CHPQA Outreach Workshop 28th January 2014 Combined Heat and Power at The University of Liverpool

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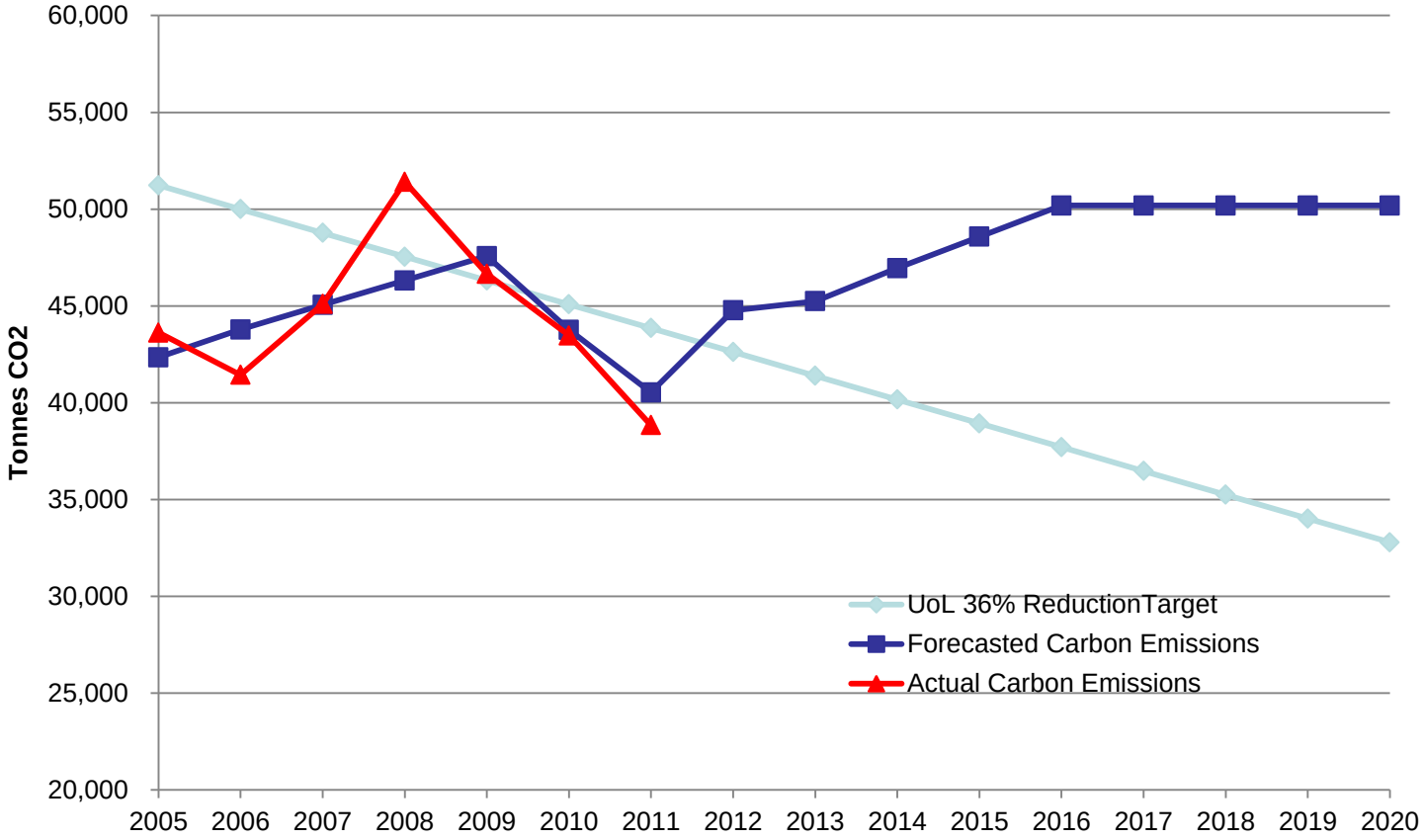
Introduction

- The Campus
- Background to the energy problem.
- Renewables and mitigation measures etc.....
- Electrical and District heating infrastructure
- CHP and the New Energy Centre Project
- How’s it operating so far?

Facts and Figures

- Main City Centre campus - 90 Acre site
- 30,000 FTE Students
- 4,700 Staff
- Mix of building stock old and new
- Abercromby Square built in 1835
- Victorian buildings (former lunatic asylum)...no change there then!!
- 1960's saw prolific development of campus
- New buildings currently under construction or planned in the next 5 years.

University of Liverpool: Projected Carbon Emissions



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Electricity

Electricity reduction is THE key factor in reducing the university carbon footprint

It is the major contributor of our carbon emissions

Every kWh (unit)of electricity contributes 0.532kg CO2 to the atmosphere

Every kWh (unit)of gas consumed contributes 0.198kg CO2 to the atmosphere

Electricity costs 9.0p/kWh

Gas costs 2.8p/kWh

Therefore, electricity is 2.5 times GREATER in both the cost and in environmental impact compared to gas

The New Energy Centre on Ashton Street - state of the art energy centre comprising Combined Heat and Power (CHP) plant and new high efficiency gas boilers supplying heating and hot water to the whole campus and generating over a third of the Universities electricity requirements.

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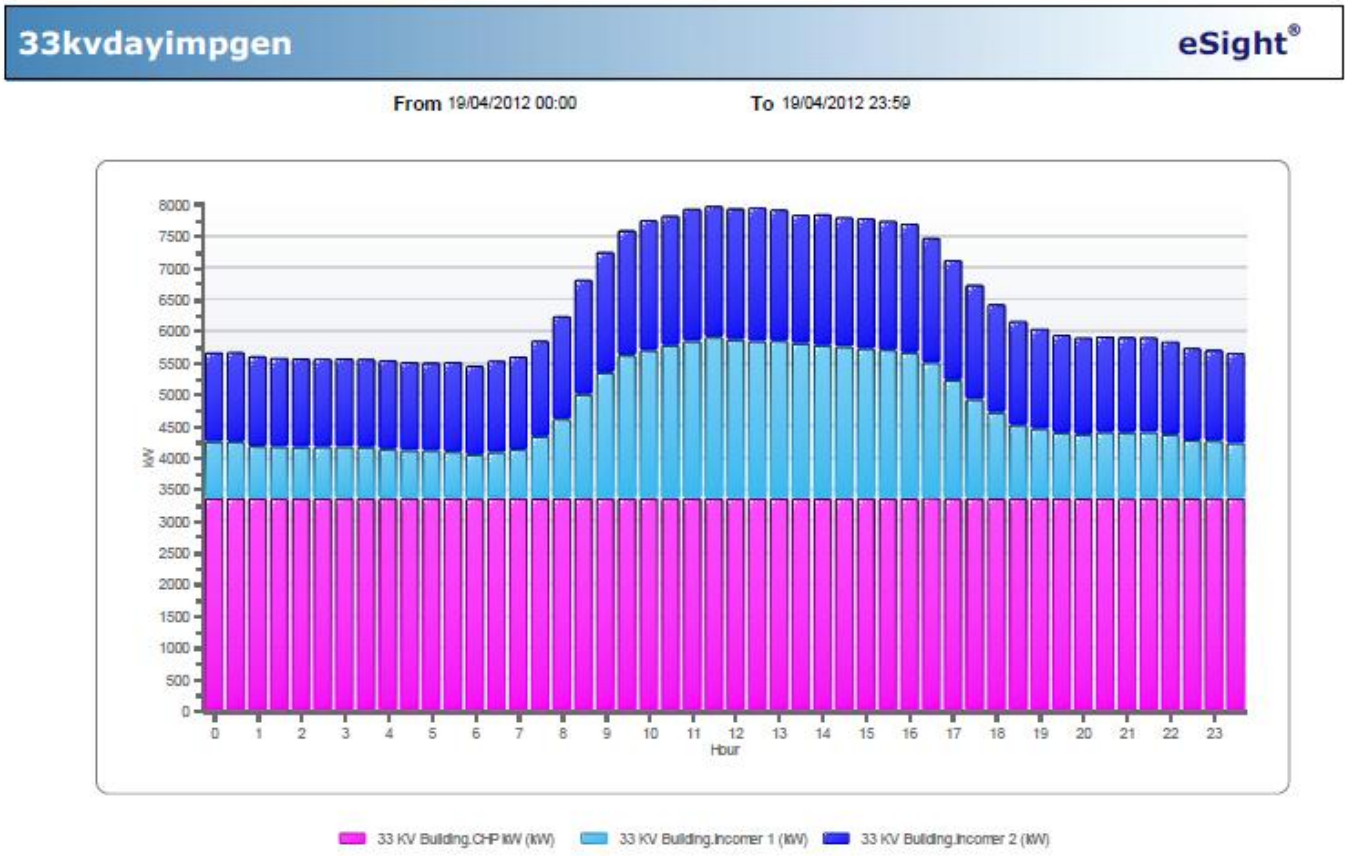

Distributing the energy around the campus

High Voltage electricity distribution network –

- 4 off 11kV distribution rings serving 34 substations around the campus
- HV/LV interconnector circuits

High Temperature Hot Water (HTHW)District Heating system-

- consisting of buried insulated pressurised mains distributing HTHW to plate heat exchangers in pant rooms 5 kilometers of buried mains
- Leak detection system and cathodic protection built into pipework

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Main 33kV Incoming Sub-Station

High Voltage Distribution Network

- The University owns, operates and maintains it's own 11kV High Voltage distribution network.
- 33kV incoming substation from REC
- 4 – 11kV distribution rings serving 34 University HV substations around the campus

11kV Switchgear

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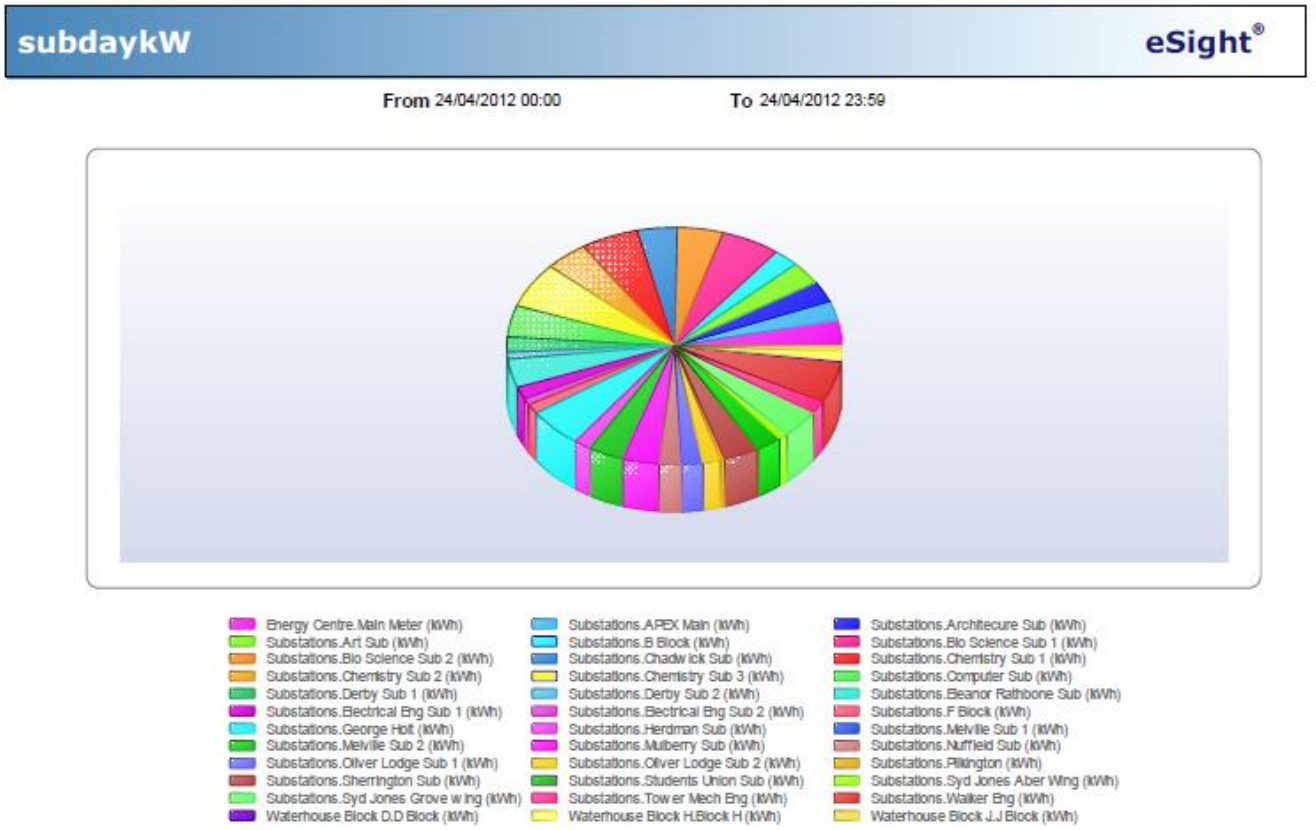


Energy Mitigation Measures

- Photovoltaic arrays
- Motor inverter controls
- Voltage optimisation
- Wind turbines
- Insulation
- Draught proofing
- Thermal imaging
- Water controls technology

Background to New Energy Centre

- The University is a large energy user, capable of supporting a large CHP/District Heating Network
- In 1986 a 3.5MWe gas turbine plant was installed in the former Quadrangle boilerhouse serving heat to two thirds of the campus and generating almost half the electricity required on site.It was the largest CHP plant in an educational establishment at that time.
- In 1986 he electricity consumption of the University was almost 23 Million kWh/yr
- In 2009 the electricity consumption of the University is almost figure at 58 Million kWh/yr, rising on average at least 3% per year
- The gas consumption of the University is now greater than 100 Million kWh/yr.
- The University is committed to reducing CO2 emissions from its estate activities and the CHP and new high efficiency boilers in the NEC will make a major contribution to achieving the challenging targets set by University SMT and Government legislation.

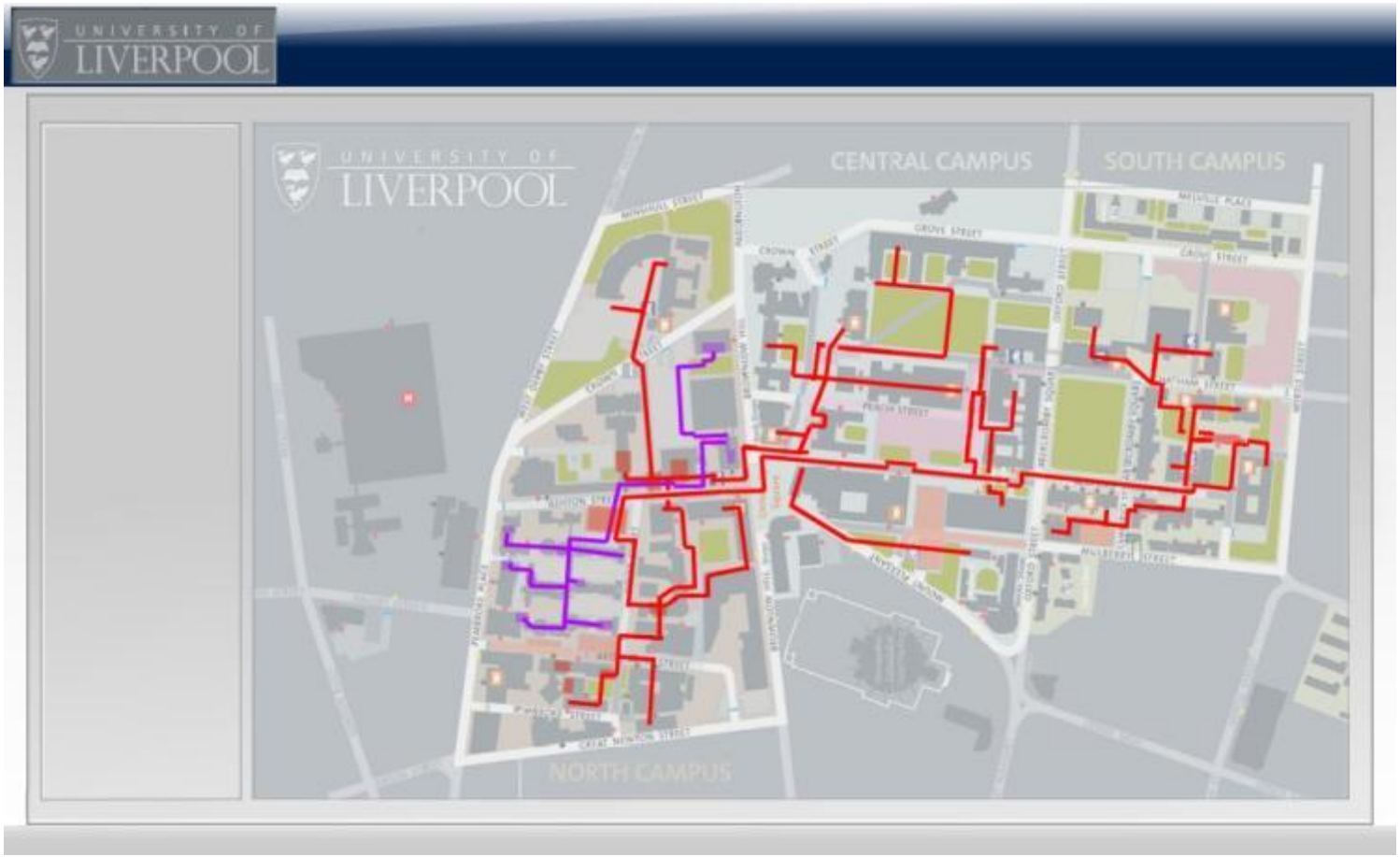
New Energy Centre - Facts

- Sited on Ashton St near Medical School buildings and the former RLI buildings
- It will supply heating and hot water services to almost all campus buildings via a High Temperature Hot Water (HTHW) district heating network of underground pipework
- The building houses a gas engine Combined Heat and Power Plant (CHP) and 3 gas boilers
- The CHP genset will generate approx: half of the annual electricity requirements on site
- All heat and power generated at the energy centre will be used on campus we do not export to the Grid

District Heating Network

- Heat from the energy centre is distributed to building plant rooms via large buried High Temperature Hot Water (HTHW) and Low Temperature Hot Water (LTHW) mains distribution pipework around campus.
- Various zones serve different parts of the campus.
- Each building served from the district heating mains has a plant room with a plate heat exchanger for distribution within that particular building.
- The buried mains are pre-insulated mains and have leak detection monitoring built in

District Heating Network



District heating mains being laid in Bedford St

District heating mains being laid in Bedford St.

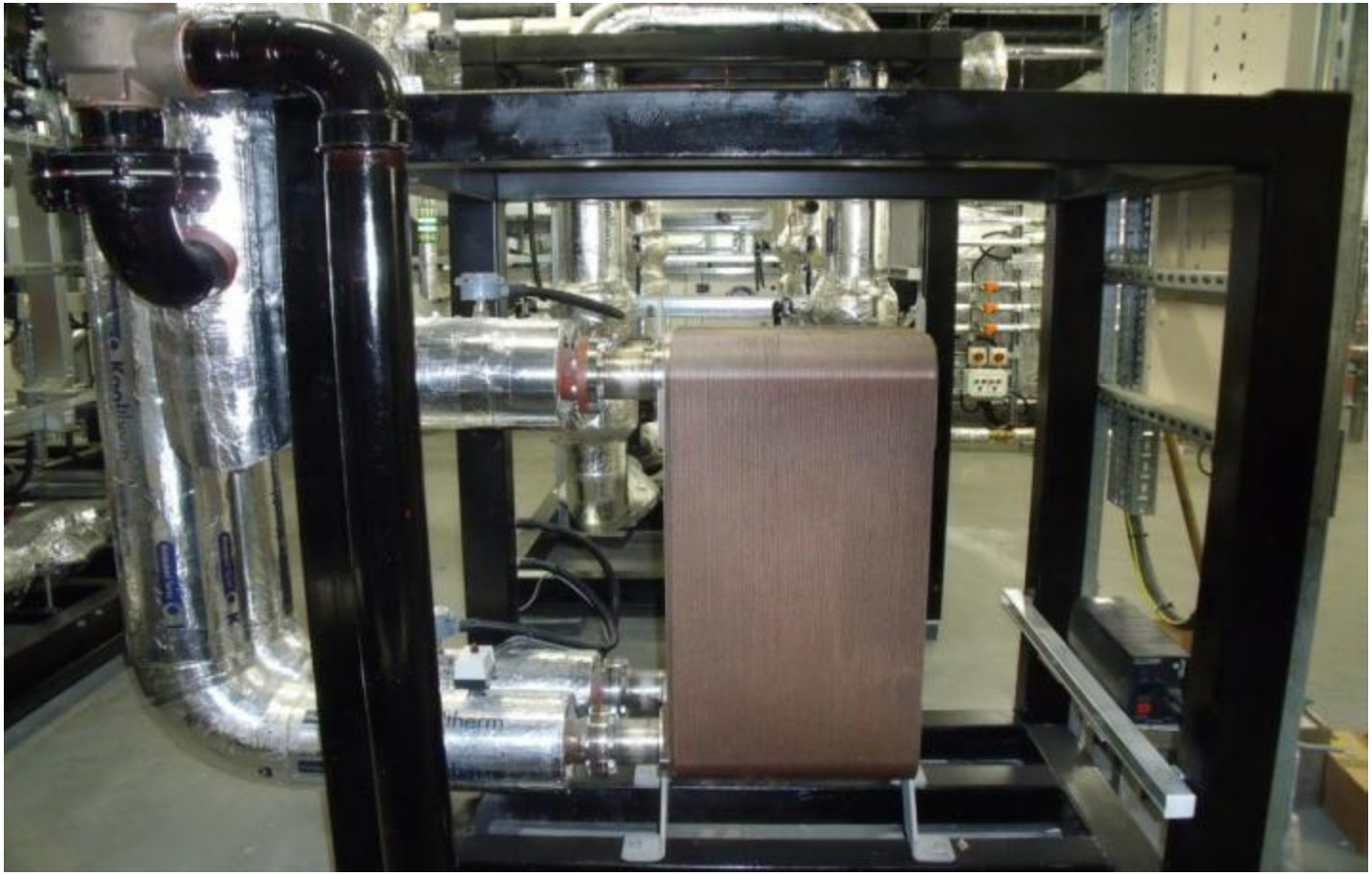
District heating mains being laid in Peach St

District heating mains being laid into Roxby B/H

HTHW Plate Heat Exchanger

APEX Building Main Plant Room

Plate Heat Exchanger



Hot Water Calorifier and Plate HX

Plant Room

Key drivers to build New Energy Centre

- Age of existing CHP plant and associated boilers
- Risk to business continuity to the University of boiler failure.
- Carbon reduction targets – Global warming
- Legislative compliance (Carbon Reduction Commitment- CRC)
- EU ETS (European Emissions Trading Scheme)
- Corporate social responsibility
- Cost of imported electricity
- Pressure on University budgets
- Comparison to other Universities – Estate Management Statistics and league tables

Key Project Information/Milestones

- Architect Levitt Bernstein (London)
- Main Contractor EMCOR (Cheadle Office)
- M&E Consultant NIFES (Manchester)
- Client ULEC (University of Liverpool Energy Company)
- Construction Start Date November 2008
- “Heat On” date 27th November 2009
- Project completion January 2010
- Project Cost £19 Million
- Main Plant items- Dan Stoker gas boilers/Dunphy burners
- Clarke Energy Jenbacher gas engine CHP plant

Planning Considerations/Issues

- Location – NEC adjacent to listed buildings stock.- planning consents required at every stage and for any changes.
- Re-use of original RLI boilerhouse?
- Size/shape of NEC.
- Building materials/cladding.
- Chimney? Size 47M a significant structure on the skyline - materials/shape? Planning consent
- Noise breakout – the NEC is adjacent to lecture theatres seminar rooms labs…etc therefore low level of noise acceptability in surrounding buildings
- Design Team – Feasibility Study/Project Control Team

North elevation of NEC

East elevation of NEC

West Elevation of NEC

Preparation of site November 2008

Erection of steel framework

Excavations for chimney base

View of NEC site looking down Dover Street.

West elevation baffles

South glazed elevation

West elevation cladding

Ashton street view of NEC

NEC as viewed from Quad B/H chimney

High Level Chimney View

Heat dump radiators on roof

CHP engine being offloaded

CHP engine being offloaded

CHP engine being eased into position

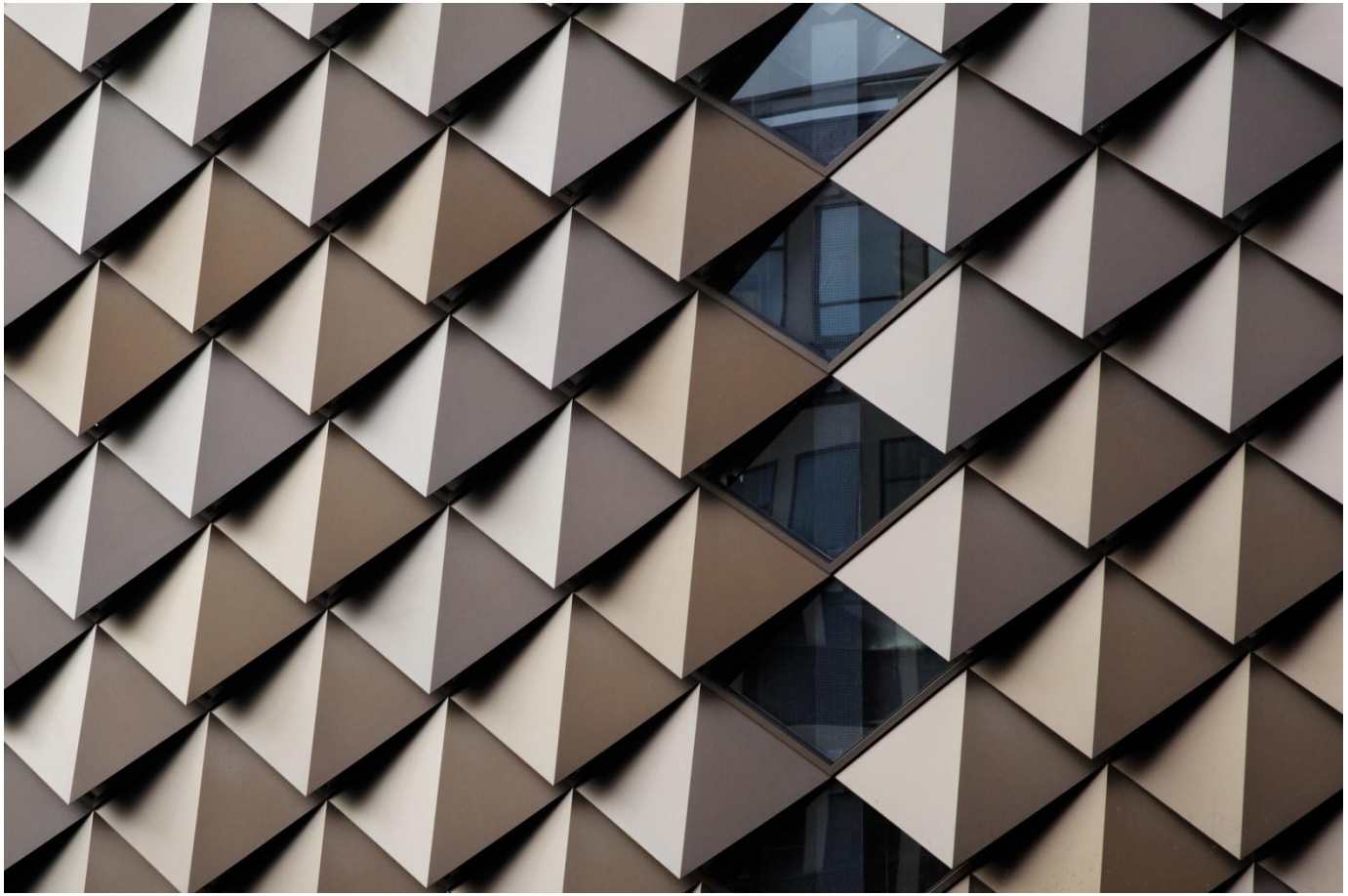
Gas Engine CHP Plant

Gas Engine CHP Plant

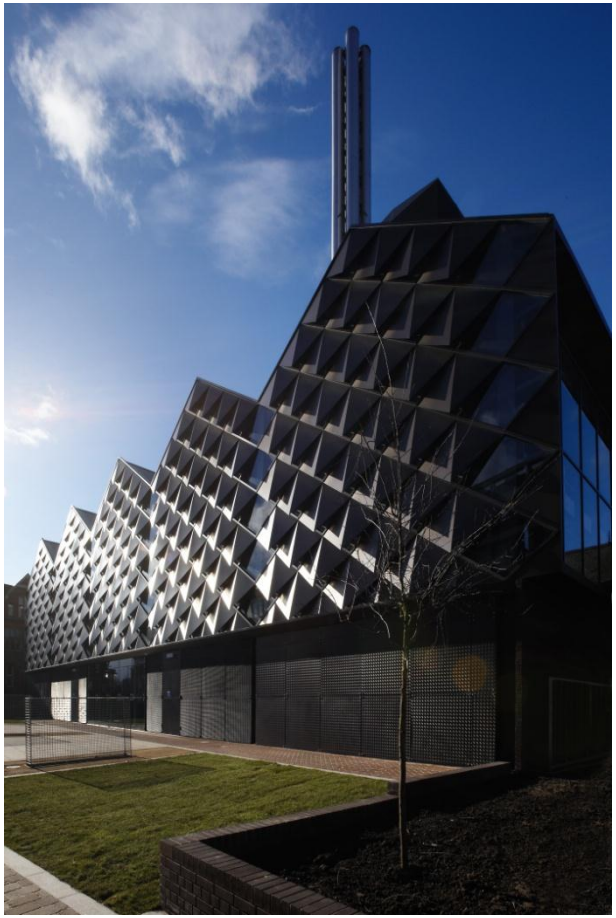
Waste heat recovery being positioned

Energy Centre

Innovative Cladding



Energy Centre



Energy Centre

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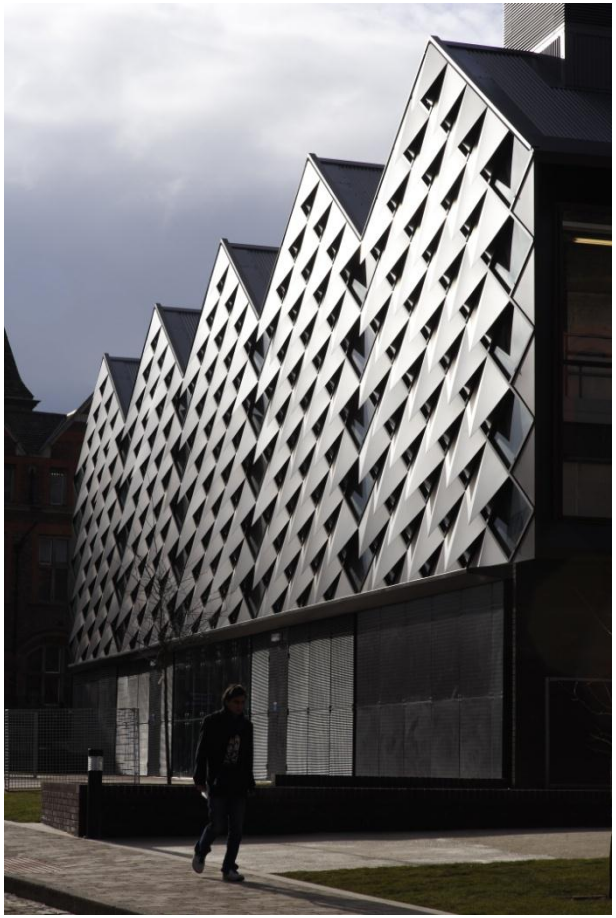

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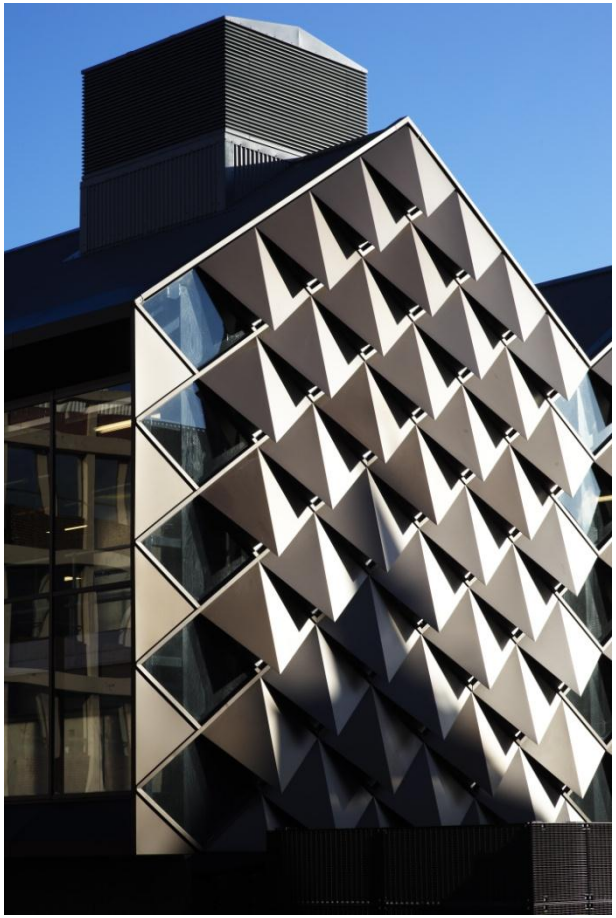
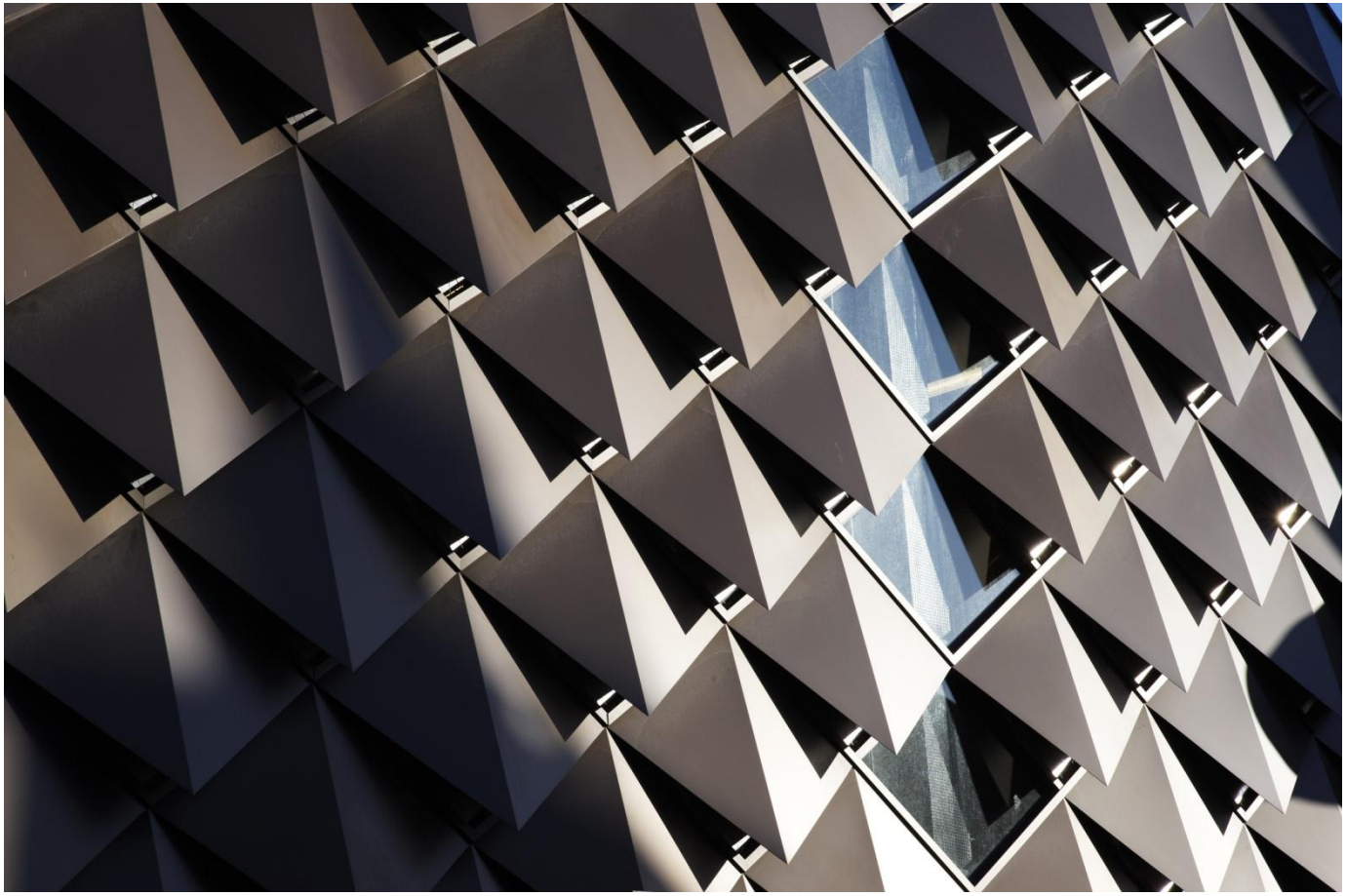
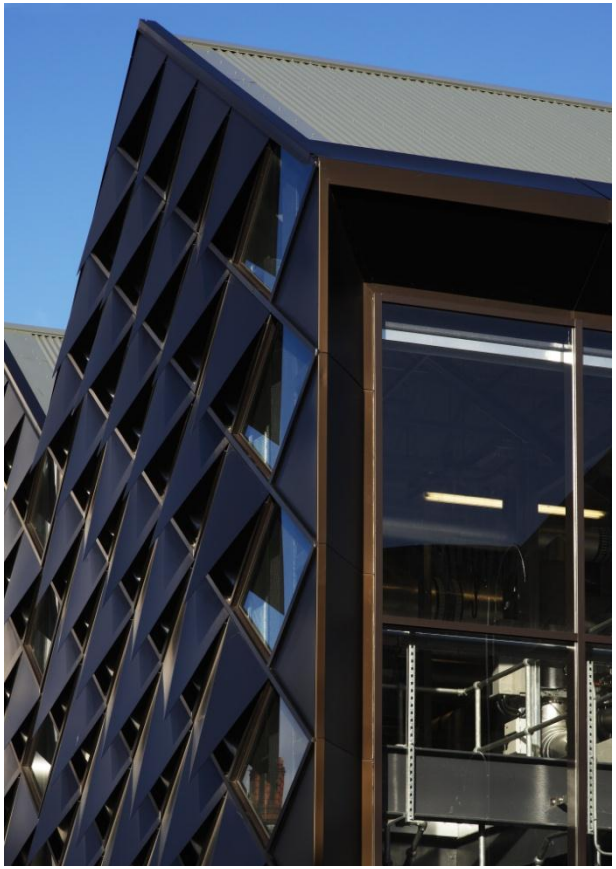


Cladding



Chimney connections

Energy Centre



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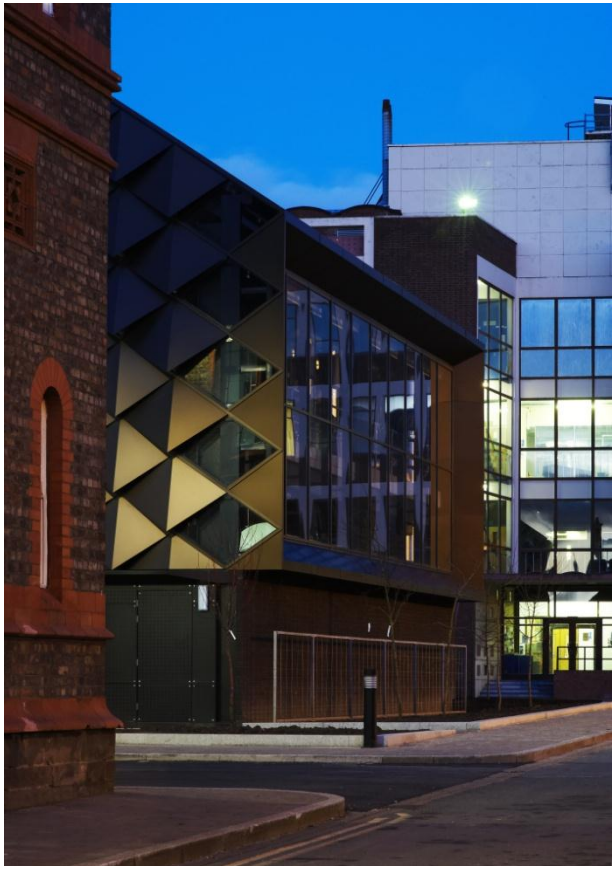

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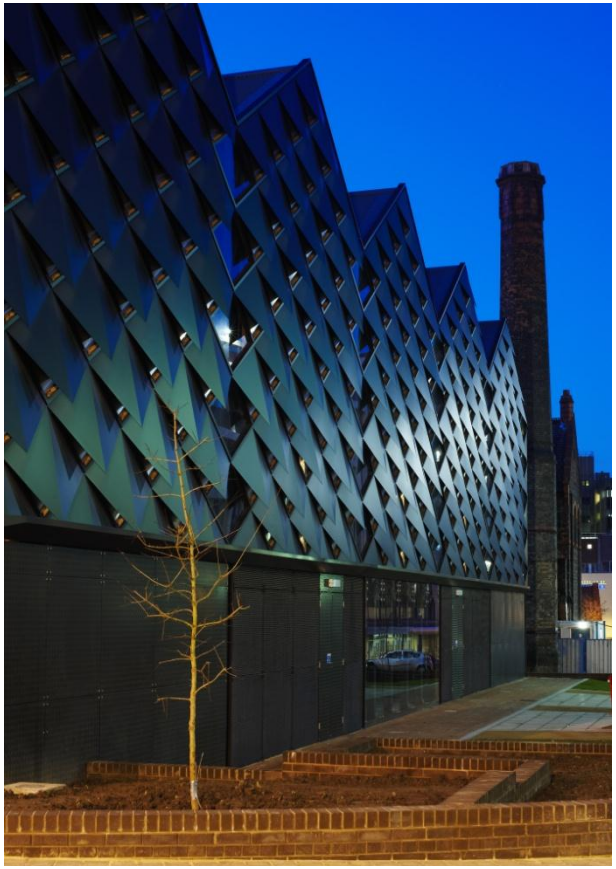

CHP Jenbacher CHP Engine

Gas burners

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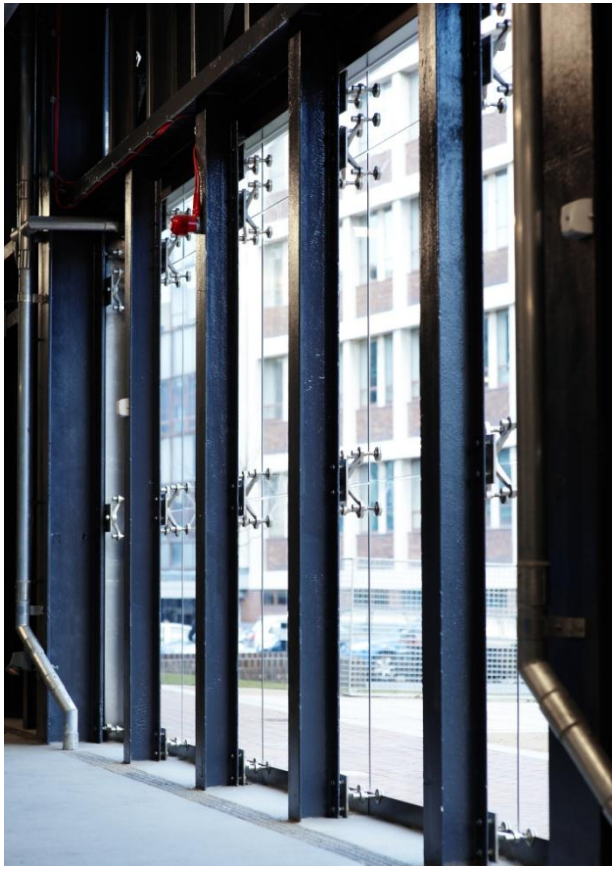

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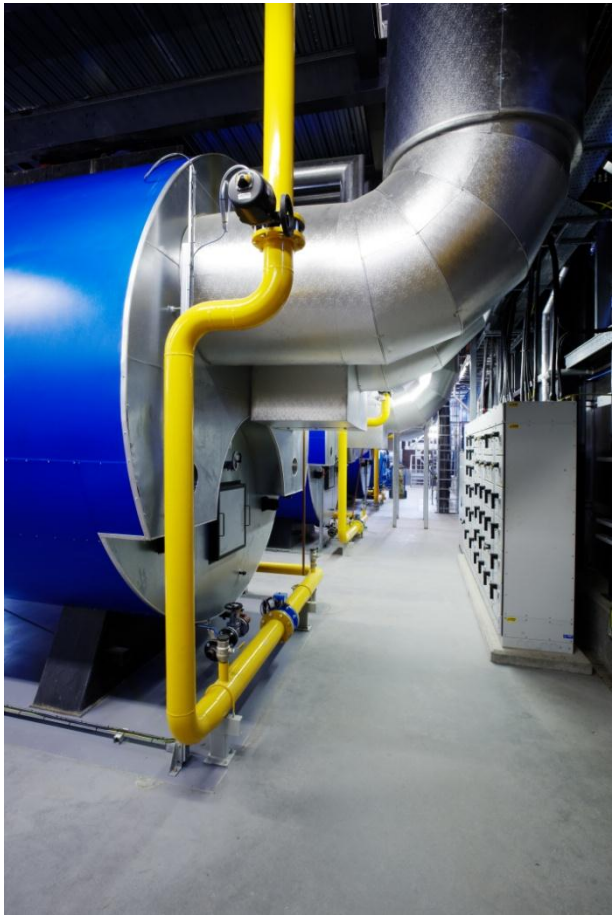

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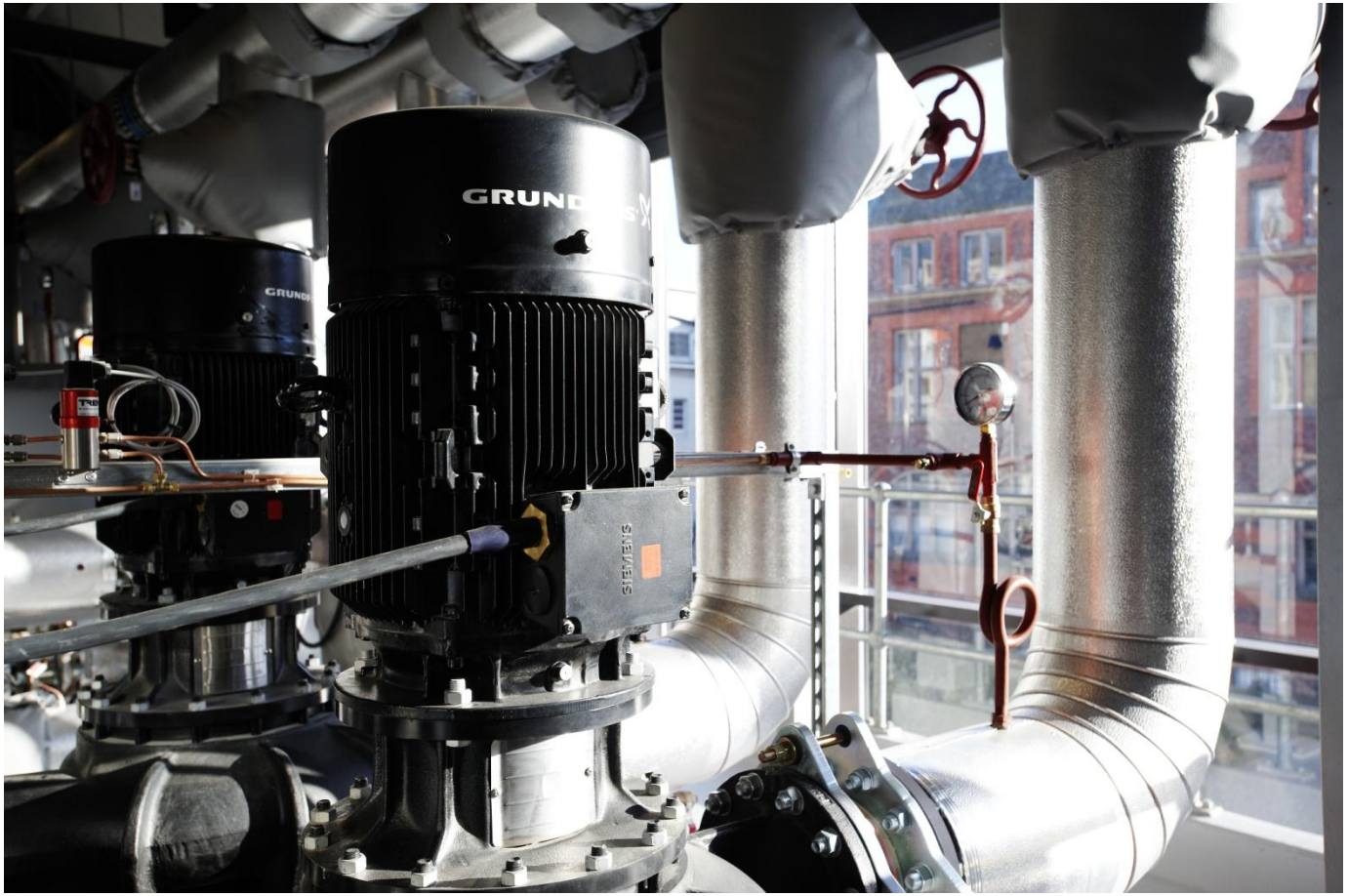

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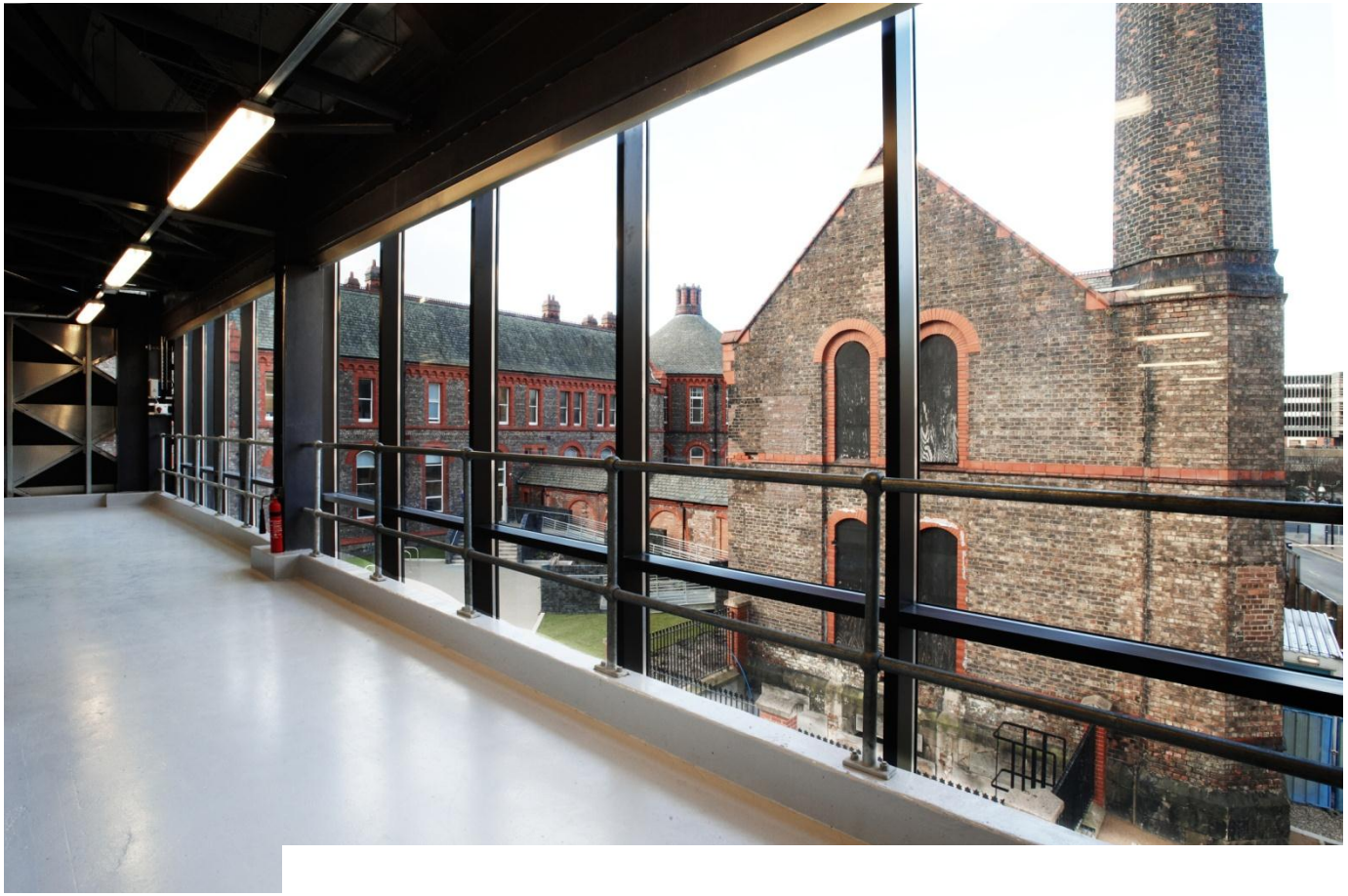

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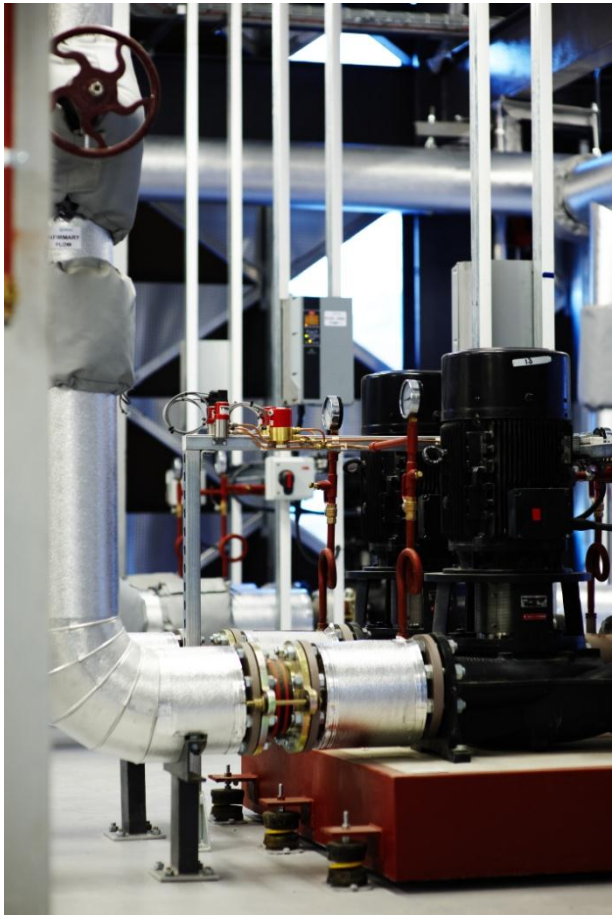
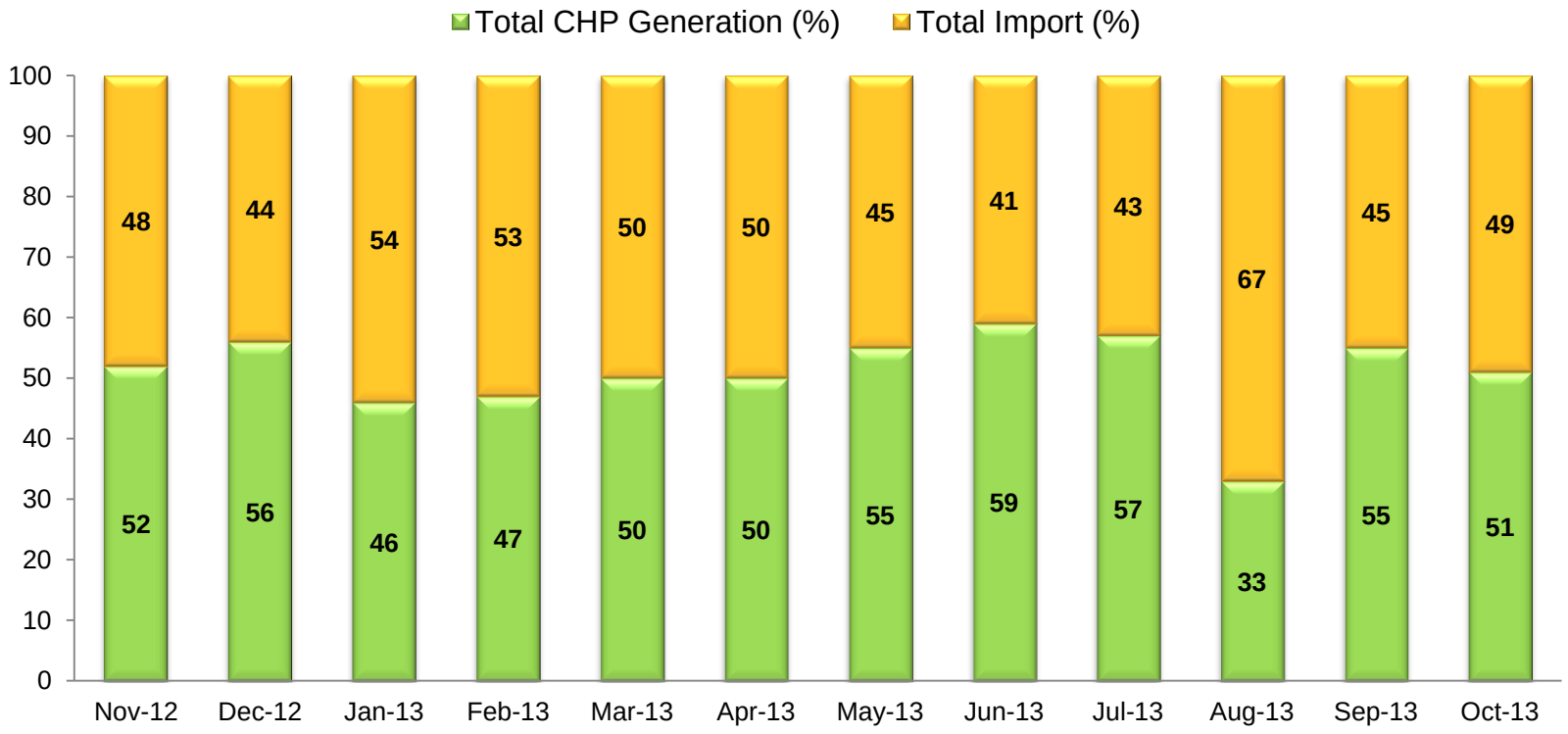


Benefits of building NEC

- The University will own and operate a state of the art environmentally friendly energy centre capable of supplying the energy requirements of the University for the next 25 years
- The NEC will go a long way to helping the University meet its challenging carbon reduction commitments
- The NEC will help the University keep energy costs under control in an ever changing utilities market
- Students will have direct access to live energy centre data for a variety of academic projects in collaboration with Mechanical Engineering Department

OPERATING PERFORMANCE

Total Campus Electricity Consumption (%) split between CHP Generation & Import



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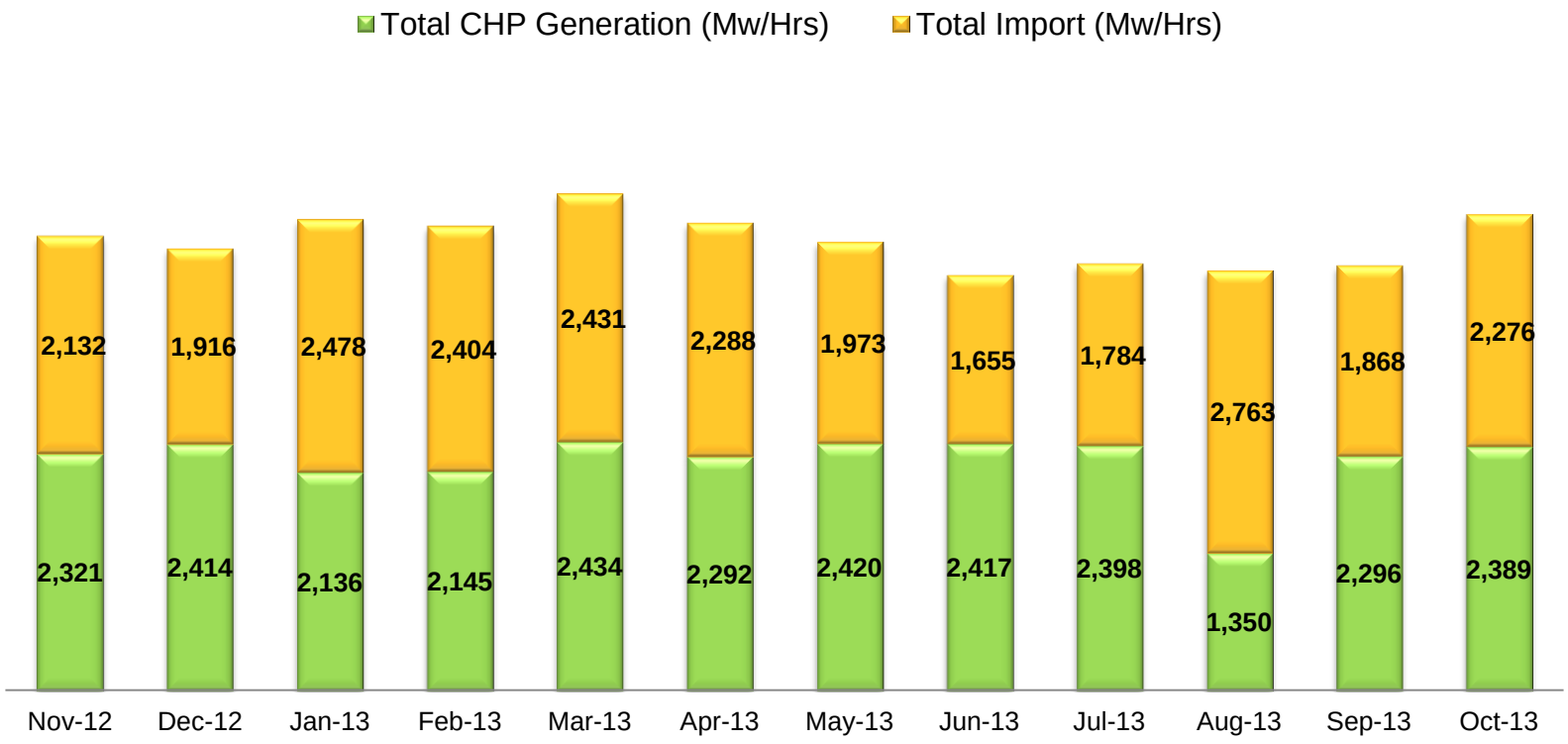
Total Campus Electricity Consumption (MW/Hrs) split between CHP Generation & Import



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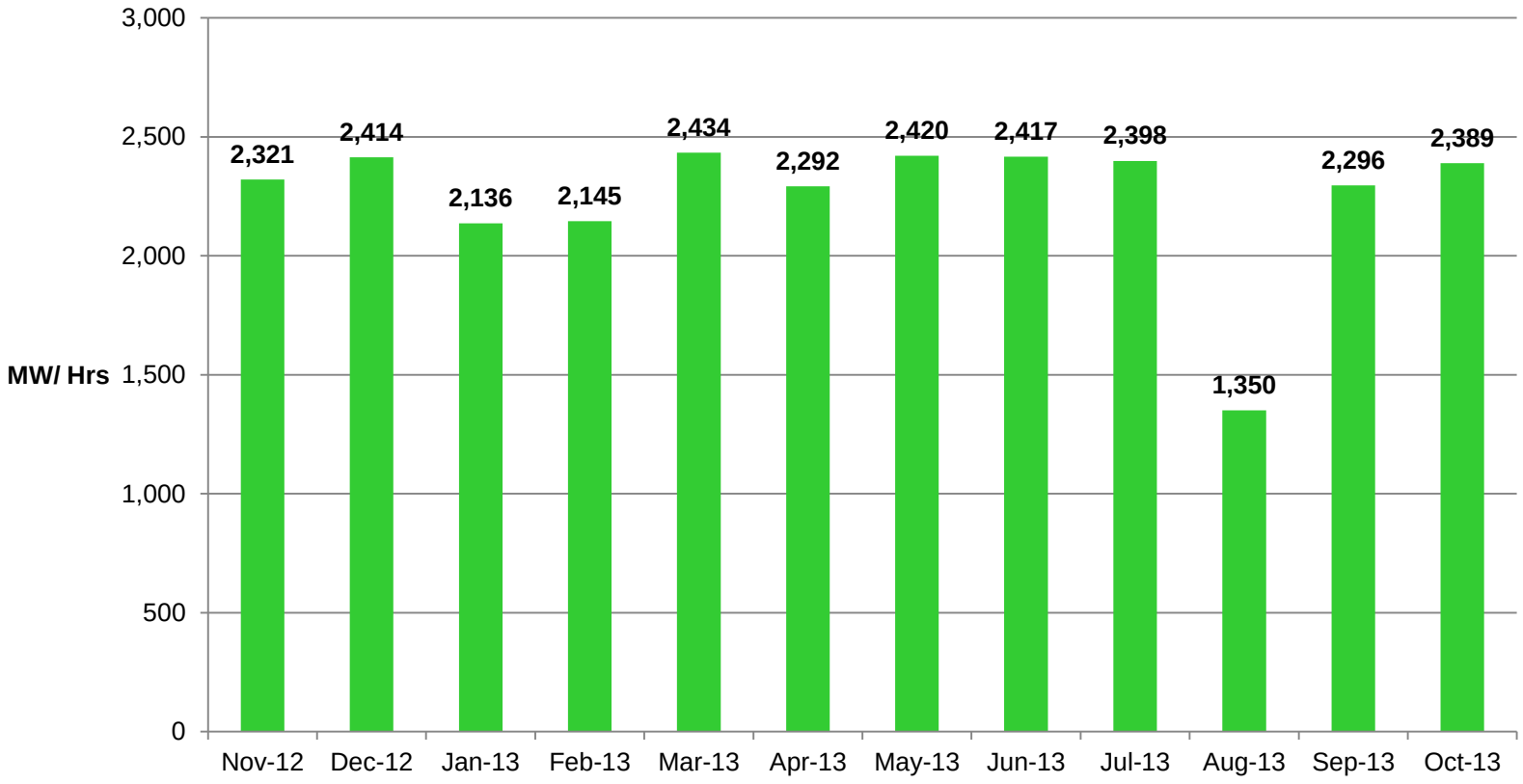
Total CHP Electricity produced (MW/Hrs)



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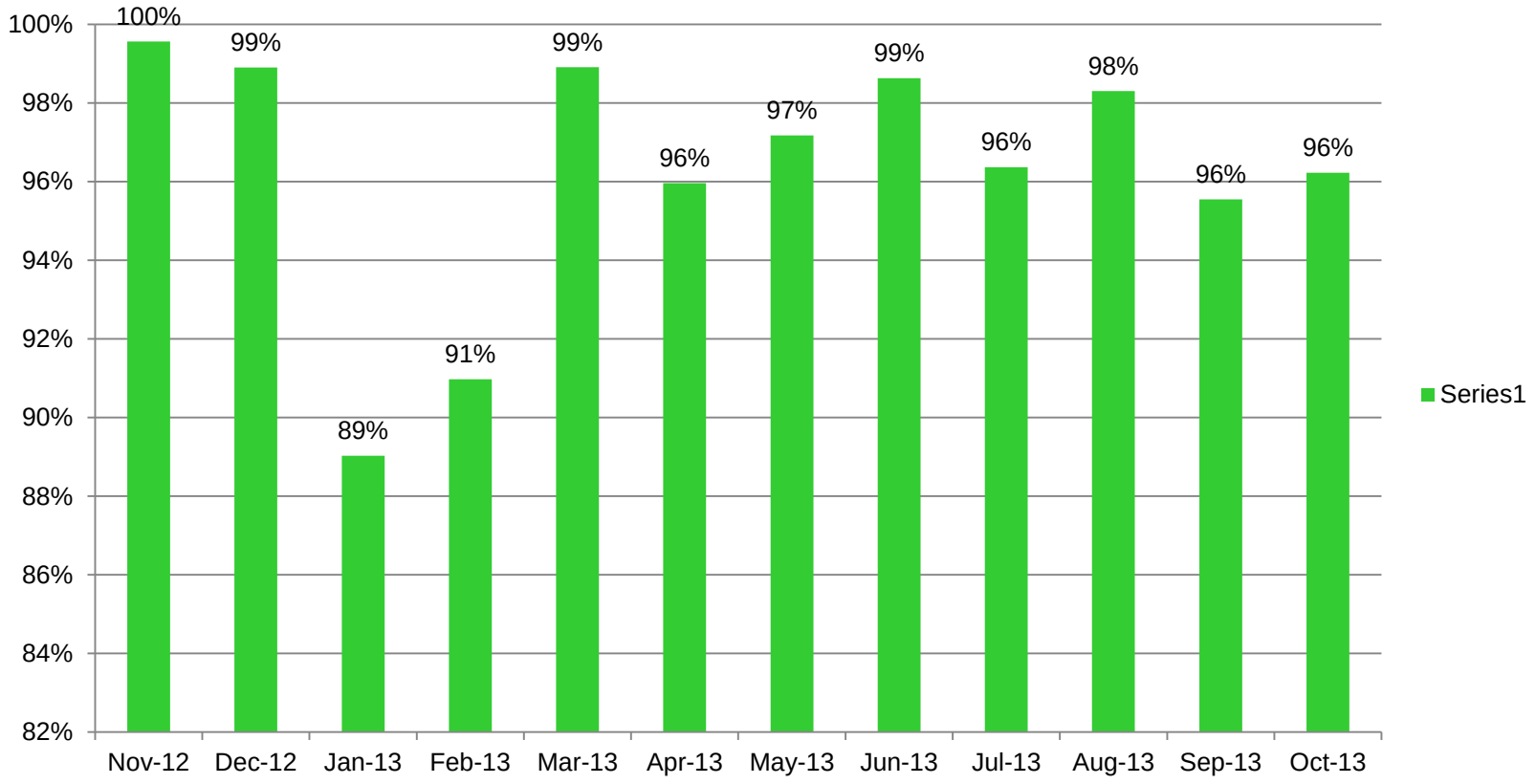
CHP availability as % of Total Available Run Hours



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THANKS FOR LISTENING

ANY QUESTIONS?