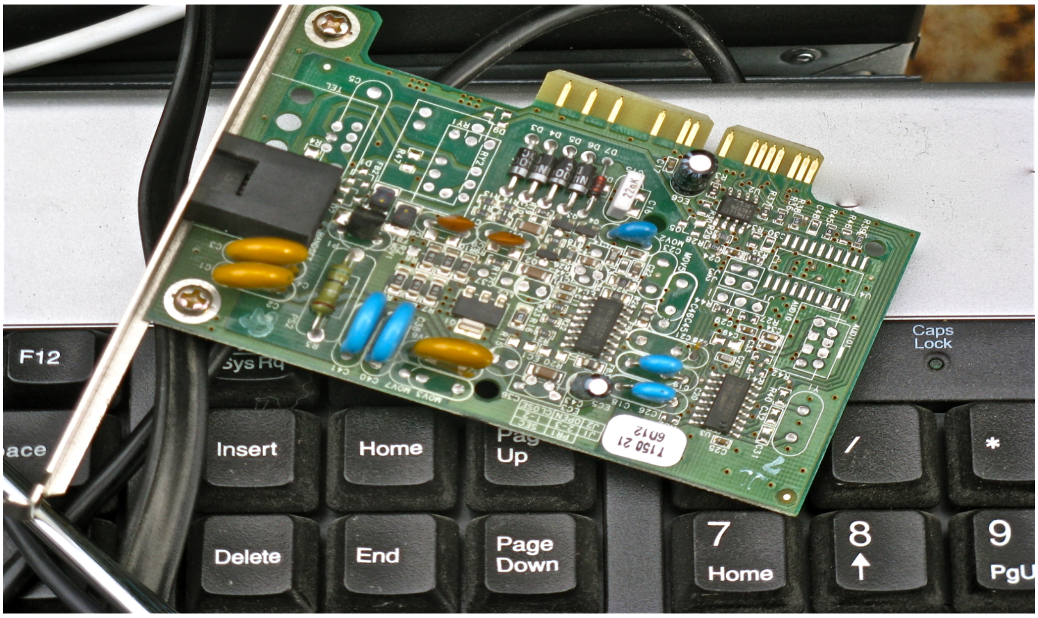
Meta Economics

National Television and Computer Product Stewardship Scheme

Targets, trajectories and implications for Scheme design



Report to the Department of Sustainability, Environment, Water, Population and Communities

July 2011

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A.B.N. 50 143 853 123

metá - (prefix): *sense of change of position or condition, behind or after, beyond, of a higher order …*

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Executive summary

Australian governments have agreed to implement a national product stewardship scheme for televisions, computers and peripheral devices to achieve an 80 per cent recycling rate for these products by 2021. The key focus of this report is on options for calculating future recycling targets under the Scheme.

Calculating recycling targets requires knowledge of the quantity of products that are being disposed of each year. Australian jurisdictions do not measure and report on the actual generation of waste television and computer products. Therefore a suitable methodology needs to be established for estimating the likely annual TV and computer waste stream, as well as a methodology for defining targets based on this estimate of waste generation so that the obligations and compliance of liable parties can be clearly specified and monitored.

Modeling the waste stream

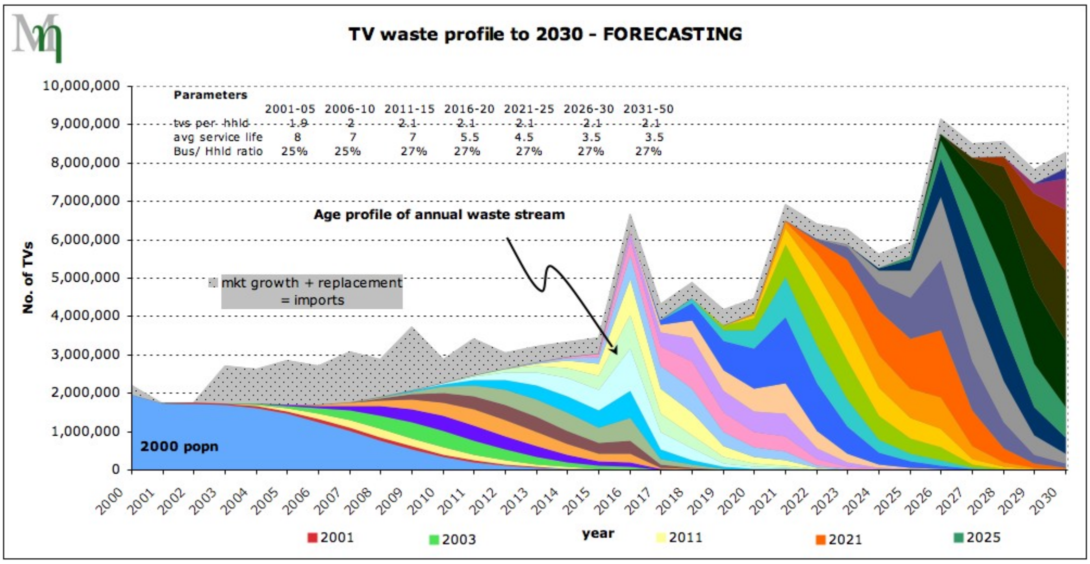
Publicly available information on the population of residential and commercial users of TVs and computers, historical import data and 'average age at disposal' estimates and forecasts obtained from the Televisions and Computers Decision Regulatory Impact Statement (released in October 2009) was used to develop a profile of the associated TV and computer waste stream to 2030 – the Meta Economics TVComp vintage model. The modelling was prepared to test and compare the performance of different proxies that could be used under the Scheme as the basis for accurately estimating waste generation.

The modeling suggests a pattern of television and computer imports and waste — representing the retirement and replacement of TVs and computers bought up to 10-20 years earlier — as shown in Figures ES.1 and ES.2. These figures depict the pattern of import and disposal of televisions and computers over time, and the modeled relationship between annual levels of waste generation (with replacement) and annual growth in the population which add together to give an estimate of imports in an particular year.

For example, Figure ES.1 shows that televisions purchased in 2010, which are on average assumed to have a lifespan of about 7 years, begin to enter the waste stream from the date of acquisition (in small numbers) and the number of these in service continues to decline over time. Assuming a commonly observed rate of statistical decay, the final remnants of TVs purchased in 2010 can be expected to be entering the waste stream well into the 2020s.

Figure ES.1 also depicts the impact of accelerated obsolescence across the TV population due to old TVs being discarded earlier in favour of new and better technology (such as high definition or 'smart' TVs). This can result in a reduction in the average age of discarded TVs. This pattern of accelerated obsolescence produced abrupt increases in waste levels, and a more rapid process of decline and replacement of in-service equipment.

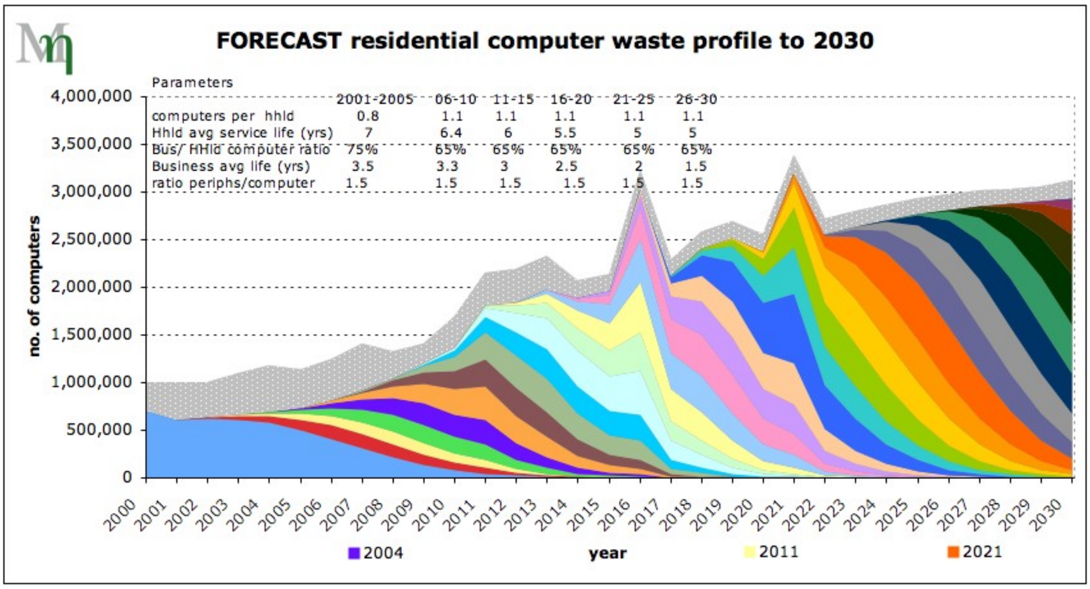
Figure ES.1 Vintages of waste TVs and annual imports, 2000-30

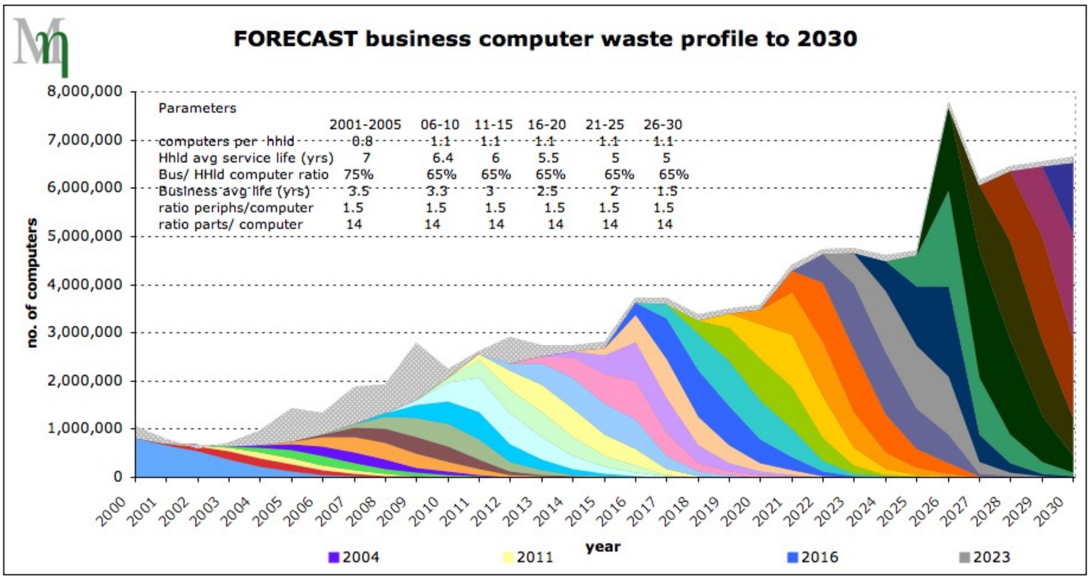


Source: Meta Economics TVComp model FORECAST

Relevant patterns of computer imports and waste driven by demand growth and replacement in the residential and commercial sectors are shown in Figure ES.2. The shorter average life of computers, particularly those used by businesses, is readily discernable in the vintage structure of the associated waste stream.

Figure ES.2 Vintages of waste computers and annual imports — residential and business use, 2000-30





Source: Meta Economics TVComp model FORECAST

Estimating waste generation

An analysis was conducted comparing Meta Economics TVComp vintage model waste estimates with proxies based on past import data, such as import data lagged by several years (reflecting the reported average lifespan of machines), or moving averages of import data over different three year periods.

The results show that all proxies struggle to predict dynamic changes in the number of televisions and computers and their disposal rates. In an idealised 'steady state' situation, proxies can be scaled so that their results closely predict the amount of waste generated. However, in reality, proxies can be expected to periodically under and over-estimate annual waste levels and sometimes spectacularly so, due to ongoing volatility in product purchase and discard behaviour.

Empirical comparison of the proxies, and consideration of the challenges of navigating ongoing volatility in product purchase and discard behaviour, suggests the desirability of an approach that:

- utilises an 'averaging' approach — with the aim of smoothing out highs and lows in annual import data; and
- relies on more recent data — which is more likely to capture the effect of emerging purchase trends (which in turn reflect market growth and replacement behaviour).

Under this approach a scaling factor is needed to negate the 'market growth' component of new imports (i.e. those products being imported that are not being used to replace existing products) and bring the import-based proxy into closer alignment with the 'replacement' component that drives the level of waste generation.

Based on the analysis to date, an annual waste estimate based on a scaled moving average of the previous 3 years of import data emerges as a reasonable performer, for both TVs and computers.

Experimentation suggests that a scaling factor of 0.9 provides a reasonable match for TV and computer waste arising between 2012 and 2021.

Policymakers have the option of differentiating the scaling factor according to the individual characteristics of the TV and computer population. The availability of flexibility arrangements within the Scheme is also a key consideration in selection of the scaling factor. Less flexibility suggests the need for a lower scaling factor in order to avoid excess costs. Updating the modeling and estimation methodology for data on import levels and the age profile of observed TV and computer waste will also be critically important.

Target trajectories

The proxy for estimating waste generation is proposed in conjunction with a target trajectory that takes account of current recycling levels and recycling infrastructure capacity and development, particularly in the early years of the Scheme. An incremental approach to targets is advised given the inherent uncertainties around estimating waste volumes. Review and recalibration of methodologies will also become increasingly important as target requirements tighten.

Given these factors, the following target trajectory has been proposed for consideration:

- **Compliance Year 1 (2012):** Set separate targets for each product class equal to current recycling levels, plus an uplift factor (depending on product category and state of readiness) so that an achievable and meaningful expansion on current effort is required.

- **Compliance Year 2 (2013):** Increase the uplift factor for each product class, so that targets are equivalent to 60-70 per cent of current recycling infrastructure capacity (based on estimates contained in the 2010 Wright/Rawtec e-waste recycling infrastructure capacity report).

- **Compliance Years 3-5 (2014/15/16):** Increase targets on a simple linear basis so that 40 per cent of the 'waste generated' estimate is required for collection and processing by year 5.

- **Compliance Years 6-10 (207/18/19/20/21):** Increase targets on a simple linear basis so that 80 per cent of the 'waste generated' estimate is required for recycling by year 10 (this represents an increase of 8 per cent each year). A target of 80 per cent would be maintained thereafter.

The proposed methodology for estimating waste generation and the proposed target trajectory will help support planning at the industry level. While it is impossible to provide complete certainty over future quantitative collection and recycling requirements because future waste levels and purchasing habits are unpredictable, the targets seek to provide a reasonable balance between certainty and the costs associated with being locked into an inaccurate waste estimate. With knowledge of aggregate imports and the share of the annual recycling target that they have been allocated each year, liable parties should be able to determine their individual annual compliance requirements.

Flexibility mechanisms

Flexibility mechanisms are likely to be a useful addition to Scheme design and industry compliance structures. These can help spread and reduce overall compliance costs, smooth abrupt changes in the market and reduce the risk of perverse environmental outcomes.

Given uncertainties and attendant costs, there is merit in building (and promoting the development of) a range of flexibility arrangements under the Scheme. Key recommendations for consideration include:

- a 3 year moving average waste estimator (as proposed in the waste proxy formulation above);
- carry-over provisions;
- grouped and third party compliance; and
- development of an industry-led contingency fund.

Chapter 1

Design issues for TV & computer stewardship

Australian governments have agreed to implement a national product stewardship scheme to increase the rate of collection and recycling of televisions, computers and computer peripherals. The aim is to ensure that, by 2021, at least 80 per cent of these products that would otherwise be part of the waste stream are diverted to recycling. The focus of this report is to assess methods for calculating future quantitative recycling targets under the Scheme and suggest practical design options that are most likely to deliver those targets in a cost effective manner.

This chapter provides background information on the development of the Scheme. It also outlines the key considerations in estimating the television and computer waste stream and setting targets for the Scheme.

1.1 Policy background

In November 2009, all Australian governments, through the Environment Protection and Heritage Council, agreed to the National Waste Policy. The Australian Government made a commitment under the policy to develop national framework legislation to support voluntary, co-regulatory and mandatory product stewardship and extended producer responsibility schemes.

The EPHC agreed that the first scheme to be covered under the legislation would be the National Television and Computer Product Stewardship Scheme, with a target of recycling 80 per cent of all TVs and computers entering the waste stream by 2021.[1] The Scheme will be implemented through regulations passed under the authority of the Product Stewardship Act, which was passed by the Federal Parliament on 22 June 2011. The main elements of the Scheme as currently agreed are:

- the Scheme will have a recycling target, that will ramp up over time to reach 80% by 2021. The target will be based on a percentage of the expected level of TV and computer waste generated each year;
- importers and domestic manufacturers (producers) of covered products will be 'liable parties';
- covered products will include televisions, computers and computer peripherals;

[1] See http://www.productstewardship.asn.au/documents/MinisterGarrettReleaseMR_NationalWaste031109_001.pdf

- liable parties will be required to be a member of an Approved Arrangement (AA), which they can do by joining a multi-member AA, or developing and implementing their own; and
- each AA will have an enforceable recycling target, which will be based on the market share of its members.

The Regulations for the new Scheme are expected to be made in 2011. However, a range of details and decision points need to be worked through in order to set the specifics of the Scheme. These include:

- determining a statistical basis for estimating waste generation;
- whether to set targets for different product classes;
- the year 1 target;
- the 10 year target trajectory to reach 80% by 2021; and
- the method for determining an importer/producer's annual obligation under the Scheme.

Some key principles are relevant to this task.

The first is to achieve the social and environmental objectives of the Scheme at least cost. The regulatory impact analysis conducted for the Scheme by PricewaterhouseCoopers and Hyder Consulting highlighted that the environmental risks associated with televisions and computers can differ, yet social choice modelling conducted by URS identified strong community support for recycling of these products. This analysis suggested that there is a strong desire within society for these goods (and perhaps, sophisticated electronics more generally) to be recycled, and the community recognises a benefit from this outcome. The existence of this social benefit, over and above the environmental benefit achieved through recycling, is a key part of the stream of benefits expected to flow from the Scheme.

With a Ministerial decision to proceed with the Scheme now in place, the Scheme needs to be designed so that it achieves its objectives in a cost effective manner. A tenet of cost effective Scheme design is to allocate resources for maximum pay-off. That is, target the low hanging fruit first, look for synergies between objectives, prioritise, and tie requirements and incentives as closely as possible to desired outcomes.

Secondly, good Scheme design (leading to consistent and efficient incentive structures) treats like goods and service providers in a similar manner. Closely substitutable goods (and competitors) should be treated the same — unless it is impractical or uneconomic to do so. In line with the first principle, the direct costs of inclusion can sometimes outweigh the direct benefits — but wider considerations such as competitive distortions and overall impacts on Scheme outcomes need to be taken into account. Cost shares should be in line with share of the problem or pay-off, or ability to pay.

Thirdly, it is important to be pragmatic in designing regulations and compliance structures. Simple, straightforward and transparent goals and requirements facilitate compliance and performance monitoring. It is important to apply pre-existing and readily available information and organisational structures wherever possible, and ground Scheme requirements in logic and fact. This is a critical element of robust scheme design.

Finally, in cases where there are significant risks or uncertainties it is important to build safeguards and flexibility into the system. Safeguards might include a slow ramp up of requirements in order to test costs and supply-side capacity, and design features that allow 'under and overs' to be spread for compliance purposes. Flexibility provides for choice and innovation in areas that are non-critical, and therefore do not need to be tightly prescribed.

Analysis and discussion of these elements in the context of target setting and compliance requirements is provided in the following chapters.

Chapter 2

Calculating waste generation

Calculating recycling targets requires knowledge of the quantity of products that are being disposed of each year. Australian jurisdictions do not measure and report on the actual generation of waste television and computer products. Therefore a suitable methodology needs to be established for estimating the likely TV and computer waste stream before a target trajectory can be established. This chapter presents modelling that has been prepared based on a range of data sources to produce a forecast of TV and computer imports and waste generation to 2030. The modelling is used to test and compare different proxies that could be used under the Scheme to estimate the likely TV and computer waste stream.

2.1 How much waste?

Computers and TVs have become ubiquitous within Australia, with nearly every household owning one of these devices. The incidence of TV sets across Australian households is estimated at over 99 per cent, with about 90 per cent of households having more than one television on the premises.[2] A range of commercial and service operations such as hospitals, airports, shopping centres, offices, retail outlets and business shopfronts and waiting rooms add to this list. Similarly, computers and peripherals are an everyday item within many households and an essential tool for most businesses and many employees.

Part of the total stock of TVs and computers within Australia are discarded each year, and replaced. However, as the Australian economy and population grows and these electronic and communication devices proliferate and reach obsolescence over time, the number of these products that are — or will be — discarded each year is changeable and uncertain.

Good data on imports and sales is critical to answering this question, though on its own it is not enough. Historical sales and trade information tells us how many units have entered the country, but as Australian jurisdictions do not measure and report on the actual generation of waste television and computer products, we can only estimate the rate at which these are being retired and discarded. What’s more, this rate can change quickly in response to a change in tastes, technology or economic circumstance, and demand for new and replacement product can also be fluid.

[2] Australian Communications and Media Authority (ACMA), 2007, *Media and Communications in Australian Families*, December 2007, Canberra, p.48-49.

2.2 Televisions

At present, the supply of new televisions within Australia is wholly reliant on imports – there is no manufacturing industry.

Knowledge of the average lifespan of a set (that is, the age at which it is discarded — not the length of time it takes to burn out), and the level of historical imports can generate a rough estimate of the level of discarded TVs that might be expected in any one year. TV imports (TV_I) can be thought to comprise replacement TVs (TV_R — from the existing TV population) plus new TVs (TV_N — linked to growth in the TV population):

$$\mathbf{TV_I = TV_R + TV_N}$$

In a static 'no growth' environment where the 'average' lifespan applies rigidly to all TV sets and user habits are immutable, past imports will be an excellent numerical guide to the number of discarded TVs in any particular year. Replacement TVs (which equal the number of discarded TVs) will normally swamp the number of TVs associated with growth in the population and this effect will be more pronounced the shorter the life of the appliance.

However, in reality, turnover in the TV population is more complex than that. Use of an 'average' lifespan can mask a potentially wide range of actual lifespans – with some TVs kept longer by users with little interest in upgrading to the latest technology and others being replaced quickly as bigger better sets become available. Meanwhile, TV 'deaths' from old age, premature burn out and accidents are occurring continuously in the background. With the technology moving rapidly and last year's cutting edge machine being this year's sale item, there is an increasing tendency for TVs to be considered a consumable and discardable item.

This highlights a key point. The number of waste TVs in any one year can be influenced by both the distribution of observed lifespans around the average and structural changes to consumer tastes that affect the range and the average. Income and population growth will also be fundamental drivers. Therefore the stream of TV waste will be comprised of TVs of varying ages and will be influenced by the availability of new or cheaper technologies and economic conditions.

Furthermore, there can also be some degree of 'storage' of broken or redundant equipment. This means that it may take some time for 'end of life' items to actually enter the waste stream. It also implies a potential backlog that can affect the 'supply' of waste televisions in a particular year. The implications of this issue for the design of the Scheme are addressed in chapter 3.

Methodology for modeling TV inflow and retirement

Changes in tastes affecting TV service life and redundancy can introduce a key source of volatility into target setting which is based on historical import data. This is illustrated in the following modeling of the Australian TV population.

The modeling is based on ABS household data and projections, Customs import data (obtained by SEWPAC) and behavioural information in the PwC Computers and Televisions RIS.

PwC note that TV imports to Australia in 2007-08 totalled 3.1 million units, and projected imports of 4.8 million units for 2027-28. Remarkably, more recent data suggest that TV imports to Australia have risen by more than 10 per cent over the last 18 months (these data were used to calibrate the TV population model developed by Meta Economics for the purposes of this study).

Key additional assumptions and drivers used in preparing the modelling (in line with parameters provided in the PwC RIS) are:

1. use of ABS data (ABS 8146.0) to determine the number of households in Australia for 2000 to 2009, and ABS mid range projections (ABS 3236.0) for 2010 to 2030;
2. 2007 survey outcomes for household ownership of TVs and computers drawn from the Australian Communication and Media Authority Australian Families survey;
3. use of a Poisson distribution to estimate the retirement profile of the Australian television stock, based on an average TV lifespan trend based on work in the PwC RIS;
4. assumption of a 4:1 TV ownership ratio between private households and the business sector for 2000 to 2010
5. assumption that the 'starting year' TV stock in 2000 reflected a 'steady state' and therefore leads to a vintage structure in the TV waste stream consistent with an average expected life in 2000 (and the preceding years) of 8 years. This being the case, virtually all TVs purchased pre-2000 leave service by around 2012.

Further — and critically — annual TV import data for the period 2000-01 to 2010-11 were used to inform and calibrate the historical estimates for imports and implied waste. Actual TV import data are a valuable check on assumptions around the per-household incidence of TVs, the starting TV population and age profile (at the time the model begins from 2000).

This data series represents a key foundation for the development of the study because it provides an actual head-count of TVs that will eventually be retired. The challenge in establishing targets for the Scheme is to deal with the uncertainty around 'when' they will be retired, noting that technological change will tend to shorten their life and economic downturn will tend to prolong it.

Parameter assumptions covering the 2000 to 2030 timeframe modeled are set out in Table 2.1. The Customs import series that forms the basis for the subsequent modelling for TVs — and for computers — appears in Table 2.2.

Table 2.1 TV population modelling parameters

	2001-05	2006-10	2011-15	2016-20	2021-25	2026-30
tvs per hhld	1.9	2.0	2.1	2.1	2.1	2.1
average service life	8	7	7	5.5	4.5	3.5
Bus/ HHld TV ratio	25.0%	25.0%	27.0%	27.0%	27.0%	27.0%

An important outcome of the modelling is the strong vintage effect that is likely to be present in the current population of TVs in Australia. The Poisson distribution is favoured for the statistical investigation of discrete occurrences in a population where the average or expected value is known, but the variation around that average value is not. It is a well established and commonly used statistical technique for modeling defects or failures within an equipment population.

Table 2.2 TV and computer import data 2000 to 2010

FY (beginning July 2000)	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
	Imports (millions of units)									
TVs	na	0.66	1.46	2.73	2.64	2.84	2.70	3.09	2.89	3.74
Computers (incl motherboards)	2.06	1.73	1.45	2.01	2.51	3.38	3.20	3.97	3.94	5.13
MFDs & printers	5.1	3.8	4.4	5.2	5.8	5.6	4.3	2.6	2.3	2.5
Parts & peripherals	10.5	33.5	58.0	57.2	60.3	60.3	47.3	35.8	26.1	27.9
Monitors	0	0.9	1.8	2.0	1.8	2.0	2.3	2.9	2.4	2.4
	Exports (millions of units)									
TVs								0.02	0.02	0.03
Computers (incl motherboards)								0.62	0.50	0.53
MFDs & printers								0.32	0.53	0.50
Parts & peripherals								3.80	2.98	2.29
Monitors								0.25	0.26	0.22

Source: Australian Customs Service (provided to SEWPAC)

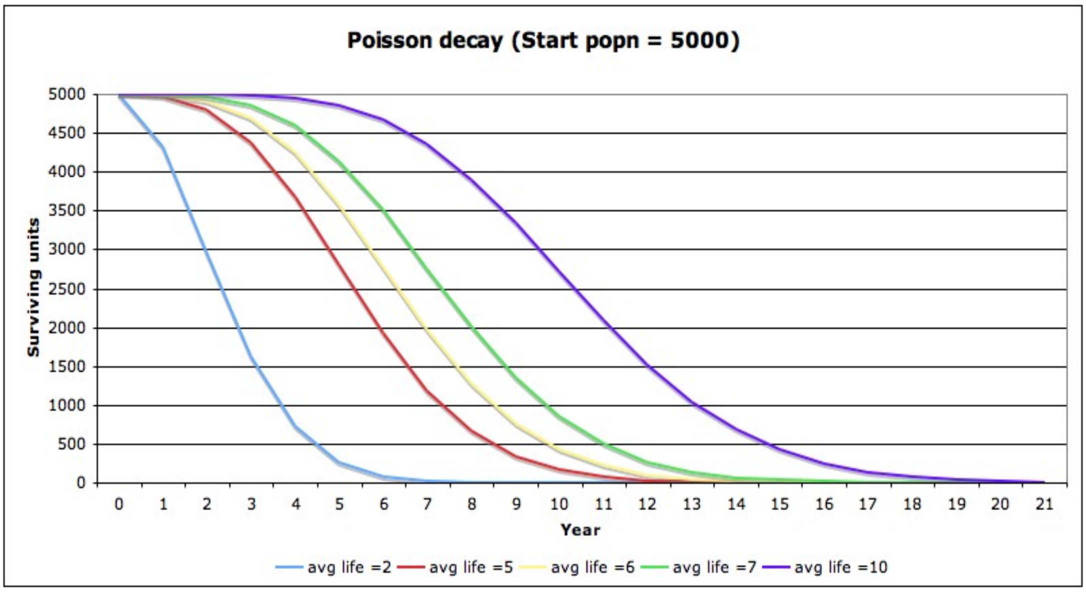
For example, the analysis shows that 5000 TV sets purchased in 2000, each with an expected or average lifespan of 8 years (as per the modeling), could be expected to follow the pattern of disposal described in Table 2.3. Of this group, two TVs are expected to be discarded within their first 12 months, and the last TV set would be expected to leave service in 2020.

Table 2.3 Poisson probability distribution (start popn = 5000, avg life = 8)

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. discarded	2	13	54	143	286	458	611	698	698	620	496	361	241	148	85	45

The pattern of exit or mortality associated with a Poisson decay statistical model for a range of illustrative ‘average’ lifespans is shown in Figure 2.1.

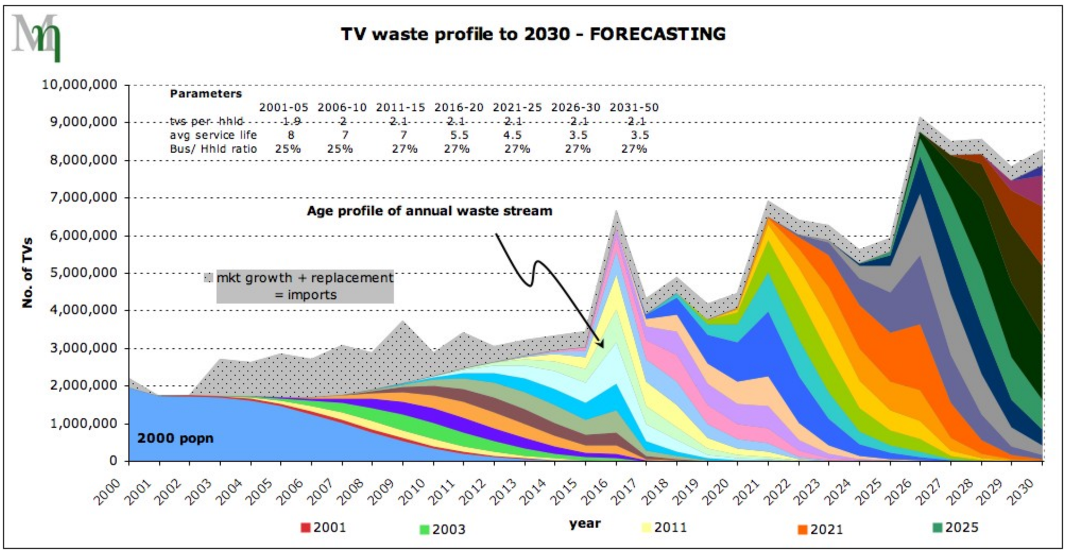
Figure 2.1 Population decay under the Poisson distribution



Modeling results

The household and usage parameters described above generate an age profile for the fleet of TVs leaving service over the period 2000 to 2030 as shown in Figure 2.2. This depicts actuals data from 2000 to 2010 and RIS-based forecasts of behavioural and technological change affecting average lifespans. The more rapid decay of the TV population is a notable feature as the expected lifespan drops from 8 years in 2000 to 7 years currently, to 3.5 years from 2026.

Figure 2.2 Vintage composition of retired TVs and annual growth



Source: Meta Economics TVComp model FORECAST

The ‘spikiness’ of waste TVs and imports in response to step changes in the average life of TVs is noteworthy. This is primarily driven by the assumption that TVs are discarded in the year that they are replaced, and a reduction in the life of TVs automatically generates a pattern of accelerated obsolescence within the surviving stock. While the model has the capability to smooth this effect, in reality these kinds of step changes may in fact be likely. The availability of cheap high definition flat screen TVs is likely to have a marked effect on the value placed on TVs of older vintages, and their accelerated movement into the waste stream. The phase out of analogue television services in the coming months may also act to induce replacement TV purchases and an increase in the number of waste TVs as different regions are ‘switched over’.

The relationship between the level of TV waste and imports is also telling. As noted, with no local production, the level of annual imports is *approximately* equal to the level of discarded TVs plus incremental growth.[3] But casual inspection of Figure 2.2 suggests that there is no strong functional relationship between historical imports in any one year and scrappage rates in a future year. The level of TV waste is a function of 10 to 15 years worth of past purchase decisions, and future levels depend on changing tastes and income that can result in accelerated obsolescence or a decision to persevere with an outdated model.

Moreover, an economic slowdown is likely to have the effect of deferring TV replacement and extending service life. In this situation past import data can significantly exceed waste generation. Unfortunately no waste estimator that is backwards looking deals well with this occurrence, and significantly lagged estimators have little hope of reflecting recent behavioural trends or changes in the economic cycle. It is only in a steady state, where TV numbers per household and expected lifespans have stabilised, that waste and historical imports tend to run in parallel.

[3] Approximately, because it is reasonable to assume that the majority of end-of life TVs will be replaced — and the bulk of these within the same year that they are discarded.

Historical imports capture a sample of the TV stock likely to be moving into the 'high obsolescence probability' band, whereas more recent import data captures the effect of more recent wastage rates, plus the accumulated impact of population growth rates and changes in tastes.

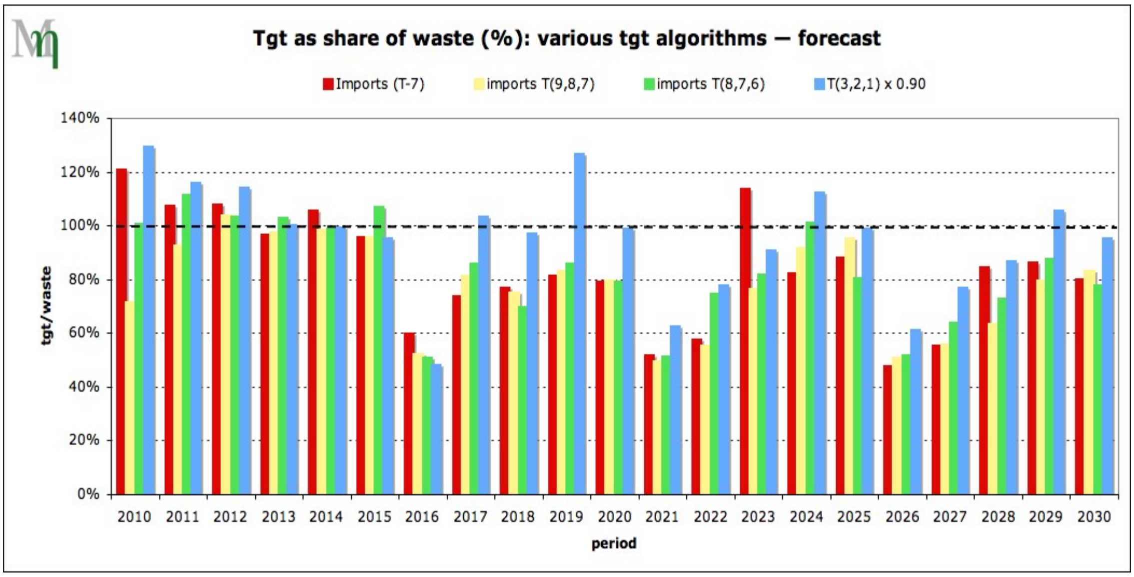
Performance of TV waste proxies

A test run of proxies for annual TV waste within the model is shown in Figure 2.3. It reflects the following parameter values, and reports the value of the waste proxy (based on import data) for each year divided by the waste generation estimate for that year (generated by the Meta Economics TVComp vintage model). When the values of the proxy and the waste generation estimate are equal, the ratio equals 100 per cent. An over-estimate of waste generation produces a percentage greater than 100 and when the proxy under-estimates waste generation, the ratio is less than 100 per cent.

Proxies tested in Figure 2.3 are:

1. TV import data from 7 years prior to the current year (in RED)
2. a moving average of TV import data for years 9, 8 and 7 years prior (YELLOW)
3. a moving average of TV import data for years 8, 7 and 6 years prior (GREEN)
4. a moving average of TV import data for years 3, 2 and 1 years prior — multiplied by a scaling factor of 0.9 (BLUE).

Figure 2.3 Performance of proxies for TV waste — 2010-2030 actuals plus RIS forecast changes



Source: Meta Economics TVComp model FORECAST

The pattern of unders and overs in figure 2.3 can be translated into a summary measure of proxy performance. The summation of annual results both above and below the line for the period 2010 to 2030 is shown in Table 2.4. The numbers reflect the difference in the number of waste TVs predicted by the relevant proxy and the number of waste TVs indicated by the model using information on past imports, usage levels and average lifespan. In addition, an indicative weighting of ‘ times 3’ is applied to over-estimated amounts to highlight the potential costs associated with such an outcome.[4]

Table 2.4 Summary performance of TV waste proxies, 2010-30

	Gap between proxy value and waste estimate (millions of TV units, 2010-30)			
	Exceed	*Exceed* (x3)*	*Undershoot*	*Exceed* — undershoot*
Imports (T-7)	1.15	3.44	25.87	-22.43
Imports (T-9,8,7)	0	0.29	28.46	-28.18
Imports (T-8,7,6)	0.1	1.23	25.41	-24.18
Imports (T-3,2,1) x 0.9	2.55	7.64	14.82	-7.18

Proxies with a tendency to over-estimate waste generation are undesirable from a compliance perspective because they can produce a situation where liable parties under the Scheme have an incentive to pursue waste that has not yet actually been generated (such as when the recycling target is high, e.g. approaching the 80 per cent benchmark set for 2021). This could easily drive up collection costs and even create a situation where operational TVs were pulled out of service early in order to satisfy Scheme requirements (depending on incentives created by flexibility arrangements and non-compliance penalties). This would be a very poor outcome for the Scheme. On the other hand, proxies that radically undershoot the waste generation estimate are undesirable from a community perspective.

A desirable or high performing proxy is one that consistently produces an waste generation estimate that is equal or close to the ‘actual’ level of waste generation in a particular year, and errs on the side of under-estimating waste generation — particularly as the recycling requirement moves closer to the 80 per cent target (to be achieved no later than 2021).

The pattern of waste in Figure 2.3, which encompasses step changes in consumer tastes and associated obsolescence, suggests that historical waste (averaged over a 3 year period) represents a more stable proxy for waste levels, and errors tend to err on the side of under-estimating waste generation — with the notable exception of a large over-estimation error expected in 2019, due to the flow on impact of a predicted step change in obsolescence occurring in 2016. Importantly, a cyclic pattern can be observed for all the proxies,

[4] Other, more elegant, non-linear weighting approaches could be conceived that ‘punish’ large overruns more severely than modest ones. Better information on costs is desirable here.

suggesting the potential benefit of a carry over approach to 'unders' and 'overs' in the program design.

Notably, the revised European directive on Waste Electrical and Electronic Equipment (WEEE) utilises a target mechanism defined in terms of prior year import levels, instead of a per capita target (as applied when the Scheme first came into force in February 2003). This is applied in conjunction with a scaling factor, presumably to account for the population growth component (ie. TVs for new households and businesses, plus extra TVs for pre-existing users) over and above the structural waste component.

Details of changes announced at the end of 2008 for the EU's WEEE directive note the development of new targets that will need to be achieved annually from 2016 and which entail:

'… setting mandatory collection targets equal to 65% of the average weight of electrical and electronic equipment placed on the market over the two previous years in each Member State.'

EC Press Release IP/08/1878, Environment: Commission proposes revised laws on recycling and use of hazardous substances in electrical and electronic equipment, 3 December 2008

Key observations from this analysis and implications for TV waste estimation include:

- rapid change in tastes, technology and associated product redundancy can be difficult to capture via historical proxies based on observed imports — particularly those that are linked to notions of the average or expected life of a long lived product.
- while near term estimators (based on import volumes) can provide closer 'sampling' of these changes, some scaling is required to ensure that 'waste generation' is not over-estimated. Two factors can mitigate the risk of an excessive burden being imposed:
    - under the assumption that disposal and replacement will most likely occur in the same year, Arrangement Administrators are likely to observe demand 'booms and busts' in real time and plan their collection activities accordingly (as long as some allowance is made for spreading under and over-shooting of targets in the compliance structure); and
    - in reality, changes in demand and waste rates will not always be as abrupt as depicted in the modeling (ie. step changes). This will help moderate demand and waste 'spikes' in the series and reduce risks of excessive burden.
- long lag import data (eg. T(9,8,7)) have a tendency to err on the side of under-estimating waste rates under scenarios of background demand growth and technological changes that accelerate obsolescence and scrappage. The opposite is likely to be the case in a declining market, which may prove onerous when recovery is slow. Long lag import data also does not capture immediate changes in tastes and technology, or intervening market growth rates. This makes for a less volatile series, but can imply greater scope for waste estimation error.

- real time information (appropriately scaled) is generally to be preferred to older information for the purposes of target setting, compliance and dynamic control.
- waste over-estimation becomes a greater concern as recycling targets push closer to the 80 per cent benchmark because of the greater risk that target obligations might require participants to collect waste that, in fact, has not yet been generated. This can have adverse implications for costs and the Scheme's environmental objectives.
- there is need to build flexibility in the system, avoid significant over-estimation and regularly review and adjust estimation approaches based on observed waste levels and collection information, including costs.

2.3 Computers

The vintage model developed by Meta Economics for TVs has also been applied to computers and related items. However, computers are a more complicated target group. The key reasons for this are:

- they are imported both as fully assembled systems and also in component form (according to the PwC RIS, about 12 per cent of computer sales in Australia are locally assembled 'white box' computers);
- the technology is moving rapidly, and penetration is increasing;
- there is (reportedly) a more active second hand market (though this does not pose a major difficulty for this analysis because it focuses on newly imported computers and end-of -life computers — that is, those that are scrapped rather than re-used);
- there is a higher level of recycling already being achieved (estimated in the Decision RIS at about 14 per cent of computer waste (by weight) in 2007-08);
- an unspecified (but presumably significant) number of low cost computer parts and peripherals are likely to accumulate as a sales inventory, and not enter service in the year of import (the PwC RIS indicates that about 28.6 million pieces of computer hardware entered Australia in 2007-08 — 37 per cent of this was 'power cords' (eg. cables, etc), 12 per cent were keyboards and mice, and 13 per cent were CPUs and hard drives;
- two distinct populations use computers and accessories — households and business. Turnover rates differ between these groups due to intensity of use and tax treatment;
- a range of peripheral devices are also being targeted. These range from technically elaborate equipment such as printers and scanners to typically low-tech devices such as speakers and keyboards.

Faced with these issues, the vintage model for computer equipment was developed with a focus on computer numbers (desktops and laptops), and their use by households and business. The usage of components and peripherals was seen as ancillary to computer consumption, with due recognition of the share of components that are assembled to produce generic computer models.

Methodology for modeling computer inflow and retirement

Like the TV model, household numbers and usage rates were used as the key basis for determining residential computer demand. For business, the number of computers in use was based on the number of people in particular user groups. Specifically, the number of business use computers was approximated by the number of people in Australia (including employees, employers and the self employed, full and part time) classified by the ABS as managers, professionals or administrative or clerical workers. Each of these people was attributed with one computer for commercial use. Workers classified to other occupational categories (eg. technical or tradespersons, sales or community services) were attributed with zero computers in the workplace.

Relevant household and business user numbers for the period 2005 to 2010 are shown in Table 2.5. For modelling purposes, ABS estimates for these series dating back to 2000 were used, together with ABS forecasts for Australian household numbers to the year 2030.

Table 2.5 ABS user group data — households and business, 2005 to 2010

Year	'05-06	'06-07	'07-08	'08-09	'09-10
	Thousands (000's)				
No. of households	7,945	8,071	8,244	8,189	8,236
No. of business computer users	4,708	4,951	5,024	5,280	5,326

Note: business users represent the sum of all workers classified to managerial, professional and administrative / clerical occupations. Data for the February quarter of the relevant financial year are shown.

Source: ABS 8146.0 (Household estimates), ABS 6291.0 (Status of employment, SuperTable E08_Aug96).

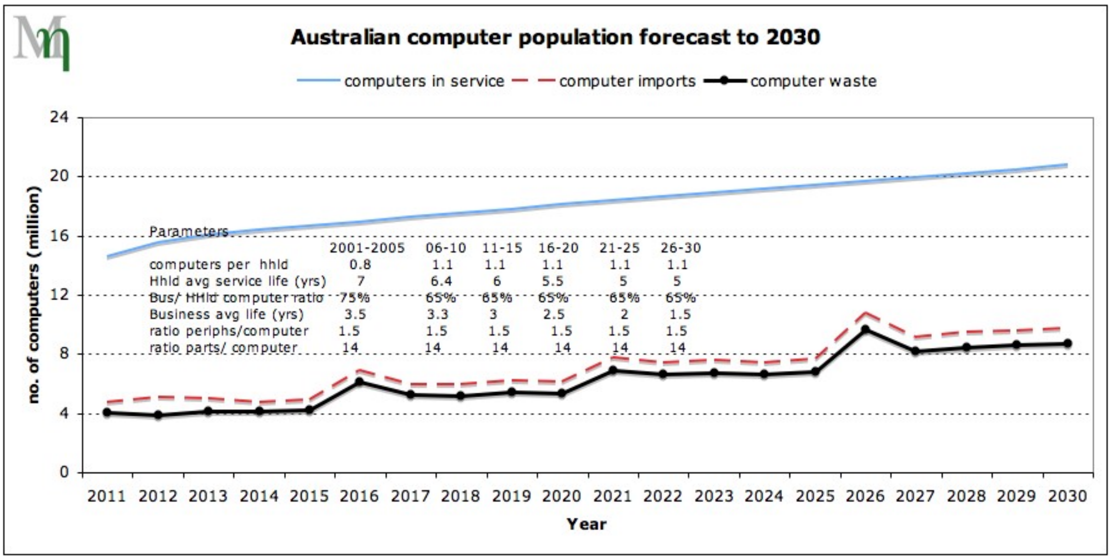
Population and usage parameters derived from the PWC RIS and which drive the model's usage and waste forecasts out to 2030 are shown below in Table 2.6. Near term estimates (ie. information on usage between 2000 and 2010) are based on actual ABS, import and survey data where available. For computers, export data reflect a mixture of re-export of new machines to other countries and some export of refurbished machines, which represent 'leakage' from the national waste stream. A reduction of around 8 per cent has been made in the model to reflect this impact on the annual quantity of computer waste available for recycling in Australia. Computer import and export information was reported earlier in Table 2.2.

Table 2.6 Computer population model forecasting parameters

	2001-05	2006-10	2011-15	2016-20	2021-25	2026-30
computers per hhld	0.8	1	1.1	1.1	1.1	1.1
hhld avg service life (yrs)	7	6.4	6	5.5	5	5
bus/ hhld computer ratio	75.0%	65.0%	65.0%	65.0%	65.0%	65.0%
business avg life (yrs)	3.5	3.3	3	2.5	2	1.5
ratio peripherals/computer	1.5	1.5	1.5	1.5	1.5	1.5
ratio parts/ computer	14	14	14	14	14	14

These parameters (based on past data and lifespan and household projections) generate the population and waste forecasts depicted in Figure 2.4.

Figure 2.4 Aggregated computer population, import and waste forecasts, 2010 to 2030

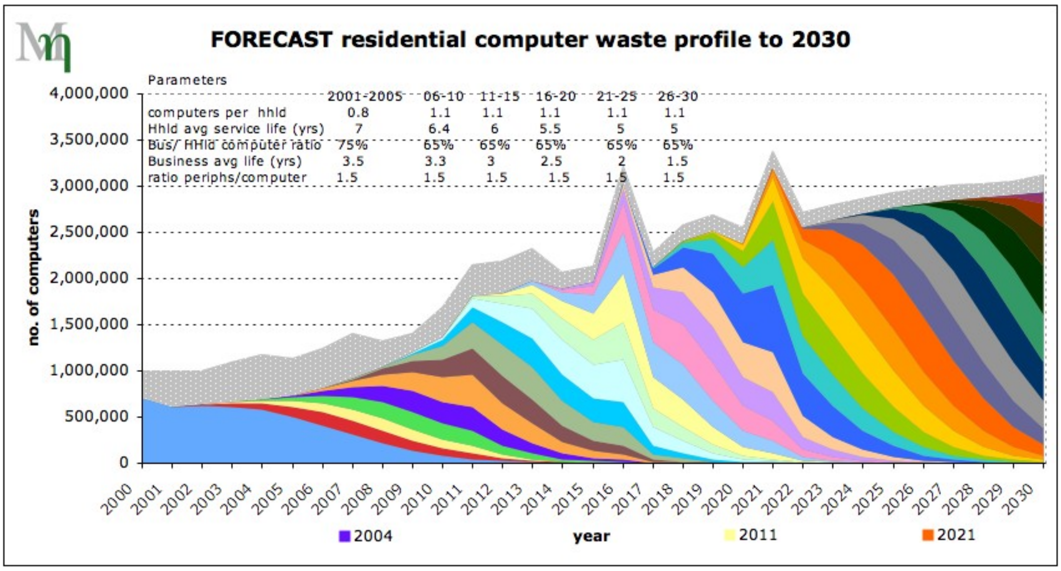


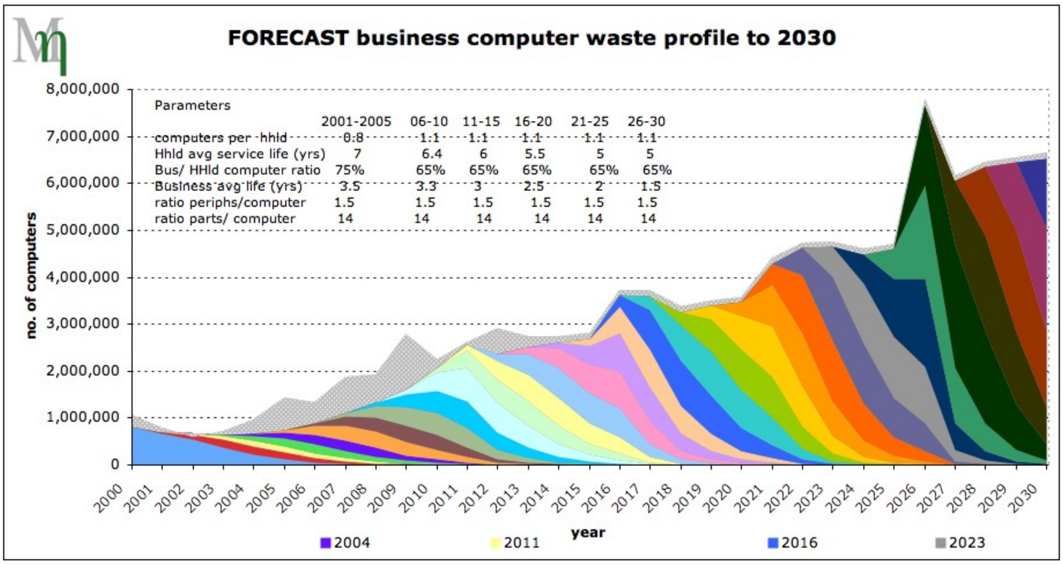
Source: Meta Economics TVComp model FORECAST

Modeling results

Estimated vintage and waste profiles for business and residential computers are shown in Figure 2.5. The influences of demand growth and technical change leading to accelerated obsolescence are similar to those illustrated for TVs. However, the shorter lifespan of these appliances, particularly for the business sector, and stronger underlying market growth sees computer vintages dissipate rapidly over a much shorter time frame.

Figure 2.5 Vintages of retiring computers, and associated imports





Source: Meta Economics TVComp model FORECAST

Performance of computer waste proxies

Figure 2.6 shows the performance of proxies using both actual import data for the decade to 2010, and forecast outcomes from 2010 to 2030.[5] Proxies include:

1. computer import data from 5 years prior to the current year (in RED)
2. computer import data from 3 years prior to the current year (YELLOW)
3. a moving average of computer import data for years 5, 4 and 3 years prior (GREEN)

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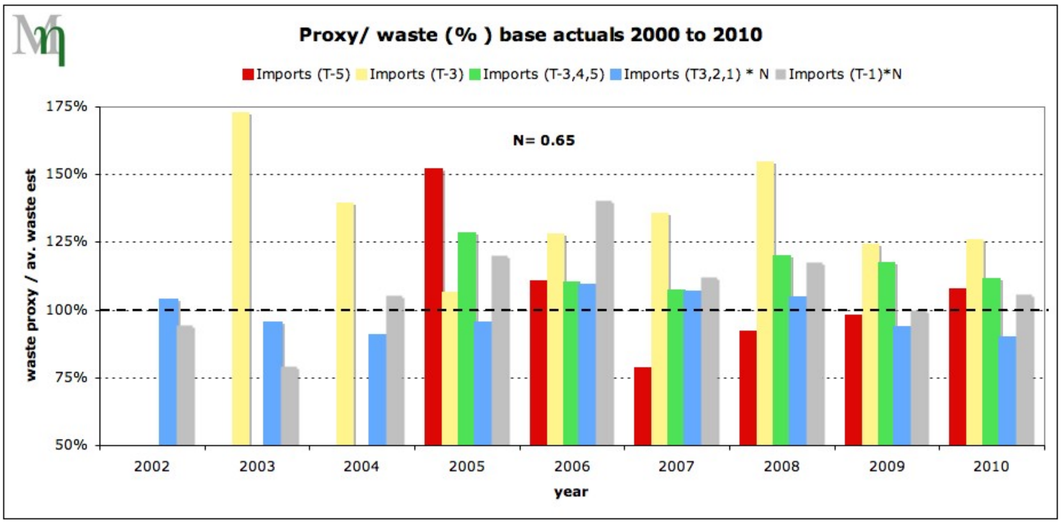
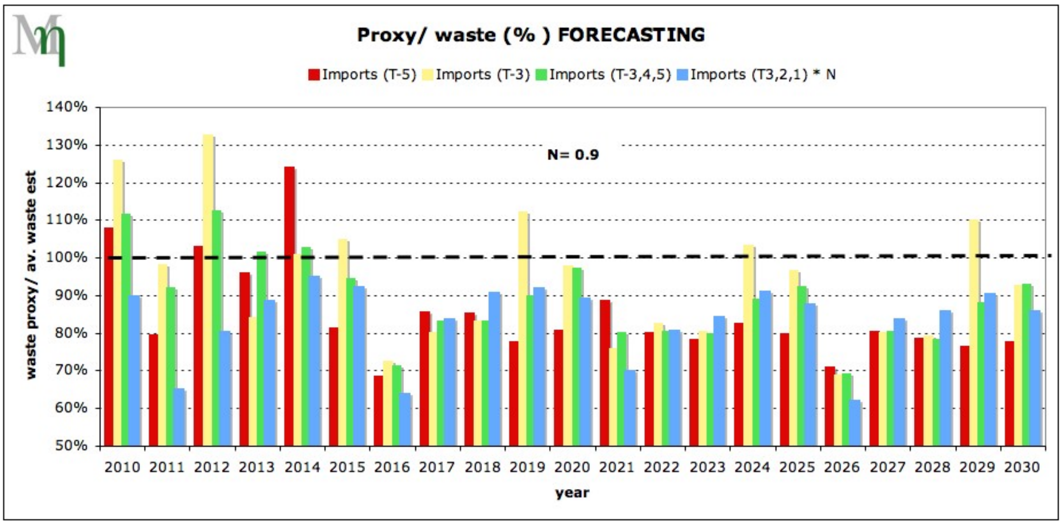
[5] Note that use of a T-5 proxy implies that post-2000 import data becomes relevant as a predictor of waste from 2005 onward.

4. a moving average of computer import data for years 3, 2 and 1 years prior, multiplied by a scaling factor (BLUE)
5. computer import data from 1 year prior to the current year, multiplied by a scaling factor (GREY).

Figure 2.6 Performance of computer waste proxies, using 2002 to 2010 import actuals and 2011 to 2030 forecasts





Source: Meta Economics TVComp model FORECAST

The patterns of unders and overs have been have been translated into a summary of proxy performance in Table 2.7 (developed as described previously for TVs).

Table 2.7 Summary performance of computer waste proxies, 2010-30

	Gap between proxy value and waste estimate (millions of TV units, 2010-30)			
	Exceed	*Exceed* (x3)*	*Undershoot*	*Exceed* — undershoot*
Imports (T-5)	1.33	3.98	23.99	-20.01
Imports (T-3)	4.09	12.28	15.80	-3.52
Imports (T-3,4,5)	1.03	3.10	18.02	-14.91
Imports (T-3,2,1) x 0.9	0.00	0.00	22.34	-22.34

The results indicate that historical import data series do not mirror estimated disposal rates particularly well in this rapid growth, faster turnover environment. The large influx of imports observed in this period (significantly in excess of model predictions based on estimates of the user population and average life parameters) introduces significant volatility. A scaling factor of **0.65** is required to 'fit' these observations of actual imports to waste generation estimates derived from the population and usage parameters.

Uncertainties over the composition of the pre-2000 computer population, and the prospect that estimates of 'average years to retirement' might have been inflated by a storage overhang of computers that affected data collection under the Byteback collection program are likely contributors to this outcome.

In the more stable 'forecast' period, where actual import data is being applied for the period 2000 to 2010, a scaling factor of **0.9** performs reasonably well (as observed previously for TVs). Gross import data is used in deriving this parameter, with adjustment to account for (new and refurbished) computer export activity being loaded into the waste stream estimate. Given the relatively short life of computers, this approach has a minimal impact on the aggregate estimate of computer waste over the medium term. If it were possible to net out re-export of new computers, this would be likely to increase the scaling factor (because slightly fewer annual imports would be being used to 'predict' annual available waste), but the impact would be small against the backdrop of uncertainties present. For reasons of practicality this has not been pursued.

A weighted recent moving average approach is likely to reflect the waste stream reasonably well, as do alternative moving average approaches with slightly longer lags (such as T-3,4,5). Use of an unadjusted T-3 proxy tends to overshoot the waste estimate due to the influence of the recent and pronounced influx of computers, while T-5 tends to undershoot the waste generation estimate although it too is clearly influenced by discrete annual import surges.

Overall, the results highlight the desirability of scaling and smoothing adjustments (eg. multi-year averaging) aimed at ameliorating the potential for compliance cost over-runs, and this objective becomes more pertinent as Scheme requirements push liable parties closer to the '80 per cent of waste generation' recycling target.

The modeling reveals no clear winner, but does highlight the desirability of a moving average approach to iron out abrupt changes in waste output and imports. And, as noted previously in a real world setting, use of import data from more recent years is likely to reduce the risk of a serious mismatch between waste generation and the proxy estimate. This is because more recent data reflect newer information on the consumption and technological trends driving current waste levels. Changes in technology, and the influx of new equipment via import channels, will invariably wash through the system from time to time.

Appropriate treatment of peripherals and computer components is an added complexity. These items amplify the number of computers and related parts that are recorded as entering the country, and which will ultimately be discarded. However, while they swell the number of parts, their influence on import values and waste tonnages is not as great. Though they add considerably to numbers (by a significant multiple), they are generally less valuable and weigh less on a per item basis.

2.4 Stockpiling — incidence and implications

The existence of a stockpile of retired computers and TVs compounds the difficulty of estimating the amount of waste generation that will be available to the Scheme. Past years waste may be accumulating in storage spaces and garages due to an aversion to sending advanced electronics to landfill, or self interested economic behaviour. For instance, householders in the ACT face a drop-off fee for computers and TVs which can deter some users from depositing their products at waste management centres. Faced with a significant disposal fee, cheaper alternatives, including storage, are used more frequently. Promotion of cheap and environmentally attractive disposal options will undoubtedly see a reduction in the incidence of stored end-of-life electronics by households.

Meinhardt (2001), a report commissioned by Environment Australia, suggests a high incidence of storage among users during the late 1990s. A survey of 100 South Australian households found that of replaced computers, about 34 per cent had been put into storage, while an additional 26 per cent had been passed on for re-use (normally within the family). The report also cites a 1999 Florida study which indicates that over 71 per cent of obsolete computers in that US state were put into storage awaiting disposal, 21 per cent were recycled and 8 per cent were landfilled.[6]

Unfortunately, the duration of storage is not discussed and it is difficult to tell from the available literature and survey work whether the ‘storage’ described is a short or long term phenomenon (ie. a month or 2 awaiting the next trip to the waste management centre, or several years). Similarly, while the experience of recent computer recycling programs in South and Western Australia point to strong pent up demand for such services, evidence is not available on the average age of waste machines, or how many of these ‘years to disposal’ were spent in a back shed or under the house.

[6] Meinhardt Infrastructure & Environment Group (2001), Computer & Peripherals Material Project, Prepared for the Department of Environment and Heritage, October 2001, pp.25-26.

The modeling work and estimates developed in the course of this project are robust under a short to medium term storage scenario because they are built on an assumption that waste computers enter the waste or recycling stream in the year that they are retired. However, a high incidence of long term storage can have a significant impact on the amount of waste generation that might come forward for processing under the proposed Scheme.

Importantly both households and Waste Management Centres themselves may be a source of stored end-of-life computers. Anecdotal evidence suggests that landfill operators in some locations are collecting and storing waste computers and TVs presented to them for disposal. This may be symptomatic of a reluctance to send e-waste to landfill. It may also reflect an expectation that a lower cost or even financially beneficial disposal option, such as the Scheme, may become available in the future. 'Saved' computers and TVs will have been diverted from landfill, and are likely to be a readily available source of supply for the new Scheme. In fact, so long as the cost of sending waste computers and TVs for recycling via the Scheme is less than or comparable to the cost of sending them to landfill, this dynamic can be expected to continue.

It means that the Scheme is likely to be 'over-subscribed' in the early years, and a buffer stock of waste TVs and computers is likely to be available to help moderate collection costs linked to delivering on targets.

The interaction between the collection activities undertaken by Arrangement Administrators, waste collection authorities and material recyclers can be expected to evolve along commercial lines. Determining the extent and national distribution of computer and TV storage, and how its volume and economics is likely to interact with the proposed Scheme is beyond the scope and resources of the current project.

2.5 Implications for target setting

In general, import data looks to be a reasonable basis for defining TV and computer waste estimates in the early years of the Scheme. In a static situation annual imports tend to be greater than annual waste because the former comprises replacement plus market growth. However, in a situation where tastes, replacement costs and technology are changeable there is no systematic ratio or relationship that sees some fixed formulation of past imports move in lockstep with future or current year waste generation levels.

What is clear is that estimates for waste generation need to be based on the particular stock, growth, turnover and technological characteristics of the product class. The TV population has different turnover characteristics to the computer population, and this means the level of waste generation in any particular year for these items can vary quite a bit. It is advisable to model each of these populations separately and establish waste estimates accordingly, based on their distinct characteristics.

Accumulation of reliable information on import levels, waste flows and current TV and computer populations and growth trends will be critical to establishing reliable waste projection baselines into the future.

However, these baselines can still be subject to cyclical factors that result in a 'spike' in product replacements and waste generation. The potential for such spikes argues in favour of an approach that places the waste collection obligation as close as possible in time to the actual occurrence. In this way, the obligation to collect a certain amount of waste is matched by the availability of that waste. Recycling targets that far exceed waste generation in a particular year can be very costly to deliver on and, in a regime of strong penalties for non-compliance, may actually accelerate the disposal rate of in-service TVs and computers.

Recent import data is the best indicator of recent levels of product replacement, although some averaging between years can help smooth the influence of one-off or step change events. While historical import data series can help ameliorate the effect of population growth in estimating waste levels (eg. imports of 5 years ago might fortuitously approximate estimated waste generation today), there is no guarantee that this will be a robust relationship over the longer term. For example, the ability of an historical import 'spike' of 4, 5, or 7 years ago to coincide with another import (and waste) spike today or next year would be entirely coincidental.

A superior approach is likely to entail using more recent data (eg. from the previous 12 to 36 months), and scale this to negate the influence of new products entering the country that are associated with market growth. This will tend to provide a reasonable and timely estimate of waste generation, and actual targets can be set as a rising proportion of this estimate.

Any historically based target (ie. relying on past rather than real time observations) always risk being out of sync with actual waste levels and patterns of consumption. Recent data will be more 'in sync' than older information, and Arrangement Administrators and the importers as a group will be in a prime position to recognise that the 'boom' (or bust) in sales that they are experiencing in the current period will begin to impact on their obligations in about 12 months time.

Importantly, Arrangement Administrators themselves should be in a position to gear their collection and recycling efforts in response to sales conditions (and cash flow) in the current period, and in clear anticipation of the likely recycling target for next year.

It should also be noted that no historically based waste proxy — even one using very recent data on imports — is likely to deal well with a major economic downturn. Backward looking proxies that estimate waste generation reasonably well within a growth market will tend to radically over-estimate waste generation during times of stagnation or negative growth. TVs and computers that are likely to be discarded during a period of economic prosperity may have their service life extended when that prosperity becomes more uncertain.

This leads to the following set of broad recommendations with respect to estimating waste generation and defining recycling targets:

1. undertake separate analysis for TVs and computers, and estimate waste generation separately for each;
2. use near-term import data for establishing rolling annual targets under the Scheme (ie. average data for the year just ended, plus 2 years prior);

3. use a scaling factor to align near term import data with actuals or modeled estimates of waste generation, to negate the influence of new products entering the country that are associated with market growth;
4. ratchet up the target over time to achieve recycling targets — noting that in the absence of flexibility mechanisms to handle 'unders and overs', collection and recycling targets that exceed actual levels of waste generation can impose significant costs on Approved Arrangements and provide an incentive to collect viable in-service appliances in order to satisfy targets;
5. re-calibrate the estimation approach every 3-4 years in the light of actual collection data and stakeholder feedback to ensure accuracy and cost effectiveness objectives are being achieved.

The Meta Economics TVComp model has been developed to support sensitivity testing of different approaches and estimation techniques under feasible future scenarios. A range of options exist in this regard, and varying the level and duration of parameter changes in line with past experience and reasonable future expectations will be important to developing and testing estimation methods and their robustness, including the recommendations provided above.

Suggestions on how to specify the target trajectory, and individual obligations under it are outlined in the following chapter.

Chapter 3

Target trajectories

The previous chapter analysed options for calculating robust estimates of television and computer waste generation, which provide a basis for setting annual recycling targets under the Scheme. The following chapter discusses and proposes an approach to setting and allocating these annual recycling targets, which need to increase over time to reach 80 per cent by 2020-21. Practical decisions here can be critical to the overall performance and cost effectiveness of the Scheme.

3.1 Product target shares

A key objective in designing compliance obligations under the Scheme is to align these with social and environmental aims. Key objectives and risks should be addressed as a priority, and greater flexibility can be applied where there is a lesser need for a prescriptive approach and rigidly defined outcomes.

In examining the rationales and goals of the proposed national product stewardship scheme for TVs and computers, it appears that old TVs and cathode ray devices (eg. old computer monitors) with a high lead content pose the greatest direct environmental concern. Computers and peripherals (and digital televisions) appear to represent a lower level of environmental hazard, although they may still contain hazardous substances such as mercury.

If this dichotomy is correct, it makes sense to establish televisions (including flat screens and all CRT devices) as a specific category of concern. That is, an equipment category that is targeted separately and for which specific compliance obligations apply. Other product categories under the Scheme appear to occupy a broadly equivalent status in terms of Scheme targeting and community concern. Computers and related products and parts might readily be grouped together for waste policy and Scheme purposes.

In general, the broader the categorisation of products, the wider the range of compliance options and the greater the likelihood that compliance costs can be minimised. As noted, the environmental integrity of this approach rests on the broad substitutability of products in a category. That is, the observation that recycling one tonne of computer boxes is environmentally equivalent to recycling one tonne of computer components or one tonne of laser printers or faxes. If this broad equivalence is not established or is offensive to the aims of the Scheme then a different categorisation might be considered.

The principle of equivalence and substitutability is also very important from an economic perspective. Treating 'like' products in a consistent way is important to achieving comprehensive and targeted impacts on production and consumption patterns within an economy. Policies that impact the price or availability of a particular product will also have implications for the level of demand for goods and services that are close substitutes for that product, and users switch away from high priced goods toward those that can do the same job more cheaply. Computers and computer parts are likely to be highly substitutable for each other. On the other hand, components such as keyboards, mice and printers are likely to be complementary to computer demand. That is, sale and consumption of these items will tend to move in the same direction as computer sales, and possibly also be ‘bundled’ with obsolete and discarded computers entering the waste stream.

These observations and considerations of cost and ease of implementation suggest the following approach to information collection, specification of product classes and developing overall targets:

1. Estimate waste generation on an annual basis for ‘TVs, screens and video display units’ (not including computer screens) as one distinct group and ‘computers, parts and peripherals’ as another;
2. A schedule of annual recycling targets (rising to 80 per cent by 2021 in line with national waste policy objectives) would apply to the estimated waste stream;
3. Gather information from Customs on both the value and number of units entering Australia (and not subject to re-export) for relevant items in these product classes, and the name of the company importing these items, above the relevant minimum import threshold;
4. Use the information on (net) import value to determine the relative significance of importers to a product class (ie. their share of the total value of imports within the relevant product class). This is an indicator of the revenue they derive from TV and computer sales, and their stake in the supply side of the industry. It is also an indicator of ability to pay. An alternative approach is to use information on the number of units imported. This could be a more reliable and consistent measure than value, as value can fluctuate over time due to inflation, exchange rate movements and factory price differences, and there is also scope for declared values to be revised by importers some time later;
5. Apply a sample based unit to weight conversion factor (or directly observed information if possible) to produce an estimate of the weight of TVs, computers and parts entering Australia. This weight information will be used to derive a weight based estimate of waste generation.
6. The ‘shares’ calculated in step 4 would be used to determine the annual recovery and recycling obligations falling on Arrangements, in line with waste generation estimates (step 1) and weight conversions (step 5).
7. Collection and recycling centres report compliance on the basis of tonnes of product received, accepted and processed. This weighbridge approach should result in major cost savings because it builds readily on established industry practice.

The 'value-significance' link established at step 4 has the merit of tying importer income from computers to the near term collection targets (eg. their liability for the following year, if the proposed weighted (T-3,2,1) averaging approach is utilised). This linkage may be beneficial in establishing the notion of extended producer responsibility and product stewardship. It would not be a big leap for importers to begin making a financial provision for next year's recycling requirement based on current year sales. This dynamic could amount to a pseudo advance disposal fee for newly imported items.

A hypothetical illustration of this approach is provided in Box 3.1.

Box 3.1 Significance and extent of responsibility for liable parties

1. Chip Pewter imports 10,000 circuit boards costing $20,000
2. MegaStore imports 2,000 computers costing $4 million
3. These units are estimated to weigh 20.5 tonnes
4. Both companies share a recycling target – Chip is allocated 20,000 / 4,020,000 (= 0.5%) of the target, Megastore is allocated 4,000,000/4,020,000 (= 99.5%) of the target
5. They are both in the same product class so (in effect) 1 kg of circuit boards = 1 kg of computer
6. Each company sets about gathering both types of item (either through their own efforts or in conjunction with an Arrangement Administrator)
7. The eventual mix depends on what is most available and cheapest to gather
8. When annual targets are reached, collection effort ceases (although recommended carry over provisions can help improve cost effectiveness and reliability within the scheme)

3.2 Target trajectories

In line with policy, the Scheme needs to achieve 80 per cent recycling of waste generated each year by 2021. This raises the issue of the best path for achieving this outcome, noting that the amount of waste generated can be quite variable, and there will be a need to gear up collection and recycling activity over time. For TVs, dedicated collection and recycling activities will need to be grown up from a very low base, as 2007/08 recycling rates as outlined in the Decision RIS are only 1 percent by weight for televisions (compared to 14 percent by weight for computers and computer peripherals).

Having selected a recycling target and timeframe, the optimal target trajectory will provide for these outcomes to be delivered at least cost. To the extent that over-compliance is desirable, it should be rewarded and, given the potential variability in the waste stream, a high degree of flexibility should be built in to ensure that targets in any particular year do not impose excessive costs. In essence, policy objectives for the Scheme are likely to be achieved if producers transit toward the 80 per cent target as quickly as logistics and national infrastructure development will allow.

The roll out of the Scheme should take into account the need for learning by doing, economies of scale and capacity constraints. Uncertainty around waste generation estimates also becomes more important as target obligations approach the 80 per cent level. Annual quantity targets need to fit comfortably below both the actual annual level of waste generation and the e-waste processing capacity of the Australian collection and recycling industry. Exceeding either of these can have adverse implications for costs and Scheme outcomes.

Capacity constraints — setting the speed limit

Without a specific knowledge of capacity constraints and supply costs related to collection and processing, it is difficult to be prescriptive about the shape of the target trajectory — other than to observe that modest requirements beyond business as usual in the early years are advisable in order to avoid the risk of cost blow-outs or immature system failures.

A focused discussion of recycling capacity and utilisation levels with Australia can be found in the Wright/Rawtec report, commissioned by DEWHA (now SEWPAC) in 2010.[7] Key findings in terms of current e-waste recycling capacity within Australia (as at May 2010) are reproduced in Table 3.1.

Table 3.1 Estimated E-waste throughput and recycling capacity (at May 2010)

Product	*Current demand*		*Current capacity*		*Potentially available capacity**	
	units	*tonnes*	*units*	*tonnes*	*units*	*tonnes*
Televisions	347,000	8,700	1,365,000	34,100	1,635,000	40,900
Computers (assembled)	570,000	10,900	1,084,000	26,500	1,483,000	34,300
All computers & peripherals	2,892,000	12,500	5,549,000	29,600	7,556,000	38,600
Mobile phones	902,000	180	1,240,250	248	2,029,500	406
Other electrical & electronic equipm't	102,000	3,820	138,750	5,252	227,500	9,000
TOTAL	4,243,000	25,200	8,293,000	69,200	11,448,000	88,500

*Note: * potentially available capacity is based on extended use of existing facilities through double shift operations and expanding the number of dismantling benches and personnel.*

Source: Wright/Rawtec (2010), p.15.

The Wright/Rawtec report indicates that current levels of recycling for TVs and computers (and other related electronics) is equivalent to about 40 per cent of current domestic recycling capacity, and this capacity could itself be extended by around 30 per cent before the need for substantial new processing facilities

[7] See Wright Corporate Strategy and Rawtec Pty Ltd (2010), A Study of Australia's Current and Future E-Waste Recycling Infrastructure Capacity and Needs, October 2010.

(and associated major investment) is triggered. Current recycling capacity for TVs, computers and peripherals is put at about 64,000 tonnes per annum, with scope to expand to around 80,000 tonnes per annum with a relatively short lead time and capital investment. Sourcing additional labour is the key requirement in this expansion.

These estimates suggest that there is considerable scope to expand current recycling rates without over-stretching current recycling infrastructure. However, care must be taken to ensure that loads also match capacity at a regional level.

Nevertheless, assuming the distribution of TVs and computers broadly matches that of the Australian population (with about 70 per cent located in and around Australia's major cities), and recycling facilities clustered around these centres, full utilisation of current processing infrastructure based on material sourced from urban areas alone suggests that the recycling target for TVs could be as high as 55 per cent of waste televisions in the early years of the Scheme without exceeding capacity (ie. the waste generation estimate for TVs in 2011-12 is 2,458,000 units, and total current television recycling capacity is 1,365,000 units, or 55 per cent of this — feasibly obtainable from urban sources).

A corresponding calculation for computers suggests that recycling of up to 27 per cent of waste computers in 2012 would be theoretically possible before facilities, or waste sources, become stretched.[8]

However, a bedding down period for the Scheme and its methodologies is prudent, together with a clear indication of future recycling requirements to assist planning and investment in future capacity. It is not uncommon for large construction projects to require 3 to 5 years to move from the approval to delivery stage. Further, an incremental approach to targets is advised given the inherent uncertainties around estimating waste generation volumes.

Early stages of the Scheme should therefore be focused on waste material processing and building up a better picture of the volume, age and composition of the TV and computer waste stream. This information can then be fed back into the process of refining the waste generation estimation methodology as the Scheme rolls forward and encompasses more stringent targets. Industry will also need to take action to develop new cooperative and supplier relationships under the Scheme, capable of dealing with future stewardship obligations.

Given these observations, a target trajectory along the following lines is recommended:

[8] The TVComp model — using import actuals for 2000-10 and average life parameters sourced from the Computers and TVs RIS indicates an available waste level for computers of about 4,022,000 units in 2011-12. Growth in following years would clearly stress existing recycling capacity, and components would also add to the processing task.

1. Compliance Year 1 (2012): Following appropriate industry consultation, set separate targets for each product class (eg. TVs, and computers & peripherals) equal to current recycling levels (in units or tonnes) PLUS an uplift factor depending on the product category and state of readiness (eg. 15 per cent, 5,000 units or 600 tonnes) so that an achievable and meaningful expansion on current effort is required. Note that this may have the effect of benefiting companies already operating product stewardship programs (eg. Apple, Dell, etc), but impose new requirements on companies that have not previously been active in this area.

2. Compliance Year 2 (2013): increase the uplift factor for each product class and apply it to calculate the new target. Targets for Year 2 should be equivalent to 60-70 per cent of current recycling capacity for product categories.[9] (Based on estimates contained in the Wright/ Rawtec 2010 report, this would imply a quantitative target for TVs of about 955,000 units and a target for computers of about 758,000 units for the year.) **Convert these waste targets into an estimated percentage of waste generation using the preferred estimation methodology.**

3. Compliance Years 3-5 (2014/15/16): increase annual recycling targets on a simple straight line basis so that 40 per cent of the 'waste generation' estimate is required for collection and processing in year 5 (2016).

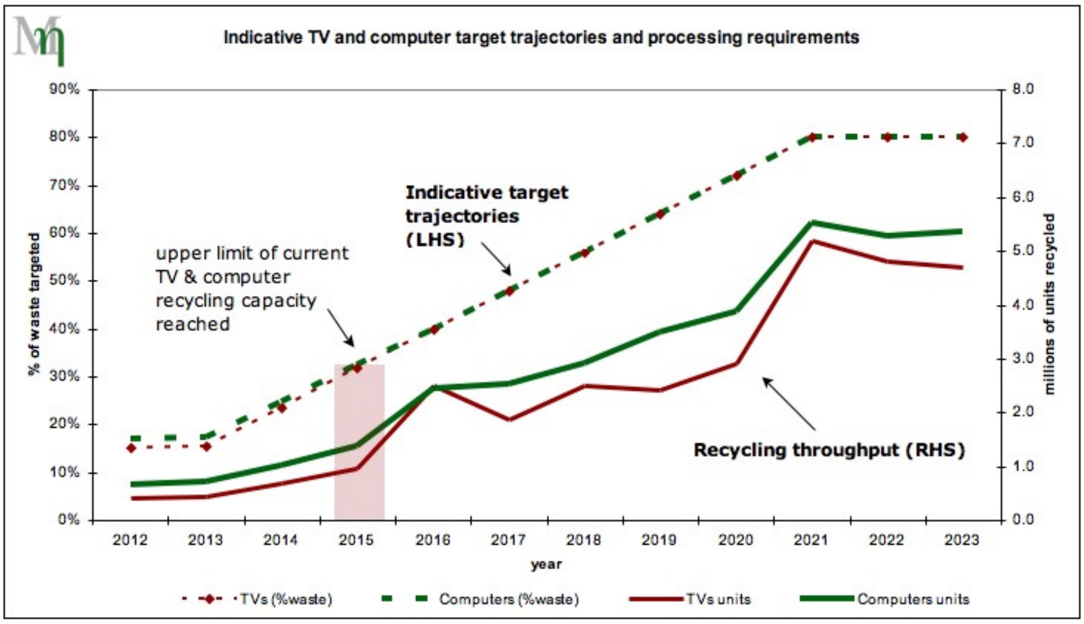
4. Compliance Years 6-10 (2017/18/19/20/21): increase annual targets on a straight line basis so that 80 percent of estimated waste generation is required for recycling in year 10 (2021) — ie. an increase in the target of 8 percentage points per year.

5. Maintain this level, thereafter (subject to review of Scheme and waste estimation procedures).

This formulation, and acceptance of the Wright/Rawtec 2010 estimates for current recycling levels and domestic capacity for TVs and end of life computers, would lead to the target trajectories and associated recycling requirements indicated in Figure 3.1. Notably, these trajectories suggest that, on current projections and assuming peripherals also fall within the target mix, the limits of current capacity are likely to come under pressure from about 2015.

[9] The Wright/Rawtec report (p.27) suggests a recycling rate for computers for 2007-08 of about 13.6 per cent, based on the PwC RIS and a rate closer to 30 per cent based on their 570,000 unit estimate for 2010. They also note a marked improvement in TV recycling since the time of the PwC RIS (see p.30-31).

Figure 3.1 Indicative target trajectories and recycling throughput



Source: based on Wright/Rawtec (2010) capacity and recycling estimates and Meta Economics TVComp model FORECAST waste estimates for TVs and computers

A discussion of proposed flexibility arrangements to support this approach is presented in the following chapter. As noted, such approaches help relieve compliance cost pressures, excess burden and potential for perverse environmental outcomes that could readily be associated with collection and recycling targets in any one year, imposed against the backdrop of a changeable consumer and technological environment.

Chapter 4

Flexibility arrangements

This chapter outlines options for flexibility arrangements which can help spread compliance costs, smooth step changes and disparities between actual and estimated waste and reduce the risk of perverse environmental outcomes. Given uncertainties and attendant costs, there is merit in building (and promoting the development of) a range of flexibility arrangements within the Scheme.

4.1 A 3 year moving average waste estimator

The desirability of a 'smoothed' or moving average approach to estimating waste generation has been discussed and demonstrated in chapter 2. Reliance on 3 years recent import data can help reduce volatility in the series, and the associated estimate of waste generation. Notably, the European WEEE scheme is moving to a 2 year rolling average, with a scaling factor, to define their recycling target.

4.2 Carryover provisions

A system of carryovers and crediting over or under compliance by Arrangement Administrators will help these entities manage their collection efforts, and reduce incentives to discard computers and TVs (and associated electronic items) that have been collected but are surplus to target requirements. Liable parties cannot be expected to incur the additional expense of recycling unless there is a compensating pay-off to these efforts, beyond annual target requirements.

Given the unavoidable uncertainty and volatility of waste generation, the capacity to carry forward recycling credits to count against future targets is environmentally and economically desirable. Arrangement Administrators could 'insure' themselves against unforseen increases in future collection costs via this mechanism. Policy makers can also reduce the risk that an over-estimate of waste generation will produce incentives for the collection of operational TVs and computers in order to comply with a strict annual recycling target.

4.3 Grouped and third party compliance

The design and draft legislation for this scheme already envisages that the joint or pooled compliance of liable parties might be achieved through a product stewardship organisation or other similar joint arrangement. These are a mechanism whereby liable parties can pool their efforts, achieve economies of scale and purchase collection and recycling services from third parties.

The approach of crediting third parties adds significant flexibility to the system, and should explicitly recognise scope for a liable party in a situation of over-compliance to transfer excess product to another liable party or Arrangement Administrator.

As a minimum, this should entail an ability to collect and process TVs and computers on behalf of a liable party, and ensure that that liable party is credited with this amount of recycled product for compliance purposes. This approach might even be extended to allow a book entry transfer of compliance tonnages between liable parties held in the compliance registry kept by the Scheme Regulator.

4.4 Contingency fund

Significant instability can arise if there are major shocks or discontinuities in the Scheme. These might take the form of a new technology that results in a major shift in consumer tastes or a slow down in future sales. A major recession, for instance, might make for a bleak sales outlook over several years and a decision to extend the service life of equipment.

Modeling conducted in Chapter 2 shows (in the main) a growing population of TVs and computers fuelled by imports, and a growing number of replacement sets mirroring those that are discarded. However, a significant downturn in the industry could see a major recycling burden shift onto the shoulders of a few suppliers. This could result in the 'waste generation' estimate being a multiple previous year imports, rather than a fraction. The number of suppliers and their ongoing revenue streams are critical to the financial viability of the Scheme.

Onerous cost burdens associated with recycling requirements for computers and TVs imported when times were more buoyant might tempt many to leave the industry if it is seen to be stagnating in the future; others might be reluctant to enter it. This can lead to a domino effect of closures, as recycling obligations are passed onto a shrinking (and less profitable) group of suppliers.

A fear of being the 'last man standing' can make for a very unstable and commercially unattractive situation. There is a dynamic problem with the Scheme as proposed because it places the burden of past decisions (and import activity levels) on the shoulders of new and current players who may be operating in a very different commercial and technological environment.

This overhang problem is well known to those in government focused on the health and welfare burden posed by an ageing population, who made insufficient provision for their future expenditure needs. The disjunct between the costs associated with a generation of retiring baby boomers and the ability of the current generation to pay for their associated health costs and pensions through the budget has led to growing effort in recent years to promote superannuation savings and life time health insurance.

In this context, an advance payment arrangement or contingency fund makes sense. While the optics of this are difficult from a budget policy perspective and government is not inclined to mandate such an approach, it could nevertheless be the focus of deeper consideration by industry itself. Such a fund could be established and held by industry, preferably in a trust account, and be insurance against a future situation where there is a large waste volume in the pipeline but few importer/producers, and little capability for these suppliers to carry the recycling burden.

Essentially, this would represent a shift toward an advance disposal fee structure, with the money held in a legacy fund. Liable parties would be shareholders of this fund – that would grow up over time and could be used to fund a growing share of future recycling costs.

A waste estimation and target setting arrangement that links next year's recycling obligation to this year's import level can help establish the need to set aside sufficient funds to finance collection and recycling efforts. However, this will be a poor substitute for measures that make this linkage explicitly and collect funds for this purpose.

Chapter 5

Conclusions: Scheme targets and approaches

The foregoing analysis highlights the range of issues and options facing policymakers in developing a scheme that delivers on government objectives for TV and computer recycling. Costs and reliability are important considerations in the development and operation of any programs, and the way recycling targets translate into annual quantitative collection and processing requirements can fundamentally affect both.

While it would be feasible to develop a scheme where computer and TV waste was collected on a best endeavours basis with an underpinning annual (and independently verified) requirement to recycle some proportion of that, such a design would provide little certainty with respect to future collection and recycling levels, and future investment needs associated with additional recycling infrastructure. A passive approach, as described, would also struggle to deliver on a 'national' waste target because it would require near-comprehensive coverage of discarded TV and computer waste.

The alternative is to try to define quantitative TV and computer waste recycling targets in advance. This requires a robust estimate of the amount of TV and computer waste being generated in a future year. Ideally, this requirement would be known far in advance and would be an accurate reflection of the actual amount of waste arising. Unfortunately, analysis suggests that in a dynamic, changeable market (as exists for TVs, computers and associated electronics) there is a tension between these desirable characteristics. Older data tends to be less able to reflect current and future changes.

Import data is a very valuable source of information on the size of the Australian stock of TVs, computers and associated devices, as there are no Australian manufacturers of televisions or computers. By going back and examining the Customs records it is possible to build up a very accurate picture of how many of these items have entered Australia. However, predicting when they will join the waste stream is a much less precise exercise. Modeling can help indicate the likely pattern of change in the future (if assumptions and other inputs are robust), but can also usefully provide a consistent framework for testing the relative performance of proxies in 'predicting' waste outcomes.

The modeling and analysis undertaken as part of this study suggests that all proxies — based on import data from previous years — struggle to cope with dynamic changes in the TV and computer population and disposal rates. In an idealised 'steady state' situation, proxies can be scaled so that their results closely predict 'waste generation'. However, in reality, proxies can be expected to periodically under and over-estimate annual waste — and sometimes spectacularly so.

Testing of different proxy formulations, and thinking about the challenges of navigating volatility in product purchase and discard behaviour, suggests the desirability of an approach that utilises an 'averaging' approach — with the aim of smoothing out highs and lows in annual import data, and also relies on more recent data — which is more likely to capture the effect of emerging purchase trends (which in turn reflect market growth and replacement behaviour). The need to negate the impact of market growth from recent import data subsequently implies the use of a scaling factor to bring the import-based proxy into closer alignment with the estimate for waste generation.

Based on the analysis to date, an annual waste estimate based on a scaled moving average of the previous 3 years of import data emerges as a reasonable performer for both TVs and computers. Experimentation suggests that a scaling factor of 0.9 provides a reasonable match for TV and computer waste arising between 2012 and 2021. This will have the shorthand form:

$$\mathbf{W_T = (T\text{-}3,2,1) \times 0.9}$$

… where W_T = waste arising in year 'T' and (T-3,2,1) represents the average value of annual import data drawn from the previous 3 years.

Policymakers have the option of differentiating the scaling factor according to the separate characteristics of the TV and computer population. Further, if carryover provisions and other important flexibility arrangements do not feature in the final Scheme design it may be necessary to reduce the relevant scaling factors to ensure that the annual values delivered by the proxy stay reliably below the modeled waste generation estimate. Experience in the early years of the Scheme, coupled with the use of actual import data and information on waste collected, should be used to refine of scaling factors.

The proxy for estimating waste generation is proposed in conjunction with a target trajectory that takes account of recycling infrastructure capacity and infrastructure development (including compliance arrangements) in the early years of the Scheme. Review and recalibration of methodologies will also become increasingly important as target requirements tighten.

Key features of the target trajectory approach discussed previously in section 3.2 (and based on quantitative analysis provided in the Wright/ Rawtec report) are shown in algebraic notation below:

Compliance Year 1 (2012)

Set separate targets for each waste category (eg. TVs, and computers & peripherals). Specify these as:

$$\mathbf{RQ_1 = RQ_0 + X}$$

Where … RQ_1 = the quantity required to be recycled in year 1
RQ_0 = the current base level of industry recycling
X = an uplift factor (to be determined by policy makers)

<u>Compliance Year 2 (2013)</u>

$$RQ_2 = RQ_0 + Y$$

Where Y = is an uplift factor (Y>X), which makes RQ_2 equivalent to about 60-70 per cent of current recycling capacity for the relevant product category.

Convert these waste targets into an estimated percentage of waste generation, using the preferred estimation methodology. Call this percentage 'C_2'

<u>Compliance Years 3-5 (2014/15/16)</u>

$$RQ_3 = W_3 \text{ x } (C_2 + 1 \text{ x } (0.4 - C_2)/3)$$

$$RQ_4 = W_4 \text{ x } (C_2 + 2 \text{ x } (0.4 - C_2)/3)$$

$$RQ_5 = W_5 \text{ x } (C_2 + 3 \text{ x } (0.4 - C_2)/3)$$

This represents a linear increase to a 40 per cent recycling requirement for 'available waste' in year 5 (2016).

<u>Compliance Years 6-10 (2017/18/19/20/21)</u>

$$RQ_6 = W_6 \text{ x } 0.48$$

$$RQ_7 = W_7 \text{ x } 0.56$$

$$RQ_8 = W_8 \text{ x } 0.64$$

$$RQ_9 = W_9 \text{ x } 0.72$$

$$RQ_{10} = W_{10} \text{ x } 0.80$$

This represents a straight line increase to an 80 per cent recycling target for year 10 (2021) — that is, an increase in the target rate of 8 percentage points each year.

Maintain the 80 per cent rate thereafter, in line with policy objectives:

$$RQ_T = W_T \text{ x } 0.80$$

The proposed methodology for estimating waste generation and the proposed target trajectory will help support planning at the industry level. While it is impossible to provide complete certainty over future quantitative collection and recycling requirements — because future waste levels and purchasing habits are unpredictable, they seek to provide a reasonable balance between certainty and the costs associated with being locked into a wildly inaccurate waste estimate. With knowledge of aggregate imports and the share of the annual recycling task that they have been allocated each year, liable parties should be able to determine their individual annual compliance requirements.