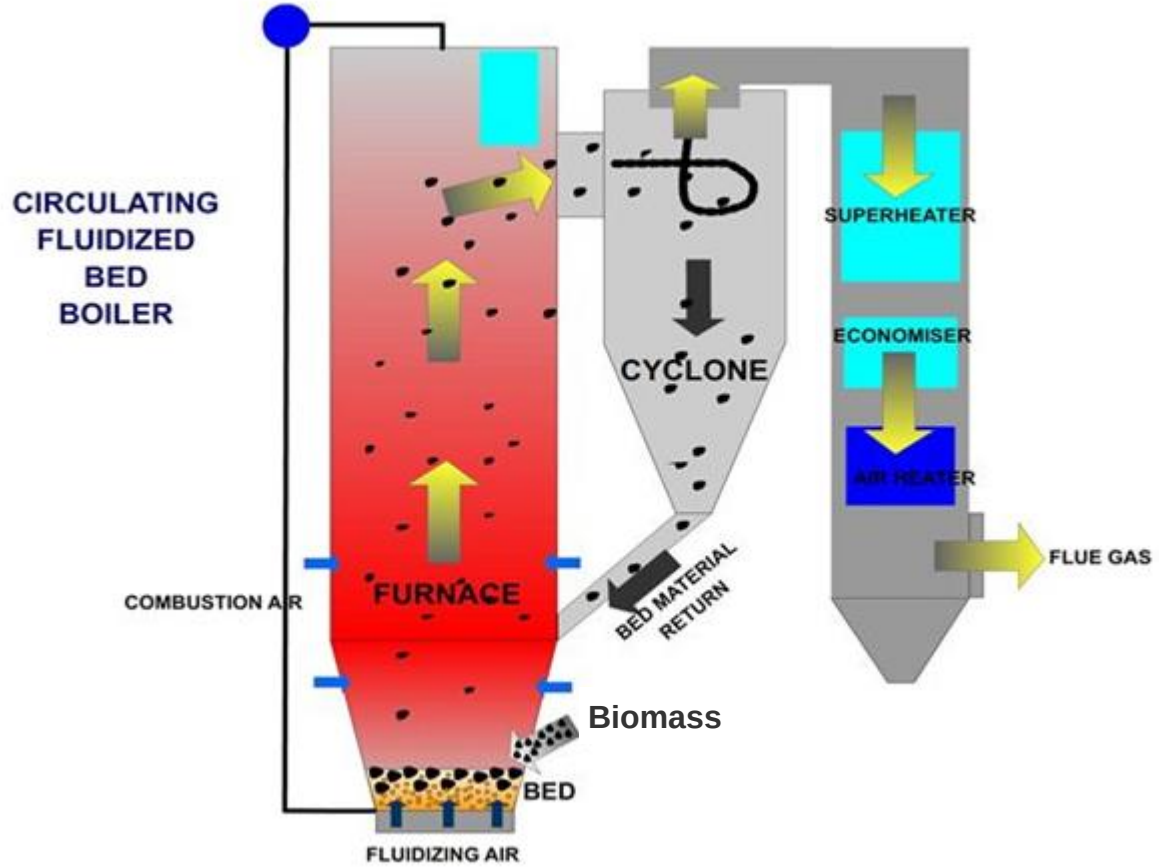
Owner's Team

- px group providing main technical owners technical and construction services
- Power plant technology/engineering services provided by Poyry Energy
- Civils and structural services provided by RPS
- Project controls provided by Mace
- Dedicated owners team plus asset management services from HCP

Expected plant layout



First large Circulating Fluidised Bed in the UK:



What is the purpose of large-scale grid connected biomass plants?

The old message:

V

Dependable new capacity

CFD:£125/MWh

Intermittent production

CFD:£155/MWh

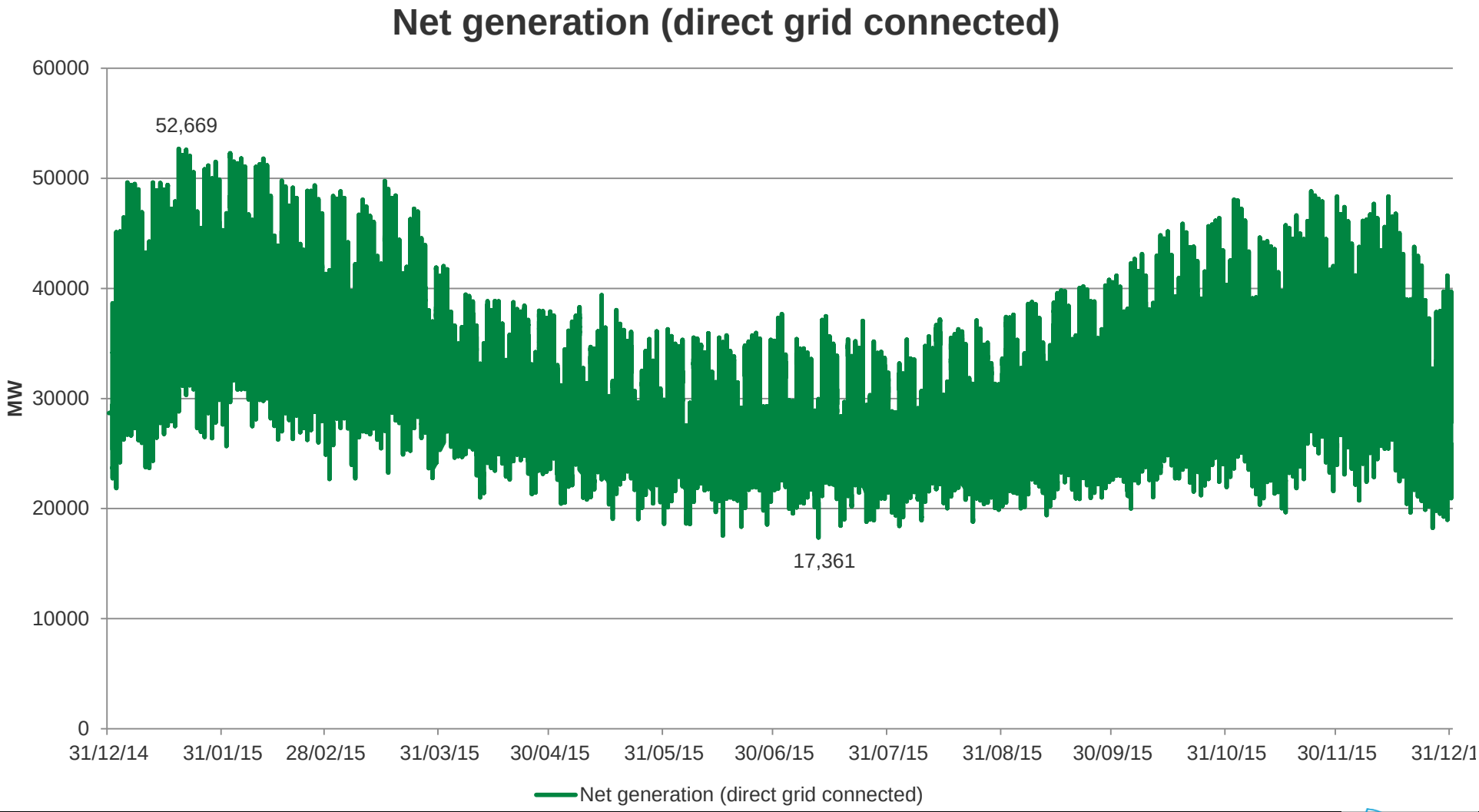
Mission statement:

“Near zero” carbon grid by 2050

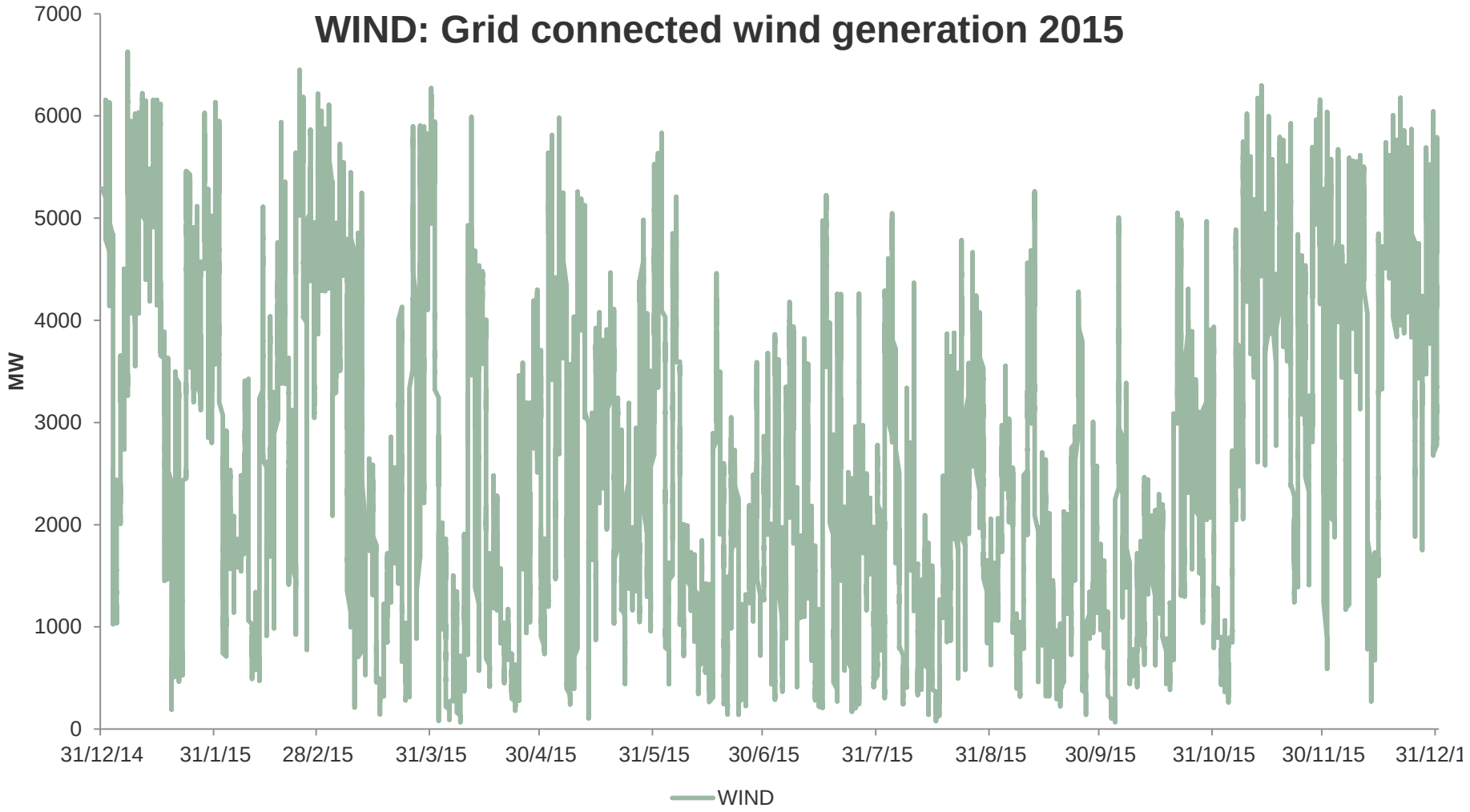
but…

still maintaining reliable and affordable power supply

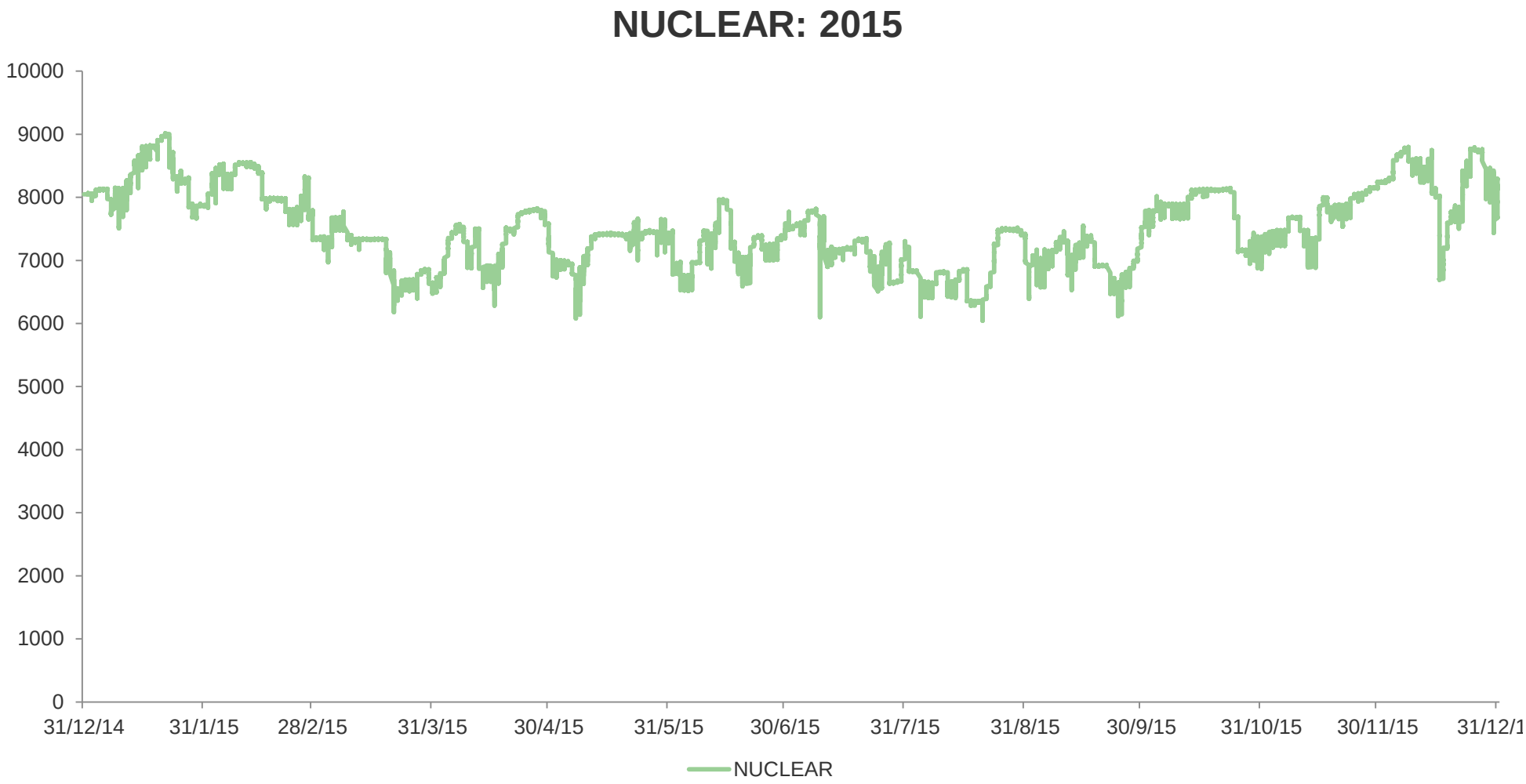
Grid Volumes: 2015



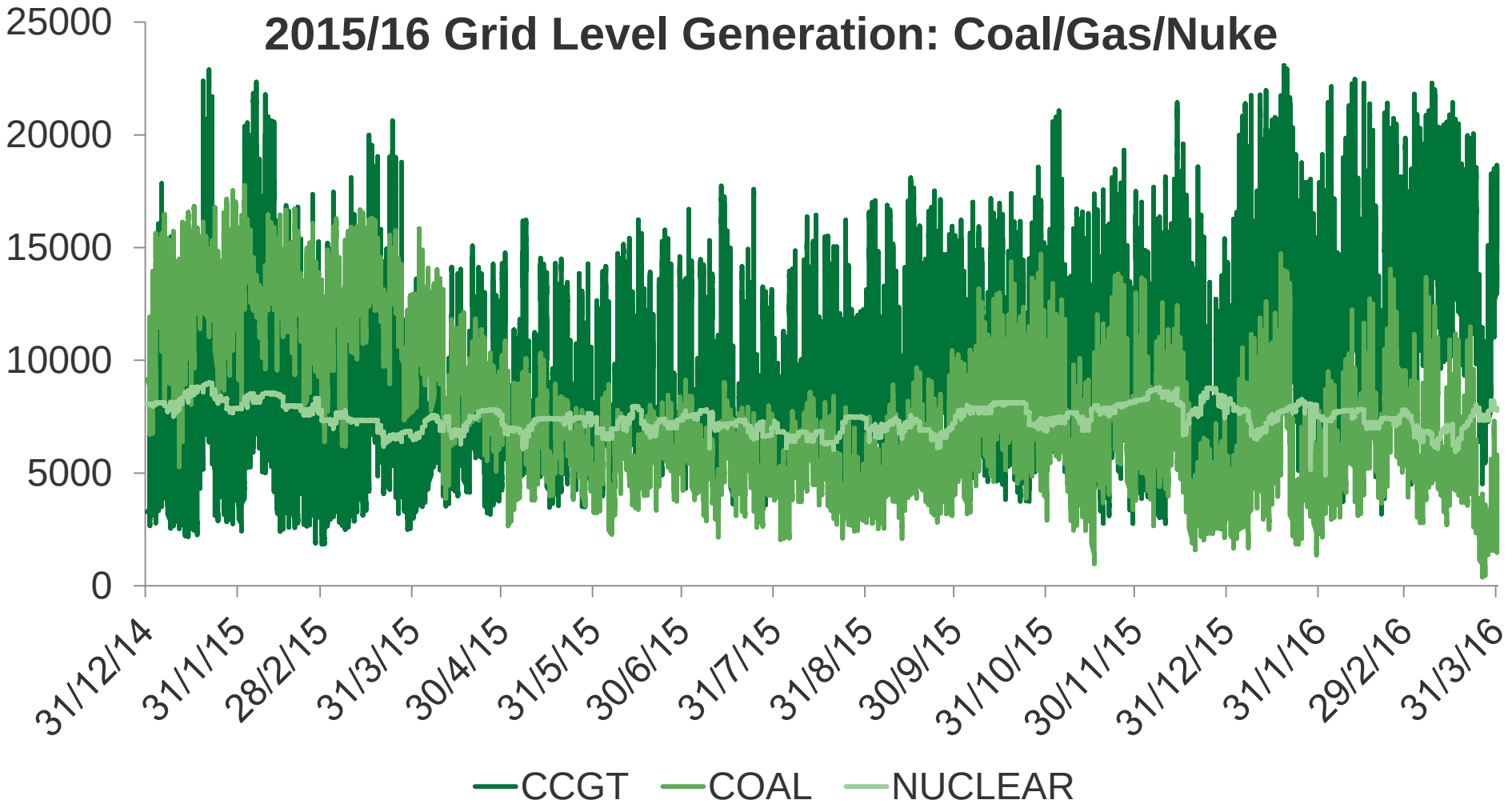
Wind Output: 2015



Nuclear: 2015



Gas and Coal?


2015/16 Grid Level Generation: Coal/Gas/Nuke
25000
20000
15000
10000
5000
0
31/12/14
31/1/15
28/2/15
31/3/15
30/4/15
31/5/15
30/6/15
31/7/15
31/8/15
30/9/15
31/10/15
30/11/15
31/12/15
31/1/16
29/2/16
31/3/16
CCGT
COAL
NUCLEAR

Nuclear: dispatchability

Historic Bid-Offer Data - Google Chrome

www.bmreports.com/servlet/com.logica.neta.bwp_PanBodData?param1=T_FIDL-4&param2=T&param3=Keadby+Generation+Limited&param4=FIDL-4&param5=2016-08-07&param6=*

neta

Historic Bid-Offer Data

*Please enter one or more of the following to identify the BM Unit(s) required. You may use wildcard characters such as * to simplify the search - see the Help pages for a full explanation.*

BM Unit ID: T_SIZB-1 **BM Unit Type:** T **Lead Party Name:**

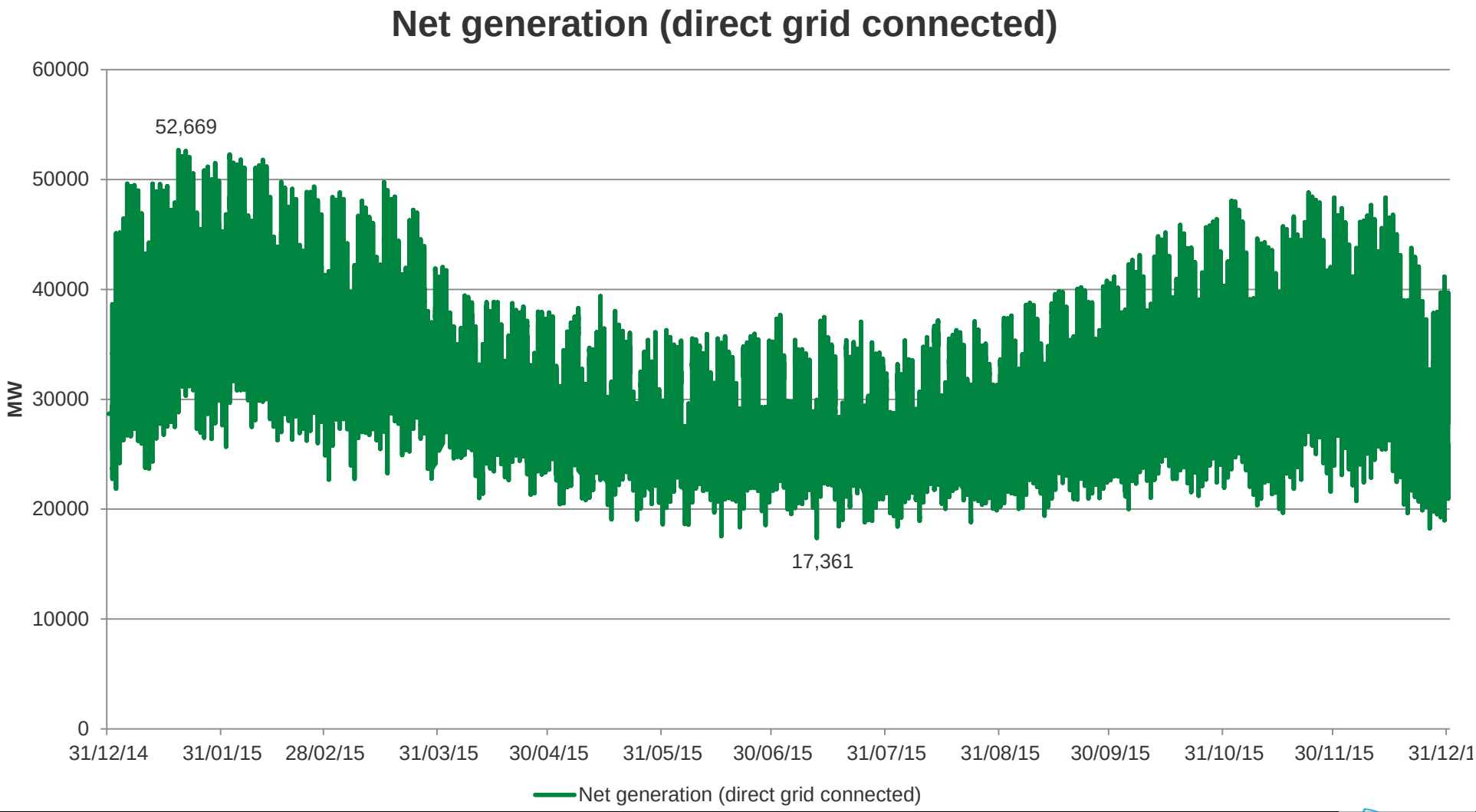
NGC BM Unit Name: **Settlement Day (yyyy-mm-dd)** 2016-08-07 **Period:** *

Go Reset

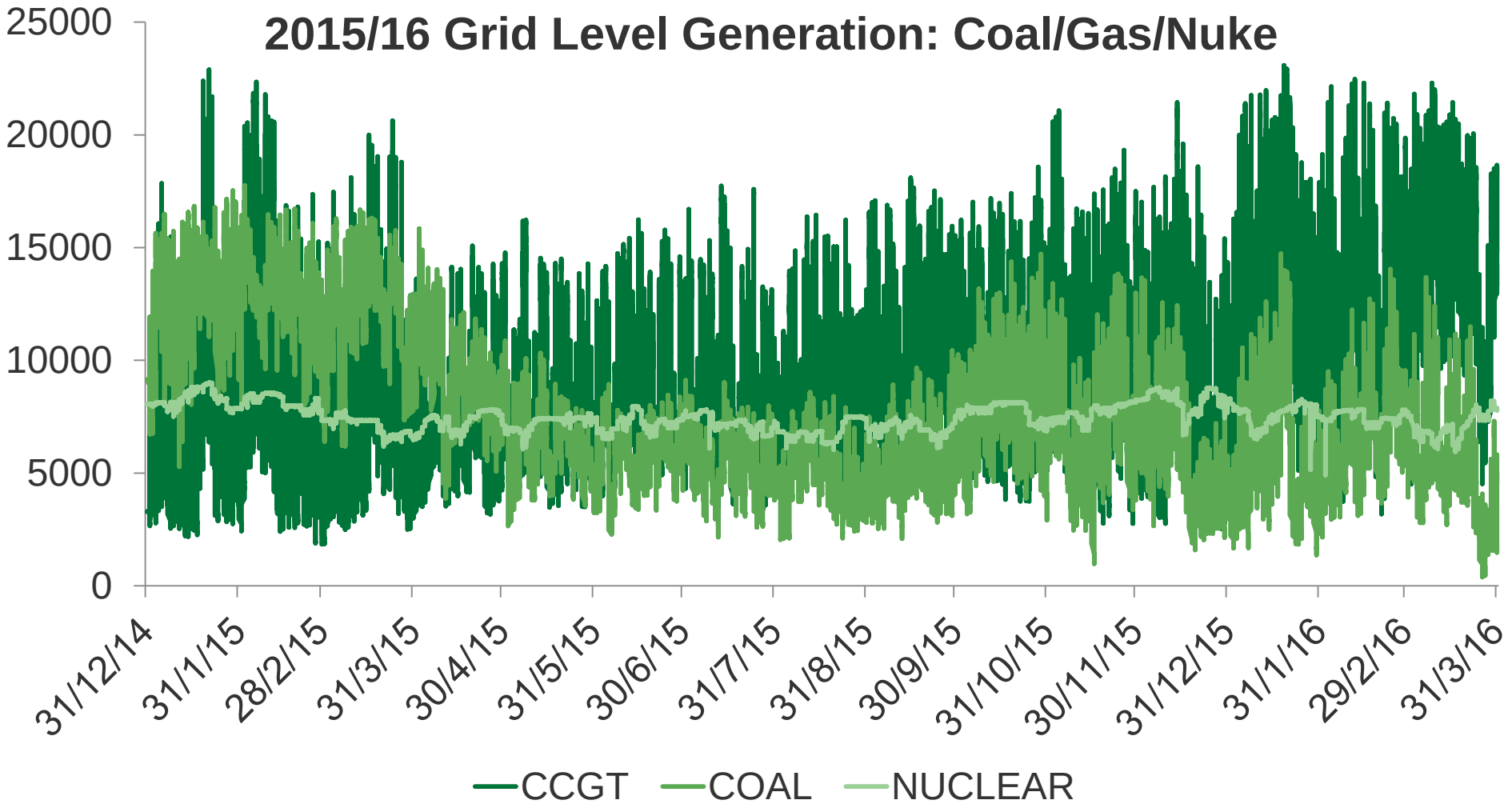
Bid-Offer Level Data

Bid Offer Pair Number	From Time (GMT)	From Level (MW)	To Time (GMT)	To Level (MW)	Bid Price (£/MWh)	Offer Price (£/MWh)
T_SIZB-1, T, EDF Energy Nuclear Generation, SIZB-1						
-1	2016-08-06 23:00	-1000.000	2016-08-06 23:30	-1000.000	-10000.00000	0.00000
1	2016-08-06 23:00	1000.000	2016-08-06 23:30	1000.000	0.00000	10000.00000
-1	2016-08-06 23:30	-1000.000	2016-08-07 00:00	-1000.000	-10000.00000	0.00000
1	2016-08-06 23:30	1000.000	2016-08-07 00:00	1000.000	0.00000	10000.00000
-1	2016-08-07 00:00	-1000.000	2016-08-07 00:30	-1000.000	-10000.00000	0.00000
1	2016-08-07 00:00	1000.000	2016-08-07 00:30	1000.000	0.00000	10000.00000
-1	2016-08-07 00:30	-1000.000	2016-08-07 01:00	-1000.000	-10000.00000	0.00000
1	2016-08-07 00:30	1000.000	2016-08-07 01:00	1000.000	0.00000	10000.00000
-1	2016-08-07 01:00	-1000.000	2016-08-07 01:30	-1000.000	-10000.00000	0.00000
1	2016-08-07 01:00	1000.000	2016-08-07 01:30	1000.000	0.00000	10000.00000
-1	2016-08-07 01:30	-1000.000	2016-08-07 02:00	-1000.000	-10000.00000	0.00000
1	2016-08-07 01:30	1000.000	2016-08-07 02:00	1000.000	0.00000	10000.00000
-1	2016-08-07 02:00	-1000.000	2016-08-07 02:30	-1000.000	-10000.00000	0.00000
1	2016-08-07 02:00	1000.000	2016-08-07 02:30	1000.000	0.00000	10000.00000
-1	2016-08-07 02:30	-1000.000	2016-08-07 03:00	-1000.000	-10000.00000	0.00000
1	2016-08-07 02:30	1000.000	2016-08-07 03:00	1000.000	0.00000	10000.00000
-1	2016-08-07 03:00	-1000.000	2016-08-07 03:30	-1000.000	-10000.00000	0.00000
1	2016-08-07 03:00	1000.000	2016-08-07 03:30	1000.000	0.00000	10000.00000
-1	2016-08-07 03:30	-1000.000	2016-08-07 04:00	-1000.000	-10000.00000	0.00000

Grid Generation: 2015



Gas and Coal?

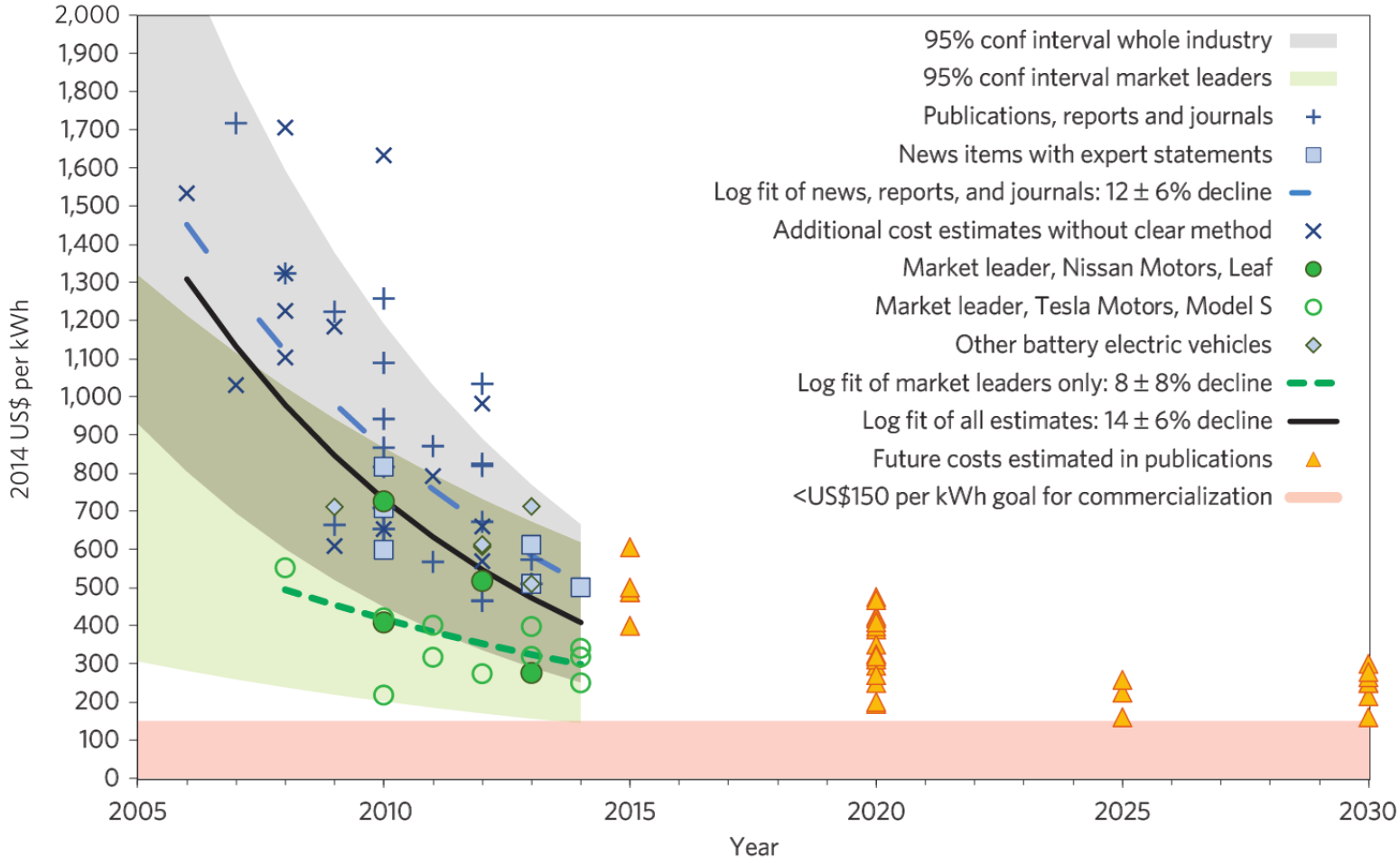

2015/16 Grid Level Generation: Coal/Gas/Nuke
25000
20000
15000
10000
5000
0
31/12/14
31/1/15
28/2/15
31/3/15
30/4/15
31/5/15
30/6/15
31/7/15
31/8/15
30/9/15
31/10/15
30/11/15
31/12/15
31/1/16
29/2/16
31/3/16
CCGT
COAL
NUCLEAR

How can we balance our grid without fossil fuel generation?

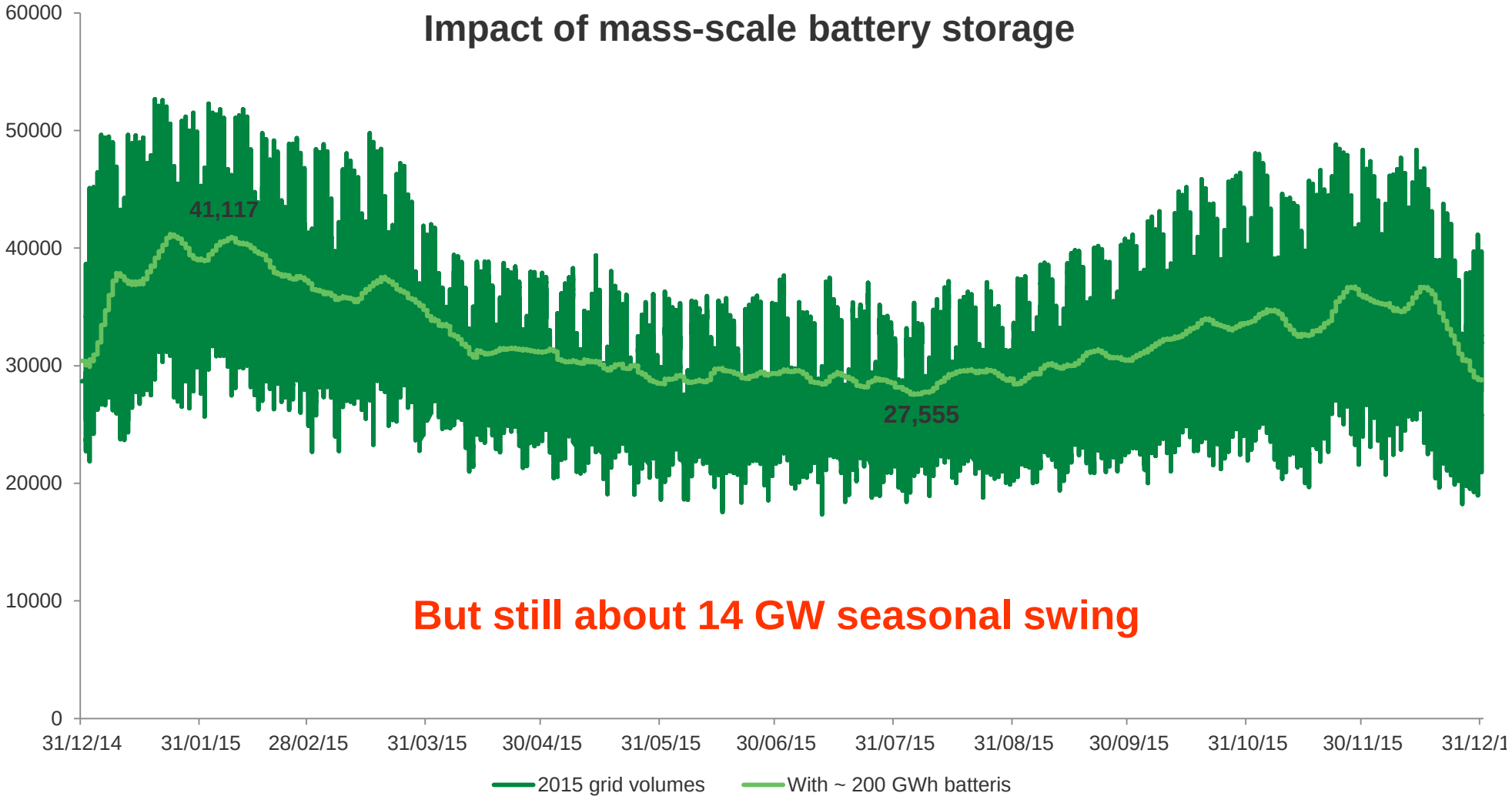

MGT
TEESSIDE

Will Batteries Solve Our Balancing Problem?

Battery costs falling fast



What if we had 200 GWh of Battery Storage?



Realisation:

Even with a huge amount of battery storage, the grid will need at least 10 GW of "dispatchable" generation

Grid-scale biomass is the closest thing* to a proven technology that can meet this need economically, without emitting fossilised carbon

* Other than Hydro

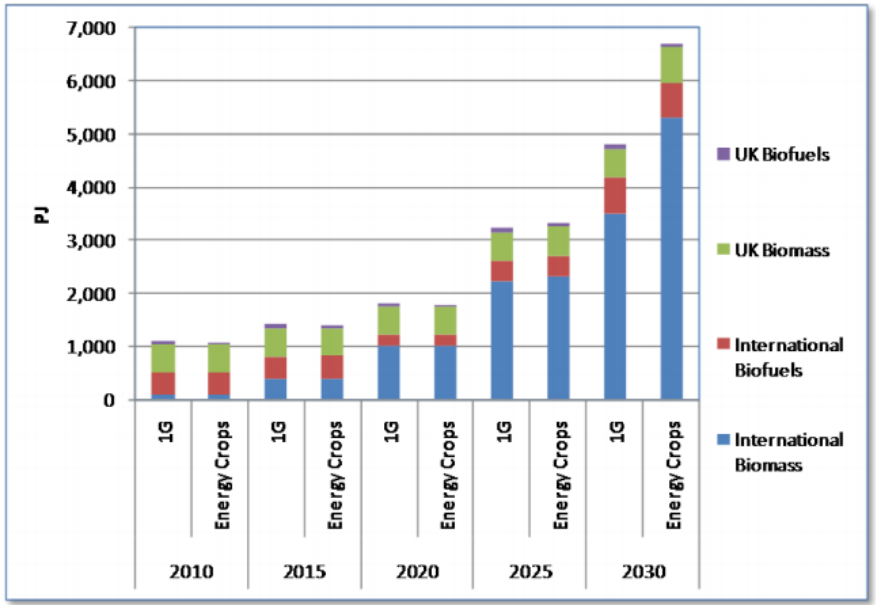
Large scale CCS might be an alternative, but needs to build momentum and prove model

Is 10 GW of grid scale biomass feasible?

We already have 2 GW operating (Drax), and another 700 MW in construction (MGT/Lynemouth) all operating near to baseload

- Assuming a 50% load-factor, and high-efficiency plant (in line with Tees REP), 10 GW of biomass generation would require about **385 PJ** of biomass fuel
- UK Government study by AEA estimates about **4,000 to 6,000 PJ** of biomass available to the UK by 2030*

Figure 1 Biomass resource available to UK at £10/GJ with easy and medium constraints met for land use maximised for first generation biofuels crops (1G) and land use maximised for energy crops



* Assumes the UK can access 10% of surplus internationally traded biomass from other countries

Challenges

- **Show the public that our supply chains are sustainable**
- Continue reducing carbon emissions in the supply chain
- Bring down fuel costs
- Broaden range of fuel-types
- Scale up generating plant and reduce fixed costs
- Improve use of heat
- Manage transition away from direct subsidies to carbon/grid pricing


MGT
TEESSIDE
Thank You
for
listening!