Informations- og kommunikationsteknologi i husholdningerne

En energipolitisk udfordring

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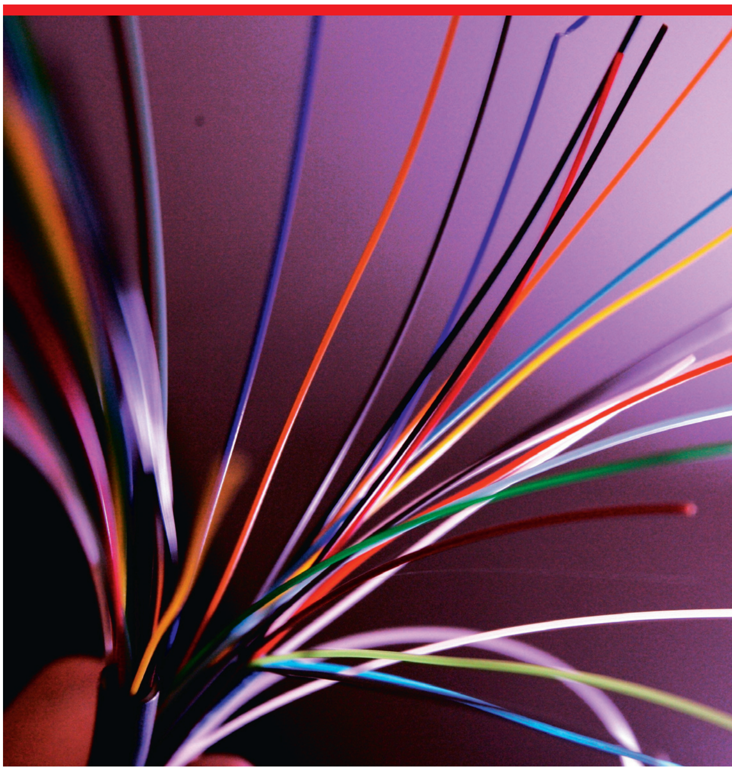

Rapport 17.2009

DTU Management

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December 2009

DTU Management
Institut for Planlægning, Innovation og Ledelse

Indholdsfortegnelse

Rapport om projektet

Informations- og kommunikationsteknologi i husholdningerne – en energipolitisk udfordring

Forord

Formålet med projektet var at undersøge de aktuelle udviklingstendenser i brugen af informations- og kommunikationsteknologi (IKT) i hjemmene og vurdere perspektiverne for den fremtidige udvikling i energiforbruget. Samtidig var det hensigten af få det IKT-relaterede energiforbrug på dagsordenen og fremme diskussionen af, hvordan en potentiel vækst i dette energiforbrug kan forebygges. Den foreliggende rapport sammenfatter resultaterne af projektet.

Projektgruppen har haft følgende deltagere:

Inge Røpke (projektleder), Mirjam Godskesen og Toke Haunstrup Christensen, DTU Management, Danmarks Tekniske Universitet
Kirsten Gram-Hanssen, Jesper Ole Jensen og Toke Haunstrup Christensen, By, bolig og ejendom, Statens Byggeforskningsinstitut, Aalborg Universitet
Troels Fjordbak Larsen, IT Energy
Ole Willum, Willum Consult
Lisbet Stryhn Rasmussen, Lokalenergi
Jens Erik Pedersen, Energirådgiveren
Anders Grønbech, Canon

Desuden har deltagerne i følgegruppen bidraget aktivt til projektet:

Lajla Klamer, TDC
Allan Bugge og Niels Jørgen Langkilde, Branchen Forbrugerelektronik
Lars Bennetzen, Alt om Data
Jørn Borup Jensen, Dansk Energi

Projektet er finansieret af Dansk Energis PSO-midler (projektnummer 338-007) samt medfinansiering fra deltagerne.

Projektet er afsluttet i 2009.

Oversigt over projektet

Baggrund og formål

Udgangspunktet for projektet var konstateringen af, at informations- og kommunikationsteknologi (IKT) i stigende grad vinder indpas i hverdagen og integreres i mange forskellige hverdagsaktiviteter. Med den stigende mængde udstyr og den øgede brugstid kunne der ventes et øget elforbrug til IKT, men indtil for få år siden var der meget begrænset interesse for de mulige energimæssige konsekvenser af udbredelsen af IKT i husholdningerne. Af nærliggende årsager retter indsatsen for at begrænse elforbruget sig typisk mod de forbrugsområder, der aktuelt tegner sig for et stort forbrug. Formålet med projektet var således at undersøge aktuelle udviklingstendenser i brugen af IKT i husholdningerne og at vurdere perspektiverne for den fremtidige udvikling i det tilknyttede energiforbrug. Samtidig var det hensigten at bidrage til at få det IKT-relaterede energiforbrug på dagsordenen og at fremme diskussionen af, hvordan en mulig fremtidig vækst i dette energiforbrug kunne forebygges.

Samtidig med dette projekt er der også andre, som har fået øje på de samme udviklingstendenser. Vores projekt har således paralleller i flere andre lande, fx i England, Frankrig og Sverige. Senest har det Internationale Energi Agentur udgivet en omfattende rapport, ”Gadgets and Gigawatts”, der understreger, at det IKT-relaterede elforbrug i hjemmene kan eksplodere, hvis der ikke skrides ind med effektive politikker for at forebygge det.

Da projektet blev planlagt, var det endnu ikke almindeligt at bruge forkortelsen IKT på dansk, så den engelske betegnelse kom til at indgå i projekttitlen. Den oprindelige idé var primært at fokusere på computeren, internettet og de tilknyttede teknologier, mens det ikke var tanken at inddrage tv, dvd o.lign. Imidlertid er den klassiske skelnen mellem underholdningselektronik og computere i stigende grad irrelevant, så de to områder flyder sammen i projektet og omtales under ét som IKT. Når man ser på energikonsekvenser, er det også værd at nævne, at tv-området aktuelt spiller en stor rolle for elforbruget, bl.a. som følge af digitaliseringen. Også af den grund kom tv til at spille en større rolle i projektet end ventet.

I det følgende gives en oversigt over projektets forskellige dele. De mere udførlige resultater fremgår af bilagene.

Sammenhænge mellem IKT-anvendelse og energiforbrug

Projektet blev indledt med et litteraturstudie, der blev anvendt som grundlag for en systematisk oversigt over sammenhængene – positive og negative – mellem husholdningers anvendelse af IKT og det tilknyttede energiforbrug. I litteraturen skelnes der typisk mellem tre typer af energikonsekvenser:

- Det direkte energiforbrug, der primært består af apparaternes elforbrug i hjemmene eller på farten.
- Det indirekte energiforbrug, der knytter sig til fremstilling, transport og bortskaffelse af udstyret samt til driften af IKT-infrastrukturen såsom serverparker og mobilmaster.
- De afledte energikonsekvenser, der knytter sig til de strukturelle effekter af IKT-anvendelsen. Dvs. effekterne af at livsstil og forbrugsmønstre mere generelt kan ændre sig, når IKT integreres i hverdagslivet.

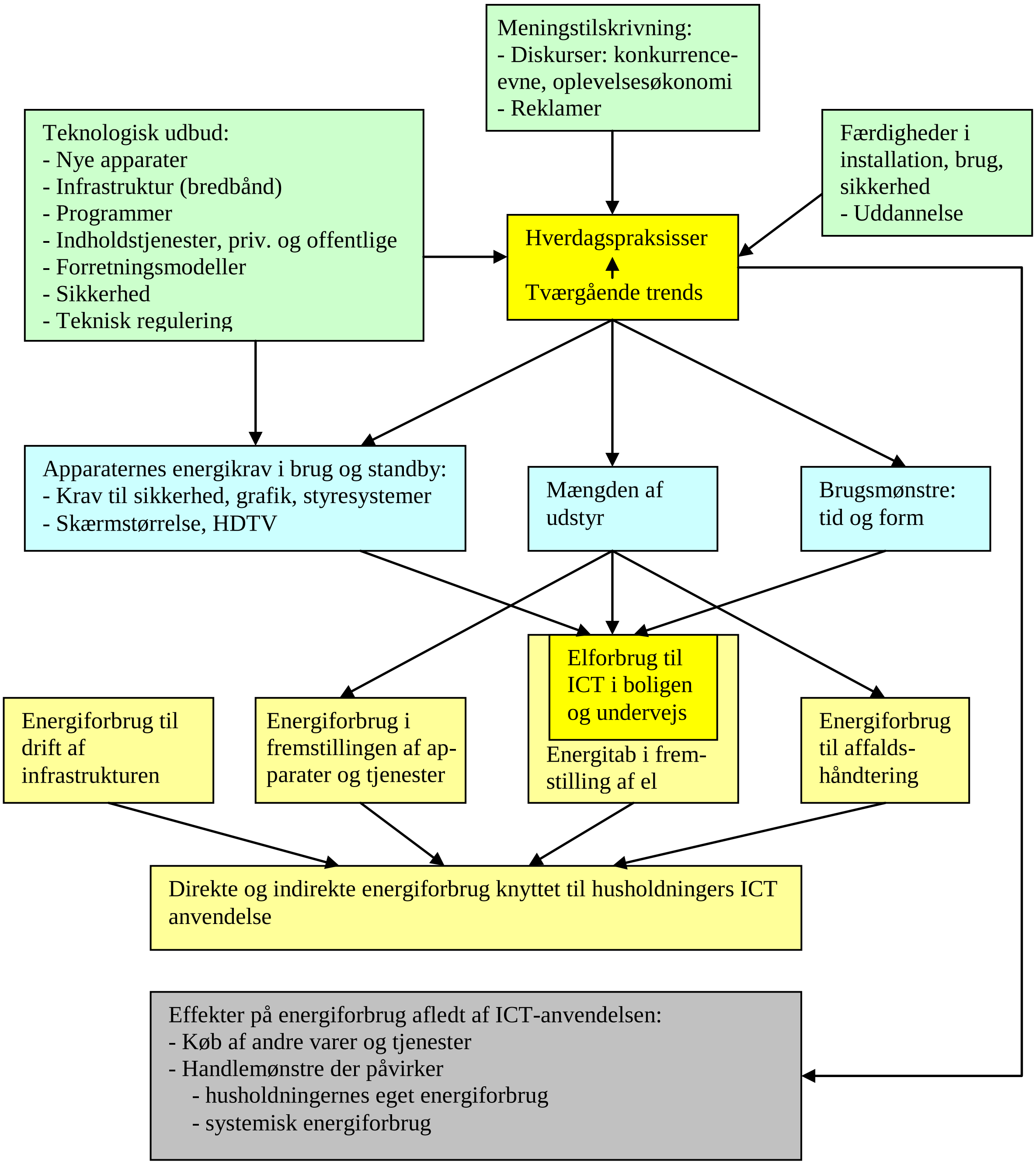
Figur 1 giver en samlet oversigt over de tre typer af energikonsekvenser samt nogle af de forhold, der indvirker på omfanget af konsekvenserne. Der er især fokus på det direkte elforbrug, hvor størrelsen bestemmes af antallet af apparater, apparaternes energieffektivitet i henholdsvis drift og standby samt brugsmønstrene, herunder tidsforbruget. Bag antallet af apparater og brugsmønstrene ligger udviklingen i de hverdagspraksisser, som apparaterne integreres i – praksisser, der igen er formet af udbuddet af nye teknologier, de samfundsmæssige diskurser, der former opfattelsen af teknologierne, samt befolkningens færdigheder i brugen af dem. Der ligger således komplekse processer bag formningen af IKT-integrationen i hverdagen.

Blandt de centrale observationer i den tidlige fase af projektet kan fremhæves:

- Betydningen af IKT-anvendelsen i hjemmet var næsten udelukkende blevet undersøgt i relation til standby. Elforbruget til standby er steget betydeligt, og trods begyndende tiltag med henblik på at begrænse standby-forbruget har effekten hidtil været begrænset.
- Udviklingen inden for tv-området bidrager væsentligt til stigende elforbrug (og har dermed bidraget betydeligt til at modvirke det fald, der har fundet sted på andre områder). Mens elforbruget pr. apparat typisk er faldet for køleskabe, vaskemaskiner osv., er det ikke tilfældet for tv. Det skyldes især tendensen til stigende skærmstørrelse, men også længere brugstider, bl.a. fordi tv ofte bruges som ”bagtæppe”. Dertil kommer, at antallet af apparater har været stigende. Digitaliseringen af tv er også energikrævende som følge af anskaffelsen af settopbokse, hvor reguleringen af energiforbruget halter bagefter introduktionen af boksene. Endelig kan HDTV ventes at blive energikrævende.
- På computerområdet vokser elforbruget hurtigt både pga. et større antal apparater og længere brugstid. Heller ikke for computere er energieffektiviteten pr. apparat faldet. Det skyldes bl.a., at computerne hele tiden bliver kraftigere, så de kan køre mere krævende operativ- og sikkerhedssystemer, grafik mv., og at skærmstørrelserne stiger. Ganske vist er bærbare computere langt mere

energieffektive end stationære computere, men den hidtidige udvikling tyder på, at de bærbare supplerer snarere end erstatter de stationære.

Figur 1.
Sammenhænge mellem IKT-relaterede forandringer af hverdagspraksisser og konsekvenserne for energiforbruget



De mere detaljerede observationer fremgår af *Bilag 1: Households' ICT use in an energy perspective*.

Papiret har i første omgang været præsenteret som konferencebidrag til en konference i COST-regi om bredbåndssamfundet i 2007. Konferencen samlede forskere inden for IKT-området, og det var karakteristisk, at debatten om IKT-udviklingens konsekvenser for energiforbruget her var stort set fraværende. Papiret bidrog således til at introducere energidebatten i denne kontekst. Det er blevet publiceret først i Proceedings og er på vej i en antologi med udvalgte papirer fra konferencen.

Det indirekte energiforbrug

Projektets hovedfokus ligger på det direkte elforbrug, men det har også været vigtigt at sætte det i perspektiv ved at anslå størrelsen af det indirekte energiforbrug. Til dette formål er der udarbejdet et litteraturstudie, der systematiserer og sammenfatter de hidtidige studier. Litteraturstudiet indgår som *Bilag 2: Residential ICT related energy consumption which is not registered at the electric meters in the residences* og er i øvrigt tilgængeligt på nettet. Det mest overraskende resultat er, at problemstillingen er så underbelyst. Der er langt fra konsensus omkring, hvordan det indirekte energiforbrug skal opgøres, og der er stor spændvidde i resultaterne. Det er dog klart, at energiforbruget til fremstilling, transport og bortskaffelse af IKT-udstyr er betydeligt, og at det for produkter med kort levetid som fx mobiltelefoner er langt større end det direkte energiforbrug, og at tv-udskiftningen i forbindelse med digitaliseringen kan koste en del energimæssigt. Driften af IKT-infrastrukturen som serverparker og sendemaster er også energikrævende, så den virtuelle verden på nettet er ikke så immateriel, når det kommer til stykket. Tendensen mod stadig øget båndbredde bidrager også til at øge det indirekte energiforbrug.

På baggrund af de foreliggende studier er forholdet mellem det direkte og det indirekte energiforbrug sammenfattet i en modelberegning. Med udgangspunkt i en husholdning, der er udstyret med en stationær pc, en bærbar, en printer/scanner og et ADSL modem, og på baggrund af antagelser om 4 års levetid for hardware og en båndbredde på 2,4 Mbits/s, er det anslået, at når der bruges 1 kWh i boligen, så går der 1 kWh til at fremstille, transportere og bortskaffe udstyret og ½ kWh til at drive internettet og IKT-infrastrukturen uden for boligen. Dette resultat fik en vis opmærksomhed i medierne, jfr. afsnittet om formidling nedenfor.

Brugen af IKT i hjemmene

Det indledende oversigtspapir (Bilag 1) danner baggrund for det videre arbejde, idet papiret munder ud i en række spørgsmål til nærmere undersøgelse. Den empiriske undersøgelse drejer sig om, hvordan IKT bliver brugt i hverdagen, og den er baseret på 14 kvalitative interview med brugere i hjemmet (ud over hovedinformanterne har også 3 ægtefæller deltaget i interviewene; i alt 10 mænd og 7 kvinder). Dertil kommer 11 kortere telefoninterview foretaget som led i udvælgelsen af informanter. Undersøgelsen fokuserer på brugere, der har lang erfaring med brugen af IKT, har evnen til at tage nye anvendelser op og anvender teknologierne en del uden dog at være ”IT-nørder”. Hensigten har været at finde frem til brugere, der forholdsvis tidligt anvender IKT på måder, der efterhånden kan ventes at blive mere udbredt i større grupper af befolkningen. Da der er forholdsvis mange studier af unges brug af IKT, har vi fokuseret på de voksnes anvendelser. Interviewpersonerne er mellem 20 og 70 år gamle, har forskellig erhvervsmæssig baggrund og kommer fra forskellige dele af landet. Som baggrund for interviewet har informanterne udfyldt to skemaer over henholdsvis det udstyr, husstanden råder over (ud af i alt 40 typer), og de aktiviteter, som udstyret bliver brugt til (ud af i alt 48 aktiviteter fordelt på 10 grupper). I *Bilag 3* findes *spørgeguiden samt de to skemaer*.

Resultaterne af interviewene er rapporteret i to konferencepapirer, der her indgår som *Bilag 4: Domestication of information and communication technologies in an energy perspective* og *Bilag 5: Households' use of information and communication technologies – a future challenge for energy savings?* Begge papirer indgår i Proceedings.

De centrale observationer fra interviewene kan sammenfattes i tre punkter:

1. Kombinationen af IKT-udstyr og internet udgør en ny infrastruktur i hverdagen, og den bliver i stigende grad integreret i alle former for aktiviteter. Da computere i sin tid blev introduceret i hjemmene, blev de primært brugt til særligt afgrænsede aktiviteter som spil og tekstbehandling. Tilsvarende blev internettet brugt til kommunikation (email), og man talte om at ”surfe på nettet” som en særlig aktivitet. I dag giver det ikke længere mening at se brugen af computere og internet som særlige aktiviteter. Interviewene viser, at teknologierne efterhånden indgår som et aspekt af stort set alle tænkelige hverdagsaktiviteter – hjemmearbejde, uddannelse, husligt arbejde, husholdningens administrative opgaver, fritidsaktiviteter, politiske og organisatoriske aktiviteter. Interviewmaterialet er rigt på beskrivelser af, hvordan informanterne anvender IKT til mange former for fritidsaktiviteter, der ikke i sig selv udspringer af IKT.
2. Inddragelsen af IKT bidrager på forskellig vis til at ændre den måde, hverdagsaktiviteterne foregår på. Et af de mest karakteristiske træk er, at en given aktivitet som fx kommunikation med venner og bekendte bliver diversificeret – dvs. de gamle former for kommunikation bliver suppleret med mange nye former. På tilsvarende vis bliver fx måden at se fjernsyn på diversificeret.
3. Brugernes måde at inddrage IKT i deres hverdagsaktiviteter er til tider meget kreativ og åbner for anvendelser, der ikke er forudset af producenterne.

En ny fase i elektrificeringen af husholdningerne
Inddragelsen af IKT i så mange forskellige hverdagsaktiviteter indebærer en kraftig stigning i antallet af computere og i brugstiden. Det bliver i stigende grad standard at have mindst en computer per person i husholdningen, og mange har flere, fx både en stationær og en bærbar. I nogle tilfælde har husholdningerne også rum- eller aktivitetsspecifikke computere. Når computeren bruges tit, er det ikke praktisk at slukke den, og standby-forbruget er i mange tilfælde fortsat betydeligt. Dertil kommer, at der anskaffes en del specialiseret udstyr til forskellige praksisser, inkl. diverse mobilt udstyr, der bliver stadig mere udbredt.

IKT har også et potentiale for at fremme elbesparelser i husholdningerne, dels gennem bedre monitering af elforbruget, så brugerne bliver opmærksomme på elforbruget og på den måde stimuleret til at spare, dels gennem bedre styring og regulering af hjemmets energikrævende systemer. Imidlertid er disse potentialer fortsat overvejende fremtidsmusik, og projektets empiriske materiale giver meget lidt dækning for at fremhæve fremskridt på dette område.

Tabel 1 og Figur 2 illustrerer, hvordan sammensætningen af husholdningernes elforbrug har ændret sig over tid. Man kan sige, at husholdningernes anvendelse af el har gennemgået forskellige faser. I den første fase frem til omkring 2. verdenskrig blev el stort set udelukkende brugt til lys. I den anden fase, der tog fart fra 1960erne, kom anvendelser til opvarmning/køling og til kraft (drift af elektromotorer i alt fra støvsugere til vaskemaskiner) til at dominere. I 1980erne begyndte elforbruget til TV og andet underholdningsudstyr for alvor at vokse, og i 1990erne er computerne kommet til. Måske indvarsles der hermed en tredje fase i elektrificeringen af husholdningerne. Denne diskussion udfoldes i en artikel, der er accepteret til publikation i Energy Policy. Den indgår her som *Bilag 6: Information and communication technologies – A new round of household electrification*.

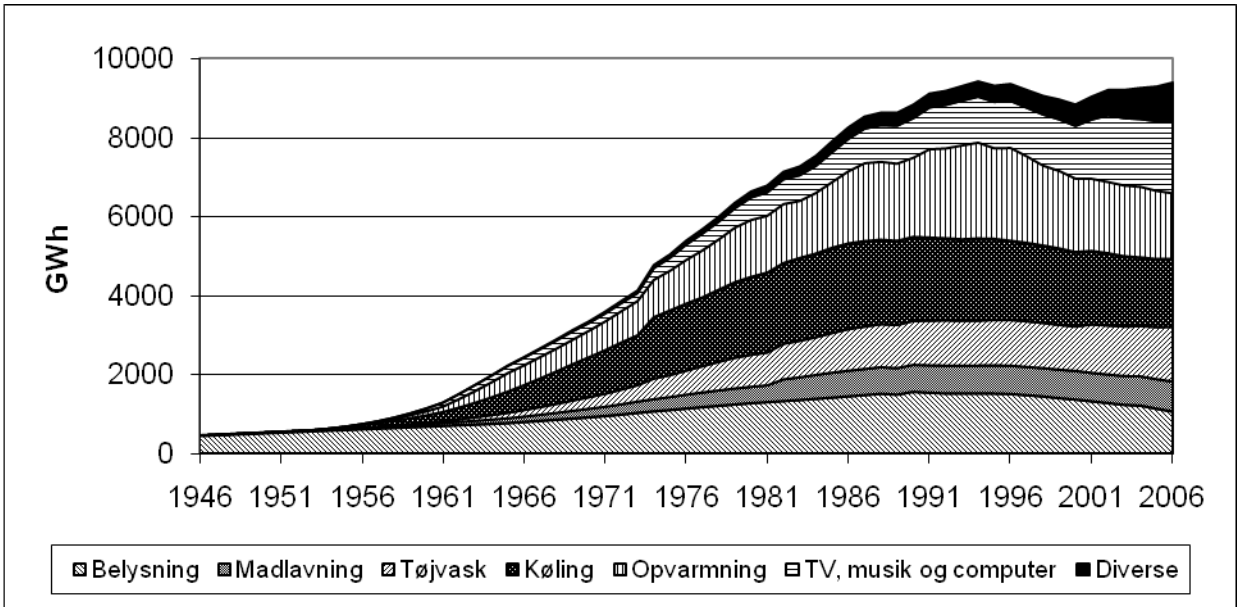
Tabel 1. Sammensætningen af husholdningernes elforbrug i procent, 1950-2006

	1950	1970	1990	2006
Belysning	**97**	**27**	**18**	**11**
Opvarmn. og kraft	**3**	**66**	**68**	**59**
Madlavning	3	6	8	8
Rumopvarmning	0	20	23	18
Køling	0	30	24	18
Vask	0	9	13	15
Diverse	**0**	**7**	**14**	**30**
TV, video, stereo	0	6	10	12
PC	-	-	1	8
Total	**100**	**100**	**100**	**100**
Energiforbrug i alt (GWh)	**522**	**3341**	**8841**	**9401**

Note: "Rumopvarmning" omfatter elektriske varmepaneler, elektriske vandvarmere og elforbrug i centralvarmesystemer (cirkulationspumper etc.). "Vask" omfatter vaskemaskiner, tørretumblere og opvaskemaskiner. "Diverse" omfatter meget forskelligt udstyr, inklusiv fjernsyn, video, stereoanlæg og computer.

Kilde: ELMODEL-bolig

Figur 2. Danske husholdningers elforbrug fordelt efter anvendelse, 1946-2006

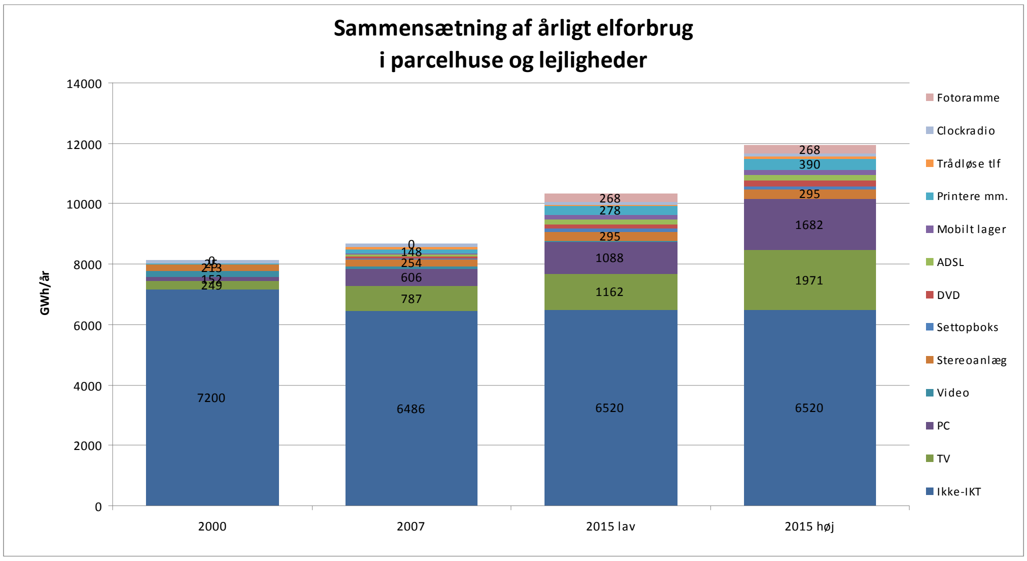


Kilde: ELMODEL-bolig

Scenarier

Resultaterne fra interviewene danner baggrund for udformning af nogle scenarier baseret på ELMODEL-bolig. Hensigten med scenarierne er at belyse de mulige konsekvenser for elforbruget, hvis nogle sandsynlige udviklinger i anvendelsen af IKT bliver realiseret. Formålet er ikke at forudsige, hvordan den faktiske udvikling bliver, men at opstille beregninger der kan stimulere den energipolitiske debat. Der arbejdes med to scenarier, hvor det ene er baseret på en forventning om fortsat kraftig vækst i bestanden af apparater og i brugstiden, mens det andet er baseret på en forventning om en mere moderat vækst. Som det fremgår af Figur 3, indikerer de to scenarier, at henholdsvis 37% (lavt scenarie) og 45% (højt scenarie) af de danske boligers årlige elforbrug i 2015 vil gå til IKT.

Figur 3.
Elforbrug fordelt på anvendelser, 2000-2015



Der er redegjort nærmere for scenarierne i en rapport, der er udkommet i SBi's rapportserie, og her foreligger som *Bilag 7: Elforbrug til IKT. To scenarier for elforbrug til informations- og kommunikationsteknologi i danske boliger 2015*. Scenarierne er også inddraget i konferencepapiret i Bilag 5.

Energirådgivning

Såvel interviewene som scenarierne viser et klart behov for en forebyggende indsats, hvis udbredelsen af IKT i hjemmene ikke skal føre til betydelige stigninger i elforbruget. Som baggrund for at diskutere hvordan en forebyggende indsats kan gribes an, er der som led i projektet gennemført en lille spørgeskemaundersøgelse af den eksisterende rådgivning af forbrugerne via energirådgiverne. Resultaterne af denne undersøgelse foreligger som *Bilag 8: Energirådgivning på IKT-området*.

Undersøgelsen viser bl.a., at kunderne er begyndt at henvende sig vedr. elforbruget til IKT, ikke mindst i forbindelse med standby-forbruget og brugen af udstyr, der er tændt hele tiden. Rådgiverne er selv interesserede i at få mere viden på området, og de efterlyser specielt mere viden om den aktuelle proces, der knytter sig til digitaliseringen af TV og de mulige energikonsekvenser heraf. Generelt mener energirådgiverne, at oplysningen til forbrugerne på området er mangelfuld, selvom Elsparefondens hjemmeside anbefales som et skridt på vejen.

Workshop om energibesparelser

Som led i projektet er der afholdt en workshop om mulighederne for at begrænse det energiforbrug, der knytter sig til husholdningernes IKT-anvendelse. Formålet var at bringe eksperter fra henholdsvis IKT-området og energiområdet sammen til en diskussion af dels den aktuelle status for energibesparelser på IKT-området, dels mulighederne for en fremadrettet indsats. Programmet for og referatet af workshoppen foreligger i *Bilag 9: Workshop om energibesparelser og husholdningers brug af IKT. Program og referat*. Også projektets følgegruppe har afholdt et møde, hvor de samme problemstillinger er blevet diskuteret.

Debatten blev struktureret med udgangspunkt i 4 temaer:

Tema 1: Forbrugere eller producenter. Hvilke tiltag retter sig mod forbrugerne på IKT-området? Får forbrugeren en mindre rolle når det gælder elbesparelser på IKT-området sammenlignet med andre områder? Og omvendt, rettes indsatsen i højere grad mod producenterne for bl.a. at mindske standby-forbruget?

Tema 2: TV-udskiftninger. Kan man sige noget om, hvilken strategi der for forbrugeren er den rigtige, hvis målet er at spare mest mulig energi? Findes der en viden om dette, som burde komme mere ud til forbrugeren?

Tema 3: Det afledte energiforbrug til IKT. Det indirekte energiforbrug vejer ofte tungt i en livscyklus-betragtning, men det indgår normalt ikke i de spareråd der gives til forbrugerne. Skal der gøres noget ved det, og i givet fald hvad?

Tema 4: Intelligente styresystemer: Er det vejen frem, som en måde at reducere energiforbruget i hjemmet med? Hvilke perspektiver er der på kort og på lang sigt? Er der nogen erfaringer fra brugere herhjemme endnu, fx fra intelligente hjem?

Den aktuelle status er ikke opmuntrende:

- Forbrugerne har meget ringe muligheder for at gennemskue energikonsekvenserne af IKT. Der findes ganske vist energimærkning af computere, men den har ringe

effekt i detailleddet. Der er nye mærkningstiltag undervejs, men processen er særdeles kompleks.
- Der er ingen energimærkning af tv eller af komplicerede settopbokse, og såvel digitaliseringen af tv som indførelsen af HDTV sker stort set uden indarbejdelse af hensynet til energikonsekvenserne.
- Der er stort set ingen opmærksomhed omkring det indirekte energiforbrug hverken i forhold til udskiftningshastigheder for udstyr eller driften af infrastrukturen.
- Der er potentialer for energibesparelser i det intelligente hjem, men der er også mulighed for yderligere stigninger i energiforbruget.

Workshop for energirådgivere
Projektets resultater er blevet diskuteret på en workshop for energirådgivere. I forlængelse af resultaterne fra undersøgelsen af energirådgivningen blev der ved workshoppen inddraget et ekspertoplæg om digitaliseringen af tv. Programmet for workshoppen fremgår af *Bilag 10: Workshop for energirådgivere*.

Formidlingsaktiviteter
Projektets resultater er løbende blevet formidlet i forskellige sammenhænge:

Videnskabelige konferencer inden for fagområderne IKT, energi og miljø:
- COST Action 298: konference om bredbåndssamfundet, maj 2007
- EASST: teknologisociologisk konference med session om teknologi og energi i hverdagslivet, august 2008
- ISEE: konference om økologisk økonomi med session om forbrug og miljø, august 2008
- ECEEE: energikonference med session om husholdningers energiforbrug, juni 2009
- COST Action 298: konference om bredbåndssamfundet, maj 2009

Inviterede oplæg til videnskabelige seminarer og workshops:
- Sigtuna, Sverige, marts 2007
- Manchester University, april 2009
- Linköping Universitet, maj 2009

Oplæg for administratorer, producenter og energirådgivere:
- To oplæg ved Bredbåndsdagene, september 2008
- Workshop om energibesparelser, september 2008
- Workshop for energirådgivere, marts 2009

I medierne har projektet fået omtale først i forbindelse med offentliggørelsen af litteraturstudiet af det indirekte energiforbrug i begyndelsen af 2009, hvor der især var opmærksomhed omkring skønnet over internettets energiforbrug. Senere har der været en del medieomtale i forbindelse med publicering af scenarierapporten i oktober 2009.

Perspektiver

Projektets primære funktion har været at belyse en udvikling, der er undervejs, og at fremme forståelsen af, at væksten i energiforbruget kan blive betydelig, hvis der ikke udvikles mere effektive politikker til at forhindre det. I den seneste tid er det blevet tydeligt, at stadig flere er blevet opmærksomme på koblingen mellem IKT og energiforbrug, sådan som det fx afspejles i de i Danmark afholdte OECD konferencer om Grøn IT. Inden for IKT-verdenen er der dog fortsat langt mere fokus på de optimistiske forestillinger om, hvordan IKT kan bidrage til at mindske energiforbruget gennem effektivisering af produktionen i andre sektorer og gennem strukturændringer, end på risikoen for vækst i energiforbruget knyttet til husholdningernes IKT-anvendelse. Den i indledningen nævnte rapport fra det Internationale Energi Agentur viser, at der inden for energiverdenen er langt mere opmærksomhed omkring denne risiko og behovet for en politisk indsats. Indtil videre koncentrerer den politiske indsats sig især om at forbedre IKT-udstyrets energieffektivitet gennem krav, der skærer de dårligste apparater fra, og gennem mærkning, der kan opfordre forbrugerne til at vælge de bedste apparater. Som det fremgår af bilag 9, er det imidlertid en lang og sej proces, før der for alvor kan ventes resultater. Som supplement til arbejdet med udstyret er der ført kampagner for at få brugerne til at begrænse standby-forbruget, men også her er der lang vej igen. I et fremadrettet perspektiv vil der være brug for at supplere de kendte typer af tiltag med grundigere studier af mulighederne for at udnytte potentialet for at opnå energibesparelser i hverdagen gennem brug af IKT: hvad består ”de grønne løfter” i, og hvad er betingelserne for deres realisering?

Bilag 1: Households' ICT use in an energy perspective

Households' ICT use in an energy perspective

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Introduction

The development of the information society has been and still is accompanied by enthusiasm and a strong sense of necessity, and the challenge for political and administrative institutions at all levels is to increase the pace of the development and remove all hindrances. The necessity springs from the drive for competitiveness and the emergence of new business opportunities in the so-called "experience economy". At the same time, other parts of the political and administrative system are concerned about environmental issues, not least, due to the prospects of global warming. Information and communication technologies (ICTs) offer both potentials for energy savings and increasing demand for energy use, so there are good reasons to bring together these two agendas. In the early 1990s, the first studies on the positive environmental prospects of ICT emerged (Freeman, 1992), and the first steps were taken towards regulating ICT energy use. Since then, the importance of ICT in relation to energy consumption has had some interest, but still the two agendas tend to develop in relative isolation, and there is still a long way to go before they are really brought together (Alakeson and Wilsdon, 2003, p. 10).

This paper is intended as a contribution to considering ICT in an energy perspective. ICTs have many other environmental impacts than those related to energy, but they are only included in so far as they influence the energy impacts. The point of departure is the integration of ICTs in households, and the energy impacts of changing household practices are discussed. Most studies of ICT and energy have concentrated on macro scenarios or the prospects seen from the production side, so households have not received much attention. In this context, the paper has an explorative character, and it is based on a combination of literature studies, discussions with experts, and a visit to the "digital home" in Taastrup, Denmark. The data used in this paper mainly refer to Denmark. The main interest is to provide a basis for further in-depth studies of households, and for more proactive political approaches dealing with the energy impacts of ICT. The intention is not, however, to quantify the complex relations between household ICT use and the related energy impacts, outline scenarios for future developments, or to assess whether ICT development in households is good or bad in an energy perspective. The integration of ICT in household practices is a fact; thus, it is less important whether the net energy impact is positive or negative than it is to find ways to avoid the negative impacts and encourage the positive. The purpose of the paper thus fits into the discussion of humans as e-actors: On the one hand, the ICT-related environmental impacts influence the quality of human life, and on the other hand, the activities and behaviour of humans as e-actors co-produce these impacts. As e-actors, we influence whether the positive or negative impacts on energy consumption become dominant; therefore, it is important to discuss ICT-use in an energy perspective to find out what we can do, individually and collectively.

In the following, some of the previous studies on ICT and energy are briefly mentioned, and the consumption approach is related to these. Secondly, the integration of ICT in everyday practices and the dynamics behind the changes are outlined, inspired by a historical perspective. Thirdly, a figure illustrating the relationships between everyday practices and the related energy impacts is presented, followed by descriptions of energy impacts directly related to ICT in households, indirect impacts outside households, and derived impacts both within and outside households. The paper concludes with some remarks on political implications and questions for further research.

Previous studies and the consumption perspective

Early studies on the emergence of the information society tended to emphasize the positive potentials related to ICTs, such as the possibilities for increased production efficiency in most sectors (Freeman, 1992); this is still central to more recent studies, although rebound effects come much more to the fore (Berkhout and Hertin, 2001; Hilty et al., 2005; Jørgensen et al., 2006). Furthermore, it is emphasized that the Internet opens opportunities for information sharing in business and academia with regard to environmental issues (Richards et al., 2001, see also a European series of conferences under the heading Informatics for Environmental Protection), and corresponding positive effects are identified in relation to consumers and environmental NGOs (Reisch, 2001).

Gradually, the enthusiasm was supplemented with more discussion on the problematic environmental impacts of ICT. Before the entry of ICTs, offices were usually considered less important when energy requirements were calculated, but since the late 1980s, offices were seen as energy consuming places. Both for economic reasons and in consideration of the environment, more attention turned towards energy savings (e.g. in 1992, the U.S. EPA introduced the Energy Star labelling for office equipment). In the late 1990s and early 2000s, a heated discussion took place in the U.S. in the wake of some provocative statements concerning the high electricity consumption of ICT equipment, titled *Dig more coal – the PCs are coming* (Huber and Mills, 1999). The statements were repudiated by many other researchers, as can be seen from the summary of the debate at http://enduse.lbl.gov/projects/infotech.html, where links can be found to the many contributions; short summaries can be found in Laitner (2003) and Cole (2003).

Other studies go beyond electricity and include both direct and indirect environmental effects of ICT use, including various categories of rebound effects, for instance (Erdmann et al., 2004; Hilty et al., 2005; Plepys, 2002). In Berkhout and Hertin's study for the OECD on the environmental impacts of ICT (Berkhout and Hertin, 2001), summarized in (Berkhout and Hertin, 2004), they distinguish between direct effects, indirect effects, and structural and behavioural effects of ICT. Direct effects stem from the production, use and disposal of hardware; indirect effects concern efficiency improvements in production processes and in design and operation of products and services; whereas structural and behavioural effects are a mixture of rebound effects and effects related to increased consumer information. Berkhout and Hertin argue that the direct effects are mostly negative, whereas the indirect efficiency effects are largely positive, and the structural effects (including rebound effects) are highly contested. Related categorizations are used in other studies, e.g. in the foresight study by Jørgensen et al. (2006) and in Hilty et al. (2005).

In most macro studies on ICT and environment, consumers play a very minor role. This role is mostly related to the indirect, structural level where the positive potential related to behavioural change is emphasized. In particular, teleshopping and teleworking are pointed out as having a potential for energy savings related to transport (just as business travel is expected to decrease because of videoconferencing). However, in studies focusing on electricity, consumers are becoming more visible (Aebischer and Huser, 2000; Aebischer and Varone, 2001; Cremer et al., 2003; Roth et al., 2006), and small sections on ICT emerge in reports on consumption and environment (European Environment Agency, 2005).

Consumers have been most visible in relation to the discussion of standby electricity use, beginning in the early 1990s (Sandberg, 1993). Since then, the energy efficiency conferences ACEEE (www.aceee.org), ECEEE (www.eceee.org) and EEDAL (http://re.jrc.ec.europa.eu/energyefficiency/events/eedal2006.htm) have had workshop sessions on standby consumption. Papers have focused on measurements of the size of ICT-related energy consumption in households (Harrington et al., 2006; Roth, 2006) and have discussed how to agree on standards, which can be useful for energy labelling and other types of product regulation (Jones, 2006; Murakoshi et al., 2005). However, standby consumption in households has increased steadily, and internationally, it is estimated to represent 4-11% of the total electricity consumption (Meier, 2005). Standby consumption can be reduced by encouraging producers to develop appliances using less energy, or by getting users to turn off the appliances instead of leaving them on standby. Internationally, the former has received by far the most attention, and this would also be the most efficient if it were successful. In 2005, however, only Japan had compulsory programmes concerning standby, whereas both Europe and USA worked with voluntary agreements (Meier, 2005). Although progress is seen, regulation and standardization is difficult because of the rapid technological development (IEA, 2001).

Nationally, there have also been campaigns targeting consumer behaviour. A Danish study (Gram-Hanssen and Gudbjerg, 2006) indicates that some households quite easily change routines and are able to eliminate the majority of their standby consumption, while others find it more difficult as they have expectations of being online all the time, and their appliances are connected to each other.

In this paper, the intention is to go beyond the relatively narrow roles assigned to consumers in studies on ICT and energy. There is a need for paying more attention to consumers, first of all because ICT is increasingly integrated in everyday life. Furthermore, a consumption perspective can highlight aspects that complement the aspects brought forth when focusing mainly on production, thus also opening up new opportunities for managing the energy impacts. In general, when a production perspective is the point of departure in environmental studies, technological changes tend to be perceived in terms of solutions, because technology can contribute to efficiency improvements. In spite of the increasing awareness of rebound effects, the perspective tends to be mostly optimistic. This differs from the consumption perspective, where new technologies are only in exceptional cases introduced to improve, for instance, the energy efficiency of household activities. New technologies serve as drivers behind consumption growth and will as such contribute to increasing environmental impacts (Røpke, 2001; Røpke, 2003). From this perspective, efficiency improvements become a modification of the main effect. The consumption perspective thus tends to bring the more problematic aspects of technological change more directly into focus – since they are not relegated to the position of rebound effects.

The organization of the paper is inspired by the studies mentioned above and considers different levels of effects (Berkhout and Hertin, 2004; Jørgensen et al., 2006). As the perspective of this paper is more narrow than those studies, the same categories are not directly applicable, but a related way of thinking is reflected in a three level categorization of the energy impacts related to ICT use in households. The impacts are thus grouped as follows:

- *Direct energy consumption* (mostly electricity) related to the use of ICT equipment in household practices, both in the dwelling and on the move.
- *Indirect energy consumption* related to the provision of households' electricity consumption, the production and disposal of ICT equipment for household use, and the running of the infrastructure, such as sending masts and servers. The term "indirect" is thus used here as it is usually used in the energy literature, rather than in the way used in ICT studies.
- *Derived energy impacts* relate to changes in the composition of consumption and in behavioural patterns influencing households' energy consumption as well as systemic energy consumption.

The two first categories of energy consumption tend to increase when the amount of equipment is increased, although this can be counteracted by increased efficiency of new equipment. In the third category, more positive impacts can be expected to dominate, such as those related to equipment installed to manage heating and lighting in the dwelling in an energy-saving way – however, the outcomes in this category will be highly contested. This category also covers the effects of teleshopping and teleworking for energy consumption of both households and the wider system. The term rebound effect is not used in this categorization, because the term is attached to the indirect effects of a change that is motivated by environmental concerns (rebound effects in consumption are discussed by Hertwich (2005). In relation to a few cases, it could be relevant here to talk about rebound effects – for instance, in the case of energy-saving heat regulation, which might save money that can be used for more energy-consuming purposes – but few of the ICT acquirements are motivated by environmental concerns, so this is omitted here.

The integration of ICT in everyday life

As a basis for dealing with the energy impacts of household ICT use, this section focuses on the ongoing process in which ICTs gain access to everyday life. The process is seen in the perspective of the history of technology, as this indicates the sweeping character of the changes.

In some respects, the integration of the computer in everyday life can be compared to the integration of the small electromotor. When the electromotor was introduced, it became integrated in a wide range of domestic appliances and tools – vacuum cleaner, mixer, refrigerator, washing machine, dishwasher, air conditioning, drilling machine, tooth brush. The electromotor could replace muscular strength and transmit energy for heating and cooling, and innovators searched for all conceivable possibilities for developing devices applying this new technology. The motor became part of the thorough transformation of household work, the near disappearance of domestic servants, and the increasing participation of women in the labour force (Cowan, 1983; Olesen and Thorndahl, 2004). The point is not that the electromotor was driving all these changes, but it became integrated in the ongoing social processes and was put to uses formed by the social dynamics. Thus, Cowan emphasizes how the technology could have been used in other ways with different social outcomes, such as collective solutions to household chores, if the social and cultural dynamics had been different. The computer has a general applicability comparable to the electromotor and can be integrated in practically all everyday activities. The computer replaces or enhances brain capacity – the ability to calculate, manage, communicate, and regulate – a quality that can be used everywhere. Presently, innovators are searching all conceivable possibilities for applying this new technology in appliances, tools, and devices that can be tempting for consumers and fit into their topical concerns and desires.

The computer is not only connected to the electricity net (directly or indirectly through batteries), like the electromotor, but can also be connected to networks of communication, including the Internet, the so-called motorway of information. The Internet introduces a new infrastructure that calls for comparisons with the introduction of electricity, telecommunication, broadcasting, and even the water supply and sewerage systems. When developing these large technological systems, many actors and interests are involved and contribute to the co-evolution of technologies and use patterns. When such a system is stabilized, it becomes an unacknowledged basis of everyday life – one more system that we are served by and serve on a daily basis (Otnes, 1988). The Internet has not yet acquired this status of unacknowledged basis of everyday life, but the new possibilities for acquiring information and entertainment and for communication are increasingly being integrated in all conceivable activities, driven by both commercial and political-administrative interests and by users themselves.

Furthermore, the present co-evolution of technologies and everyday life is characterized by increasing mobility. This trend can be seen as a continuation of previous efforts to make all sorts of equipment available for activities on the move, such as the portable gramophone, the portable typewriter, the transistor radio and all sorts of equipment for the car and the camping trip. The mobile phone is probably the most successful innovation ever in this line of mobile appliances, and Levinson (2004, p. 13) argues that this follows from the basic human need to talk and walk. Since in large geographical areas the mobile phone is combined with wireless access to the Internet, then the mobile encyclopaedia, mobile library, and mobile entertainment centre are available as well. The development of wireless connections and better batteries permit more and more activities to be carried out on the move, gradually reducing the difference between what can be done at home and on the move.

These general observations are reflected in the ongoing integration of computer, Internet, and mobile phones in numerous everyday practices. The pervasiveness of these technologies can be illustrated with examples from the different spheres of everyday life. The use of computer and Internet is increasingly integrated in:
Work and education: Telework, e-learning, ordinary school work, well-equipped home offices, video conferences.
Reproductive work: Shopping, banking, public services, health monitoring, the intelligent home (regulation of heating, lighting, security systems), security, child care (entertainment, monitoring), cooking (find the recipe), do-it-yourself (exchange experiences, find information). Computer and Internet also add a new task to the list of reproductive activities, namely ICT maintenance, just as the car once added the task of car wash.
Leisure: Social communication, entertainment, games, creativity, documentation, hobbies, gambling, sex.
Civil society: Organizations, political activities.

Theories concerning the formation of practices in everyday life point out three constituent aspects of a social practice: The competences needed to carry out the practice, the material devices used for the activity, and the meaning attached to it (Shove and Pantzar, 2005; Warde, 2005). This theoretical framework has been used to discuss the formation and change of specific practices, but it can also be used to illustrate more general dynamics cutting across many practices. ICT is an example of generic technological change – a change of basic technologies influencing all sorts of applied technologies – which provides a supply of renewed material devices for many different practices. Simultaneously, these practices are influenced by changes in the other two constituent aspects, as technological change co-develops with changing discourses that offer new meanings to various practices, and with the development of training in the use of the new technologies. In Figure 1 (next page), the three constituent aspects are illustrated in the top part of the figure, surrounding everyday practices. For all three aspects, government regulation, subsidies, campaigns, and other activities play a decisive role alongside the governance enacted by the firms and organizations involved – for instance, in the provision of safety, standards, business models, and training, as well as in influencing the discourses through reports on the need for keeping up in the competitive race, the prospects for experience economy, and the potential for using ICT in various sectors.

In the formation of everyday practices, the ICT-related dynamics meet with other social dynamics related to dominant social concerns and trends of the time. Examples are the long-term trend towards individualization and personal independence, the discourse on busyness, stress and the balance between work and family life, and the preoccupation with body and health. In Figure 1, these cross-cutting trends are mentioned within the box of everyday practices. In relation to each specific practice, many other, more detailed concerns will be important.

Direct energy consumption

The most immediate energy impacts of the integration of ICT in everyday practices are visible in household electricity consumption. Still this impact is not large compared to other categories of energy consumption in households, but it is increasing. Denmark has been particularly successful with regard to decoupling household energy consumption from economic growth. From 1990 to 2005, household energy consumption increased only 4.4%, but electricity consumption for lighting and appliances increased 18% (Energistyrelsen, 2006). Most electricity is used for white goods, but the importance of media technologies, including TV, video, computers and related equipment, is increasing. Presently, approximately 20% of electricity consumption is used for media equipment, and about half of this is used for standby (Gram-Hanssen, 2005).

As illustrated in Figure 1, energy consumption related to the use of ICT depends on the quantity of ICT equipment, the energy efficiency of this equipment, and the patterns of use, that is, the number use hours, the time on standby, and the intensity of use (the energy consumption of some appliances depends on the kind of use). In the following, some of the present trends influencing electricity consumption will be highlighted.

Presently, television and video weigh more heavily than computers, and in the near future, a particular burst of energy consumption can be expected in relation to the digitization of television and the diffusion of HDTV, High Definition TeleVision. The increasing energy consumption is related to the need for set-top boxes that can be combined with existing TV sets or are integrated in new sets. In spite of increasing interest in keeping down energy consumption of TV sets, little interest has been directed towards set-top boxes, and many

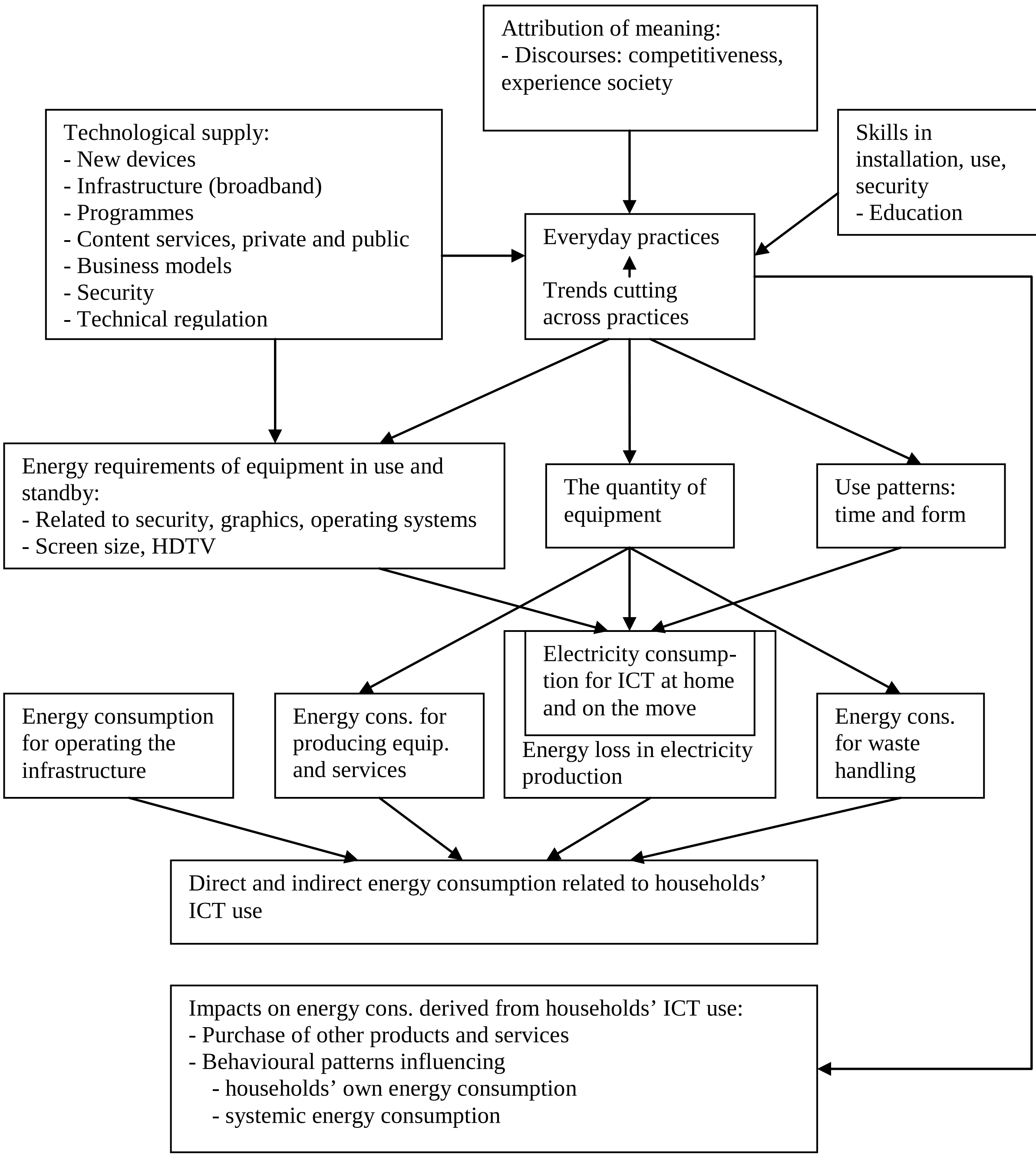

Figure 1. Relations between ICT-related changes of everyday practices and the ensuing impacts on energy consumption.

models are rather ineffective. Since the stock of TV sets is large - nearly one set per person (Energistyrelsen, 2006) - and since many people have to follow suit, if they want to watch television (except for a large group connected to cable TV who can carry on as usual), the impact can be expected to be considerable. Of course, digitization can be an opportunity to replace older energy-consuming models with newer and more energy-effective models (LCD (Liquid Crystal Display) flat screens are more efficient than the old CRT (Cathode Ray Tube) screens); however, replacements are often combined with increasing screen size, counterbalancing the efficiency improvements. The interest in so-called home cinema equipment has increased, including acquirement of plasma screens, which are particularly energy-consuming. TV sets prepared for receiving HDTV are also more energy-consuming, because of the higher resolution. Instead of following the trend towards increasing average efficiency exhibited by white goods, the average efficiency of TV sets has been relatively stable and even decreased a little (Energistyrelsen, 2006). As mentioned, the number of TV sets is already very high, but the diffusion of flat screens might increase the number further, as these screens are easy to place everywhere, bringing TV into kitchen and bathroom and adding to the use of TV as a kind of "background" for other activities.

Digitization of television does not seem to be directly related to any profound changes in the practice of watching television. The quality of the picture improves, and it is possible to turn on subtitles in various languages. When digitization is combined with the use of media centres / harddisk recorders, the opportunities for flexibility are increased, as programmes can be shifted in time more easily than with the use of video and DVD. Visions regarding interactive television are discussed (Jensen and Toscan, 1999), but it still remains to be seen whether practices change more profoundly.

While television is bound to a particular practice, computers and Internet are integrated in a wide variety of practices. The increasing energy consumption related to computer and Internet springs from the integration in an increasing number of practices and the ensuing increase in time use and amounts of equipment. When time use at the computer increases, household members increasingly demand their own computer so they do not have to wait for their turn. The demand for individual independence that is well-known from the acquisition of TV sets now makes itself felt for computers – that each person should have his or her computer seems obvious for younger generations. A less developed trend – which might become more important in the future – is the emergence of activity-specific or room-specific computers - for instance, specially equipped computers for use in the kitchen, the bathroom, or in the garage, where conditions may be tough.

Due to rapid technological change and ever more advanced applications, there is not only a demand for more computers, but also for ever more powerful computers and other ICT equipment. Demand thus increases for:

- higher quality, such as larger screens with better resolution
- more processing power, needed e.g. to run the latest versions of operating and security systems and the advanced graphics in games
- more data storage capacity, needed for the increasing amounts of photos, videos, sound files, mails
- larger bandwidth, needed for video-streaming and for upstream P2P (peer to peer) file-sharing of videos and music.

These changes constitute a strong force counterbalancing improvements in energy efficiency.

Seen over a long period, various factors have influenced the energy efficiency of computers (based on Cole, 2003). To increase the processing power of computers without increasing the size, heat reduction was necessary, and this stimulated efficiency improvements. With the introduction of laptop computers energy-saving was encouraged because of the desire to increase battery life, and the advances for laptops were later brought into desktop computers; this was the case, for instance, for built-in power management, which was brought from laptops to desktop computers in the early 1990s. The U.S. conservation programme, Energy Star, strongly encouraged further improvements, so from the mid-1990s, standby consumption decreased drastically, and impressive savings were achieved in business offices in the U.S. However, the power levels in operation did not change much, because the efficiency improvements co-developed with more powerful microprocessors, more memory, and more disk storage. The monitor part of the computer became more energy-intensive in the 1990s, because of the almost universal shift to colour screens and larger screens with higher resolution. However, over a more extended period of time, the shift from CRTs to LCDs saves energy.

Since modern computers are very diverse due to consumer-specified features, the power requirements vary so much that it can be difficult to assess the general trend (Cole, 2003, p. 138). Danish data indicates that the average new desktop computer does not require less energy in operation than computers a few generations older (T. Fjordbak Larsen, pers. comm.). However, an increasing number of new computers are laptops, and they are more energy-effective than desktop computers. In 2006, for the first time, the number of laptops sold in Denmark exceeded the number of desktop computers. This can be an energy-saving trend, if the laptops replace the desktop computers, but it is difficult to assess to which extent the laptops are additions rather than replacements. Desktop computers are still cheaper in terms of processing power per dollar, so a person interested in playing games or carrying out other demanding graphical activities will often prefer a desktop. Furthermore, it is easier to extend a desktop computer with supplementary graphics cards or other peripherals.

Power management functions offer good opportunities for energy savings, but they have to be activated. This is not always done, either because of lack of knowledge or because of technical difficulties related, for instance, to network connections and coupling to other equipment.

The question of complementarity versus substitution in the case of laptops and desktops can be raised in a more general context. In many cases, ICT equipment incorporates a variety of functions and can, in principle, replace other, more specialized appliances. An example is the camera phone, which can render the camera superfluous. However, the camera in the mobile phone cannot provide the same quality and capacity as the dedicated camera; therefore, the camera phone may become part of a diversification process rather than part of a rationalization of the number of appliances. Another example is the combined printer-scanner-copy machine, which can reduce the number of appliances attached to the computer. However, it is expensive to run a scanner because of the need for colour cartridges, so it can be cheaper to invest in a supplementary laserprinter for printing texts.

The trend towards diversification of equipment seems to be strong, as reflected in the wide variety of available devices advertised in magazines. Not the least in regard to mobile devices, the supply is widening as more mobile functions become available. Rapid technological change implies that multiple generations of equipment co-exist (such as tape recorders – CD players – MP3 players, and video – DVD – hard disk recorders). Consumers thus tend to have an increasing number of small and/or supplementary devices, often related in various ways to the core products – the computer and the TV set. The direct energy consumption of each of these devices in the use phase is usually not large (except for standby consumption that can be high for some products), but the sum of the small contributions may be significant. Adding to this is the phenomenon that less attention is focused on the energy consumption of the peripheral devices than on the energy-efficiency of the computer and the TV set. One reason may be the quick renewal rate, which does not allow producers to pay much attention to optimizing energy-efficiency; and another reason may be the lack of regulatory attention, partly due to the difficulties related to regulating products that are changing so quickly.

A particular trend adding to ICT-related energy consumption emerges from the phenomenon of multi-tasking. Especially young people are able to manage computer, television, music centre, mobile phone, and the electric guitar – all at the same time. A Danish study thus demonstrates the high electricity consumption by teenagers (Gram-Hanssen et al., 2004). Older generations may be less able to multi-task, but they are able to install systems that use electricity without anybody being present, such as surveillance cameras and other security systems. One of the visions related to the "intelligent home" is the possibility of communicating with the security systems at a distance (for instance, opening the door for the postman bringing a parcel or the plumber coming to repair an installation in the house).

The "intelligent home" is based on a network infrastructure in the house and a central server (sometimes more than one) with Internet connection. Running the central infrastructure can be very energy-demanding, as an early study indicates (Huser and Aebischer, 2002). Presently, few people have realized this idea, but the increasing number of servers, routers, wireless networks etc. in homes illustrate that a pro-active approach would be highly relevant to avoid large increases in energy consumption.

As part of the trend towards so-called pervasive computing, electronics is increasingly added to manage such electric equipment as white goods, cookers, and cooker hoods, and RFID tags are about to be integrated in many other goods. This will add to the problems with electronic waste, but it is difficult to assess the energy impacts.

Finally, it is worth mentioning that the search for new ways of using ICT has resulted in more functions using energy in the use phase – functions which were previously carried out without energy consumption in the use phase. Examples are the electronic diary and shopping list, maps for navigation, photo frames showing digital pictures, and surveillance.

Summing up, the increasing direct energy consumption related to ICT equipment has many sources. The effect of increasing quantities of equipment and of more time spent on activities using ICT is difficult to counterbalance with efficiency improvements, especially because the equipment in itself becomes more powerful, and because in some cases the attention on energy-efficiency is limited.

Indirect energy consumption

Relatively few data are available for elucidating the indirect energy consumption related to household use of ICT, but it is possible to give a broad outline.

The first component of the indirect energy consumption relates to the provision of the electricity used for operating the household equipment. This component differs between countries in accordance with the efficiency achieved in electricity production. Due to a high degree of combined power and heat supply, this efficiency is relatively high in Denmark. This component of the indirect energy consumption is thus only about the same size as the direct electricity consumption.

The second component relates to the energy used for the production of ICT equipment. For desktop computers used at home, Kuehr et al. (2003, p. 4) estimate that more energy is needed to produce the machine than to power it during the use phase – contrasting sharply with other durable goods like refrigerators, where relatively much more energy is needed in the use phase. Later estimates (e.g. Jönbrink and Zackrisson, 2007) suggest that energy consumption in the use phase for computers is about two to three times the energy needed for manufacturing (the different results are probably related to both increased use time per computer and increased production efficiency), but this is still far from the proportions that are characteristic for other durable goods.

For mobile phones, the economic life is very short (the average service life for mobile phones in Europe is estimated to be one year), and this makes the relative importance of the energy consumption in the production phase even greater (Jönbrink and Zackrisson, 2007; Legarth et al., 2002). In general, the rapid rate of renewal for ICT equipment implies that energy use for production is a very important category.

The third component relates to waste handling. The high-tech parts of computers and other electronic equipment are difficult to recycle, while the bulk materials like steel and aluminium are easier to handle (Klatt, 2003). Recycling processes require energy, but as they provide materials that can substitute virgin materials requiring more energy to extract, the net result is usually positive. Overall, the energy aspect of waste handling is negligible, whereas the problem with toxins and working environment are huge (Hilty et al., 2006; Jönbrink and Zackrisson, 2007).

Finally, the fourth component relates to the operation of the ICT infrastructure. Few studies are available, but they indicate that the issue is important (e.g. Hille et al., 2007). A recent report from IDC illustrates the enormous growth of digital information and the need for storage capacity, not only at user level but also for service providers such as Google (Gantz et al., 2007). Some service providers run large parks of servers, so services that appear to be virtual – immaterial – from a user perspective can be based on quite extensive material investments. The virtual world of “Second Life” thus has a material basis in the servers of Linden Lab. Running the base stations in the UMTS-network for mobile phones also requires much electricity (Emmenegger et al., 2006), and in general, the increasing number of mobile devices with Internet access will add to the energy consumption of the infrastructure.

Derived energy impacts

While both direct and indirect energy consumption tend to increase when the number of appliances and the time spent using them are increased, the derived energy impacts are more likely to be positive. Most obviously, ICT can be used directly for energy savings. Thus, ICT can be used for managing heating and lighting in the dwelling (lowering of the temperature at night, sensors turning off the light when nobody is in the room), and ICT can also make it easier for households to monitor their energy consumption and thus encourage savings. The Danish Electricity Saving Trust estimates a potential for electricity savings from 10 to 30% in households by using intelligent building systems to control the electric equipment. For instance, in summer cottages, heated by electricity and only used occasionally, using such systems has a large potential for reducing consumption; however, today, existing systems are too expensive due to a lack of competition, and also the standards are closed, meaning that they cannot communicate with the electronic equipment of existing systems (Ingeniøren newsletter, 21.04.2006).

Also, the Internet can be used for making available relevant information on energy savings, as can be seen, for instance, at the homepage of The Danish Electricity Saving Trust http://www.elsparefonden.org/ and the recently initiated public campaign to encourage people to help save one ton of CO_2. While these impacts are positive in an energy perspective, it should not be overlooked that the Internet, in an analogous way, can encourage energy-intensive consumption – for instance, by making available new options for booking cheap flights and finding exotic travel destinations (Reisch, 2001).

While it is relatively simple to see that ICT can be used for energy-saving purposes, it is far more complex to consider the effect on the various practices into which the use of ICT becomes integrated. In some cases, the use of ICT is just an "add on", where more equipment is added to well-known activities that are not much changed. An example can be the use of a "running computer" for monitoring one's training efforts; such an addition does not change the practice of running in ways that has an impact on energy consumption. The same goes for quality improvements, such as larger screens, HDTV, and better graphics in game consoles.

In other cases, practices are changed more profoundly by the integration of ICT. Environmental improvements, including energy savings, have been expected from such changes, especially in relation to teleshopping, teleworking, and the replacement of material products such as newspapers and CDs by Internet-based services. Jørgensen et al. (2006) summarize a number of studies on telework and transport. Whereas some of the early studies were very optimistic with regard to the potential for energy savings, more recent studies emphasize that a substantial part of the transport savings are counterbalanced by increased transport for other purposes and increased transport by other family members. In general, the results regarding structural impacts are highly sensitive to system boundaries, and are dependent on behavioural assumptions. Studies are often inconclusive, because it is difficult to know, for instance, whether people will continue to shop in stores, even though they buy some things via the Internet, and whether they will move further away from their workplace to take advantage of lower property prices when they work at home part of the week.

Supplementary to the discussion on derived impacts in relation to individual practices, it is possible to raise the issue from a more general perspective: If consumers tie their money and their time to the acquirement and use of ICT, then less money and time are available for other purposes – and the question is, whether these other purposes are more or less energy-intensive per monetary unit and/or per unit of time. It may seem surprising that the question is raised in terms of both money and time, as one of these two perspectives could appear to be sufficient, particularly if an economic maximization model is applied (Linder, 1970). However, in practice, both time and money constitute limitations on consumption, and institutional constraints imply that the two factors cannot be reduced to the one or the other. To start with the monetary perspective, the acquirement of ICT equipment and services takes up an increasing share of consumers' income. In general, competition on hardware keeps prices down and energy intensities high. In some cases, service providers have succeeded in keeping high prices due to monopolistic or oligopolistic market conditions, which implies a relatively low energy intensity per monetary unit (examples are charges for telephoning, Internet access, and packages of television programmes). However, public regulation is quite active with regard to breaking the monopolistic tendencies, not only because of the general wish to promote competition, but also because of the particular interest in developing the information society. A recent project thus demonstrates that the energy intensity of ICT-based leisure activities is relatively high (Hille et al., 2007, p. 166-67).

From the perspective of time, it is worth considering whether the integration of ICT tends to take up time that could have been used for other purposes, or whether, on the contrary, time is freed for other purposes. If, for instance, reproductive activities, such as paying the bills, shopping, and contacting the taxing authorities, can be carried out in a shorter time by using the Internet, then time is freed for either working more (and earning more money) or having more leisure time (where money can be spent). Also, activities usually considered to be leisure, such as planning holiday travels, can be accomplished more effectively, thus freeing time. Multi-tasking and accomplishing tasks on the move can add to the productivity increase. On the other hand, the Internet is known to be time-consuming. One can become absorbed in surfing and sidetracks, thus reducing the time available for other activities and related consumption.

It is difficult to conclude anything regarding the consequences of the changing composition of time use and consumption in the wake of ICT integration in various practices. But it can be argued with more certainty that the supply of ever-changing ICT and the integration of ICT in a wide variety of products and practices serve as part of the motor driving consumption growth. It is difficult to imagine the achievement of any kind of satiety in this dynamic setting.

Concluding remarks

As emphasized in the introduction, the intention of this paper is not to assess whether the integration of ICT in household practices is good or bad in an energy perspective. In any case, the issue is so complex that even very elaborate studies would hardly be able to lead to any decisive conclusions. It is more important to find ways to avoid the negative energy impacts of ICT development, and to encourage the positive impacts. The issues dealt with in this paper suggest various ways in which the net result can be improved:

- The indirect energy consumption, especially that which is related to the production of ICT equipment, carries great weight. Therefore, "The simplest and most effective way to reduce environmental burden may be to ensure that users need fewer new PCs in the first place", as Kuehr et al. (2003, p. 14) argue. In chapters 8, 10 and 13 in their anthology it is discussed how the lifespan of computers can be extended through more effective used-computer markets, smooth transfer of software licenses to secondary users, and easier ways to upgrade computers. The issue of lifespan extension is highly relevant, also for other ICT equipment and not least for mobile phones.
- Power management functions are important for electricity consumption in the use phase, and it is still highly relevant to focus on the reduction of standby consumption, both by technical means and through changed patterns of behaviour.
- Digitization of television should be complemented with intense campaigns for the choice of energy-efficient replacements.
- The focus on the energy use of the core products, the computer and television, should be broadened to also include the wider range of ICT equipment.
- Economic considerations have not been the focus of this paper, but it should be mentioned that the net energy impact of ICT use is influenced by the price of energy. For instance, there is a potential in using ICT for energy savings, and the realization of this potential depends, at least partly, on energy prices. The price of energy for transport is also decisive with regard to the derived impacts - for instance, whether people decide to move further away from their workplace when they have the opportunity to telework part of the week. In

short, price incentives, as well as other incentives not directly related to the technology, influence the net energy impact of ICT use.

The above suggestions relate to direct and indirect energy consumption, whereas it is much more difficult to consider how positive energy impacts can be encouraged and negative impacts prevented when focus is turned to the derived impacts. To improve the basis for elaborating suggestions for a pro-active approach to ICT-related energy consumption, further in-depth studies of household ICT use could be useful. Such studies could deal with questions such as:

- In which practices are ICT becoming integrated? For which household members?
- In which cases does the ICT integration serve as an add-on to previous ways of carrying out the activities, and in which cases do the activities change more profoundly?
- Does the use of ICT save time, for instance, in relation to shopping, banking transactions, and enquiries to public authorities?
- Does the use of ICT save transport in relation to the same activities?
- What does social communication via ICT imply for people's wish to meet socially?
- Is ICT applied for the purpose of saving energy?
- How often are various appliances replaced?
- Do several generations of appliances co-exist?
- Which functions are served by diversified equipment?
- Which functions are merged in rationalized equipment?
- What do households do with equipment they want to discard?

Hopefully, such studies on households' ICT use in an energy perspective can encourage the increased integration of the agendas related to the information society and to climate change, respectively.

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Bilag 2: Residential ICT related energy consumption which is not registered at the electric meters in the residences

Residential ICT related energy consumption which is not registered at the electric meters in the residences

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June 2008

Background

The development of the ICT hardware has resulted in products with rapidly increasing functionality and capacity providing the users with a whole new range of possible applications. Due to the product development the energy consumption measured per functional unit has decreased. However the functional unit of each product is constantly expanding as the increased capacity opens up to new applications. E.g. 15 to 20 years ago an average pc was merely an advanced typewriter / calculator. Today the average residential pc is still named “a pc”, though the increased functionality also has made it a video machine, a stereo equipment, a radio, a TV, a communication device (email, fax, (video-) phone etc.), a toy, a photo album, a photo laboratory, a library etc. This development leads to new use patterns that inevitably imply an increased electricity consumption.

The main focus of the project *“Behavioural and technical potentials for energy conscious development of residential ICT applications”* is on the electricity consumption, which is related to the application of ICT in the households. This means the electricity consumption that is caused by the ICT equipment in the form of computers, screens, printers, routers etc. This electricity consumption is easy to read from the electric meter connected to the residence. However there are other causes to energy consumption, which can be directly related to the use of ICT in the households as it is outlined in figure 1.

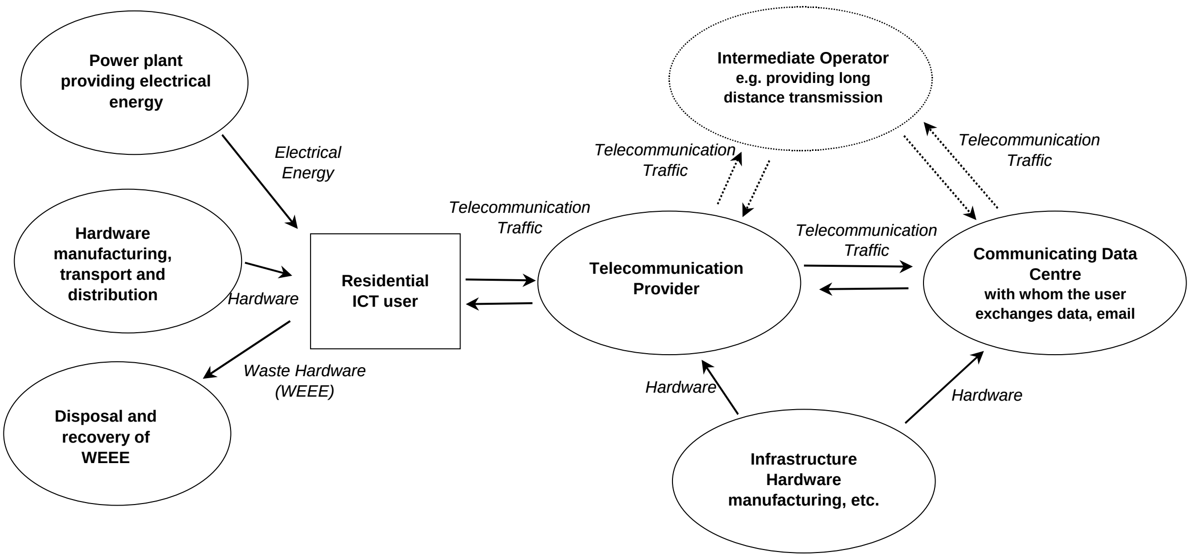

***Figure 1** Outline of residential energy consumption*

One aspect derived from the residential ICT activities is the energy consumption related to the manufacturing (including raw material extraction), transport (over the entire life cycle) and disposal of the ICT equipment.

Another aspect of the application of residential ICT is the integration of the Internet and other telecommunication, which has expanded and gained increasing importance over the last decade. The operation of this infrastructure also gives rise to energy consumption. When the residential ICT user is communicating with “the cyberspace” this communication requires energy consumption.

This communication is performed through a telecommunication provider, who supplies access to the Internet, email, web-hotel, cable TV, telephony etc. This telecommunication provider operates a number of servers, switchboards, networks and other energy consuming hardware. Through the telecommunication provider the user can carry out the communication with other servers exchanging data, email, telephony etc. – named the “Communicating data centre” in figure 1. The operation of servers, server-room air-conditioning and other equipment at the data centres also requires energy. In some cases the telecommunication provider would direct your traffic through another (intermediate) telecommunication provider e.g. to connect to overseas servers through optical fibre cables. Finally the manufacturing of infrastructure hardware requires energy.
This energy consumption that takes place outside the residence will be dealt with in more detail in the following sections.

Purpose

The purpose of this paper is to perform a literature study in order to uncover the energy consumption related to the application of residential ICT, but which does not appear on the electric meters in the households. This is:

- The energy consumption related to the manufacturing, transport and disposal of the residential ICT equipment.
- The energy consumption related to the ICT infrastructure related to residential ICT application.

Primary Energy

To be able to compare the energy consumption in the use phase with the other phases of the life cycle it is necessary to convert the different sorts of energy consumption to the same unit being primary energy measured in MJ (Mega Joule). This is an aggregation of the total life cycle energy and it is the sum of the 'Net Calorific Value' (Material Energy) and the energy used for manufacturing (process energy). As primary energy is a key issue of this paper it might be worthwhile to assign a few words to this subject.

All materials need energy to be produced. This processing energy - needed for extraction, refining and further processing of virgin resources into 'ready-to-use' materials - will typically be electrical or thermal. Some materials like plastics are synthesised from energy sources like gas or oil and thereby have an inherent energy content.

The total energy input to a material is the sum of processing and inherent energy. In order to add these energies, a common unit - primary energy - is needed. Primary energy is the combustion values of the fuels used to generate the processing energy or the combustion value of the gas or oil applied for e.g. plastics synthesis. This implies that e.g. electrical energy has to be multiplied by a factor corresponding reciprocally to the efficiency of the electricity generation system. This factor is typically in the order of two to three.
Some of the inherent energy in plastics may be recovered by incineration. This energy corresponds to the combustion value of the material. It should be remembered that this energy cannot be recovered to 100%, and it has to be corrected by the efficiency of the incineration system. The Primary energy consumption is also referred to as “Gross Energy Requirements” [99].

In this context the conversion factor 9 MJ/kWh [101] is applied in case there is a need to convert electrical energy to primary energy. This factor is derived from two conversion factors:

- 3,6 MJ electrical energy / kWh electrical energy, and
- 2,5 MJ primary energy / MJ electrical energy

The last factor expresses that a total of 2,5 MJ of energy has been consumed to be able to supply 1 MJ of electrical energy at the power outlet. Some of the energy consumption referred to in the following also cover heating and fuel for transport. The same conversion factor is used to calculate the primary energy consumption for these categories of energy consumption. The error this may introduce is considered to be insignificant as electricity consumption is the dominating energy category.
In the following sections a number of values of primary energy consumption will be presented and discussed. For comparison it could be mentioned that the average electricity consumption in a detached house in Denmark occupied by a family of 4 persons, would be approx. 5.000 kWh/year [7], which corresponds to 45.000 MJ primary energy per year.

Energy consumption for manufacturing, transport and disposal

The primary energy consumption related to the manufacturing (including extraction of raw material), transport and disposal of desktop PCs is presented in table 1. The values from ref. 1, 39 and 80 are based on genuine LCAs (life cycle assessment) while the values from ref. 18 and 19 are based on screening methodology. This might to some extent explain the differences though the time of the data generation and variations in the analysed equipment are also assumed to be important.

Equipment	Energy Consumption [MJ / Unit]	Year data	Reference
Control Unit	5.597	2001	Loerincik [1]
Chips and Microchips	3.750	2001	Loerincik [1]
PWB	1.399	2001	Loerincik [1]
Bulk Materials	448	2001	Loerincik [1]
Control Unit	1.930	2003 or earlier	Plepys [10]
Control Unit	2.594	2005	Jönbrink [18]
Control Unit	3.900	2000	Legarth & Willum [19]
Control Unit & 17" CRT screen	5.040	1998-2001	Kuehr & Williams [39]
Control Unit & 15" CRT screen	3.544	1998 or earlier	Atlantic Consulting and IPU [80]

Table 1 *Energy Consumption for the manufacturing, transport and disposal of desktop computers. Applied abbreviations: PWB: Printed Wired Board, CRT: Cathode Ray Tube.*

Values from ref. 1 are divided up in groups of components and it is demonstrated that the manufacturing of chips and microchips (semiconductors) is contributing heavily to the energy consumption. If you examine the results from the other studies you will uncover a similar pattern. The increasing improvement of the semiconductors´ functionality implies the utilization of chemicals and materials of an ever-increasing purity in the manufacturing processes. Plepys [10] claims that the energy consumption caused by this extreme purification is very energy-intensive and

that this is not taken into account by performing the respective LCAs. If you accept this reasonable argumentation the values represented in this context should be considered to be lower to than “true values”.
The energy consumption in the life cycle (except the use phase) of an ICT product is mainly caused by the manufacturing and transport. The disposal phase will usually only contribute marginally to the energy balance. If the waste ICT equipment is disposed of in accordance with the WEEE directive [102] energy recovery might reduce the total energy consumption by a few percent. Some of the referred studies do not include the disposal phase and this is a reasonable approximation if you consider energy consumption. (If you would also consider the depletion of scarce resources like copper, silver, platinum etc. this approximation would not be justified.)
The primary energy consumption for the manufacturing etc. of PC screens is presented in table 2.

Equipment	Primary Energy Consumption [MJ / Unit]	Year data	Reference
CRT Screen, Size not specified	1.445	2001	Loerincik [1]
LCD Screen, Size not specified	653	2001	Loerincik [1]
CRT Screen 17"	1.410	2005	Jönbrink [18]
LCD Screen 17"	1.225	2005	Jönbrink [18]
CRT Screen 15"	979	2000	Legarth & Willum [19]
TFT Screen 15"	5.940	2000	Legarth & Willum [19]
TFT Screen 17"	7.850	2000	Legarth & Willum [19]
CRT Screen 17"	18.538	2001	Socolof [91]
TFT Screen 15"	1.989	2001	Socolof [91]

Table 2 *Energy Consumption for the manufacturing, transport and disposal of pc screens. Applied abbreviations: CRT: Cathode Ray Tube, LCD: Liquid Crystal Display, TFT: Thin Film Transistor. (LCD and TFT are both flat screens).*

These values are together covering a wide range. The values from ref. 18 and 19 are based on screening methodology, while ref. 1 and 91 are real LCAs. Especially the LCA performed by Socolof [91] seems to be a very thorough and comprehensive study, and several ICT manufacturers were involved. The energy consumption for manufacturing of a 17” CRT screen calculated by Socolof [91] is radically different from the results obtained by the other authors. As CRT screen are being phased out [98] the reason for this difference will not be dealt with any further.
The primary energy consumption for the manufacturing etc. of PC laptops is shown in table 3.

Equipment	Primary Energy Consumption [MJ / Unit]	Year data	Reference
Laptop	3.710	2001	Loerincik [1]
Chips and Microchips	2.300	2001	Loerincik [1]
PWB	408	2001	Loerincik [1]
Bulk Materials	1.002	2001	Loerincik [1]
Laptop with 15" LCD	1.368	2005	Jönbrink [18]
Laptop with 14" TFT LCD	1.868	Publ. 2005	Oikawa [51]

***Table 3 Energy** Consumption for the manufacturing, transport and disposal of laptops. Applied abbreviations: PWB: Printed Wired Board, LCD: Liquid Crystal Display, TFT: Thin Film Transistor.*

Compared to the desktop PCs the energy consumption to manufacture laptops appears to be lower. This conclusion is supported by the two authors Loerincik [1] an Jönbrink [18], who both have compared desktop and laptop PCs within the same study. It is somewhat surprising that the manufacturing of laptops implies less energy consumption bearing in mind that the manufacturing of semiconductors is an important contribution. Furthermore it should be expected that a product being more compact and complex would imply increased energy consumption. This might be explained by the circumstance that the same basic inventory data for materials and components are used no matter whether it is a desktop PC or a laptop. At least this is the case for the VHK-tool [99] applied by Jönbrink [18]. It would be reasonable to expect that in the reality the materials and components for laptops would require more energy for the manufacturing processes.

In table 4 the energy consumption related to the manufacturing, transport and disposal of printers and multi functional devices (MFD) is presented. The values cover a wide range, which can be explained from diversity in functionality and capabilities.

Equipment	Primary Energy Consumption [MJ/Unit]	Year data	Reference
Printer, average weight 20 kg	11.540	2001	Loerincik [1]
EP-Copier MFD, monochrome, Basic workgroup	7.369	2005	Stobbe [44]
EP-Copier MFD, colour, Advanced workgroup	14.639	2005	Stobbe [44]
EP-Printer SFD, monochrome, Standard Laser Printer	2.861	2005	Stobbe [44]
EP-Printer SFD, colour, Advanced Laser Printer	4.973	2005	Stobbe [44]
IJ-Printer MFD, personal	1.528	2005	Stobbe [44]

***Table 4** Energy Consumption for the manufacturing, transport and disposal of printers and related equipment. Applied abbreviations: EP: Electro Photography; IJ: Ink Jet; MFD: Multi Functional Device; SFD: Single Functional Device.*

The values from the tables 1 to 4 are presented graphically in figure 2.

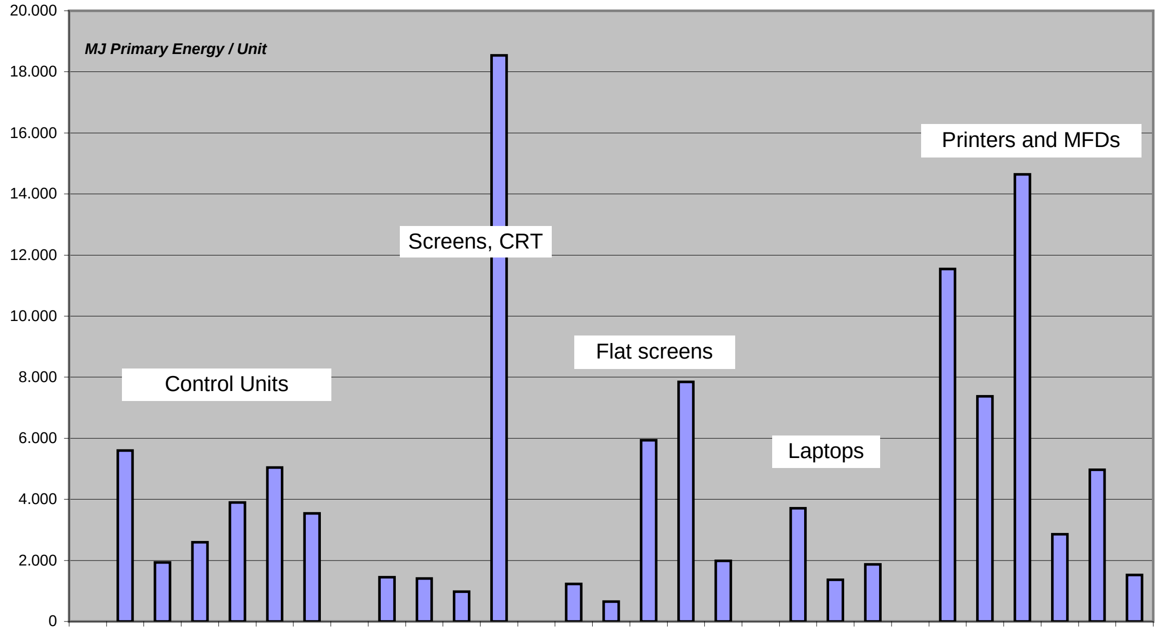

Figure 2 *Primary Energy Consumption [MJ/Unit] for the manufacturing, transport and disposal of desktop PCs, screens, laptops, printers and MFDs. Applied abbreviations: CRT: Cathode Ray Tube, MFD: Multi Functional Device.*

The manufacturing of smaller ICT devices also consumes considerable amounts of energy. The manufacturing of a PDA requires 499 MJ primary energy [20] and for a cellular phone it is 111 MJ primary energy [27].
It can be quite difficult to relate all these values to something more substantial. In the previous section the average electricity consumption corresponding to 45.000 MJ primary energy per year for an average family was mentioned as a value for comparison.
Another way to approach these figures is to compare the primary energy consumption in the use phase to the total primary energy consumption related to the manufacturing, transport and disposal for the respective products. This is done for those of the above-mentioned studies that have considered the use phase. The results are shown in table 5. Values for other products and more general statements have been added for comparison.

Compared item	Use / Manufacturing	Reference	Year
Desktop computer	0,3	Kuehr & Williams [39]	1998-2001
Refrigerator	8,0	Kuehr & Williams [39]	1998-2001
Most appliances	>1	Kuehr & Williams [39]	1998-2001
CRT screeen, 17"	0,1	Socolof [91]	2001
LCD screeen, 15"	0,4	Socolof [91]	2001
Desktop computer (Control Unit & 15" CRT)	2,9	Atlantic Consulting and IPU [80]	1998 or earlier
Home Desktop PC	3,8	Jönbrink [18]	2005
Laptop at home	2,7	Jönbrink [18]	2005
LCD at home	2,7	Jönbrink [18]	2005
CRT at home	5,0	Jönbrink [18]	2005
ICT equipment	1-6	Stevels [97]	2004
Printer excl. paper	0,5 - 6	Stobbe [44]	2005
Printer incl. paper	1 - 62	Stobbe [44]	2005
PDA	0,42	Toffel [20]	2004
Cellular Phone, UMTS	0,07	Emmenegger [6]	Publ. 2006

Table 5 *The ratio of the primary energy consumption in the use phase vs. the primary energy consumption related to the other phases of the life cycle (manufacturing, transport and disposal) for various ICT equipment. Applied abbreviations: CRT: Cathode Ray Tube, LCD: Liquid Crystal Display, PDA: Personal Digital Assistant, UMTS: Universal Mobile Telephone System (3G).*

These ratios also cover a wide range of values. While the energy consumption related to manufacturing etc. should be considered to have a “true value”, which you could be able to determine for a specific product, this is not the case for the use phase of the same ICT-product as it is dependent on the behaviour of each individual ICT user. The use phase models that have been applied in these studies are thus an average estimate.

One should therefore be very careful to interpret the figures in table 5, but it seems like newer studies estimate the use phase to be relatively more important than older studies when it concerns PCs and displays. When it comes to printers and copiers it can be seen that the use phase contribute heavily to the energy consumption – especially if paper consumption is included. For comparison it can be mentioned that a package containing 500 pieces of A4 paper requires 74 MJ of primary energy to be produced [1].

For the mobile devices (PDA and cellular phone) the use phase is estimated to be less important compared to manufacturing. This is especially striking for the cellular UMTS phone. One reason for this is that the average lifetime of a mobile phone is only one year and the manufacturing phase will thus be more dominating than e.g. for the PDA with lifetime of 3 years. The highly effective power management of the newer cellular phones is another cause. As the energy consumption is related to the battery lifetime, which is an important commercial parameter, this issue has attention in the development departments by the manufacturers. There is no specific data to calculate a ratio for the GSM phone, but the available data [6] indicate that the ratio would be somewhat higher compared to the UMTS phone.

Energy consumption related to the infrastructure

The energy consumption related to the operation of the ICT infrastructure is a theme, which is only moderately illuminated, and the average residential ICT user probably does not spend many a wakeful night wondering about this issue.

Cremer et. al. 2003 [5] estimates the electricity consumption of telecommunication to be 6% of the ICT related electricity consumption in 2001 increasing to 11% in 2010. Other authors [49, 50 & 90] also support that the infrastructure is gaining increasing importance in terms of energy consumption.

The energy consumers in the ICT infrastructure are outlined in figure 1. The energy consumption of the telecommunication providers can be extracted from their respective environmental reporting [3, 81 and 85]. When they also report the amount of their telecommunication traffic it is possible to calculate the energy consumption in proportion to the performed telecommunication traffic. Such values are presented in table 6.

Transmission / Source	Energy Consumption in kWh / GB	Energy Consumption in MJ primary energy / GB	Year data
Telecom traffic, Swisscom 2005 [82]	10,7	96	2005
Telecom traffic, Swisscom 2000 [82]	30,3	273	2000
Voice and data traffic in mobile and fixed networks, Telecom Italia 2006 [81]	3,9	36	2006
Voice and data traffic in mobile and fixed networks, Telecom Italia 2003 [81]	17,5	157	2003
Cable TV, Internet and telephony in mobile and fixed networks, TDC 2006 [3 and 95]	1,4	13	2006
Cable TV, Internet and telephony in mobile and fixed networks,TDC 2004 [3 and 95]	1,7	15	2004
Cellular - to cellular phone in the UMTS network [6]	325	2.922	Publ. 2006
Cellular - to cellular phone in the GSM network [6]	247	2.219	Publ. 2006
Digital Power Group. Creation, transfer and storage [50]	3,9	35	Publ. 2007

Table 6 *The primary energy consumption related to the operation of different ICT infrastructures. Applied abbreviations: UMTS: Universal Mobile Telephone System (3G), GSM: Global System for Mobile Communications.*

The values from the telecommunication operators are derived from their published environmental reporting. The energy consumption includes electricity as well as heating and fuels for transport. The values given in kWh/GB are directly derived from the references while the values expressed in MJ primary energy/GB are converted from these values by the factor 9 MJ/kWh [101] as discussed in the previous section about primary energy.

These figures cover a wide range, but it is a common trend for all three operators that the energy efficiency has improved over time. When you compare values covering the same (or almost the same) year the differences are not really that striking. Differences among the operators in terms of mix of voice, data, fixed or mobile traffic will probably be able to explain some the differences in energy efficiency. Only TDC [3] accounts for their mix in traffic, which is dominated by cable TV (82%) and Internet (14%).

Another reason for the differences could be the applied equipment. According to Moore's law [103] the density of transistors will double approximately every 18 month. This means that a new server unit will have an increased functionality, but still take up the same space in the server room. If the increased functionality would imply a corresponding increase in the energy consumption this would hamper a proper and reliable function of the hardware [108] and also imply a disproportionate increase in the demand for cooling capacity in the server rooms [95]. The result is thus that newer hardware will consume less energy compared to the performed functionality.

TDC does not state their telecommunication traffic as an amount of transmitted data. They state their performance as "Capacity pull" measured in kbps (kilo bits per second), which corresponds to the total amount of sold bandwidth. From TDC environmental reporting [3] it can be calculated that an average customer who has an Internet connection with a bandwidth of 1Mbit/s implies energy consumption by TDC of 66 kWh/year (595 MJ primary energy/year), which correspond to an average data volume of 47 GB/year. By comparing the capacity pull to the actual measured traffic in the TDC network [95] the ratio between the actual data traffic and the sold bandwidth can be calculated. It is thus possible to calculate the values in table 6 that are comparable to the values given by Swisscom and Telecom Italia.

When it comes to mobile telecommunication a distinct increase in the energy consumption is demonstrated. These values only cover electricity consumption related to operate the infrastructure. The lower energy efficiency in the UMTS network is due to a higher electricity consumption to operate the base stations compared to the GSM network. Emmenegger [6] has calculated the energy consumption including the manufacturing of hardware in the UMTS infrastructure to 5397 MJ primary energy/GB. This means that the energy consumption from the manufacturing of the infrastructure hardware is almost the same as the energy used to operate the mobile infrastructure. No such figures relating to the energy consumption for manufacturing of the infrastructure hardware were available from the telecommunication operators.

The last value in table 6 has been calculated from the statement: "Creation, storage and transmission of 10 MB data corresponds to the combustion of 1 kg of coal" [Digital Power Group taken from ref. 50]. Based on data from an average Danish coal-powered plant [88] the 10 MB data/kg coal has been converted to 3,9 kWh electricity consumption /GB data.

The energy consumption by the telecommunication provider has then been accounted for. The energy consumption at the telecommunication provider also covers the traffic to the residential ICT user, and approximately half of the traffic to/from the "Intermediate Operator" and the "Communicating data centre".

It has not been possible to find data about the energy consumption related to the data transmission between the Internet provider and other operators and data centres in the ICT infrastructure - e.g. through an optical fibre cable across the Atlantic Ocean. Several sources [95, 104 & 105] however estimate the energy consumption for the operation of the long distance fibre cables to be insignificant compared to the energy consumption required to operate the telecommunication operators network.

Returning to figure 1 the energy consumption initiated as a result of the communication with the "Communicating data centre" has to be accounted for. Koomey 2007 [4] has calculated that servers and related cooling and auxiliaries are responsible for 1,2% of the electricity consumption in the

USA in 2005, and the consumption is estimated to be 1,5 - 2,0% if data storage and networks are included. Since 2000 this energy consumption has increased by almost a factor two. Other authors also predict the energy consumption of data centres to increase considerably in the future [62 & 72]. Literature about the energy consumption of servers and data centres is rather comprehensive. But very few authors relate the energy consumption to performance in terms of the transmitted data traffic. Fujitsu-Siemens [106] state the electricity consumption for two of their servers as a function of the capability in terms of “throughput” in Mbit/s and the number of simultaneous users. From these data the electricity consumption can be calculated to be 0,0002 to 0,001 kWh/GB. This value only covers the electricity consumption to run the servers. There will also be an energy consumption to provide cooling to the server room. This energy consumption is estimated to be of the same size as the energy consumption to operate the servers [71]. Furthermore electricity consumption to operate data storage and networks has to be added. Koomey [4] estimates this to be 20 to 40% of the total energy consumption of a data centre.
It is thus possible to calculate an estimate for the energy consumption by the “Communicating data centre” to be 0,0006 to 0,004 kWh/GB transmitted.
In table 7 the estimate of the energy consumption related to transmitted data volume in the telecommunication infrastructure is presented.

	Energy Consumption in 10^{-3} kWh / GB	**Energy Consumption in 10^{-3} MJ primary energy / GB**
Actual data transmission (mainly by fibre cables)	~0	~0
Communicating data centre, server	0,2 - 1,2	2 - 11
Communicating data centre, Cooling	0,2 - 1,2	2 - 11
Communicating data centre, data storage and networks	0,1 - 1,7	1 - 15
Total	0,6 - 4	5- 37

Table 7 *Estimate of the energy consumption to operate the ”Communicating data centres” in relation the transmitted data volume.*

Several sources [71, 95 &106] conclude that the energy consumption of the infrastructure hardware is almost independent of the current load, because the base functionalities are running uninterrupted no matter what the current load might be. In that sense there is no direct relation on a day to day to basis between the transmitted data and the energy consumption as it is indicated in table 7. There is a relation however seen over a little longer time span in the sense that an increased application of the Internet (e.g. downloading of movies and music) implies the installation of additional energy consuming hardware.

Left to account for in figure 1 is now the energy consumption related to the manufacturing, transport and disposal of the infrastructure hardware. As mentioned above only one study dealing with the infrastructure hardware has been identified. From this study [6] it can be calculated that the energy consumption related to the manufacturing etc. is almost the same as is required to operate the UMTS infrastructure. A rough estimate for the energy consumption needed to manufacture the infrastructure hardware can be derived by extrapolating the use / manufacturing ratio for other hardware (table 5). For a desktop PC the ratio can be calculated from Jönbrink [18] to be 5,2 for an office PC (and 3,8 for the same device used at home), and Stevels [95] estimate an interval from 1 to 5 for "electronic products". Stevels does not explicitly state that it refers to consumer electronics, but it is assumed to be so from the context. Kuehr & Williams [39] estimate the ratio to be 0,3 for a desktop PC. The establishment of this figure is however not explained and no reference is given so this value is not given any priority. It is expected that the professional hardware applied to operate the ICT infrastructure is running more or less around the clock. It should thus be expected that the use / manufacturing ratio is considerably higher than for an office PC. It would be more relevant to compare to a high utilization EP-Printer [44] where the ratio can be calculated to 6,2 if paper consumption is excluded. But even such a printer would not have an operating frequency comparable to the infrastructure hardware. Based on these considerations the ratio of the energy consumption of the use phase vs. the energy consumption for the manufacturing etc. is estimated to be at least 12, and this value is applied to derive a conservative estimate for the energy consumption related to the manufacturing of the infrastructure hardware as it is presented later in table 8, well knowing this is an arbitrary choice.

Sensitivity Analysis

The results derived above will be summed up in table 8 in the next section. But before doing this it is considered worthwhile to perform a sensitivity analysis to evaluate the reliability of the results and the assumptions that have to be made, and to what extent the conclusions may be influenced.
The energy consumption to manufacture residential hardware presented in tables 1 to 4 are considered to be robust within those differences that are shown. Beside the main ICT products (PC, screen, laptop and MFD) there is also ADSL modem. The energy consumption to manufacture this item is estimated to 133 MJ primary energy using the VHK Tool [99]. With the purpose of comparing the energy consumption for manufacturing the hardware to the energy consumption to operate the hardware a product lifetime has to be estimated. This is set to an average of 4 years based on previous considerations [19]. An increase in the lifetime will reduce the significance of the load from the manufacturing and vice versa. But even if a lifetime of 6 years is assumed the energy consumption related to the manufacturing will still be of the same size as the residential energy consumption.
An average bandwidth of 2,4 Mbit/s has been calculated on the basis of statistics for Demark [107]. This covers both residential and professional users and is thus not quite representative for an average residential customer. However with the increase in the availability of the bandwidth and the decrease in prices [107] it is expected that a bandwidth of 2,4 Mbit/s will be representative in the near future.
The energy consumption by the Internet provider (in table 8) is based on data from TDC [3 & 95], who is the market leader in Denmark. Other telecommunication providers [81 & 82] show values that are somewhat higher but still of the same size. The values based on TDC data are thus considered to be reliable.
As it appears from the previous (table 7) the energy consumption related to the "Communicating Data Centres" is not in the same way based on solid foundation. By the calculation of the energy consumption it is assumed that the energy needed to operate the hardware is equal to the energy needed to cool the server room [71]. This rule of thumb is considered to be rather conservative and it is expected that an increased focus on the energy consumption by the data centre operators would reduce the energy needed for cooling. The average presented in table 8 is thus considered to be conservative.
The manufacturing of the infrastructure hardware also implies energy consumption. This is derived from an estimate of 12 for the ratio of the energy consumption of the use phase vs. the energy

consumption for the manufacturing of the hardware, as reasoned about in the previous section. Though this energy consumption seems to be associated with sincere uncertainty. However even considerable deviations from the value stated in table 8 will not change the conclusion that the energy consumption related to the manufacture of the infrastructure hardware is of minor importance compared to the energy needed for the operation.
On the basis of the above considerations it can be concluded that the conclusions derived from this study in the next section are robust to any reasonable deviations in the applied data and assumptions.

Conclusions

All the items outlined in figure 1 have thus been taken into consideration and an attempt to estimate the overall energy consumption related to residential ICT can be done. This is done for a typical Danish household assumed to have one desktop pc, one laptop, one MFD and one ADSL modem. The results are presented in table 8 below.

	MJ primary energy/year	kWh/year	kWh/year
			Totals
Residential Electricity consumption of the hardware listed below based on [110]	2.702	300	**300**
Manufacturing of one PC, Control Unit	876	97	
Manufacturing of one Screen, LCD 17"	811	90	
Manufacturing of one Laptop	579	64	
Manufacturing of one Combined printer, scanner etc (MFD) for personal use	382	42	
Manufacturing of one ADSL Modem	33	4	
Manufacturing of hardware used in the residence			**298**
Internet provider (2,4 MBit/s) based on [3] and [95]	1.417	157	
Communicating Data Centre average	2	0,3	
Manufacturing of hardware used outside the residence	118	13	
Energy consumption of the infrastructure taking place outside the residence			**171**

Table 8 *Estimate of the total energy consumption related to residential ICT and the integrated application of the Internet for a typical Danish household with ADSL-connection.*

The figures in table 8 are aiming at representing a typical Danish household. The figures are in values of primary energy in the unit MJ. As primary energy is probably somewhat awkward to many readers the values are converted to kWh bearing in mind that not all energy consumption is electricity consumption.

The figures presented in table 8 are based on the following assumptions:

Electricity consumption of the residential hardware listed below is based on [110].
Energy consumption to manufacture residential hardware are based on:

Control unit: Average values from [1, 10, 18 & 19].
LCD Screen, 17” : Average values from [1, 18 & 19].
Laptop: Average values from [1, 18 & 51].
MFD is represented by the Ink Jet MFD from [44], which is the product type with the highest penetration in Danish residences [110].
ADSL Modem is estimated from the content of a Cisco 677 by means of the VHK-Tool [99].

Lifetime of residential hardware: 4 years

Average bandwidth of the users connection in 2007 estimated from [107] :	2,4 Mbit/s
Transmitted data for 1 Mbit/s bandwidth connection in 2006 calculated from TDC data [3 & 95]:	47 GB/year
Energy consumption to operate the "Communicating data centres" are average values calculated from table 7.	
Ratio use phase vs. energy consumption for manufacturing etc. of the infrastructure hardware:	12

It is obvious from the previous section, that the values presented in table 8 are associated with considerable uncertainty and should thus merely be considered as an approach to estimate the order of magnitude of the energy consumption related to the increasing application of residential ICT and the related infrastructure.
It can however be concluded that the energy consumption, which does not appear on the electric meters in the households is significant and exceeds the electricity consumption which takes place within the residence. A rule of thumb based on the values in table 8 will be:

- When 1 kWh is consumed in the residence 1 kWh is consumed to manufacture, transport and dispose of the hardware and ½ kWh is consumed to run the Internet and the applied ICT infrastructure outside the residence.

For cellular phones the manufacturing phase is responsible for the major part of the energy consumption. The highly effective power management of the newer cellular phones combined with a very short product lifetime is the cause for this.

The most important energy consumption related to the application of office printers and copiers is caused by the use of paper. The energy consumption from the manufacturing of the paper exceeds the energy consumption for manufacturing of the hardware and the electricity consumption in the use phase several times.

The most essential energy consumption of the infrastructure is related to the Internet provider. The energy efficiency of the Internet provider's infrastructure is however increasing. For one operator this has increased more than 100% per year [81]. This means that more data volume is transmitted compared the amount of energy consumed.

The application of the ICT infrastructure is increasing and so is the energy consumption related to this. The energy consumption of the infrastructure hardware is almost independent of the current load, because the base functionalities are running uninterrupted no matter what the current load might be. In that sense there is no direct relation on a day to day to basis between the transmitted data and the energy consumption. There is a relation however seen over a little longer time span in the sense that an increased application of the Internet (e.g. downloading of movies and music) implies the installation of additional energy consuming hardware.

The amounts of stored data have increased dramatically over the last years. Energy consumption to store and keep these amounts of data accessible might be more important in the future if this increase continues at the same rate.

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Bilag 3: Spørgeguide samt skemaer

Spørgeguide

Forud for interviewet fremsendes de to skemaer (Udstyr og elforbrug; Aktiviteter)
Prøv at få dem tilbage i udfyldt stand inden interviewet.

Orientering om projektet
Vi er interesserede i brugen af computer og internet, inkl. mobilt udstyr:
- Hvad bliver det brugt til?
- Indgår det i forandringer af hverdagen?
- Hvad betyder forandringerne for energiforbruget?

Giv en oversigt over interviewets forløb.

Husstanden og hverdagen
Formål: At skabe et overordnet billede af familien og dens hverdag – herunder evt. også, hvornår IKT bliver brugt. Fokus er således på konteksten for analysen af informanternes IKT-brug

- Hvem består familien af? Alder, køn?
- Voksnes arbejde og fritidsinteresser?
- Evt. børnenes skole og fritidsaktiviteter?
- Hverdagens tidsstruktur og arbejdsdeling?
- Bevægelsesmønstre, transporttid?
- Evt. en typisk weekend?

Husstandens IKT udstyr generelt
Formål: At skabe et overblik over husstandens IKT-beholdning og et første indblik i udstyrets brug

Med udgangspunkt i skemaet over udstyr kan det afdækkes
- Hvor står udstyret (i bestemte rum, mobile)?
- Hvem bruger apparaterne (personlige eller fælles)?
- Er der noget af udstyret, der næsten altid / ofte er tændt?
- Er der noget af udstyret, der ikke rigtig er i brug?
- Bruger I udstyr i flere generationer (fx video-dvd-mediecenter)?
- Er forskelligt udstyr smeltet sammen (fx printer-scanner-kopimaskine)?
- Er nogen i husstanden opkoblet til arbejdspladsen?
- Hvilken form for tv modtager husstanden?
- Har I planer om at anskaffe nyt udstyr?

Godt hvis snakken kan kombineres med en rundvisning (vurderes i forhold til den konkrete situation – rundturen kan eventuelt lægges sidst i interviewet).

Brugen af udstyret
Formål: Først og fremmest at kortlægge bredden i anvendelsen af computeren (evt. også mediecenter el.lign.), dvs. computerens integrering på tværs af hverdagens praksisser

Skemaet over aktiviteter gennemgås i fællesskab (for hovedinformanten – med supplerende oplysninger om de øvrige husstandsmedlemmer).
Det belyses:

- Hvilke aktiviteter er computeren blevet integreret i?
- Hvilke aktiviteter kræver lang tid ved computeren?
- Hvilke aktiviteter klares hurtigt?
- Bruges computeren så tit, at den helst skal være tændt hele tiden?
- Bruges forskellige computere til forskellige formål?
- Stiller nogle aktiviteter særlige krav til computerens styrke?
- Eller til supplerende udstyr? Specialiseret udstyr?
- Hvor tit er der brug for at udskifte computeren? (eller opgradere den)?
- Hvem vedligeholder udstyret (opdateringer, sikkerhed) og løser tekniske problemer?
- Hvad sker der med det udstyr, der bliver overflødigt / går i stykker?

Udvalgte aktiviteter
Formål: At uddybe beskrivelsen af udvalgte aktiviteter for herved at skabe grundlag for detaljeret analyse (herunder analysen af afledte energikonsekvenser).

En eller nogle få særlig vigtige aktiviteter vælges ud (typisk den/de aktiviteter, informanten er udvalgt på). Gerne aktiviteter hvor den aktuelle måde at gøre tingene på adskiller sig fra tidligere.
Det belyses:

- Hvordan udføres aktiviteten i praksis?
- Hvordan gjorde du/I tidligere?
- Betyder de nye teknologier bare en tilføjelse til de kendte praksisser (fx løbe-computeren), eller ændres praksissen mere grundlæggende?
- Bruger du/I mere eller mindre tid på aktiviteten?
- Koster aktiviteten flere eller færre penge? Hvad koster mere, hvad spares?
- Bliver der mere eller mindre ansigt-til-ansigt kommunikation?
- Ændres behovet for transport?

Energi
Formål: At samle op på og uddybe energi-vinklen på anskaffelse og brug af IKT

Hvis energi ikke allerede er dækket, tages det op til sidst:

- Tænker du/I på energiforbruget i forbindelse med anskaffelse af udstyr?
- I forbindelse med brugen af det?
- Slukker du/I for standby?
- Bruger du/I IT til at styre eller spare på energiforbruget?
- Hvis der spares: Er det mest miljøovervejelser eller interesse for at spare penge, der ligger bag?
- Hvor mange kvadratmeter er boligen?
- Hvilken opvarmningsform anvendes?

Hvor meget udstyr har husstanden? Skriv antallet

Apparat / udstyr	**Antal hjemme (eller i bilen)**	**Antal i sommerhus**
Traditionelt TV		
TV med LCD-skærm		
TV med plasma-skærm		
Video		
DVD		
Blu-ray afspiller		
Projektor		
Mediecenter		
Hjemmebiograf		
Surround-sound anlæg		
Parabolantenne, satellitmodtager		
Settop-boks / dekoder / selector		
Stereoanlæg		
Mindre radio, båndoptager, CD-afspiller, Walkman		
MP3, fx iPod		
DAB-radio		
Spillekonsol		
Stationær PC		
Bærbar PC		
Printer, scanner		
Selvstændig firewall enhed, hub eller router, switch		
Server		
Trådløst netværk		
Eksternt webkamera		
Ekstern harddisk		
Ekstern CD-ROM/DVD brænder		
Telefax		
Digitalkamera		
Videokamera		
PDA, note-book, note-pad, smartphone		
Fastnet telefon		
Mobiltelefon		
Trådløs telefon		
Dual phone (fastnet og IP)		
Telefonsvarer		
GPS		
Sikkerhedssystem, overvågningskamera		
Løbe-computer		
Sundhedsudstyr, der kan kan kobles til pc’en		
Elspareskinne		
Andet:		

Hvor stort er husstandens årlige elforbrug (gerne ud fra en årsopgørelse)? ______________

Hvad er hastigheden (båndbredden) på husstandens internetforbindelse? Angiv gerne for både download og upload (fx 512 Kbit / 256 Kbit): _______________

Hvad bruger du computeren og nettet til (inkl. net via mobilen)? Hvor meget? Sæt kryds

Aktivitet	**Hver uge**	**Hver måned**	**Sjæld-nere**
Kommunikation			
Email			
Messenger el. lign.			
IP-telefoni, fx Skype			
Video-telefoni			
Chat			
Sociale netværk (fx MySpace, Facebook)			
Interessefællesskaber, nyhedsgrupper (fx hobby, politik)			
Andet:			
Underholdning			
Musik på nettet			
TV på nettet			
Film på nettet			
Benytter podcast			
Kigger på klip fra YouTube o.lign.			
Lægger selv musik, billeder, video på YouTube o.lign.			
Spil over nettet			
Poker, spil om penge			
Virtuelle verdener, fx Second Life			
Andet:			
Information			
Nyheder			
Søgning via Google o.lign.			
Opslagstjenester som Wikipedia o.lign.			
Modtager nyhedsbreve			
RSS feeds			
Egen hjemmeside			
Blogger			
Bidrager med nyheder, oplysninger til Wikipedia el.lign.			
Andet:			
Køb og salg			
Finder oplysninger om varer og tjenester, sammenligner priser			
Køber varer til download (film, musik, bøger, programmer mv.)			
Køber varer, der sendes			
Køber fra privatpersoner, fx via Den Blå Avis på nettet, Lauritz.com			
Sælger selv over nettet			
Andet:			
Arbejde hjemme			
Kommunikation			
Løsning af opgaver, sagsbehandling mv.			
Video-konference			
Jobsøgning, indlagt profil			
Andet:			

Uddannelse			
Løsning af opgaver, rapporter			
Kontakt til uddannelsesstedet eller andre studerende			
Fjernundervisning			
Andet:			
Hobbyaktiviteter og frivilligt arbejde			
Foto			
Kreative aktiviteter, fx gør-det-selv, musikudøvelse, syning			
Foreningsarbejde, politisk arbejde			
Andet:			
Administration og økonomi			
Netbank			
Kontakt til det offentlige: pension, skat, daginstitution, jobcenter...			
Finansielle forretninger, investeringer			
Andet:			
Husholdningen / styring af boligen			
Madlavning, hente ideer			
Styring af el, vand, varme, lys			
Timing af vask, opvask, ovn			
Sikkerhed, overvågning			
Andet:			
Sundhed			
Søgning på Netdoktor o.lign.			
Monitering af egen sundhedstilstand, sportsresultater o.lign.			
Interessefælleskaber vedr. sygdomme, kost, slankekure, rygning			
Andet:			

Bilag 4: Domestication of information and communication technologies in an energy perspective

Domestication of information and communication technologies in an energy perspective

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Introduction

Information and communication technology (ICT) increasingly permeates everyday life in industrialized societies. Computer, internet, mobile phones and many other related technologies have become standard devices that most people take for granted. These changes have implications for the energy consumption of societies. Households see their electricity consumption increase, energy is required for the production of the equipment for households, and the running of the infrastructure needed for the internet and mobile telephony demands energy. ICTs also promise to save energy, for instance, by contributing to more energy efficient production processes and by saving transport when tasks can be carried out from home. In this paper we intend to highlight some of the energy implications of ICTs from the household perspective (the implications related to the particular use of ICT for planned energy savings in households are described in another paper in the project of which this paper is a part). Obviously, even a thorough treatment of this topic would only be part of the puzzle regarding the overall energy implications of ICT, but it is an important part that has attracted less attention than the energy implications related to production processes.

Previous processes of domestication of new technologies in everyday life have implied increasing energy consumption. The classic example is the construction of the car-based society where changes in the patterns of settlement, shopping routines, leisure activities, and many other conditions involved longer travelling distances and higher fuel consumption. Another example is the electrification of households. Combined with the small electromotor and radio technology, electrification opened up an era where household tasks became mechanized and supported by convenience technologies, and where entertainment became available in mediated form, all implying a steady increase in electricity consumption. The domestication of ICTs can be seen as a new phase in the continuing electrification of everyday life where the computer and other devices combined with the new infrastructure of the internet open up new opportunities for communication, mediated entertainment, leisure activities, and support for household tasks.

Both the previous and the present processes of domestication are strongly supported by ideas of modernity and progress, and many actors are involved in removing barriers for the diffusion of the new technologies, while few consider the potential energy implications. We do not know enough about the historical processes to assess how strongly the concern for the related energy consumption was expressed before the 1970s, but we suggest that the primary concern was to secure provision of sufficient and low priced electricity and petrol within the restrictions of economic resources for investment and the balance of payments. In the 1970s energy provision became a serious concern due to the oil crises, and in the 1980s the environmental aspects of energy consumption came high on the agenda. In spite of the increasing focus on energy issues, the interest in promoting the "information society" has not been curbed by concerns for increasing energy consumption. Two dominant social agendas tend to be kept separate: one is to make sure that society is not lacking behind in the competitive race for being an advanced information society; another is to take the first steps to prevent climate change. When the two agendas are brought together, it is often done in an optimistic way suggesting that ICT can help to save energy. Among the more problematic aspects, the issue of standby consumption has attracted attention, but with this exception, the integration of ICT in everyday life proceeds with little concern for the energy implications. New normal standards are developed, and like previous processes of domestication of new technologies, they may become very energy consuming if aspects of energy consumption are not integrated much more actively into the construction process.

The following two sections briefly introduce the theoretical approach of our study. The approach is inspired by the practice theoretical perspective, which we combine with ideas from domestication research in our study of the integration of ICT into everyday practices. The theoretical sections are followed by a short introduction to our empirical work (qualitative interviews). Then follows our empirical analysis, which is divided into two parts: The first shows the pervasiveness of the integration of new ICTs into everyday practices and elaborate on the direct and indirect energy impacts. The second part provides a detailed analysis of the integration of ICT into a specific everyday practice (the practice of "staying in touch" with friends and relatives) and discusses what kind of derived energy impacts that might follow from changes in this practice.

Theoretical approach: Domestication in a practice perspective

Studies on domestication of ICTs emerge from two different traditions: media studies and technology studies (Sørensen, 2006). Silverstone et al. (1989; 1992) introduced the domestication concept and the concept of the moral economy of the household when they studied how ICTs became integrated in family life. Their main research interests centred on the autonomy and identity of the family and of the individual members of the family. The technology studies approach to domestication focuses on the negotiated space between designers' script for a technology and users' interests, as well as the implications of this interplay for the construction of a wider everyday life. Domestication is seen as a multi-sited process that transcends the household space and involves the set-up of institutions and collective discourses (Sørensen, 2006).

This paper shares ideas from these strands of domestication research and combines them with a practice theoretical approach that modifies the perspective slightly. Whereas technology studies usually have an artefact as the focal point and discuss the construction of a set of practices related to this artefact, the practice theoretical approach suggests to focus on a particular practice and to discuss the change over time in this practice, for instance, when practitioners include new artefacts in the performance of the practice (Shove and Pantzar, 2005; Shove et al., 2007). Practices can be seen as clusters of activities where the coordination and interdependence make it meaningful to describe them as entities (Schatzki, 2002). A practice is thus an integral bundle of activities that make sense to people as an entity, which is recognizable across time and space. The entity can only exist when the activities involved are carried out by people, and this enactment transforms the entity over time. When new technologies are introduced, they meet with and often have to be incorporated into pre-existing practices to survive – and both practices and technologies change in the process. Sometimes new technologies involve the introduction of a new practice, but this is a relatively seldom occurrence (for a review of practice theory as inspiration for environmental studies, see

(Røpke, 2008); also, see (Christensen and Røpke, Forthcoming) for a discussion on how practice theory can inspire studies on ICTs in everyday life).

The present phase of domestication of ICTs calls for the application of a practice theoretical perspective. When the home computer was first introduced, it made sense to discuss how it was domesticated as a particular object integrated in a few specific practices such as playing games and using word-processing. In the same way "surfing on the internet" made sense as a particular practice in the beginning. Since then, computer and internet have developed into a general infrastructure which can be used for so many different purposes that it is more reasonable to change the focus to various practices and consider how the new infrastructure is incorporated into these. New practices have also emerged in relation to the new infrastructure, but the integration of ICTs in almost all ordinary practices dominates the construction of the new normal standards in everyday life – standards with important implications for energy consumption.

Categories of energy impacts

When practices change over time, the related energy consumption is affected in various ways. In the following assessment of the energy impacts of ICT integration in everyday practices, we consider three types of effect that can all be either positive or negative (for elaboration of this brief outline, see (Røpke et al., Forthcoming) and (Willum, 2008)):

- The impact on direct energy consumption, usually electricity. Electricity consumption changes when practice changes involve the use of new types of equipment and eventually the discarding of old equipment. Sometimes practices that did not involve the use of electricity are electrified, and sometimes new devices are introduced as an "add on" to otherwise unchanged practices. In general, the electricity consumption depends on the energy efficiency of the equipment and the length of time it is used or left in standby mode. Some equipment is very energy-consuming such as plasma screens, projectors, and game computers, and some equipment must be turned on at all times, for instance, home servers, connections for IP-telephones, surveillance cameras, and set-top boxes that are updated continually. Simultaneously, ICTs offer a potential for direct energy-savings related to the management of lighting, heating, and washing machines.
- The impact on indirect energy consumption. Two types are included here (as we do not deal with the waste handling part of the life cycle):
    - Upstream energy use related to the production of the equipment used for the practice. This part of energy consumption is particularly relevant for devices with a short lifespan. Due to the rapid rate of renewal for much ICT equipment the economic life is often very short, particularly for small devices such as mobile phones. The indirect energy consumption is also increased by the use of specialized and diversified devices instead of multi-purpose equipment, as specialization usually calls for a larger number of devices.
    - The energy used for the running of the ICT-related infrastructure such as sending masts and servers. This part of energy consumption attracts increasing attention, for instance, because of the interest in placing the large server parks of Google close to cheap energy provision. Also, the increasing bandwidth of internet connections opens for download and upload of larger amounts of data which requires more sending capacity.
- The derived energy impacts. Changes of a practice often influence other practices as well as the possibilities for consumption in other areas, and in this way wider impacts on energy consumption can occur. In particular, we consider the derived impacts related to
    - Economic resources. If practice changes are expensive, they absorb a larger part of the income and free fewer resources for other activities that may be energy consuming.

- Time use. In the same way, a time-consuming activity may free less time for other activities. This can either reduce energy consumption if energy-consuming activities are given up, or increase energy consumption if the need for time-saving devices increases.
- Transport. As transport is very energy consuming, derived impacts in this area are particularly relevant. These have also been the subject of several studies on the potential for energy savings related to teleshopping and teleworking.

Changes of practices codevelop with changes in systems of provision, production processes, transport systems and many other conditions that are decisive for the overall energy impacts of social life. Therefore, it should be emphasized that our discussion of the energy implications of practice changes in everyday life can only provide a part of the puzzle – however, an under-researched part.

Empirical basis: Interviews in Denmark

The present paper is based on a case study carried out in Denmark in 2007-8. Statistics show that Denmark belongs to the group of countries where ICTs have diffused widely, so it is a relevant place to study the emerging energy impacts. As the intention is to contribute to a proactive approach towards the potential negative energy impacts, we are interested in uncovering emerging trends rather than documenting the present energy consumption. The study is thus based on interviews with persons whose use of ICTs may indicate the direction of ICT-applications in the near future. We have tried to find people who have long experience with the use of ICTs, and who have the competence to take up new applications. A few of them can be characterized as lead users in von Hippel's sense or as early adopters who are fascinated by new technologies and interested in playing with them, but most informants are just relatively heavy users with little or no fascination of the technology as such. Thus, they resemble the majority of the population and, at the same time, are a little ahead of the majority with regard to the use patterns.

Use patterns differ according to age, gender, education, and income. This is not only so because, for instance, the younger generations have grown up with ICT and thus find it easier to apply the technologies: differences are not only about competences, but also relate to different concerns and interests. To get a broad picture, we have included informants in age groups from the twenties to the seventies, men and women, with different educational background, different family situation and from different areas in the country. After a first round of in-depth interviews with seven informants, we carried out short telephone interviews with 18 people in order to select informants, who could elucidate additional use patterns in a second round of interviews. In-depth interviews of about two hours have been carried out with fourteen main informants in their homes, and in three cases, the partners of these informants took part in the interviews as well. In total, seventeen persons were interviewed in their home. In addition, 11 more people were interviewed only by phone, usually about fifteen minutes.

Before the in-depth interviews, informants were instructed to fill in two forms, one covering all the ICT equipment of the household (40 types of equipment were mentioned, and informants stated how many they had of each type), and the other covering the use of computer and internet in relation to a list of 48 activities organized in the following groups: communication, entertainment, information, purchase and sale, work at home, education, hobbies and volunteer work, administration and finances, domestic work and management of the dwelling, and finally health. Informants ticked off which applications they used each week, monthly, or more seldom. These forms served as a take-off for the semi-structured interviews that covered the everyday life of the families, the activities involving ICTs and changes in these activities over time, as well as the changes in equipment, internet and television connections over time. If energy concerns were not brought up by the informants themselves, the interviews concluded with direct questions on energy.

The pervasive integration of ICTs
The concept of ICT is relatively new, but the group of ICTs includes old technologies such as the telephone, radio and television. Although the interpretive flexibility related to the old technologies was wide and the role of and meaning attached to the technologies changed over time, they tended to be integrated in practices defined by the technologies: phoning, listening to the radio and watching television. The same could be said about practices related to the home computer and the internet at the time these technologies were first introduced, but presently they constitute a general infrastructure that can be integrated in a wide variety of practices. Few of these practices are "defined" by the use of computer and internet, but most practices are "redefined" through the integration process.

The most striking observation from our material is the pervasiveness of the integration of the new ICTs, computer, internet and mobile phone, in everyday practices. This may not be surprising, considering that ICTs support the generic activities of communication, search for information and shopping, which are integrated aspects of almost all practices in modern societies. Nevertheless, we were impressed by the degree and the ways in which our informants integrate ICTs in a variety of practices. In the following examples, we focus on some of the informants' leisure activities where, sometimes, not only the generic ICT-uses are integrated, but also more peculiar uses appear.

Several informants are active sportspeople, and some are involved in unpaid work as coaches and organizers. Mary is a coach in the local *karate* club where she trains a children's team once a week. She communicates with their parents through email and contributes with news and information about the team to the club's webpage. She also finds inspiration for her work as a coach by looking at the webpages of other karate clubs.

Tyge, his wife and one of their two children are active in *various sports*: running, playing badminton and practising step dance. Beyond the training, both parents are involved in coach meetings and take part in the committee of the local athletic association. Much communication in relation to the committee work is done by email, and almost daily Tyge receives mails with questions from members of the association; sometimes he responds while he is at work. He also uses the webpage of the municipality to search information about how to apply for funds for the sports activities.

Esben is a member of a *rifle* club, and until recently he had much work as a treasurer for the club through a period of 6-7 years. He used the computer for the accounts and found it useful to have a laser printer which could print giro forms in the correct black colour. Esben has a safe for keeping weapons for the club, and he has installed a webcamera in the room with the safe. If anything moves in the room, a picture message is sent to Esben's mobile.

The informants (or their partners), who like to *run*, all have running computers – measuring the distance and gradients of the route and monitoring the speed and pulse of the user. Also, Esben and his wife use a running computer for their long walking tours, and Esben uploads the results to the computer on their return. Michael is not interested in using the running computer he received as a subscriber to a magazine, but he has used the magazine's net-based route map where it is possible to draw one's route and measure the length.

Merete takes lessons in *line dance*. When she cannot figure out the steps, she finds the dance on YouTube: Here are videos with people who instruct in the dances.

Lise rides her *horse* one and a half hour every day. Presently, the horse is stabled at the neighbouring farm while Lise and her husband renovate their stable. When it is finished, Lise intends to have two horses who can keep each other company. She plans to install a webcamera in the stable and to access the recordings through a website so she can keep an eye on the horses without having to go out during the night. She also considers to monitor the fold in the daytime so she can watch the horses while she is at work. Then, in case of bad weather, she could decide to go home earlier. Lise teaches others to ride twice a week. She would like to video-record her trainees because you can learn much from watching yourself riding. For this purpose she would like to replace her old video camera with a new digital one which records directly on a DVD. She would also like her husband to record herself riding – and she could record his running.

The renovation of the stable is part of a larger *do-it-yourself* project where Lise and her husband renovate their home, the main building and two wings of an old farm. Preparing the rebuilding of the main house, Lise used the programme Microsoft Visio to visualize both the front and the lay-out of house. The programme is designed to visualize projects, systems and processes in flow charts, for instance, but Lise found that it served well for her purpose, and the drawings were very useful as inputs for decision-making and for discussions with others. In relation to the rebuilding project, Lise finds net shopping very useful. For instance, they succeeded in finding old roofing tiles fitting with the ones they already had.

Singing in a *choir* is also a popular pastime among the informants (surely, statistically overrepresented in this material). The couple Merete and Michael participates in a choir for beginners, organized by the rhythmic evening school. The choir has a Facebook group where the music is available so the members can practise at home. Facebook is also used for attempts to attract more men to the choir, flagging all the nice female members, and for social communication between the members. Merete uses YouTube to search for songs they plan to sing, to get an impression of how they sound in the original version.

With a basis in an association for elderly people, Brian took the initiative to establish a choir eight years ago. The choir practices once a week, and both Brian and his wife participate. Brian is responsible for the webpage of the choir which can be booked for concerts. He has also made the webpage for the choir in which one of his daughters sing.

Benny works with research in the history of music, and in his leisure time he composes and sings in a choir. He is a member of a small association of composers which has its own concert choir specialized in performing newly composed music, inspired by the vocal music style from the Renaissance. When the choir gives concerts, Benny records the music on a mini-disc, and later he edits the results on the computer, removing the applause. Sometimes he burns a CD with the sound file and discusses the result with the other composers. Benny is on the committee of the association where the members often use Skype’s chat feature to communicate, and a few times they have had meetings over Skype, supported by webcameras.

For many years Brian was involved in *amateur theatre*, both as an actor and in other functions. Now he does not act any more, but he follows the local scene, and not so long ago he video-recorded their performance of a well-known musical. Brian knows the musical so well that it was easy for him to decide when to zoom in and out. He made four recordings of the whole musical and used them as a basis for editing one high quality version. The result was burned on DVDs and Brian sold around 100 copies.

Helle is interested in *genealogy*. Her interest was aroused when her cousin made a website where family members could upload information about their ancestors and develop a genealogical tree. Helle finds information for the website by searching in online databases and by interviewing her mother. The search is made easier these years as the church registers are scanned and made available on the internet. The website of Helle’s cousin includes a page for every ancestor where it is possible to write about the person's childhood, schooling, working life and so on, and to upload photographs and film. The information is available for everybody.

The informants with schoolchildren are in contact with the *school* through the internet. Almost daily, Mary logs on to the internal pages of her daughter's class. Here she finds week plans for the class and the homework that is set for the pupils. Mary can also write messages to the teachers through the website and take part in a forum for debate.

The interview material could be the basis for filling many more pages with other examples of the integration of ICTs in various practices, from political grassroots activities to travel experiences. The examples illustrate that all kinds of public institutions, organisations, associations and interest groups have embraced the internet, and that our informants actively support this by using the facilities, sometimes very creatively. The political encouragement of the information society is visible, for instance, in the digitization of archives and in the communication systems used in schools. Many activities also involve the use of commercial products, additional to the computer, such as video recorders and running computers, commercial services such as Facebook and Picasa, and commercial software such as image editing programmes. The search for business opportunities in relation to the uptake of computer and internet results in a proliferation of supportive tools that interact with the practices in which they become integrated (e.g. work on digital photographs). Business innovation often involves a search for products or services where designers try to script specific uses, and of course, this also goes for much specific ICT equipment and software. However, the interpretive flexibility of computer and internet and – although to a lesser extent – of the many related products and services is great and opens up a large potential for user creativity. Some of Lise's ideas, mentioned above, are illustrative; as she says: "I use my pc for everything I can possibly think of using it for".

The integration of ICTs does not proceed smoothly, as the examples above may indicate. On the contrary, nearly all informants mention problems, for instance, with compatibility. At the time of the interviews, the diffusion of Windows Vista created many problems and frustrations. For instance, Merete and Michael have Vista on their new laptop, but Merete's new MP3-player and the editing programme for Michael's digital camera does not work with Vista, and they cannot find a Vista-compatible driver for their scanner; in the short term, they solve their problems by using their old computer. In addition to Vista, many other problems occur. For instance, Helle and Sten experienced problems with the installation of Skype and with the setting up of the virus programme so that it did not prevent the playing of advanced games. Two of our informants belong to the group of "amateur experts" for whom it is a hobby in itself to help others with their ICT-problems. After his retirement, Brian tries to commercialize his consultancy (beyond the family) and offers to come to people's homes to repair their computers and to teach them how to use various standard programmes. Brian's market segment is retired people who usually have very basic problems. Due to his consultancy work, Brian found he had to install Vista on his new computer, but he is really annoyed with the programme and has difficulties in doing the usual things. Esben helps a large group of family and friends without any pay, except for the odd bottle of wine. His interest in computers goes back to Commodore 64, and he enjoys repairing computers, cleaning them for viruses, and trying out new equipment, programmes and internet services. One of the persons Esben helps is his 82-year old father-in-law. When he needs help, they communicate over Messenger, and if it is a bit complicated, Esben takes over the control of his father's computer over the internet by using a crossover programme. The programme is freely available on the internet, and Esben uses it when helping others as well.

Summing up, the combination of commercial innovation, public encouragement and user creativity implies widespread changes in many everyday practices, even sometimes encouraging people to engage in practices which did not interest them before (cf. the genealogy example), and these practice changes affect energy consumption. The pervasive integration of ICTs in everyday life is therefore fundamental to increasing energy consumption in several ways (here with focus on direct and indirect energy impacts – examples of derived energy impacts will be discussed later):

- When people integrate computers and internet in all sorts of doings, they increasingly want to have access to their own personal computer, not sharing it with anyone. For heavy users, like most of our informants, this has already been standard for years, and many have more than one computer per person. Several reasons are mentioned for having more than one computer: For instance, some of the informants keep their old computers with previous versions of operating systems in order to execute software that is not compatible with newer operating systems such as Microsoft Vista (cf. the example with Merete and Michael), and some informants have two or more computers dedicated different practices (like Sten, who finds it convenient to have two computers running at the same time while he plays World of Warcraft; one for World of Warcraft and Skype, and one for browsing the internet, e.g. visiting websites describing the guilds in World of Warcraft). The growing number of computers contributes to an increase in the indirect energy consumption related to the production of computers and also, if more than one computer is running at the same time, an increase in the direct energy consumption.
- Integration in many practices makes it unpractical to turn off the computer(s). While at home, many of the informants leave their computer turned on (sometimes in standby mode) and walk to and fro it several times during an ordinary evening or weekend. Most of these informants connect this with a question of convenience – for instance Norman, who explains that he and his wife are annoyed if they have to wait for the computer to start up, e.g. if they want to see the weather forecast on the internet.
- As long as the practices only call for the use of computer and internet, they may not be very energy consuming (e.g. simple communication without demand for advanced graphics), and it is, indeed, possible to be a heavy user without having a high energy consumption. But specialized equipment is increasingly offered for many practices, which also contributes to the indirect energy consumption. Some of the examples from our interviews are running computers, webcams, headsets, external hard disks and, in a certain sense, also digital cameras.
- When ICTs are integrated into so many practices, it becomes even more important to become mobile. This calls for mobile internet access (new equipment) and results in more data traffic on the infrastructure that supports the mobile internet (sending masts etc.). In both cases, the outcome will be an increase in the indirect energy consumption.
- Finally, the integration of the internet in more and more practices involves a general increase in data transmission and bandwidth adding to indirect energy consumption for running the infrastructure.

For each single practice ICT is integrated into, the increase in direct and indirect energy consumption might seem negligible. However, like in the saying “many a little makes a mickle”, the important observation is that the pervasive integration of ICT across a large number of practices involves considerable effects for the total energy use related to everyday life.

In the following, we try to develop our analysis further by studying a specific practice more detailed in order to illuminate some of the possible derived energy impacts from practice changes related to the integration of ICT. Our tentative results might inform further studies on the wider energy impacts of the pervasive integration of ICT in everyday practices.

“Stay in touch” – a practice in change?

A considerable part of the informants’ use of ICT is related to communication of some kind. However, communication is, in itself, a general feature of all social interaction and mediated as well as non-mediated communication is embedded in virtually all social practices. It is therefore meaningless to identify communication – or, for that matter, social interaction – as a specific and delimited practice. Instead, we have chosen to study the practice of "staying in touch" with friends and relatives, which several of the informants identify as a meaningful cluster of activities that makes sense as an entity.

There are several reasons for choosing the practice of "staying in touch" as a case for more detailed study: First of all, the practice is important for the reproduction of meaningful relations between friends and relatives. Secondly, our interviews show that ICTs play a particular role in this practice; the changes due to the integration of ICT are therefore so profound that it makes sense to discuss the derived energy impacts. Finally, all informants have experiences with the practice, which provides us with a broad empirical material.

The practice of "staying in touch" comprises the communication between relatives and friends who do not meet on a regular and daily basis and where the focal point of the communication is an exchange of "news" about the individual life and doings of the interlocutors. This excludes the communication related to the daily practical and symbolic reproduction of the relations between close relatives, i.e. between partners or between parents and their children living at home, as well as the communication related to volunteer work, sports or similar kinds of communities of interests.

Before the "digital revolution" in personal communication at the turn of the century, the practice of "staying in touch" involved physical meetings (co-presence) and mediated communication in the form of phone calls and in some cases even letters. Today, these forms of interaction have been supplemented with – and with regard to letters and landline telephone calls to some degree displaced by – a wide range of other media and internet services like mobile phone calls and short text messages (SMS), email, instant messaging, weblogs, IP-telephony and social networking websites like Facebook and MySpace. It is important to note, that there is a great variety in the number and combination of new media that the informants employ in relation to the practice of "staying in touch"; some informants primarily use email and mobile phone, while others combine up to several internet services. Also, the informants ascribe different meanings to the media; for instance, some informants associates MSN Messenger with different threats like virus and spyware or the risk of child abuse (two of the informants have forbidden their children to use Messenger), while others enthusiastically embrace it as an "interesting and quick" (Mary) way of communicating with friends and relatives. In spite of these differences, the interviews show that for most people a number of new ICTs have been integrated into the practice of "staying in touch".

In order to illustrate how new ICTs are integrated into the "stay in touch"-practice – and how the practice is changed – we will provide a more detailed description of how the informant Grethe combines different internet services in her performance of the practice:

Grethe is 51-year old, trained as a library assistant and employed as IT consultant at the local library. She lives with her husband Rasmus, who is a bricklayer, in a detached house in a Danish provincial town. Grethe and Rasmus both have children from previous marriages: Grethe has two grown-up sons (21 and 30 year), while Rasmus has two children (13 and 15 year) who live at their mother's place and visit Grethe and Rasmus often. Grethe differs from most of the other informants with regard to the large number of internet services she integrates into the practice of "staying in touch" with friends and relatives. This may partly be due to her great interest in new ICT and her playful attitude towards trying out new media and services. However, most of her examples of ICT use are comparable with the descriptions given by other informants.

The following list summarizes how Grethe integrates ICTs into the "stay in touch"-practice:

- *Email*. On a typical day, Grethe sends and receives several personal mails to/from relatives and friends. Often in order to make some kind of appointment or to get news about their personal lives and to hear how they are. She explains that emailing represents an easy way to "keep in contact" with friends and relatives in a busy everyday life. Similar examples of sending/receiving personal emails can be found in all interviews.
- *Instant messaging*. Grethe often communicates with friends and relatives through instant messaging (particularly Google Talk and the chat-feature on Facebook). When she is working at her computer – and logged in to her Google and/or Facebook account – her contacts can see that she is "online", and they often write short greetings to her. According to Grethe, most of it is "just chit-chat" like "hi, when shall we meet again?" or "what are you doing right now?" Sometimes she log out of Google Talk and Facebook (or change her status to "offline") because she feels that the messages interrupt her in her work. Thus, the use of instant messaging can create a fragmented experience of time. Some of the other informants also use instant messaging, and their descriptions resemble Grethe's very much. For instance, Esben (a 51-year old electrician) communicates with his nephew in Australia through Messenger. The nephew also sends him pictures via Messenger, and Esben prints out the pictures and gives them to his mother (the nephew's grandmother). Esben finds it easy and cheap to use Messenger.
- *Facebook*. Grethe originally created a profile on Facebook because she was interested in visiting her niece's profile on Facebook. Later she became "friend" with her sons, and then with their friends (whom she already knew) and so on. She describes Facebook as a "paradise of teenagers" and as "pure amusement". Grethe and her "friends" write short greetings to each other. While Grethe does not use Facebook to get into contact with old friends, some of the other informants have re-activated old friendships through Facebook. One of these is the 28-year old Benny, who rediscovered several old schoolmates (from public school and high school). By reading the personal news posted on their profiles or sending/posting messages to them, he gets an idea of "how their life is today". Their reunion on Facebook has been followed up by a "reunion party". There seems to be an element of ambivalence related to the informants' experience of Facebook; they find the universe of Facebook both fascinating and captivating, but at the same time – and for the same reason – they are afraid of using too much time on Facebook. One of the informants, Gry (35-year old and writing on her master thesis in anthropology) even describes herself as "addicted" to Facebook, and she has found it necessary to set up a number of rules for her own use of Facebook. Gry has 120 "friends" on Facebook (many of these are related to her work as volunteer in a political party).
- *Web albums (digital photographs)*. At social gatherings with friends or relatives Grethe often takes pictures with her and Rasmus' digital camera. Afterwards she edits the pictures in Google's image editing programme Picasa, uploads them to a folder on Picasa's web album and invites, by email, her friends or relatives from the social gathering to visit the folder and download the pictures. Also, Grethe uses Picasa's web album to keep in contact with one of their old neighbours that moved to Singapore some time ago. She uploads photographs from social gatherings in the neighbourhood and shares them with the old neighbours so that they can follow the life on the street. Similarly, the old neighbours upload pictures from their own life in Singapore and share them with Grethe and Rasmus. In this respect Grethe differs to some degree from the other informants, as none of these integrate web albums in the practice of "staying in touch" with friends and relatives to the same extent. Grethe's story illustrates the multiplicity of internet services that can be integrated into this practice.
- *Weblogs*. Rasmus' children write about their personal life on their own blogs, and if Grethe or Rasmus have not heard from them for some time, Grethe sometimes visits their blogs to see "what they potter about with at the moment" and occasionally leaves a greeting in the

form of a comment. Grethe explains that it is a way of "keeping in contact" with the children if they are too busy to stay in touch with their father and her.

These examples of the integration of ICT into the practice of "staying in touch" can be supplemented with other examples from our interview material. For instance, several informants use *IP-telephony* (Voice over IP, VoIP) regularly. One example is Benny, who talks with his parents via Skype. Benny and his wife have given his parents a webcam in present so that they now can both hear and see each other through Skype. "It gives a really nice feeling that one can see each other", Benny explains. Also, the 49-year old truck driver Sten frequently plays with his 26-year old son, who has moved to another part of Denmark, in the *multiplayer online role-playing game* World of Warcraft. Their characters "meet" and "fight together" in the World of Warcraft-universe and, while playing, father and son talk with each other through Skype. Their conversations are about shared experiences in the game as well as about personal matters not related to the game. Sten has also established a kind of friendships with fellow players he has never met before. World of Warcraft is their shared interest, but he also learn about their personal life through their conversations via Skype (while they play together).

On the basis of this brief introduction to our empirical results, general observations can be made about the possible changes of the practice of "staying in touch" that follows with the integration of ICT: First of all, our interview material shows that a *multiplicity of possibilities for mediated social interaction* with friends and relatives have emerged on the internet. Some of these resemble previous forms of communication to a great extent (e.g. the use of Skype as a cheap alternative to phone calls on the landline telephone), while it in other cases is less obvious to establish a line back to previous communication forms (e.g. video-telephony, instant messaging, multiplayer online role-playing games, weblogs and sharing digital photographs on the internet). Another important observation is that *mediated interaction is intertwined with non-mediated, co-present interaction*. Our interviews include only few examples of relationships based exclusively on mediated interaction (one of these exceptions is Sten, who does not meet physically with the fellow players he learn to know in World of Warcraft).

Several of the informants describe the new possibilities for internet-based interaction as a *convenient way* of staying in touch with friends and relatives in a busy everyday life. To communicate through internet services seems to be less committing than other modes of interaction such as phone conversations and – of course – physically co-presence. It is easier to finish the interaction (e.g. a conversation on Messenger) without violating traditional norms of "good behaviour" such as those related to phone conversations, and internet-based interaction rarely last for a long time. Furthermore, many internet services are based on asynchronous interaction (e.g. email, Facebook and blogs). However, some of the internet services, for instance instant messaging, seem to contribute to an experience of *time fragmentation* or are viewed as potentially *time-consuming*. Several of the informants therefore develop "strategies" to protect themselves from being interrupted by personal messages or from using too much time on e.g. Facebook.

Social networking websites such as Facebook and MySpace (but also other internet services like multiplayer online role-playing games) seem to make it *easier to establish contact to and keep in contact with a larger number of friends and acquaintances*: Old friendships can easier be re-activated (like in the case of Benny and his old schoolmates); peripheral acquaintances or friendships with persons living abroad are easier maintained (like in the case of Grethe and Rasmus' old neighbours in Singapore); and new friendships can be established around a shared interest (like Sten and his fellow players on World of Warcraft or like Merete, who is looking for persons on Facebook to share dinners with). Like a rolling snowball, some of the most dedicated users of social networking services build up a larger and larger network of social relations (many of these quite peripheral).

Summing up, our interviews indicate, that the practice of "staying in touch" with friends and relatives can be in a slow transformation (partly as a result of peoples active integration of new ICTs). To some degree, mediated interaction with friends and relatives has become a continuous flow of frequently recurring interactions, where each interaction often is short-time and in many cases asynchronous. This mode of mediated interaction has similarities to what Licoppe (2004) denotes as "connected presence" in relation to the use of mobile phones (see also Christensen, Forthcoming on family members' use of mobile phones). This raises the question of what kind of derived energy impacts that can be the result of these emerging changes.

Derived energy impacts of the changing practice of "staying in touch"

Before discussing the derived energy impacts, it is worth noting that our analysis of the "stay in touch"-practice supports the previous observations regarding the increasing direct and indirect energy consumption that follow from the pervasive integration of ICTs in everyday life. First, the frequent use of a multiplicity of different internet services for mediated interaction supports the trend towards individual computers that are turned on and online during most of the evenings and weekends (as well as increasing data transmission on the internet). Secondly, some internet services call for specialized equipment (e.g. Skype that necessarily depends on microphone and speakers/headphones for voice-calls and also webcams for audio-visual calls). Thirdly, in a situation where social interaction with friends and relatives is increasingly scattered over time and over a multiplicity of media, it seems likely that the demand for mobile internet access will increase. However, the observations that can be made with regard to the derived energy impacts are rather ambiguous, and the following should therefore be regarded as tentative attempts to outline some of the possible derived impacts with regard to economic resources, time use and transport.

Most of the internet services used by the informants are free of charge (among the exceptions are Skype Out – used for calls to ordinary phone numbers – and World of Warcraft). The integration of ICT into the practice of "staying in touch" therefore seems to result in a very limited increase in the user's expenditure – or even a decrease, if the use of the internet displaces the use of the landline telephone (as was the case for several of the informants). However, a considerable increase in expenses might be expected in relation to the diffusion of mobile internet access via mobile phones, PDAs etc, which might free fewer resources for other energy consuming activities. But as mobile internet access in itself can be expected to involve substantial indirect energy consumption in relation to the production of the required equipment as well as increasing data transmission, it is unlikely that the total energy consumption is going to decrease.

With regard to the derived impacts related to time use, the most significant change seems to be the previous mentioned increase in the fragmentation of the time experience, which calls for new strategies to handle the time fragmentation. These strategies might include the use of new services and products. For instance, Grethe sometimes uses a service called Meebo, which through simultaneous connections to multiple instant messaging-services makes it possible for her to see her MSN Messenger and Google Talk messages and contacts in the same window. To what extent these new strategies to handle time fragmentation involve increased energy consumption is, however, difficult to determine on the basis of our empirical material.

With regard to transport, our interviews do not indicate that mediated interaction "substitutes" physical co-presence or reduce the number of physical gatherings between relatives and between friends (and thus results in less transport). This is perhaps related to the understanding that this kind of relations should, above all, be based on physical interaction (co-presence) to be "real" or "authentic". For instance, Benny feels that he to some degree has to "compromise himself" when he, via Facebook or MySpace, is contacted by people he has never met before. And if these contacts are not followed up by physical interaction (co-presence), they tend to die out after only a few instances of mediated interaction.

Rather than reducing transport, the new possibilities of establishing contact with and to stay in touch with a larger number of friends (the “rolling snowball”-effect) might in fact implicate more transport. As one’s social network is enlarged, the number of occasions to meet increases correspondingly. For instance, our empirical material includes examples of informants, who have re-established contact with old schoolmates via Facebook and, as a result of this, attended “re-union parties”. Another example is Merete, who looks for new friends to share dinners with (mentioned above). A third example is Grethe and her husband Rasmus, who stay in touch with their old neighbours now based in Singapore. Although this contact has not yet resulted in a visit to Singapore, it is likely that the use of ICT to stay in touch with old friends living abroad increases the likelihood of following the mediated interaction up with a visit.

Concluding remarks

By having practices instead of single artefacts as the focal point of the analysis of everyday life, technology and energy consumption, it becomes possible to analyze new aspects of the complex interaction between a given practice and groups of artefacts (in our case ICTs), which are integrated into the practice and thereby contribute to changes not only in the practice itself but also in the energy consumption related to everyday life. This appears from our (tentative) study of the practice of “staying in touch” with friends and relatives, which indicates that changes in this practice have to be analyzed in relation to the complex of different ICT products and services that are integrated into the practice. These products and services contribute – separately and together – to the change of the practice itself and the changes in the direct, indirect and derived energy impacts.

In this study, our focus has been on the use of computer and especially the internet, but it is obvious that also other technologies like the mobile phone and the landline telephone play an important role as material elements of the practice of “staying in touch”. Likewise, also other constitutive elements of practices such as images/meanings and skills/competences should be included in further studies on how ICT is integrated into everyday practices. For instance, with regard to the practice of “staying in touch”, several of our interviews indicate the existence of some kind of interplay between, on the one hand, the new possibilities of staying in touch with friends and, on the other, widespread ideas about globalization and how geographical distance should not hinder social interaction – an interplay, which might contribute to changes in the practice and perhaps result in increased transport. In a similar way, it would be interesting to study whether the images of friendship are in change and – if so – what the implications could be for the practice of “staying in touch” and the transport related to face-to-face interaction (co-presence).

As these examples illustrate, the combination of the perspectives of domestication and practice theory creates a fruitful and productive analytical approach, which raises a number of interesting research questions (although these questions are far from answered by our own tentative study).

With regard to the analytical results of our study, our interviews indicate that the pervasive integration of ICTs across a large number of practices contributes to an increase in the direct and indirect energy consumption related to everyday life. With regard to the derived energy impacts, the conclusions are more ambiguous. However, our discussion of the changes of the “stay in touch”-practice suggests that more travelling could be a result of the new possibilities of maintaining a broader network of friends and relatives via internet services. Future studies may provide a more elaborate analysis of this.

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Bilag 5: Households' use of information and communication technologies – a future challenge for energy savings?

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Households' use of information and communication technologies – a future challenge for energy savings?

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Keywords

Information and communication technologies, energy consumption, energy savings, energy efficiency, home, consumers, TV, domestication, scenarios, everyday life, practices, interviews, households, consumption dynamics.

Abstract

Increasing consumption of electricity due to a growing number of information and communication technology (ICT) appliances in households is a major challenge to reducing energy consumption. Several studies have predicted escalating ICT-related energy consumption, but relatively little has been said and done about possible initiatives to curb this increase.

This paper presents results of a research project focusing on how dynamics of consumption influence household energy consumption on ICT. Results of the project include scenarios on how electricity consumption on ICT is expected to grow, suggesting that in a few years on average ICT will make up half of household electricity consumption. Recent initiatives from various actors to prevent this development are presented and discussed, and difficulties in regulating this area, as compared to other parts of household electricity consumption are highlighted. Through presentation and discussion of qualitative interviews with families having extensive ICT use in their everyday lives, the interviews illustrate how users domesticate and use technologies in many different ways. The interviews reveal a variety of practices and dynamics in different aspects of everyday life, including sport, shopping, entertainment and different hobbies. The growing electricity consumption related to ICT is thus as dependent on the consumers' use and domestication of the technologies as on the energy efficiency of the appliances. By analysing the interviews with the use of theories of domestication of technologies, it is argued that aspects such as consumers' creativity in technology use and their non-adaption are relevant aspects to include in policy and regulation discussions on how to limit the escalating electricity consumption from household ICT use.

Introduction

In recent years the amount of ICT in households has risen dramatically, and as a consequence we have also seen growing electricity consumption for these types of consumer electronics. Even though we know that ICT is having an important impact on energy consumption, there is still quite scarce knowledge on this aspect of households' electricity consumption. As stated by the British Energy Saving Trust: "To conclude, consumer electronics is the most under-represented sector in terms of data and information held. It is also the fastest moving sector which makes it very difficult to monitor and forecast. Priority should be given to improve the evidence and knowledge base, especially on consumer behaviour" (Owen, 2006). New knowledge is needed, as well as new policy and strategies to handle this growing challenge.

On the background of this insight a research project has been put together, which on the one hand focuses on the estimation of electricity consumption related to household ICT use and on the other hand focuses on understanding consumers' use of the technologies to give recommendations on how to regulate it. In this project we define ICT as including information and communications technologies (computers, laptops, monitors etc.), as well as consumer technologies (TVs, DVDs etc.). When estimating electricity consumption, electricity consumed directly in the home as well as energy used indirectly to maintain the communication channels and produce the hardware was investigated. For direct electricity consumption in the homes, the project built scenarios to quantify different possible futures of ICT-related electricity consumption in households. Questions have been raised, such as how future household electricity consumption can be influenced by further expansion in the number of ICT appliances and in the use of the ICTs, combined with more efficient ICTs. The study of consumers' use of ICT builds on qualitative studies with people who have extensive ICT use; people who can be seen as pioneers in the use of ICT and who can possibly indicate the directions ICT will take in the near future . The purpose of these qualitative interviews is firstly to give input to the quantitative scenarios of how electricity consumption related to ICT might expand, and secondly, and perhaps more importantly, to reveal how and why consumers adopt these technologies and the different ways in which it happens. Most efforts in policy and regulation of ICTs focus on the technologies and on how they can be made more efficient. One idea in this project is that knowledge of consumers' use and domestication of technologies has to be incorporated into the efforts to regulate the electricity consumption related to ICT use, and for this purpose knowledge revealed in the qualitative interviews is relevant. Finally as a last element in the project, main actors within policy issues have been invited to a workshop to discuss the results of the project and contribute their viewpoints on how to regulate, or in other ways prevent the escalating electricity consumption from ICTs.

The following sections of this paper first introduce the methodologies of the different parts of the project. This is followed by the results from the scenarios on how ICTs are expected to consume half of all electricity in households in the near future. The following section is an introduction to the kinds of policy instruments and initiatives that are currently in use or being discussed in relation to ICT and household electricity consumption. One of the conclusions here is that the main focus is on more efficient technologies. This discussion points towards the conclusion that consumers and their use of ICT are not really seen as part of either the problem or the solution. Taking this as a challenge, the rest of the article focuses on how different consumers use and domesticate technologies in very different ways. Theories of domestication are introduced and the qualitative interviews are analysed within this theoretical framework. The insights are used to point towards how, for instance, the creative or the resistant consumer has to be seen as part of a political regulation of household ICT use.

Methodology

The project consisted of four parallel parts:

- An extensive literature study to quantify the indirect energy required for households' use of ICT. This includes the energy consumption related to the manufacturing, transport and disposal of residential ICT appliances and the energy consumption related to the ICT infrastructure related to residential ICT application (Willum, 2008).
- Scenarios for households' ICT-related electricity consumption. This part is based on the forecast model "Elmodel Bolig" developed and owned by the Danish energy authorities and major energy suppliers. The model contains a large volume of data on households' use and ownership of energy-consuming appliances (including ICT) based on survey data combined with data on the energy efficiency of the products. On the basis of this the model, it can be estimated how present household electricity consumption is used in different types of product. With input on possible future ownership and patterns of use, the model can correspondingly estimate future electricity consumption.
- Qualitative interviews with ICT users: 14 in-depth interviews with ICT users. The interviews lasted from 1½ hours to 3 hours, and took place in the informants' homes. The informant's were aged between 25 and 75 years, and in three cases included their partners. Potential informants were asked to fill in a short questionnaire concerning their

ICT use (we wanted people who were interested in ICT, but not people who were experts). The themes of the interviews were the use of different ICTs, and the practices related to them. Energy use was not a central issue, although informants were asked about their experiences and practices in relation to energy consumption and the ICT equipment.

– Workshops with relevant policy actors: A workshop on possible ways to reduce ICT-related energy use in households was held with representatives from different parts of the sector – producers, interest groups, policy makers, practitioners etc. Here, different themes were discussed: producer-consumer regulation, TV replacements, regulation of the indirect energy use for ICT and intelligent home control.

Scenarios

Purpose, method and assumptions

The purpose of these scenarios is not to predict the future, but rather to raise substantive debate about possible future developments – what is likely to happen if no action is taken? The scenarios are based on standard assumptions from Elmodel-bolig forecasting model, complemented by the project's own assumptions on growth in use and ownership of PCs and TVs in the coming eight years compared to the previous seven years. When comparing the present with the previous years and when predicting the future development, the total number of households and the mean size of households are taken into account. An increasing number of households only consist of one person, meaning that even with a steady population we will see a growth in the number of households, and this is also part of the explanation for the growing number of ICTs. However, in the scenarios we have not taken account of how the international financial situation will influence consumer behaviour. There are two scenarios, a low and a high, for the year 2015, with different assumptions in number and use of TVs and PCs respectively. Assumptions related to ownership and use of technologies in the scenarios are shown in Table 1. The low scenario is based on the assumption that we will see continued growth, but with lower growth rates in the future compared to what we have seen up till now, both related to number and use of TVs as well as PCs. Whereas in the high scenario we assume escalating growth rates in the number of TVs and a stable growth rate in the number of PCs. Furthermore in the high scenario the time of use per appliance is expected to have a higher growth rate for TVs, whereas for the PC we expect the growth rate to be a little more modest than the very high rate we saw in the previous period.

Table 1. Calculation base for ICT scenarios. Columns "2000" and "2007" show actual stock and use of ICT on average per household in Denmark. For 2007 the actual growth in percent between 2000 and 2007 is shown. Column "2015, low" and "2015, high" show the assumptions for respectively the low and high scenario, and the predicted growth compared with 2007 is shown in percent.

	2000	2007		2015, low		2015, high	
			% growth		% growth		% growth
TV, number per household	1.4	1.9	35%	2.1	10%	3.1	63%
TV, time of use per appliance? (hours)	3.5	4.6	31%	5.2	13%	6.2	35%
PC, number per household	0.8	1.6	100%	2.4	50%	3.3	106%
PC, time of use per appliance? (hours)	2.4	5.4	125%	7.0	30%	8.0	48%

The arguments for these trends are found partly in the qualitative interviews, where there are different examples of what extensive ICT use might look like, and partly in the literature on ICT use.

The arguments for continued growth in the number of TVs are that new types of TV on the market, including digitalisation, will increase households' need and desire to buy new TVs. When households buy a new TV, experience shows that they usually use the old TV in a secondary room rather than dispose of it. Arguments for continued growth in the use of TV are that TVs can be used as radios and that the big TV screens can be used as picture frames when not actually being used for watching TV (Crosbie, 2008). Arguments against a continued high growth rate are that computers may take over some of the roles of TV as a channel for news, information and entertainment. This might influence the number of TVs as well as the use of TVs. The total number of TVs may be reaching a saturation point as many families already have TV in most of their rooms including living room, kitchen, bedroom and children's rooms, though TVs in bathrooms may be a new area for expansion.

The arguments for continued high growth rate of computers in the scenarios are based on the premise that individualisation in the household makes it normal for every person in a household have their own PC, including older citizens and young children. Furthermore we will see more specialisation in the use of computers, making it normal for each person have several computers for different purposes as computers become more integrated in still more everyday activities (one for IP telephone, one for games, etc). Arguments for a continued growth in the use of PCs derive from evidence that we see still more activities and hobbies requiring computers as an integrated part.

Other assumptions for the scenarios are formed from the belief that technologies, such as DVD and set top boxes, will follow the development of TVs, that printers etc. will follow the development of PCs, and that all households will have Internet connection, two electronic photo-frames and a mobile hard disk. For wireless telephones no further development is expected, for clock radios and Hi-fis, the hitherto development is expected to continue. Technology type (for TV: CRT, LCD or plasma screen, and for PC: laptop or stationary) are based on present sales figures which are extrapolated and combined with assumptions of average lifetime per appliance. Energy efficiency of technologies is based on knowledge of the hitherto development of energy efficiency per appliance type and this development is predicted to continue both in relation to standby and on modes.

There may be many arguments for and against all these assumptions, however, the purpose here is not to predict how the future will actually be, but rather to exemplify that there is likely to be a form of continued growth in ICT use and ownership, and then to quantify the likely consequences for electricity consumption.

Findings and interpretations

With these assumptions the scenarios show an increase in ICT-related electricity consumption in Denmark from approximately 2,200 GWh per year in 2007 to almost double (4,200 GWh per year) in the 'low' scenario, and 5,100 GWh in the high scenario, per year in 2015. In Figure 1 this is shown for an average Danish household, where we also see that ICT-related electricity consumption will be between 45 and 50% of households' electricity consumption in 2015, compared to around 20% today. The scenario for "Non ICT" follows the standard prognoses from EL-Model Bolig.

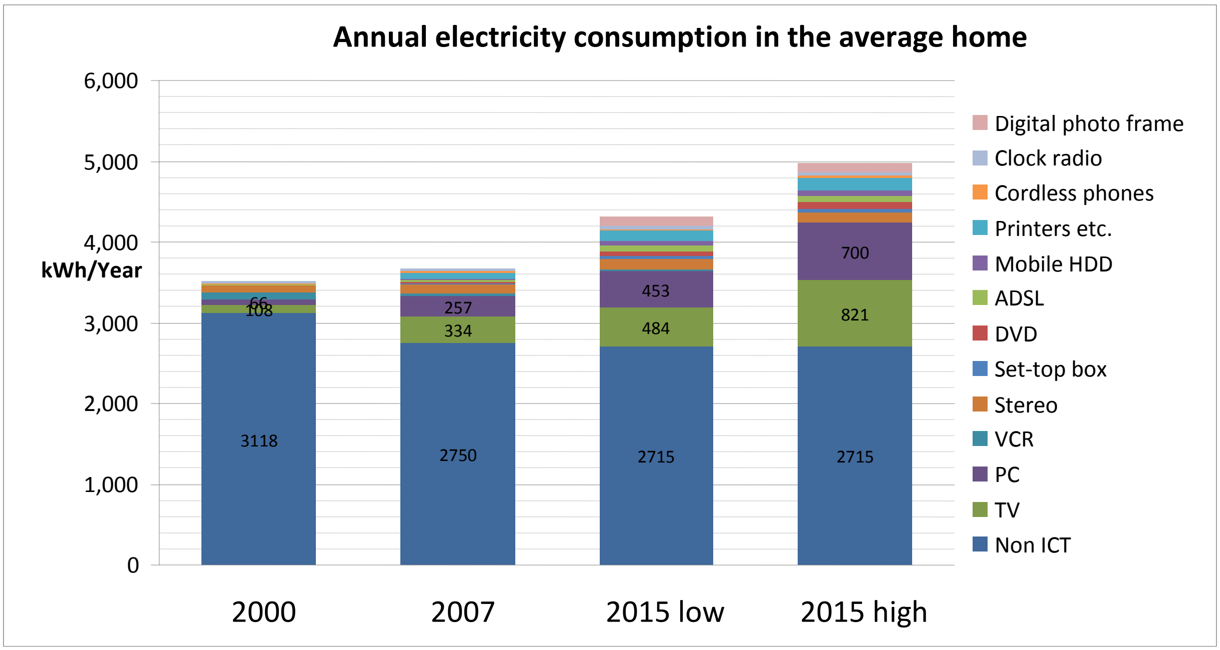

Figure 1. Scenario calculations "high" and "low" for ICT-related electricity consumption in households. *The scenarios are for 2015 together with actual ICT consumption in 2000 and 2007 and are shown as a proportion of households' total electricity consumption.*

These scenarios show that if nothing is done to prevent it, it is very likely that household's ICT-related electricity consumption will expand in the future even though standard assumptions of more efficient technologies are included in the calculations. This means the expansions we are predicting follow primarily from a growing number of technologies in households, together with growing use of these technologies. The scenarios highlight that strong focus on the consumer behaviour related to ICT is needed. In the following section we will continue with a description of the type of initiatives that are already in place or are being discussed as means to prevent this escalating electricity consumption from household ICT use.

Initiatives and challenges for ICT energy efficiency

In the following section we will give a short review of current international and Danish activities to reduce environmental impacts from the use of ICT, and some of the challenges for these initiatives, especially related to the role of the consumer.

It has taken some time to realise what impacts the emergence of ICT technologies might have on electricity consumption and other environmental impacts. As early as in the 1990s, literature included headlines such as "Dig more coal – the PC's are coming", "IT and the $8 Billion Electric Bill", "The Internet: the most important driver for future electricity demand in households", and "Future shock: Challenges from a new generation of appliances", all of these raising the issue of electricity consumption related to the emerging number of ICT appliances in households. Although this caused the International Energy Agency (IEA) in 2002 to label this development as one of the main challenges for future energy policy (IEA, 2002), it has taken time for national and international regulation to tackle this challenge. In recent years a number of political initiatives to reduce ICT-related energy consumption have been launched, but it is clear that these initiatives also face various challenges.

Our workshop with representatives from different parts of the sector (producers, interest groups, policy makers, practitioners etc.) on possible ways to reduce the ICT-related energy use in households, showed that several actors see energy efficiency of products and environmental labelling as the primary tools. A main initiative is the EU Eco-design Directive, which is expected to have a great influence on the efficiency of ICT equipment. The Eco-design Directive aims at establishing minimum standards for ICT equipment in order to keep the poorest products (in relation to the energy efficiency) out of the market, as well as to develop energy labels for ICT and abandon certain technologies (for instance the incandescent light bulb). So far standards for two groups of products have been established (external power suppliers and simple digital signal converter TV boxes). Also, a standard on maximum standby consumption for all equipment has been established. As production and trade of ICT products are global, it is obvious that possibilities for establishing environmental labelling of ICT products at national level are very difficult. There have been national initiatives in Denmark to establish an energy label for TVs, but these stranded after resistance from members of The Consumer Electronics Association[1] and discussions concerning different standards to measure energy consumption. The international approach however means that there are many different opinions amongst producers on how the labelling should be arranged, with a slower ensuing decision-making process. Consequently, international regulation such as the Eco- design Directive reacts relatively slowly compared to the speed of the market and the development of new products. It has been argued that new low-energy TV screens (OLED and FED) could have been developed much faster with public support, and could possibly have been on the market by the time of the digital shift, at the end of 2008 (Crosbie, 2008).

Another shortcoming of the present labelling system is that it does not include the indirect energy consumption related to the use of ICT technology. It requires energy to manufacture and dispose of appliances and objects, and it requires energy to ensure that the infrastructure is in place. A study conducted as part of the project shows that for each kWh used at home, it takes roughly 1 kWh to produce, transport and dispose of the hardware, and ½ kWh to operate the Internet and related facilities (Willum, 2008). This consumption is largely driven by consumer demand and usage of ICT technology, but it has not been addressed at all in existing policies. Therefore, energy labelling as we know it might not be able to include all environmental aspects of the product.

Moreover, it has proven difficult to involve the retailers in energy questions, and therefore relevant information on the energy qualities of ICT products does not often reach consumers. An acknowledgment of this barrier is that the private Consumer Electronics Association have launched a campaign towards retailers to make them promote 'green IT', with a competition and a prize for the salesmen who are best at selling green IT products.

At national level, in 2007 the Danish government launched their 'Green IT' action plan. This plan includes a number of different initiatives towards industry and private consumers. For instance, industries are encouraged to launch their 'good stories' on how they have reduced their power consumption by using intelligent IT, as well as a 'knowledge bank' to illuminate and visualise the ICT-related power consumption. Several members of the Consumer Electronics Association and IT Business[2] have taken an active part in the campaign. Initiatives towards consumers include an information campaign targeting the young 'digital natives' through Arto and Facebook. However, it is difficult to see

[1] The Consumer Electronics Association (in Danish 'Branchen Forbruger Elektronik, BFE) is an umbrella organisation for various interest organisations amongst producers, manufacturers and providers within consumer electronics.

[2] The Danish IT Industry Association (ITB) is the largest and leading independent representative for the IT business community in Denmark, and counts more than 500 IT member companies.

how this will seriously engage consumers in energy savings on a wider scale, and the campaign has also been criticised for being too unambitious.

The ICT-theme is also being increasingly integrated into existing policies for energy reductions in homes. The Electricity Saving Trust that was established in 1997 to promote electricity reductions in households, industries and institutions, carries out a number of activities to reduce ICT-related electricity consumption, including advice provided on their homepage, and in campaigns, directed towards ICT producers as well as consumers. They also engage in energy-related discussions on topics such as remote sensing in households, and launch tools to monitor and control consumption in the home. Such ‘intelligent home management’ is seen by the Energy Saving Trust as an important opportunity for saving electricity and energy. As a consequence, the concept of 'the intelligent home' is increasingly being linked with concepts of 'sustainability' and 'energy-savings'. The Energy Saving Trust sees a large potential for intelligent management and operation of the home and has launched a web-based control unit ('MyHome') that enables intelligent control of equipment in the home, including ICT-related equipment, lighting, white goods, and heating etc. The Trust optimistically estimates that it is possible to save up to one-third of the domestic energy consumption by using intelligent control. However, this is not without problems. Those of our informants who had established such control systems also see large potentials in this type of solutions, but they also points out a number of barriers. One is the different standards – for instance, the preferred control system (Lauritz Knudsens’ programmable system, ‘LK IHC’) is not compatible with the system that the Electricity Saving Fund promotes (Z-wave technology). Another problem is the lack of user-friendliness in the ‘LK IHC’ control board; it is very difficult to program and thereby adapt the system to the individual family.

The ICT theme is also increasingly being raised in the Danish ‘energy-saving centres’, where independent energy consultants can take initiatives for energy savings into private households, industries etc., as well as advising consumers who are seeking information on energy savings. A survey of energy consultants carried out as part of the project showed that ICT-related issues were raised regularly in questions from consumers, but also that the energy consultants felt they lacked information on these issues.

In generally, one of the big challenges in the TV market is the pending digitalisation of TV services and the shift from CTR screens to digital screens (mainly LCD of plasma), which implies a large technological shift in household ICT equipment. On the one hand, this can be seen as a possibility to increase energy efficiency, but on the other hand it contains risks for more energy-consuming ICT equipment and, due to complex and changing standards, a short lifetime for the equipment, leading to large indirect energy use (in production and disposal). This also gives the consumers a number of new types of screens and new ways to combine TV, PC and the Internet. Today, TV can be used for other purposes, for instance showing pictures (photographs) or listen to the radio. However, it requires more energy to listen to the radio on TV compared to digital radio – and apparently many consumers prefer to listen to the radio over the TV, as they find the sound quality better (Crosbie, 2008). The complexity of the ICT , and the many different ways ICT can be combined and used by consumers, makes it difficult to give simple and concrete advice to consumers on how to make the best energy choice. Our workshop with central actors involved in energy savings related to ICT shows that there is a lack of information for consumers on energy-efficient ICT solutions for the home, for instance on which type of TV to choose. Largely, consumers are left to themselves to find ways to reduce ICT-related energy-consumption. Moreover, it is debatable whether the traditional consumer approach, with information, advice on limiting consumption etc. is a feasible way to gain energy savings from consumers, especially since household ICT technologies include many small sources, each one with limited power consumption. Traditional advice to reduce standby consumption can be problematic for much ICT equipment. For instance, data information stored on DVD and set-top boxes are lost if they are turned off. Set-top boxes are updated continuously as the suppliers require, and therefore it is recommended not to turn them off (Crosbie, 2008). Therefore we can conclude that there is a void in current ICT and energy-saving policies on how to approach the consumers. We argue that an important problem in the existing policies for reducing ICT-related energy consumption is the understanding of the consumer. The intended role of the consumer in existing policies is roughly to buy (the coming) eco-labelled ICT products, to use ‘intelligent home control’ and to avoid standby consumption from the ICT-equipment. As we have indicated above, and as our interviews with consumers show, questions of energy savings are more complex and strongly interwoven with the general use of the ICT equipment. We therefore advocate for a better understanding of consumers’ rationales and use of ICT equipment, by applying a domestication perspective to the subject as described in the next section.

Domestication: understanding consumers in the home

Domestication theory and research on ICT development in households

Using the domestication perspective on ICT integration in households is a way of understanding energy behaviour and energy consumption by consumers in their homes. Domestication is a concept that largely originates from anthropology and consumption studies (Haddon, 2006).It represents "a shift away from models which assume adaptation to new innovations to be rational, linear, mono-causal and technologically determined" and it provides "a theoretical framework and research approach, which considers the complexity of everyday life and technology's place within its dynamics, rituals, rules, routines and patterns" (Berker at al., 2006). In other words, a domestication approach offers a way to understand ICT in the context of everyday life and the home. There are different roles at stake for the home, and different ways that the meaning of home motivates the purchase and use of technologies (Aune, 2007), as well as the understanding of 'energy savings'. Applying a domestication perspective to the use and development of technology will allow a more detailed understanding of consumers, and the dynamics behind consumption and savings.

Two of the first to use the domestication approach to study households' adaptation of ICT were Silverstone and Hirst (1992). They emphasised the domestication process in relation to the symbolic and cultural environment of the household, including for instance the family structure and the 'moral economy' of the household (an approach that has later been discussed, see Berker et al, 2006). Studies of household use of ICT have moved from a work-focus in the 1980s, to a mixture of home-based utilities and entertainment in the 1990s, and to more advanced social networking and household automation in the 21st century (Brown, 2008). Several studies are on impacts related to household adaptation of ICT, intentional as well as unintentional (Brown, 2008). Examples are studies that identified negative social impacts on family life, reduced communication with other household members, and increasing social isolation (Brown, 2008). Different groups of users have been studied according to their family situation (nuclear families, singles etc.), their work situation, social class etc. In addition studies have concerned single ICTs or have taken a holistic view of ICTs as an entire ensemble (Haddon, 2006). But there is also research showing that users struggle with the technology and find new ways of adopting it in the household, leading to new ways of using the ICTs. The lesson is that researchers "should keep an open mind and avoid pre-assigning or pre-defining use" (Brown, 2008; 399). The domestication approach has also been combined with other theories, for instance ethnology and in 'netnography' studies. Also the social consequences of ICT have been partly studied through comparisons of adaptation and use in relation to 'time rich – money poor' and 'money rich – time poor', as well as discussions on the 'digital divide' (Haddon, 2006). It is obvious that the physical context, for instance different uses and understandings of 'home' has a large influence on the domestication process (see Aune, 2007). In cross-cultural studies the context also becomes highly relevant for domestication of ICT, for instance sizes of apartments, use of rooms in different cultures and other subjects. In the light of the ICT nature, others have argued for studies of domestication beyond the home, for instance in game-halls, education centres, or other places where portable ICT (mobile phone, PC etc.) might be used (Haddon, 2006).

In spite of several studies pointing to increasing ICT-related energy consumption in the home (for instance Aebischer og Huser, 2000; Cremer et al, 2003; Baer et al, 2003; Owen, 2006), energy consumption has been absent in most domestication studies of ICT (for instanced based on the review papers by Brown (2008), Dwivedi (2008) and Haddon (2006)). However, recent studies on ICT and electricity consumption (for instance Crosbie (2008) and Røpke et al (forthcoming), as well as several papers from the recent EASST conference) might indicate that the picture is about to change.

There are several ways to use domestication theory and several examples of overlaps between domestication theory and other research traditions (Haddon, 2006). One approach that has been especially relevant for our research is evident in studies by Lie and Sørensen and others, who have tried to link the domestication approach to the Social Construction of Technology approach, emphasising that social shaping continues after the products have left the shelf at the retailer. The ‘Norwegian approach' to domestication theory (Berker at al, 2006) emphasises the creativity of consumers, and their ability to form the product. This is parallel to the decline of technological determinism in SST theory. It is inspired by Latour's use of 'script' as the producers' intention and vision about the product, contrasted with the consumer’s use and appropriation of the commodity. However, as Latour has never tested the concepts in practice, there is a need for a concept such as 'domestication' to establish a link between action, meaning and materiality (Aune, 1998).

In relation to the model developed by Silverstone et al, suggesting four phases in the domestication process: 'appropriation', 'objectification', 'incorporation' and 'conversion', Lie and Sørensen’s approach uses three of the same phases, and adds a cognitive dimension (Aune, 1998; 54). In contrast Silverstone’s model, the 'appropriation' phase is toned down, as the most important aspect for Lie and Sørensen is to understand the learning process in domestication. Several authors, for instance Lie and Sørensen, have noted that the appropriation phase might not be relevant, for instance in non-domestic situations where the purchaser and the user are not the same, or in domestic situations where one family member decides the acquisition of a technology that all members of the household will use (Hynes and Rommes, 2006; 128). Creativity in the domestication process of ICT is, however, not the only theme we will focus on. Former studies of ICT have suggested certain characteristics of the domestication process (Haddon, 2006), which we will discuss in relation to the findings from the interviews with ICT users:

- ICT implies evolutionary (not revolutionary) changes in households
- ICT is domesticated in a personal and creative way
- Non-adaptation of ICT is widely expressed amongst users

Although these themes are strongly intertwined, and have several sub-themes, we will use them to structure our findings. The following section presents some of our findings from the interviews with ICT users.

Findings from interviews: consumers' use and understanding of ICT technologies

Evolution rather than revolution

Domestication theory generally suggests that changes due to ICT adaptation in the home are more evolutionary than revolutionary in nature, and the use of ICT equipment is often built upon existing practices. This contrasts with the utopian visions envisaged by some earlier writers for the integration of ICT in households (Haddon, 2006). Several statements from our informants confirm this and suggest that typically, ICT technologies are carefully integrated into every-day life and built upon existing practises, rather than changing them radically. Also, the motives for acquiring ICT appliances are often to carry out different practices easier and faster, not to establish entirely new routines. For instance, one informant was asked about the main difference between today, where he has got much more internet capacity (cable), compared to the situation before, when he had a more restricted modem access. He stated that the main difference is that today it is easier to send large files, although the practice remains the same, i.e. working from home and sending large data files to the workplace. In another example, concerning the reason for desiring a new digital video-camera, instead of an existing VHS-based camera, a female informant stated that using the digital camera is simply much easier, faster and more flexible. , although the camera fulfils the same basic purpose (recording horse-riding and watching it afterwards for instruction).

> *"It's easier to get into the box. I want one with a DVD in it, so you just put it over in the DVD player… in our old one, Video 8, you had to plug into the video, and then over to DVD. It's too inconvenient".*

Even for an informant in a household with massive use of ICT, both in relation to entertainment, work, intelligent control of light and heating, safety and other features, the informant's main experience was that: "It's so much easier to shut down all lighting and appliances when you go out the door." In this example, as a part of establishing the 'intelligent home', the informant had installed a comprehensive IT-based management system that controls the entire electric system in the house, as well as the heating.

These small examples illustrate that ICT often allows users to carry out certain routines in a simple, faster, easier or smarter way, rather than establishing entirely new practices. From an energy perspective, it is therefore difficult to pinpoint the changes in activity patterns in households, but easier to quantify the energy consumption by the technologies. However, the way the practices are being carried out involves an increasing use of ICT, and especially the internet. It is evident that ICT can be characterised as a 'pervasive' technology, i.e. that it is being used in relation to almost all kinds of activities, and ICT is increasingly integrating with other domestic technologies (Røpke et al, 2008). In a longer perspective, however, domestication of ICT, and the adaptation of existing practices, might lead to changing consumption patterns, but in a shorter time-scale it will lead to surprisingly few new practices.

In parallel with this, other studies of users' selection of ICT emphasise the technology's ability to fit into the design of the home and everyday life, including the aesthetic of the home (Crosbie, 2008). The ability to fit into existing practices and the design of the home is central for selecting ICT. In our interviews we have also found that a main driver for new and smarter ICT is a strong desire amongst informants to establish order amongst the various ICT medias and technologies (wires, plugs, routers, DVDs, CDs etc.), and to avoid mess in the home. This, for instance, includes wireless LAN to avoid mess with the cables to the laptop, or establishing a central server in the home to collect CDs and DVDs in one place, which several of the users interviewed had done. The desire for more control of time and space has also been highlighted as a strong motivation for acquiring and developing ICT solutions in the home in former studies (Silverstone, 1993).

This can, however, mean that certain ICT solutions are rejected. For example, one informant had deliberately chosen to abandon digital TV in order to avoid multiple boxes, hubs and remote controls, which in his eyes would be the consequence of a future change in image standards for TV (it has been decided to change the digital TV-format to mpeg 4 in 2012, and only a few of today's TVs are prepared for this). This person had established a central server in the house with TV, DVDs, pictures etc., connected to all TVs in the house. With the analogue TV signal it is possible to distribute to several TVs, whereas the digital signal will require a separate top-set box for each TV.

> *"Another box means more power plugs and more cables to be connected. What I want is solutions that are integrated in the same unit. Why do I need a hub, a broadband, a router and perhaps an extra hub to make it all work, if I could get just one box with it all, and with a sufficient number of connections in it?"*

Therefore, as digital TV would require top-set boxes, cables and remote controls for all six TVs in the house, this user made sure that his present TV-provider would continue to deliver an analogue TV signal, enabling him to continue with an analogue TV solution. In general, we see that users often balance technical qualities against aesthetic qualities. For instance, the wireless LAN solution for the PC has an aesthetic quality (avoiding cables), but might not have enough bandwidth for image transfer, which one of our interviewees explained. She had therefore dismissed this solution.

Personal meaning and creativity

Some of the first domestication studies demonstrated that users often impose their own personal meaning on the technologies, even though these meanings differed from the meanings of the designers, dealers and others (Haddon, 2006). A general observation is that the technologies need to fit into everyday life and the design of the context. However, in the long term the interaction might change, and later studies have focused on this. The conclusion is that the domestication of ICT is an ongoing process, more than a one-off event (Haddon, 2006). Adding a personal meaning to the technology as a part of the domestication process, includes different aspects.

An evident characteristic of ICT use and domestication that came out of our interviews was the creativity amongst consumers. ICT has become a new area where you can be very creative in projects at home. Many acquisitions and applications are driven by creativity, where it is not necessarily close functional needs that are met, but more a desire to test and develop the technology. This applies both to the more 'geeky' informants, and the 'normal' consumers, since there are many opportunities for choice and combination of technologies, while there are few standard options and few places to get advice. This does not necessarily mean that new functions or practices are developed, but often new ways to carry out relatively simple functions using ICT in a very creative way.

One example is the user who from his ‘Second Life’-home – a perfect copy on his ‘real-world’ home – had made it possible for his avatar (his alter ego in Second Life) to turn a light in his ‘real’ home on and off (see Figure 2). While in Second Life he is able to take his avatar into his virtual house and touch the virtual light switch – a few seconds later, the light in his ‘real world’ living room would turn off. This implies several complicated ICT operations and technologies, in Second Life as well as in the real world, that go way beyond any conceived or conventional use of ICT. The communication between Second Life and his real home is based on mail correspondence between various mail servers, controlled by a piece of software developed by the informant himself. He has tried to make it work the other way as well, but this is more complicated. In the real world, his home is under reconstruction to an ‘intelligent home’, enabling -based power control of all sockets and switches in the home. This function has involved a massive investment of creative energy from the informant, although turning lights on and off from Second Life has few practical implications in the short run.

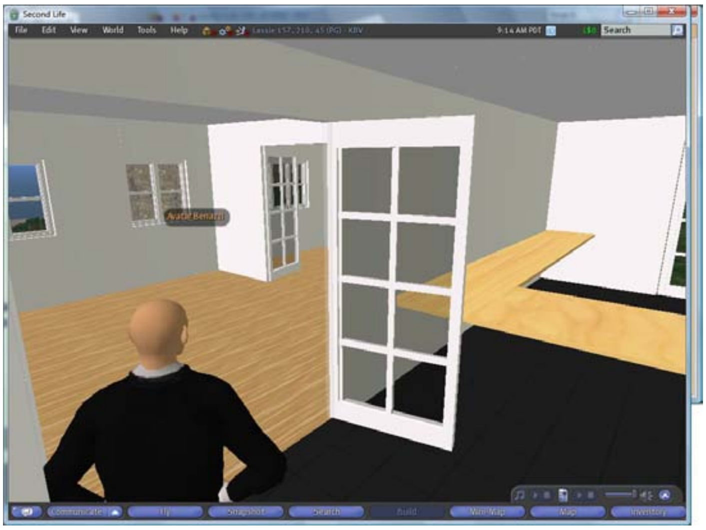

Figure 2. The Second Life avatar as an example on ICT creativity. *The avatar enters a copy of the real home, where he is able to turn the light in the real home on and off.*

> *"Naturally, it's great to be able to control your own house in Second Life. I can decide to turn on a light, when I'm on holiday, for instance."*

In the long run, the idea is to develop the concept to build an entire copy of the house in Second Life, allowing control of all sockets in the real house. This will also allow a differentiated access for different members of the family to the various functions in the house.

As a part of a rebuilding project, one informant has designed his own version of 'the future home' based on extensive ICT use for house management, information and entertainment. This includes intelligent management of all lighting, heating and door locks in the house. For instance, the lighting automatically turns on when someone enters the room, switches have been programmed for different types of lighting, the heating can be controlled from a touch-screen in the kitchen and there are other facilities. For TV and entertainment a central server in the house has been set up to manage all DVDs and CDs, so that films and music are collected in one place. An Apple TV box that combines TV and video on demand has been installed, and the basement has been designed as a cinema-like room for watching films with blue-ray and a projector, or for playing with the X-box.

A number of more special features have been made, for instance for the children's rooms on the first floor. From a screen one can 'see' when the bathroom on is free, and if the children don't come down when dinner is served, they can be 'motivated' by cutting off all power on the first floor, which has proven very efficient. Also, to prevent long showers, the light automatically starts to shut down gradually after 7 minutes, leaving the shower in darkness a few minutes later. These features have been designed and developed in collaboration with the other members of the household, in a process of 'no-tolerance'. If the technology (typically selected by our informant) did not work immediately and without problems for the other members of the household, it was not accepted by them, and he would have to start over again. Here, the creative part of the domestication process has been in the initiating phases (getting the idea on how to design certain solutions) as well as in the following phases (discussions and adaptation amongst the different family members). The domestication process involves not just the ICT appliances, but also the use and design of the whole house. For instance, the family has decided to establish an 'acoustic' corner in the living room, for activities that do not involve ICT. The creativity was apparently a strong motivation for the planning, design, implementation and development of these solutions, although the respondent retrospectively related the work process to improving control of the home, and all the appliances:

> *"...The thing is about leaving the house and pushing a button, knowing that no unnecessary power is turned on …(and)...all the plugs that are turned off. All the standby-equipment shuts down… Generally, the knowledge that here we have got something comfortable and at the same time we have reduced our electricity consumption to a minimum"*

Also in other interviews we have found a large amount of creativity in the domestication process of ICT. For example, one informant was using a software program designed for route diagrams to draw up suggestions for interior decoration and housing design in the rebuilding process she was working on at the time of the interview. Using this program had enabled her to draw up a number of different solutions for the internal design of the house to discuss with friends and relatives, and this had already given her valuable feedback and good ideas. The same interviewee also had plans to set up web-cameras in the horse stables in order to watch her horses from the laptop – both at home and at work – which again would allow smoother and more optimal planning of her every-day life.

> *"So I can see how the horse is doing, so I don't have to go out there at night……I hope I can also use it when I'm at work….If it's bad weather and they get uneasy, I can go home half an hour earlier"*

The creativity amongst our interviewees runs from smaller solutions (for instance, installing PCs in the ceiling of the car, to allow the children to watch DVDs and take the PCs on holiday) to larger solutions, for instance rebuilding an old house with the most up-to-date type of ICT control and intelligent management. The desire to use new technology ranges from dealing with well-known challenges (for instance children's long showers), imagined challenges (for instance web-monitoring of the house to improve security and avoid possible crime), and even non-challenges, such as the avatar turning the light in the living room on and off. We argue that this creativity characterises the ICT more than other types of domestic technologies, and therefore makes the intended use and domestication process more unpredictable. In an energy perspective, on the one hand this raises a challenge in designing energy-saving solutions and providing advice to the users, but on the other hand we argue that the creativity can be seen as a resource for energy savings, and that advanced users should be involved in designing energy-saving solutions for the home. Several of the creative ICT users we have interviewed, for instance users creating their own version of an intelligent home, had energy savings as one of their main reasons for establishing intelligent power control systems, and their experience could serve as valuable input for future energy-saving campaigns.

Non-adaptation

Many domestication studies have been concerned with the lack of adoption of certain technologies (Haddon, 2006). Besides reasons such as lack of social networks and limited financial resources, identity and managing the image of the home can be seen as parameters for rejecting ICT. Other studies show that there are different motives for not purchasing or using certain technologies, for instance lack of resources (Hynes and Rommes, 2006; 127), suspiciousness toward new technologies, or a desire to control the impulse to buy it (Lehtonen, 2003). However, the adaptation can also relate to the relations between household members (for instance teenagers and parents), and strategies for controlling the medias (Haddon, 2006).

The interviews revealed several examples on non-adaptation and a number of different reasons for this. Some of these are closely related to creativity, where consumers are able to say “no” to certain products or technologies, but instead design similar solutions based on other ICT products. ICT consumers are not passive recipients and users of the ICT solutions that are sold and promoted on the market, but they are critical recipients, developers and users. Several informants expressed practices and reflections that reflect both positive and critical attitudes to ICT, and these affect both their acquisition and use of ICT solutions. The consumer has to be selective, partly due to the many technological options available, and partly because of the uncertain future of technological development and standards in the near future. This selectivity includes financial, aesthetic, functional, social and environmental considerations. The non-adaption of certain technologies is often linked to creative solutions that give the users the same function by using other technologies.

One informant (and his family) does not use a traditional TV or media centre. Instead, they use PCs to watch TV, primarily based on the internet, where different TV channels are available. Their rationale is that PCs are able to deliver the same service as a traditional TV and a media centre, and with less costs:

> *"Why should we pay so much when we can buy a laptop for DKK 4500 (app. 600 €). …It's got a CD and DVD player as well, and it uses much less power. It has been designed not to use power. …. The largest problem (with the media centres) is the noise, because they have to be cooled, as they normally dump a huge graphic card into it, which is not necessary…the laptop here, it says nothing".*

Another informant has turned down the offer of having a fibre-based TV connection established to his home, which would have given him 100 MB of broadband. Instead he has decided to keep his old cable connection. His argument is that the 100 MB broadband is just sufficient for 5-6 TVs watching different channels, but no more, and this would reduce the flexibility of the connection. Due to the changing standards of the digital TV format, the new cable would mean that they would probably have to buy set-top boxes at some time, and as each TV needs its own box, this would, according to the informant, lead to a mess of boxes and cables (see quotation p. 9). He and his family have therefore decided to keep their 'old' analogue cable connection for TV, having ensured that they will still be able to get the analogue signals from their TV operator, although the TV signal in general will go digital in 2009. This shows how the uncertainty of the future standards, combined with aesthetic and practical considerations of the technology, might lead to technological non-adoption, although maintaining a functional adoption by using other technologies.

However, there are also examples of households who are simply not interested in the technology, for different reasons. One informant (from a single-person household) lived with a boyfriend who brought a lot of ICT equipment into their home. After they split up, she misses very few of the ICT facilities he brought into the home.

> *"I actually think it became a bit clumsy. I can see that it was very smart with a large flat-screen TV, as the picture and sound quality were so much better and we could sit here in the dark. It was very cinema-like and fun, but I was falling over it all the time in such a small flat I have here.*
>
> *What he did to connect the computer and the TV was very clever, but it's just so clumsy… with my wants I don’t need all kind of things that can be connected…. He spent so much time putting it together, but he thought it was fun. But I don’t think it's fun, I don’t know how to do it and it doesn’t interest me very much"*

The critical and non-adaptive approach to ICT-technology is widespread amongst our informants. This does not necessarily mean that they reject the service delivered by a certain technology, but instead get the service from other ICT products. With the huge number and types of ICT products for the home, a critical approach is simply a necessity for the consumer.

Implications for future energy policy

The different themes on ICT in households, emphasised by domestication, can be illustrated by changes in how certain practices are carried out in the household. One example is the practice of watching TV; an interesting aspect in an energy context. Firstly, TV represents the major energy consumer amongst the ICT, but our analysis shows that there is an absence of consumer guidance on this area. Even amongst experts it is very difficult to find the 'right' solution to basic answers on energy savings for TVs. Secondly, the TV media is currently undergoing radical development. This development includes new hardware (from CRT to LCD and other types of screens), digitalisation of the transmission signals, integration into other media (computer, mobile phones etc.) and the general organisation of the production and distribution of TV. This development opens up the potential for new interpretations and practices related to TV use, where the understanding of 'traditional TV use' (watching the telly!) is challenged.

In our interviews we have found several examples of changing practices in the use of TV. Watching TV is taking on new forms, in terms of the social contest (who watches, when and where?). There are social, spatial and temporal changes compared to 'traditional' TV-watching practices (if there ever was such a thing). Also, we see that TV is increasingly being integrated into other medias, and conversely other medias are being integrated into the use of TVs (see Crosbie, 2008), and TV programmes are today being produced from many different sources – national companies, private companies, amateurs, friends etc. Finally, watching TV is under competition from other medias; the Internet and other ICT are increasingly substituting TV as the only medium for news and entertainment. Our interviews demonstrate a wide variety in consumers' choices on TV strategies, for instance to substitute traditional TV screens and TV signals with PC and Internet-based TV, to use new types of TV services (such as Apple's Internet-based TV-box), or to maintain a traditional analogue signal.

Another example is the intelligent home. Two of our informants were in a process of designing their own intelligent home, based on intelligent management of all electricity (sockets/switches) and other features with implications for energy consumption in the home. Using intelligent management for to control energy consumption was highly relevant for these people, as they had already several ICT components in their homes, and were interested in reducing the energy consumption of their homes. For these informants it is important to note that the high level of ICT in their homes also reflects an everyday life where the home is used extensively for work (for all adults in the household), which – along with the extensive use of ICT – is probably the main reason for a relatively high electricity consumption. Therefore it is difficult to assess the potential energy savings with intelligent home control from these examples, as it is connected to a certain way of using the home. However, these informants' lifestyles could be a picture of a future everyday life for many people, where intelligent home control could be highly relevant. For others, such solutions would be highly irrelevant.

The creativity in the process of domestication is characteristic of households' use of ICT. In our interviews there are several examples of users developing creative solutions and raising relevant questions related to energy savings. This makes it difficult to design general energy-saving advice on the basis of a traditional expert-based top-down approach which, as described previously, is how the existing energy-saving policy can be characterised. Instead, energy efficiency related to ICT calls for much more user involvement in defining and developing energy-saving strategies. To prevent the escalating electricity consumption related to ICT use, which has been demonstrated through the scenarios, we therefore suggest a combination of a top-down and bottom-up approach, where users' experience and solutions are discussed and developed with experts on ICT and energy savings.

An example parallel to this argument has already been seen through one of our informants, who has established an intelligent home in which his wife and children have acted as users with 'non-tolerance' towards the new technologies introduced in the home. This means that technical ICT solutions that did not work were abandoned immediately. The potential of exploiting the experience gained by this informant has already been identified by one of the main TV operators in the market. As, due to forthcoming digitalisation, this operator is about to send out thousands of set-top boxes, they are very interested in learning about how to deal with 'non-tolerance' from users. They have therefore hired our informant to teach them about this issue on the basis of his own experience in establishing the intelligent home.

We have seen many examples of 'user-driven innovation' in domestic ICT use, including initiatives to reduce energy consumption in the home. We also need to see technical ICT knowledge and energy-efficient ICT as two integrated parts; it makes little sense to talk about energy efficiency without having the general technical competence to understand the technologies. Therefore, initiatives for energy savings should be designed and carried out with the 'traditional ICT experts', i.e. by trying to involve traditional ICT experts in identifying and developing energy-saving solutions for consumers, instead of operating with energy-saving experts on ICT. Compared to other consumer goods, ICT too complicated for 'laymen' to give meaningful advice on how to save energy. Therefore, energy savings related to ICT require new ways of collaborating between users, producers, experts and energy-saving agents, and therefore they represent a break with past policies for energy savings in households.

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Bilag 6: Information and communication technologies – A new round of household electrification

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Information and communication technologies – A new round of household electrification

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Abstract
Information and communication technologies (ICTs) increasingly permeate everyday life in industrialized societies. The aim of this paper is to explore ICT-related transformations of everyday practices and discuss the implications, particularly for residential electricity consumption. The present socio-technical changes are seen in a historical perspective, and it is argued that the integration of ICT into everyday practices can be seen as a new round of household electrification, comparable to earlier rounds that also led to higher electricity consumption. A case study carried out in Denmark in 2007-8 explores the present changes in everyday life. Based on qualitative interviews, the study focuses on people's ways of integrating ICTs into their everyday practices, on any significant changes in these practices, and on the influence of the changed practices on electricity consumption. The paper concludes with a discussion on the implications for energy policy.

Keywords: information and communication technology (or: ICT), household energy consumption, practice theory

1. Introduction
Information and communication technology (ICT) increasingly permeates everyday life in industrialized societies. Computers, the Internet, mobile phones and many other related technologies have become standard devices that most people take for granted. Like many previous technologies, ICTs are involved in transforming everyday practices, and like previous transformations, the present processes are reflected in changing energy consumption. ICT use thus has impacts on both direct electricity consumption in the home and indirect energy consumption related to providing ICT-devices and operating ICT-infrastructure. The aim of this paper is to explore the processes of ICT-integration in everyday life and discuss especially the implications for residential electricity consumption. The present socio-technical changes are seen in a historical perspective, and it is argued that the integration of ICT into everyday practices can be seen as a new round of household electrification, comparable to earlier rounds that also led to higher electricity consumption.

Until recently, few studies have focused on the energy impacts of ICT in households, but the political relevance of this issue is increasingly acknowledged. Various scenario-studies indicate that the share of residential electricity consumption related to ICT (including consumer electronics) may rise to about 50 percent within the next one or two decades unless preventive action is taken. Thus, Owen (2007, p. 3) concludes that by 2020, "entertainment, computers and gadgets will account for an extraordinary 45 percent of electricity used in the home" (see also Jensen et al., 2009; Market Transformation Programme, 2008, p. 14). The International Energy Agency also issues warnings: "electronic devices have made a major contribution to the recent growth in total residential electricity use and will become one of the largest end-use categories in years to come" (IEA, 2009, p. 3).

The paper is based on a case study in Denmark, which provides a useful example for two reasons. First, elaborate material on the historical development of electrification in Denmark is available (Wistoft et al., 1991; Wistoft et al., 1992), which makes it possible to place present changes in a historical perspective. Second, ICTs have diffused widely in Denmark, making it relevant to study emerging energy impacts in this country. By 2008, 88 percent of the Danish population had at least one personal computer at home, 85 percent had access to the Internet, and 90 percent of this group had a broadband connection such as ADSL, optical fibre access etc. (Statistics Denmark, 2008). With 37 broadband subscribers per 100 inhabitants, Denmark had the highest penetration of high-speed Internet connection in the OECD in 2008. With regard to bandwidth, however, Denmark is lagging behind such countries as Korea, Japan and Finland, and prices per Mbit/s are relatively high (OECD, 2009a). Electricity consumption reflects the diffusion of ICTs: The share of residential electricity consumption used for consumer electronics, computers and related equipment has increased from 17 percent in 1997 to 26 percent in 2006 (Gram-Hanssen et al., 2009). While total residential electricity consumption has been stable since the early 1990s, the growing electricity use for ICTs constitutes a serious challenge.

Traditionally, ICTs are distinguished from consumer electronics, which include equipment for entertainment such as radio, television and music players. But this distinction becomes increasingly blurred and irrelevant as computers, for example, are used to watch television, and televisions are combined with hard disk recorders. Still, to delimit our study, we have chosen to focus mainly on practices that integrate the computer, Internet and related devices, although we are well aware that some of the most immediate energy-consuming trends are related to the development of television (Crosbie, 2008).

The paper starts by outlining the history of household electrification based on an interpretation of available historical studies. Then, the present socio-technical changes related to ICT are analysed, based on an empirical case study carried out in 2007-8. Based on qualitative interviews, the study focuses on how people integrate ICTs into their everyday practices, whether these practices are changing in significant ways, and how changes in practice influence electricity consumption. The presentation includes an outline of the theoretical and methodological approach, the findings regarding changing everyday practices, and the immediate implications for electricity consumption. The paper concludes with a discussion of the implications for energy policy.

2. The history of household electrification

The history of the first hundred years of electrification in Denmark is presented in two large volumes (Wistoft et al., 1991; Wistoft et al., 1992), which are the main source for this section (the page references in this section refer to these publications unless otherwise stated). The work covers production, distribution and consumption in all sectors, but this paper concentrates on household electrification.

The development of *total residential electricity consumption* started, when the first electric light was turned on in 1891, but the real jump in electricity supply took place from 1905 to 1920, when 80-90 percent of households in cities and larger towns acquired electricity (1991, p. 134). During the period between the world wars, electricity diffused into the countryside, and in 1939, 75 percent of the population in the countryside and 98 percent of the population in the cities had electricity (1991, p. 213). After the Second World War, growth was resumed, first moderately, and then at a fast pace from the late 1950s. The energy crises in 1972-73 and 1979-82 motivated serious efforts to save energy, but electricity consumption continued to grow. Whereas the government succeeded in keeping the level of total energy consumption constant from 1972 to 1991 (through improved insulation, co-generation of heat and electricity, and other measures), household electricity consumption grew by 53 percent from 1976 to 1991 (1992, p. 244). The long-term trend towards ever increasing residential electricity consumption was not broken until the early 1990s. Since then, household electricity consumption has been virtually constant (Energistyrelsen, 2008).

Over time, the *composition of residential electricity use* changed dramatically, as electricity became used for an ever-increasing range of purposes. From a *consumer perspective*, electricity is used to obtain services – directly in the form of lighting, or more indirectly as input to the processes of preparing food, for example, or washing clothes. The history of household electrification is the story of electricity as a condition for using the various artefacts involved in meaningful domestic practices. But the 'invisible' input of electricity received little attention from consumers, except in the very beginning when electricity was synonymous with light.

Viewing electrification from a *technical perspective* highlights a different aspect of the story. Electricity is used for such basic functions as providing light, transmitting sound, heating, powering mechanical devices, and processing data. The introduction of these basic functions into the domestic sphere was usually based on a technological breakthrough, materialized in new basic technologies such as the electric bulb, the small electromotor, the vacuum tube and the transistor. Sometimes the basic technology was a product that could be applied directly in households, like the telephone and the light bulb. In other cases, the basic technology was applied in many different consumer products, like the electromotor built into many appliances. Basic technologies were also combined – in the washing machine, for example, which combined an electromotor and a heating element and, more recently, data processing technology as well. In addition to the infrastructure used to provide electricity, some new basic technologies depended on the development of supplementary infrastructure – radio and television broadcasting networks, or more recently mobile telephone networks and infrastructures to provide Internet, such as cables, fibre net and Wimax.

The following account of electrification views the history from a combination of the consumer and technical perspectives. The traditional story, as well as the statistics, is based on the consumer perspective, while priority in our account is given to the technical perspective. Our point is that new rounds of household electrification tend to emerge in connection with the introduction of new basic functions.

The introduction of the telephone is usually not considered to be part of household electrification, because it came with its own dedicated net, integrating power supply and transmission. From a technical perspective, however, the telephone was the first use of electricity in homes and thus deserves brief mention. In Denmark, the telephone net was established at a rapid pace, starting in the early 1880s and covering the whole country before 1920 (Wistoft, 2007). Thus, the first basic function of domestic electricity use was the *transmission of sound*, which is related to the first important member of the ICT family of devices.

Considering the telephone to be a separate system, electricity was basically synonymous with *light* during the first decades. Lighting can thus be said to constitute the first round of household electrification. This application was so dominant that light still constituted 97 percent of residential electricity consumption in 1950 (see Table 1 and Figure 1). The exclusive use of electricity for lighting was problematic for power plants, because of the large fluctuations in demand throughout the day, and starting in the 1920s, other uses were actively promoted (1991, p. 222; Forty, 1986, reports on the same situation in Britain). These uses can be seen as the first seeds or signs of later rounds of household electrification. The first real success was the electric iron, owned by as many as 28 percent of households in 1938 (1991, p. 236). The iron uses electricity for *heating*, and many other heating devices became available (such as electric cookers, electric heaters, toasters and warming pans), but few people could afford such luxuries. The second successful device during the period between the world wars was the vacuum cleaner, owned by 15 percent of households in 1938 (1991, p. 236). The vacuum cleaner uses electricity to replace manual *power* through the application of a small electromotor. Other power devices such as potato peelers and dishwashers became available (1991, pp. 86-87), and when very small motors entered the market, they were combined with or integrated into products like sewing machines (1991, p. 264), but again such products were reserved for the few. The most successful device before World War II was the radio, which needed no motivation from electricity companies. From the establishment of the state *broadcasting* service in 1926, the radio diffused rapidly, and within a few years it was the most common device in the home, owned by 37 percent of households in 1938. The radio did not consume much energy, but it kept people awake, and they used light until later in the evening (1991, pp. 236-237).

The second round of household electrification took off in the late 1950s and was based on the use of electricity for power and heating, which were integrated into rapidly diffusing appliances meant to ease household chores. Refrigerators replaced larders and iceboxes, first in cities and later in the countryside, and in 1971, 80 percent of all households had a refrigerator (1992, p. 124). While refrigerators were difficult to share, both freezers and washing machines had a long history with different kinds of collective arrangements before they ended up being privately owned (many people in housing blocks still rely on shared laundries). Around 40 percent of households owned washing machines and freezers in 1970 (1992, pp. 124, 127), followed by the dishwasher and the tumble dryer (Olesen and Thorndahl, 2004, p. 305). Also electric cookers and water heaters diffused in the 1960s, and electric space heating was installed in some new houses (1992, p. 131). In addition, a wide range of smaller kitchen appliances gained a footing, as well as equipment for body care. The resulting composition of household electricity consumption is shown in Table 1 and Figure 1: lighting was reduced to 27 percent, while appliances based on small electromotors and/or heating elements amounted to 66 percent of electricity consumption in 1970.

Also during this round of electrification, seeds were sown for the next round, first of all in relation to television, which achieved the quickest diffusion ever (1992, p. 134). Regular TV broadcasting started in 1951 but could be received only in Copenhagen. In 1960, TV signals were available to everybody, and already in 1965, 75 percent of households had a TV set. In spite of this popularity and the high energy consumption of the first TV sets (3-400 Watt, 1992, p. 135), television and other entertainment technologies still constituted a relatively small part of electricity consumption in 1970.

The technological background for the third round of household electrification was the emergence of the transistor and later the microchip, which made it possible to install an ever-increasing number of transistors in a very limited space. This miniaturization enabled the inclusion of advanced *data-processing* facilities for monitoring, management and manipulation in a multitude of products, as well as development of the general-purpose personal computer. Advanced data processing can thus be considered a new general household application of electricity, constituting a third round of electrification. The first implications for electricity consumption became visible in relation to standby consumption. When teletext services emerged in the late 1970s, they gave rise to the development of more advanced wireless remote controls for televisions, later followed by remote controls for many other electronic appliances. Since remote controls only work when appliances are (partly) turned on, this development implied a massive increase in standby electricity consumption.

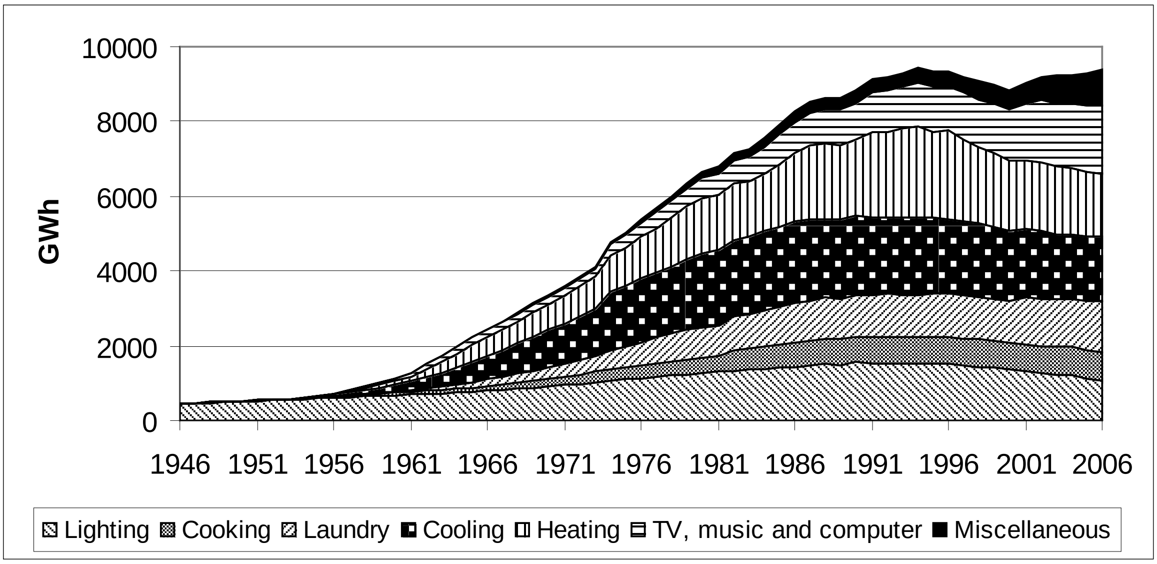
Table 1. The composition of household electricity consumption in percent, 1950-2006

	1950	1970	1990	2006
Light	**97**	**27**	**18**	**11**
Heating and power	**3**	**66**	**68**	**59**
Cooking	3	6	8	8
Heating	0	20	23	18
Cooling	0	30	24	18
Laundry	0	9	13	15
Miscellaneous	**0**	**7**	**14**	**30**
TV, video, stereo	0	6	10	12
PC	-	-	1	8
Total	**100**	**100**	**100**	**100**
Total energy consumption (GWh)	**522**	**3341**	**8841**	**9401**

Note: "Heating" includes electrical heating panels, electrical water heaters and electricity consumed by central heating systems (circulation pumps etc.). "Laundry" includes washing machines, tumble dryers and dishwashers. "Miscellaneous" includes many different small appliances, including the television set, VCR, stereo and personal computer.

Source: ELMODEL-bolig. ELMODEL-bolig is an extensive software model that can be used to calculate total electricity consumption in Danish households by different types of appliances (ELMODEL-bolig includes about 30 different types of appliances). The model includes historical data about the stock of appliances in Danish households and the average time of use per appliance (a representative survey including about 2,000 households is conducted every second year). This data set is combined with information about the average efficiency (measured in watt) of each type of appliance in order to calculate the total yearly electricity consumption for each type of household appliance. The results for 1974-2006 are estimated to have high validity, whereas the figures for 1946-1973 are more uncertain. However, as this paper focuses on electricity consumption related to modern ICT, this does not affect the overall picture shown in Table 1 and Figure 1, since the real take-off of new ICTs did not occur before the late 1980s and early 1990s. For further information, see the website of ELMODEL-bolig (only in Danish): http://www.elmodelbolig.dk/ - or see Larsen et al., 2003. The figures used in Table 1 and Figure 1 are calculated and provided by Troels Fjordbak Larsen as part of the project on which this paper is based.

Figure 1. Danish household electricity consumption distributed by final use (GWh), 1946-2006



Source: ELMODEL-Bolig.

The home computer was first introduced in the 1980s as a special-purpose machine that could be used to play games, replace the typewriter and calculator, and run various special-interest programmes. In the mid-1990s, however, the introduction of the Internet changed this situation completely, since the new infrastructure opened up a whole new range of possibilities. With the development of laptops, other mobile devices and mobile access to the Internet, the number of applications is escalating.

The impetus from the third round of electrification is reflected in the rapid growth of the "Miscellaneous" group seen in Table 1 and Figure 1 – from 14 percent in 1990 to 30 percent in 2006. In addition to the electricity consumption for TV, video, stereo and PC that is specified in the table, the "Miscellaneous" group includes other ICTs. In total, 26 percent of residential electricity consumption in 2006 relates to ICT. It should be noted that the growing share of electricity consumption for ICTs also reflects the effectiveness of policies in other fields, causing the use of electricity for space heating to decrease considerably (see Figure 1), and the energy efficiency of white goods to improve (effectively counterbalanced, however, by continued growth in the stock of white goods, see Figure 1). Without the growth in ICT, residential electricity consumption would have fallen in recent years. Electricity consumption from 2000 to 2007 for non-ICT fell by nearly 10 percent, while electricity consumption for ICT increased by an impressive 135 percent (Gram-Hanssen et al., 2009).

Previous rounds of household electrification co-evolved with radical changes in everyday practices. Electric lighting opened for changes in daily rhythms and the experience of space, which involved many cultural changes (Garnert, 1994), and the use of household appliances based on heating and powering co-evolved with profound transformations in family life, household chores and women's participation in the labour market (Cowan, 1983; Olesen and Thorndahl, 2004). The present round of electrification may involve similar radical changes in everyday life. These changes are important to study in order to understand the dynamics and drivers involved and to develop a pro-active approach to the energy impacts that may follow.

3. Theoretical and methodological approach in the empirical study

The theoretical framework for the empirical study is based on practice theory. Basically, this means that the focus is on the practices that make sense to people in their everyday lives and on the co-evolution of new technologies and changing everyday practices. Practice theories have a long and heterogeneous history, developing as responses to classical dualisms like the structure-actor opposition in social theory. More recently, the work of the philosophers, Schatzki (1996, 2002) and Reckwitz (2002), has contributed to the formulation of a more coherent approach to the analysis of practice, and this work is increasingly reflected in a variety of fields. Warde (2005) has brought the approach into consumption studies, and Shove and her collaborators have operationalized the approach in empirical studies on consumption and technological change (Shove et al., 2007; Shove and Pantzar, 2005). Having elaborated in detail on the practice theory approach elsewhere (Røpke, 2009; Christensen and Røpke, Forthcoming), we make only a few necessary points here, as background to the empirical study.

In brief, the point of departure is that people in their everyday lives are engaged in meaningful practices – cooking, eating, sleeping, visiting friends, and watching television. A practice is seen as a cluster of bodily-mental activities, linked together in a meaningful entity that is recognizable across time and space. The entity only exists when people carry out the activities involved, and the enactment of these activities transforms the entity over time. Individuals thus meet practices-as-entities as these are formed historically, and through their own performance of these practices, they reproduce and change these entities over time. When performing the practice, practitioners integrate the elements of material, meaning and competence involved in the practice (Shove and Pantzar, 2005): watching television, for instance, involves the television, the competences related to its use (e.g. selecting programmes), and the meanings people attach to the activity (e.g. relaxation). Over time, this configuration of elements co-evolves – for instance with the emergence of new technologies and new social discourses concerning the meaning of the activity. This perspective informs the way we have asked questions in the empirical study and the way we have interpreted the results.

As the aim of the study is to uncover emerging trends in the use of ICTs rather than to document present energy consumption, the qualitative interview method was chosen due to its explorative qualities with regard to identifying and describing new and not yet stabilized practices related to ICT use. The focus on emerging trends led us to choose informants with long experience in the use of ICTs and with competence to take up new applications. The study is thus based on interviews with persons whose use of ICTs is likely to indicate the direction of ICT applications in the near future. Although a few of them can be characterized as lead users in von Hippel's sense (Von Hippel, 1988), or as early adopters who are fascinated by new technologies and interested in playing with them, most informants are just skilful users of diverse forms of ICT but with little or no fascination with the technology as such. Thus, they resemble the majority of the population and, at the same time, are a little ahead of the majority with regard to use patterns.

Use patterns differ according to age, gender, education, and income. For instance, younger generations have grown up with ICT and thus find it easier to apply the technologies, and educated people often become familiar with ICT through their work. To obtain a broad picture, we chose informants from 20 to 70 years of age, men and women with different educational backgrounds, different family situations, and from different areas of the country.

All informants were recruited with the help of the authors' personal networks; friends, colleagues and other personal contacts were asked to suggest persons from their own personal networks who used ICT in connection with many daily activities but were not really computer experts. On the basis of these suggestions, the informants who appeared to have a diverse use of ICT were contacted. After a first round of in-depth interviews with seven informants, we carried out short telephone interviews with 18 more people, in order to select informants who could elucidate additional use patterns in a second round of interviews. The telephone interviews usually took about 15 minutes; the prospective informants were asked if they used the computer and Internet in connection with personal communication, entertainment, shopping, personal hobbies or to upload information to the Internet (e.g. video recordings or family pictures). Seven informants with ICT use that had not been covered during the first round of interviews were selected for the second round of in-depth interviews.

In-depth interviews lasting about two hours were carried out with 14 main informants in their homes; in three cases, these informants' partners took part in the interviews as well. In total, 17 persons were interviewed face to face. Before the in-depth interviews, informants were instructed to fill in two forms. One form covered all the ICT equipment in the household (40 types of equipment were mentioned, and informants stated how many they had of each type); the other covered use of the computer and Internet in relation to a list of 48 activities that were organized in the following groups: communication, entertainment, information, purchase and sale, work at home, education, hobbies and volunteer work, administration and finances, domestic work and management of the dwelling, and finally health. Informants ticked off which applications they used each week, monthly, or less often. These forms served as the basis for the semi-structured interviews (Kvale, 1996) covering the families' everyday lives, the activities involving ICTs and changes in these activities over time, as well as the changes in equipment and Internet and television connections over time. If the informants did not bring up energy concerns themselves, the interviews concluded with direct questions regarding energy.

The following analysis is based on condensation of the transcribed interviews into summaries that organize the informants' descriptions of their use of ICT according to the groups of activities listed above.

4. Use of ICT in Danish households

Two general observations can be made on the basis of our interviews. First, ICTs have become integrated in a wide range of the informants' everyday practices. Although ICTs, such as the computer and the mobile telephone, were introduced for carrying out a limited number of practices – like playing games, word-processing, communication – they are no longer seen as dedicated to specific activities. Rather, they have become part of almost any practice. This indicates that the interpretive flexibility of these 'new' ICTs is much wider than the flexibility of the 'old' ICTs, since the latter tended to be integrated into practices defined by the technology itself: phoning, listening to the radio, or watching television. In contrast, the home computer and the Internet constitute a general infrastructure that can be integrated into a wide variety of practices.

Second, the integration of new ICTs in everyday practices is in many cases accompanied by diversification of these practices. This diversification is particularly pronounced in connection with the informants' daily communication with relatives and friends, but examples were also found in relation to other practices, e.g. watching television on an ordinary television set and on the Internet (reported in Jensen et al., 2009). Previous consumption studies have identified similar processes of continued diversification in other fields of consumption and describe this as an important driver behind consumption growth in general (Pantzar, 1992; Røpke, 2001).

A more detailed presentation of these observations starts below with the practices related to "staying in touch" with friends and relatives, which serves as a good example of the diversification that accompanies the integration of ICTs. Then, we turn to the integration of ICTs in relation to other domains of everyday life, where their use might seem less obvious: do-it-yourself; sports and recreational activities; and volunteer work. These examples are illustrative of the diffusion of ICT across many practices.

4.1 "Stay in touch"

In this paper, practices related to "staying in touch" comprise communication between relatives and friends who do not meet on a regular daily basis, and where the aim of the communication is to exchange news about their lives and activities. This category excludes communication related to the daily practical and symbolic reproduction of the relations between close relatives, i.e. between partners or between parents and children. The practices related to "staying in touch" are important for reproducing meaningful relations between friends and relatives. All informants have experience with these practices, and several identified these practices as a cluster of activities that can be understood as an entity.

Before the so-called digital revolution in personal communication, practices of "staying in touch", in addition to physical presence, involved mediated communication in the form of telephone calls and sometimes letters. Today, these forms of mediated interaction have been supplemented – and to some degree replaced – by a wide range of other media and Internet services such as mobile telephone calls and short text messages (SMS), email, instant messaging, weblogs, IP-telephony and social networking websites like Facebook. The informants employ a great variety of combinations of new devices and services to "stay in touch"; some informants primarily use email and mobile telephones, while others combine several Internet services. The informants ascribe different meanings to the media; for instance, some informants associate MSN Messenger with threats like virus, spyware or the risk of child abuse (two of the informants have forbidden their children to use Messenger), while others enthusiastically embrace it as an "interesting and quick" way of communicating with friends and relatives. In spite of these differences, the interviews show that most people have integrated a number of the new ICTs into the practices related to "staying in touch".

In the following presentation, we focus primarily on one informant, Grethe, who – compared with the other informants – uses a large number of Internet services in her daily communication with friends and relatives. Since examples similar to Grethe's different uses of the Internet can be found in the other interviews, her account is illustrative of the diversity of the use of ICTs in the practice of staying in touch with others. Grethe is 51 years old, trained as a librarian, and she works with development of services and organization at the local library. She takes great interest in new ICT and has a playful attitude towards trying out new media and services. Together with her husband Rasmus, who is a mason, she lives in a detached house in a provincial town. Grethe and Rasmus both have children from previous marriages: Grethe has two adult sons (21 and 30 years old), while Rasmus has two children (13 and 15 years) who live with their mother and visit Grethe and Rasmus often.

Like most of the other informants, Grethe sends and receives several personal *emails* to/from relatives and friends on a daily basis. She often uses email to make appointments or to obtain news about the others' personal lives. Grethe explains that emailing represents an easy way to "stay in contact" in a busy everyday life.

> Grethe: 'How is it going with one thing and another?' you know. ...If you are busy and don't have much time to see each other, then it's nice to just send a mail like that (...). Make dates and just keep in touch regularly.

Grethe also often communicates with friends and relatives through *instant messaging*, particularly Google Talk and the chat feature on Facebook. When she is working at her computer – and logged on to her Google and/or Facebook account – her contacts can see that she is online, and they often write short greetings to her. Grethe explains that most of it is "just chit-chat": "Hi, when shall we meet again?" or "what are you doing?" Sometimes, she logs out or changes her status to offline, because the messages interrupt her work. Some other informants also use instant messaging on a regular basis. Esben, a 51-year old electrician and service manager, finds it easy and cheap to use Messenger to communicate with his nephew in Australia. The nephew sometimes sends pictures via Messenger, which Esben prints out and gives to his mother, his nephew's grandmother.

Grethe has a profile on *Facebook*, which she originally created because she was interested in visiting her niece's Facebook profile. Later, she became "friends" with her own sons, and then with some of their friends and so on. Grethe and her "friends" write short greetings to each other, and she describes Facebook as a "paradise for teenagers" and as "pure amusement". Facebook was still quite new at the time we conducted the interviews, and therefore only a few other informants used Facebook. One of these is the 35-year old female university student, Gry, who has 120 "friends" on Facebook. Although many of her "friends" are connected with her work as a volunteer in a political party, Gry also meets several personal friends and acquaintances on Facebook. Some of the acquaintances are old friends, e.g. from high school, who have found her profile on Facebook and invited her to be their "friend". Gry thinks that Facebook has made it possible for her to stay in contact with more acquaintances, some of whom are "people I wouldn't have been in contact with otherwise...". Gry likes to visit her friends' profiles as she is curious to know how they are doing. Interestingly, most of the informants experienced with Facebook feel some ambivalence in relation to it; they find the universe of Facebook fascinating and captivating, but at the same time – and for the very same reason – they are afraid of spending too much time on Facebook. Gry even describes herself as "addicted" to Facebook:

> Gry: You always have to just check your Facebook, even though it's ridiculous. Nothing new has happened (…), but I just have to check anyway and click into my friends – see what they have joined... I really think you have to make some rules for yourself, because you can use an awful lot of time on nothing.

Grethe frequently takes digital photographs when she and Rasmus are together with friends and relatives (e.g. at dinner parties). Afterwards, she edits the pictures in Google's image editing programme Picasa, uploads them to a folder on Picasa's *web album*, and then by email invites those who attended to visit the folder and download the pictures. Grethe also uses Picasa's web album to stay in contact with former neighbours who moved to Singapore some time ago. She uploads and shares photographs with them from social gatherings with their neighbours so that they can follow life on their street. Similarly, the former neighbours upload pictures from their own life in Singapore and share them with Grethe and Rasmus.

Rasmus' children write about their personal life on their own *weblogs*, and if Rasmus or Grethe have not heard from them for some time, Grethe sometimes visits their blogs to see "what they are busy with at the moment". She also occasionally leaves a greeting in the form of a comment. Grethe explains that the weblog is a way of "keeping in contact" with them, when they are too busy to stay in touch with their father and her.

The empirical material includes other examples of how the integration of new ICTs results in a diversification of the practices related to "staying in touch" with friends and relatives. For instance, several informants use *IP-telephony* (Voice over IP, VoIP) on a regular basis. One example is 28-year-old Benny, who makes audio-visual calls to his parents via Skype; it "gives a really nice feeling that one can see each other", he explains. Another example is Steen, a 49-year-old truck driver, who frequently plays the *multiplayer online role-playing game,* World of Warcraft, with his 26-year-old son. Their characters "meet" and "fight together" in World of Warcraft, and while they are playing, they use Skype to talk together about shared game experiences as well as personal matters that have nothing to do with the game.

Some general observations can be made about "staying in touch" and the use of ICT: First of all, our interviews reflect the diversification enabled by the multiplicity of possibilities for mediated interaction with friends and relatives that has emerged on the Internet. Some of these possibilities resemble previous forms of communication (e.g. Skype as an inexpensive alternative to landline telephony), while in other cases the link to previous modes of communication is less obvious (e.g. video-telephony, instant messaging, multiplayer online role-playing games, weblogs and sharing digital photographs on the Internet). Our interviews also support results from other studies on mediated communication which indicate that, along with the integration of new ICTs, the practice of "staying in touch" with others may be in the process of transformation towards a continuous flow of frequently recurring interactions. Each interaction often lasts a short time and in many cases is asynchronous. This mode of mediated interaction is similar to what Licoppe (2004) denotes as "connected presence", and Christensen (2009) refers to in his analysis of the daily mediated communication between family members (both studies focus on mobile telephone usage).

Another important observation is that the diversification is closely related to an increase in both the number of devices people employ in their communication with others, and the length of time these devices are in use or turned on. Thus, several of the informants explained that they often had their home computers turned on and online during most of the afternoon, as they experienced it as inconvenient to turn the computer on and off each time they wanted to check their mail, visit Facebook, see who was online on instant messaging services and the like. However, this use pattern, which is characterized by frequent use of the computer and the Internet during afternoons and weekends, is not only a result of the diversification and increased use of ICT for mediated communication; it is also a result of the integration of ICT in almost every kind of everyday practice. This pervasiveness of ICT is in focus in the following sections, which discuss the use of ICT in relation to do-it-yourself, recreational activities and unpaid work.

4.2 Do-it-yourself

Several informants had experiences with do-it-yourself (DIY) in relation to renovating and refurbishing their homes, and all of them used ICTs. Lise is employed in the IT department of an insurance company and lives in an old farmhouse together with her husband. At the time of the interview, Lise and her husband were busy with a larger DIY project; they were renovating their home, the main building and two wings of the old farm. To prepare the rebuilding of the main house, Lise used the programme Microsoft Visio to visualize both the front and the layout of the house. Although the programme is designed to visualize projects, systems and processes through the use of flowcharts, Lise found that it served her purpose well. The drawings were very useful as input for decision-making and for discussions with others. A similar example is John, a 37-year-old project manager. He lives together with his wife and two children in a detached house in the countryside, where the family is in the middle of a thorough indoor renovation of their main house. John has used Second Life to visualize their new home and illustrate how it will look inside and out when the renovation is finished. Compared to traditional programmes used for visualization, John especially likes the possibility in Second Life to move the avatar around in the virtual version of their future home; it gives the feeling of actually being there:

> John: You can really get a feeling of what kind of a house you’re actually making. (…). You can find a lot of programmes for doing this, but you can’t feel as if you can go inside. … (…) But here I could actually say to my friends [with an avatar in Second Life], ”Just come by our place so you can (…) walk around our [new] house. This is how it looks.”

John also experiments with creating a connection between the ‘virtual house’ in Second Life and the actual electrical system in his home, so that it is possible to control the switches in the house directly from Second Life and for instance turn lights off or on from his workplace.

Lise also finds net shopping very useful in connection with the rebuilding project. They succeeded in finding old roofing tiles that match the ones they already had, for example. Other informants describe similar examples. Tyge, a 43-year-old IT employee, has bought many products and materials, such as plumbing articles, via net shopping, which he finds convenient; the products are delivered directly to his home address, and he can shop from home at any time. Some of the informants document the different steps in the rebuilding process by taking digital photographs, which they use both for their memories and to show friends and others interested in rebuilding projects.

4.3 Sports and recreational activities

Several informants are active in sports. Lise rides her own horse every day. The horse is presently stabled at a neighbouring farm while Lise and her husband renovate their stable. When it is finished, Lise intends to hold two horses. She will install a web camera in the stable and access the recordings through a website, both from work and home. She also considers monitoring the fold in the daytime, so she can keep an eye on the horses while she is at work:

> Lise: So I can see how the horses are doing and don't have to go out there at night. (…) I hope I can also use it when I'm at work (…). If it's bad weather and they get uneasy, I can go home half an hour early.

Esben, who is 51 and a member of a rifle club, gives another example of web-based monitoring. He has a safe where he stores the club's weapons at home, and for security reasons, he has installed a web camera. If anything moves in the room where the safe is, a picture message is sent to his mobile.

Lise teaches riding twice a week, and she wanted to video-record her trainees to use as a learning tool. For this purpose, she plans to replace her old video camera with a new digital camera that records directly onto a DVD. She also wants to record her husband running; and he could record her riding. The informants (or their partners) who like to run all have running computers that measure the length and gradients of the route and monitor the speed and pulse of the runner. Esben and his wife also use a running computer for their long walking tours, and he uploads the results to the computer on their return. Another informant uses an internet-based route map on which it is possible to draw his route and measure its length.

ICT is also used for recording in connection with other kinds of recreational activities Benny, who works with music history research in his professional life, also composes and sings in a choir in his leisure time. He is a member of a small association of composers, which has its own concert choir specializing in new compositions inspired by Renaissance vocal music. Benny sometimes records the choir's concerts on a mini-disc and later edits the results on the computer, removing the applause. He can then burn the sound file onto a CD so he can discuss the composition with the other composers. Brian, a 70-year-old retired businessman who was involved in amateur theatre for many years, no longer acts; but he follows the local theatre and has video-recorded their performance of a well-known musical. He made four recordings of the whole musical and used them to edit one high-quality version, which was then put on DVD. About 100 copies were sold.

A popular pastime among the informants is singing in a choir. 53-year-old librarian, Merete, and her husband Michael, participate in a beginners' choir that has a Facebook group where the music is available so the members can practise at home. The Facebook group is also used to try to attract more men to the choir by 'advertising' about all the nice female members as well as for social communication between the members. Merete also uses YouTube to search for songs they plan to sing and hear how they sound in the original versions. She uses the Internet in relation to other pastimes, such as her line dance class. When she cannot figure out the steps, she finds videos that teach the dances on YouTube.

Another informant, Helle (the partner of Steen, the truck-driver), became an amateur genealogist when her cousin made a website where family members could upload texts, photographs and films about their ancestors and develop a genealogical tree. One way Helle finds information for the website is by searching online databases, which is now easier since church registers have been scanned and made available on the Internet.

4.4 Volunteer work in associations or political parties

Several informants are involved in volunteer work as coaches or active members of associations. Benny is on the committee of the small association of composers, the members of which use a website to exchange information and coordinate activities. The website includes both a weblog and "internal pages", which are only for members. The committee members also often use Skype's chat feature to communicate about practical details (e.g. to arrange time and place for meetings), and they have held a few meetings over Skype, supported by web cameras. Tyge, who runs and plays badminton at the local athletic association, is involved in coach meetings and takes part in the association's committee. Much communication related to committee work is carried out by email, and he receives mails almost daily with questions from association members. Tyge also uses the local municipality website to search for information about how to apply for funds for sports activities. Similarly, one of the other informants, a female karate coach who trains a children's team, communicates with their parents by email. She also contributes news and information about the team to the club's website and finds inspiration for her work as a coach on the websites of other karate clubs.

ICT is also used to establish and maintain broader networks related to volunteer work with contacts and persons with similar interests. Thus, Benny has a profile on both MySpace and Facebook, where he primarily introduces visitors to his interests in singing and composing. He mainly uses Facebook to receive news about coming events by reading the messages posted on the Walls of his friends' Facebook profiles. Benny explains that some fellow members of the association are much better than he at utilizing these kinds of contacts to develop collaboration with people in other countries. An example of this involves an English writer, who originally contacted Benny and the other members via MySpace:

> Benny: (...) an English writer, who I had contact with, but the others [members of the association] have a lot of contact with him (...). And it has developed into concrete cooperation – he is a writer and writes lyrics to our music (...) and that has meant a lot. I met him several times. When the others invited him to Copenhagen, I went along. And I think that is just great.

The female university student, Gry, also uses Facebook as a way of gathering news and information in relation to her involvement in voluntary political work; she finds Facebook useful for organizing campaigns and meetings. Gry has many political contacts, and Facebook's list of "friends" helps manage all her contacts.

4.5 Dynamics and barriers

The interview material can supply many more pages of examples of the integration of ICTs in various practices, from political grassroots activities and travel experiences to parents' communication with teachers at their children's schools. The examples illustrate that all kinds of public institutions, organizations, associations and interest groups have embraced the Internet, and that our informants actively support this by using the facilities, sometimes very creatively. That political encouragement exists for developing information society is apparent, for instance, in the digitalization of archives and the communication systems used in schools. Many activities also involve the use of commercial products in addition to the computer, such as web cameras and running computers, commercial services such as Facebook and Picasa, and commercial software such as image editing programmes. Since business firms search for business opportunities to implement the widespread diffusion of computers and the Internet, practitioners are offered a proliferation of supportive tools that interact with and become integrated in their practices. Business innovation often involves a search for products or services where designers try to script specific uses, and this of course also applies to much specific ICT equipment and software. However, the interpretive flexibility of the computer, the Internet and – although to a lesser extent – the many related products and services is great and offers a large potential for user creativity. Some of Lise's ideas mentioned above are illustrative; as she says: "I use my PC for everything I can possibly think of using it for".

The integration of ICTs does not always proceed as smoothly as the examples above may indicate. On the contrary, nearly all informants mention problems, for instance with compatibility. At the time of the interviews, the diffusion of Windows Vista created many problems and frustrations. For instance, Merete and Michael have Vista on their new laptop, but Merete's new MP3-player and the editing programme for Michael's digital camera do not work with Vista, and they cannot find a Vista-compatible driver for their scanner; in the short term, they solve their problems by using their old computer. There are also many other problems. Helle and Steen experienced problems with the installation of Skype and with setting up the virus programme so that it did not prevent them from playing advanced games. Some of our informants regard it as a hobby in itself to help others with their ICT problems. Esben helps a large group of relatives and friends, without compensation except for an odd bottle of wine. His interest in computers goes back to Commodore 64, and he enjoys repairing them, cleansing them of viruses, and trying out new equipment, programmes and Internet services. One person Esben helps is his 82-year- old father-in-law, who can communicate his problems to Esben over Messenger. If it is a bit complicated, Esben can take control of the old man's computer on the Internet by using a freeware crossover programme.

To sum up, the combination of commercial innovation, public encouragement and user creativity adds up to widespread changes in many everyday practices, and sometimes even encourages people to engage in practices that did not interest them previously (cf. Helle's interest in genealogy). We turn now to the energy implications of these changes in practice.

5. Implications for energy consumption

As already mentioned, the use of ICT is reflected in the increasing share of household electricity consumption. In this section, we concentrate on exemplifying the links between the observed practices and the related electricity consumption, rather than providing a detailed overview of the variety of links between ICT use in households and energy use. For such an overview of direct, indirect and derived energy impacts, we refer to Røpke et al. (2008) and Willum (2008).

In the first place, increased electricity consumption results from the increasing number of computers. When people integrate computers and the Internet into all sorts of activities, they increasingly want to have access to their own personal computer instead of sharing one with others. For heavy users, like most of our informants, this has already been standard for years, and many have more than one computer per person. Several reasons are mentioned for having more than one computer: For instance, some informants keep their old computers with previous versions of operating systems in order to be able to use software that is not compatible with newer operating systems such as Microsoft Vista (cf. the example with Merete and Michael); and some informants have two or more computers dedicated to different practices. People increasingly combine several ICTs in their performance of single practices; and/or they perform two or more practices simultaneously with each practice depending, for instance, on different Internet services. One example is Steen, who finds it convenient to have two computers running at the same time while he plays World of Warcraft; one for World of Warcraft and Skype, and one for browsing the Internet for additional information.

The pervasive integration of especially the computer and the Internet across everyday practices also makes it impractical to turn off the computer(s). While at home, many informants leave their computer turned on (sometimes in standby mode) and return to it several times during an ordinary evening or weekend. Most of these informants consider this a question of convenience.

In addition to computers, many other related devices use electricity. Specialized equipment is available for many practices, such as the webcams, headsets, external hard disks and digital cameras used by our informants. Some equipment is not very energy-consuming while other devices contribute more to the electric bill: such as plasma screens, projectors, and game computers, as well as equipment that must be on at all times, such as home servers, IP telephone connections, surveillance cameras, and set-top boxes that are continually updated. The process of diversification adds to the growing variety of ICT equipment, since specialized devices can be more attractive than multi-purpose equipment due to their improved performance (e.g. a digital camera usually produces better pictures than the camera in a mobile telephone).

The pervasive integration of ICTs into everyday practices increases the importance of the availability of mobile devices. Mobility thus becomes an aspect of the diversification process of both practices and devices. One participant in our short telephone interviews, a 20-year-old technician, described how he used his mobile telephone intensively to “chat” with friends on MSN Messenger and check his e-mail while on the move.

For each single practice into which ICT is integrated, the increase in direct and indirect energy consumption may seem negligible; however, the pervasive integration of ICT across a large number of practices involves considerable impact on total energy use related to everyday life. ICT may also be used to reduce electricity consumption in the home, for instance by managing heating and lighting. One informant was engaged in such management, but in general the potential for using ICT for energy savings has not yet been tapped. The increasing energy consumption related to household use of ICT may also be counteracted by derived energy impacts related, for instance, to teleshopping and teleworking, but until now, studies of these impacts tend to be inconclusive (Jørgensen et al., 2006).

6. Policy implications

In conclusion, the third round of household electrification may be said to be proceeding at full speed and, like the previous rounds, contributing to increasing electricity consumption. There is, however, an important difference: while previous rounds were combined with active promotion of increased electricity consumption, the present round takes place in an era characterized by increased focus on climate change and a call for energy savings. Until recently, this fact has had little influence on the domestic integration of ICT, but this may be about to change.

Producers naturally focus on providing hardware and software that consumers can be expected to find tempting, and as the empirical study illustrates, users are engaged in applying the new technologies in the development and diversification of a wide range of existing practices. The rationales of ICT integration emerge from each practice, such as using ICTs to find special materials for renovating houses, attract new members to a club, improve sports performance, socialize and so on. The interpretive flexibility of the new technologies opens many possibilities, and amidst all this engagement, the implications for energy consumption tend to disappear from sight or end up at the bottom of the priority list. This low priority also relates to the complexities involved in the acquisition of ICT equipment and software, which requires users to familiarize themselves with new technical terms.

Public regulation has begun to intervene in market processes with campaigns to increase consumer awareness of standby consumption, by implementing standards that remove the worst products from the market, and by labelling products to encourage consumers to buy the most energy-effective brands (Jensen et al., 2009; IEA, 2009; OECD, 2009b). But regulation is lagging behind – the process takes time, the number of devices is huge, and the technological development so fast that it is difficult to keep up. Obviously, it is important to speed up the process to put more effective public regulation in place, as recommended by IEA (2009).

Since the basic functions of data processing can be used for monitoring, managing and manipulating all kinds of equipment, ICT also holds promise of saving household energy consumption. The first steps have been taken with sensors to regulate lighting, and many other ideas are in the pipeline. During recent years, increased attention has been focused on the possibilities of reducing domestic energy consumption through the use of ‘smart metering’ to provide feedback to households about their energy use. Studies indicate that the most promising feedback systems provide households with frequent information on a disaggregated level (i.e. appliance-specific breakdown) and in an accessible and appealing way by the use of computerized and interactive tools (Darby 2006; Fisher 2008).

The most important perspective relates perhaps to the integration of wind energy and other sustainable energy sources into energy systems. This calls for smart metering to encourage consumers to use energy when the sustainable sources are available, and to store energy for later use (e.g. in batteries for electric cars). Actually, such trends may add to residential electricity consumption while saving fossil energy in a macro perspective. If the potentials of ICT for saving energy are to be realized, public intervention will be needed, since the necessary preventive incentive in the form of continuously high energy prices has not emerged automatically, in spite of the approach of peak oil – a situation where petroleum extraction cannot be increased any more (Campbell and Laherrere, 1998).

Previous rounds of electrification have co-evolved with broad social transformations. Such products as the vacuum cleaner and the refrigerator were first integrated into existing cleaning and cooking practices, and then gradually became part of profound changes in everyday life. There is no doubt that the computer, Internet and other ICTs will gradually become part of radical socio-technical transformations, although the direction of these changes is not yet clear. From an energy perspective, it is important to emphasize that the direction may be influenced by a wide range of policies – extending beyond narrow energy policies. For instance, ICT may be used for working at home and saving energy for transport – unless, encouraged by tax exemptions for work-related transport, people are motivated to move further away from their workplaces and travel further the few days they do go to work (Jørgensen et al., 2006).

At present, the potential of ICT for saving energy is often emphasized, both by ICT communities (e.g. at OECD conferences on Green ICT) and by green organizations (see WWF publications: Buttazoni, 2008; Pamlin and Pahlman, 2008). The risk exists that this promotion will end as a pious hope and function as a Trojan horse for infusing more ICT into everyday life. Like Hilty (2008), we wish to emphasize that realizing the potential for energy savings will not come about by itself. In addition to policies focusing on improvement of ICT equipment's energy efficiency, there is a strong need to develop policies that can curb rebound effects, encourage all actors to focus on applying ICT in ways that save energy, and influence the direction of the emerging socio-technical transformations. It is beyond the scope of this paper to develop a political programme to encourage realization of the positive potential of ICT and to curb the negative impacts, but some elements may be suggested: ensure a drastic rise in the price of energy and maintain a high price over time, combined with economic compensation to the poor, nationally and globally; remove "perverse" subsidies for transport; subsidize development of renewable energy technologies and investment in the transition of energy systems towards better integration of these technologies; and increase consumer awareness of the impacts related to the number of devices as well as the importance of energy efficiency. Hopefully, further work in this field will open for the development of much more elaborate programmes.

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Bilag 7: Elforbrug til IKT

Elforbrug til IKT

To scenarier for elforbrug til informations- og kommunikationsteknologi i danske boliger 2015

Kirsten Gram-Hanssen
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Toke Haunstrup Christensen

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Resume

Boligsektorens udvikling i elforbrug fra 1974 og frem til i dag viser en stigende andel af elforbrug til informations- og kommunikationsteknologi (IKT) i de danske hjem fra 17 % i 1997 til 26 % i 2006. Informations- og kommunikationsteknologi dækker i denne sammenhæng over TV, DVD, spillekonsoller, PC, printere, forskellige former for radioer samt alle former for telefoner mv.

Med udgangspunkt i denne viden om et voksende forbrug til IKT opstilles i denne rapport to scenarier for elforbruget til IKT i 2015 på baggrund af antagelser om, at såvel bestanden af apparater som brugen af apparater må forventes fortsat at stige.

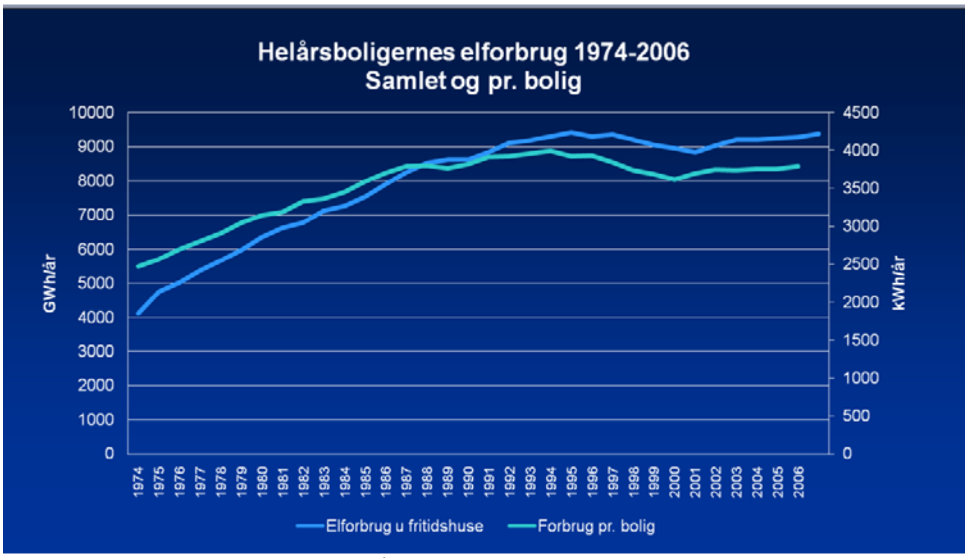
Der opstilles og argumenteres for ét scenarie med en forventning om fortsat kraftig vækst i antal og brug og ét scenarie med forventning om mere moderat vækst. De to scenarier indikerer, at henholdsvis 37 % (lavt scenarie) og 45 % (højt scenarie) af de danske boligers årlige elforbrug i år 2015 vil gå til informations- og kommunikationsteknologi.

Scenarieberegningerne er foretaget ved hjælp af ELMODEL-bolig, et prognoseredskab der er udviklet og ejet af Energistyrelsen og de danske elselskaber.

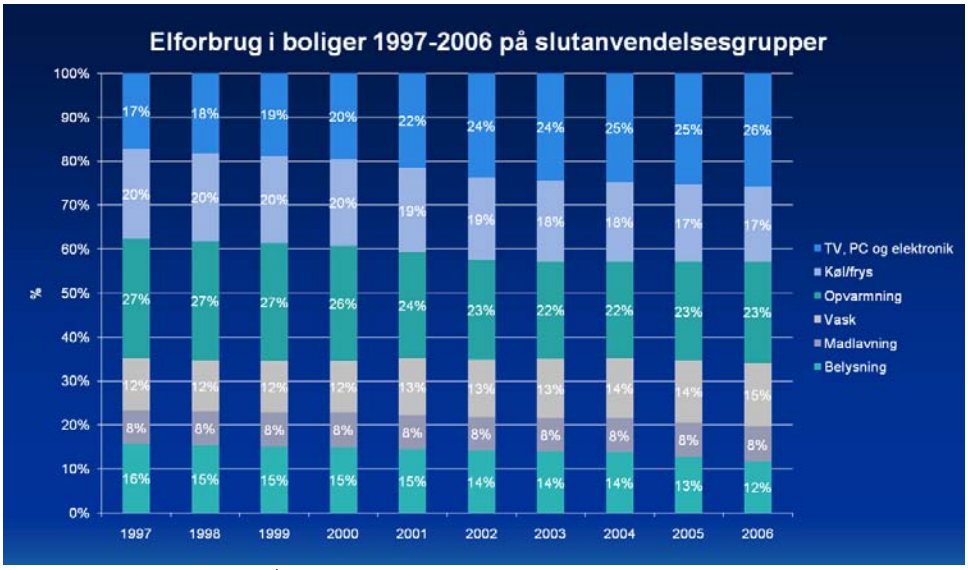
Formålet med scenarierne er ikke at forudsige, hvordan den faktiske udvikling vil blive, men at opstille beregninger for mulige elforbrugs-konsekvenser af nogle sandsynlige udviklinger. Scenarierne skal dermed ses som bidrag til energipolitiske overvejelser om håndteringen af IKT-området.

Baggrund

I Danmark bruges der hvert år ca. 35 TWh el, hvoraf knap 10 TWh forbruges i private boliger. Udviklingen i elforbruget har siden midten af 1970'erne udvist en stigning på ca. 6 % p.a. frem til midten af 90'erne, hvorefter udviklingen har været ganske beskeden, og endog faldende enkelte år. Ses der på forbruget pr. bolig, jf. figur 1, understreges denne udvikling idet der sker en udvikling fra et forbrug på omkring 2.500 kWh/år i 1974 til ca. 4.000 kWh/år i 1994 og ca. 3.700 kWh/år i 2006. Det faldende forbrug pr. bolig skal dog ses i sammenhæng med, at der også er et fald i antallet af personer pr. bolig i denne periode.



Figur 1. Elforbrug i Danmark 1974-2006 i helårshuse. Kilde: Dansk Energi 2007.



Figur 2. Udvikling i fordelingen på slutanvendelsesgrupper 1997-2006. Kilde: ELMODEL-bolig.

De seneste 10 års konstante forbrug dækker imidlertid over væsentlige forskydninger i hvilke slutanvendelser i boligen elforbruget går til. Som det fremgår af figur 2 falder andelene til belysning, køl/frys og opvarmningsapparater, madlavning er forholdsvis konstant, mens forbruget til vask stiger svagt. Den store ændring ses for TV, PC og elektronik, hvor andelen stiger fra ca. 17 % i 1997 til ca. 26 % af det årlige forbrug i boligerne i 2006.

Det synes derfor oplagt at se nærmere på årsagerne til udviklingen for PC, TV mv., i det følgende kaldet informations- og kommunikationsteknologi (IKT), samt ikke mindst hvorledes udviklingen kunne tænkes at se ud fremover. Nærværende rapport fokuserer på sidstnævnte, idet der i det følgende er opstillet og beskrevet to scenarier for udviklingen frem mod 2015 for husholdningers elforbrug til IKT apparater.

Forudsætninger

I det følgende beskrives baggrunden for at opstille scenarier for husholdningers elforbrug til informations- og kommunikationsteknologi (IKT) i år 2015. Formålet med at opstille og beregne disse scenarier er ikke at forudsige, hvordan fremtiden faktisk bliver, men derimod at lave nogle beregninger på de sandsynlige energiforbrugsmæssige konsekvenser af forskellige udviklingstendenser. Scenarierne skal dermed ses som et diskussionsoplæg til mulige energipolitiske indgreb frem for som et prognoseredskab for, hvordan energiforbruget faktisk vil udvikle sig.

Scenarieopstillinger

Udgangspunktet for scenarierne er, at vi inddrager ændringer i antallet af apparater pr. husstand, ændringer i brugstiden for apparater, ændringer i energieffektivitet og type af apparater, samt demografiske ændringer i husstandsstørrelser. Demografiske ændringer i husstandsstørrelsen baseres på fremskrivninger af den hidtidige udvikling, hvor en stadig større andel af befolkningen bor i husstande med kun en person, hvilket alt andet lige vil betyde et større antal apparater pr. person.

Det skal indledningsvis fastslås, at scenarierne ikke forholder sig til konjunktursvingninger eller øvrige makroøkonomiske tendenser, men alene er baseret på den historiske udvikling i udbredelse og anvendelse af apparater, samt de antagelser for den nære fremtid, der er skitseret i det følgende.

For antal, brug og type af apparater opstilles der et højt og et lavt scenarie. For antal og brug af apparater ses der særskilt på TV og PC, og med udgangspunkt i den udvikling, der har været i perioden 2000-2007, opstilles og argumenteres der for, hvorvidt der frem til 2015 vil ske en mindre, en tilsvarende eller en større vækst. Som baggrund for at foretage disse vurderinger bruger vi dels de kvalitative interview, der er gennemført med familier med lang erfaring i brugen af IKT (se Røpke et al, 2008; Jensen et al, 2009), dels øvrig litteratur om udviklingen inden for IKT anvendelse.

Selve scenarieberegningerne er fortaget ved hjælp af datamodellen ELMODEL-bolig, som er en bottom-up model der ud fra survey blandt danske husstande omkring deres ejerskab og brug af elapparater kombineret med effektforbrug på apparater samt øvrige tilgængelige oplysninger beregner danske husstandes slutforbrug. Scenarierne for typen af teknologier er fremkommet ved at opstille tidsserier for de enkelte teknologiers årlige salgstal og energiforbrug. Dette er gjort med udgangspunkt i den foreliggende fordeling af salget på teknologier, hvilket skaffes fra BFE's (Branchen ForbrugerElektronik) salgsstatistikker i kombination med resultater fra spørgeskemaundersøgelser fra ELMODEL-bolig. For TV skelnes mellem typerne: CRT, LCD og Plasmaskærme, og for PC skelnes mellem stationære og bærbare maskiner. Data for energiforbrug hentes fra ELMODEL-boligs baggrundsrapporter om husholdningsapparaters elforbrug som også inkluderer forventede fremtidige energieffektiviseringer for de enkelte apparater.

Tallene for energiforbruget knyttet til alle øvrige apparater (dvs. "ikke-IKT") bygger på ELMODEL-boligs basisfremskrivning, som baseres på fremskrivninger af den hidtidige udviklingstendens mht. effektiviteten, antallet og sammensætningen af ikke-IKT apparater i husstandene.

Antal TV

For antallet af TV er der i det lave scenarie for 2015 regnet med, at den stigning der har været i TV i perioden 2000-2007 klinger af, så vi i perioden frem til 2015 vil se en halvt så stor stigning. For det høje scenarie har vi derimod regnet med lidt over en fordobling i tilvæksten af antal apparater pr. husstand for perioden 2007-2015 sammenlignet med den forudgående periode.

Argumentet for det lave scenarie er, at vi på den ene side fortsat må forvente en vækst i antal fjernsyn, bl.a. som følge af at mange køber nye fladskærms TV i de kommende år uden at de lidt ældre fjernsyn bortskaffes. Samtidig vil digitaliseringen af sendenettet sandsynligvis indebære, at mange køber nyt fjernsyn, mens deres gamle fjernsyn udstyres med settop-boks og overgår til andre rum i husstanden.

Der er desuden ingen tegn på, at tendensen til at børn har eget fjernsyn, samt at man har fjernsyn i både soveværelse og køkken, vil klinge af. Når det lave scenarie på den anden side sættes til en lidt lavere vækst end i de foregående år, er argumentet at PC i nogle tilfælde kan forventes at overtage nogle af fjernsynets roller, samt at vi ser en begyndende mætning i form af antallet af TV, da mange husstande allerede i dag har et TV pr. person samt et i hvert af de centrale rum.

Argumentationen for det høje scenarie er en fortsat tendens til at have ét fjernsyn pr. person i husstanden og til at have fjernsyn i de fleste af husets rum. Fjernsyn i badeværelset er således et nyt sted at udvide antallet af TV. I det høje scenarie tænkes TV og PC som to teknologier, der bruges til forskellige ting og derfor supplerer hinanden frem for at erstatte hinanden, og et øget antal PC betyder derfor ikke, at husstanden har færre TV.

Brugstid for TV

For brugstiden af TV regner vi i det lave scenarie med en halvt så stor stigning i de kommende år som vi har set i den forudgående periode, hvorimod vi i det høje scenarie regner med en noget større stigning.

Begge scenarier tager udgangspunkt i den vurdering, at det bliver stadig mere almindeligt at bruge fjernsynet som baggrundstæppe med lyd og billede tændt hele tiden. Dette gælder både de mange ældre der bor alene og gennem fjernsynet får en form for selskab og de yngre mennesker, som i stigende grad er vant til at have mange medier tændt samtidig. En fortsat individualisering betyder desuden, at det vil blive stadig mere almindeligt, at personer i samme husstand ser forskellige film eller tv-udsendelser hver for sig, således at mange apparater ofte vil være tændt samtidig.

Undersøgelser viser desuden, at fladskærms TV ophængt centralt i stuen kan bruges som billedramme til at vise familiens egne billeder, når TV'et ikke er i brug, eller når det blot bruges til at høre radio. Ved at bruge fladskærmen som billedramme undgår man også at have "en grim sort skærm" hængende på væggen, men samtidig er der selvfølgelig et elforbrug forbundet med dette.

Antal PC

For antallet af PC regnes der i det lave scenarie med samme vækst i perioden 2007-2015 som i den forudgående periode, hvorimod der i det høje scenarie regnes med en dobbelt så stor stigning.

Argumentationen for stigningen er, at brugen af hjemme PC er inde i en udviklingsfase, hvor computere integreres i stadig flere hverdagspraksisser, og hvor nye anvendelsesområder hele tiden opstår. Mange af disse anvendelsesområder medfører en differentieret brug af forskellige computere, således at én PC fx bruges til IP telefoni, en anden til spil, en tredje kører som server osv.

Individualiseringstendensen betyder samtidig, at det bliver helt almindeligt, at hver person i en husstand har sin egen PC, og herunder bliver det stadig mere almindeligt, at stadig yngre børn bruger PC, samt at ældre borgere også tager computeren til sig. Alt i alt tegner der sig en sandsynlig fremtid med et stadig stigende antal computere i de danske husstande. I forhold til denne udvikling repræsenterer det lave scenarie et konservativt skøn over stigningen, mens det høje scenarie bygger på en antagelse om, at især integrationen af computere i flere og flere af hverdagslivets praksisser i kombination med en differentieret anvendelse af computerne vil accelerere væksten i antallet af PC'er.

Brugstid PC

Brugstiden for PC er i det lave scenarie sat til en stigning, der er halvt så stor som i perioden 2000-2007, hvorimod stigningen i det høje scenarie er sat til at være næsten lige så høj som i den forudgående periode.

Argumentationen for, at brugstiden for computere vil fortsætte med at stige er, at computerens anvendelsesmuligheder i hverdagslivet er inde i en udvikling, hvor alle former for hobbyer og fritidsaktiviteter samt almindelige informationssøgninger, musikafspilning m.m. indebærer brugen af PC. Dermed bliver det stadig mere aktuelt at have flere computere stående tændt hele tiden for at undgå at tænde og slukke. Samtidig antages stigningstakten for brugstiden pr. apparat dog at aftage lidt ("flade ud") i de kommende år.

	2000	2007		2015, lavt scenarie		2015, højt scenarie	
			% vækst		% vækst		% vækst
TV, antal pr. husstand	1.4	1.9	35 %	2.1	10 %	3.1	63 %
TV, tidsforbrug pr. apparat (timer)	3.5	4.6	31 %	5.2	13 %	6.2	35 %
PC, antal pr. husstand	0.8	1.6	100 %	2.4	50 %	3.3	106 %
PC, tidsforbrug pr. apparat (timer)	2.4	5.4	125 %	7.0	30 %	8.0	48 %

Tabel 1. Opsummerer forudsætningerne omkring antal og brugstid for PC og TV. Kolonne 2000 og 2007 viser det faktiske gennemsnitlige antal og brug af IKT pr. husstand i Danmark. For 2007 er der beregnet en procentvis stigning i forhold til 2000. Kolonnerne 2015 høj og lav viser antagelserne for henholdsvis det høje og det lave scenarie, og til sammenligning er den procentvise vækst i forhold til 2007 vist.

Øvrige apparater

Ud over de detaljerede opstillinger for TV og PC gøres der følgende forudsætninger for en række andre IKT apparater: Udviklingen i antallet af settopbokse (simple og avancerede) og DVD (samt tilsvarende teknologi som fx harddisk optager) følger udviklingen i antallet af TV (altså 1:1). Video udfases, mens øvrige apparater med relation til TV (surroundsound og spillekonsol) følger den relative udvikling for TV i udbredelse og anvendelse.

Apparater med relation til PC: ADSL-forbindelser, eller tilsvarende internetforbindelser, stiger i antal op til en pr. husstand, men ikke mere idet det forventes at en internetforbindelse kan deles af alle husstandens PC. Forbruget pr. enhed vurderes at falde svagt som følge af en naturlig udvikling i effektiviteten, både hvad angår ON og standby-modes.

Mobile lagringsenheder (flytbare harddiske) antages også at nå op på en pr. husstand, men ikke højere da der igen forventes at kunne være en trådløs forbindelse mellem denne og alle husstandens computere, som gør brug af den. Her antages også en svag forbedring af standby-mode forbruget, mens ON-mode effektniveauet fastholdes, da en eventuel effektivitetsforbedring her ventes at blive opvejet af et ønske om en større kapacitet.

Vedrørende telefoni vurderes de trådløse telefoner allerede i dag at have nået et mætningspunkt i udbredelsen og fastholdes derfor på dette niveau. For stereoanlæg og clockradioer fortsættes den observerede udvikling i begge scenarier (surround-sound følger som nævnt TV). En svag forbedring af standbyforbruget ventes også her.

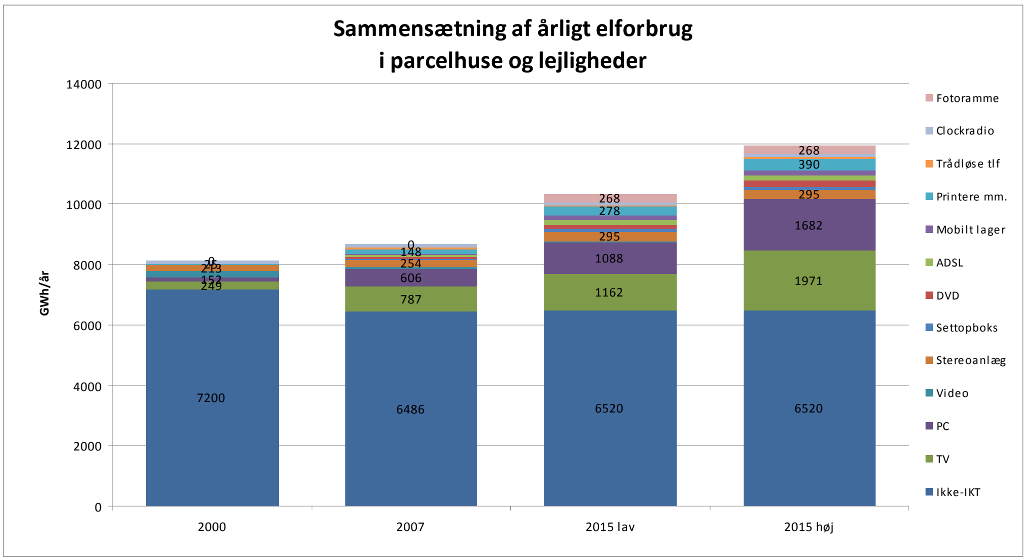
Det nye apparat der ventes at erobre hjemmet er digitale fotorammer. For dette apparat er der opstillet et forløb der resulterer i ca. 2 fotorammer i gennemsnit pr. husstand i 2015 (dvs. i tillæg til evt. brug af fladskærms-TV'et som billedramme). Der er yderligere antaget en udvikling mod større skærme og gradvis integration af trådløs kommunikation. Dette resulterer i en samlet stigning i elforbrug pr. enhed trods en formodet energieffektivisering af produktet for fastholdt størrelse. Da brugstiden er vurderet til 12 timer i gennemsnit pr. døgn kommer elforbruget pr. enhed op på ca. 50 kWh/år i 2015.

For afbildningsudstyr (printer, scanner, fax, kopimaskine samt kombinationer heraf) ventes antallet at følge PC i begge scenarier. Disse apparater er slået sammen, da de også i praksis er ved at smelte sammen som teknologi. Der antages en svag forbedring af standbyforbruget frem mod 2015.

Resultater af scenarieberegninger

Overordnede resultater

Med de i afsnit 2 beskrevne forudsætninger er følgende resultater for 2015 opnået for henholdsvis lavt og højt scenarie med 2000 og 2007 som referencer. Som det ses i figur 3 ventes et samlet forbrug i 2015 til IKT på ca. 3800 hhv. 5400 GWh. Dette svarer til ca. 37 % hhv. 45 % af det samlede elforbrug i danske husstande. Forbruget til de enkelte apparattyper er anført herunder i tabel 2.



Figur 3. Elforbrug fordelt på anvendelser, 2000-2015.

Tabel 2. Elforbrug fordelt på anvendelser, 2000-2015.

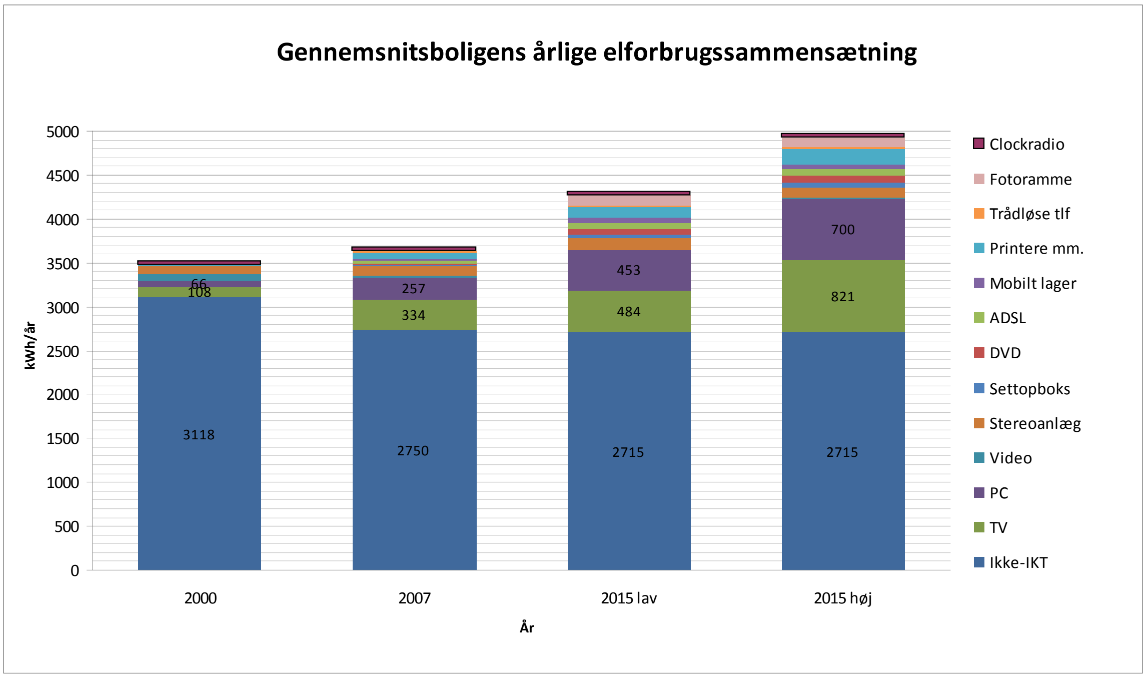
	2000	2007	2015 lav	2015 høj
Ikke-IKT	7200	6486	6520	6520
TV	249	787	1162	1971
PC	152	606	1088	1682
Video	189	55	15	15
Stereoanlæg	213	254	295	295
Settop-boks	3	32	116	120
DVD	0	42	153	206
ADSL	5	83	165	173
Mobilt lager	0	25	144	151
Printere m.m.	25	148	278	390
Trådløse tlf	18	72	58	58
Clockradio	77	84	92	92
Fotoramme	0	0	268	268
SUM	8132	8673	10 353	11 941

De største stigninger ses ikke overraskende for TV og PC, hvor ikke mindst TV-forbruget i det høje scenarie når næsten 2 TWh, eller 17 % af husstandens forbrug. For PC ses et forbrug på hhv. 1,1 og 1,7 TWh i lavt og højt scenarie for 2015. I forhold til 2007 svarer niveauerne for TV og PC i det høje scenarie til en årlig stigning på ca. 12 % hhv. 14 %, i det lave scenarie er der årlige stigninger på 5 % hhv. 8 %. Som nævnt i forudsætningerne vurderes der i gennemsnit at være ca. 2 TV og 2 PC hhv. 3 TV og 3 PC pr. hjem i 2015 i lavt og højt scenarie.

Forbruget til videoer ses at svinde bort i takt med udfasningen til fordel for DVD. Summen for de to apparater ses således kun at udvise en svag stigning ift. år 2000. Settop-bokse ses at stige fra næsten 0 til ca. 120 GWh pr. år i 2015. Her er 5/6 af forbruget i 2015 i de avancerede modeller (med optagefunktionalitet mv.). Forbruget til ADSL-bokse (herunder alle øvrige former for netforbindelser samt trådløse netværk) er beregnet til over 170 GWh i 2015. Det høje forbrug er forbundet med den høje brugstid, samt at standby-effektniveauet er næsten på højde med forbruget under kommunikation gennem enheden. Stigningen for mobile lagringsenheder er meget lig den for settop-bokse og ADSL-enheder. Der ventes en bestand på knap et apparat i gennemsnit pr. bolig i 2015. For printere mv. ventes ca. en fordobling ift. 2007 niveauet, hovedsagelig grundet en fordoblet udbredelse.

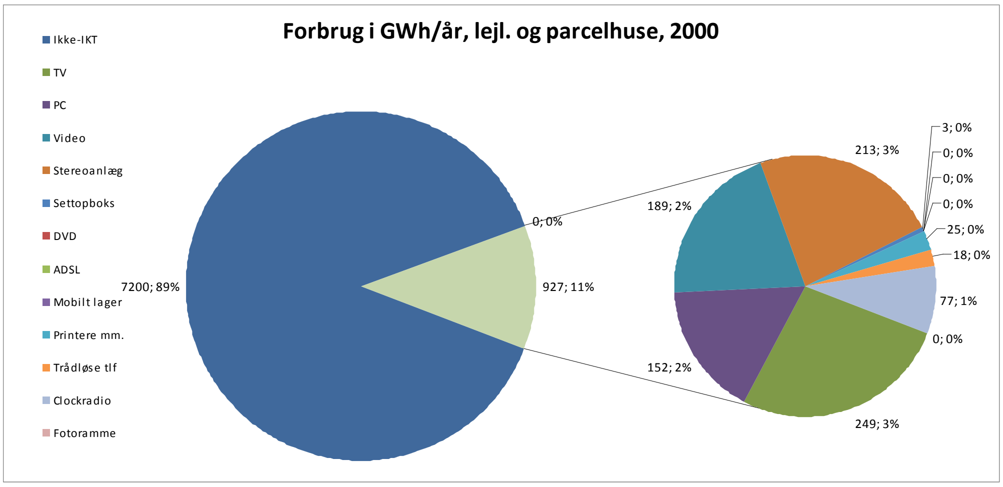
For trådløse telefoner ventes et fald ift. 2007, da udbredelsen stort set er mættet allerede i 2007. Således skyldes faldet den effektivitetsforbedring der forventes, ikke mindst på grund af Eco-design direktivet på strømforsyningsområdet. For clockradio forventes den historiske udvikling i udbredelsen fortsat frem mod 2015, fx ved at den gør sit indtog i børneværelserne. Effektivitetsudvikling for strømforsyninger gør at stigningen i elforbruget er beskedne 1 % p.a. Digitale fotorammer ventes i scenarierne at blive populære. Dette understøttes af BFE der forventer et fortsat stigende salg af fotorammer. Frem mod 2015 ventes bestanden at stige til ca. 2 fotorammer i gennemsnit pr. husstand. Det årlige elforbrug pr. enhed ventes at stige fra 20 til 60 kWh, primært grundet større skærme. Herved kan der for 2015 beregnes et årligt forbrug på knap 270 GWh.

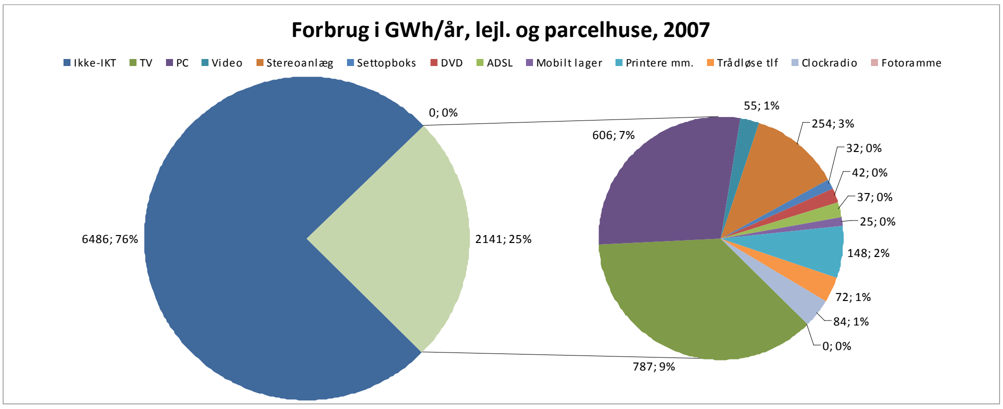
Oversættes tallene til det årlige forbrug for en gennemsnitlig dansk husstand, vil det se ud som vist i figur 4.

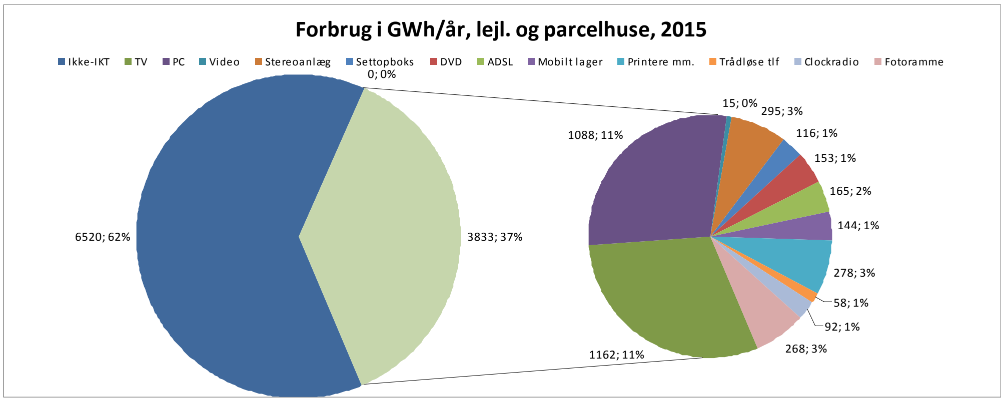


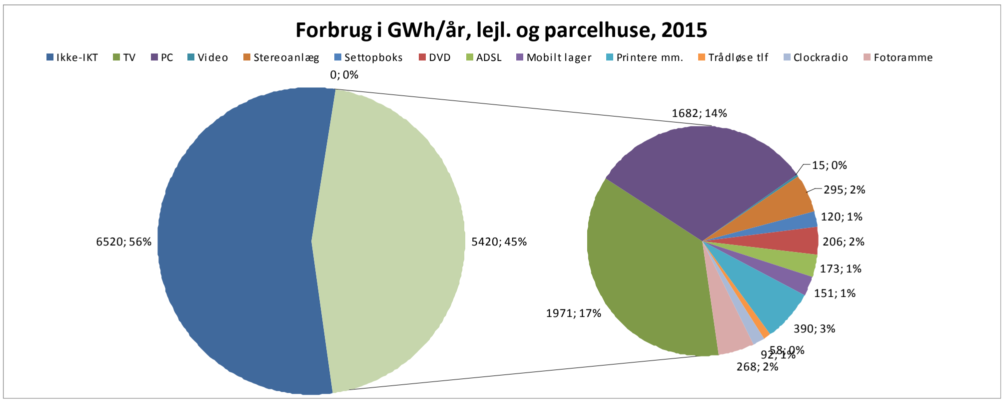
Figur 4: Gennemsnitligt årligt elforbrug fordelt på apparattyper i danske husstande i år 2000, 2007 samt for højt og lavt scenarie år 2015

De årlige forbrug til TV og PC ses at andrage 484 og 453, hhv. 821 og 700 kWh/år i lavt og højt scenarie. Samlet når forbruget 5.000 kWh/år for en gennemsnitsbolig i det høje scenarie, eller ca. 1/3 mere end i dag. De fire procentvise fordelinger ses i figur 5:







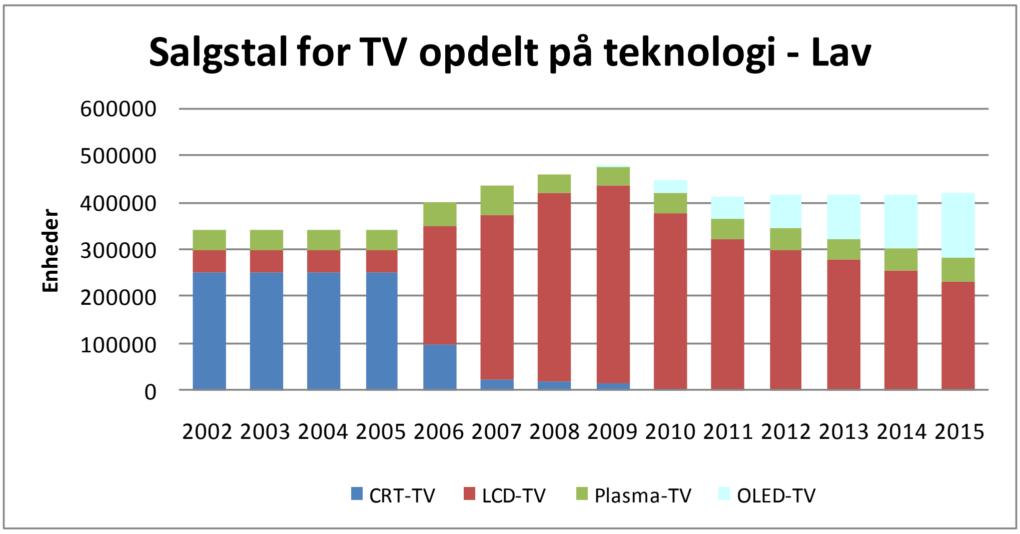


Figur 5. Elforbrugets fordeling for en gennemsnitlig husstand år 2000, 2007 samt år 2015 for henholdsvis lavt og højt scenarie.

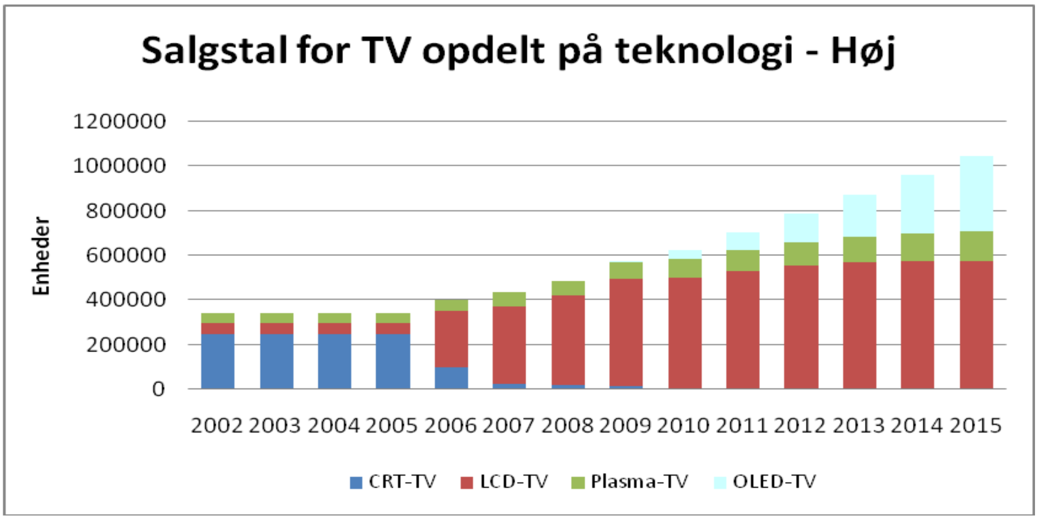
Detaljerede resultater

I det følgende angives mere detaljerede beregningsresultater for TV og PC, som er de bærende apparater for fremskrivningsscenarierne. Der opgøres årlige salgstal ud fra antagelser om bestanden, jf. tidligere, og gennemsnitlige, normalfordelte levetider. Forbruget beregnes ud fra brugstid og effektniveauer for ON- og standbymode. For standby forbruget regnes der med at en vis procentdel af apparater er på standby i det omfang de ikke er i brug. Denne procentdel er baseret på oplysninger fra Elmodel bolig. Der er regnet med en effektivisering af apparaterne, udtrykt i gradvist lavere effektniveauer, der imidlertid mere end opvejes af stigende brugstid, således at det samlede forbrug pr. enhed ventes at stige.

Salg, bestand og forbrug, TV-apparater



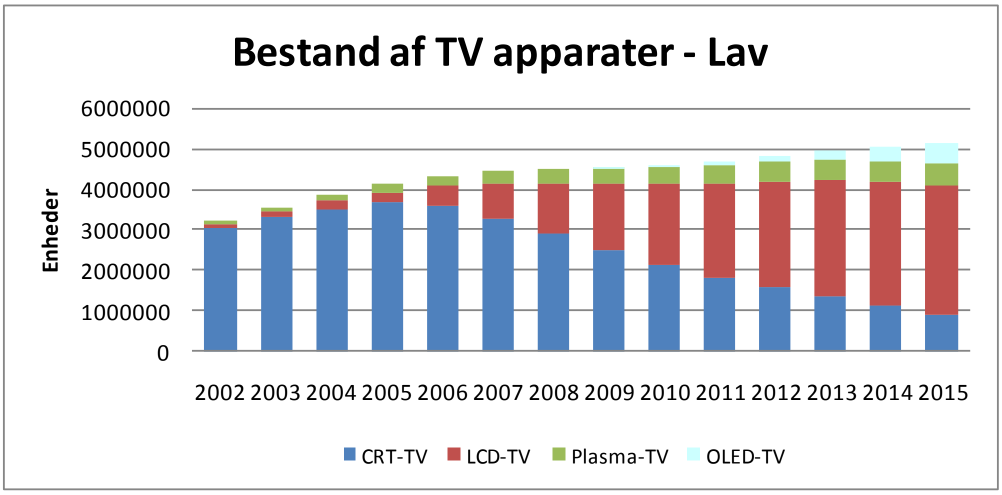
Figur 6. Salg af forskellige typer af TV-apparater 2002-2015 – Lavt scenarie.



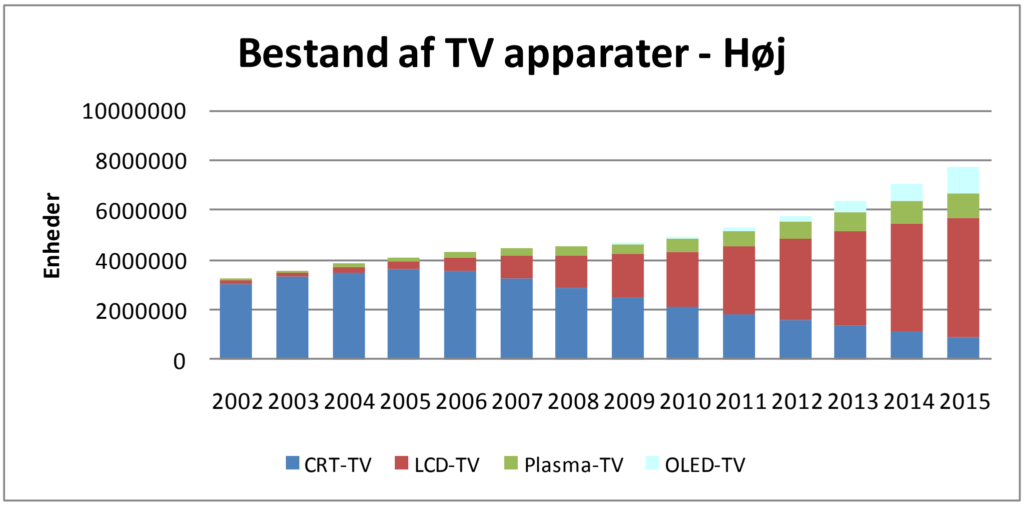
Figur 7. Salg af forskellige typer af TV-apparater 2002-2015 – Højt scenarie

Det ses af figur 6-7, at en vis indtrængning af den helt nye OLED-teknologi er indregnet. Således er der regnet med indledende 1 % i 2009, stigende lineært til knap 1/3 af salget i 2015. Markedsandelene er antaget at gå fra LCD. Der ventes endvidere et vist niche-marked for Plasma-typen, mens CRT-teknologien salgsmæssigt ventes udfaset med udgangen af 2009.

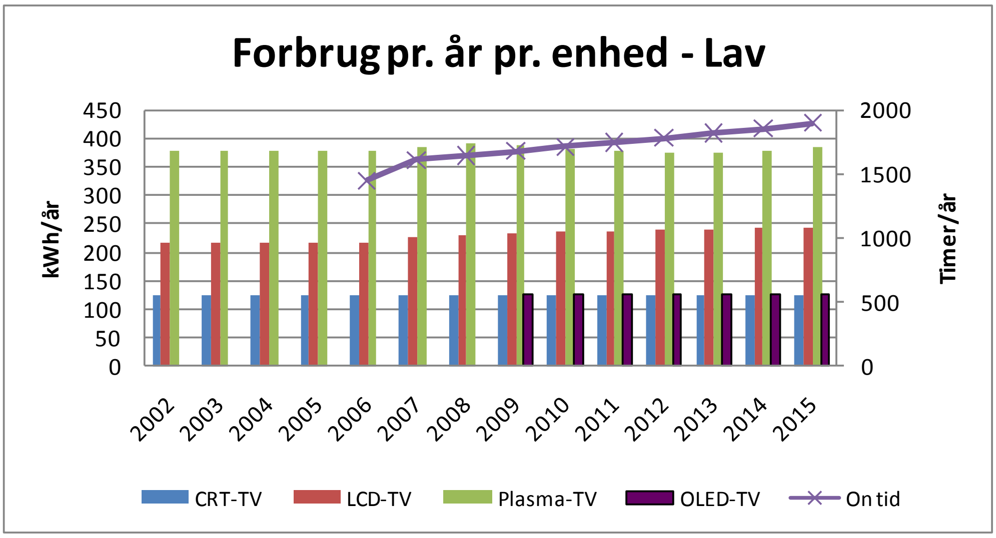
Ud fra salget frem til 2007, samt det fremtidige forventede salg afhængigt af højt eller lavt scenarie, samt en antagelse om 12 års middellevetid (25 % spredning om denne middelværdi) kan bestandens sammensætning beregnes, som vist i figur 8-9. Det ses, at der stadig i 2015 er knap 1 mio. TV-apparater af CRT-typen – lidt mindre end bestanden af OLED-TV i det høje scenarie. 4,8 mio. enheder, eller ca. 60 % af bestanden er LCD-TV.



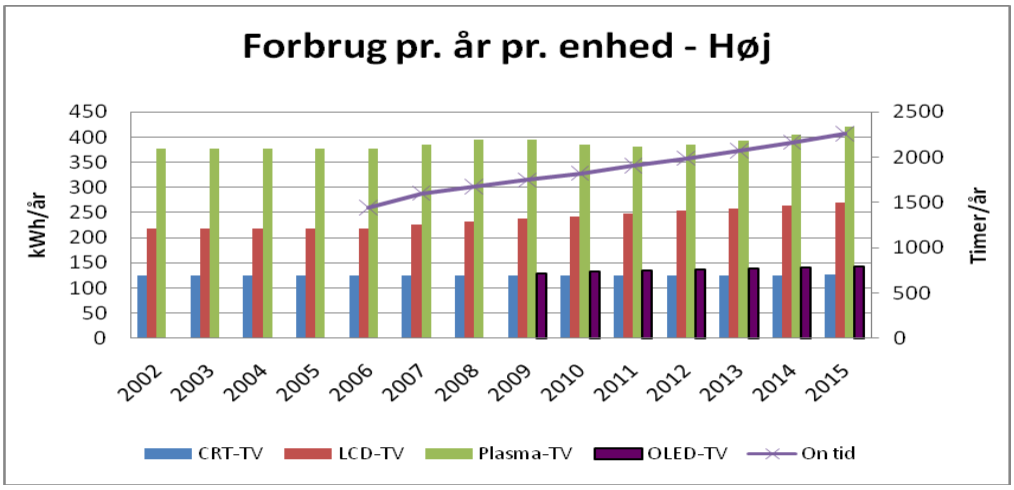
Figur 8. Bestand af TV-apparater, beregnet ud fra salg og levetider, Lavt scenarie



Figur 9. Bestand af TV-apparater, beregnet ud fra salg og levetider, Højt scenarie.

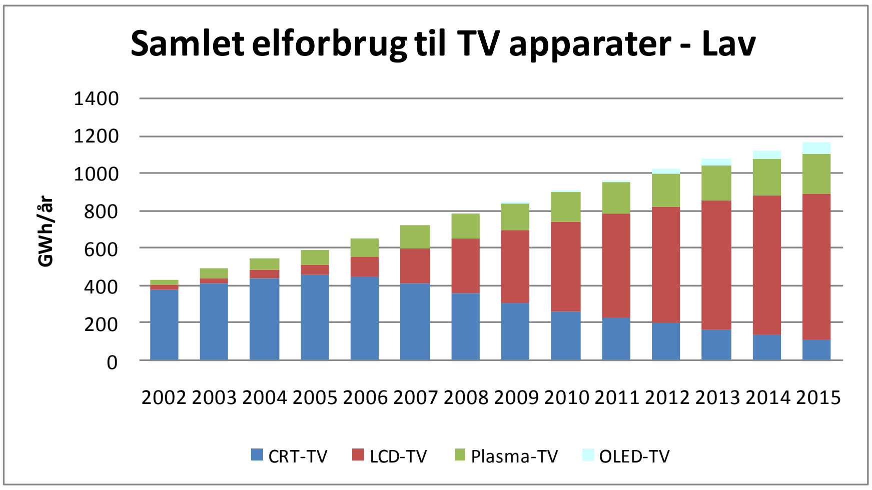


Figur 10. Årligt forbrug til TV pr. teknologi samt anvendt On-tid, Lavt scenarie.

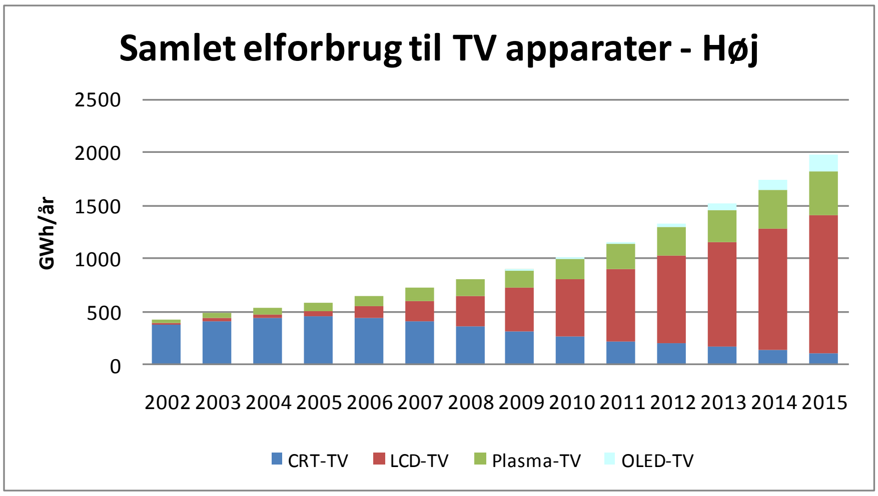


Figur 11. Årligt forbrug til TV pr. teknologi samt anvendt On-tid, Højt scenarie.

Det fremgår af figur 10 og 11, at der som nævnt ventes en gradvis stigning i forbruget pr. enhed. Dette er resultatet af en forventning om at stigende benyttelsestid opvejer den løbende effektivisering af skærmene.



Figur 12. Samlet elforbrug til TV-apparater 2002-2015, Lavt scenarie.

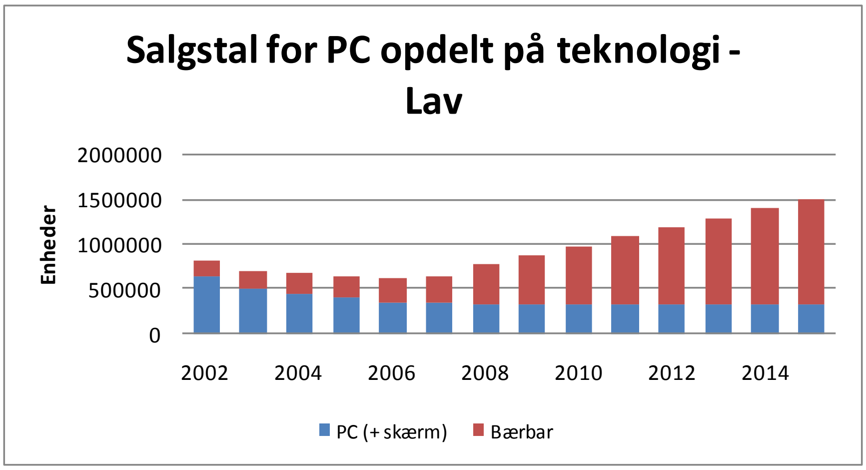


Figur 13. Samlet elforbrug til TV-apparater 2002-2015, Højt scenarie.

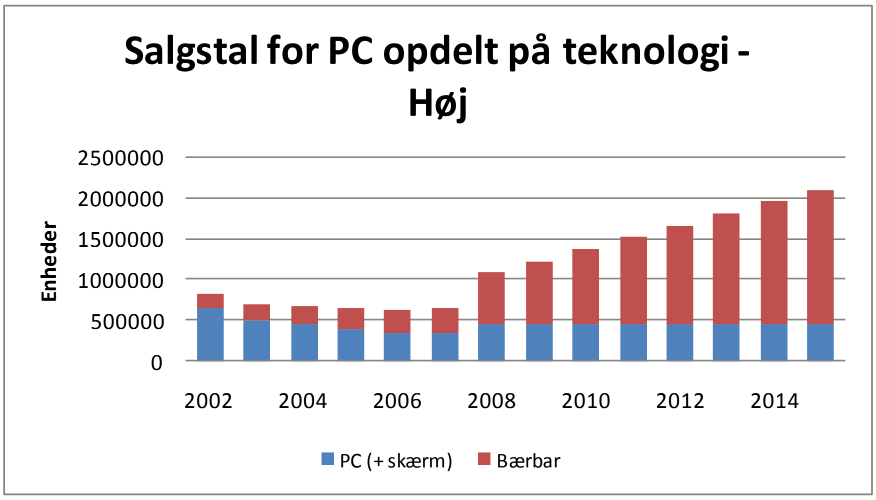
Det samlede forbrug til TV-apparater ses i figur 12 og 13 at gå fra ca. 400 GWh i 2002 til knap 2 TWh i 2015 i det høje scenarie. 1,3 TWh eller 2/3 af forbruget sker i LCD-skærme.

Salg, bestand og forbrug, PC

Som for TV præsenteres i det følgende figurer for salg, bestand samt enhedsforbrug og samlet forbrug for PC.

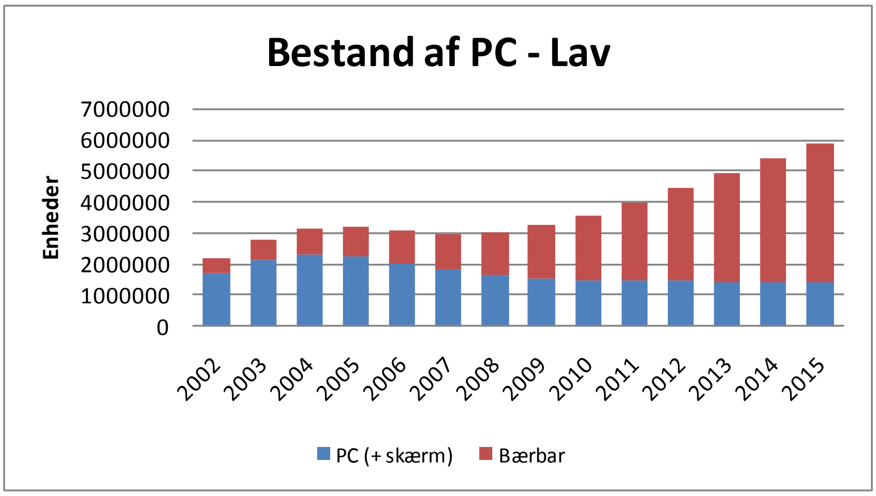


Figur 14. Salg af PC 2002-2015, Lavt scenarie.

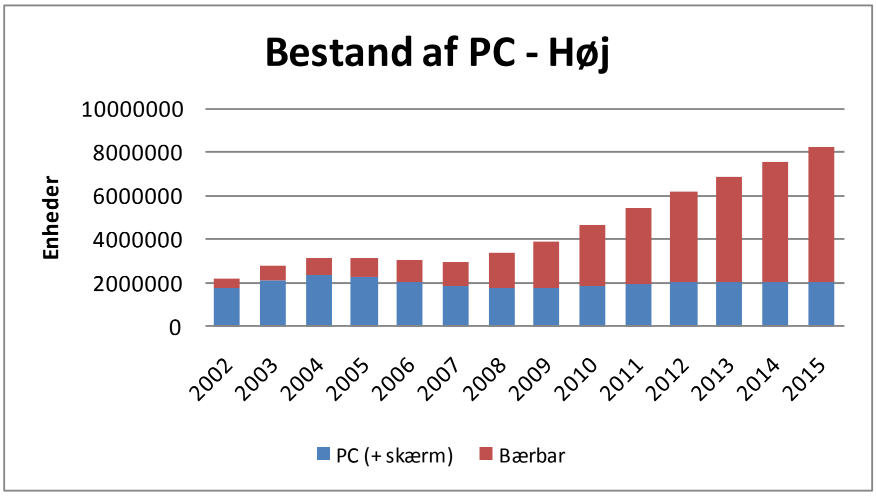


Figur 15. Salg af PC 2002-2015, Højt scenarie

Salget vurderes at nå ca. 1,5 mio. enheder hhv. godt 2 mio. enheder i lavt og højt scenarie, som det fremgår af figur 14 og 15. Dette giver følgende bestande af de to forskellige typer af PC:

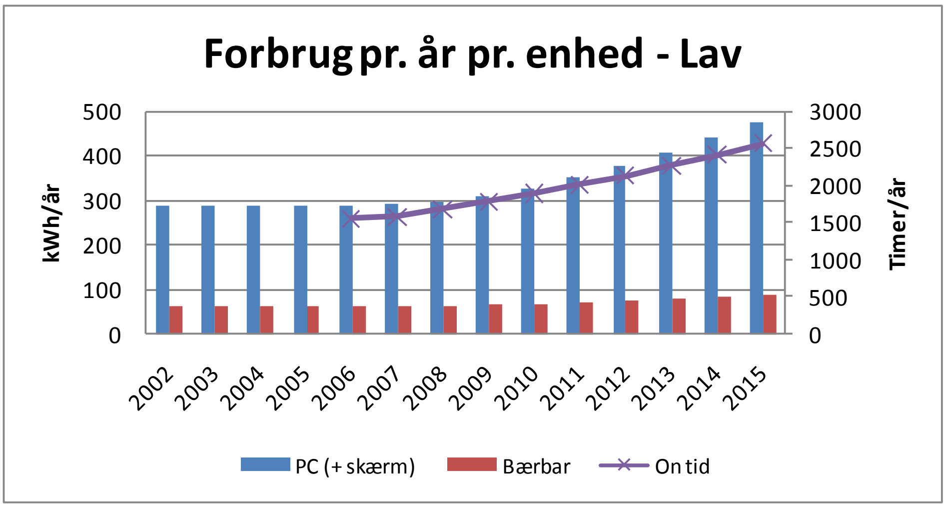


Figur 16. Bestand af PC, Lavt scenarie.

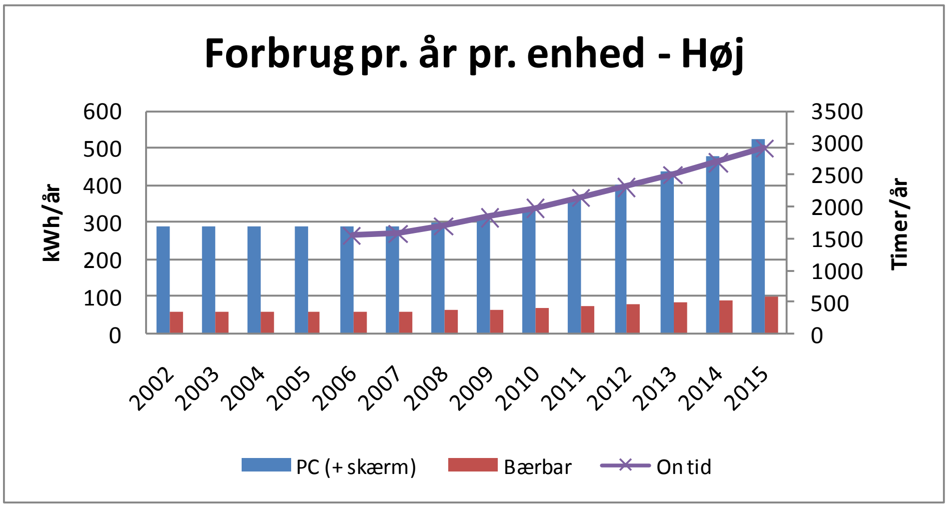


Figur 17. Bestand af PC, Højt scenarie.

For både Lavt og Højt scenarie ses en vækst i bestanden frem mod 2015, der således runder 6 hhv. 8 mio. enheder. Der er regnet med en middellevetid på 4 år samt 25 % spredning om middelværdien.

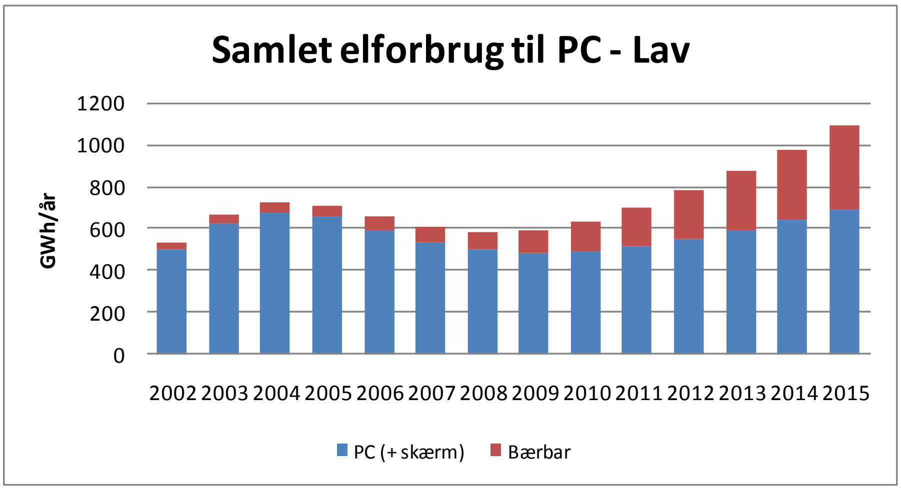


Figur 18. Enhedsforbrug og benyttelsestid for PC, Lavt scenarie.

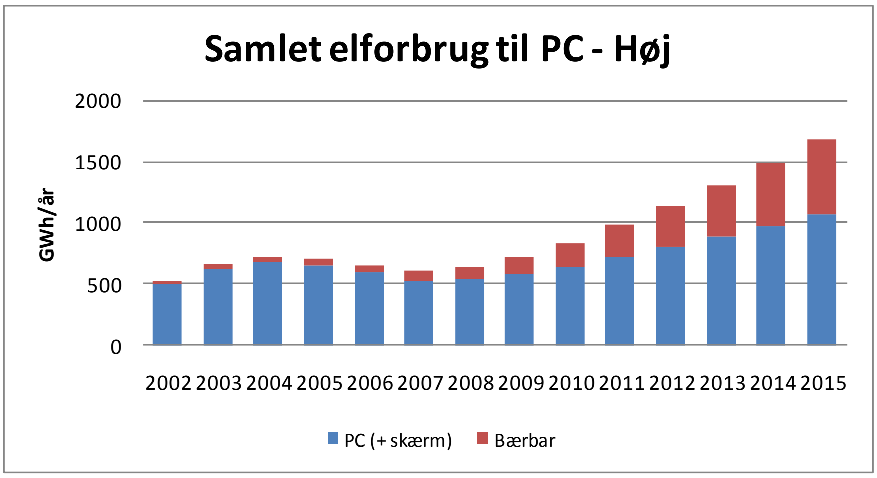


Figur 19. Enhedsforbrug og benyttelsestid for PC, Højt scenarie.

Det forventes at forbruget pr. enhed til bærbare PC stiger svagt grundet større benyttelsestid, samt at forbruget pr. stationære PC stiger væsentligt, dels grundet større benyttelsestid og dels på grund af en forventet stigning i kraftigere maskiner.



Figur 20. Samlet elforbrug til PC, Lavt scenarie.



Figur 21. Samlet elforbrug til PC, Højt scenarie.

Scenarierne indikerer kraftige stigninger i elforbruget frem mod 2015 for PC. Ca. 2/3 af forbruget ventes at ligge i de stationære, trods det forhold at kun ca. 25 % af bestanden i 2015 vurderes at være stationære. Dette skyldes altovervejende at stationære PC ses at komme meget højt op i enhedsforbrug som følge af høj benyttelsestid og større ydeevne.

Salg, bestand og forbrug, øvr. IKT apparater

For diverse detaljerede resultater for de mindre IKT-apparater henvises til det i projektet udviklede regneark.

Referencer

Jensen, J.O., Gram-Hanssen, K., Røpke, & Haunstrup Christensen, T. (2009). *Households' use of information and communication technologies - a future challenge for energy savings?* In: Proceedings from the ECEEE Summer Study 2009, Cote d'Azur, France, 1-6 June 2009.

Røpke, I., Haunstrup Christensen, T. & Jensen, J.O. (2008). *Domestication of information and communication technologies in an energy perspective*. Paper for the EASST/4S conference "Acting with science, technology and medicine", Rotterdam, August 20-23 2008. Session: Energy in Everyday Life

Bagsidetekst:

I denne rapport opstilles to scenarier for elforbruget til informations- og kommunikationsteknologi (TV, DVD, spillekonsoller, PC, printere, forskellige former for radioer samt alle former for telefoner mv.) i 2015 på baggrund af antagelser om, at såvel bestanden af apparater som brugen af apparater må forventes fortsat at stige.

Der opstilles og argumenteres for ét scenarie med en forventning om fortsat kraftig vækst i antal og brug og ét scenarie med forventning om mere moderat vækst.

De to scenarier indikerer at henholdsvis 37 % (lavt scenarie) og 45 % (højt scenarie) af de danske boligers årlige elforbrug i år 2015 vil gå til informations- og kommunikationsteknologi.

Formålet med scenarierne er ikke at forudsige, hvordan den faktiske udvikling vil blive, men at opstille beregninger på mulige elforbrugskonsekvenser af nogle sandsynlige udviklinger. Scenarierne skal dermed ses som bidrag til energipolitiske overvejelser om håndteringen af IKT området.

Energirådgivning af privatkunder på IKT-området

Lisbet Stryhn Rasmussen, Lokalenergi

Sammenfatning af spørgeskemaundersøgelse hos energirådgivere i forhold til IKT udstyr

I forbindelse med IKT projektet har vi undersøgt energirådgivernes rådgivning vedr. informations- og kommunikationsudstyr i forhold til deres privatkunderådgivning. Vi ville gerne finde ud af omfanget af denne rådgivning samt om der er områder, hvor de i særlig grad kunne bruge mere viden, samt deres holdning til IKT som fremadrettet indsatsområde.

I alt 40 energirådgivere med tilknytning til privatkunder fra henholdsvis elbranchen, Energitjenesten og de grønne guider fik mailet et spørgeskema i juni 2008. 21 besvarede spørgeskemaet, heraf 10 fra elbranchen, 7 fra Energitjenesten og 3 grønne guider.

Resultatet af undersøgelsen

- Der er ret mange henvendelser omkring elforbrug og IKT – primært vedr. standby. 48 % får jævnligt eller ofte henvendelser. Flest henvendelser handler om standby-forbrug (81 %)
    - standbyforbrug på et givent apparat
    - brug af elspareskinner og sluk på stikkontakten
    - køb af nyt udstyr
    - energiforbrug på udstyr, der er tændt hele tiden (f.eks. ip-telefoni, server og settop bokse)

- Intelligent styring anbefales relativt sjældent (19 %).

- Få tager en LCA-betragtning (indirekte energiforbrug til produktionen af udstyret samt drift af infrastrukturen) med i deres rådgivning (29 %).

- 2/3 efterlyser mere viden om tv-energiforbrug f.eks. konkrete oplysninger om elforbrug både i drift og på standby på de enkelte apparater samt en vejledning om hvornår et apparat er et godt køb rent energimæssigt.

- Oplysning til forbrugerne er mangelfuld
    - 67 % mener der bør gøres langt mere for at oplyse forbrugerne om energibesparelser og IKT.
    - Hovedparten af rådgiverne henviser kunderne til Elsparefondens hjemmeside (81 %) og 19 % henviser til forhandlere.
    - Gør brug af ældre pjecer som ”Gode elvaner” (76 %)

- I forhold til begrænsning af energiforbruget foreslår rådgiverne en indsats rettet mod producenterne i forhold til at udvikle energieffektive produkter samt brug af energimærkning af produkterne.

Resultater (se figurer efter tabellerne)

	Total	
Hvor ofte henvender privatkunder sig til jer for at få rådgivning om energiforbrug på IKT området?	**Procent**	**Antal**
Aldrig	10%	2
Sjældent	33%	7
Jævnligt	29%	6
Ofte	19%	4
Andet - uddyb gerne	10%	2
Total	**100%**	**21**

	Total	
Hvilke problemstillinger indenfor energi henvender kunder sig med?	**Procent**	**Antal**
Standby forbrug	81%	17
Rådgivning/køb af elspareskinner	52%	11
Valg af nyt IT udstyr	33%	7
Valg af nyt TV udstyr	24%	5
Energiforbrug på udstyr, der er tændt hele tiden (f.eks. ip-telefoni, server, settop bokse)	48%	10
Andet - uddyb gerne	24%	5
Total	**262%**	**55**

	Total	
Hvilke energi spørgsmål stiller kunderne oftest?	**Procent**	**Antal**
Hvor meget standby bruger et givent apparat?	52%	11
Hvordan undgår man standby?	52%	11
Hvad skal jeg se efter, når jeg køber nyt udstyr?	48%	10
Hvor kan jeg finde råd og hjælp til valg af produkt?	33%	7
Andet - Uddby gerne	14%	3
Total	**200%**	**42**

	Total	
Hvilke råd/anvisninger giver I typisk til kunderne?	**Procent**	**Antal**
Sluk på stikkontakten	81%	17
Brug elspareskinner	86%	18
Køb udstyr med lavt elforbrug	81%	17
Brug IKT teknologi til at overvåge, styre og begrænse forbruget f.eks. Elsparefondens 'min bolig', Housekeeper og lign.	19%	4
Begræns anskaffelsen og mængden af IKT, køb kun det mest nødvendige	19%	4
Andet - uddyb gerne	14%	3
Total	**300%**	**63**

	Total	
Henviser I kunderne videre til andre?	**Procent**	**Antal**
Elsparefondens hjemmeside	81%	17
Forhandlere	19%	4
Ved ikke hvem vi skal henvende til	10%	2
Andre - angiv gerne	24%	5
Total	**133%**	**28**

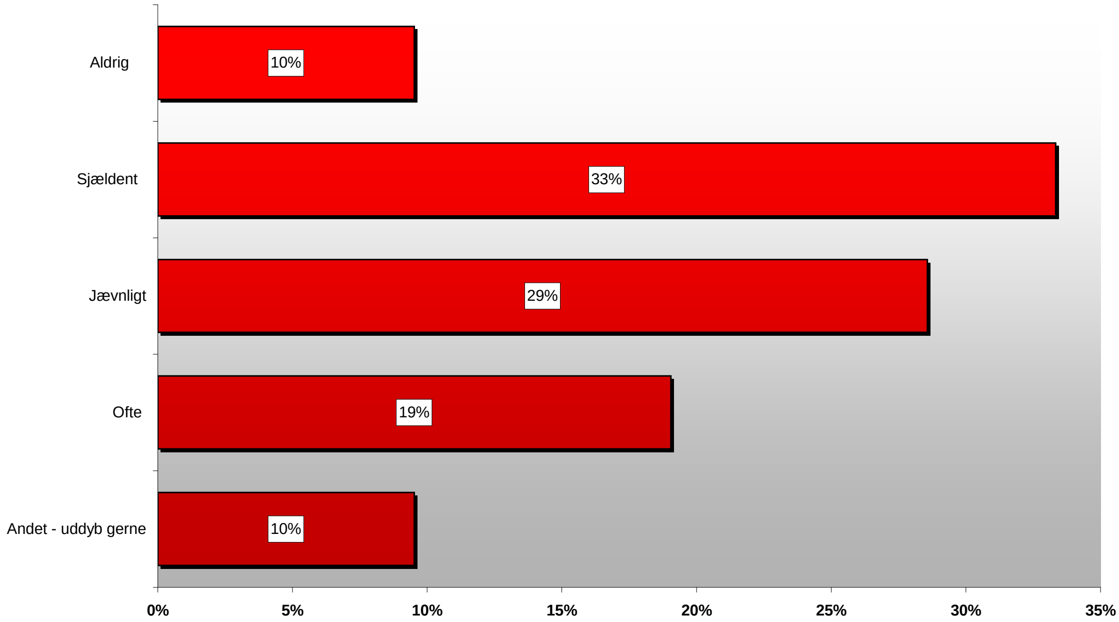
	Total	
Hvilke materiale har I om IKT og energi, som I kan sende til kunden	**Procent**	**Antal**
Standbypjecen "Hvorfor betale for ingenting?" (Myter og fakta)	52%	11
Gode Elvaner	76%	16
Selv udarbejdet noget materiale	33%	7
Andet	33%	7
Total	**195%**	**41**

	Total	
Er der områder, hvor du i særlig grad kunne bruge mere viden til din rådgivning?	**Procent**	**Antal**
Jeg oplever ikke at jeg mangler viden	14%	3
Fastnet- og mobiltelefoner	48%	10
Computere	43%	9
TV	62%	13
Standby	29%	6
Andet	43%	9
Total	**238%**	**50**

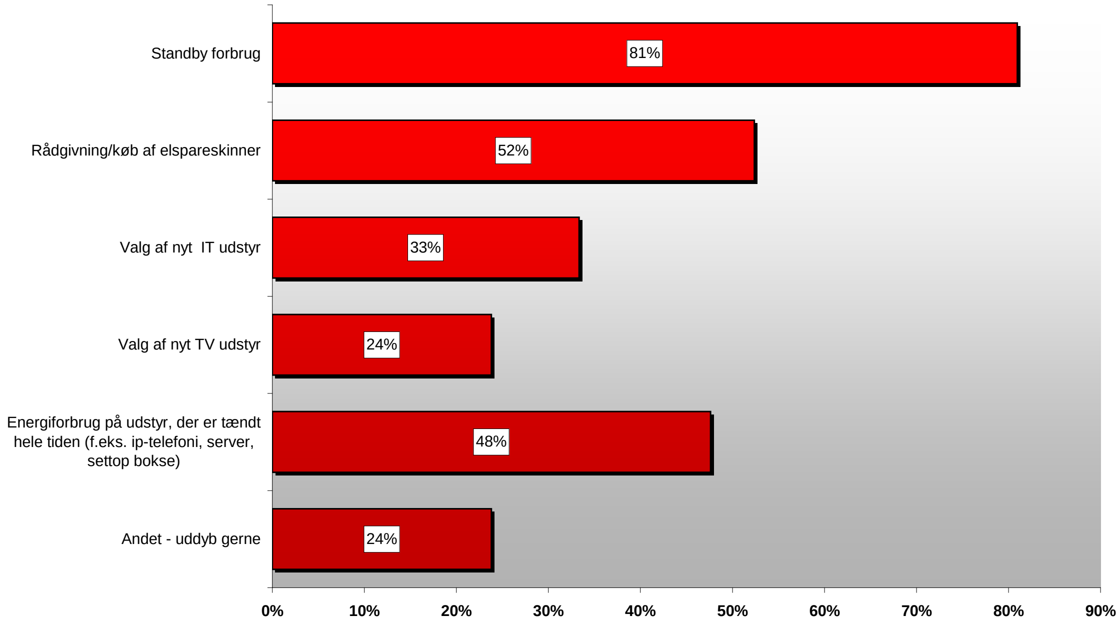
	Total	
Er en forbrugerrettet energispareindsats på IKT området realistisk?	**Procent**	**Antal**
Nej, vi skal ikke regne med besparelser, fordi forbrugerne er ikke interesserede	0%	0
Den nuværende indsats er tilstrækkelig	5%	1
Der burde gøres langt mere for at oplyse forbrugerne om energibesparelser og IKT	67%	14
Andet	29%	6
Total	**100%**	**21**

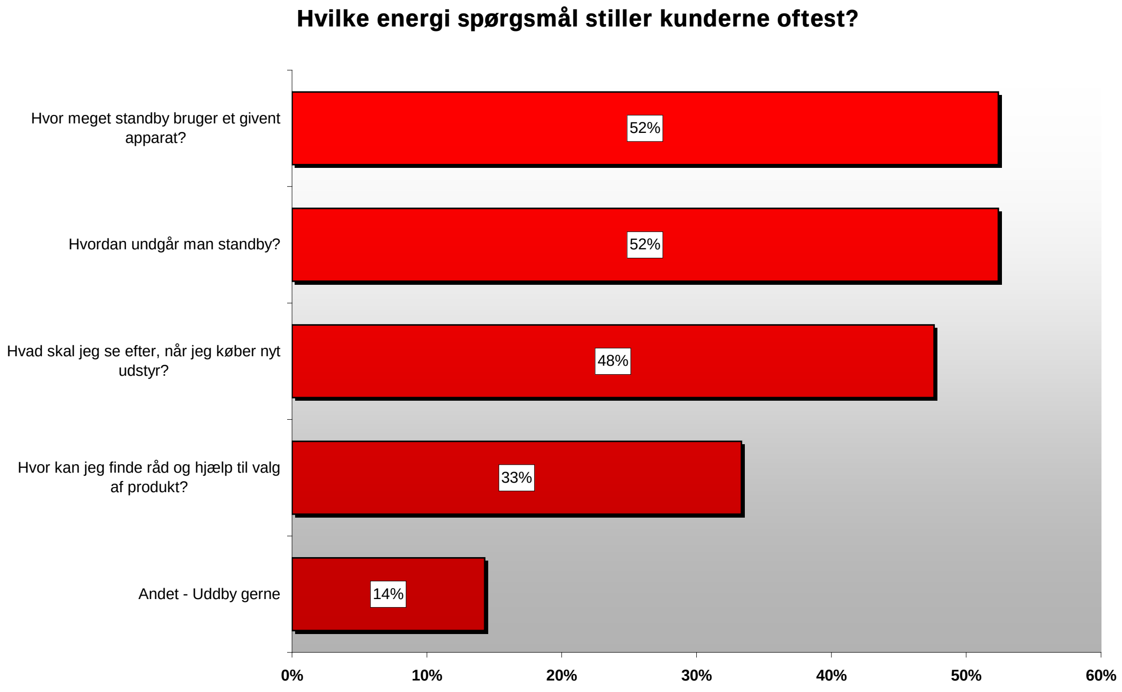
	Total	
Laver man en vugge til grav analyse viser det sig, at en del af energiforbruget til IKT ligger i produktionen af udstyret og i driften af infrastrukturen (drift af server, sendenet). Inddrager du det i din rådgivning?	**Procent**	**Antal**
Nej	52%	11
Ja	29%	6
Ved ikke	19%	4
Total	**100%**	**21**

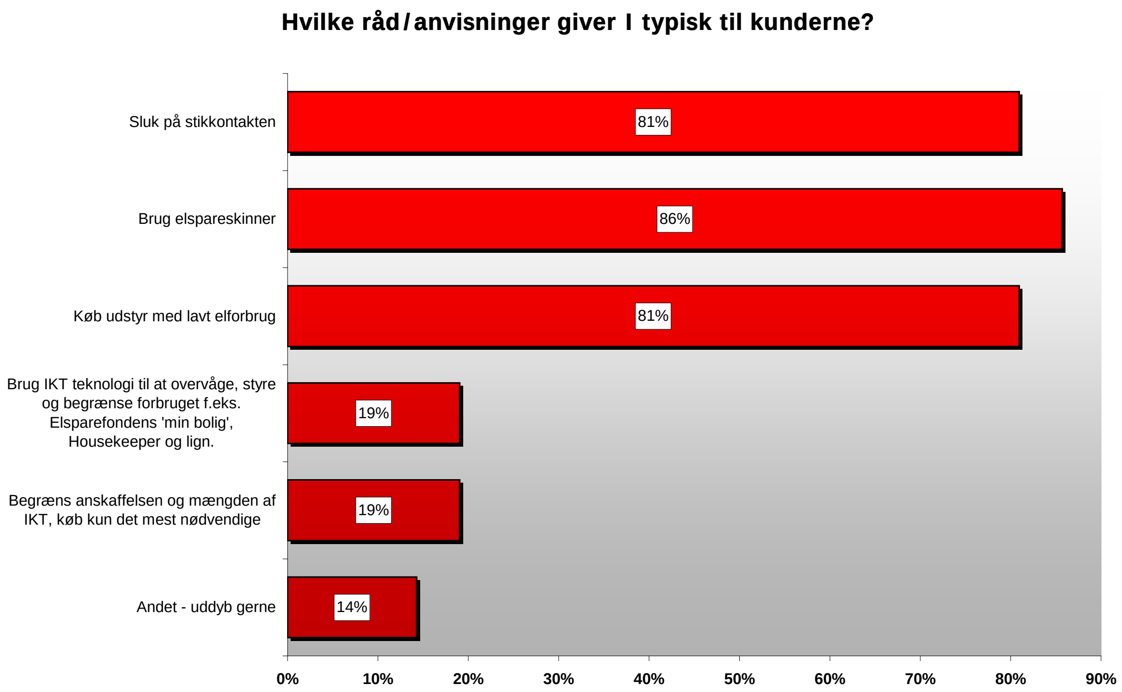
Hvor ofte henvender privatkunder sig til jer for at få rådgivning om energiforbrug på IKT området?



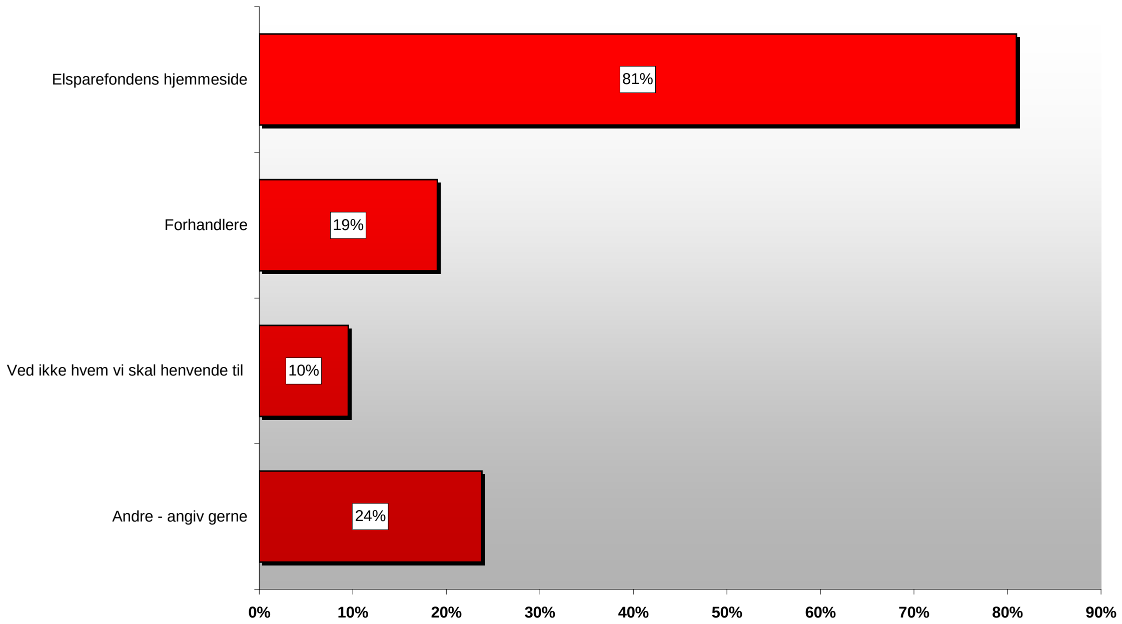
Hvilke problemstillinger indenfor energi henvender kunder sig med?



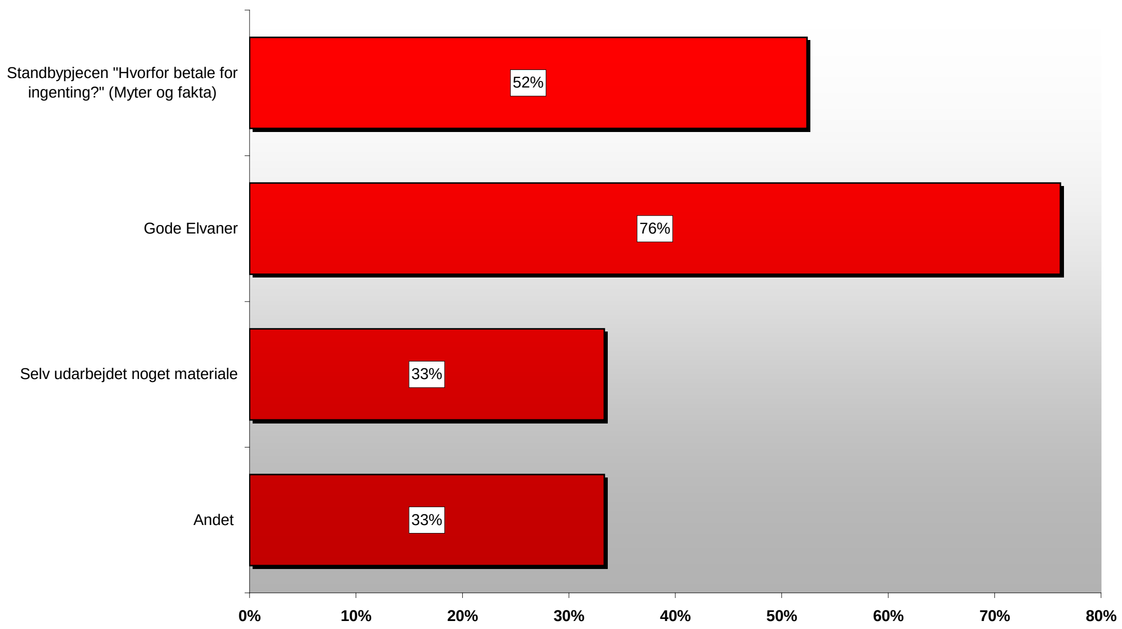

Hvilke energi spørgsmål stiller kunderne oftest?
Hvor meget standby bruger et givent apparat?
Hvordan undgår man standby?
Hvad skal jeg se efter, når jeg køber nyt udstyr?
Hvor kan jeg finde råd og hjælp til valg af produkt?
Andet - Uddby gerne
52%
52%
48%
33%
14%
0%
10%
20%
30%
40%
50%
60%

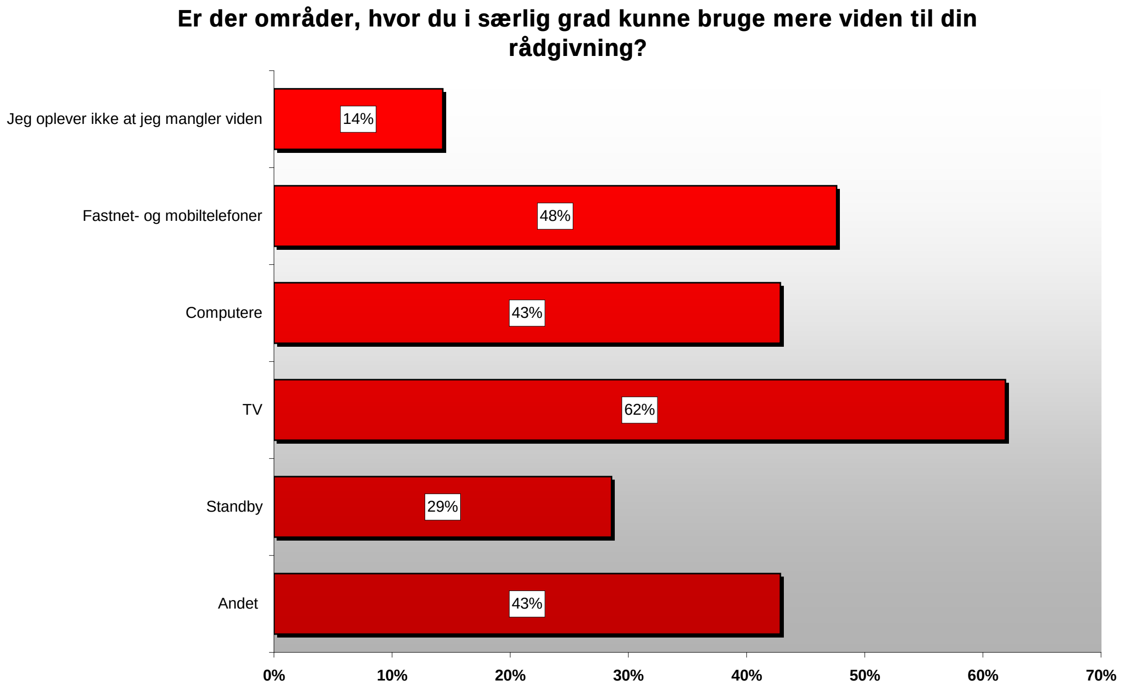

Hvilke råd / anvisninger giver I typisk til kunderne?
Sluk på stikkontakten
Brug elspareskinner
Køb udstyr med lavt elforbrug
Brug IKT teknologi til at overvåge, styre og begrænse forbruget f.eks. Elsparefondens 'min bolig', Housekeeper og lign.
Begræns anskaffelsen og mængden af IKT, køb kun det mest nødvendige
Andet - uddyb gerne
81%
86%
81%
19%
19%
14%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%

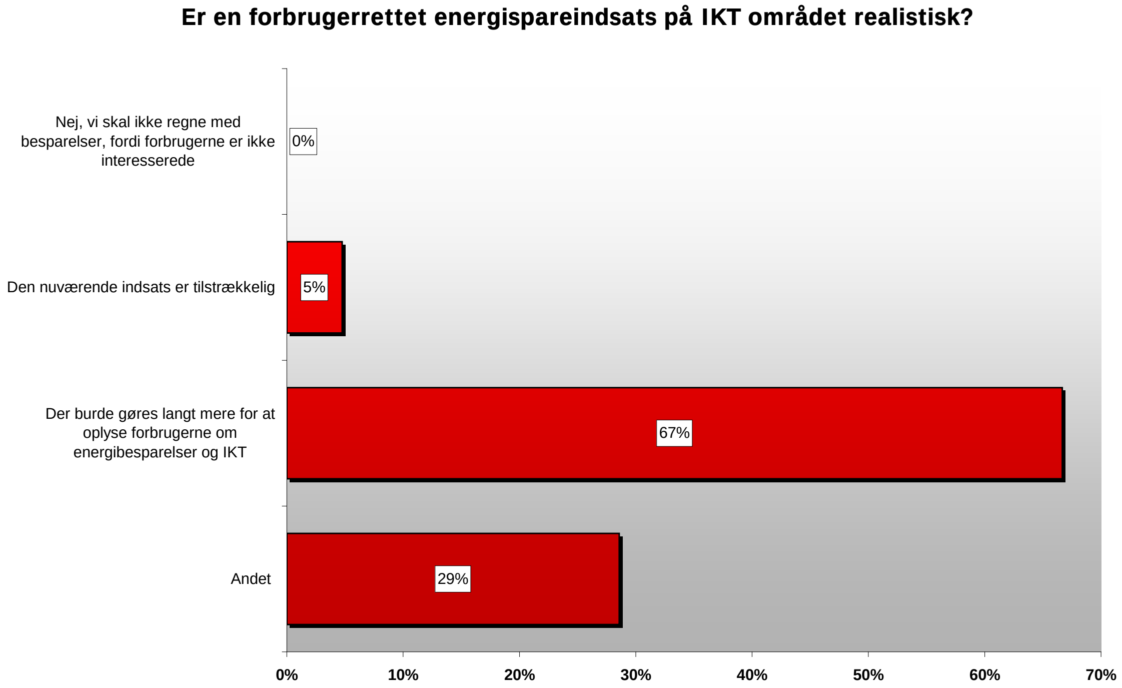
Henviser I kunderne videre til andre?

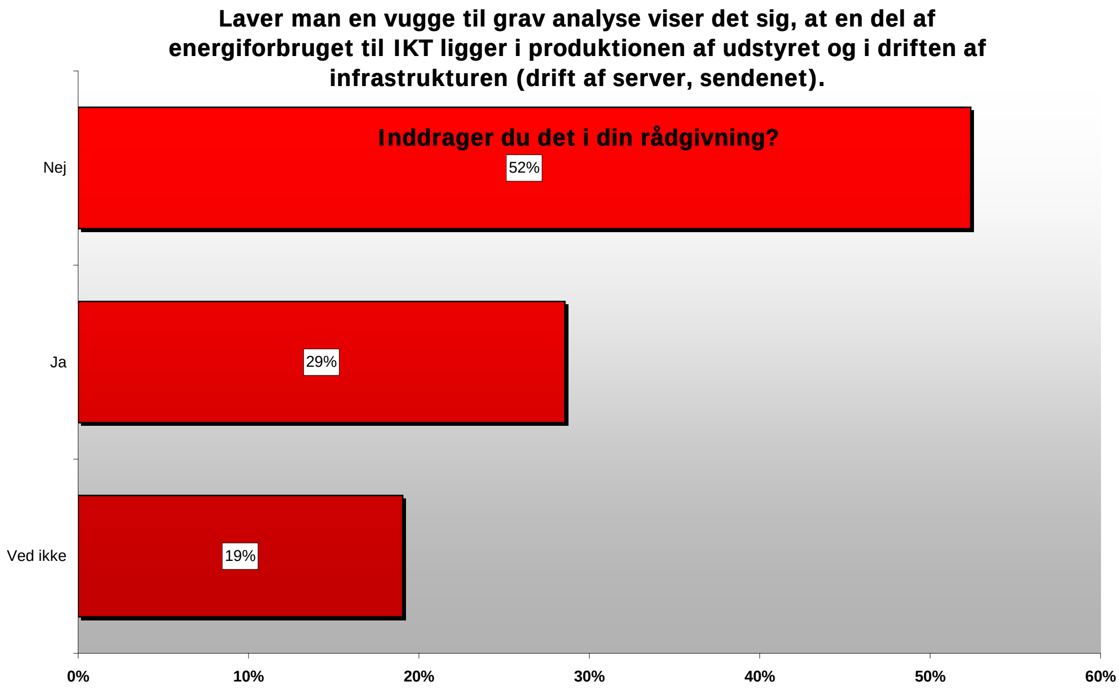


Hvilke materiale har I om IKT og energi, som I kan sende til kunden




Er der områder, hvor du i særlig grad kunne bruge mere viden til din rådgivning?
Jeg oplever ikke at jeg mangler viden
14%
Fastnet- og mobiltelefoner
48%
Computere
43%
TV
62%
Standby
29%
Andet
43%
0%
10%
20%
30%
40%
50%
60%
70%


Er en forbrugerrettet energispareindsats på IKT området realistisk?
Nej, vi skal ikke regne med besparelser, fordi forbrugerne er ikke interesserede
0%
Den nuværende indsats er tilstrækkelig
5%
Der burde gøres langt mere for at oplyse forbrugerne om energibesparelser og IKT
67%
Andet
29%
0%
10%
20%
30%
40%
50%
60%
70%


Laver man en vugge til grav analyse viser det sig, at en del af energiforbruget til IKT ligger i produktionen af udstyret og i driften af infrastrukturen (drift af server, sendenet).
Inddrager du det i din rådgivning?
Nej
52%
Ja
29%
Ved ikke
19%
0%
10%
20%
30%
40%
50%
60%

Supplerende kommentarer til de enkelte spørgsmål

Nr.4: Hvor ofte henvender privatkunder sig til jer for at få rådgivning om energiforbrug på IKT området? (Andet - uddyb gerne)

- I forbindelse med standby, aldrig køb af produkter
- Sjældent / da de fleste af den type henvendelser kanaliseres til anden afdeling

Nr.5: Hvilke problemstillinger indenfor energi henvender kunder sig med? (Andet - uddyb gerne)

- Indkøb / viden om solar anlæg
- Vi får ikke henvendelser
- Efterisolering, valg af varmeforsyning, solvarme mmm.
- For højt elforbrug - generelt / Indkøb af hårde hvidevarer
- Hjælp til elregningen

Nr.6: Hvilke energi spørgsmål stiller kunderne oftest? (Andet - Uddyb gerne)

- Må man slukke helt for produkterne
- Hvad kan jeg gøre for at mindske mit elforbrug

Nr.7: Hvilke råd/anvisninger giver I typisk til kunderne? (Andet - uddyb gerne)

- oplyser om solarpaneler / solarventi. / samt hvilke firmaer kunderne kan henv. sig til.
- Starter et projekt den 19 aug. vedr. anvendelsen af elektroniske målere.

Nr.8: Henviser I kunderne videre til andre? (Andre - angiv gerne)

- Energitjenesten.dk / sparenergi.dk / m.fl.
- Vores egen hjemmeside
- Forbrugerrådets tests af div. Produkter
- Nej vi klarer dem selv

Nr.9: Hvilke materialer har I om IKT og energi, som I kan sende til kunden (Andet)

- Sender ikke ud til kunder
- Pjecer om solar paneler / solarventi
- www.sparenergi.dk
- Vi har ikke noget specielt om IKT men meget andet om energibesparelser
- "Elsparefondens guide til et lavere elforbrug"
- ELDA, Elforsyningens database

Nr.10: Er der områder, hvor du i særlig grad kunne bruge mere viden til din rådgivning? (Andet)

- Generelt er der ikke meget information, der bliver sendt direkte til os fra f.eks Elsparefonden.
- Jeg har ikke optimal viden på disse områder, men vejleder generelt også mest om alternativ energi form.

- Vedr. TV især store fladskærme mener jeg der burde stå strømforbruget ved brug og standby synligt på et klistermærke på TVet i butikken.
- Masser af produktgrupper, hvor det er svært at finde oplysninger om el-forbrug både i aktiv og stand-by. Mangler oversigter over hvad er lavt forbrug, a la Elsparefondens for PCere og skærme på andre produktkategorier.
- Energiområdet er kæmpe stort, så ny opdateret viden er altid velkommen.
- Da der er stor forskel i standby forbrug og elforbrug på de forskellige fabrikater, vil det være rart med konkrete måleresultater i stedet for gennemsnitstal.
- - ud fra de henvendelse jeg tager mig af
- Bredbåndsløsninger hvor telefon, internet og TV er samlet. / / IP telefoni

Nr.11: Er en forbrugerrettet energispareindsats på IKT området realistisk? (Andet)

- Der burde gøres mere i forhold til udvikling af energisparende komponenter, så standbyforbrug nedsættes samt mere fokus på strømforbrug i drift.
- Jeg ved det ikke
- Jeg tror der er meget viden, men at det måske er handling og etablerings økonomi der mangler.
- Mange kunder er ikke interesserede, så det er vigtigt at påvirke producenterne. Det jeg godt kan bruge mere viden om er: "hvad er det laveste forbrug man kan få pt.?" Men det ændrer sig jo som bekendt hele tiden.
- Indsatsen er på visse områder tilstrækkelig p.t., men det er jo en prioritering hos de enkelte selskaber...

Nr.13: Hvad synes du, det kunne være godt at gøre i forhold til begrænsning af energiforbrug til IKT udstyr?

- Påvirke politikere og producenter til større fokus på elforbruget
- Indsats giver mest hvis det er i forholdet til producenterne. / En anden ting, som ikke har noget med kommunikation og information at gøre er: Jeg bliver så gal når man går ud for at købe en lampe og så er alle pæne lamper designet til halogenpærer, hvorfor bliver der ikke designet lamper til sparepærer???
- Praktisk vejledning og økonomisk etablerings hjælp.
- Oplysning
- Det skal være mere synligt hvilket strømforbrug de forskellige apparater bruger. Jeg tager selv et sparometer/elmåler med i butikken når jeg køber nyt, men det gør almindelige mennesker jo ikke.
- Nemmere adgang til oplysning om forbrug. Mærkning. / Lovgivning om max. forbrug. / Indsats i forhold til Teleselskaber (TDC, YouSee, ..) som er dem mange kunder køber et standardprodukt af - hvor det ikke engang er muligt at få oplyst forbrug.
- Ved ikke nok om mulighederne
- Produkterne skal laves med så lille forbrug som muligt og det skal være let for kunderne at vælge gode produkter - fx energipile. Derudover er information om adfærd jo altid vigtig!
- Påvirke producenter til at udvikle mere energieffektive produkter. Specielt indenfor energiforbrug til standby vil der være en del at hente. Der kunne evt. stilles om oplysning om standbyforbrug i forbindele med salg af IKT-udstyr.
- Gør bl.a noget ved strømforsyningerne
- Der burde være begrænsning på tilladte maksforbrug på nye apparater, så kunder ikke kan undgå at købe energisparende produkter. Desuden vil en ekstra regning ved storforbrug af el skabe større fokus på eget forbrug.

- Tilbyde en form for hjemme-besøg/homeparty
- Det må absolut være fabrikanterne, der i første omgang skal have stillet nogle krav, for at få adgang til markedet.
- Jeg forventer at indførelsen af elektroniske elmålere giver nogle nye muligheder for at "styre/begrænse energiforbruget, uden at brugerne behøver at tænke så meget over problematikken. / Ellers EU- krav om max. forbrug på udstyret. evt. mærkning som andre apparater så problematikken synliggøres.
- Kampagner med oplysninger om besparelser, på en sjov måde
- Mere oplysning og flere målrettede kampagner.
- Mere oplysning
- Efteruddannelse af energirådgivere. / Mere rådgivning overfor kunderne.
- - energimærkning / - oplysning / - lovgivning om max. Forbrug

Bilag 9: Workshop om energibesparelser og husholdningers brug af IKT. Program og referat

Statens Byggeforskningsinstitut
AALBORG UNIVERSITET

Workshop om energibesparelser og husholdningers brug af IKT

Tid: Onsdag d. 24.9 kl. 10-13. Sted: DTU, bygning 424, 2. sal, lokale 213 (se kort på bagside)

Program

10-10.20: **Velkomst og introduktion** til projektet og workshoppen, ved Inge Røpke, DTU Management. En kort præsentation af projektet og temaerne for workshoppen.

10.20-10.50. **Tema 1: Forbrugere eller producenter.** Ligger potentialet for elbesparelser hos producenterne – eller er der noget at komme efter hos forbrugerne?

10.50-11.20. **Tema 2: TV-udskiftninger.** Hvad er den rigtige strategi set fra et energimæssigt synspunkt – og hvem rådgiver forbrugerne om det?

11.20-11.40. **Pause**

11.40-12.10. **Tema 3: Det afledte energiforbrug til IKT.** Hvordan håndteres det indirekte men store energiforbrug til fremstilling og drift af IKT-teknologier i en spareindsats?

12.10-12.40. **Tema 4: Intelligente styresystemer.** Hvilke potentialer for elbesparelser rummer intelligent styring? Og hvilke barrierer er der?

12.40. **Opsamling og afslutning med en let frokost**

Foreløbig deltagerliste

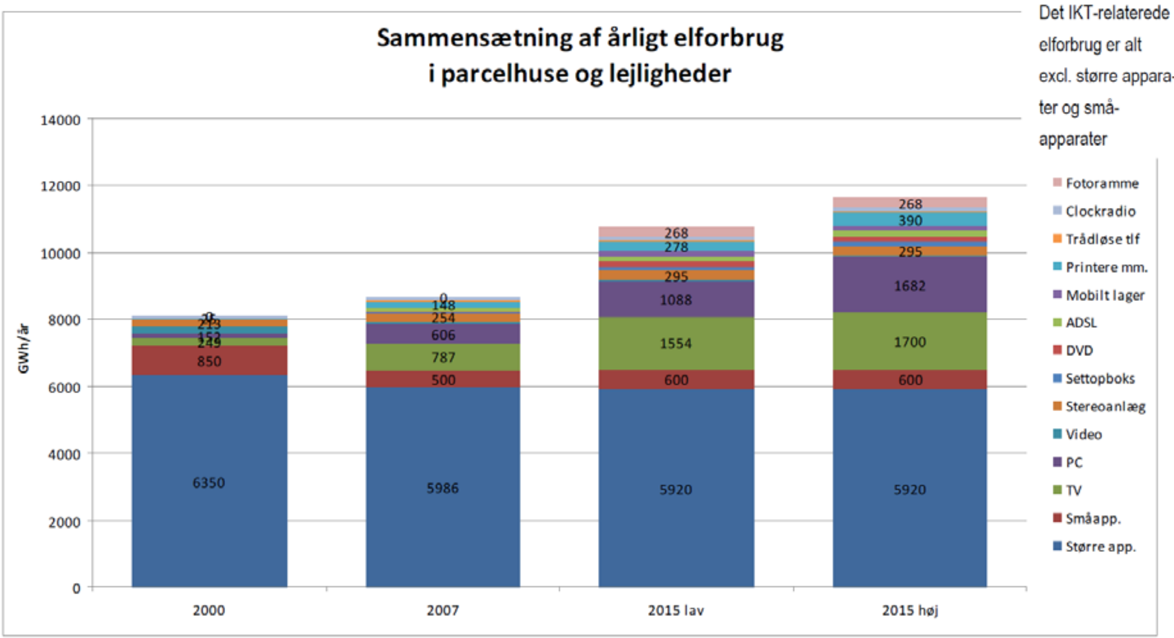
Anders Hjort Jensen, Elsparefonden
Anders Grønbech, Canon
Richard Schalburg, Dansk Energi
Niels Jørgen Langkilde, BFE
Anne Nielsen, Energistyrelsen
René Laursen, Innovation Lab
Miriam Sjödahl Jakobsen, IT- og Telestyrelsen
Mette Lundberg, IT Branchen
Claus Bülow, ToNeMe

Inge Røpke, DTU Management
Jesper Ole Jensen, SBi
Lisbet Stryhn Rasmussen, Lokalenergi
Pernille Arborg, studentermedhjælp

Stærk stigning i det fremtidige IKT-relaterede elforbrug?

Workshoppen er en del af et forskningsprojekt, der gennemføres i samarbejde med DTU, SBi og en række andre parter. Det skal belyse udviklingen i energiforbruget i danske husstande som følge af en øget mængde IKT-udstyr, herunder også afledte energieffekter. Projektet er finansieret af Elforsk-midler. Det bygger primært på en række interviews med IKT-brugere og på opstillinger af forskellige scenarier for den fremtidige IKT-udvikling ved hjælp af Elmodel Bolig. Derudover er der gennemført separate undersøgelser af hhv. de indirekte miljøeffekter af IKT-udviklingen og af rådgivning mht. IKT-relateret elforbrug fra henholdsvis elselskaber, energitjenester og grønne guider. Projektet afsluttes i 2008.

Formålet med scenarierne er ikke at forudsige fremtiden, men at rejse kvalificeret debat om mulige fremtider – vel at mærke, hvis der ikke gribes ind. Scenarierne er baseret på standard forudsætninger fra Elmodel-Bolig, suppleret med projektets egne antagelser. Der er opstillet to scenarier for år 2015, med forskellige forudsætninger indenfor antal og brug af hhv. TV og PC. Det 'lave' scenarie bygger på, at bestanden og brug af TV og PC i store træk vil fortsætte den udvikling der har været siden 2000. Det 'høje' scenarie bygger på en større vækst i bestanden af TV og brugen af TV, mens der for PC'er er forudsat en væsentlig højere stigning end hidtil, både med brug og bestand. Med disse forudsætninger viser scenarierne en stigning i det IKT-relaterede elforbrug fra omkring 2.200 GWh pr. år i 2007 til knap det dobbelte (4.200 GWh pr. år) i det 'lave' scenarie – og i det høje scenarie et elforbrug på 5.100 GWh pr. år i 2015. Det svarer til, at det IKT-relaterede elforbrug vil udgøre mellem 45 og 50% af husstandenes samlede elforbrug i 2015, mod omkring 20% i dag.



Det IKT-relaterede elforbrug er alt excl. større apparater og småapparater

Spørgsmålet er, hvad der kan gøres for at forebygge en sådan stigning i elforbruget. Dette er baggrunden for diskussionen af de fire temaer.

Uddybning af temaer

Tema 1: Forbrugere eller producenter

Elforbruget til IKT-teknologier har indtil videre haft begrænset opmærksomhed blandt forbrugerne. Man kan diskutere, om den traditionelle forbrugerpolitik med oplysning, gode råd om at begrænse forbruget mm. er en farbar vej, særligt da der er tale om mange små kilder, med et enkeltvist begrænset elforbrug.

En rundspørge til landets energirådgivere viser, at der er ret mange henvendelser omkring elforbrug og IKT (50% får jævnligt/ofte henvendelser, primært om hhv. standby, elspareskinner og køb af nyt udstyr), og at flertallet mener der bør gøres langt mere overfor forbrugerne. Dog har hovedparten af energirådgiverne størst tiltro til en indsats rettet mod producenterne, f.eks. gennem krav til energieffektive produkter. Spørgsmålet er bl.a.:

- Kan vi bruge de 'sædvanlige' spare-metoder overfor forbrugerne når det gælder IKT-området – eller står vi overfor en helt ny udfordring, hvor nye metoder må tages i brug?
- Vil den grønne IT-bølge også smitte af på forbrugerne?
- Hvordan kan forbrugerne påvirkes, hvad skal de påvirkes til, og hvem skal gøre det?
- Hvor store energisparepotentialer er der tilbage i en indsats overfor producenterne?
- Vil indsatsen overfor producenterne medføre nye valgmuligheder, krav om brug m.m. for forbrugerne, og ændre billedet af de mest energirigtige løsninger?

Tema 2: TV-udskiftninger.

Med overgangen til digitalt TV, nye typer skærme og nye måder at kombinere TV, PC og internet på, står forbrugerne overfor mange valgmuligheder. Vores tese er, at det er svært, ud fra et energimæssigt synspunkt at pege på den mest optimale løsning – og at der ikke er tilstrækkelig rådgivning på området. Eksempelvis viser rundspørgen til energirådgiverne, at 62% efterspørger mere viden om TV-energiforbruget. Desuden medfører digitaliseringen risiko for, at mange i løbet af kort tid vil vælge at skifte deres TV ud, på grund af skiftende standarder. Spørgsmålene er bl.a.:

- Hvad er den energimæssigt set mest optimale løsning på kort og på lang sigt?
- Er der risiko for hurtige udskiftninger af TV-apparater og -skærme på grund af udvikling og mangel på rådgivning?
- Er der tilstrækkelig viden til rådgivning af forbrugerne omkring energimæssige hensyn?

Tema 3: Det afledte energiforbrug til IKT
Der er et stort indirekte energiforbrug relateret til brug af IKT-teknologien. Dels kræver det energi at fremstille og bortskaffe apparater og genstande, og dels kræver det energi at sørge for, at infrastrukturen er på plads.
Et studie gennemført som en del af projektet viser, at for hver kWh der forbruges i hjemmet går der i runde tal 1 kWh til at fremstille, transportere og bortskaffe produktet, og ½ kWh til at drive internettet og faciliteter der understøtter det. Dette forbrug er i høj grad styret af forbrugernes efterspørgsel på og brug af IKT-teknologi. Spørgsmålet er, om man derfor skulle gøre mere for at indarbejde det i miljøindsatsen overfor forbrugerne. Det kan være svært, da synligheden er endnu mere fraværende end de øvrige miljøforhold, der i forvejen betyder lidt for den almindelige forbruger.

Det er også ret få energirådgivere der tager det med i deres rådgivning; 52% inddrager ikke en vugge til grav betragtning i rådgivningen til kunderne, mens 29 % medtager energiforbruget til produktionen af udstyret og driften af infrastrukturen. Spørgsmål:

– Skal der gøres mere for at inddrage disse forhold i miljøindsatsen overfor forbrugerne?
– Hvilke handlingsmuligheder tilbydes forbrugerne – er der fx mere miljøvenlige alternativer der kan vælges imellem?
– Hvilke typer af regulering kunne ellers anvendes?

Tema 4: Intelligente styresystemer
Intelligent styring af husstandens forbrugsgoder ses af flere som en mulighed for elbesparelser. Nogle elselskaber anbefaler fx Electronic Housekeeper, mens Elsparefonden anbefaler Z-wave og har lanceret 'Min Bolig', en web-baseret styreenhed. Men hvor store potentialer er der ved disse teknologier? De brugere vi har talt med, som har erfaringer med intelligent styring, peger på barrierer og uløste problemer bl.a. i form af forskellige standarder og manglende brugervenlighed. Bl.a. peger de på LK's programmerbare elskab (LK IHC), som den foretrukne løsning, men med manglende brugervenlighed, der gør det svært at tilpasse individuelt. Et andet problem er mange forskellige standarder, som gør, at løsninger som fx Z-wave-teknologien p.t. ikke kan kommunikere med LK's system. Nogle af spørgsmålene er:

– Hvad kræver intelligent styring? Kan det uden problemer installeres i alle nye som ældre huse? Og hvilke typer forbrugsgenstande kan det styre?
– Kan de forskellige systemer fungere sammen, eller er manglen på en standard en barriere?
– Hvad er potentialerne og hvad er barriererne?
– Hvad er status for brugen, og gøres der nok for at udbrede ideen? Intelligent styring indgår eksempelvis relativt sjældent i energirådgivernes anbefalinger til kunderne (19% anbefaler Elsparefondens 'Min bolig' og Electronic Housekeeper).

Sammenfatning af workshop om energibesparelser og husholdningers brug af IKT, 24/9 2008

Sammenfatningen omfatter kun et udvalg af de emner, der blev diskuteret. Specielt er nogle af de mere generelle overvejelser om betydningen af IKT blevet udeladt (fx fordelene ved at kunne håndtere store informationsmængder, de potentielle systemiske effekter knyttet til indkøb på nettet, distancearbejde og hjemmebiografer, samt problemerne knyttet til affaldshåndtering). Fokus er på det konkrete og praksisnære, der har betydning for husholdningers brug af IKT. Enkelte steder er der lagt supplerende oplysninger ind, bl.a. links til nogle relevante hjemmesider. Det er kun i få tilfælde skrevet ind i sammenfatningen, hvem der har sagt hvad. Ind imellem er der rejst spørgsmål, hvor der er brug for afklaring.

Deltagere
Anders Hjort Jensen, Elsparefonden
Anders Grønbech, Canon og IT Branchen
Niels Jørgen Langkilde, BFE
Anne Nielsen, Energistyrelsen
Miriam Sjödahl Jakobsen, IT- og Telestyrelsen

Inge Røpke, DTU Management
Jesper Ole Jensen, SBi
Lisbet Stryhn Rasmussen, Lokalenergi
Pernille Arborg, studentermedhjælp

Tema 1: Forbrugere eller producenter

Begge parter må nødvendigvis involveres. Derudover er det vigtigt at være opmærksom på detailleddet. Generelt er forbrugernes interesse for energispørgsmål i relation til IKT, inkl. forbrugerelektronik, lav. Selv om Lisbets undersøgelse demonstrerer, at energirådgiverne får en del spørgsmål om IKT, viser det kun en interesse for sagen blandt den lille gruppe af forbrugere, der henvender sig til energirådgivere. Undersøgelser i detailhandelen viser, at under 10% af kunderne spørger til miljø.

Mærkning kan være et centralt middel. Centrale problemstillinger i den forbindelse:

- Mærkning forudsætter enighed om, hvordan produkter skal sammenlignes: en fælles platform. Kun på den måde kan forbrugerne sikres gennemskuelighed og få en reel valgmulighed. Energy Star etablerer et sammenligningsgrundlag, og mærket kan tildeles til de bedste 25% af produkterne. Det er meldt ud, at kravene vil blive skærpet i 2009. EUs Ecodesign direktiv sigter omvendt på at etablere minimumsnormer, så de ringeste produkter skæres fra. Normerne fastsættes på basis af omfattende studier, der bl.a. afgrænser den udvalgte produktgruppe, undersøger markedsforhold og bedst tilgængelige teknologi og afdækker forbedringspotentialet for produktgruppen. Desuden fastsættes målemetoderne til at efterprøve, om produkterne overholder de fastsatte minimumsnormer. Ecodesigndirektivet blev vedtaget i 2005, og der er indtil nu udpeget 15-20 produktgrupper, hvor der er igangsat studier. Det forventes, at der igangsættes yderligere 8-10 studier i løbet af 2009. Indtil videre

er der vedtaget normer for 2 produktgrupper (eksterne strømforsyninger/opladere og simple digitalbokse til konvertering af digitale TV-signaler) samt desuden en horisontal norm som fastsætter maksimum standbyforbruget i en lang række forbrugerprodukter. Det er en god idé at kombinere krav, der skærer bunden fra, med et elitemærke, der præmierer de bedste.
- IT Branchen siger nej til nationale ordninger, fordi markedet er globalt. Der er tilslutning til brugen af Energy Star efter harmonisering med EU i 2007. Er det så Energy Star, der er grundlaget for samarbejdet mellem Elsparefonden og IT Branchen om computere og fladskærme, hvor der for et par år siden er etableret kriterier for mærket ”Anbefalet af Elsparefonden”? Der arbejdes i øjeblikket på et kriterie-dokument for produkter til kopi og print.
- Elsparefonden og BFE har tidligere diskuteret, om de i fællesskab kunne indføre en dansk mærkning af tv baseret på kravene i Energy Star. Det er strandet på, at nogle af BFEs medlemmer (med hovedsæde i Asien) mener, at de amerikanske regler er en blindgyde, og at man bør vente på EU-reglerne, fordi de vil sætte standarden i fremtiden. Dette virker mærkeligt, fordi Energy Star er harmoniseret med EU, og EU er med i en samarbejdsaftale om Energy Star. Måske hænger modstanden sammen med, at de store producenter med stærke brands nok har interesse i minimumsnormer, der kan udelukke de såkaldte bambusmærker, men ikke i at blive presset til at konkurrere om at være bedst på energiområdet?
- I forbindelse med udvikling af ecodesignkrav (normer) for tv overvejer EU at fastsætte et krav om energimærkning for denne produktgruppe under den eksisterende energimærkningsordning. Det vil betyde, at tv får den velkendte klassificering fra A-G (energipilene). Hvad kan relationen forventes at blive mellem Energy Star og en sådan europæisk ordning?
- Som reaktion på vanskelighederne med at nå en aftale om mærkning af tv har Elsparefonden overvejet at lægge positivlister på fondens hjemmeside, baseret på at fonden selv går ud i markedet og tester produkterne. Fonden ser det ikke som nogen dækkende løsning, og BFE har for nylig tilkendegivet, at de gerne vil arbejde videre med en mærkning, indtil der foreligger en europæisk ordning. Der er endnu ikke drøftet konkrete tiltag.
- Producenterne ligger ikke i DK, og det danske marked er meget lille. Det gør det vanskeligt at etable mærkning på dansk niveau, og den danske indflydelse på overnational mærkning er beskeden.
- Der kommer 100.000 nye forbrugerelektronikprodukter på markedet om året (kan det virkelig passe?). Hvordan kan mærkning håndtere det?

Detailleddet kunne spille en stor rolle for udbredelsen af energirigtige produkter. Det er en 15 år gammel diskussion, at man kan prøve at oplyse forbrugere og producenter, men at kæden falder af i detailleddet. Som det er i øjeblikket, presser Dansk Supermarked priserne. Detailleddet er meget prisfikseret og styrer rådgivningen, så de får flest penge i kassen. Diskussionen berørte bl.a.:
- Canon oplever, at det er svært at få budskabet om energirigtige produkter ud i detailleddet. Det er væsentlig lettere at sælge energirigtige løsninger til erhvervskunder.
- BFE arbejder med at informere sælgerne i butikkerne om energiforbrug. I den forbindelse er der etableret en konkurrence mellem sælgerne om at være den bedste rådgiver. Her testes bl.a. i miljøviden.
- Elsparefonden var i starten mest fokuseret på producentleddet, men har nu i længere tid forsøgt sig med kontakt til detailleddet. Ind imellem har fonden haft held til at få en ”grøn væg” med nogle elsparepærer og den slags, men generelt er det op ad bakke.

- Hvad kunne være forhandlernes incitament til at sælge energirigtige produkter? Kunne man forestille sig kæder, der slog sig op på udelukkende at sælge grøn elektronik? Som en parallel til Wal-Marts strategi-skift og til erfaringerne fra inddragelse af miljøhensyn i forbindelse med bilsyn. Det virker ikke realistisk med grønne kæder eller butikker: de store kæder må have hele paletten af produkter. Ligesom FDB sigter på at synliggøre miljømærkede produkter, kan man måske forestille sig, at elektronikbutikkerne kunne synliggøre grøn elektronik. Det kunne være godt, hvis de inden for hver varekategori altid havde et grønt tilbud, gerne med et mærke fra Elsparefonden.
- Generelt har aftaler mellem producenter og detailhandel ikke noget med energi at gøre, og mekanismerne i disse aftaler kan være hindringer for at fremme grøn elektronik.
- Internethandel betyder, at detailhandelens eventuelle energimærkning af varerne får vanskeligere vilkår (ved vi, hvor stor en andel der købes i udlandet over nettet?).

Kampagner over for forbrugerne kunne bringe energihensynet mere på dagsordenen, end det er i dag. Forbrugernes interesser er afgørende for, om detailleddet vil fokusere på energibesparelser, og kampagner kan måske skabe efterspørgsel efter energirigtige produkter. Problemstillinger i den forbindelse:

- For tv og pc gælder, at det er langt vanskeligere at gennemskue produktets karakter, end det er for et køleskab eller en vaskemaskine. Kompleksiteten bidrager til, at energiaspektet kommer meget langt ned på dagsordenen. Har kampagner en chance i den situation?
- En kampagne kunne gøre forbrugerne mere opmærksomme på størrelsen af det energiforbrug, der knytter sig til IKT. Fx: ’Hvad betyder dit tv for din el-regning?’. I den forbindelse kan forbrugerne gøres opmærksom på omkostningerne over hele den tid, de har produktet – lavere anskaffelsesomkostninger kan (i nogle tilfælde) føre til højere driftsomkostninger til el.
- Af energimæssige hensyn kunne man opfordre forbrugerne til at overveje, hvor mange fjernsyn de har brug for, og hvor store de behøver at være. Tilsvarende kan forbrugerne opfordres til at nøjes med færre features på nogle af apparaterne (fx muligheden for at bruge tv-skærmen i forbindelse med ip-telefoni).
- Forbrugerne kan også rådgives til at undlade at bruge tv som radio og som ”baggrundsstøj”.
- Kampagner kan også modvirke den ”rebound effect”, der kan følge med billiggørelsen af store skærme: fx brugen af tv som billedramme (hvad enten det er med stillestående billeder eller energimæssigt mere krævende visning af akvariefisk i bevægelse).
- Forbrugerne vil måske snarere blive drivkraft for HDTV. Nu har de investeret i fladskærme og forventer højere kvalitet. Samtidig med at kvaliteten kan blive ringere end tidligere, fordi signalerne fra fx Boxer bliver ”smalle” og kommer til at se dårlige ud på en skærm med høj opløsning.
- Er det energimæssigt en fordel at se tv på computeren? På den ene side vil man generelt bruge en mindre skærm på pc’en, men på den anden side er der også en processor, der kører. På en laptop er processoren dog ikke særlig energikrævende. Omvendt får tv i stigende grad processorer.
- Er der forskel på tv-skærme og computerskærme? Principielt er de ens, men der kan være forskel på hvilken kvalitet skærm producenterne vælger til hhv. tv og computere. For at få bedre kontrast slukkes noget af lyset i en tv-skærm, og det mindsker energiforbruget. Gælder det generelt? Niels Jørgen Langkilde nævnte en undersøgelse, der skulle vise, at tv-skærme generelt er mindre energikrævende end computerskærme. Kan vi se den?

Tema 2: Tv-udskiftninger

De seneste års tv-udskiftninger indebærer et betydeligt økonomisk og miljømæssigt ressourcespild, fordi det har været svært at fremtidssikre anskaffelserne. HD-ready har været en tvivlsom betegnelse, der ikke nødvendigvis sikrer, at tv'et kan vise HD. Mange har købt MPEG2 tunere uden at være klar over, at MPEG4 snart vil være nødvendig for at kunne se fx DRs nye kanaler. Der er "nogen", der har sovet i timen, i forbindelse med denne proces. Det ville være godt, hvis betingelserne for de fremtidige anskaffelser kunne forbedres. Der er hårdt brug for vejledning i forbindelse med digitaliseringen af tv – og for inddragelse af energihensyn i denne vejledning. Problemstillinger i den forbindelse:

- Projektets statistiske grundlag for vurderingen af energiforbruget til tv kan forbedres ved en opsplitning af data i Elmodel Bolig i hhv. effektivitet pr. apparat pr. time og brugstid. Det kunne være interessant at sammenligne datagrundlaget for modellen med oplysninger om brugstid fra Gallups medie undersøgelser – hvis det ikke allerede gøres.
- Der er stor usikkerhed forbundet med rådgivning af forbrugerne på tv-området. Fx er det svært at forudsige, hvor udbredt HDTV bliver.
- Kompleksiteten øges af, at rådgivningen af den enkelte må tage udgangspunkt i, hvordan forbrugeren får sit signal. Samtidig kan forbrugeren have interesse i en vis fleksibilitet i apparatet, så det evt. senere kan flyttes fx til sommerhuset.
- Det er reelt umuligt at sige, hvad der er den energimæssigt mest optimale løsning på kort og langt sigt, bl.a. fordi det er svært at sørge for fremtidssikring, så man ikke skal skifte udstyr for tit og dermed øge det indirekte energiforbrug. Alligevel ville det være godt med udvikling af en form for retningslinjer til forbrugerne i forbindelse med anskaffelser af nyt tv-udstyr, gerne i form af et værktøj.
- Mediesekretariatet har 50 mill. kr. til en informationskampagne i forbindelse med digitaliseringen, baseret på husstandsomdelte brochurer. Konsulentfirmaet Advice har fået opgaven med at udforme kampagnen og har præsenteret forskellige oplæg. De har imidlertid ikke været tilfredsstillende, fordi vejledningen ikke var platformsneutral. Der er på ingen måde lagt op til at inddrage energihensyn i denne kampagne, men det kunne måske være et forsøg værd at prøve at påvirke kampagnen. Tiden er knap, for kampagnen halter bagud i forhold til forbrugernes anskaffelser af nyt udstyr.
- I øjeblikket skal der købes en settopboks pr. tv. Men en settopboks med flere udtag lanceres om et par måneder. Indtil videre ser det ud til, at den vil kræve ledninger, og det vil næppe være spiseligt for forbrugerne.
- Der er to typer af settopbokse: Den simple boks kan tage multiplex 1 og 2, der omfatter DRs kanaler, både de nuværende og de 5-6 nye, samt TV2 og de regionale kanaler. Her er signalerne ikke kodet, og det er gratis at se dem. Den komplicerede boks indeholder en kortlæser og kan dermed tage de kodede kanaler. Elsparefonden og BFE har forhandlet om standarder for de simple bokse som grundlag for tildeling af et "Anbefalet af Elsparefonden" mærke (hvornår kan det ses i butikkerne?), men der er ingen diskussion af energikrav til de komplicerede bokse.
- Der vedtages minimumsstandarder for settopbokse (både simple og komplicerede?) i EU d. 26/9 2008. De skal danne grundlag for en fælles mærkningsordning, men den vil først træde i kraft d. 1/1 2010, dvs. kort efter digitaliseringen i DK. Da forbrugerne skal købe bokse inden da, er det reelt overladt til forbrugerne at sørge for at vælge energirigtige bokse, før

mærkningen træder i kraft. Teoretisk set kan der blive brug for 2 mill. bokse. Foreløbig ser det ud til, at de fleste vil købe simple bokse.

- Mange producenter vil kombinere den komplicerede settopboks med en harddisk. Det komplicerer forhandlingerne om energiforbruget, fordi der gives tillæg i forhold til antallet af tunere, harddisk mv.
- Den settopboks, der skal bruges til at modtage udbudet fra Boxer, er ikke udviklet endnu. Der er endnu ingen Boxer-godkendt MPEG4-boks.
- Det er et stort problem for producenterne, at settopboksene ikke er ens i forskellige lande.

Der er efterhånden en række vejledninger for forbrugerne i forbindelse med digitaliseringen af tv, jfr. disse links:
http://www.recordere.dk/indhold/templates/design-udenkomm.aspx?articleid=1662&zoneid=6
http://www.samvirke.dk/samvirke/arkiv/Sider/HER%20ER%20DIT%20NYE%20TV-SIGNAL.aspx
http://www.samvirke.dk/samvirke/arkiv/Sider/Digitalforvirring.aspx
Samt Brancheforum Digitale Medier: http://www.digitaliseringen.dk/get/13.html
Ingen af disse introduktioner nævner energiforbruget som et hensyn, man skal inddrage i overvejelserne.

Tema 3: Det indirekte energiforbrug

Der er ikke tradition for at inddrage det indirekte energiforbrug som et relevant hensyn for sparebestræbelser, men det kunne være relevant at inddrage dette aspekt i højere grad. Diskussionen omfattede bl.a.:

- Projektets beregninger af det indirekte energiforbrug ser ud til at harmonere med Canons beregninger af, at CO2-emissionerne i forbindelse med virksomhedens produkter fordeler sig med halvdelen hver i hhv. produktionsleddet og anvendelsen.
- Elsparefonden har til formål at fokusere på det direkte energiforbrug. Men det kunne være nyttigt at supplere med information om det indirekte energiforbrug, herunder at se nærmere på hvordan forholdet mellem direkte og indirekte energiforbrug adskiller sig for forskellige produktgrupper.
- Genbrug af elektronik er klart en fordel, både fordi det løser et affaldsproblem, og fordi det sparer energi mv. at udvinde ressourcer af skrot frem for gennem minedrift. Til trods for genbrug ligger det i sagens natur, at det indirekte energiforbrug øges, når antallet af apparater går op, og når levetiderne for apparaterne går ned.
- For nogle produkttyper kan det være en fordel med fornyelse, fordi nye apparater bruger mindre energi i brugsfasen end de gamle, der erstattes. Denne sammenhæng ser imidlertid ikke ud til at være så relevant for forbrugerelektronik og computere, fordi nye produkter ofte er ligeså energikrævende som de produkter, der erstattes (jfr. data fra Elmodel Bolig).

Tema 4: Intelligente styresystemer / det digitale hjem

Der er klart et potentiale for energibesparelser knyttet til intelligent styring af varme, lys, vaskemaskiner mv., men der er endnu et stykke vej til at realisere potentialet. Diskussionen omfattede bl.a.:

- IT-Branchen har arbejdet med det digitale hjem et stykke tid. Det har primært drejet sig om at introducere forskelligt udstyr til forbrugerne og har ikke haft et energifokus. Elsparefonden har så for et års tid siden indledt en dialog med IT-Branchen om det digitale hjem for at fremme et energiperspektiv. Resultatet præsenteres på Boligmessen i Herning.
- Elsparefonden vurderer, at op til en tredjedel af hjemmets energiforbrug kan spares gennem effektivisering. ”Min Bolig” skal dels bidrage til at synliggøre energiforbruget, dels tilvejebringe nogle redskaber til nedbringelse af energiforbruget. Besparelser kan opnås ved natsænkning af temperaturen, bevægelsesmålere til styring af belysning, effektivisering af udluftning, timing af vaske- og opvaskemaskiner til at køre om natten.
- Ved at have en plantegning af sin bolig og informationer om boligens systemer på ”Min Bolig” kan man reducere behovet for kontakt til fx håndværkere, der kan afgive tilbud på opgaver ud fra de foreliggende oplysninger.
- Forskellige service providers som sikkerhedsfirmaer og forsikringsselskaber har vist interesse i ”Min Bolig”. Hvis man fx etablerer overvågning, fugtmåler i kælderen, ventilation el.lign., kan man få nedslag i forsikringspræmier mv. På længere sigt kan energidelen af systemet blive en biting.
- Man kunne være bekymret for, om kriminelle også kunne hacke sig ind og se, om der var noget at stjæle.
- I arbejdet med ”Min Bolig” har det været afgørende for Elsparefonden at spare energi uden at skabe nyt elforbrug. Hjemmet skal kunne bindes op mod webben fx gennem en router, der ikke behøver at være tændt hele tiden.
- Det har også været vigtigt med enkle løsninger: plug-and-play, der ikke kræver kabling. Elsparefonden mener, at kabling næppe vil være accceptabelt for særlig mange, og fonden er derfor kritisk over for den løsning, som Claus Bülow har etableret i sit hus baseret på omfattende kabling.

Bilag 10: Workshop for energirådgivere

Invitation til Workshop
om
Fremtidens IKT-udstyr (pc, tv ol.) i husholdningerne

Hvordan tegner fremtiden sig og hvilke muligheder er der for at begrænse elforbruget indenfor IKT?

Dato og tid: 19. marts 2009 10:00 – 15:00
Sted: NRGI Dusager 22, 8200 Århus N

Et projekt under Elselskabernes forskning og udviklings ordning ELFORSK er ved at være afsluttet, og du inviteres derfor til workshop. Projektet "Adfærdsmæssige og tekniske potentialer for energirigtig udvikling af husholdningers IKT løsninger" er bl.a. udarbejdet af DTU, SBi og Lokalenergi.

Kom og få den sidste nye viden vedr. udviklingstendenser og fremtidsperspektiver inden for informations- og kommunikationsteknologi (IKT).

Hvad kan der gøres for at spare på det IKT-relaterede elforbrug? Det er velkendt, at standby-forbruget er stigende, men de mange nye teknologier medfører også et øget forbrug, nye problemstillinger og en øget kompleksitet. Så spørgsmålet er, hvor der skal sættes ind – er det overfor forbrugeren eller overfor producenterne? Er det gode spare råd eller er det information om nye tekniske løsninger, der mangler? Og er forbrugerne i det hele taget interesserede? Hvad er mulighederne og barriererne i de tekniske løsninger?

Formiddagen starter med at projektleder Inge Røpke (DTU) gennemgår projekt resultater. Efterfølgende vil Johs Chr. Johansen fra Brancheforum Digitale Medier give os den sidste nye viden om digitaliseringen af TV og overgangen til det nye TV-signal, samt informere om nutidens og fremtidens IKT, og give os gode råd til, hvordan vi kan rådgive kunderne bedst på området, IKT - udstyr så som fjernsyn, dvd-optagere og settopbokse mm.

Om eftermiddagen kan du høre hvordan Elsparefonden håndterer emnet i dag og i fremtiden, samt hvad elselskaberne kan bruge IKT til?

Herefter er der Workshop, her har du mulighed for at være med til at formulere og diskutere konkrete spareråd vedr. IKT-udstyr.

Program

10:00 Velkommen (Lisbet Stryhn Rasmussen Lokal Energi og Jens Erik Pedersen Energirådgiveren)

10:10 Gennemgang af F&U projektet (projektleder Inge Røpke, DTU)

10:40 Pause

10:50 Den sidste nye viden om nutidens og fremtidens IKT (Johs Chr. Johansen, BDiM)

12:15 Frokost

13: 00 Hvad gør Elsparefonden på dette område (Projektleder Anders Hjorth Jensen, Elsparefonden)

13:15 Hvad kan elselskaberne bruge IKT til? (Richard Schalburg, Dansk Energi)

13:30 Workshop (alle)

14:50 Afslutning (Lisbet Stryhn Rasmussen Lokal Energi og Jens Erik Pedersen Energirådgiveren)

Deltagelse er gratis, tilmelding **senest d. 12. marts 2009** på jep@energiraadgiveren.dk

De bedste hilsner

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Rapporten sammenfatter resultaterne af projektet *Informations- og kommunikationsteknologi i husholdningerne – en energipolitisk udfordring*. Informations- og kommunikationsteknologi vinder i stort omfang indpas i hjemmene – computere, printere, mobiltelefoner, underholdningselektronik. Projektet sigter på at afdække, hvordan udstyret bliver brugt, og hvad udviklingen betyder for energiforbruget nu og i den nærmeste fremtid. Resultaterne understreger, at der er hårdt brug for en forebyggende indsats, hvis energiforbruget til IKT ikke skal eksplodere. Det gælder både for det direkte elforbrug i husholdningerne og for det indirekte energiforbrug knyttet til fremstilling af udstyret og drift af den nødvendige infrastruktur.

Projektet er gennemført i samarbejde mellem DTU Management, Statens Byggeforskningsinstitut, IT Energy, Willum Consult, Lokalenergi, Energirådgiveren og Canon. Projektet er finansieret af Dansk Energi, PSO Program 2006, og af deltagerne.

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