AEA Energy & Environment
From the AEA group

Biomass in the NAEI

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Scope

- What is biomass
- Why biomass is increasingly important
- What the implications in terms of emissions
- Where the uncertainties lies
- What the policy impacts might be

What is biomass

- Biomass is biological material derived from living, or recently living organisms (May be plant or animal derived)
- regarded as carbon neutral
- Main categories
  - Virgin wood (pellet, chip, log)
  - Waste wood (pellet, chip, off-cuts)
  - Energy crops (e.g. miscanthus)
  - Agricultural waste (e.g. manure)
  - Industrial wastes (e.g. food processing, sewage sludge, textiles paper pulp wastes)
- Other important features for emissions;
  - moisture content,
  - bark content,
  - source of waste level of treatment

History of Biomass use

- Traditional picture
  - non-traded rural fuel
  - off-gas grid homes
  - principally secondary heating through open fires or cast iron stoves
  - Exceptions but not many
- During the 90s increase in waste wood combustion from wood working industry to avoid landfill tax and provide heat as a by-product
  - technology simplistic
  - designed for mass reduction rather than excellence in combustion
  - Measurements made on wood waste plant in mid 90s to support NAEI.
- Last few years massive upsurge in installations which tend to be modern imported state of the art appliances but need not be.

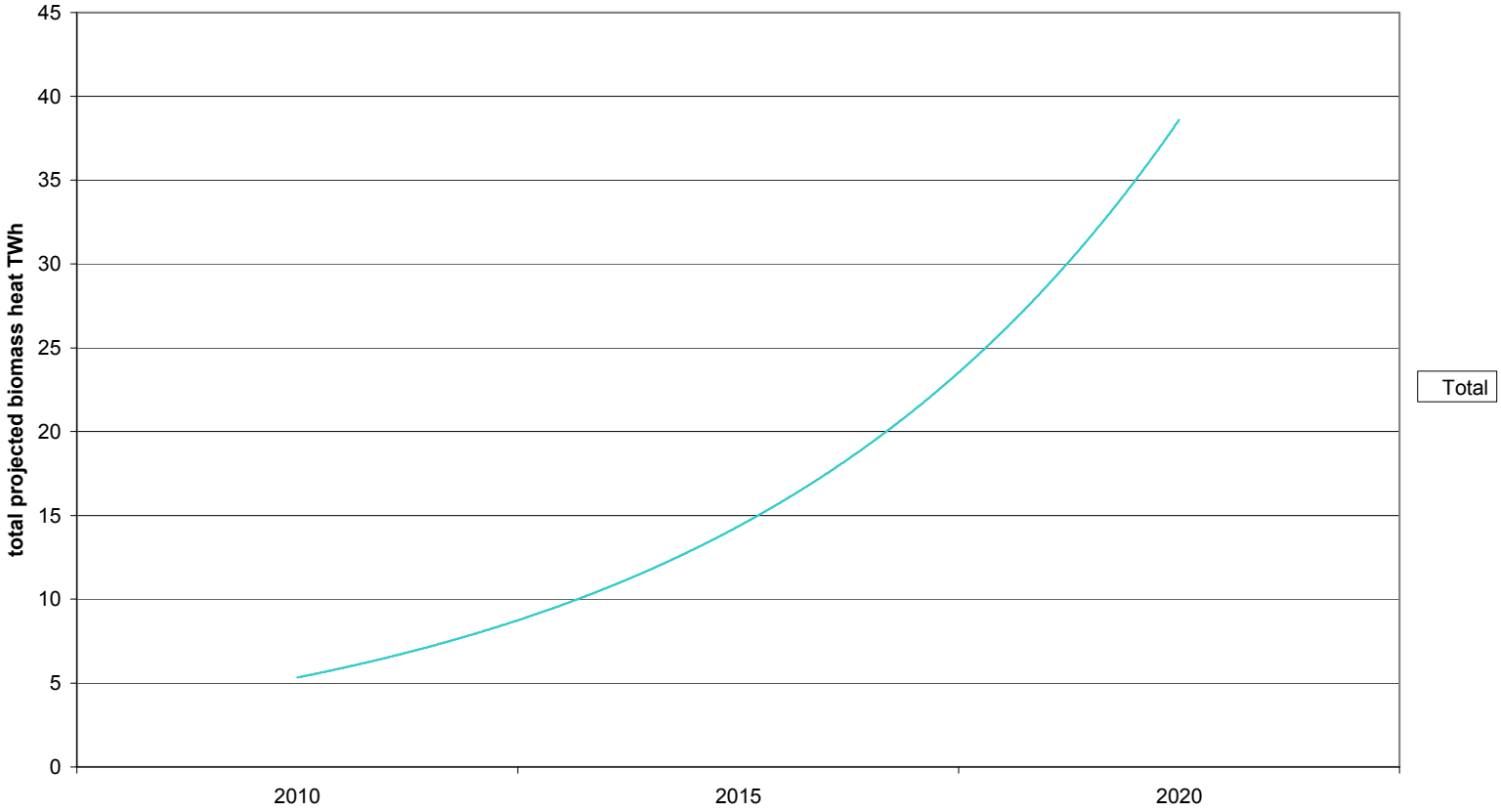
How can it be used

- Anaerobic digestion giving gas to make electricity in a gas engine and some heat (potential for injection of cleaned methane into the grid - biogas).
- Pyrolysis / gasification to make fuels for combustion generally also for electricity and some heat
- Mass burn currently smaller plant for heat/hot water larger for electricity (and heat) range of detailed technologies;
  - Adapted coal fired power stations
  - Dedicated biomass electricity units up to 350MW proposed
  - Smaller CHP plant down to 300kWout (100kW electrical 200kW heat)
  - Industrial and domestic pellet, chip and log units
- Majority of applications woody biomass
- Technologies under continuous and active development and application

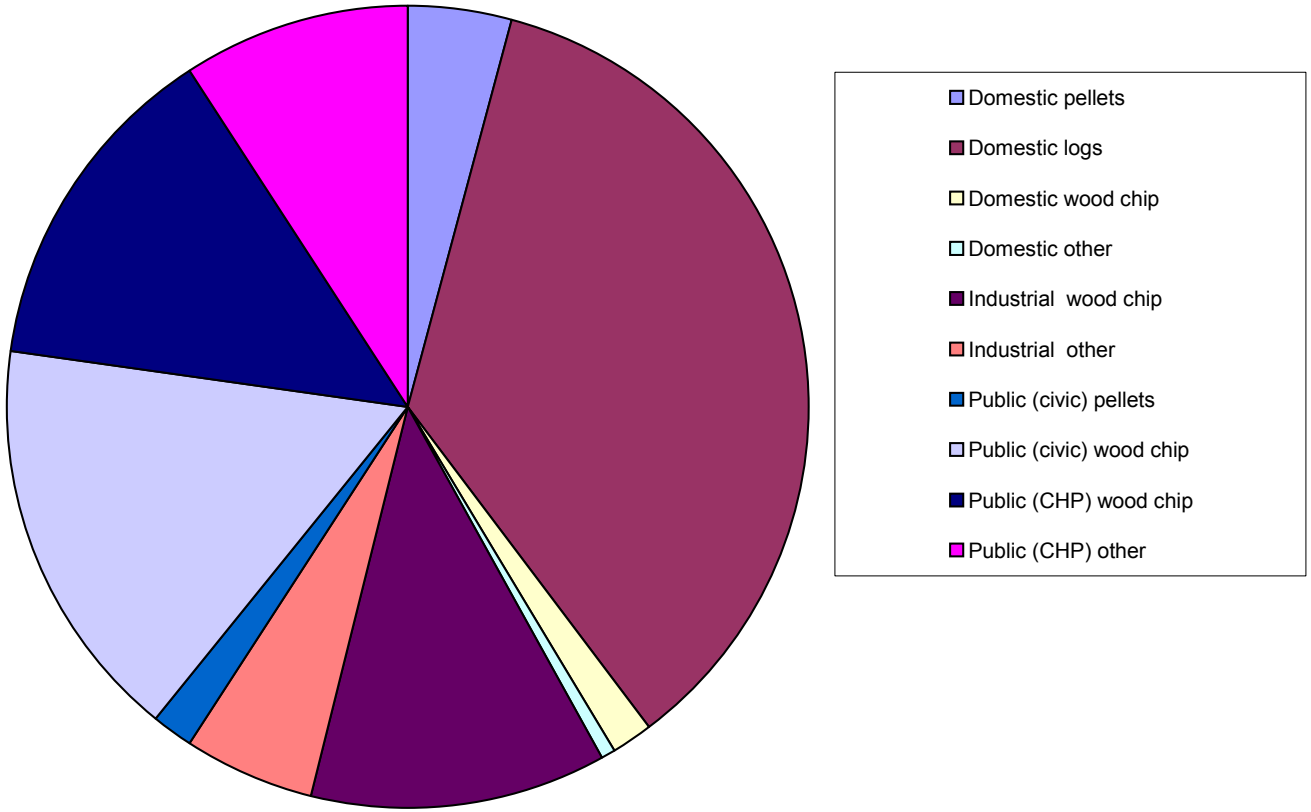
Drivers for Increased Biomass Use

- Issues
  - Climate change; biomass energy is regarded as approaching carbon neutrality (excluding limited supply chain impacts)
  - Sustainable
  - Energy security and diversification
  - economics
- Policy Reponses
  - EU Biomass Action Plan
  - UK Energy White Paper
  - UK and DAs Renewable Energy Strategies
  - Biomass Task Force
  - Biomass Strategy
  - Planning e.g. Merton rule 10-20% of energy demand of developments from renewables
  - Zero-carbon new homes by 2016

Projections from Enviros / NERA for BERR of Biomass Uptake to 2020 – 52 of 90TWh by 2020

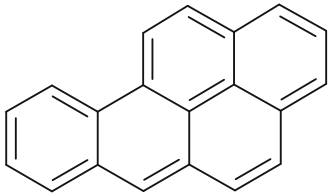


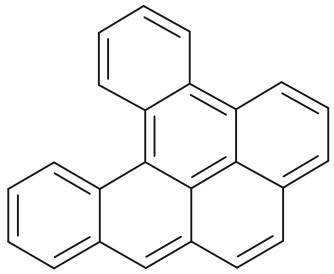
2020 Sector Distribution



Pollutants Associated with Woody Biomass

- Particles (PM_{10} / $PM_{2.5}$)
- Nitrogen oxides (NO_2, N_2O (GHG), NO)
- Polyaromatic hydrocarbons (PAHs) formed from incomplete combustion



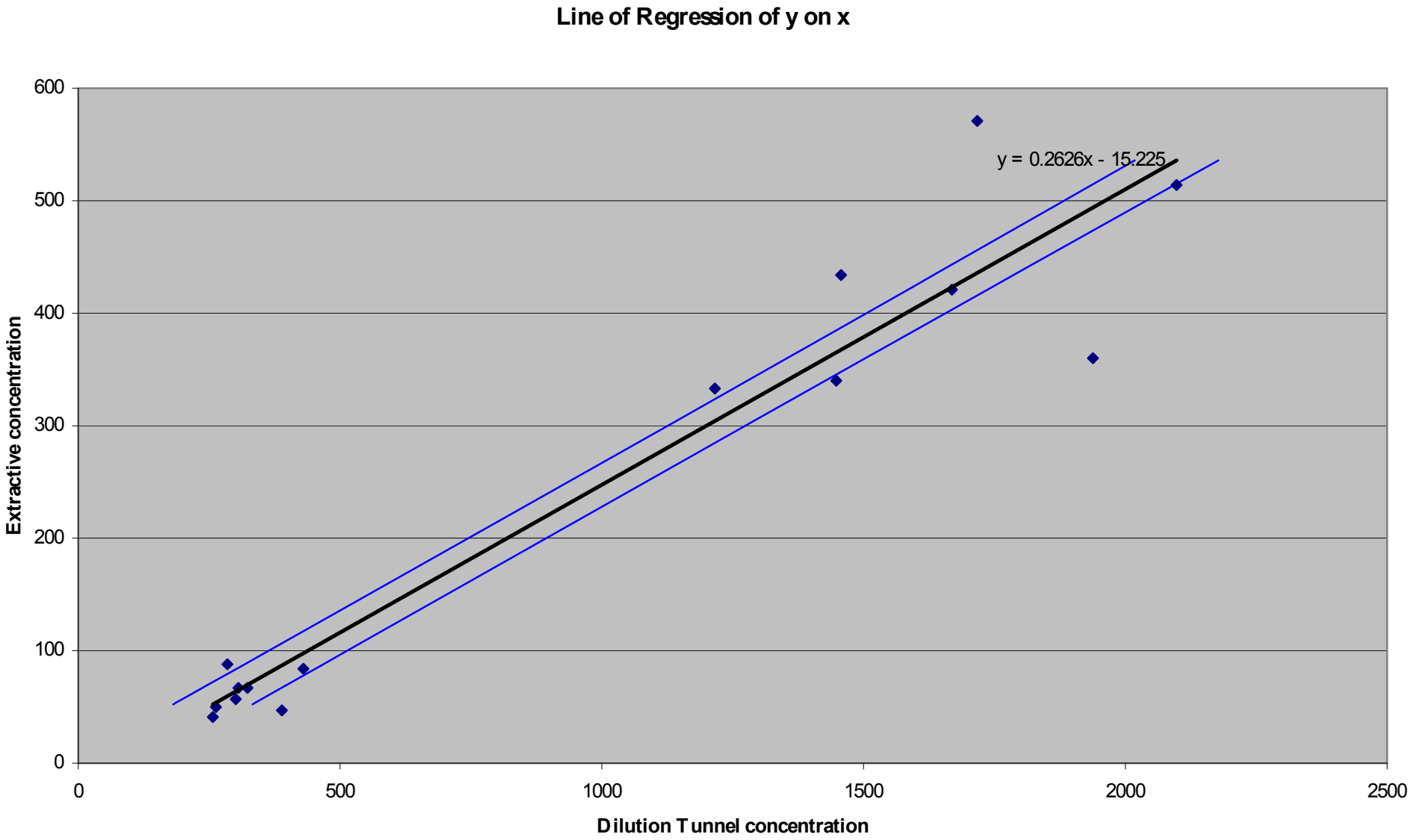


- Methane (GHG)
- Metals when treated wood is burned As, Cu, Cr(VI)
- Dioxins associated with organohalogen treated wood or poor combustion

Particles

- Air quality regulation in terms of PM_{10} and $PM_{2.5}$
- Most measurements based on Total Particulate
- No agreement on measurement method
- Smaller units the particles increase post emission as the result of condensation processes; depend on temperature
  - Coarse material entrained chars resulting from poor combustion and or excessive air velocities through a fuel bed
  - fine alkali metal salts intrinsic to the fuel vary between species and much higher for grasses such as miscanthus than wood
  - No necessary relationship with plant size technology and controls more important
- Necessary to know the fuels to be used in future and type of plant likely; modern plant emissions lower and TSP ≈ PM_{10} ≈ $PM_{2.5}$

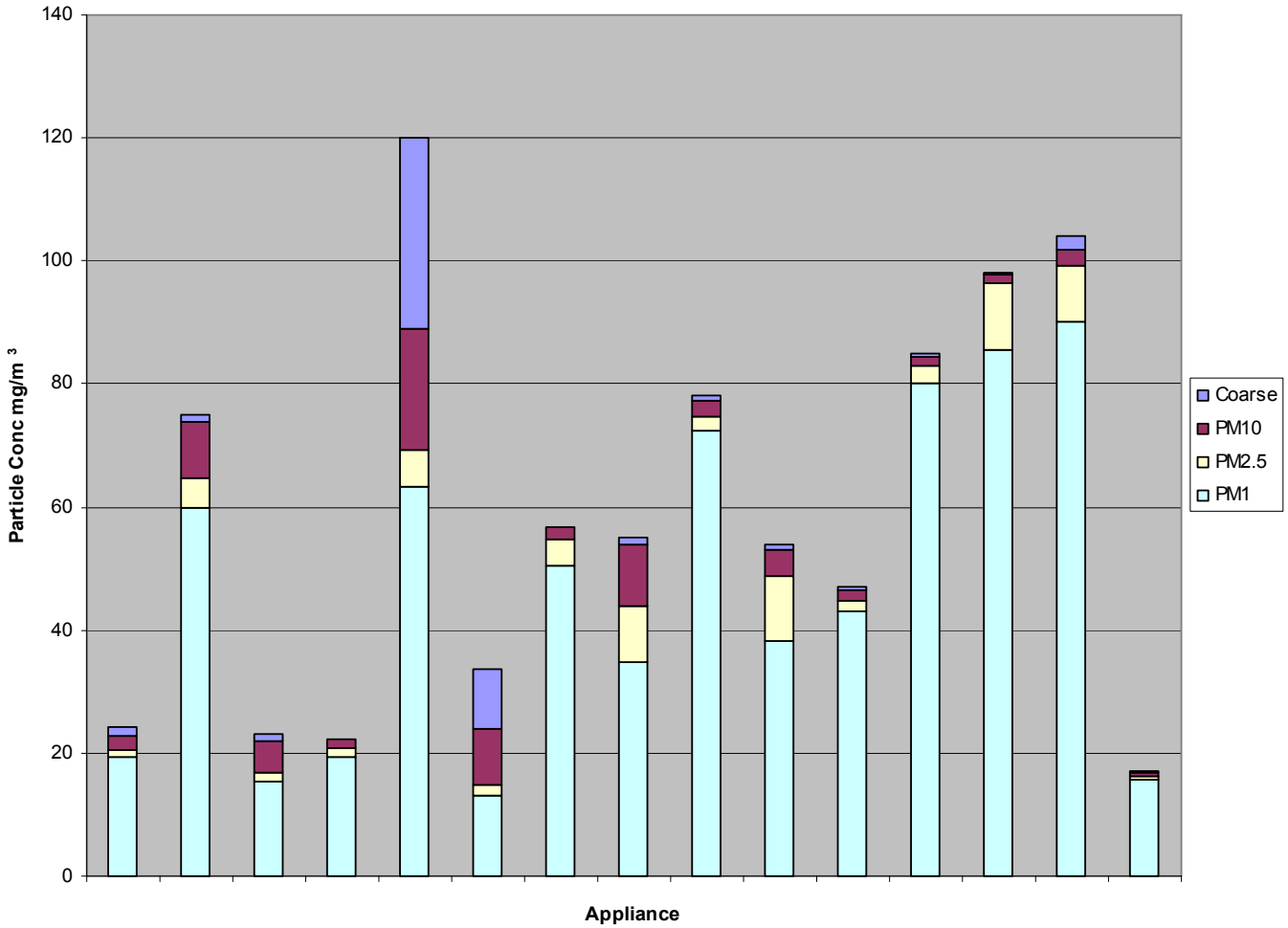
Comparison of Norwegian and German Measurement Protocols



Method Comparison

- Difference between national standard methods a factor of >4
- Importance of measurement method taken into account in regulation
- Comparison of data becomes confused
- Other issues
  - include lack of accreditation of test houses for the work they are doing,
  - use of filters which don't catch fine particles
  - lack of standardisation
  - Different firing methods
  - Range of test fuels in use

Size Distribution (Erlich *et al.* 2007)



Particle Abatement measures

- Good combustion
- Clean fuels; waste materials / bark
- Cyclones / multicyclones
- Fabric filters
- Ceramic filters
- Electrostatic precipitators

Nitrogen Oxides

- Pollutants of concern are NO_2, N_2O, NO as turns into NO_2
- Nitrogen in fuels a function of the species and soil conditions
- Greater rates of fertilisation linked to higher N content possible link to future trends of growth of energy crops
- Atmospheric nitrogen oxidation limited in biomass systems as a result of lower temperatures
- Drier fuels give higher emissions as temperature higher;
- Combustion technology influences the emissions. Possible to convert fuel-N into nitrogen rather than NOx.
- Further abatement possible but expensive no current driver

What is the NAEI doing ?

- Improved emission factors through literature survey and measurement
- Added GHG pollutants (methane, N_2O, based on measurements)
- Added primary NO_2 from measurements
- Analysed future trends in biomass usage and possible technologies

- Does not include any policy response to increased biomass usage
- Does assume adoption of state of the art technology though no legislative or market driver

- Provided projections of emissions of particles and NO_x using energy statistics from Enviros / NERA study

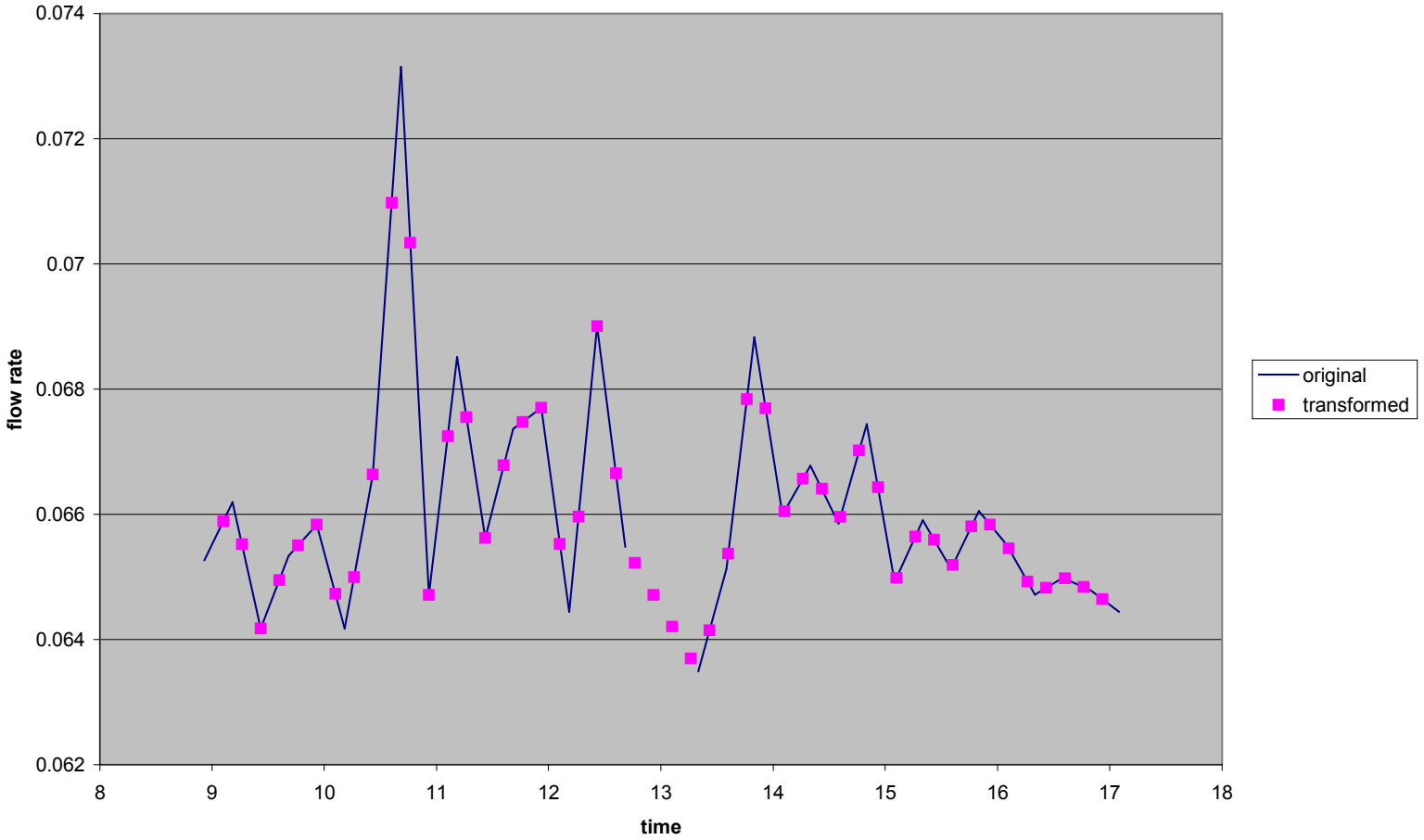
Measurements

- Added to Scottish Government study of size fractionated particle emissions
- Looked at 3 plant in detail for wide range of pollutants (NO_2, N_2O, NO, methane, sulphur hexafluoride, PFCs, PAHs, dioxins, PCBs, benzene).
- Units covered a range of sizes and technological sophistication however all wood chip.
- Methane SF_6 and PFCs undetectable (<8g/GJ and <1g/GJ).
- N_2O detectable but low concentrations (2.8 g/GJ – 6g/GJ) implies 870 – 1900 $gCO2_{eq}$/GJ
- PAHs (BaP ranged from 4.7 8.2

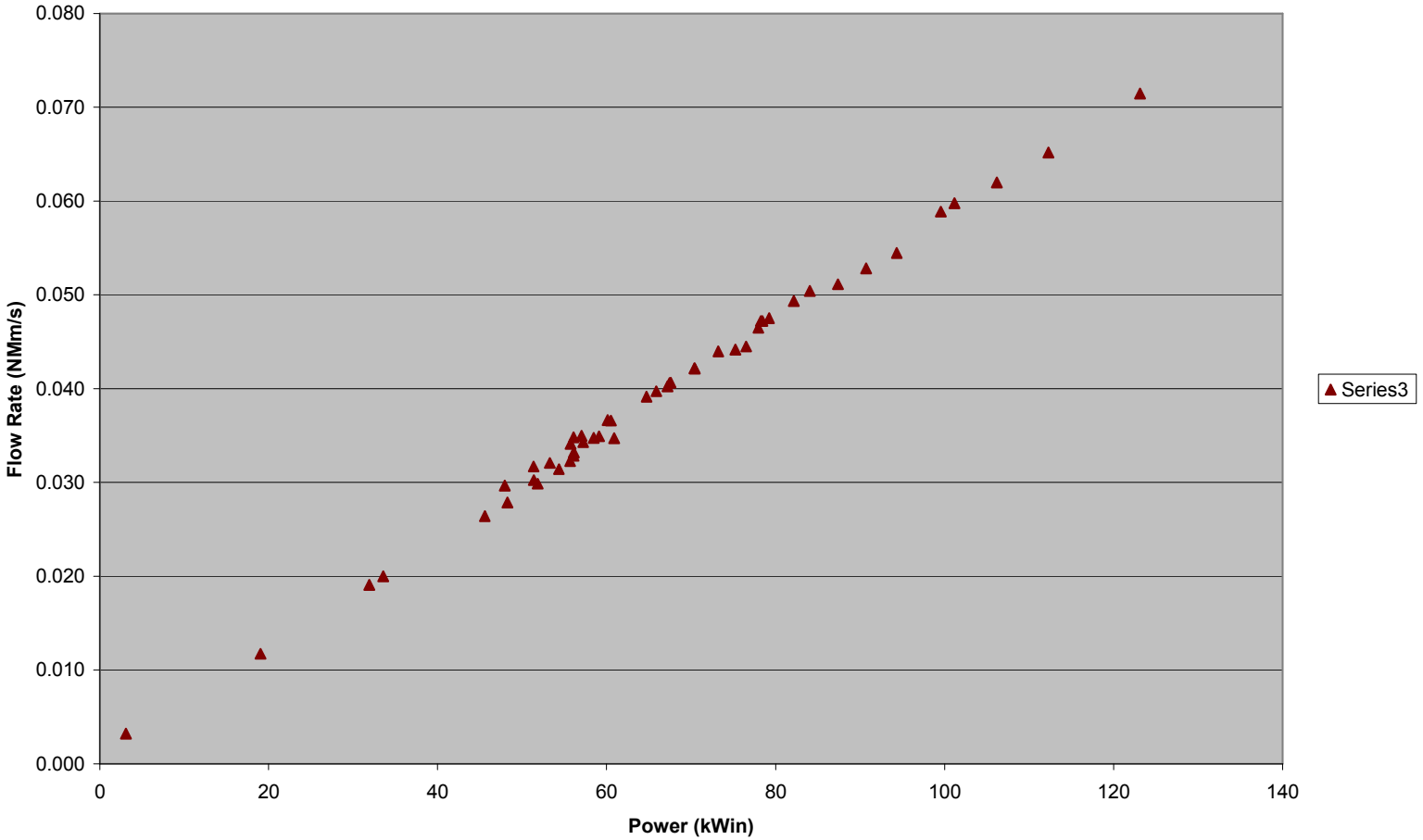
Particles EFs from Scottish Government Study

Site Code	Fuel Type	Average PM_{10}	Average $PM_{2.5}$	2.5 /10 (%)
A (120kW)	Chip	28.5	16	56
B (600kW)	Chip	55.1	42.2	76
C (300kW)	Chip	14.9	16	107
D (220kW)	Pellet	60.3	50	83
E (70 kW)	Log	68.7	18.5	27
F (400 kW)	Chip	25.5	18.7	73

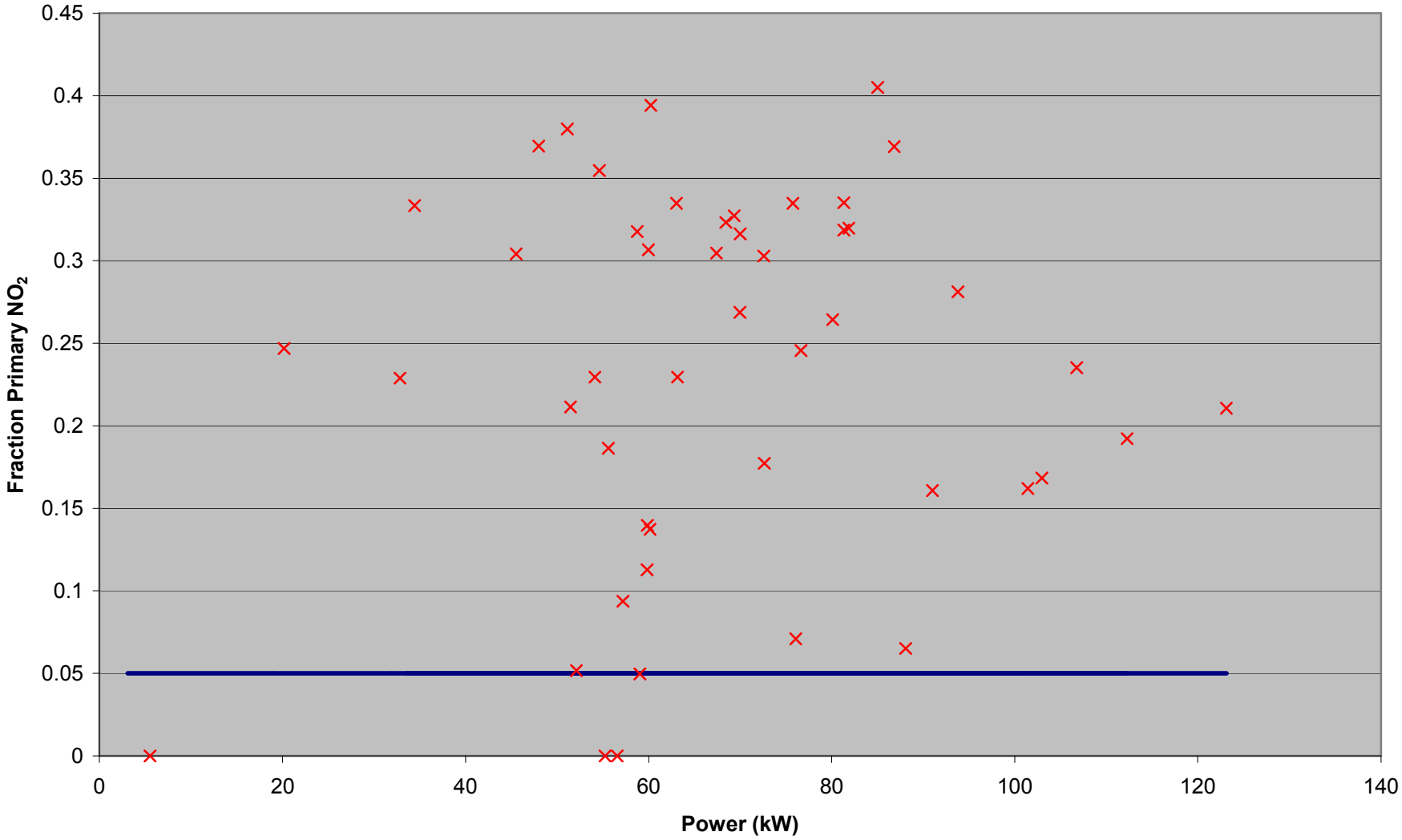
Load Plant A


0.074
0.072
0.07
0.068
0.066
0.064
0.062
flow rate
8
9
10
11
12
13
14
15
16
17
18
time
original
transformed

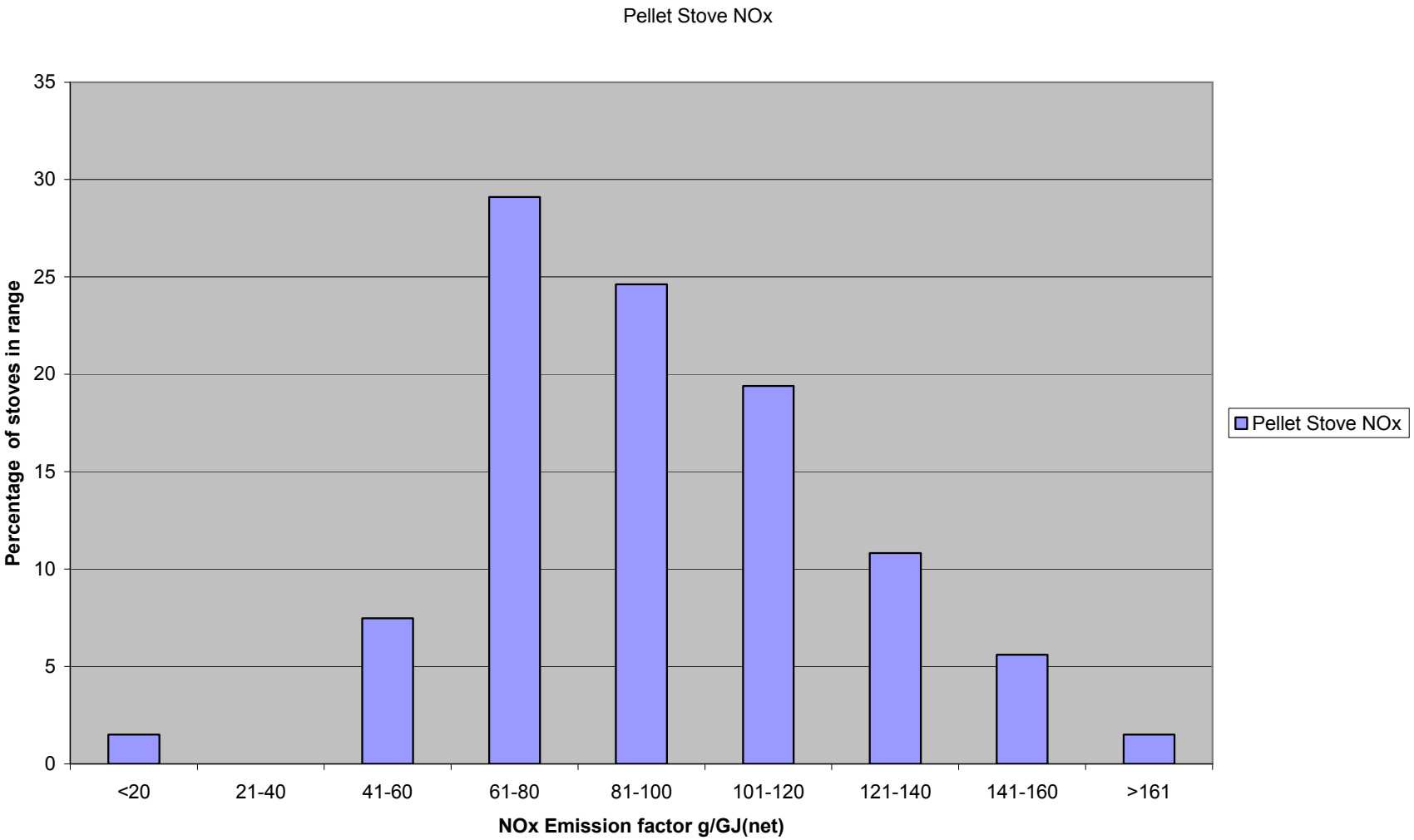
Flue gas flow vs Power



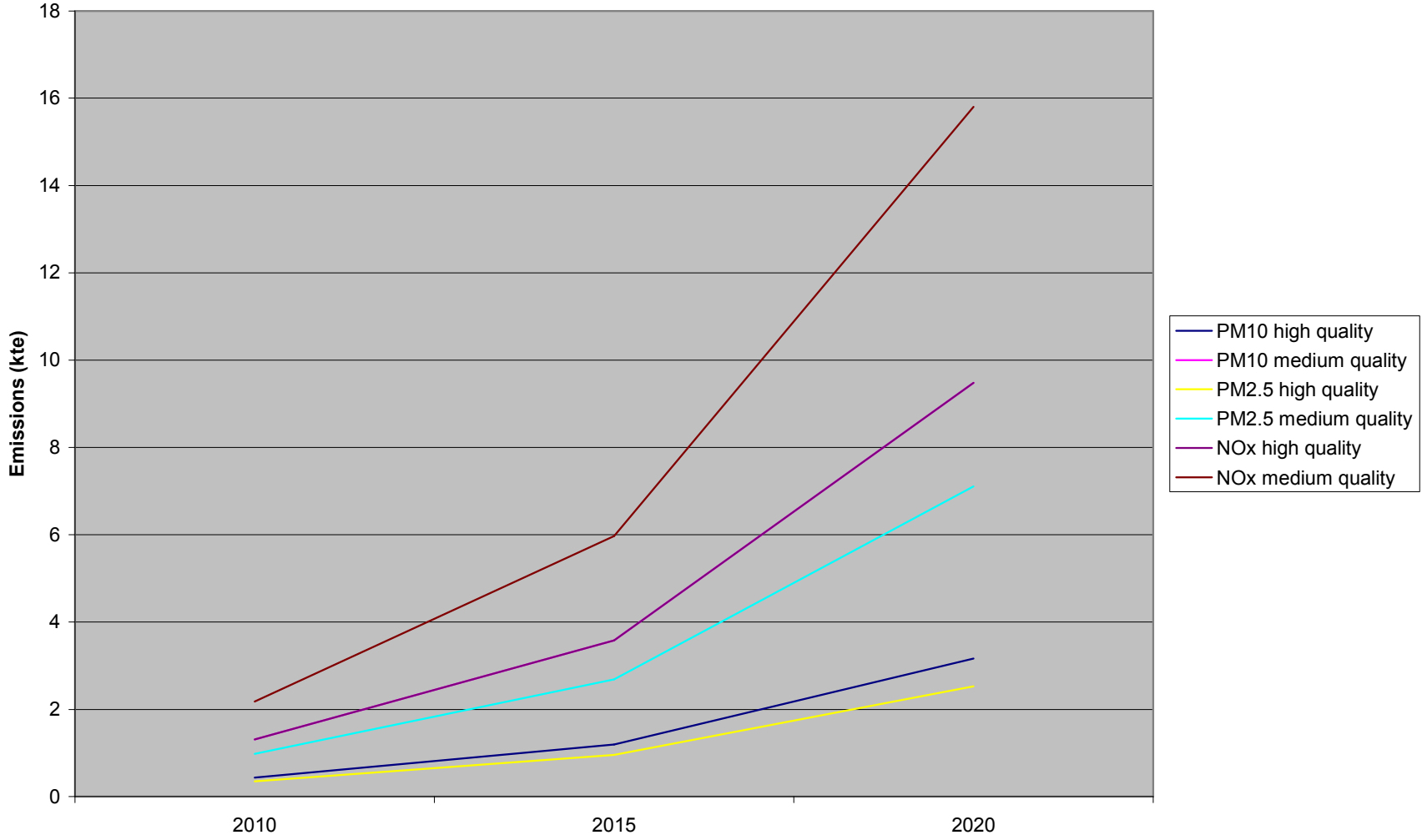
Fractional Primary NO_2 (NO_2 /NO_x)



Distribution of NO_x emissions



Emission Projections



Uncertainties

- Measurement methods
- No standardisation in biomass community
- Some pollutants no accepted method e.g. size fractionated PM
- Effect of load may be significant
- Fuel type and moisture 6 tests 3 plant limited range
- Literature good for particles, NO_x, CO, VOCs, poor for others
- Skewed distribution of dioxin emissions
- Technology worst >> best what policy or economic drivers are there for the best when it is more costly
- Does installed capacity reflect usage “deemed” overestimate ?
- Fuel use statistics and type
- Scale of Imports e.g. Port Talbot perhaps 90% imported
- Fuel quality schemes

What the NAEI doesn't do

- Predict market outcomes
- Technology splits beyond published information
- Fuel statistics

- Future problems
  - Quantifying take up of a non-traded fuel especially fuel imports which appear excluded from current forecasts
  - Non-woody biomass technologies such as gasification
  - These are currently not important
  - Mix of sizes e.g. emissions from Port Talbot plant caught in Pollution Inventory likely to be v different to domestic logs which is largest single future category in Enviros study
  - Need to monitor the market

Perceived Policy needs

- Emissions impact of policy decisions
- Flexibility to look at other technologies
- Incorporation of non-incineration waste to energy technologies
- Different policy measure across UK
- Geographic uptake sensitivity (off gas grid, non-smoke control, non-AQMA)

END…

and brief interlude…