Preliminary Report for

VIA Technologies, Inc.

Energy Calculations for VIA C7®-D Processor

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Energy Calculations for VIA C7®-D Processor

Calculation Assumptions

PROCESSOR ENERGY CONSUMPTION

Based on data from VIA, the energy-efficient VIA C7®-D processor is capable of running up to 1.8GHz with ultra low power consumption of around 20 watts peak power (TDP) and in 'deeper sleep mode' draws about 2 watts[1]. When the computer is turned off (but still plugged into an active mains supply) it is assumed that the processor uses no energy at all.

The average power consumption (load factor) of a processor is difficult to determine. It is a function of the type of tasks being performed on the computer, the usage profile and the power management algorithms unique to the processor.

To assume a processor runs at peak power all the time would result in a significant overestimate of energy consumption. According to data from Energy Star, 'performance mode' is only needed for around 1 hour each working day. For much of the day the processor is not operating at anything near peak capacity and can be considered to be 'idling' or in 'sleep' mode.

According to Energy Star[2], scaling power requirements to match demand can reduce energy use by 25% - 75%. Pending further information on the specific performance of the VIA C7-D processor, we here assume a 'ballpark' 50% reduction in energy use during idling periods.

USAGE PROFILE

The usage profile used to calculate the overall processor load factor is set out in Table 1 below. Note that in the absence of further data on the performance of the VIA C7-D processor it has been assumed that performance mode requires the VIA C7-D processor to operate at peak power (20W), that idle mode consumes 50% of peak power (10W - see assumptions above), that sleep mode consumes 10% (2W) and that no power is consumed when the computer is turned off.

Note that the annual profile given in Table 1 (derived by Energy Star[3]) provides a composite picture of overall computer usage rather than reflecting the habits of an individual user or machine. It recognizes that many office computers are left idling rather than being turned off.

The load factor of 36.8% should be considered as a rough estimate only – but arguably provides a more realistic basis for calculating overall energy consumption than TDP.

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[1] Source: VIA Technologies, Inc. (VIA C7®-D Datasheet)

[2] Calwell and Foster (2005) *Research Findings for Future Computer Energy Efficiency Specifications* http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/computer/TierII_Prescriptive_vs_Performance_Slides.pdf#search=%22Energy%20Star%20processor%20load%22

3 Summary of Assumptions for EPA ENERGY STAR® Savings Estimates. Available at http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/computer/Assumptions_Prelim_Draft_Comp_Spec.pdf#search=%22average%20CPU%20utilization%20rates%20office%20computers%22

Table 1: Usage data used for Load Factor calculation	**Mode**			
	Standby/Off	**Sleep**	**Idle**	**Performance**
hours per year	2344	280	5886	250
% of time	27%	3%	67%	3%
watts (estimated by mode)	0	2	10	20
% of max watts	0%	10%	50%	100%
Load factor (%)	0.00%	0.32%	33.6%	2.9%
Total load factor (%) =	**0% + 0.32% + 33.6% + 2.9% = 36.8%**			

The lifetime of the PC within which the processor is installed is assumed to be three years[4]. No assumptions are made about the energy associated with production of end-of-life waste management.

CARBON INTENSITY OF ENERGY

Electricity can be produced from a range of different fuels (fossil and renewable) at different efficiencies. The global average carbon intensity of electricity is 0.501 kilogrammes of carbon dioxide (CO_2) per kilowatt-hour of delivered energy[5].

SEQUESTRATION OF CARBON DIOXIDE BY TREES

Newly planted trees absorb (or sequester) carbon dioxide ($CO_{2)}$ from the atmosphere. The sequestered carbon is locked into above and below ground biomass (trunk, branches, roots and so on) and the adjacent soil.

Afforestation or reforestation of land is not a long-term solution to tackling climate change for a variety of reasons; the permanence of the carbon sink cannot be guaranteed, and there is simply not enough land to offset more than a few years worth of carbon emissions.

Several organisations do offer tree-planting as a means of offsetting emissions but, increasingly, this form of offset is being replaced with technology-based projects which invest in improved energy efficiency or renewable energy[6].

Notwithstanding the problems with tree-planting, the use of trees as an *indicator* of emissions is a highly visual and resonant way of communicating the scale of CO_2 emissions arising from energy use.

The amount of CO_2 that is absorbed by a growing tree depends on numerous interacting factors; type of tree, quality of soil, climate, planting density, harvesting regime and so on. However, the carbon content of an existing tree can be readily estimated and such post-hoc analyses are usually used as a basis for offsetting calculations. Based on their experience of several diverse projects, Carbon Neutral

[4] Source: VIA Technologies, Inc (personal communication)
[5] Source: WBCSD/WRI Greenhouse Gas Protocol. Available at http://www.ghgprotocal.org
[6] For example, industry leaders Climate Care now offset only 20% of emissions with forestry projects on the basis that this avoids double-counting, provides additionality and is readily verifiable. See http://www.climatecare.org/projects/index.cfm?content_id=E17E5E13-0AFA-DB60-5640550B1039396A

use a working figure of 0.2 tonnes of carbon (0.73 tonnes of CO_2 (tCO_2)) per tree[7]. That is, over its lifetime an 'average' forestry project can be expected to sequester approximately 0.73 tCO_2 for every tree planted. If this is averaged out per year then this equates to an annual sequestration rate of around 7.3 kilogrammes of CO_2 per tree.

Analysis

LIFETIME ENERGY CONSUMPTION

Lifetime energy consumption is a product of the peak processor power consumption, load factor and usage. Using the assumptions set out earlier, it can be calculated using the following formula:

Lifetime energy use (kWh) =
Processor max power (W) x load factor (%) x lifetime usage (hrs)/1000
20W x 36.8% x (24 x 365 x 3) /1000 = **193kWh**

CARBON DIOXIDE EMISSIONS

Lifetime carbon dioxide (CO_2) emissions are a product of the lifetime energy use and carbon intensity of the consumed energy. Using the assumptions set out earlier, they can be calculated using the following formula:

Lifetime carbon dioxide emissions ($kgCO_2$) =
Lifetime energy usage (kWh) x carbon intensity of energy ($kgCO_2$/kWh)
193kWh x 0.501$kgCO_2$/kWh = **97$kgCO_2$**

EQUIVALENT TREE PLANTING

Since each tree sequesters around 730kg of CO_2 (0.73tCO_2) over its lifetime, **a single tree would be sufficient to absorb the lifetime emissions from 8 VIA C7-D processors.**

Looking at it another way, **the CO_2 emissions from a single VIA C7-D processor is roughly equivalent to 13 years of tree growth.**

OTHER CO_2 EQUIVALENTS

The lifetime carbon dioxide emissions (97$kgCO_2$) from a single VIA C7-D processor is also equivalent to:

- Driving 520 kilometres in a typical petrol car
- Driving 930 kilometres in a Toyota Prius hybrid car
- Flying 320 kilometres

[7] Source: Carbon Neutral. See http://www.carbonneutral.com/uploadedfiles/Sequestration%20by%20forestry-TCNC.PDF