SUBMISSION

Inquiry into ACT Greenhouse Gas Reduction Targets

ACT Government Standing Committee
Climate Change, Environment and Water

My comments concern item 2cii of the Standing Committee reference: *"The ACT's future energy supplies, taking account of the draft ACT Government Energy Strategy due to be published in late 2008 and options for sourcing or producing sufficient renewable energy to meet the needs of the ACT"*, and relate in particular to the carbon footprint of a gas-fired power plant planned for Hume (28-45 MW) and a gas-fired power plant proposed for Williamsdale (500-600 MW).

RECOMMENDATIONS

- **The ACT government should substitute the polluting gas-fired power plants proposed for Hume and Williamsdale with non-polluting solar farms;**

- **The Commonwealth Government, through Geoscience Australia's Onshore Energy Security Program, should conduct a feasibility study on the ACT geothermal energy potential;**

- **The ACT government should legislate for installation, and/or retrofitting, of geothermal heat pumps in larger-size buildings where possible.**

SUBSTITUTE SOLAR FARMS FOR PROPOSED GAS-FIRED PLANTS

The 28MW gas-fired power plant proposed for Block 2023 in Hume will emit 170,000 tonnes CO_2/year [1]. This represents 4.2% of the year 2000 emission level for the ACT. The 500 MW gas-fired power plant proposed for Williamsdale will add a further 74.8% to the year 2000 emission level, assuming similar emission characteristics. The combined 79% increase in CO_2 emissions will make it virtually impossible to achieve the major aims of the ACT Climate Change Strategy 2007-2025 [2]: reduction of the ACT carbon footprint to the year 2000 level by 2025 and 60% reduction of the year 2000 level by 2050.

Operation of the two proposed gas-fired power plants at the upper end of proposed capacity (45 MW and 600 MW respectively) would lead to a 96.5% increase, rather than a 79% increase, of the year 2000 emission level.

The ACT currently has no polluting gas-fired power plants, other than three methane burners at the Mugga Lane Tip, each of a nominal 1 MW. The ACT government has a

fundamental decision to make: to start up on a substantially polluting gas-path or to proceed on a non-polluting renewable energy-path. I strongly urge the government to choose the non-polluting renewable energy option through solar farms.

Carbon footprint, gas-fired plants versus coal-fired plants and versus grid-power

Statements to the effect that a gas-fired power plant has about half the carbon footprint of a coal-fired power plant (57%) have been made repeatedly by proponents of the Canberra Technology City (CTC) project and by supporting ACT politicians, including the Chief Minister. Such statements are misleading. The 57% figure relates only to scope-1 emissions (direct emissions from combustion at power plant), not to scope-2 emissions (consumption of electricity, heating, cooling or steam brought in from elsewhere), nor to scope-3 emissions (fugitive emissions from mining). These emissions combine to a 76% carbon footprint, rather than a 57% footprint!

I cite emission data from the National Greenhouse Accounts (NGA) Factors- October 2008 [3, tables 1, 2, 6, 7, 8], expressed in kg CO_2-e per GJ:

	Scope-1				Scope-2	Scope-3
	CO_2	CH_4	N_2O	Total	Total	Total underground/open cut
Black coal	88.2	0.03	0.2	89.3?	N/A	0.305+0.014/0.045
Natural gas	51.2	0.1	0.03	51.3?	N/A	14.2
Grid-power				N/A	249+0.89	47

There are no scope-2 emissions for black coal and natural gas, nor scope-1 emissions for grid-power. There seems to be some ambiguity in classifying emissions as scope-1, scope-2 or scope-3. A clarification from the Department of Climate Change (Glen Whitehead, email 25-11-2008) reads: *"Scope 2 emissions occur only from the consumption of electricity, heating, cooling or steam brought in from outside the facility. Therefore scope 2 emissions don't apply to the consumption of natural gas or black coal (ie there are only scope 1 and scope 3 emissions from these fuels). Scope 1 emissions relate to only direct emissions (from sources within the boundary of an organisation), therefore there are no scope 1 emissions from the consumption of purchased electricity (because the scope 1 emissions occur at the power station, these are scope 2 emissions for the end user)."*

Comparison of scope-1 + scope-3 emission data combined indicates that for the ACT and NSW the level of CO_2-equivalent emissions of a gas-fired power plant is ~73.3% of the level of emissions of a black coal-fired power plant. This is substantially higher than the often quoted figure of 57% which relates to scope-1 emissions only (in fact ~57.4%).

The figure of 73.3% for scope-1 + scope-3 emissions in the ACT and NSW derives from the high content of CO_2 in Moomba gas (Cooper Basin), varying between 10% and 30% of total volume [4]. Santos has plans to sequester this CO_2, but it is currently just vented. The ACT and NSW receive a considerable part of their gas supplies from the Cooper Basin gas fields. The remainder comes from Bass Strait gas fields. South Australia probable gets a larger part of its gas supplies from the Cooper Basin. According to the NGA data [3, table 37] scope-3 emissions for South Australia are

18.6 kg CO_2-e per GJ (compare with 14.2 for ACT/NSW, see above table) and this results in a higher relative figure for CO_2-equivalent emissions of a natural gas-fired power plant versus a black coal-fired power plant of (51.3+18.6)/89.6= 78.0%, within South Australia. This higher figure would also apply to the ACT at those times that its gas is sourced more exclusively from the Cooper Basin.

For a more proper comparison of the carbon-footprints of natural gas-fired and black coal-fired power plants, their thermal efficiencies also need to be taken into account. In absence of knowledge about relevant, specific, data for the proposed Tuggeranong power plant this comparison is based on average performance of power plants Australia-wide over the period 1995-2005. According to [5, table 4-19] the average thermal efficiency of natural gas-fired power plants is 33.18% and for coal-fired power plants is 34.58%. The above figures for CO_2-equivalent emissions for gas-fired power plants relative to coal-fired power plants thus need to be multiplied by a factor of 34.58/33.18= 1.042. Consequently, emissions of a gas-fired power plant in the ACT are expected at 73.3*1.042= 76.3% of the emissions of a coal-fired power plant of similar energy output. For South Australia the equivalent figure would be 78.0*1.042= 81.3%.

A further comparison of the carbon footprints of gas-fired and coal-fired power plants with grid-power should be based on convolving the sum of Scope-1 + Scope-3 emissions with the relevant thermal efficiency factors for gas-fired and coal-fired power plants as follows:

Gas-fired power plant	(51.3+14.2)/0.3318=	197.41
Coal-fired power plant	(89.3+0.319)/0.3458=	259.16
Grid-power	249+0.89+47=	296.87

This means for relative carbon footprints in the ACT/NSW:

Gas-fired power/grid-power:	197.41/296.87=	66.5%
Coal-fired power/grid-power:	259.16/296.87=	87.3%
Gas-fired power/coal-fired power:	197.41/259.16=	76.3%

Carbon footprint over life cycle

Comparison of the carbon footprints of gas-fired plants, coal-fired plants and grid-power merely on the basis of past or present data could be misleading. It is instructive to also compare the carbon footprints integrated over the life cycles of the various plants. As demonstrated above and based on past and present data, the carbon footprint of gas-fired power relative to grid-power for the ACT and NSW is 66.5%. Currently the Mandatory Renewable Energy Target (MRET) is 2% [6], but the federal government is committed to an MRET of 20% by 2020 [7]. Assuming a negligible carbon footprint for renewable energy, this would mean that the carbon footprint of grid-power would have to reduce substantially ─ at least by 18% (20%-2%). Thus the carbon footprint of grid-power can be expected to be reduced by 2020 from the current 296.87 kg CO_2-e per GJ to 243.43 kg CO_2-e per GJ. However, the Hume gas-fired power plant is expected to retain its current carbon footprint of 197.41 kg CO_2-e per GJ. By 2020 the relative footprint of the Hume gas-fired power plant versus grid-power would then have increased from 66.5% to 81.1%. It is as yet unknown what the

MRET target will be after 2020, but it is bound to substantially increase if the federal government is going to pursue a carbon reduction of 60% or more by 2050.

Clearly at some stage in the life cycle of the proposed Hume gas-fired power plant, taken from 2010 to 2050, the carbon footprint of gas-fired power is bound to exceed that of power drawn from the grid!

Such a carbon footprint would clearly counteract the aim of the ACT government [2] to reduce ACT greenhouse emissions by 60% of 2000 levels by 2050. The ACT government then would face its own worst-case scenario: *"While it may be tempting to put the excuse of short-term financial cost above the benefit of long-term abatement, if nothing is done the eventual outcome will be unaffordable in environmental, economic and social terms"* [2, ACT Climate Change Strategy 2007-2025, "Weathering the Change", p 5].

ACT GEOTHERMAL POTENTIAL FEASIBILITY STUDY

ACT birthplace of many green concepts

Canberra has seen the birth of four concepts that can make a substantial contribution to averting the global climate change crisis: CO_2 geo-sequestration (Dr Peter Cook: CO_2 CRC); geothermal energy from hot-fractured-rocks (Dr Doone Wyborn and Dr Prame Chopra: BMR/ANU/Geodynamics); solar thermal energy through concentrator disks and heat storage (Dr Keith Lovegrove: ANU); solar photovoltaic energy through reduced silicon, "Sliver", cells (Prof Andrew Blakers: ANU). The first concept concerns removal of greenhouse gas emissions from mainly coal-fired power plants. The latter three concepts concern provision of pollution-free renewable energy, with base-load capacity/capability for concepts two and three. Geothermal energy leader Geodynamics [8] expects to establish proof-of-concept of energy extraction from hot-fractured rocks in its Cooper Basin tenements during the first half of 2009. There are reasonable expectations of delivery, on a decade timescale, of 10,000 MW of pollution-free base-load renewable energy from the Cooper Basin alone. ActewAGL and/or ACTEW could secure a share of supply by following the footsteps of AGL's competitor, Origin Energy. The ACT government, as owner of ACTEW and half-owner of ActewAGL, could invest in the development of HFR [9][10] and other base-load renewable energy supplies, rather than contribute to a one billion dollar gas-fired polluter in Hume. In building on home-grown innovative concepts the ACT government would be seen as an innovative world leader in combating climate change. Yet, if the ACT would proceed in building a polluting gas-fired power plant virtually at the doorsteps of its residents, Canberra risks becoming known as Australia's pollution capital.

No legislation for geothermal exploration in the ACT

Legislation for geothermal exploration is now in place in all states of the Australian Commonwealth and is pending in the Northern Territory. The ACT distinguishes itself as the only Australian jurisdiction with no active legislative agenda for geothermal exploration. Clearly there is an opportunity for the ACT government to shore up its climate change credentials! Scope for pioneering Hot Fractured Rock (HFR) geothermal energy and for more conventional hydrothermal geothermal energy

may be limited in the ACT, given the ACT's limited size and its geological make-up. However, there may be potential for direct use of geothermal heat in industrial, commercial and energy efficiency applications.

Pre-feasibility geothermal study required

Nearly all ACT dams are on major fault zones, such as the Cotter Fault (Corin, Bendora, Cotter) and Deakin Fault (Burley Griffin, Ginninderra), and these faults could be passage ways for geothermal heat. Simple dropping of heat-flow probes in accumulated sediments in ACT dams may indicate whether the ACT is prospective for further geothermal exploration. Such a pre-feasibility study could be carried out by Geoscience Australia, if the ACT asks for its fair share of the federal government's Onshore Energy Security Program [11].

GEOTHERMAL HEAT PUMPS

Geothermal heat pumps operate satisfactorily in the main building of Geoscience Australia. The geothermal heat pump system at Geoscience Australia delivers up to about 0.5 MW, cooling and heating the main building [12]. Volcanic bedrock comparable to the Geoscience Australia location (dacitic ignimbrite) is common in Canberra. Suitability of Canberra's sedimentary bedrock for geothermal heat pump systems has not been tested to my knowledge, but there is no obvious reason to suspect that it would be less prospective. Presence of sedimentary bedrock in the Canberra region is limited compared with volcanic bedrock.

Geothermal heat pumps have a small carbon footprint, basically limited to the grid power and/or solar power required to operate the flow pumps.

Increase in the ACT carbon footprint could be limited if, where practical and possible, new larger-size buildings would be designed around geothermal heat pump systems. Actual reductions in carbon footprint may be achieved by retrofitting existing buildings.

Chris Klootwijk

REFERENCES

[1] http://www.ctceis.com.au/document/index/1 EIS 24 Greenhouse Gas Assessment October 2008 by GHD.

[2] http://www.npi.gov.au/overview/reports/act-location-report.html

[3] http://www.climatechange.gov.au/workbook/pubs/workbook-oct2008.pdf

[4] Wycherley, H., Fleet A., Shaw, H., 1999. Some observations on the origins of large volumes of carbon dioxide accumulations in sedimentary basins. Marine and Petroleum Geology 16, 489-494.

[5] http://www.climatechange.gov.au/inventory/2005/pubs/trends2005.pdf

[6] http://www.mretreview.gov.au/

[7] http://www.climatechange.gov.au/renewabletarget/index.html

[8] http://www.geodynamics.com.au/IRM/content/home.html

[9] http://www.agea.org.au/

[10] http://www.pir.sa.gov.au/geothermal/ageg

[11] http://webmap.ga.gov.au/minerals/research/oesp/work_program.jsp

[12] http://www.ga.gov.au/image_cache/GA10493.pdf

ADDITIONAL DOCUMENTATION

This submission is based in part on material extracted from objections to construction of a gas-fired power plant on Block 1671 (Tuggeranong) and Block 2023 (Hume) and from comments on the Environmental Impact Statement (EIS) and the Health Impact Assessment (HIA) for the gas-fired power plant. I add copies of these documents hereafter as a well-documented source of reference.

210 MW gas-fired power plant on Block 1671:

Objection #1, lodged with ACTPLA on: 05/05/2008
Objection #2, lodged with ACTPLA on: 26/05/2008
Objection #3, lodged with ACTPLA on: 27/05/2008

28 MW gas-fired power plant and data centres on Block 1671:

Objection #4, lodged with ACTPLA on: 25/06/2008
Objection #5, lodged with ACTPLA on: 30/06/2008
Comments on EIS and HIA, lodged with GHD and Director Health Protection Services ACT Health on: 08/12/2008

28 MW gas-fired power plant and data centres on Block 2023:

Objection #6, lodged with ACTPLA on: 26/01/2009
Objection #7, lodged with ACTPLA on: 02/02/2009

Objection #1, lodged with ACTPLA on 05/05/2008

OBJECTION
Proposed development – Block 1671 Tuggeranong
210 Mw Gas Turbine Power Station and Communications facility

I address concerns as follows:

POLLUTION & CLIMATE CHANGE CONCERNS

- The plan does not show provision for collection and sequestration of CO_2. Emission of CO_2 is substantial according to the figures provided. The Preliminary Assessment Report refers to "best practice natural gas emissions between 514 and 658 kg CO_2 per eMWh". In prolonged peak operation this would mean emission of 2,590,560 kg CO_2/day (514*24*210) to 3,316,320 kg CO_2/day (658*24*210). I will come back later why prolonged peak operation can be expected. A figure between 2.5 to 3.3 million kg CO_2/day is substantial and will increase Australia's carbon footprint. This when Australia is committed to reducing its carbon footprint by 60% by 2050. I am surprised that there is no mention of consultation with the Greenhouse gas CRC. This CRC is housed in the Canberra CBD. Its head, Dr Peter Cook, is a long-term Canberra resident, was the instigator of CO_2 geo-sequestration in Australia and headed a previous Government-funded CO_2 geo-sequestration CRC.

- The plan shows no provision for scrubbing of nitrous oxides on entry of the plant, nor on exit through the exhaust stacks. Provision of gas is planned from the Cooper Basin, which is derived originally from Permian coal seams, and also as coal-seam-gas from Permian seams in the Sydney-Gunnedah-Bowen Basin. Coal-seam-gas can be impure. It may be cleaned at the point of extraction for the purpose of the average power plant user, but the Tuggeranong power plant cannot be described as the average power plant. Its planned location at 600 m from an ACT government health facility and less than a kilometre from Macarthur residents is closer than common for a gas–fired power station. The plan mentions that plume studies indicate maximum NO_2 emissions of 245 microgram/m^3 at ground level, just ¼ of one percent below the EPA maximum level. In the absence of local control on the level of pollution of the gas entering the power plant it is ridiculous to claim that this figure complies with EPA recommendations and insulting to concerned residents to call this ¼% a safety margin. Furthermore the plan does not consider that prevailing western winds may cause a downdraft over Isaacs Ridge with potential trapping of NO_2 in an eddy between the ridge and the power plant, leading to potentially higher concentrations at ground level. Nor does the plan consider the particular location of the power plant close to the upper parts of three populated valleys: Jerrabombera, Tuggeranong and Woden. Prevailing western winds may cause eddy-trapped NO_2 to roll down Jerrabombera Valley and accumulate. Easterly seawinds may push NO_2 across Isaacs Ridge into the Woden and Tuggeranong valleys. It would be difficult to choose a more problematic, if not dangerous, location than the current one near the upper parts of these three heavily populated and populating valleys.

- The 12 turbines will operate in frequent stop-start mode. This will lead to incomplete burn-off. Consequently considerable quantities of unburnt methane gas will escape. Methane gas is a far more powerful greenhouse gas (>20 times) than CO_2. With greenhouse gas emissions soon to be considerably taxed and/or charged this plant may not be economical.

- Steam from the three steam turbines will act as condensation cores. This will increase potential for fog conditions in the Jerrabombera, Tuggeranong and Woden valleys. Also, and more worrying, combination of steam and polluting particles will increase potential for smog and consequent health effects.

INCREASED PRESSURE ON WATER RESOURCES

- Cooling for the power plant is estimated at 600 Ml/year. This is the equivalent of about 5 days of water usage during shoulder seasons and close to 1% of current water usage in the ACT. Such usage, and the necessary provisions for security of supply, will considerably increase pressure on water supply for the population of the ACT and surroundings and will worsen water restrictions.

- It is disingenuous to claim that water will be obtained separately from Tantangera Dam. ActewAGL is eying the Tantangera supply already for use by Canberra residents. ActewAGL will be in competition with itself and with any other user of scarce supply in the Murray Darling Basin in its bid for water supply from Tantangera earmarked for this power plant.

- If ActewAGL would obtain water supply from Tantangera earmarked for the power plant, it is unclear how ActewAGL will separate it from supply for Canberra residents. Unless there is substantial new investment in infrastructure, ActewAGL will have to use the same supply and purification channels. It is also unclear how ActewAGL wil manage priorities of supply with the certainty of forthcoming and ongoing scarcity problems. Will supply for the power plant have priority over residents?

PRESSURE ON AIRPORT NOISE CORRIDOR AND FLIGHT PATHS

- The plan does not contain a risk assessment of thermal turbulence to commercial and private aviation. The plant is designed for frequent stop-start operations and may well be called upon to operate, frequently, unscheduled, at peak power. Yet there is no assessment whether/how thermal turbulence from the plant will affect private and jet flights in and out of Canberra Airport. The plant will be located about 2 km from the western edge of the Canberra Airport noise corridor, about 3 km to the west of the departure trajectory and about 4 km to the west of the landing trajectory. Any substantial thermal turbulence risk will push aircraft movements away from the western part of the noise corridor. Proposed residential development in Tralee, Environa and the Poplars, outside control of the ACT government, will increase pressure to limit aircraft movements in the central and eastern parts of the noise corridor. The unavoidable effect will be increased noise pollution for Jerrabombera residents and the wider Canberra community.

QUESTIONABLE ECONOMICS

- The location of the power plant minimises distance to existing power infrastructure (high-voltage power lines, gas lines, water mains). ActewAGL is minimising its infrastructure costs, yet it charges its customers a fixed abstraction charge for provision of infrastructure.

- Frequent start-stop operation of the power plant has little to do with power provision for the data hub ─ its energy requirements are entirely predictable. It has more to do with ActewAGL minimising its exposure to spot prices on the energy markets at times of unforeseen energy demand from ACT consumers.

- Forthcoming tax and other charges on greenhouse gas pollution will negatively affect the economics of the power plant. ActewAGL may well be forced to chase spot price delivery to the national grid, increasing operational usage at the cost of noise and toxic gas pollution of Canberra residents.

- If not forced economically, urgent national demand in times of scarcity may force the plant to operate at far higher usage, if not peak level, than local supply requires.

- Nothing may stop ActewAGL management to chase spot price delivery to the national grid, just to increase its financial bottom line. If not management policy, it may be the operator-on-duty who is chasing spot-price delivery to increase their performance bonus.

MISSED OPPORTUNITIES

- Canberra is the birthplace of at least three concepts that are going to, or can, make a substantial contribution to averting the global crisis of climate change: CO_2 geo-sequestration (Dr Peter Cook); geothermal energy from hot-fractured-rocks (Dr Doone Wyborn and Dr Prame Chopra); solar thermal energy (Dr Keith Lovegrove). The former concept cares for reducing greenhouse gas emissions. The latter two concepts will provide pollution-free renewable base-load energy. Energy from hot-fractured rocks is within a few months of establishing proof-of-concept through Geodynamics. There are reasonable expectations of delivery, on a decade timescale, of 10,000 eMW of pollution-free renewable energy from the Cooper Basin alone. ActewAGL could secure a share of supply, just like its main competitor, Origin Energy, has done. The ACT has a substantial budget surplus. As half-owner of ActewAGL it could invest part of its surplus in the development of HFR and other base-load renewable energy supplies, meanwhile sparing it having to contribute to a 2 billion dollar polluter. In building on these home-grown concepts the ACT government would be seen as an innovative world leader in combating climate change. Yet in building a polluting gas-fired power plant virtually at the doorsteps of its residents, Canberra risks to become known as Australia's pollution capital.

I do strongly object to the time limit placed on the consultation process. I only became aware of this serious issue on return from a short geological fieldtrip on Thursday the

24th of April. During a public meeting on Monday the 28th of April I was left with the understanding that an extension of the consultation process would be sought. I only came to understand this morning that this has not materialized and that the deadline of submission is today, the 5th of May. This may well be the day that the Dutch celebrate victory in their fight against (foreign) government suppression, but this unreasonable ─ if not mischievously ─ short deadline does not help in researching and preparing a sound submission. From all what I can gather there is far more expertise available within the Canberra community than what has been called upon in this ActewAGL planning process. Short-circuiting of normal community consultation procedures is concerning, the more so with ActewAGL management proving singularly unable to answer questions at the public meeting on Monday the 28th of April. It may have been brave of management to show up at a hostile community meeting, but I left the meeting with the disquieting feeling that the planning process was severely lacking in factual knowledge and foresight.

For the record. I am a live-long research scientist with a geological/geophysical background. I am a Honorary Visiting Fellow at the Research School of Earth Science of the Australian National University, but stress that I speak here privately and in no relation whatsoever to the ANU. I am a shareholder of Geodynamics.

Dr Chris Klootwijk

Objection #2, lodged with ACTPLA on 26/05/2008

OBJECTION
Proposed development ─ Block 1671 Tuggeranong
210 Mw Gas Turbine Power Station and Communications facility

This is an objection to both the Development Application and the Preliminary Assessment. This adds to my initial objection submitted on 5/5/2008. I add a copy of my initial objection hereafter for convenience.

In this additional objection I further discuss previously raised points, add concerns on acid rain and security of location, and provide references:

NATIONAL & GLOBAL CONCERNS

Carbon dioxide emissions ActewAGL's planning documents do not show plans for capture and sequestration of CO_2. Carbon dioxide is the greenhouse gas that is mainly responsible for accelerating global warming and an impending global climate crisis of increasingly alarming magnitude and speed. Data provided indicate at peak output an emission rate of 3000 tons of CO_2 per day. This surely will not help Australia to reach its Kyoto target, nor its commitment to 60% reduction of CO_2 emissions by 2050. Neither to reach reductions of 70% to 90% called for by the Garnaut review [1]. With the ACT's power plant increasing total emissions for Australia, other states will have to go through more pain to reduce their emissions. Is the ACT's approach a fair one to an Australia-wide and global problem? Should or would the Commonwealth Government let its territory get away with it? Will future climate-change legislation allow the ACT to operate this plant in this way? These are questions to be addressed more widely than just within the ACT.

On a more pedestrian note, with CO_2 emission charges expected in the range of $20-$40/ton (carbon trading has started in Australia at $19/ton [19/5/2008], European trading is currently at about 20 Euro/ton], a daily bill of $60,000 to $120,000 will not be kind to ActewAGL's bottom line. The plant may only be economical in chasing the lucrative spot market. This would mean running the plant up to peak capacity, often and for prolonged periods. ActewAGL management has informed concerned residents that the plant would only occasionally run at peak capacity. This may be their intention, but will their intention be maintainable in the face of adverse economics? Capture of CO_2 emissions is expected to reduce power output by more than 30%. Retaining a peak output of 210 eMW would require installation of additional power plant facilities with an output of about 70 eMW. In turn this would increase other emissions, such as nitrous oxides by more than 30% ─ unless scrubbing for nitrous oxides and also sulphur oxides is installed, in turn further reducing output.

The ACT, Australia and the world are facing an unprecedented challenge to reduce CO_2 emissions. It is highly irresponsible to install a substantial CO_2 emitter, it is even more irresponsible to not plan for CO_2 capture. On this ground alone this Development Application should not be allowed to proceed. There surely are realistic renewable energy alternatives but this Development Application has not addressed alternatives in any serious way.

REGIONAL CONCERNS, ACT, NSW, KOSCIUSKO NATIONAL PARK

Acid Rain Acid rain develops from nitrous oxides and sulphur oxides mainly produced by cars, fossil fuel burning power plants and lightning [2][3] ─ the ACT and surroundings experience frequent summer lightning. Acid rain becomes a problem on the ground when a region has insufficient capacity for NO_2 uptake by vegetation and soil and/or insufficient natural alkaline capacity to neutralize acidity. Capacity for NO_2 uptake by vegetation is a contentious issue [4] ─ vegetation may be a net emitter or a net absorber.

The ACT, and its upstream water catchment in adjacent NSW and in the Kosciusko National Park, has little natural capacity for neutralizing acid rain. The geology of this region consists mainly of acid volcanics and acid granites with only very limited occurrence of carbonates (limestone). The nearest substantial carbonate deposits are more than 50 km from Canberra. Carbonate deposits near Yass and Taemas are downstream of the ACT and carbonates at Blue Water Hole and near Wee Jasper are outside the ACT water catchment. These carbonate deposits do nothing to buffer alkalinity in ACT water streams. There is a carbonate deposit of some note upstream of the ACT near Bredbo, but its size is not comparable to the Wee Jasper deposit.

This precarious geological situation ─ lack of sizable carbonate deposits and abundance of acid rocks ─ is comparable to eastern North America [3], a region with wide regions of bedrock, exposed from land-ice scraping during the last ice age, with precariously little carbonate deposits. It was here that acid rain was first recognised as a serious problem and traced to emissions of major power plants. Surely the proposed power plant in Tuggeranong may not be of the size of power plants in North America, but accumulation of pollutants over time has to be considered. It is a question of maintaining or exceeding balance.

Can balance be maintained or will accumulation of acid rain agents over time run out of control? Present levels of nitrous oxides and sulphur oxides may be below the critical load of the ACT region, so there may be no noticeable occurrence of acid rain. However, it is open to questioning whether this will remain so with the additional emissions from ActewAGL's gas-fired power plant. The plant's emission of nitrous oxides is considerable according to the DA documentation provided by ActewAGL. Emission of sulphur oxides, another contributor to acid rain, is not even addressed in the Development Application. Why not? Yet such emissions are to be expected from to-be-supplied coals seam gas. Coal contains sulphur and gas extracted from coal will contain sulphur. Amounts will vary with the particular coal seam that is mined.

If the power plant's contributions increase nitrous oxides and sulphur oxides concentrations above the critical load factor, then acid rain development will get out of control. We will then experience slow acidification of streams in the ACT and slow acidification of the ACT water supply. Vegetation will start dying back with dire consequences for the Kosciusko National Park and the Namadgi National Park, for the extensive government and private plantations in the region and for frequency and magnitude of bushfires. When the cause of such disasters is traced back, who is going to compensate whom? Will the ACT government have to compensate the NSW government? Will ActewAGL have to compensate private investors in plantations?

In absence of a widely present natural alkaline buffer, it is not clear what capacity or capability the ACT has to prevent acid rain developing other than through removal of nitrous oxides and sulphur oxides from the exhaust stacks. However this will reduce the power output. Anticipated Commonwealth Government requirements to limit carbon dioxide emissions will further reduce the power output. Conceivable, the plant may sooner or later cease to be economical and may have to shut down in favour of more economical renewable energy alternatives. Such alternatives are becoming realistic options that can be implemented in time frames of years, far less time than realization of carbon geo-sequestration, and should be seriously researched now!

LOCAL CONCERNS

Nitrous oxides and other impurities ActewAGL's exhaust plume study concludes to an expected maximum concentration of nitrous oxides at ground level of 245 microgram/m^3. Its executives claim this to comply with the maximum allowable level (246) set by the NSW EPA. It is very brave, if not foolish, to claim a margin of less than half of one percent as safe, the more because of obvious inadequacies in the plume study:

(a) The study used a numerical model (AUSPLUME) that is described in readily available literature as inappropriate for the valley-and-ridge topography of the proposed Tuggeranong site and as underestimating emissions in case of such considerable topography [5][6]. AUSPLUME is also described as to inadequately model dispersion in extreme (high) concentrations for point sources with stack heights less than 100 m and for dispersion in complex terrain such as plume impact on hills [7][8];

(b) The study did not include on-site meteorological data even though ActewAGL has demonstrated its capacity to obtain such data by carrying out extensive wind studies for potential location of wind farms. Local wind data are important in case of the valley-and-ridge topography of the proposed Tuggeranong site and are known to lead to better model performance [9];

(c) The study did not consider present or future variations in nitrous oxides, sulphur oxides and other impurities of to-be-supplied coal seam gas, sourced from varying deposits and basins. This is not an inconsequential issue. Coal seam gas is extracted from coal seams and will reflect the level and kind of impurities of the coal that is being fractured (in-situ) in the extraction process [10]. Without wanting to be alarmist it should be pointed out that NSW coal is known for average concentrations of Naturally Occurring Radioactive Materials (NORM's) – Uranium, Thorium and Radon to mention a few – that are 2 to 10 times higher than Queensland coal [11].

Background level NOx

The Plume study by SDA ENGINEERING used a background level for nitrous oxide of 75.6 microgram/m^3. However the latest Capital Territory Ambient Air Quality Report (2006) [12] details a background level of 0.044 ppm for 2006. Average background level for the period 1998-2006, the 2003 bushfire year excluded, is 0.04375. The 2006 value of 0.044 ppm therefore is quite representative. The two above values equate at standard P & T to 90.32 microgram/m^3 and 89.9

microgram/m^3 respectively. Taking 90 microgram/m^3 as representative, and substituting this for the value of 75.6 used in the plume study makes for a worst-case scenario that exceeds the NSW EPA maximum by more than14 microgram/m^3. This is totally unacceptable, the more so because the NSW EPA maximum (246 microgram/m^3) exceeds maxima set by other states in Australia and countries overseas.

Sulphur dioxide emission data not provided
The DA and PA documents provide no data on sulphur emissions. Yet coals seam gas is know to contain sulphur and SO_2 formed from burning of coals seam gas is a known contributor to formation of acid rain. Provision of data on SO_2 emissions is essential to ascertain acid rain potential within the ACT, surrounding NSW and the Kosciusko and Namadgi National Parks. See my point above on acid rain.

Turbine emission specifications at 630 m altitude
It is unclear whether the DA emission data are based on actual performance data of the Titan turbines at an altitude of 630 m or whether they are extrapolated from operational observations at lower altitudes. If the latter, what are the expected error ranges and confidence levels for emissions?

Dangerous topography The proposed Tuggeranong site is near the upper parts of three populated valleys – Jerrabombera, Tuggeranong and Woden – and close to Isaacs Ridge. This is an unusual and inadequate site and could be considered as one of the worst possible locations for a power plant. Fossil fuel power plants are generally located on open plains for best control on size and shape of the exhaust plume and expanding plume head. Possible effects of eddies, downwind of Isaacs Ridge, for trapping of nitrous oxides and incomplete combustion of toxic gases have not been addressed in reports filed for consideration by the Community or ACTPLA. The presence of secondary ridges ─ shooting from Isaacs Ridge, between Macarthur and Fadden, between Fadden and Wanniassa and between Wanniassa and Farrer ─ further increases potential for eddy formation and gas entrapment.

You do not have to be a rocket scientist, or even a mere rock scientist, to appreciate the dangers of eddies. Downwind eddy-potential of the Tuggeranong site, with its highly unusual topography for a polluting power plant, warrants detailed, on-site, study of expected concentrations of nitrous oxides and sulphur oxides at ground level, of potential for incomplete combustion of carbon monoxide trapped within eddies, and of potential for eddies to preferentially dump heavy NORM elements at ground level.

Affects on flight path and Canberra-Queanbeyan noise sharing The exhaust plume and spreading plume head may affect plane movements and noise sharing across Canberra and Queanbeyan. The Tuggeranong site is 2.4 km from the western edge of the Canberra Airport Noise Corridor [13], about 3.5 km from the main airport departure trajectory and 4.7 km from the main landing trajectory [14][15]. Planes may have to avoid the western edge of the corridor in order to avoid turbulence and pollutants within the plume head (if not, frequent flyers may soon start referring to the customarily experienced shake and smell as the Canberra-Hump-And-Dump and to Canberra as the Humpty-Dumpty Capital). However, extended and frequent use of the central and eastern parts of the corridor is already under threat by

the proposed developments of Tralee, Environa and The Poplars [16] – within NSW and outside direct control of the ACT government. Pressure may increase for noise sharing across Canberra and Queanbeyan.

Security of location ActewAGL told the Tuggeranong community at a briefing of concerned residents (28/4/2008) about possible security requirements for the data centre. Data from the Department of Defence could be stored there amongst others. Is a site opposite the Mugga Lane landfill really secure? This landfill has an extensive network of pipes, burrowed through the landfill for extraction of methane. This is environmentally beneficial, but also dangerous as a ready-made terrorism target. The network of pipes could easily be used in reverse to pump an explosive mixture through the landfill or to dump explosives directly down the pipes ─ a worrying prospect for an adjacent 2 billion dollar plant complex and its gas mains. Preventive plugging of the pipes has downsides too. It would remove a potential methane-generated energy supply for the power plant. The landfill site, thoroughly primed for flow, would keep accumulating methane, a greenhouse gas with more than twenty times the potency of CO_2.

Power requirements The planning documents fail to properly point out the power requirements for the data centre and for the ACT that would justify construction of a 210 eMW power plant. In absence of such justification, and with apparent up-scaling from a supposed previously proposed power plant in Hume proper, the proposal reeks of stacking as many power modules on the proposed Tuggeranong site as ActewAGL can get away with under health and safety regulations. Surely there must be better justification to risk live and well-being of the Canberra and Queanbeyan populations rather than the maximising of ActewAGL's corporate profits and a flawed health risk analysis.

Cogeneration myths The article in the Financial Times London (14/05/2008), reprinted in the Canberra Times (24/05/2008, News p11) sheds a different light on what may have prompted the cogeneration of power plant and data centre, promoted as essential by ActewAGL. Rather than being an established essential requirement "Jeremy Green, principal analyst at Ovum, says that while the idea of siting energy-intensive activities close to power stations is ""not uncommon"" he believes this may be the first time it has been done with a large data centre". This refutes ActewAGL's argument that co-generation is a vital requirement for the data centre. If large data centres can operates elsewhere without co-generation, then they should be able to operate in that way in the ACT.

The article also states "The decision to site the CTC next to a power station is central to its efficiency. Normally, 10 to 15 per cent of electricity is lost in transmission from the power station to the distribution grid. Because the data centre will draw its energy from the adjacent power station, this energy loss is eliminated". This highlights a more believable reason for co-generation. It indicates that a single preferred client may benefit from increased efficiency and presumably cheaper rates in a sweetheart deal. A deal that is presumably not available to other off-site clients that draw electricity from this station through the grid. The estimate of 10% to 15 % savings in energy is higher than transmission losses quoted elsewhere [Geodynamics] and relates only to the particular client that happens to be on-site. Energy savings of that magnitude are not available to other off-site clients.

The article debunks the myth that co-generation is essential for operation of the data centre and shows it for it what it is, just a sweetheart deal with limited overall energy savings for the total of on-site and off-site clients.

Flawed logic in security of energy argument
The proposed power plant is promoted as a secure source of energy during a supply crisis. This argument is dangerously flawed. Times of supply crises are quite likely also times of very heavy pollution — the Canberra bushfire of 2003 is a telling example. It is irresponsible planning to have to rely in such crises on maximum output, and consequent maximum pollution, from a polluting gas-fired power plant. Under such conditions, if the background level of pollution itself is not already above the NSW EPA limits, combined background and power plant emissions surely will. Reliance should be on a non-polluting energy source instead. Health officials should be aware!

It is questionable whether it would be legal to construct and operate a power plant that is specifically meant to operate under the very conditions that would make its operation illegal. Lawyers should be aware.

Restrictions on further development
Presence of a power plant that drives pollution up to maximum allowable levels, if not above, will constrain further development in the region, certainly emission-intensive developments. Operation of the proposed Tuggeranong power plant may well pre-empt further developments in the Hume industrial area. It is hard to imagine that this could be the intention of the ACT government. Hume is a designated industrial area and is still in the process of development. The proposed power plant also may restrict light industrial and/or residential developments in the Jerrabombera, Tuggeranong and Woden valleys.

RENEWABLE ENERGY ALTERNATIVES
Provision of renewable energy has not been addressed in the Development Application as a realistic alternative to the gas-fired power plant. Conversations with ActewAGL executives during the community briefing of 17/05/2008 make me wonder whether they are sufficiently aware of renewable energy alternatives that are currently available. The ACT government should call for independent advice on renewable energy options. In my opinion, as an experienced geoscientist with an interest in renewable energy, renewable energy can provide the planned 210 eMW in combinations of intermittent and base load power:

- Energy for cooling and heating of the data centre can be provided by a geothermal heat pump system. Geoscience Australia has demonstrated the capacities of such a plant to reduce the energy requirements for a large building.

- A purpose built roof stacked with solar panels can provide the 33MW of power thought required by the data centre, during hours of sunshine. The Tuggeranong site has a total surface of 211,048.3 m^2. High performance commercially available, solar panels (Solartec [17], base pack, 6 panels over 7.2 m^2 delivering 1.29KW) can provide 33MW with a footprint of 184,186 m^2. Solar panels

currently under development, eg Prof Andrew Blakers ANU [18], will provide in the near future higher output at lower cost.

- The 210 MW peak output of the power plant can be provided additionally and/or alternatively by base load renewable energy, either through solar thermal plants such as under development at the ANU [19, Prof Keith Lovegrove] or overseas [20, Prof Andrew Mills], or through HFR geothermal plants under development in Australia [21, Geodynamics]. Canberra is the birthplace of the Hot-Fractured-Rock geothermal energy concept, conceived and now being realized by local resident Dr Prame Chopra and former resident Dr Doone Wyborn. Both have long associations with Canberra indeed – ANU graduates, BMR/AGSO employees and ANU Visiting Fellows. Their brainchild has led to an entirely new industry. Starting from scratch and evolving in less than a decade, there are now more than 30 companies exploring for geothermal energy within Australia. Exploration is expanding at astonishing pace – more than $750 million dollar of expenditure is expected for the coming year – and the world is watching what Australians are pioneering. Australia is uniquely endowed with geothermal energy resources and provision of 10,000 eMW, coming progressively on stream within decades and sustainable over at least fifty years, is projected from Geodynamics' tenements in the Cooper Basin alone [21]. To put this into proper perspective, this is the output of five large power plants of Hunter Valley size (2000 eMW), about 85% of the total power capacity of NSW in 2005[11], and close to 50 times the output of the power plant proposed by ActewAGL. Geothermal energy is shaping up as a leading opportunity to reach Australia's renewable energy target of 20% by 2020.

The ACT has the opportunity for an enormous PR coup by sourcing its new energy requirements entirely through renewable, Canberra-developed, energy sources: geothermal heat pump system (Geoscience Australia); solar panels (ANU, Prof Andrew Blakers), solar thermal (ANU, Prof Keith Lovegrove), HFR geothermal (Drs Prame Chopra and Doone Wyborn). The ACT can lead the nation by applying local innovations! What a promotion of local know-how and local can-do! What a contrast with a polluting, gas-fired, power plant! If London can become the renewable energy showpiece of the UK [22], surely Canberra as Australia's national capital can do it!

For the record: I am a life-long research scientist with a geological/geophysical background. I am a Honorary Visiting Fellow at the Research School of Earth Science of the Australian National University, but stress that I speak here privately and in no relation whatsoever to the ANU. I am holding shares in geothermal energy companies. I am a resident of Macarthur.

Dr Chris Klootwijk

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Objection #3, lodged with ACTPLA on 27/05/2008

OBJECTION
Proposed development – Block 1671 Tuggeranong
210 Mw Gas Turbine Power Station and Communications facility

This is a further objection to both the Development Application and the Preliminary Assessment and adds to my earlier objections submitted on 5/5/2008 and on 26/5/2008.

Power plant – impost on ACT net water consumption cap

It has just come to my attention (ABC local news 27/5/2008, Ross Sully reporting) that the ACT Government has negotiated with other states a cap of 40 Gl on its net water consumption from the Murray-Darling system. The proposed Tuggeranong power plant will consume 0.6 Gl, reportedly to be acquired (ActewAGL community briefing 28/4/2008) from Tantangera Dam. This water will evaporate and constitutes therefore a net impost on the consumption cap. Locking up 1.5% of the ACT's potential water usage in a power plant of disputable merits seems poor policy in itself. Renewable energy alternatives (see my objection lodged 26/5/2008) do not impose on the ACT water consumption cap and unmask such lock-up as an unacceptable proposition.

For the record: I am a life-long research scientist with a geological/geophysical background. I am a Honorary Visiting Fellow at the Research School of Earth Science of the Australian National University, but stress that I speak here privately and in no relation whatsoever to the ANU. I hold shares in geothermal energy companies. I am a resident of Macarthur.

Dr Chris Klootwijk

Objection #4, lodged with ACTPLA on 25/06/2008

OBJECTION
Proposed development – Part Block 1671 Tuggeranong
Natural Gas Co-generator Facility and Communications Facility

This is an objection to both the revised Development Application and the revised Preliminary Assessment and adds to my previous objections submitted on 5/5/2008, 26/5/2008 and 27/5/2008.

SUMMARY

- The CALPUFF model is geared for long-distance pollution studies. Usage is cautioned for near-source pollution studies, such as the Tuggeranong location. The DEM terrain dataset from geoscience Australia is too coarse and too inaccurate to confidently predict effects of Isaacs Ridge on levels and distribution of regional pollution and local pollution hotspots. Despite this deficiency the study clearly shows ridge-related pollution hotspots in Macarthur-Fadden, Wanniassa, Farrer-Mawson with an enhanced pollution spur towards Garran, Upper Mugga Lane and Hume. These hotspots are consistently identified for all four pollutants studied: NO_2, SO_2, PM_{10} and formaldehyde. These hotspots may also have higher background levels than measured at the Monash monitoring site. Background levels at the hotspots should be monitored locally and individual results applied in modelling studies. Results from the CALPUFF study should be treated as indicative only. Effects of Isaacs Ridge on distribution of pollutants should be studied using several models and their outcomes should be compared for consistency. Patterns of consistency between outcomes from different models may be interpreted more confidently. Clearly, the Tuggeranong location near Isaacs Ridge is a dangerous location for a power station.

- The Tuggeranong location near Isaacs Ridge is a worst possible location for a polluting gas-fired power station. Permanent development of pollution hotspots is a near certainty. The power station should be relocated onto an open plain whose simple terrain minimises risks for development of pollution hotspots and where shape and extent of the pollution plume can be predicted with adequate confidence. The Canberra Spatial Plan needs to be revisited regarding a perceived imbalance between requirements for preservation of open plain nature reserves (eg the proposed Callum Brae Nature Reserve) and requirements to site polluting industrial facilities at safe distances from residential developments.

- Extensive water usage in the chilled absorption process needs reconsideration in regard to the cap on net water usage in the ACT. Adding absorption chillers to the power plants' exhaust stacks may save 9MW of power, but adds substantial negatives that are not addressed in ActewAGL's planning documents. Cooling requires yearly consumption of 435 ML. The cooling water evaporates and is lost, locking up more than 1% of the ACT allocation from the Murray-Darling system. This will strain ACT water restrictions and

pricing. The water will come down from Tantangera Dam, losing its potential energy. Yet this water and its potential energy can readily be used through existing Snowy Hydro infrastructure in generating pollution-free power whilst conserving the water for the Murray-Darling. Alternative purchase of 9MW of power from Snowy Hydro means that no new investment is required for absorption chillers, steam exhaust stacks, dedicated water storage, water transport and pumping. Absence of steam reduces fog and smog potential. Absence of chillers means hotter exhaust gasses, thus stronger plume rise and less heat dissipation at ground level. Heat stress on flora and fauna will be less and so will bushfire risk. Clearly, proposed re-use of waste heat from the exhaust stacks for cooling the data centres does not "stack" up as the advantageous process promoted by ActewAGL. With so little in favour of co-location of power plant and data centres and so much against it, power for the data centres should be generated at a more appropriate off-site location.

- With global climate change galloping out of control, it is highly irresponsible to construct a gas-fired power plant which does not capture its CO_2 emissions. Operation of such a plant could become restricted under foreshadowed government requirements to reduce Australia's carbon footprint by at least 60% by 2050. The ACT government should show the foresight expected of it, follow the lead of the Queensland, Victorian, Western Australian [1][45] and New South Wales governments [33], climb out of the pockets of the fossil fuel industry, and actively pursue non-polluting renewable energy alternatives.

- The revised plan is clearly geared for up-scaling. Personal assurances to the contrary may not outlast the utterer. The only guaranty against up-scaling is down-scaling of water, gas and high-voltage grid infra-structure, commensurate with requirements for the down-scaled power station.

- NO_2 and SO_2 from the Tuggeranong power plant and the proposed peaking power plant may cause acid rain effects. The ACT and adjacent NSW is nearly entirely made up of acid volcanics and acid granites with very little limestone deposits and thus little capacity for alkaline buffering against acid rain. Renewable energy alternatives need to be considered seriously.

- A full and independent Environmental Impact Study is required to address in particular: pollution dangers to residents of the Tuggeranong, Woden and Jerrabombera valleys; impost of absorption chilling on the ACT water supply; potential for acid rain damage to the ACT, nearby NSW and the Kosciusko and Namadgi National Parks.

RECOMMENDATIONS

- No polluting gas-fired power station should be allowed to operate near Isaacs Ridge because of dangers of permanent pollution hotspots.
- Arguments against co-generation far exceed arguments in favour of co-location of power station and data centres. A polluting gas-fired power station should be located off-site on an open plain
- CO_2 emissions from the power plant should be sequestered.

- Alternative sourcing of energy, in particular solar thermal and/or geothermal, should be vigorously pursued.
- A full and independent Environmental Impact Study needs to be conducted.

1 POLLUTION CONCERNS

1.1 Strength/limitations CALPUFF

CALPUFF is a puff model that is generally regarded superior to the AUSPLUME plume model. The US EPA approved CALPUFF for study of long range pollution transport beyond 50 km, but advises that use of CALPUFF at shorter distances requires approval by reviewing authorities on a case-by-case basis [2][3][4]:

[4] *"The EPA has proposed the use of CALPUFF for applications involving long-range transport, which is typically defined as transport over distances beyond 50 km. Therefore, the use of CALPUFF for EPA regulatory applications involving transport distances of less than 50 km requires approval by the relevant reviewing authorities. As described in Section 7.2.8 of the EPA's proposed Guideline on Air Quality Models, the CALPUFF model may also be used in special cases involving complex flows on a case-by-case basis with concurrence from the reviewing authorities."*

CALPUFF uses grided data [2]. Unavoidably, finer topographic detail is lost in the griding process. This drawback has the stronger negative effects on studies of pollution in complex terrain close to the pollution source. This drawback impacts in particular on study of the effects that Isaacs Ridge and offshoot ridges have on distribution of pollution from the Tuggeranong power plant.

Evaluation of CALPUFF pollution predictions against observations and also against predictions from other models calls for vigilance in interpreting modelled outcomes. An US analysis of CALPUFF by Chang and co-workers in 2003 [5][6] found results to be heavily dependent on the wind field model used (note that the present CALPUFF study lacks on-site wind data), had a mean bias within 35%, had random scatters of a factor 3-4, and no more than 50-60% of CALPUFF's predictions were within a factor of 2 of observations. An Australian evaluation of CALPUFF and comparison with AUSPLUME and TAPM by Dr Hurley and co-workers of the CSIRO Division of Atmospheric Research [7][8][9] documents several cases of considerable underestimation of observed pollution by both AUSPLUME and CALPUFF and also a case of extreme overestimation by CALPUFF. Hurley argues that CALPUFF should be used with caution [9].

On the strength of these evaluation studies and US EPA guidelines for usage, the outcomes of the present CALPUFF study should be treated with considerable caution. Further caution is required because the CALPUFF modelling of complex terrain effects was based on a topographic dataset that was too widely grided and too inaccurate in altitude to adequately represent the complex terrain of Isaacs Ridge.

1.2 Inadequate topographic data

The CALPUFF study underestimates effects of Canberra's valleys and ridges on pollution hotspots. Modelling of pollutants distributions suffers from poor location

and altitude sampling of the complex terrain of Isaacs Ridge and associated ridge offshoots. Terrain values are based on a US Geological Survey dataset with a resolution no better than 1 km and on a Digital Elevation Model (DEM) from Geoscience Australia with a resolution no better than 250 m. Such wide sampling smooths Canberra-type topography by reducing terrain steepness through lowering and uplifting of adjacent hill and valley sections respectively. Sampling representation is worsened by accuracy limitations of the DEM data, obtained from a fixed-wing aircraft engaged in other geophysical studies. Locations have accuracy common for 1:250,000 scale maps (Canberra maps are generally at 1:25,000 scale and some may be at 1:10,000 scale) and altitudes have an average root mean square error of 20 m and up to 200 m in steep terrain [10]. Such a coarse and crude topographic dataset poorly identifies pollution hotspots and underestimates levels of pollution.

The rationale for usage of such a coarse and crude datasets is not presented in the pollution study. The consortium may well have had access to a more refined topographic dataset. On the second Community Consultation Meeting organised by ActewAGL (15/6/2008) a detailed drive-trough GIS panoramic study was shown on a wide screen. The level of local detail in topography was considerable and suggests that is was derived from a topographic dataset more detailed than the DEM from Geoscience Australia. Why was this more detailed dataset not used in the CALPUFF study? If CALPUFF cannot handle higher resolution datasets then it is not well suited to determine pollution distributions and pollution levels for the complex terrain of Isaacs Ridge and ridge offshoots between Macarthur-Fadden, Fadden-Wanniassa and Wanniassa-Farrer. If CALPUFF can handle detailed topographic data then available detailed datasets should be used for proper evaluation of pollution risks.

CALPUFF requires grided terrain datasets [2]. It is unavoidable that finer detail of complex terrain is lost in the griding process, irrespective of the scale of the dataset. This is a serious drawback for proper analysis of effects of pollution by nearby complex terrain, such as around Isaacs Ridge and offshoots ridges. Usage of a grided, and therefore flattened, topographic dataset in the CALPUFF pollution study unavoidably leads to underestimation of levels of pollution levels. Locations of the more substantial pollution hotspots may be less affected.

1.3 Inadequate meteorological data

The CALPUFF study relies on meteorological observations from stations at Canberra Airport and Tuggeranong Hill. This is some improvement over the AUSPLUME study that relied on data from Wagga Wagga. However, the CALPUFF study, like the AUSPLUME study, suffers from absence of local meteorological observations, covering block 1610 and other areas in the Isaacs Ridge, Long Gully Road and Mugga Lane precinct. This is a region of complex terrain, its meteorological behaviour has to be properly observed and cannot be extrapolated with sufficient confidence from other stations. Local observations should cover a substantial, representative, period. The US EPA recommends for CALPUFF studies a five year observation record:

[4] *"For a regulatory analysis, such as that supporting a permit to construct a source of air pollution, the considerations regarding the length of meteorological period are similar when applying CALPUFF in screening mode as when applying other models. The EPA's Guideline on Air Quality Models prescribes the use of five continuous*

years of representative meteorological data. Also, the Interagency Workgroup on Air Quality Modeling (sic) *(IWAQM) demonstrated the year-to-year variability in CALPUFF screening impacts using a five-year meteorological period in their Phase II report. Based on this demonstration, IWAQM also recommends that five years of meteorological data should be used with CALPUFF in the screening mode in order to identify long-range transport impacts that could reasonably be considered to be the highest."*

[11] *"Five consecutive years of the most recent representative sequential hourly National Weather Service (NWS) data, or one or more years of hourly sequential on-site data."*

However, the present CALPUFF study relied on a one-year only record from an off-site location, Tuggeranong Hill.

1.4 Pollution studies on the run

Blind Freddy can see that the complex terrain of the Tuggeranong location is highly unusual for a power station and that such complex terrain requires adequate local topographic and meteorological input to safeguard local residents from adverse impacts. Yet local input is manifestly lacking in the present CALPUFF study. Use of off-the-shelf datasets in both the CALPUFF and AUSPLUME pollution studies are poor examples of studies on the run. These studies do not, and can not respond adequately, to the legitimate health concerns of local residents. ActewAGL has to collect for the specific purpose of pollution studies, local topographic and meteorological data, spanning a representative period and adequately covering the areas of concern. Anything less constitutes shoddy practices and whitewashing attitudes.

1.5 Pollution hotspots

The present CALPUFF study in all its crudeness clearly establishes Isaacs Ridge-related pollution hotspots in Macarthur-Fadden, Wanniassa, and Farrer-Mawson with a spur towards the Garran hospital [12]. There are further pollution hotspots in the upper part of Mugga Lane and in Hume. A broad swath of enhanced pollution extends from Isaacs Ridge westwards towards the Tuggeranong town centre-Kambah region and another broad swath extends from Isaacs Ridge to southern Jerrabombera. The location of the pollution hotspots is consistent for all four pollutants studied, eg: NO_2 [12, fig. 7.1]; SO2 [12, fig. 7.3]; PM_{10} [12, fig. 7.6]; formaldehyde [12, fig. 7.8]. These pollution hotspots are most worrying, foremost for potential health effects on local residents, but also for potential local acid rain effects, and not unimaginably for possible dumping from local ridge-confined eddies of heavy Uranium particulates and/or heavy gaseous elements from Naturally Occurring Radioactive Materials (NORM's, see my objection lodged on 26/05/2008 [13]). The message is loud and clear. Better be safe than sorry. Relocate the power station away from Isaacs Ridge, onto an open plain.

1.6 Monitoring background levels at individual pollution hotspots

The same complex terrain that leads to pollution hotspots from the power station also may lead to similarly located hotspots containing pollution from other industrial and residential activities in the Tuggeranong, Woden and Jerrabombera valleys. This requires ongoing monitoring of "background" pollution levels, locally at identified

pollution hotspots. Justification has to be demonstrated, not just assumed, for application of a regionally uniform background pollution level in any pollution study.

1.7 Cumulative pollution levels: background & co-generator & peaking plant

Outgoing CEO and incoming chairman of ActewAGL, John Mackay, is quoted in the Canberra Times of 21/06/2008 [14] as saying:

"After this project is sorted out the consortium will go straight back to the peaker plant".... "He believes there are only six sites for a peaker plant including the four which were assessed for the Tuggeranong power station. The remaining two are the former Hume timber mill and the old abattoirs at Oaks estate near Queanbeyan"

This means five of the six sites under consideration by ActewAGL for a peaking plant are in the vicinity of the co-generator with some in the immediate vicinity. Pollution hotspots for the co-generator identified in the present CALPUFF study ─ Macarthur-Fadden, Wanniassa, Farrer-Mawson towards Garran, Mugga Valley and Hume ─ are also likely hotspots for background pollution and also for pollution from the proposed peaking plant. Residents in these pollution hotspots may have to bear the cumulative effects from two, and possibly three, sources of enhanced pollution. Very worrying are various statements by the incoming CEO of ActewAGL, Michael Costello, about increasing the output of peaking plant from 100 MW in the original proposal to 350 to 450 MW or 400 to 600 MW [15] with consequent increases in pollution.

[15] *"Mr Costello said the consortium was told three weeks ago a 100MW peaking station was commercially unviable. He said the firm spent weeks perusing other options before making the announcement to scrap the peaking station on the Tuggeranong site and scale down the data centre.""It's too small. It has to be 350 to 450 [megawatts] so that site was not suitable whether there were protests or not,'" 'Mr Costello said. He said ActewAGL was committed to building a 400-600MW gas power station in Canberra, but it would be well away from town centres."*

These kind of planning attitudes demonstrate insensitivity of ActewAGL management for the wellbeing of local residents and may border on criminal negligence.

As if three sources of pollution were not already bad enough, an ACTPLA planning report on development of the Hume Industrial Estate, obtained under an FOI request, proposes two sites along Isabella Drive, just east of Macarthur-Gilmore, as likely sites for a cemetery [16]. Possible extension with a crematorium would add a further source of pollution for the region and in particular for the above identified pollution hotspots.

1.8 Variability in polluting content of sourced gas

The CALPUFF plume study only considers a single natural gas source, it is unclear whether it represents gas from the Moomba gas field or from gas fields in Bass Strait.

*"**EXECUTIVE SUMMARY***
ActewAGL proposes to construct and operate a natural gas-fired cogeneration facility in Tuggeranong, Australian Capital Territory. This project involves installing three

Caterpillar Titan 130-20501S Axial Gas Turbine Generators. ***Each unit has a rated output of 14 MW and uses natural gas as its sole fuel source.*** *The intended capacity of the facility is 28MW continuous electrical generation provided by the operation of two gas turbines, the additional gas turbine will be employed as a standby."*

However, it highly likely that over the lifespan of the power plant coal seam gas from Queensland and New South Wales coal basins will be used as sources. I have pointed in my objection of 26/5/2008 to variations in impurities of coal seam gas sources and in particular to higher concentrations of Naturally Occurring Radioactive Materials (NORM's) in NSW coal fields compared with Queensland coal fields. Such variability in gaseous and particulate content is not addressed in the present CALPUFF plume study, but is likely to affect content and level of pollution. Study results therefore have to be treated with considerable caution.

Gas sourced from the Moomba gas field is well known for its very high CO_2 content in comparison to other gas sources [17]. Apparently it is such an embarrassment for the operator of the gas field that SANTOS has offered to geo-sequester the CO_2 gas captured by their client consumers [18][19]. It is not clear from the present CALPUFF pollution study whether this very high CO_2 content of the Moomba gas is used in the quoted figure for the Tuggeranong power plant's CO_2 emission of 188 Kt $CO_{2\text{-}e}$/yr. It has to be clarified whether the figure used properly represents expected emissions rather than an underestimation based merely on an undisclosed average gas composition.

1.9 Inter-comparison of diverse model predictions

The CALPUFF model outcomes on distribution and level of pollution and location of pollution hotspots should not be treated as hard facts. The above concerns do warrant their usage for indicative purposes only. Outcomes of different models, such as AUSPLUME, CALPUFF, TAPM, AERMOD, that show consistency can be interpreted with greater confidence. The dangerous location of the power plant in the near vicinity of the complex topography of Isaacs Ridge system requires such inter-comparison. The CSIRO Division of Atmospheric Research has the expertise to inter-compare numerical modelling studies. Follow-up analogue studies can be undertaken at the Geophysical Fluids Laboratory of the Research School of Earth Sciences, ANU. Relocation of the power plant to an open plain environment will reduce the need for elaborate modelling studies.

2 SECURITY OF GAS SUPPLY MYTH

The development consortium advances security of gas supply as a major reason to supply the data centres with gas-fired power. However, Australia has experienced three major explosions in gas distribution systems over the past decade alone. The Esso Longford gas explosion in Melbourne (25/9/1998 [20]) and the Apache Energy Varanus Island gas explosion (03/06/2008 [21][22]) caused major and prolonged disruption to gas supplies in Victoria and Western Australia. The Moomba gas plant, the proposed supplier of gas for the Tuggeranong power plant, suffered a gas explosion on New Years Day 2004 [23][24] that caused substantial supply problems [25].

Mining of coal seam gas is not without danger either as evidenced by the more than occasional occurrence of coal mining incidents [26][27]. In contrast, the Australian national electricity grid has no record of outages of magnitudes experienced with gas explosions as described above. This exposes the argument of security of gas supply as an unjustified, if not dangerous, myth.

3 POLLUTING POWER PLANTS BEST LOCATED AT SEA-LEVEL

The Tuggeranong power plant will be located at an altitude of about 630 m and will operate in a temperature range between -5°C and +40°C. Air at 630 m of altitude is more than 7% less dense than air at sea-level [28]. The quoted temperature variations will cause a further 13% variation in air density [28]. The two effects are cumulative. On a hot afternoon, the air around the power plant could be up to 20% less dense than air at sea-level. Yet, the power plant will emit the same amount of pollutants as at sea-level. Air that is 20% less dense will thus be 20% more polluted. People breathing this less dense air will have to breathe greater volumes for the same oxygenation, thus will breathe 20% more pollution!

No data are provided regarded anticipated performance of the Titan turbines at an altitude of 630 m. Pollution characteristics may be equivalent to operation at sea-level, but could be worse.

Clearly polluting power plants are best located at sea-level where the air has optimal density and where temperatures vary within the limited range of a sea-climate. That is where the major power plants in NSW are located, namely in the lower Hunter Valley and near Lake Macquarie. Operation of a polluting gas-fired power plant at the altitude of the ACT and across the wide temperature range of ACT's land climate is a poor choice of options.

4 MANIPULATION OF BACKGROUND POLLUTION LEVELS

The original AUSPLUME pollution study applied a background level for nitrous dioxide (NO_2) of 75.6 microgram/m^3. The source of this figure could not be established. The CALPUFF pollution study in the revised plan applies a NO_2 background level of 131 microgram/m^3. This represents the highest one-hour-average recorded by the Monash monitoring station during the 2003 bushfires. Capital Territory Ambient Air Quality Reports [29] data show an average background level of NO_2 for the period 1998-2006 of 89.8 microgram/m^3 (see my objection of 26/05/2008), with data for the bushfire year 2003 excluded as non-representative.

It is inconsequential to apply an unrepresentatively low background level of NO_2 in the AUSPLUME study of the original plan and an unrepresentatively high background level of NO_2 in the CALPUFF study of the revised plan. This practice reeks of data manipulation ─ in the original study to keep worst case scenario emissions of the larger power plant just below the NSW EPA allowable maximum of 246 microgram/m^3 ─ in the revised study to belittle potential health effects of the emissions of the scaled-down power plant.

ActewAGL cannot have it both ways. The CTAAQR average background level of 89.8 microgram/m^3 should have been applied in both studies.

5 IMPOST ON ACT NET WATER CONSUMPTION

The ACT government and other state ministers agreed in late May 2008 to cap the ACT net water consumption from the Murray-Darling system to 40GL/yr. The revised power plant will consume 435 ML/yr in a process that re-uses heat from the exhaust stacks to drive absorption chillers. This water is said to be acquired (ActewAGL community briefing 28/4/2008) from Tantangera Dam so as not to strain the ACT's own water supply. However, buying increasingly scarce water from the Snowy Mountains, if available at all, will not be cheap.

The cooling procedure is promoted to save 9MW in power from the electricity grid. However, it is not reported that the 435 ML will evaporate and be lost, thus locking up more than 1% of the ACT's allowed net water consumption from the Murray-Darling system. Such a loss will strain water pricing by ActewAGL and will strain water restrictions in the ACT. Lost also is the potential energy of the water stored at altitude in the Snowy Mountains. The water will just flow down the Murrumbidgee or be piped down to the ACT. However, the potential energy of this water can readily be used through the Snowy Hydro scheme for generation of pollution-free power, potentially in multiple cycles of pumped storage through the Tumut-3 hydro-electric station, and the water will still be available for use within the Murray-Darling system.

Alternative purchase of 9MW of power from the Snowy Hydro scheme will buy pollution-free power, will retain the water for further use and will not strain the ACT water budget. This readily available alternative also eliminates the need to install bulky absorption chillers, steam exhaust stacks, a dedicated water storage and water pumping and transport facilities. Furthermore, absence of steam will substantially reduce fog and smog potential. This alternative also reduces pollution at ground level (scenario 3 of the CALPUFF study, pp 27) because plume rise is not restricted by the absorption chillers (scenario 1). Clearly this readily available alternative is superior by far over ActewAGL's purported clever re-use of exhaust heat.

6 NO VALID ARGUMENT FOR CO-LOCATION

The above valid arguments against operation with absorption chillers also mean that there is no valid argument for co-generation and thus no valid argument for co-location of power station and data centres [30][31][32] .

[31] **"***Cogeneration (also combined heat and power, CHP) is the use of a heat engine or a power station to simultaneously generate both electricity and useful heat.... CHP is most efficient when the heat can be used on site or very close to it. Overall efficiency is reduced when the heat must be transported over longer distances."*

ActewAGL's argument for co-location of power station and data centres is based primarily on efficiency gained in re-using the power station's exhaust heat through absorption chillers for cooling of the data centres. A far lesser argument for co-location is reduction in transmission losses of electricity. If implementation of absorption chillers is not feasible because of the severe impost on the ACT's net water allocation, then the argument for co-location of power station and data centres will hinge solely on reduction in transmission losses. Any user of electricity and any producer of electricity faces such losses. Such losses do not constitute a valid argument for co-location of power station and data centres on the same site. As is

happening anywhere else, power can be generated very effectively off-site, limiting pollution dangers for local residents.

ActewAGL's arguments for co-location of power station and data centres and the ACT's government support for a polluting gas-fired plant as the territory's first independent energy source are in stark contrast to the energy policy of the NSW government. In a policy approach that leaves ActewAGL and the ACT government squarely in the Luddite corner, the NSW government will supply energy for the Sydney desalination plant from the 63 turbine Capital Wind Farm that is currently under construction in Bungendore [33]. This $1.7 billion desalination project is comparable in cost to the original ($2 billion) and scaled-down ($1 billion) power station cum data centres project. Energy demands of the NSW desalination plant and the ACT project are also comparable, 210/28 MW versus the output of 63 wind turbines. If the NSW project can operate with non-polluting renewable power that is generated off-site, so should the ACT project be able to operate. It all boils down to the political will to go for non-polluting power sources "*that do not produce a single kilogram of CO_2 emissions"* [34] and do not further aggravate global climate change. The NSW government's approach leaves the credibility of ACT government's climate change approach in tatters. ACT residents will suffer the polluting consequences of poor government policy.

7 EVIDENT POTENTIAL FOR UPSCALING

The revised plan scaled down the data centres from 13 to 8 by omitting the southernmost 5 data centres. The size of the block on offer was reduced by omitting its southernmost part. The size of the power station was scaled down to 3 turbines and 3 chillers and these were moved disingenuously about 150 m southwards and about 100 m closer to Tuggeranong residents. A secure holding area was created. Its size is large enough to fit the original 9 turbine power station. The revised plan states that the secure holding area is required for construction purposes. This looks like a smokescreen. No such holding area was envisaged in the original plan even though this required more extensive construction.

There has been no downsizing of gas pipes, water mains or high voltage power lines. They are all the same as in the original plan. Clearly, the scaled-down setup of the revised plan can painlessly be up-scaled into the originally planned set-up. Up-scaling can be extended even further and farther into adjacent parts of block 1610 that were not included in the original plan. This has transpired from communications from the deputy chief of the Chief Minister's department [35], obtained under an FOI request.

Assurances that up-scaling of the power plant would not occur at the proposed site are not believable when infrastructure is not reduced commensurate with requirements for the scaled-down power station.

8 HEAT DISSIPATION INTO ADJACENT BUSHLAND

Co-location of the gas-fired power station and the data centres means that both the heat from the electricity generation and the heat from the electricity consumption are dissipating at the same time at the same location. This is a highly unusual situation. The power station will generate from at least 2 turbines at least 28 eMW for use by

the data centres. Further energy equivalent to another 9 eMW will be generated from the absorption chillers. According to Canberra Technology City's documentation on co-generation, handed out at the second Community Consultation Meeting (15/06/2008 [36]), 98% of this 37 eMW will dissipate as waste heat from the data centres. This heat hardly can dissipate upwards into the plume of hot exhaust gasses. It will have to dissipate mainly at low levels into the surrounding environment of timbered broadacre land and bushland reserve. The amount of heat dissipating from nearly 37 eMW on a 24/7 basis is substantial and represents a sizable portion of electricity consumption by Canberra residents (possibly more than 30% although factual data on electricity consumption in the ACT are hard to come by for commercial-in-confidence restrictions). ActewAGL's revised development application does not address the existence, shape and magnitude of a local heat-island, nor what effects such a temperature hotspot may have on local flora and fauna and on bushfire risks.

Note that the original site investigation report prepared by Bill Guy & partners, dated November 2007, is included in the revised plan without modification. The report states that a water flux of 60 l/sec is required. This would mean ~1.9 GL on a yearly basis. Clarification is required whether the figure of 435 ML/year quoted in the main report supersedes the figure of 1.9 GL/year and also supersedes the figure of 0.6 GL/year quoted in the original plan. If a peak supply of 60 l/sec is required for fire fighting purposes then it should be clarified whether co-location of the gas-fired power station and the data centres and consequent formation of a ground-level heat-island would increase the potential for fires in the data centres.

9 GREENHOUSE GAS EMISSIONS

Emissions from the power station are estimated at 188 Kt $CO_{2\text{-}e}$/yr. This is promoted as a reduction of 56% in emissions compared with power obtained from the national electricity grid. It is also promoted as a mere 0.0336% of total Australian greenhouse gas emissions for the 2005 inventory year, estimated at 559.1 Mt $CO_{2\text{-}e}$.

This promotion reads as if the world is not facing an unprecedented climate crisis. If CO_2 emissions could be kept at their current level, it is now widely accepted that a global temperature rise could be contained to 2 °C and a sea-level rise to 6 m. The severe effects of such global changes are hard to imagine. Rise of emissions beyond these dire predictions are to be avoided at all cost. The federal government has committed to a 60% reduction in CO_2 emissions against 1990 or 2000 levels [37] and the upcoming Garnaut Report is anticipated to call for even more stringent reductions of 70% to 90%.

It is therefore more proper to describe the power station's greenhouse gas emissions (188 Kt 188 Kt $CO_{2\text{-}e}$/yr /yr) in terms of a 100% increase in emissions compared with non-polluting renewable energy options and in terms of 0.336% of the reduced Australian greenhouse emissions called for in the Garnaut Report.

If the ACT is going to **increase** its greenhouse gas emissions when emissions need to be **reduced**, other states will have to make greater sacrifices! Non-polluting renewable energy options are available (see my objection of 26/05/2008 and below) and can be pursued by a more forward looking government. The polluting option

advocated by ActewAGL would not come cheap, at an estimated 20$/t to 40$/t the 188Kt $CO_{2\text{-}e}$ emissions would come at a yearly cost of 3.8 to 7.2 million dollar. Such costs alone would make renewable energy options attractive.

10 RENEWABLE ENERGY ALTERNATIVES

I have addressed in my objection of 26/05/2008 renewable energy options as follows:

- Geothermal heat pump
- Solar photovoltaic
- Solar thermal
- Geothermal, Hot Fractured Rock

The ACT has a further non-polluting renewable energy option available, by using the Cotter catchment to generate hydro-electric power. The Cotter catchment has three dams: Corin (70.9 GL), Bendora (11.5 GL) and the Cotter (3.9 GL) [38]. Head between the Corin and Bendora dams is 173 m and head between the Bendora and Cotter dams is 280m [39], well in excess of the head of the Tumut-3 dam (150.9 m) which can deliver 1500 eMW [40]. The Cotter dam will be enlarged to 80 GL. This offers an opportunity to install a hydro-electric power station. Pumped storage from the Cotter dam into the Corin and/or Bendora dams could better aerate the proposed recycled water supply [41] from the Lower Molonglo sewerage treatment plant [42].

11 LIP SERVICE TO RENEWABLE ENERGY AND CLIMATE CHANGE

The ACT government as 50% owner of ActewAGL is paying lip service to setting and pursuing renewable energy targets and to combating climate change. Its budget papers for 2008-2009 [43][44] promote investments of 100 million dollar over the period 2008-2012 *"To Meeting the Challenges of Climate Change"* [44]. This works out as primarily an investment in tree planting (~36%), with a mere 0.4% investment into unspecified renewable energy targets, and a mere 0.07% investment into a solar farm feasibility study. In contrast, the ACT government as part owner of ActewAGL was, and still is, prepared to invest the ten times larger amount of 1 billion dollar into a polluting gas-fired power station. This disparity in financial commitments is astounding on the mere figures alone. It is even worse considering the additional damage to regional and local flora and fauna that may derive from acid rain emanating from the polluting gas-fired power station. This disparity in financial commitments certainly gives the lie to the ACT government's claim of:

*"**A Proven Commitment to Sustainability.** The Government has worked to improve sustainability since 2001-02, implementing wide-ranging actions to address climate change and committing to a reduction of 60 per cent of emission levels by 2050."*

It is telling observation that whilst the ACT government keeps promoting a polluting gas-fired power station, the premiers of Queensland and Victoria and a high-level government delegation from Western Australia are touring western North America inspecting solar thermal power stations in anticipation of construction within Australia [45].

12 LAND PLANNING PRIORITIES REQUIRE REASSESSMENT

The Hume Industrial Land Planning study [24], made available under a FOI request, proposes extension of the Hume industrial estate towards Tuggeranong suburbs, so close that a planned cemetery is to be used as a buffer between industrial development and residential suburbs.

[16] *"This study has identified Area 8E to the east of Monaro Highway as potential developable land for a cemetery site and recommends that this site be subject to a planning variation that amends the Territory Plan map and written statement 'B8'. It is proposed that Area 8E to the east of the Monaro be varied to accommodate Industrial Precinct 'a' land uses. Such a Territory Plan variation would consolidate the stretch of industrial development along the Monaro Highway, whilst also increasing the area of land available for general industrial development. The section of Area 8E to the west of the Monaro could retain its current land use zoning status or be rezoned to a broadacre land use, making provision for an alternative cemetery site. This form of land use preserves the heritage significance of Rose Cottage and provides a visual and aesthetic buffer between the Hume Industrial Area and neighbouring residential developments."*

Canberrans may well argue that a cemetery deserves more respect than to function as a buffer between industrial development and residential development.

Planning for extension of industrial development very close to Tuggeranong suburbs starkly contrasts to planning for nature reserves in the ACT, in particular for the Callum Brae Nature Reserve in Symonston [16][46]. Part of the proposed Callum Brae Nature Reserve is open plain land at considerable distances from ridges. Such land would be far better suited for a power station than the proposed location on Tuggeranong block 1610 near to Isaacs Ridge.

There may well be perfectly good arguments for safeguarding threatened flora and fauna in proposed nature reserves. There are also perfectly good arguments to safeguard the wellbeing and health of Canberra residents. Canberra planners may have to revisit their arguments for planned extension of an industrial estate cum power station up to the border of Tuggeranong suburbs, whilst planning at the same time for preservation of nature reserves in open spaces that are well away from suburbs and that are seemingly well suited for industrial development. I am a keen nature lover, yet I value my health above preservation of some valuable grasslands and protection of some threatened fauna.

13 ACID RAIN DANGERS

My objection of 26/05/2008 details the potential of a gas-fired power plant to cause acid problems within the ACT, adjacent NSW and the Kosciusko and Namadgi National Parks. My concerns related to a proposed 210 MW gas-fired power plant. The present proposal for a 28 MW power plant and a just announced plan for a 500 MW power plant on the ACT-NSW border near Williamsdale [47] seriously aggravate the potential for development of acid rain. In absence of substantial limestone deposits, the region has little capacity for alkaline buffering and acid rain problems could gallop out of control. Alternative energy sourcing from non-polluting renewable energy sources needs serious consideration.

14 ENVIRONMENTAL IMPACT STATEMENT

The points discussed above call for a full and independent Environmental Impact Study to address specifically: dangers of pollution hotspots caused by locating the co-generator close to Isaacs Ridge; impost of the absorption chilling process on water supply to the ACT; potential for development of acid rain problems in the ACT, neighbouring NSW and the Kosciusko and Namadgi National Parks.

It is inconceivable that ActewAGL has not carried out its own environmental impact study, given the proposed location of the power plant as close as about 900 m to Macarthur residents. ActewAGL's failure to carry out such a study is the more surprising with ActewAGL's outgoing CEO, John Mackay, stating on ABC Local Radio (25/06/2008) words to the effect that a proposed 500 MW peaking plant at Williamsdale is located " *about 6 kilometer from the few nearest residents"* and *"probably needs an EIS"*! [48].

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For the record: I am a life-long research scientist with a geological/geophysical background. I am a Honorary Visiting Fellow at the Research School of Earth Science of the Australian National University, but express here private views that bear no relation whatsoever to the ANU. I hold shares in geothermal energy companies and reside in Macarthur.

Dr Chris Klootwijk

Objection #5, lodged with ACTPLA on 30/06/2008

OBJECTION
Proposed development – Part Block 1671 Tuggeranong
Natural Gas Co-generator Facility and Communications Facility

This is an objection to both the revised Development Application and the revised Preliminary Assessment and adds to my previous objections submitted on 05/05/2008, 26/05/2008, 27/05/2008 and 25/06/2008.

CATASTROPHIC RELEASE OF CO_2

The proposed eight data centres (GC1*3, GC2*3, GC3*2) of Canberra Technology City's Tuggeranong plant all use substantial amounts of liquified CO_2 for cooling. Catastrophic release of this CO_2 may pose substantial dangers for the populations of Jerrabombera, Tuggeranong and Woden valleys. It is not unthinkable for a catastrophic release to occur. Co-generation causes the highly unusual situation that the heat released from generating power and the heat released from consuming this power for cooling the data centres is dissipating at the same location at the same time and will create a substantial heat island at the site (see objection dated 25/06/2008). This poses risks for an on-site generated fire. There are also substantial bushfire risks. Many bushfires have gone through the Long Gully-Mugga Lane area in the past.

Liquified CO_2 will be gassified quickly in a large-scale fire. Such a mass of CO_2 gas may undergo an initial thermal uplift but may soon descend because a CO_2 cloud is heavier than air. The cloud will hug the terrain whilst descending towards the lower parts of the topography where it will accumulate. CO_2 in substantial concentration is lethal.

[1] *"CO_2 gas has a slightly irritating odor, is colorless and heavier than air. It cannot sustain life."*

[2] *"According to occupational exposure and controlled atmosphere research into CO_2 toxicology, CO_2 is hazardous via direct toxicity at levels above 5%, concentrations not encountered in nature [except perhaps at or near an active volcano or at water-logged soils]. At these high levels there is risk of death from carbon dioxide poisoning. At lower levels there may health effects and there certainly are complaints of exposure at lower levels."*

[3] *"According to the Australian Maritime Safety Authority, "Prolonged exposure to moderate concentrations can cause acidosis and adverse effects on calcium phosphorus metabolism resulting in increased calcium deposits in soft tissue. Carbon dioxide is toxic to the heart and causes diminished contractile force. At concentrations of three per cent by volume in air, it is mildly narcotic and causes increased blood pressure and pulse rate, and causes reduced hearing. At concentrations of about five per cent by volume it causes stimulation of the respiratory centre, dizziness, confusion and difficulty in breathing accompanied by headache and shortness of breath. At about eight per cent concentration it causes*

headache, sweating, dim vision, tremor and loss of consciousness after exposure for between five and ten minutes."

A chilling example is the death of more than 1700 people in the catastrophic CO_2 release from Lake Nyos in Cameroon in 1986 [4][5][6][7].

I have pointed out (see objections dated 26/05/2008, 25/06/2008) that the particular location of the Tuggeranong plant, in the higher part of Jerrabombera Valley and near the upper parts of the Tuggeranong and Woden valleys, is dangerous for polluting and toxic gasses. Jerrabombera Valley is primarily at risk from a directly descending CO_2 cloud. Tuggeranong and Woden valleys are at risk from a descending CO_2 cloud that is first lifted across Isaacs Ridge. Ridge-related pollution hotspots identified in the CALPUFF study (see objection dated 25/06/2008), eg Macarthur-Fadden, Wanniassa, Mawson-Farrer with a pollution spur towards Garran, Upper Mugga Lane and Hume, are particularly at risk.

It is doubtful that much pre-warning can be given for catastrophic CO_2 gas release and descend of a CO_2 cloud. It is even more doubtful that entire valleys can be evacuated in time. This dangerous situation should not be allowed to develop. Data centres with liquefied CO_2 cooling should be located in the lower parts of a valley, well away from ridges and watersheds where catastrophically-released CO_2 clouds can be lifted into adjacent valleys. CO_2-cooled data centres should not be allowed at the dangerous Tuggeranong location.

RECOMMENDATIONS

- Ascertain potential for catastrophic CO_2 release as part of a full and independent Environmental Impact Study.
- Ascertain dangers of a catastrophic CO_2 release for the populations of Jerrabombera, Tuggeranong and Woden valleys.
- Ascertain potential for co-locating the Tuggeranong and Belconnen data centres with the proposed Williamsdale power station and ascertain potential for catastrophic CO_2 release against local topographic conditions and local populations.
- Ascertain potential for alternative cooling through extensive use of geothermal heat pumps (see objections dated 26/05/2008 and 25/06/2008).

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[3] http://en.wikipedia.org/wiki/Carbon_dioxide
[4] http://en.wikipedia.org/wiki/Lake_Nyos
[5] http://www.geology.sdsu.edu/how_volcanoes_work/Nyos.html
[6] http://www.newscientist.com/article/mg13518344.400-the-deadly-cloud-hanging-over-cameroon-a-lethal-gas-bubbledup-from-the-bottom-of-lake-nyos-six-years-ago-killing-thousands-of-peopleand-livestock-years-of-study-have-revealed-why-but-the-risk-of-disasterremains-.html
[7] http://www.snopes.com/horrors/freakish/smother.asp

For the record: I am a life-long research scientist with a geological/geophysical background. I am a Honorary Visiting Fellow at the Research School of Earth Science of the Australian National University, but express here private views that bear no relation whatsoever to the ANU. I hold shares in geothermal energy companies and reside in Macarthur.

Dr Chris Klootwijk

Comments on Environmental Impact Statement and Health Impact Assessment, lodged with GHD (EIS) and the Director Health Protection Services ACT Health (HIA) on 08/12/2008

Environmental Impact Statement
Canberra Technology City
GHD Pty Ltd

COMMENTS

(includes comments on Heath Impact Assessment and Solar Thermal Pre-feasibility Study)

Summary remarks

- **EIS is mere STATEMENT not STUDY.**
  This EIS does not qualify as an Environmental Impact Study because no studies have been carried out for this specific purpose. A need for further study clearly emanated from the 600+ objections to the DA/PA. However, this need is ignored and objections from the affected community are not addressed.

- **Not a full EIS.**
  A Health Impact Assessment (HIA) is excluded from the statutory EIS process, despite assurance to the contrary by minister Barr [1]. Likewise a pre-feasibility study on solar thermal energy supply [2] is not addressed in this EIS, despite its obvious relevance as an alternative to the gas-fired energy supply proposed by CTC.

- **Not an independent EIS.**
  GHD refers to a study that it had carried out for ACTPLA [3]. GHD earmarked in this study, apparently on its own account, part of Block 1610 for future industrial development. It now uses its own suggestion to diminish the communities' objections regarding visual impacts of the CTC development [4]. This unjustified and highly inappropriate reference belies GHD as an independent analyser.

- **Unsatisfactory EIS commenting process**
  It is poor process that comments on an EIS are to be addressed to the consultant that carried out the EIS, rather than ACTPLA ─ the statutory arbiter on validity of the DA/PA. This reduces the commentator to a mere editorial aide to the consultant. It is an even poorer process for the HIA to be excluded from the EIS and for making no proper avenue available to comment on the HIA in any useful way.

- **Pollution modelling inadequate**
  CALPUFF modelling lacks adequate topographic and meteorological input and does not address $PM_{2.5}$ and O_3 pollution. In absence of such crucial input and believable output data, there is no credence to any proposition ─ in the

EIS, HIA or otherwise ─ that pollution from the proposed gas-fired power station in Tuggeranong would have no ill-health effects on residents of the ACT or nearby NSW.

- **Noise power spectrum of power plant to be determined** Possible effects of high-pitch noise from the Tuggeranong power plant and data centres on pets and wildlife should be studied. In particular whether wildlife may experience as a "Shu-Roo" effect, the standing wave interference patterns of high-pitch noises from the power plant turbines and data centre chillers. If so, this would effectively destroy the remaining wildlife corridor.

- **Carbon footprint to be determined over life cycle**
  With Mandatory Renewable Energy Targets (MRET) increasing from 2% at present to 20% by 2020 and presumably to higher levels before 2050, the carbon footprint of gas-fired power is bound to exceed that of grid power some time between 2020 and 2050. Overtaking will happen sooner with increased uptake of voluntary Greenchoice renewable energy.

- **Gas option leaves ACT Climate Change Strategy in tatters**
  The ACT's main climate change document *"Weathering the Change ─ ACT Climate Change Strategy 2007-2025"* estimates current greenhouse gas emissions in the ACT at about 4.45 million tonnes per year [5]. The strategy aims for a reduction to the 2000 level (4.059 million tonnes) by 2025 and a further reduction by 60% of the 2000 level by 2050. However, CO_2 emissions of the proposed Tuggeranong 28MW gas-fired power plant are estimated at 170,000 tonnes per year [6], adding yearly 4.2% to the 2000 emissions level. CO_2 emissions of the proposed Williamsdale 500 MW gas-fired power plant would add a further 74.8% to the 2000 emissions level (assuming similar emissions characteristics). Adoption of the gas option to power Canberra would add 79% to the 2000 emissions level and begs the question how a 60% reduction by 2050 could possibly be achievable? Clearly, alternative non-polluting renewable energy options should be pursued!

- **Economic impact study to include pollution-related health costs**
  Any believable economic impact study should include an estimate of health costs related to the proposed Tuggeranong power plant. Exclusion of health costs identifies this study as a biased example of capitalizing profits and socializing costs and further stamps the EIS as incomplete.

- **Pre-feasibility study on geothermal energy in ACT required**
  The ACT should ask for its fair share of the federal government's "Onshore Energy Security Program" to carry out a pre-feasibility study on geothermal energy prospects in the ACT. This study could be carried by Geoscience Australia and may concentrate on heat flow mapping of bottom sediments in ACT dams that are located on major fault zones.

- **Data centres to be powered by off-site solar thermal plant**
  The large-scale greenhouse gas emissions and the substantial, inadequately detailed, air and noise pollution from the gas-fired power plant clearly indicate an alternative solution with an off-site solar thermal power plant as the preferred power source!

Embracing the gas option in this first, smaller-scale, plant, followed by a large-scale plant in Williamsdale, will have serious, enduring consequences for the Canberra people and the ACT environment:

- *Greenhouse gas emissions will leave the ACT Climate Change Strategy in tatters;*
- *Nitreous oxides, ozone and particulates may have serious, inadequately studied, health consequences for people and wildlife in the ACT;*
- *The environment of the ACT and neighbouring NSW may be irreparably damaged by acid rain!*

My comments should be read in conjunction with my objections against the proposed development on part block 1671 Tuggeranong for a natural gas co-generator facility and communications facility, lodged with ACTPLA on 5/5/2008, 26/5/2008, 27/5/2008, 25/6/2008 and 30/6/2008.

I comment hereafter also on the Health Impact Assessment (HIA) and on the Solar Thermal Pre-feasibility Study (STPS [2]). No appropriate avenue has been made available to comment on these studies in any other way. The HIA and STPS should be included in any full and independent Environmental Impact Study!

ENVIRONMENTAL IMPACT STATEMENT
The chapter numbering of the main EIS document is followed.

10 Greenhouse gas assessment & Appendix E

Carbon footprint, gas-fired plant versus coal-fired plant and versus grid-power

Section 5.1 of Appendix E [6, p 21] states: *"The emissions intensity of natural gas (51.3 kg CO_2-e per GJ) is considerably lower than options including purchasing electricity from the NSW grid (249 kg CO_2-e per GJ, low efficiency due to transmission losses) and (for the purposes of comparison) a black coal fired power plant (89.3 kg CO_2-e per GJ)"*. This would mean that a gas-fired power plant produces only 57% of the emissions of a coal-fired power plant. Statements to this extent have been made repeatedly by CTC proponents and by supporting ACT politicians including the Chief Minister. Such statements are misleading. They relate only to scope-1 emissions (direct emissions from combustion at power plant), not to scope-2 emissions (consumption of electricity, heating, cooling or steam brought in from elsewhere), nor to scope-3 emissions (fugitive emissions from mining).

I cite emission data from the National Greenhouse Accounts (NGA) Factors- October 2008 [7, Tables 1, 2, 6, 7, 8], expressed in kg CO_2-e per GJ:

	Scope-1				Scope-2	Scope-3
	CO_2	CH_4	N_2O	Total	Total	Total underground/open cut
Black coal	88.2	0.03	0.2	89.3?	N/A	0.305+0.014/0.045
Natural gas	51.2	0.1	0.03	51.3?	N/A	14.2
Grid power				N/A	249+0.89	47

There are no scope-2 emissions for black coal and natural gas, nor scope-1 emissions for grid power. There seems to be some ambiguity in classifying emissions as scope-1, scope-2 and scope-3. The following is a clarification received from the Department of Climate Change (Glen Whitehead, email 25-11-2008): *"Scope 2 emissions occur only from the consumption of electricity, heating, cooling or steam brought in from outside the facility. Therefore scope 2 emissions don't apply to the consumption of natural gas or black coal (ie there are only scope 1 and scope 3 emissions from these fuels). Scope 1 emissions relate to only direct emissions (from sources within the boundary of an organisation), therefore there are no scope 1 emissions from the consumption of purchased electricity (because the scope 1 emissions occur at the power station, these are scope 2 emissions for the end user)."* An example of such ambiguity is the classification of annual operating emissions for the proposed CTC power plant by GHD [6, p 18]: scope-1= 126.500 tonnes CO_2-e/yr; **scope-2= 1,500**; scope-3= 42,000.

Comparison of scope-1 + scope-3 data combined indicates that for the ACT and NSW the level of CO_2-equivalent emissions of a gas-fired power plant is ~73.3% of the level of emissions of a black coal-fired power plant. This is substantially higher than the often quoted figure of 57% which relates to scope-1 emissions only (in fact ~57.4%).

The figure of 73.3% for scope-1 + scope-3 emissions in the ACT and NSW derives from the high content of CO_2 in Moomba gas (Cooper Basin), varying between 10%

and 30% of total volume [8]. Santos is planning to sequester this CO_2, but it is currently just flared off. The ACT and NSW get a considerable part of its gas supplies from the Cooper Basin gas fields. The remainder comes from Bass Strait gas fields. South Australia probable gets a larger part of its gas supplies from the Cooper Basin. According to the NGA data [7, Table 37] scope-3 emissions for South Australia are 18.6 kg CO_2-e per GJ (compare with 14.2 for ACT/NSW, see above table) and this results in a higher relative figure for CO_2-equivalent emissions of a natural gas-fired power plant versus a black coal-fired power plant of (51.3+18.6)/89.6= 78.0%. This higher figure would also apply to the ACT at times that its gas is sourced more exclusively from the Cooper Basin.

For proper comparison of the carbon-footprints of natural gas-fired versus black coal-fired power plants, their thermal efficiencies also need to be taken into consideration. In absence of knowledge about relevant specific data for the proposed Tuggeranong power plant this comparison is extended to power plants Australia-wide over the period 1995-2005. According to [9, table 4-19] the average thermal efficiency of natural gas-fired power plants is 33.18% and for coal-fired power plants is 34.58%. The above figures for CO_2-equivalent emissions for gas-fired power plants relative to coal-fired power plants thus need to be multiplied by a factor of 34.58/33.18= 1.042. Consequently, emissions of a gas-fired power plant in the ACT are expected at 73.3*1.042= 76.3% of the emissions of a coal-fired power plant. For South Australia the equivalent figure would be 78.0*1.042= 81.3%.

Proper comparison of the carbon footprints of gas-fired and coal-fired power plants with grid-power should be based on convolving the sum of Scope-1 + Scope-3 emissions with the relevant thermal efficiency factors for gas-fired and coal-fired power plants as follows:

Gas-fired power plant	(51.3+14.2)/0.3318=	197.41
Coal-fired power plant	(89.3+0.319)/0.3458=	259.16
Grid-power	249+0.89+47=	296.87

This means for relative carbon footprints in the ACT/NSW:

Gas-fired power/grid-power:	197.41/296.87=	66.5%
Coal-fired power/grid-power:	259.16/296.87=	87.3%
Gas-fired power/coal-fired power:	197.41/259.16=	76.3%

Comparison of the above data with Section 5.1 from Appendix E [6, see above] demonstrates that GHD has been comparing apples with pears. This is not helpful to install confidence in the remainder of their report.

Green power

The carbon footprint of grid-power in the ACT is reduced through the voluntary Greenchoice program offered by ActewAGL. According to the latest available data, there are currently 9000 Greenchoice customers. They are paying a premium for grid-power electricity from *"sources that have a reduced impact on the environment, and sources that cannot be depleted or can be replaced such a wind power, solar, mini-hydro and biomass."*[10].This has saved this year so far 19,130 tonnes of greenhouse gas emissions. Publicly available data are seemingly lacking (2-12-2008) to what extent Greenchoice power reduces the yearly carbon footprint of ActewAGL's grid-

power. However, it is obvious that further uptake of Greenchoice power will increase the carbon footprint of gas-fired power relative to grid-power (see preceding chapter), making grid-power more attractive from a carbon footprint point of view than gas-fired power.

Carbon footprint over life cycle

Comparison of the carbon footprints of gas-fired plants, coal-fired plants and grid-power on the basis of past or present data is bound to be misleading. Instead, one should compare the carbon footprints integrated over the life cycles of the various plants. As demonstrated above and based on past and present data the, relative carbon footprint of gas-fired power versus grid-power in the ACT and NSW is 66.5%. Currently the Mandatory Renewable Energy Target (MRET) is 2% [11], but the federal government is committed to an MRET of 20% by 2020 [12]. Assuming a negligible carbon footprint for renewable energy, this would mean that the carbon footprint of grid-power would reduce substantially ─ at least by 18% (20%-2%). Thus the carbon footprint of grid-power can be expected to be reduced by 2020 from the current 296.87 kg CO_2-e per GJ to 243.43 kg CO_2-e per GJ. However, the Tuggeranong gas-fired power plants can be expected to keep its current carbon footprint of 197.41 kg CO_2-e per GJ. By 2020 the relative footprint of the Tuggeranong gas-fired power plant versus grid-power would then have increased from 66.5% to 81.1%. It is as yet unknown what the MRET target will be after 2020, but it is bound to substantially increase if the federal government is going to pursue a carbon reduction of 60% or more by 2050.

Clearly at some stage in the life cycle of the proposed Tuggeranong gas-fired power plant, taken from 2010 to 2050, the carbon footprint of gas-fired power is bound to exceed that of power drawn from the grid!

Such a carbon footprint would clearly counteract the aim of the ACT government [5] to reduce ACT greenhouse emissions by 60% of 2000 levels by 2050. It would seriously question whether the ACT can live up to its stated aim *"While it may be tempting to put the excuse of short-term financial cost above the benefit of long-term abatement, if nothing is done the eventual outcome will be unaffordable in environmental, economic and social terms"* [5, ACT Climate Change Strategy 2007-2025, "Weathering the Change", p 5 ─ statement directly below the bust of the Chief Minister].

Total CO2-equivalent emissions related to operation of the proposed Tuggeranong gas-fired power station are estimated at 170.000 tonnes per year [6]. This represents 3.8% of current greenhouse gas emissions in the ACT [5, p 15] and the yearly output of about 79000 cars [5, p 20]. Pursuing the gas option for the 500 MW gas-fired power plant proposed by ActewAGL for Williamsdale would increase ACT's greenhouse gas emissions on an ongoing basis by as much as (500/28)*170.000= 3.03 million tonnes/year. Emissions from these two gas-fired power plants alone would represent 72% of current ACT emissions and 79% of year 2000 emissions.

This sounds like another dream going up in gas and unnecessarily so. ACT's emissions targets would look far more realistic by installing a small solar thermal power plant [2], followed by one or more larger solar thermal power plants [13].

11 Resource use, sustainability and renewable energy (Appendix E)

Geothermal heat pumps

Geothermal heat pumps/chillers are rejected (Appendix E, Table 5) for the reason that *"there is not sufficient requirement"*, yet they operate to satisfaction in the main building of Geoscience Australia. The geothermal heat pump system at GA delivers about 0.5 MW, cooling and heating the main building [14]. The Geoscience Australia location and the Tuggeranong Block 1671 location have comparable volcanic bedrock. Block 1671 should be equally suited for installation of geothermal heat pumps. With 10 large buildings proposed on site (8 data centres, 2 power station buildings), the output performance of the GA geothermal unit should be up-scalable by an order of magnitude for the buildings on the CTC campus. This should account for some 5 MW of the ~37 MW (28 MW turbines, 9 MW chillers) required, representing ~13% of energy requirements.

Solar photo-voltaics

Solar photo-voltaics is treated poorly (Appendix E, Table 5 and main text 6.4.2). Proposed panel coverage is over a mere 40% of the area and that with a density of only 60%. On this basis energy output during daylight hours is estimated at 2.7% of the daily needs in mid-winter, up to 8.9% in mid-summer. However, full coverage of the site would increase these figures to respectively 11.25% in mid-winter and 37% in mid-summer.

Together, geothermal heat pumps and solar photo-voltaics may deliver between 16% and 50% of total energy needs!

Solar thermal

Solar thermal energy supply is rejected (Appendix E, Table 5) as it would have to be off-site. However, the alternative data centre/power plant proposed by the Sanctuary Energy - Wizard Power – Springfield Land Corporation consortium [15] indicates the feasibility of a solar thermal energy supply at an off-site location. A pre-feasibility study on a solar thermal power plant for the ACT, commissioned by the ACT government and ActewAGL and carried out by Parsons Brinckerhoff, led the Chief Minister to apply for federal funding under the federal government's infrastructure program [2, 16]. Worley Parsons have proposed to construct within Australia up to 34 solar thermal power plants of 250 MW at a cost of 1 billion dollar each [13]. This offers a unique opportunity for the ACT to acquire one or more non-polluting, renewable energy power plants, instead of the 500MW, polluting, gas-fired power plants flagged by ActewAGL for a Williamsdale location.

Geothermal - Hot Fractured Rock & hydrothermal prospects

Geothermal energy supply is rejected as it would have to be off-site (Appendix E, Table 5). Most likely, but such energy can be supplied through high voltage DC power lines over large distances with minimal energy losses. For illustratation, AGL ─ ActewAGL's parent company ─ has gone into Joint Venture with Torrens Energy, a junior geothermal energy company, and AGL's main competitor, Origin Energy, has gone into Joint Venture with leading geothermal energy company, Geodynamics. There are currently another 30 geothermal energy companies actively exploring for resources [17]! Geothermal energy is anticipated to come onto the market within the next five years and has enormous potential for pollution-free renewable supply of base load power [18].

Adequate and secure base load power for a data centre developments can right now be supplied through a large-scale solar thermal power plant and soon through geothermal power plants. There is absolutely no need to secure power supply through a polluting gas-fired power plant representing outdated technology.

Missing legislation for geothermal exploration

Legislation for geothermal exploration is now in place in all states of the Australian Commonwealth and is pending in the Northern Territory. The ACT distinguishes itself as the only Australian jurisdiction with no active legislative agenda for geothermal exploration. Clearly there is an opportunity here for the ACT government to shore up its climate change credentials! Scope for pioneering Hot Fractured Rock (HFR) geothermal energy and for more conventional hydrothermal geothermal energy may be limited in the ACT, given the ACT's limited size and its geological make up. However, there may be potential for direct use of geothermal heat in industrial, commercial and energy efficiency applications. The Northern Territory stirred the Australian enterprising spirit with *"you never never know if you never never go"!* However, the Australian Capital Territory seems to be content with *"where the bloody hell are you"?*

Pre-feasibility study required

Scope for the pioneering Hot Fractured Rock (HFR) type or the conventional hydrothermal type of geothermal energy may be limited, given the ACT's size and its geology. However, there may well be potential for direct use of geothermal heat in industrial, commercial and energy efficiency applications. Nearly all of the ACT dams are on major fault zones, such as the Cotter Fault and Deakin Fault, and these faults could be passage ways for geothermal heat. Simple dropping of heat-flow probes in accumulated sediments in ACT dams may indicate whether the ACT is prospective for further geothermal exploration. Such a pre-feasibility study could be carried out by Geoscience Australia, if the ACT asks for its fair share of the federal government's Onshore Energy Security Program [58].

16 Air Quality

No new modelling has been carried out despite substantial concerns raised on the CALPUFF modelling regarding inadequacy of topographic and meteorological input and potential danger for accumulation of radioactive particles in pollution hotspots when coal seam gas is going to be used in future. A relevant extract from my objection to the DA/PA (25/6/2008) follows:

> **1.1 Strength/limitations CALPUFF**
>
> CALPUFF is a puff model that is generally regarded superior to the AUSPLUME plume model. The US EPA approved CALPUFF for study of long range pollution transport beyond 50 km, but advises that use of CALPUFF at shorter distances requires approval by reviewing authorities on a case-by-case basis [19][20][21]:
>
> [21] *"The EPA has proposed the use of CALPUFF for applications involving long-range transport, which is typically defined as transport over distances beyond 50 km. Therefore, the use of CALPUFF for EPA regulatory applications involving transport distances of less than 50 km requires approval by the relevant reviewing authorities. As described in Section 7.2.8 of the EPA's proposed Guideline on Air Quality Models, the*

CALPUFF model may also be used in special cases involving complex flows on a case-by-case basis with concurrence from the reviewing authorities."

CALPUFF uses gridded data [19]. Unavoidably, finer topographic detail is lost in the griding process. This drawback has the stronger negative effects on studies of pollution in complex terrain close to the pollution source. This drawback impacts in particular on study of the effects that Isaacs Ridge and offshoot ridges have on distribution of pollution from the Tuggeranong power plant.

Evaluation of CALPUFF pollution predictions against observations and also against predictions from other models calls for vigilance in interpreting modelled outcomes. An US analysis of CALPUFF by Chang and co-workers in 2003 [22][23] found results to be heavily dependent on the wind field model used (note that the present CALPUFF study lacks on-site wind data), had a mean bias within 35%, had random scatters of a factor 3-4, and no more than 50-60% of CALPUFF's predictions were within a factor of 2 of observations. An Australian evaluation of CALPUFF and comparison with AUSPLUME and TAPM by Dr Hurley and co-workers of the CSIRO Division of Atmospheric Research [245][25][26] documents several cases of considerable underestimation of observed pollution by both AUSPLUME and CALPUFF and also a case of extreme overestimation by CALPUFF. Hurley argues that CALPUFF should be used with caution [26].

On the strength of these evaluation studies and US EPA guidelines for usage, the outcomes of the present CALPUFF study should be treated with considerable caution. Further caution is required because the CALPUFF modelling of complex terrain effects was based on a topographic dataset that was too widely grided and too inaccurate in altitude to adequately represent the complex terrain of Isaacs Ridge.

1.2 Inadequate topographic data

The CALPUFF study underestimates effects of Canberra's valleys and ridges on pollution hotspots. Modelling of pollutants distributions suffers from poor location and altitude sampling of the complex terrain of Isaacs Ridge and associated ridge offshoots. Terrain values are based on a US Geological Survey dataset with a resolution no better than 1 km and on a Digital Elevation Model (DEM) from Geoscience Australia with a resolution no better than 250 m. Such wide sampling smooths Canberra-type topography by reducing terrain steepness through lowering and uplifting of adjacent hill and valley sections respectively. Sampling representation is worsened by accuracy limitations of the DEM data, obtained from a fixed-wing aircraft engaged in other geophysical studies. Locations have accuracy common for 1:250,000 scale maps (Canberra maps are generally at scale 1:25,000 and some may be at scale 1:10,000) and altitudes have an average root mean square error of 20 m and up to 200 m in steep terrain [27]. Such a coarse and crude topographic dataset poorly identifies pollution hotspots and underestimates levels of pollution.

The rationale for usage of such a coarse and crude datasets is not presented in the pollution study. The consortium may well have had access to a more refined topographic dataset. On the second Community Consultation Meeting organised by ActewAGL (15/6/2008) a detailed drive-trough GIS panoramic study was shown on a wide screen. The level of local detail in topography was considerable and suggests that is was derived from a topographic dataset more detailed than the DEM from Geoscience Australia. Why was this more detailed dataset not used in the CALPUFF study? If CALPUFF cannot handle higher resolution datasets then it is not well suited to determine pollution distributions and pollution levels for the complex terrain of

Isaacs Ridge and ridge offshoots between Macarthur-Fadden, Fadden-Wanniassa and Wanniassa-Farrer. If CALPUFF can handle detailed topographic data then available detailed datasets should be used for proper evaluation of pollution risks.

CALPUFF requires gridded terrain datasets [19]. It is unavoidable that finer detail of complex terrain is lost in the griding process, irrespective of the scale of the dataset. This is a serious drawback for proper analysis of effects of pollution by nearby complex terrain, such as around Isaacs Ridge and offshoots ridges. Usage of a gridded, and therefore flattened, topographic dataset in the CALPUFF pollution study unavoidably leads to underestimation of levels of pollution levels. Locations of the more substantial pollution hotspots may be less affected.

1.3 Inadequate meteorological data

The CALPUFF study relies on meteorological observations from stations at Canberra Airport and Tuggeranong Hill. This is some improvement over the AUSPLUME study that relied on data from Wagga Wagga. However, the CALPUFF study, like the AUSPLUME study, suffers from absence of local meteorological observations, covering block 1610 and other areas in the Isaacs Ridge, Long Gully Road and Mugga Lane precinct. This is a region of complex terrain, its meteorological behaviour has to be properly observed and cannot be extrapolated with sufficient confidence from other stations. Local observations should cover a substantial, representative, period. The US EPA recommends for CALPUFF studies a five year observation record:

[21] *"For a regulatory analysis, such as that supporting a permit to construct a source of air pollution, the considerations regarding the length of meteorological period are similar when applying CALPUFF in screening mode as when applying other models. The EPA's Guideline on Air Quality Models prescribes the use of five continuous years of representative meteorological data. Also, the Interagency Workgroup on Air Quality Modeling* (sic) *(IWAQM) demonstrated the year-to-year variability in CALPUFF screening impacts using a five-year meteorological period in their Phase II report. Based on this demonstration, IWAQM also recommends that five years of meteorological data should be used with CALPUFF in the screening mode in order to identify long-range transport impacts that could reasonably be considered to be the highest."*

[28] *"Five consecutive years of the most recent representative sequential hourly National Weather Service (NWS) data, or one or more years of hourly sequential on-site data."*

However, the present CALPUFF study relied on a one-year only record from an off-site location, Tuggeranong Hill.

1.4 Pollution studies on the run

Blind Freddy can see that the complex terrain of the Tuggeranong location is highly unusual for a power station and that such complex terrain requires adequate local topographic and meteorological input to safeguard local residents from adverse impacts. Yet local input is manifestly lacking in the present CALPUFF study. Use of off-the-shelf datasets in both the CALPUFF and AUSPLUME pollution studies are poor examples of studies on the run. These studies do not, and can not respond adequately, to the legitimate health concerns of local residents. ActewAGL has to collect for the specific purpose of pollution studies, local topographic and meteorological data, spanning a representative period and adequately covering the areas of concern. Anything less constitutes shoddy practices and whitewashing attitudes.

None of the above concerns have been addressed.

In the context of the Health Impact Assessment a new CALPUFF run has been carried out on request of Golder Associates. However, instead of improving the detail of topographic input, this run was carried out with a denser network of output receptors. This means that the CALPUFF output remains equally inadequate, but we now have a better view of this inadequate output. Crap viewed on high-definition TV still looks like crap! An example of inconsequential and misleading science!

No CALPUFF modelling has been carried out on the distribution of particulates in the 2.5 micron range ($PM_{2.5}$), nor on Ozone (O_3). This is a serious and regrettable omission. A recent study by the Canadian Medical Association on the "National illness cost of air pollution" focussed on these two pollutants as being particularly lethal [29, 30, 31, 32]. This study concluded amongst others that in 2008:

- 21000 Canadians will die from the effects of air pollution;
- The economic costs of air pollution will top CD$ 10 billion.

In absence of better data, extrapolation to Australia on a per-capita-basis would mean 12852 deaths by air pollution Australia-wide and 213 deaths within Canberra. These highly worrying extrapolations demand:

- Proper modelling of the distribution of these two pollutants by the proposed Tuggeranong power station, taking into consideration pollution from sources such as the Mugga Lane Tip methane burners and the 500 MW gas-fired power station proposed by ActewAGL for a Williamsdale location;
- Adaptation of the CMA software to local conditions and estimation of the illness costs of air pollution.

In absence of such crucial data there can be no credence in any proposition ─ in the EIS, HIA or otherwise ─ that pollution from the proposed gas-fired power station in Tuggeranong would have no ill-health effects on Canberra residents.

21 Hazards, risks and public safety

This addresses composition of natural gas variations, but does not address concerns expressed regarding accumulative deposition in pollution hotspots of radioactive particulates in case of future gas supply from NSW coal seams. A relevant extract from my objection to the DA/PA (15/06/2008) follows:

> **1.5 Pollution hotspots**
>
> The present CALPUFF study in all its crudeness clearly establishes Isaacs Ridge-related pollution hotspots in Macarthur-Fadden, Wanniassa, and Farrer-Mawson with a spur towards the Garran hospital [33]. There are further pollution hotspots in the upper part of Mugga Lane and in Hume. A broad swath of enhanced pollution extends from Isaacs Ridge westwards towards the Tuggeranong town centre-Kambah region and another broad swath extends from Isaacs Ridge to southern Jerrabombera. The location of the pollution hotspots is consistent for all four pollutants studied, eg: NO_2 [33, fig. 7.1]; SO2 [33, fig. 7.3]; PM_{10} [33, fig. 7.6]; formaldehyde [33, fig. 7.8]. These pollution

hotspots are most worrying, foremost for potential health effects on local residents, but also for potential local acid rain effects, and not unimaginably for possible dumping from local ridge-confined eddies of heavy Uranium particulates and/or heavy gaseous elements from Naturally Occurring Radioactive Materials (NORM's, see my objection lodged on 26/05/2008 [34]). The message is loud and clear. Better be safe than sorry. Relocate the power station away from Isaacs Ridge, onto an open plain.

24 Micro-climate

This addresses potential heat island effects, but only regarding increased natural heat absorption from coloured buildings and disturbed grounds. It does not address concerns about heat effects from the co-locating the power station and the data centres. This proposition, an untried world's first, would mean that the heat generated by the power station in creating electricity has to dissipate at the same location as the heat generated from applying this electricity for cooling the data centres. The data centres' heat cannot go up, because that's were the hot exhaust gas plume from the power station goes. Instead this heat this heat will have to dissipate at low, or ground, level and would surely affect nearby eco-systems. Ongoing dissipation of up to 37MW of heat is no sinecure! A relevant extract from my objection to the DA/PA (15/06/2008) follows:

8 HEAT DISSIPATION INTO ADJACENT BUSHLAND

Co-location of the gas-fired power station and the data centres means that both the heat from the electricity generation and the heat from the electricity consumption are dissipating at the same time at the same location. This is a highly unusual situation. The power station will generate from at least 2 turbines at least 28 eMW for use by the data centres. Further energy equivalent to another 9 eMW will be generated from the absorption chillers. According to Canberra Technology City's documentation on co-generation, handed out at the second Community Consultation Meeting (15/06/2008 [35]), 98% of this 37 eMW will dissipate as waste heat from the data centres. This heat hardly can dissipate upwards into the plume of hot exhaust gasses. It will have to dissipate mainly at low levels into the surrounding environment of timbered broadacre land and bushland reserve. The amount of heat dissipating from nearly 37 eMW on a 24/7 basis is substantial and represents a sizable portion of electricity consumption by Canberra residents (possibly more than 30% although factual data on electricity consumption in the ACT are hard to come by for commercial-in-confidence restrictions). ActewAGL's revised development application does not address the existence, shape and magnitude of a local heat-island, nor what effects such a temperature hotspot may have on local flora and fauna and on bushfire risks.

Note that the original site investigation report prepared by Bill Guy & partners, dated November 2007, is included in the revised plan without modification. The report states that a water flux of 60 l/sec is required. This would mean ~1.9 GL on a yearly basis. Clarification is required whether the figure of 435 ML/year quoted in the main report supersedes the figure of 1.9 GL/year and also supersedes the figure of 0.6 GL/year quoted in the original plan. If a peak supply of 60 l/sec is required for fire fighting purposes then it should be clarified whether co-location of the gas-fired power station and the data centres and consequent formation of a ground-level heat-island would increase the potential for fires in the data centres.

HEALTH IMPACT ASSESMENT

Community concerns

Golder Associates states in the pre-amble to its report *"Golder had indicated to the community that it would review submissions received by ACTPLA so that health issues could be identified"* [36, p ii]. Yet it states in the body of its report *"Golder had indicated to the community that it would provide feedback on submissions received by ACTPL. Submissions received by ACTPLA were not provided to Golder; however, the evaluation by ACTPLA in relation to the updated Preliminary Assessment endeavours to capture and respond to community concerns"* [36, p 13].

Concerns expressed by the community in 600+ objections to the DA/PA submitted to ACTPLA have not been addressed in this study by Golder Associates. The Department of Health, ACTPLA, ACTPLA's parent department and ultimately the Chief Minister have treated this health impact assessment with contempt by not forwarding this extensive documentation of serious community concerns. Likewise Golder Associates have failed to actively procure copies of the community's objections. Disregard of these legitimate and well-documented community concerns seriously undermines the value of this health impact assessment.

Inadequate pollution studies

Golder Associates has not carried out pollution studies on particulates in the 2.5 micron range ($PM_{2.5}$) nor on Ozone (O_3). Yet a recent widely promoted study by the Canadian Medical Association [29, 30, 31, 32] identified $PM_{2.5}$ and O_3 as the more relevant, lethal, pollutants. The CMA modelling software should be run with ACT-specific input for an estimate of local pollution-related deaths and sickness and an estimate of their economic costs. In absence of such an ACT-specific study, a simple estimate based on equation of environments and on a per-capita basis would indicate 213 pollution-related deaths per year in Canberra. Although a mere guesstimate, such a figure is most worrying and justifies dedicated modelling.

In absence of proper pollution studies addressing $PM_{2.5}$, O_3 and in absence of CMA-derived studies, Golder Associates' assertion (p iii) that *"emissions to air from the operation of the facility would not affect the health of people residing in these areas"* simply is not backed up with believable data. Golder Associates undermines its own statement (above) with a subsequent confused statement in the same paragraph (p iii) *"Although air emissions from the developments will be unlikely to impact on human health, emissions from the facility will affect the regional ambient air quality"*.

Golder Associates makes the untenable assumption (p 28) *"For the purpose of modelling it was assumed that all particles are in the PM_{10} range"*. It is well known that $PM_{2.5}$ particles travel far wider than PM_{10} particles and this alone justifies extension of the region of study far beyond the suburbs of Macarthur, Fadden and Gilmore. $PM_{2.5}$ particles can be more lethal than PM_{10} particles and are the primary concern of asthma sufferers.

Economic costs of pollution-related deaths and sickness

Outcomes of CMA-based modelling of ACT-specific economic costs for pollution related death and sickness should be incorporated into costs/benefits modelling of the CTC project. This is missing from the Economic Impact Report that has been added

to the EIS [37]. I note that this report was not submitted as DA/PA documentation. It was included in the EIS/HIA on the fly, bypassing proper scrutiny by ACTPLA!

Inadequate topographic control in CALPUFF modelling

Golder Associates did organize a rerun of the CALPUFF modelling. However, in the rerun it only refined the **receptor output grid** from 250 m spacing to 100 m spacing, but did not refine the **topographic input grid**. This is close to useless. Rather than reducing the spacing of the output grid, Golder Associates should have reduced the spacing of the input grid (topographic grid). Consequently, as indicated above under the EIS, the pollution output pattern is most likely seriously underestimated quantitatively, if not qualitatively. All what has been achieved in this futile modelling is a better view of crappy output data. This does nothing to shore up confidence in Golder Associates' competence on pollution research.

Further polluting modelling required

Clearly there is a need for further pollution modelling based on adequate topographic data based on 1:10,000 scale maps in the vicinity of the power plant (eg within a 5km radius). Modelling should take into account accumulative pollution from the CTC power plant, the Mugga Lane Tip methane burners and the proposed 500 MW gas-fired power plant near Williamsdale. In addition to CALPUFF, at least one other modelling package should be applied. Only outputs that agree across two packages should be relied upon. Preferably further modelling should be carried out by an independent organisation such as the CSIRO (eg Dr Peter Hurley, Marine and Atmospheric Research).

Acid deposition

Golder Associates dismisses (p 11) a potential danger of "acid deposition" with the statement *"While oil vapour and variation on gas composition require further assessment, Golder considers these will be unlikely to lead to an appreciable difference in the air quality of the region*". This statement is untenable in regard to potential accumulation in obvious pollution hotspots of radioactive particles from coal seam gas supplies, discussed in my objection of 25/6/2008 as follows:

> **1.5 Pollution hotspots**
>
> The present CALPUFF study in all its crudeness clearly establishes Isaacs Ridge-related pollution hotspots in Macarthur-Fadden, Wanniassa, and Farrer-Mawson with a spur towards the Garran hospital [38]. There are further pollution hotspots in the upper part of Mugga Lane and in Hume. A broad swath of enhanced pollution extends from Isaacs Ridge westwards towards the Tuggeranong town centre-Kambah region and another broad swath extends from Isaacs Ridge to southern Jerrabombera. The location of the pollution hotspots is consistent for all four pollutants studied, eg: NO_2 [38, fig. 7.1]; SO2 [38, fig. 7.3]; PM_{10} [38, fig. 7.6]; formaldehyde [38, fig. 7.8]. **These pollution hotspots are most worrying, foremost for potential health effects on local residents, but also for potential local acid rain effects, and not unimaginably for possible dumping from local ridge-confined eddies of heavy Uranium particulates and/or heavy gaseous elements from Naturally Occurring Radioactive Materials (NORM's, see my objection lodged on 26/05/2008 [39]). The message is loud and clear. Better be safe than sorry. Relocate the power station away from Isaacs Ridge, onto an open plain**.

Acid rain

Golder Asociates dismisses dangers of acid rain with the statement (p 42) *"The PAE (2008) assessment of the impact of the development on rain acidity was based on findings of a study conducted in the Hunter Valley in 1987 that reported that the acidity of rainfall in the Hunter Valley was equivalent to, or slightly greater than the global background. Given the annual oxides of nitrogen emissions from the Hunter Valley were estimated to be 49,400 tpa and annual oxides of nitrogen emissions for the ACT are 7,992 tpa (8,062 tpa, including the developed [sic]), PAE concluded that no impact on rainfall acidity was expected."*

This statement is baseless. Firstly, it does not include nitrogen emissions from the Mugga Lane Tip methane burner nor from the proposed 500 MW gas-fired power station at Williamsdale. Secondly, it does not reflect that acid rain may well be problematic because of near absence of carbonate buffers in the ACT and surrounding regions. Comparisons with the Hunter Valley are futile. The geologies of the two regions are totally different. The Hunter Valley is largely made up of Permian and younger sediments from the Sydney Basin and these contain carbonates crucial for neutralizing acid rain. The ACT region largely consists of Silurian-Devonian acid volcanics and acid granites and lacks substantial carbonate deposits. Golder Associates should address the arguments in my objections lodged on 26/05/2008 and 25/06/2008, as follows:

> **REGIONAL CONCERNS, ACT, NSW, KOSCIUSKO NATIONAL PARK (26/5/2008)**
>
> **Acid Rain** Acid rain develops from nitrous oxides and sulphur oxides mainly produced by cars, fossil fuel burning power plants and lightning [40][41] ─ the ACT and surroundings experience frequent summer lightning. Acid rain becomes a problem on the ground when a region has insufficient capacity for NO_2 uptake by vegetation and soil and/or insufficient natural alkaline capacity to neutralize acidity. Capacity for NO_2 uptake by vegetation is a contentious issue [42] ─ vegetation may be a net emitter or a net absorber.
>
> The ACT, and its upstream water catchment in adjacent NSW and in the Kosciusko National Park, has little natural capacity for neutralizing acid rain. The geology of this region consists mainly of acid volcanics and acid granites with only very limited occurrence of carbonates (limestone). The nearest substantial carbonate deposits are more than 50 km from Canberra. Carbonate deposits near Yass and Taemas are downstream of the ACT and carbonates at Blue Water Hole and near Wee Jasper are outside the ACT water catchment. These carbonate deposits do nothing to buffer alkalinity in ACT water streams. There is a carbonate deposit of some note upstream of the ACT near Bredbo, but its size is not comparable to the Wee Jasper deposit.
>
> This precarious geological situation ─ lack of sizable carbonate deposits and abundance of acid rocks ─ is comparable to eastern North America [41], a region with wide regions of bedrock, exposed from land-ice scraping during the last ice age, with precariously little carbonate deposits. It was here that acid rain was first recognised as a serious problem and traced to emissions of major power plants. Surely the proposed power plant in Tuggeranong may not be of the size of power plants in North America, but accumulation of pollutants over time has to be considered. It is a question of maintaining or exceeding balance.
>
> Can balance be maintained or will accumulation of acid rain agents over time run out of control? Present levels of nitrous oxides and sulphur oxides may be below the critical

load of the ACT region, so there may be no noticeable occurrence of acid rain. However, it is open to questioning whether this will remain so with the additional emissions from ActewAGL's gas-fired power plant. The plant's emission of nitrous oxides is considerable according to the DA documentation provided by ActewAGL. Emission of sulphur oxides, another contributor to acid rain, is not even addressed in the Development Application. Why not? Yet such emissions are to be expected from to-be-supplied coals seam gas. Coal contains sulphur and gas extracted from coal will contain sulphur. Amounts will vary with the particular coal seam that is mined.

If the power plant's contributions increase nitrous oxides and sulphur oxides concentrations above the critical load factor, then acid rain development will get out of control. We will then experience slow acidification of streams in the ACT and slow acidification of the ACT water supply. Vegetation will start dying back with dire consequences for the Kosciusko National Park and the Namadgi National Park, for the extensive government and private plantations in the region and for frequency and magnitude of bushfires. When the cause of such disasters is traced back, who is going to compensate whom? Will the ACT government have to compensate the NSW government? Will ActewAGL have to compensate private investors in plantations?

In absence of a widely present natural alkaline buffer, it is not clear what capacity or capability the ACT has to prevent acid rain developing other than through removal of nitrous oxides and sulphur oxides from the exhaust stacks. However this will reduce the power output. Anticipated Commonwealth Government requirements to limit carbon dioxide emissions will further reduce the power output. Conceivable, the plant may sooner or later cease to be economical and may have to shut down in favour of more economical renewable energy alternatives. Such alternatives are becoming realistic options that can be implemented in time frames of years, far less time than realization of carbon geo-sequestration, and should be seriously researched now!

13 ACID RAIN DANGERS (25/6/2008)

My objection of 26/05/2008 details the potential of a gas-fired power plant to cause acid problems within the ACT, adjacent NSW and the Kosciusko and Namadgi National Parks. My concerns related to a proposed 210 MW gas-fired power plant. The present proposal for a 28 MW power plant and a just announced plan for a 500 MW power plant on the ACT-NSW border near Williamsdale [43] seriously aggravate the potential for development of acid rain. In absence of substantial limestone deposits, the region has little capacity for alkaline buffering and acid rain problems could gallop out of control. Alternative energy sourcing from non-polluting renewable energy sources needs serious consideration.

Pollution problems associated with local altitude

Golder Associates has not addressed health and pollution problems in relation to the idle atmosphere at 600-700 m altitude and the wide temperature range of a land climate. See my objection of 25/6/2008:

3 POLLUTING POWER PLANTS BEST LOCATED AT SEA-LEVEL

The Tuggeranong power plant will be located at an altitude of about 630 m and will operate in a temperature range between -5°C and +40°C. Air at 630 m of altitude is more than 7% less dense than air at sea-level [44]. The quoted temperature variations will cause a further 13% variation in air density [44]. The two effects are cumulative. On a hot afternoon, the air around the power plant could be up to 20% less dense than air at sea-level. Yet, the power plant will emit the same amount of pollutants as at sea-level. Air that is 20% less dense will thus be 20% more polluted. People breathing this

less dense air will have to breathe greater volumes for the same oxygenation, thus will breathe 20% more pollution!

No data are provided regarded anticipated performance of the Titan turbines at an altitude of 630 m. Pollution characteristics may be equivalent to operation at sea-level, but could be worse.

Clearly polluting power plants are best located at sea-level where the air has optimal density and where temperatures vary within the limited range of a sea-climate. That is where the major power plants in NSW are located, namely in the lower Hunter Valley and near Lake Macquarie. Operation of a polluting gas-fired power plant at the altitude of the ACT and across the wide temperature range of ACT's land climate is a poor choice of options.

Pollution from Mugga Lane LFG Power Station

This facility has an annual output of 46000 kg of nitrous oxides (p 31). A back-of-the envelope calculation by Golder Associates estimates this output to be about 5 times higher than the CALPUFF modelled nitreous oxides output from the proposed Tuggeranong power plant (p 42). However, this rough calculation is based on a steady-state assumption. No information is available whether one-hour rates of emission could substantially exceed the factor 5 estimated above. Clearly proper monitoring of emissions over a representative time frame is an absolute requirement.

Golder Associates calculates the 1-hour average NO2 concentration "in the order of 50 $\mu g/m^3$". This is a rubbery figure. It potentially allows for a range from 5 $\mu g/m^3$ to 500 $\mu g/m^3$. Given the high level of pollution from the Mugga Lane LFG power station, it is an absolute necessity that CALPUFF modelling be rerun, properly taking account of this source of pollution! CALPUFF modelling has to be corroborated by modelling using other accredited software packages.

At such a high level of pollution, proper scrubbing of the Mugga Lane Tip power plants should be an absolute first priority for the ACT government. The ACT government must have been well aware of the levels of pollution from the Mugga Lane Tip power plants because the data are in the National Pollutant Inventory [45]. If as high as stated by Golder Associates, it is a disgrace that the ACT government has allowed this level of pollution to continue. The more so because the nearby sawmill facility (Integrated Forest Products) produced another 17000 kg of nitrous oxide per year before operations ceased.

Frequency range of power station noise ─ effects on pets and wildlife

Golder Associates recommends further study of the tonale effects of noise produced by the turbines, transformers and roof-top chillers of the proposed Tuggeranong power station. This study should focus in particular on what effects high frequency noises may have on pets in the suburbs and on the kangaroo population in the adjacent paddocks. Interference of high-frequency noises from the above diverse sources may form standing wave patterns. Animals moving through these standing waves may experience these as frequency sweeps in a way similar to the high pitch "Shu Roo" effect [46, 47, 48]. This would effectively destroy what is left over from the nature buffer zone as a wildlife corridor!

SOLAR THERMAL PRE-FEASIBILITY STUDY

ActewAGL's request for proposals for a Solar Farm Feasibility Study closed on the 11th of April 2008 [2, p 1]. ActewAGL lodged its proposal for a 210 MW gas-fired power plant with ACTPLA on the 27th of March 2008. Lodgement prior to the 1st of April 2008 allowed ActewAGL to file DA/PA documents without the full and independent EIS that would have been required for lodgement from that date onwards. Simultaneity of a tender request for a non-polluting renewable energy supply and lodgement of a proposal for a polluting gas-fired power supply reeks of duplicity.

It is stated [2, p 26]: *"Current investigations of large 500 MW solar thermal plants in Victoria and Queensland are driven by the desire to capture economies of scale to reduce costs to a level that, after introduction of carbon trading, would allow solar thermal to be cost competitive with a coal or gas plant."* Is the ACT involved in such studies? If not, why not? If yes, why did ActewAGL only announce its intention to build a 500 MW gas-fired power plant at Williamsdale?

It is stated [2, p 30]: *"Transmission line (132kV) cost (estimate based on a nominal length of 7.5 km [Cost ($)] 3,750.000.* It is also stated [2, p 31]: *"The nominal capital cost of the gas connection was estimated to be $1,500.000 based on a nominal 7.5 km pipeline to a connection point with a supply pipeline".* Such relative low cost estimates for a 7.5 km length high voltage power line and 7.5 km gas line belie ActewAGL's argumentation that infra-structure costs would be substantial for blocks other than Tuggeranong Block 1671.

It is stated [2, p 38]: *"This fund is to be focused on research rather than commercialisation and includes a proposed Solar Energy Institute, which is to include CSIRO and ANU."* Wonderful! However, a move by the ACT government to secure power from a 28MW gas-fired plant in Tuggeranong and a 500 MW gas-fired plant in Williamsdale would deny the Solar Energy Institute [49, 50] easy access to a solar laboratory and would not reflect much confidence in the aims of the Solar Energy Institute. There is scope here for the ACT government to better define its intended support than what is summarized [2, p 37]: *"Support from the ACT Government is not clearly defined. It could take the form of assistance with land packages* (does this sound familiar?) *and relief from local duties and taxes. Some direct capital assistance may be possible although usually such additional support is likely to be considered in the context of the total ACT Government funding support."* A stated intention by the ACT government to secure power from solar power plants rather than gas-fired power plants surely would boost its chances to secure funding from the Solar Energy Institute funding base for research within the ACT.

The ACT government should take to heart the developing saga of the Ron Gooding Power Station – Alice Solar City project. The Ron Goodin power plant's Titan gas-fired turbines proved excessively noisy. After a 20 million dollar, 25 km relocation of the noise turbines [51][52][53], Alice Springs got selected as one of five solar cities in Australia and received funding from the Federal Government for half the $6.6 million Alice Springs Ilparpa solar power plant as part of the Alice Solar City project [54][55][56].

Note that the noisy Ron Goodin Titan gas-fired turbines are from the same manufacturer as for the proposed Tuggeranong power plant [57].

If the above two paragraphs sound familiar to ACT government officials, please read all of the above!

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For the record: I am a life-long research scientist with a geological/geophysical background. I am a Honorary Visiting Fellow at the Research School of Earth Science of the Australian National University, but express here private views that bear no relation whatsoever to the ANU. I hold shares in geothermal energy companies and reside in Macarthur.

Dr Chris Klootwijk

Objection #6, lodged with ACTPLA on 26/01/2009:

OBJECTION
Proposed Development – Block 2023 Hume
Proposed Communications Facility and Major Utility Installation
DA 200813657

This is an objection to both the Development Application and the Preliminary Assessment.

Major concerns, detailed hereafter, urge substituting the proposed on-site gas-fired power plant with on-site/off-site renewable energy facilities.

MAJOR CONCERNS:

(1) FLAWS IN POLLUTION MODELLING

- **No site-specific meteorological data.**
  The present and previous CALPUFF studies [1][2] have relied on meteorological observations from stations at Canberra Airport and Tuggeranong Hill. There are no meteorological data that are specific to the Isaacs Ridge, Long Gully Road and Mugga Lane precinct. This is a region of complex terrain, its meteorological behaviour has to be properly observed and cannot be extrapolated with sufficient confidence from other stations. Local observations should cover a substantial, representative, period. The US EPA [3][4] recommends for CALPUFF studies a five year observation record. However, the CALPUFF studies relied on a one-year only record from an off-site location, Tuggeranong Hill.

- **No detailed topographic input.**
  A coarse 9 Second Digital Elevation Model has been used with input data grided at about 250 m intervals. This model has an average error of 20 m in altitude, but in steep terrain the altitude can be up to 200 m in error. These coarse and inaccurate input data seriously underestimate the magnitude of relief. The extent of pollution hotspots and the magnitude of pollution therefore are underestimated. The problem is worse for tree-lined ridges, because the 10-15 m+ height of trees will add to the pollution-trapping effect of the local topography.

  The two CALPUFF studies [1][2] underestimate effects of Canberra's valleys and ridges on pollution hotspots. Modelling of pollutants distributions suffers from poor location and altitude sampling of the complex terrain of Isaacs Ridge and associated offshoot ridges. Terrain values are based on a US Geological Survey dataset with a resolution no better than 1 km and on a Digital Elevation Model (DEM) from Geoscience Australia with a resolution no better than 250 m. Such a coarse sampling smoothes Canberra-type topography by reducing terrain steepness by lowering the directly adjacent hill sections and by uplifting the directly adjacent valley sections. Sampling

representation is worsened by accuracy limitations of the DEM data. Locations have accuracy common for 1:250,000 scale maps (Canberra maps are generally at 1:25,000 scale and some may be at 1:10,000 scale) and altitudes have an average root mean square error of 20 m and up to 200 m in steep terrain [5]. Such a coarse and crude topographic dataset poorly identifies pollution hotspots and underestimates levels of pollution.

The rationale for usage of such a coarse and crude datasets is not presented in either of the pollution studies. To make matters worse, CALPUFF requires grided terrain datasets [6]. It is unavoidable that finer detail of complex terrain is lost in the griding process, irrespective of the scale of the dataset. This is a serious drawback for proper analysis of effects of pollution by nearby complex terrain, such as around Isaacs Ridge and offshoot ridges between Macarthur-Fadden, Fadden-Wanniassa and Wanniassa-Farrer. Use of a grided, and therefore flattened, topographic dataset in the CALPUFF pollution studies unavoidably leads to underestimate levels of pollution levels. The locations of the more substantial pollution hotspots may be less affected.

- **No local data on background pollution.**
  Background pollution levels are likely to be higher at pollution hotspots. The same complex terrain that leads to pollution hotspots caused by the gas-fired power plant most likely also leads to similarly located hotspots containing pollution from other industrial and residential activities in the Tuggeranong, Woden and Jerrabomberra valleys. This requires ongoing monitoring of "background" pollution levels, locally at identified pollution hotspots. Justification has to be demonstrated, not just assumed, for application of a regionally uniform background pollution level in any pollution study.

- **No modelling of Mugga Lane Tip pollution source**
  Pollution from the Mugga Lane Tip methane burners (3) has not been modelled as a separate source of pollution. This pollution is registered only as an unquantified contribution to the pollution level registered at the Monash monitoring site. This unquantified contribution from a location at the outer of the pollution plume is then processed as a blanket background contribution across the plume and across the region. Such a poor procedure ignores that pollution substantially increases from the outer of the plume to the source of the plume and that ridge-trapped pollution hotspots will further increase the level of pollution. Its impact depends on the pollution output of the burners, estimated at 0.7 ton per annum [7][8][1: table 3.1].

- **No modelling of other potential pollution sources**
  Other potential pollution sources have not been modelled, such as the 500-600 MW gas-fired power plant at Williamsdale and a crematorium suggested for Block 1671.

- **Whitewash**
  Use of a detailed 100*100 m grid for output data (receptors) does not make much sense when input data (topography and pollution sources) are inadequately detailed at an about 250*250 m grid. A detailed look at crappy output still shows crap! It seems also that the detailed receptor network is

centered on Block 1671 and not on Block 2023. Altogether, one gets the impression of a superficial study carried out as an add-on to a previous additional study on Block 1671 carried out by PAE on request of Golder Associates for the Health Impact Assessment [9: pp 38-44].

(2) $PM_{2.5}$ POLLUTION LEVELS ENCROACH NEPM/WHO GUIDELINES

The $PM_{2.5}$ pollution data are of particular concern. There are no data on background pollution within the ACT for $PM_{2.5}$. The PAE study [1] argues that the PM_{10} data monitored at Monash will do, because all PM_{10} pollution should be below the 2.5 micron level. The study then estimates from the Monash data a background level of 21 $\mu g/m^3$ (24 hour period), based on the 75th percentile of results monitored at Monash in 2003, This procedure follows EPA Victoria's modelling guidance [41], with 2003 taken in the present [1] and in the previous CALPUFF study [2] as a representative year. NEPM and WHO guidelines stipulate a maximum of 25 $\mu g/m^3$ (24 hour period), to be exceeded no more than 7 times a year.

The PAE modelling of the power plant pollution shows its additional $PM_{2.5}$ pollution at selected receptors in the range of 0.2 - 0.9 $\mu g/m^3$ (24 hour period). However, the report does not draw attention to the $PM_{2.5}$ pollution in the Hume-South Tralee hotspot, which is substantially higher with pollution levels above 1 $\mu g/m^3$ in Hume and above 2 $\mu g/m^3$ in South Tralee. Moreover, there are no data available on regional distribution of $PM_{2.5}$ pollution from the three 1 MW Mugga Lane Tip methane burners, nor for the 500-600 MW Williamsdale power plant, nor for the possible crematorium on Block 1671. Neither is there measured $PM_{2.5}$ background data available for identified pollution hotspots, nor for $PM_{2.5}$ pollution attributed to present and future traffic along the Monaro Highway. Winter night thermal inversions, frequently occurring within the Tuggeranong Valley, will worsen the pollution problem, in particular where the inversion layer intersects topographic ridges.

It is therefore well possible, if not likely, that the pollution levels from all these contributions combined will regularly exceed the NEPM and WHO guidelines.

This reasoning depends, of course, considerably on the assumed background level of 21 $\mu g/m^3$ (24 hour period), but this is the argued estimate of PAE [1, pp B6-B7], based on the 75th percentile (third quartile) in accordance with EPA Victoria's modelling guidance [41].

Note: *The PAE report [1, pp 11, 12, 38] states that the 75th percentile of the PM_{10} pollution monitored at Monash has been added as the background $PM_{2.5}$ pollution leve. The PAE report also states [1, p 11] that this procedure is in accordance with addition of the 75th percentile specified in the Victorian EPA study [41]. However, the latter study specifies addition of the 70th percentile, not the 75th percentile [41, p 29]. Adding further to confusion, the 70th percentile level is quoted as well in the PAE study [1, p 12].*

The pollution figures in the PAE study for Block 2023 [1: figures 5.1-5.20] document pollution in an area smaller than shown in the initial PAE study for Block 1671 [2: figures 7.1 to 7.32]. This is unfortunate, in particular for the $PM_{2.5}$ pollution levels because $PM_{2.5}$ pollution is well known to be far-travelled. The $PM_{2.5}$ hotspot centered

on central Hume (1 μg/m^3 +) and South Tralee (2 μg/m^3 +) is particularly worrying because it makes the accumulated pollution encroach the maximum concentration level according to NEPM and WHO guidelines. The southward continuation of this hotspot is only partially documented. It is not clear how this hotspot extends toward Fernleigh Park and whether it affects Burra and Royalla residents.

Dangers of exposure to elevated levels of $PM_{2.5}$ are well documented [10], in particular in regard to respiratory problems (eg asthma sufferers, children and the elderly) and cardiovascular problems. $PM_{2.5}$ pollution is estimated to have caused 22,000-52,000 deaths per year in the USA (in the year 2000) and 200,000 deaths per year in Europe [11]. The Canadian Medical Association estimates 21,000 deaths per year (in the year 2008) in Canada, caused by air pollution ($PM_{2.5}$, O_3) [12][13][14][15].

(3) MAIN POLLUTION HOTSPOT CAUSED BY RIDGE DOWNDRAFT

- The Chief Minister's taskforce has managed to locate the gas-fired power plant between a rock and a hard place ─ between a major, somewhat crescent shaped, ridge to the west and north of the power plant and the National Library Repository to the southeast of the power plant. The ridge to the west and north is substantial with an elevation up to 130 m above the main level of Block 2023. The main ridge extends from the Mugga Lane Tip northward, but two smaller east-west ridges, a main one near the Woden Homestead and a smaller one located north of the Stonyhurst Homestead, give the ridge a crescent-like shape around the power plant location. A more problematic location for a power plant would be hard to find. This unfortunate set-up will cause with prevailing north-western winds a substantial downdraft of pollution from the hot exhausts plume and will trap heat dissipated from cooling the data centres.

- The pollution figures show without exception [1: figures 5.1 to 5.20] that prevailing north-western winds down-drafting across the ridge located to the west and north of the power plant cause a highly polluted hotspot to the southeast of the power plant. This pollution hotspot is centered on central Hume and South Tralee.

- The National Library Repository is located within this major pollution hotspot. The combination of nitrous and sulphur dioxide exhausts, heated vapour from the power plants' chillers (420 Megaliters per year) and further heat dissipation from cooling the data centres, will most likely pose a serious acidity threat to the repository. Best practice of environmental control and hermetic sealing of access may not be enough to prevent collections from being affected by power plant-generated acidity over the lifespan of the power plant.

- Other pollution hotspots already identified in the previous PAE study for Block 1671 [2: figures 7.1 to 7.32] again show up prominently in the present PAE study for Block 2023 [1: figure 5.1 to 5.20]. In particular Fadden and West Macarthur, but also Wanniassa-Monash-West Gowrie, Gilmore-Chisholm, Theodore-Calwell, the Macarthur Horse paddocks, Environa-Tralee

Station and Upper Mugga Lane. Pollution at the Macarthur hotspot may have been reduced a bit compared with the Block 1671 location, but Gilmore-Chisholm is copping it for the worse.

- Location of a polluting gas-fired power plant on Block 2023 very close to a substantial, somewhat concave, ridge ─ much closer than would have been the case at Block 1671 ─ is a very worrying scenario for creation of downwind pollution hotspots. Why is it that the CTC proponents and their backers in the ACT government continue to ignore warnings about ridge-trapping pollution hotspots that have been clearly delineated in a previous [2] and the present [1] PAE CALPUFF study. Is it plain incompetence or is there a mischievous thread?

- A polluting power plant on this Block 2023 location may cause substantial health dangers for workers in Hume and for future residents in South Tralee and Environa. The Stanhope government has already located the Symonston Jail close to the Jerrabombera residential development. One may wonder whether locating a polluting gas-fired power plant close to the future South Tralee and Environa residential developments, establishes a pattern of political manoevering with the ultimate aim for stamp duty to flow to ACT government coffers rather than to governments across the ACT-NSW border. One may wonder whether the ACT government is following this path aiming to keep residential growth in the Queanbeyan precinct to 5% of regional growth [16: pp 9, 28], rather than the 10% of regional growth aimed for by the Queanbeyan City Council [16: pp 26, 29]. If so, such playing with people's health, if not lives, would raise serious questions about morality and duty of care.

(4) NO ECONOMIC MODELLING OF HEALTH CARE COSTS

There is no economic modelling study on health care costs related to the power plant's pollution amongst the DA/PA documents. An appropriate blueprint for modelling would be the 2008 study by the Canadian Medical Association (CMA) "No breathing room, national illness costs of Air pollution" [15]. Health care costs that are properly attributable to the power plant's pollution should be born by the CTC consortium. If it were any other way, this private consortium would get away with capitalizing profits but socializing costs.

(5) GAS OPTION SHATTERS ACT CLIMATE CHANGE STRATEGY

The ACT's main climate change document *"Weathering the Change ─ ACT Climate Change Strategy 2007-2025"* estimates current greenhouse gas emissions in the ACT at about 4.45 million tonnes per year [17]. The strategy aims for a reduction to the 2000 level (4.059 million tonnes) by 2025 and a further reduction by 60% of the 2000 level by 2050. However, CO_2 emissions of the proposed Hume 28 MW gas-fired power plant are estimated at 170,000 tonnes per year [18], adding yearly 4.2% to the 2000 emissions level. CO_2 emissions of the proposed Williamsdale 500 MW gas-fired power plant would add a further 74.8% to the 2000 emissions level (assuming similar emissions characteristics). Adoption of the gas option for powering the ACT would ultimately add 79% to the 2000 emissions level and begs the question how a 60%

reduction by 2050 could possibly be achievable? The ACT is currently free of major sources of pollution such as a gas-fired power station. However, a choice now for a gas-fired power station in Hume would put the ACT on a path to substantial greenhouse gas pollution. The ACT has to make a crucial and fundamental choice. Clearly, alternative non-polluting renewable energy options should be seriously investigated and be pursued!

(6) POWER PLANT CONSUMES ONE PERCENT OF ACT WATER CAP

The ACT government and other state ministers agreed in May 2008 to cap the ACT net water consumption from the Murray-Darling system to 40GL/yr. The power plant will consume 435 ML/yr [19: 419ML to be supplied and a further 2.5% to be obtained through roof catchment of rain] in a process that re-uses heat from the exhaust stacks to drive absorption chillers. The 419 ML/yr of water is said to be acquired (ActewAGL community briefing 28/4/2008) from Tantangera Dam (Snowy Mountain Scheme) so as not to strain the ACT's own water supply. However, buying increasingly scarce water from the Snowy Mountains, if available at all, will not be cheap.

The cooling procedure is promoted to save 9MW in power from the electricity grid. However, it is not reported that the 435 ML will evaporate and be lost, thus locking up more than 1% of the ACT's allowed net water consumption from the Murray-Darling system. Such a loss will strain water pricing by ActewAGL and will strain water restrictions in the ACT. Lost also is the potential energy of the 419 ML/yr of water stored at altitude in the Snowy Mountains. The water will just flow down the Murrumbidgee or be piped down to the ACT. However, the potential energy of this water can readily be used through the Snowy Hydro scheme for generation of pollution-free power, potentially in multiple cycles of pumped storage through the Tumut-3 hydro-electric station, and the water will still be available for use within the Murray-Darling system.

Alternative direct purchase of 9MW of power from the Snowy Hydro scheme will buy pollution-free power, will retain the water for further use and will not strain the ACT water budget. This readily available alternative also eliminates the need to install bulky absorption chillers, steam exhaust stacks, a dedicated water storage and water pumping and transport facilities. Absence of steam will substantially reduce fog and smog potential in the Jerrabomberra, Tuggeranong and Woden Valleys. Absence of steam also will reduce the risk of acidity damage to the National Library Repository. This alternative also reduces pollution at ground level (scenario 3 of the CALPUFF study, [2: pp 27]) because plume rise is not restricted by cooling the plume through the absorption chillers (scenario 1). Clearly this readily available alternative is superior by far over CTC/ActewAGL's purported clever re-use of exhaust heat.

LESSER CONCERNS:

(7) NO VALID ARGUMENT FOR CO-LOCATION

The above valid arguments (6) against operation with absorption chillers also mean that there is no valid argument for co-generation and thus no valid argument for co-location of power plant and data centres [20][21][22].

CTC/ActewAGL's argument for co-location of power station and data centres is based primarily on efficiency gained in re-using the power plants' exhaust heat through absorption chillers for cooling of the data centres. A far lesser argument for co-location is reduction in transmission losses of electricity. If implementation of absorption chillers is not feasible because of the severe impost on the ACT's net water allocation, then the argument for co-location of power station and data centres will hinge solely on reduction in transmission losses. Any user of electricity and any producer of electricity faces such losses. Such losses do not constitute a valid argument for co-location of power station and data centres on the same site. As is happening anywhere else, power can be generated very effectively off-site, limiting pollution dangers for local residents.

CTC/ActewAGL's arguments for co-location of power station and data centres and the ACT's government support for a polluting gas-fired plant as the territory's first independent energy source, are in stark contrast to the energy policy of the NSW government. In a policy approach that leaves CTC/ActewAGL and the ACT government squarely in the Luddite corner, the NSW government will supply energy for the Sydney desalination plant from the 63 turbine Capital Wind Farm that is currently under construction in Bungendore [23]. This $1.7 billion desalination project is comparable in cost to the original ($2 billion) and scaled-down ($1 billion) power plant cum data centres project. Energy demands of the CTC data centres and the NSW desalination plant are of the same order of magnitude, 28+9 MW versus the output of 63 wind turbines, each capable of producing about 2MW. If the NSW project can operate with non-polluting renewable power that is generated off-site, so should the ACT project be able to operate. It all boils down to the political will to go for non-polluting power sources "*that do not produce a single kilogram of CO_2 emissions"* [24] and do not further aggravate global climate change. The NSW government's approach leaves the credibility of ACT government's climate change approach in tatters. ACT residents will suffer the polluting consequences of poor government policy.

(8) NO RENEWABLE ENERGY CONTRIBUTION

No attempt has been made by the CTC-ActewAGL consortium to source energy from renewable sources. Yet these could contribute significantly to reduce the energy demand of the data centres. The CTC-ActewAGL consortium seems determined to simply copy a northern hemisphere design for a data centre complex without any intellectual effort to adjust the design to local possibilities for reduction of energy consumption.

There are real possibilities here that are all ignored:

- **Geothermal heat pumps**
  Geothermal heat pumps/chillers were rejected in a report prepared by GHD for the EIS [25: table 5] for reason that *"there is not sufficient requirement"*, yet geothermal heat pumps operate to satisfaction in the main building of Geoscience Australia. The geothermal heat pump system at GA delivers about 0.5 MW, cooling and heating the main building [26]. The Geoscience Australia location and the Hume Block 2023 location have comparable volcanic bedrock (dacitic ignimbrite at GA and rhyodacitic ignimbrite at

Block 2023). Block 2023 should be equally suited for installation of geothermal heat pumps. With 8 large buildings proposed on site (6 data centres, 2 power station buildings), the output performance of the GA geothermal unit should be up-scalable by an order of magnitude for the buildings on the CTC campus. This could account for some 5 MW of the ~37 MW (28 MW turbines, 9 MW chillers) required, representing ~13% of energy requirements.

- **Solar photo-voltaics**
  Solar photo-voltaics is treated poorly in the GHD report for the EIS [25: table 5 and main text 6.4.2]. Proposed panel coverage is over a mere 40% of the area and that with a density of only 60% [Note this relates to Block 1671]. On this basis energy output during daylight hours is estimated at 2.7% of the daily needs in mid-winter, up to 8.9% in mid-summer. However, full coverage of the site would increase these figures to respectively 11.25% in mid-winter and 37% in mid-summer.

  Together, geothermal heat pumps and solar photo-voltaics may deliver between 16% and 50% of total energy needs! *Note this argument relates to the larger Block 1671 (~18 hectare), not to Block 2023 (~12 hectare).*

- **Solar thermal**
  Solar thermal energy supply is rejected in the GHD report for the EIS [25: table 5] as it would have to be off-site. However, the alternative data centre/power plant proposed by the Sanctuary Energy - Wizard Power – Springfield Land Corporation consortium [27] indicates the feasibility of a solar thermal energy supply at an off-site location. A pre-feasibility study on a solar thermal power plant for the ACT, commissioned by the ACT government and ActewAGL and carried out by Parsons Brinckerhoff, led the Chief Minister to apply for federal funding under the federal government's infrastructure program [28][29]. This funding request has been accepted on an initial short list of projects to be funded from federal infrastructure funds [43]. Worley Parsons have proposed to construct within Australia up to 34 solar thermal power plants of 250 MW at a cost of 1 billion dollar each [30]. This offers a unique opportunity for the ACT to acquire one or more non-polluting, renewable energy power plants, instead of the 500 MW, polluting, gas-fired power plants planned by ActewAGL for a Williamsdale location.

- **Geothermal - Hot Fractured Rock & hydrothermal prospects**
  Geothermal energy supply is rejected as it would have to be off-site [25: table 5]. This is most likely so, but such energy can be supplied through high voltage DC power lines over large distances with minimal energy losses. For illustration, AGL ─ ActewAGL's parent company ─ has gone into Joint Venture with Torrens Energy, a junior geothermal energy company, and AGL's main competitor, Origin Energy, has gone into Joint Venture with leading geothermal energy company, Geodynamics. There are currently another 30 geothermal energy companies actively exploring for geothermal resources [31]! Geothermal energy is anticipated to come onto the market within the next five years and has enormous potential for pollution-free renewable supply of base load power [32].

Absence of genuine efforts to reduce energy consumption does not agree with the Territory Plan objectives [45], endorsed in the draft development control plan for the Hume West industrial area [44, Section 2.3], to *"Encourage the design and construction of industrial and commercial buildings that are energy efficient, functional and flexible."*

(9) ACID RAIN CONCERNS

Local Concerns

Concerns for acidity problems due to the proposed Hume gas-fired power plant focus on the main pollution hotspot centered on the power plant location and extending south-eastward to Hume and South Tralee. Combination of nitrous dioxide and sulphur dioxide exhaust with copious amounts of steam (435 ML/year), heat dissipation from cooling the data centres and downdraft of plume heat by prevailing north-western winds coming in across the crescent shaped hill to the west and north will cause acidity dangers for the National Library Repository, for workers in Hume and for residents and school children in South Tralee.

Downdraft of this heated acidic plume will be particularly aggressive to local vegetation. It is highly questionable whether woodlands that are identified as "endangered ecological communities" (yellow box/red gum woodland between Block 2023 and Stonyhurst Homestead; red gum/carex swamp woodland directly northeast of Stonyhurst Homestead) will survive such an acidic environment. Yet these woodlands are considered of moderate to high conservation value (44). Equally questionable is survival of screening vegetation along Mugga Lane and Monaro Highway and survival of revegetation of the Dog Trap Creek Corridor, both specified as required in NCA's draft development control plan for the Hume West industrial area (44).

Regional Concerns

Approval for a 28 MW gas-fired power plant at Block 2023 constitutes a fundamental choice for polluting gas-fired power plants in a jurisdiction that has been uniquely blessed with absence of such major sources of pollution. It signals approval from the powers that be for a 500-600 MW gas-fired power plant at Williamsdale proposed by ActewAGL. There are serious dangers from such a large power plant for extensive greenhouse gas emissions (see the above section 5) and for acid rain in the ACT, adjacent parts of NSW and the Namadgi and Kosciusko National Parks.

Acid rain develops from nitrous oxides and sulphur oxides mainly produced by cars, fossil fuel burning power plants and lightning [33][34] ─ the ACT and surroundings experience frequent summer lightning. Acid rain becomes a problem on the ground when a region has insufficient capacity for NO_2 uptake by vegetation and soil and/or insufficient natural alkaline capacity to neutralize acidity. Capacity for NO_2 uptake by vegetation is a contentious issue [35] ─ vegetation may be a net emitter or a net absorber.

The ACT, and its upstream water catchment in adjacent NSW and in the Kosciusko National Park, has little natural capacity for neutralizing acid rain. The geology of this region consists mainly of acid volcanics and acid granites, with only very limited occurrence of carbonates (limestone). The nearest substantial carbonate deposits are

more than 50 km from Canberra. Carbonate deposits near Yass and Taemas are downstream of the ACT and carbonates at Blue Water Hole and near Wee Jasper are outside the ACT water catchment. These carbonate deposits do nothing to buffer alkalinity in ACT water streams. There is a carbonate deposit of some note upstream of the ACT near Bredbo, but its size is not comparable to the Wee Jasper deposit.

This precarious geological situation ─ lack of sizable carbonate deposits and abundance of acid rocks ─ is comparable to eastern North America [34], a region with wide regions of bedrock, exposed from land-ice scraping during the last ice age, with precariously little carbonate deposits. It was here that acid rain was first recognised as a serious problem and traced to emissions of major power plants. Surely the proposed power plants in Hume and Williamsdale may not have the combined exhaust output of power plants in North America, but accumulation of pollutants over time has to be considered. It is a question of maintaining or exceeding balance.

Can balance be maintained or will accumulation of acid rain agents over time run out of control? Present levels of nitrous oxides and sulphur oxides may be below the critical load of the ACT region, so there may be at present no noticeable occurrence of acid rain. However, it is open to question whether this will remain so with the additional emissions from ActewAGL's gas-fired power plants. The plant's emission of nitrous oxides is considerable according to the DA documentation provided by the CTC consortium. Emission of sulphur oxides may increase when coals seam gas is to be supplied. Coal contains sulphur and gas extracted from coal will contain sulphur. Amounts will vary with the particular coal seam that is mined.

If the power plants' contributions increase nitrous oxides and sulphur oxides concentrations above a critical load factor, then acid rain development will get out of control. We will then experience slow acidification of streams in the ACT and slow acidification of the ACT water supply. Vegetation will start dying back with dire consequences for the Kosciusko National Park and the Namadgi National Park, for the extensive government and private plantations in the region and for frequency and magnitude of bushfires. When the cause of such disasters is traced back, who is going to compensate whom? Will the ACT government have to compensate the NSW government? Will ActewAGL have to compensate private investors in plantations?

In absence of a widely present natural alkaline buffer, it is not clear what capacity or capability the ACT has to prevent acid rain developing other than through removal of nitrous oxides and sulphur oxides from the exhaust stacks. However this will reduce the power output. Anticipated commonwealth government pressure to limit carbon dioxide emissions will further reduce the power output. Conceivable, the plants may sooner or later cease to be economical and may have to shut down in favour of more economical renewable energy alternatives, such as solar thermal power plants. Such alternatives are becoming realistic options that can be implemented in time frames of years, far less time than realization of carbon geo-sequestration, and should be seriously researched now!

(10) RESTRICTIONS ON FURTHER DEVELOPMENT

Presence of power plants that drive up pollution toward maximum allowable levels (see in particular the above section (2) on $PM_{2.5}$ pollution levels) will constrain further development in the region, certainly emission-intensive developments. Operation of the proposed Hume and Williamsdale power plants may well pre-empt further developments in the Hume industrial area. It is hard to imagine that this could be the intention of the ACT government. Hume is a designated industrial area and is still in the process of development. The proposed power plant also may restrict light industrial and/or residential developments in the Jerrabomberra, Tuggeranong and Woden valleys.

(11) VARIABILITY IN POLLUTING CONTENT OF SOURCED GAS

The CALPUFF plume studies [1][2] only consider a single natural gas source. Presumably this is an average mix of gas sourced from the Cooper Basin (SA/Qld) and from Bass Strait (Vic) as supplied to NSW and the ACT according to the National Greenhouse Accounts [36]. However, it highly likely that over the lifespan of the power plant coal seam gas from Queensland and/or New South Wales coal basins will be used as sources. This may well lead to variations in impurities of coal seam gas sources and in particular to higher concentrations of Naturally Occurring Radioactive Materials (NORM's) ─ Uranium, Thorium and Radon to mention a few ─ because NSW coal fields have on average higher NORM contents than Queensland coal fields by a factor 2 to 10 [37].

Particulates with NORM's will have high density and will not remain in suspension for long. They may drop mainly in the main pollution hotspot centered on Hume and South Tralee and also in ridge-bound, eddy-trapping, pollution hotspots such as Fadden, depending on prevailing westerly or easterly winds. Such radioactive pollution will accumulate and may increase over time to levels that are considered dangerous.

(12) LOCAL HEAT DISSIPATION EFFECTS

Co-location of the gas-fired power station and the data centres means that both the heat from the electricity generation and the heat from the electricity consumption are dissipating at the same time at the same location. This is a highly unusual situation. The power station will generate from at least 2 turbines at least 28 eMW for use by the data centres. Further energy equivalent to another 9 eMW will be generated from the absorption chillers. According to Canberra Technology City's documentation on co-generation, handed out at the second Community Consultation Meeting (15/06/2008 [38]), 98% of this 37 eMW will dissipate as waste heat from the data centres. The amount of heat dissipating from nearly 37 eMW on a 24/7 basis is substantial and represents a sizable portion of electricity consumption by Canberra residents (possibly more than 30%, although factual data on electricity consumption in the ACT are hard to come by for commercial-in-confidence restrictions).

This heat hardly can travel upward into the plume of hot exhaust gasses. It will have to dissipate mainly at low levels. However, dissipation is restricted by the substantial crescent shaped ridge to the west and north of the power plant and the prevailing north-western winds. Heat will therefore accumulate and be dissipated mainly toward

the pollution hotspot centered on Hume and South Tralee. This heat will reinforce acidity problems for the National Library Repository and for the endangered woodlands between Block 2023 and the Stonyhurst Homestead and to the northeast of Stonyhurst Homestead, see above section (9).

(13) DUE PRIORITY FOR POWER PLANT CONSTRUCTION?

Construction of the polluting gas-fired power plant is planned as phase 1, prior to construction of any of the data centres that the power plant is proposed to service [39]. Why this high priority? It should be possible to run the first few data centres with only limited energy requirements from the grid once the power line and switchyard are constructed.

There is no justification in the planning documents for first-off construction of the pollution gas-fired power plant to be an operational requirement. Absence of such justification poses the question whether this surprising priority would establish a fait-accompli before a newly-to-be-developed ACT super-department for the Environment, Climate Change, Energy and Water [42] may raise serious concerns, or before planning for and/or construction of an off-site solar thermal plant can materialize? Or, whether it possibly is an attempt to cash in on free carbon permits when carbon trading starts in 2010 [40]?

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FOR THE RECORD

I am a life-long research scientist with a geological/geophysical background. I am a Honorary Visiting Fellow at the Research School of Earth Science of the Australian National University, but express here private views that bear no relation whatsoever to the ANU. I hold shares in geothermal energy companies and reside in Macarthur.

Dr Chris Klootwijk

NOTE ON ADDITIONAL DOCUMENTATION

This objection is based in part on material extracted from my previous objections to construction of a gas-fired power plant on Block 1671 and on my comments on the Environmental Impact Statement and on the Health Impact Assessment for the gas-fired power plant. I attach copies of these documents hereafter because they represent a well-documented source of reference.

210 MW gas-fired power plant on Block 1671:

Objection #1, lodged with ACTPLA on: 05/05/2008
Objection #2, lodged with ACTPLA on: 26/05/2008
Objection #3, lodged with ACTPLA on: 27/05/2008

28 MW gas-fired power plant and data centres on Block 1671:

Objection #4, lodged with ACTPLA on: 25/06/2008
Objection #5, lodged with ACTPLA on: 30/06/2008
Comments on EIS and HIA, lodged with GHD and Director Health Protection Services ACT Health on: 08/12/2008

This additional documentation is not included in the short version of this objection.

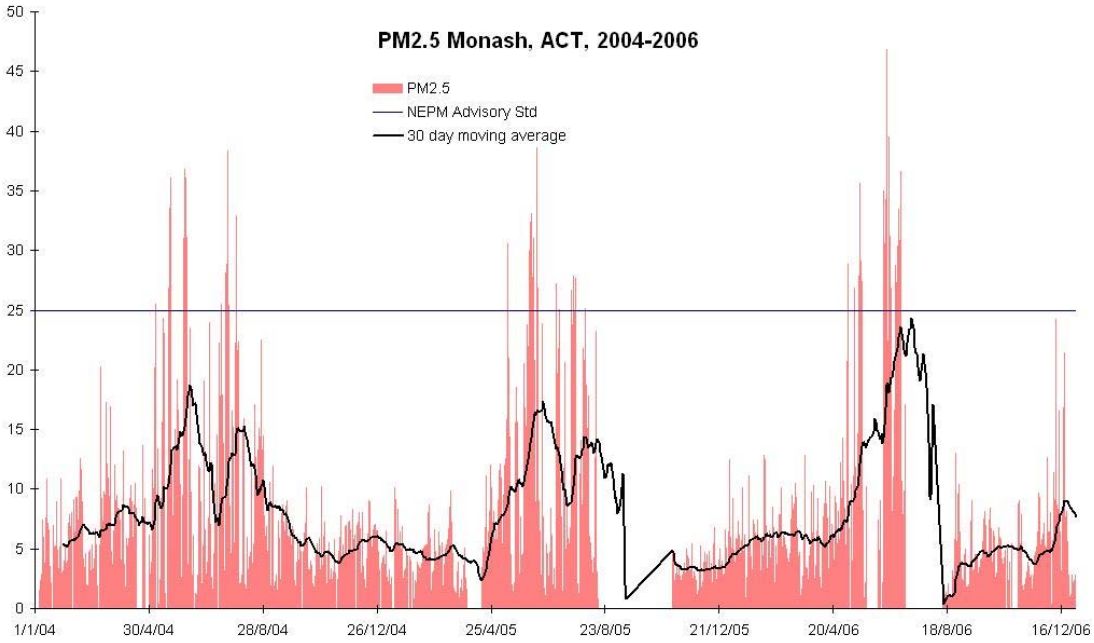
Objection #7, lodged with ACTPLA on 02/02/2009:

OBJECTION
Proposed Development – Block 2023 Hume
Proposed Communications Facility and Major Utility Installation
DA 200813657

This is an objection to both the revised Development Application and the revised Preliminary Assessment and adds to my previous objection submitted on 26/01/2009.

I have just become aware that the ACT government has been monitoring $PM_{2.5}$ pollution levels at the Monash monitoring site since at least very early 2004 [1] [2][3][4]. The $PM_{2.5}$ pollution data are most important because they monitor concentrations of minute particulates that are far travelling, can lodge deep in the lungs, can enter the bloodstream, and are generally regarded as a major cause of chronic illness and death for children, the elderly and in particular asthma sufferers [5][6][7][8]. However, none of the three pollution reports prepared by consultants for the CTC consortium in regard to pollution from gas-fired power plants at Tuggeranong or at Hume, mentions any of these $PM_{2.5}$ pollution data. The latest pollution report by consultant Pacific Air & Environment for the proposed gas-fired power plant/data centre in Hume specifically states that $PM_{2.5}$ pollution data are not available [9: p B6].

Disregard of available $PM_{2.5}$ pollution data is most unfortunate. These data are interpreted by the ACT Commissioner for Sustainability and the Environment to demonstrate that $PM_{2.5}$ pollution levels exceeded the WHO and the NEPM guidelines for a maximum concentration of 25 μgram/m^3, on at least 47 occasions over the monitoring period 2004-2006 [4]. The WHO and NEPM guidelines allow a maximum of 5 breaches per year. The Monash data show that this maximum of 5 breaches was exceeded substantially in each of the three years monitored (as read from the graph reproduced hereunder, in 2004: at least 14 times; 2005: at least 14 times; 2006: at least 19 times).



These pollution data substantiate serious concerns expressed in my previous objection (26/01/2009), in particular regarding:

- Background $PM_{2.5}$ pollution levels in the ACT being very high;

- Additional $PM_{2.5}$ pollution from a gas-fired power station at Hume, and/or at Williamsdale, and/or from a crematorium in Tuggeranong, will increase the number of breaches from a number that already substantially exceeds the allowed maximum of 5 breaches per year.

I conclude that emergence of these most worrying $PM_{2.5}$ pollution data:

- Further erodes the credibility of the pollution study carried out by PAE for the CTC consortium in regard to the Hume gas-fired power plant;

- Poses series questions about the validity of the Environmental Impact Statement and Health Impact Study for the Tuggeranong gas-fired power plant whose conclusions may be transferred to the Hume gas-fired power plant;

- Poses serious questions about the ACT government's unrelenting support for the CTC consortium's proposal for a gas-fired power plant/data centre, whilst not ensuring that crucial pollution data in its possession are available to, and included in, the DA/PA evaluation process overseen by ACTPLA;

- Demonstrates clear grounds for substituting the polluting gas-fired power station proposed for Block 2023 in Hume with an off-site non-polluting solar thermal power station.

References

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For the record
I am a life-long research scientist with a geological/geophysical background. I am a Honorary Visiting Fellow at the Research School of Earth Science of the Australian National University, but express here private views that bear no relation whatsoever to the ANU. I hold shares in geothermal energy companies and reside in Macarthur.

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