

## **Transpower Grid Upgrade Submission**

Submitter Dr Laura Bennet

My submission is made on behalf of myself and Mr Adrian Kinsler, both parties are owners of 107 Highridge Road, Clevedon, Auckland.

The issues we raised in our submission stand. Does not adequately avoid, remedy or mitigate adverse effects on the environment (section 5(2)(c) of the Act).

1. Does not amount to or promote the efficient use and development of resources (section 7(b) of the Act).
2. Does not maintain and enhance amenity values or the quality of the environment (sections 7(c) and (f) of the Act).
3. Will generate significant adverse effects on the environment.
4. Is inconsistent and contrary to relevant regional and district policy statements and plans (section 171(a) of the Act).
5. Failed to give adequate consideration to alternative sites, routes, or methods of undertaking the work (section 171(b) of the Act).
6. Is not reasonably necessary for achieving Transpower's objectives for which the designation is sought (section 171 (c) of the Act).

We provide the following references for consideration of our objections.

**Default discount rate and undue costs to individuals and business:** We refer the BOI to the New Zealand Treasury (**references 1 and 2**) about how one costs the default discount rate, and the implications for which rate to select on determining the DDR for government projects (reference 2).

The current Proposal would not have been judged the most economically viable and thus have past the second Grid Investment Test by the Electricity Commission if Transpower had adopted the treasury recommended default discount rate of 10% (vs. Transpower's choice of 7%).

The choice of what default discount rate is chosen is important. As stated in reference 2: "When the government is making judgements, the choice of discount rate matters as it can affect the decision made." and "Overall, the paper concludes that the social rate of time preference is appropriate (subject to estimation considerations) when the government is considering new government activities or ceasing existing government activities, because society's preferences are important."

At this time no clear case for choosing a lower discount rate has ever been made to the public. **Costs to individuals** Further there has been inadequate or non-existent assessment has been made of the cost to the public (in terms of property value and business losses, particularly to those owning properties which are close to the towers and substations who will receive no compensation) as highlighted in section **2.3.12 Externalities**. We believe that a formula for compensation can be reached if this Proposal or any proposal which constitutes the use of pylons is chosen.

### **Adverse health effects from electro-magnetic radiation**

There is considerable international over the question of whether ELF-EMF has non-thermal effects on our bodies which may lead to illness. There is considerable public concern over this. No one can give an absolute assurance that magnetic fields are safe, and as yet we do not know if there is a lower limit of exposure

The current exposure guidelines from the ICNIRP and IEEE are not precise and without controversy. Indeed, we recommend that the BOI log onto the ICNIRP website where they will currently find on the front page (as of this submission on the 25<sup>th</sup> February 2008) of their website an

announcement for a new conference on the topic which makes it clear that there is “puzzlement” amongst experts not certainty ([www.icnirp.de](http://www.icnirp.de))

There is widespread discussion that thermal limits are outdated, and that biologically-based exposure standards are needed. ICNIRP themselves acknowledges that current guidelines do not take into account potential non-thermal effects of ELF-EMFs (below 100microtesla).

To assist the BOI in understanding the controversy about the science, exposure limits and the politics around defining the health issues, we refer the BOI to **reference 3**; which is an excellent primer on this complex subject.

This report derives from an international working group of scientists, researchers and public health policy professionals (The BioInitiative Working Group) has released its report on electromagnetic fields (EMF) and health. They document serious scientific concerns about current limits regulating how much EMF is allowable from power lines, cell phones, and many other sources of EMF exposure in daily life. The report concludes the existing standards for public safety are inadequate to protect public health.

In this report they raise the issue of who determines standards and why there is debate on the subject. “One reason is that exposure limits for ELF and RF are developed by bodies of scientists and engineers that belong to professional societies who have traditionally developed recommendations; and then government agencies have adopted those recommendations. The standard-setting processes have little, if any, input from other stakeholders outside professional engineering and closely-related commercial interests. Often, the industry view of allowable risk and proof of harm is most influential, rather than what public health experts would determine is acceptable.”

We ask the BOI to consider this issue seriously and why it is that members of the public are raising the need to be proactive on this subject.

### **On the question of research. What constitutes convincing or satisfactory research?**

It is suggested that there is adequate or unconvincing data on potential harmful effects of the non-thermal effects of ELF-EMF. This is not the case, as discussed below

What is debated is how best to approach the issue of what to do about the potential health risks – what prudent or precautionary approaches should we take in terms of planning for health as environmental risk factor.

A reduction in exposure is a generic recommendation from all agencies including the World Health Organisation (**reference 6**), and that it is up to individual countries to establish what works best for them. In Europe, some government’s have already acted to reduce exposure limits to below that recommended in current ICNIRP guidelines (Italy, Russia, China, Switzerland, see reference 3, table 3.3, the SAGE report state that the Netherlands and Slovenia have also reduced levels, reference 4, pg33) The SAGE report (**reference 4a and 4b**) and the SCENIHR report (**reference 5**) are further examples of international government concern and thinking on this subject. The SAGE group state that they do not feel compelled to follow WHO guidelines (reference 4a, page 34)

We agree that the risks are not high, but nonetheless we argue that they are real, particularly for sensitive sectors of the population (unborn children, children, sick adults, the elderly). However, the SAGE report (pg 29 **reference 4a, and supporting paper S6, reference 4b**) makes it clear that the life of one child saved is a significant cost-benefit saving to our society. “

“We take the value to society of preventing a fatal case of childhood leukaemia as £4M, and for a nonfatal case, £0.5M. This gives an aggregate value of preventing a single case of £1.6M. To obtain the value of preventing one case per year going forward in time, we used the HSE and Treasury Green Book procedures on discounting future benefits to obtain a value of preventing one case per year going forward of £50M. We recognise that alternative approaches are possible, described in Supporting Paper S6, but all these variations are fortuitously likely to result in similar answers to the Treasury approach, at least to within a factor of two or so, and we proceed on this basis”

There are of course also significant ethical issues regarding our duty of care to prevent injury and illness.

In terms of precedence, we already take a precautionary approach to the reducing the additive benzene in our petrol (at great cost to this industry and the reason we have reduce our octane rating of premium petrol from 96 to 95) (**reference 7**). This despite the fact that while we have strong epidemiological evidence causes illnesses; albeit rare (adult leukaemia) there as yet no consensus in the scientific literature about how the illness is caused (mechanisms of action –see **reference Ahmad Khan**). It has been argued by some that there is regulation for benzene not because there are strong experimental data (of a sufficiency to be compelling), but because in the USA at least, there have been several successful lawsuits. The same is not yet the case for EMF

While only a small number of deaths and illnesses may be attributable to EMF, we should nonetheless utilise the precautionary principle to actively reducing exposure (**reference 8**) Delaying public health initiatives until there is “satisfactory proof” according to the affected industries, is what has caused previous public health disasters. There was nearly a 100 years before NZ established satisfactory guidelines for the protection of workers and the public against asbestos exposure from the time of the first formal human population observations (see **reference Kjellstrom for review**). A shorter, but nonetheless, prolonged time frame has existed for smoking, and passive smoking. An appropriate public health approach is to be proactive in reducing exposure.

Overall, we would argue that the potential physical health effects are added to the *mental health* (reference 9) effects of having pylons in our communities, the significantly negative impact on the environment (of the current proposal and future schemes which will be necessary as our cities grow and communities grow around pylons), and the loss of land and business values (which are either inadequately or not compensated for) and our clean-green branding then undergrounding is looking like a long-term cost-effective strategy.

### **The scientific data: Specific scientific references to consider**

I (Dr Laura Bennet) am a senior scientist at the University of Auckland who specialises in fetal physiology. I have more than 20 years research experience and 78 original science papers, 53 reviews and book chapters. I am not a specialist on EMF, but have considerable experience in determining the impact of adverse effects on the developing fetus. It is this expertise I bring to the table.

**Epidemiology:** Every health agency who has assessed the effects (see the list in **reference 3**) conclude that the human population data (epidemiology) for some health effect such as childhood leukaemia remain valid. Debate about other illnesses (miscarriage and other cancers, neurological and psychological illnesses). Combining studies (meta analyses) to overcome statistical population issues in individual studies strengthens the finding. Current new studies (**references Draper and Lowenthal**) provide a more robust approach to population selection criteria and have confirmed

that the association between childhood leukaemia and EMF remains statistical. The Draper was a key finding in the foundation of the SAGE group.

**Experimental proof:** Critics say that without definitive experimental proof (i.e. animal or cell studies) then the epidemiological evidence is “poor or weak” and without such proof we cannot put in place satisfactory public health strategies. This is the crux of the current debate. What constitutes definitive, satisfactory, conclusive proof? When do strong human population data become valid.

The precautionary approach document makes it clear that we can take good steps based on pooling data from various research lines. Currently, the data suggest that we need to protect against EMF exposure as low as 0.4microtesla, and maybe lower, and that we need to consider ionisation of the air (which clumps particulates together such as pollution, pollens, other agents such as insecticides, **reference 3** provides a good background on both issues).

It should be noted that all good science has research papers for and against, such is the nature of debate, interpretation, and the variances in experimental approaches. There is no magical number of papers which say act now. Such “for and against” debate still exists in the literature today for subjects like asbestos, and the literature is not pure, being very much open to industry manipulation (see **reference Egilman**). We should not be naive about this or the desire of industry to downplay potential harmful effects as minimal and therefore only worthy of minor (and cheap) precautionary approaches.

It is often stated, for example, that while EMF is a class 2 carcinogen according to IARC, so is coffee, and we all drink coffee and seem to do okay. Indeed we may live longer and have a reduced risk for some cancers (**reference Higdon**) Nonetheless, many diseases, particularly cardiovascular diseases and some cancers are related to our coffee intake (**reference Higdon**). More importantly, what is okay for a healthy adult, is not okay for pregnant women and fetuses. If you are pregnant coffee will significantly increase your risk of miscarriage (**references Weng**) and if you are fetus it can increase your chances of death (**reference Bech**), can reduce your growth (potentially only in boys, **reference Vik**) can alter your organ development and function including the brain (**references Eteng and Nehlig**) and may cause you to have childhood leukemia (**reference Menegaux**).

Caffeine does not have the same effect on these populations as it does on healthy adults, and for neither population are the effects consistent (this why they are risk factors). EMF may be considered in this capacity. Of significant concern is the potential for these effects to act on vulnerable or sensitive populations; the fetus, children (**reference Kheifets**) and adults at risk of illness especially the elderly. This is because cells and organs are either developing (fetus/child) or beginning to deteriorate. Further, embryonic development (the movement and alignment of cells and their migration is very much dependent on electric fields (**reference Funk**)). Inappropriate cues at the wrong time of maturation may have long-lasting consequences.

As a fetal physiologist I believe the BOI must very carefully assess the literature on at risk populations. Here it is necessary to keep in mind that pylons will be with us for a long time and the population will grow around them as they are already doing (and in time the associated need for more pylons and substations). In particular we may specifically disadvantage lower-socio economic and specific ethnic groups (given the lower prices of houses near pylons) who are already have a significant health burden. In a recent study EMF altered the reflexes of offspring from mothers exposed during pregnancy to EMF in combination with and poor diets (**reference Anselmo**).

**The concept of fetal organ and function programming.** In the fetal literature it is increasingly clear that a perturbed environment in early fetal life is thought to elicit a range of physiological and

cellular adaptive responses in key organ systems. These adaptive changes result in permanent alterations and might lead to pathology in later life. These environmental factors include maternal nutrition, fetal oxygen lack (hypoxia), fetal exposure to infection, maternally ingested drugs, alcohol, caffeine, and environmental toxins. These environmental factors may only be deleterious at certain times in development and may be quite subtle (the difference between how much protein and carbohydrates your mum ate during the first few weeks of pregnancy for example, or how stressed she got in mid-pregnancy). The pathologies included heart disease, hypertension, diabetes, cancer, obesity.

This programming concept is called the developmental or fetal origins of adult health and disease (**references McMillen, Bennet, Ozanne, Nuyt,**). Had we truly understood just how vulnerable the fetus is to even subtle alterations in its environment we may have saved a lot of babies from death and disability (**reference Grandjean**)

This concept started with epidemiological evidence which related birth weight and size to adult outcomes (**reference Barker**). There are now data to show that cancer (including leukemia) is also something that can be initiated before birth (**references Ozanne, Jackson, Greaves, Burjaniova**). The fetus is specifically vulnerable to exogenous factors. A fetal exposure during a critical time window may explain why current epidemiological studies may still be negative in adults. EMF, while not the leading mediator of the prenatal origins of cancer, nonetheless is a potential mediator (**reference Blackman**).

Reference 3 provides a comprehensive list of papers on the various scientific mechanisms believed to underpin how EMF causes illness. To this I add some additional research from well established laboratories publishing in top ranked, peer reviewed journals)

Dysregulation of cell cycle is important in the development of cancer (oncogenesis). This may occur through altered DNA (genetic) and/or DNA expression (epigenetic). While the etiology of childhood leukaemia remains unresolved, there are good data to show that there are chromosomal translocations and epigenetic lesions (**references Greaves 1 and 2, Deschler**). Importantly, these alterations may have their origins in fetal life (**reference Greaves 1**), and recent data show that EMF can alter fetal red blood cells, **reference Ferreira**).

A specific focus of action is the impact of EMF on cellular redox (respiratory) state. One possibility is via oxygen free radical formation inside cells. Free radicals kill cells by damaging macromolecules, such as DNA, protein and membrane. Several reports have indicated that electromagnetic fields (EMF) enhance free radical activity in cells (**reference Simko**). EMF can induce release of oxygen free radicals in umbilical cord blood (**reference Lupke**). 50 Hz extremely low-frequency electromagnetic fields exposure reduces cell tolerance towards oxidative attacks. The fetus, particularly the preterm fetus, is vulnerable to oxidative stress (**Reference Buonocore**).

Cell proliferation and differentiation can be influenced (**reference Veliznov**): cellular proliferation can be promoted (**references Piacentini, Wolf**) and programmed cell death (apoptosis) delayed or switched off. For the fetus this has consequences as cells proliferation, differentiation and physiological apoptotic cell death is an important and staged (gestational timing) process. In the fetal brain for example cell proliferation, migration, differentiation and physiological apoptosis (**references Bennet, Barrett**). Protecting cells from apoptosis in fetal life could lead to inappropriate numbers of cells and altered maturation.

Transcription factors play essential roles in controlling normal blood development and their alteration leads to abnormalities in cell proliferation, differentiation and survival. In many childhood acute leukemias, transcription factors are altered through chromosomal translocations

that change their functional properties resulting in repressed activity or inappropriate activation (**reference Berman**). Very early relapse of acute lymphoblastic leukaemia is characterized by an increased proliferative capacity of leukemic blasts and up-regulated mitotic genes (**reference Kirschner-Schwaber**).

**Finally**, it is perhaps curious, that some argue that there are no biologically meaningful effects of EMF (non-thermal), yet, ELF-EMF is used clinically to promote bone and tissue repair – the field has a long history, ever since the use of electric fish to cure headaches. While this latter fact is of historical interest, nonetheless the effect of ELF EMFs and electrical currents alone is very real, very biological, and very much in clinical use (**reference Funk**).

This brief discussion and reference list clearly shows that for childhood leukaemia alone there are several lines of significant research. Yes we need more, but no, we cannot say that there are insufficient data to be concerned. There is much yet to be done on establishing what kind of exposure is required, timing (acute vs chronic) age at exposure (fetal, childhood etc) dose and so forth. We do need to avoid several assumptions when studying the fetus

1. The fetus is a very small adult. Obvious, but it is striking how much of our scientific literature uses adult cells and animals to assess fetal condition, and that we assume that a dose which does no harm in the adult will also do no harm to the fetus. (**reference Mellor**),
2. that a fetus is the same at any gestational age (**references McMillen, Barrett, Bennet**)
3. that a low dose of anything is, by definition, not as harmful as a high dose (**reference Ohtaki**), and exposure is linear (**reference Conolly**).

**On the question of exposure.** There are several new studies using modelling which show that we should be concerned about the fetal exposure to EMF vs. that modelled for an adult.

Modelling of fetal exposure by vectorial analysis has shown that n that under worst case conditions the basic restrictions recommended by ICNIRP guidelines are exceeded within the central nervous system (CNS) of the mother, whereas in sole field exposure they are not. However, within the fetus the induced current densities do not comply with basic restrictions, either from single reference-level electric fields or from simultaneous exposure to electric and magnetic fields. Basic limits were considerably exceeded (**reference Cech**). Similar findings have been made by others (**reference Dimbylow 1 and 2**) who suggests that the ICNIRP public reference level is a conservative predictor of local specific absorption rates in the fetus .

Induced electric field and current density in a child's body compared to that of an adult are different because of the different proportions of the child body relative to those of the adult body, leading to differences in the induced electric field and current density values in various organs (**reference Hirata**).

On tissue exposure as a whole. The least conducting parts of the tissue exposed, usually the cell membranes, will experience the largest electric fields, possibly 10 or 100 times the average field (**reference Dawson 1** ) Thus even small average electric fields in heterogeneous material can result in local fields that may be biologically significant for individual cells. For contact currents a contact current of 1 mA [the occupational reference level set by ICNIRP], the current density in brain does not exceed the basic restriction of 10 mA/m<sup>2</sup>. The restriction is exceeded slightly in the spine, and by a factor of more than 2 in the heart. For a contact current of 0.5 mA (ICNIRP general public reference level), the basic restriction of 2 mA/m<sup>2</sup> is exceeded several-fold in the spine and heart. Several microamperes of contact current produces tens of mV/m within the child's lower arm bone marrow (**reference Dawson 2**). See also (**reference Nagaoka**) on modelling of pregnant women for the assessment of EMF exposure.

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