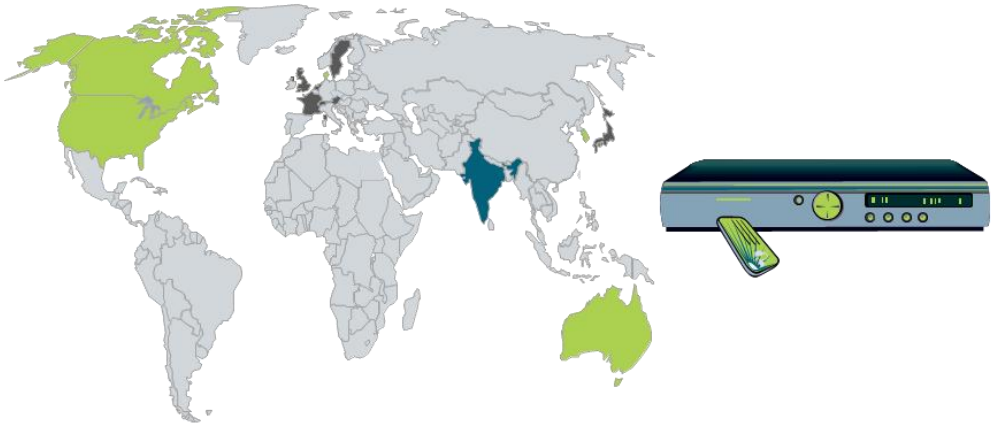
Technology: Simple and Complex Set Top Boxes



Participating countries:
Australia, Canada, Denmark, Republic of Korea USA

Other funding countries:
Netherlands, Austria, France, Japan, Switzerland, Sweden, UK

Other regions covered:
EU

Benchmarking report for Simple and Complex Set Top Boxes

Issue date: 15 April 2014

For further information refer to http://mappingandbenchmarking.iea-4e.org/matrix
or email operating.agent@mapping.iea-4e.org

1 Summary

This report is the result of analysis of set top box product performance data collated in 2012/ 2013 for Australia, EU and USA, together with smaller datasets for Canada and Denmark.

This is not a conventional benchmarking report like those produced previously under this Annex: none of the datasets is representative of the whole market in its respective country and none can be directly compared to any other on a fair basis due to substantial differences in the mix of product types and features for the products included. These differences between datasets stem from the very different television markets in each country, from variation in the mix of product functionality available in each market and from the differences in policies in place for which data is collected.

USA, EU and Australia datasets included between 300 and 330 products each. However, the types of product included in these datasets varied substantially between the different datasets: the EU dataset consisted entirely of complex set top boxes, whereas the Australian dataset had around 10% complex type; the USA dataset had over 95% complex type. There was further substantial variation in the signal type (satellite/cable/Internet Protocol etc) and functionality (HD, play/record etc). Furthermore, product mix and functionality change between years and so trends are not clear. The principal analysis metric used was typical electricity consumption (TEC) in kWh per year based on a specific daily usage cycle aligned with ENERGY STAR of 14 hours in on mode and 10 hours in sleep mode. No normalisation was deemed necessary as the test methods all returned comparable energy data.

Inherent functionality differences between markets appear to explain the rank of performance levels as far as comparative analysis was possible. Furthermore, filtering country datasets to narrow but potentially more comparable sub-sets of products results in datasets too small for statistical significance.

Whilst the national datasets are not directly comparable, the products themselves are derived from very similar technologies. Some types of benchmark could probably be derived if the product data was regrouped by technology and features rather than by country. This assessment would be outside of the remit of the Mapping and Benchmarking Annex and was not attempted in this analysis.

Of the participating countries, mandatory minimum requirements are in place covering simple set top boxes in Australia and in the EU; for complex type boxes in Australia and for standby only in the Republic of Korea. Both the EU and Australia have similar voluntary Codes of Conduct in place for complex set top boxes and the US DOE signed a voluntary agreement with industry players in December 2013, also covering complex type boxes. ENERGY STAR criteria apply to all types of set top box in both the USA and Canada.

A discussion of these results with policy makers and consultants responsible for set top box policies concluded with the following observations:

- Cable and satellite signal types tend to have higher standby power although more efficient technical solutions have been deployed by some service providers.

- Anecdotal evidence from experts implies that in the future, Internet Protocol TV (IPTV) will increase in dominance and bring better efficiency, although growth is limited by infrastructure availability in some countries.
- Set top boxes are generally not benefiting from the same technology-based efficiency improvements seen in computers, mainly due to economic pressures.
- Regulators are often only able to verify appropriateness of standards and allowances after enactment of the standards, as data simply isn't available beforehand.
- The voluntary approach to making regulations has been adopted by policy makers in the EU and USA as the most appropriate approach, with service providers as influential stakeholders.

Contents

1 Summary 2
2 Introduction 5
3 Data, markets and analysis method 6
3.1 Important cautions for interpreting and using mapping and benchmarking information 7
3.2 About the datasets and types of product included 7
3.3 Test methodologies, data normalisation, and metrics 10
3.4 Approach to analysis 12
4 Product types included in the datasets 14
4.1 Signal types included in datasets 14
4.2 Mix of simple and complex STB 17
4.3 Presence of play/record function 19
4.4 Other functionality and product features 22
5 Comparison of energy performance - challenges and limitations 24
5.1 Approach to country comparisons of STBs 24
5.2 Limitations of comparing datasets between countries 24
6 Results of webinar discussion with policy practitioners 26
7 Policies 27
8 Conclusions and recommendations 31
Annex 1 Size and characteristics of datasets

2 Introduction

This report is the result of analysing data collated between October 2012 and August 2013. Three substantive datasets were provided for which mapping documents were considered worthwhile: for Australia, EU and USA, and these were published in February 2014. Smaller datasets were also received from Canada, the Republic of Korea and Denmark but these included no more than 20 products in any year. No mapping documents were prepared for these countries although their data does appear in this benchmarking report.

This is not a conventional benchmarking report similar to those produced previously under this Annex: none of the datasets is representative of the whole market in its respective country, and none can be directly compared to any other on a fair basis due to substantial differences in the mix of product types and features for the products included. These differences between datasets stem from the very different television markets in each country, from variation in the mix of product functionality available on each market, and from the differences in policies in place.

Whilst the national datasets are not directly comparable, it is important to emphasise that the products themselves are derived from very similar technologies, and some types of benchmark could probably be derived if the product data was regrouped by technology and features rather than by country. This regrouping option would be outside the general remit of the Mapping and Benchmarking Annex, which is to compare and contrast average product efficiency across different countries or regions. This approach was not attempted.

This report is published as a record of the datasets that were available, how they differed, and to point out the challenges presented in the analysis. To avoid misinterpretation, energy performance data is included only where comparisons are deemed fair. It does include some broad conclusions on energy efficiency issues that arose through the analysis, and through a technical webinar held in November 2013 with policy experts from several participating countries.

3 Data, markets and analysis method

Data was invited from IEA 4E Mapping and Benchmarking Annex participating countries in October 2012. By August 2013 the request yielded data from Australia, Canada, Denmark, Republic of Korea and USA (ENERGY STAR datasets). In addition, enquiries placed with those responsible for the EU Voluntary Agreement yielded in May 2013 a product dataset for the EU and some market average data from a previous European Commission report on Voluntary Agreement progress. Characteristics of the datasets are shown in Table 1 on page 9, with further details shown in Table 4 in Appendix 1.

The dataset for the Republic of Korea consisted only of standby data, not representative of the whole market, so it was agreed that it would be omitted from the analysis. The datasets for Denmark and Canada had less than 20 products in any given year, and were included in the benchmarking analysis but did not merit production of a mapping document.

The USA, EU and Australia datasets included between 300 and 330 products for which typical annual energy consumption could be calculated. Despite containing similar volumes of products, the types of product included in these datasets varied substantially between the different datasets: the EU dataset consisted entirely of complex set top boxes, whereas the Australian dataset had around 10% of its products of the complex type; and the USA dataset had over 95% complex type. There was also substantial variation in the signal type and features included. The differences between datasets are described in detail in section 3.2, with the consequences described in section 5.2.

None of these datasets is representative of the whole market in their respective country: the US dataset includes only better-performing products as it is substantially derived from the ENERGY STAR database. The EU dataset reflects only the subscription service or complex products, but is highly representative of that part of the EU market, accounting for over 80% of EU sales. Conversely, the Australian dataset is highly representative of the free to air or simple products, with only a few complex type products included.

Whilst data is available from 2007 up to 2013, the only year with substantial representation in USA, EU and Australia datasets is 2011. In particular, the EU dataset only has product data for 2011, supplemented by market average data on some types of unit for 2010.

Details of Australia, EU and USA datasets and separate results for each country are included in the country mapping documents, which are available from http://mappingandbenchmarking.iea-4e.org/matrix.

Table 1 provides an overview of the datasets and their variability with full details in Table 4.

3.1 Important cautions for interpreting and using mapping and benchmarking information

Considerable efforts have been taken to ensure the integrity of the data supplied, and any data manipulation and analysis (for products for which this is necessary). The generic approaches are detailed in the overall Mapping and Benchmarking Framework[1] and in the Set Top Box Product Definition.[2] A *Framework for Grading Mapping and Benchmarking Outputs* has been developed that is used across all of this project's outputs. These gradings are based on a scale as follows:

- **Robust**: Datasets are representative of the full market and there is significant confidence in the transformation used to make the dataset comparable with others. Comparisons within and between such datasets are as reliable as reasonably possible. Robust data points are joined by solid lines in the graphs.
- **Indicative**: Datasets are not fully representative of the market and/or there are minor concerns with the reliability of the transformation used to make the dataset comparable with others. Hence indicative data provides meaningful but qualified comparisons. Indicative data points are joined by dashed lines in the graphs.
- **Illustrative**: Datasets poorly represent the market and/or there is significant concern with the reliability of the transformation used to make the dataset comparable with others. Hence any associated results and conclusions must be treated with caution. Illustrative data points are joined by dotted lines in the graphs.

Data of a quality that does not meet the definition of any of these remains ungraded and is often not used, but if it is displayed to add context then the points are not joined by any line.

3.2 About the datasets and types of product included

3.2.1 Basic definition of a set top box

The analysis covers set top boxes (STB) as used to convert digital TV signals to a signal compatible with the existing TV receiver and TV monitor technology, including analogue signal, composite video, s-vhs, IP, component video and HDMI. Note: standalone digital television adapters (digital to analogue converters)[3] are not included.

Both Simple STB (free access) and Complex STB (conditional access) are included. 'Conditional access' is for receiving subscription services through built-in access control or the use of an access card-key or similar (e.g. CableCard type services).

[1] Refer to Annex framework at http://mappingandbenchmarking.iea-4e.org/, accessed 23 July 2012.
[2] Refer to detailed product definition at http://mappingandbenchmarking.iea-4e.org/matrix?type=product&id=14
[3] Digital television adapter, otherwise known as a digital-to-analogue converter or a converter box is a television tuner that receives a digital television transmission and converts the digital signal into an analogue signal that can be received and displayed on an analogue television set.

Note: standalone digital television adapters (digital to analogue converters)[4] are not included.

The following types of STB are included according to signal sources (more than one can apply to any given STB):

- Cable STB
- Satellite STB
- Terrestrial STB
- Cable digital transport adapter (DTA)
- Internet protocol (IP) STB
- Thin client / remote STB

See the Set Top Box Product Definition[2] document for further information.

3.2.2 Sources and quality grading

Table 1 provides an overview of the datasets and their quality gradings according to the categories described in section 3.1. The USA, Australian and EU datasets are considered illustrative, since none is representative of the full market of their country/region and none is sales weighted; the Danish and Canadian datasets are considered ungraded due to being small sample sets. This grading is entirely associated with how representative the sets are of the full market; gradings were not affected by normalisation as this was not required.

Further information about the datasets is given in Table 4 on page 32 and in the respective mapping report for each country.

[4] Digital television adapter, otherwise known as a digital-to-analogue converter or a converter box is a television tuner that receives a digital television transmission and converts the digital signal into an analogue signal that can be received and displayed on an analogue television set.

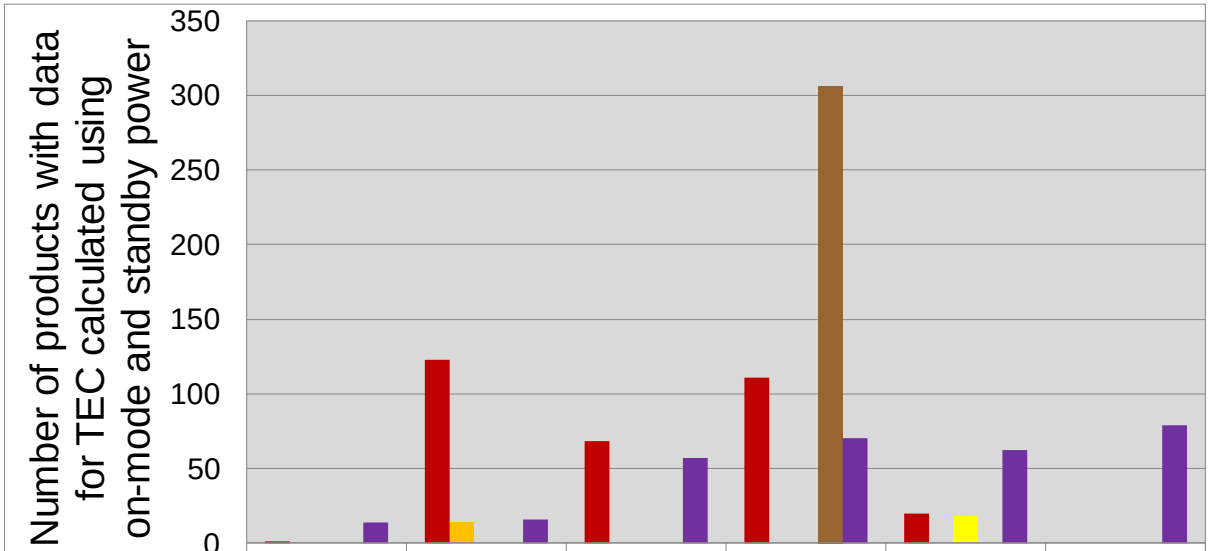
Table 1. Summary of the source and assigned quality for datasets.

Country	Assigned quality	Source and comments
Australia	**Illustrative**	Government database of simple set top boxes, plus some additional complex set top boxes (STBs), total 323 products.
Canada	**(Not graded)**	Sample survey of 14 STBs in homes, all complex type.
EU	**Illustrative**	Industry database of 306 complex set top boxes (CSTBs) prepared for monitoring of the EU voluntary agreement for complex set top boxes.
Denmark	**(Not graded)**	18 simple STBs registered for an endorsement scheme for best efficiency products.
USA	**Illustrative**	ENERGY STAR list of registered products at Jan 2010, Feb 2011, Jun 2013, plus a dataset collated for developing new criteria covering 2007 to 2010. (ENERGY STAR is a federal government endorsement scheme for better performing products on the market).

3.2.3 Products included

The principal metric used in this analysis was typical electricity consumption (TEC) in kWh per year, based on a specific daily usage cycle (see section 3.3.3). The count of products of all types in each dataset for which TEC could be calculated is shown in Figure 1.

The largest single data bin is for the EU in 2011 with just over 300 products; the Australian set has over 100 products for 2009 and 2011, over 50 for 2010; the USA has over 50 products for 2010 to 2013 inclusive. All other data bins are significantly weaker and not suitable for statistical analysis. However, the mix of product types varied significantly between bins, meaning that comparisons between them would not be fair or even necessarily valid.



	2008	2009	2010	2011	2012	2013
Australia	1	123	68	111	20	0
Canada	0	14	0	0	0	0
Denmark	0	0	0	0	18	0
EU	0	0	0	306	0	0
USA	14	16	57	70	62	79

Figure 1. Count of products for each country and year for which TEC could be calculated (TEC for on mode and standby mode only).

3.2.4 Sales weighted data

No sales weighted data was available for any country, other than some figures reported in the EU voluntary agreement report, which were not used in this analysis.

3.3 Test methodologies, data normalisation and metrics

3.3.1 Test methodologies

The following test methodologies are in use:

1. IEC 62087 Edition 3 (2011) *Methods of measurement for the power consumption of audio, video and related equipment*. This standard covers power measurements for a wide range of products. It provides the basis of test methods for and general conditions for the EU Code of Conduct. Edition 3 contains a complete rework of STB measurement to make it consistent with EU, Australian and ENERGY STAR requirements. Edition 2 was published in 2008; Edition 3 in April 2011.
2. AS/NZS 62087.2.1:2008 *Power consumption of audio, video and related equipment, Part 2.1: Minimum energy performance standards (MEPS) requirements for digital*

television set-top boxes. This standard for Australia and New Zealand contains the MEPS and regulatory requirements.

3. AS/NZS 62087.1:2010 *Power consumption of audio, video and related equipment, Part 1: Methods of measurement* is the Australian and NZ standard based on the 2008 IEC 62087 Ed2:2008 standard.
4. CSA C380-08 *Test Procedure for the Measurement of Energy Consumption of Set-Top Boxes (STBs)* is the Canadian standard used for both US and Canadian ENERGY STAR criteria for set top boxes Version 2.0.
5. *ENERGY STAR® Program Requirements Product Specification for Set-top Boxes, Test Method Rev. Jan-2011*. This standard takes effect with ENERGY STAR specification for set top boxes Version 3.0, but uses the test set up and instrumentation requirements of CSA C380-08.

   Note: US DOE published a notice of a proposed rulemaking for a test procedure for set top boxes (78 FR 5075 on January 23, 2013). However, this was withdrawn in December 2013 following announcement of the voluntary agreement on energy efficiency signed with set top box manufacturers and service providers.

6. ANSI/CEA-2043 *Set-top Box (STB) Power Measurement.*[5] This standard was under development during 2013. It defines a method for measuring set top box power consumption based on IEC62087 and clarifies test procedures, definitions, terms, and provides localization for North American markets. CEA-2043 supersedes CEA-2013 and CEA-2022.
7. ANSI CEA 2022:2007 *Digital STB Active power consumption measurement*. This standard establishes test methods for the measurement of STB power consumption. It is currently being revised to integrate the IEC 62087 Ed3:2011 requirements and will be superseded by CES-2043.
8. ANSI CEA 2013:2007 *Digital STB Background power consumption.* This standard defines background power consumption for STBs and provides test methods to measure these background power states. It uses the terms ‘sleep’ and ‘active’ extensively. It will be superseded by CES-2043.
9. IEC 62301 *Household electrical appliances – Measurement of standby power, edition 2.0 (2011)*. This is used to define the general test conditions for the measurement of standby and on mode power described (in detail) in the EU Ecodesign Voluntary Agreement. (Note: IEC 62087 Ed 3 does not rely on IEC 62301 for standby measurements as it contains its own methods).

3.3.2 Normalisation of data

Performance results from the various standards are closely comparable, subject to the uncertainties associated with differing definitions of operational modes described in the Set Top Box Product Definition document. No normalisation adjustments were deemed required.

[5] See http://standards.ce.org/apps/group_public/project/details.php?project_id=51.

3.3.3 Consumption metrics

The principal metrics for STB energy performance are:

a) Power for 'on' or 'active' mode, also called TV mode (W), which may have variants depending upon the additional functionalities available.

b) Power for various types of 'standby' mode: The principal mode analysed was 'active standby' also called 'sleep mode'. Insufficient quantity of data was available for the other types of standby to merit their analysis.

c) Power for 'deep sleep' state (W), but only used since 2011, and was available only for a very small proportion of products.

d) Typical energy consumption (TEC) per year (kWh/year) based on the ENERGY STAR criteria Version 3.0. Several definitions of TEC are given in the criteria but the only one used in this analysis was the basic 'on/sleep' form of TEC. This assumes 14 hours per day in 'on mode' and 10 hours per day in 'active standby/sleep mode', multiplied by the relevant power levels for that product. Insufficient data was available on 'auto-power-down mode' or on 'playback mode' to merit analysis of the variants of TEC.

3.4 Approach to analysis

Data cleaning to use a consistent set of terminology was the main task undertaken. No normalisation was required as all test methods returned a comparable measure of power demand. Data cleaning involved the following steps:

1. Each dataset had different ways of identifying the features of the products and so these were interpreted to derive a consistently labelled set of features. The consistent set of features sought out is listed in Table 2.
2. On mode, on/active mode and on (average) mode (IEC 62087 Ed3:2011) were assumed equivalent across the board.
3. Sleep mode (US ENERGY STAR) was assumed equivalent to standby mode (EU VA) and equivalent to standby active.
4. To avoid potentially misleading averages being calculated, it was decided that if fewer than 7 products were present in any data bin, that bin would be deemed insufficient and the result excluded from the analysis.

The data was analysed using a spreadsheet tool. This tool used the following formula to calculate the typical energy consumption (TEC) for each product for which the necessary data was available:

TEC = (14 x on mode power) + (10 x sleep mode power)

Only single room configuration data was analysed – there were insufficient products with multi-room configuration data to merit analysis.

Time series graphs were then derived using the spreadsheet tool. For each country and combination of countries, the graphs that could be produced were:

- Power in 'on mode' over time.
- Power in 'standby/sleep mode' over time.
- TEC derived from 'on mode' and 'standby/sleep mode'.

For each graph, average TEC, or power calculation, the product types included were subject to the following filters that could be combined in any permutation:

i. Country/region.
ii. Models with play/record mode, without play/record mode or all types (including unknown).
iii. Models with HD, without HD or all types (including unknown).
iv. Models that are simple type, models that are complex type, or all types (including unknown).
v. Any combination of signal types (cable, IP, satellite, terrestrial, thin client/remote,and/or cable digital transport adapter).

This enabled presentation and comparison of the averages for each country, and cross-examination of possible reasons for differences based on the features of products included. It was through this process of filtering and cross-comparing that it became evident that there were rational reasons (or at least possible reasons) that could explain all differences in performance between countries (see section 5).

Table 2. List of the set top box features that were identified from all the available datasets.

Feature
Auto power down
Additional tuners (cable/satellite)
Additional tuners (terrestrial)
High definition resolution
Multi-room capability (multi decode and display)
Digital video recorder
Removable media player (DVD, BluRay etc)
Removable media player/recorder (DVD, BluRay etc)
Remote controller (Korea)
CableCARD
Deep sleep state available
Advanced video processing (AVP)
High efficiency AVP also called HEVC (High Efficiency Video Coding)
Full HD resolution
Ultra high definition resolution
3D TV processing (frame compatible or non-frame compatible)
(Advanced) home network interface (could be ethernet, Wi-Fi or MoCA)
Return Path Broadband Modem (ADSL or DOCSIS)
DOCSIS (one particular type of return path modem)

4 Product types included in the datasets

4.1 Signal types included in datasets

There are six possible input signal types for these products. All datasets had a designation of this for all products, in descending order of count across all datasets:

1. Cable STB.
2. Satellite STB.
3. Terrestrial STB.
4. Internet protocol (IP) STB.
5. Cable digital transport adapter[6] (DTA).
6. Thin client/remote[7] STB.

The signal type affects the inherent energy consumption of the STB due to different requirements for signal decoding and amplification. Considering the differences in signal type between datasets is important to ensure fair comparisons.

Cable digital transport adaptor and thin client/remote signal types both accounted for a negligible volume of data and were not analysed. As seen in Figure 2, when data from all countries and product types is considered together, products for terrestrial signals dominate the 2009 and 2010 datasets. There is a fairly even distribution of signal types between the main four for 2011 and 2012; 2013 is split between cable, IP and satellite.

However, Figure 3, Figure 4, and Figure 5 show that the mix of signal types included varies by country. This is most striking for Australia, which is dominated by terrestrial signal type for all years, and accounts for almost all of the terrestrial products in the whole analysis. The EU and USA datasets have a similar proportion of signal type mix for 2011.This alone does not make the datasets comparable, as simple/complex attribute and functionality must also be considered (see subsequent sections).

[6] Digital television adapter, otherwise known as a digital-to-analogue converter or a converter box is a television tuner that receives a digital television transmission and converts the digital signal into an analogue signal that can be received and displayed on an analogue television set.
[7] A thin client or remote STB is designed to interface between a multi-room STB and a TV (or other output device) and that has no ability to interface with the Service Provider directly. Thin client / remote STBs must rely solely on a separate STB for accessing content.

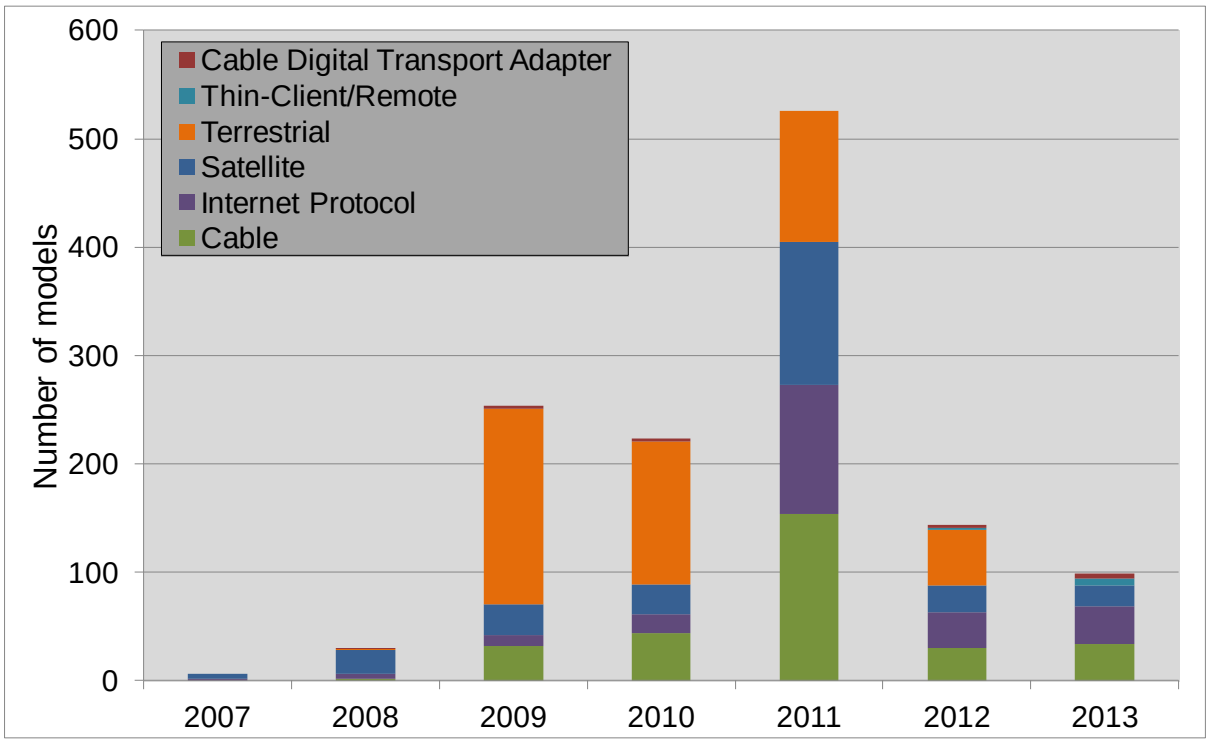


Figure 2. Count of products by signal type for all datasets.

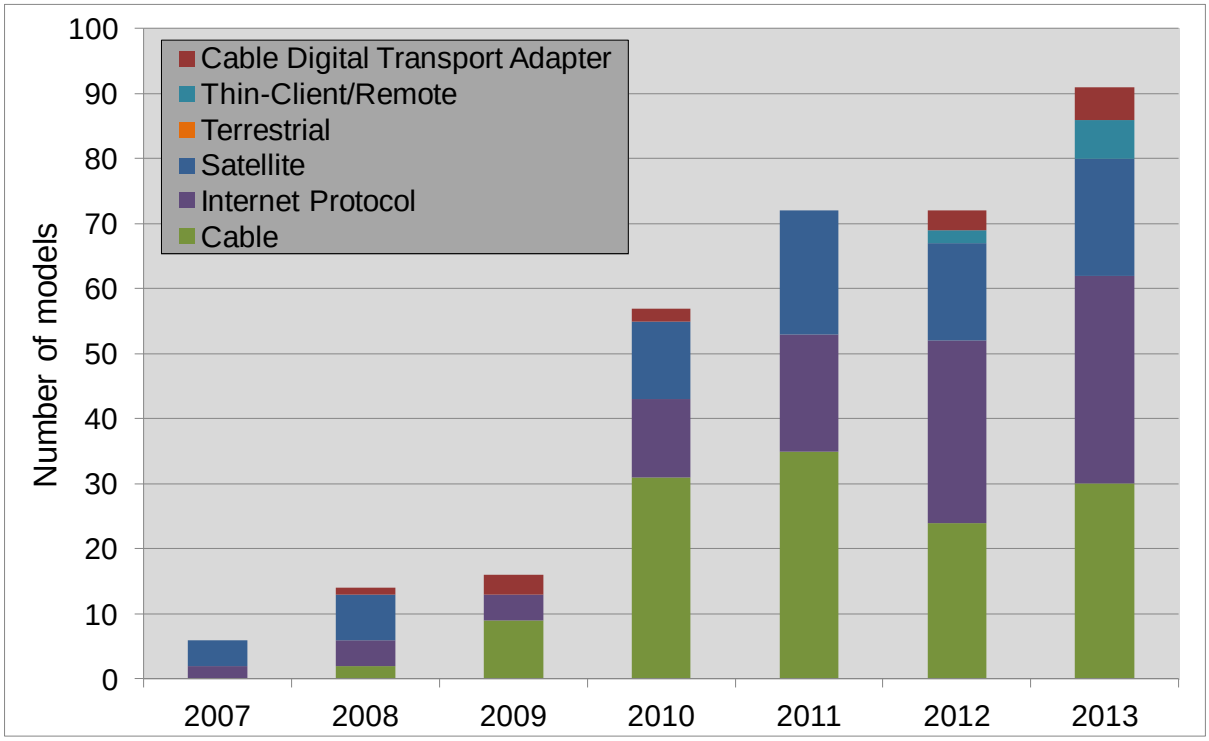


Figure 3. Count of products by signal type for USA dataset only.

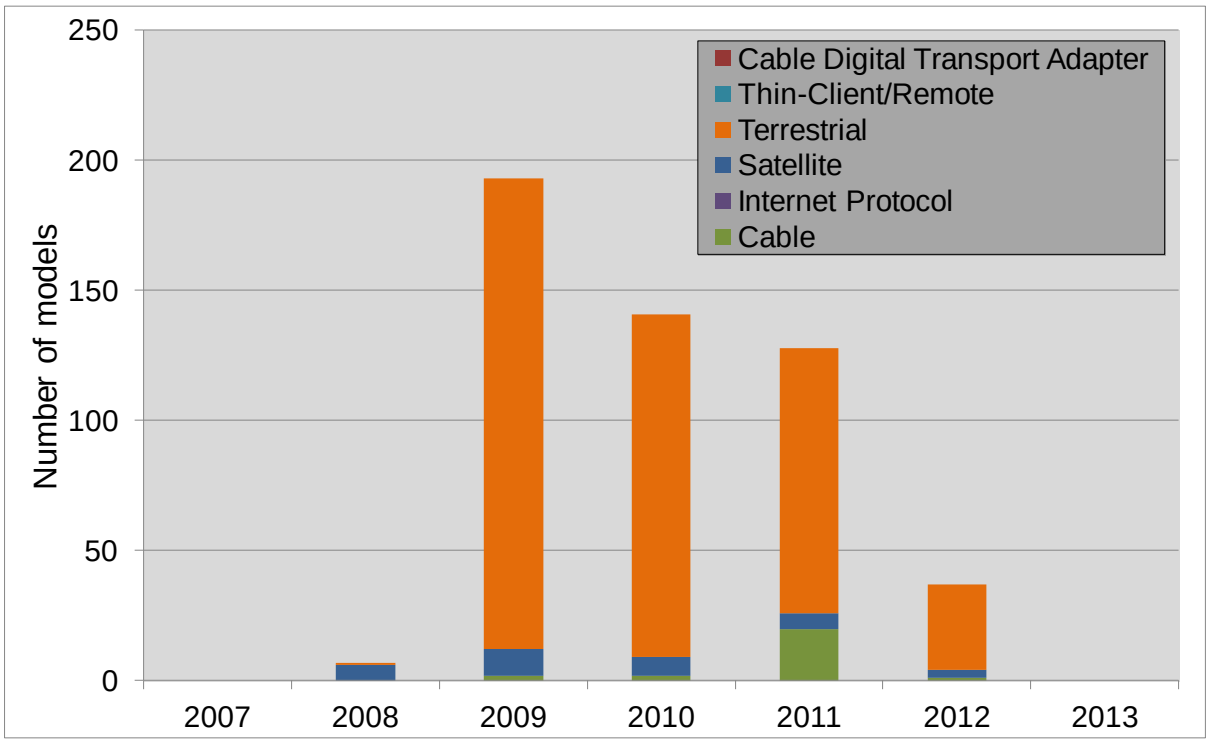


Figure 4. Count of products by signal type for Australian dataset only.

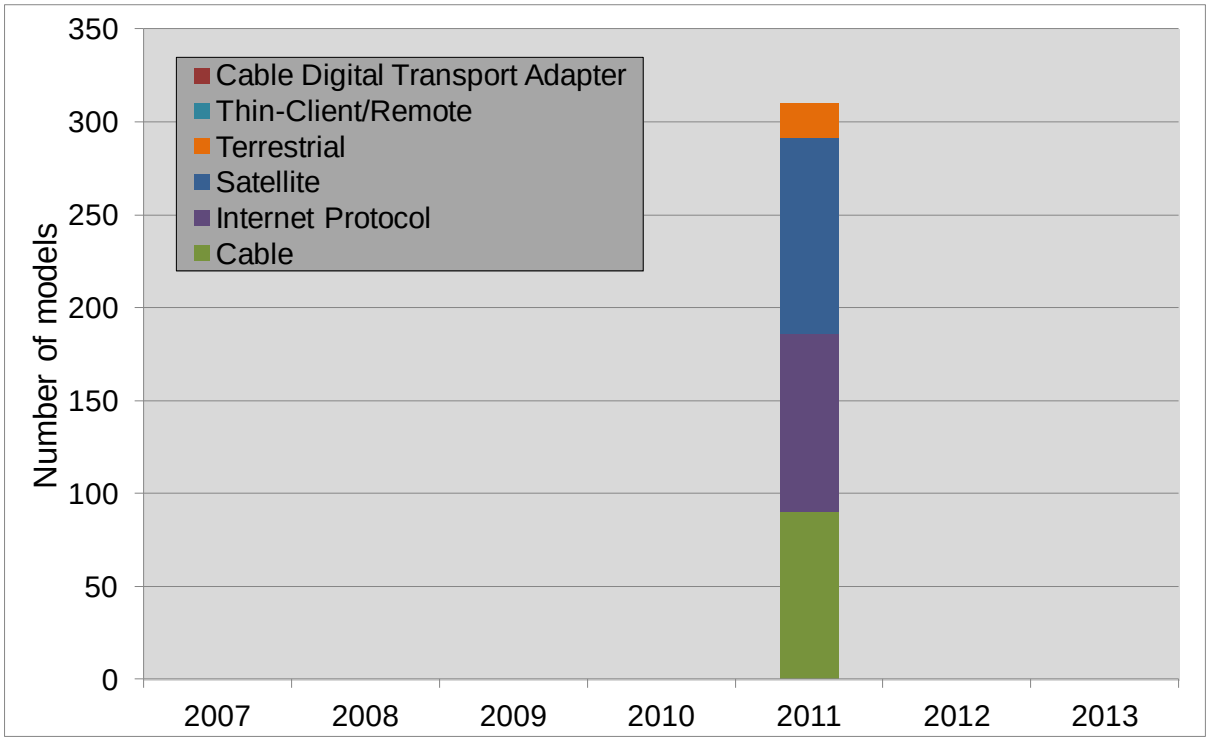


Figure 5. Count of products by signal type for EU dataset only.

4.2 Mix of simple and complex STBs

Set top boxes can be either complex type (conditional access or pay TV) or of simple type (free view channels). This designation also affects energy consumption, e.g. due to decoding functionality and the need for complex type boxes to check for data download and intermittent account settings. Complex type boxes dominated the overall dataset, as shown in Figure 6. Looking at this mix by country in Figure 7, Figure 8 and Figure 9 shows that Australia accounts for virtually all the simple type boxes in the dataset.

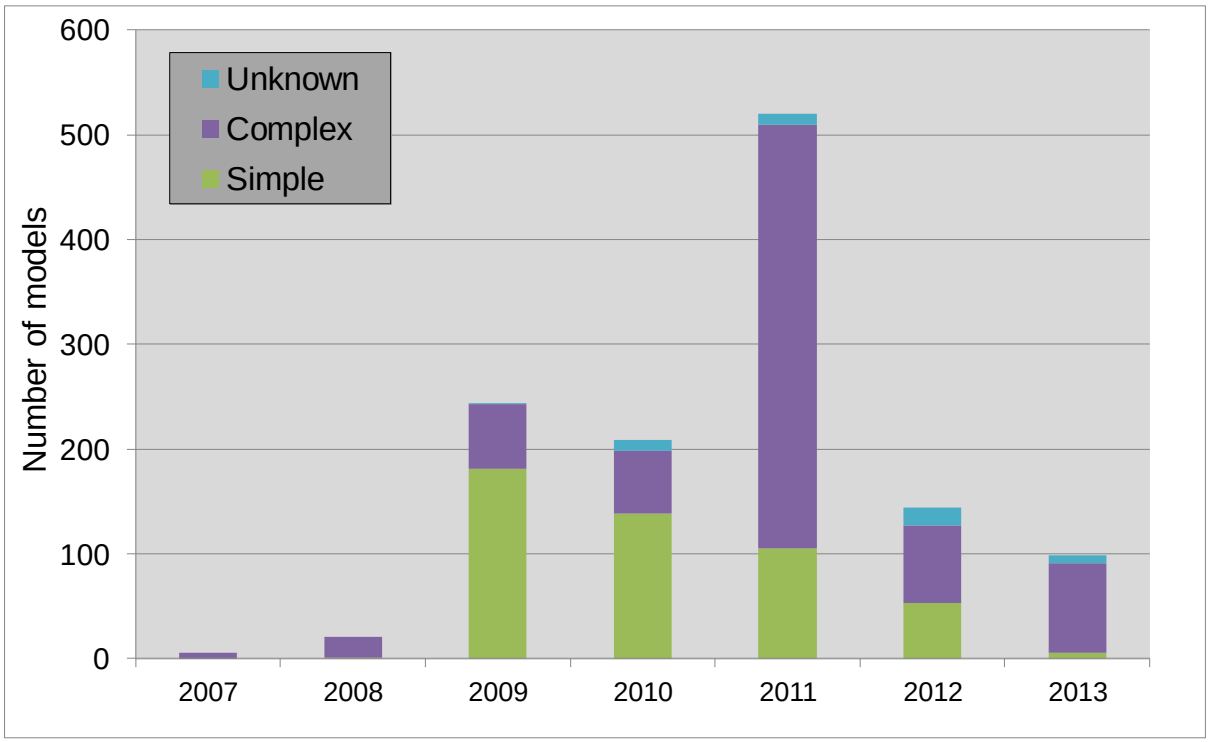


Figure 6. Count of products by simple/complex designation for all datasets.

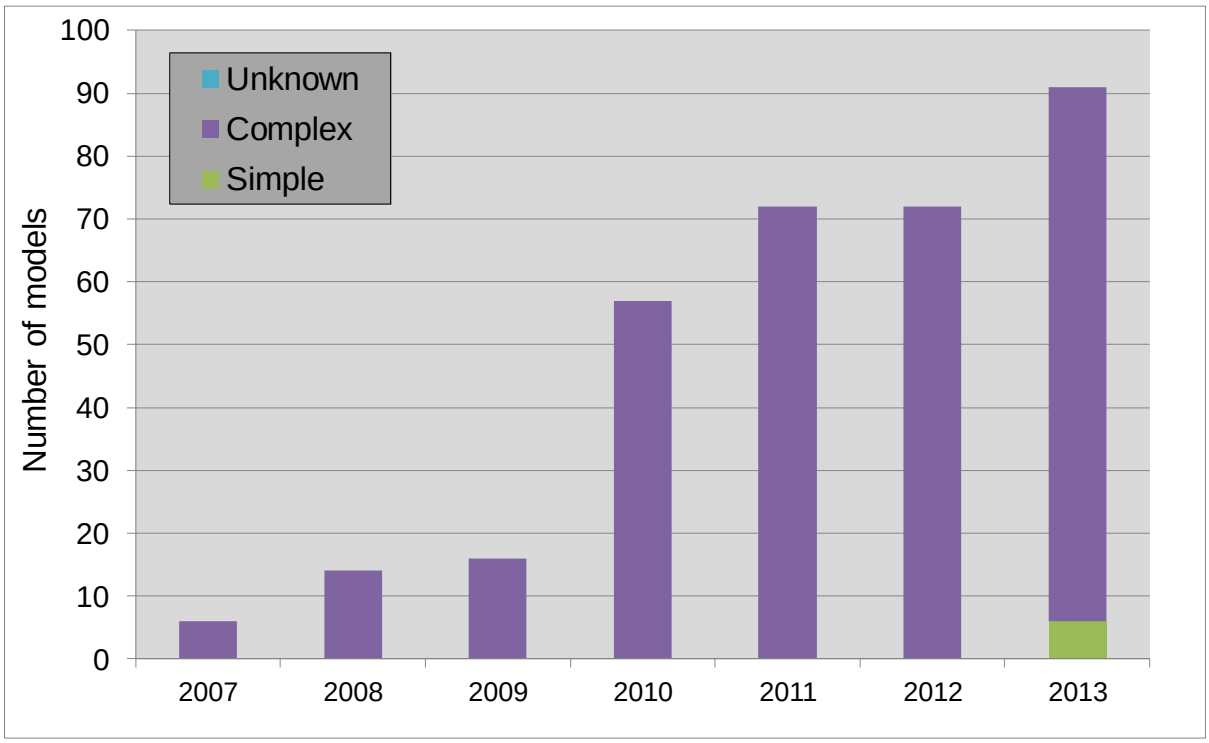


Figure 7. Count of products by simple/complex designation for USA dataset.

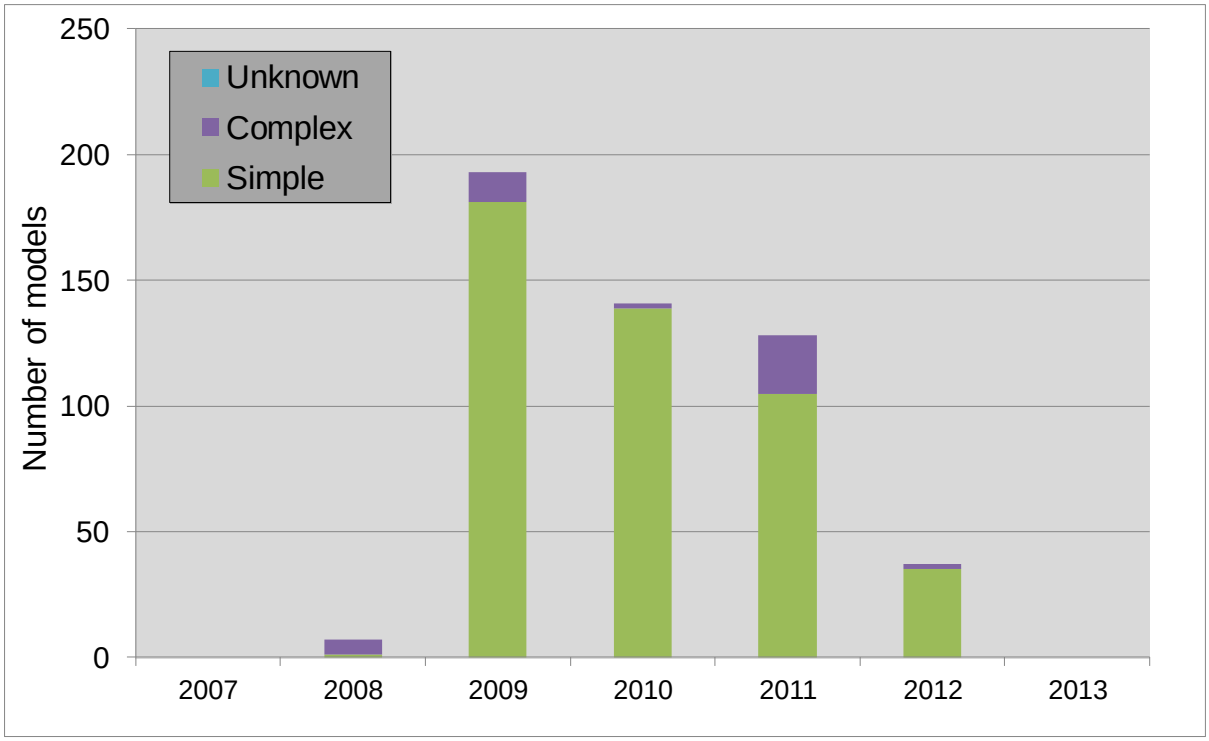


Figure 8. Count of products by simple/complex designation for Australia dataset.

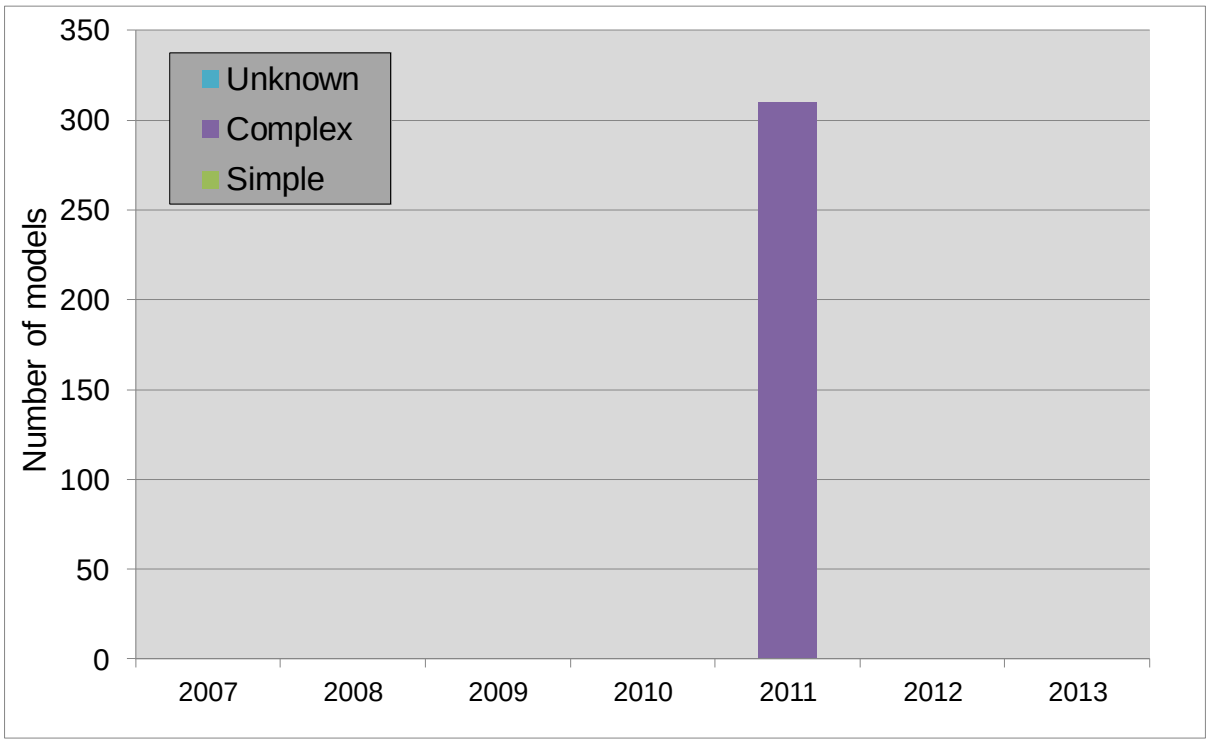


Figure 9. Count of products by simple/complex designation for EU dataset.

4.3 Presence of play/record function

A significant factor in overall power demand is the presence of a play/record function. The distribution of this function for products across all countries is shown in Figure 10, and by country in Figure 11, Figure 12, and Figure 13. The Australian dataset has no products with play/record functionality noted; the EU has 50%, and the USA 30% to 45% with play/record. Direct comparability between countries is limited by these differences, as well as differences in the proportions of simple/complex, and signal types.

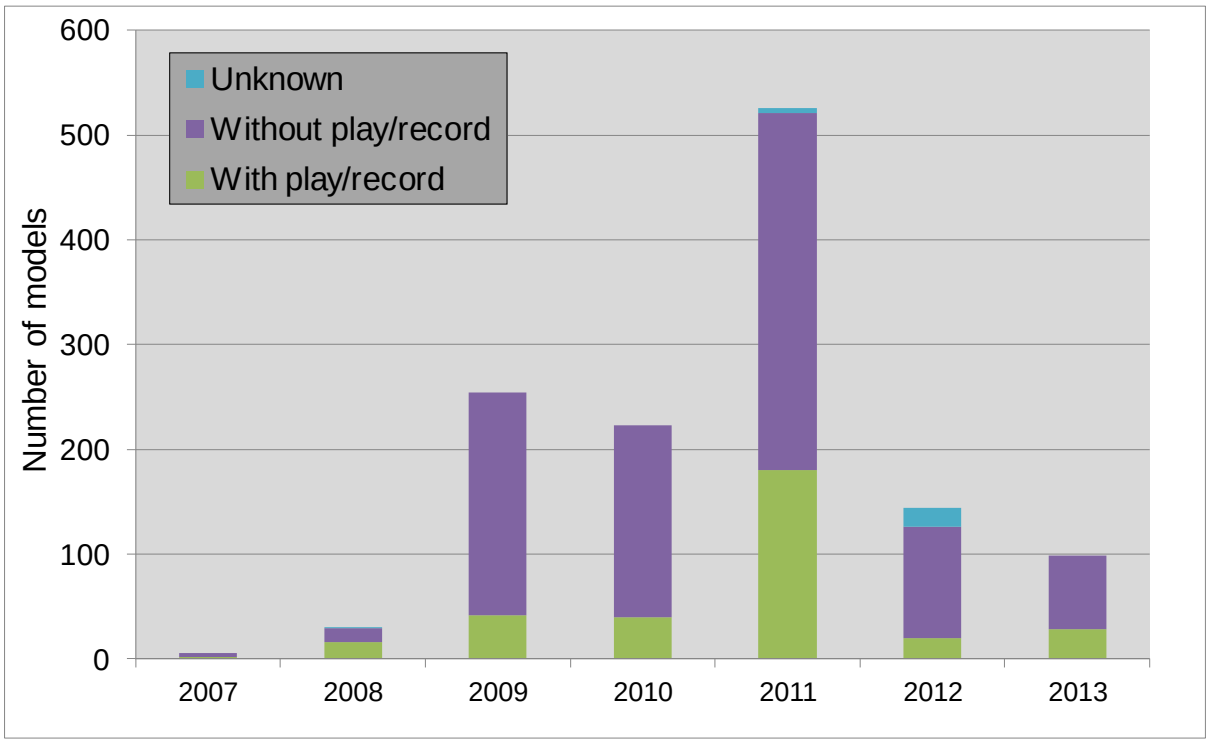


Figure 10. Count of products with and without play/record functionality for all datasets.

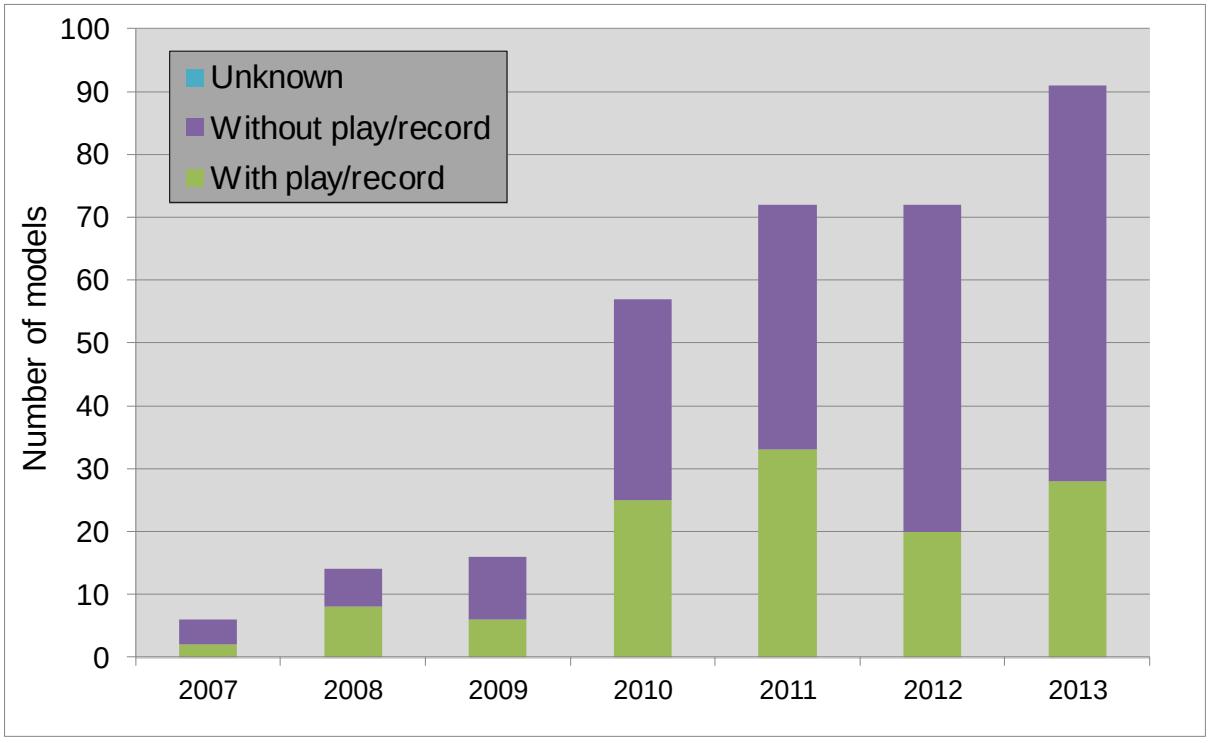


Figure 11. Count of products with and without play/record functionality for USA dataset.

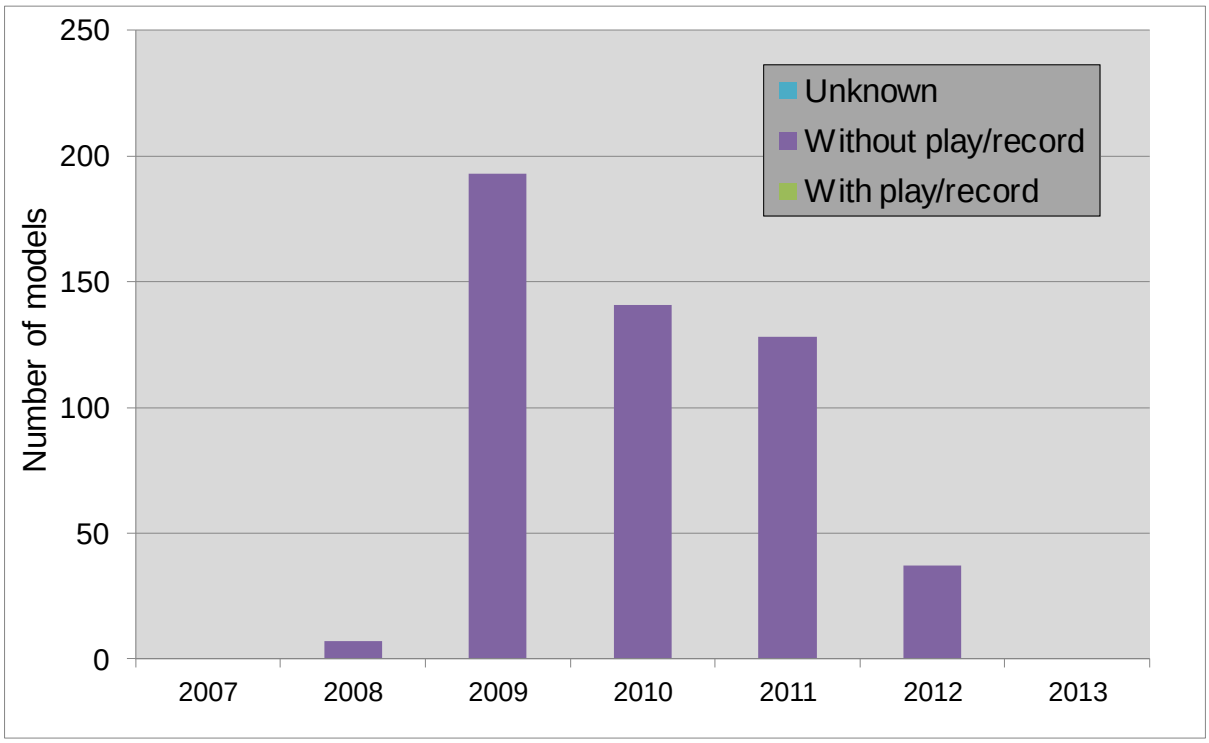


Figure 12. Count of products with and without play/record functionality for Australia dataset.

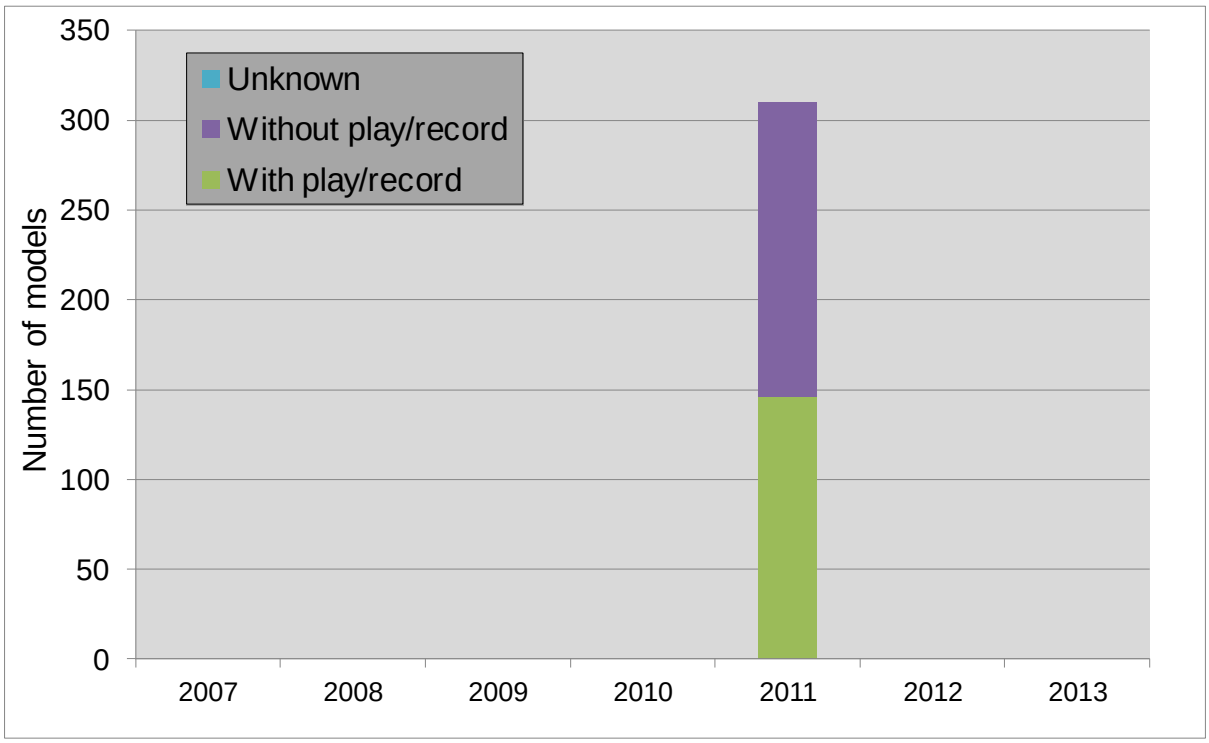


Figure 13. Count of products with and without play/record functionality for EU dataset.

4.4 Other functionality and product features

The permutations of features noted in the product information were analysed. The percentages of all products that claim a feature (in descending order of popularity) are:

- High definition (HD) is the most popular single feature (in 75% of products).
- Advanced video processing (40%).
- Passive standby (35%).
- Return path modem (23%).
- Auto power down (APD) (22%).
- Digital video recorder (DVR) (22%).
- Additional tuners (15%).

Where any two features appear together in the same product (with or without others), the most common pairs are:

- HD and advanced video processing.
- HD and return path modem.

The most popular triple combination of features appears to be HD/advanced video processing/return path modem. This combination accounts for 289 out of the 1391 products (in 21% of all products).

For HD alone, the overall proportions across all countries and products are shown in Figure 14. These proportions of around 90% HD, and remainder non-HD are similar in each of the three main country datasets when all types are considered together. Proportions do, however, vary when filtered down to particular signal types or, for example in the Australian set virtually all of the complex products are non-HD.

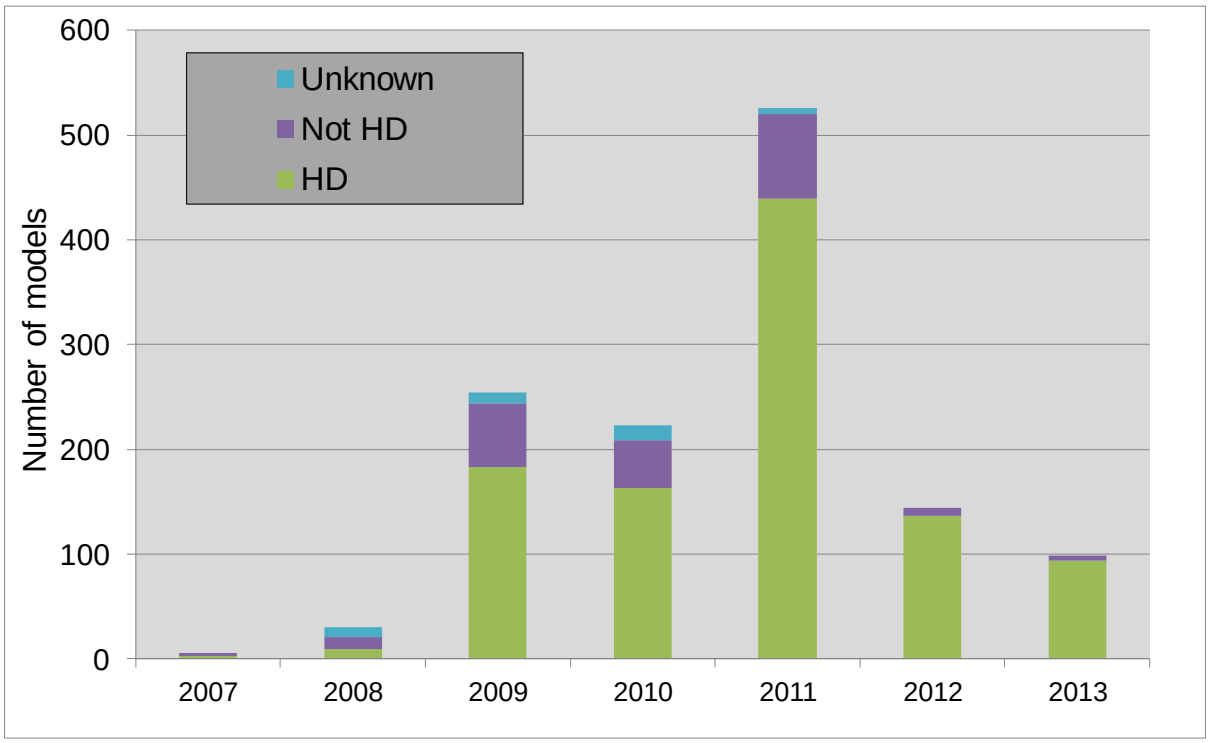


Figure 14. Count of products with and without high definition (HD) capability, for all datasets together.

5 Comparison of energy performance - challenges and limitations

5.1 Approach to country comparisons of STBs

Analysis of energy performance was carried out for many types and sub-types of product, but differences between countries were largely explainable by remaining differences in functionality. When datasets were filtered to contain only a very specific sub-type and functionality of product, the numbers of products remaining resulted in figures of poor robustness (e.g. almost always fewer than 20 products, often 10 or fewer and not available for more than two countries).

There is therefore significant risk that the resulting benchmarking graphs could be misinterpreted given the lack of comparability between national product types. The interpretation of figures in the case of this product requires a high level of market insight and an understanding of the specific data being viewed to draw any conclusions. The decision was taken not to present such potentially misleading results. The limitations of undertaking the comparisons are explained in the next section.

5.2 Limitations of comparing datasets between countries

Key issues affecting comparability of datasets between countries were:

1. **Television media delivery markets** differ substantially between countries: some are mainly subscription markets (complex products), others are mainly free view (non-subscription, simple type). In terms of signal type, terrestrial dominates some (Australia), cable infrastructure dominates others (USA). Each of these has direct implications on power demand, and many segments cannot be compared on a fair basis. Hence even complete datasets for a country would not necessarily be comparable with other countries on a fair basis.
2. Available data **was not representative of the whole market in any given country**, and depends heavily on the policies in place, which also influence the mechanisms for data gathering. USA data is probably one of the more comprehensive but it is entirely based on ENERGY STAR and so focuses on better performing products. The only EU data was from the voluntary agreement and covers only complex products (accounting for over 80% of that market segment). The Australian government dataset is mostly simple type boxes (coming from a mandatory registry of products).
3. The products in each market have **different mixes of functionality**. Features such as play/record, HD and auto-power down can affect power demand significantly.

4. **Product mix and functionality change between years**, as does the number of products in datasets, and so any energy usage trends over successive years are complex to understand and comparisons may not be useful.

   Overall power could only be compared in a fair way when products are grouped to have the same mix of type, signal and features. **Narrowing down the market segments to do that would result in far fewer data points to make an average and only one or two countries being compared**. Few permutations yield data for more than two countries; most result in data for only one.

   For example, to compare one of the more popular permutations: only cable type; complex boxes; without play/record functionality; and with HD capability. This produces a dataset of 102 products across all countries, with about 70% from USA and 30% from EU. This is, from a total of 1,391 products with data, equal to 7% of the whole dataset. With this fairly narrowly defined sub-set, the EU average TEC is 89 kWh per year in 2011 and that for the USA is 147 kWh per year.[8] However, this difference in average could arise from issues such as the presence of DOCSIS[9] and CableCard[10] (around half of the USA products have one or both but none of the EU ones), or home network interface (one third of the USA products have this; none of the EU ones), and several other features which vary as well. These remaining functionality/feature differences confuse the comparison of annual consumption between the USA and EU market segments.

The conclusion is that comparison between countries may not yield robust results. An alternative approach of ignoring country and breaking down the datasets purely by type may yield different but more useful insight into these products. As noted in the Introduction, this regrouping of data by technology rather than by country would be outside the usual remit of the Mapping and Benchmarking Annex. This approach was therefore not attempted, but options for possible analysis are discussed in section 8.

[8] USA average varies between 109 and 147 kWh per year for 2010 to 2013.
[9] DOCSIS is a type of broadband cable modem popular in the USA.
[10] CableCard is one example of a built-in access card-key control system popular in the USA.

6 Results of webinar discussion with policy practitioners

A technical discussion was held in November 2013 with policy makers and consultants responsible for set top box policies. Fourteen took part in a discussion that clarified some of the main differences between markets, and further examined the lack of comparability between datasets. It also discussed current trends and expectations.

This set of conclusions from the discussion was agreed for publication:

- Cable and satellite signal types tend to keep higher standby than IP type; one supplier (BSkyB) has shown that there are alternative technical solutions to avoid permanent high standby for satellite types.
- Internet Protocol TV (IPTV) set top boxes inherently use less power than boxes fed by other signal types - potentially less than 1 W standby coupled with greater efficiency of unicast (a tailored data service sent to a single subscriber location) rather than broadcast dissemination. In future, as the market share of IPTV increases it should therefore bring better overall efficiency to markets that can develop the infrastructure and fast broadband needed for IPTV (mainly achieved through cable networks to date).
- Set top boxes are generally not benefiting from the same technology based efficiency improvements seen in computers, mainly due to economic pressure for lowest possible cost (set top boxes are often bundled free with a service whereas computers are associated with functionality proportional to product cost). In addition, service providers feel obliged to facilitate ‘instant-on’ accessibility of media for consumers, which carries energy consumption penalties.
- Regulators are often only able to verify appropriateness of standards and allowances after their enactment, as energy consumption data simply is not available beforehand. Despite regulators working closely with manufacturers and applying expert insight, technology and functionality advance so rapidly that historical data is not available at the time of setting standards. Policy makers increasingly aim to update standards regularly, to keep them closely in line with measured product performance and also use adders (additional energy allowances for new functionality). However, there remains the possibility that these allowances have unintended consequences if a combination of adders given to a single product result in an overly generous allowance overall. Furthermore, this approach may result in a situation where standards are tracking product performance (to avoid hindering innovation and consumer service), rather than standards pushing technology towards increased efficiency/reduced consumption.
- The voluntary approach to making regulations is increasingly seen as the most appropriate approach, with service providers as the most influential stakeholders for efficiency.

7 Policies

Policies in the participating countries are summarised in Table 3 with more details below.

Table 3. Overview of policies for set top boxes in place in participating countries.

Country/ region	Mandatory MEPS	Voluntary measures
Australia	Since 2008 for simple and complex types	Code of Conduct for complex type only since 2010
EU	Ecodesign regulation for simple type since 2009	Code of conduct for complex type, version 8 since 2009 Voluntary agreement for complex type (an ecodesign measure) since 2011
Republic of Korea	None	E-standby power program since 2003
USA	(Proposed rulemaking was withdrawn in 2013 following the voluntary agreement)	ENERGY STAR version 3 since 2011 for complex and simple types; proposed version 4 due to take effect in 2014 Voluntary agreement for complex type agreed 2013, running until 2017
Canada	(Only for terrestrial digital television adapters, since 2010)	US ENERGY STAR criteria for set top boxes are also adopted in Canada

1. **Australian MEPS**
   MEPS are defined in AS/NZS62087.2.1:2008 *Minimum energy performance standard (MEPS) requirements for digital television set top boxes*. This definition distinguishes between Free to Air (FTA) and Subscription TV (STV) with different requirements for each.
   - FTA products 'receive and decode FTA **terrestrial** digital television broadcast signals, for use by a video display device or a recording device'.
   - STV products 'receive, decode and descramble digital television broadcast signals from a **cable or satellite** source, for use by a video display device or a recording device'. This includes products to decode FTA signals transmitted via cable or satellite and includes conditional access products.

2. **Australian Conditional Access Set Top Box (CSTB) Code of Conduct (CoC)**
   This code covers satellite STBs, including those with recording technologies and first came into effect in 2010 with further tiers in 2012, 2014 and 2017. The performance limits and TEC parameters are closely based the EU Ecodesign Voluntary Agreement, including its additional allowances.

3. **USA ENERGY STAR**
The specification in force at January 2013 is ENERGY STAR Technical Specification for Set-top Boxes Version 3.0, which came into effect September 1 2011.[11] Version 3.0 covers a very wide range of product types and functionalities, and defines six basic STB types (cable, satellite, Cable Digital Transport Adapter (DTA), Internet Protocol (IP), terrestrial, Thin Client/Remote). The specification also defines ten additional functionalities with associated consumption allowances that can be added in a modular fashion, which include: conditional access, HD, multi-room and multi-stream, recording and removable media playback. Version 3 covers three operational modes: on mode; sleep mode, and deep sleep state. A final version of criteria, Version 4.1, was published in January 2014 with ongoing consultation. Version 4.1 is due to be finalised in March 2014 and come into force in December 2014 to supersede Version 3.0.

4. **USA DOE Notice of Proposed Rule Making for set top boxes**[12]
Launched in late 2012 but was suspended in December 2013 on announcement of the US voluntary agreement.

5. USA voluntary agreement for energy efficiency of set top boxes
DOE, the Natural Resources Defense Council (NRDC), the American Council for an Energy-Efficient Economy (ACEEE), the Appliance Standards Awareness Project (ASAP), the Consumer Electronics Association (CEA) and the National Cable & Telecommunications Association (NCTA) announced non-regulatory energy efficiency standards for pay-TV set top boxes[13] in December 2013. The agreement, which runs to 2017, covers all types of set top boxes from pay-TV providers, including cable, satellite and telephone companies. The agreement also requires the pay-TV industry to publicly report model-specific set top box energy use, and requires an annual audit of service providers by an independent auditor to ensure boxes are performing at the efficiency levels specified in the agreement. The agreement aims to improve set top box efficiency by 10% to 45% (depending on box type) by 2017.

6. **EU Regulation (EC) No 107/2009**
The EU regulation specific to simple STBs is the *Commission Regulation (EC) no 107/2009 of 4 February 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for simple set-top boxes*. This regulation governs simple set top boxes, which are defined as having no conditional access (CA) functions, and no recording functions based on removable media in a standard library format, but can have additional functions such as time-shifting/recording functions using an integrated hard disk and a second tuner.

[11] Available at http://www.energystar.gov/index.cfm?fuseaction=products_for_partners.showSetTopBoxes, under the 'Current' tab, accessed 27 September 2012.
[12] US Department of Energy, 10 CFR Parts 429 and 430, Docket no. EERE-2012-BT-TP-0046, RIN: 1904-AC52, Energy conservation programme: Test Procedure for set top boxes. Available from http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/33.
[13] See https://www.ncta.com/sites/prod/files/VOLUNTARY-AGREEMENT-ENERGY-EFFICIENCY-OF-SET-TOP-BOXES.pdf

7. **EU Code of Conduct**[14]
   This voluntary Code of Conduct sets an aspirational energy efficiency performance target to be achieved by the best CSTBs in class. The document defining this is the *Code of Conduct on Energy Efficiency of Digital TV Service Systems Version 8*, European Commission Joint Research Centre, Ispra, 15 July 2009[15]. This code only covers 'complex set top boxes' which are distinguished from simple STBs on the basis of having 'conditional access' – i.e. are products with systems to prevent unauthorised viewing of content. This code closely aligns with the ENERGY STAR specification on base functions, and on additional functionalities, and includes the same six types of system as listed above. The code excludes personal computers and game consoles fitted with integrated digital TV tuners.

8. **EU Ecodesign Voluntary Agreement**
   The European industry is negotiating on a voluntary agreement to agree a minimum energy efficiency specification with the European Commission instead of a mandatory measure. The draft document, current as of February 2014, was *Voluntary Industry Agreement to improve the energy consumption of Complex Set Top Boxes within the EU. Proposal from the industry group, Version 3.1 19 June 2013.*[16] (A draft version 4 is available from the same location that includes additional material for Tier 3 requirements). The structure and approach is very similar to the EU Code of Conduct, but with less stringent requirements. The voluntary agreement proposal covers the complex set top box, which is defined as 'a standalone device equipped to allow conditional access that is capable of receiving, decoding, and processing data from digital broadcasting streams and related services, and providing output audio and video signals', and where 'conditional access' means 'the encryption, decryption, and authorization techniques employed to make access to content conditional upon prior authorisation'. The voluntary agreement proposal covers many variations of functionality, similar to the ENERGY STAR list, and adopts the same basic six types of STB as per US ENERGY STAR and the EU Code of Conduct. The voluntary agreement excludes products without conditional access, and devices whose primary function is not the reception of television signals.

9. **Switzerland** has regulated set top boxes according the EU Code of Conduct, Version 8.

10. **The Republic of Korea** has had a standby regulation[17] in place since 2003 covering cable, satellite and IP set top boxes, with the overall regulation updated several times since.

[14] See http://re.jrc.ec.europa.eu/energyefficiency/html/standby_initiative.htm
[15] PDF available from http://re.jrc.ec.europa.eu/energyefficiency/pdf/CoC_Digital_TV-version%208_2009.pdf
[16] Available from http://cstb.eu/?page_id=16.
[17] Ministry of Knowledge Economy Notification No. 2011-23, e-Standby Power Program, Regulation on Standby Power Reduction Program, February 2011, Korea Energy Management Corporation (KEMCO). Available from http://www.kemco.or.kr/nd_file/kemco_eng/MKE_Notice_%202011-23_e-standby_Program.pdf.

11. **Canada** has had regulatory requirements applicable only to terrestrial digital television adapters[18] since 2010[19] (this type of product was excluded from this analysis – see Product Definition document). ENERGY STAR set top box criteria are applicable for the Canadian market[20] as well as for the USA.

[18] Digital television adapter, otherwise known as a digital-to-analogue converter or a converter box is a television tuner that receives a digital television transmission and converts the digital signal into an analogue signal that can be received and displayed on an analogue television set.
[19] Canadian requirements for digital television adapters are at http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6907
[20] See http://www.nrcan.gc.ca/energy/products/categories/electronics/set-top-box/14039

8 Conclusions and recommendations

The following overall conclusions have been drawn from this assessment:

1. Because of product count, only USA, Australian and EU datasets merited any attempts at comparative analysis.
2. The TV broadcast market in each of these countries is significantly different to the others in the mix of product/service type, which brings differences in the inherent energy consumption of typical set top boxes in use in each country.
3. None of the datasets reflects the whole market in any of the countries included in the study, and dataset coverage varies in additional ways (such as the USA dataset being from ENERGY STAR and so covering only better performing products), introducing further issues that limited the comparability between countries.
4. Inherent typical functionality differences between products in the markets appear to explain the rank of performance levels, as far as analysis is possible. Furthermore, filtering country datasets to obtain potentially more comparable sub-sets of products results in datasets which are too small to have any statistical significance.
5. The consensus amongst policy practitioners is that in the future, the subscription services will turn increasingly to IPTV. This should bring lower energy consumption in set top boxes, but requires fast broadband, and so is limited by infrastructure availability in many countries.
6. Set top boxes do not generally benefit from the efficiency improvements seen in computers, mainly due to economic pressures. Efficiency gains are further hampered by the perceived need to provide ‘instant-on’ accessibility of media.

The following recommendation for policy makers is suggested:

- Policy makers could consider an alternative approach to analysis of set top box performance: instead of a comparison between countries, the country datasets could be merged and then split by product type - i.e. grouping simple (free to air, non subscription) products separately to complex (subscription) products; and then split by signal type (satellite, cable, terrestrial and IP etc). The resulting sets could be further split by functional differences: HD versus SD, playback/recording facility, home networking interface etc. Regression analysis could be applied, with the year as a separate independent variable (this alternative approach was not pursued as it is outside the usual remit of the M&B Annex).

Annex 1 Size and characteristics of datasets

Table 4. Size and characteristics of the datasets from each country.

Country	Total count of products for which TEC is calculable	Range of years with TEC calculable and >=5 products	Maximum count of products in any year (year)	Percentage of set for which TEC is calculable that are complex STBs	Dominant signal types in dataset	Overall percentage with DOCSIS (for example)	Source and representativeness of full market
USA	328	2007-2013	79 (2013)	>95% complex	Cable 30%; IP 30%; satellite 15%	25% in 2010; 30% in 2013	ENERGY STAR - better products only (post 2010). Not representative of full market.
Australia	323	2009-2012	123 (2009)	10% complex	>90% terrestrial	None	Highly representative of simple STB market; poor representation of complex market
EU	306	2011 only	306 (2011)	100% complex	Equal cable/IP/Satellite - with a few terrestrial	Only a few % in 2011	Voluntary Agreement - highly representative of complex STB market only; no simple STBs
Denmark	18	Only 2012	18 (2012)	0% complex	100% terrestrial	Unknown	Better products only, of limited types. Not representative
Canada	14	Only 2009	14 (2009)	(no data on whether complex or not)	50% cable; 30% satellite 20% IP	Unknown	Small sample.Not representative
Korea	10	Only 2010	6 (2010)	(no data on whether complex or not)	Slight dominance of cable over IP; a few satellite except 2012 when one third were satellite	Unknown	Mandatory scheme but few products had adequate data to calculate TEC. Not representative (focuses mainly on standby)